ECCO

THE ITALIAN CLIMATE CHANGE THINK TANK

INDUSTRY AND ELECTRIFICATION

Strategic opportunities for the National Energy and Climate Plan

POLICY BRIEFING

February 2024

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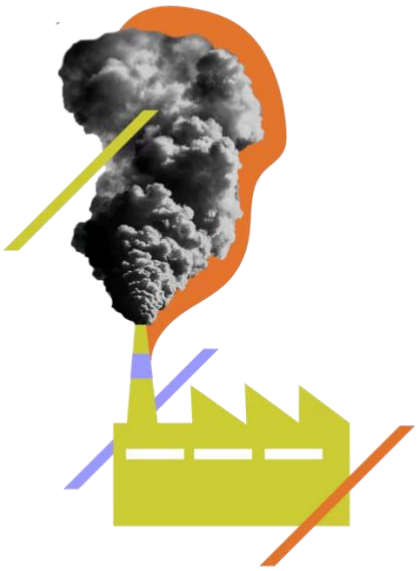

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Summary of the proposal

Framing the country's industrial development prospects within the path of reducing greenhouse gas emissions represents a strategic opportunity. The definition of the National Energy and Climate Plan (NECP) due by next June, is a unique opportunity for action.

On the basis of the in-depth studies carried out by ECCO, there is an evident need to ensure that the NECP:

1. Dedicates a chapter to the decarbonisation of the manufacturing industry, considering the relevance of the sector for the economy of the country (15% of GDP) as well as its contribution to national emissions (22% of Italian emissions in 2021).
2. Identifies the electrification of low-temperature industrial process heat as a solution for decarbonisation by 2030, indicating:
    a. A clear goal to be achieved by 2030 accompanied by a financial strategy, identifying instruments that may favour this transformation, taking into account the availability of public funds through the RePowerEU.
    b. Measures which could promote renewables' deployment in industry, while favouring electrification, also for non - energy intensive sectors.
    c. Policies and measures to reduce the imbalance between gas and electricity tariffs, especially for non-energy intensive sectors, thereby ensuring that businesses opting for electrification can safeguard the competitiveness of their productions both in the short and longer term.

Key findings

The significant contribution to national emissions by the manufacturing sector depends on its reliance on the use of fossil fuels for energy purposes, as well as on emissions that are inherent in certain production processes (e.g. cement, chemicals, etc.).

The decarbonisation of production processes presents complexities related to the availability of technological solutions, which are not always fully developed or economically viable, and implies the need to safeguard business competitiveness.

Furthermore, the manufacturing sector produces those technologies that have a cross-sector impact on decarbonisation; the so-called 'clean technologies' (e.g., batteries, heat pumps, etc.), as also recognised by many recent and ambitious public investment plans aimed at their promotion (for example, IRA or the Green Deal Industrial Plan).

The electrification of low-temperature process heat appears to be a solution that is already applicable, especially for certain production processes. The industrial energy demand for the heat generation at temperatures lower than 150°C in Italy was 7Mtoe in 2021. The electrification of the 50% of this demand would allow for a reduction of emissions of approximately 8MtCO_2 by 2030. This would substantially contribute to reaching the Effort Sharing Regulation (ESR) targets, as 40% of emissions from the manufacturing industry in Italy falls under the ESR scope. Based on the current proposal of the Plan, Italy foresees an emissions gap under ESR of 22-29MtCO_2 in 2030. The Commission

recommended Italy to close such a gap with further efforts under the Regulation[1] with the submission of the final Plan by June 2024.

The electrification of industrial process heat at medium and low-temperature, where compatible with production processes, for example in the food and beverage sectors, or the textiles can offer advantages in terms of cost and energy security, particularly if accompanied by on-site generation of electricity from renewables.

This solution would also entail development opportunities for technology production chains and enabling components. These include industrial heat pumps, a market that would undergo significant development, and where Italy could acquire a competitive global positioning, thanks to its domestic technological expertise and a robust component supply chain.

Therefore, it appears of utmost relevance that the NECP, which is today the key legal instrument for planning climate and energy policies, foresees a section or a chapter explicitly dedicated to the decarbonisation of the manufacturing industry. Within this chapter, the NECP would need to focus on the specificities of the different sectors and production processes, indicating policies for supporting supply and demand of 'green' products and accompanying them with an implementation strategy. This would mean that, for each policy, the Plan should identify a dedicated financial strategy as well as the social implications of the industrial transformation and ways to address that, such as impacts on employment or the need for upskilling and re-skilling of the workforce in specific sectors.

The following report shows some preliminary results regarding the potential of industrial electrification, highlighting the technical and economic opportunities and bottlenecks. With the support of technical partners and the active involvement of stakeholders, from now until June, ECCO will be developing sector-specific technical and economic analyses, including those on the market perspectives of the supply chain for electrification technologies, with a focus on industrial heat pumps: such a study would aim at giving an informed contribution to the definition of the final version of the Italian National Energy and Climate Plan.

[1] Paragraph 1 of the operative text of the COMMISSION RECOMMENDATION of 18.12.2023 on the draft updated integrated National Energy and Climate Plan of Italy covering the period 2021-2030 https://commission.europa.eu/system/files/2023-12/Recommendation_draft_updated_NECP_Italy_2023.pdf

1 THE MANUFACTURING INDUSTRY AND THE NECP

1.1 THE STRATEGIC ROLE OF THE MANUFACTURING INDUSTRY IN DECARBONISATION

In the process of decarbonisation of the economy, imagining the pathway for the reduction of emissions from the industrial manufacturing sector by 2050 is a challenge that needs to reconcile the need to pursue climate goals with that of preserving and revamp the strategic role and the competitiveness of the national and European manufacturing sector.

The manufacturing industry is directly responsible for approximately 22%[2] of national greenhouse gas emissions[3]. These are the result of so called 'process emissions' (for example in the chemical, cement and steel sectors) and of the use of fossil fuels for energy production. In particular, 35% of the energy demand of the industrial sector is satisfied by natural gas[4]. As shown in Figure 1, the industrial sectors with the highest consumption of natural gas are non-metallic mineral processing (21% of overall industrial consumption), chemicals (19%), and paper and printing (15%). However, the demands of the food (9%) and textile (3%) industries are also significant.

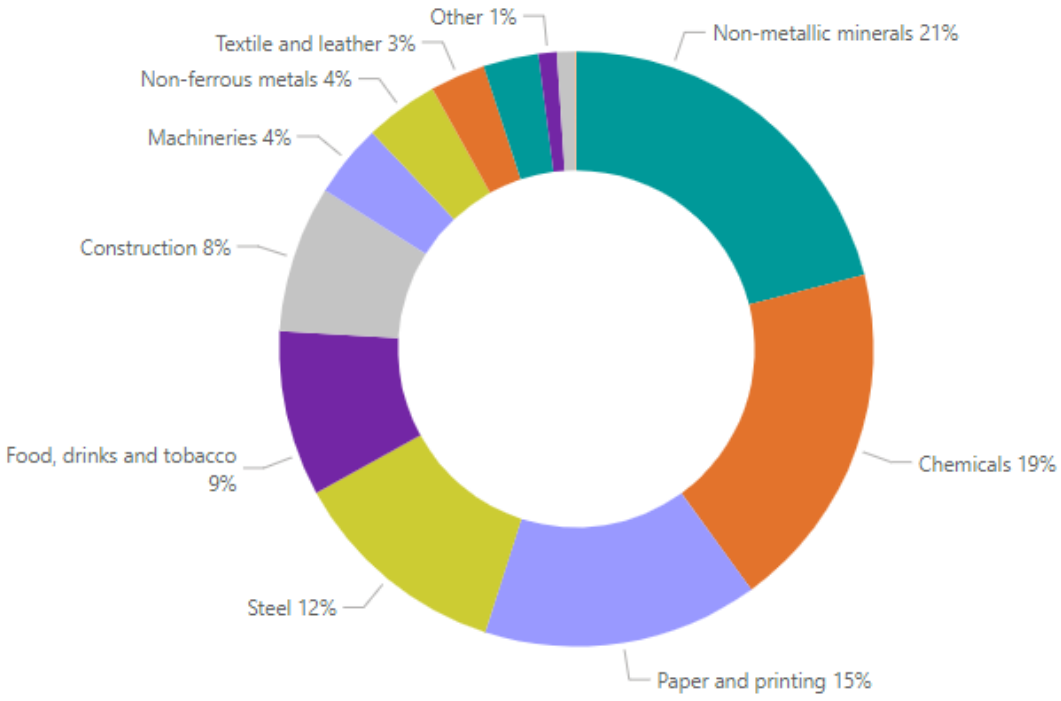

Figure 1 – *Subdivision of natural gas consumption per industrial sub-sector within the manufacturing industry in 2021. Total: 8.9 Mtoe[5].*

[2] This rises to 31% when also considering emissions deriving from the use of electricity.
[3] Processing by ECCO of data from ISPRA. Furthermore, forecasts for the situation of reference in 2030 show that the manufacturing sector will still be second only to transportation in terms of emissions, representing 21% of the national total, a figure that is fundamentally unchanged from current levels.
[4] Processing by ECCO of Eurostat data.
[5] "Il piano nazionale integrato per l'energia e il clima" (The National Energy and Climate Plan), ECCO, December 2023.

The technologies produced by the manufacturing industry contribute to the decarbonisation of the entire spectrum of economic activities and can take advantage from market opportunities which may result by such a process. Manufacturing technologies allow for the production of clean electricity, for the use of zero-emission means of transportation, for the management of domestic heating without consuming gas, and the production of low-temperature heat for industrial transformation processes with electricity, also from renewable sources.

It is therefore no coincidence that the European Union sees the increase in the manufacturing capacity of "clean technologies"[6] as a strategic factor in the achievement of climate goals for 2030. With the Net Zero Industry Act, promoted by the European Commission at the beginning of 2023, the European Union aims to satisfy 40% of demand for the installation of "*net-zero*" technology through European production by 2030[7].

1.2 OPPORTUNITIES FOR THE ITALIAN MANUFACTURING SECTOR

The manufacturing sector plays a fundamental role in the economy of the country. Italian manufacturing is second in the European Union and eighth in the world[8] in terms of added value. In 2019[9], it was represented by approximately 360 thousand businesses, for an added value of EUR 250 billion, fixed investments of EUR 33.5 billion, and 3.8 million workers.

However, over the last thirty years, our country has seen profound changes in its industrial ecosystem, as well as a partial process of deindustrialisation, which has seen the manufacturing sector's contribution to GDP fall from 20.1% in 1990 to 14.9% in 2021[10]. Deindustrialisation is a phenomenon that has also affected other European countries to a similar extent, but in the case of Italy, it has been accompanied by a significant loss in competitiveness, due to the impoverishment of manufacturing specialisation. Italy is now eleventh in the UNIDO global Competitive Industrial Performance Index (CIP), falling from its fourth-place position in 1990.

Decarbonisation is a complex challenge for the manufacturing sector, and, in terms of this challenge, it is necessary to guarantee that businesses maintain their competitiveness and have increased energy security, and that opportunities arise for the revitalisation of the Italian manufacturing industry, particularly for small and medium-sized enterprises (SMEs) (see box below).

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[6] The manufacturing technologies identified by the EU's Net Zero Industry Act include photovoltaic and thermal solar technology, technology for onshore wind-generated energy and offshore renewable energy, battery/accumulator technology, heat pumps and geothermal energy technology, electrolysers and fuel cells, sustainable biogas/biomethane technology, carbon capture and storage technology and network technology.

[7] https://www.consilium.europa.eu/en/press/press-releases/2024/02/06/net-zero-industry-act-council-and-parliament-strike-a-deal-to-boost-eu-s-green-industry/

[8] UNIDO data for 2022, measured in US dollars at constant prices for 2015.

[9] ISTAT (Italian National Statistics Institute) data for 2019.

[10] With regards to this parameter, Italian manufacturing has fallen to 10th place in the EU, behind countries such as the Czech Republic (21.1%), Germany (18.9%), Poland (16.7%) and others (UNIDO data).

THE WEIGHT OF SMALL AND MEDIUM-SIZED ENTERPRISES IN THE ITALIAN MANUFACTURING SECTOR

The national manufacturing sector is highly fragmented, due to the significant weight of small and medium-sized enterprises (SMEs) and micro-enterprises, in terms of number, added value and employees (Figure 2). According to data published by the OECD for 2019, in Italy, employees in smaller businesses in the manufacturing sector accounted for 21.2% of the total, compared to 10.3% in France and 5.9% in Germany. At the same time, the proportion of employees working in companies with a workforce of over 250 was only 27.7% of the total in Italy, compared to approximately 61% in France and Germany.

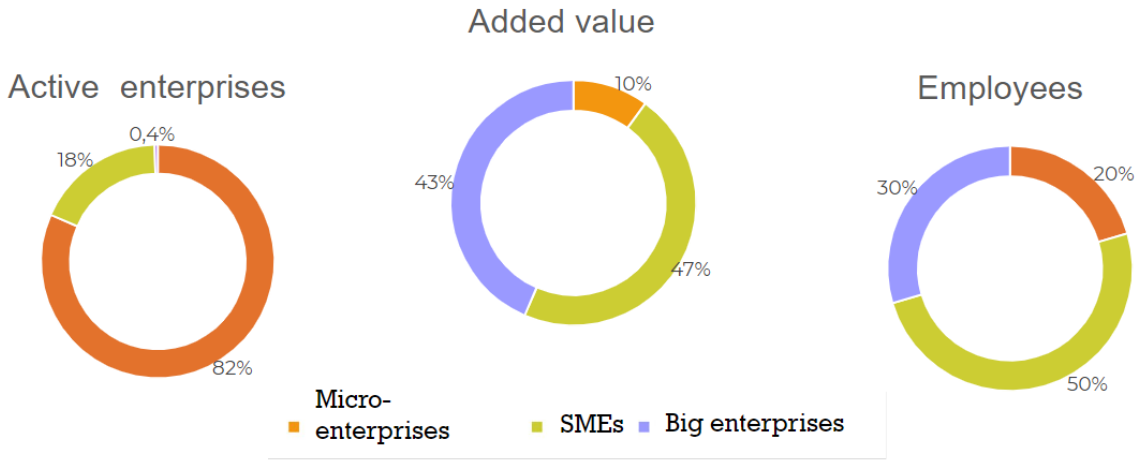

Figure 2 – *Characteristics of the industrial manufacturing sector in Italy. Processing by ECCO of ISTAT (Italian National Statistics Institute) data for 2019.*

Such a characteristic of the national industrial context, often seen as a problem for competitiveness, can represent a significant source of innovation with a view to decarbonisation. SMEs are characterised by an elevated level of flexibility and of product specialisation, but they often suffer from structural problems when seeking to access credit to finance investments necessary for growth and innovation.

When provided with suitable support, SMEs can make a significant contribution to reducing emissions. SMEs, which are most likely to be concentrated in non-ETS sectors, have a high potential for rapid response to market challenges, thanks to decentralised energy solutions that can allow them to contribute to the circular economy.

1.3 A STRATEGY FOR THE MANUFACTURING INDUSTRY AND THE NECP

The Italian manufacturing industry is a complex collection of interconnected sectors. Climate policies struggle, so far, to recognise the specific nature of the various sectors, and in the current proposal for a revision of the NECP, the manufacturing sector is generically mentioned as a single "industry" sector, without further specifying about supply chains or technologies.

There is no specific sector analysis dedicated in providing better understanding of the potential contribution that individual supply chains could make to decarbonisation and the economic transformation of the country. There is no analysis of the impact of policies that are either planned or that have already been implemented, nor is there any indication of a prioritisation of the actions to be taken on the basis of their effect. **The complexity of the challenge posed by industrial transformation instead requires a categorisation of policies with further examination according to sectors and on the basis of the expected (direct and indirect) effect in both the short and long term.**

The lack within the NECP of specific references to manufacturing chains that are strategic in terms of decarbonisation is even more evident with regards to European (the Net Zero Industry Act) and national regulation (the implementation of European plans in funding programmes related to the NRRP), which instead mention and finance actions for the transformation of industry and the development of net-zero supply chains. Furthermore, the domestic industrial sector's heavy dependence on natural gas, despite the high performances in energy efficiency achieved over time, poses a risk to businesses. The competitiveness of companies is, in fact, closely related to the availability of natural gas at an affordable price, but the recent energy cost crisis has shown how risky this relationship is in terms of security and cost of energy supplies. Furthermore, businesses are increasingly called on to transform their production processes with a view to sustainability.

The Integrated National Energy and Climate Plan (NECP) therefore needs to dedicate a specific chapter to the manufacturing sector, providing strategies and policies aimed at:

1. reducing emissions from direct (and indirect) consumption of fossil fuels for energy use.
2. identifying strategic manufacturing chains that enable decarbonisation.

These two components, which are related to the need for security and competitiveness of energy sources, and to the opportunities that are inherent in the creation and development of new ancillary industrial chains, are tangibly represented in the potential for electrification of industrial processes that require heat at medium and low temperatures.

2 THE OPPORTUNITY FOR THE ELECTRIFICATION OF INDUSTRIAL HEAT GENERATION

The many, interconnected crises[11] of the recent years have demonstrated how strategies concerning domestic industrial manufacturing need to be able **to respond in an integrated manner to the need to ensure the energy security of businesses, their competitiveness in international markets, and coherence with regard to decarbonisation efforts**. A strategy for the electrification and the energy efficiency of industrial transformation processes requiring low-temperature heat could reconcile all these needs.

According to the results of our analysis (presented in detail in sections 4 and 5), the electrification of medium- and low-temperature heat (below 150°C) could have high potential for application in less energy intensive sectors, such as food, beverage and textiles. The businesses concerned may be able to increase the security of their energy supplies, emancipating themselves from the volatile cost and supply of natural gas. The shift to electrical energy carriers, also associated to the on-site generation of energy from renewables, may also lead to financial benefits in the medium and long term, as a result of increased compliance with European regulations on sustainable financing[12]. However, the imbalance between electricity and gas prices remains a fundamental obstacle, that needs to be removed to allow electrification to safeguard the competitiveness of businesses in both the short and long term.

Furthermore, the electrification of industrial heat offers significant opportunities for the development of the domestic supply chains of instrumental ancillary items, including industrial heat pumps (see box below), accumulator systems, electricity network cabling, etc. As well as favouring decarbonisation, the development of domestic supply chains for the electrification of industrial processes contributes to reducing the reliance on foreign supplies and can have positive consequences in terms of direct and indirect employment, as well as in complementary investments. As of now, this market still appears not to attract much attention from large-scale players, and, due to the elevated level of engineering that characterises electrification solutions for businesses, its potential for development in Europe and Italy continues to be generally unexpressed.

[11] According to a recent study carried out by MBS Consulting and Innovation Team with the support of ECCO, the 2022 energy crisis has had a severe impact on enterprises in the manufacturing sector with a high volume of business that use gas in their production processes. The study also revealed that as many as 70% of the businesses interviewed see a margin for a further reduction in gas demand, and 55% are prepared to invest in this direction.
[12] Noera, M. e Moro, B, *Mappatura degli strumenti finanziari per la transizione green* (Mapping of financial instruments for the green transition), ECCO Technical Report (October 2023).

ECONOMIC OPPORTUNITIES FOR THE DOMESTIC SUPPLY CHAIN FOR INDUSTRIAL HEAT PUMPS

Data from the European Heat Pump Association show that in 2022, Italy was the second European country for sales of heat pumps, with approximately 513 thousand units, second to the 621 thousand for France, but ahead of Germany with its 275 thousand. According to findings by the International Energy Agency, Italy is the second country in the world behind Poland for growth in the sale of heat pumps in the 2020-2021 period. The Italian segment is one of the most dynamic in a market that, in recent years, has exploded in Europe, where it has reached 20 million units in use (of which 5 million were commissioned between 2021 and 2022). The majority of these are in the residential sector, but the industrial heat pump sector is still developing, and offers market potential.

In terms of production, the domestic supply chain for heat pumps does not appear to correspond to the high demand. In the 2018-2022 period, the average value of heat-pump production (PRODCOM data from Eurostat) in Italy was around EUR 128.5 million, behind Sweden (664.2 million), Germany (617 million), France (526.9 million) and Spain (166.1 million). This is despite Italy having the highest number of heat-pump production plants (50)[13], suggesting that production is on a relatively reduced scale, and is often a sideline for larger enterprises specialised in other areas. At the same time, Italy holds the number-one position in Europe for value of production sold regarding components (parts of refrigeration machines or equipment, and heat-pump parts, PRODCOM data from Eurostat).

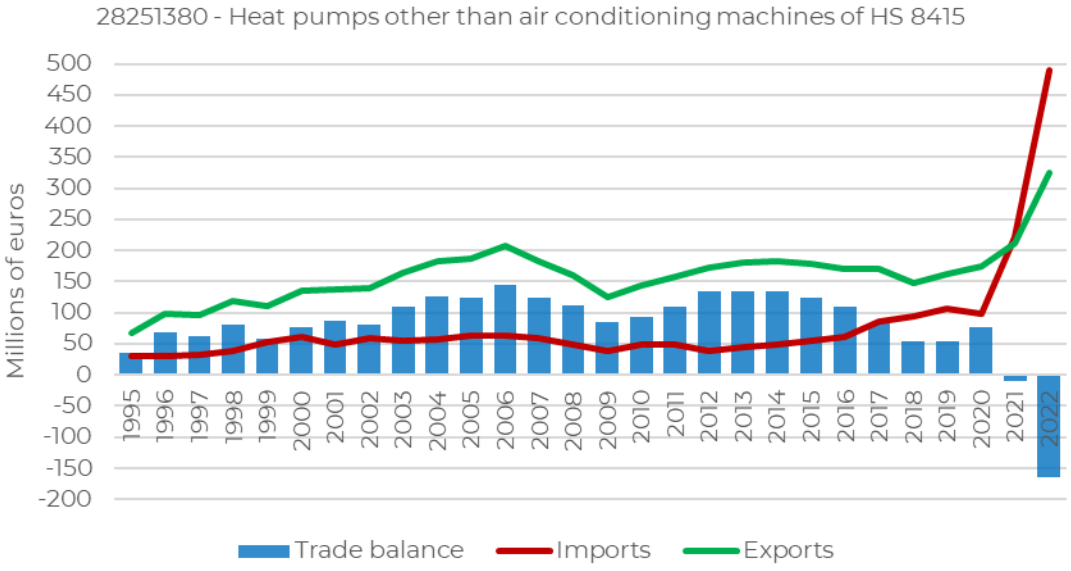

Figure 3 – *Export, import and commercial trade balance for heat pumps in Italy. Source: PRODCOM data from Eurostat in millions of euros at current prices.*

The margins for bolstering the national heat-pump supply chain, in particular for specialised industrial-use systems, are considerable. They are based on the aforementioned existence of particular specialisation in components, which is also demonstrated by a positive trade balance for exports. They are, however, also justified by the recent emergence of a commercial

[13] Lyons, L., Lecomte, E., Georgakaki, A., Letout, S. and Mountraki, A., *Clean Energy Technology Observatory: Heat pumps in the European Union - 2023 Status Report on Technology Development, Trends, Value Chains and Markets*, Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/69478, JRC134991.

shortfall in finished products, which, since 2021, has emerged as a result of growing domestic demand, leading to a sharp increase in imports (Figure 3). Part of this demand could be "captured" by domestic manufacturers, above all considering forecasts for a continuation in market expansion that IRENA estimates at 35 million units worldwide in 2030. Some studies[14] have calculated that 5% of the potential for electrification of industrial heat generation in Europe (37 TWh) corresponds to a market for heat pumps worth EUR 2.3 billion, with the opportunity to create 14,500 new jobs.

3 ENERGY CONSUMPTION AND INDUSTRIAL EMISSIONS IN ITALY

Between 1990 and 2021, national greenhouse-gas emissions from the Italian industrial sector fell by 35%[15]. This fall is due to a number of factors, including the adoption of the EU ETS system in 2005[16], the implementation of measures to improve energy efficiency, the shift from more emission-intensive fossil fuels to natural gas and renewables, a fall in industrial manufacturing production levels and a reduction in the number of active enterprises.

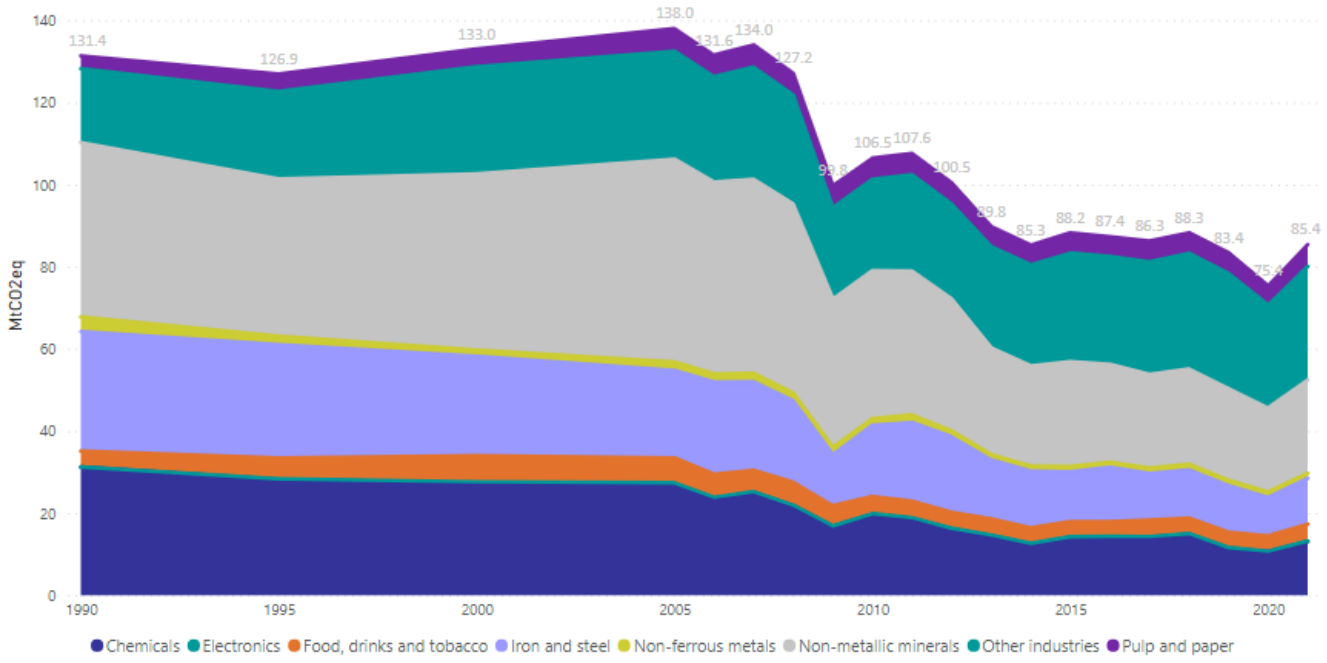

Figure 4 – *Trend in industrial emissions subdivided by sector ($MtCO_2eq$).*

Production plants can be divided between those subjects to the EU ETS Directive (electricity generation, energy intensive sectors and plants with power supplies of more than 20MWt) and those included in the Effort Sharing Regulation[17], where energy production is less significant.

[14] De Boer, R., Marina, A., Zühlsdorf, B., Arpagus, C., Bantle, M., Wilk, V., Elmegaard, B., Corberán, J., Benson, J., Strengthening Industrial Heat Pump Innovation: Decarbonising Industrial Heat, 2020.
[15] Processing by ECCO of data from ISPRA.
[16] "EU emissions trading system", *European Commission*.
[17] "Effort sharing 2021-2030: targets and flexibilities", *European Commission*.

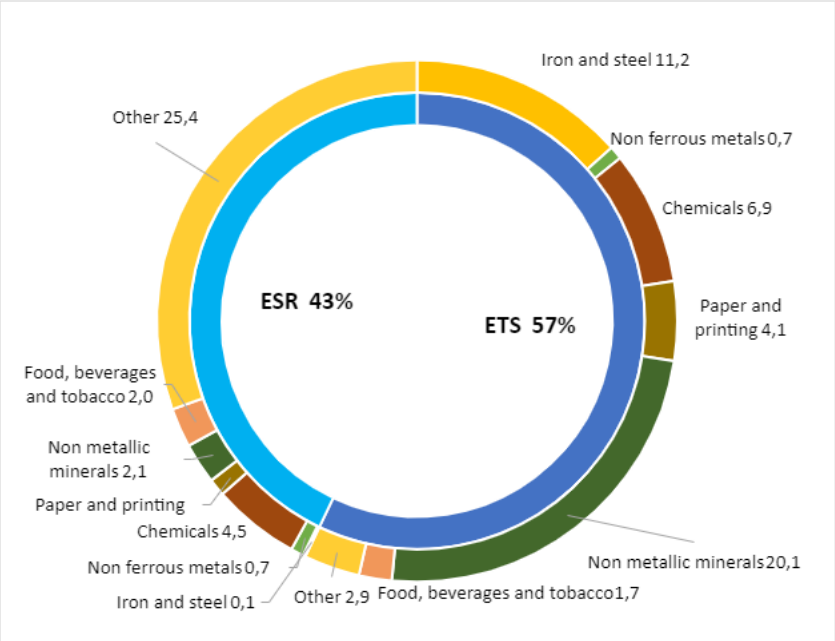

Figure 5 – *Subdivision in percentage of industrial greenhouse-gas emissions among sectors subject to ETS and ESR regulations. Emissions from the individual sub-sectors are shown in terms of absolute value in millions of tons of CO_2eq and refer to 2019.*

The Italian economy has a tradition of energy efficiency that dates far back[18]. With the introduction of the EU ETS in 2005, the industry sector began to reduce more intensively the final consumption of energy, which has shown a stronger trend than added value, leading to an average reduction in energy intensity of 2.7% per year between 2005 and 2019.

Looking back, the industrial sector shows a constant growing trend in electrification of final consumption ever since 1990, with an increase in pace since 2005. In this sector, electricity consumption in 2019 accounted for 41.8% of the final energy consumption[19].

The 2022 energy crisis caused an 8% fall in energy final consumption in the industrial sector[20], and businesses with energy costs higher than 10% of income rose to 42%. However, according to a study by MBS Consulting Innovation Team and ECCO, some of the many emergency measures adopted during the crisis will lead to structural reductions in consumption trends. The study revealed that 70% of businesses see opportunities for further reductions, and 55% are ready to invest in this direction.
For this reason, the scenario developed by ECCO is aimed at investigating the potential of energy efficiency and electrification for the purpose of achieving the 2030 goals, and the policies best suited to achieving them.

[18] The International Energy Efficiency Scorecard still places Italy in 5th place on a global scale for the energy efficiency of its economy. https://www.aceee.org/international-scorecard
[19] "Indicatori di efficienza e decarbonizzazione del sistema energetico nazionale e del settore elettrico" (Indicators of efficiency and decarbonisation of the domestic energy system and the electricity sector), ISPRA, 2021.
[20] "Crisi energetica ed efficienza" (Energy crisis and efficiency), *Osservatorio Energia*.

4 THE SCENARIO FOR THE ELECTRIFICATION OF DOMESTIC MANUFACTURING SECTORS

ECCO has prepared an emissions' scenario looking towards 2030, called ECCO-FF55. The scenario has been developed on the basis of 2021 data, a year in which the industry emitted 86 $MtCO_2eq$, of which 54 $MtCO_2eq$ was from the consumption of energy and 32 $MtCO_2eq$ was from production processes.

In 2021, final consumption of energy by industry totalled 29Mtoe, subdivided as follows:

- 11 Mtoe of natural gas.
- 7 Mtoe of other fuels.
- 10 Mtoe of electricity.

The consumption of natural gas and other fuels was calculated on the basis of UNFCCC inventories, while the data regarding the consumption of electricity were obtained from the National Energy Balance[21].

In terms of energy efficiency, the ECCO-FF55 scenario forecasts a progressive and constant improvement in the energy efficiency of production processes, with an average annual rate of improvement in emission performance of 2.5%. This value is based on the adjustment factor of product benchmarks, as provided for in the fourth phase of the EU ETS[22].

The ECCO-FF55 scenario is part of a wider-ranging effort that, among the various strategies for reduction examined, provides for the electrification of medium- and low-temperature heat, net of the portion of fuels used to produce electricity via HE cogeneration systems and relative losses. In 2021, the industry sector consumed 18 Mtoe of heat, of which 7 Mtoe was at a temperature of less than 150°C. The proposed scenario forecasts that 50% of the generation of low-temperature heat, equivalent to 3.5 Mtoe, can be electrified through appropriate policies to support transition, and with the removal of obstacles, including those related to costs. As shown in Figure 6, the potential for electrification appears to be concentrated in certain sub-sectors such as food and beverage, or under the category "other", which includes a range of sub-sectors (including textiles), many of which fall within the scope of the Effort Sharing Regulation. The estimate is for a reduction of 8.3 $MtCO_2eq$ by 2030, through the electrification of this portion of direct heat, without intervening on cogeneration systems.

[21] "Simplified energy balances", *EUROSTAT*.
[22] EU ETS Directive consolidated text https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023L0959

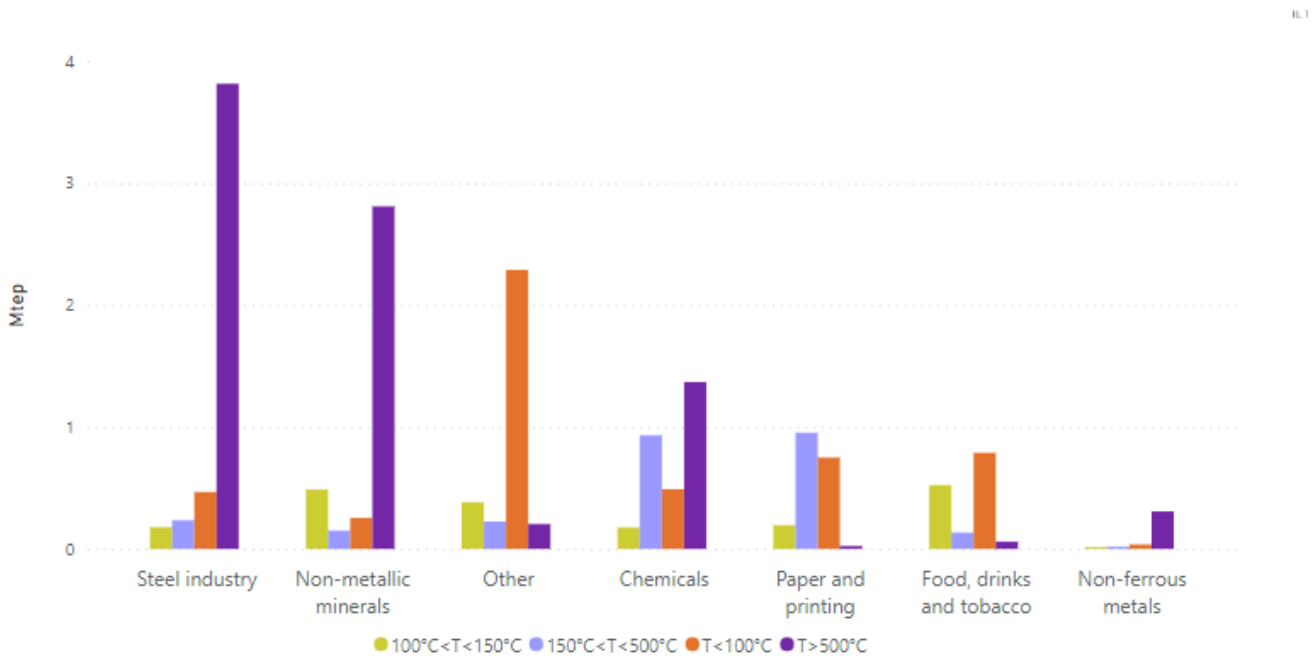

Figure 6 – *Consumption of thermal energy by Italian industrial sectors subdivided by temperature levels in 2021*[23].

The spreading of renewable sources for the generation of electricity is also allowing for the gradual decarbonisation of the industrial sector. Considering, for example, a company that uses a 30-MW gas boiler to generate the heat required for its production processes. In this case, it emits approximately 40,000 tCO_2 per year, while by installing one or more electrically powered industrial heat pumps with a COP of 3, it would generate 16,000 tCO_2 in exclusively indirect emissions, considering the current mix of domestic electricity generation (261 kg CO_2/MWh[24]). With an emission factor of 142 kg CO_2/MWh, indirect emissions would fall even further to 9 kt of CO_2.

[23] Processing by ECCO of data from UNFCCC, National Energy Balance and Kosmadakis, Georg; "Estimating the potential of industrial (high temperature) heat pumps for exploiting waste heat in EU industries", *Applied Thermal Engineering*, 20 April 2019.

[24] "Indicatori di efficienza e decarbonizzazione del sistema energetico nazionale e del settore elettrico" (Indicators of efficiency and decarbonisation of the national energy system and the electricity sector), ISPRA, 2022.

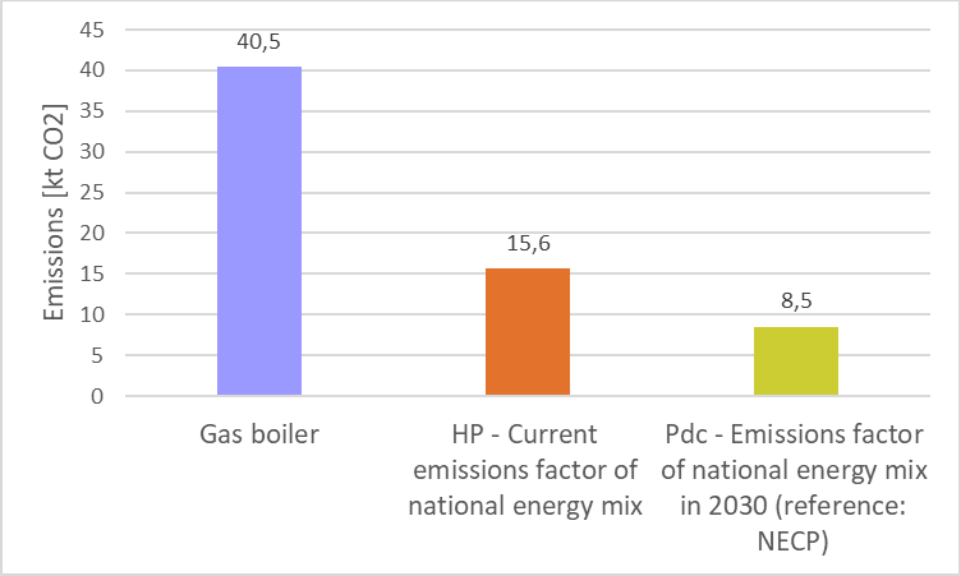

Figure 7 – A comparison of CO_2 emissions from a gas-fired boiler and the indirect emissions caused by an electric heat pump of the same capacity, considering the current emission factor of the national energy mix, and with the factor forecast for 2030 by the NECP.

In the ECCO-FF55 scenario, this hypothesis would see the consumption of natural gas fall from 11.5 Mtoe in 2021 to 7.6 Mtoe in 2030. The reduction in consumption of gas and of emissions is mostly due to measures to improve energy efficiency and for electrification. In the proposed scenario, electricity consumption in the industrial sector falls from 11 Mtoe in 2021 to 9.1 Mtoe in 2030. This reduction is the result of both actions to improve energy efficiency and increase electrification of production processes.

In the ECCO-FF55 scenario as a whole, which – as well as electrification – also involves the use of biomethane, green hydrogen and the reconversion of the ILVA plant in Taranto, greenhouse gas emissions from the Italian industrial sector amount to 67 Mt in 2030, 37% less than in 2021. For further details of the ECCO-FF55 scenario, please refer to the ECCO report "Il Piano Nazionale Integrato per l'Energia e il Clima – un piano per l'azione" (The National Integrated Energy and Climate Plan - a plan for action)[25].

Estimating the investment necessary to decarbonise the industry sector is a complex process. The sector is characterised by a range of processes, which are connected by articulated supply chains. The challenge becomes even more complex when considering the need to balance the reduction of greenhouse gas emissions with the need to ensure that companies remain productive and competitive.

In terms of an assessment related to the electrification of industrial heat generation, the ECCO-FF55 scenario provides for the electrification of 3.5 Mtoe of heat generation at temperatures lower than 150°C between 2023 and 2030. With an investment for electrification technology of between EUR 0.1 and 0.5 million per thermal MW and a running time of 6,000 hours per year, the required investment ranges between EUR 0.8 and 3.2 billion according to the solution adopted.

[25] "Il Piano Nazionale Integrato per l'Energia e il Clima – un piano per l'azione" (The National Integrated Energy and Climate Plan - a plan for action), ECCO, December 2023.

5 ELECTRIFICATION SCENARIO - ANALYSIS OF BOTTLENECKS

The competitiveness of the domestic manufacturing sector is currently closely tied to the availability of natural gas at accessible prices. The limitations of this form of dependency are evident, particularly considering the recent energy cost crisis, therefore electrification, especially with regards to on-site electricity generation, may be seen as an opportunity. Such opportunity presents technical, economic and financial challenges. The wide-scale adoption and distribution of new technologies may encounter obstacles of regulatory or technical-economic nature. An initial analysis of such obstacles can be found in the following sections.

5.1 COMPARISON BETWEEN ELECTRICITY AND GAS COSTS

There is a significant imbalance between the prices of electricity and of gas that makes the use of natural gas more favourable in terms of operating costs. As demonstrated by Table 1, the cost items related to general system charges, excise duties and VAT are significantly higher for electricity and are disproportionate compared to the amounts paid for the consumption of natural gas. This results in high operating costs for companies that decide to use technologies such as heat pumps, electric boilers and solar thermal energy to generate the heat required for production processes.

Cost items	Unit charges[26]			
	Electricity		Gas	
	€/MWh	€/GJ	€/Sm3	€/GJ
Raw materials	147.1	40.9	0.5	13.6
Transmission, distribution and metering	9.5	2.6	0.2	4.4 (67% more than electricity)
General system charges	38.9	10.8 (2534% more than gas)	0.02	0.4
Excise duties	12.5	3.5 (+1684% more than gas)	0.01	0.2
Total excluding VAT	208.0	57.8	0.7	18.6
VAT	45.8	12.7 (VAT at 22%)	0.1	1.9 (VAT at 10%)
Total including VAT	253.8	71.6	0.8	20.5

Table 1 – *Comparison between the units making up tariffs for electricity and natural gas for industrial use. The values refer to the economic conditions established by ARERA for the 4th quarter of 2023 and have been estimated on the basis of an industrial consumer as described below.*

The comparison is based on an average representative business with a consumption of electricity of 13,600 MWh/year and of natural gas of 5.3 million cubic metres/year. In this case, the manufacturer receives an electricity bill of approximately EUR 3.4 million/year and a gas bill of EUR 4.2 million/year, for a total of EUR 7.6 million/year (Table 2).

[26] Charges have been converted into €/GJ on the basis of net energy. For the sake of simplicity, consideration has not been made of the energy mix and the efficiency of electricity generation. The conversion factors used are: 1 KWh = 0.0036 GJ; 1 Sm3 = 0.0385 GJ.

If the manufacturer decides to electrify its production process with the installation of one or more heat pumps, gas consumption would fall to 0 and electricity consumption would increase to 30,800 MWh. In this situation, the manufacturer would be faced with an electricity bill of approximately EUR 7.7 million, higher than the previously described situation (Table 3).

Cost items PRE-ELECTRIFICATION	Total annual cost	
	Electricity [€]	Gas [€]
Raw materials	2.000.626	2.784.639
Transmission, distribution and metering	129.265	898.712
General system charges	528.780	83.714
Excise duties	170.000	39.745
VAT	632.278	380.681
Total	3.405.978	4.187.490

Table 2 – *Cost items from the electricity and gas bills for an average industrial business that consumes 13,600 MWh of electricity and 5.3 million m³ of natural gas per year. The unit charges used for the calculation are based on the 4th quarter of 2023.*

Cost items POST-ELECTRIFICATION	Total annual cost	
	Electricity [€]	Gas [€]
Raw materials	4.530.694	0
Transmission, distribution and metering	273.918	0
General system charges	1.181.417	0
Excise duties	385.000	0
VAT	1.401.626	0
Total	7.772.654	0

Table 3 – *Cost items from the electricity and gas bills for an average industrial business that consumes 30,800 MWh of electricity per year. The unit charges used for the calculation are based on the 4th quarter of 2023.*

The disproportion in tariffs is one of the main obstacles that threatens to limit the adoption of electrification technologies in the industrial sector. A round table organised by ECCO in December 2023, involving the main stakeholders from the sector demonstrated that the uncertainty surrounding gas supply experienced with the price crisis had led to the adoption of "safe" solutions that are, however, not in line with decarbonisation goals, such as the installation of diesel-run backup units. In order for these solutions to serve as an incentive for companies to set in motion an effective process for the decarbonisation of medium-low-temperature heat production, it will be necessary to restore the balance between general system charges, excise duties and VAT for electricity and for natural gas. Doing so would mean that businesses deciding to stop using gas would not encounter disadvantages in terms of energy costs.

5.2 INVESTMENT COSTS

Investment costs for electrification technologies are higher than those for traditional systems that use fossil fuels for the production of direct heat and of steam. According to projected costs published by the European Commission, a traditional natural-gas boiler has an investment cost of EUR 0.11

million/MW[27], while an electric boiler requires an investment of EUR 0.12 million/MW (9% more). CAPEX increases significantly for heat pumps (EUR 0.33 million/MW, 200% more) and for solar thermal energy (EUR 0.47 million/MW, 327% more).

5.3 CONNECTION TO THE ELECTRICITY POWER GRID

Another aspect that emerged during the round table organised by ECCO was that the connection for new high-consumption users to the electricity power grid is a complex process with the current infrastructure. There is, therefore, a need to improve the distribution capacity of the grid, particularly in industrial districts, and to increase on-site electricity production. Despite the fact that the demand for electricity in the industrial sector may increase due to electrification, one should bear in mind that the increased efficiency that some technologies allow would reduce this increase, especially with the use of heat pumps.

5.4 LOAD MODULATION SERVICES

Some electricity intensive industrial consumers traditionally provide the Italian electricity system with interruptibility services. With the application of the new Testo Integrato del Dispacciamento Elettrico (Integrated Text for Electricity Dispatching), similar services will be increasingly present in the dispatching service market and should allow consumers to participate in offering a range of flexibility products, including forms of ultra-rapid reserves to be supplied for brief periods and rendered possible through the installation of batteries. In general, as occurs in the markets in other European countries, an increasing portion of the value of reserve and balance service will be supplied by grid management companies on-site to customers (rather than by activating gas-powered generation plants). This, on the one hand, is consistent with decarbonisation, and on the other hand provides an additional opportunity for the market to recover investments in the electrification of energy consumption.

5.5 STAFF TRAINING

The lack of engineering skills and knowledge necessary for the redesigning of production lines and the integration of processes, as well as a shortfall in personnel trained in these matters, is an obstacle to the spreading of electrification solutions in the industrial sector, together with the lack of a clear political framework[28].

6 THE ROLE OF THE NECP AND INDUSTRIAL ELECTRIFICATION

The energy efficiency increase and the electrification of industrial transformation processes that use low-temperature heat calls for a national industrial strategy. Such a strategy needs to recognise the

[27] "Long term projections of techno-economic performance of large-scale heating and cooling in the EU", European Commission.
[28] Wei, Max; McMillan, Collin; de la Rue du Can, Stephane; "Electrification of Industry: Potential, Challenges and Outlook", 13 November 2019.

specificities of sectors and production processes, and at the same time should include measures to promote complementary and ancillary supply chains.

The NECP needs to set out an integrated approach that takes these elements into account, adequately considering the specific nature of sectors, first and foremost with a macro-distinction of energy intensive and non-energy intensive sectors. In its current form, it merely offers a list of measures, but none of these are tailored to the demands for industrial electrification of the various sectors. At the same time, these measures are not associated with actions to develop ancillary supply chains.

Revision of the NECP needs to include a specific chapter dedicated to manufacturing industry, allowing the specification of:

- A clear goal to be achieved by 2030 accompanied by a financial strategy, identifying instruments that may favour this transformation, taking into account the availability of public funds through the RePowerEU.
- Measures which could promote renewables' deployment in industry, while favouring electrification, also for non - energy intensive sectors.
- Policies and measures to reduce the imbalance between gas and electricity tariffs, especially for non-energy intensive sectors, thereby ensuring that businesses opting for electrification can safeguard the competitiveness of their productions both in the short and longer term.

These tools all contribute to achieving goals for decarbonisation and for the penetration of renewable energy sources into the electricity system; they can favour energy security and the sustainability of production processes in the domestic industrial sector, and last but not least, they focus investments and research & development on supply chains for electrification technologies.

It would also be advisable to foresee, with regards to potential for development, which actions would support the creation or amplification of a domestic supply chain of products and technologies that enable the electrification of industrial heat generation.

An industrial strategy for integrated decarbonisation for the electrification of industrial processes is shown in Figure 8. The measures for the electrification of industrial processes need to be included in the overall strategy aimed at the specialisation of a number of manufacturing chains, in this case that of industrial heat pumps.

This can be followed by the identification and differentiation of policies for supply and demand. In the first case, policies for supply act directly on the production capacity of businesses, with the aim of improving financial conditions, technological competitiveness, access to infrastructure, human capital and know-how. In the case of policies for demand, the aim is to modify (in this case stimulate) demand for products from the relative supply chain.

In turn, policies for supply and demand can be classified as "direct" or "indirect", depending on whether they act directly on the businesses involved or whether they provide indirect support by acting on favourable related factors. A number of examples of policies regarding the supply chain for products for electrification are listed to the right in Figure 8.

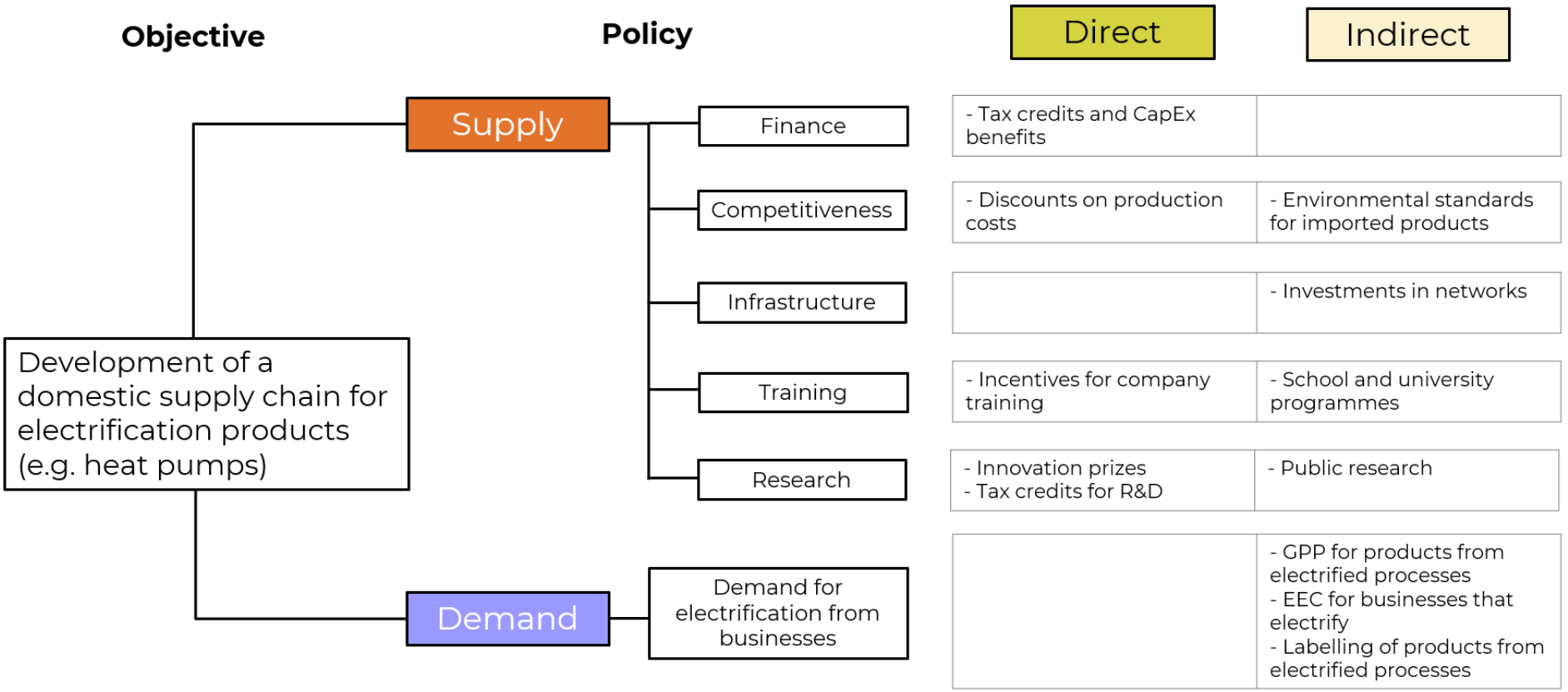

Figure 8 – *Analytical diagram prepared by ECCO for the identification of industrial policies aimed at the development of a domestic supply chain of products for electrification.*

7 CONCLUSIONS

Enterprises are looking for solutions for the decarbonisation and the sustainability of their production processes. Industry is calling for an in-depth sector-based examination that can foster a decarbonisation strategy, taking into account the particular nature of the various sectors. However, the national regulatory framework lacks mid- and long-term indications for the orientation of investments.

The transformation of industry through the electrification of low- and medium-temperature process heat offers energy supply advantages and economic opportunities to Italian businesses, particularly SMEs. In defining a strategy for electrification, it is essential to assess the socio-economic impacts of the choice of different technologies, and to balance supply-side policies that bolster the domestic production chain of technologies combined with policies that foster the demand by user companies of such technologies.

The electrification of the industrial sector poses technical, economic and financial challenges, such as imbalances in the cost of electricity and gas, high investment costs for technologies such as heat pumps, and the need to integrate new high-consumption users into the electricity grid. The installation of energy storage systems and the lack of qualified personnel are further obstacles.

On the 5th of December 2023, ECCO organised a meeting on the upcoming revision of the NECP that focused on industrial electrification and energy efficiency. The round table saw the participation of companies that produce and use electrification technologies, industrial associations, consultancy firms and ESCO, institutions, the research sector, universities and European think-tanks that work on this theme. What emerged from the discussions was the **need** of businesses for **a clearer and differentiated guidance tailored to sector-specific characteristics , to steer investments for sustainability and decarbonisation**. Secondly, the necessity to continue with an in-depth study of sectors, working on scenarios that can highlight the options for reductions that have already a high maturity level, with a particular focus on energy supply for industry available in the short-term.

In light of the revision of the NECP due in June 2024, ECCO is promoting **an initiative aimed at exploring the technical and economic potential of electrification for industrial process heat** in the sectors in which this potential has been identified. **Throughout 2024, an analysis will be conducted on the financial and policy implications of these decarbonization scenarios, engaging technology manufacturers, service providers, and energy suppliers through dedicated sector-specific working groups.**

THE ITALIAN CLIMATE CHANGE THINK TANK

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