TEMPO

Reliable, Cost-Competitive Electrification of Industrial Heat

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Non-Public

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Reliable, Cost-Competitive Electrification of Industrial Heat

RESEARCH
Began in 2015

CO-FOUNDED
In 2021 by Dr. James Klausner

USA	AUSTRIA	SPAIN
San Diego	Dornbirn	Madrid

50 Employees

$40M Breakthrough Energy Ventures, Khosla Ventures, Prelude Ventures & others

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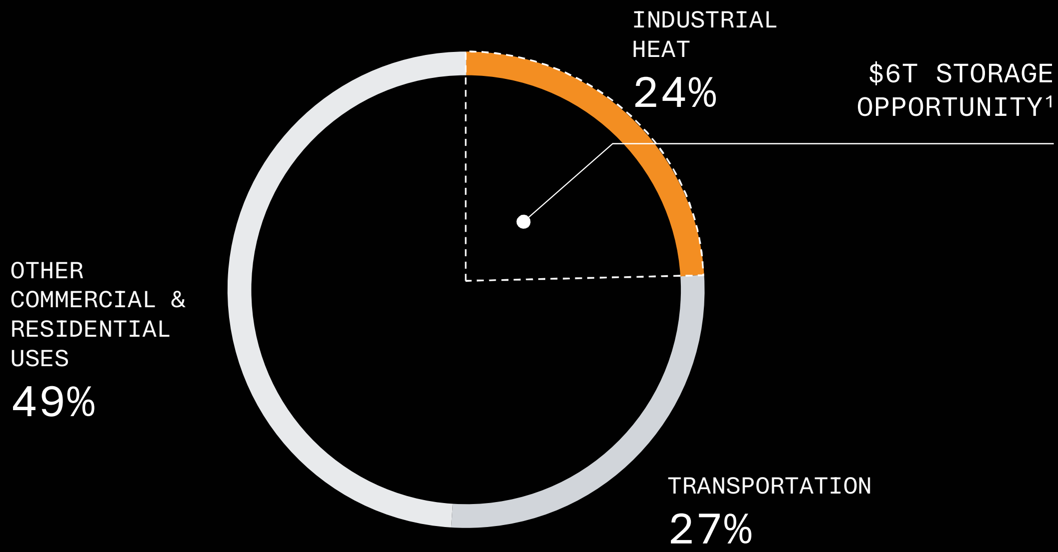
Industrial Heat: The Last Frontier in the Energy Transition

GLOBAL ENERGY CONSUMPTION



Sources: McKinsey, Net-zero electrical heat: A turning point in feasibility (2024), IEA (2025)
1 Based on 24% of IEA Global Energy Consumption in 2024 (~180 PWh).

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Clean, Reliable, Cost-Competitive Industrial Heat

THE CHALLENGE

~24% of global emissions come from industrial heat.

Industrial customers face:

- Geopolitical risks
- Volatile natural gas prices yielding unpredictable long-term operating costs
- Pressure to decarbonize
- Limited electrification options for their application

OUR SOLUTION

Tempo is a thermochemical energy storage (TCES) system that delivers constant-temperature (up to 1200°C) clean hot air at lower cost, with zero emissions.

- Reduce energy costs
- Provide reliable, predictable heat
- Monetizable grid-balancing resource
- Reduce or eliminate emissions (hybrid or full electrification)

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Tempo Technology

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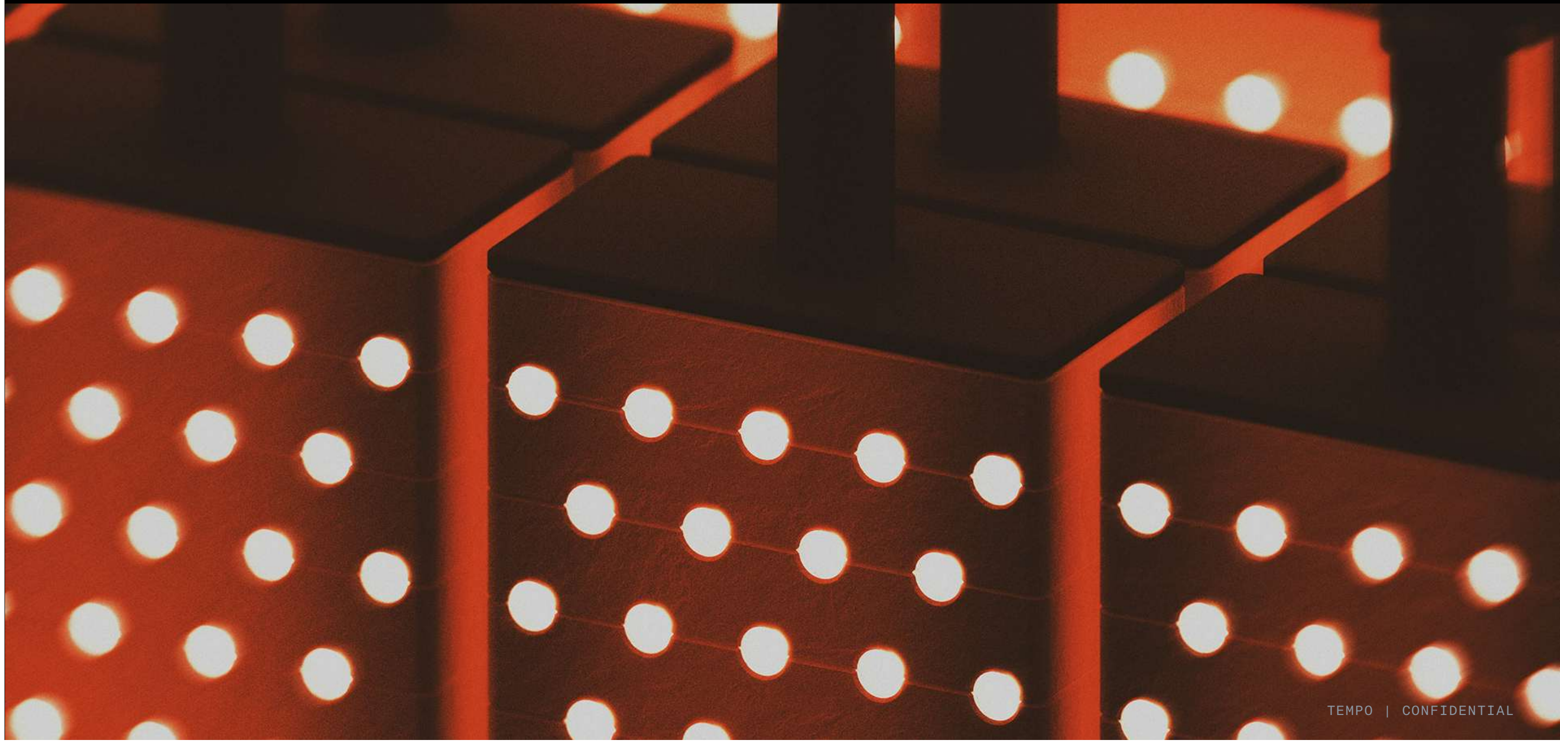
2015

Thermochemical Energy Storage Material Breakthrough

Proprietary Thermochemical Storage Material (TSM):

Stable, reversible, metal oxide formula discovered that can be charged by self-resistive heating.



BEYOND SENSIBLE HEAT:

Thermochemical Storage Material (TSM)

Tempo has developed mixed metal oxide materials that store energy thermally and chemically via a reversible redox reaction

CHEMICAL COMPOSITION:

Proprietary Metal Oxide materials

CHARGING:

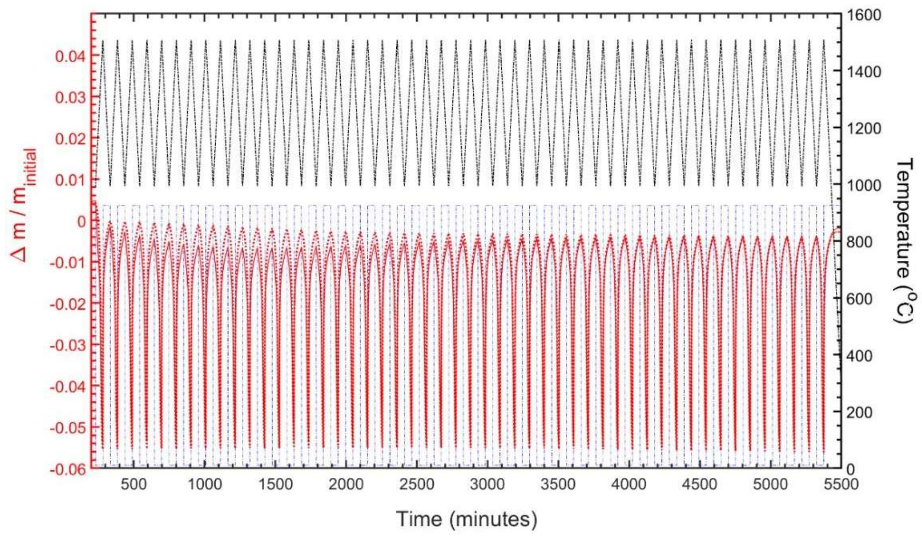
When heated above 1200°C, the material reduces and releases oxygen, storing energy as sensible and chemical heat

DISCHARGING:

When air flows through the material, the air simultaneously absorbs sensible heat and oxidizes the material, releasing chemically stored heat

METAL OXIDE MATERIAL:

- Chemical energy storage, in addition to sensible storage
- Excellent thermal shock resistance
- Deformation-resistant at peak operating temperature to an equivalent load of 5 meters (1.5 bar)
- Non-toxic, not flammable



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A Unicorn Thermochemical Battery Material. Ours Alone.

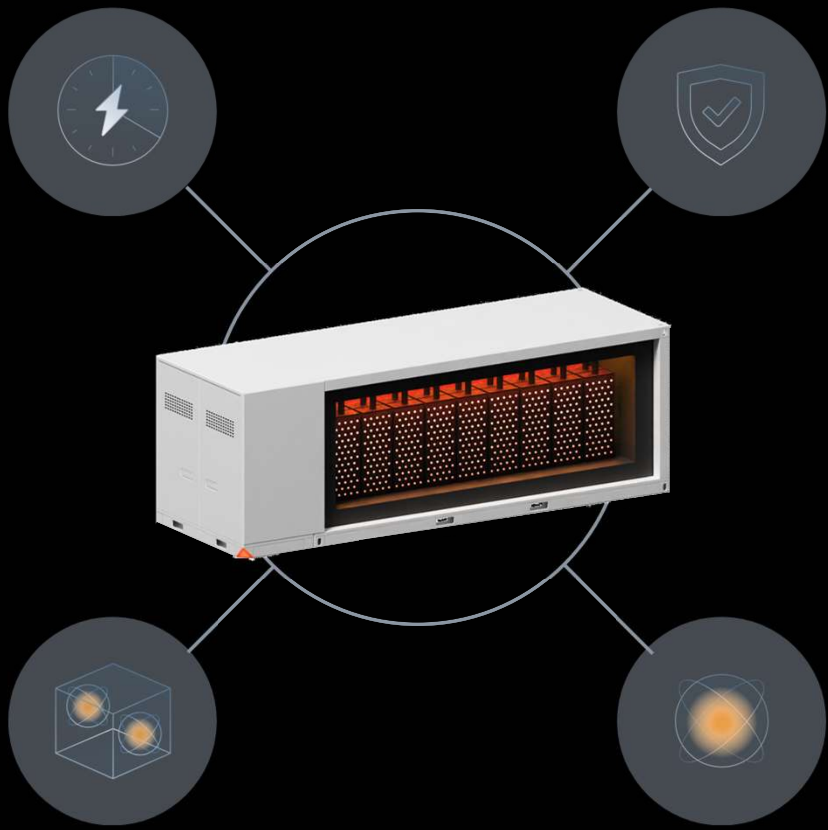
900-1450°C STORAGE RANGE

Fast charge

ELECTRICALLY CONDUCTIVE

No unsafe reaction with air

DIRECT TO AIR HEAT TRANSPORT



Inexpensive, safe, abundant materials

IRON, MAGNESIUM, MANGANESE

Chemical storage + sensible heat

HIGHEST TEMPERATURE AND ENERGY DENSITY

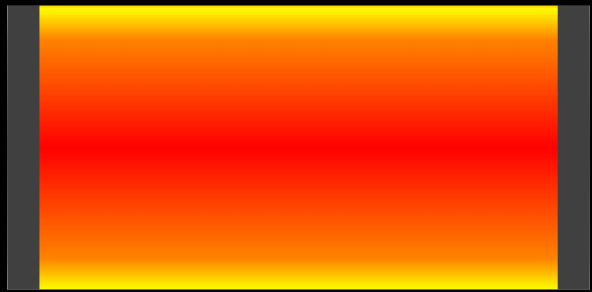
Self-Resistive Heating Reduces Charge Times

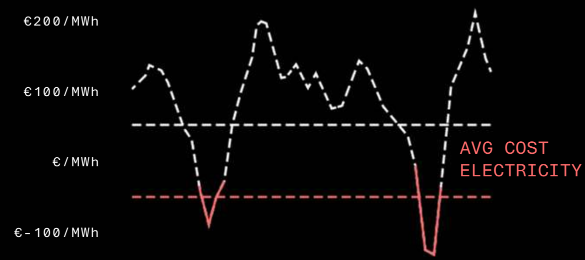
Fast charging, in as little as 4 hours, is key to allowing capture of the cheapest electricity on the market

TEMPO:

Using self-resistive heating

Self-resistive heating is faster, more reliable, and more uniform

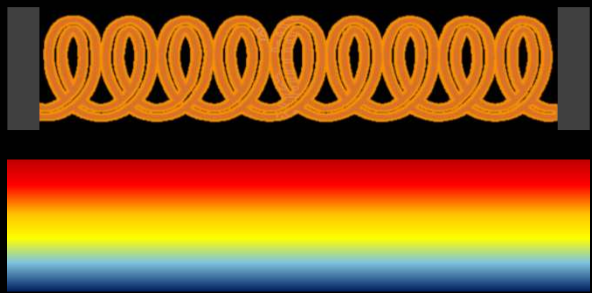


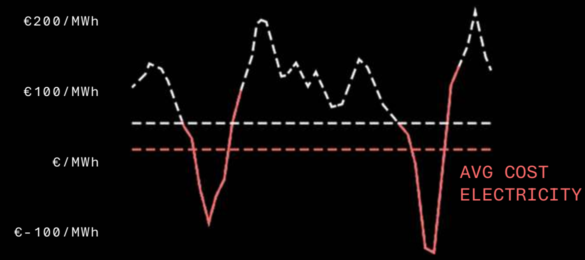


MOST THERMAL BATTERY SYSTEMS:

Using separate resistive coil heaters

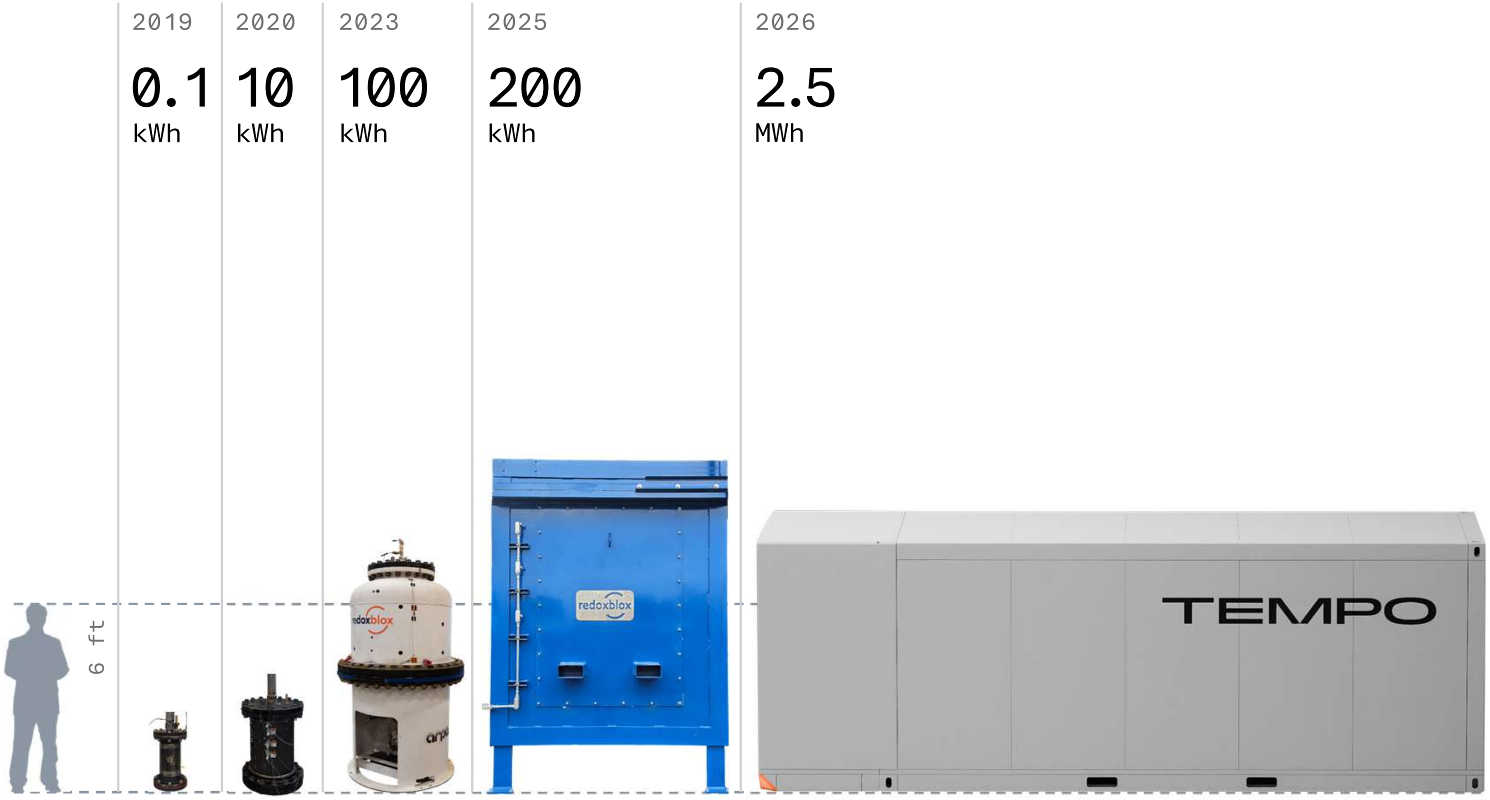
Heating elements are brittle, unreliable, and slow. We have removed them from the system





FROM MATERIALS BREAKTHROUGH TO INDUSTRIAL SCALE

Technology Development History



ARRAYS OF ANY SIZE CAN BE DELIVERED AND ASSEMBLED QUICKLY

Modularity Keeps Construction Cost and Risk Low

One Module	Two Modules	Small Array	Large Array
2.5 MWh	5 MWh	22.5 MWh	120 MWh

ARRAYS OF ANY SIZE CAN BE DELIVERED AND ASSEMBLED QUICKLY

Thermal Array

POWER CABINET

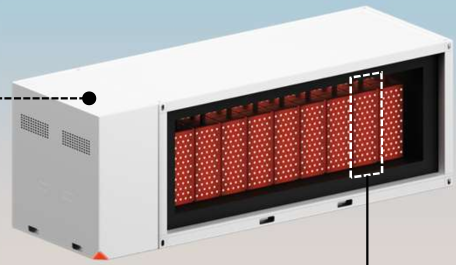
- Charging power electronics
- Discharge blowers
- Battery Management System

THERMAL MODULE

TSM storage cells, electrodes, insulation

RECTIFIER

- Supplies DC current to multiple thermal batteries



Thermochemical Cell

Thermal Array Manifold

THERMAL ARRAY

Number of modules defines MWh capacity

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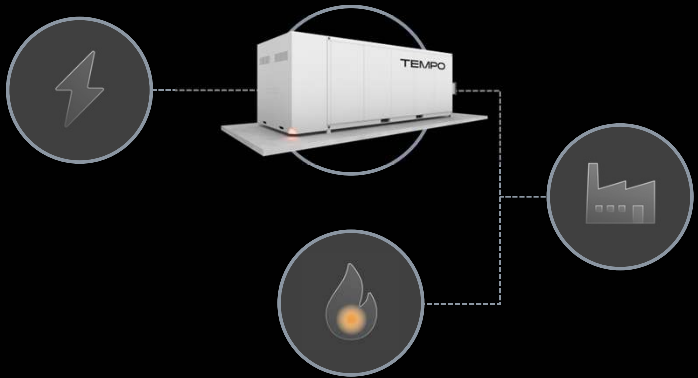
Hybrid Operation

Seamless Hybrid (Electricity-Gas) Operation

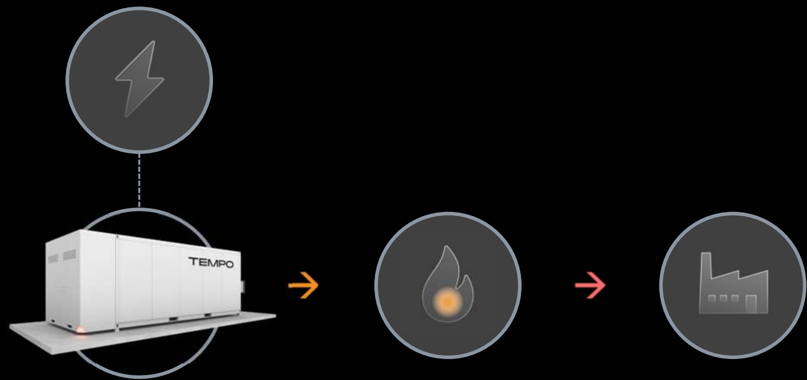
MODE 1



Parallel Hybrid

Switch between electrified heat and gas, or operate them simultaneously optimizing economics

MODE 2



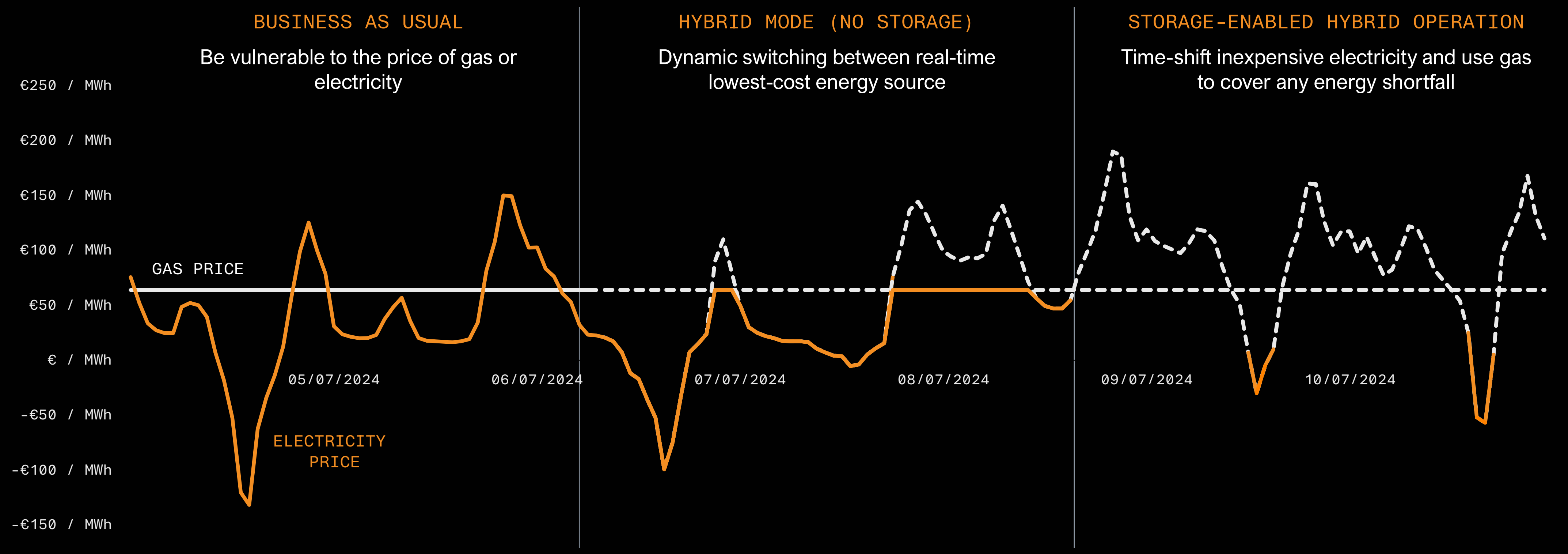
Boost Hybrid: Bringing Electrified Heat Output to Higher Temperatures

Extend electrification to higher-temperature industrial processes

Note: Pre- and post-boost temperatures vary by application

LOWEST ENERGY COST WITH GAS BACK-UP

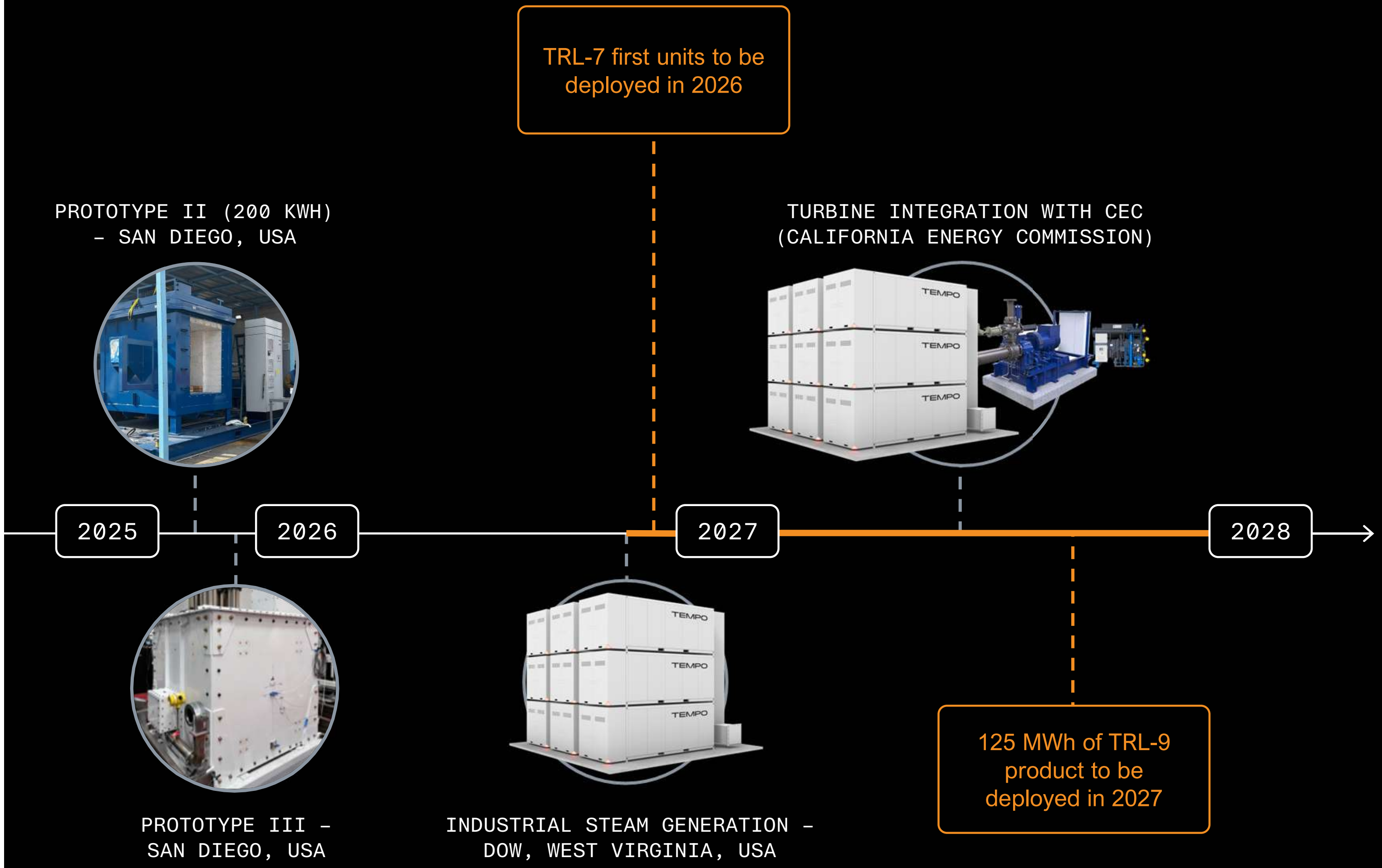
Optimizing Economics of Electricity/Gas Consumption with Thermochemical Energy Storage



Next Steps

Completed and Planned Systems

Tempo is transitioning from validated technology to field deployment and commercial scale-up, with a clear roadmap from prototypes to production systems.



Next Steps

01 Feasibility study and detailed value analysis to demonstrate the utility of Tempo technology

- Heat requirements that define system power (MW) and battery capacity (MWh)
- Electricity and fuel costs across different scenarios
- Integration with the final equipment (boiler, furnace, dryer, calciner)
- Value analysis to quantify savings
- Quantification of CO_2 reduction

02 “Early Adopters” Access Initial Production

- Delivery of the first systems by Q4 2026

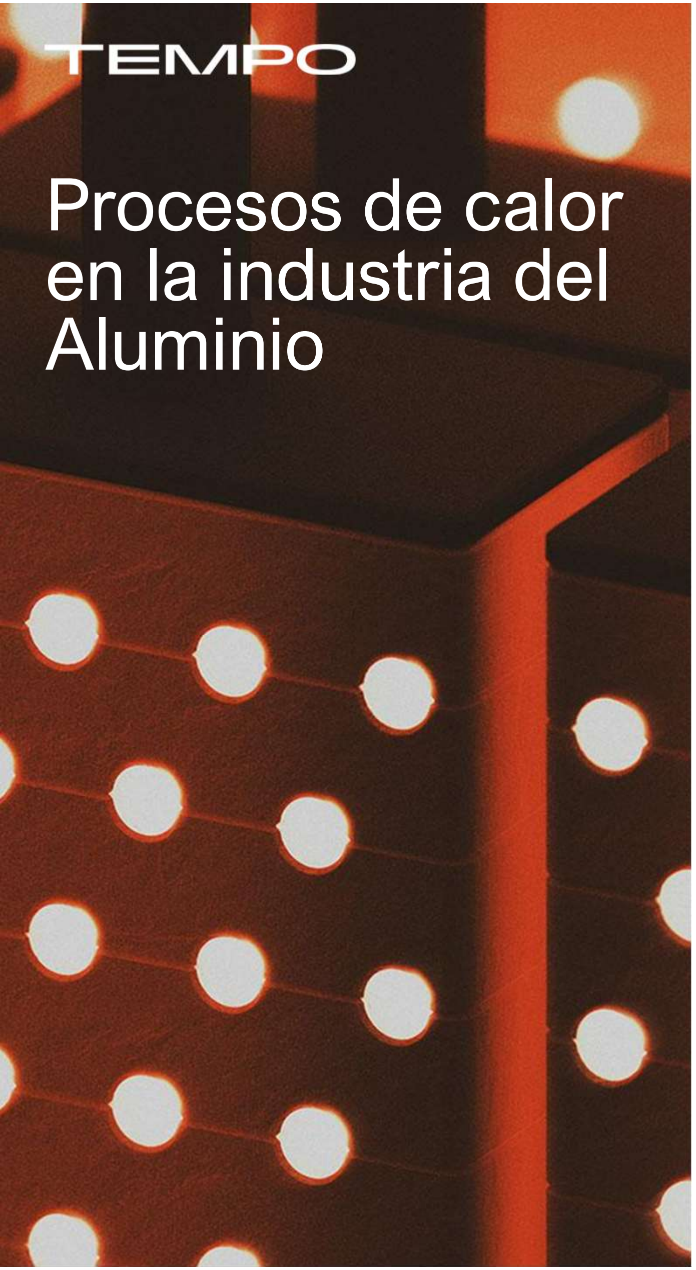
2026 – 2027 – 2028

- Early Adopters formalize orders with special conditions
- Delivery to early adopters
- Operation and performance validation
- Delivery of subsequent batches

03 Regular Delivery of Commercial Systems

- Delivery starting in late 2027+
- Size and delivery depend on use case and required capacity
- System footprint: 3.5 GWh per hectare

Aluminum applications



Procesos de calor en la industria del Aluminio

1. Obtención del aluminio primario

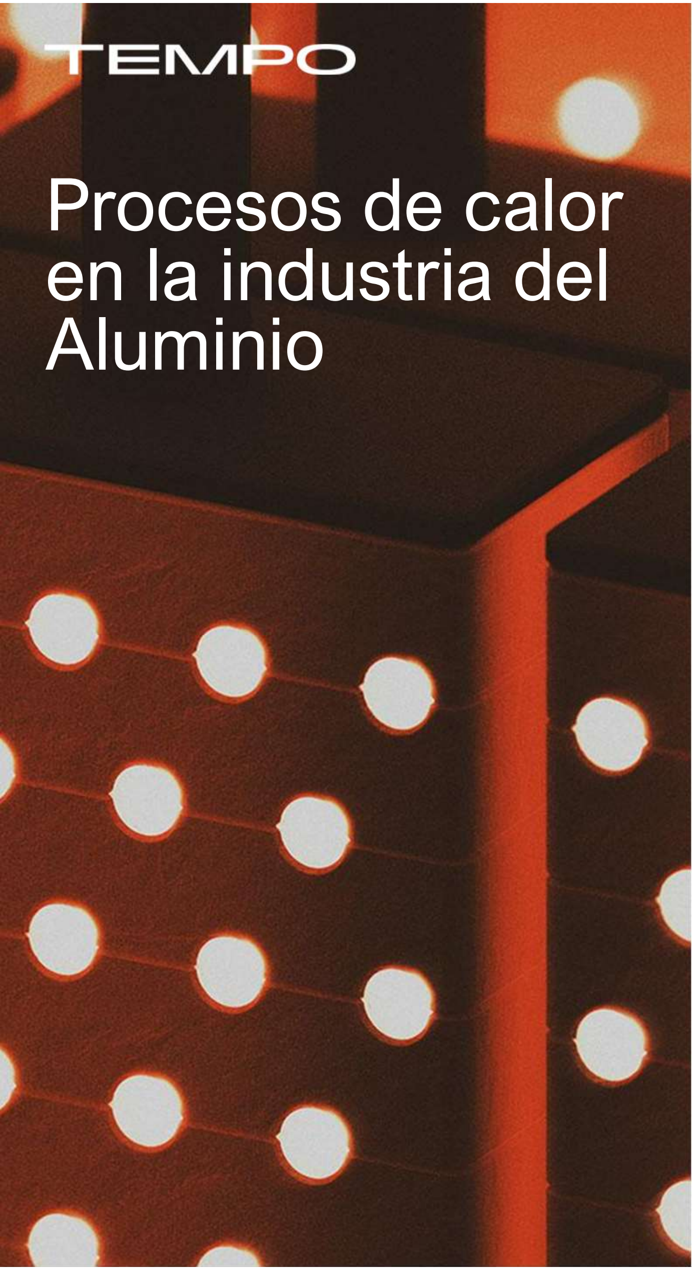
Calcinación de la alúmina: El hidróxido de aluminio extraído de la bauxita se calienta en hornos rotatorios a unos **1000 °C - 1100 °C** para eliminar el agua combinada químicamente y obtener óxido de aluminio puro (alúmina) en forma de polvo seco.

Electrólisis (Proceso Hall-Héroult): *Se utiliza calor generado por resistencia eléctrica (efecto Joule) de alta intensidad para mantener un baño de criolita fundida a unos **950 °C - 960 °C**. En este estado líquido se disuelve la alúmina para poder separar el aluminio puro mediante corriente eléctrica.*

2. Fundición y Reciclaje (Procesado)

Fusión del metal: El aluminio se funde en hornos de reverbero o de inducción a temperaturas superiores a su punto de fusión, alcanzando entre **700 °C y 780 °C** para poder ser aleado, limpiado de impurezas y moldeado en lingotes o tochos.

Homogeneización: Como se describió anteriormente, los tochos fundidos se recalientan y se mantienen a temperaturas de **530 °C a 580 °C** para uniformar su estructura química antes de ser deformados.



Procesos de calor en la industria del Aluminio

3. Transformación (Deformación plástica)

Extrusión en caliente: Los tochos de aluminio se precalientan mediante hornos de inducción magnética o de gas a unos **450 °C - 500 °C**. El calor ablanda el metal disminuyendo su resistencia, lo que permite empujarlo a través de una matriz para crear perfiles con formas complejas.

Laminación en caliente: Los lingotes masivos se calientan a unos **400 °C - 500 °C** antes de pasar por los rodillos de laminación. El calor permite reducir drásticamente el espesor del bloque sin que el metal se agriete.

4. Tratamientos Térmicos Finales (Propiedades mecánicas)

Recocido: Se aplica calor (entre **300 °C y 410 °C**) para ablandar el aluminio que se ha endurecido excesivamente debido al trabajo en frío (como el laminado final o trefilado), recuperando su ductilidad.

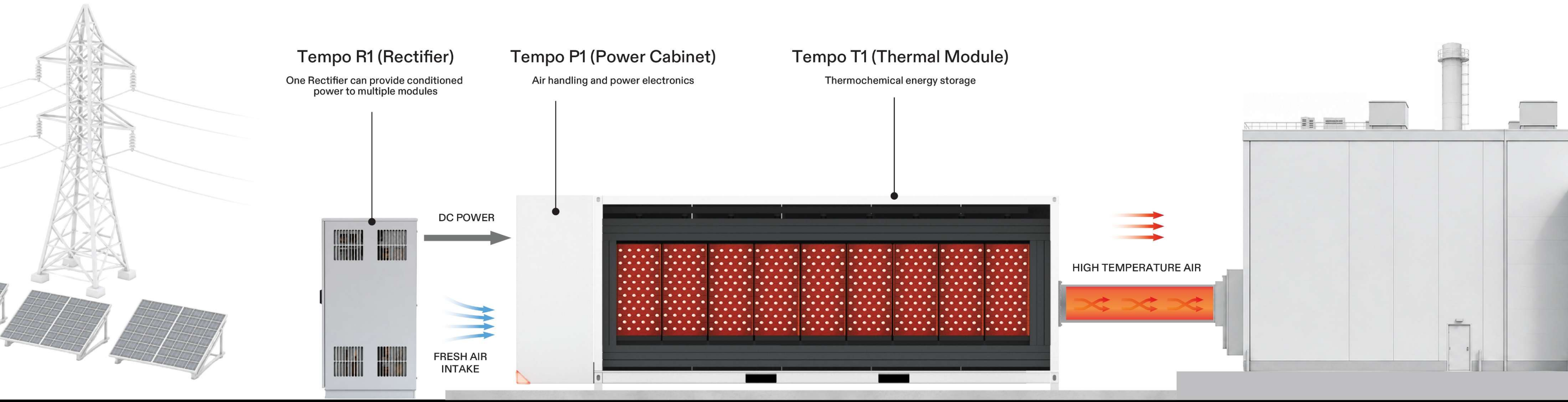
Solubilización: Se calienta la pieza a unos **500 °C - 540 °C** para disolver los elementos de aleación y luego se enfría rápidamente en agua (temple).

Maduración o Envejecimiento Artificial: Las piezas templadas se introducen en hornos a temperaturas bajas y controladas (entre **150 °C y 200 °C**) durante varias horas para que precipiten micropartículas que endurecen y aumentan drásticamente la resistencia mecánica final del aluminio.

Summary

Clean, Reliable, Cost-Competitive Industrial Heat

Charge rapidly when electricity is inexpensive → Control charging rate and air flow for each module → Store energy thermochemically → Mix in ambient air to achieve target temperature → Deliver clean electrified heat



Tempo is the First and Only Company to Combine these Capabilities

HOTTER:
100-1200°C CONTINUOUS OUTPUT

Serving industries where electrified heat has never been possible before

CHARGING IN AS FAST AS FOUR HOURS

Enabling customers to seize and time-shift low-cost electricity

SIMULTANEOUS CHARGING AND DISCHARGING

Enabling continuous 24/7 heat delivery while independently optimizing electricity charging schedules / economics

VERSATILE HEAT DELIVERY VIA HOT AIR

Superheated air has similar characteristics to fossil fuel combustion products, enabling simple integration with a wide range of industrial devices

HYBRID OPERATION

Serving industries where full electrification is not practical due to grid capacity, space for on-site generation, etc.

COST-EFFECTIVE AND RELIABLE

Factory-built modules and simple on-site installation

Thank You

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