Industrial Heat

Balancing decarbonisation and competitiveness in 2025-26: a contradictory objective for European manufacturers?

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Executive Summary

In today's climate of pessimism, a rollback of climate ambitions can sometimes seem like a foregone conclusion.

After a pivotal period marked by major European commitments and a post-Covid acceleration of decarbonisation policies (Green Deal, strengthened climate targets, large-scale funding), Europe is now going through a phase of scepticism.

The fragility of its industrial base, which was thrown into turmoil via the energy crisis along with the context of intense international competition, is fuelling a debate on the role of the energy transition in the loss of industrial competitiveness and comes part and parcel with a temptation to scale back climate ambitions.

Yet this sentiment masks the progress still underway, as well as the reality that a reasonable and well-planned decarbonisation policy remains the only way to rebuild sustainable industrial competitiveness, shield the economy from geopolitical shocks, and address climate challenges.

The current economic doom-and-gloom weighs all the heavier on decarbonisation ambitions given that industrial players are entering a pivotal phase. After a period of focus on making voluntary commitments, they are now entering a new phase marked by greater complexity. The "simple" decarbonisation levers (quick-win energy savings, greening of electricity) have now largely been exhausted. Thermal uses, by contrast, remain overwhelmingly fossil-based, and tackling them at scale has become non-negotiable for hitting 2030 targets. This new phase requires strong internal leadership and access to adequate market-based solutions.

Thermal uses account for a substantial share of industrial energy consumption (around 55% in France, excluding already electrified heat), and are still over 80% carbon-intensive, predominantly natural gas-based. The diversity of applications (utilities, core processes), the disparity between sites and the variety of technical needs (temperatures, consumption profiles, heat transfer media) all add complexity to the transition. On top of this also comes a major commercial challenge: competitiveness remains a decisive criterion in the choice of solutions given a context of volatile energy prices and regulatory uncertainty.

Despite these challenges, industrial heat can prevail due to a wealth of competitive and technically sound solutions. The market is brimming with technologies that can replace fossil-fuel-based industrial heat: biomass, waste-heat recovery (sometimes combined with heat pumps), electrification (electric furnaces and boilers, heat pumps), geothermal energy, solar thermal, biomethane, and small modular nuclear reactors (SMRs). Each of these has specific strengths, but their relevance depends heavily on the local context, industrial needs and market developments. The LCOH (levelized cost of heat) of decarbonised alternatives often lies between €55 and €90/MWh, which can be competitive relative to natural gas whose cost fluctuates between €45 and €70/MWh depending on the size of the industrial consumer and the country, to which EU ETS-related surcharges that vary from one player and one sector to another are added; these are very likely to rise over time.

Faced with these challenges, the energy ecosystem is gearing up to support the transition through innovation at every level, both on the side of incumbent players (ESCOs, large energy utilities) and of start-ups and new entrants. From a technical and technological standpoint, this is reflected through diversifying solution portfolios and developing the capabilities required to optimise and control energy systems at the heart of industrial processes. On the commercial side, third-party financing and investment models are developing, with their contractual subtleties, but they still need to overcome structural hurdles: competitiveness of their financial support offer versus expected returns, and management of counterparty risk. Lastly, some players are managing to assemble end-to-end offerings to support industrial players across all their issues in a multi-site, multi-country fashion, thereby helping to overcome the organisational and skills-related challenges inherent in scaling up decarbonisation.

Introduction: is industrial decarbonisation really at a dead end, as prevailing pessimism suggests?

After the era of major European ambitions, a temptation to turn back the clock

After a "post-Covid era" marked by major decarbonisation ambitions (Green Deal, 2030 climate targets strengthened from -40% to -55%[1], large-scale funding), Europe is now going through a period of scepticism. The energy crisis, the war in Ukraine and de-industrialisation are creating a climate of pessimism, in which energy transition policies are sometimes singled out as being culpable for the loss of industrial competitiveness.

Signs of wavering are multiplying at the EU level: a stronger emphasis on "simplification" (CSRD[2] and taxonomy at the start of the year, CBAM[3] currently), challenges to the -90% emissions target by 2040 and a desire to soften it by resorting to "international credits" (championed by several Member States, including France). At the member state level, Germany is making a "big return to gas", following Belgium which had already taken this path, France has been unable to finalise its Multiannual Energy Plan draft, and there have been two threatened moratoria on renewable projects within a matter of months.

Energy transition policies: main culprit or scapegoat?

Attributing de-industrialisation solely to the energy transition would be simplistic, however. This phenomenon is part of a long-term trend (the share of manufacturing industry in French GDP has, for example, fallen relatively steadily from around 16% in the 1990s to 9.4% in Q1 2025 in France[4]), driven by multiple structural factors: political and economic choices, international competition, technological change[5]. Decarbonisation policy has certainly reshuffled the deck in terms of energy competitiveness, notably through the gradual phase-out of fossil fuels and the introduction of mechanisms such as the EU ETS, but it is rather the heavy dependence on Russian gas that laid the groundwork for the current industrial crisis.

At the same time, decarbonisation also offers unprecedented opportunities: harnessing competitive renewable resources (hydro, wind, solar; depending on geography), strengthening energy sovereignty, and developing future-oriented industrial sectors.

Despite headwinds, progress is real

Current difficulties—rising costs, regulatory uncertainty, administrative complexity—are real, but they should not overshadow tangible progress. Despite headwinds, many industrial players are continuing their decarbonization efforts: reducing carbon intensity,

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[1] Compared with 1990
[2] Corporate Sustainability Reporting Directive
[3] Carbon Border Adjustment Mechanism (MACF, *Mécanisme d'Ajustement Carbone aux Frontières* in French)
[4] Source: INSEE
[5] For example, the rapid shift in mobility towards electric vehicles, with China taking an extremely strong lead over Europe

launching first-of-their-kind projects (a new zero-emission[6] carbon brake plant, geothermal heating at Safran, first prototypes of electric glass furnaces, developing biomass solutions, waste heat recovery combined with heat pumps, etc.), and gradually adapting their business models.

The EU continues to support this dynamic through subsidies, calls for projects, and incentive mechanisms. The risk of a rollback exists, fuelled by growing climate-sceptic discourse and the temptation to prioritize short-term competitiveness. Yet, a reasoned and planned decarbonization policy remains the only way to rebuild sustainable industrial competitiveness, protect the economy from geopolitical shocks, and address climate challenges whose economic impacts are increasingly quantified[7].

Despite these long-term realities, this study aims to shed light on a more pragmatic short-term question: for industrial players in 2025–26, is pursuing decarbonization and competitiveness simultaneously a contradictory objective?

[6] Scope 1 and Scope 2

[7] A recent study carried out by Austrian economist Sigrid Stagl for the European Parliament estimates the GDP loss incurred by the EU due to climate inaction at between 3% and 7% in a status quo scenario

1 A pivotal period for industrial players' decarbonisation commitments

The current economic doom-and-gloom weighs all the heavier on industrial players' decarbonisation ambitions as they enter a pivotal period: after a key phase devoted to making voluntary commitments, scoping out issues and launching the "simplest" decarbonisation projects, they are now moving into a new phase of greater complexity.

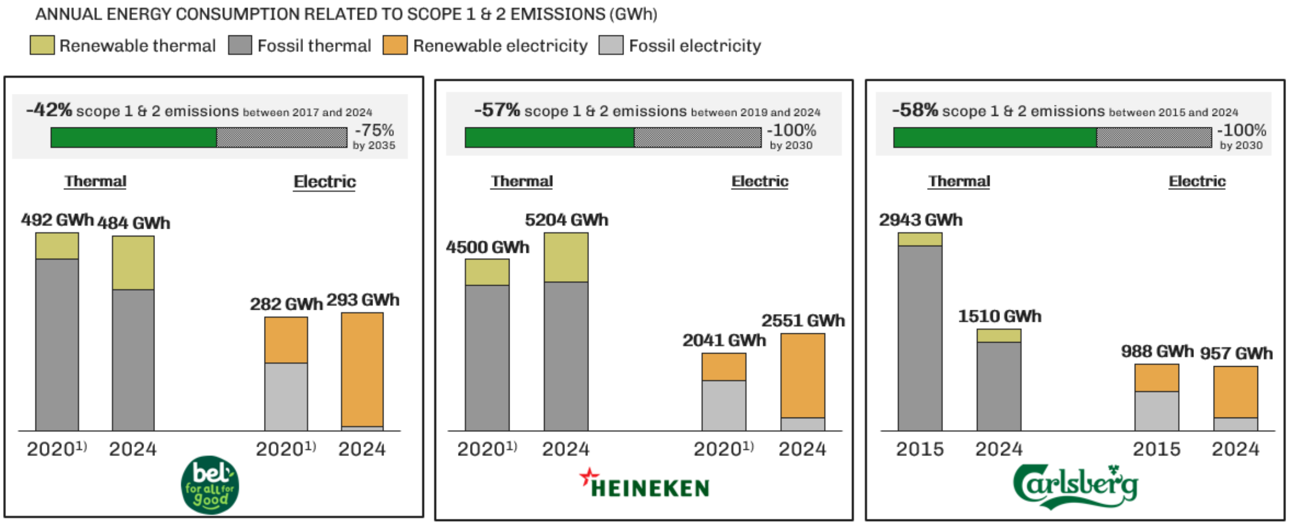
On one hand, we have entered the second half of the 2020s, and 2030 is approaching fast; the horizon within which their short- and medium-term decarbonisation commitments will be assessed. For many of them, the outcome risks falling short of their set of ambitions. In fact, more than 200 companies have had their "Net Zero by 2050" commitment withdrawn by the SBTi in 2024, due to deviating from their short-term decarbonisation trajectory – including "big names" such as Procter & Gamble, Microsoft, Diageo and Unilever.

On the other hand, after a phase during which there were still many "simple" decarbonisation levers to tap into (e.g. quick-win energy-efficiency measures such as large-scale roll-out of LED lighting, or greening of electricity consumption through large-volume purchases of low-cost Guarantees of Origin for renewable electricity[8]), and in which more complex or innovative topics could be handled on a case-by-case basis in an exploratory manner, companies are now entering a new period where they will have to tackle the less obvious levers and the large-scale roll-out of measures head-on. This raises serious question marks around technical, economic and organisational feasibility.

As a result, many companies currently find themselves stuck in the middle: they have greened a large share of their electricity consumption and therefore almost exhausted their "simplest" lever, while thermal uses remain predominantly fossil-based, despite a few isolated projects in their asset portfolios (see the illustration for several companies in the food & beverages sector – Figure 1).

For many of them, addressing these thermal uses on a much larger scale (requiring dedicated organisational capabilities, as well as significant internal or external investment capacity) is non-negotiable for achieving their 2030 targets (or 2035, depending on the company). Strong internal leadership and access to suitable market solutions will be key success factors.

[8] N.B. The 2025–2030 period will also be marked by the ongoing tightening of international rules for accounting decarbonisation actions (in particular, a major revision of the reporting framework is being finalised by the GHG Protocol, with the aim of tackling "greenwashing" and supporting levers that genuinely encourage additionality), which will affect, among other things, methods for procuring low-carbon electricity: large-scale procurement of Guarantees of Origin may no longer be sufficient to justify "renewable" sourcing, forcing a switch to more robust tracking systems to ensure close time-step matching between renewable production and consumption, local sourcing, or a genuine contribution to the development of a new greenfield project



1) Energy consumption details are not available for previous reporting periods

Sources: Annual reports of companies, E-CUBE Strategy Consultants Analysis

Figure 1 - Short-term decarbonisation ambitions and renewable penetration in thermal and electrical uses for three companies in the food & beverages sector

2 Decarbonising thermal uses: a central but highly complex challenge

Thermal uses account for a substantial share of industrial energy consumption, and therefore of its carbon footprint, making their rapid and large-scale decarbonisation critical.

Thermal uses in industry cover a very wide range of applications, which are generally divided into two main categories: “utilities” (generation of cooling, steam, hot water, etc.) and “core processes” (drying, cooking, dehydration, melting, pasteurisation, etc.). These uses make up a significant share of total energy consumption in industry. To illustrate, for France in 2024:

- The sum of natural gas consumption (36%), coal (2%), renewable and recovered heat consumed on site (9%) and heat purchased by industrial companies (6%) represents around 55% of industry’s final energy consumption[9].
- More than 80% of this consumption is still fossil-based[10], with natural gas as the predominant energy source (around 68% of energy consumption directly attributable to thermal uses, and accounting for 36% of total final energy consumption) – see Figure 2.
- This breakdown has changed very little in recent years: the share of natural gas in the total energy mix has fallen only slightly from 38% to 36% between 2021 and 2024, coal from 3% to 2%, while the share of sold heat has remained stable at 6%, as has electricity at 36%.

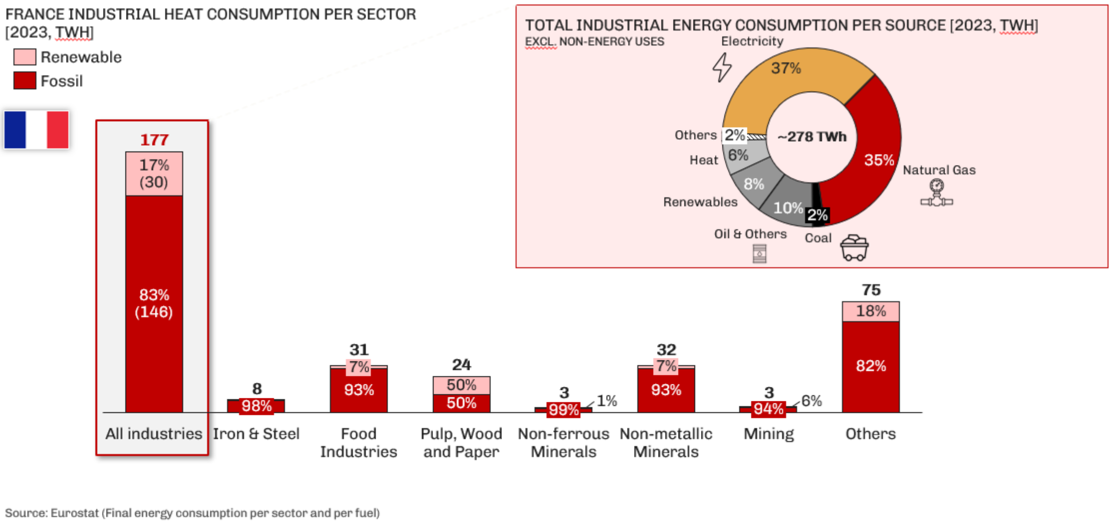


Figure 2 - Final energy consumption in industry by sector and by type of energy, France, 2023

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[9] Excluding non-energy uses. Considering that part of the thermal demand is also met by electricity (36% of the consumption mix), the share of energy consumption devoted to heat uses is above 55%.

[10] Assuming a 63% share of renewables and recovered energy in the heat sold to industrial companies (source: SDES, *Key figures for energy – 2025 edition*).

At the EU level, the mix may differ (notably in terms of the share of coal versus natural gas), but the overall picture is broadly similar in many geographies, except for the Nordic countries (see Figure 3 below).

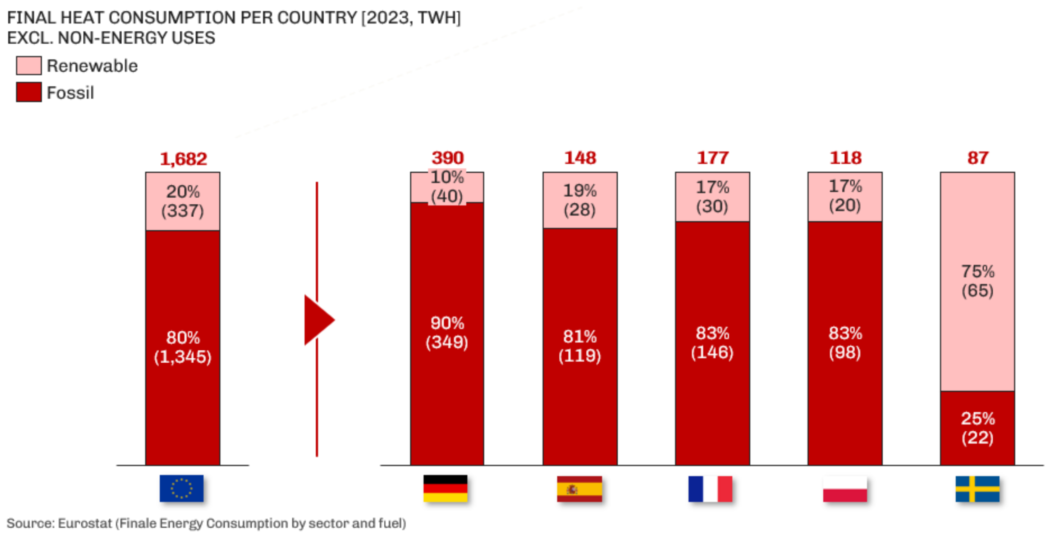

Figure 3 - Final energy consumption for heat uses (excluding electricity consumption) in industry, European average and several European countries, 2023

These issues arise both for industrial heat produced on site and for heat distributed via the grid. In countries such as Germany and Poland, the latter is still 68% and 90% fossil-fuel based respectively (excluding waste heat). At the EU level, nearly half of the heat distributed via district heating networks still comes from natural gas, coal and petroleum products – see Figure 4.

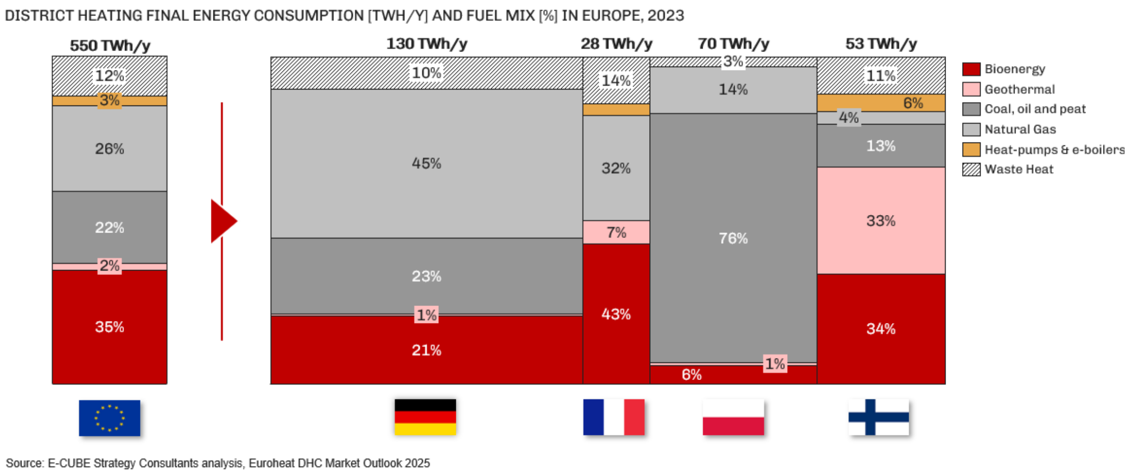

Figure 4 - Production and energy mix of district heating networks in the EU, 2023 data

Decarbonising thermal uses involves particularly high technical complexity due to their fragmented nature and the diversity of use cases

The fragmented nature of consumption is a first source of complexity. Although a significant share of fossil-fuel consumption and associated greenhouse gas emissions[11] is concentrated in a few specific industrial sectors (petrochemicals, steel, cement, etc.) and in major industrial areas that group a large part of them together (e.g. in France: Fos-sur-Mer, Dunkirk, etc.), a substantial portion of this consumption remains much more fragmented. To illustrate (see details in Figure 5):

- More than 18% of natural gas consumption and nearly 9% of coal consumption in Europe is in the food & beverages industry.
- Around 9% of natural gas and about 4% of coal is consumed in the pulp & paper sector.
- Within the main consuming sectors ("chemicals and petrochemicals" – 23% of natural gas and 24% of coal, "non-metallic minerals" – 17% of natural gas and 33% of coal, and iron and steel – 10% of natural gas and 25% of coal consumption), a minority share may be relatively fragmented (for example in downstream and fine chemicals).
- The other sectors not mentioned above account for just under a quarter of natural gas consumption.

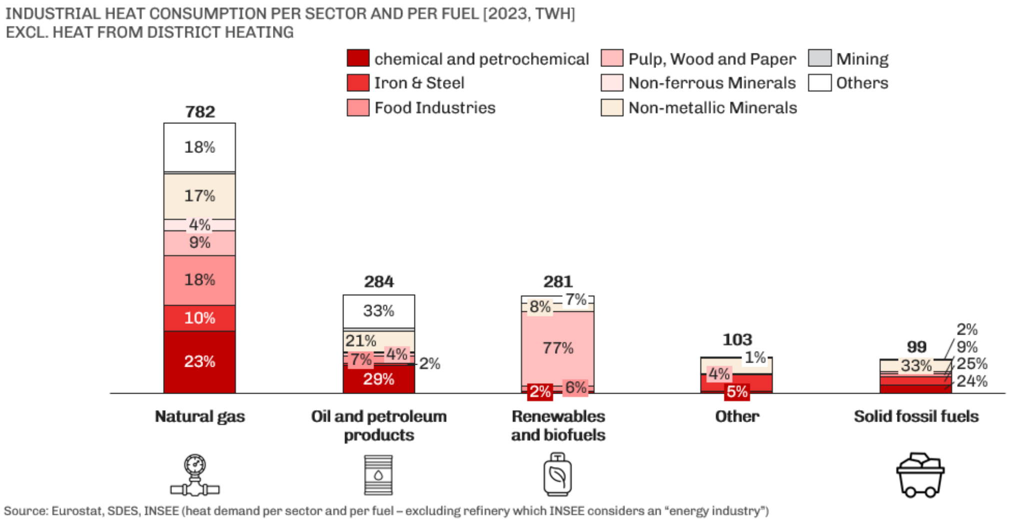

Figure 5 - Breakdown of energy consumption by fuel and by industrial sector – Europe, 2023

It is easy to see how trying to address the decarbonisation of thermal uses across thousands of players and sites complicates both the economic equation – by limiting the potential for economies of scale (even though a degree of partial centralisation at the level of small clusters is possible and is being considered for the deployment of solutions such as SMRs[12]) – and the ability to design public support schemes that effectively target the most promising levers.

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[11] Greenhouse gases
[12] SMR = Small Modular Reactors.

This fragmented landscape translates to a very wide variety of technical requirements to address individual sector needs, which affect the relevance of the different alternative energy sources for replacing fossil consumption:

- The levels of consumption and the equipment required at the scale of a single site or an industrial ecosystem vary significantly as do consumption profiles (steady needs throughout the day and seven days a week; hourly, daily, weekly or seasonal variations, etc.). Without this being universally true for all subsectors and sites, we can, for example, observe:
    - Processes that are predominantly continuous on a daily, weekly and annual basis in sectors such as non-metallic materials production or chemicals.
    - Numerous sites operating five days out of seven and substantial daily variations depending on production campaigns in manufacturing industries (automotive, textiles, assembly industries, etc.).
    - A very wide variety of profiles in the food & beverages industry, with a mix of subsectors that are seasonal (following harvest cycles, as in sugar production, or seasonal demand, as in beverage production) and other subsectors that operate largely on a continuous basis (e.g. production of milk powder or starch).

While natural gas offered great flexibility in terms of plant capacity and the ability to manage demand variations over short time intervals, the range of “low-carbon” technologies displays very different levels of performance in this respect, and some solutions, such as biomass, still need to operate in combination with a gas “backup” to handle short-term variations (see Figure 8 below).

- Temperature levels vary enormously from utility uses at above 120°C (very common in the food & beverages industry and speciality chemicals, for example) to process uses such as baking that may require temperatures of 800°C and beyond (e.g. glass or ceramics kilns) – see Figure 6. Whereas natural gas can cover this broad range of temperatures, the low-carbon solutions now being developed generally only cover narrower temperature bands.
- The types of thermal carriers required are also different: hot water, steam, a need for direct-contact combustion with a flame, etc. For processes such as baking, changing the energy carrier can have a concrete impact on the properties of finished products, requiring industrial players to make deep changes to their offerings (for example, in bread baking, switching from a gas-fired oven to an electric oven will have physical consequences on the taste and texture of the bread).

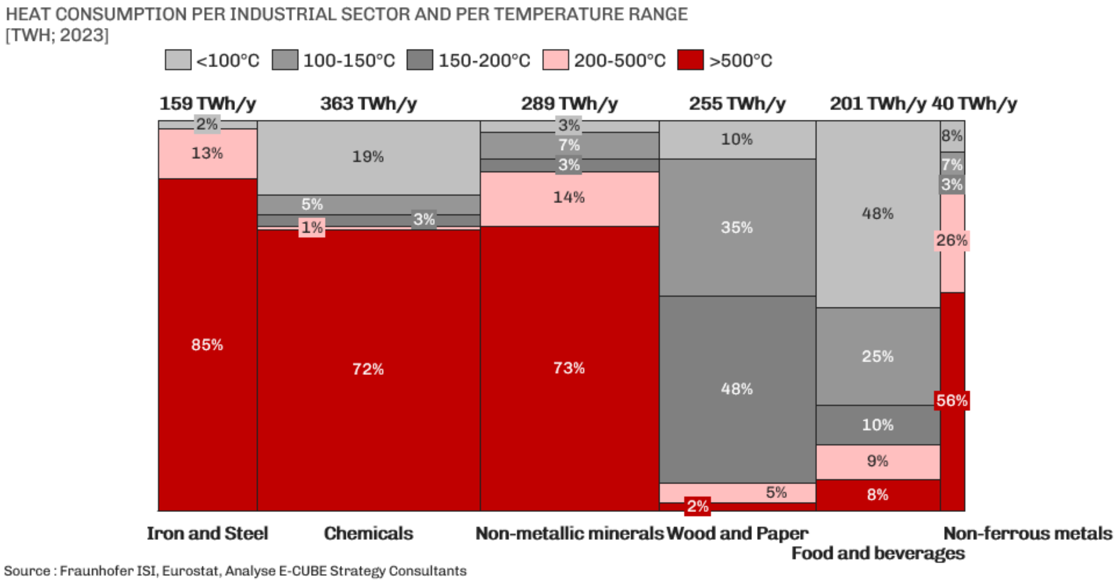

Figure 6 - Breakdown of energy consumption for heat uses by temperature range and by industrial sector, 2023

On top of technical challenges comes a commercial challenge that is particularly complex in today's economic environment

For industrial decision-makers, economic competitiveness has always been a key factor in the choice of a technical solution, alongside its decarbonising potential; this is true across all sectors. There may, however, be differences: some sectors are less sensitive to energy prices (since energy accounts for a smaller share of production costs, or because they are better able to pass on additional costs to consumers downstream in the value chain), while others are under greater pressure to decarbonise (sectors further downstream in the production chain with strong exposure to end consumers).

The post-covid period, marked by a very sharp rise in EU ETS prices, followed by the energy crisis with gas prices climbing to several hundred €/MWh, created a favourable context for launching alternative projects: awareness of the risks linked to dependence on natural gas, and a widespread belief in an upward trend in carbon taxes. The current macroeconomic context is radically different:

- Lack of competitiveness of European industry,
- Natural gas prices back down to levels close to those seen before the energy crisis and projected to remain low over the long term – see Figure 7,
- Uncertainty over whether European public authorities will maintain their decarbonisation ambitions.

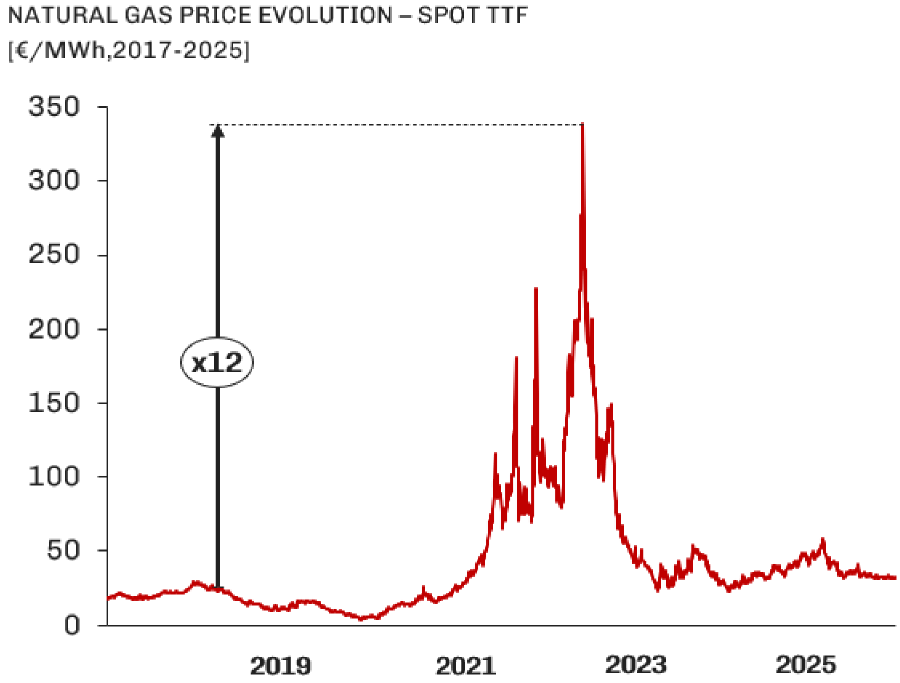

Figure 7 - Spot price of natural gas, TTF market, 2017–2025

Thus, the current situation is far from conducive to taking far-reaching decisions to convert from gas-based solutions to low-carbon alternatives, even more so given the need to scale up these conversion technologies. Tools that have historically been used to push through projects more quickly in anticipation of future market developments (setting an internal carbon price higher than EU ETS market prices, artificially "boosting" the IRR of low-carbon investments, etc.) are less common today if there is no longer a stable consensus on how markets will evolve (increases in fossil-fuel prices, at least in their "carbon cost" component). Waiting things out and postponing decisions is therefore widely favoured, despite the obvious risks associated with dependence on natural gas that were highlighted by the recent energy crisis, which remains fresh in people's minds.

3 Despite these challenges, industrial heat can prevail, because there are competitive and technically relevant solutions

The market is brimming with technological solutions to replace fossil-fuel-based industrial heat

Some solutions are very mature and already widely deployed, but still have clear potential, such as biomass. Biomass has historically accounted for the bulk of projects supported in France by the Heat Fund (68% of the renewable heat production capacity – on industrial or tertiary sites and for district heating networks – supported in 2024). In mainland France there are around 720 biomass installations with a capacity exceeding 1 MW, for a production potential of 28.6 TWh of renewable heat, shared between installations on industrial sites and on heat networks.

Waste-heat recovery, by nature the most obvious decarbonisation solution – since it directly reduces energy consumption – still represents potential to be tapped into: it accounted for 8% of the renewable and recovered heat (EnR&R) production capacity supported by the Heat Fund budget in 2024. In some cases, adding a heat pump[13] can raise the temperature level of the recovered heat so that it can be reintegrated into a process, as implemented for example by the Wienerberger Group in summer 2025 at its Ségala plant to recover drying vapours.

Beyond heat pumps, there are many options for electrifying utilities or processes at varying levels of maturity. While some electric furnaces are still at the pilot stage, as in the glass industry (the first 100% electric furnace in the container glass industry was commissioned by Verallia at its Cognac site at the end of 2024, representing an investment of €57 million; over the same period Saint-Gobain commissioned a hybrid furnace enabling electricity to provide up to 50% of the required heat), other technologies – such as some bakery ovens, dryers (ceramics, clay products) or Mechanical Vapour Recompression units for milk powder production or paint booths – are already technically largely electrifiable.

Among innovative electrification solutions, electric boilers attract strong industrial interest. Able to operate in tandem with a gas boiler, the possibility of arbitraging their use according to electricity market prices and monetising their electrical flexibility on system services makes them a solution which, in some situations, can offer short payback times and profitability without the need for subsidies (this varies according to the characteristics of flexibility markets, the profile of power prices, specific tax regimes in each geography, and the connection costs specific to each industrial site). More innovative still, some projects envisage combining electric boilers with electro-thermal storage (ETES) solutions, which store the heat produced in high heat-capacity materials such as

[13] Heat pump

refractory bricks, molten salts or thermal fluids, so that it can be released later over several days or even weeks, depending on industrial needs.

Geothermal energy – shallow (geothermal heat pumps) or deep where the resource exists – is a relevant solution for heating industrial sites, as illustrated by the project initiated by Safran to cover more than 80% of the heat needs of its Villaroche site (assembly of engine parts for Safran Aircraft Engines). At the EU level, several countries, including the Netherlands (already relatively advanced in exploiting this potential), Germany and Hungary, have set specific geothermal development targets for 2030.

Although still relatively rare directly on industrial sites, solar thermal technologies are a relevant solution for supplying certain industrial sites for low-temperature uses (for example: a 12 MWth plant on a Lactalis site in France; a 13 MWth plant on Boortmalt's malting plant in Issoudun; a project under development combining solar thermal, thermal storage, waste-heat recovery and a heat pump on another Boortmalt malting plant in Croatia[14]), as well as for district heating networks (a model already developed in Northern European countries).

Biomethane as an alternative to natural gas has huge technical advantages, as it avoids any physical modification to the heat production process; however, it suffers from a lack of competitiveness (the production cost of the molecule is often above €100/MWh for a large part of the exploitable potential, to which must be added the cost structure of gas supply: transmission and distribution costs, taxes[15]), and from uncertainties surrounding its "decarbonising" status in the GHG Protocol[16]. Despite this, it can already be a relevant solution for certain industries that have access to the necessary feedstocks (notably the food & beverages sector), or for players with limited sensitivity to energy costs who prioritise the flexibility and absence of CAPEX associated with the solution (L'Oréal, AstraZeneca). In some countries, governments have also chosen to give industrial players privileged access to subsidised biomethane (France, Italy, UK), bringing the final price much closer to that of natural gas.

With a more innovative and long-term profile, the small modular nuclear reactor ("SMR") sector could represent a relevant solution for large district heating networks (Eastern Europe), large industrial clusters or very large individual industrial sites. Several start-ups are developing heat-only (or combined heat-and-power) solutions tailored to these industrial and network heat markets. For large-scale deployment in geographies that are not yet structured into clusters, as is currently the case in France, nationally led industrial planning could be necessary to enable such solutions to take hold.

Comparing the competitiveness and relevance of these different solutions in a generic way is not easy, because their cost and technical suitability are highly dependent on local

[14] Commissioning scheduled for 2027, project co-financed by the European Commission's Innovation Fund

[15] The share of biomethane consumed by industrials is exempt from EU ETS (provided the biomethane is certified sustainable under RED criteria), but not always from national taxes – in France, the TICGN exemption on the biomethane share is no longer in force; in other countries such as Denmark, tax advantages remain.

[16] Scope 1 carbon accounting framework currently under revision at GHG Protocol level

contexts (available resources, labour costs, input costs, tax regime, etc.), the type of thermal use targeted (temperature level, flexibility requirements) and site-specific technical constraints. To illustrate:

- The available connection capacity to the electricity grid and the associated cost can be a major barrier to electrification.
- The competitiveness of heat pumps depends essentially on the actual Coefficient of Performance (COP), which varies widely according to operating conditions, the target temperature level, the initial temperature level, etc.
- Operating biomass plants entails significant technical and logistical challenges: biomass supply and storage, flue-gas treatment, maintenance outages, etc.
- Beyond their carbon impact, these different technologies can generate their own environmental impacts that also need to be considered (land footprint, consumption of raw materials and water, etc.).

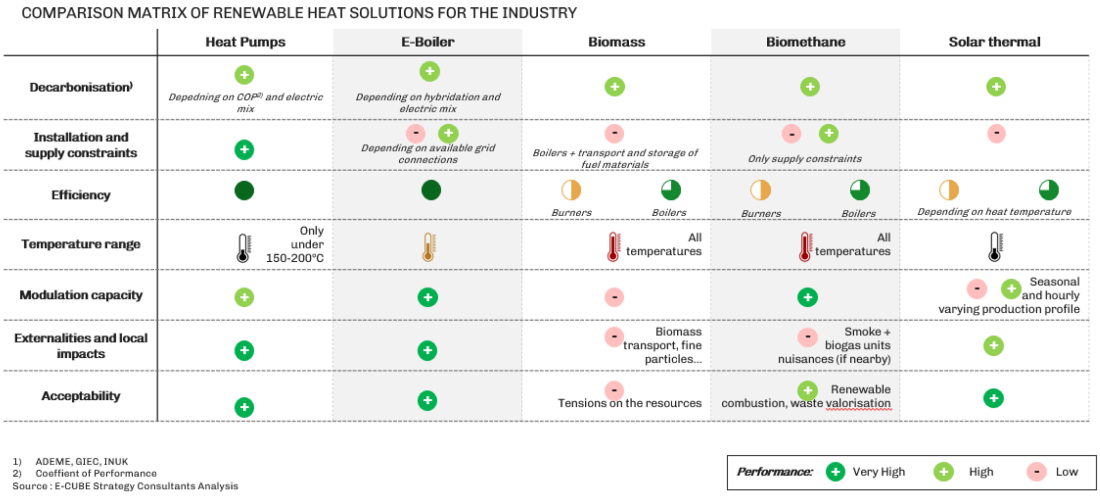

Figure 8 - Comparative assessment of the technical and environmental characteristics of selected low-carbon heat solutions

If we set aside a "worst-case" scenario of a complete abandonment of European climate targets, all these solutions can present a favourable business case compared with natural gas for certain processes and certain configurations.

While the relative techno-economic relevance of these various low-carbon solutions compared with one another varies according to multiple parameters, the central issue today remains their prospective competitiveness versus natural gas.

In today's conditions (current natural gas prices, EU ETS I mechanism in force and partly no longer covered by free allowances), there is competitiveness versus natural gas.

On average, across the EU, industrial players bought their natural gas in 2024 at prices between €63/MWh[17] for "I3" consumers (smaller industrial companies but with relatively energy-intensive processes[18] – representing around 20–40% of total non-residential consumption in most Member States) and €45.5/MWh for "I5" consumers (large, highly energy-intensive companies[19] – generally representing less than 20% of non-residential consumption, though with significant differences between Member States). For intermediate "I4" consumers, delivered natural gas purchase prices averaged €52/MWh. These costs include transmission costs and all national taxes (environmental taxes, renewables charges, other[20]) but do not include surcharges linked to the EU ETS mechanism.

These averages mask significant geographical disparities – see Figure 9:

- For I3 consumers, the natural gas price (€63/MWh on average) ranged from €48/MWh for Spanish industrials to more than €70/MWh for German and Polish industrials, and more than €100/MWh in Sweden (versus €69/MWh in France).
- For I4 consumers (€52/MWh on average), prices ranged from €43/MWh (Spain) to around €60/MWh (Germany, Poland) and even €90/MWh (Sweden).
- These variations are less marked for large I5 consumers, although there is still a difference of more than €15/MWh between countries (€31/MWh in Sweden versus €48/MWh in Germany, for a European average of €46/MWh).

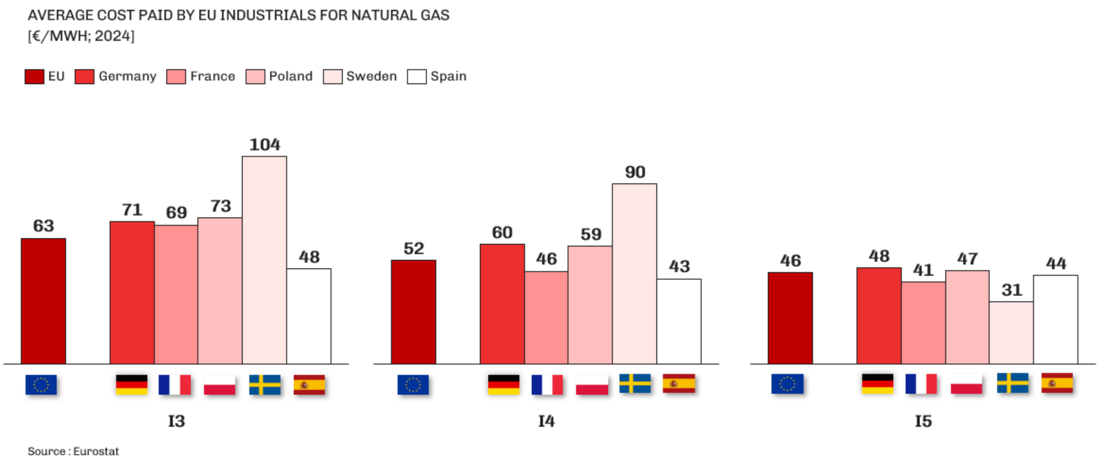

Figure 9 - Average delivered natural gas purchase price for industrial customers by country and consumer category, 2024

[17] This value, as well as all historical natural gas supply cost data provided in this paragraph, comes from Eurostat data
[18] Company consumption between 10 and 100 TJ, i.e. around 2.8–27.8 GWh/year.
[19] Consumption between 1,000 and 4,000 TJ, i.e. between 278 GWh and 1.1 TWh/year.
[20] Excluding VAT

If we add the cost associated with the EU ETS, which averaged €65/tCO2e in 2024, i.e. around €13/MWh (bearing in mind that not all industrial players are covered by EU ETS I and, for those that are, a fairly large share of their emissions is still covered by free allocation or historical allowance stocks), we obtain supply cost levels at which a number of renewable heat technologies can be competitive, or even highly competitive. Indeed, the LCOH[21] of decarbonised alternatives, although highly variable depending on the technology and certain local conditions, can in many cases fall within a range of around €55–90/MWh (sometimes with subsidies), leaving substantial competitive headroom – see Figure 10 below.

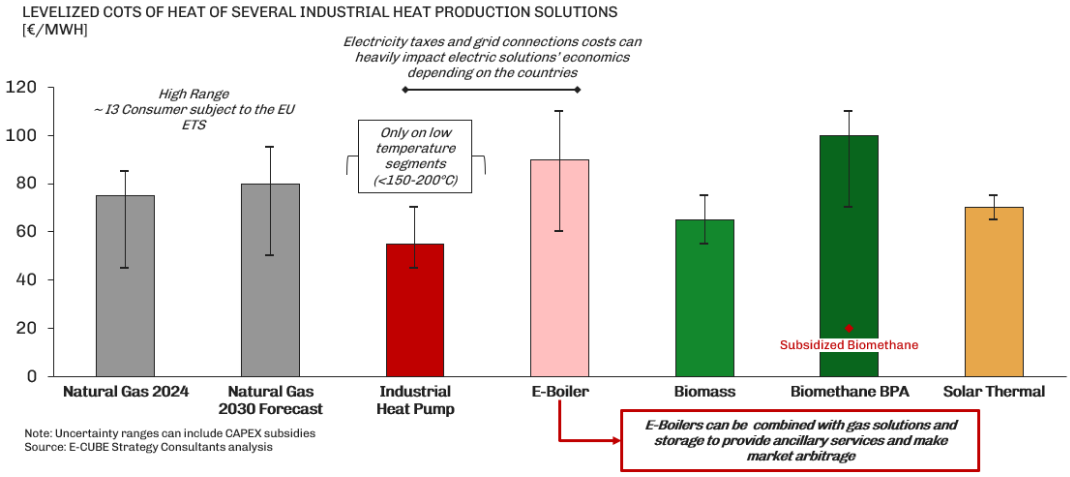

Figure 10 - Range of LCOH for industrial heat by energy vector

Of course, low-carbon heat installations generally require a higher upfront investment than fossil-fuel solutions, and the future trajectory of all the components of the natural gas price therefore remains a decisive factor for decarbonisation projects. Here, analysing a combination of quantitative and qualitative elements suggests that the long-term competitiveness of low-carbon heat remains credible, even if short-term market signals may seem less favourable.

The competitiveness of low-carbon solutions in the long term must in fact be assessed by considering the likely evolution of the different components of the cost of natural gas supply:

- **"Energy" component:** the cost of sourcing the molecule is currently the main uncertainty factor. Wholesale prices in 2025 have so far been slightly higher than average 2024 prices[22]. Futures, however, are currently trending strongly downwards, fuelling industrial companies' belief in an upcoming fall in gas prices: Cal 29 is currently at €26.3/MWh on THE and €23.9/MWh on PEG, i.e. around €10–

[21] Levelized Cost of Heat, i.e. the average heat production cost discounted over the asset's depreciation period.
[22] Analysis of average day-ahead and month-ahead prices at PEG (France), THE (Germany), ZTP (Belgium) and TTF (Netherlands).

15/MWh below current prices. Price projections by specialist brokers are more mixed, with, depending on the player:

   - Central scenarios ranging between about €30–40/MWh in 2030 and between €24 and €32/MWh in 2040,
   - High scenarios ranging between about €45 and €60/MWh,
   - Low scenarios ranging between about €20 and €30/MWh.
   - Taking a central assumption, one would therefore tend to assume relative stability in the "molecule" component between now and 2030 (around €34/MWh), followed by a possible slight decline to around €28/MWh by 2040.

- **"Network" component and national taxes:** regarding the other elements that make up the supply cost for final industrial consumers:
   - The "network" share is relatively small for industrial consumers: around €2–3/MWh for the largest consumers (I5) and around €6–7/MWh for the smallest (I3), with no significant change over the past ten years. In future, we can expect an increase in overall gas network costs per unit of volume supplied, due to declining consumption trajectories in the EU; however, this increase should have a greater impact on consumers connected to distribution networks than on those connected to the transmission network.
   - The tax component has seen strong historical growth in Europe: +12–13% per year on average for "I3" and "I4" consumers and +7% per year on average for "I5" consumers over the past five years (2019–2024). The main components are capacity charges (including taxes to finance strategic reserves, ensure security of supply and fund the network in addition to network tariffs) and environmental taxes (carbon taxation). Going forward, this upward trend is likely to continue in a context of decarbonisation and management of energy security issues in the EU (even though member states may make contrasting choices as to how this burden is shared between different categories of consumers).

- **"EU ETS" component:**
   - Despite strong volatility, the carbon price on the EU ETS I market has broadly moved from a stable state at around €20–25/tCO2e between 2018 and 2020, to a new stable state at around €80/tCO2e (with swings between €60 and €100/tCO2e depending on the period) since 2022. It now weighs significantly on companies covered by the scheme, particularly due to structural reform of the market, which has reduced allowance surpluses historically accumulated by some sectors and is progressively phasing out free allocation. Looking ahead to 2030, the various projections for this market fall within a range of around €100–150/tCO2e, i.e. about €20–30/MWh added on top of the natural gas price. The range of projected

prices beyond 2040 widens further, spanning from around €110/tCO2e (equivalent to a virtually flat €20/MWh over the 2030s) up to more than €200/tCO2e (i.e. more than €40/MWh) in the IEA "Net Zero 2050" scenario, reaching around €180–250/tCO2e in 2050 – see Figure 11, History and projections of EU ETS prices.

- While the cost of the EU ETS does not currently weigh equally on all sectors covered by the scheme – those most exposed to carbon leakage are still largely covered by free allocation (the steel, chemicals, cement and lime, ceramics and aluminium sectors in particular received as many free allowances in 2023 as the emissions they generated) – it is expected to weigh increasingly heavily on these sectors in the future with the introduction of the CBAM and the progressive phase-out of associated free allowances from 2026 (the complete end of free allowances is still currently planned for 2034, although discussions are under way at European level to postpone this deadline in connection with ongoing debates on the rollout of CBAM).

- In addition, the introduction of the EU ETS II market will also affect smaller companies that are not currently covered by EU ETS I. By 2030 (if its implementation schedule is not pushed back, as is currently under discussion), this could represent an additional cost of a few euros up to around €10/MWh for these consumers (with the price capped at €45/tCO2e up to 2030). In the longer term, one could expect prices to gradually converge towards those of EU ETS I.

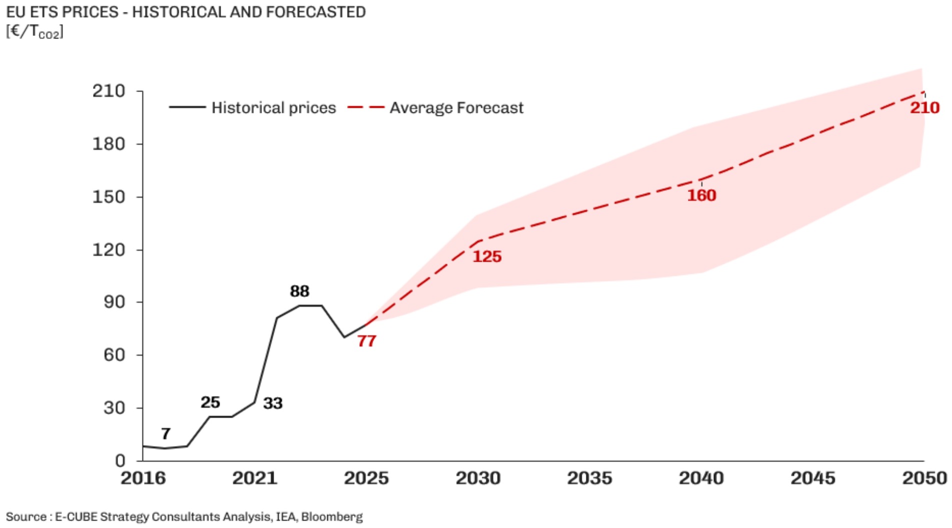

Figure 11 – Historical and projected EU ETS prices

Thus, even in a scenario of a drastic fall in wholesale prices of natural gas over the next 10 to 15 years (which is far from evident as a scenario), the various upward components of the supply cost should offset this effect, so as to maintain a long-term business case for low-carbon solutions that is at least comparable to today's. Only a complete abandonment of Europe's decarbonisation ambitions (dropping implementation of the CBAM, abandoning the EU ETS I trajectory and cancelling the introduction of EU ETS II) would contradict this projection.

Despite the existence of relevant business cases for low-carbon heat solutions compared to natural gas, industrial players will only be able to commit if public authorities provide greater visibility.

The EU and its member states are already doing a great deal to support low-carbon thermal solutions for industry: subsidies (Heat Fund, DECARB IND calls for projects, Major Decarbonisation Projects, funding for studies on low-carbon industrial zones in France, the opening in December of a €1 billion auction in favour of industrial heat in Europe under the Decarbonisation Bank, etc.). However, given the diversity of technical and economic contexts, these support-mechanisms struggle to be calibrated in a way that makes them fully effective (either they are steered towards specific technologies, or the CAPEX support rules are not calibrated in such a way as to generate acceptable IRRs for the players, etc.). Above all, these schemes cannot be sufficient in themselves if they are not accompanied by a clear signal that Europe will see its energy transition through to completion (for decarbonisation and sovereignty) and will do what is necessary to support its industries in this process.

Since the beginning of 2025, this has indeed been the direction set with the Clean Industrial Deal, but the current contradictory signals do not provide the same visibility: a one-year postponement of the implementation of ETS II, ongoing discussions about calling into question the reduction trajectory for free allowances in ETS I, etc.

If it is too complex for individual industrial players to accept the "commodities risk" given the level of uncertainty it entails in the current market context, should it not be the states themselves that bear this risk?

In the electricity sector, which will cover part of tomorrow's heat needs, things are moving in this direction, with explicit choices on technology pathways (a return to nuclear in several countries, but also investments in strengthening grids and flexibility mechanisms). In the heat sector, this kind of overarching "global vision" owned by the state is not present in the same way. Yet it could be developed, notably through:

- The decision to take on the "commodities risk" on behalf of industrial players (in the context of a clear political direction seeking to move away from fossil gas and to drive decarbonisation), for example by introducing Contracts for Difference-type mechanisms for low-carbon heat.
- A stronger role in industrial planning – for instance, by developing, where it is still largely absent as in France, industrial ecosystems suited to hosting "semi-

centralized” low-carbon solutions (particularly nuclear heat and electricity from SMRs).

4 The energy sector ecosystem is gearing up to support this transition

Faced with the range of uncertainties and difficulties that industrial players are encountering, and in addition to the action of public authorities, market players have a crucial role to play in enabling these solutions to scale up. In recent years, despite a challenging context, there has been significant progress in the maturity and sophistication of offerings designed to address the sector's needs – but there is still substantial potential for development.

We identify three major areas of innovation currently maturing on the market:

1. The range of technical and technological solutions is expanding, and players are gaining capabilities in technological flexibility.
2. Technology offerings that include third-party financing and investment solutions are becoming more extensive and more sophisticated.
3. Some players are increasingly managing to assemble global offerings to support industrial companies both on strategic and operational aspects, across all their decarbonisation issues (all "scopes") and on an international scale.

The range of technical and technological solutions is expanding, and players are gaining capabilities in technological flexibility.

As shown in the previous chapter, the range of technical solutions available to provide low-carbon heat to industrial customers has expanded considerably in recent years, and innovation is continuing. Many start-ups are emerging, often initially with a strong technology focus, for example:

- Celsius Energy (FR), Accenta (FR), Lithium de France or Gaia Energy / Aardyn (NL) in geothermal energy,
- Newheat (FR) or Azteq Energy (BE) in solar thermal,
- Kyoto (NO), Epyr (FR), Rondo Energy (USA), Kraft Block (DE) in electro-thermal storage, etc.

Today, innovation is essentially driven by the start-up ecosystem, and the way these new solutions are brought to end customers is still maturing:

- The major historic ESCOs (ENGIE, Dalkia, Veolia, GreenYellow, Honeywell, etc.) are gradually integrating these new solutions, mainly through acquisitions and/or partnerships with the specialist players mentioned above. The challenges associated with rolling out these new offerings are numerous for these companies, since they imply major structural changes:
    - In terms of organisational and technical capabilities (design and operation of these new technologies, sometimes hybridising them with existing fossil-fuel solutions) and in terms of commercial capabilities,

    - In financial terms, with a structural shift in business models (development of contracts that incentivise energy and carbon efficiency) and in sources of margin. Whereas companies historically focused on operating gas boilers derived a significant share of their margin from "P1" supply, profitability sources are more complex and diversified in a portfolio combining different technologies. By way of illustration, the probability of obtaining a "P1" contract associated with the installation of a heat pump will be lower, but the margin associated with installation ("P7") and with the maintenance contract ("P2") will be higher.
- The new technology players themselves are still searching for their own go-to-market model. Some, such as Celsius Energy, position themselves squarely as technology providers (design, EPC, implementation) working either directly for end customers or on behalf of ESCOs or utilities; others position themselves as heat suppliers, including the financing component (e.g. Accenta, Newheat). For many of them, this positioning is not yet firmly fixed and retains a degree of flexibility depending on opportunities, placing them either as technology partners of incumbent ESCOs or as competitors, depending on market access opportunities and client expectations.

Going forward, the "winning" solutions on the technical side will hinge on:

- The ability to move away from too strong of a "technology" label and to optimise the technology mix according to needs and client context. As highlighted above, thermal uses display a very broad variety of technical characteristics, and no single technology today offers a techno-economic combination that succeeds every time. A technologically "agnostic" positioning and the ability to claim expertise across all low-carbon solutions are therefore key to an ESCO-type positioning directly facing clients.
- Beyond mastery of individual technologies, the internalisation of skills in operating and optimising energy systems in a broader sense. The ability to operate a thermal production system that is often multi-energy without disrupting downstream industrial processes and in a high-performance way (economic and "carbon" optimisation of the system) will be a key success factor – one on which a company like Newheat claims specific expertise, developed over many years and R&D programmes. With the development on the market of electro-thermal solutions (electric boilers with or without associated thermal storage), there is also the challenge of mastering electricity markets and system services. This convergence of electrical and thermal systems also opens opportunities for electro-technical specialists such as Schneider Electric.

Offerings that include third-party financing and investment solutions are becoming more extensive and more sophisticated

Investment is one of the real bottlenecks in the decarbonisation of industrial heat – and the market is also innovating and seeking appropriate solutions here, in a changing political and economic environment that does little to make things easier.

Even when a solution is economically competitive, industrial heat equipment represents a complex type of investment for industrial players: amounts quickly reach several million to several tens of millions of euros, and payback periods are too long compared with standard industrial investment criteria (>7 years or even >10 years, versus a typical standard of ≤3 years).

Conversely, third-party investment offerings represent an opportunity to generate additional value for the market players mentioned above. Infrastructure investment funds also see it as an opportunity to position themselves in a new, under-served market.

Offerings of new technologies have therefore been growing strongly in recent years, starting from energy-efficiency actions but seeking to extend into renewable heat, which offers opportunities to invest in larger assets. The competitive landscape is diverse:

- Among utilities, ESCOs and historic energy-services players, the capacity to deploy CAPEX on their own balance sheet differs from one player to another but is often limited to very large assets (district heating networks, very large industrial biomass plants, etc.). Some of these companies, constrained in their investment capacity on balance sheet, have created dedicated platforms in partnership with investment funds:
    - This model has developed particularly strongly in North America, with partnership models between energy companies and funds – see Figure 12:
        - AlphaStruxure, founded in 2019 by Schneider Electric and the Carlyle fund, is one of the pioneers of the model, notably promoting its concept of an "autonomous" electric micro-grid[23] at the scale of a tertiary or industrial site, combining on-site electricity generation (PV), storage, electrified equipment and smart energy management.
        - Schneider Electric also created GreenStruxure in 2020 with ClearGen and Huck Capital, on a similar model but targeting smaller clients.
        - Similar models subsequently gave rise to Redaptive (Honeywell) and Viridis (McKinstry and Generate Capital) in 2023.
        - Sofiac is another example of a Canadian company created in 2020 on an "energy-as-a-service" model, as a joint venture between an energy-performance company (Ecoloner) and an investment fund.
    - In Europe, this type of initiative is more recent but has been expanding rapidly since 2024:
        - Creation of Effiwat by Equans, Banque des Territoires and Tikehau at the end of 2023,
        - DWS's entry into Perfesco (EDF) in 2024,

[23] But connected to the grid

  - Creation of Powesco as a spin-off from Enerlis in 2024 and a €150m capital raise from White Summit Capital,
  - Sofiac's entry into the French market accompanied by capital raises (equity of €60m invested by Mirova, Ademe Investissement and Fondaction at the beginning of 2024, supplemented by €150m of debt raised from La Banque Postale AM, MUFG and BNP Paribas),
  - Bluepearl initiative (a network of specialist ESCOs) with DWS.
- Among start-ups developing new technological solutions, as highlighted above, several are positioning themselves on an "infrastructure" model, carrying investments in dedicated SPVs (Newheat, Accenta, etc.). These business models require significant investment capacity and make them attractive platforms for infrastructure funds seeking to grow in this market.
- Lastly, some players are developing pure "investment fund" models, such as Kyotherm (which raised funds from Infravia Capital Partners at the end of 2024) in France or SEEIT (a UK fund active on the European market). Sofiac also falls into this category on the French market.

OVERVIEW OF ENERGY-AS-A-SERVICE JV DEVELOPED BY LARGE ESCOs IN THE US

ESCO		Schneider Electric		Siemens	Johnson Controls	Honeywell	McKinstry
Energy efficiency dedicated JV *(creation date)*		AlphaStruxure *2019*	GreenStruxure *2020*	Calibrant Energy *2020*	IonicBlue *2021*	Redaptive *2023*	Viridis *2023*
Financial partner		Carlyle	ClearGen 1) HUCK	Macquarie	Apollo CIB BIC	*Honeywell direct participation*	Generate
Targeted customer segment		*Airports, Campuses, Large industrial*	*Commercial, Governmental, Small industrial*	*No specific segment*	*Commercial, Tertiary*	*Commercial, Industrial*	*Healthcare, Industrial, Campuses*
Typical project size		5 – 15 MW	1 – 5 MW	1 – 5 MW	1 – 5 MW	0.1 – 5 MW	n.a. 2)
Technical offer	PV on site	✓	✓	✓	✓	✗	✓
	HVAC	✓	✓	✓	✓	✓	✓
	Process heat	✓	✓	✓	✗	✗	✓
	BESS	✓	✓	✓	✗	✗	✓
	Lightning	✓	✓	✓	✓	✓	✓
	Other 3)	✓	✓	✓	✓	✓	✓

1) ClearGen announced a dedicated envelop of $500m to be invested through the GreenStruxure platform 2) no projects identified 3) Variable speed drive, energy management, thermal insulation
Sources: press reviews of market players. E-CUBE Strategy Consultants analysis

Figure 12 - Examples of joint ventures between ESCOs and investment funds in North America

The challenges are significant if these third party-financing models are to scale up properly, with different types of competitive advantages depending on the positioning described above:

- The cost of the third party-financing option is one of the main challenges, particularly in the current context, where demonstrating the long-term competitiveness of low-carbon heat solutions versus natural gas is difficult. It remains complex to identify the "market zones" and positionings that can reconcile investors' IRR expectations (often large infrastructure funds expecting IRRs of around 15%) with project competitiveness requirements (IRRs rather around ~10%, depending on the project).

- These models involve a long-term commitment for an industrial site, which is an additional barrier both for the industrial player itself (difficulty in organising and securing approval for a 10-15-year commitment) and for reasons linked to counterparty risk management when structuring project finance (dependence on a single offtaker in a context of de-industrialisation).
- Depending on the player's positioning, further challenges arise:
    - **Commercial:** access to an industrial client base for non-technical players (e.g. investment funds) or for players historically focused on tertiary clients or district heating networks (e.g. Coriance, Idex); ability to sell global offerings (when the task is given to sales teams historically focused on audits, installation, etc., which involve very different interlocutors and sales pitches).
    - **Technical and operational:** managing the risks and performance of the installations. This risk varies according to the degree of internalisation of technical expertise within the investment structure. For "pure play" investment players such as Kyotherm, it requires strong mastery of contract engineering to ensure an appropriate sharing of risks and value with operational partners.

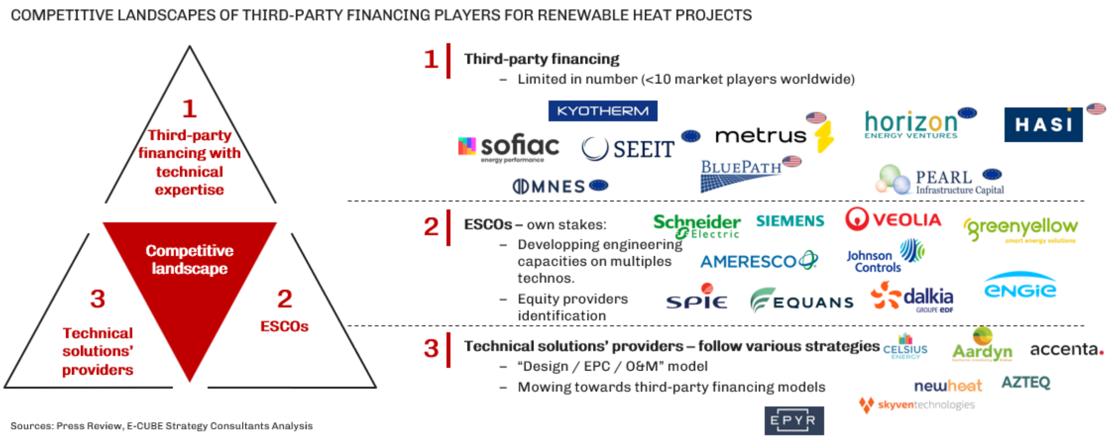

Figure 13 - Competitive landscape of third-party investors in low-carbon industrial heat

4.3 Some players are increasingly managing to assemble global offerings, including at an international scale

Faced with the organisational, technical and financial difficulties involved in developing a decarbonisation approach at the scale of a multi-business, multi-geography industrial group, some companies are tempted by the idea of entering into multinational partnerships with large "global decarbonisation partners".

In theory, this kind of positioning is extremely promising: it enables an expert company with the right skills to be given the overall responsibility for managing their transition in a genuinely optimised and accelerated way. In practice, however, it entails major complexities.

Negotiating such a contract is delicate and necessarily lengthy if agreements are to be found. It requires careful thought on the following points in particular:

- The allocation of risks and the remuneration mechanisms for the partner:
    - Depending on its different "levels" of involvement, from upstream strategy (advisory) through to operational delivery,
    - Inclusion of KPIs linked to the economic and carbon performance of the solutions proposed compared with a target trajectory: the benefits of this type of partnership (acceleration, gains in quality and competitiveness of the decarbonisation plan) must be measurable and must provide a tool for aligning interests between partners so as to ensure a "healthy", balanced long-term contract.
- The degree of control, exit conditions from the partnership, or options for periodic re-tendering: in the same spirit of ensuring a "healthy" contract, the client must not relinquish its control capabilities, which can be a fine line to tread given that it does not necessarily have all the internal capabilities needed to assess the relevance of the options proposed by its partner. Defining the right level of possible competitive re-tendering (at certain project stages, for example) and negotiating in advance the conditions for partially or fully exiting the partnership (ownership of intellectual property and studies carried out upstream, for example) are therefore key elements.
- The scope of the partnership and how it ramps up (e.g. starting with pilot sites, testing partners on a given technology or process before expanding, versus defining a very broad scope right from the outset).
- The degree of capability transfer and even the possibility of "doing things together": at national level, the partnership between La Poste Immobilier and EDF is an interesting example in this respect, as it led to the creation of a joint venture, Terseren, which is responsible for the end-to-end design and delivery of the energy-transition and decarbonisation trajectories for La Poste Immobilier's property portfolio, with the future aim of extending its offering to third-party beneficiaries.

In practice, few players have succeeded in building a genuine capability to offer this type of solution on a truly global scale. Although major utilities such as ENGIE (through ENGIE Impact), Veolia, TotalEnergies, etc. have many of the necessary "building blocks" to provide comprehensive offerings, the commercial structuring (high-level dialogue with senior executives), contractual arrangements (as described above) and internal operating model (getting different BUs and business lines to work together, developing dedicated tools, etc.) represent major challenges that few have fully overcome.

Schneider Electric is certainly the most advanced example of this type of offering, through its “Sustainability Business” division, now renamed “SE Advisory Services”, which provides global decarbonisation advisory and partnership services for large industrial accounts (SBTi roadmaps, design and deployment of global decarbonisation plans, brokerage of corporate PPAs, implementation of solutions for measuring and managing key energy and resource KPIs within the organisation, advisory and support on “value chain / Scope 3” strategies and carbon offsetting, etc.), enabling the company to deploy its operational solutions across its clients’ industrial sites. This entity has been built through successive acquisitions of consulting teams, including most recently EcoAct. Schneider has developed global partnerships with companies such as ROCA, Albéa and Forvia. A similar type of partnership was also signed between Siemens and Heineken at the beginning of 2024.

Conclusion

Reconciling decarbonisation with industrial competitiveness represents a major challenge for European industry today, confronted with an uncertain economic, political and geopolitical context. While there are many obstacles – volatility in energy prices, the technical complexity of thermal uses, regulatory uncertainty, and short-term profitability requirements – there is now a range of technological solutions and business models capable of addressing these issues.

The low-carbon industrial heat market has expanded considerably: biomass, waste-heat recovery, electrification (heat pumps, electric boilers), thermal storage, geothermal energy, solar thermal, biogas, small nuclear reactors and so on. Each of these solutions has specific strengths, but their relevance depends heavily on local contexts, industrial needs and market developments. Recent innovations, driven by start-ups, industrial partnerships and new financing models, are evidence of a profound transformation dynamic in the sector.

For decarbonisation to take root in a lasting way, it is essential that public policies provide sufficient visibility and stability, while adapting support schemes to industrial realities. The EU and its member states must continue their efforts to support industrial players, reduce uncertainty and share the "commodities risk" associated with the energy transition.

Finally, the success of this transformation will depend on the ability of stakeholders to work together, pool expertise and structure global offerings of solutions that integrate technical, economic and organisational dimensions. The ramp-up of third party-financing solutions, the emergence of global partnerships and the professionalisation of decarbonisation offerings are all levers for accelerating the transition.

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- **Climate Strategy & Decarbonisation:** Supporting industrial players and tertiary groups in understanding the impacts of the energy and environmental transition on their activities and business models. Supporting and challenging their decarbonisation strategy (targets and roadmap) and their climate adaptation strategy

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