Innovate UK | Business Connect

29th June 2026

Hot topic: New technologies for high-temperature heating in manufacturing

Innovate UK Business Connect welcome

Agenda

11:00	Welcome & Introduction
11:05	Industrial Decarbonisation Research and Innovation Centre - Scene setting: *Chris Williams & Charlotte Plews*
11:20	Materials Processing Institute - Energy & Process Decarbonisation Centre: *Hichem Hakka*
11:30	Technology focus:
	Secal TKS - *Steve Pakenham-Walsh*
	Caldera - *Andy Joynson*
	Coolbrook - *Rob Savidge*
11:50	Q&A
12:25	Summary
12:30	Close

About us

We are the home of the UK's innovation networks, connecting businesses, researchers, investors and partners to accelerate innovation.

As a strategic delivery partner to Innovate UK, part of UK Research and Innovation (UKRI), we combine data, insight and sector expertise to connect people and opportunities, helping ideas move from concept to scale.

UKRI Innovate UK | Business Connect

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Innovate UK | Business Connect

Industrial Decarbonisation Research and Innovation Centre

Scene Setting

Chris Williams & Charlotte Plews

IDRIC Innovate UK | Business Connect

Hot Topic: New technologies for high-temperature heating in manufacturing

Electrification and decarbonising industrial heat

Charlotte Plews and Chris Williams

29 June 2026

IDRIC

UK Research and Innovation

IDRIC - accelerating decarbonisation of industry by boosting competitiveness and productivity

Green Industrial Futures, Realised.

Policy & Engagement

Development of effective policy and regulatory frameworks

Research & Innovation

Whole systems solutions integrating technology, policy and business models

Skills & Leadership

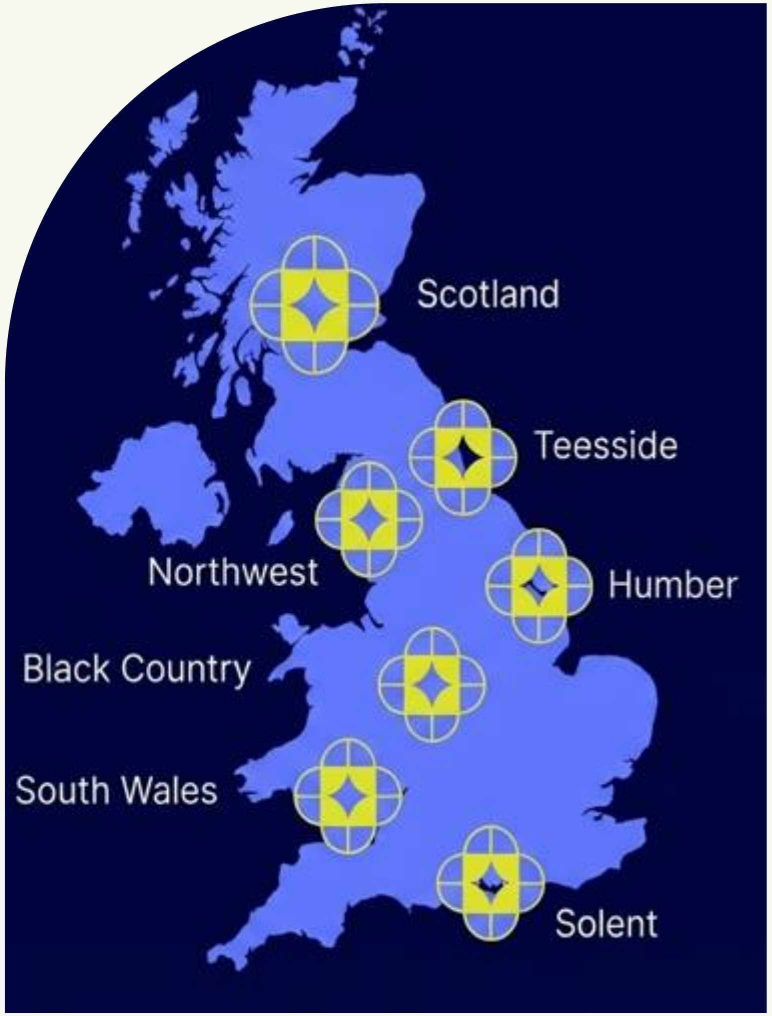
Collaborations at scale & pace across the innovation ecosystem

Knowledge Exchange

Cross-learning, evidence gathering and independent advice

Watch our Three Years of Impact Video

Scale of IDRIC



100 Research Projects

46 Research Institutions

197 Co-delivery Partners

Technology options for decarbonising our industry

Improving energy and resource efficiency

Electrify industrial processes

Switching to low-carbon fuels such as hydrogen

Capturing CO_2 emissions and:
- converting to materials and fuels (carbon capture & utilisation)
- storing CO_2 permanently underground (carbon capture & storage)

Greenhouse Gas Removal technologies:
- Bioenergy with Carbon Capture and Storage (BECCS)
- Direct Air Capture (DAC)

Cross cutting issues

Environmental considerations

Skills & training

Social & economic

Systems & scale up

Policy & regulation

Key outputs

14 reports bringing together IDRIC's key research findings, and making recommendations to industry and policymakers:

- CCS: Carbon capture
- CCS: CO_2 transport & storage
- Carbon dioxide removal technologies
- Hydrogen: generation
- Hydrogen: transport & storage
- Industrial heat and energy efficiency
- Electrification
- Life cycle assessment (LCA)
- Circular economy
- Policy and governance
- Green finance and economic considerations
- Public perceptions and just transition
- Skills, workforce planning, and EDI
- Systems planning and decision-making tools

- Synthesis of collective insights on the key research and innovation needs, barriers and priorities to address and accelerate net zero progress.
- Based on extensive documented conversations with our stakeholders.

Enablers

- Knowledge exchange
- Policy & regulation
- Skills

Research & Innovation Priorities

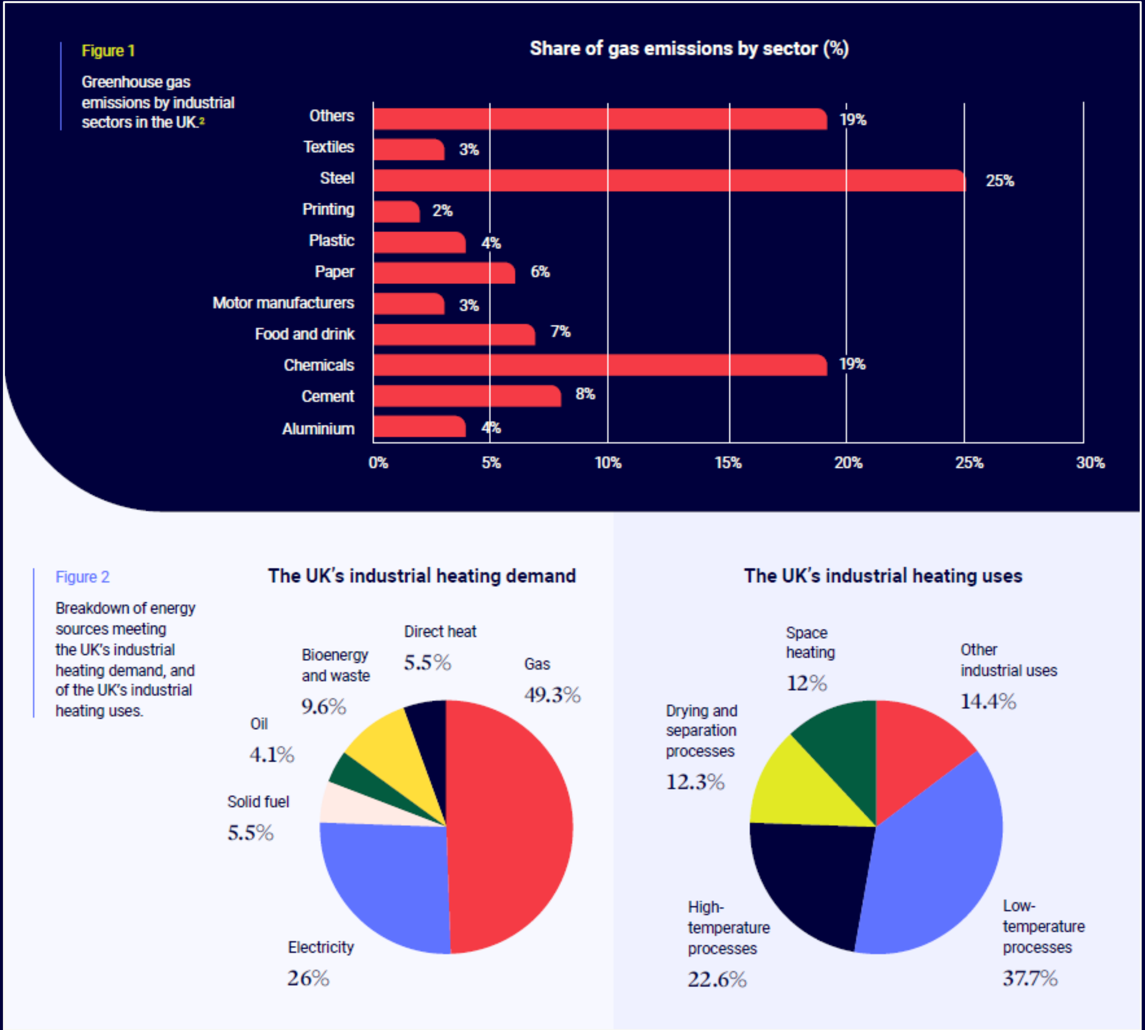
- Technology
- Environment & sustainability
- Society & economy

Frontiers Series Reports: Electrification & Industrial Heat

- Over half (54.1%) of the energy used by industrial sectors is to meet heating demand
- Almost half of this (49.3%) is gas
- Sustainable fuels (hydrogen, ammonia, and biomass) present clean alternatives

Research & Innovation Priorities

- Systems integration at industrial clusters and dispersed sites, enabled by flexible and responsive digital tools
- Research, development, and demonstration projects for electrification of heat processes
- R&I to support place-based shared assets and by-products (such as waste heat) to enable electrification



Source: Frontiers Report: Industrial Heat and Energy Efficiency, IDRIC
https://idric.org/industrial-decarbonisation-frontiers-reports-industrial-heat/

Key insights from IDRIC's R&I Agenda

Key focus areas

Advance low-carbon heat technologies and hybrid solutions for hard-to-electrify industries	**Challenges**
• Develop alternative heat technologies such as microwave, plasma, geothermal	• High costs and complexity of process electrification
• Assess hybrid solutions combining electrification, hydrogen, and waste heat recovery	• Infrastructure readiness and grid capacity limitations
• Explore and research whole-system efficiency gains from process replacement through electrification	• Underutilised energy efficiency potential

Scan to read the full R&I Agenda here:

Dispersed sites' needs – forthcoming report on LIDP

Key insights

~50% of UK's industrial emissions from outside the major clusters

- SME-dominated, often tenanted
- Processes tend to be lower-temperature
- Frequently distant from hydrogen and CO_2 infrastructure

Emerging high-temperature technologies = R&I priorities

- High-temperature heat pumps
- Process electrification for medium/high temperature heat
- Industrial waste-heat recovery (under deployed)

Barriers to electrification

- **Grid capacity** restricting pace of electrification
- **Price signal**: electricity predicted to remain approx. four times the price of gas to 2050

Enablers of electrification

- **Efficiency first**: 15% energy reductions readily available
- **Demand aggregation and as-a-service models**
- **Collaborative investment and infrastructure**: threefold gain in energy and carbon savings

Dispersed sites' needs – forthcoming report on LIDP

Key insights

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COMING SOON: Lessons from the Local Industrial Decarbonisation Plans (LIDP)

Report to be published late summer/early autumn 2026

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- **Demand aggregation and as-a-service models**
- **Collaborative investment and infrastructure**: threefold gain in energy and carbon savings

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New Independent Advisory Board

Chris Williams
Industry Wales

Jane Gaston
Net Zero North West

Ben Burggraaf
Net Zero Industry Wales

Philippa Parmiter
NECCUS

Matthew Rhodes
Camirus

Chris Rowell
Tees Valley Combined Authority

Jonathan Oxley
CBI

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Oxford City Council

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Carbon Capture and Storage Association

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Department for Energy Security & Net Zero (DESNZ)

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Progressive Energy

Clare Jackson
Hydrogen UK

Daniel Paterson
Make UK

Paul Davies
7CO2

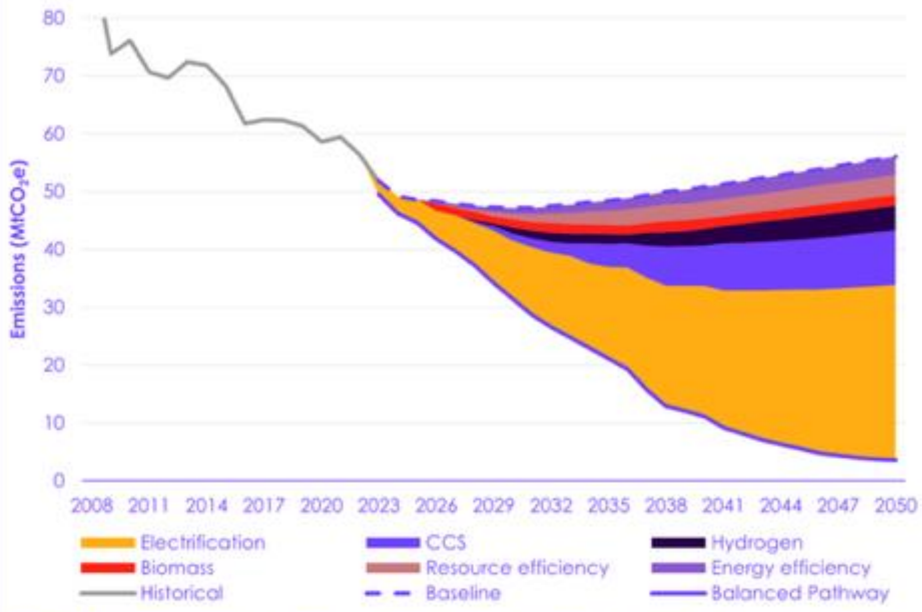
Tony Parton
CR Plus

Ruth Herbert
EET

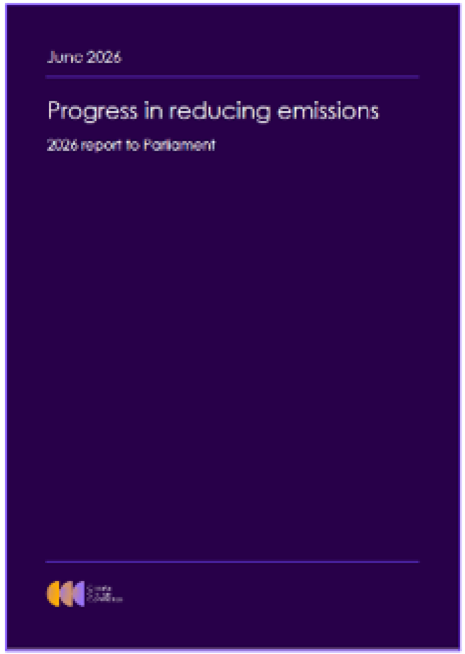
Arjan Geveke
Energy Intensive Users Group

CCC Reports

Figure 7.3.2 Sources of abatement in the Balanced Pathway for industry



Description: The largest share of emissions reduction in industry is from electrification. Contributions also come from CCS, hydrogen, resource efficiency, energy efficiency, and biomass.
Source: DESNZ (2024) *Provisional UK greenhouse gas emissions national statistics 2023*; DESNZ (2024) *Final UK greenhouse gas emissions national statistics 1990-2022*; CCC analysis.
Notes: (1) We generally account for emissions reductions due to measures to reduce demand for high-carbon activities (including low-carbon choices and efficiencies) first, before the impact of low-carbon technologies. (2) The industry baseline is based on the UK Government's Energy and Emissions Projections, with an adjustment to remove the effect of efficiency and climate policy. The decline in baseline emissions to 2032 reflects recent trends, while the subsequent rise to 2050 reflects government assumptions about a future increase in industrial output. Industry also delivers CO_2 removals through BECCS (0.8 $MtCO_2e$ in 2050), but we account for these in our engineered removals pathway, rather than the industry pathway.



24 June 2026

Progress in reducing emissions
2026 report to Parliament

Read more

Key actions for electrification

Rapid progress over the next year is essential to keep the 2030 NDC in reach, with the pace of emissions reduction needing to almost double. To achieve this, the Government needs a more ambitious plan for electrification. It must urgently remove barriers facing households and businesses to transition to efficient, low-carbon electric technologies. Key actions for electrification include:

1. **Make electricity cheaper.** While progress has been made in the past year to remove some policy costs from electricity bills, this is not sufficient to incentivise many households and businesses to transition to low-carbon heating. Remaining policy costs should be removed from electricity bills for both households and non-residential users so that the greater efficiency of heat pumps compared to fossil fuel heating is reflected in lower bills. Lower bills would also improve the case for investing in the UK's energy-intensive sectors.
2. **Create the conditions for a more rapid transition to EVs.** Propelled by the zero-emission vehicle (ZEV) mandate, the market continues to drive down the price of electric cars, allowing more households and businesses to benefit from the lower costs of EV ownership. With clear and consistent incentives and messaging, the adoption of electric cars can outpace current ambition, and the adoption of electric vans can catch-up. To flourish, the UK car industry needs to continue its pivot to the technologies of the 21st century. This requires the Government to stand firm behind the ZEV mandate and remove barriers to EV adoption. Crucial to this is increasing access to affordable charging, allowing the one-third of homes without access to off-street parking to benefit from lower running costs. It is also important to remove regulatory barriers and minimise any 'hassle factor' to consumers from the planned introduction of electric vehicle excise duty.
3. **Accelerate the installation of heat pumps in buildings.** The UK has one of the lowest market shares of heat pump installations in Europe (Figure 4). The Government must ensure installations accelerate in all segments of the market by:
   - Urgently addressing the gap left by the closure of the Energy Company Obligation (ECO) scheme. In the last three years, this scheme accounted for around a third of retrofit heat pump installations in the UK, providing targeted support for low-income households. Without a sufficient replacement, installations could fall significantly this year.
   - Removing any unnecessary barriers that make a heat pump harder to install than a gas boiler, so that low-carbon heating installations become the default choice by 2035. This could be done by: reducing regulatory barriers, addressing skills gaps, improving advice to households and businesses, and enabling market conditions which reduce installation costs.
   - Introducing a comprehensive programme to decarbonise public sector buildings, following the closure of the Public Sector Decarbonisation Scheme. The Government should consider restricting the installation of fossil-fuel boilers in public buildings. Moving instead to low-carbon combined heating and cooling systems can both reduce fossil fuel dependency and protect vulnerable people from rising temperatures, as set out in the Climate Change Committee's (CCC) Adaptation Committee report on A Well-Adapted UK, published earlier this year.
4. **Deliver on industrial electrification.** Exemptions to electricity network and policy costs will not be sufficient to incentivise industrial electrification on their own. The Government should now set out a plan to deliver its ambition for industrial electrification. This should confirm suitable use cases and establish the conditions necessary to make electrification the economically rational choice – addressing both capital and operating cost barriers.

Trade Associations

ELECTRIFY INDUSTRY
Powered by MAKE uk

Hydrogen UK

ade

CCSA

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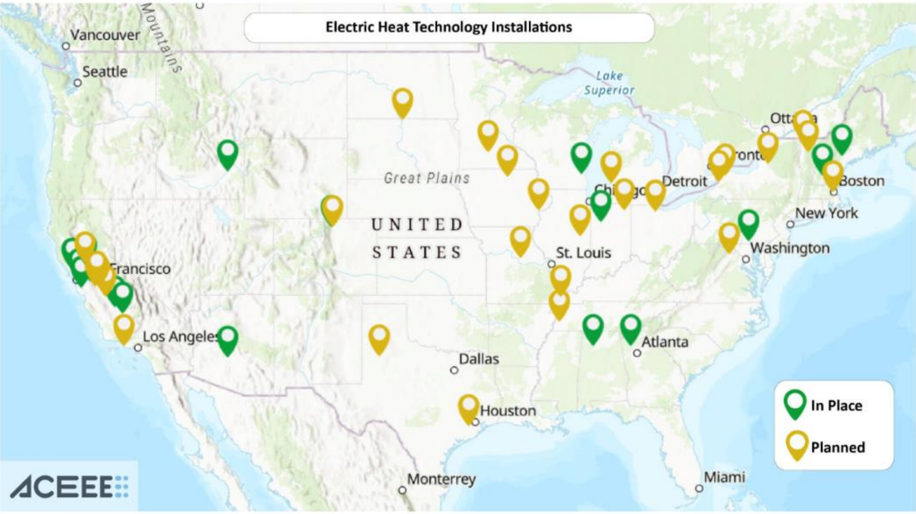
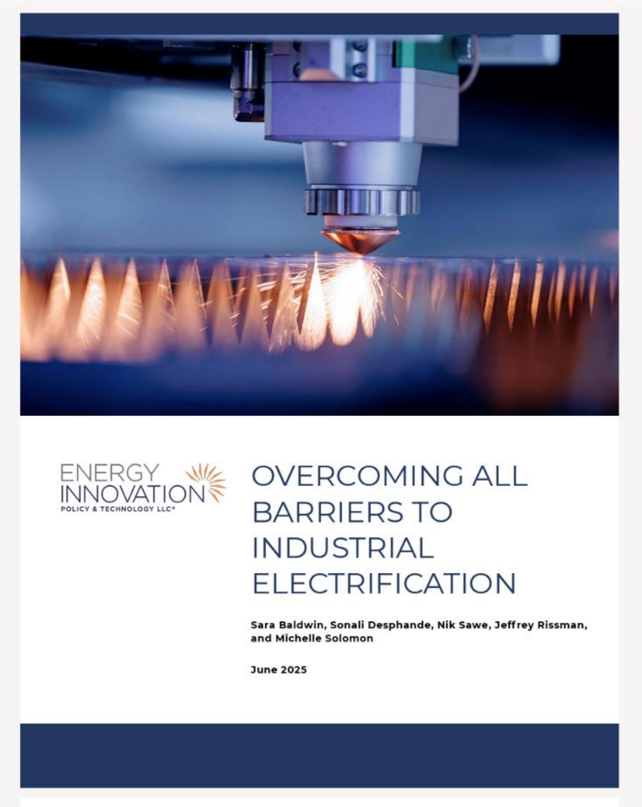
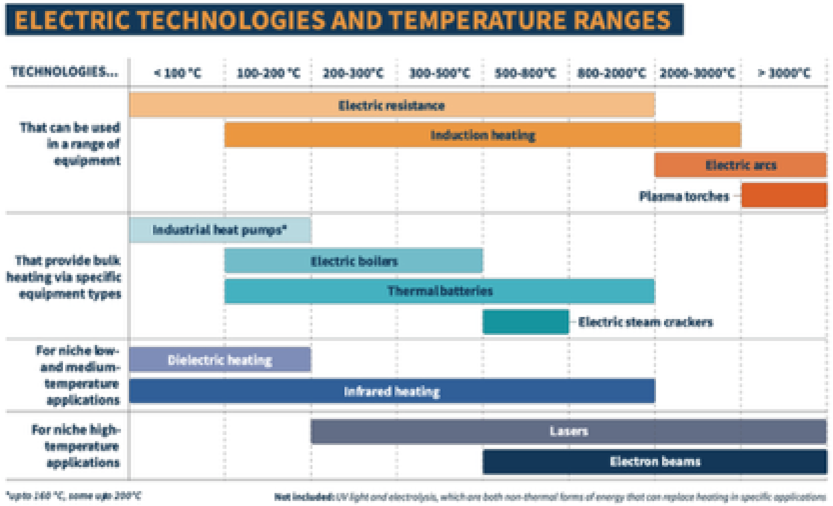


USA


ENERGY INNOVATION
POLICY & TECHNOLOGY LLC®
OVERCOMING ALL BARRIERS TO INDUSTRIAL ELECTRIFICATION
Sara Baldwin, Sonali Desphande, Nik Sawe, Jeffrey Rissman, and Michelle Solomon
June 2025


BENEFITS OF ELECTRIFICATION FOR INDUSTRIAL FIRMS
1 Improved workplace health and safety
2 Improved process control
3 Increased productivity
4 Stronger appeal to environmentally conscious buyers, including those with green procurement policies
5 Avoided pollutant monitoring & inspections
6 Reduced liability and insurance premiums
7 Reduced exposure to fuel price volatility
8 Reduced or no exhaust treatment
9 Reduced noise
10 Reduced need for cooling water
11 Reduced fees for waste disposal


ELECTRIC TECHNOLOGIES AND TEMPERATURE RANGES
TECHNOLOGIES...
< 100 °C
100-200 °C
200-300°C
300-500°C
500-800°C
800-2000°C
2000-3000°C
> 3000°C
That can be used in a range of equipment
Electric resistance
Induction heating
Electric arcs
Plasma torches
That provide bulk heating via specific equipment types
Industrial heat pumps*
Electric boilers
Thermal batteries
Electric steam crackers
For niche low- and medium-temperature applications
Dielectric heating
Infrared heating
For niche high-temperature applications
Lasers
Electron beams
*upto 160 °C, some upto 200°C
Not included: UV light and electrolysis, which are both non-thermal forms of energy that can replace heating in specific applications

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Home / Latest Insights / China Energy Transition Review 2025

China Energy Transition Review 2025

China's surge in renewables and whole-economy electrification is rapidly reshaping energy choices for the rest of the world, creating the conditions for a decline in global fossil fuel use.

9 Sep 2025 | 43 Minutes Read

Download PDF

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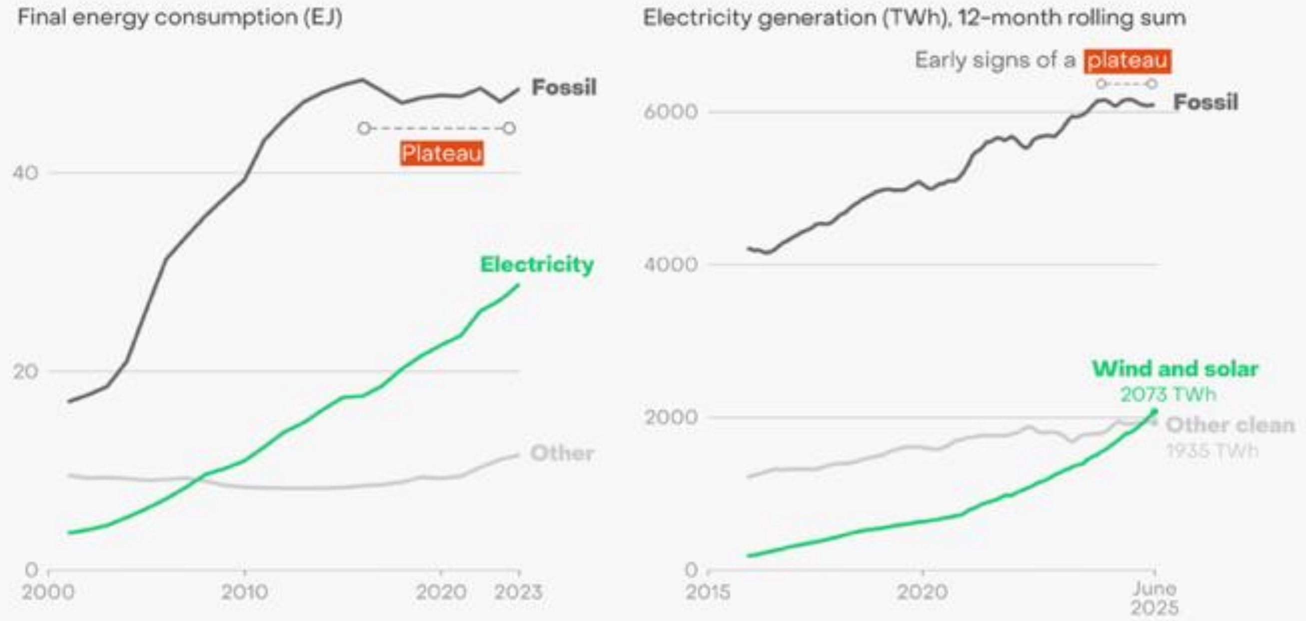
Explore Latest Data

China's rapid electrification and rising solar and wind power will soon drive down its fossil fuel use



Source: IEA World Energy Balances, Monthly electricity data, Ember
Final energy consumption: 'Other' includes biofuels, heat, geothermal and solar thermal. Final energy consumption from fossil refers to the on-site burning of fossil fuels or other energy sources for heating, transportation, or other purposes. Non-energy use of fossil fuels is excluded in the figure.
Electricity generation: 'Other clean' includes bioenergy, nuclear and hydro.

EMBER

EU Electrification Action Plan

European Commission

EN

Energy

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Home > Topics > EU's energy system > Electrification

Electrification

While the decarbonisation of the EU's electricity system is making steady progress, more energy demand needs to shift from fossil fuels to clean electricity.

Page contents

EU Electrification Action Plan
Electrify Now
Electrification of transport
Related links

In 2024, renewables accounted for 47.5% of the gross electricity consumed in the EU, up from 28.6% in 2014 (source: Eurostat). Despite this, electricity represents only 23% of final energy consumption. This must grow to meet the EU's climate targets, reinforce efficiency by integrating the energy system and bringing the benefits of clean energy to consumers.

EU Electrification Action Plan

The Clean Industrial Deal and the Affordable Energy Action Plan introduced a key performance indicator on

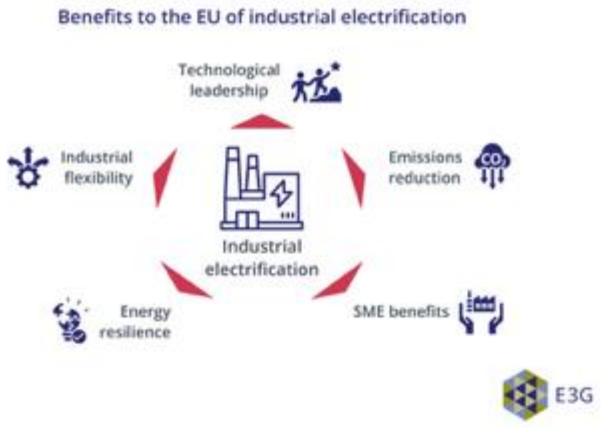

Figure 2: Industrial electrification can contribute to a range of the EU's current core objectives, as outlined in the Political Guidelines 2024–2029 and the Commissioner mission letters.

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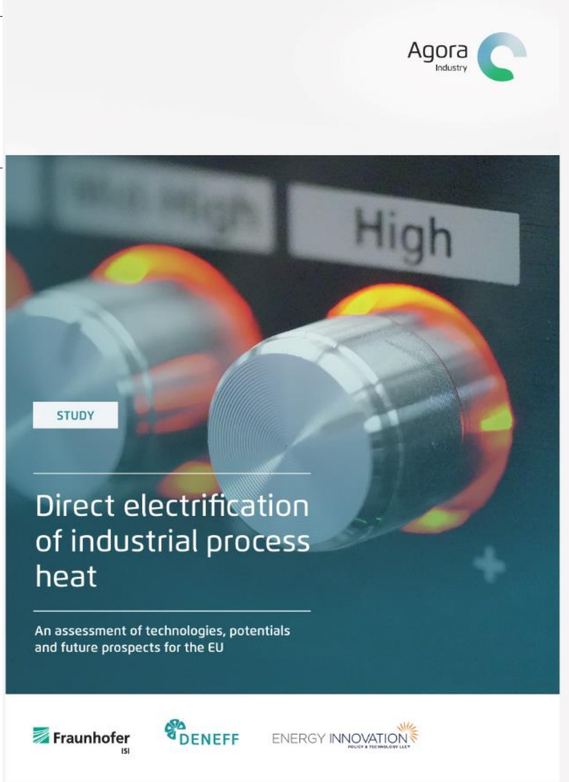
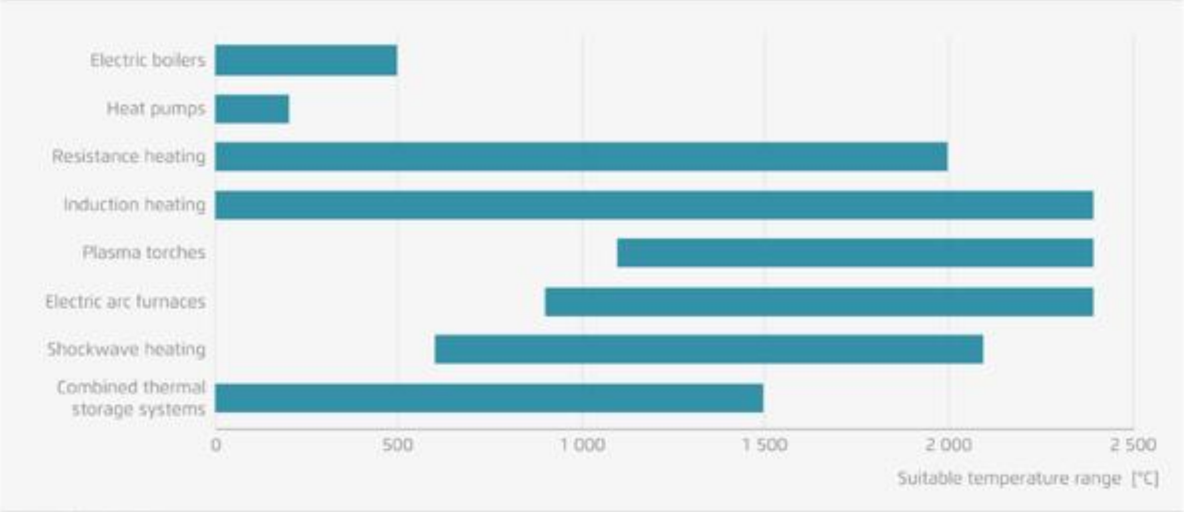


Potential development of suitable temperature range of electric heating technologies until 2035 → Fig. 2

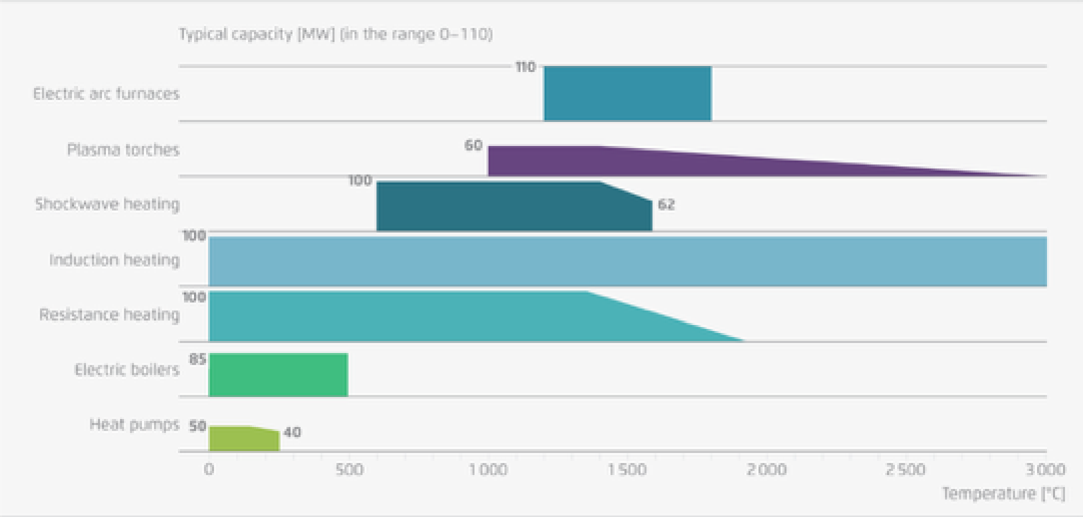


Fraunhofer ISI (2024)

2 **Direct electrification technologies expected to be available by 2035 could meet 90 percent of the energy demand not yet electrified by European industry.**

Technologies readily available today, such as heat pumps and electric arc furnaces, could already deliver more than 60 percent of this demand. To tap into this potential, quickly ramping up technologies for the direct electrification of process heat at all temperature levels is key.

Potential development of electric heating technologies by 2035 – expected capacity versus temperature → Fig. 15



Fraunhofer ISI (2024)

60 – 90% is the innovation opportunity

DESNZ – UK View

GOV.UK

Home > Business and industry > Business and the environment

Research and analysis

Future opportunities for electrification to decarbonise UK industry

This study aims to improve the evidence base for industrial electrification and to identify the non-fiscal barriers to industry adopting electrification solutions.

From: Department for Energy Security and Net Zero
Published 5 November 2024

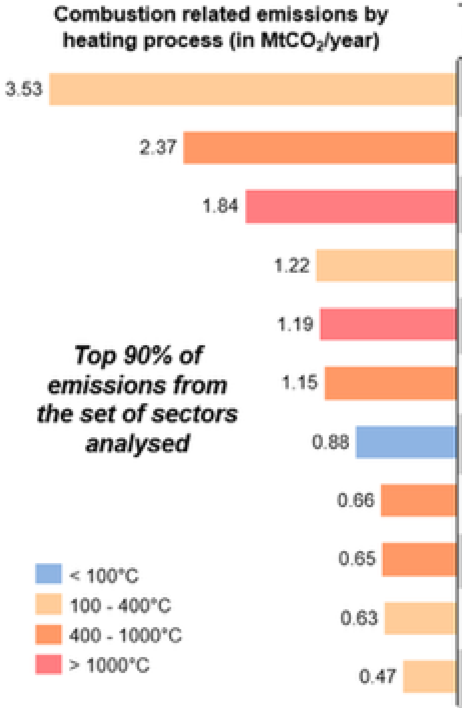
Future Opportunities for Electrification to Decarbonise UK Industry

A report for DESNZ

October 2023

ERM

For most UK industrial heating processes, an electrification alternative can be identified as under development. This study initially considered 10 UK industrial sectors - covering those with the greatest emissions in the National Atmospheric Emissions Inventory (NAEI) point source database. Through researching the processes within these sectors, it was concluded that the majority of emissions were associated with combustion of fossil-fuels for heat generation (with temperature requirements ranging from less than 100°C to more than 1000°C).



Heating Process	Electrification technologies
Steam Generation	Compression Heat Pump, Electric boiler, MVR
Pyrolysis Steam Cracker	Electric Cracker
Calcination and Sintering	Plasma Furnace, Electric Arc Calciner
Atmospheric Distillation Unit	Resistance Furnace
Glass Melting Furnace	Resistance Furnace
Hydrogen Production SMR	Resistance Furnace
Space Heating	Compression Heat Pump, Electric Boiler
Clinker Pre-heating	Resistance Kiln
Brick Firing Kiln	Resistance Kilns, Microwave-assisted Kiln
Ovens	Microwave / Infrared Dryer
Catalytic Reforming	Resistance Furnace

Figure E1: Depiction of the combustion emissions from heating processes and the associated electrification technologies that could abate these processes (data available in Table 5 of the appendix).

Table 5: Table showing combustion heating processes, their CO_2 emissions, and the associated electrification technologies to abate these processes.

Temperature	Heating Processes	Electrification Technologies	Combustion emissions ($MtCO_2$ / year)
< 100°C	Space Heating	Compression Heat Pump, Electric Boiler	0.88
	Thermal Drying	Electric / Microwave / Infrared Dryer	0.27
100 – 400°C	Steam Generation	Compression Heat Pump, MVR, Electric boiler	3.53
	Ovens	Microwave / Infrared Dryer	0.63
	Polymer Melt/ Extruding	Electric / Microwave / Infrared Dryer, Electric Reactor	0.22
	Brick Drying	Electric Dryer	0.17
	Haber-Bosch Process	Centrifugal Compressor Reactor	0.14
	Atmospheric Distillation Unit	Resistance Furnace	1.22
	Vacuum Distillation Unit	Resistance Furnace	0.22
	Hydrocracking	Resistance Furnace	0.37
	Thermal Cracking/ Visbreaking	Resistance Furnace, Plasma Furnace	0.08
	Catalytic Reforming	Resistance Furnace	0.47
400 - 1000°C	Clinker Pre-heating	Resistance Kiln	0.66
	Cracker	Electric Cracker	0.08
	Reformer	Electric Reformer	0.07
	Paper Lime Production	Electric Arc Calciner	0.06
	Annealing Furnace	Resistance Furnace	0.10
	Brick Firing Kiln	Resistance Kiln, Microwave-assisted Kiln	0.65
	Hydrogen Production SMR	Resistance Furnace	1.15
	Pyrolysis Steam Cracker	Electric Cracker	2.37
> 1000°C	Calcination and Sintering	Plasma Furnace, Electric Arc Calciner	1.84
	Glass Melting Furnace	Resistance Furnace	1.19
	Foundries	Induction Furnace, Resistance Furnace	0.08

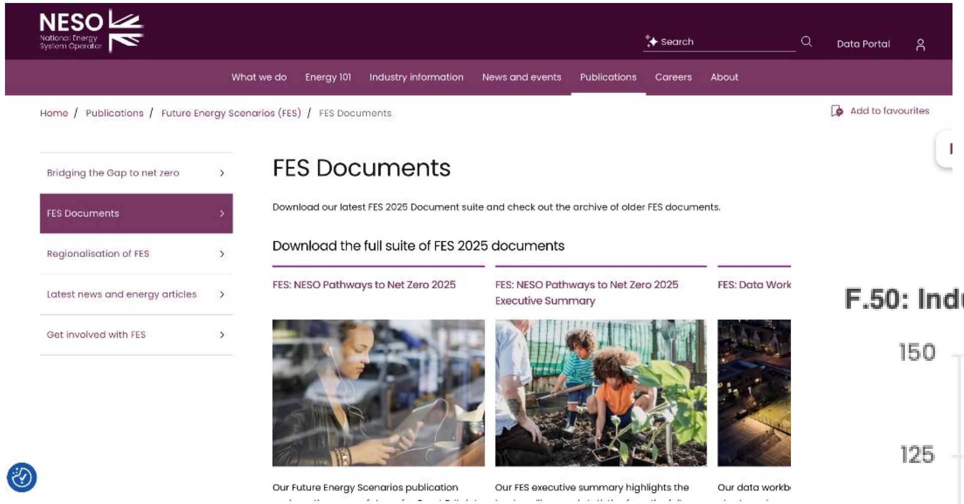
Aldersgate Group report

01 With a supportive policy environment, electrification of industry could deliver more than 40% of the greenhouse gas emissions reductions needed by industry to help reach the UK's net zero target.

02 Researchers from the University of Leeds have modelled such a scenario and implications for electricity distribution networks. In this scenario, industrial electricity use will **increase by 78% between 2024 and 2050**. Increased electricity demand from industry and other uses, such as heat pumps and electric vehicles, will put pressure on the distribution network.

03 Without further investment, **the network becomes significantly constrained from 2030**. This means industrial sites in many regions may not be able to access the electricity they need to decarbonise. By 2050 Yorkshire and the Humber is the only unconstrained region.

NESO FES



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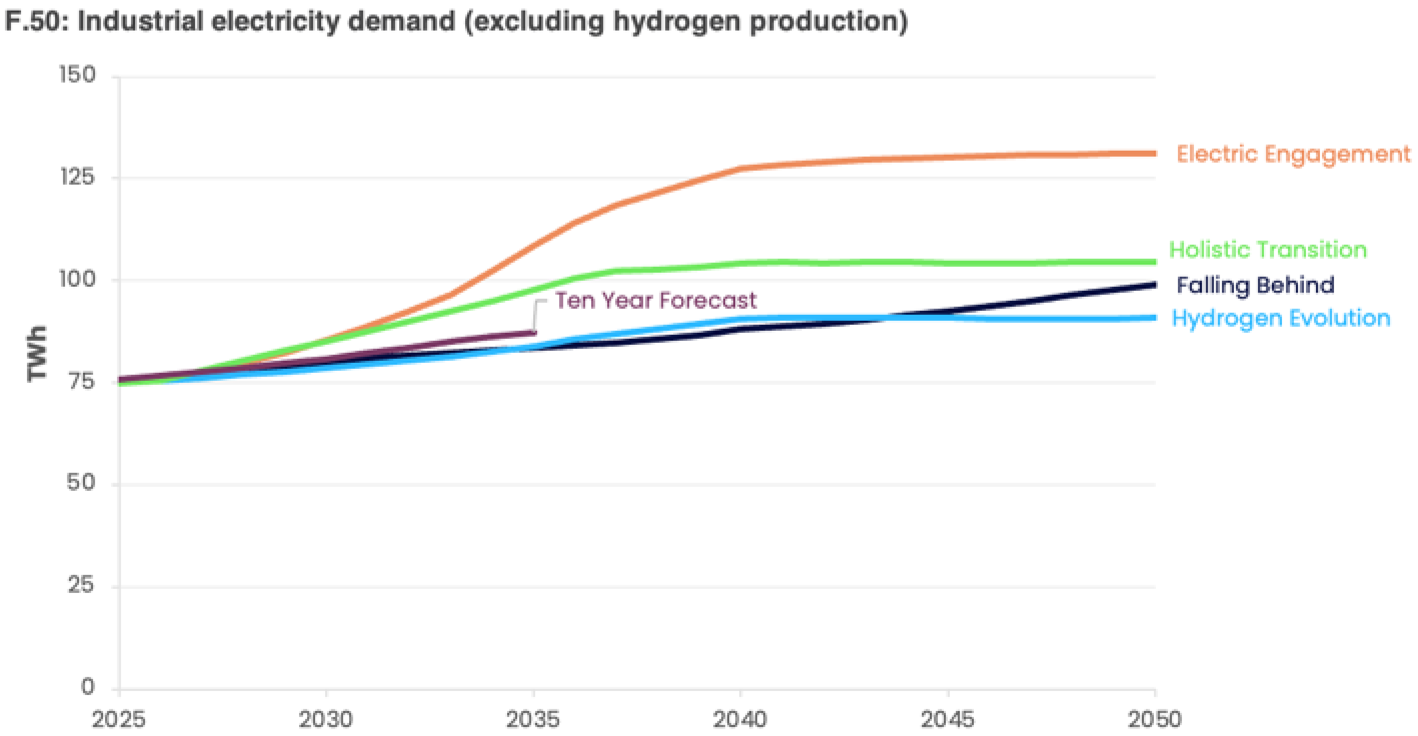
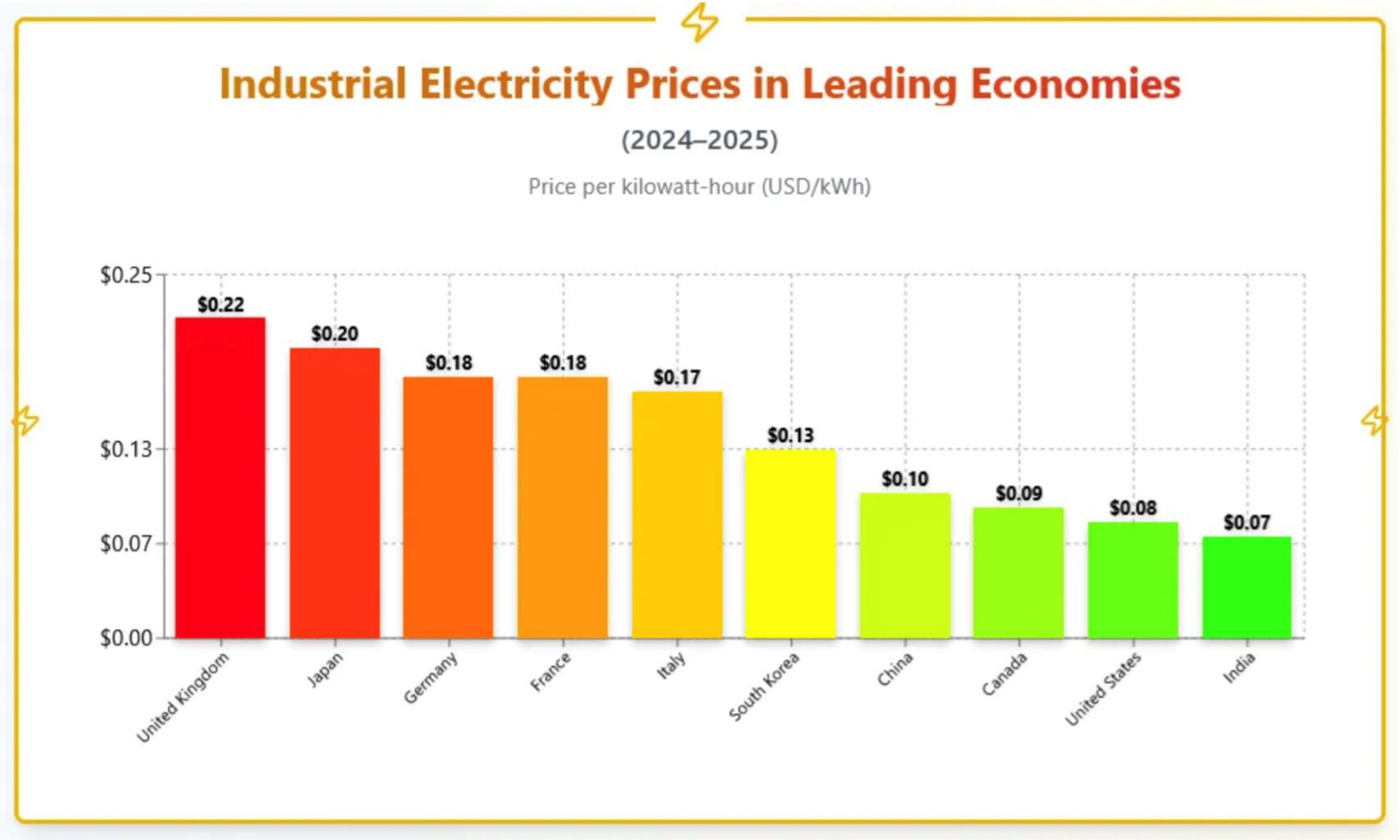


F.50: Industrial electricity demand (excluding hydrogen production)
TWh
150
125
100
75
50
25
0
2025
2030
2035
2040
2045
2050
Electric Engagement
Holistic Transition
Falling Behind
Ten Year Forecast
Hydrogen Evolution

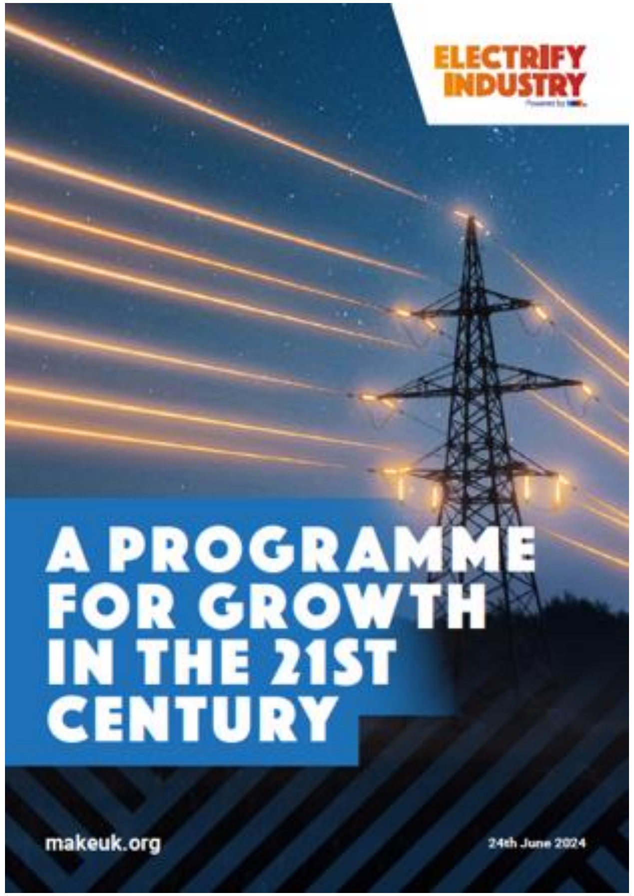
Industrial Electricity Prices in the UK



https://www.rhnuttall.co.uk/blog/industrial-electricity-prices-by-country/

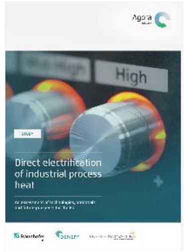
Barriers

- Electricity Price
- Grid connection – (flex can help)
- R&D – no programme in the UK!
- Skills
- Supply Chain



Opportunities

We can see that the world is electrifying its industry :-
- We need to catch up
- We need to ensure resilience, sustainability and GROWTH for our manufacturing base
- We need an electrification programme (alongside the Hydrogen and CCS programmes)



60 – 90% of future energy demand is the innovation opportunity

UKRI have organized some examples that support tackling some barriers and opportunities:

- New heating technology development
- Efficiency improvement technology
- Energy Storage technology
- Technology Centres to help industry pilot and de-risk

IDRIC

UK Research and Innovation

Powered by research and innovation and funded by UKRI, IDRIC supports the development of innovative decarbonisation solutions at pace and scale in the places where it matters most.

Thank You

info@idric.org
www.idric.org

Find out more about our impact and reports:

https://idric.org/centre-team/

Materials Processing Institute

Energy & Process Decarbonisation Centre

Hichem Hakka

Innovate UK | Business Connect

Accelerating Industrial Heat Decarbonization

From Research to Industrial Deployment

Materials Processing Institute

Energy & Process Decarbonisation Centre

Hichem Hakka, PhD

Associate Director – Excellence & Business Transformation

Head of Energy & Process Decarbonization / Green Metal

Materials and Process Innovation for a Sustainable Future

Why Industrial Heat Matters

High-temperature heat is essential to everything we make

~66% of the total final energy consumption in industry is for heat
Primarily at temperatures above 150 °C

Decarbonising industrial heat is critical to achieving our net-zero future

INDUSTRIAL HEAT IS USED ACROSS MANY SECTORS

EVERY PROCESS HAS UNIQUE REQUIREMENTS

- Temperature range
- Atmosphere control
- Heating rate & cycle time
- Product quality
- Cost & competitiveness

There is no one-size-fits-all solution.

Institute

Industrial Decarbonisation Pathways

;

Multiple routes are needed – today's focus is on the electrification of high-temperature heat

ENERGY EFFICIENCY
Reduce energy demand through better processes, equipment and digitalisation

ELECTRIFICATION
Use electricity to generate heat through advanced technologies

HYDROGEN
Use hydrogen as a fuel or reducing agent where direct electrification is not feasible

ALTERNATIVE FUELS
Sustainable biofuels, waste-derived fuels and other low-carbon options

ALTECARBON CAPTURE & STORAGE
Capture and store emissions from hard-to-abate processes.

TODAY'S FOCUS: ELECTRIFICATION

- Resistance Heating
- Induction Heating
- Infrared Heating
- Microwave Heating
- Plasma Heating
- Electric Arc Heating
- Thermal Energy Storage

Selection depends on temperature, material, production rate, atmosphere and economics

No single technology will decarbonise every process
The right solution depends on the process, the product and the site

Collaboration across industry, technology providers and research organisations is essential

Institute

The Electrification Technology Landscape

A diverse set of electric technologies can deliver high-temperature heat across the industry

The right choice depends on the process, the product and the site

Resistance Heating

Mature, simple and reliable. Ideal for ovens, dryers and low to medium temperature applications.

Induction Heating

Efficient, precise and fast. Widely used for melting, forging, bonding and heat treatment.

Infrared Heating

Excellent for surface heating, drying, coating and fast-response processes.

Microwave Heating

Volumetric heating for specific materials and applications.

Plasma Heating

Enables very high temperatures and unique atmospheres. Used in metallurgy, waste treatment and advanced materials.

Electric Arc Furnaces

Very high temperature processing for steelmaking, refining, recycling and speciality materials.

Thermal Energy Storage (Electric)

Stores electricity as heat and delivers on demand. Supports flexibility and integration.

Technology selection is multi-criteria – it depends on the process, temperature needs, material, throughput, atmosphere, site constraints and economics.

Collaboration across industry, technology providers and research organisations is essential.

Electrification is not about replacing everything – it's about using the right technology, in the right place, to decarbonise industrial heat.

Bridging the Scale-up Gap

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From early-stage research to industrial deployment – we close the gap where impact happens

TRL 3/4 ← **RESEARCH & DEVELOPMENT** Prove feasibility and develop solutions →

DEMONSTRATION & DEPLOYMENT Prove performance and deliver value → TRL 7/8

LABORATORY RESEARCH

- Fundamental studies
- Material discovery
- Concept development
- Initial process modelling

LABORATORY TESTING

- Proof o concept
- Bench-scale testing
- Process optimisation
- Performance validation

PILOT SCALE DEVELOPMENT

- Pilot-scale trials
- Integrated system testing
- Operating window evaluation
- Risk & safety validation

DEMONSTRATION (TRL 5-6)

- Demonstration at relevant scale
- Performance at real conditions
- TEA & LCA
- De-risking for deployment

INDUSTRIAL DEPLOYMENT (TRL 7-8)

- Commercial scale implementation
- Continuous improvement
- Reliability and availability
- Full value realisation

The scale-up gap is where many innovations stall.
We provide the facilities, expertise and partnerships to bridge it.

Multi-disciplinary expert team

World-class infrastructure

Agile project delivery & PM excellence

MPI CAPABILITIES ACROSS THE JOURNEY

Process & materials development

Expertise in high-temperature processes and materials.

Pilot & test infrastructure

Versatile furnaces, plasma, induction, MW, EAR, and specialised rigs.

Advanced testing & characterisation

Thermal, chemical, emissions, mechanical and microstructure analysis.

Modelling & digital tools

Process modelling, simulation, LCA and TEA.

Industrial collaboration

Working with industry, academia, and technology providers to deliver real-world impact.

From TRL ¾ to TRL 7/8 – we turn innovation into industrial impact

De-risk

Demonstrate performance

Reduce emissions

Create value

Key Considerations for Electrifying Industrial Heat

Successful adoption requires a holistic view beyond the technology itself

PROCESS REQUIREMENTS

- Operating temperature and heat profile
- Throughput and cycle time
- Atmosphere and process chemistry
- Product quality and consistency

Right technology for the right process

POWER SUPPLY & INFRASTRUCTURE

- Power availability and reliability
- Grid capacity and stability
- Electrical infrastructure and distribution
- Future energy mix and carbon intensity

Reliable, affordable and sustainable power

ECONOMICS & BUSINESS CASE

- Capital investment
- Operating costs
- Energy efficiency and savings
- Payback period and ROI
- Policy and incentives

Commercially viable and future-proof

TECHNICAL & OPERATIONAL

- Technology maturity and reliability
- Integration with existing operations
- Maintainability and uptime
- Skills and capability development

Safe, reliable and operationally robust

SUSTAINABILITY & ENVIRONMENT

- Emissions reduction potential
- Resource efficiency
- Environmental impact and compliance
- Circularity and future regulations

Deliver real decarbonisation and long-term value

Cross-cutting Enablers

- Stakeholder engagement
- Data, monitoring & digitalisation
- Partnerships & collaboration
- Innovation & continuous improvement
- Standards, regulation & policy support

Technology is only one piece of the puzzle.
Integrated thinking delivers impact.

A successful transition to electrified heat depends on aligning technology, infrastructure, operations and strategy.

Thank you

I hope this has provided valuable insights into electrifying industrial heat and how MPI can help you on your decarbonisation journey.

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Scan to learn more about our Energy & Process Decarbonisation capabilities and pilot facilities

Helping industry move from innovation to industrial impact.

Secal TKS

Technology Focus

Steve Pakenham-Walsh

Kinetic Heat Transfer — Step-change energy efficiency for heavy thermal processing

Monday 29th June 2026

info@secaltks.com

Focus on Decarbonisation.

In February 2026, the Department for Energy Security and Net Zero (DESNZ) issued the final 2024 Greenhouse Gas emission (GHG) figures for the UK

By what percentage do you think the UK's industrial GHG emissions have fallen relative to the 1990 baseline for Net Carbon Zero?

A) 50%   B) 60%   C) 70%   D) 80%

Focus on Decarbonisation

C) 70%

**97% of which is Carbon Dioxide (67.9% CO^2)
according to the 2024 Final report**

**Savings of 32.1% plus would meet and
mitigate
Net Carbon Zero**

DESNZ Publication February 2026

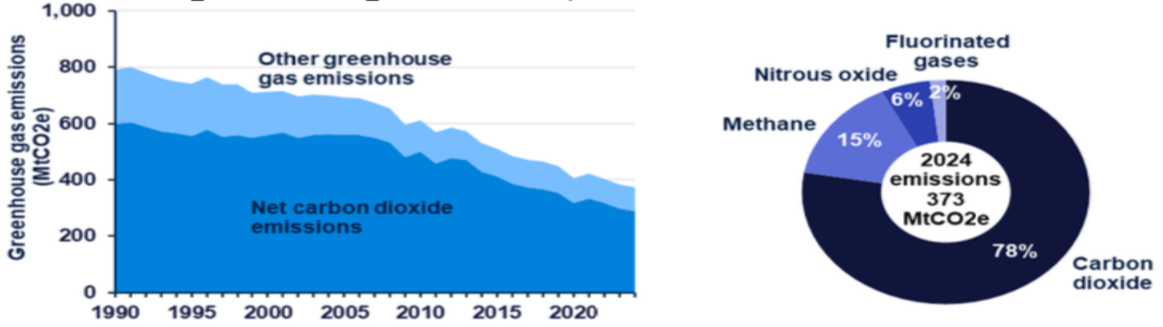
UK Government

2024 UK Greenhouse Gas Emissions, Final Figures

5 February 2026 **Accredited Official Statistics**

In 2024, total UK net territorial greenhouse gas emissions were estimated to be 373 million tonnes carbon dioxide equivalent (MtCO2e), a decrease of 3% (11 MtCO2e) from 2023 and 53% (417 MtCO2e) from 1990. Carbon dioxide made up around 78% of the 2024 total.

UK territorial greenhouse gas emissions, 1990-2024



- Lower gaseous fuel and coal use in the electricity supply and industry sectors caused the largest emissions reductions in 2024. Electricity supply emissions fell by 16% (7 MtCO2e), largely due to higher net electricity imports, greater renewable generation, and the closure of the UK's last coal-fired power station in September 2024. Industrial emissions fell by 7% (4 MtCO2e), largely due to blast furnace closures in the iron and steel industry and lower coal use across the sector.

- Emissions from buildings and product uses rose by 4% (3 MtCO2e), due to higher gas use likely driven by an easing of energy cost pressures. Domestic transport emissions remained at a similar level to 2023 and this remains the largest emitting sector, responsible for 30% of all UK emissions in 2024.

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DESNZ

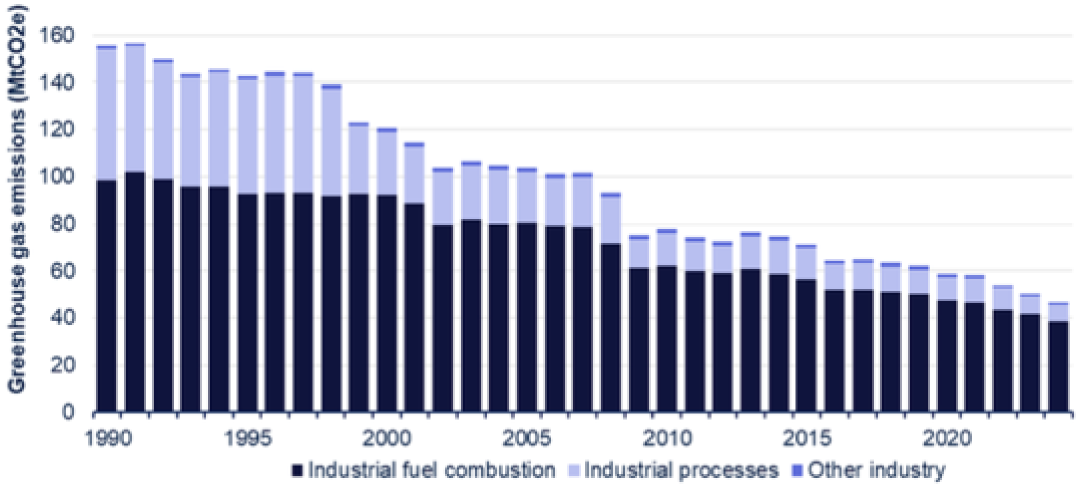
2024 UK Greenhouse Gas Emissions, Final Figures

have been responsible for 12% of greenhouse gas emissions in the UK in 2024, with carbon dioxide emissions accounting for 97% of these emissions.

Between 2023 and 2024, there was a 7% decrease in greenhouse gas emissions from industry, largely due to blast furnace closures in the iron and steel industry and lower coal use across the sector. In 2024, greenhouse gas emissions from industry were 70% lower than in 1990. Over this period, industrial process emissions fell by 88%, whilst industrial fuel combustion emissions fell by 61%. Emissions reductions were largest between 1999 and 2009, with a significant drop in 2009 likely driven by economic factors. Since then, industry sector emissions have continued to gradually decrease.

The fall in industrial process emissions is largely the result of plant closures and installation of abatement equipment. Most notably, nitrous oxide emissions from adipic acid production fell up until the closure of the only UK production facility in 2009, whilst HFC emissions from halocarbon production have reduced significantly following the introduction of abatement at production facilities in 1999. In 2024, the largest source of industrial process emissions was cement production, with other processes such as lime, sinter, and iron and steel production also significant contributors.

https://assets.publishing.service.gov.uk/media/6982292019d3abdb495f37cd/2024-final-greenhouse-gas-emissions-statistics-statistical-release.pdf



Source: Table 1.2, Final UK greenhouse gas emissions statistics 1990-2024 Excel data tables

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The Hierarchy of Decarbonisation

Tier 1) Avoid / Reduce demand

Eliminate unnecessary energy use and process steps (process redesign, product/process consolidation).

Tier 2) Improve energy efficiency

Eliminate unnecessary energy use and process steps (process redesign, product/process consolidation).

Tier 3) Electrify / switch to low-carbon energy (Hydrogen)

Replace fossil combustion with low-carbon electricity and low-carbon fuels (direct electrification, green hydrogen, biogas) supplied from renewable sources.

Tier 4) Capture and abate residual emissions

Apply end-of-pipe or process capture (CCS, process scrubbing, catalytic abatement) and industrial symbiosis to remove unavoidable point emissions.

Tier 5) Remove or offset remaining CO^2

Permanent removals and verified offsets (afforestation, BECCS, direct air capture + storage) to address residual emissions and achieve net-zero.

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Heat Treatment Furnace – WEIR Minerals Ltd

Trials at WEIR Minerals from March through to August 2025

Radiant burner system used 9,023.76 kWh (Natural) Gas

Radiant burner Process time 30 hrs 43 minutes*

Emitter system used 3,390.07m^3 kWh (Natural) Gas (62% gas reduction)

Emitter system process time 5 hrs 43 minutes* (81% time reduction)

*** Average consumption/time of three trials**

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Heat Treatment Furnace – WEIR Minerals Ltd

Courtesy of Innovate funding January 2026, independent validation was carried out by a qualified Research Technology Organisation (RTO) Materials Processing Institute (MPI)

Materials Processing Institute

- Conclusion; kinetic heat transfer is 5 – 6 times faster than radiant flame
- Saving 56% energy through shorter process times
- Additional metallurgical studies need to be conducted to further understand the full impact of Kinetic Heat Transfer

MPI validation places the G12 furnace 23.9% “Beyond Net Carbon Zero”

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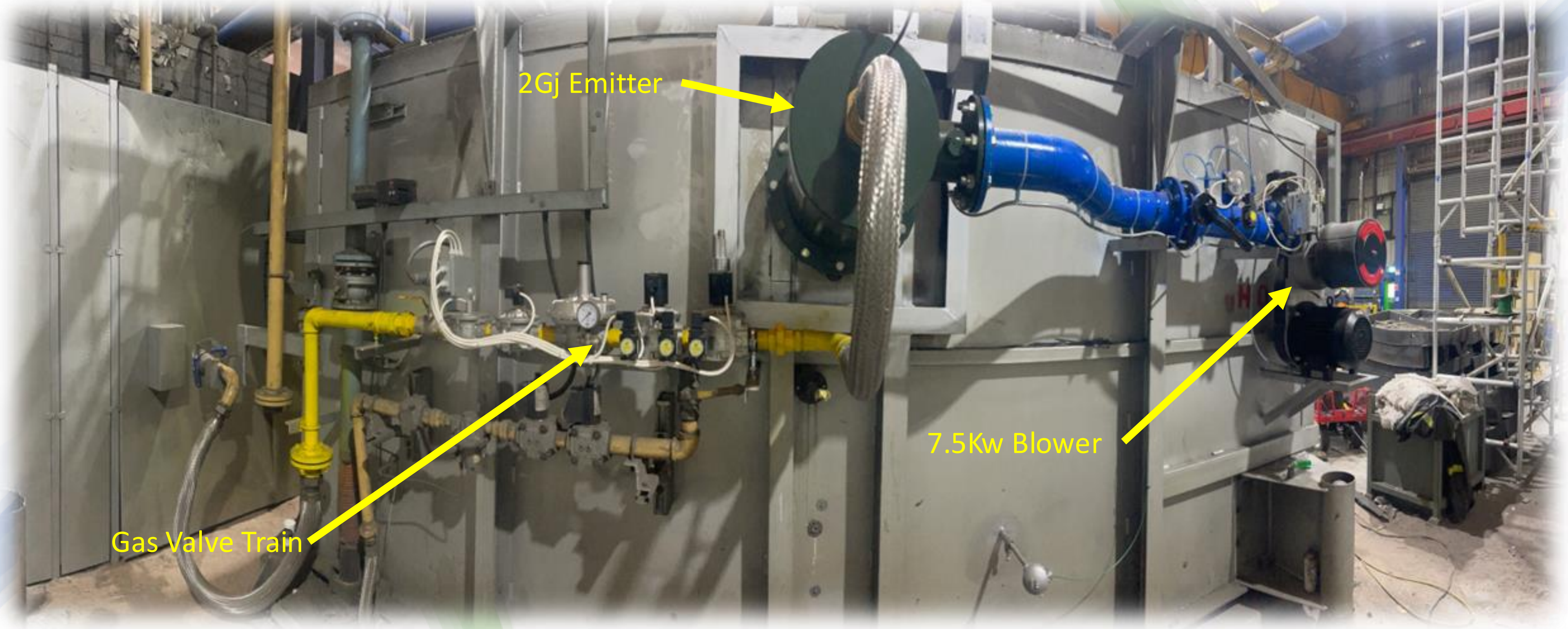
Emitter Retro-Fit G12 Furnace



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Technical Overview

Flameless Kinetic heat transfer technology

Direct retrofit with minimal process adaptation

+45% reduction in gas consumption

+50% faster processing times, vastly improving yield

Proportional reductions in CO^2 output

Negligible NOx output due to lower operating temps.

Minimal maintenance

Improved refractory longevity

Unrivalled heat transfer uniformity

Hydrogen fuel source future-proofing

99.994% combustion efficiency

Zero Delta-T or thermal shock

Positioning ratio of up to 20 existing burners : 1 TKE

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Zero Scale Formation on reheat

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Caldera

June 2026

Cutting Costs & Carbon with Storage Boilers

Benefits of thermal energy storage

Cut electricity costs by charging when power is cheapest

Handle variable and peaky heat loads without oversizing electrical connections

Reduce grid connection and capacity costs

Make both on-site & grid connected renewables work for process heat

What makes Caldera different?

Built for the temperatures our customer processes need

Charge faster — capture more value

Discharge flexibly — right-size your equipment

Modular size & minimal footprint suits customer's needs

'Plug and play' installation

Lowest cost of ownership

<200°C heat. Why?

Industrial heat, represents 20% of global energy demand [1], and plant managers know they must eventually decarbonise.

c. 45% of industrial heat is <200°C [2]

sources: 1. IEA, 2. Clean Growth Fund

Caldera Storage Boiler benefits

- Ability to harvest intermittent low-cost electrons
- Modes: electric boiler or stored heat, or simultaneous
- Efficiency: 94% round-trip
- Safe: PED Cat 2, non-toxic, non-flammable material
- Superior heat load following
- Durable: unlimited cycles; few moving parts
- Install: retrofit or green field
- Modular: any scale of energy storage or power input/output

Each Storage Boiler system includes Heat Cells and all necessary Balance of Plant

Storage Boiler system

STORAGE BOILER COMPONENTS:

Heat Cell(s) – Caldera's unique thermal storage unit.

Power & Control Module – Conventional switchgear, thyristor controls and energy management system.

Ultra-Pure Water Treatment (not shown) – Treats RO water or condensate before feeding into Heat Cell.

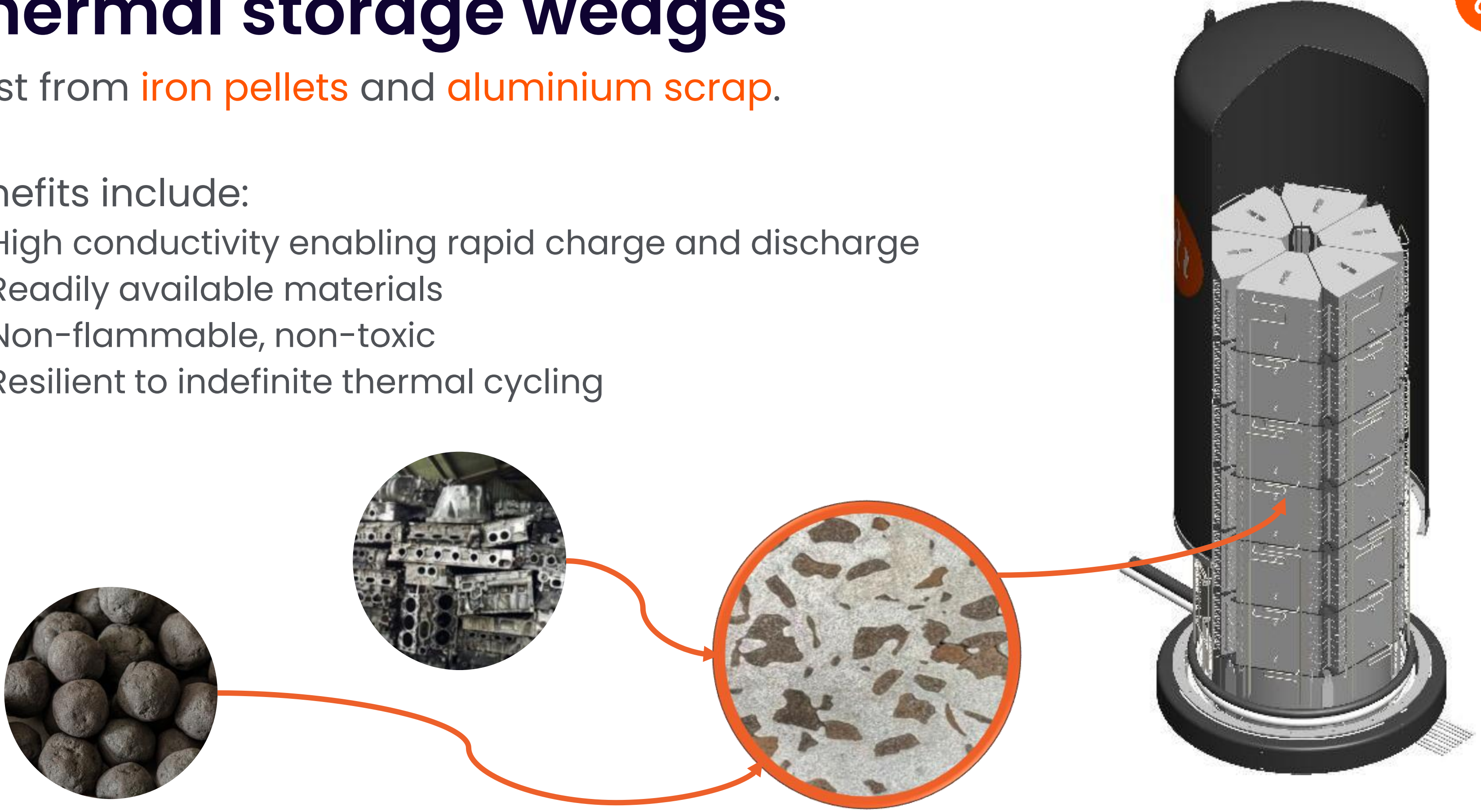
Transformer (not shown) – normally customer supplied; feeds LV to Power & Control Module from site's MV grid.

Thermal storage wedges

Cast from iron pellets and aluminium scrap.

Benefits include:

- High conductivity enabling rapid charge and discharge
- Readily available materials
- Non-flammable, non-toxic
- Resilient to indefinite thermal cycling

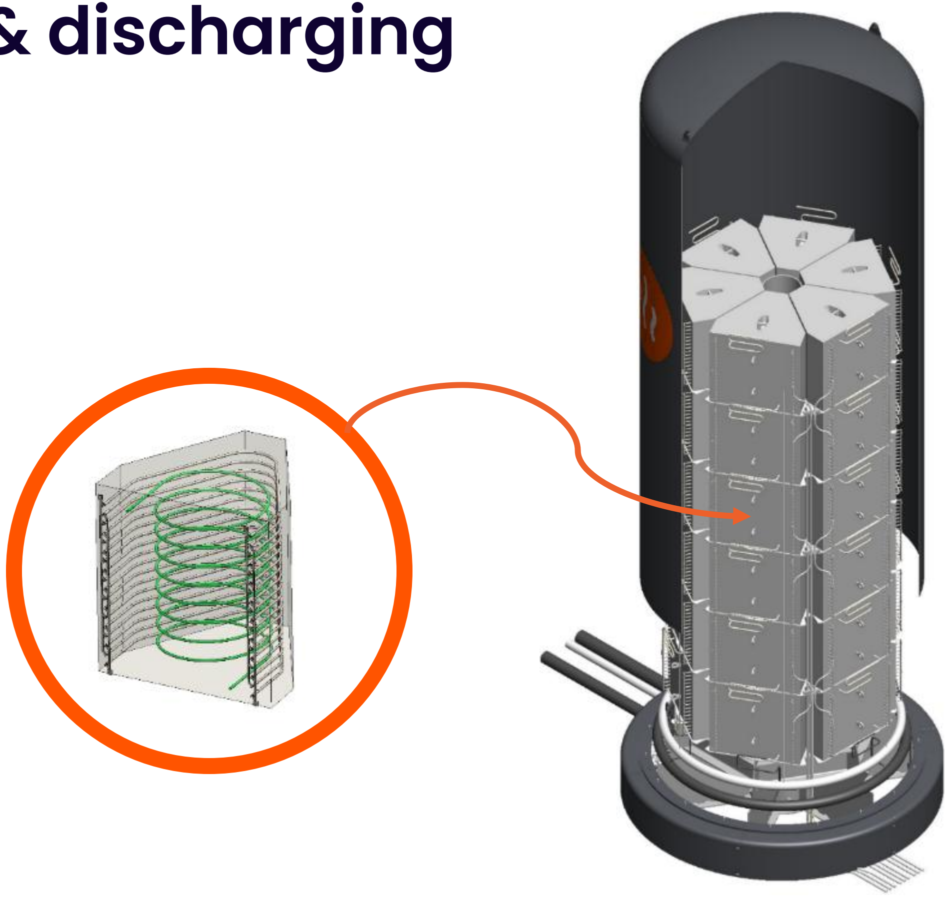


Embedded charging & discharging

Conventional resistive elements are embedded within the wedge, heating it to 500°C.

Ultra-pure water passes through the embedded hi nickel alloy coil, flashing to steam.

The rate of energy discharge is controlled by varying the water flow into the Heat Cell.



Vacuum insulated cover delivers best in class performance

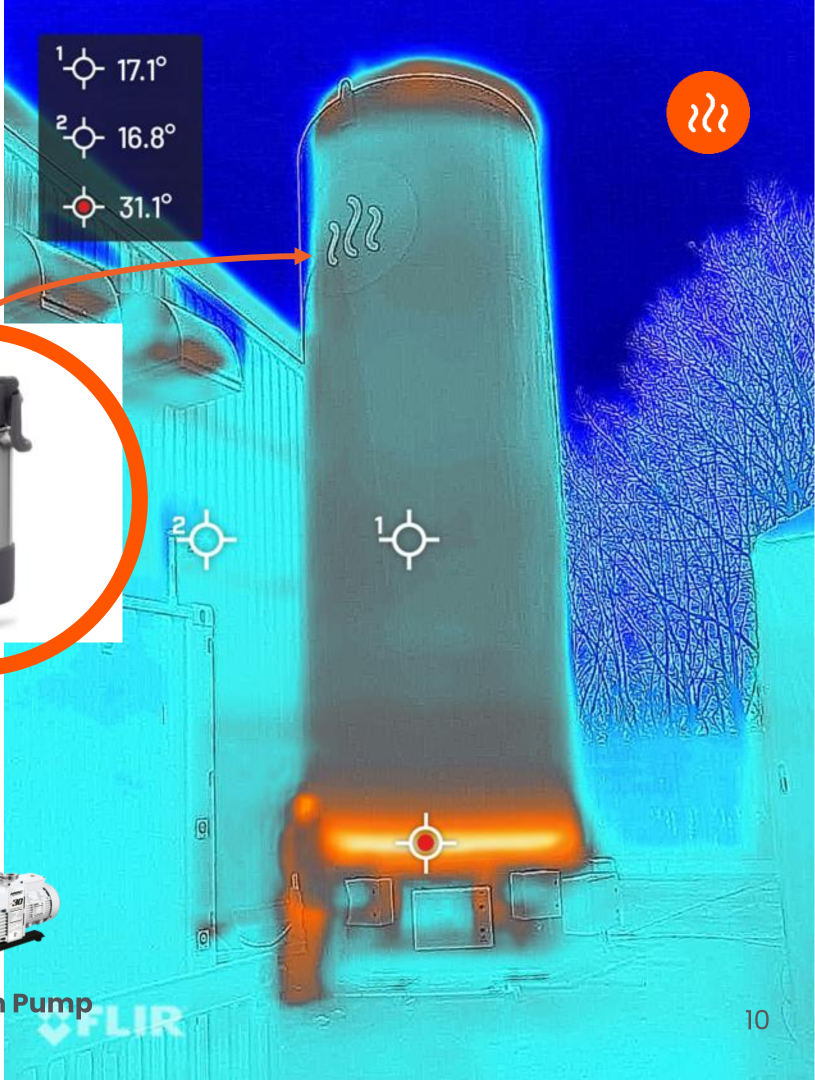
The core of the cell is encased in a double-walled vessel, effectively an inverted vacuum flask.

The vacuum prevents conduction and convection of heat. An additional insulator prevents radiative losses.

The ‘indefinite’ vacuum is 'topped up' as needed by an inexpensive pump.

The exterior is slightly warmer than ambient when core is 500°C!

Equivalent solid insulation systems eg Ca Si board performs 10-15x worse.



Vacuum Pump

Heat pumps & MVR can complement Storage Boilers for full electrification

- Storage Boiler easily follows and meets ‘peaky’ demand profiles
- Heat pump runs at high efficiency when continuous and generally lower temps
- Avoids heat pump durability issues with fast ramping up/down
- CapEx is optimised

+

Suitable across sectors

Ideal for process heat applications such as:

Distilling

Pharmaceuticals

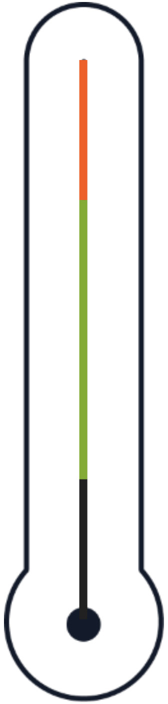
Brewing

Food Processing

Paper

Heat Networks*

90–204^{0}C



'Sweet spot' for Caldera technology

<90^{0}C

Works well, also heat pumps may be more economic

* Business case for space heating is rarely strong if <65^{0}C water required.

Caldera

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Rob Savidge FREng Senior Advisor – Turbomachinery, Coolbrook Technologies Ltd

COOLBROOK

The problem

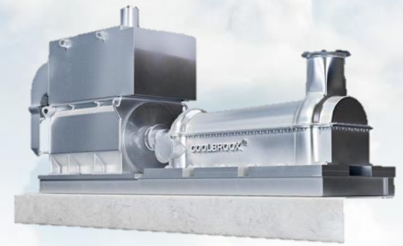
01
Burning of fossil fuels for heat generation is the major source of industrial CO_2 emissions

02
Emissions from energy intensive industry have not reduced with the required pace

03
No electric technologies available to produce sufficient temperatures for key industrial processes

04
Other solutions to reduce industrial emissions highly expensive and/or lack the required scale

The solution



COOLBROOK

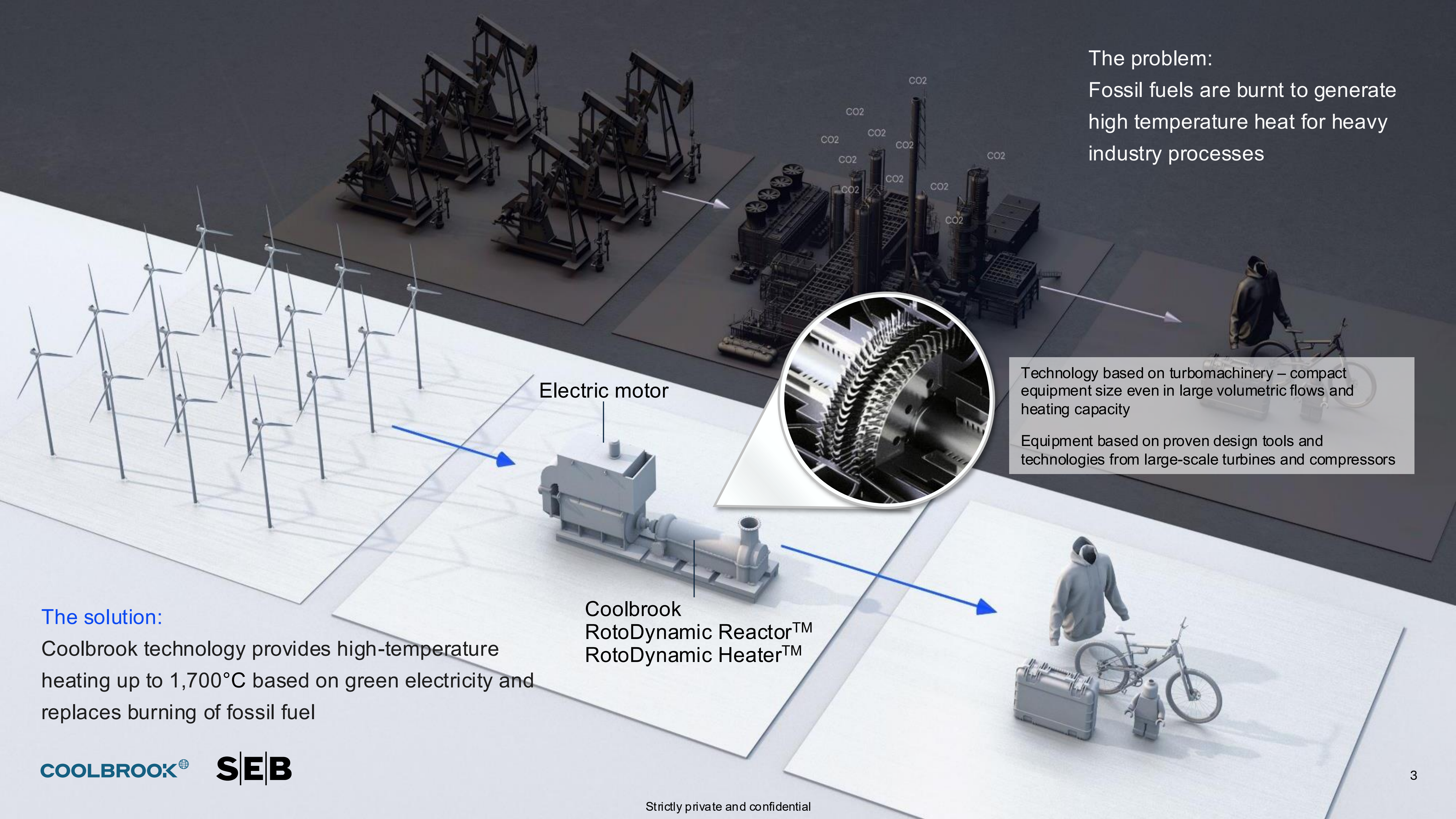
Coolbrook is electrifying the world's most polluting industrial processes with disruptive RotoDynamic Technology

-2.4 Gt

of annual CO_2 emission reduction potential equaling 30% of global industrial CO_2 emissions

Potentially the most significant single technology to reduce industrial CO_2 emissions globally

The problem:
Fossil fuels are burnt to generate high temperature heat for heavy industry processes



Technology based on turbomachinery – compact equipment size even in large volumetric flows and heating capacity

Equipment based on proven design tools and technologies from large-scale turbines and compressors

The solution:
Coolbrook technology provides high-temperature heating up to 1,700°C based on green electricity and replaces burning of fossil fuel

COOLBROOK® S|E|B

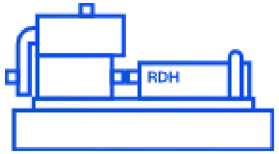

Rocket
science

Turbo
machinery

Chemical
engineering

RotoDynamic technology based on commercially proven technologies

RotoDynamic Technology combines the general principles of **rocket science, turbomachinery** and **chemical engineering**



High energy density and **easy to scale up to high thermal capacities** and **volumetric flows –** known technology solutions to reach very **high temperatures up to around 1700 °C**

Based on **proven design tools** and **technologies** from large-scale turbines and compressors and is comparable to other traditional rotating devices

Same maintenance approach as for industrial gas turbines and compressors with **~95+%**[1] availability with proper maintenance

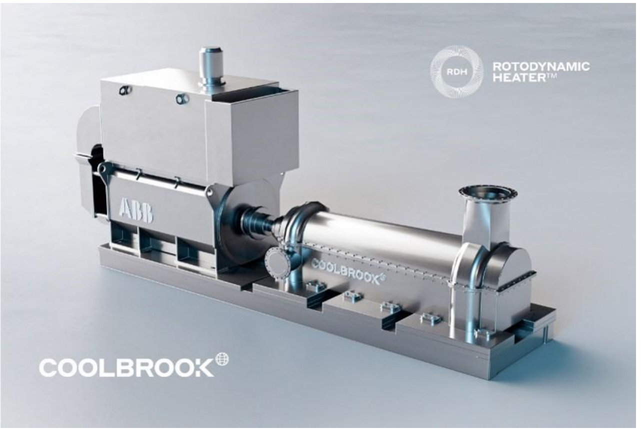
1) Availability Analysis of Gas Turbines Used in Power Plants, Carazas & de Souza, 2009

Our technologies to electrify key industrial processes and reduce CO_2 emissions

RDH ROTODYNAMIC HEATER™

Examples of potential customers:

ArcelorMittal, SSAB, UltraTech Cement, Linde, HeidelbergCement Group, Cemex, BASF, JSW, Conch, Holcim, adani, Neste



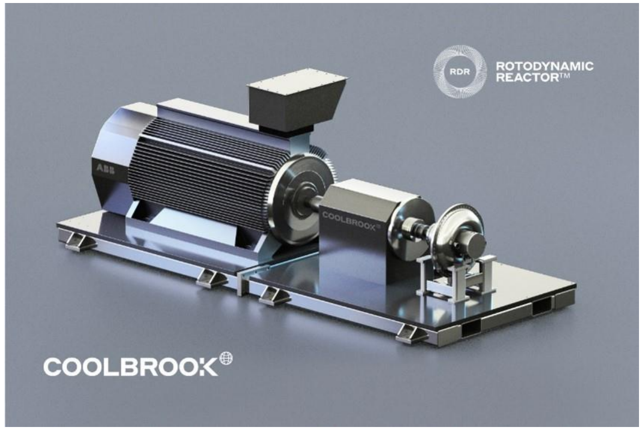
- Application | Electrically driven heater to replace fossil fuel burning in high temperature processes in e.g. steel, cement, hydrogen and chemicals production
- Tech Features | Possibility to heat gases up to ~1,700 °C compared to ~600 °C in competing electric alternatives
- Benefit | High efficiency and compact equipment size combined with competitive CAPEX and OPEX – enables also increased energy efficiency and higher plant output
- CO_2 | Process emissions reductions with up to 100% from high heat provision
- First 900degC 8mW heater now sold to Adani Cement, India, Q1 2027 first run.

Total market: 1 trillion EUR – emission reduction potential 2.0 Gt/a

RDR ROTODYNAMIC REACTOR™

Examples of potential customers:

Shell, ExxonMobil, Dow, Reliance Industries Limited, lyondellbasell, Borealis, ADNOC, INEOS, Braskem, sabic, TotalEnergies, BASF



- Application | Electrically driven reactor to replace fossil-fired cracker furnaces in petrochemical industry
- Tech Features | Quick heating, short residence time and high temperature enable up to 20% higher ethylene yield
- Benefit | Higher product yield and uptime combined with lower CAPEX and OPEX and compact equipment size
- CO_2 | 100% reduction in process emissions from steam cracking

Total market: 100 billion EUR – emission reduction potential 0.3 Gt/a

RotoDynamic technology has been proven at pilot and vetted by multiple partners

Recent pilot test highlights

- Successful large-scale pilot testing completed for the RotoDynamic Heater (RDH) technology at Brightlands Chemelot Campus in the Netherlands
- Achieved 1,000+°C with air, steam and nitrogen (exceeds the temperature range of conventional resistive heaters by several hundred degrees)
- The tests validate the technical pathway up to 1,700°C, covering more than 95% of the temperature range required to cover the EUR 1 trillion market
- First hydrocarbon cracking tests concluded in December 2023 – test program continuing through 2024-2025

Pilot partners:

ABB, Linde, Schmidtsche Schack, Shell, Braskem, سابك sabic, Cemex, UltraTech Cement, Netherlands Enterprise Agency, Brightlands

"For the first time, it is shown that by using renewably-powered RDR and RDH, it is possible to completely decarbonize the highest-emitting industries which have been labelled as 'hard-to-abate'."

~ Dr. Liping Xu, formerly Cambridge University and Dr. Budimir Rosic, Oxford University commented on the milestone

University of Cambridge, University of Oxford

Milestones

Q2 2022
Air tests with main equipment conducted in Finland ✓

12 Dec 2022
Opening ceremony and start of test campaign in Brightlands ✓

Q3 2023
High-temperature tests for RDH with air and steam ✓

Q4 2023 - 2024
RDR test runs with various hydrocarbon feeds ✓

Pilot photos