Breakthrough Energy

Cleantech for Europe

With analyses led by SYSTEMIQ

CLEANTECH REALITY CHECK

ELECTRIFIED INDUSTRIAL HEAT

Charging up the industry

What is electrified industrial heat ?

Industrial heat represented 10-15% of the EU's final energy demand (1,800 TWh) in 2020, and is categorised into three ranges of temperature: low (<100°C) representing 15-25% of demand, medium (100-400°C) 30-40%, and high (>400°C) 45-55%.[1] For the low-temperature range, industrial heat pumps and thermal energy storage (Power-to-Heat, or PtH) and e-boilers are the preferred solution, with heat pumps offering the highest efficiency. Medium temperature heat range is currently not feasible for heat pumps, therefore will need to rely on other technology such as Thermal Energy Storage. High temperature heat electrification solutions are process-specific (e.g., electric furnaces) and still nascent, therefore shifting the near-term focus on the <400°C heat demand range.

Key take-aways

- Currently, only 100 TWh of EU industrial heat is electrified, mostly in low-heat range, way off from the ~425 TWh needed to reach EU's 1.5°C goals in 2030. In the next five years, ~350 TWh more Power-to-Heat (PtH) must be installed, which requires €100-150 billion of investment for PtH technology and up to €300 billion for accompanying the buildout of renewables.
- Recently, Thermal Energy Storage (TES) solutions deployed in industrial facilities have shown positive signs of economic viability. However, a scalability issue persists, mostly factored by lack of technology awareness and difficulty in accessing financial instruments or incentive mechanisms, which are often geared to other PtH technologies.
- The EU must increase the awareness of industry stakeholders and financiers towards PtH technology, in particular novel ones such as TES. Impact-aligned incentive mechanisms could support a stronger business case for industry heat electrification deployment.

ELECTRIFIED INDUSTRIAL HEAT

CHARGING UP THE INDUSTRY

STRATEGIC OBJECTIVES FOR EUROPE

- **Decarbonise 50-75% of industry-related emissions** attributable to industrial heating[1]
- Accelerate **electrification goals** to **decrease reliance on fossil fuel** imports from other countries (e.g., natural gas)
- Allow higher **penetration of renewables** into the EU grid
- Maintain **industrial competitiveness and jobs** by decoupling costs from fossil fuel volatility risks, which contributed to 35-45% of EU aluminium, zinc and silicon production taken offline[2]

CURRENT PROGRESS OF HEAT ELECTRIFICATION IN THE EU

OFF-TRACK — ON-TRACK

STATUS: NOT ENOUGH PROGRESS As The EU focuses on 2030 decarbonisation goals, electrifying industrial heating is still off-track due to low deployment rates, especially in the medium (100-400°C) and high (>400°C) temperature ranges.

<100 TWh industrial heat in low-to-medium range was delivered via electrified technology in 2022[2]

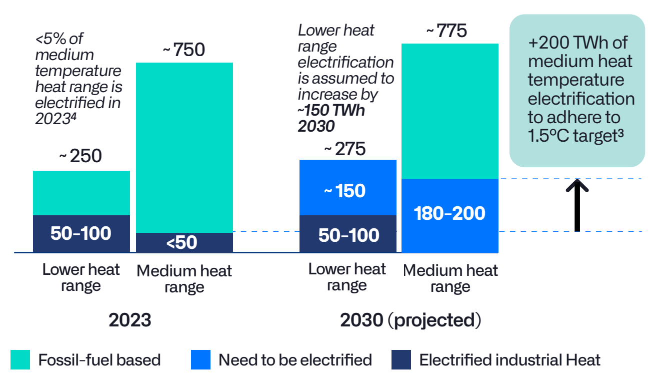
~425 TWh of heat in low-to-medium range required by 2030 to reach 1.5°C[3]

ELECTRIFICATION IS SHOWING SIGNS OF PROGRESS, BUT NOT MUCH IN MEDIUM HEAT RANGES

- Less than 10% of the EU's industrial heat is electrified, mostly in the low-heat range. To reach 1.5°C goals in 2030, **~350 TWh** (~6x current capacity) more Power-to-Heat must be installed in the next five years.
- **~200 TWh** of medium temperature industrial heat needs to be electrified **in 2030.** This requires accelerated commercial deployment of Thermal Energy Storage solutions of **~40-50 TWh/year** in the next five years.
- To reach the required electrification levels, around **€100 to 150 billion of investment for PtH technology is required,**[5] and up to **€300 billion** for accompanying renewables buildout.[6]

Electrification of industrial heat demand <400°C

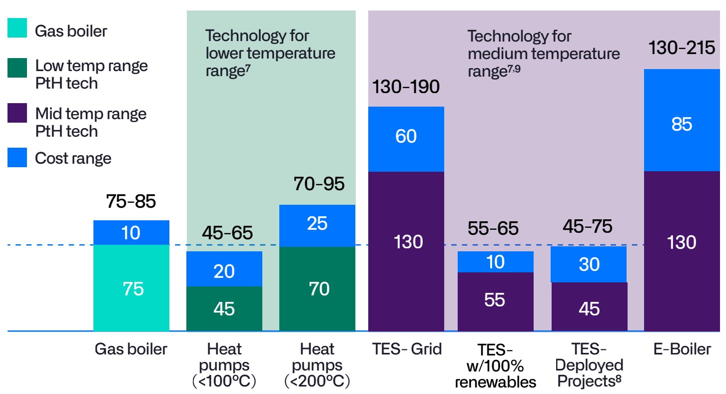
TWh



LOW TEMPERATURE HEAT HAS ACHIEVED AN AFFORDABILITY TIPPING POINT, BUT MEDIUM HEAT IS STILL FAR FROM COST COMPETITIVENESS IN MOST CASES

Comparison of 2030 cost of heat for Thermal Energy Storage (TES) Power-to-Heat technologies[7]

€/MWh-thermal



- For lower heat ranges (0-100°C), electrified heat technology is close to reaching cost parity with gas boilers.
- For medium range, the main barrier for Power-to-Heat is wholesale electricity price and grid fees, resulting in 20-40% cost difference.[7]
- The main drivers to achieve cost competitiveness are onsite pairing with renewables and project tailoring to site.

Notes: 1. Decarbonizing Industrial Heat- an important puzzle piece to solving climate change (CleanTech for Europe, 2023) | 2. EURElectric Power Barometer 2024 | 3. Climate Action Tracker Paris Agreement Compatible Sectoral Benchmarks (2020) | 4. Based on assumptions that deployed heat pumps and Power to Heat technologies are in industries with lower heat demands. | 5. Based on CAPEX assumptions from Global ETES Opportunity (Systemiq, 2023) | 6. Assuming 70% Wind and 30% Solar PV balance for VRE mix, CAPEX for Offshore Wind is at €2300-2800/kWh and CAPEX for Utility scale Solar PV is at €800-1200/kWh, sourced from European Commission Directorate-General for Economic and Financial Affairs: The Development of Renewable Energy in the Electricity Market (2023) | 7. Numbers are calibrated for EU from Global ETES Opportunity (Systemiq, 2023) | 8. Based on 3 case studies of deployed Thermal Energy Storage projects in Spain and Germany. Technical details around % mix of dedicated VRE and grid electricity used are not available. | 9. Using assumptions of 95% efficiency of Power-to-Heat technologies, and VRE is dedicated to supply Power-to-Heat technologies, and LCOE from Global ETES Opportunity (Systemiq, 2023) and World Energy Outlook 2024 (IEA)

ELECTRIFIED INDUSTRIAL HEAT

CHARGING UP THE INDUSTRY

ENABLERS – WHAT IS GOING WELL

SUCCESSFUL CASES FOR DEPLOYED PROJECTS

Low energy prices make electrified industrial heating cost competitive with gas boilers in the Nordic & Iberic regions. Furthermore, with Thermal Energy Storage (TES) technology being able to retrofit existing fossil power plants installations, the required initial investments are reduced.

START OF FLEXIBLE DEMAND ASSETS INTEGRATION TO THE HEAT & POWER SYSTEM

Several EU Member States have started the integration of flexible assets into their heat & power system by conducting flexibility assessments (e.g., Spain, Netherlands) and mandating heat decarbonisation roadmaps (e.g., Germany), which supports TES deployment.

ACCESS TO WHOLESALE PRICES WITH RE SOURCE

Energy-intensive industrial sites can access wholesale power prices by connecting TES technology to a renewable electricity (RE) source, either directly or through a private wire. This reduces the cost of heat greatly, depending on geographic location.

BARRIERS – WHAT IS NOT GOING WELL

LACK OF FINANCING AND FISCAL INCENTIVES

In most EU countries, with the exclusion of countries such as Spain and Germany, TES technology does not have demand-side mechanisms to leverage as point of entry. Support mechanisms are lacking, such as public incentives (accessible for Li-ion batteries and heat pumps) and project de-risking mechanism (e.g., first loss guarantees, direct financing).

AWARENESS AND SCALABILITY ISSUES OF TECHNOLOGIES

Even with successful pilot and implementation projects, electric heat technology solutions are facing issues to scale up due to low awareness of technology from industry and low electrification of targeted industries. The EU's Emissions Trading Scheme 2 (ETS 2) is expected to increase electrification but will only be launched in 2027.

UNSUPPORTIVE GRID CONNECTION PROCESSES AND FEES

TES technologies face challenges due to lengthy processes industries encounter when increasing or adjusting grid connection capacity. Generally, industry also lack access to the grid's dynamic price signals and do not have additional revenue streams from ancillary (e.g., capacity payments).

ACTION AGENDA – WHAT NEEDS TO BE DONE

1 **Increase awareness of technology:** Electrified heat technologies outside of heat pumps are still not well known, resulting in higher perceived risk profiles or lower access to funds to de-risk the projects. For example, in Germany, hydrogen is seen as the main replacement of natural gas, while TES technologies are not yet considered in planning and analysis.

2 **Provide supportive mechanisms to build competitive business cases:** Introduce specific criteria for sectors that can act as lead-markets for clean industrial heat applications to promote novel Power-to-Heat technologies. Incentives (e.g., revenue mechanism) and fees (e.g., grid fees) should also reflect externalities outside of decarbonising heat e.g., curtailment avoidance, grid balancing services, and off-peak demand. Schemes should also be more inclusive to novel technologies, as these have to showcase business case certainty for cost effective heat decarbonisation to accelerate scalability by 2030.

3 **Introduce de-risking mechanisms for novel technologies, focused on demand (industry):** Mechanisms such as guarantees should focus not only on CAPEX but also on OPEX (e.g., power price guarantee) to provide additional incentive for project implementation, which is critical in cost improvements for novel Power-to-Heat technologies in medium and high-temperature heat ranges. The EU-Catalyst partnership is a good example on de-risking novel technologies for industrial heat.

4 **Provide clarity on prices and taxes related to fossil fuels moving forward:** Currently, industrial players are skeptical of fully adopting heat electrification technologies due to uncertainty on energy prices and other costs related to it in the coming years, increasing project risk.

"Increasing the collective awareness of both industrial actors and financiers is critical to accelerate the uptake of electrified industrial heat solutions and power-to-heat technologies in sectors that need to reduce their emissions if we want to reach our decarbonisation goal."

Susanne König, Chief Finance Officer of **Kraftblock GmbH**