D 1.1

Potential Industrial Applications

APRE

UNIVERSITÀ DEGLI STUDI FIRENZE | DIEF DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

CUSTIS

SDU

Geothermal UKRAINE

SINTEF

RIVACOLD MASTERING COLD

neo-eco

FORMAGGERIA TOSCANA

www.geosynproject.eu

info@geosynproject.eu

#GEOSYNPROJECT

Funded by the European Union

D 1.1	**Potential Industrial Applications**
DELIVERABLE TYPE	Report
MONTH AND DATE OF DELIVERABLE	Month 12, 31/10/2025
WORK PACKAGE	WP1 & Geothermal Heating and cooling integration for industrial applications: Framework & Data Collection
LEADER	GU
DISSEMINATION LEVEL	PU - Public
PROGRAMME	HORIZON EUROPE
GRANT AGREEMENT	101172812
START	1 November 2024
DURATION	36 Months

GEOSYN has received funding from the EU's Horizon Europe research and innovation programme under Grant Agreement no. 101172812.

Contributors

NAME	ORGANISATION
Yuliia Demchuk	**GU**
Taras Popadynets	**GU**

Peer Reviews

NAME	ORGANISATION
Dario Bonciani	**COSVIG**
Lorenzo Talluri	**UNIFI**
Paride Gullo	**SDU**

Document Log

VERSION	ORGANISATION	REVIEWER	MODIFICATIONS
V 1.0	02/07/2025	Yuliia Demchuk	Initial draft created and overall document structure defined.
V 1.1	11/07/2025	Yuliia Demchuk	Added content for the Introduction and Methodology sections.
V 1.2	17/07/2025	Yuliia Demchuk Taras Popadynets	Completed Industrial Energy Use analysis (Chapter 3). Drafted Chapter 4.
V 1.3	11/08/2025	Yuliia Demchuk	Added Appendixes A-E.
V 1.4	13/08/2025	Yuliia Demchuk	Completed Interview analysis (Chapter 5)

Funded by the European Union

V 1.5	18/08/2025	Yuliia Demchuk	Prepared case study descriptions in Chapter 6.
V 1.6	23/09/2025	Taras Popadynets	Comprehensive revision.
V 1.7	31/10/2025	Yuliia Demchuk Taras Popadynets	Final version.

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 the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Index of Contents

1 Introduction 9
1.1 Purpose and Objectives 9
2 Methodology Overview 11
2.1 Industrial Applications Mapping Approach 11
2.2 Selection Criteria for Industry Interviews 14
2.3 Additional Case Studies Identification 15
3 Industrial Energy Use and Decarbonization Pathways 17
3.1 Industrial Energy Use and Emissions in the EU 18
3.2 Temperature Requirements and Process Heat & Cooling Demand 26
4 Screening Industrial Use Cases and Facilitating GEOSYN Adoption 28
4.1 Industrial Applications Screening For Integration of GEOSYN Technology 28
4.2 Waste Heat Utilization and Recovery Strategies 31
4.3 Industries Candidates Mapping 34
5 Industry Interviews 37
6 Additional Case Study Selection Outcome 43
7 Conclusions 47
8 Appendixes 47
Appendix A 47
Appendix B 49
Appendix C 51
Appendix D 52
Appendix E 53
Appendix F 59

Funded by the European Union

Index of Tables

Table 1 Template for Stakeholder Mapping in Geothermal Industrial Applications 12
Table 2 Industry Selection Criteria 14
Table 3 Temperature Band Classification and Associated Industry Sectors. 26
Table 4 Identified potential industrial applications for the GEOSYN technology 28
Table 5 Potential of industrial heat pumps to meet process heat demand through waste heat utilization 34
Table 6 Overview of Additional Case Studies. 44

Index of Figures

Figure 1 Summary of the approach used to map and select additional virtual case studies..... 11
Figure 2 Sources of Data for Industrial Applications Mapping 12
Figure 3 Interview Sections for Industry Engagement..... 15
Figure 4 Energy consumption by end-use sectors in EU27, 2023 by Eurostat 18
Figure 5 Evolution of final energy consumption in the industry sector by energy product, EU, 1990-2023 (PJ)..... 18
Figure 6 Overview of the final energy demand in the EU industry with applications and temperature levels 19
Figure 7 Total final energy consumption by industrial sector, EU, 2023..... 20
Figure 8 Sectors with Highest Heat Demand, TWh 20
Figure 9 Sectors with Lowest heat demand, TWh 21
Figure 10 Heat demand breakdown by EU28 country (%), 2015 21
Figure 11 Europe Industrial Cooling Systems Market..... 22
Figure 12 Final energy consumption for process cooling per country (industrial sector), EU27+UK, in 2016..... 23
Figure 13 Distribution of GHG emissions in the European Union (EU-27) in 2023, by sector..... 24
Figure 14 Estimated direct emissions of the industry in Europe by end use and sub-sector in 2018..... 25
Figure 15 Temperature share and final energy demand for heating and cooling by EU countries in 2015 26
Figure 16 Projection of the share of heat pumps in industrial process technologies across..... 27
Figure 17 Availability of waste heat and process heat demand in selected sectors across the EU28..... 32
Figure 18 Examples of potential reuse of waste heat generated from various process with respect to the temperature..... 33
Figure 19 Mapped industrial applications for GEOSYN solutions in partner and other EU countries 35
Figure 20 Distribution of mapped stakeholders by industrial sector 35
Figure 21 Share of primary energy sources in interviewed industries..... 38
Figure 22 Number of interviewed industries being familiar with geothermal energy solutions ... 39

Funded by the European Union

Figure 23 Previously considered/implemented geothermal technologies. 40
Figure 24 Willingness to exploring a GEOSYN solution 40
Figure 25 Key factors Influencing investment decisions in geothermal-based heating & cooling systems. 41

Partners short names

APRE	AGENZIA PER LA PROMOZIONE DELLA RICERCA EUROPEA
UNIFI	UNIVERSITA DEGLI STUDI DI FIRENZE
COSVIG	CONSORZIO PER LO SVILUPPO DELLE AREE GEOTERMICHE
SDU	SYDDANSK UNIVERSITET
GU	NGO GEOTHERMAL UKRAINE
SINTEF	SINTEF AS
SINTEF ER	SINTEF ENERGI AS
RIVACOLD	RIVACOLD SRL
NEO ECO	NEOECO DEVELOPPEMENT
S.M.F.	FORMAGGERIA TOSCANA S.R.L.

Abbrevations

H&C	Heating and cooling
HTHP	High temperature heat pump
GHG	Greenhouse gas
NDA	Non-Disclosure Agreement
P&ID	Piping and Instrumentation Diagram
IHC	Integrated heating and cooling

Funded by the European Union

Executive Summary

The GEOSYN project aims to accelerate the integration of geothermal heating and cooling (H&C) technologies into European industrial processes, supporting the European Union (EU)'s decarbonisation agenda and improving energy efficiency across multiple sectors. This Deliverable D1.1 lays the foundation for systematically mapping potential industrial applications, evaluating temperature and process requirements, and identifying pathways for effective deployment of high temperature heat pump (HTHP) and heat-driven cooling systems.

The report highlights the scale of industrial energy demand in Europe, where more than two-thirds of final energy use is dedicated to heating processes, much of it still reliant on fossil fuels. Approximately 37 % of industrial heat demand lies below 200 °C, representing a strong opportunity for heat pump integration. By targeting food and beverages, pulp and paper, cement, chemicals, and pharmaceuticals, GEOSYN can significantly reduce carbon emissions, optimise resource use, and enhance competitiveness.

Key activities related to D1.1 carried out include:

- mapping and screening of industrial applications, identifying high-potential sites with strong geothermal integration opportunities;
- structured interviews with 50 companies across diverse industrial sectors, assessing energy demand profiles, awareness of geothermal solutions, and willingness to the EU climate neutrality target plan;
- analysis of key factors influencing industrial decision-making, including cost, operational compatibility, environmental benefits, and regulatory drivers;
- selection of five additional (virtual) case studies across Italy, France, Croatia, and Ukraine to demonstrate the scalability of GEOSYN solutions under real industrial conditions.

Overall, this report establishes a robust analytical framework to guide the demonstration and replication of geothermal-based H&C in Europe, positioning GEOSYN as a transformative contributor to industrial decarbonisation. This deliverable provides the foundation upon which demonstration activities in WP2 and WP3 will build.

Funded by the European Union

1 Introduction

The GEOSYN project aims to foster the integration of innovative geothermal technologies into European industrial processes, facilitating a sustainable energy transition while enhancing energy efficiency and reducing greenhouse gas (GHG) emissions. The project focuses on the synergistic application of geothermal H&C systems within a broad range of industrial sectors, capitalising on Europe's diverse geothermal potential. By targeting industrial processes with substantial H&C demands, GEOSYN aspires to optimise energy use, support decarbonisation strategies, and contribute to EU climate targets.

This deliverable D1.1 represents a foundational step within the GEOSYN framework by systematically identifying and evaluating industrial processes and sectors where geothermal energy can provide tangible environmental and economic benefits. This initial analysis sets the stage for the selection of EU demonstration sites and the formulation of replication strategies, ensuring that the project outcomes can be scaled and transferred to similar industrial contexts across Europe.

The activities presented in D1.1 are part of Task 1.1 "Analysis of potential industrial applications" (M1–M12), led by GU with the active participation of COSVIG, UNIFI, and APRE. The task focuses on a comprehensive mapping and assessment of industrial applications where geothermal H&C technologies can be effectively deployed. It encompasses the analysis of temperature profiles, waste heat recovery possibilities, and comparative energy performance evaluations. This structured approach ensures a data-driven and sector-specific identification of geothermal integration opportunities.

1.1 Purpose and Objectives

The main purpose of Deliverable D1.1 is to establish a solid knowledge base on the potential for integrating geothermal H&C solutions within the European industrial landscape. By identifying suitable industrial sectors and processes, this deliverable aims to guide the GEOSYN project in selecting high-impact demonstration cases and to outline a pathway for wide-scale replication across diverse geographical and industrial settings.

The specific objectives of D1.1 are:

- comprehensive assessment of various industrial sectors, identifying processes with significant H&C demands for which the GEOSYN solution can be efficiently integrated;
- leverage existing knowledge and strategic reports, to align the assessment with broader EU priorities and ensure consistency with ongoing industry developments and best practices;
- mapping of potential industrial applications based on key criteria, such as key industrial processes, process temperature ranges, used heat carriers, specific

heating and cooling needs, the potential for cascade use of geothermal heating and cooling, and the geothermal potential of the region;

- engage with key industrial stakeholders through structured interviews and consultations to gather insights on operational requirements, perceived barriers, and drivers for the adoption of geothermal solutions in industrial settings;
- selection and identification of five additional high-potential (virtual= demonstration sites across different EU regions for detailed assessment of GEOSYN technology replicability;

By fulfilling these objectives, D1.1 provides a robust analytical foundation to steer the subsequent phases of GEOSYN, enabling the successful demonstration, validation, and replication of geothermal solutions across Europe's industrial sectors.

2 Methodology Overview

This chapter outlines the methodological framework employed to identify and assess potential industrial applications for geothermal energy within the scope of Deliverable D1.1. The approach followed different steps, as summarised in Figure 1, and integrates systematic data collection, stakeholder engagement, and analytical techniques to map industrial sectors and evaluate their compatibility with geothermal energy solutions, particularly the GEOSYN technology. The methodology is designed to ensure comprehensive coverage, data accuracy, and stakeholder inclusivity across partner countries and other EU regions.

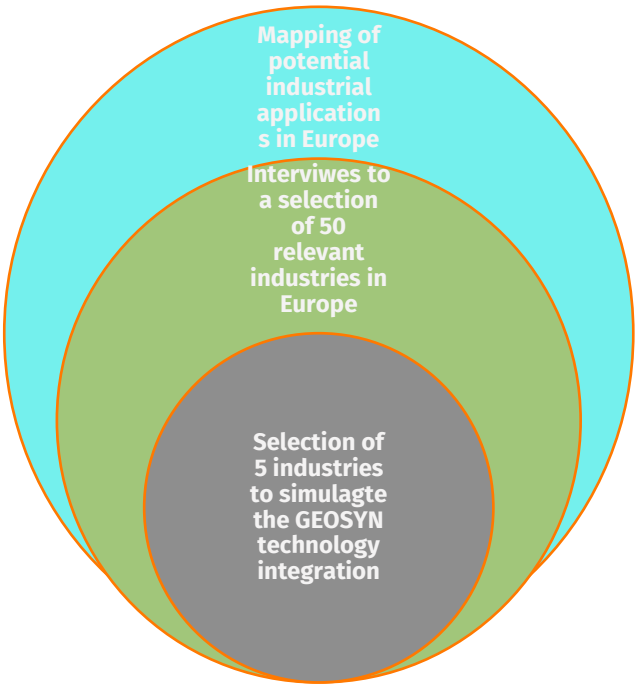

Figure 1. Summary of the approach used to map and select additional virtual case studies.

2.1 Industrial Applications Mapping Approach

The identification of potential industrial applications for geothermal energy began with a comprehensive data collection process. Data was gathered through extensive online research, leveraging a variety of credible sources, including (Figure 2).

Extensive volume of data from Eurostat[1] was analysed to understand the current state of the industry, including the distribution of energy and heat demand, as well as the GHG emission levels across various industrial sectors. This analysis informed the identification of high-impact areas in which renewable heating and cooling GEOSYN solutions can support decarbonization and improve energy efficiency.

[1] https://ec.europa.eu/eurostat

Figure 2 Sources of Data for Industrial Applications Mapping.

Additionally, specific industrial sectors - such as wood, paper, cement, food, chemical, and pharmaceuticals, etc. - were mapped, with data collection focused on identifying where GEOSYN solutions could be effectively integrated. This analysis targeted both partner countries (Italy, Norway, Ukraine, Denmark, and France) and other EU member states with significant potential for renewable heat applications. Emphasis was placed on companies with high heating and cooling demands, as well as those with processes suitable for cascade utilization of geothermal resources.

To ensure consistency and reliability, all collected data underwent a standardized pre-processing workflow. This includes validation, filtering of irrelevant content, and categorization based on industry type, geographical location, key industrial processes, process temperature ranges, used heat carriers, specific heating and cooling needs, the potential for cascade use of geothermal heating and cooling, and the geothermal potential of the region. A standardized data template was developed to structure this information systematically (Table 1).

Table 1 Template for Stakeholder Mapping in Geothermal Industrial Applications.

NAME OF COMPANY	
COUNTRY	
INDUSTRY SECTOR	
INDUSTRIAL PROCESSES	
HEAT CARRIER	*Steam, water, air, other - specify*
PROCESS TEMPERATURE RANGE	*°C*
HEATING AND COOLING NEEDS	*Temperature, pressure, mass flow rate, kW*
POSSIBILITY TO USE HEATING AND COOLING IN CASCADE	

GEOTHERMAL POTENTIAL	*Temperature, (BHT/WHT) °C* *Depth, m* *Reservoir/geological conditions*
FINANCIAL PART	*Cost of electricity, cost of heating, cost of cooling*
DISTANCE TO THE END USER	*m*
ALREADY USE RENEWABLES? WHICH KIND?	
CONTACTS	

For processing and analysis, tools such as Microsoft Excel, were used.

To facilitate data collection and stakeholder involvement, a *Stakeholder Mapping Survey* was designed based on the template in Table 1. The Survey was uploaded to a shared Google Drive folder to streamline data submission and ensure accessibility. The Survey is available online in English[2] and translated into Ukrainian[3] and Italian[4], to engage industries in both countries effectively.

A tailored letter (Appendix A) was prepared and sent to targeted companies by emails, inviting them to participate as stakeholders in the GEOSYN project. The letter outlined the project's objectives, the potential benefits of geothermal energy integration, and assurances of compliance with confidentiality requirements to encourage data sharing on operational processes. This step was critical to evaluate the GEOSYN technology under real-world conditions.

Major international and national industrial organizations and associations in partner countries were identified. A separate letter (Appendix B) was distributed to these organizations by email addresses, providing an overview of the GEOSYN project and requesting their assistance in disseminating the stakeholder invitation within their networks. This approach aimed to broaden the project's reach and engage a diverse range of companies.

Feedback from companies and industrial associations was iteratively incorporated into the mapping process. Responses to the Stakeholder Mapping Survey were analysed to refine the data template and address gaps in information. This iterative approach ensured that the methodology remained responsive to stakeholder needs and real-world constraints. Given the sensitive nature of industrial process data, non-disclosure agreements (NDAs) were implemented.

All collected data were processed and analysed to identify viable industrial applications for GEOSYN solution (Chapter 4).

The approach faced potential limitations, such as open-source industrial related data availability where some industries may have limited publicly available data, mitigated through direct outreach and partnerships with industrial associations. Geographical variability posed another challenge due to the significant variation in geothermal potential across regions. Additionally,

[2] https://forms.gle/4Qcu7sfWaAMEEshi8
[3] https://forms.gle/6oHXNiFpAQiLznQk7
[4] https://forms.gle/k8oN6wtpXHMmZ9tW9

Funded by the European Union

stakeholder response rates presented a concern with anticipated low participation from companies, countered by using follow-up communications and leveraging personal contacts and industrial networks to enhance engagement.

This comprehensive methodology ensures a robust and inclusive approach to identifying and evaluating industrial applications for geothermal energy, laying the foundation for the successful implementation of the GEOSYN solution.

2.2 Selection Criteria for Industry Interviews

The purpose of the interview is to understand the company's energy profile, industrial processes, and potential opportunities for integrating the geothermal GEOSYN solution.

Following the initial industry mapping, it was decided to establish specific selection criteria to choose 50 industries from European countries for interviews.

Industries were evaluated based on multiple parameters to ensure their suitability for geothermal heating and cooling applications. The key selection criteria include (with the most important listed first) (Table 2):

Table 2 Industry Selection Criteria.

1	**Energy Intensity**	Priority is given to industries with high energy consumption per unit of output, as they offer greater potential for cost savings and efficiency improvements.
2	**Thermal Demand & Temperature Requirements**	Industries with significant demand for high-temperature heating or process cooling are preferred, aligning with the capabilities of the GEOSYN heating and cooling technology.
3	**Geographical Distribution**	Industries located in regions with suitable geothermal resources are favored to maximize the feasibility of geothermal integration.
4	**Industrial Relevance**	Focus is placed on sectors in which heating and cooling are critical to production processes, such as food processing, chemical, paper, wood, and cement industries.
5	**Waste Heat Potential**	Industries that generate waste heat, which can be harnessed through GEOSYN geothermal-integrated systems.
6	**Innovation & Sustainability Commitment**	Companies with a demonstrated commitment to sustainability, energy transition and innovative energy solutions.
7	**Willingness to Collaborate**	Industries expressing interest in participating, sharing data, and piloting geothermal solutions are given additional consideration.

Funded by the European Union

The selected industries were invited to participate in interviews focused on exploring potential geothermal applications.

To facilitate this process, a structured set of questions (Appendix C) was developed and organized into four key sections (Figure 3).

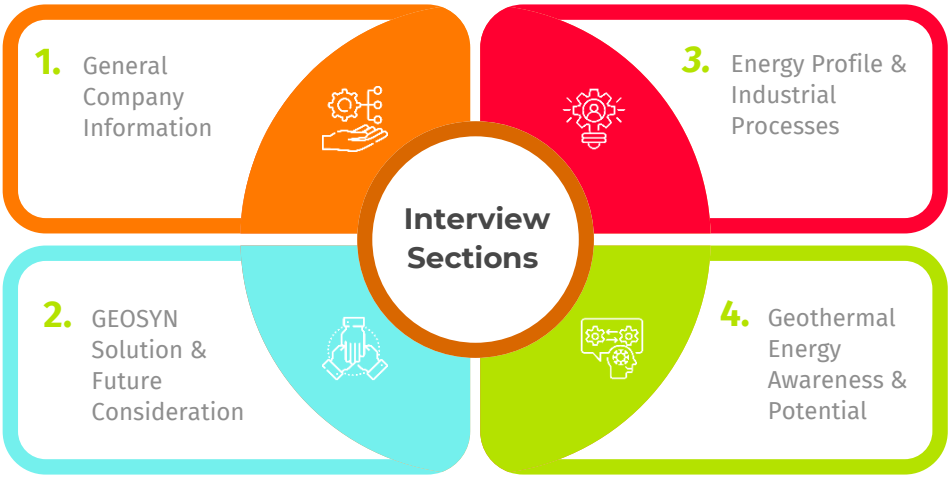

Figure 3 Interview Sections for Industry Engagement.

A GEOSYN brochure, including these questions in PDF format, was shared via email with the selected companies to gather their feedback. Engagement and data collection were further supported through a combination of emails, phone calls, and in-person meetings.

To enhance the methodology, a follow-up strategy was implemented to address non-responses and deepen engagement. This included sending reminder emails and scheduling additional calls to clarify questions or provide further project details.

Data collected from the interviews and feedback forms was systematically recorded in a database, enabling real-time analysis and updates.

This comprehensive approach ensures a balanced selection process that prioritizes technical feasibility, economic viability, industry engagement, and alignment with sustainability goals.

2.3 Additional Case Studies Identification

Following the stakeholder interviews and survey conducted during the project, five virtual case studies were selected from various European countries and industrial sectors (Chapter 6). Additional invitation letters (Appendix D) were sent to selected stakeholders, inviting them to participate in the project as virtual case study candidates. These were identified among the interviewed companies that submitted comprehensive and technically detailed data on their operational processes. The selection process prioritized those industries that demonstrated a clear potential for geothermal energy integration and were willing to collaborate under conditions of confidentiality.

Funded by the European Union

To proceed, selected companies agreed to sign NDAs, ensuring that sensitive industrial information could be shared securely. Once the NDAs were in place, each company provided detailed technical documentation to support the evaluation of GEOSYN's integration potential and demonstrate geothermal heating and cooling solutions in action.

This information typically included:

- piping and Instrumentation Diagrams (P&IDs) of the plant;
- operating temperature levels *(°C)*;
- heating and cooling capacities *(kW, MW, etc.)*;
- potential for integrating geothermal energy or other renewable sources;
- used heat transfer fluid *(e.g., steam, air).*

The methodology for selecting and analysing these case studies was structured to ensure sectoral diversity, geographical balance, and relevance to GEOSYN's scalability goals. Each case serves to demonstrate the practical application of geothermal heating and cooling in industrial settings, supporting the broader aim of validating the solution under real operational conditions.

Funded by the European Union

3 Industrial Energy Use and Decarbonization Pathways

The industrial sector is one of the largest energy consumers and carbon emitters in the European Union, making it a critical focus for decarbonization efforts. This chapter examines how geothermal heating and cooling can be integrated into industrial energy systems to reduce GHG emissions, improve energy efficiency, and support the EU's climate goals. Within the GEOSYN project framework, a comprehensive analysis has been conducted to assess the technical feasibility and potential impact of deploying geothermal solutions across various industrial sectors in Europe. The chapter outlines current energy use patterns, identifies key industrial emitters, and explores the role of temperature-specific process heat in shaping decarbonization pathways—laying the foundation for targeted, sustainable energy transitions.

The transformation of industrial production is essential for the EU to meet its climate ambitions, including achieving climate neutrality by 2050 and reducing GHG emissions by **55 %** by 2030, as set out in the **European Green Deal**[5]. This ambitious target is supported by several cornerstone EU policies, i.e.: the **Industrial Emissions Directive (2010/75/EU)**[6], which requires the implementation of Best Available Techniques (BAT) to maximize energy efficiency and minimize GHG emissions; the **Energy Efficiency Directive (2012/27/EU)**[7], mandating regular energy audits or certified energy management systems at industrial sites; the **Renewable Energy Directive most recently revised under RED II and RED III**[8], which establishes binding targets for the deployment of renewables across all sectors, including specific goals for renewable heating and cooling in industry.

According to the International Energy Agency (IEA)[9], indirect GHG emissions from space cooling have increased significantly since 1990, nearly tripling to just over 1 Gt GHG by 2022. This rise in emissions is driven by growing energy demand for cooling, which has more than tripled since 1990, a trend that is projected to continue without significant policy intervention.

Moreover, escalating energy prices - driven by global fossil fuel shortages and geopolitical upheavals - alongside growing pressure to reduce the carbon footprint of manufactured goods, have spurred companies worldwide to actively pursue process-heat decarbonization. This includes shifting to renewable process heating technologies such as geothermal, biomass, and heat pumps, as well as investing in energy efficiency and electrification strategies to future-proof operations[10].

[5] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
[6] https://eur-lex.europa.eu/eli/dir/2010/75/oj/eng
[7] https://eur-lex.europa.eu/eli/dir/2012/27/oj/eng
[8] https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-directive_en
[9] https://www.iea.org/energy-system/buildings/space-cooling
[10] IEA Renewables 2023 Analysis and forecast to 2028 - https://iea.blob.core.windows.net/assets/96d66a8b-d502-476b-ba94-54ffda84cf72/Renewables_2023.pdf

Funded by the European Union

3.1 Industrial Energy Use and Emissions in the EU

The industry sector is one of the highest energy consumers in the EU and accounted for **24.6 %** of the final energy consumption in the EU in 2023[11], ranking third behind transport (**32.0 %**) and households (**26.3 %**)[12] (Figure 4).

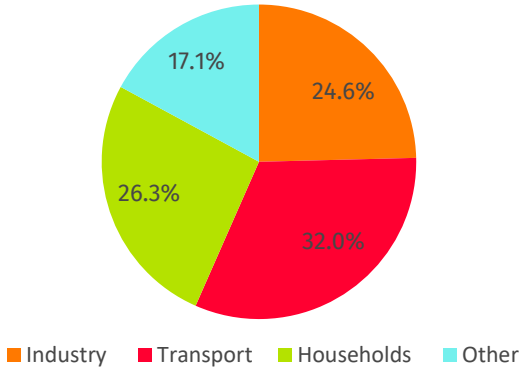

Figure 4 Energy consumption by end-use sectors in the EU27 in 2023 by Eurostat[11].

Electricity (**32.6 %**) and natural gas (**31.3 %**) accounted for nearly two-thirds of the final energy consumption in the EU's industry sector in 2023[11] (Figure 5).

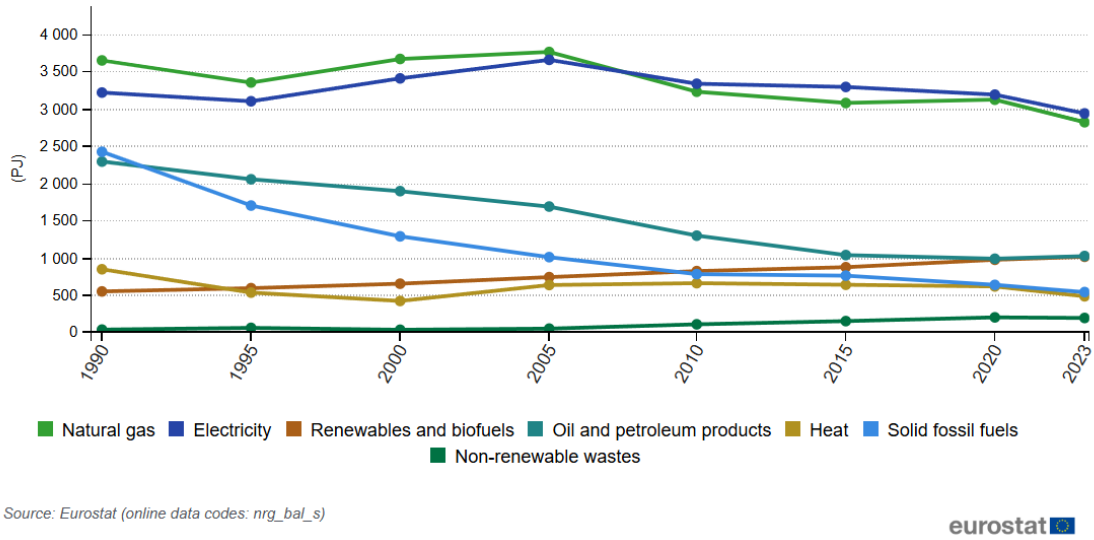

Figure 5 Evolution of the final energy consumption in the industry sector by energy product in the EU in 1990-2023 (PJ)[11].

Energy in industry is essential not only for process activities - such as heating, drying, and chemical reactions - but also for supporting infrastructure, like space heating, cooling,

[11] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Final_energy_consumption_in_industry_-_detailed_statistics
[12] https://ec.europa.eu/eurostat/statistics-explained/SEPDF/cache/110026.pdf

Funded by the European Union

ventilation, and lighting. Final consumption data from Eurostat indicates that industry uses a mix of energy resources - natural gas, electricity, renewable energy resources, oil, and heat—to serve these diverse demand[13].

Industries consume considerable amounts of energy, primarily driven by the demand for thermal energy. Around **81 %** of their final energy use is dedicated to heating, with **66 %** specifically for process heat. Currently, a significant portion of this heat is generated from fossil fuels - coal, oil, and gas - resulting in approximately **552** Mt CO_2/year.

Process heat is required across a range of temperatures, depending on the application. While heavy industries rely on very high temperature heat (above 200 °C) for energy-intensive operations, about **37 %** of industrial process heat demand is at temperatures below **200 °C** - making it suitable for geothermal energy[14] (Figure 6).

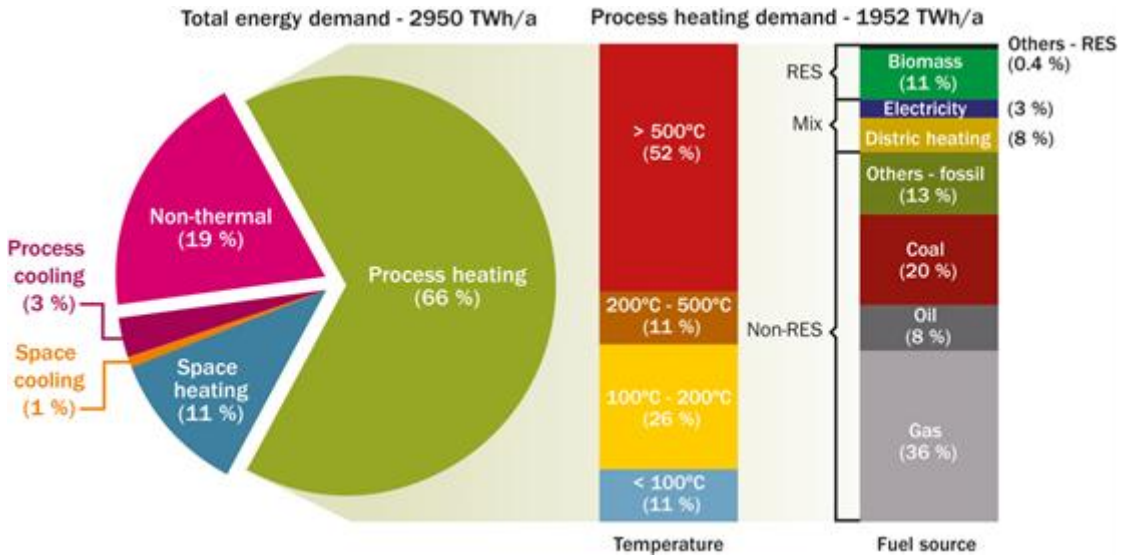

Figure 6 Overview of the EU's final energy demand with respect to applications and temperature levels[15].

Within the industrial sector, the highest energy consumers in the EU in 2023 were the chemical and petrochemical industry (**21.5 %** of total industrial energy consumption), the non-metallic minerals, including cement, glass, bricks, and ceramics sectors (**14.5 %**) and the paper, pulp and printing industry (**14.3 %**)[16], followed by food, beverages & tobacco (**12.9 %**) iron & steel (**10.6%**), and others (Figure 7).

[13] https://ec.europa.eu/eurostat/statistics-explained/SEPDF/cache/110026.pdf
[14] https://www.suprheat.dk/applications/application-potential/
[15] https://publications.tno.nl/publication/34636827/LyEUaZ/TNO-2020-heatpump.pdf
[16] https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20221202-2

Funded by the European Union

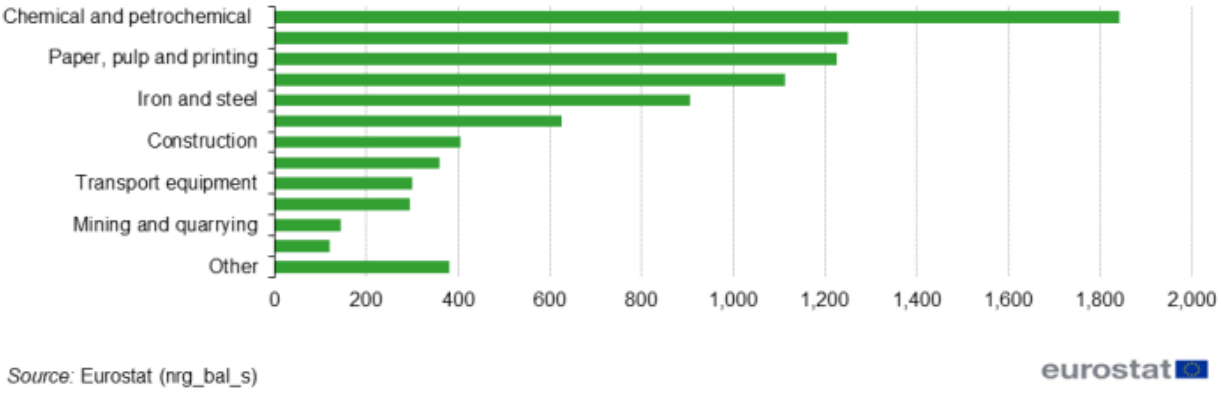

Figure 7 Total final energy consumption by industrial sector in the EU in 2023[17].

In 2015 the total annual heat demand of the EU's industrial sector was approximately **1,600 TWh**[18] (Figure 8 and Figure 9).

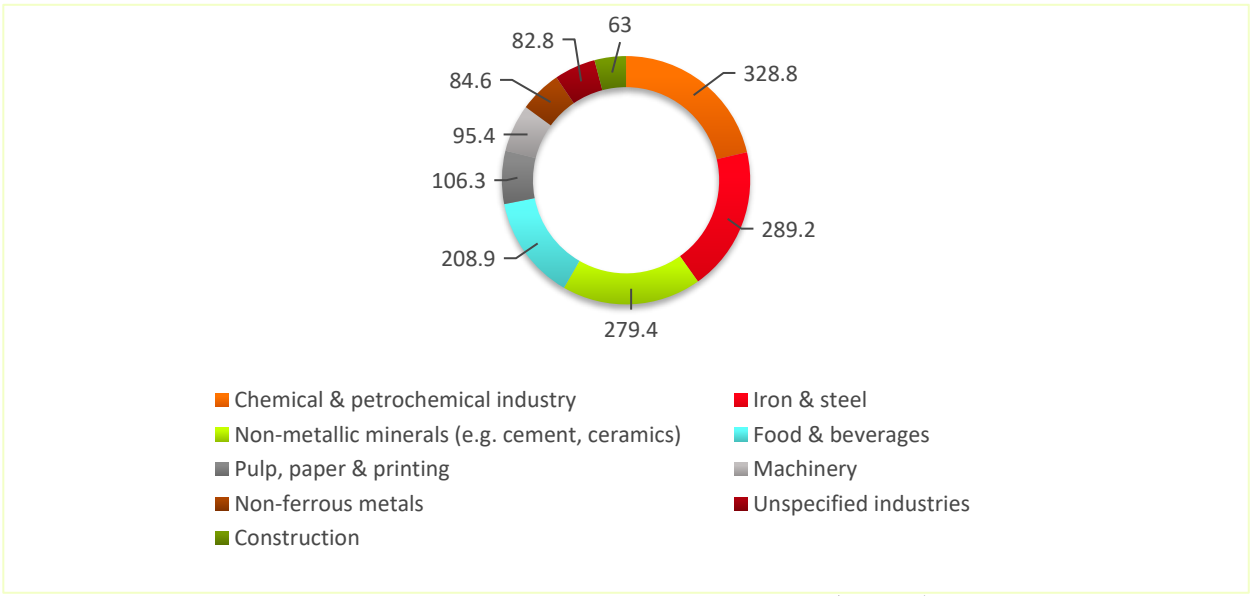

Figure 8 Sectors with the highest heat demand (in TWh)[20].

[17] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Final_energy_consumption_in_industry_-_detailed_statistics#The_highest_industrial_energy_consumers_in_the_EU
[18] https://www.mdpi.com/2076-3417/14/19/8994

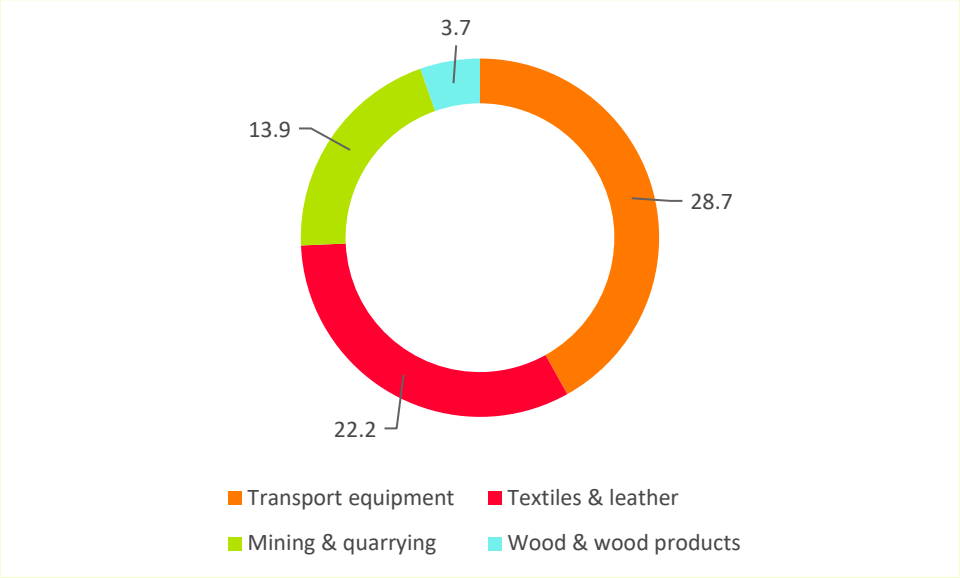

Figure 9 Sectors with the lowest heat demand (in TWh)[20].

A substantial portion of heat demand originated from a few EU countries: Germany accounted for **22.0 %**, followed by France (**10.4 %**), Italy (**10.1 %**), the United Kingdom (**8.0 %**), and Spain (**7.8 %**). The remaining countries featured considerably smaller shares[19] (Figure 10).

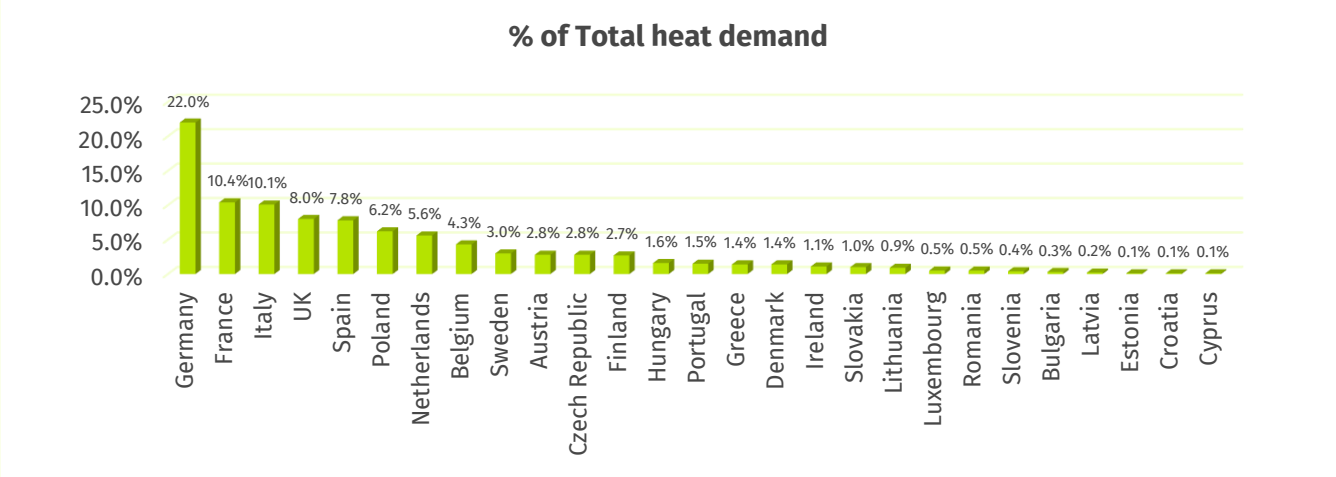

Figure 10 Heat demand breakdown in the EU28 country (%) in 2015[20].

[19] Papapetrou, M.; Kosmadakis, G.; Cipollina, A.; La Commare, U.; Micale, G. Industrial Waste Heat: Estimation of the TechnicallyAvailable Resource in the EU per Industrial Sector, Temperature Level and Country. Appl. Therm. Eng. 2018,138, 206–216

[20] European Commission Energy Balance Sheet—2017 Edition. Available online: https://ec.europa.eu/eurostat/web/products-statistical-books/-/ks-en-17-001

Funded by the European Union

The Europe industrial cooling systems market was valued at USD 6.30 billion in 2024 and is projected to reach USD 9.45 billion by 2030, expanding at a CAGR of 6.5% from 2025 to 2030[21]. Market growth is primarily driven by the rapid expansion of energy-intensive sectors such as industrial manufacturing, food and beverages, pharmaceuticals, and data centers, coupled with increasingly stringent EU climate policies and decarbonization mandates.

Major industries—including power generation, chemicals, oil & gas, and manufacturing—are progressively adopting advanced cooling technologies such as closed-loop, dry, and hybrid systems to reduce water consumption and lower carbon emissions. This shift is expected to be a key driver of market expansion over the forecast period.

The proliferation of data centers across Europe, particularly in technologically advanced and climate-favorable regions such as the Nordics, the Netherlands, and Ireland, is also contributing significantly to market demand. These facilities require high-performance cooling solutions, including liquid-based and evaporative systems, to ensure operational reliability, thermal stability, and energy efficiency. Furthermore, the integration of IoT-enabled monitoring and automation is enhancing system performance through predictive maintenance and energy optimization—supporting Europe's broader digital transformation agenda and accelerating market growth.

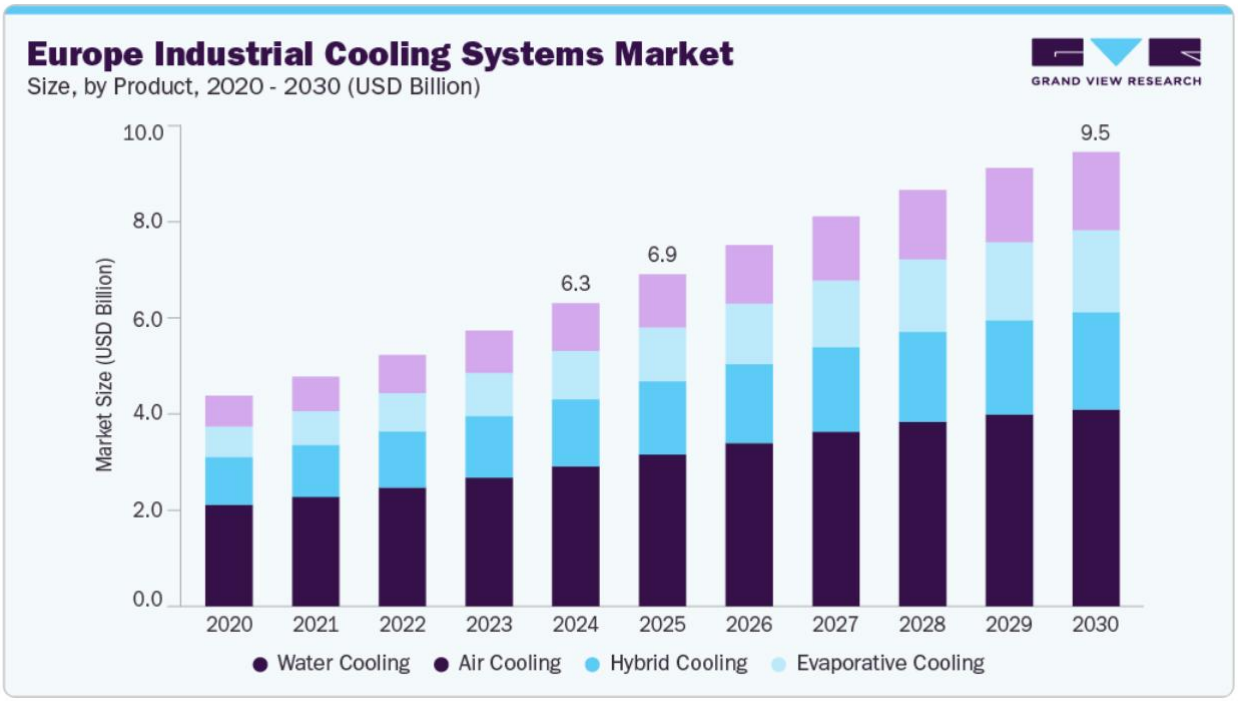

Figure 11 Europe Industrial Cooling Systems Market[23].

The surge in digital infrastructure—driven by the growth of cloud computing, edge computing, AI, big data analytics, and 5G deployment—is further fueling the need for efficient thermal

[21] Europe Industrial Cooling Systems Market (2025 - 2030) https://www.grandviewresearch.com/industry-analysis/europe-industrial-cooling-systems-market-report

Funded by the European Union

management solutions. The rising volume of data being generated and processed has prompted substantial investment in hyperscale and colocation data centers, particularly in Germany, the Netherlands, Ireland, France, and the Nordic countries.

According to the International Energy Agency (IEA)[22], energy consumption in industrial cooling could be reduced by up to 40% with modern, digitally controlled systems, a major factor influencing procurement decisions, thereby driving Europe's industrial cooling systems industry growth.

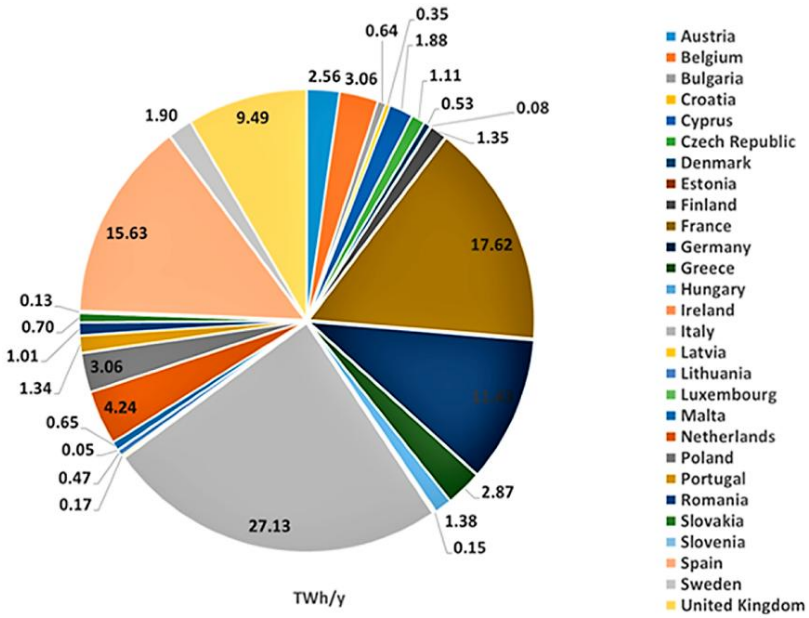

Figure 12 Final energy consumption for process cooling per country (industrial sector), EU27+UK, in 2016[23].

Energy production - including electricity and heat generation - is responsible for more than **70 %** of the total GHG emissions in the EU, as illustrated in Figure 13. The energy supply sector contributed approximately **23.9 %**, while the industry sector was responsible for around **19.9 %** of total EU GHG emissions as of 2023.

[22] https://www.iea.org/energy-system/buildings/space-cooling
[23] https://www.mdpi.com/2071-1050/15/4/3698

Funded by the European Union

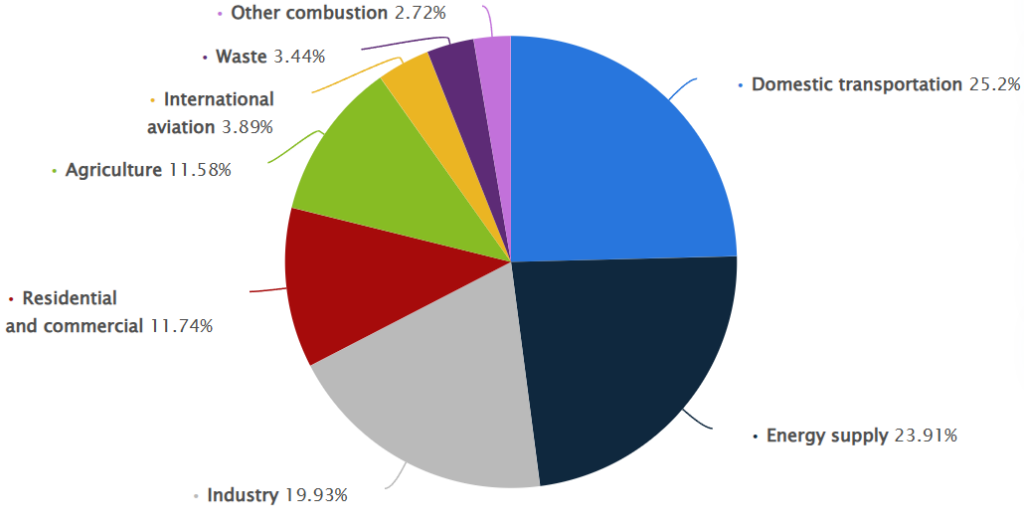

Figure 13 Distribution of GHG emissions in the EU27 in 2023, by sector[24].

Such an energy demand, driven by industrial energy-intensive processes, such as steelmaking, cement production, and chemical manufacturing, the sector accounts for nearly a quarter of total GHG emissions in Europe. A significant portion of these emissions results from the generation and use of heat - primarily through the combustion of fossil fuels for high- and medium-temperature processes. Over **70 %** of industrial emissions are directly related to heat generation - either from furnaces or steam/hot water systems - highlighting the critical role of thermal energy use in industrial decarbonization strategies (Figure 14).

[24] https://www.statista.com/statistics/1325132/ghg-emissions-shares-sector-european-union-eu/

Funded by the European Union

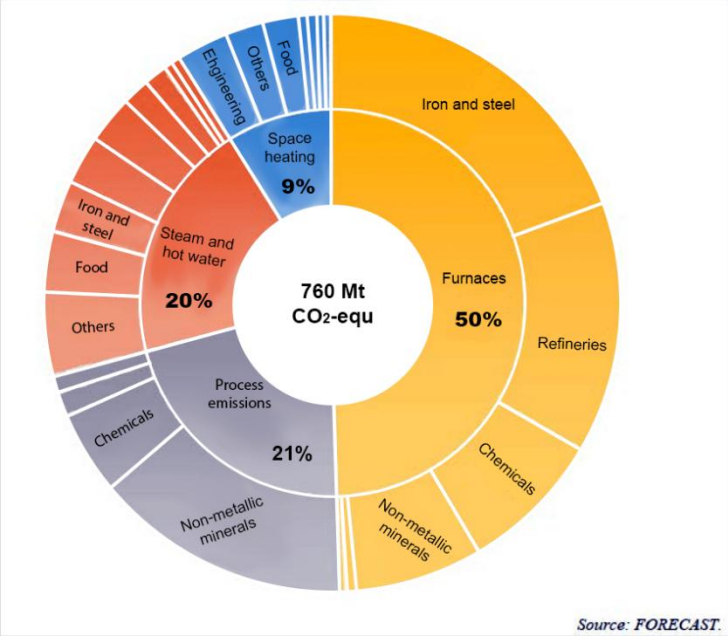

Figure 14 Estimated direct emissions of the industry in Europe by end use and sub-sector in 2018[25].

Furnaces 50%	Representing the largest share of industrial emissions, this segment is dominated by iron and steel, refineries, and chemicals. These emissions stem primarily from the combustion of fossil fuels for high-temperature heat.
Process Emissions 21%	These are non-combustion emissions generated from chemical and physical processes, such as those in the chemicals and non-metallic minerals sectors (e.g., cement and lime production).
Steam and Hot Water 20%	These emissions come from generating medium- and low-temperature heat for industrial processes, with significant contributions from iron and steel, food, and other manufacturing sectors.
Space Heating 9%	This smaller segment includes heating emissions for industrial buildings, with notable contributions from the food, engineering, and other sectors.

[25] https://www.researchgate.net/publication/342707922_Energy-intensive_industries_Challenges_and_opportunities_in_energy_transition

Funded by the European Union

3.2 Temperature Requirements and Process Heat & Cooling Demand

Each industrial sector relies on specific production processes that are closely tied to temperature requirements. Whether in manufacturing, food processing, chemical production, or energy generation, temperature plays a critical role in ensuring efficiency, product quality, and operational safety. Understanding these temperature-dependent processes is essential for optimizing performance, integrating GEOSYN solution, and exploring opportunities for energy savings and sustainability.

Industrial process heat is commonly grouped into four temperature bands. These temperature thresholds are pivotal when assessing the technological pathways available for process heat decarbonization as well as for GEOSYN innovation (Table 3).

Table 3 Temperature Band Classification and Associated Industry Sectors.

Temperature Band	Range	Typical Sectors
Low-temperature	**< 100 °C**	Food & beverage, pulp & paper, transport equipment, textiles & leather
Lower-medium	**100–200 °C**	Chemical & petrochemical, food & beverage, pulp & paper, machinery, textiles
Upper-medium	**200–500 °C**	Chemicals, non-metallic minerals, some sectoral overlap from pulp & paper
High-temperature	**> 500 °C**	Iron & steel, non-metallic minerals (cement, ceramics), non-ferrous metals, heavy chemicals

Figure 15 illustrates the temperature share and final energy demand for H&C by EU countries in 2015[26]. It provides a comparative view of how energy is used across temperature ranges for industrial and space heating/cooling.

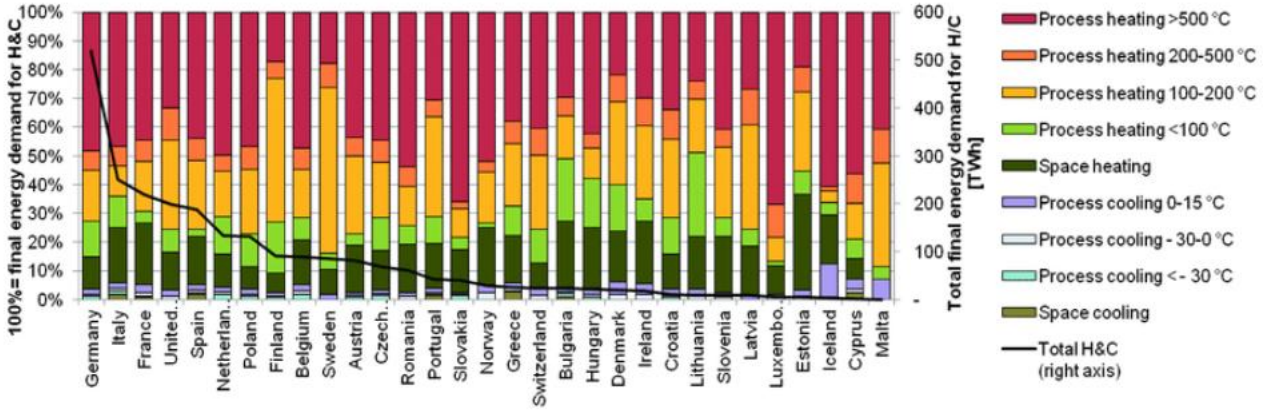

Figure 15 Temperature share and final energy demand for heating and cooling by EU countries in 2015[26].

[26] https://www.researchgate.net/publication/312173884_A_bottom-up_estimation_of_heating_and_cooling_demand_in_the_European_industry

Funded by the European Union

Germany, Italy, and France show the highest total final energy demand for heating and cooling, with large contributions from high-temperature process heating (**>200 °C**).

As a result, globally, industrial heat pumps are expected to supply more than 10 % of industrial demand at temperatures below **200 °C** by 2030. In the EU-27 plus the United Kingdom, the largest demand comes for heat pumps today, heat pumps are expected to be responsible for about **20 %** of industry heating processes for temperatures up to 200°C in 2030 (Figure 16). This is an increase of more than **10 %** compared to the level as per 2023[27].

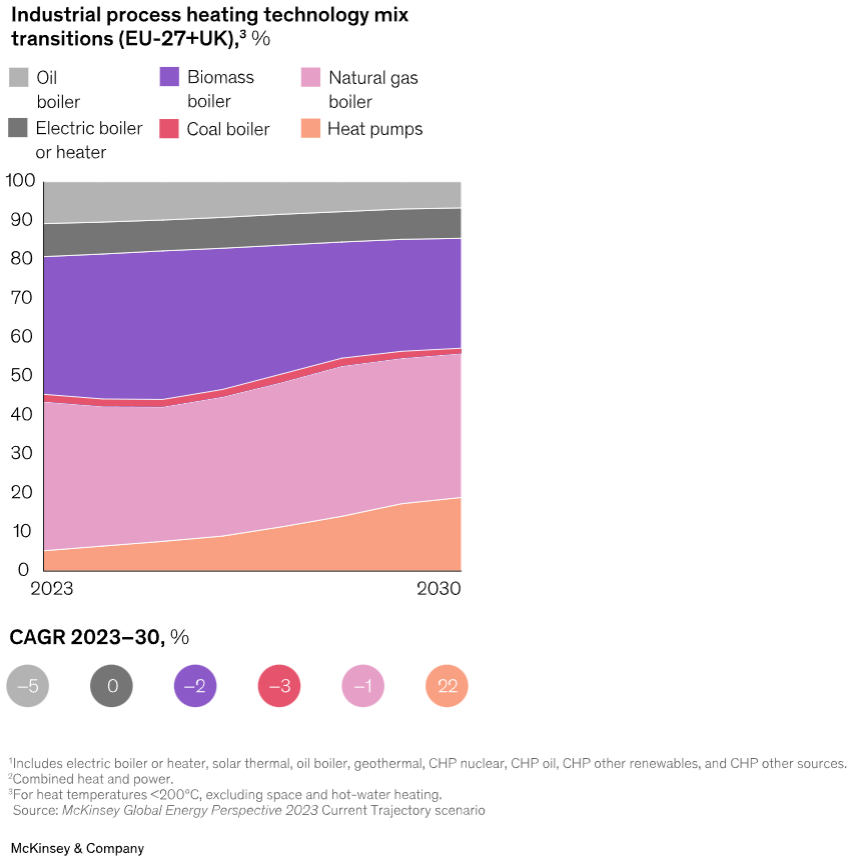

Figure 16 Projection of the share of heat pumps in industrial process technologies across Europe[27].

This sharp uptake underscores the strategic role of innovation and systems integration in decarbonizing low- and medium-temperature heat. This leads new technologies and the integrated solutions proposed under the GEOSYN project to be critical to accelerating this transition - enabling efficient deployment, interoperability with existing energy systems, and ultimately supporting the EU's climate neutrality goals.

[27] https://www.mckinsey.com/industries/industrials-and-electronics/our-insights/industrial-heat-pumps-five-considerations-for-future-growth#/

Funded by the European Union

4 Screening Industrial Use Cases and Facilitating GEOSYN Adoption

This chapter explores the practical integration of GEOSYN technology across diverse industrial sectors. It begins by identifying and analyzing key industrial processes for which medium-enthalpy geothermal energy and advanced heating and cooling systems can deliver meaningful carbon reductions and energy efficiency gains.

Through detailed sector screening, the chapter highlights high-potential use cases, particularly in the chemical, pharma, food and beverage, paper, and mineral processing industries. It also examines waste heat utilization strategies, emphasizing the role of HTHPs in recovering low-grade heat and converting it into usable process energy. Finally, the chapter presents a geographic mapping of over 200 industrial players across 15 countries, showcasing real-world opportunities for GEOSYN deployment and outlining stakeholder engagement efforts essential to scaling adoption.

4.1 Industrial Applications Screening For Integration of GEOSYN Technology

Geothermal sources within the **150–250 °C** range - classified as medium-enthalpy - align with findings from the GEOSYN project and present viable opportunities for direct-heat applications, including integration into various industrial processes. These applications support GEOSYN's broader objective of advancing the renewable energy transition within the industrial sector. Medium-enthalpy geothermal energy also shows strong potential for direct-use systems or hybrid configurations involving heating and cooling systems.

Modern industrial decarbonization pathways are increasingly adopting high temperature heat pumps (HTHPs) capable of delivering process heat up to **250 °C**. The advanced HTHP systems proposed by GEOSYN enable the upgrading of low-grade waste heat and geothermal sources into high temperature thermal energy, making them suitable for demanding industrial applications, such as sterilization, drying, evaporation, and distillation. These systems can significantly reduce dependence on fossil-fuel boilers and contribute to substantial reductions in carbon emissions.

As part of the effort to identify potential industrial applications for the GEOSYN solution, detailed production processes and their corresponding temperature ranges were analyzed.

Industrial process cooling is a vital component for maintaining efficiency, precision, and safety across a wide range of sectors, including food & breweries, dairy, chemical processing, and information technology. As industries continue to grow and evolve, the demand for reliable and efficient cooling solutions has intensified, making them essential for optimizing operational performance and extending the lifespan of industrial machinery[28].

[28]https://www.researchgate.net/publication/386553622_Industrial_Cooling_Systems_a_Comprehensive_Review_of_Technologies_Challenges_and_Future_Directions

Funded by the European Union

Based on this analysis, the following high heat & cooling demand sectors were prioritized, although low-temperature heat use industries were also considered (Table 4).

Table 4 Identified potential industrial applications for the GEOSYN technology.

Sector / Type	Industrial Processes	Cooling Temperature Range (°C)	Heat Process Temperature Range (°C)	Heat carrier used	Heat Demand, TWh	Savings Potential via Heat Pumps, TWh/year	References
Chemical & Petrochemical	Distillation, reactor heating, evaporation, polymerization reactions, soap production, synthetic rubber, catalytic reactions	10–40 °C	150–250 °C	Water/Steam	328.8	119	Source[29] [30]
	Compression		110–170 °C	Water, Thermal oil			
Iron & Steel	Preheating, annealing, drying, washing		180–250 °C (some higher)	Water, Steam	289.2		Source[31]
Non-metallic minerals	Drying, calcining, curing (e.g. gypsum), glass production		150–250 °C	Air, Steam	279.4	43	Source[32]
Cement	Raw meal drying, Pre-heating of feedstock		200–250 °C	Hot air, Steam	–		Source[33] [34]
Ceramics	Glazing, kiln flue recovery, drying		150–250 °C	Air, Steam	–	–	Source[35] [36]

[29] C. Arpagaus, F. Bless, M. Uhlmann, J. Schiffmann, S. Bertsch
High temperature heat pumps: Market overview, state of the art, research status, refrigerants, and application potentials
Energy, 152 (2018), pp. 985-1010, 10.1016/j.energy.2018.03.166. Available online:
https://www.sciencedirect.com/science/article/abs/pii/S0360544218305759

[30] https://www.researchgate.net/figure/Typical-temperature-levels-of-common-industrial-processes-and-the-limitations-of_fig1_303863369

[31] https://www.gigkarasek.com/blog/waste-heat-utilization-blog01

[32] https://www.researchgate.net/publication/380190517_Industrial_Waste_Heat_Utilization_in_the_European_Union-An_Engineering-Centric_Review

[33] Potential savings in the cement industry using waste heat recovery technologies
https://www.sciencedirect.com/science/article/pii/S0360544223012045?

[34] Technological Energy Efficiency Improvements in Cement Industries https://www.mdpi.com/2071-1050/13/7/3810?

[35] Industrial Waste Heat Utilization in the European Union—An Engineering-Centric Review
https://www.researchgate.net/publication/380190517_Industrial_Waste_Heat_Utilization_in_the_European_Union-An_Engineering-Centric_Review

[36] https://en.wikipedia.org/wiki/Ceramic_engineering

Food & Beverages (F&B)	Various – see breakdown below	0–15 °C (refrigeration/ cooling)	100–250 °C	Water, Glycol, Air	208.4	123	Source[34] [37] [38]
Dairy	Milk pasteurization, ricotta making sterilization, drying		90–180 °C	Water, Steam	–	–	Source[39]
	Milk cooling	+2 °C to +4 °C		Glycol, Water			Source[40]
	Cold storage (refrigeration)	0 °C to +5 °C		Glycol, Ammonia			
Meat & Poultry	Cooking, smoking, rendering		100–200 °C	Water, Steam	–	–	Source[41]
	Meat processing and storage	0 °C to +2 °C		Ammonia, Glycol			
Bakery & Confectionery	Baking, frying, chocolate tempering		150–250 °C	Steam, Air	–	–	Source[42]
Breweries	Wort boiling		80–160 °C	Water, Glycol	–	–	Source[43]
	Fermentation control (breweries, wineries)	+5 °C to +15 °C		Water, Glycol			
Beverages (non-alcoholic)	Pasteurization, CIP (clean-in-place), carbonation	4–6 °C.	70–150 °C	Water, Glycol	–	–	Source[44]
	Beverage cooling before packaging	+1 °C to +5 °C		Water, Glycol			
Fruits & Vegetables	Blanching, canning, drying		100–180 °C	Water, Air	–	–	Source[45]
	Pre-cooling & Cold Storage	0–5 °C					
Sugar & Starch	Evaporation, crystallization		120–200 °C	Water, Steam	–	–	Source[46]

[37] C. Arpagaus, F. Bless, M. Uhlmann, J. Schiffmann, S. Bertsch
High temperature heat pumps: Market overview, state of the art, research status, refrigerants, and application potentials
Energy, 152 (2018), pp. 985-1010, 10.1016/j.energy.2018.03.166. Available online:
https://www.sciencedirect.com/science/article/abs/pii/S0360544218305759

[38] https://www.researchgate.net/figure/Typical-processes-and-temperature-ranges-in-the-F-B-industry-8_fig1_319951196

[39] Datta et al. (2017), "Food Processing Technology" Heldman & Hartel (2013), "Food Science and Technology"

[40] https://esource.bizenergyadvisor.com/article/dairy-farms

[41] Toldrá (2010), "Handbook of Meat Processing" Sun (2016), "Meat Processing and Quality"

[42] Pyler & Gorton (2008), "Baking Science & Technology" Beckett (2008), "Industrial Chocolate Manufacture and Use"

[43] https://www.anugafoodtec.com/

[44] Cemeroglu (2017), "Food Microbiology and Hygiene" Farid & Lees (2017), "Beverage Processing"

[45] Fellows (2016), "Food Processing Technology", Lewicki (2008), "Drying of Fruits and Vegetables"

[46] Loisel et al. (2012), "Sugar Processing and Refining", Singh (2011), "Starch: Chemistry and Technology"

Funded by the European Union

Oils & Fats	Refining, deodorization		150–250 °C	Steam, Water	–	–	Source[47]
Fish & Seafood	Steaming, drying, canning		100–180 °C	Water, Glycol	–	–	Source[48]
Pet Food	Extrusion, drying, sterilization		120–200 °C	Water, Steam	–	–	Source[49]
Pulp & Paper	Drying		90–240 °C	Water, Steam	106.3	230	Source[50] [51]
	Bleaching		150–160 °C	Water, Steam			
	Boiling		150–190 °C	Water, Steam			
Transport Equipment	Paint curing, surface cleaning		150–200 °C	Water, Air	28.7	–	Source[52]
Textiles & Leather	Dyeing, drying, pressing		150–200 °C	Water, Steam	22.2	–	Source[53]
Wood	Kiln drying, veneer pressing		150–200 °C	Air, Steam	3.7	–	Source[54]
Data centres (DC)	Server cooling, IT infrastructure	18–27 °C (air) / 15–20 °C (liquid)	-	Chilled water, Air, Glycol			Source [55]

4.2 Waste Heat Utilization and Recovery Strategies

Industries that consistently produce large amounts of waste heat are especially well-suited for the economical implementation of industrial heat pumps. Sectors, such as steel, paper, food, and chemicals fall into this category. Deploying GEOSYN solution in these industries has the potential to meet a significant portion of their process heat requirements in an environmentally sustainable manner, while also offering notable competitive benefits.

Among these, the food, paper, and chemical sectors stand out with particularly strong potential, as shown in Figure 17. In the diagram, positive values indicate the quantity of recoverable waste

[47] Gunstone (2011), "Vegetable Oils in Food Technology" , Akoh & Min (2008), "Food Lipids: Chemistry, Nutrition and Biotechnology"
[48] Olafsdóttir et al. (2006), "Fish Drying and Smoking", Eyo (2001), "Fish Processing Technology"
[49] Owen & Phalen (2017), "Pet Food Processing Technology", Buff et al. (2014), "Pet Food Science and Technology"
[50] Maruf, M.N.I.; Morales-España, G.; Sijm, J.; Helistö, N.; Kiviluoma, J. Classification, potential role, and modeling of power-to-heat and thermal energy storage in energy systems: A review. Sustain. Energy Technol. Assess. 2022, 53 Pt B, 102553.
[51] Arpagaus, C.; Blessa, F.; Uhlmanna, M.; Schiffmann, J.; Bertsch, S.S. High temperature heat pumps: Market overview, state of the art, research status, refrigerants, and application potentials. Energy 2018, 152, 985–1010. https://doi.org/10.1016/j.energy.2018.03.166
[52] IEA (2020), "Industrial Heat Pumps Technology Brief"
[53] Heldman & Hartel (2013), "Food Science and Technology" (for process heat ranges)
[54] Zabiegała et al. (2019), "Wood Processing Technologies"
[55] https://www.itsupportsingapore.sg/data-centre-cooling-systems/

heat, whereas negative values reflect the corresponding demand for process heat[56]. The arrows below highlight the temperature increase achievable through the use of heat pumps[57].

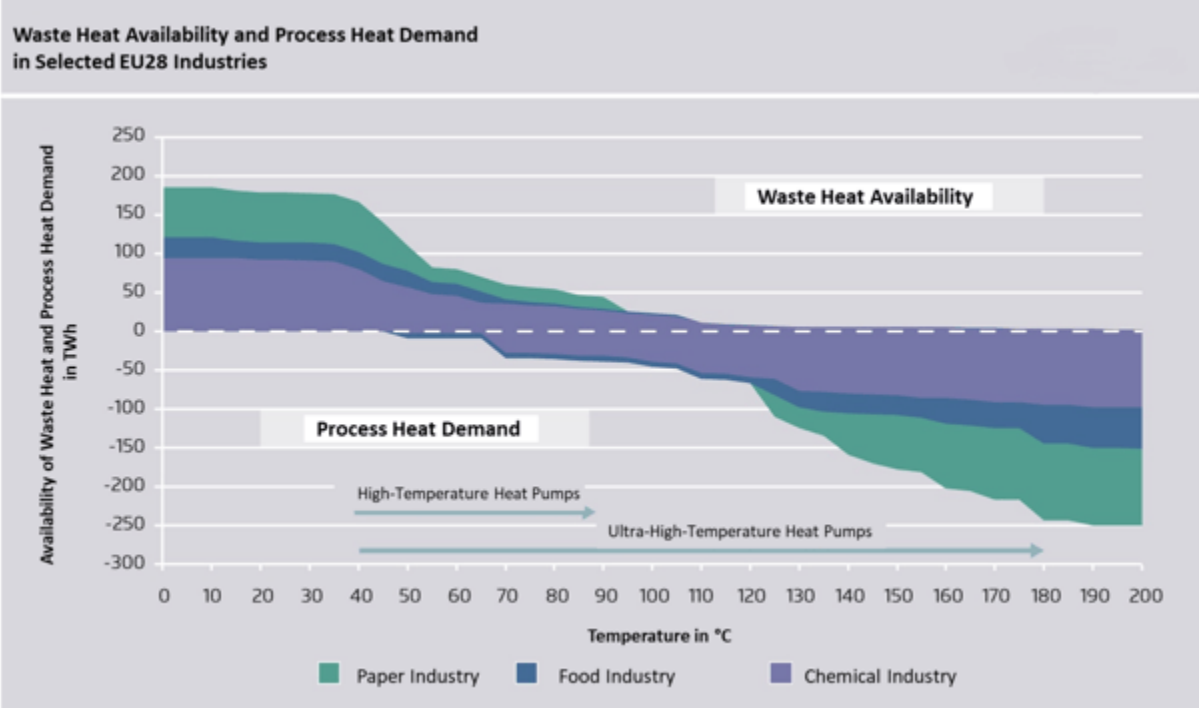

Figure 17 Availability of waste heat and process heat demand in selected sectors across the EU28 in 2021[58].

Currently, the reuse of industrial waste heat is primarily based on the cascade approach, for which high temperature waste heat is progressively applied to processes with lower temperature needs. Despite this, a considerable amount of waste heat still remains at the end of the industrial lifecycle process, typically at temperatures too low to be directly reused within the facility.

GEOSYN technology could provide an efficient means of tapping into these low-temperature waste heat sources by elevating their temperature, enabling their return to industrial operations - for instance, in the form of process steam.

[56] Marina et al. (2021): An Estimation of the European Industrial Heat Pump Market Potential. Renewable and Sustainable Energy Reviews 139, 110545. https://doi.org/10.1016/j.rser.2020.110545
[57] Agora Industrie, FutureCamp (2022). Power-2-Heat: Gas savings and emissions reduction in industry. Agora-industrie.de. https://www.agora-industry.org/publications/power-2-heat-1
[58] https://www.gigkarasek.com/blog/waste-heat-utilization-blog01

Funded by the European Union

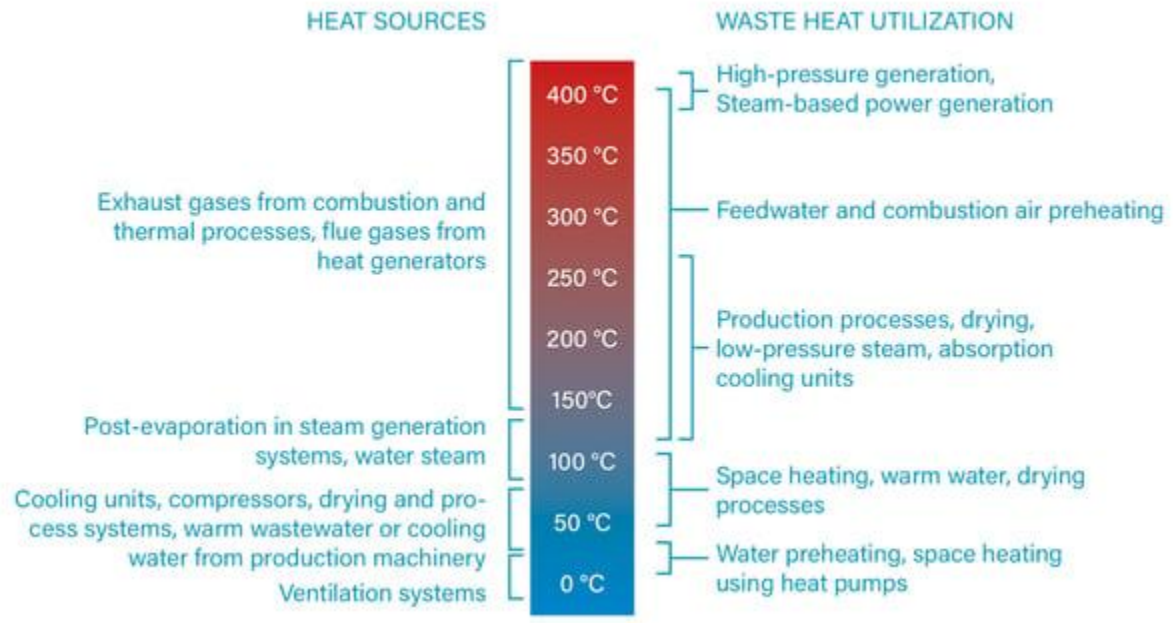

Figure 18 Examples of potential reuse of waste heat generated from various process with respect to the temperature[59].

European industry holds considerable unused thermal energy reserves. Recent research highlights a significant potential for waste heat recovery, which could play a key role in advancing the energy transition (REFERENCE).

The EU's total technical annual waste heat potential is estimated to be around **920 TWh**, with approximately **300 TWh** deemed economically viable. This amount could cover about **40 %** of industrial process heat needs at temperatures below **200 °C** (see Figure 6), or roughly **10 %** of the heating demand in European residential buildings.

Thanks to advances in heat pump and waste heat recovery technologies, these thermal resources can now be utilized in a way that is both environmentally sustainable and economically beneficial.

Modern industrial heat pumps are now capable of reaching temperatures as more than **100 °C**, significantly expanding their potential applications in process heat supply. However, despite these technological strides, their adoption across industry remains relatively low. Still, their impact could be considerable - heat pumps have the capacity to meet up to **37 %** of Europe's industrial process heat demand, offering major opportunities for cutting GHG emissions[60] (Table 5).

[59] https://www.gigkarasek.com/blog/waste-heat-utilization-blog01
[60] Ko B, Cerutti A, Duerr M, Iancu A, Kona A, Janssens-Maenhout G. JRC Technical Reports: Covenant of Mayors for Climate and Energy: Default emission factors for local emission inventories. 2017. https://doi.org/10.2760/290197.

Funded by the European Union

Table 5 Potential of industrial heat pumps to meet process heat demand through waste heat utilization[61].

Temperature range	Application examples	Potential process heat	Share of EU demand	GHG emission savings/year
≤ 100 ℃	Warm water, space heating, low-temperature processes	222 TWh/a	11 %	51 million tons of GHG emissions
100-200 ℃	Process steam, high-temperature processes	508 TWh/a	26 %	95 million tons of GHG emissions
Total		**730 TWh/a**	**37 %**	**146 million tons of GHG emissions**

4.3 Industries Candidates Mapping

As part of the process to identify potential industrial applications, real industries candidates were mapped across the **15** EU and associated countries to integrate GEOSYN technology to cover their heating and cooling needs. In total, **200** industry players were identified (Appendix E), primarily from GEOSYN project partner countries - Denmark, France, Italy, Norway, and Ukraine. Additional companies were mapped in Austria, Croatia, the Czech Republic, Finland, Germany, Poland, Portugal, Romania, Spain, and Sweden (Figure 19).

The majority of identified stakeholders are located in Italy and Ukraine. Within the GEOSYN project, dedicated activities are planned in these countries to engage the public and policymakers through info-sessions and workshops (WP5), followed by the development of policy recommendations for the implementation of geothermal solutions. As a result, direct feedback is crucial important.

[61] https://www.gigkarasek.com/blog/waste-heat-utilization-blog01

Funded by the European Union

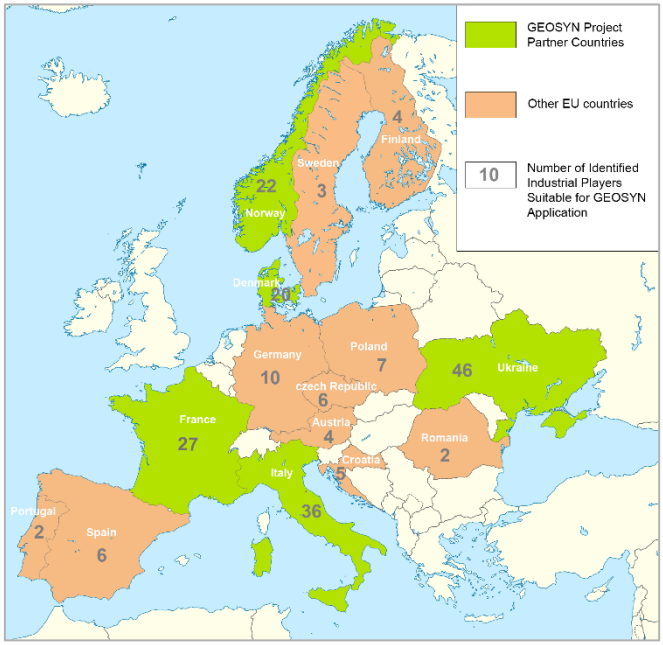

Figure 19 Mapped industrial applications for GEOSYN solutions in partner and other EU countries (developed by authors).

The mapped stakeholders span **13** industrial sectors (Figure 20), along with data centers and supermarkets. Priority was given to entities with high energy consumption and significant demand for high-temperature heating or process cooling, aligning with the capabilities of GEOSYN heat pump technology. Enterprises of all sizes—small, medium, and large—were represented among the mapped industries.

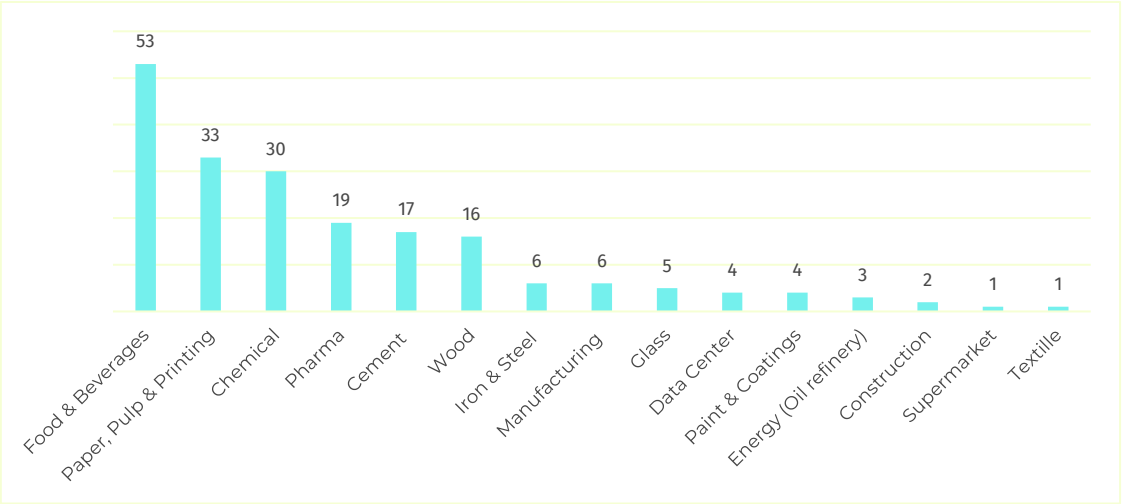

Figure 20 Distribution of mapped stakeholders by industrial sector (developed by authors).

In addition, 49 key national and international industry associations within the GEOSYN partner countries have been identified as key stakeholders in advancing industrial decarbonization strategies. These organizations play a central role in facilitating information exchange,

influencing policy development, and guiding best practices across various sectors. A detailed list of these associations is provided in Appendix F.

Leveraging these associations as dissemination channels significantly broadens the project's outreach, enabling communication with a wide range of industrial actors. This approach not only enhances visibility of the GEOSYN project but also promotes greater awareness and understanding of the sustainable geothermal HTHP and cooling solutions being proposed. Engaging these networks is essential to encourage adoption of clean technologies in production processes and support the transition toward a low-carbon industrial future.

5 Industry Interviews

As part of the GEOSYN project, interviews were conducted with 50 industrial companies that could potentially apply geothermal technologies, including the proposed GEOSYN solution. The objective was to gather their perceptions of geothermal energy and assess their interest in participating in future project activities.

The industries were selected according to the criteria described in Chapter 2.2 and represent companies from Norway, Denmark, Italy, France, Ukraine, Portugal, Croatia, Austria, and Finland.

Following the interview structure outlined in Appendix C, the results are presented below:

General Company Information

The surveyed companies vary widely in terms of workforce size and production area. Key observations include:

- **Average Employees per Facility:** Typically ranges from small sites with 15–20 employees to large facilities employing over 1,500 staff.
- **Average Production Area:** Facilities also vary in size, from small production areas of 120–1,500 m² to large industrial sites spanning several hectares
- **Core Activities & Products:**
    - **Cement** – Production and distribution of cement, clinker, and ready-mix concrete.
    - **Glass** – Manufacturing of premium glass bottles, decorative finishes, and industrial glass products.
    - **Chemical** – Manufacture of specialty chemicals, surfactants, garden care products, coatings, paints, surface treatments, and specialty materials.
    - **Paper & Pulp** – Production of various paper grades, sustainable paper products, pulp, cardboard, corrugated packaging, sanitary paper, and fiber-based alternatives to plastic.
    - **Pharmaceuticals** – Production of medicines, insulin, biopharmaceuticals, and raw materials for pharma products.
    - **Dairy & Ice Cream** – Production of milk, cheeses, dairy products, and frozen desserts.
    - **Food** – Enzyme production, sugar manufacturing, gluten-free bakery products, fish meal & marine oils, and meat processing.
    - **Energy & Petrochemicals** – Petroleum, natural gas, petrochemicals, renewable energy solutions, polyolefins, and base chemicals.
    - **Wood** – Renewable packaging materials, biomaterials, and wood-based construction products.
    - **Brewery** – Beer production.
    - **Data Center** – Colocation, hosting, and IT infrastructure management services.
    - **Manufacturing** – Production of customizable decorative tiles (zellige, terrazzo, terracotta, cement).

Funded by the European Union

Energy Profile & Industrial Processes

- **Key Industrial Processes:** Heating and cooling requirements across a broad temperature range (30°C to 250°C), using heat carriers such as steam, hot water, and chilled water.
- **Heating & Cooling Needs:**
    - Heating: up to 20 MW, pressure ranges from atmospheric to 10 bar
    - Cooling: often involve chilled water or brine in the 0–15 °C range.
- **Heat Carriers:** Steam, hot water, air, electric heating, infrared, and in some cases geothermal steam.
- **Cascade Utilization Potential:** 42 % of facilities reported possible cascade use of heating and cooling. High potential cases include chemical reactors, glass furnaces, large steam-driven processes, and facilities with simultaneous heating and cooling requirements. Medium potential cases are typically smaller-scale facilities, batch processes, or operations with narrow temperature differentials.
- **Main Energy Sources** (Figure 21):

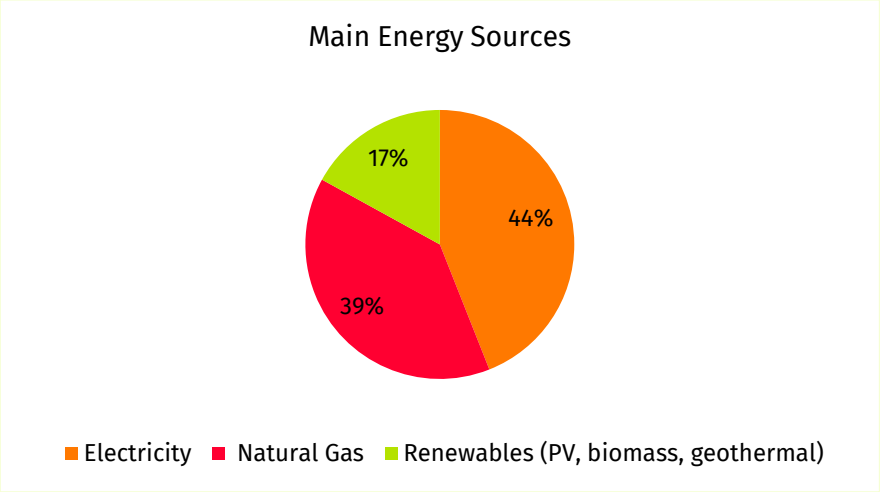

Figure 21 Share of primary energy sources in the interviewed industries.

Geothermal Energy Potential

The majority of the interviewed industries were strategically selected from locations with promising geothermal potential. Industries situated in regions with suitable geothermal resources are more likely to successfully integrate geothermal energy, enhancing both economic and operational feasibility.

To assess geothermal potential for these industries, publicly available sources were used, including:

- Denmark - GEUS portal[62]
- France - French geothermal resources survey, BRGM contribution to the market study in the LOW-BIN project[63]
- Italy – GeoThopica 2.0 geothermal data portal[64]
- Norway - Geothermal Energy in Norway and Hordaland[65]
- Ukraine - Atlas of the energy potential of renewable energy sources of Ukraine[66]
- Portugal - Portuguese Geothermal Resources Catalog[67]
- Croatia - Interactive Geothermal Potential Map[68]
- Austria - Geothermal Atlas[69]
- Finland – Geothermal Energy in Finland[70]

Only 7 % had previously considered or implemented geothermal technologies.

GEOSYN Heat Pump Solution & Future Considerations

To better understand the current awareness and potential adoption of geothermal heat pump technologies within industrial sectors, a set of targeted questions was designed to assess three key aspects: (1) familiarity with geothermal energy solutions, (2) previous experience with or consideration of such technologies, and (3) the willingness to explore GEOSYN's proposed solution in future projects, as illustrated in Figures 22–24.

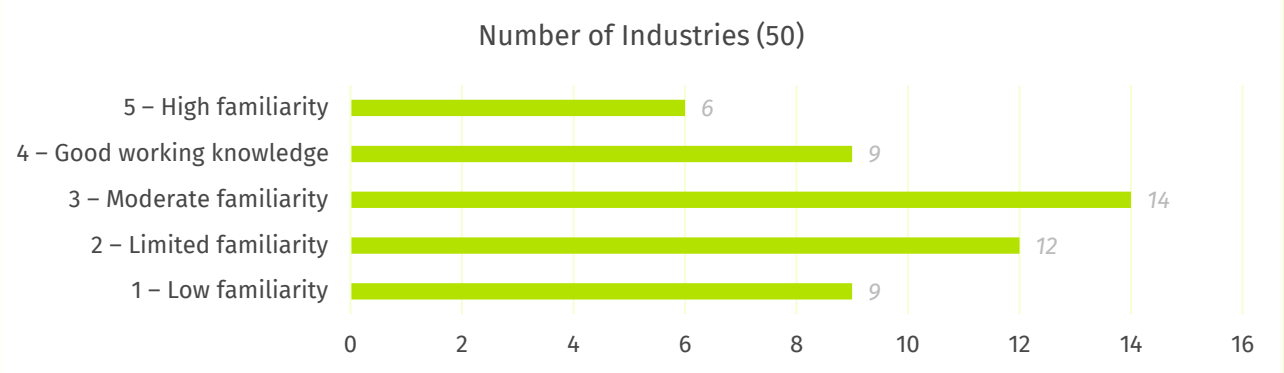

Figure 22 Number of interviewed industries being familiar with geothermal energy solutions (familiarity from 1 to 5).

[62] https://data.geus.dk/geoterm/
[63] https://inis.iaea.org/collection/NCLCollectionStore/_Public/49/062/49062839.pdf
[64] https://geothopica.igg.cnr.it/index.php/it/
[65] https://www.uib.no/sites/w3.uib.no/files/attachments/kirstimidttomme_pres.pdf
[66] https://www.ive.org.ua/wp-content/uploads/atlas.pdf
[67] https://geoportal.lneg.pt/en/databases/geothermal_resources/#!/intro
[68] https://gis.azu.hr/portal/apps/experiencebuilder/experience/?id=eb8ff05af11340d88195dd04fe2d5e7b
[69] https://geothermieatlas.geosphere.at/
[70] https://www.egt.ee/sites/default/files/documents/2022-06/4%20-%20Geothermal%20energy%20in%20Finland.pdf

Funded by the European Union

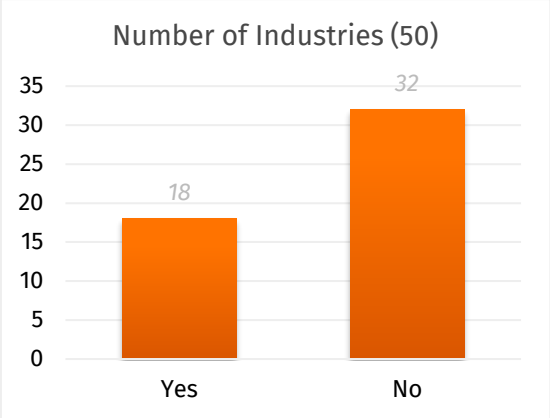

Figure 23 Previously considered/implemented geothermal technologies.

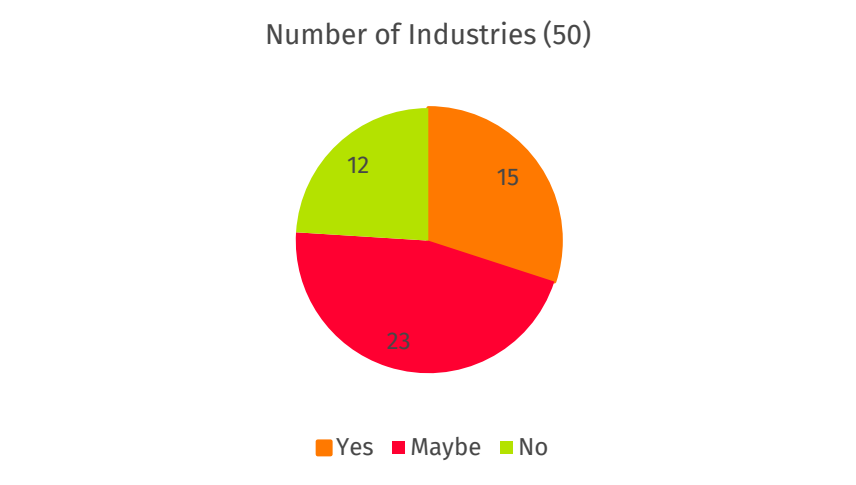

Figure 24 Willingness to explore a GEOSYN solution.

From the interviews, several key factors emerged that would influence an industry's decision to invest in a geothermal-based heating and cooling system. The most frequently mentioned considerations were (Figure 25):

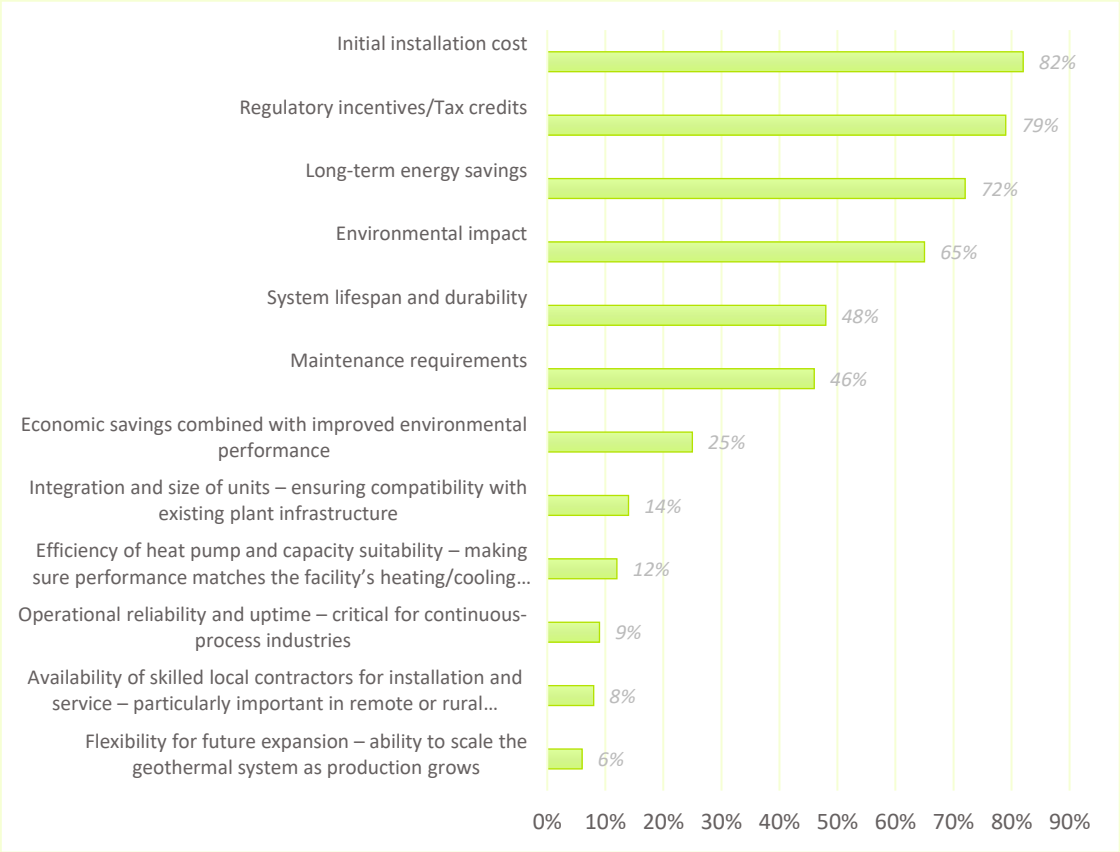

Figure 25 Key factors Influencing investment decisions in geothermal-based heating & cooling systems.

The interviews provided valuable insights into the current level of awareness, readiness, and perceived barriers regarding the adoption of geothermal-based heating and cooling systems in the industrial sector.

Awareness and familiarity remain limited – although many companies are located in regions with significant geothermal potential, most have never previously considered or implemented geothermal technologies.

Interest increases when specific solutions are presented – although the overall implementation rate is low, and general interest remains modest, a notable proportion of respondents indicated openness to exploring the GEOSYN solution.

Investment decisions are driven by both economic and non-economic factors – initial installation cost and long-term energy savings dominate decision-making, but environmental impact, regulatory incentives, and system reliability are also important. Additional operational considerations such as compatibility with existing infrastructure, heat pump efficiency, and availability of skilled contractors could influence the success of geothermal integration.

Funded by the European Union

In summary, while geothermal adoption in industry is still at an early stage, the combination of technical feasibility, economic incentives, and tailored solutions, such as the ones demonstrated within GEOSYN, could accelerate uptake in strategically selected regions. This presents a strong opportunity for targeted demonstration projects to build trust, reduce perceived risks, and showcase tangible benefits.

6 Additional Case Study Selection Outcome

To further demonstrate the benefits from the GEOSYN concept, five virtual case studies were selected from the interviewed industries. These case studies were used to evaluate operational flexibility strategies (e.g., start-up and ramp-up scenarios) of the GEOSYN solution, as if it were implemented in the selected virtual industrial plants.

The additional case studies were drawn from different industrial sectors, facility sizes, and process input parameters, covering a wide range of conditions to demonstrate the scalability of the GEOSYN solution. They represent industries from Italy, Ukraine, Croatia, and France (Table 6).

Based on the input parameters provided by the industries, the study will include a comprehensive analysis of the process heating requirements of each plant and evaluate the potential integration of a HTHP into the existing system. A validated system model of the GEOSYN heat pump/chiller will be employed to assess its capacity to meet the thermal demands of the selected plants. Additionally, a simulation model will be developed to evaluate the integration of the HTHP within the industrial process, using minimal plant data.

The performance of the proposed HTHP system will be benchmarked against the currently used heating technologies with respect to:

- Efficiency (COP)
- Environmental Impact (Carbon Emissions)
- Operating Costs

The operating cost evaluation will also consider dynamic electricity pricing specific to each plant's location, thereby identifying opportunities to optimize heat pump operation.

It should be noted that, due to NDAs signed with the participating industries, company names remain confidential. Only general information has been included in the case study descriptions.

Funded by the European Union

Table 6 Overview of Selected Virtual Case Studies.

Item	Case Study I	Case Study II	Case Study III	Case Study IV	Case Study V
Country	Italy	Ukraine	France	Croatia	Ukraine
Industry Sector	Geothermal Brewery	Paper	Cement	Food	Dairy
Core Activities	Beer production, brewpub, restaurant	Production of corrugated cardboard from waste paper	Manufacture of hydraulic binders from clays	Meat production	The use of steam is essential for pasteurization processes, while cooling is required for the incoming raw materials and during the pasteurization itself.
Size of the production area	120 m^2	20 ha	5.000 m^2	80.000 m^2	
Number of employees	15	500	20	1740	500
Process temperature range	Cooling: 0 °C-0.5 °C is the temperature generated by the current compression refrigeration units, to: • Keep fermenters at 20°C for 15 days • Reduce the fermenter temperature of 4 °C/day in a second step and up to 4 °C • Keep the most at 4 °C for 20 days, in a third step Keep the cold storage room at 21°C all over the year	180 °C	200-250 °C	45-83°C; desired temperature increase range – 170°C	184 °C; Condensate return temperature to the boiler: 85-90°C; Cooling temperature: 1-3°C
Heat carrier	Steam	Steam	Air flow	Steam	Steam
Heating and cooling needs	**Heating demand:** 18.178,2 KWh (fully covered by geothermal steam) **Cooling demand:** > 17.800 kWh/y of electricity, for the whole beer production process and for the	**Steam demand:** 3 tons/hour and 12 tons/hour	150°C per hour **Heating demand:** 4MW	**Heating:** Water temperature: 45 C, 83 C Steam – pressure 7 bar Steam generators (gas) – 19 MW (total – in 3 devices)	Steam is used in the production in the amount of 1,5 to 5 t/hour with pressure 10 bar (184 C). Heeting needs: Thermal capacity of the existing boilers – 13,1 MW

Funded by the European Union

	brewpub. The refrigeration unit capacity is 10 kW.			Heat exchange : steam-water **Cooling**: Total capacity: around 12 MW NH3: -42 C, Glycol: -7 C Heat exchange: NH3 – prpoylene glycol, NH3 – ethylene glycol, NH3 – air, glycol – air	Cooling needs: Existing cooling capacity of refrigeration units – 4 MW Energy needs for heating: 627 Watts of heat per 1 kg of products , 544 watts electric energy per 1 kg of products . Energy needs for cooling: 2 million kWh of electricity per year .
Possibility to use heating and cooling in cascade	Yes	No	No - Already used to dry the inputs clays	Yes	Yes
Main energy sources currently used in your facility	HT geothermal heat, grid electricity, photovoltaic	Natural gas	Natural gas	Gas and electrical power	Natural gas and electricity
Other comments	Consider to cover energy demand which is very high for cooling and currently covered with an electricity powered compressor chiller		The process described here is the drying of incoming material using a ventilated air flow	Availability of waste heat - Yes	Availability of waste heat: Yes (from the cooling of condensers of refrigeration machines (temperature range 45–35°C) and from the cooling tower system used for condenser cooling (temperature range 32–25°C). Heat capacity of waste/low-potential heat: 4 MW.

Funded by the European Union

7 Conclusions

Deliverable D1.1 confirms the significant potential for integrating GEOSYN geothermal and HTHP solutions into European industry, particularly in low- and medium-temperature applications and in processes with a high above 0°C cooling demand.

The study demonstrates that industrial demand for renewable heat is substantial and growing. More than one-third of industrial heat demand can be served by technologies operating below 200 °C, providing a strong case for heat pumps and geothermal integration.

Sectoral opportunities are diverse. Food, paper, cement, chemicals, and pharmaceuticals stand out as priority sectors, where heating and cooling needs align closely with GEOSYN's technical capabilities.

Stakeholder engagement is crucial. While awareness of geothermal solutions remains limited, including for the cooling production, structured engagement revealed clear interest in exploring GEOSYN's potential—especially when specific operational and economic benefits were presented.

Case studies provide a scalable pathway. The five additional industrial case studies selected under D1.1 represent different countries, facility sizes, and process profiles, ensuring a balanced validation of GEOSYN technology under varied conditions.

By combining industrial mapping, stakeholder outreach, and technical modelling, GEOSYN establishes a replicable approach that can be scaled across multiple European regions and sectors.

In conclusion, GEOSYN is well positioned to play a pivotal role in Europe's industrial energy transition. The findings of D1.1 provide a strong evidence base for the project's next phases—demonstrating real-world applications, validating operational flexibility, and preparing replication strategies that can significantly accelerate decarbonisation in European industry.

8 Appendixes

Appendix A

Template for Request Letter: Collaboration and Data Provision for Stakeholder Mapping

Date

Letter

Subject: *Request for Collaboration and Data Contribution for Stakeholder Mapping – GEOSYN Project*

Dear Colleagues,

On behalf of **Geothermal Ukraine**, we are reaching out to you in connection with the EU-funded Horizon Europe **GEOSYN project** - *Geothermal Synergy: Enhancing Industrial Energy Efficiency Through Steam High-Temperature Heat Pumps And Heat-Powered Cooling Systems With Operational Flexibility And Public Trust* (ID: 101172812). This initiative is focused on validating an innovative geothermal steam heat pump system integrated with heat-powered refrigeration for industrial applications. Specifically, it aims to address the cascading use of heat from both deep and shallow rock formations, offering an environmentally sustainable solution for heating and cooling needs.

About the GEOSYN Project

The GEOSYN project brings together 10 partners from 5 EU countries - Italy (APRE, UNIFI, COSVIG, RIVACOLD, S.M.F.), Norway (SINTEF), Denmark (SDU), Ukraine (Geothermal Ukraine) and France (NEO-ECO). Our goal is to develop a steam heat pump combined with a heat-powered refrigeration cycle, utilizing water as a natural refrigerant, to maximize the cascading use of geothermal energy. This technology is designed to serve industries with temperature needs in the **150°C** to **250°C** range, including sectors such as food and beverages, cement, chemicals, textiles, etc. The solution incorporates high-temperature underground thermal energy storage (**50–150°C**), utilizing both closed-loop and open-bedrock systems, offering operational flexibility. It aims to transition industrial sectors from reliance on fossil fuels to renewable geothermal energy, enhancing energy efficiency, affordability, sustainability, and security.

Stakeholder Mapping and Data Contribution Request

As part of the GEOSYN project, we are conducting a ***Stakeholder Mapping*** to identify key industries suitable for integrating GEOSYN technology. This process will help ensure that our solutions are tailored to real-world needs. To support this, we are collecting valuable data, including temperature ranges, volumes, and the feasibility of upgrading waste heat to higher temperatures for industrial applications.

Given your expertise and strategic role within the *country's* industrial landscape, we kindly request your assistance in sharing relevant data, as outlined in **Annex 1**. Your contribution will be critical to ensuring the accuracy and comprehensiveness of the stakeholder map. Please be assured that any data shared will be handled with the highest level of confidentiality and used exclusively for the purposes of the GEOSYN project. If necessary, we are more than willing to sign a Non-Disclosure Agreement (NDA) to formalize our commitment to safeguarding your sensitive information.

Should you have any questions or require additional details about the project or the data request, please do not hesitate to contact us. We sincerely appreciate your consideration and hope for your valuable contribution to this important initiative. Thank you for your time and collaboration!

Sincerely,
Geothermal Ukraine Team
On behalf of GEOSYN project Consortia
info@geothermalukraine.org

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 European Commission. Neither the European Union nor the granting authority can be held responsible for them.

www.geosynproject.eu #GEOSYNPROJECT
info@geosynproject.eu

Funded by the European Union

Annex 1

Survey - Stakeholder mapping in *Country*

NAME	*COMPANY*
COUNTRY	
INDUSTRY SECTOR	
INDUSTRIAL PROCESSES	
HEAT CARRIER (steam, water, air, other - specify)	
PROCESS TEMPERATURE RANGE, °C	
HEATING AND COOLING NEEDS (Temperature, pressure, mass flow rate, kW)	
POSSIBILITY TO USE HEATING AND COOLING IN CASCADE	
GEOTHERMAL POTENTIAL:	
Temperature, (BHT/WHT) °C	
Depth, m	
Reservoir/geological conditions	
FINANCIAL PART (cost of electricity, cost of heating, cost of cooling)	
DISTANCE TO THE END USER, m	
ALREADY USE RENEWABLES? WHICH KIND?	
CONTACTS	

We kindly request that you complete the table in Annex 1 and return it to us via email at info@geothermalukraine.org by *Date*.

Alternatively, you can easily fill Survey out **online** using the following Google Forms Link.

Thank you for your support and cooperation!

www.geosynproject.eu #GEOSYNPROJECT
info@geosynproject.eu
Funded by the European Union

Appendix B

Template Letter to International and National Industry Organizations and Associations Requesting Support in Disseminating the Stakeholder Invitation

Date

Letter

Subject: *Request for Collaboration and Data Contribution for Stakeholder Mapping – GEOSYN Project*

Dear Colleagues,

On behalf of **Geothermal Ukraine**, we are reaching out to you in connection with the EU-funded Horizon Europe **GEOSYN project** - *Geothermal Synergy: Enhancing Industrial Energy Efficiency Through Steam High-Temperature Heat Pumps And Heat-Powered Cooling Systems With Operational Flexibility And Public Trust* (ID: 101172812). This initiative is focused on validating an innovative geothermal steam heat pump system integrated with heat-powered refrigeration for industrial applications. Specifically, it aims to address the cascading use of heat from both deep and shallow rock formations, offering an environmentally sustainable solution for heating and cooling needs.

About the GEOSYN Project

The GEOSYN project brings together 10 partners from 5 EU countries - Italy (APRE, UNIFI, COSVIG, RIVACOLD, S.M.F.), Norway (SINTEF), Denmark (SDU), Ukraine (GEOTHERMAL UKRAINE) and France (NEO-ECO). Our goal is to develop a steam heat pump combined with a heat-powered refrigeration cycle, utilizing water as a natural refrigerant, to maximize the cascading use of geothermal energy. This technology is designed to serve industries with temperature needs in the 150°C to 250°C range, including sectors such as food and beverages, cement, chemicals, textiles, etc. The solution incorporates high-temperature underground thermal energy storage (50–150°C), utilizing both closed-loop and open-bedrock systems, offering operational flexibility. It aims to transition industrial sectors from reliance on fossil fuels to renewable geothermal energy, enhancing energy efficiency, affordability, sustainability, and security.

Stakeholder Mapping and Data Contribution Request

As part of the GEOSYN project, we are conducting a ***Stakeholder Mapping*** to identify key companies among *type of industry sector* suitable for integrating GEOSYN technology. This process will help ensure that our solutions are tailored to real-world needs. To support this, we are collecting valuable data, including temperature ranges, volumes, and the feasibility of upgrading waste heat to higher temperatures for industrial applications **Annex 1**.

We would greatly appreciate it if you could distribute this request to the wider network of companies within *Organization Name*. Your contribution will play a pivotal role in ensuring that the stakeholder map is both accurate and comprehensive. Please be assured that any data shared will be handled with the highest level of confidentiality and used exclusively for the purposes of the GEOSYN project. If necessary, we are more than willing to sign a Non-Disclosure Agreement (NDA) to formalize our commitment to safeguarding your sensitive information.

Should you have any questions or require additional details about the project or the data request, please do not hesitate to contact us. We sincerely appreciate your consideration and hope for your valuable contribution to this important initiative. Thank you for your time and collaboration!

Sincerely,
Geothermal Ukraine Team
On behalf of GEOSYN project Consortia
info@geothermalukraine.org

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 European Commission. Neither the European Union nor the granting authority can be held responsible for them.

Annex 1

Survey - Stakeholder mapping in *Country*

NAME	*COMPANY*
COUNTRY	
INDUSTRY SECTOR	
INDUSTRIAL PROCESSES	
HEAT CARRIER (steam, water, air, other - specify)	
PROCESS TEMPERATURE RANGE, °C	
HEATING AND COOLING NEEDS (Temperature, pressure, mass flow rate, kW)	
POSSIBILITY TO USE HEATING AND COOLING IN CASCADE	
GEOTHERMAL POTENTIAL:	
Temperature, (BHT/WHT) °C	
Depth, m	
Reservoir/geological conditions	
FINANCIAL PART (cost of electricity, cost of heating, cost of cooling)	
DISTANCE TO THE END USER, m	
ALREADY USE RENEWABLES? WHICH KIND?	
CONTACTS	

We kindly request that you complete the table in Annex 1 and return it to us via email at info@geothermalukraine.org by *Date*.

Alternatively, you can easily fill Survey out **online** using the following Google Forms Link.

Thank you for your support and cooperation!

Appendix C

Industry Interview: Assessing Energy Profile & Geothermal Opportunities

Date of the interview:
Interview to:

General Company Information

1. Brief overview of industry, including name, core industrial activities and primary products or services.
2. How many employees work at facility and what is the approximate size (in square meters) of production area?

Energy Profile & Industrial Processes

3. What are the key industrial processes that require heating or cooling and what temperature ranges and heat carrier do they typically operate at?
4. Heating and cooling needs (temperature, pressure, mass flow rate, kW)
5. Possibility to use heating and cooling in cascade?
6. What are the main energy sources currently used in your facility (e.g., electricity, natural gas, etc.)? Already use renewables - which kind?

Geothermal Energy Awareness & Potential

7. How familiar are you with geothermal energy solutions for industrial heating and cooling?
8. Have you previously considered or implemented any geothermal technologies?

GEOSYN Heat Pump Solution & Future Considerations

9. Would you be open to exploring an innovative GEOSYN solution?
10. What factors would influence your decision to invest in a geothermal-based H&C system (e.g., cost savings, environmental impact, regulatory incentives...?)

Funded by the European Union

Appendix D

Template of Invitation Letter to Participate in the EU-Funded GEOSYN Project as a Virtual Case Study

Date

***Subject**: Invitation to Participate in the EU-Funded GEOSYN Project as a Virtual Case Study*

To whom it may concern

On behalf of project Consortium, **Geothermal Ukraine** is pleased to invitate *Industry Name* to participate in the **GEOSYN Project** - *Geothermal Synergy: Enhancing Industrial Energy Efficiency Through Steam High-Temperature Heat Pumps And Heat-Powered Cooling Systems With Operational Flexibility And Public Trust* (ID: 101172812), funded by the Horizon Europe Programme.

The GEOSYN aims to advance the development and integration of high-temperature heat pump (HTHP) technologies capable of serving both heating and cooling needs within industrial processes. Our goal is to support the transition from fossil fuel dependency to renewable geothermal energy, thereby contributing to the EU's industrial decarbonization objectives while improving energy efficiency, cost-effectiveness, and energy security.

We are currently seeking industrial partners within the EU to serve as demonstration sites (virtual case study) for a **pre-feasibility assessment** of integrating HTHP technology into existing production processes. This assessment is fully funded by the GEOSYN project. The technology under evaluation is suitable for industrial applications with temperature requirements in the range of **150°C** to **250°C**, including sectors such as: **energy, food & beverages, chemicals & pharma, textiles, pulp & paper, cement,** or any other industry operating within this temperature range.

Participation in the study does not require any financial contribution. All associated costs are covered through project funding.

To assess the potential fit and benefits of the technology at your facility, we kindly request basic operational input under a Non-Disclosure Agreement (NDA). Approximate values are sufficient at this stage. Key data parameters include:

- Operating temperature range *(ideally between 150–250°C)*
- Heating and cooling capacities *(kW, MW, etc.)*
- Type of heat transfer fluid used *(e.g., steam, air, etc.)*
- P&ID (Piping and Instrumentation Diagram) of the plant – *optional*

Benefits of participation:

- Explore innovative solutions to reduce energy consumption and emissions.
- Influence the development of future industrial decarbonization strategies.
- Join a collaborative European effort advancing sustainable technology adoption.

Should you require any additional information or have questions regarding the project or data submission, please do not hesitate to contact us. We appreciate your consideration and look forward to the possibility of collaborating with you on this important initiative.

For more information about the project, please visit our official website: https://geosynproject.eu/

Sincerely,
Geothermal Ukraine Team
On behalf of GEOSYN Consortium
info@geothermalukraine.org

www.geosynproject.eu #GEOSYNPROJECT
info@geosynproject.eu

Funded by the European Union

Appendix E

Potential Industrial Candidates for GEOSYN Solution Integration

No.	Name of Company	Country	Industry Sector	Website
1	2	3	4	5
1	Borealis Polyolefine	Austria	Chemical	www.borealisgroup.com
2	AGRANA Stärke GmbH - Aschach Plant	Austria	Food	www.agrana.com
3	Laakirchen Paper Mill	Austria	Paper, Pulp & Printing	www.heinzelpaper.com
4	Lenzing AG	Austria	Wood	www.lenzing.com
5	Petrokemija	Croatia	Chemical	www.petrokemija.hr
6	PIK Vrbovec	Croatia	Food	www.pik-vrbovec.hr
7	Vindija	Croatia	Food (Dairy)	www.vindija.hr
8	Spačva	Croatia	wood	www.spacva.eu
9	Tvin	Croatia	wood	www.tvin.hr
10	Madeta	Czech	Food (Dairy)	www.madeta.cz
11	Mondi Štětí	Czech	Paper, Pulp & Printing	www.mondijobs.cz
12	Precheza	Czech	Chemical	www.precheza.cz
13	Kemifloc a.s.	Czech	Chemical	www.kemifloc.cz
14	Papírny Větřní	Czech	Paper, Pulp & Printing	www.jip.cz
15	OP Papírna s.r.o.	Czech	Paper, Pulp & Printing	www.delfortgroup.com
16	Heidelberg Materials	Denmark	Cement	www.beton.heidelbergmaterials.dk
17	Hempel	Denmark	Chemical	www.hempel.com
18	Novonesis	Denmark	Chemical	www.novonesis.com
19	Chemetall Danmark	Denmark	Chemical	www.chemetall.com
20	Rockwool	Denmark	Construction	www.rockwool.com
21	High Density Denmark Data Center Campus	Denmark	Data center	www.atnorth.com
22	Avista Oil green	Denmark	Energy (Oil refinery)	www.avistagreen.dk
23	Arla Foods Taulov Dairy	Denmark	Food (Dairy)	www.arla.dk
24	Nordic Food Partners	Denmark	Food (Dairy)	www.nordicfoodpartners.dk
25	Fayrefield Foods	Denmark	Food (Dairy)	www.fayrefield.dk
26	Mammen dairies - Onsild Dairy	Denmark	Food (Dairy)	www.mammencheese.dk
27	Danish Crown	Denmark	Food (Dairy)	www.danishcrown.com
28	Mirit Glas	Denmark	Glass	www.miritglas.com
29	Smurfit Westrock Ejby	Denmark	Paper, Pulp & Printing	www.smurfitkappa.com
30	LEO Pharma	Denmark	Pharma	www.leo-pharma.com
31	Novo Nordisk	Denmark	Pharma	www.novonordisk.com
32	Chemvet Holding	Denmark	Pharma	www.chemvet.dk
33	Dancann Pharma	Denmark	Pharma	www.dancann.com

Funded by the European Union

1	2	3	4	5
34	WOCA	Denmark	Wood	www.wocadenmark.com
35	I-Wood	Denmark	Wood	www.i-wooddenmark.com
36	UPM-Kymmene	Finland	Paper, Pulp & Printing	www.upm.com
37	Huhtamaki Oyj	Finland	Manufacturing (producing packaging solutions for food and beverages)	www.huhtamaki.com
38	Metsä	Finland	Paper, Pulp & Printing	www.metsagroup.com
39	Stora Enso	Finland	Wood	www.storaenso.com
40	Heidelberg Materials France cimenterie de Beaucaire	France	Cement	www.ciments.heidelbergmaterials.fr
41	Green Danida	France	Cement	
42	Neo-Cem	France	Cement	
43	Holcim Haut-Rhin	France	Cement	www.holcim-haut-rhin.fr
44	LyondellBasell	France	Chemical	www.lyondellbasell.com
45	Evergreen Garden Care	France	Chemical	www.evergreen-bourth.fr
46	Basf Health And Care Products France	France	Chemical	www.basf.com
47	Solvay	France	Chemical	www.solvay.com
48	Kraton Polymers	France	Chemical	www.kraton.com
49	CAMPUS DATA CENTER DATA4	France	Data center	www.data4group.com
50	TotalEnergies	France	Energy	www.totalenergies.com
51	Diafood France	France	Food	www.colin-ingredients.com
52	Dr. Oetker	France	Food	www.oetker.fr
53	C.N.I.E.L	France	Food (Dairy)	www.cniel.com
54	Ferme des Peupliers	France	Food (Dairy)	www.fermedespeupliers.fr
55	Ferme de Viltain	France	Food (Dairy)	www.viltain.fr
56	Saint-Louis	France	Glass	www.saint-louis.com
57	Saverglass	France	Glass	www.saverglass.com
58	ArcelorMittal	France	Iron & Steel	www.france.arcelormittal.com
59	Essilor	France	Manufacturing - Optical Products (Lenses)	www.essilor.com
60	Mosaic Factory	France	Manufacturing (Mosaic)	www.mosaicfactory.com
61	Releaf Paper Innovation Center	France	Paper, Pulp & Printing	www.releaf-paper.com
62	Papeteries de Gennevilliers	France	Paper, Pulp & Printing	
63	OCP Répartition - Lillle	France	Pharma	www.ocp.fr
64	H2 PHARMA	France	Pharma	www.h2pharma.com
65	Wood Specifics by Saint Palais	France	Wood	www.wood-specifics.com
66	WOOD PURITY	France	Wood	www.wood-purity.com
67	Dow Chemical Company Ltd	Germany	Chemical	www.de.dow.com
68	TIB Chemicals AG	Germany	Chemical	www.tib-chemicals.com
69	Protection Chemicals	Germany	Chemical	www.protection-chemicals.co
70	Borggreve Biscuit Factory	Germany	Food	www.kekshersteller.de

Funded by the European Union

1	2	3	4	5
71	Wolf ButterBack	Germany	Food	www.butterback.de
72	Südzucker AG	Germany	Food	www.suedzuckergroup.com
73	Papierfabrik Palm, Wörth Plant	Germany	Paper, Pulp & Printing	www.palm.de
74	Venus	Germany	Pharma	www.venuspharmagmbh.de
75	EGGER Holzwerkstoffe	Germany	Wood	www.egger.com
76	Pfleiderer Teisnach	Germany	Wood	www.pfleiderer.com
77	Vapori di Birra	Italy	Beverage	www.vaporidibirra.com
78	Royal Cement Italia	Italy	Cement	https://royalcementitalia.herokuapp.com/#
79	Holcim	Italy	Cement	www.holcim.it
80	Cementir Italia S.p.A.	Italy	Cement	www.cementirholding.com
81	FLUORSID	Italy	Chemical	www.fluorsid.com
82	Chimec Spa	Italy	Chemical	www.chimec.com
83	Gap Chemical	Italy	Chemical	www.gapfertilizzanti.com
84	Nearchimica	Italy	Chemical	www.nearchimica.it
85	Chimicaitaliana International	Italy	Chemical	www.chimicaitalianainternational.com
86	Menarini (Lusochimica facility)	Italy	Chemical	www.lusochimica.it
87	Solvay Chimica Italia	Italy	Chemical	www.solvay.com
88	Schneider Electric	Italy	Data Center	www.se.com
89	Barilla G. e R. Fratelli S.p.A.	Italy	Food	www.barillagroup.com
90	Almar	Italy	Food	www.almar.it
91	Gruppo Petti	Italy	Food	www.ilpomodoropetti.com
92	GranTerre	Italy	Food	www.granterre.it
93	Amica chips	Italy	Food	www.amicachips.it
94	Parmacotto	Italy	Food	www.parmacotto.com
95	All Glass	Italy	Glass	www.allglass.it
96	TOP GLASS Industries	Italy	Glass	www.topglass.com
97	Chimet SPA	Italy	Iron & Steel	www.chimet.com
98	Acciaierie d'Italia	Italy	Iron & Steel	www.acciaierieditalia.com
99	JSW Steel Italy - Piombino	Italy	Iron & Steel	www.jswitaly.com
100	Luxottica	Italy	Manufacturing (Optical Products (Lenses)	www.essilorluxottica.com
101	Pirelli Tires	Italy	Manufacturing (Rubber Industry)	www.pirelli.com
102	Twente paints	Italy	Paint & Coatings	www.twentepaints.com
103	B.A. Special Chem & Color S.R.L.	Italy	Paint & Coatings	www.bacolor.it
104	Industrie Celtex SPA	Italy	Paper, Pulp & Printing	www.industrieceltex.com
105	Sofidel	Italy	Paper, Pulp & Printing	www.sofidel.com
106	Paperdì	Italy	Paper, Pulp & Printing	www.paperdi.it
107	Raipaper	Italy	Paper, Pulp & Printing	www.raipaper.it
108	Pieretti	Italy	Paper, Pulp & Printing	www.icpsrl.it

1	2	3	4	5
109	Tecnopaper	Italy	Paper, Pulp & Printing	www.tecnopaper.it
110	Lucense	Italy	Paper, Pulp & Printing	
111	Inres (coop)	Italy	Supermarket	www.coopetruria.coop.it
112	Cogne Macchine Tessili	Italy	Textille	www.cognetex.com
113	Hedrum Cementstøperi	Norway	Cement	www.hedrumcement.no
114	Norsk Lut	Norway	Chemical	www.norsklut.no
115	Nouryon	Norway	Chemical	www.nouryon.com
116	Veidekke Industri	Norway	Construction	www.veidekke.no
117	STACK Infrastructure OSL01A Data Center	Norway	Data center	www.stackinfra.com
118	Aker Solutions	Norway	Energy	www.akersolutions.com
119	GLH Glutenfrihuset	Norway	Food	www.glutenfrihuset.no
120	FoodMan	Norway	Food	https://foodman.no/hjem
121	Friele Foods	Norway	Food	www.higbrands.com
122	Rørosmeieriet	Norway	Food (Dairy)	www.rorosmeieriet.no
123	Idun Industry	Norway	Food (Dairy)	www.idun-industri.no
124	Hol Ysteri	Norway	Food (Dairy)	www.holysteri.no
125	Norsk Hydro	Norway	Iron & Steel	www.hydro.com
126	Kongsberg Maritime	Norway	Manufacturing (High-tech Systems and Components)	www.kongsberg.com
127	Jotun	Norway	Paint & Coatings	www.jotun.com
128	MMK Follacell	Norway	Paper, Pulp & Printing	www.follacell.no
129	Ranheim Paper & Board	Norway	Paper, Pulp & Printing	www.ranheim-pb.no
130	Nordic Paper Greåker	Norway	Paper, Pulp & Printing	www.nordic-paper.com
131	Hellefoss Book Paper	Norway	Paper, Pulp & Printing	www.hellefoss.com
132	Xellia Pharmaceuticals	Norway	Pharma	www.xellia.com
133	Pharma north Norway	Norway	Pharma	www.pharmanord.no
134	Nordic Pharma	Norway	Pharma	www.nordicpharma.net
135	Cementownia Odra S.A.	Poland	Cement	www.odrasa.com.pl
136	Grupa Azoty	Poland	Chemical	www.grupaazoty.com
137	Synthos S.A.	Poland	Chemical	www.synthosgroup.com
138	Qemetica Silicates	Poland	Chemical	www.qemetica.com
139	Maspex	Poland	Food	www.maspex.com
140	Mlekovita	Poland	Food (Dairy)	www.mlekovita.com.pl
141	Barlinek S.A	Poland	Wood	www.barlinek.co.uk
142	SECIL	Portugal	Cement	www.secil.pt
143	Navigator	Portugal	Paper, Pulp & Printing	www.thenavigatorcompany.com
144	Brutăria cu Maia	Romania	Food	www.brutariacumaia.ro
145	Bread & Spices București	Romania	Food	www.breadandspices.ro

Funded by the European Union

1	2	3	4	5
146	Çimsa Cementos	Spain	Cement	www.cimsacementos.es
147	Cementos Portland Valderrivas	Spain	Cement	www.valderrivas.es
148	Foodplant	Spain	Food	www.foodplant.es
149	Ebro Foods	Spain	Food	www.ebrofoods.es
150	LC Paper	Spain	Paper, Pulp & Printing	www.lcpaper.net
151	Finsa-Fibranor	Spain	Wood	www.finsa.com
152	SCA Sundsvall Ortvikens Pappersbruk	Sweden	Paper, Pulp & Printing	www.sca.com
153	Akzo Nobel Powder Coatings	Sweden	Paint & Coatings	www.akzonobel.com
154	Nordic Paper Säffle	Sweden	Paper, Pulp & Printing	www.nordic-paper.com
155	Mykolaivcement	Ukraine	Cement	www.cemark.ua
156	Ivano-Frankivsk cement plant	Ukraine	Cement	www.ifcem.if.ua
157	Podilskyi Cement	Ukraine	Cement	www.cemark.ua
158	Cement	Ukraine	Cement	www.cemark.ua
159	Rivne Azot	Ukraine	Chemical	www.azot.rv.ua
160	DniproAzot	Ukraine	Chemical	www.azot.com.ua
161	SUMYKHIMPROM	Ukraine	Chemical	www.sumykhimprom.com.ua
162	Sataniv Fruit Canning Plant	Ukraine	Food	www.vasha-konserva.com.ua
163	Nizhyn cannery	Ukraine	Food	www.nezhin.ua
164	Enzym Group	Ukraine	Food	www.enzymgroup.com
165	Radekhivskyi sugar	Ukraine	Food	www.radsugar.com
166	RUD	Ukraine	Food (Dairy)	www.rud.ua
167	Galychyna	Ukraine	Food (Dairy)	www.galychyna.com.ua
168	Sambirskyi Milk Plant	Ukraine	Food (Dairy)	www.sambir.ua
169	Molokia Ternopil Plant	Ukraine	Food (Dairy)	www.pjsc.molokija.com
170	Bilotserkivske	Ukraine	Food (Dairy)	www.bilotserkivske.com
171	KOMO Dubno	Ukraine	Food (Dairy)	www.komo.ua
172	Bashtanka Cheese Plant	Ukraine	Food (Dairy)	www.milkalliance.com.ua
173	Starokonstantinovskiy dairy plant	Ukraine	Food (Dairy)	www.ukrproduct.com
174	Tulchyn Butter and Cheese Factory	Ukraine	Food (Dairy)	www.terrafood.ua
175	Loostdorf	Ukraine	Food (Dairy)	www.loostdorf.com
176	Yuriya	Ukraine	Food (Dairy)	www.voloshkovepole.com.ua
177	Globinsky pig farm	Ukraine	Food (Meat)	www.corp.globino.ua
178	Myronivsky Hliboproduct	Ukraine	Food (Poultry and Meat Processing)	www.mhp.com.ua
179	ZAPORIZHSTAL	Ukraine	Iron & Steel	www.zaporizhstal.com/en-us
180	Zhydachiv pulp and paper Mill	Ukraine	Paper, Pulp & Printing	www.zhkpaper.com
181	Izmail pulp and paperboard Plant	Ukraine	Paper, Pulp & Printing	www.ckk.com.ua
182	Zhytomyr Cardboard Factory	Ukraine	Paper, Pulp & Printing	www.cardboard.com.ua

Funded by the European Union

1	2	3	4	5
183	Torgtekhnika	Ukraine	Paper, Pulp & Printing	www.vinpak.com.ua
184	Poninka Paper Factory	Ukraine	Paper, Pulp & Printing	www.pkpf.com.ua
185	Trypillya Packaging Plant	Ukraine	Paper, Pulp & Printing	www.tuk.org.ua
186	Kokhavynska Paper Factory	Ukraine	Paper, Pulp & Printing	www.kpf.ua
187	Paper-Mal	Ukraine	Paper, Pulp & Printing	www.papir-mal.com.ua
188	Lubnypharm	Ukraine	Pharma	www.ubnypharm.com
189	Ternopharm	Ukraine	Pharma	www.ternopharm.com.ua
190	Zdorovye	Ukraine	Pharma	www.zt.com.ua
191	Chervona zirka	Ukraine	Pharma	www.chervonazirka.com.ua
192	Arterium	Ukraine	Pharma	www.arterium.ua
193	Borshchahivskiy CPP	Ukraine	Pharma	www.bcpp.com.ua
194	Darnytsia	Ukraine	Pharma	www.darnytsia.ua
195	Kyiv Vitamin Plant	Ukraine	Pharma	www.vitamin.com.ua
196	Galychpharm	Ukraine	Pharma	www.galychpharm.com
197	POLYMER	Ukraine	Wood	www.pkf-polymer.com
198	CIO	Ukraine	Wood	www.ppsio.com
199	PODILWOOD	Ukraine	Wood	www.podilwood.km.ua
200	Kronospan	Ukraine	Wood	www.kronospan.com

Funded by the European Union

Appendix F

List of Key National and International Industry Associations as Stakeholders Itentified within GEOSYN Partner Countries

International			
No.	**Sector / Category**	**Organization**	**Website**
1	*2*	*3*	*4*
1	International Association of Industries	BusinessEurope	www.businesseurope.eu
2	International Association of Industries	ERT- European Round Table of Industrialists	www.ert.eu
3	International Association of Industries	EUROCHAMBRES- Association of European Chambers of Commerce and Industry	www.eurochambres.eu
4	International Association of Industries	SMEUnited	www.smeunited.eu
5	Cement	European Cement Association	www.cembureau.eu
6	Paper	Confederation of European Paper Industries	www.cepi.org
7	Food	FoodDrinkEurope	www.fooddrinkeurope.eu
8	Chemical	Chemical Parks in Europe	www.chemicalparks.eu
9	Chemical	International Council of Chemical Associations	www.icca-chem.org
10	Chemical	European Chemical Industry Council (Cefic)	www.cefic.org
11	Steel for Packaging	APEAL- Association of European Producers of Steel for Packaging	www.steelforpackagingeurope.eu
12	Textile	EURATEX (European Apparel and Textile Confederation)	www.euratex.eu
13	Energy	European Renewable Energy Research Centres Agency	www.eurec.be
14	Energy	Petrochemicals Europe (CEFIC)	www.petrochemistry.eu
Denmark			
15	National Association	Danish Industry	www.danskindustri.dk
16	National Association	Danish Chamber of Commerce	www.danskerhverv.dk
17	Cement	Heidelberg Materials	www.heidelbergmaterials.com
18	Food	Danish Agriculture & Food Council (Landbrug & Fødevarer)	www.lf.dk
19	Wood	Dansk Træindustri	www.dansketraeindustrier.dk
France			
20	National Association	France Industrie	www.franceindustrie.org
21	Cement	France Ciment	www.metiers-ciment.fr
22	Paper	L'Union française des industries des cartons, papiers et celluloses (COPACEL)	www.copacel.fr
23	Food	ANIA	www.ania.net
24	Chemical	France Chimie	www.francechimie.fr
25	Chemical	National Federation of Chemical Industries	www.fnic-cgt.com
26	Chemical	Fédération Chimie Energie	www.fce.cfdt.fr

Funded by the European Union

27	Wood	Fédération Nationale du Bois	www.fnbois.com
28	Wood	Union des Industriels et Constructeurs Bois	www.uicb.pro
29	Peroleum	French Association of Petroleum Industry	www.energiesetmobilites.fr
Italy			
30	National Association	Confindustria	www.confindustria.it
31	Cement	AITEC – Associazione Italiana Tecnico Economica del Cemento / Italian Technical and Economic Association of Cement	www.aitecweb.com
32	Paper	Assocarta	www.assocarta.it
33	Paper	Federsider (Italian Federation of Paper Recycling and Processing Industries)	www.unirima.it
34	Food	Federazione Italiana dell'Industria Alimentare	www.federalimentare.it
35	Food	Assolatte (Italian Dairy Industry Association)	www.assolatte.it
36	Chemical	Federchimica	www.federchimica.it
37	Glass	Italian Association of Glass Processing Machinery and Accessories Suppliers	www.gimav.it
38	Mechanical, engineering, and industrial automation	ANIMA Federazione delle Associazioni Nazionali dell'Industria Meccanica Varia ed Affine	www.anima.it
Norway			
39	National Association	Federation of Norwegian Industries	www.norskindustri.no
40	Cement	Norwegian Concrete Association	www.betong.net
41	Food	Federation of Norwegian Agricultural Co-operatives (Norsk Landbrukssamvirke)	www.landbruk.no
42	Wood	Treindustrien (Norwegian Woodworking Association)	www.treindustrien.no
Ukraine			
43	National Association	Ukrainian league of industrialists and entrepreneurs	www.uspp.ua
44	National Association	Association of "Eco-industrial parks of Ukraine"	www.eipu.org
45	National Association	Ukrainian Chamber of Commerce and Industry	www.ucci.org.ua
46	Cement	Association of cement producers of Ukraine	www.ukrcement.com.ua
47	Paper	Ukrpapir	www.ukrpapir.org
48	Food	Ukraharchoprom	www.ukrfood.org
49	Chemical	Union of Chemists of Ukraine	www.chemunion.org.ua

Funded by the European Union

“Geothermal Heating & Cooling for Industry

APRE

UNIVERSITÀ DEGLI STUDI FIRENZE | DIEF DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

COSVIG

SDU

Geothermal UKRAINE

SINTEF

RIVACOLD MASTERING COLD

neo-eco

FORMAGGERIA TOSCANA

www.geosynproject.eu

info@geosynproject.eu

#GEOSYNPROJECT

Funded by the European Union