

Thermal Inspection Report

# Site loss analysis

Following thermal inspections at your facility, heat losses from uninsulated equipment have been calculated.

|                   |                   |
|-------------------|-------------------|
| Client / Customer | Prepared By       |
| Example Facility  | OPTERM INDUSTRIAL |
| Arthur Bennett    | 28 August 2026    |

Simulation Parameters

This analysis is calculated with **25°C** ambient temperature, **0 km/h** wind speed, and **90%** boiler efficiency. The facility is projected to operate **7,200 hours** annually. Fuel: **Natural Gas (8,250 kcal/m³)** · Unit price: **£16.00/m³**

|                    |                       |                        |                          |
|--------------------|-----------------------|------------------------|--------------------------|
| Daily              | Weekly                | Monthly                | Annual                   |
| £1,114             | £7,818                | £33,879                | £406,548                 |
| 601 kWh<br>69.6 m3 | 4,219 kWh<br>488.6 m3 | 18,281 kWh<br>2,117 m3 | 219,377 kWh<br>25,409 m3 |



Scan QR code to track loss in real-time

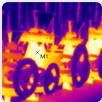
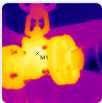
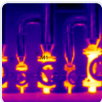
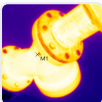
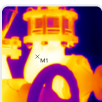
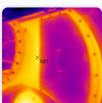
Total Energy Waste

219,377

kWh / Year

Identified Leak Points

Example Facility · 28 August 2026

| #  | Image                                                                               | Leak Source                                           | Temp (Bare → Ins.)                | Qty     | Bare kWh | Insulated kWh | Saving kWh | Annual Loss TL |
|----|-------------------------------------------------------------------------------------|-------------------------------------------------------|-----------------------------------|---------|----------|---------------|------------|----------------|
| 01 |    | <b>Globe Valve (DN100)</b><br>Kazan Dairesi Kollektör | <b>150.0°C → 33.6°C</b><br>OSHA ✓ | 4 Adet  | 27.462   | 2.132         | +25.329    | ₺50,892        |
| 02 |    | <b>Globe Valve (DN50)</b><br>Kazan Dairesi            | <b>150.0°C → 32.4°C</b><br>OSHA ✓ | 12 Adet | 47.460   | 4.145         | +43.316    | ₺87,954        |
| 03 |    | <b>Globe Valve (DN32)</b><br>Kazan Dairesi            | <b>150.0°C → 31.7°C</b><br>OSHA ✓ | 6 Adet  | 17.561   | 1.680         | +15.882    | ₺32,545        |
| 04 |    | <b>Strainer (DN100)</b><br>Kazan Dairesi              | <b>150.0°C → 33.6°C</b><br>OSHA ✓ | 2 Adet  | 14.712   | 1.142         | +13.569    | ₺27,263        |
| 05 |    | <b>Float Trap (DN100)</b><br>Kazan Dairesi            | <b>150.0°C → 33.6°C</b><br>OSHA ✓ | 6 Adet  | 47.077   | 3.655         | +43.422    | ₺87,243        |
| 06 |    | <b>Flange Pair (Set) (DN100)</b><br>Kazan Dairesi     | <b>150.0°C → 33.6°C</b><br>OSHA ✓ | 18 Adet | 30.894   | 2.399         | +28.495    | ₺57,253        |
| 07 |   | <b>Ball Valve (DN100)</b><br>Kazan Dairesi            | <b>150.0°C → 33.6°C</b><br>OSHA ✓ | 4 Adet  | 19.615   | 1.523         | +18.092    | ₺36,351        |
| 08 |  | <b>Flat Surface</b><br>Kazan Kapağı                   | <b>150.0°C → 35.8°C</b><br>OSHA ✓ | 1.12 m² | 14.595   | 841           | +13.754    | ₺27,047        |

|                                                                                       |                                                                  |                                                                                  |
|---------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------------------------------------------------------------------------|
| <div>Annual Financial Loss</div> <div>₹406,548</div> <div>25,409 m3 fuel wasted</div> | <div>Energy Waste</div> <div>219,377</div> <div>kWh / year</div> | <div>Carbon Footprint</div> <div>49.2</div> <div>Ton CO<sub>2</sub> / year</div> |
|---------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------------------------------------------------------------------------|

5-Year Financial Projection

Calculated on a compound basis assuming a 30.0% annual cost escalation (inflation / fuel price increase); amounts reflect the projected price level of each year.

| Scenario                                                                       | Yr 1     | Yr 2     | Yr 3     | Yr 4     | Yr 5       | 5-YR TOTAL |
|--------------------------------------------------------------------------------|----------|----------|----------|----------|------------|------------|
| <div>Current state (uninsulated)</div> <div>If no action is taken</div>        | ₹406,548 | ₹528,513 | ₹687,067 | ₹893,187 | ₹1,161,143 | ₹3,676,457 |
| <div>After insulation</div> <div>With reference thickness &amp; material</div> | ₹32,463  | ₹42,201  | ₹54,862  | ₹71,320  | ₹92,716    | ₹293,562   |
| <div>Cumulative saving</div> <div>Δ (Current – Insulated)</div>                | ₹374,086 | ₹486,312 | ₹632,205 | ₹821,866 | ₹1,068,426 | ₹3,382,895 |

HSE & OSHA COMPLIANCE (PERSONNEL PROTECTION)

Post-insulation surface temperatures are reduced to safe levels (Max: 35.8°C), eliminating thermal burn risks and ensuring full compliance with international OSHA standards.

|                                                                                       |                                                                                                 |
|---------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| <div>5-Year Cumulative Loss</div> <div>₹3,676,457</div> <div>If no action taken</div> | <div>5-Year Cumulative Saving</div> <div>₹3,382,895</div> <div>Achievable with insulation</div> |
|---------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|

|                                                                                                                                                                                        |                                                                                                                                                                               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <div>Annual CO<sub>2</sub> Emission</div> <div>49.24</div> <div>Ton CO<sub>2</sub> / Year</div> <div>Emission factor: 0.202 kgCO<sub>2</sub>/kWh<br/>Source: IPCC AR6 / IEA 2023</div> | <div>Equivalent Comparisons</div> <div>Passenger cars (annual exhaust)<div>21 vehicles</div></div> <div>Trees (annual carbon absorption capacity)<div>2,345 trees</div></div> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

5-Year Emission Projection (Tonnes CO<sub>2</sub>)

| Scenario              | Yr 1 | Yr 2 | Yr 3  | Yr 4  | Yr 5  | 5-YR  |
|-----------------------|------|------|-------|-------|-------|-------|
| Uninsulated (current) | 49.2 | 98.5 | 147.7 | 197.0 | 246.2 | 246.2 |

Calculation Note

CO<sub>2</sub> emission is derived by dividing annual heat loss energy (219,377 kWh) by boiler efficiency (90%) and multiplying by the fuel-specific emission factor. Vehicle comparison uses IPCC AR6 averages; tree comparison uses USDA Forest Service data. Comparisons are for awareness purposes only, not exact equivalents.

Bare Surface Heat Loss

$$Q = h \cdot A \cdot (T_s - T_a)$$
$$h = h_{rad} + h_{conv}$$
$$h_{rad} = \varepsilon \cdot \sigma \cdot (T_s^4 - T_a^4) / (T_s - T_a)$$

$\varepsilon$  = 0.20-0.90 (seçilen emissivite) ·  $\sigma$  = 5.67×10<sup>-8</sup> W/m²K⁴  
T values in Kelvin

Cylindrical Insulation Resistance

$$R = \ln(D_2/D_1) / (2\pi \cdot \lambda \cdot L)$$
$$Q_{ins} = (T_p - T_s) / R_{total}$$
$$R_{total} = R_1 + R_2 \text{ (2-layer)}$$

D<sub>1</sub>: inner dia · D<sub>2</sub>: outer dia  
T<sub>s</sub> converged via Bisection method (80 steps)

Convection Coefficient (ISO 12241)

$$h_{cv} = 1.4 \cdot (\Delta T/D)^{0.25} \text{ (} v < 0.1 \text{ m/s)}$$
$$h_{cv} = 4 + 4v \text{ (} v \geq 0.1 \text{ m/s)}$$

v: wind speed (m/s) · D: outer dia (m)  
 $\Delta T = T_s - T_a$

Temperature-Dependent Thermal Conductivity

$$\lambda(T) = a + b \cdot T + c \cdot T^2$$
$$T_m = (T_{process} + T_{surface}) / 2$$
$$\lambda \text{ units: W/m}\cdot\text{K}$$

a, b, c coefficients derived from material measurement data via regression

Materials Used — λ(T) Regression Coefficients

| Material               | a        | b          | c       | λ 100°C | λ 200°C | λ 300°C | λ 400°C | T <sub>max</sub> |
|------------------------|----------|------------|---------|---------|---------|---------|---------|------------------|
| İzocam Şiltesi Tip 650 | 0.030857 | 0.00013000 | 3.14e-7 | 0.0470  | 0.0694  | 0.0981  | 0.1331  | 650°C            |

λ values in W/m·K. Coefficients derived from TS EN 14303, ASTM C177 measurement data.

Assumptions & Limitations

- Calculations assume steady-state conditions
  - Facility operates 7200 hours annually
  - Ambient temperature assumed constant at 25°C
  - Wind speed 0 km/h
- Boiler/system efficiency 90%
  - Valve multipliers per VDI 2055 Table B.1
  - Section 6.1-6.2 (ISO 12241) calculations
  - These are engineering simulation results; actual values may differ based on real operating conditions