FEBRUARY 2024

SYSTEMIQ

ACHIEVING THE POTENTIAL FOR ELECTROTHERMAL ENERGY STORAGE

AN ACTION PLAN FOR GERMANY

Country-specific memo to

CATALYSING THE GLOBAL OPPORTUNITY FOR ELECTROTHERMAL ENERGY STORAGE: PROMISING NEW TECHNOLOGIES FOR BUILDING LOW-CARBON, COMPETITIVE AND RESILIENT ENERGY SYSTEMS

With the support of Breakthrough Energy

ETES IS A PROMISING ENABLER OF NET-ZERO INDUSTRY IN GERMANY

Electrifying industrial heat is critical for decarbonisation and can increase energy security. ETES is a new, commercially available technology to electrify heat in industry and other sectors.

To reach net-zero greenhouse gas (GHG) emissions by 2045, the German energy system will see mass electrification in all sectors. Integration and balancing of large volumes of variable renewable energy will be required for the target of ~80% clean electricity by 2030.[1]

ETES is a promising new technology for building low-carbon, competitive and resilient energy systems in Germany.

WHAT IS ELECTROTHERMAL ENERGY STORAGE (ETES)?

ETES technologies electrify (industrial) heat. The asset can convert electricity into heat at chosen times, such as when the electricity price is low. The heat is stored in the asset and can be discharged to provide continuous heat, for example, to use in industrial processes.

ETES is available at commercial scale through 40+ technology providers. Models that are commercially available today can reach up to 400°C, with higher temperatures in development.

ETES is currently the only technology for electrification of heat that can store energy. Other technologies that electrify heat – heat pumps, electric boilers and electric furnaces – do not have integrated energy storage.

BENEFITS OF ETES FOR THE GERMAN ECONOMY

INCREASED ENERGY INDEPENDENCE

Large-scale adoption of ETES could help reduce the equivalent of up to 40% of German gas usage today, which translates to a reduction of up to ~110 million tonnes CO_2e or 17% of German energy-related GHG emissions. ETES could also help key sectors like food and beverage, chemicals and cement avoid exposure to global gas price fluctuations.

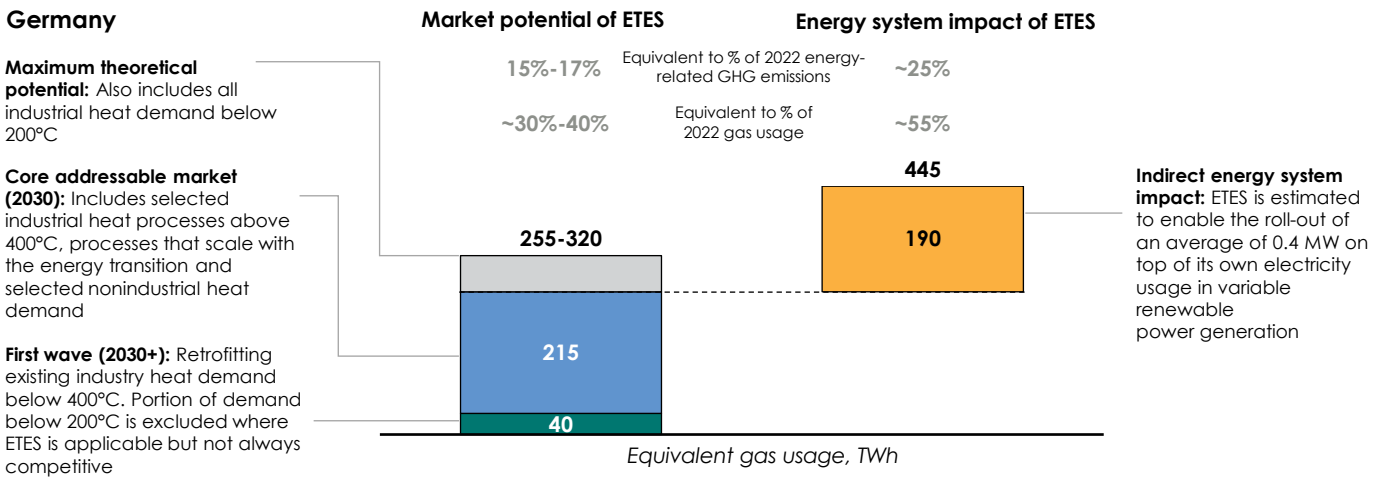
LOWER GRID INVESTMENTS

Peak electricity demand can be up to ~8% lower if industrial heat electrifies with storage. This reduces the grid capacity expansion required compared to electrification without storage. Installation of ETES technologies at German industrial sites could add up to 5 GW of off-peak electricity demand to the German energy system by 2030.

COST-EFFECTIVE AND FLEXIBLE INDUSTRY HEAT DEMAND

ETES is the most efficient technology today for storing zero-carbon energy for heat usage. It is also a relatively low investment compared with equivalent systems. Other technologies to electrify heat require additional storage (such as batteries) to align with variable renewable energy. These have lower energy storage efficiency (~80%) and 0.3–4 times higher capital costs by 2040.[2]

So far only 4 MW[3] of ETES projects have been built or taken to final investment decision in Germany. ETES is an emerging commercial technology and less well known compared with other decarbonisation of industry technologies. As with other energy storage, existing policies, regulations and energy market design can unintentionally disincentivise uptake. **Targeted changes can make ETES more affordable and accessible, and support the piloting and advancement of lower technology readiness level ETES technologies.**



Please see Figure 5 of the main report or the Technical Appendix for full details on assumptions and sources

1: Germany draft NECP revision 2023; 2: *Driving to Net Zero Industry,* LDES Council; 3: Databaseof the European energy storage technologies and facilities

CRITICAL ENABLERS
to accelerate ETES uptake in Germany

Enabler in place | Enabler in progress | Enabler not in place

AFFORDABILITY

- **Grid costs charging structure** reflects congestion alleviation and off-peak utilisation benefits of flexible demand
- ETES can participate in **balancing mechanism**, **capacity markets** and **ancillary market services**
- ETES is eligible for **net-zero subsidies** supporting heating and energy storage technologies
- **Electricity market design** gives right signals to incentivise flexible assets to come into the system
- Customers can use **private wires** to directly connect renewables sites with industrial sites, eliminating grid charges

ATTRACTIVENESS

- **Public procurement** requirements are in place for industrial products with low embedded carbon
- **Industrial users are familiar** with thermal storage technology and applications
- Industrial users have the access and capability to **optimise in the wholesale price market**

ACCESSIBILITY

- Companies are readily **able to connect and access grid** capacity required
- Companies are able to deploy **private wires** between renewables generation and industrial sites

ACTIONS NEEDED
by stakeholders in Germany

POLICYMAKERS AND REGULATORS

- **Continue with reforms to electricity market design to roll out demand-side response for industrial users** with auctions to procure demand-side response capacity at the most economic prices as well as **capacity market auctions** for energy storage.
- **Lighten reporting rules/penalties for the Klimaschutzverträge scheme** so that companies are not put off by onerous reporting requirements.
- **Introduce regulatory sandbox for small-scale pilots and introduce grants and guarantees for first-of-a-kind commercial projects** for nascent ETES technologies at lower technology readiness level.
- **Ensure that green procurement policies are adopted at state and local levels more consistently** due to wide local variation in emissions targets and decentralised purchasing standards.

GRID OPERATORS

- **Shift definition of storage to include ETES or remove need to reinject into the grid for §118 (6) EnWG** so that ETES can be exempt from grid fees in line with battery storage and generation.
- **Consider redefining the connection queue to prioritise flexible assets to shorten the wait time from one to two years.**

INDUSTRIAL END USERS

- **Assess market appetite and, if possible, introduce green premium price products to help fund the cost gap between ETES and boilers.** There is increasing demand from sectors across the board for Scope 2 and Scope 3 decarbonisation.
- **Execute business case comparisons for a cost-effective electrification plan for sites.** Applicable industries of food and beverage, chemicals and pulp and paper can invest the time to work with technology companies to assess whether ETES would be a cost-effective solution for electrifying processes.
- **Collaborate with technology companies and other value chain stakeholders to rapidly improve technology** towards commercial deployment.

TECHNOLOGY PROVIDERS

- **Identify and focus commercial activities and product design on locations and sectors where ETES technologies are competitive today.** This will sustain technology providers whilst technology continues to mature and market conditions improve further.
- **Work with policymakers, grid operators and industry to raise awareness of ETES applications and benefits and to drive forward the implementation.** This is especially important because there will be a much wider variety of applications in the future.
- **Establish relationships with grid operators and utilities to provide a turnkey solution for customers** that removes the complexity of permitting, grid connection and charging pattern optimisation.

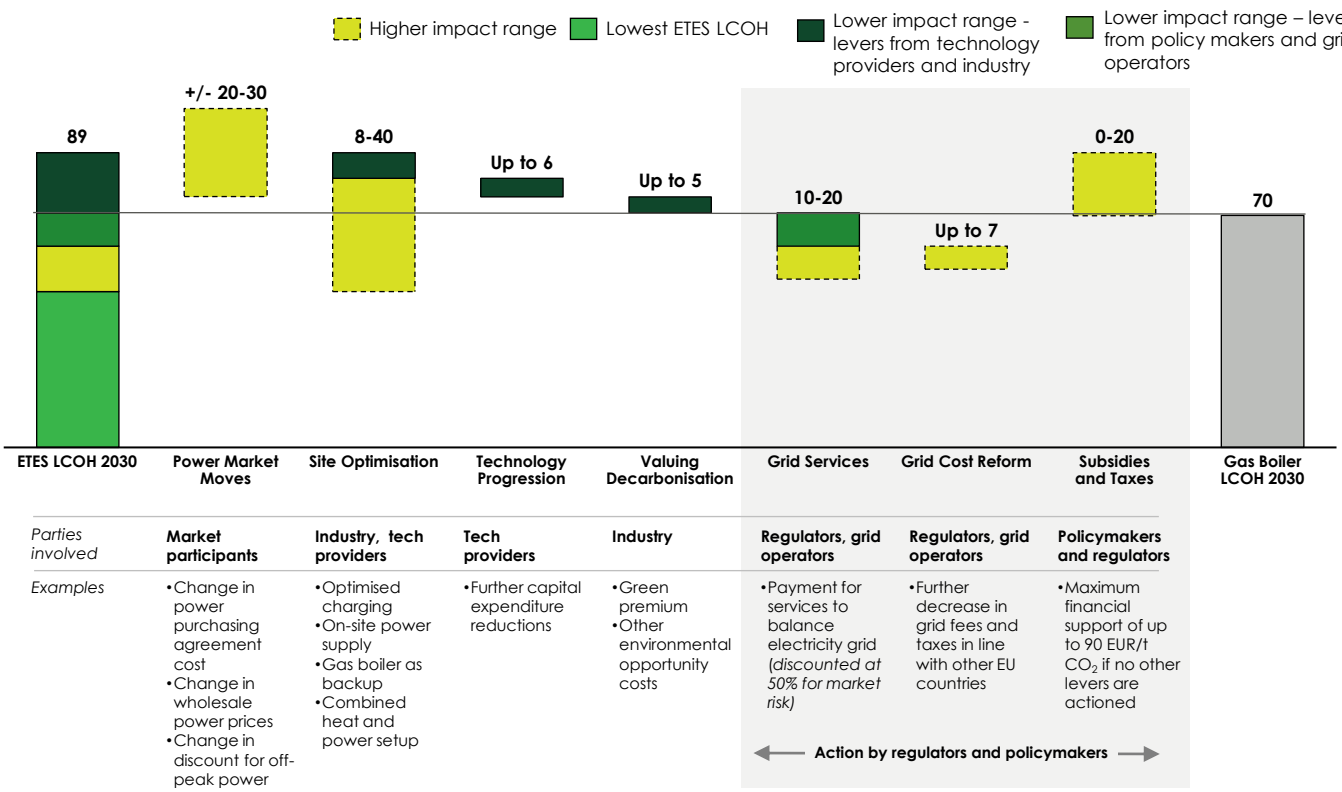
LEVERS TO CLOSE THE ETES AFFORDABILITY GAP

The immediate use case of ETES is anticipated to be replacement of industrial gas boilers in the food and beverage and chemicals sectors. To serve this market, ETES technologies need to achieve cost parity with gas boilers. The figure below illustrates the levers to close the affordability gap by 2030, an important moment because ETES assets being considered now will be operational before 2030.

Almost all levers can be actioned now by the relevant parties, except the technology progression (which requires production scale). In the absence of all other levers, a moderate subsidy of at most ~20 EUR/MWh thermal (~90 EUR/t CO_2) will be required for ETES to reach cost parity with gas boilers.

It is important that technology providers, industrial end users, policymakers and grid operators act now to realise the impact these levers. If all levers materialise, **the affordability gap in Germany can be closed without subsidies.**

Levers to bridge the affordability gap in Germany, levelised cost of heat (LCOH) in EUR/MWh thermal 2030



Please note that the LCOH for a specific case can be different from the generic numbers represented in this graph. See the Technical Appendix for details on the assumptions.

Sources: Technology provider interviews, P2H Cost Calculator (2022) – Agora, IRENA Remap 2030, TNO Technology fact sheet (2015), Thermal Energy Storage (2023) – RTC, Industrial Thermal Batteries (2023) – LDES, Prospects for LDES in Germany (2022) – Aurora, expert interviews, TSO And DSO websites; Capturing the green-premium value from sustainable materials (McKinsey, 2022); Scaling textile recycling in Europe–turning waste into value (McKinsey, 2022); The Promising Effect of a Green Food Label in the New Online Market (Jiang Y, Wang HH, Jin S, Delgado MS, 2019); Historical gas TTF futures and day-ahead spot market power (investing.com); ERCOT; Thermal Batteries: Opportunities To Accelerate Decarbonization of Industrial Heat (Renewable Thermal Collective, 2023)

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