FEBRUARY 2024

SYSTEMIQ

ACHIEVING THE POTENTIAL FOR ELECTROTHERMAL ENERGY STORAGE

AN ACTION PLAN FOR THE US TEXAS (ERCOT) REGION

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 THE UNITED STATES

Electrifying industrial heat is critical for decarbonization 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 2050, the US 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%[1] clean electricity by 2030.

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

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 can be stored for days 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 752°F, 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 US ECONOMY

INCREASED ENERGY INDEPENDENCE

Large-scale adoption of ETES could help reduce the equivalent of up to 14% of US natural gas usage today, which translates to a reduction of 499 million tonnes CO_2e or 10% of US energy-related GHG emissions. ETES could also help key sectors like food and beverage and chemicals avoid exposure to global gas price fluctuations.

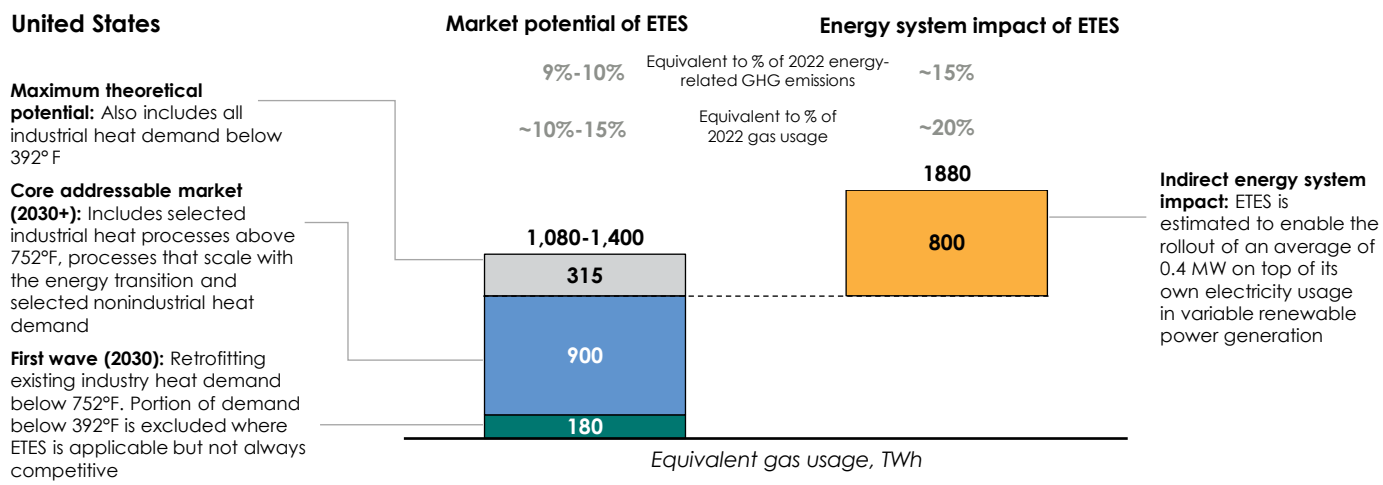
LOWER GRID INVESTMENTS

Peak electricity demand can be up to ~5% lower if industrial heat electrifies with storage. This reduces the grid capacity expansion required compared to electrification without storage. Installation of ETES technology at US industrial sites could add up to 23 GW of off-peak electricity demand to the US 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, 850 MW[3] of ETES projects have been built or taken to final investment decision in the United States. ETES is an emerging commercial technology and less well known compared with other decarbonization of industry technologies. As with other energy storage, existing policies, regulations and energy market design can unintentionally disincentivize uptake. **Targeted changes can make ETES more affordable and accessible and support the piloting and advancement of lower technology readiness level ETES technology.**



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

1: IEA World Balances Energy Data; 2: *Driving to Net Zero Industry,* LDES Council; 3: Department of Energy Storage Database

CRITICAL ENABLERS

to accelerate ETES uptake in the US Texas (ERCOT) region

The affordability, attractiveness and accessibility of ETES depends on the policies, regulations and market structure in place. These vary significantly across states in the United States. The rest of this document focusses on the Texas (ERCOT) region as an example electricity market. There may be other US electricity markets that have more or less favorable ETES conditions.

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

AFFORDABILITY

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

ATTRACTIVENESS

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

ACCESSIBILITY

- Decarbonisation technology grid connections are prioritized during supply chain delays
- 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 US Texas (ERCOT) region

POLICYMAKERS AND REGULATORS

- **Ensure that ETES is defined as an eligible technology in the Performance Credit Mechanism** being proposed by Texas Lawmakers. Could serve as a revenue source for ETES.
- **Clarify ETES eligibility, including for industrial uses, for the new § 45Y and § 48E technology-neutral credits** enacted by the Inflation Reduction Act due to phase in by 2025.
- **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.
- **Allow utilities to provide a revenue optimization service for ETES.** Given previous precedence for industrial users to connect via a retail electricity provider, industrial users may not be able to directly access and optimize in the wholesale markets.
- **Introduce mandatory sustainability criteria across public procurement policy** to support the market signal for low-embodied-carbon products.
- **Build on FERC Order 2023 and consider applying ERCOT's "connect & manage" scheme to non-energy-only markets.** This could facilitate faster connection of ETES resources across the country through the use of streamlined ERIS studies to help relieve clogged interconnection queues.

GRID OPERATORS

- **Change grid fees in line with some European countries to incentivise flexible and off-peak load through** (1) removing baseload discount, (2) transmission system operator introducing time of usage component and (3) distribution system operator to increase differential between winter peak and other time bands.
- **Introduce mechanisms to prioritise grid connections for assets that have the most benefit to the grid** — e.g., in the UK and Spain, regulators are proposing queue skipping for RES and storage — or **consider introducing interruptible grid connections** like Denmark.

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 decarbonization.
- **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 optimization.

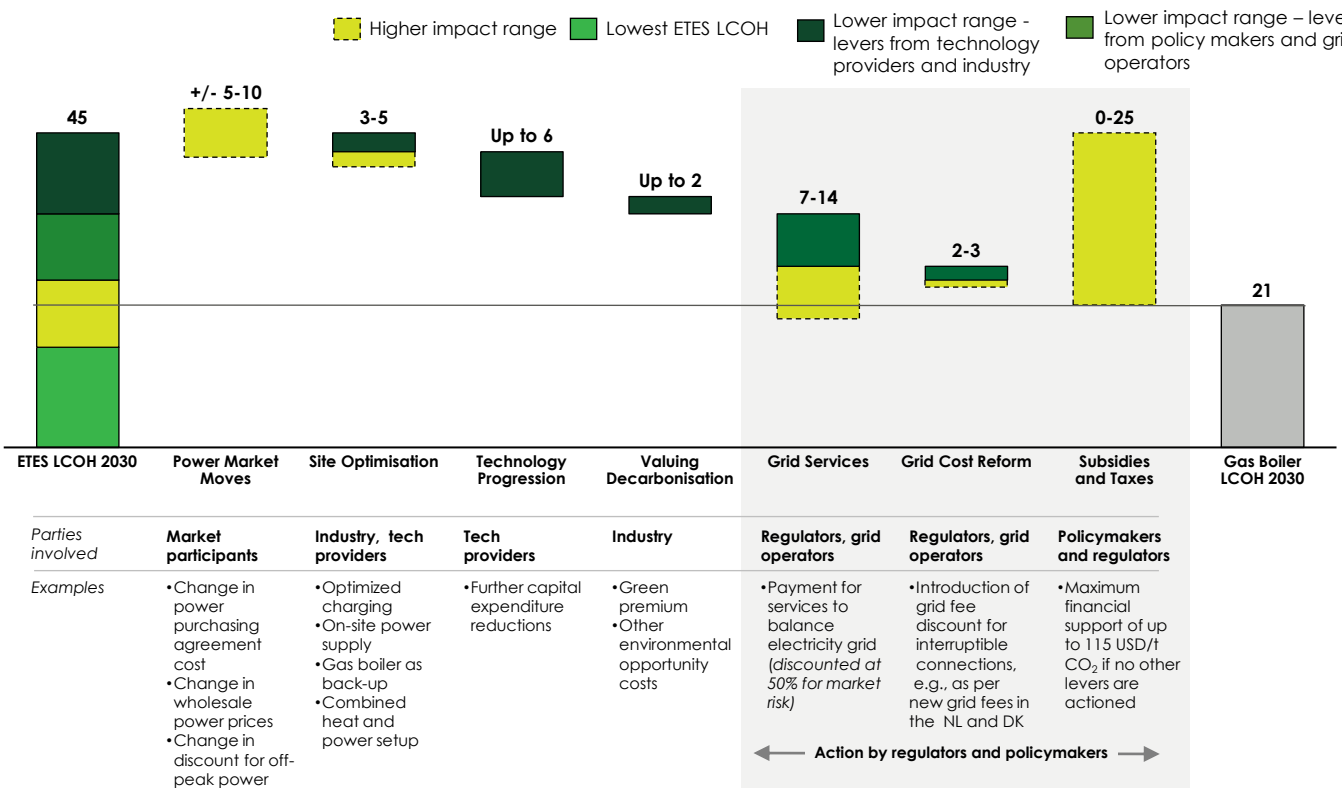
LEVERS TO CLOSE THE ETES AFFORDABILITY GAP

The immediate use case of ETES is anticipated to be replacement of industrial gas boilers in the pulp and paper and chemicals industries. 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 ~25 USD/MWh thermal (~115 USD/t CO_2) will be required for ETES to reach cost parity with gas boilers. This does not take the impact of the Inflation Reduction Act tax credits into account.

It is important that technology providers, industrial end users, policymakers and grid operators act now to realize the impact of these levers. If all levers materialize, **the affordability gap in the US Texas (ERCOT) region can be closed without subsidies.**

Levers to bridge the affordability gap in the US (ERCOT) region, levelized cost of heat (LCOH) in USD/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); 1 EUR = 1.08 USD

ACKNOWLEDGEMENTS

This memo was developed by Systemiq with the support of Breakthrough Energy. The complete publication, list of contributors to this report and up-to-date contact details can be found at https://systemiq.info/etes.

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