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Report of Contributors				
	Name	**Organisation**	**Role/ Title**	E-mail
Report leader	Sonia Bianconi	(EHPA)	EU Projects Manager	**sonia.bianconi@ehpa.org**
Contributing Author(s)				
Reviewer(s)	Simon Spoelstra	(TNO)	Senior Project Manager	**simon.spoelstra@tno.nl**
	Riccardo Marchetti	(EURAC)	Researcher	**riccardo.marchetti@eurac.edu**
Final review and quality approval	Simon Spoelstra	(TNO)	Senior Project Manager	**simon.spoelstra@tno.nl**

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DLR: Deutsches Zentrum Fur Luft - Und Raumfahrt Ev

EHPA: European Heat Pump Association

MYK: Nv Mayekawa Europe Sa

SINLOC: Sinloc-Sistema Iniziative Locali Spa

EURAC: Accademia Europea Di Bolzano

EHP: Euroheat & Power

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ABBREVIATIONS AND ACRONYMS

ASPAPEL: Spanish association for pulp and paper manufacturers

CAPEX: Capital Expenditure

CEFS: European Association of Sugar Manufacturers

CEPI: Confederation of European Paper Industries

CHP: Combined Heat and Power

CIRFS: European Man-Made Fibers Association

COP: Coefficient of Performance

DHC: District Heating and Cooling

EAAS: Energy as a Service

EED: Energy Efficiency Directive

ESCO: Energy Service Company

FPI: Food Processing Initiative

GHG: Greenhouse Gas

HAAS: Heat as a Service

HP(s): Heat pump(s)

HTHP(s): High-temperature heat pump(s)

IED: Industrial Emissions Directive

IHP: Industrial heat pump

I-ThERM: Industrial Therma Energy Recovery Conversion and Management

MVR: Mechanical Vapour Recompression

NECP(s): National Energy and Climate Plan(s)

OPEX: Operating Expenditures

PPA(s): Power Purchase Agreement(s)

PUSH2HEAT: Pushing forward the market potential and business models of waste heat valorisation by full-scale demonstration of next-gen heat upgrade technologies in various industrial contexts

PV: Photovoltaics

RED: Renewable Energy Directive

RES: Renewable Energy Sources

ROI: Return on Investment

SPIRIT: Implementation of sustainable heat upgrade technologies for industry

SUSHEAT: Smart Integration of Waste and Renewable Energy for Sustainable Heat Upgrade in the Industry

WHR: Waste heat recovery

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1. INTRODUCTION

This report aims to identify the non-technical barriers hindering the deployment of industrial heat pumps (IHPs) in Europe, analyse their underlying causes, and propose practical solutions. It focuses on heat pump applications in industrial processes and builds on field and desk research to provide a more holistic analysis of non-technical barriers and potential solutions.

The document opens with an overview of the most sector-relevant regulations at the EU level and their actual impact on industrial heat pump deployment. The overview covers both legislation (RED III, EED, IED, EU ETS, EU Taxonomy) and some of the most relevant recent Communications published by the European Commission, such as the EU Clean Industrial Deal, EU Action Plan for Affordable Energy, and EU Grid Action Plan.

The analysis at EU level is followed by a review of key points contained in the National Energy and Climate Plans (NECPs) of the 27 EU Member States, lastly updated in late 2024, with the aim of capturing national trends regarding industrial heat pumps, as well as industrial electrification and waste heat recovery (WHR) for industrial processes.

Beyond the review of EU and national policy documents, this report also captures the opinions and perceptions of industrial heat pump technology providers, as well as those of sectors with the greatest potential to electrify and integrate heat pumps in their production processes. To this end, two types of surveys were shared, respectively with industrial heat pump manufacturers and companies from the food & beverage, pulp & paper, and chemical sectors. Online interviews were conducted with key associations from the same sectors to obtain qualitative feedback on the realistic market potential of industrial heat pumps for their process industry.

These results were complemented with outcomes from a webinar conducted within the framework of the SPIRIT Project, existing papers on the topic, and lessons learned from three demonstration sites, resulting in the final outcome of this deliverable: an inventory of non-technical barriers and solutions for the deployment of industrial heat pumps in the EU. This inventory is structured around seven key categories, aiming to analyse challenges and provide recommendations related to cost of technology, infrastructure, awareness, trust, policy and regulations, skills, and collaboration & synergies.

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2. EUROPEAN POLICY AND REGULATORY LANDSCAPE FOR INDUSTRIAL HEAT PUMPS

The European Union has set ambitious climate targets, aiming to achieve net-zero greenhouse gas emissions by 2050. Industrial heat pumps (IHPs) and waste heat recovery (WHR) technologies are pivotal in this transition, offering significant potential for decarbonising industrial processes. However, the current EU policy and regulatory framework provides limited and often ambiguous support for these technologies.

While various directives and regulations touch upon aspects of industrial electrification and energy efficiency, they lack specific provisions to promote the widespread adoption of IHPs and WHR systems. This chapter examines the key EU policies and regulations relevant to industrial heat pumps, as well as communications and other policy documents published by the European Commission. Although these communications are less "binding" than formal legislation, they provide clear insight into the policy direction the EU is taking and the priorities shaping industrial decarbonisation.

The overview draws on the paper "Waste into Wealth"[1] by the European Heat Pump Association and is integrated with additional EU regulations and communications relevant to industrial heat pump technology.

1 European Heat Pump Association (2024), *Waste into Wealth: How Heat Pumps Can Recycle Heat to Save Energy – and the EU Policy That Matters*, available at: https://ehpa.org/news-and-resources/position-papers/waste-into-wealth-how-heat-pumps-can-recycle-heat-to-save-energy/

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2.1 Renewable Energy Directive III

The Renewable Energy Directive (RED III)[2] serves as the EU's primary instrument for promoting renewable energy across Member States. Its objectives include increasing the share of renewables in the EU's energy mix, reducing greenhouse gas emissions, and enhancing energy security.

In relation to industrial energy use, Article 22a of the directive establishes general provisions for Member States to increase their share of renewable energy sources in the industrial sector. It sets a non-binding target of a 1.6 percentage point annual average increase for the periods 2021–2025 and 2026–2030.

The same article also mentions that when considered cost-effective, Member states should include policies promoting renewable-based electrification of industrial processes in their National Energy and Climate Plans.

Regarding waste heat, Article 22a restricts its definition to applications within district heating and cooling (DHC) systems, without providing broader considerations for industrial waste heat recovery. Additionally, the directive encourages Member States to incorporate relevant policies and measures into their National Energy and Climate Plans with the aim of reducing fossil fuel used for heating below 200 ºC. However, no binding obligations are imposed on Member States in this regard.

The revision of the Renewable Energy Directive provides only broad guidelines and lacks concrete obligations for promoting the adoption of industrial heat pumps and other renewable energy technologies in industry. As a result, its effectiveness in accelerating industrial decarbonisation remains uncertain.

2 European Parliament & Council of the European Union (2023), Directive (EU) 2023/2413 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023L2413&qid=1699364355105

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2.2 Energy Efficiency Directive

The Energy Efficiency Directive (EED)[3] sets EU-wide targets to reduce energy consumption through efficiency measures in buildings, industries, and transportation. It mandates energy savings, promotes smart metering, and supports renovations for energy-efficient infrastructure.

As far as industrial heat pumps and waste heat recovery are concerned, the directive and its revision do not place sufficient emphasis on these technologies. Article 25, paragraph 4 states that high-efficiency cogeneration and/or efficient district heating and cooling from waste heat would bring more benefits than costs. Therefore, Member States must take measures to promote the installation of waste heat utilisation systems, including in the industrial sector. This is one of the few articles that has an indirect impact on industrial heat pump development.

Article 26 refers to the recovery of waste heat in data centres, stating that Member States shall ensure that data centres with a total rated energy input exceeding 1 MW should put in place processes to reuse the waste heat unless not technically or economically feasible.

In the Annex X, heat pumps are specifically mentioned as a relevant efficiency technology for the assessment of national heating and cooling potentials, which also includes industrial applications. However, no additional reference to industrial heat pumps is made.

Further references to "waste heat" in the directive indicate either the broader use of waste heat or exclusively its use in district heating and cooling.

3 European Parliament & Council of the European Union (2023), Directive (EU) 2023/1791 on energy efficiency and amending Regulation (EU) 2023/955. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AJOL_2023_231_R_0001&qid=1695186598766

2.3 Industrial Emissions Directive

The Industrial Emissions Directive (IED)[4] sets strict emission limits for pollutants from large industrial facilities such as power plants, refineries, and steelworks. Its main goal is to reduce environmental pollution from industrial operations through the adoption of Best Available Techniques (BATs)—i.e., practices and technologies that minimise environmental impact.

The impact of the directive on industrial heat pump rollout is limited. Some argue that the IED could promote marginal improvements in fossil fuel-based technologies at the expense of electrification efforts.[5]

2.4 European Union Emissions Trading System

The EU Emissions Trading System (EU ETS) sets a cap on the total emissions allowed from certain industries, allowing trading of allowances between participants.

While some industries receive free allowances to support specific sectors, no specific mention is made of industries that utilise waste heat. Waste heat recovery from industrial processes should be eligible for free allocation within the EU ETS. This would make it more financially attractive for EU industries to adopt waste heat recovery measures, allowing sustainable EU industries to remain competitive.

4 European Parliament & Council of the European Union (2010), Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control). Consolidated version available at: https://eur-lex.europa.eu/eli/dir/2010/75/2024-08-04

5 Jan Rosenow, Cordin Arpagaus, Stefan Lechtenböhmer, Sem Oxenaar, Elian Pusceddu, *The heat is on: Policy solutions for industrial electrification*, Energy Research & Social Science, Volume 127, 2025, 104227, ISSN 2214-6296. Available at: https://doi.org/10.1016/j.erss.2025.104227

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2.5 EU Taxonomy

The EU Taxonomy[6] is a classification system developed by the European Union to define which economic activities are to be considered environmentally sustainable. Part of the EU Green Deal, the EU Taxonomy aims to guide investments towards sustainable projects, guides companies in reporting their environmental impact, and encourages banks to finance green projects.

In the EU Taxonomy, waste heat recovery is recognised as a climate-mitigation and green-investment measure, although it does not provide details on the specific ways the recovered heat can be reused.

2.6 EU Clean Industrial Deal

The EU Clean Industrial Deal[7], launched in February 2025, presents measures to strengthen decarbonisation efforts in EU industry and enhance its competitiveness. The Deal outlines actions to support every stage of production, with a focus on:

- Energy-intensive industries, which urgently need support to decarbonise, switch to clean energy, and address high costs, unfair global competition, and complex regulations.
- The clean-tech sector, which is central to future competitiveness and essential for industrial transformation, circularity, and decarbonisation.

The Deal includes several actions that can benefit the industrial heat pump market, including:

6 European Parliament & Council of the European Union (2020), Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088 (Taxonomy Regulation). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32020R0852

7 European Commission (2025), The Clean Industrial Deal: A joint roadmap for competitiveness and decarbonisation (COM/2025/85 final). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52025DC0085

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- Lowering electricity costs across Europe through the Action Plan for Affordable Energy (more information provided in section 2.7).
- Incorporating criteria such as sustainability, resilience, and "made in Europe" in public procurement, through the Industrial Decarbonisation Accelerator Act (to be published in Q4 2025).
- Mobilising over €100 billion for clean manufacturing, decarbonisation, and innovation, including a new state-aid framework to simplify support for clean technologies.
- Focusing on workforce development and simplifying administrative and permitting procedures.

2.7 EU Action Plan for Affordable Energy

The Action Plan for Affordable Energy [8] is a key component of the European Commission's Clean Industrial Deal. This Plan focuses on lowering energy prices for citizens, businesses, and industry. The main measures of this plan, which could significantly impact industrial heat pump deployment if implemented, include:

- Lowering national-level electricity taxation and removing non-energy cost components from bills, by concluding the revision of the Energy Taxation Directive and issuing guidance to Member States.
- Reducing network charges by designing tariff methodologies that reward flexibility, demand-shifting, and digital grid integration, and by providing guidance on how Member States can use public budgets to lower such charges.
- Accelerating grid expansion, modernisation, and digitalisation, including faster permitting for renewables and infrastructure, and deployment of the European Grid Package to support backbone infrastructure investments.
- Enhancing cross-border access to low-cost electricity through expanded transmission capacity, greater market integration, and more interconnections.
- Decoupling retail electricity bills from volatile fossil gas prices by promoting long-term Power Purchase Agreements (PPAs) and other long-term supply contracts for renewables.

8 European Commission (2025) Action Plan for Affordable Energy: Unlocking the true value of our Energy Union to secure affordable, efficient and clean energy for all Europeans (COM/2025/79). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52025DC0079&qid=1741780110418

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- Improving demand-side flexibility by encouraging retail contracts and tariffs that reward consumers for shifting consumption to lower-cost hours, thereby enabling more efficient system usage.
- Enhancing heating and cooling efficiency by scaling up waste-heat recovery, reuse, and deployment of heat pumps in industrial and district heating applications.
- Accelerating electrification of industry, heating, and cooling to support the transition to low-carbon electricity, leveraging flexibility from electrification and providing policy certainty for large-scale industrial heat-pump investments.

2.8 EU Action Plan for Grids

Launched in November 2023, the EU Action Plan for Grids[9] outlines a comprehensive strategy to modernise and expand Europe's electricity grids, aiming to support the EU's clean energy transition. The plan recognises that electricity consumption is expected to increase by approximately 60% between 2023 and 2030, driven by the electrification of various sectors, including industry, heating, and transportation.

As an unstable electrical grid is one of the main barriers to the wider deployment of heat pumps in industry, the plan aims to ensure that grid infrastructure can effectively support the widespread adoption of heat pumps and other low-carbon technologies.

2.9 Conclusion

The analysis of the European policy and regulatory landscape for industrial heat pumps reveals a mixed picture. On one hand, EU directives and frameworks, such as the Renewable Energy Directive III, the Energy Efficiency Directive, and the EU Taxonomy, recognise the importance of industrial electrification, energy efficiency, and waste heat recovery as pathways for decarbonisation. These instruments encourage Member States to promote renewable energy use in industry, acknowledge heat pumps as relevant technologies, and provide guidance for green

9 European Commission (2023), Action plan for grids. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2023%3A757%3AFIN&qid=1701167355682

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investments. The EU Emissions Trading System further underline the importance of emissions reduction, creating indirect incentives for the adoption of IHPs.

On the other hand, these policies often lack specificity and enforceable obligations for industrial heat pumps. Provisions are frequently limited to general recommendations, cost-effectiveness conditions, or applications in district heating rather than broader industrial processes. This leaves significant gaps in policy support for widespread deployment of industrial heat pumps and waste heat recovery technologies. For example, RED III and the EED highlight electrification only if it is cost-effective, which may inadvertently slow adoption of technologies that have high upfront costs but offer substantial long-term decarbonisation potential.

Looking ahead, many documents currently in the works have the potential to provide a stronger framework for industrial heat pump adoption.

These instruments include: the European Electrification Action Plan, which will set electrification targets across sectors and address barriers to industrial heat recovery and upgrade; the Heating and Cooling Strategy, which will guide low-carbon heating technologies, waste heat recovery, and system integration; the Industrial Decarbonisation Accelerator Act, which aims to simplify permitting, mobilise demand for low-carbon industrial products, and introduce criteria for clean industrial investments; and the European Grid Package, which seeks to modernise, expand, and digitalise the electricity grid to accommodate electrified demand and renewables.

Continued alignment of these initiatives with the demonstrated potential of industrial heat pumps will be critical to ensuring that the EU's climate and industrial competitiveness goals are met while facilitating large-scale deployment of these technologies.

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3. NATIONAL POLICY AND REGULATORY LANDSCAPE FOR INDUSTRIAL HEAT PUMPS

3.1 A study of the National Energy and Climate Plans

To gain a clear understanding of the pathways pursued by the 27 EU Member States for industrial decarbonisation, the updated National Energy and Climate Plans (NECPs) submitted in 2024[10] are reviewed and analysed. These plans have been chosen as the basis for the study because they generally provide both an overview of the current situation and forward-looking national targets for reducing energy-related emissions across key sectors, including industry.

The analysis covers all 27 Member States and focuses on the extent to which the NECPs reference industrial heat pumps, industrial waste heat recovery, and industrial electrification. While the NECPs are not the sole documents guiding national energy policy, they offer valuable insight into the directions Member States are pursuing and highlight the technologies considered more promising and feasible to implement.

The fact that some countries explicitly address industrial waste heat recovery or electrification, while others do not, is a strong indication of their intended trajectories and it also underlines the potential role of industrial heat pumps in shaping Europe's energy future.

The key findings of this desk-based review are briefly summarised below for each country.

10 National Energy and Climate Plans, available at: https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en

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Austria

References to industrial heat pumps: No

References to industrial waste heat recovery: Yes, mainly mentioned in general terms or in relation to DHC

Austria's NECP highlights the relevance of industrial waste heat as a contributing source to the overall decarbonisation of the heating sector. It emphasises the importance of maintaining or enhancing the role of waste heat from industrial processes and other sources (p.83).

The plan also acknowledges the complexity of industrial decarbonisation, citing the sector's structural and technical diversity. It points to opportunities such as the integration of waste heat, including low-temperature waste heat, into district heating systems, alongside other measures that collectively support a multidimensional approach to reducing emissions in industry (p.135).

References to industrial electrification: Yes, there are only slight references to it mainly in the context of hydrogen. The NECP notes that hydrogen can be used when electrification is not possible as in the following paragraphs:

"According to the Austrian Hydrogen Strategy, hydrogen will play an important role in particular for selected applications in industry (e.g. in the iron and steel industry or in the chemical industry) and in certain areas of mobility (especially in the heavy shift), where electrification alone will not be sufficient" (p.81).

"[...] Therefore, the use of renewable gases is most useful in energy and economics, primarily in sectors that cannot be electrified" (p.157).

Belgium

References to industrial heat pumps: Yes

Industrial heat pumps are mentioned as one of the technologies that can contribute to greening industrial heat demand. Specifically, the report states that further electrification of industry can lead to emission reductions (direct and indirect), and to this end, it references a study by Technopolis and VITO, which identified interesting

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technologies such as industrial heat pumps, electric boilers, solar thermal, biomass boilers, waste heat use, district heating, and thermal storage. (p. 343)"

References to industrial waste heat recovery: Yes,

The NECP states that waste heat recovery can also play a role in achieving this heat production (p. 343). Excess heat is mainly mentioned as functional to district heating and not much for use in industrial processes. In the section on industrial and commercial enterprises in Wallonia, the Plan mentions waste heat recovery as one element that could contribute to the reduction of energy costs, in the framework of new voluntary agreements with companies aimed at achieving carbon neutrality by 2050. (p.156)

References to industrial electrification: Yes

The document mentions the electrification of transport, heating, and industry as a factor expected to increase the share of electricity in the energy mix (p. 35). More specifically, it also refers to the need for greater reception capacity on the transmission network, as a high degree of industrial electrification—and therefore more customers connected to the transmission system—is anticipated (p. 163).

Bulgaria

References to industrial heat pumps: No

References to industrial waste heat recovery: No, waste heat is only mentioned in relation to district heating and cooling, not industrial processes (p.75)

References to industrial electrification: Yes

The plan states that "in line with Europe's decarbonisation objective, electricity demand is projected to increase by 2050 due to electrification of heating, transport and industry, as well as the production of green hydrogen" (p.211).

Croatia

References to industrial heat pumps: No

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References to industrial waste heat recovery: No, waste heat is only mentioned in relation to district heating and cooling, not industrial processes (pp. 251-252)

References to industrial electrification: No, electrification is only mentioned in relation to buildings and transport

Cyprus

References to industrial heat pumps: No

References to industrial waste heat recovery: No, not even in relation to DHC, as there is none in Cyprus

References to industrial electrification: No, electrification is only mentioned in general terms and mainly linked to buildings and transport

Czechia

References to industrial heat pumps: Yes

The plan identifies heat pumps "as one of the technologies that can help decarbonise the heating sector". It includes "proposals for reforms aimed at: adjustment of RES fee support for sources using waste heat, transfer of support for industrial heat pump technology to priority projects (in the Modernisation Fund) or adjustment of the emission factor of electricity". (p.333)

References to industrial waste heat recovery: Yes, see above

References to industrial electrification: Yes,

There is only one reference to industrial electrification which is of limited relevance: "The results of simulations of the evolution of the electricity system show that imported electricity is increasing due to a lack of domestic generation capacity and increasing electricity consumption due to electrification (especially in transport, heating but also in industrial productions)" (p.258).

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Denmark

References to industrial heat pumps: No, only large heat pumps are mentioned in relation to DHC.

References to industrial waste heat recovery: Yes

With the Climate Agreement for Energy and Industry, etc. of 7 September 2021, it was decided to introduce an energy-friendly screening scheme in which, in return for a tax exemption for taxed surplus heat. In this framework, companies are obliged to:

1. To carry out energy reviews of waste heat processes and installations, which shall be verified by independent external experts;

2. Based on the energy review, implement energy efficiency measures for companies' processes and installations related to waste heat with a payback period of up to 5 years (p. 125).

References to industrial electrification: No, electrification is only mentioned in general terms and mainly linked to DHC

Estonia

References to industrial heat pumps: No

References to industrial waste heat recovery: No, waste heat is only mentioned in relation to DHC, not industrial processes

References to industrial electrification: No, electrification is only mentioned in general terms and mainly linked to buildings and transport

Finland

References to industrial heat pumps: Yes

In the section on the sectoral changes expected to impact Finland's energy system, EU ETS prices are mentioned as one of the main factors that will increase electricity demand. This trend is also reflected in the low-carbon roadmaps prepared by all

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major industries and sectors. In district heating and industry, fossil fuels are increasingly being replaced with renewables and waste heat recovery. Electrification is a major trend in the industrial sector and in heating and cooling, bringing more electric boilers, heat pumps and electricity-based industrial processes (p. 171).

References to industrial waste heat recovery: Yes

The plan states that "the need to replace natural gas from Russia has driven industrial companies to look for alternative energy sources such as renewable gases and the utilisation of waste heat, as well as energy efficiency investments. Other key drivers for the increase of renewable energy in industry are the EU ETS price and national energy taxation, which favour renewable energy sources and electricity. "(p.118)

References to industrial electrification: Yes

In 2022, Finland introduced the Energy Investment Aid scheme to award funding from the EU Recovery and Resilience Facility (RRF), using a method like the Energy Aid programme. The scheme will provide around EUR 540 million in funding for energy investments, including - among other measures - the electrification of industries. The funding is granted in 2021–2024 and the funded projects must be finished by 2026 (p.206).

France

References to industrial heat pumps: Yes

The installation of heat pumps and the use of mechanical vapour compression are mentioned as two ways electrification can lead to energy efficiency gains in the industry (P. 264).

References to industrial waste heat recovery: Yes

The NECP makes reference to Article 14 of Directive 2012/27/EU on energy efficiency, according to which "industrial installations generating unrecovered waste heat must carry out a cost-benefit analysis in the case of new installations and in the event of substantial renovation. This analysis shall make it possible to assess, for an industry, the cost-effectiveness of the recovery of waste heat through a connection to a district heating or cooling system and shall be accompanied by the implementation of

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solutions deemed to be cost-effective. The main industrial sectors concerned by the measure are chemical, glass, cement, lime, plaster, paperboard, metal processing and agri-food" (p128).

The plan also establishes some measures for industrial and tertiary waste heat recovery, which are the following:

- work towards the establishment of a Guarantee Fund to cover the risk of a failure of the industrial waste heat supplier and subsidise a biomass heat installation in the event of a failure of a waste heat supplier;
- study the feasibility of recovering nuclear waste heat;
- deepening the possibilities for heat recovery from wastewater (networks, treatment plants): support for technology development, feasibility studies (mandatory for large installations according to thresholds to be defined), projects under the Heat Fund (p.169)

References to industrial electrification: Yes

The plan underlines a very important point concerning the electricity price by saying that its competitiveness is a prerequisite for the realisation of decarbonisation projects based on electrification. This aspect is treated in reference to nuclear power, whose promotion will facilitate the electrification of the French industry, incentives for the use of fossil fuels which will be reduced to foster electrification (p.130)

In addition, industrial electrification is also mentioned as one area of action of the France 2030 plan, a €54 billion investment plan focuses on decarbonising the economy, developing green technologies, and fostering industrial champions. As mentioned in the plan "this massive investment targets the decarbonisation of highly emitting industrial sites (e.g. steel, heavy chemicals, cement plants, aluminium) and the deployment of mature solutions (renewable heat, energy efficiency, electrification)" (p.114).

Germany

References to industrial heat pumps: No, large scale heat pumps are mentioned in a broader sense, also including DHC systems. The report states that "for large heat pumps (i.e. with a thermal output of more than 500 kW), an estimated expansion of 4 GW per year would be necessary in heating networks to achieve the target of climate

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neutrality in 2045. […] In 2030, large heat pumps are to generate 86 TWh per year in heating networks" (p.67).

On top of this, the German NECP states that "Measures currently under examination by the German government concern large heat pumps and are about coordination of approval process for applicants and public authorities" (p.322).

References to industrial waste heat recovery: Yes

Waste heat recovery is mentioned in general terms, and it is not explicitly said that the recovery will be done through heat pumps. Nevertheless, its relevance and potential are recognised in the following section: "[…] the estimated volume for waste heat and cooling in 2030 totals around 7 TWh per year. The potential supply of waste heat from the manufacturing industry is estimated at 4.8 TWh, considering the transformation of the sectors concerned and how this heat can be deployed via heating networks. In addition, the potential for waste heat from data centres is expected to amount to 2 TWh in 2030. This is due to the increase in energy consumption by data centres to 25 TWh/a in 2030, a third of which, i.e. around 7 TWh/a, could be used as waste heat. Based on an energy demand in heating and cooling of around 1400 TWh/a, waste heat and cooling would account for 0.4%, thus raising the target by 0.2%" (p.66).

Waste heat recovery is also mentioned a lot in relation to district heating and cooling. More specifically the plan mentions the Federal Funding Programme for Efficient Heat Networks which "supports the construction, expansion, and conversion of heating networks to renewable energy and the use of unavoidable waste heat" (p.147).

References to industrial electrification: Yes

In a paragraph specifically addressing batteries, the plan states that "the electrification of industry, transport and other sectors is essential to significantly cut greenhouse gas emissions and achieve net-zero emissions targets, as enshrined in the EU's Net-Zero Industry Act, among others" (p.263).

Greece

References to industrial heat pumps: Yes

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The plan mentions that in the industrial sector, support will be given to energy-efficient heating and cooling technologies, such as heat pumps, which use refrigerants with low global warming potential for medium-temperature industrial applications and DHC (p.360).

References to industrial waste heat recovery: Yes

In the industrial sector, the plan foresees support for heat and cold recovery, including making better use of waste heat for electricity generation, recovering high-temperature heat more efficiently, and developing hybrid plants that combine waste heat with renewable energy in industrial processes (p.360).

In addition, the report states that "measures for the use of local district heating networks within industrial areas that exploit waste heat from specific industries and crafts to meet the thermal needs of many other industries will be considered" (p.250).

References to industrial electrification: Yes

The plan states that Greece's industry has a high rate of electrification (p.64).

In this framework the decarbonisation of industry can be divided into two main sub-categories: decarbonising sub-sectors of industry that can be electrified and managing emissions from industrial sub-sectors classified as hard-to-abate.

For the first sub-category, the NECP states that where mature technological equivalents exist for the use of electricity instead of fuel, these will gradually be prioritised, encouraged, and incentivised. The gradual conversion of many industrial processes to purely (or primarily) electric ones will also be driven by the evolution of greenhouse gas (GHG) emission allowance prices.

The same paragraph highlights that the increase cost of emissions might render the final product of non-green industry which might weaken the overall Greek industry against non-EU countries that have much lower environmental standards. The plan states that to make electricity costs more predictable bilateral contracts with renewable energy plants will be regulated (p.214).

An interesting measure that is mentioned and is relevant for future implementation of industrial heat pumps is the extension and reinforcement of electricity transmission

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and distribution channels as well as lower electricity prices to ensure electrification (p.31).

Hungary

References to industrial heat pumps: No

References to industrial waste heat recovery: No, waste heat is only mentioned in relation to DHC, not industrial processes

References to industrial electrification: No, electrification is only mentioned in general terms and mainly linked to buildings and transport

Ireland

References to industrial heat pumps: No

References to industrial waste heat recovery: No, waste heat is only mentioned in relation to DHC, not industrial processes

References to industrial electrification: Yes

Concerning industrial decarbonisation, the Irish plan sets ambitious targets in the section on key objectives policies and measures. More specifically among others the following targets stand out:

- Reduce fossil fuel demand in industry by 10% by 2030 through energy efficiency measures.
- Through the work of the Industrial Heat Decarbonisation Working Group, increase the electrification and decarbonisation of industry, with associated energy efficiency gains, so that 70-75% of industrial heating is carbon neutral by 2030.
- Expand and enhance supports from the Sustainable Energy Authority of Ireland, IDA Ireland, and Enterprise Ireland with a focus on achieving energy demand reduction, electrification, and biomass adoption in industry.
- Electrification of new and current manufacturing processes displacing the use of fossil fuels where possible and as soon as possible (p.38).

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Italy

References to industrial heat pumps: No

References to industrial waste heat recovery: Yes, although waste heat is mainly mentioned in relation to DHC, not industrial processes

In reference to the hard to abate industrial sectors, the plan indicates the recovery of waste heat as "a very effective priority action to be taken to reduce emissions and consumption (p.234).

References to industrial electrification: Yes

With regards to emission reductions, the replacement of fossil fuels, especially through electrification and the use of hydrogen, is described in the plan as a priority for industry" (p.59).

A challenge that is brought to light when it comes to electrification is the risk of black out. The plan states that "this risk must also be considered in the light of the electricity consumption of the various production sectors. In particular, the high electrification of industry makes this sector particularly vulnerable" (p.77).

Latvia

References to industrial heat pumps: No

References to industrial waste heat recovery: Yes, although waste heat is mainly mentioned in relation to DHC, not industrial processes

More specifically, the plan reference Latvia's intent to "develop and promote the use of waste heat in district heating and cooling, for example by using a data centre, a waste water treatment system (recovery of waste heat stored in wastewater after biological treatment and before discharge into the environment) or waste heat from industrial plants" (p.27).

References to industrial electrification: Yes

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The NECP only briefly refers to industrial electrification on page 113 where it states that the renewable energy (RE) share target for the building sector is not expected to be met. However, the RE share targets for the industry, construction, and ICT sectors are expected to be significantly exceeded, primarily due to more targeted electrification in the industrial sector.

Lithuania

References to industrial heat pumps: No, however heat pumps of industrial size are mentioned in relation to district heating and cooling (p.72)

References to industrial waste heat recovery: Yes

In the plan waste heat is mainly considered in relation to DHC. Lithuania has taken the decision to count waste heat (or cold) in the gross final consumption of renewable energy sources for heating and cooling up to 2030. (p.149)

Planned measures to improve energy efficiency over the period 2020–2040 are listed and include: adopting efficient products and technologies, shifting to low-temperature DH, promoting industrial efficiency, electrification and decarbonisation, expanding smart metering, and using waste heat (p.260).

References to industrial electrification: Yes

One reference is made in the context of hydrogen. On page 48, the plan notes that hydrogen can be used for decarbonisation purposes in "processes and sectors where direct electrification is not technically feasible or competitive". Electrification is also included in the list of objectives in the framework of the decarbonisation of the industry (p. 98).

Luxembourg

References to industrial heat pumps: No

References to industrial waste heat recovery: Yes

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The plan mentions waste heat from industry and data centres but only to be recovered and fed into district heating and cooling systems (p.91)

References to industrial electrification: No, electrification is only mentioned in general terms and mainly linked to transport

Malta

References to industrial heat pumps: No

References to industrial waste heat recovery: No

References to industrial electrification: No

Netherlands

References to industrial heat pumps: Yes

Industrial heat pumps are included in the list of technologies eligible for the SDE++ subsidy (p. 89).

Additionally, the plan cites the deployment of industrial heat pumps as one of the reasons for the projected increase in electricity consumption in industry (p. 139).

References to industrial waste heat recovery: No, waste heat is only mentioned in relation to DHC, not industrial processes

References to industrial electrification: Yes

To achieve the mission of a climate-neutral and circular industry by 2050, one stated intermediate target is to make the industrial heat system more sustainable—up to 300 °C—through reuse and electrification (p. 55).

One tool to make this happen is the National Investment Scheme for Climate Projects Industry (NIKI), a subsidy scheme to roll out innovative techniques in green chemistry or electrification on a large scale in industry. As also stated in the NECP, the NIKI scheme will support larger sustainable investments, using these techniques, with a subsidy for the early years. An amount of 2 024 million euros was allocated for the first

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opening while around 1 billion euros has been set aside for subsequent openings (p. 64).

Poland

References to industrial heat pumps: No

References to industrial waste heat recovery: No, waste heat is only (briefly) mentioned in relation to DHC, not industrial processes (p.25)

References to industrial electrification: No

Portugal

References to industrial heat pumps: Yes

Industrial heat pumps are mentioned on page 67 which reads that "the second largest contribution to the increase of the fraction of renewables in heating and cooling is expected to come from heat pumps. For example, there has been an increasing demand for shallow geothermal systems, the reliability and availability of which makes it possible to meet the needs of residential buildings and services, and possibly to produce industrial heating and cooling".

References to industrial waste heat recovery: Yes

The plan recognises that "at industry level, priority should also be given to decarbonising heating and cooling needs, focusing on the characterisation of installations and needs, including through [...] harnessing excess heat that can be identified as technically and economically feasible" (p.25).

References to industrial electrification: Yes

Among the action measures to promote the decarbonisation of industry, the plan lists "Promoting electrification in industry" which is defined as a crucial process to reduce energy bills and GHG emissions while promoting greater competitiveness of the industry (p. 127). The document also mentioned industrial electrification as one of the priorities for investment to strengthen Portugal's industry and innovation (p. 280).

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Romania

References to industrial heat pumps: Yes, but they are only mentioned in the description of a debate that involved a "broader range of stakeholders, including the Ministry of Environment, Waters, and Forests, the Ministry of Development, Public Works, and Administration, and organisations such as SAMER and CONCORDIA. The discussions emphasised a coordinated approach to meet decarbonisation targets, with the Ministry of Energy outlining support for renewable investments and advancements in geothermal energy and industrial heat pumps" (p.53).

References to industrial waste heat recovery: Yes

Industrial waste heat recovery is mentioned in one of the policies and measures (PAM) that the plan sets to align with the energy national targets. More specifically PAM 45 concerns the replacement of conventional fuels with RES in manufacturing industries. This measure aims at replacing fossil fuels with electricity, hydrogen, RES (including biomass), and thermal energy (including heat produced by auto producers and waste heat from industrial thermal processes), in compliance with the rules regarding environmental protection" (p.141).

References to industrial electrification: Yes

Electrification of transport and industry is listed in the plan as one of the main measures that will contribute to a lower demand for fossil fuels (p.73).

In addition to this, PAM 59 on the "Support for the expansion and modernisation of the electricity distribution network" will contribute to the "rapid electrification of many industrial branches, including electromobility" (p.155).

Finally, the plan recognises that "the transportation and industrial sectors are set to go through electrification, which will have a positive impact on the country's energy landscape. As a result of these efforts, Romania anticipates a reduction in its dependence on imported petroleum products" (p. 228).

Slovakia

References to industrial heat pumps: No

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References to industrial waste heat recovery: Yes

The plan states that a "more efficient use of waste heat in both the energy and manufacturing industry is a high priority" (p.53).

In the heating sector, efficient centralised heating systems will be supported, with heat supplied from renewable energy sources and waste heat from industrial processes (p.69)

Waste heat from industrial processes or tertiary sectors (e.g. data centres or hospitals) is also mentioned in the plan as a source to recover and feed into district heating and cooling networks (p.123).

References to industrial electrification: Yes

The NECP states that "the main measure leading to emission reductions in industry is to move away from solid fossil fuels and petroleum products through the electrification of production" (p.97).

Industrial electrification of the iron and steel sectors is highlighted in the context of implementing key decarbonisation investments in energy-intensive industries (p.50).

The plan also makes reference to the importance of stepping up the development of the electricity grid to increase energy security and promote RES-based electrification (p.73).

Slovenia

References to industrial heat pumps: No

References to industrial waste heat recovery: Yes

Industrial waste heat recovery is barely mentioned in the plan and mainly in relation to DHC (p.149). Concerning its reuse in the industry, when listing the objectives towards decarbonisation, the NECP mentions "a share of at least 30 % of RES (including waste heat) in industry" (p.36)

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References to industrial electrification: No, electrification is only mentioned in general terms and mainly linked to buildings and transport

Spain

References to industrial heat pumps: Yes

In the plan, heat pumps are mentioned as a viable solution for a significant number of industrial uses, and their uptake is encouraged by targeted support schemes in the framework of the PERTE (Strategic Projects for Economic Recovery and Transformation) Programme (p. 144).

References to industrial waste heat recovery: Yes

Overall, the plan mainly emphasises the importance of integrating waste heat with the renewable electricity to power large heat pumps for district heating (p. 247).

Nevertheless, regarding industry, the plan reads that "priority will be given to the implementation of energy competitiveness and innovation measures aimed at increasing process efficiency, waste heat recovery, the incorporation of renewable energy and the integration of CO_2 capture technologies to reduce emissions" (p.101).

References to industrial electrification: Yes

The plan mentions that the electrification of the industry in Spain is increasing (p.23). In general, a lot of references are made about the "electrification of the Spanish economy" (see pages: 33, 37, 42, 43, 56, 69, 114, 130, 137, 405, 449)

Under the Measure 1.10. – "Decarbonisation of the industrial sector" the plan highlights that one of the actions to be promoted is electrification and it adds that "as regards the possibilities of self-consumption of electricity in the industrial sector, although it is being exploited intensively to date, additional potential remains." Furthermore, the same chapter emphasises that "decarbonising industrial processes through their electrification will entail increased demand for electricity, creating needs for new transmission and distribution infrastructure and renewable electricity generation units" (p.142-143).

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Sweden

References to industrial heat pumps: No, only large-scale heat pumps are mentioned in relation to DHC

References to industrial waste heat recovery: No, waste heat is only mentioned in relation to DHC, not industrial processes

References to industrial electrification: Yes

A lot of references about the future increased electrification of the Swedish industry are made in the plan (p.4), which will also happen thanks to the construction of new nuclear power reactors (p.13). In relation to this target, in February 2022 a national electrification strategy was adopted by the government (p.164).

The plan also highlights that "In the industrial sector, electrification takes place as industries shift their production and the start-up of various electricity-intensive activities. […] barriers related to new electricity generation, grid deployment and critical materials are assumed to be solved" (p.174).

3.2 Final remarks of the NECPs analysis

Looking at the NECPs overall, heat pumps are recognised across all Member States as a key technology with the potential to decarbonise heating and cooling in the EU (Figure 1). However, most plans focus primarily on residential applications, with only 10 explicitly mentioning industrial heat pumps. In contrast, waste heat recovery is referenced in 17 NECPs, though the majority describes its use for supplying large-scale heat pumps in district heating and cooling networks rather than for reuse in industrial manufacturing processes. Often, waste heat is acknowledged as a by-product of industry, but instead of being reintegrated into industrial processes, it is mainly considered for district heating and cooling.

Electrification is also widely mentioned. While it is most often discussed in the context of residential and transport sectors, 18 NECPs extend the reference to industry. Overall, all Member States include electrification as a target for the future positioning it as a central pathway to decarbonisation. In some cases, hydrogen is mentioned as a residual option, mainly where industrial electrification is considered less feasible.

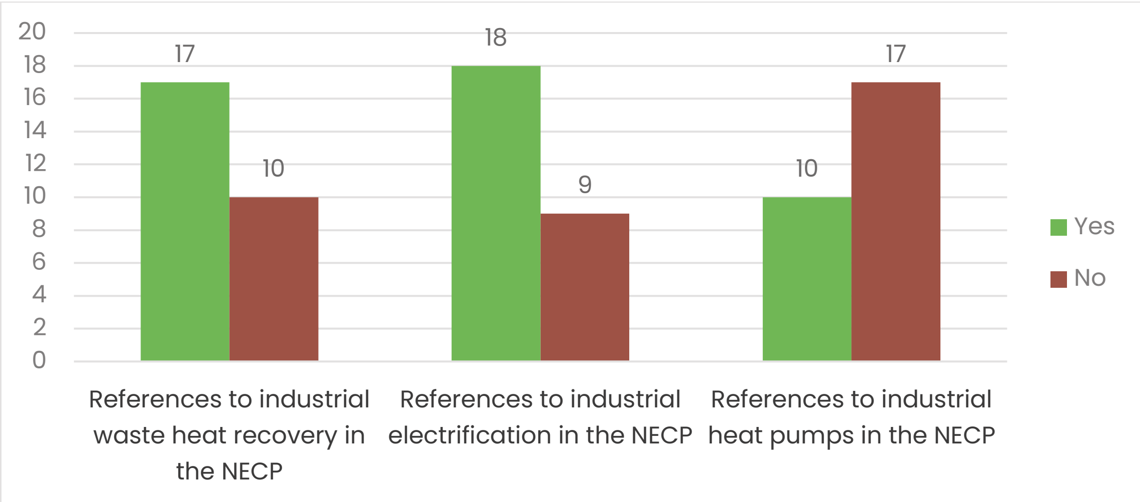

Figure 1: References to Industrial heat pumps, waste heat recovery and industrial electrification in the 27 EU Member States' NECPs

Looking in more detail at these data,

Figure 2_illustrates how frequently industrial heat pumps, waste heat recovery and industrial electrification are referenced in the updated NECPs across Member States. Seven countries (in green) include all three concepts, highlighting a comprehensive approach to industrial decarbonisation. Nine Member States (in yellow) mention two of the three, showing partial but yet significant attention to the topic. Five countries (in orange) refer to only one, suggesting more limited consideration. Finally, sic Member States (shown in red) make no reference to any of the three, indicating that industrial decarbonisation measures in these areas are not yet explicitly integrated into either their ongoing measures or their future strategies.

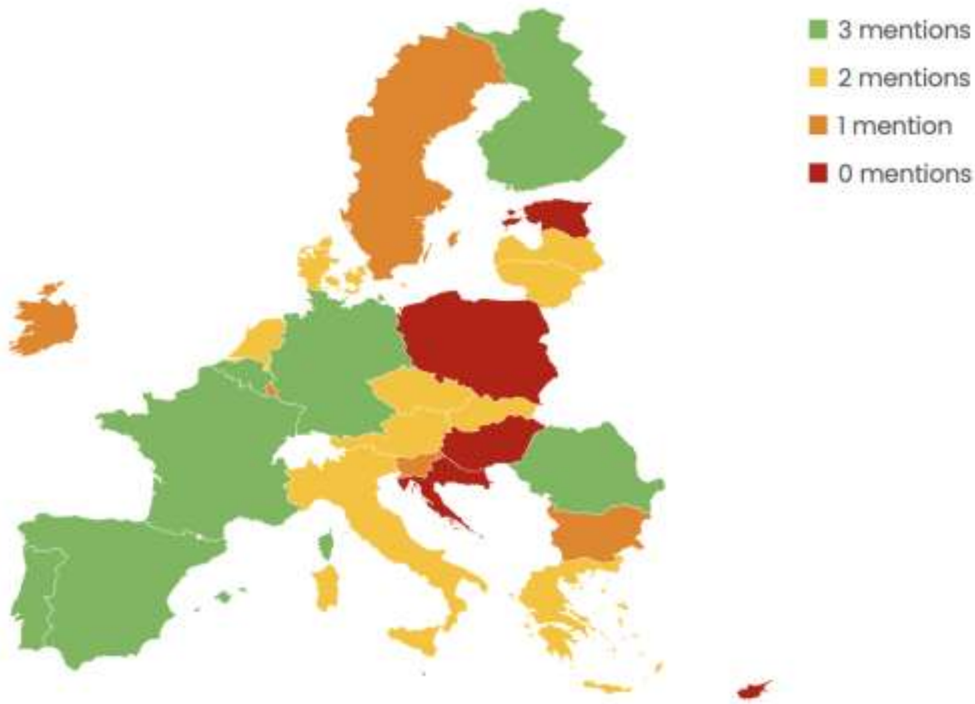

Figure 2: Number of references to industrial heat pumps, waste heat recovery and industrial electrification per country

To conclude, the review of the revised NECPs reveals that while industrial electrification, industrial heat pumps, and industrial waste heat recovery are occasionally mentioned, the level of focus and specificity varies significantly across Member States. Industrial electrification is generally acknowledged, often linked to broader decarbonisation objectives or energy efficiency measures, but concrete targets, funding mechanisms, or deployment plans remain limited in many NECPs. Industrial waste heat recovery is frequently cited in relation to district heating and cooling rather than as a direct tool for industrial process decarbonisation, and industrial heat pumps are only explicitly addressed in a subset of countries.

Overall, the analysis indicates that the potential of heat pumps applications for the industry receives limited attention in most NECPs. For Europe to achieve its industrial decarbonisation goals effectively, there is a clear need to strengthen the attention, planning, and incentivisation of these technologies.

A greater governmental focus on industrial heat pumps deployment in alignment with EU energy and climate priorities is essential to unlock their full potential, build trust and foster private investment in the technology.

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4. THE PERSPECTIVE OF THE INDUSTRY

To complement the findings from the regulatory analysis at both EU and national levels, the SPIRIT Project carried out surveys and online interviews to collect the views of three key target groups. Table 1 shows a summary of the respondents' profiles, data collection methods, number of people contacted and number of actual respondents.

Target group	Data/Information collection method	Number of questions	Number of people contacted	Number of respondents
Manufacturers of high-temperature heat pumps for industrial applications	Surveys (mix of close and open-ended questions)	25	Around 130 from the EHPA Industrial Heat Pump Committee, SPIRIT, Push2Heat, and SUSHEAT projects consortiums	10
National and European Associations representing the interests of the food, paper and chemical industry	Online interviews	12	15	5
Companies in the food and beverage, paper and pulp, and chemical process industry sectors	Surveys (mix of close and open-ended questions)	28	No data (surveys were shared by the associations with their members)	9

Table 1: Overview of respondent categories, data collection methods and participation

Before delving into the results of this field research, it is important to highlight its two main limitations.

The first limitation relates to the low response rate. Despite reaching out to a significant number of stakeholders, only a small share of them completed the surveys or agreed to participate in interviews, as shown in Table 1. Additionally, the lack of direct contact with companies in the food and beverage sector — as EHPA had to communicate through their respective EU and national associations — posed a challenge in securing a higher number of responses.

The second limitation concerns this same group of respondents. The results from food & beverage, paper & pulp, and chemical companies may be biased, as it is very likely that only companies already aware of industrial heat pumps and already considering to electrify their processes took the time to respond.

To help counterbalance these two limitations and broaden the perspective beyond the survey and interview participants, complementary studies on the topic were analysed (see Chapter 5). The survey and interview results will be compared with the main findings of these studies to assess potential alignment.

In addition, a question on non-technical barriers to the uptake of industrial heat pumps was asked during one of SPIRIT events, engaging a wider audience of over 30 industrial stakeholders.

This event was the webinar *"The Road to Sustainable Industrial Heat: A Roundtable on the Future of Industrial Heat Pumps"*, organised by the European Heat Pump Association within the framework of the SPIRIT and PUSH2HEAT projects on 22 May 2025. In response to the question *"What is the primary non-technical challenge preventing a stronger uptake of heat pumps in industry?"*, more than half of respondents (>50% industrial stakeholders) cited the electricity-to-gas price ratio. This was followed by 41% identifying high initial investment and installation costs (see Figure 3), while only 6% pointed to the lack of business models and low awareness of the technology as the main barrier.

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For the purposes of this research, it is important to highlight that these responses are broadly consistent with the findings of the surveys and interviews conducted in the project, which are presented in the following sections.

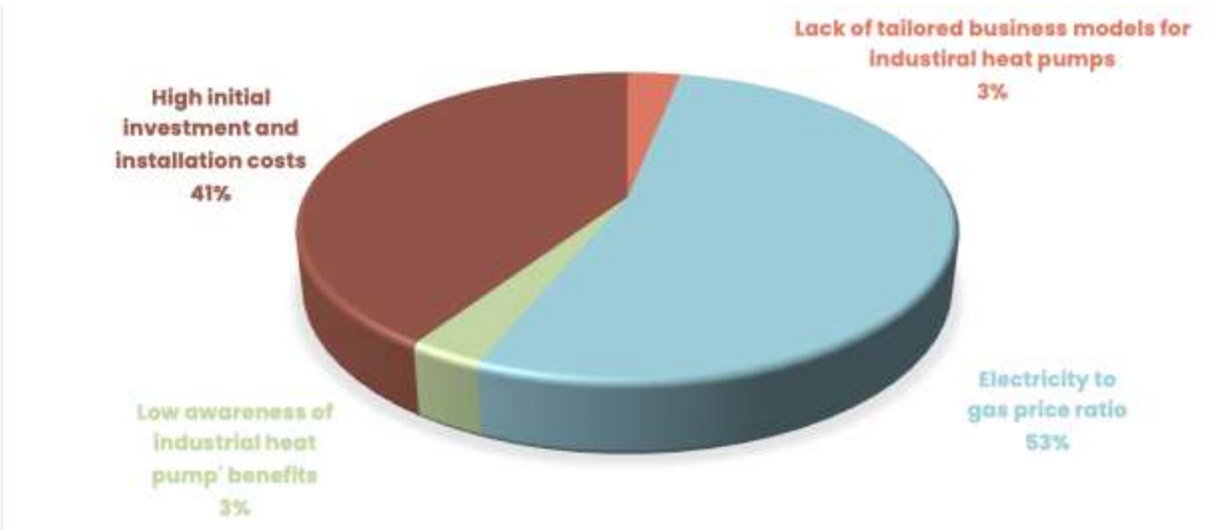

Figure 3: Answer to the question "What is the primary non-technical challenge preventing a stronger uptake of heat pumps in industry?", asked during the webinar "The Road to Sustainable Industrial Heat: A Roundtable on the Future of Industrial Heat Pumps"

4.1 The perspective of the industrial heat pump manufacturers

The first target group consisted of manufacturers of industrial high-temperature heat pumps (HTHPs) who provided insights into benefits, non-technical barriers, opportunities, and strategies to accelerate adoption. A total of 10 responses were collected between July 2024 and February 2025.

The results are organised below according to key themes identified by respondents: perceived benefits, main challenges to adoption and recommended actions.

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4.1.1 Perceived benefits of industrial heat pumps

Through the surveys, manufacturers confirmed numerous known advantages of industrial HTHPs, both technical and strategic:

- Efficiency and sustainability: HTHPs are considered one of the most efficient solutions for decarbonising industrial processes and heating across the EU27. They can recover waste heat and operate at 3–5 times the efficiency of fossil-fuel boilers, delivering significant CO_2 and cost savings.

- Versatility: The ability to provide simultaneous heating and cooling, generate steam, and integrate with thermal storage is highly valued. HTHPs also facilitate sector coupling, including district heating networks and data centres.

- Reliability and established knowledge base: Respondents emphasised high reliability, long service life, broad industrial applicability, and a well-developed knowledge base among technicians and contractors.

- Contribution to green goals: HTHPs support electrification, the circular economy, and CO_2-neutral operations, making them central to a sustainable industrial future.

4.1.2 Challenges to adoption

Despite the benefits, respondents recognised that there are still several barriers to the uptake of industrial heat pumps. As shown in Figure **4**, high upfront costs and financing challenges were cited as the primary obstacles preventing end users from shifting from fossil fuel-based boilers to heat pumps. In second place were limited awareness and a lack of understanding of the technology's benefits among industrial actors and decision-makers. Trust and reliability concerns also persist, including misconceptions regarding achievable temperatures, refrigerant safety, and operational performance. Additionally, some respondents highlighted that a shortage of qualified professionals further limits deployment. Regulatory and market factors—such as fragmented electricity pricing, insufficient incentives, and weak regulatory support—also reduce competitiveness compared to fossil-based solutions.

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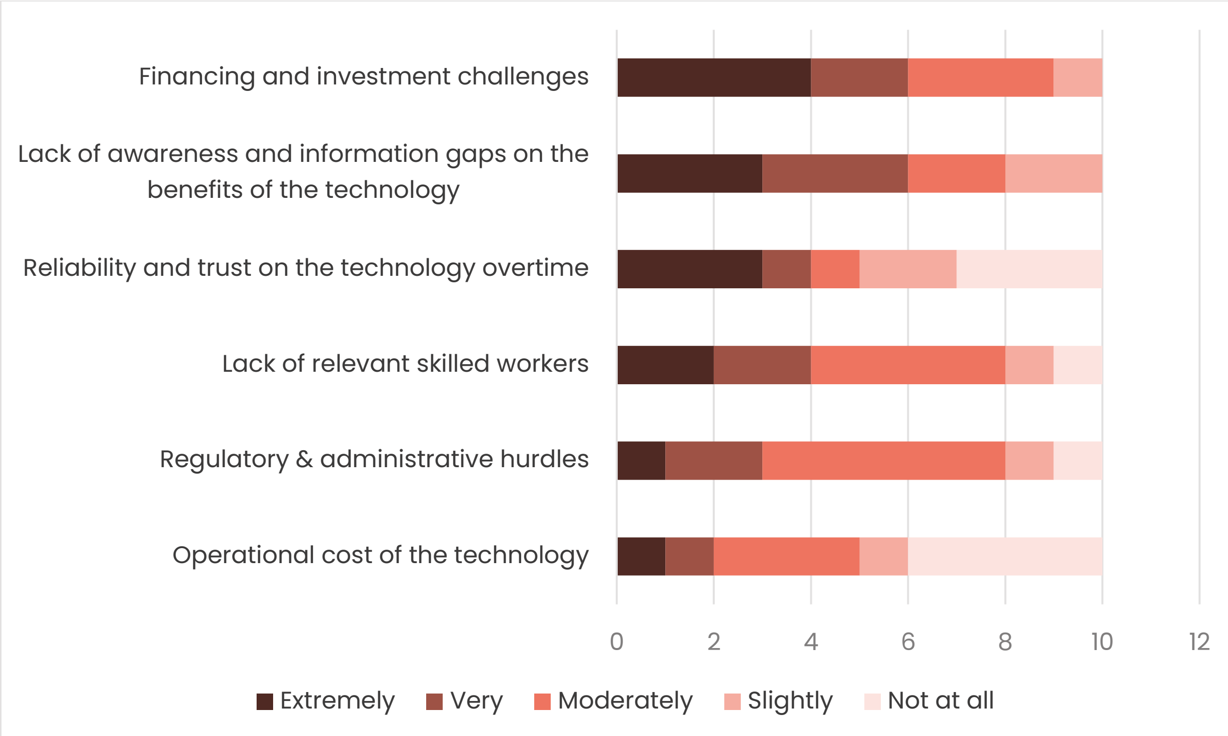

Figure 4: Main non-technical barriers rated by industrial heat pump manufacturers

Focus on misconceptions and unawareness of the benefits

Going a bit more into detail on the lack of awareness and information gaps, one of the threats identified by 9 out of 10 respondents is indeed the existence of misconceptions and a lack of understanding regarding high-temperature heat pumps. Among these the respondents listed the following:

Misconceptions

- Belief that heat pumps can only supply hot water up to ~65 °C.
- Perception that hydrocarbon refrigerants are too explosive for normal industrial use, although they are safely managed in the petrochemical industry.
- Lack of awareness that HTHP designs are typically safer than standard industrial LPG-fired boilers or even domestic gas boilers.
- Over time, trust in the technology should grow, enabling lower safety margins and costs (as seen with NH_3 in refrigeration systems).
- Misconception that HTHPs cannot reach above 90 °C or produce steam.
- More general concerns about:

- Long-term operational costs
- Reliability
- Outdoor temperature limitations
- Low COP performance

Unawareness and lack of understanding

- Limited awareness of the efficiency gains heat pumps can deliver.
- Lack of understanding of how HTHPs integrate into existing and new energy systems, including:
  - Where they make sense
  - What requirements must be met
  - Upfront investment considerations
- General lack of knowledge among industrial actors.
- Heat pumps are often associated only with household applications, with little awareness of their potential to replace fossil boilers in diverse industrial sectors.
- Knowledge gap between experts: heat pump specialists often lack experience with steam systems, while steam engineers are unfamiliar with HTHPs.

Focus on the skills gap

Zooming in the "lack of relevant skilled workers" category, a shortage of skilled professionals represents a significant threat to the successful implementation and operation of high-temperature industrial heat pumps. Looking at the skills aspect, respondents identified the following professional profiles as essential:

- System engineers
- Installers/operators
- Heat/cold-as-a-service providers
- Application engineers
- Installation and service engineers
- Project managers
- Heat pump experts / consultants with up-to-date heat pump knowledge
- Project developers
- Heating and cooling engineers
- Researchers
- Thermal exchange experts
- Compressor technology experts
- Process and control engineers

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When asked whether there are currently enough professionals with these skills, 5 respondents answered no, 1 answered yes, and 4 were unsure.

Nine respondents emphasised that addressing this skills gap is very important or important for boosting the development, sales, and integration of industrial heat pumps. Some measures suggested to overcome the skills gap are listed in the following section on Recommended Actions, while a broader overview of the main professional figures that are needed for a strong industrial heat pump value chain will be included in SPIRIT Deliverable 5.5.

4.1.3 Recommended actions

Considering the benefits of high-temperature industrial heat pumps and the identified bottlenecks, the targeted respondents have suggested some actions to tackle the barriers and boost the deployment of heat pumps in the process industry.
In line with the main challenges identified in Figure **4** the recommended measures to overcome these are illustrated in the chart below (Figure 5).

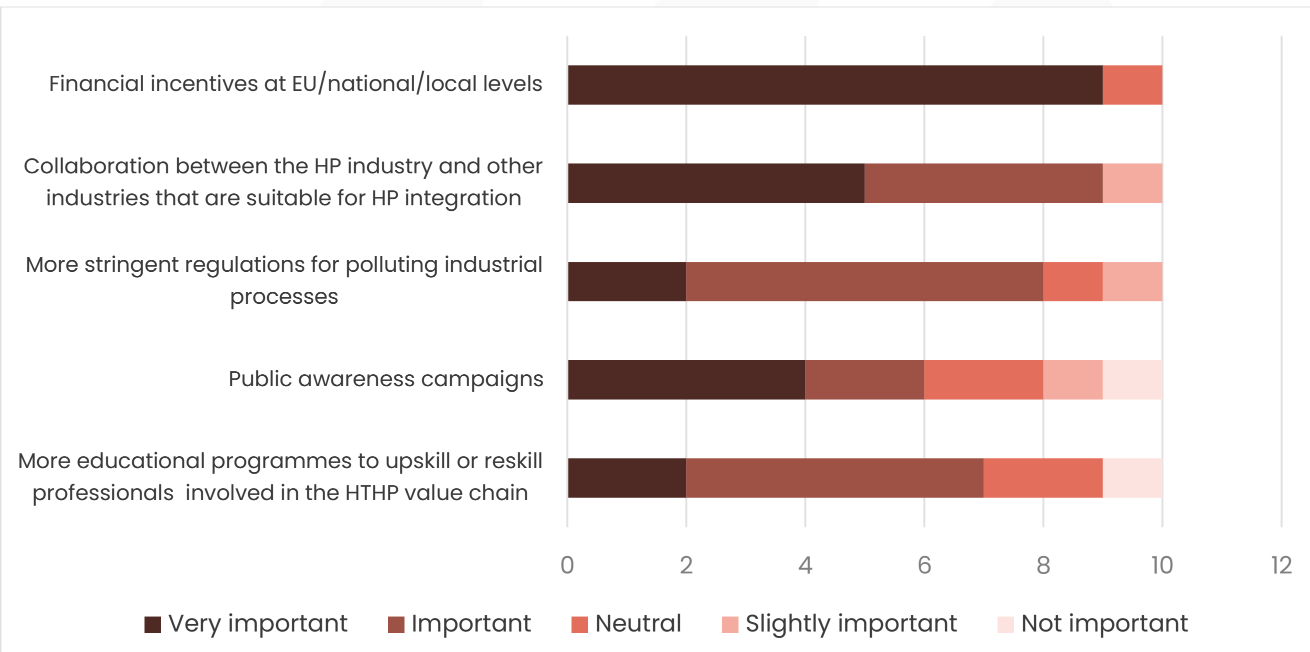

Figure 5: Actions suggested by IHP manufacturers to overcome non-technical barriers and promote the uptake of industrial heat pumps

More specifically, under each topic, respondents proposed to implement the following actions:

- Incentives and financial measures
  Targeted incentives for innovative systems were also recommended. Awareness of existing schemes is low, with only two respondents out of ten able to cite examples for Scandinavian countries and the EU.
  Respondents listed the following financial mechanisms to be boosted:
    - Introduce heat pump-specific subsidies to support first installations and build credibility.
    - Establish stable, national-level financing mechanisms.
    - Improve electricity-to-gas price ratios to enhance competitiveness.

- Collaboration across sectors

  Integration with other industrial and energy sectors is essential to enhance industrial high-temperature heat pumps adoption potential. According to the respondents, strengthening collaboration among manufacturers, end users, district heating and cooling operators, grid operators, investors, and consultants will help to:
    - Update outdated knowledge.
    - Provide guidance on financing and investment options.
    - Align stakeholder requirements to create cohesive deployment plans.

- Regulations, policy support and standards

  Stronger, enforceable policies are needed to phase out fossil-based heating and promote clean alternatives. In line with this, the respondents suggested the following measures to be implemented at EU and National levels:

    - Establish clear standards for industrial HTHP deployment.
    - Introduce binding targets for industrial decarbonisation (2030, 2040, 2050).
    - Implement incentives and penalties aligned with emissions reduction objectives.
    - Strengthen support for the Renewable Heating and Cooling Directive.
    - Prioritise waste heat in decarbonisation goals.

- Awareness-raising

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An overall increase in knowledge of industrial HTHPs among policymakers, urban planners, legislators, and consultants regarding the full range of benefits offered by large heat pumps is recommended. The suggested measures to increase awareness include:

- Increase the number of demonstration projects (supported by dedicated funding) to showcase the actual benefits of industrial heat pumps and build trust on the technology.
- Launch more and high-quality public information campaigns and stakeholder engagement.

- Training and skills

  Increasing a skilled workforce capable of developing, integrating, operating and maintaining industrial heat pumps is essential to ensure the full potential of this technology is unlocked. The main measures listed by the respondents to achieve this are:

  - Re-train contractors and installers to expand expertise beyond conventional heating technologies.
  - Make the field more attractive to students by expanding vocational and university programs on sustainable heating technologies.
  - Offer on-the-job training and updated technical manuals.
  - Foster collaboration between industry, government and academia to align workforce supply with demand.

4.2 The perspective of the end-users

Between September 2024 and April 2025, five online interviews were conducted with representatives of associations from the food, paper, and chemical sectors—three key industries where the potential of high-temperature heat pumps has already been demonstrated. The Associations that were interviewed were:

a. **CEFS** – The European Association of Sugar Manufacturers (EU)
b. **CIRFS** – The European Man-Made Fibers Association (EU)
c. **Plastics Europe** (EU)
d. **ASPAPEL** – the Spanish association for pulp and paper manufacturers (Spain)
e. **FPI** - Food Processing Initiative (Germany)

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The discussions took place on Microsoft Teams, they last around one hour each and were based on 12 questions, previously shared with the candidates. These questions tried to investigate the views of the organisations towards high-temperature heat pumps as a mean to decarbonise the processes of the different industries addressed.

As this deliverable specifically focuses on the non-technical aspects, the questions were tailored so to examine the economic, legal and social factors that prevent or encourage the uptake of this technology in the European process industry.

More specifically, through the 12 questions the respondents touched upon the following topics:

- Their industry and membership base
- Awareness of the use of heat pumps in their industry
- Current energy sources used in their sector (fossil fuels/electricity/biomass…)
- Awareness about their members' inclination to install a heat pump/electrify their processes
- Existence of a sector roadmap for the decarbonisation of industrial processes
- Industrial heat pump's relevance in their sector when compared with other technologies
- Main challenges for a stronger uptake of industrial heat pumps in their sectors
- Awareness of incentives supporting industrial heat pumps in their sector
- Perceived risks associated with the adoption of this technology
- Financial challenges associated with the adoption of this technology
- Need to reskill/upskill workers to integrate heat pumps
- Need for collaboration between different stakeholders.

With the aim of gaining a deeper understanding of the actual needs and perspectives of the companies, the representatives of the associations interviewed were asked to share a survey with their members. A total of nine responses were received: seven from representatives of companies in the food & beverage sector, one from the paper & pulp sector and one from the chemical industry. For confidentiality reasons, the names of the companies are not disclosed.

The following paragraphs provide an overview of the main outcomes of the interviews, organised by relevant sector and an aggregated summary of the responses received through the surveys.

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4.2.1 The perspective of the food & beverage sector

Outcomes from the interview with the European Association of Sugar Manufacturers

CEFS represents the interests of the sugar manufacturers in the EU and Switzerland. They have around 40 members, a lot of which are subsidiary companies of larger sugar producing groups.

Current energy sources used in the sector

Sugar production in Europe remains heavily reliant on fossil fuels, primarily natural gas, following a historical transition from coal. However, the 2022 energy crisis saw many factories temporarily revert to coal or oil. While biomethane—produced from sugar beet residues—is increasingly used as a circular economy solution, it still only meets 5–10% of energy needs. Some companies are exploring steam drying beet pulp for combustion. Mechanical Vapor Recompression (MVR) systems have been installed in a few facilities, though uptake remains limited.

Electrification trends and inclination to install IHPs

There is general awareness of MVR, which functions similarly to a heat pump, but very limited knowledge or trust in broader industrial heat pump applications. A few members recognise that MVR can lead to 5–10% energy savings, but many question whether HPs can deliver the heat volumes required by sugar factories—especially during the intensive 4-month production season. This condensed timeline demands very high hourly heat output, posing a major barrier to HP feasibility.

Sectoral decarbonisation roadmap

The sector does not follow a single decarbonisation roadmap. Instead, CESF has developed a "toolbox" approach, offering various decarbonisation options based on specific company needs. Most members favour a combination of energy efficiency measures and biomass-based solutions rather than electrification. While temperature requirements are consistent across the sector, energy consumption varies significantly depending on the product and process setup.

Relevance and feasibility of IHPs

IHPs face scepticism regarding technical feasibility and capacity constraints. The perception is that electricity-driven MVR is less attractive than thermal vapour recompression due to high electricity prices—sometimes four times higher than gas.

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The Energy Taxation Directive discussions are seen as crucial: to encourage electrification, electricity for industrial users must be taxed as close to zero as possible, rather than increasing fossil fuel taxes.

Barriers to IHPs uptake and perceived risks

Several barriers hinder the widespread uptake of HPs in the sugar industry:

- High upfront costs and the need to redesign heat schemes across facilities.
- Uncertain ROI: If the payback period exceeds 10–20 years, companies are unlikely to invest, especially in a sector where market survival is not guaranteed.
- Regulatory instability: After the abolishment of the quota system and a surge in sugar imports from Ukraine, prices dropped, creating an unstable market. A strong regulatory framework is needed before large investments can be made.
- Process conservatism: Sugar manufacturing has changed little over 150 years. The fear of disrupting well-functioning, seasonal processes is strong, especially as downtime risks significant sugar beet spoilage and logistical bottlenecks.

Financial considerations: incentives and support mechanisms

There is low awareness of HP-specific incentives. Some isolated grants have been given, such as for biomass boilers or Combined Heat and Power (CHP) in Spain, but nothing tailored to HPs. The sector identifies the following financial supports as crucial:

- Lower electricity taxation
- CAPEX subsidies
- Heat-as-a-service models, where a third-party operator installs and manages the HP, could ease the burden on sugar factories and allow State Aid compliance by subsidising the operator, not the factory.

Skills and workforce requirements

Integrating HPs would require workforce training, but this poses significant challenges. Sugar factories are located in rural areas, making it hard to attract and retain young, tech-savvy talent. Older workers are less likely to reskill, and overall, the industry is already struggling with workforce renewal.

Stakeholder collaboration

Initiatives like SPIRIT are viewed positively, as they offer a proof of concept that could reduce scepticism and inspire broader adoption. Demonstrating that HPs can work reliably in real-world sugar production settings is seen as essential to overcoming the trust barrier.

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Outcomes from the interview with Food-Processing Initiative

FPI represents 128 German members across the entire food value chain, including technology providers, food producers, packaging companies, and IT solution providers. While not focused on a specific type of food production, most members are technology and IT providers offering solutions and machinery to the rest of the industry.

Current energy sources used in the sector

The food processing industry primarily relies on gas and electricity, with some companies reverting to oil in response to geopolitical disruptions such as the war in Ukraine. A small but growing number are shifting towards renewable energy sources, including biogas and solar power. Common setups involve burning either biogas or fossil gas to produce both heat and electricity, reflecting a still heavily fossil-dependent landscape.

Electrification trends and inclination to install IHPs

While there is movement toward energy transition, largely driven by greenhouse gas protocols and sustainability reporting requirements, there is no concrete data on heat pump adoption within the sector. Larger companies are beginning to change energy sources, but most of the industry continues to depend on gas due to its historically low cost in Germany and across Europe. Electrification and energy efficiency measures are only now being explored, and even then, not for all processes. A comprehensive needs analysis is seen as a prerequisite for integrating new technologies like IHPs.

Sectoral decarbonisation roadmap

The sector currently lacks a unified roadmap for decarbonisation. This is due to the high diversity among member companies, each with distinct processes and energy needs. Instead of a one-size-fits-all plan, the focus is on identifying specific technologies that best match individual company needs and facilitating connections with relevant experts or solution providers. This approach has been used for other technologies but not yet for heat pumps.

Relevance and feasibility of IHPs

At this stage, there is uncertainty about the relevance and viability of heat pumps in food processing. Given the current priorities and lack of implementation examples, many members are not considering HP investment seriously yet.

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Barriers to IHP uptake and perceived risks

The food processing sector faces several hurdles in adopting industrial heat pumps:

- Lack of awareness about the potential and applicability of HPs.
- Absence of real-world use cases, which creates uncertainty.
- Complex installation processes and high capital investment requirements.
- Lack of “plug-and-play” solutions, which discourages adoption.
- A disconnect between academia and industry: research often focuses on technical potential, while companies need clear answers on integration, cost, and return on investment.
- A volatile political and economic environment, particularly in Germany, with regulatory and policy uncertainties slowing down planning.
- Legal and regulatory ambiguity that creates risk aversion.
- Process reliability: Food production operates around the clock; any interruption can result in significant financial loss.
- The risk of ineffective integration or poor performance may damage the technology's reputation.
- A lack of in-house expertise on the technology or relevant regulations could result in operational or compliance issues.

Financial considerations: incentives and support mechanisms

Although support mechanisms exist, awareness of them is limited. For instance, Germany’s KfW development bank offers low-interest loans for sustainable transformation, but uptake and visibility within the sector remains low. There’s also a perception that overregulation could suffocate innovation, rather than support it.

HP adoption is hindered by:

- High upfront capital costs
- Unclear or extended ROI timelines

These make it difficult for companies, especially smaller ones, to justify the switch without strong financial support or assurance of performance.

Skills and workforce requirements

The industry faces a shortage of skilled labour, and the few available workers are often overburdened. Reskilling or upskilling to integrate new technologies like HPs is seen as challenging and resource intensive. Without adequate workforce capacity, even a technically feasible solution becomes impractical.

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Stakeholder collaboration

Collaboration is viewed as essential to overcoming these barriers. Organisations like FPI actively connect industry players with solution providers, researchers, and financial institutions. This role will be crucial in enabling technology transfer, building trust in new systems like HPs, and fostering sector-wide momentum toward decarbonisation.

4.2.2 The view of the chemical sector

Outcomes from the interview with Plastics Europe

Plastics Europe represents the interests of the European plastics industry. With around 50 companies, the association focuses on the production of monomers and their polymerisation. Some of the members are vertically integrated across the value chain (also focusing on adaptation to end-user needs), other specialise only in petrochemicals or polymer production.

Current energy sources used in the sector

The sector remains heavily reliant on fossil fuels, especially in steam crackers, the starting point for monomer production. These crackers operate at very high temperatures (750–850°C), typically heated by internal combustion. Steam demand is also significant throughout the plastics production chain. Nonetheless, some major players—such as BASF—are pioneering change. BASF received €310 million in German public funding to install a large-scale heat pump for steam generation at their plant in Southwest Germany. Meanwhile, companies like INEOS, SABIC, and Linde are exploring electrification of steam crackers, signalling that electrification is being considered, albeit cautiously.

Electrification trends and inclination to install IHPs

The plastics industry doesn't view decarbonisation simply as electrification. Instead, the focus is on "defossilisation"—removing fossil-based carbon from the process. Since plastics are inherently carbon-based, carbon-free plastics are not technically feasible. That said, HPs could be part of broader electrification and energy efficiency strategies, but their role is expected to remain modest.

Sectoral decarbonisation roadmap

Plastics Europe has developed a 2050 roadmap structured around three pillars:

- Circular economy
- Net-zero emissions
- Sustainable plastics use

These elements are interdependent, with circularity serving as a foundation for net-zero goals. The roadmap predates the Ukraine war and is still in its early stages; a progress report is due in 2026. Early developments show promise, including high-efficiency projects like the INEOS steam cracker in Antwerp, but challenges remain—particularly regarding regulatory clarity around the eligibility of key decarbonisation technologies.

Relevance and feasibility of IHPs

Awareness of heat pumps across the plastics sector is mixed. While approximately half of members understand what a heat pump is, very few are familiar with their industrial applications. This low familiarity contributes to a general lack of confidence in the technology's role in decarbonising plastic production processes.

Heat pumps may offer a small but meaningful contribution to CO_2 reduction in plastics production. For example, BASF's system aims to cut emissions by 100,000 tonnes, though the extent to which these impacts plastics versus chemicals is unclear. Relevance varies depending on how broadly the value chain is assessed. Heat pumps may play a larger role when considering steam generation, circularity, and carbon capture and storage together. However, high operating temperatures, complex plant integration, and lack of track record within the plastics sector limit their wider deployment.

Barriers to IHPs uptake and perceived risks

Major obstacles include:

- Technical challenges: High heat requirements and tightly integrated processes make retrofitting difficult.
- Low awareness and trust: the absence of demonstration projects makes stakeholders hesitant.
- Financial competition: existing processes often reuse internally generated heat, which has no export value and is essentially free, making it hard for HPs to compete on cost.
- Scalability gap: while lab-scale and full-scale funding are available, there's a funding gap at the pilot-to-industrial transition stage, hindering innovation.

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Financial considerations: incentives and support mechanisms

Heat pumps are still viewed as expensive thermal energy sources in plastics production. Aside from Germany's investment in BASF's project, there is limited awareness of EU-level incentives. Better CAPEX support, incentives for mid-scale demonstrations, and a clearer regulatory pathway are needed to stimulate investment.

Skills and workforce requirements

Unlike some sectors, the skills barrier is relatively low. Plastics plants already operate similar technologies (e.g. compressors, cryogenic cooling), and staff are capable of managing HP systems. If implemented as turnkey systems managed by third-party providers, integration would be even easier. Therefore, upskilling is not seen as a major issue.

Stakeholder collaboration

The sector acknowledges that more collaboration is needed to understand the role of IHPs in plastics production. Demonstration projects like BASF's are key to reducing scepticism and fostering knowledge transfer across companies. While near-term potential remains uncertain, stakeholders believe there's value in exploring the possibilities further.

Outcomes from the interview with the European Man-Made Fibres Association

CIRFS represents the interests of European man-made fibre producers (including synthetic fibres like polyester, nylon, aramid, and cellulosic fibres such as viscose rayon). The association includes 22 full members – medium to large companies that extrude fibres in the EU, Switzerland and Turkey - and 20 associate members (industry partners, research institutes, chemical suppliers).

Current energy sources used in the sector

Fiber producers in the man-made fibres industry primarily rely on traditional energy systems—such as boilers, burners, cogeneration, and natural gas—to drive their processes. While some have invested in photovoltaics (PV) and even hydropower or biomass-based steam engines, industrial heat pumps (HPs) are not currently in use. Electricity is used in some cases, but not through HP integration.

Electrification trends and inclination to install IHPs

There is a general awareness of HP technology, but very limited practical experience. Most companies know the technology exists and have even conducted feasibility studies, but these projects rarely progress to implementation. A key barrier is the lack of skilled manpower to manage and integrate HPs, especially into decades-old, complex production systems that require detailed analysis and custom solutions.

Sectoral decarbonisation roadmap

While many companies have developed decarbonisation roadmaps, often predating the EU Green Deal, current economic conditions make implementation difficult. The lack of planning certainty, research partnerships, and reliable data on energy needs further complicate strategic decision-making.

Relevance and Feasibility of IHPs

A critical challenge for industrial heat pump integration in the sector is temperature compatibility. Many industrial processes in this sector require temperatures above 150°C, often exceeding 200°C—a range where current HP technology is either limited or inefficient. Additionally, process variability across companies means that standardised HP solutions are hard to implement, and each use case needs tailored engineering.

Barriers to IHP uptake and perceived risks

Several systemic obstacles hinder HP adoption:

- Financial risks: Companies lack clarity on available subsidies, support levels, and return on investment. The financial commitment is significant, and without government certainty, most are unwilling to invest millions.
- Technical complexity: HPs are perceived as difficult to integrate, operate, and repair, especially compared to familiar technologies like gas boilers or PV systems. Concerns include flammability, reliability, and downtime risks.
- Green electricity supply is often limited or unstable, raising concerns about whether HPs can consistently operate 24/7.
- Bureaucracy: Companies report excessive regulatory hurdles when applying for incentives, discouraging investment in HPs and even PV systems.

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Financial considerations: incentives and support mechanisms

The man-made fibres sector operates in an extremely competitive global market, with 80% of production based in Asia of which two-thirds in China. European producers face thin margins, high energy prices, and intense cost pressures, further exacerbated by the ongoing energy crisis. Energy prices in the EU are three times higher than in the United States, creating a significant disadvantage. Meanwhile, green products—though necessary for long-term competitiveness—face unfair competition due to the lack of a supportive legal framework.

Skills and workforce requirements

Lack of skilled personnel: Most companies don't have in-house HP experts. Upskilling is needed but not always feasible due to limited resources and internal resistance to new technologies.

Stakeholder collaboration

Despite these challenges, interest in HPs is growing. Initiatives like the CIRFS-EHPA knowledge hub aim to bridge the gap between HP providers and fibre producers, promoting collaboration and knowledge exchange. There's also support for alternative models such as "heat as a service", where companies purchase heat from site owners who install and manage HPs—reducing complexity for the end user.

4.2.3 The view of the paper and pulp sector

Outcomes from the interview with the Spanish Association for Pulp and Paper Manufacturers

ASPAPEL represents the paper mills in Spain, covering 95% of the country's total pulp and paper production. The association has 53 members operating 72 mills and it advocates for their interests at national and EU levels.

Current energy sources used in the sector
The pulp and paper sector in Spain uses primarily natural gas (50%), biomass (30%), and electricity (20%). Within this energy mix, natural gas accounts for approximately

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65% of thermal energy use, while biomass—often derived from the industry's own process residues—provides a significant renewable alternative. The sector relies heavily on steam generation, mainly through boilers and cogeneration systems. There is approximately 800 MW of cogeneration capacity installed and running. In total, the industry consumes 4.5 TWh of electricity and 19 TWh of fossil fuels annually. Detailed breakdowns are available in ASPAPEL's Annual Sustainability Reports.

Electrification trends and inclination to install IHPs

Although no heat pumps are currently operational in Spanish paper mills, the first IHP is being developed in the Basque Country as part of an EU-supported project. Across the sector, all members are in the process of integrating decarbonisation technologies, with many already moving toward biomass and increased electrification—particularly considering the implementation of electric boilers.

However, adoption of industrial heat pumps remains in an early exploratory phase, with strong interest but limited deployment. Broader integration is likely as technologies mature and as demonstration projects validate their viability.

Sectoral decarbonisation roadmap

ASPAPEL is developing a sectoral roadmap, both internally and in coordination with CEPI (Confederation of European Paper Industries). Over the past four years, ASPAPEL has supported members in developing individual site-specific decarbonisation plans. While many mills are prepared to start implementing these measures, they are often waiting on government support to proceed. Recent government funding schemes have begun to address this, but progress remains slow due to administrative bottlenecks and limited clarity.

Relevance and feasibility of IHPs

Heat pumps are viewed as a potentially significant part of the sector's decarbonisation strategy, particularly because the temperature ranges (140–150ºC) align well with process requirements in many facilities. However, their true impact will depend on technological maturation—standardisation, affordability, and ease of integration are still needed.

Wider deployment also hinges on:

- Competitively priced electricity
- Grid infrastructure improvements
- Success stories from demonstration projects

- Assurances that IHPs can handle continuous operations typical of the pulp and paper industry

Barriers to IHP uptake and perceived risks

The sector faces several interconnected challenges in scaling up heat pump use:

- High electricity demand from IHPs may overload existing grid infrastructure, particularly in areas with limited capacity.
- Electricity price volatility in Spain presents a financial risk, especially when switching from predictable fuel costs.
- Complex, high-temperature continuous processes require steam at exact specifications; any deviation risks operational failure and loss of competitiveness.
- Capital investment and infrastructure costs can be prohibitively high—some companies have reported that grid connection upgrades cost twice as much as the IHP itself.
- The switch to heat pumps must not compromise reliability, or else risk damaging their reputation within the industry.

Financial considerations: incentives and support mechanisms

Spain's national decarbonisation plan includes funding opportunities for both existing facilities and new builds. While regional governments also offer support, the current timelines are often too short to allow thorough exploration and application of heat pump solutions. Many facilities await outcomes from existing funding rounds and are hopeful that the 2026 support schemes will provide better opportunities for HP-related projects. Additionally, ASPAPEL sees potential in the Innovation Fund, although the paper sector has not been a major participant to date. More inclusion of paper mills in EU demonstration projects could help address this gap.

From a financial point of view, high upfront investment costs, combined with infrastructure upgrades (especially grid-related), pose a major obstacle. In some cases, the cost of preparing for heat pump installation (e.g., grid reinforcement) can be greater than the heat pump itself, rendering the project economically unfeasible.

Skills and workforce requirements

While reskilling will be necessary, the industry already employs technically skilled personnel with experience in cogeneration and steam systems. The main learning curve involves understanding integration without process disruption. With proper support, this challenge is seen as manageable.

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Stakeholder collaboration
Stakeholder cooperation is seen as essential. ASPAPEL:

- Organises webinars at the national level and in partnership with CEPI
- Participates in EU projects like PUSH2HEAT
- Collaborates with research institutions such as TECNALIA
- Engages directly with the European Commission

Such collaboration is vital to bridge knowledge gaps, build market confidence, and scale up deployment across the sector.

4.2.4 The voice of the end user companies – an aggregated analysis

To complement the responses from the associations, 9 representatives of potential companies that could integrate high temperature heat pumps in their industrial processes have expressed their views and concerns on the topic. Among these the three end users of the SPIRIT demonstration sites are included.

Background information and company profiles

In terms of profiling, all 9 respondents stated to be familiar with HTHPs and their applications in the industry.

With reference to the sector and subsectors of the companies, 7 came from the food & beverage sector - more specifically producing: sugar, vegetables and fruits processes, fish, chocolate, bakery - 1 from the paper & pulp and 1 from the chemical sectors.

The main processes using heating in the plants that have been mentioned are the following:

- Water evaporation from the juice in sugar production,
- Maize steeping and starch drying,
- Pasteurisation, sterilisation at Ultra High Temperatures,
- Fat melting, drying of sourdough,

- Air treatment and Cleaning in Place processes,
- Blanching & peeling,
- Shrimp cooking,
- Paper drying.

Out of the nine companies interviewed, eight have already implemented measures to recover waste heat. The measures reported include:

- Heat recovery systems and heat pumps,
- Waste heat recovery from low-temperature steam and condensate water,
- Using hot condensate or glycol heat exchangers to preheat water or products,
- Direct heat recovery in continuous process lines,
- Recuperation from ammonia and air compressors,
- Heating production facilities

8 out of 9 respondents stated that their companies have considered or at least explored the use of high-temperature heat pumps in their processes.

Investigating the decision-making process

Two of the survey questions aimed to investigate the main factors influencing the decision-making process when a company considers investing in industrial heat pumps, as well as the departments involved in the decision.

The respondents ranked the main factors influencing the decision-making process for adopting new technologies in their company, as shown in Figure 6.

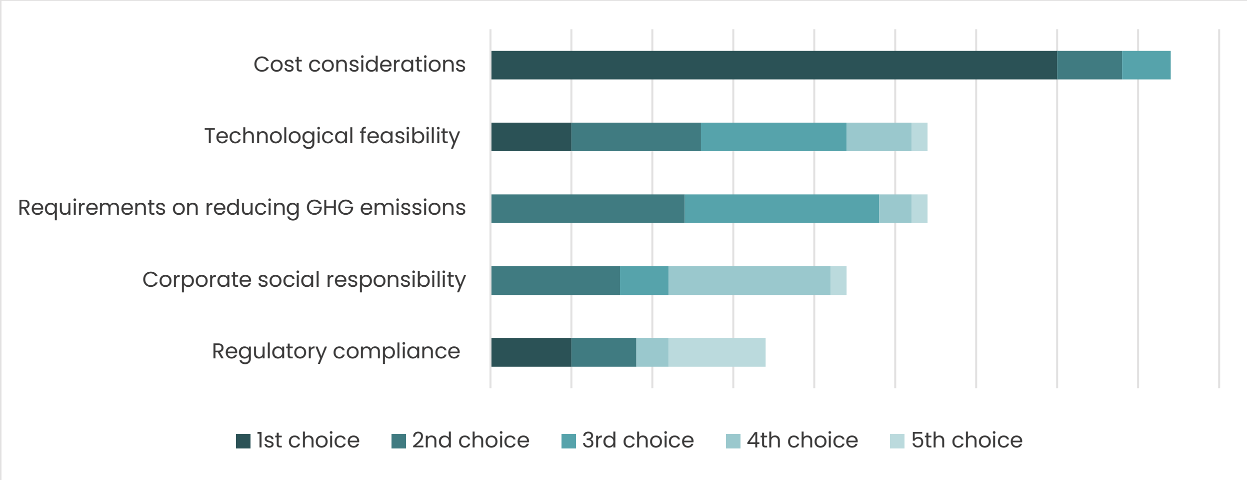

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Figure 6: Factors influencing decisions of buying and installing an industrial heat pump from the end-user's side

For the great majority of respondents, the cost of the project is the primary aspect evaluated when considering an investment. The second factor is the technical feasibility of the system, which should be thoroughly assessed to ensure that production processes are not negatively affected by the integration of the heat pump. This consideration is closely followed by industry requirements to reduce GHG emissions, which are imposed at the EU level. Another aspect influencing the decision-making process is corporate social responsibility, which can be defined as the company's commitment to sustainable practices, environmental responsibility, and maintaining a positive reputation among stakeholders. Finally, regulatory compliance at both national and regional levels also plays a role in influencing the decision, as companies need to be aware of laws and regulations that may affect the investment and the overall feasibility of the project.

Looking at the actors that are involved in this type of decisions (multiple answer question), 8 respondents mentioned the operations management department, 7 the engineering department and 3 the CEO/Executive Leadership.

The cost factor

In line with Figure 6, when asked to evaluate the impact that cost considerations have on the decision to adopt HTHP, all respondents indicated a "high impact". Out of the 9 respondents, 6 have identified specific economic challenges and uncertainties that deter companies from investing in these technologies. Among these, they mentioned the return on investment, operational costs, the cost of electricity relative the gas prices and the cost of electricity transmission and distribution. In addition, some respondents also mentioned some technical barriers such as the technical feasibility and integration with existing steam system, reliability and the availability of additional grid connection.

Regulatory and policy factors

Regulatory and policy factors are worth investigating, as they can either positively or negatively influence the adoption of new sustainable heating technologies. For example, a more favourable taxation policy on electricity can encourage the uptake of heat pumps, whereas the absence of restrictions on industrial GHG emissions may

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delay their adoption. To assess awareness of policies affecting companies' ability to integrate HTHPs, nine respondents indicated that they were not aware of any. When asked how they would normally navigate regulatory challenges when considering new technologies (a multiple-choice question), 8 stated that they would consult experts in the field, 4 would collaborate with regulatory bodies, and 2 would seek legal advice.

Incentives and support

Incentives and support mechanisms are a good way to encourage early adopters of a technology, giving them the opportunity to demonstrate the viability of such technologies to similar companies.

When asked what type of incentives or support mechanisms would encourage their company to adopt this technology respondents answered as follows:

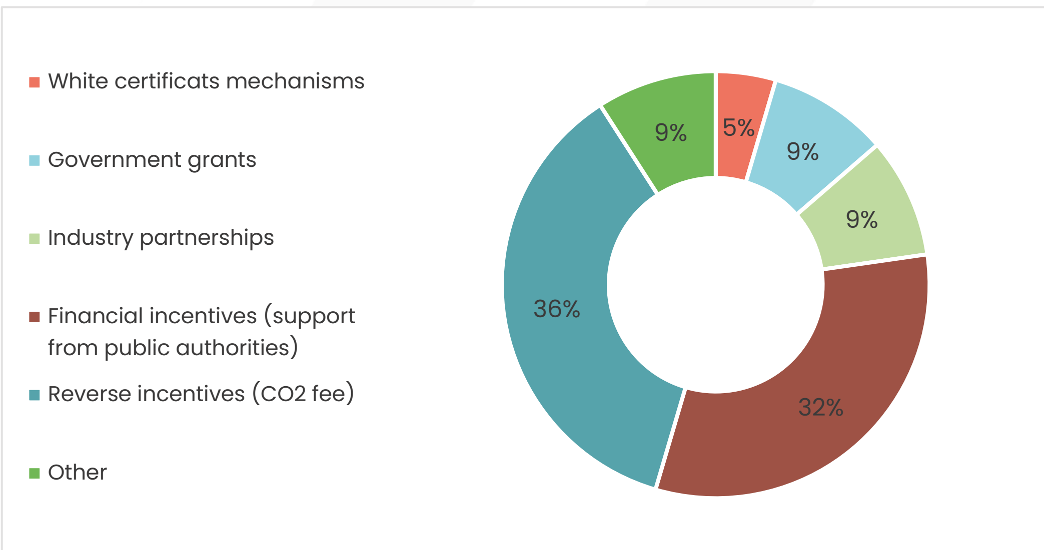

Figure 7: Incentives that would encourage the uptake of industrial heat pumps from the end-users' side

Two respondents specified a more favourable electricity-to-gas price ratio would definitely encourage deployment of the technology.

Asked whether, to their knowledge, there are any governmental initiatives or programs at the national or local level that could facilitate the adoption of these technologies, six respondents out of nine answered positively. The initiatives mentioned were the Spanish PERTE de Descarbonización Industrial, Certificados de Ahorro Energético, the

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Flemish Ecologiepremie+ and the Flemish Call Groene Warmte and the Enova subsidy from Norway.

Perceived risks and concerns

The responses collected regarding the perceived risks of implementing high-temperature heat pumps in industrial processes indicate that most end users associate the technology with moderate to high levels of risk.

As shown in Figure 8 the areas identified as the most significant concerns include the cost of technology development and integration, the technical complexity, and the return on investment, all of which received a high number of "high" and "very high" risk ratings. Technology reliability and the coefficient of performance were also perceived as potential challenges, with responses clustering around the moderate to high range.

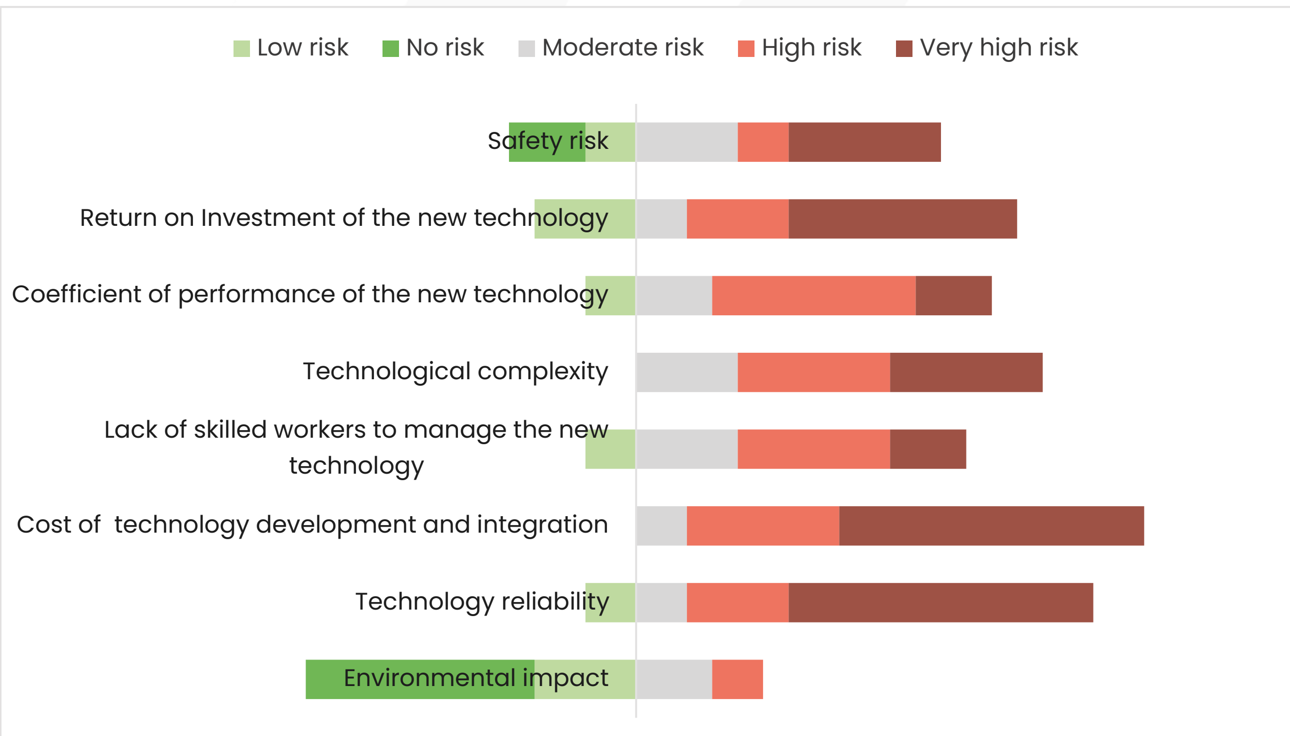

Figure 8: Perceived risks to industrial heat pump adoption on the end-users' side

The lack of skilled workers and safety risks were generally rated as moderate, suggesting that while these are recognised issues, they are not considered major barriers to implementation.

In contrast, the environmental impact of adopting high-temperature heat pumps was largely perceived as low to moderate risk, implying that respondents do not foresee significant environmental drawbacks.

Overall, the results suggest that while the technology is viewed as promising, its successful deployment may depend on addressing economic and technical uncertainties and ensuring adequate workforce training and system reliability.

Information gaps and education

When it comes to awareness of the benefits and challenges of industrial heat pumps, seven respondents indicated that they would like to receive more information on the topic. The two respondents who did not express this need are end users already involved in the SPIRIT project. As shown in Figure 9, concerning the most effective and useful methods for obtaining this information, more than half of the responses voted for demonstration site visits and the sharing of case studies and best practices from the industry. Other relevant and interesting ways to gather information that were selected included - in order of preference - webinars, publications, and governmental initiatives at both national and local levels.

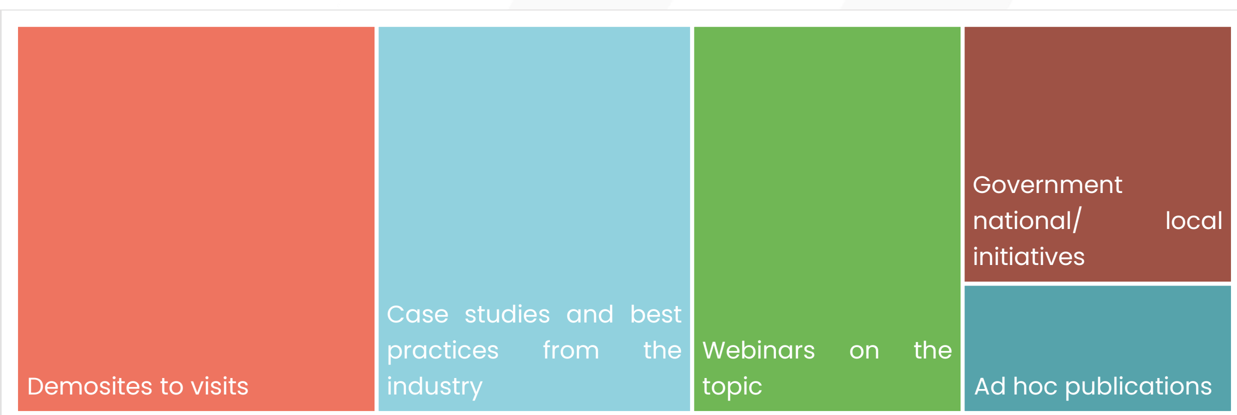

Figure 9: Most effectively rated methods to raise awareness on the industrial heat pump technology

In terms of collaboration with other industries or organisations to share information and experiences regarding the adoption of new renewable technologies, the responses received were as follows: two indicated “always”, five indicated “often”, and two indicated “rarely.”

Business models

Looking at the future most of the respondents foresaw an increased/stable adoption of the technology in their company. While when it comes to considering alternative business models to purchase, only 3 voted in favour. Of these 3, 2 specifically mentioned the heat as a service (HAAS) model, while the third, on top of the HAAS model mentioned the leasing/renting option, conversion cost (per running hour), ESCO contract, shared heat pump for industrial cluster/park. A more detailed overview of the business models available for industrial heat pumps can be found in SPIRIT Deliverable 5.3. on “Business Models and Contractual Agreements”.

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5. ALIGNMENT WITH EXISTING LITERATURE

In the last years, since the SPIRIT project proposal was drafted and submitted in 2021, increasing attention has been given to high-temperature heat pumps, which are now recognised at multiple levels as a key technology for industrial decarbonisation. Consequently, numerous studies, papers and webinars have investigated not only the technical opportunities and challenges posed by this technology, but also the reasons why the industry has not yet fully electrified its existing processes or integrated large heat pumps to reduce CO_2 emissions.

This paragraph aims to complement the results gathered through the SPIRIT surveys above and to examine whether the outcomes of the field research conducted in the project reflect and align with the findings of other studies on the topic, thereby helping to mitigate the limitations imposed by the relatively small number of industry responses collected.

One relevant study[11] on the adoption of waste heat recovery technologies, including industrial heat pumps, was published in January 2022 as part of the Horizon 2020 I-ThERM project. The paper is primarily based on structured questionnaires about barriers to the adoption of WHR technologies, which were issued to a number of EU industries, yielding 46 responses.

Figure 10 presents the main answers to the question: "If you have not considered installing a WHR system at all, what is(are) the reason(s)?" The most commonly reported barriers were "lack of information/technology knowledge," "high initial cost," and "lack of financial support/government incentives." These were closely followed by

[11] Christodoulides, P., Aresti, L., Panayiotou, G. P., Tassou, S., & Florides, G. A. (2022). *Adoption of waste heat recovery technologies: Reviewing the relevant barriers and recommendations on how to overcome them*. Operations Research Forum, 3(1), Article 3. Available at: https://doi.org/10.1007/s43069-021-00108-6

"lack of available infrastructure," "risk of production disruptions," and "running and maintenance costs".

Reason	Number
Lack of information (i)/technology knowledge (ii)	20
Technology risk (iii)	10
No requirement for using the recovered heat (x)	12
High initial cost (iv)	18
Running and maintenance costs (iv)	13
Lack of financial support/governmental incentives (v)	18
Size/available space limitations (vi)	10
Lack of available infrastructure (vii)	15
Production constraints (viii)	12
Risk of production disruptions (viii)	13
Risk of the system negative impact on the company operations (ix)	7
Policy/regulations restrictions (x)	2
Other	0

Figure 10: barriers to the uptake of Waste Heat Recovery solutions identified in the framework of the I-ThERM project

When asked about potential solutions to overcome both technical and non-technical barriers, the 46 respondents suggested:

- research and testing,
- technological innovation to reduce capital costs,
- demonstrated case studies,
- improved availability of information,
- increased installation incentives.

Overall, we can see a strong alignment between the answers gathered through the SPIRIT surveys and those identified in the I-ThERM study, with a significant overlap in the concerns and solutions considered most relevant. This alignment demonstrates continuity across years and industries and reinforces the findings of the SPIRIT field research.

Another relevant paper supporting the results of the SPIRIT surveys is *"Direct Electrification of Industrial Process Heat: An Assessment of Technologies, Potentials* *and Future Prospects for the EU"* by Fraunhofer ISI.[12] The study analyses barriers to electrification in process industries and provides policy recommendations.

Key economic barriers identified include:

- High electricity costs compared to natural gas,
- High initial investments, which encompass not only the technology itself but also the necessary modifications to on-site and surrounding infrastructure.

Organisational barriers include:

- Insufficient deployment of grid infrastructure,
- Challenges arising from changes to production structures when replacing fossil systems with direct-electric installations,
- Long lifetimes of existing process heat installations, which make early replacement expensive and limit electrification opportunities,
- Lack of knowledgeable experts to track technical possibilities,
- Political uncertainty slowing electrification investments.

The report "Electrification Action Plan" by Eurelectric[13] echoes Fraunhofer ISI's study by highlighting similar barriers to industrial electrification, and adds the following:

- Lack of commercially viable solutions for heavy industry
- Limited number of manufacturers
- Weak carbon pricing and EU policies for decarbonisation
- Low awareness of heat consumption in companies
- Incoherent investment incentive mechanisms
- Need for combined process and electrical expertise

Based on these, the report recommends:

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12 Fraunhofer ISI (2024), *Direct electrification of industrial process heat. An assessment of technologies, potentials and future prospects for the EU*. Study on behalf of Agora Industry. Available at: https://www.agora-industry.org/publications/direct-electrification-of-industrial-process-heat

13 Eurelectric (2024), *Eurelectric Electrification Action Plan*. Available at: https://www.eurelectric.org/publications/eurelectric-electrification-action-plan/

- Set clear targets and measure progress, including a 35% electrification target of final energy use by 2030 and an indicator in NECPs.
- Ensure EU energy security by promoting large-scale electrification with clean domestic power, stimulating investment.
- Remove non-electricity-related taxes and levies from electricity bills.
- Provide incentives for industrial pilot projects on electric solutions.
- Modernize grid infrastructure.
- Ensure proper implementation of EU legislation (e.g., Clean Energy Package, Fit for 55).
- Raise consumer awareness through campaigns, observatories, and training programs.

In line with the previous studies, the more recent report *"Supercharging Electrification: Europe Energy Security & Competitiveness"* by Schneider Electric[14] argues that the core barrier to electrification is not technology but rather economics and accessibility. It similarly identifies high electricity prices, complex financing mechanisms, fragmented policy incentives, information asymmetries, and underdeveloped local delivery ecosystems as the main obstacles to accelerating electrification.

Finally, one last relevant paper worth mentioning is *"The Heat Is On: Policy Solutions for Industrial Electrification"* by J. Rosenow et al. This research, also based on expert surveys and a literature review, identifies various barriers to industrial electrification, as shown in Figure 11. Since the categorisation of these barriers closely aligns with the SPIRIT outcomes, their structure and classification helped inform the development of the SPIRIT matrix presented in the following chapter.

14 Schneider Electric (2025), *Supercharging Electrification: Europe Energy Security & Competitiveness*. Available at: https://www.se.com/ww/en/insights/sustainability/sustainability-research-institute/supercharging-electrification-europe-energy-security-competitiveness

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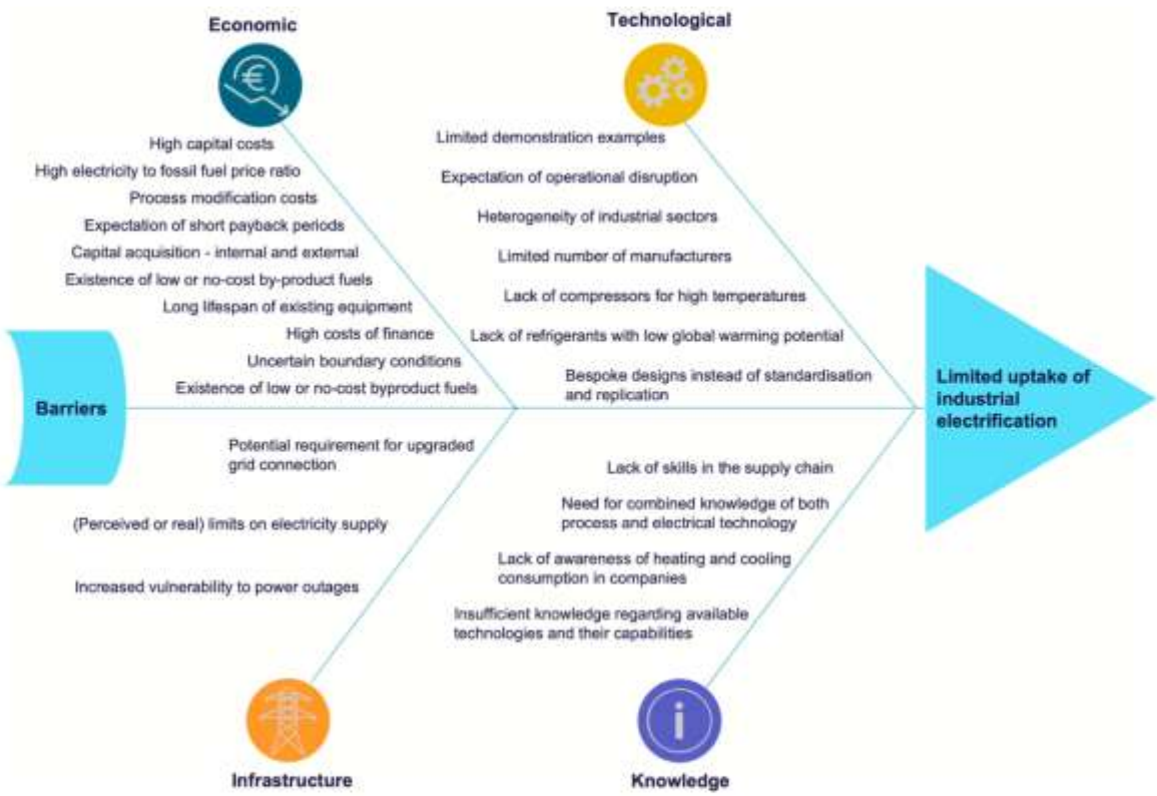

Figure 11: barriers to industrial electrification from "*The Heat is on – policy solutions for industrial electrification*"

In addition to these research papers, substantial policy work on industrial heat pumps has been undertaken. In recent years, EHPA has increasingly focused on industrial heat pump technology, gathering and communicating the key needs of manufacturers to inform the EU decision-making process on this topic. A recent outcome of this policy work is the position paper *"Industrial Heat Pumps to Decarbonise Europe's Industry"*[15], which informed several recommendations presented in the next chapter.

Taken together, the evidence from the literature and previous research projects show a consistent pattern: despite growing recognition of industrial heat pumps as a key decarbonisation technology, their deployment and the electrification of the industry continue to be constrained by non-technical factors. These findings sensibly reflect

15 European Heat Pump Association (2025), Industrial heat pumps to decarbonise Europe's industry. Available at: https://ehpa.org/news-and-resources/position-papers/industrial-heat-pumps-to-decarbonise-europes-industry/

the results of the SPIRIT interviews and surveys and help to validate them. Building on this convergence, the next chapter presents a consolidated and complete inventory of non-technical barriers and corresponding solutions for industrial heat pump deployment.

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6. NON-TECHNICAL BARRIERS AND SOLUTIONS – AN INVENTORY

The previous chapters have provided an overview of the European and national regulatory and policy frameworks and have captured the opinions and perspectives of the two main target groups involved in the industrial heat pump value chain: technology manufacturers — representing the supply side — and technology end users — representing the demand side.

The sections below present an inventory of non-technical barriers to the uptake of industrial heat pumps, along with potential solutions and it is based on the following sources:

- Analysis of relevant EU policies and regulations
- Review of updated National Energy and Climate Plans
- Findings from interviews and surveys with relevant stakeholders
- Lessons learned from the demonstration sites
- SPIRIT 1st policy brief
- Existing position papers, literature and studies on the topic

The aim of this inventory is to take a holistic approach to compiling the barriers to industrial heat pump deployment. It brings together the perspectives of different sectors and types of actors, thereby helping to address the challenges through a range of targeted solutions.

The barriers and relevant solutions are compiled under 7 different categories:

- **COST** includes high upfront CAPEX requirements, OPEX challenges linked to electricity price competitiveness versus fossil fuels, uncertain payback periods, market dynamics affecting financial attractiveness, shortages of subsidies and scalability gaps in funding
- **INFRASTRUCTURE** includes grid capacity limitations affecting connection and stability, high grid expansion costs, indirect CAPEX related to production interruptions, heating and infrastructure planning requirements specific to certain industries, and process disruption risks that impose additional indirect costs.

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- **AWARENESS** includes end users' knowledge of the technology and available support mechanisms, technology providers' understanding of the application market, and policy makers' awareness of both the technology and successful support mechanisms.
- **TRUST** includes concerns about the reliability and feasibility of industrial heat pumps on the end user side.
- **POLICY & REGULATIONS** includes national and EU frameworks that do not sufficiently incentivise industrial heat pump adoption, as well as unclear regulations and guidelines.
- **SKILLS** includes the shortage of qualified personnel for industrial heat pumps.
- **COLLABORATION** includes cross-sectoral cooperation on industrial heat pumps.

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6.1 Cost

CAPEX: high upfront investment costs

Industrial heat pumps need to be adapted to the specific needs of the end user. Because they are **custom-made, the cost of manufacturing and integration is quite high**, as it involves several highly specialised professionals and often requires **readjustments** throughout the process.

Recommendations

- Member States should put in place **financial support for industries that want to electrify** their production processes via high temperature heat pumps under the form of tax deductions or grants.
- **Low-interest loan programmes** should be established to ease access to finance and encourage the deployment of industrial heat pumps.
- **Power Purchase Agreements** should be adopted: these long-term contracts allow an industrial customer to buy electricity from a provider at a predetermined price for a fixed period, ensuring price stability, reducing exposure to market volatility, and improving investment predictability.
- Increase **funding for EU and national R&D&I projects** to achieve **cost reductions through standardisation**, including research and development of modular components for industrial heat pumps to bring down costs.
- Member States and the European Union should implement **clear policies** that promote industrial decarbonisation through electrification and the adoption of industrial heat pumps, with well-defined targets. Policy clarity is essential to drive investment.
- Member States and the European Union should establish **subsidies programmes and grants for** developing existing and testing new **alternative business models** for industrial heat pumps like Energy as a Service or Heat as a Service.
- **Funding for audits**: ensure specific funding for industries to do an audit of their **industrial process** to identify the potential for implementing industrial heat pumps and waste heat recovery.

OPEX: Electricity vs fossil fuel prices

Giving that an electricity input is needed to power a heat pump, **high electricity prices** make it hard for companies to switch from **more affordable fossil fuel**-based alternatives to green technologies like heat pumps.

In some countries **electricity price volatility** represents a significant **financial risk**, especially when switching from more predictable fossil fuel costs.

Recommendations

- Improve electricity-to-gas price ratios to enhance competitiveness by **lowering taxes and levies on electricity**. The EU should provide **country-specific recommendations** through the Energy Taxation Directive, and national governments should implement these recommendations to make electricity costs more competitive.
- Creating a legal framework that **fosters** the **production of renewable energy sources** in the EU will ensure that the phase-out of fossil fuel imports makes EU industry and industrial heat pumps more competitive compared to fossil fuel alternatives.

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SUBSIDIES: Shortage

The last updated versions of the National Energy and Climate Plans shows that national **recognition and incentives for industrial heat pumps deployment** are still rare and not widespread equally in all EU Member states.

SUBSIDIES: Scalability gap in funding

While lab-scale and full-scale funding are available, there's a **funding gap at the pilot-to-industrial transition stage**, hindering innovation. There is a lack of incentives for mid-scale demonstrations.

Recommendations

- Increase the number of **EU/national industrial heat pump specific incentives** especially for first time adopters who are taking a bigger risk to demonstrate if the technology is a feasible solution for their industry and the whole sector.
- **Implement indirect incentives** with penalties aligned with emissions reduction objectives
- The **Innovation Fund pilot auction for industrial process heat decarbonisation can help** support not only innovative technologies but also mature, investment-ready projects, helping overcome the high CAPEX barrier and addressing the current lack of subsidies for industrial heat pump deployment. This auction is also an instrument to fill the gap for mid-scale demonstrations.

UNCERTAIN BAYBACK PERIOD

If the **payback period is too long**, **companies are unlikely to invest**, especially in sectors where market survival is not guaranteed due to strong international competition.

Recommendations

- For a clearer forecast of the investment, companies should make good **use of existing digital twin models**.
- More EU and national funds should be dedicated to **research on technology integration** and on forecasting models that are more accurate for specific technologies and tailored to processes.

ALTERNATIVE GREEN TECHNOLOGIES

In some sectors, existing processes often **reuse internally generated heat**, which is essentially free, making it hard for Heat pumps to compete on cost (Example: Paper and pulp: use of biomass)

Recommendations

- Even in processes with internally reused heat, **industrial heat pumps can upgrade low-temperature heat to higher temperatures**, displacing fossil fuels or reducing biomass use, thereby increasing overall energy efficiency and reducing carbon emissions.
- End-user companies should investigate and identify production processes in which heat pumps can operate most effectively and efficiently.

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6.2 Infrastructure

GRID CAPACITY: connection and stability

High electricity demand from industrial heat pumps may overload existing grid infrastructure, particularly in areas with limited capacity.

There are **concerns** about whether IHPs can consistently **operate 24/7.**

GRID COST: to expand the connection

The **cost to connect to the grid can be prohibitively high** with some companies reporting that grid connection upgrades cost twice as much as the heat pump itself.

Recommendations

- Guarantee timely access to the grid for electrified industrial processes and implement the measures in the EU Grid action plan. In particular:
- **Improving the long-term planning of grids** to accommodate more renewables and electrified demand by steering the work of system operators as well as national regulators.
- Introducing regulatory **incentives** and improved network tariffs **for smarter grids.**
- **Improving access to finance for grids projects** by increasing visibility on opportunities for EU funding programmes, especially for smart grids and modernisation of distribution grids.
- **Stimulating faster permitting for grids deployment** by providing technical support for authorities and guidance on better engaging stakeholders and communities.
- Improving and securing grid supply chains, including by harmonising industry manufacturing requirements for generation and demand connection.
- Grid operators should **consider the flexibility potential of industrial heat pumps:** when planning infrastructure (power plants, transmission, storage), they should assume that heat pumps don't always run at full power on demand, but can shift their operation to balance the grid, based on the cost of electricity. Ignoring this flexibility could overestimate system costs and lead to unnecessary investments.
- **Energy storage solutions** should also be further developed and implemented to maximise the use of existing grid.

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PROCESS DISRUPTION

The **interruption of the production process** to accommodate an industrial heat pump may result in a **loss of profit**, which is one of the main **concerns** of companies exploring ways to electrify their processes.

Recommendations

- End users and technology providers should **establish sector/process specific methods that allow a smooth integration** without interrupting the production
- More demonstration cases covering a larger range of processes should be implemented.

HEATING & INFRASTRUCTURE PLANNING FOR INDUSTRIES

The potential need to **redesign heat schemes and infrastructure across facilities** to accommodate industrial heat pumps can result in higher investment costs. These costs are also difficult to identify in the very early phases when investment decisions are made.

Recommendations

- **Subsidies and incentives** should also cover these often-overlooked costs, which make up a significant part of the investment needed to install an industrial heat pump and ensure safety compliance
- If these costs are expected to be prohibitively high, **alternative business models** such as Heat as a Service or Energy as a Service, which would have a much lower impact on the end-user's infrastructure should be investigated.

6.3 Skills

SKILLS SHORTAGE FOR INDUSTRIAL HEAT PUMPS

The **industry faces a shortage of skilled labour**, and the few available workers are often overburdened. **Reskilling or upskilling to integrate new technologies** like HPs is **seen as challenging and resource intensive.** This **problem is even bigger in rural areas** where some of the factories (especially those linked to food and paper production) are located. Here there is a even **higher shortage of skilled tech-savy workers**.
A **lack of in-house expertise on the technology or relevant regulations could result in operational or compliance issues**.

Recommendations

- Develop and **deliver EU-wide recognised certifications and training programs** for engineers, technicians in industrial sectors on industrial heat pump adoption.
- Member states should allocate resources to re-train contractors and installers to expand expertise beyond conventional heating technologies.
- Member states should make the field more attractive to students by expanding vocational and university programs on sustainable heating technologies. Also, they should push for on-the-job training and updated technical manuals.
- Replicate initiatives such as the SPIRIT Summer school on industrial heat pumps

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6.4 Awareness

TECHNOLOGY AWARENESS: end users

Many **companies** that could benefit from integrating heat pumps into their industrial processes are **not fully aware of the technology** or the advantages it offers for their sector. This lack of awareness represents a **major barrier to adoption**, as it leads to **general ignorance** of the technology's benefits and a lack of confidence in its potential, often fuelled by **misconceptions**.

Low awareness of implementation examples in similar processes holds back investment.

APPLICATION MARKET AWARENESS: technology providers

Technology providers' awareness of the industrial processes and **applications** suitable for their heat pump technologies could also be improved

TECHNOLOGY AND APPLICATION MARKET AWARENESS: policy makers

Policy makers at both national and EU levels often **lack full awareness of the potential of industrial heat pumps.** This slow recognition contributes to an **unclear regulatory framework** for the technology, which in turn undermines trust and slows their adoption.

Recommendations

RTOs, universities, trade associations (representing the interests of the technology provided and of the end users), government authorities and agencies, companies that have installed industrial heat pumps, industrial heat pump manufacturers should come together and organise activities like:

- **Matchmaking events** across sectors,
- **Demonstration site visits** displaying successful integration of heat pump in an industrial setting,
- **Webinars** on the topic also presenting best practices and lessons learned from first-time adopters,
- More and **high-quality public information campaigns** (increased dissemination efforts of what is already there),
- EU and national **financial support to promote dissemination** and awareness raising efforts (e.g. through grants),
- **Training** opportunities on industrial heat pumps targeting master's and PhD students, as well as representatives of companies whose processes could integrate industrial heat pumps (e.g., SPIRIT Summer School)
- **European industrial heat pump and waste heat recovery guidelines**: develop comprehensive EU-wide guidelines for the implementation of industrial heat pumps and waste heat recovery, ensuring consistency, sharing of best practices
- Increase awareness about **industrial heat pump** applications by putting them **as a key area to develop in different European Commission's legislative initiatives**: Clean Industrial Deal, Industrial Decarbonisation Accelerator Act, Electrification Action Plan and Heating and Cooling Strategy.

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SUPPORT MECHANISMS AWARENESS: end users

Companies lack knowledge and clarity on available national and European **support mechanisms**, subsidies, and incentives, which makes investing in the technology appear riskier, as the entire burden seems to fall on the company

SUPPORT MECHANISMS AWARENESS: policy makers

Policy makers lack knowledge of best practices of industrial heat pumps subsidies and incentives that have worked across Europe

Recommendations

- EU and National funding authorities should introduce and effectively promote heat pump-specific subsidies to support first installations and build credibility. Provide **guidance on financing and investment options** through clear written guidelines, info-days, FAQs section on website, Info desk
- Policy makers and relevant stakeholders should **make better use of the results from EU projects on industrial heat pump** development and integration, as well as private initiatives. Lessons learned from these actions should be shared so that successful support mechanisms are well known and can be effectively replicated.

6.5 Trust

TECHNOLOGY RELIABILITY & FEASIBILITY

Companies are reluctant to switch to industrial **heat pumps** because they **see it as a less reliable alternative compared to fossils fuel alternatives**.
The **absence or scarcity of demonstration projects** makes stakeholder hesitant.
Companies are afraid that switching to **heat pumps could compromise their process** thus **damaging their reputation** within the industry.

FEAR OF PROCESS DISRUPTION

Some production processes have only slightly changed over decades and the **fear of disrupting well-functioning processes is strong**. This aspect is even more relevant when the production is seasonal, and downtime means significant loss (ex. Sugar industry).

Recommendations

- National and EU authorities should increase dedicated funding to **support demonstration projects** showcasing the actual benefits of industrial heat pumps **and build trust on the technology.**
- End users should implement industrial heat pumps incrementally, by starting with **pilot in low-risk areas and then scale gradually** once benefits and stability are proven, to minimise risk and build confidence.
- Associations, technology manufacturers and system simulations companies should **spread awareness on digital twins to** run virtual simulations and **predict impacts of the change.**
- Heat pump manufacturers should work together to **develop common standards**, thus increasing the potential of applications for industrial heat pumps.
- **For seasonal operations: schedule changes and maintenance in the off-season** or during low demand periods can help minimize unplanned downtime (Sugar industry).

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6.6 Policy and Regulations

UNFAVOURABLE EU FRAMEWORK

There are signs of **decreasing recognition of heat pump technology in the EU political agenda**: the **Heat Pump Action Plan** was not published, and the **LIFE-CET Heat Pump call** has been removed from the 2025 programme.

Regulatory instability in some EU manufacturing sectors does not allow enough margins for structural investments.

There is a **lack of clear and strong references** to waste heat recovery, industrial electrification and industrial heat pumps **in relevant EU regulations** for the sector.

Recommendations

Put heat pump back at the centre of the European political agenda by:

- **Reintegrating the LIFE-CET Heat pumps calls in the 2026 programme** to investigate industrial heat pumps potential, raise awareness and establish connections
- **Increasing** EU Horizon Europe and Innovation Fund calls for innovative projects aiming to develop pilot sites and integrate **industrial heat pumps** for the first time in certain industrial settings and processes
- Introducing clear and **binding targets for direct electrification for industrial processes** and **prioritise waste heat** in decarbonisation goals: set a EU based target for industrial electrification and require Member States to set national targets for direct electrification for industry, especially for the clean electrification of heating processes.
- Setting a **binding and target for renewables in industry**: the current Renewable Energy Directive only asks Member States to increase the share of renewables in industry by a minimum "indicative" percentage-point. Member States should be required to meet a concrete target.
- Ensuring that **industrial heat pumps** are clearly and explicitly **represented in the Electrification Action Plan,** including dedicated measures for their faster roll out.
- **Making heat pumps default for industrial heat up to 200°C** by strengthening the wording in existing regulations like the RED III and including it as a requirement in permitting and licensing of all new and renovated industrial facilities.
- Expanding the role of waste heat beyond DHC and introduce a **comprehensive definition of waste heat recovery** also expanding to its **use in the process industry**

UNFAVOURABLE NATIONAL FRAMEWORK and BUROCRACY HURDLES

The **lack of references** to industrial heat pumps, waste heat recovery and industrial electrification in the last update of the **NECPs** suggest that heat pumps are not considered among the valid solutions to decarbonise industrial processes in EU at large. In the **NECPs** there is a **low recognition of waste heat recovery potential for industrial processes**

There is a lack of clear political direction fully dedicated to industrial decarbonisation and electrification, which could strongly steer the industry towards investing in clean technology solutions. Without **government certainty**, most companies are unwilling to make significant investments.

Companies report **excessive regulatory hurdles when applying for incentives**, discouraging investments.

Recommendations

- All Member States and local authorities should recognise the benefits and clearly incorporate strategies for the adoption of Industrial heat pumps in their National Energy and Climate Plans and Heating and Cooling Assessments and Local Plans.
- Clear and stronger targets for renewables in industry: the current Renewable Energy Directive only encourages **Member States** to **increase renewables in industry** by indicative minimum percentage points (RED art. 22a). This should be a **requirement** and not just a suggestion.

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6.7 Collaboration

CROSS-SECTORAL COLLABORATION on industrial heat pumps

A **disconnect between academia and industry**: research often focuses on technical potential, while companies need clear answers on integration, cost, and return on investment.

This lack of collaboration discourages new business opportunities, as **end users don't know what is available, and technology manufacturers don't know what the end users need**.

Recommendations

- **Foster collaboration between industry, government and academia** to align workforce supply with demand. Strengthen and replicate the work of organisations like Food Process Initiative (Germany) that actively connect industry players with solutions providers, researchers and financial institutions.
- Promote and replicate **matchmaking initiatives** like CEPI & EHPA collaboration to create opportunities for the two industry segments to meet and discuss on what are the best solutions to electrify the end user process industry, **also through Grants under the LIFE-CET Heat Pumps Call**.
- EU/National associations representing the interests of manufacturers in various sectors should carry out more **communication and networking activities involving representatives of industrial heat pump technology** to exchange on needs and solutions (E.g. ASPAPEL organises webinars on industrial HPs, participates in the EAB of projects like P2H, collaborates with research organisations focusing on industrial heat pumps)
- Ensure that initiatives endorsed by the European Commission, such as the **Heat Pump Accelerator Platform**, are **kept active** so that high-level dialogue among a diverse range of experts and stakeholders continues, by strengthening policy support for heat pump technology in the industry.

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