



INDUSTRY BRIEF



GreenCape

# Decarbonising industrial heating

Evaluating low-carbon alternatives for industrial thermal systems





## This industry brief is written for:

Sustainability and environmental, social and governance (ESG) managers at companies whose operations rely on carbon-intensive boiler systems for process heat and steam generation. It provides an overview of relevant technologies, key cost drivers and regulatory considerations for lower-carbon heat sources.

## Sustainable Development Goals (SDGs) alignment

7 AFFORDABLE AND  
CLEAN ENERGY



8 DECENT WORK AND  
ECONOMIC GROWTH



## Main insights

- **Decarbonisation commitments and regulatory pressures are accelerating the transition to lower-carbon industrial heat technologies:** In most cases, switching from carbon-intensive boiler systems to low-carbon alternatives carries a cost premium. However corporate net-zero targets export, market requirements regulatory pressures and carbon tax risks are increasingly compelling industries to invest in lower-carbon heat solutions to manage future carbon costs and remain globally competitive.
- **Low-carbon alternatives can deliver heat at a lower operating cost than heavy fuel oil based systems:** Among the technologies assessed, heavy fuel oil (HFO) emerged as one of the least competitive fuel types due to both its high operating costs and carbon intensity. On an energy-input basis, HFO-based heat generation is generally more expensive than biomass, natural gas and heat pump systems, while also producing significantly higher greenhouse gas (GHG) emissions. As carbon tax rates increase and available allowances decline, the cost differential between HFO and lower-carbon alternatives is expected to widen further.
- **Industrial heating transitions typically rely on hybrid integration rather than one-to-one equipment replacement:** Low-carbon technologies are typically integrated alongside existing systems to ensure reliability and continuity of heat supply. Both cost reductions and emissions produced will depend on how the system is operated (i.e. which technology meets baseload heat vs peak demand/ used as back-up).
- **Heat-as-a-Service lowers barriers to adoption:** Heat-as-a-Service (HaaS) allows companies to avoid upfront capital costs and operational complexity by outsourcing ownership and management of boiler systems to a service provider. It is a practical option for companies with limited capital or no in-house boiler expertise.



# Glossary of acronyms / abbreviations

**CBAM** Carbon Border Adjustment Mechanism

**CAPEX** Capital expenditure

**CSDDD** Corporate Sustainability Due Diligence Directive

**CSRD** Corporate Sustainability Reporting Directive

**DBSA** Development Bank of Southern Africa

**EU** European Union

**ESCO** Energy services company

**ESG** Environmental, social and governance

**FSC** Forest Stewardship Council

**GHG** Greenhouse gas

**HaaS** Heat-as-a-Service

**HFO** Heavy fuel oil

**IDC** Industrial Development Corporation

**KPI** Key performance indicator

**LCOH** Levelised cost of heat

**MRV** Monitoring, reporting and verification

**O&M** Operations & maintenance

**PPA** Power purchase agreement

**SA** South Africa

**SBTi** Science-Based Targets initiative

## Terms / definitions

- **Baseload heat:** Continuous heat demand required to maintain core industrial operations.
- **Blended finance:** A financing structure that combines concessional (public or donor) funding with private capital to improve project viability.
- **Carbon budget:** A legally binding limit on total Scope 1 emissions allocated to a company over a defined period under South Africa's Climate Change Act.
- **Coefficient of performance:** The ratio of useful heat output to electrical energy input for a heat pump.
- **Dispatchable energy:** Energy that can be produced on demand and controlled to meet load requirements.
- **Levelised cost of heat (LCOH):** The discounted lifetime cost of producing heat, incorporating capital expenditure, fuel, operations and maintenance.
- **Science-Based Targets initiative (SBTi):** A corporate framework under which companies commit to absolute greenhouse gas emission reduction targets aligned with the Paris Agreement's 1.5°C pathway. SBTi targets cover both Scope 1 and Scope 2 emissions.
- **Scope 1 emissions:** Direct emissions from sources owned or controlled by an entity.
- **Scope 2 emissions:** Indirect emissions from the consumption of purchased electricity, heat or steam.

# 1

## Context

### The case for transitioning

South Africa (SA)'s industrial sector relies heavily on fossil fuels for heat and steam generation. This demand has been met through on-site combustion systems powered by coal, HFO and gas due to their ability to provide reliable, dispatchable and high-temperature process heat. These systems are also among the largest contributors to direct (Scope 1) emissions within industrial operations. As regulatory frameworks tighten and carbon-related costs continue to increase, exposure to emissions from heat and steam generation is increasingly translating into financial, compliance and strategic risks for businesses. **Table 1** summarises the key local and international regulatory and policy drivers shaping industrial heat decisions, along with their implications for business operations.

**Table 1:** Summary of key regulatory and policy mechanisms influencing industrial heat transitions and their implications for businesses

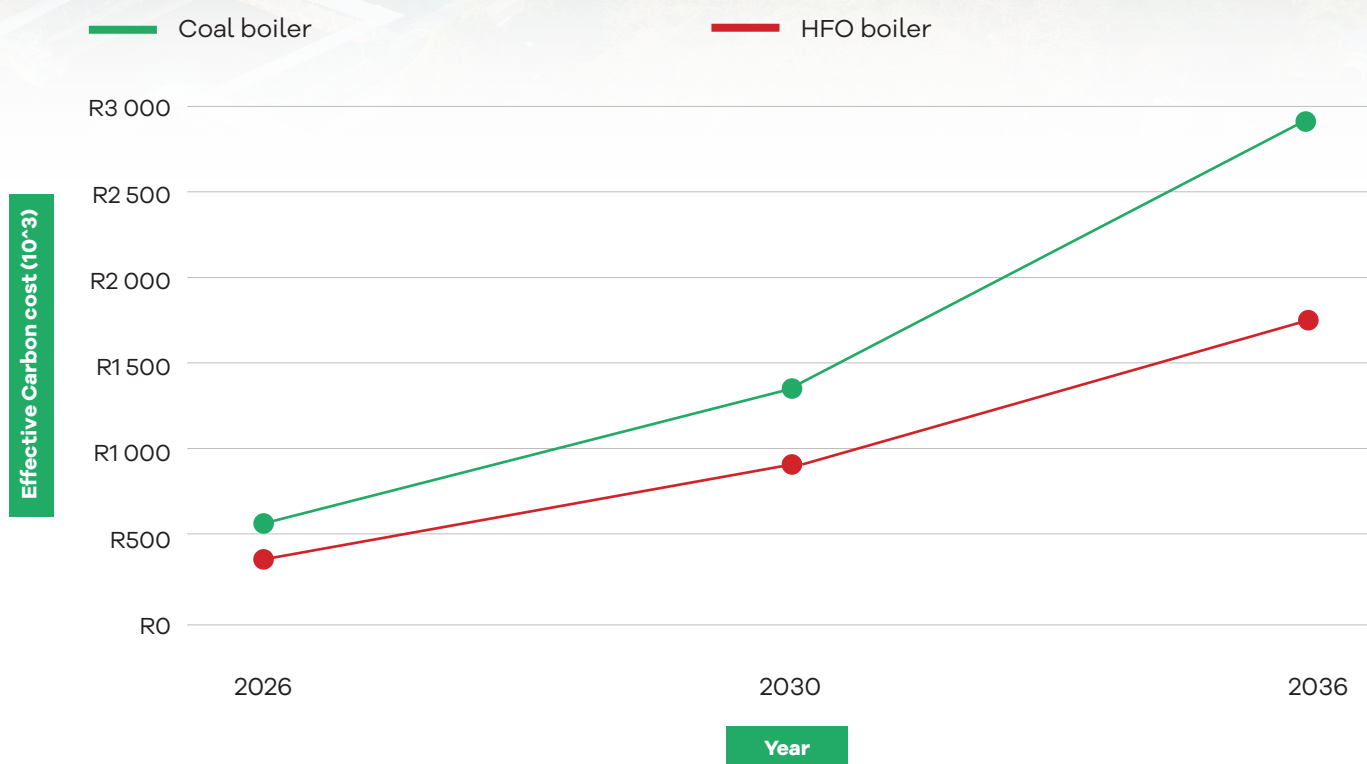
| Driver                                                                              | What it means for industrial operations                                                                                                                                                                                                                                                                                                                                 | Progress                                                                                                                 |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| <b><u>South African Carbon Tax</u></b>                                              | SA carbon tax rises from ~R190/tCO <sub>2</sub> e (2024/25) to a projected R462/tCO <sub>2</sub> e by 2030. Tax-free allowances decline progressively. Coal boiler operators face direct, rising liability on every tonne of CO <sub>2</sub> emitted as illustrated in <b>Figure 1</b> .                                                                                | Already in effect. Cost impact accelerates as allowances reduce.                                                         |
| <b><u>South African Carbon Budget Compliance (Climate Change Act)</u></b>           | Large emitters (≥30 000 tCO <sub>2</sub> e/year, Scope 1) face legally binding declining emissions limits from 2026–2030. Non-compliance triggers a penalty tax rate of R640/tCO <sub>2</sub> e. Applies to mining, oil & gas, power generation, cement, glass, food & beverage sector.                                                                                 | First compliance period runs 2026–2030. Coal-intensive processes with inflexible emissions profiles are at highest risk. |
| <b><u>EU Carbon Border Adjustment Mechanism (CBAM)</u></b>                          | From January 2026, the EU levies a carbon charge on imported goods (steel, cement, aluminium, fertilisers, electricity and hydrogen) based on embedded emissions (product carbon footprint). Coal-fired heat in exported goods becomes a direct financial liability that affects product pricing and market access <sup>1</sup> .                                       | Already in effect. Exporters to EU markets must report and pay for embedded emissions from their production processes.   |
| <b><u>EU Supply Chain Reporting</u></b>                                             | The EU Corporate Sustainability Reporting Directive (CSRD) and Corporate Sustainability Due Diligence Directive (CSDDD) require large EU companies to audit and disclose the sustainability performance of their suppliers. South African exporters that cannot demonstrate decarbonisation progress risk losing preferred-supplier status (European Commission, 2022). | Requirements phased in for large EU companies from 2024 onwards; cascades to suppliers.                                  |
| <b><u>Science-Based Targets initiative (SBTi) and corporate decarbonisation</u></b> | Companies aligned to the SBTi or with Net Zero commitments must demonstrate absolute Scope 1 emissions reductions. Coal boilers are among the largest and most visible sources of Scope 1 emissions in industrial operations (SBTi, 2021).                                                                                                                              | Deadline-driven by internal SBTi commitments or corporate sustainability roadmaps and strategies.                        |

### The cost of inaction: Carbon Tax liability

While the policy and regulatory developments outlined above are often discussed in the context of compliance and sustainability reporting, they also have increasingly tangible financial implications for industrial operations. For businesses that continue to rely on carbon intensive heat generation, rising carbon costs represent a growing operating expense that must be considered alongside fuel, maintenance and energy costs when evaluating future thermal system investments.

1. Companies not exporting to the EU are not directly subject to CBAM charges, but may face indirect exposure through supply chain requirements from EU-affiliated buyers.





**Figure 1** illustrates carbon tax exposure for coal and HFO-fired industrial boilers under the South African carbon tax pricing pathway\*.

Coal-fired boilers experience the largest increase in carbon tax liability over time, reflecting their higher emissions intensity per unit of heat delivered. As carbon tax rates rise and available allowances decline, the cost differential between carbon-intensive and lower-carbon heating technologies is expected to widen. This progressively weakens the long-term attractiveness of coal and HFO and strengthens the business case for transitioning to lower-carbon industrial thermal solutions.

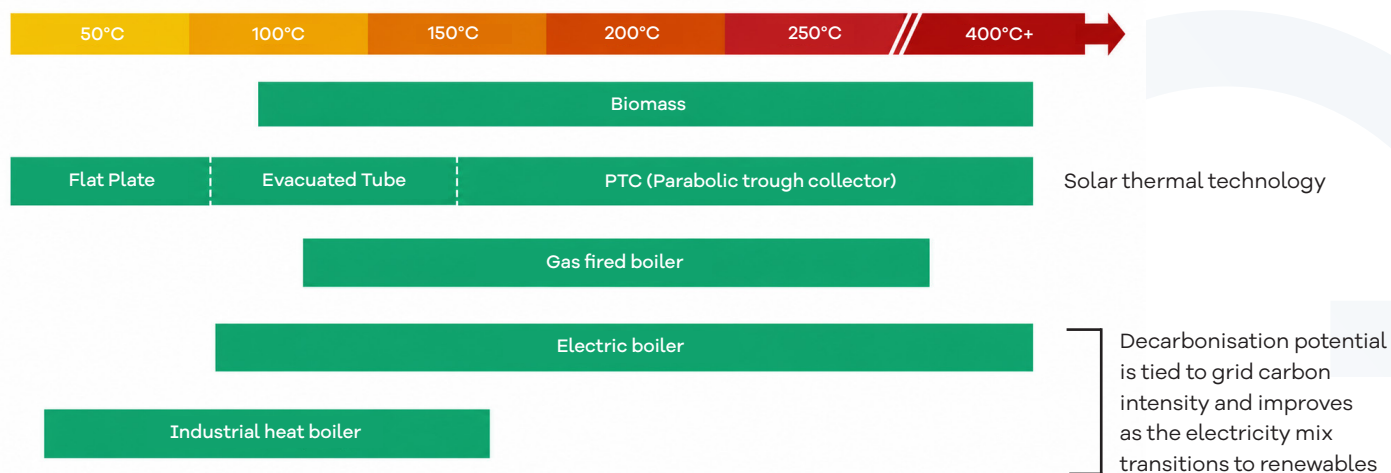
## Matching heat technologies with operations

Selecting a suitable industrial heat technology depends on how heat is used within operations, the emissions profile of the technology, and its ability to deliver heat cost-effectively over its operational lifetime.

Determining viability requires a granular analysis of the site's process heat demand profile across two key variables:

- **Operating temperature:** The specific temperature range required by the process heat or steam application.
- **Utilisation profile:** The daily, weekly and seasonal operational patterns of the thermal demand, including whether demand is continuous (baseload) or intermittent (batch/peak).

\*Calculations based on an industrial facility consuming approximately 50 000 GJ of process heat annually. The analysis assumes a constant annual heat demand, unchanged fuel consumption, and no material improvements in energy efficiency, emissions performance, fuel switching.



**Figure 2:** Thermal technologies related to operation temperature and process temperature range in different industrial sectors

Source: Rosales-Pérez (2023)

## Technology overview

The following section provides a structured overview of the available industrial heat technologies, covering their key characteristics, advantages, limitations, cost profiles and carbon liability.





## Biomass systems

Biomass boilers burn organic feedstock (wood pellets, wood chips or agricultural residues) to produce high-pressure heat or steam for industrial processes.

### Advantages

- Lower net emissions when sustainable feedstock is used.
- Similar operational profile to coal (easy retrofit).
- Eligible for carbon offset credits\* under the SA Carbon Tax Act.

### Limitations/Risks

- Viability dependent on availability and location of feedstock.
- Moisture content of wood chips must be controlled to maintain combustion efficiency.
- Requires dedicated storage, handling, and logistics infrastructure.

**Cost profile:** Primary cost driver is feedstock supply chain security and pricing. Securing long-term supply contracts before committing to a biomass system is essential.

**Carbon reduction potential<sup>3</sup>:** Biomass can achieve approximately 80–95% reduction in net CO<sub>2</sub> emissions per GJ of heat relative to carbon intensive sources, depending on feedstock type and supply chain emissions.

### Key implementation considerations

- Secure long-term feedstock supply contracts before committing to the technology.
- Conduct a local supply chain assessment, identify reliable suppliers within viable logistics distance.
- Factor storage infrastructure and handling equipment into a CAPEX budget.
- Engage an accredited MRV provider early to ensure carbon tax compliance.

### Carbon liability under different regimes

|                             |                                                                                                |
|-----------------------------|------------------------------------------------------------------------------------------------|
| SA Carbon Tax               | Low Scope 1 emissions.<br>Measurement, reporting and verification (MRV) <sup>4</sup> required. |
| SA Carbon Budget            | Low Scope 1 emissions, MRV required.                                                           |
| EU CBAM                     | Low embedded emission.                                                                         |
| SBTi / Net Zero commitments | Qualifies as near-zero Scope 1 if feedstock is sustainably sourced <sup>5</sup> .              |

### \* Carbon credits and offsets

Biomass and renewable heat projects may generate carbon credits under the Voluntary Carbon Market (VCM), provided additionality requirements are met, and sustainable feedstock sourcing is independently verified. Under South Africa's carbon tax framework, approved carbon offsets can also be used to reduce a company's carbon tax liability up to permitted allowance thresholds. For a more information on carbon markets and offset mechanisms relevant to South African industrial operators, refer to GreenCape's Carbon markets brief on carbon credits and the voluntary carbon market.

- Carbon reduction values are indicative ranges based on emissions per unit of heat delivered (kgCO<sub>2</sub>/GJ) relative to conventional carbon-intensive baseline fuels commonly used (coal and HFO). Values are derived from combustion and lifecycle emission factors reported in literature and industry sources, actual values may vary depending on the incumbent fuel source, boiler efficiency, moisture content, utilisation profile and transport distances.
- A framework requiring facilities to accurately measure emissions from biomass combustion (including CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O). MRV obligations are governed by the National Greenhouse Gas Emission Reporting Regulations (NGGER) administered by DFFE, with verified data informing both carbon tax liability (National Treasury) and carbon budget compliance (DFFE).
- Sustainably sourced feedstock is biomass from legally compliant forestry or agricultural operations that cause no net deforestation (sawmill residues, wood chips or bark from FSC (Forest Stewardship Council) -certified pine or eucalyptus plantations, waste wood or agricultural crop residues).

## Solar thermal systems

Solar thermal systems use collector arrays to convert sunlight directly into usable process heat. Different collector types cover different temperature ranges. In industrial applications, solar thermal is most effective when integrated as a pre-heating system that reduces the primary fuel demand of an existing boiler rather than as a standalone baseload replacement.

### Advantages

- Near-zero Scope 1 and Scope 2 emissions.
- No fuel cost once operational, predictable long-run operating cost.
- Can reduce baseline fuel demand through preheating without disrupting primary systems.
- CBAM-favourable: Near-zero embedded emissions in exported goods.

### Limitations/Risks

- Intermittent output: Cannot provide 24/7 baseload heat without a backup system.
- High CAPEX.
- Significant area required, space constraints may limit scale.
- Limited to medium temperatures without parabolic trough systems, which carry significantly higher capital cost.

**Cost profile:** CAPEX-dominated cost structure: Upfront investment and financing terms are the primary lever for viability. Once operational, running costs are very low.

**Carbon reduction potential:** Solar thermal eliminates 100% of Scope 1 and Scope 2 emissions for the heat fraction it supplies.

### Key implementation considerations

- Assess available roof and ground space early as this is often the primary feasibility constraint.
- Engage a specialist to size the system correctly for your heat demand profile.
- Consider solar thermal as a preheating integration rather than a full replacement to reduce CAPEX and improve payback.
- Implementation of thermal energy storage systems can improve the use case for solar thermal systems.

### Carbon liability under different regimes

|                             |                                                                          |
|-----------------------------|--------------------------------------------------------------------------|
| SA Carbon Tax               | Scope 1 liability effectively eliminated.                                |
| SA Carbon Budget            | Scope 1 liability effectively eliminated.                                |
| EU CBAM                     | Near-zero embedded emissions.                                            |
| SBTi / Net Zero commitments | Eliminates both Scope 1 and Scope 2 emissions; Aligns with SBTi targets. |





## Gas systems

Gas-fired boilers use natural gas or LPG. They deliver high-temperature heat, are flexible and dispatchable.

### Advantages

- Lower emission factor than coal or HFO: Immediate carbon intensity reduction.
- Flexible and dispatchable, suitable for variable and peak heat demand.
- Mature technology with established supply chains.
- Can serve as a bridging fuel while longer-term low-carbon solutions are developed and financed.

### Limitations/Risks

- Full Scope 1 liability: Remains subject to carbon budget obligations and rising carbon tax.
- Not aligned with net-zero or SBTi absolute emissions reduction targets.
- Fuel price and supply volatility.
- Investing in gas infrastructure now risks stranded asset exposure as carbon costs escalate.

**Cost profile:** Primary cost drivers are the gas fuel price and supply contract terms. In regions with reliable gas supply, LCOH can be competitive with coal in the near term. However, rising carbon tax rates may erode this advantage progressively.

**Carbon reduction potential:** Delivers approximately 40–50% reduction in CO<sub>2</sub> emissions per GJ of heat compares to coal/HFO systems (does not fully eliminate taxable emissions).

### Key implementation considerations

- Conduct a regional gas supply security assessment before committing.
- Model the stranded asset risk: What is the remaining useful life of the asset at 2030 carbon tax rates?
- If considering gas as a bridging fuel, define the transition endpoint and timeline upfront.
- Negotiate supply contracts with exit or renegotiation provisions to preserve flexibility.

### Carbon liability under different regimes

|                             |                                                                                    |
|-----------------------------|------------------------------------------------------------------------------------|
| SA Carbon Tax               | Full Scope 1 liability; Lower rate than coal/HFO.                                  |
| SA Carbon Budget            | Remains subject to carbon budget penalty if Scope 1 ≥30,000 tCO <sub>2</sub> e/yr. |
| EU CBAM                     | Lower embedded emissions than coal; Not CBAM-exempt.                               |
| SBTi / Net Zero commitments | Not aligned with net-zero targets.                                                 |





## Electric element boilers

Electric boilers convert electrical energy directly into heat via resistance or electrode elements, generating steam or hot water for industrial processes.

### Advantages

- Zero Scope 1 emissions: Eliminates carbon tax & carbon budget liability entirely.
- High controllability and responsiveness to demand changes.
- High controllability and demand responsiveness. Suitable for a wide temperature range.
- Renewable PPA configuration: near-zero Scope 1 and 2;
- Full SBTi and CBAM alignment.

### Limitations/Risks

- Grid-powered systems are exposed to Eskom tariff escalation and outages.
- Renewable PPA (if not already in place) requires lengthy contract negotiation and minimum volume commitments.

### Cost profile:

- For grid-powered systems, the primary cost driver is the contracted Eskom electricity tariff. Given Eskom's escalation trajectory, this creates long-run cost exposure.
- For renewable PPA-powered systems, the electricity price is typically lower and more stable than Eskom's electricity tariff, improving the LCOH.

### Carbon reduction potential:

- Deliver high carbon reductions when powered by low-carbon electricity. With coal-based grid electricity, emissions from Scope 1 to Scope 2 with limited net reduction.
- When supplied by renewable energy they can achieve high emission reductions in operational emissions compared to coal.

### Key implementation considerations

- Establish clearly upfront whether the target is compliance (Scope 1 reduction) or full decarbonisation (Scope 1 and 2), this determines whether grid (coal-based) or renewable power is required.
- For renewable PPA configurations, engage an energy trader or IPP early (PPA structuring and contracting takes time to conclude). Negotiate take-or-pay volumes carefully to match your actual heat demand profile.
- Electric boilers are directly exposed to grid supply interruptions due to their reliance on continuous electrical input to generate process heat<sup>6</sup>. Grid interruptions can directly translate into production downtime, particularly in applications requiring continuous steam or process heat. Recent outage data from [Wetility](#) indicates that the national system experienced more the 90 000 outage events in 2025 across 57 municipalities.

### Carbon liability under different regimes

|                             |                                                                                                                                                                                                   |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SA Carbon Tax               | Zero Scope 1 liability (cost of carbon paid by generator).                                                                                                                                        |
| SA Carbon Budget            | Exits local Scope 1 carbon budget thresholds.                                                                                                                                                     |
| EU CBAM                     | Grid: High embedded emissions; Scope 2 still counted under CBAM calculations.<br>RE (PPA): Near-zero embedded emissions.                                                                          |
| SBTi / Net Zero commitments | Grid: Not aligned with SBTi unless paired with low-carbon electricity (retains high Scope 2 footprint).<br><br>RE (PPA): Eliminates both Scope 1 and Scope 2 emissions; aligns with SBTi targets. |



6. Non-electric heating systems also depend on electricity for auxiliary functions, e.g. conveyor systems for fuel handling or a range of control, monitoring and safety systems.



## Heat pumps

An industrial heat pump extracts heat from low-temperature sources (such as ambient air, wastewater or industrial waste heat) and elevates it to a higher temperature suitable for applications (steam generation, hot water or process heating). Operating through a thermodynamic cycle they deliver ~3 to 5 units of usable heat for every unit of electricity consumed. A performance measured by the coefficient of performance (COP).

### Advantages

- Zero Scope 1 emissions: Eliminates carbon budget liability.
- Can reduce lifecycle emissions and support SBTi-aligned pathways when powered by low-carbon electricity (renewable energy PPA or clean grid energy mix).

### Limitations/Risks

- Grid-powered systems are exposed to Eskom tariff escalation and outages.
- Renewable PPA (if not already in place) requires contract negotiation, minimum volume commitments.
- Heat pump efficiency declines as the required temperature lift increases. For high-temperature steam applications, heat pumps are often most effective when integrated into hybrid systems as a preheating technology rather than the primary heat source.

### Cost profile:

- For grid-powered systems, the primary cost driver is the contracted Eskom electricity tariff. Given Eskom's escalation trajectory, this creates long-run cost exposure.
- For renewable PPA-powered systems, the electricity price is typically lower and more stable than Eskom's electricity tariff, improving the long-run LCOH.

### Carbon reduction potential:

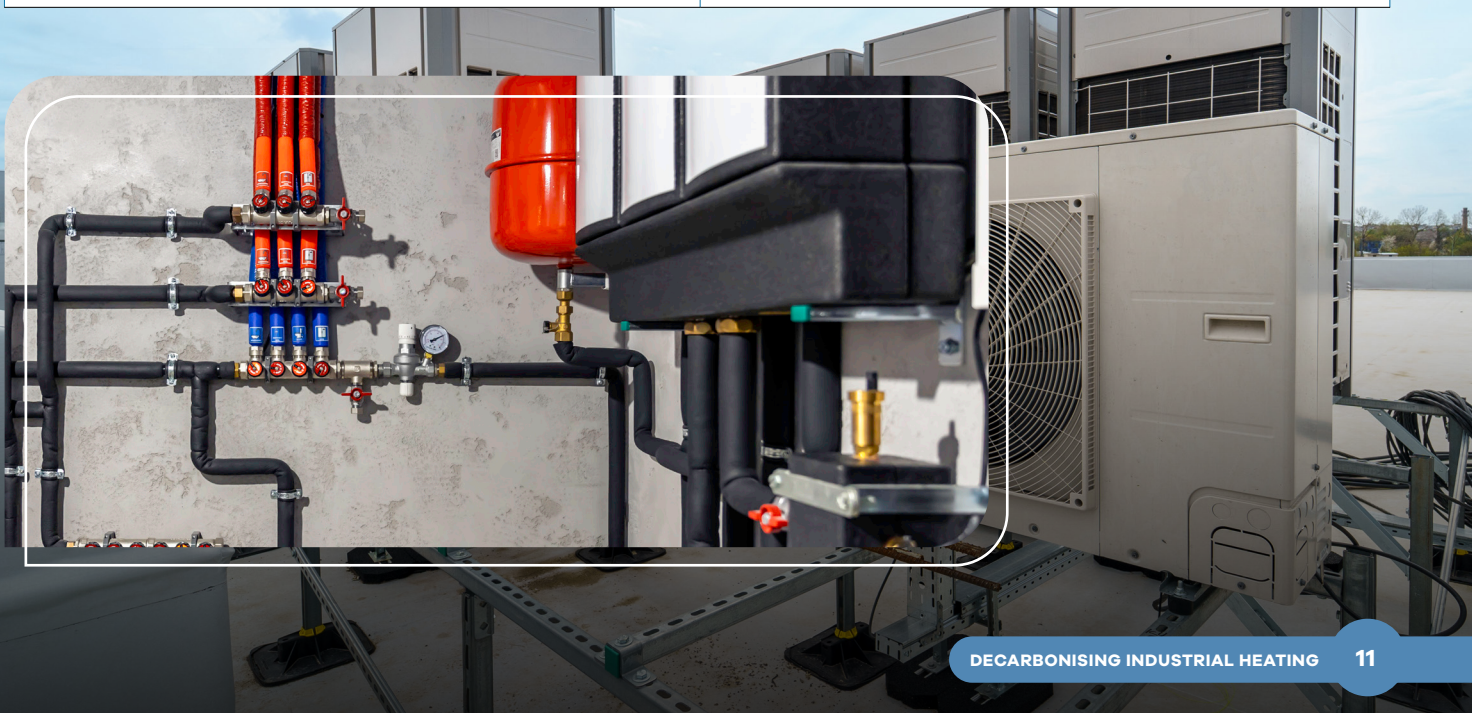
- Deliver high carbon reductions when powered by low-carbon electricity. With coal-based grid electricity, emissions from Scope 1 to Scope 2 with limited net reduction.
- When supplied by renewable energy they can achieve high emission reductions in operational emissions compared to coal.

### Key implementation considerations

Identify and characterise available low-grade heat sources early; Assess process temperature requirements against heat pump operating range.

### Carbon liability under different regimes

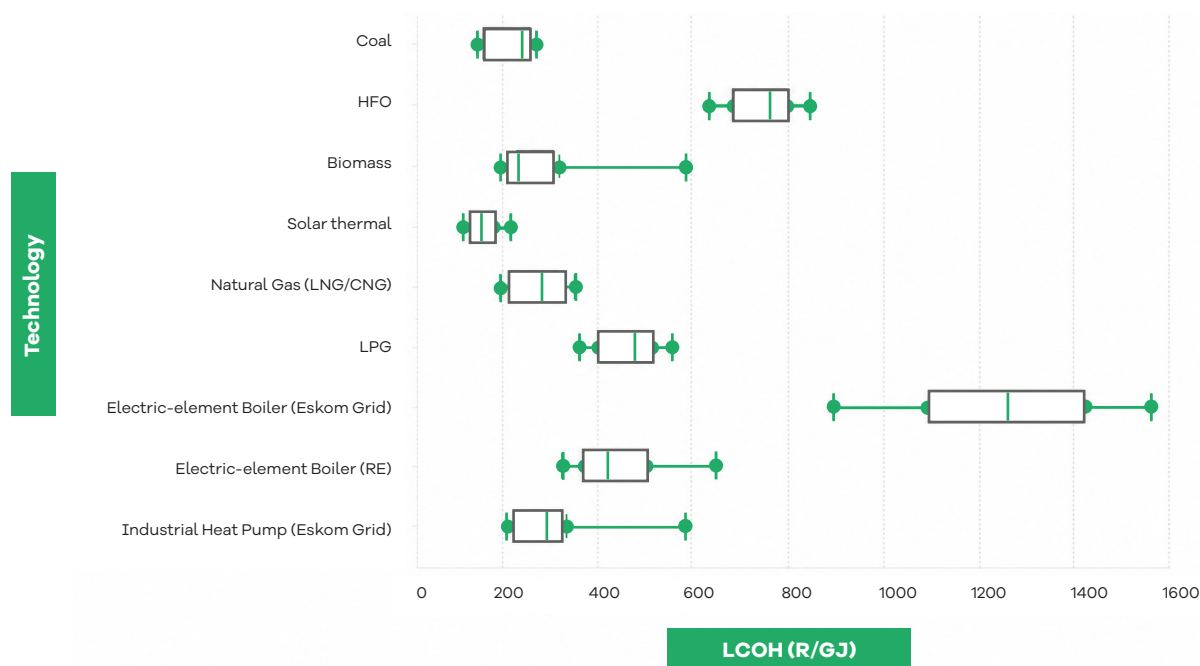
|                             |                                                                                                                                                                                               |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SA Carbon Tax               | Zero Scope 1 liability (cost of carbon paid by generator).                                                                                                                                    |
| SA Carbon Budget            | Exits local Scope 1 carbon budget thresholds.                                                                                                                                                 |
| EU CBAM                     | Grid: High embedded emissions; Scope 2 still counted under CBAM calculations.<br>RE (PPA): Near-zero embedded emissions.                                                                      |
| SBTi / Net Zero commitments | Grid: Not aligned with SBTi unless paired with low-carbon electricity (retains high Scope 2 footprint).<br>RE (PPA): Eliminates both Scope 1 and Scope 2 emissions; aligns with SBTi targets. |



## 2

# Technology lifecycle cost comparison

The levelised cost of heat (LCOH) was used as the primary metric for comparing industrial heat-generation technologies on an equivalent basis, expressing the total lifetime cost of producing one gigajoule of useful heat as a single discounted figure. The model incorporates capital expenditure, financing costs, operation and maintenance and fuel/ electricity input<sup>7</sup>. Uniform assumptions applied across all technologies included a discount rate of 10% per annum, an inflation rate of 6% per annum, and system lifetimes of 20–25 years. **Figure 3** presents the resulting LCOH ranges for each technology.



**Figure 3:** Comparison of different LCOH values for different technologies

Source: GreenCape analysis (adapted from Hess, 2016, Van Vuuren et al, 2017, Rozon. 2023)

- The LCOH values are presented as ranges to reflect the variability in project economics arising from site-specific conditions, fuel availability and operational characteristics. This highlights that the cost competitiveness of each technology is highly dependent on the application and local context.
- Fuel or electricity costs represent the largest contributor to LCOH. Feedstock costs drive the variability for coal and biomass systems, while electricity tariffs have a significant influence on the economics of electric boilers and heat pumps. Solar thermal has a comparatively stable LCOH because it does not incur ongoing fuel costs. However, this advantage is offset by its higher upfront capital investment compared to combustion-based technologies.
- Several lower-carbon technologies are already cost-competitive with coal and HFO on a lifecycle basis, indicating that investment decisions can be justified on economic grounds alone, even before accounting for the potential benefits of carbon tax savings or other decarbonisation incentives.



7. Technology-specific inputs: CAPEX, thermal efficiency or coefficient of performance and fuel pricing were informed by engagements with South African industrial heating service



# 3

## Implementation pathways: In-house vs outsourced

### In-house implementation (build, own and operate)

The company purchases and owns the heat generation asset directly, funding it through internal cash reserves, equity or corporate debt. The company bears full responsibility for design, procurement, installation, operation and fuel sourcing and ongoing maintenance.

- Best suited for: Large industrial operations with strong balance sheets, access to low-cost capital, in-house utility management expertise, and long-term tenure.
- **Advantages:** Full operational control and flexibility; no long-term service contract obligations; low lifecycle cost when the asset is well-managed.
- **Disadvantages:** High upfront capital requirement; balance sheet impact reduces borrowing capacity for core business investments; full operational risk is retained internally, requiring in-house feedstock procurement, technical expertise and O&M capability.

For this implementation pathway, it is important to assess the remaining useful life of thermal system:

- **Replacement-ready assets**, where coal/HFO boilers are approaching end-of-life or require major capital reinvestment, present an opportunity to redesign the thermal energy system around future operational requirements and lower-carbon technologies.
- **Assets with significant remaining useful life** may be better suited to a phased transition, where retrofit and optimisation measures are implemented before full system replacement. This can include boiler efficiency improvements, solar thermal pre-heating, waste heat recovery, fuel switching or hybridisation of the existing system.

### Heat-as-a-Service (HaaS): Outsourced implementation

HaaS is an outsourced utility model where a specialised third-party Energy Services Company (ESCO) designs, finances, builds, operates, and maintains the thermal asset. The industrial customer signs a long-term service agreement to purchase delivered thermal energy (steam or hot water) at a specified tariff per Gigajoule (R/GJ), with zero upfront capital requirements. This approach is best suited for businesses seeking to allocate capital to core manufacturing processes rather than utility infrastructure, and those lacking dedicated in-house boiler operation or fuel-supply logistics expertise.

- **Advantages:** Transfers technical fuel-supply and operational risks entirely to the ESCO.
- **Disadvantage:** Requires long-term contract commitments and results in a higher nominal cost of heat over the asset life to cover the ESCO's risk and capital costs.

**Table 3** sets out how responsibilities are divided between the ESCO and the off-taker across the key areas of a HaaS arrangement.



**Table 3:** Allocation of operational, financial and emissions reporting responsibilities under a HaaS model

| Responsibility area                                          | ESCO role                                                                                                     | Off-taker (Industrial customer) role                                                                              |
|--------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| <b>Capital investment</b>                                    | Secures project finance, purchases, and owns the heating assets.                                              | No capital commitment; pays an agreed operational tariff for delivered heat.                                      |
| <b>Equipment procurement, installation and commissioning</b> | Full responsibility from procurement through to commissioning and handover to operations.                     | Provides site access and integration support during installation.                                                 |
| <b>Fuel / feedstock supply</b>                               | Manages fuel procurement, logistics and supply chain risk for the duration of the contract.                   | Zero operational involvement in supply chains.                                                                    |
| <b>Operations and maintenance</b>                            | Conducts daily operations, preventative maintenance, and asset management.                                    | Adheres to site safety protocols to ensure ESCO operators can work safely.                                        |
| <b>Carbon tax liability</b>                                  | Primary liable entity under the Carbon Tax Act as the operator of combustion equipment.                       | Not directly liable, but carbon tax costs are typically passed on and reflected in the heat tariff <sup>8</sup> . |
| <b>Scope 1 GHG reporting</b>                                 | Combustion emissions sit on the ESCO's Scope 1 inventory under the GHG Protocol operational control approach. | Not attributed Scope 1 emissions from the boiler.                                                                 |
| <b>Scope 2 GHG reporting (purchased heat)</b>                | Not applicable: the ESCO operates as a heat supplier, not a purchaser.                                        | Purchased heat is accounted for as Scope 2. If the ESCO uses a low-carbon source, Scope 2 intensity decreases     |
| <b>Decarbonisation commitments</b>                           | No obligation to support the off-taker's sustainability targets unless contractually specified                | Retains full responsibility for its decarbonisation strategy and any other sustainability reporting.              |
| <b>Technology selection</b>                                  | Designs the optimal technology configuration based on resource availability.                                  | Specifies temperature, pressure, decarbonisation and steam volume requirements.                                   |

## Key considerations for a HaaS model:

- **Long-term commitment:** 10-20 year contracts required for ESCO bankability (shorter tenors = higher heat supply tariffs to recover investment)
- **Steam tariff structure:** Understand escalation mechanisms (CPI-linked, fuel price indexation, or fixed).
- **Minimum offtake (take-or-pay clauses):** Penalties for under-utilisation ensure ESCO debt service is covered even if demand drops. Negotiate flexibility for planned shutdowns or demand variability.
- **Exit provisions:** What happens if industrial site closes or demand changes?

8. Consider including a performance-based clause that prevents the ESCO from passing through carbon tax costs arising from avoidable fuel consumption due to poor boiler efficiency and inadequate maintenance.



## Sustainable finance options

For projects that meet verified green criteria, companies can access specialised financing structures that offer lower interest rates or interest-rate adjustments tied to ESG key performance indicators (KPIs):

- **Development Bank of Southern Africa (DBSA) Green Finance Facility:** offers concessional and blended finance for green infrastructure projects. The facility specifically supports renewable energy, industrial energy efficiency, low-carbon heat systems, waste-to-energy and climate resilience infrastructure.
- **The Industrial Development Corporation (IDC) Energy Strategic Business Unit:** provides loan and investment funding for clean energy projects, including technologies directly relevant to industrial heat transition. For companies moving away from coal-fired boilers, eligible technologies include biomass-to-power, waste-to-energy, heat-to-energy, green hydrogen, and heating-as-a-service models, as well as energy storage and efficiency improvements.
- **South African commercial bank sustainable finance programmes:** Major South African banks have published sustainable finance frameworks and are active in both green bonds and sustainability-linked lending. Relevant frameworks can be found at:
  - [Nedbank sustainable finance](#)
  - [Standard Bank sustainable finance](#)
  - [Absa Group \(Renewable energy & asset finance\)](#)
  - [RMB sustainable finance solutions](#)





# Conclusion

For South African industrial operators, transitioning away from coal-fired thermal systems is likely to become increasingly attractive as carbon costs become more material, low-carbon technologies mature and energy markets continue to evolve. A successful transition therefore begins with understanding the existing thermal energy system. Assessing process heat demand, temperature requirements, energy consumption and boiler performance provides the foundation for selecting technologies that are technically appropriate. In many cases, the most effective solution is a phased and integrated approach in which low-carbon technologies complement existing infrastructure while maintaining operational reliability and production continuity.

Depending on site-specific requirements, industrial operators may consider one or a combination of the following pathways:

- **Integrate complementary technologies into the existing thermal system:** This approach focuses on reducing fossil fuel consumption while retaining existing infrastructure. Opportunities include improving boiler efficiency, recovering waste heat, integrating solar thermal systems for preheating or low-temperature process heat and adopting co-firing or fuel-switching configurations that enable lower carbon intensive alternatives to partially replace coal without requiring a complete redesign of the thermal system.
- **Replace major thermal assets where the business case supports it:** As existing equipment reaches the end of its operating life, facilities may consider replacing coal-fired systems with lower-carbon alternatives that are aligned with process heat requirements. Depending on the application, this may include biomass boilers for high-temperature steam demand, industrial heat pumps for low- to medium-temperature processes, electric boilers where low-carbon electricity is available, or hybrid systems that combine multiple technologies to improve flexibility and resilience.
- **Explore alternative delivery and financing models.** Organisations that wish to reduce upfront capital expenditure or technical risk may consider commercial models such as **HaaS**, where a third-party provider designs, builds, operates and maintains the thermal energy system while supplying heat under a long-term service agreement. These models can enable access to thermal technologies without requiring significant upfront investment or in-house operational expertise.



For more information and support, contact:



[www.greencape.co.za](http://www.greencape.co.za)



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