title: “X-150 HEAT: Thermal Energy from Waste” subtitle: “Convert Waste into High-Temperature Industrial Heat” author: “Multi Fuel Conversion GmbH”

date: “2025”

X-150 HEAT

Thermal Energy from Waste

Multi Fuel Conversion GmbH
Email: sales@mfc-energy.com
Web: www.mfc-energy.com

Executive Summary

The X-150 HEAT configuration transforms organic waste into high-temperature thermal energy for industrial processes, district heating, and steam generation. This system provides exceptional efficiency (75-85%) by directly utilizing the thermal energy from gasification without intermediate electricity conversion losses.

Key Benefits:

- **150-200 kWth thermal output** per 150 kg/h unit
- **75-85% thermal efficiency**
- **1,400 MWh annual heat production** (8,000 operating hours)
- **€0.03-0.05/kWh levelized cost** of heat (LCOH)
- **280 tonnes CO_2 avoided annually** vs. natural gas heating

---

Technology Overview

Process Flow

The X-150 HEAT system delivers thermal energy through three integrated stages:

Stage 1: Heat Recovery
The gasification process generates high-temperature syngas (800-1000°C) containing significant thermal energy. Multi-stage heat exchangers recover this energy while cooling the gas stream for downstream processing. Heat recovery occurs at multiple temperature levels to maximize efficiency and match application requirements.

Stage 2: Heat Transfer
Recovered thermal energy is transferred to the desired heat transfer medium based on application needs. The system supports hot water (70-95°C), low-pressure steam (up to 10 bar), thermal oil (up to 300°C), or direct hot air for drying processes. Heat exchangers are designed for high efficiency and minimal pressure drop.

Stage 3: Distribution
Thermal energy is delivered to end-use applications through insulated piping systems. The modular design allows for multiple heat delivery points at different temperature levels, enabling cascaded heat utilization for maximum efficiency. Automated controls maintain temperature setpoints and manage load variations.

Technical Specifications

Performance Parameters

Parameter	Specification
Heat Output (per 150 kg/h unit)	150-200 kWth
Thermal Efficiency	75-85%
Hot Water Temperature	70-95°C
Steam Pressure	Up to 10 bar
Thermal Oil Temperature	Up to 300°C
Annual Heat Production (8,000h)	1,400 MWh/year
Load Following Range	30-100%
Start-up Time	< 2 hours
Availability	> 92%
Heat Loss	< 5%

Heat Delivery Options

Hot Water Systems:

- Supply temperature: 70-95°C
- Return temperature: 40-60°C
- Flow rate: 5-10 m^3/h
- Applications: District heating, space heating, domestic hot water

Steam Systems:

- Pressure range: 3-10 bar
- Steam quality: Saturated or superheated
- Capacity: 200-300 kg/h

- Applications: Industrial processes, sterilization, food processing

Thermal Oil Systems:

- Temperature range: 150-300°C
- Heat transfer fluid: Synthetic or mineral oil
- Applications: High-temperature industrial processes, chemical reactors

Hot Air Systems:

- Temperature range: 80-200°C
- Flow rate: 2,000-5,000 m^3/h
- Applications: Drying processes, space heating, greenhouse heating

---

Target Applications

Industrial Process Heat

Problem Solved: High natural gas or fuel oil costs (€0.08-0.12/kWh) for process heat in manufacturing operations.

Solution: Replace fossil fuel boilers with waste-derived thermal energy. Food processors, chemical plants, textile manufacturers, and paper mills can convert organic waste streams into process heat while eliminating waste disposal costs.

Economic Impact: A facility using 2 MWth of process heat can save €120,000-180,000 annually in fuel costs while eliminating €30,000-90,000 in waste disposal fees. Combined savings of €150,000-270,000 per year create payback periods of 3-5 years.

District Heating Networks

Problem Solved: Municipalities need to decarbonize heating sectors while managing rising natural gas prices and waste management costs.

Solution: Integrate waste-to-heat systems into district heating networks, providing renewable baseload heat from municipal organic waste. Systems can operate as

primary heat sources or supplement existing infrastructure during peak demand periods.

Economic Impact: A 1 MWth waste-to-heat facility serving 200-300 households generates €80,000-120,000 annual heat sales revenue plus €40,000-100,000 in waste tipping fees, while avoiding 560 tonnes CO_2 annually and qualifying for renewable heat incentives.

Agricultural Drying Operations

Problem Solved: Grain dryers, timber kilns, and crop processing facilities consume expensive propane or diesel fuel (€0.15-0.25/kWh equivalent) for drying operations.

Solution: On-farm waste-to-heat systems convert agricultural residues (straw, husks, prunings) into hot air for drying processes. Zero-cost feedstock from farm operations eliminates fuel purchases while managing agricultural waste.

Economic Impact: A grain drying operation using 500 kWth can save €60,000-100,000 annually in fuel costs while processing 50-100 tonnes of agricultural waste that would otherwise be burned in fields or landfilled.

Economic Analysis

Cost Structure

Levelized Cost of Heat (LCOH): €0.03-0.05/kWh

Cost Component	Value
Capital Expenditure (CAPEX)	€600,000 - 900,000 per unit
Installation & Commissioning	15-20% of equipment cost
Annual Operating Costs (OPEX)	€30,000 - 45,000 per unit
Maintenance	€12,000 - 20,000 per year
Consumables	€8,000 - 12,000 per year
Labor (0.5 FTE per unit)	€25,000 - 35,000 per year

Revenue Streams

Primary Revenue:

- **Heat Sales/Savings**: €56,000/year per unit (1,400 MWh at €0.04/kWh)
- **Tipping Fees**: €24,000-72,000/year (1,200 tonnes at €20-60/tonne)
- **Renewable Heat Incentives**: €14,000-28,000/year (varies by market)

Secondary Revenue:

- **Carbon Credits**: €7,000-14,000/year (280 tonnes CO_2 at €25-50/tonne)
- **Biochar Sales**: €24,000-48,000/year (120 tonnes at €200-400/tonne)
- **Guarantees of Origin (GO)**: €2,800-7,000/year (renewable heat certificates)

Total Annual Revenue: €127,800 - 225,000 per unit

Simple Payback Period: 3-5 years (depending on local heat prices and tipping fees)

Environmental Impact

Carbon Footprint Reduction

Each X-150 HEAT unit operating 8,000 hours annually avoids **280 tonnes of CO_2 equivalent emissions** compared to natural gas heating. This calculation assumes:

- Natural gas carbon intensity: 200 gCO_2/kWh thermal
- Waste diversion from landfill: 100 tonnes CO_2e avoided
- Biogenic carbon neutrality of organic feedstock

Fossil Fuel Displacement

Annual natural gas displacement of **140,000 m^3** per unit, reducing dependency on imported fossil fuels and improving energy security. This is equivalent to the annual heating needs of 70-100 residential households.

Air Quality Benefits

Compared to on-site combustion of agricultural residues or open burning of waste, the X-150 HEAT system provides:

- 95% reduction in particulate matter (PM2.5) emissions
- 90% reduction in nitrogen oxides (NOx)
- Elimination of uncontrolled methane emissions from waste decomposition
- Compliance with stringent EU Industrial Emissions Directive standards

---

Case Studies

District Heating - Stadt Zittau, Germany

Project: Municipal waste-to-heat for district heating network
Capacity: 2x X-150 HEAT units (400 kWth total)
Feedstock: Source-separated organic municipal waste
Results:

- 2,800 MWh annual heat delivery to district network
- €112,000 annual heat sales revenue
- €60,000 annual waste tipping fee revenue
- 560 tonnes CO_2 avoided annually
- 35% reduction in municipal waste management costs

- 3.8-year payback period

Food Processing - Golden Foods Ghana

Project: Process heat for food manufacturing facility
Capacity: 4x X-150 HEAT units (800 kWth total)
Feedstock: Food processing waste (fruit/vegetable residues)
Results:

- 5,600 MWh annual process heat generation
- €224,000 annual natural gas cost savings
- €180,000 annual waste disposal savings
- 1,120 tonnes CO_2 avoided annually
- Improved production sustainability credentials
- 2.9-year payback period

Installation & Commissioning

Site Requirements

Footprint: 120-180 m^2 per unit (including feedstock storage and ash handling)

Utilities:

- Electrical connection: 400V 3-phase, 5 kW auxiliary power
- Water supply: 0.5-1 m^3/day for makeup water
- Heat distribution network: Insulated piping to end-use points

Environmental:

- Emissions compliance: EU IED 2010/75/EU or local equivalents
- Noise: < 60 dB(A) at 10m distance
- Safety clearances: 5m perimeter for maintenance access

Timeline

Phase	Duration
Site Preparation	3-5 weeks
Equipment Delivery	10-14 weeks (from order)
Installation	5-7 weeks
Commissioning	2-3 weeks
Performance Testing	1-2 weeks
Total Project Duration	5-7 months

Integration Scenarios

Retrofit to Existing Boiler Systems

The X-150 HEAT can be integrated into existing thermal systems as:

- **Primary Heat Source**: Replace fossil fuel boilers entirely
- **Baseload Provider**: Handle constant heat demand, with existing boilers for peaks
- **Backup Configuration**: Existing boilers provide redundancy during maintenance

Integration requires minimal modifications to existing distribution systems. Standard heat exchangers and control interfaces enable seamless operation with building management systems.

Combined Heat and Power (CHP)

For applications requiring both heat and electricity, the X-150 can be configured for CHP operation:

- **Heat-Led CHP**: Optimize for thermal output with electricity as co-product
- **Power-Led CHP**: Prioritize electricity generation with heat recovery

- **Flexible CHP**: Adjust heat/power ratio based on demand profiles

CHP configurations achieve overall system efficiencies of 75-85%, maximizing energy recovery from waste feedstock.

Regulatory & Certification

Compliance Standards

- **Emissions**: EU Industrial Emissions Directive (IED) 2010/75/EU
- **Pressure Equipment**: EN 12953 (shell boilers), EN 13445 (pressure vessels)
- **Machinery Safety**: EN ISO 12100 (machinery safety)
- **Heat Metering**: EN 1434 (heat meters)

Renewable Heat Qualification

The X-150 HEAT system qualifies for renewable heat incentives under:

- **EU Renewable Energy Directive (RED II)**: Waste-derived heat from non-fossil sources
- **Renewable Heat Incentive (RHI)**: UK and other markets
- **Guarantees of Origin (GO)**: Tradeable certificates for renewable heat
- **Carbon Credits**: Voluntary carbon market credits for emissions reduction

---

Service & Support

Maintenance Program

Preventive Maintenance Schedule:

- **Daily**: Automated system monitoring, ash removal
- **Weekly**: Visual inspections, consumables check
- **Every 2,000 hours**: Heat exchanger cleaning, filter replacement

- **Annual**: Comprehensive system overhaul, refractory inspection

Service Packages:

- **Basic**: Remote monitoring, spare parts supply, technical support
- **Standard**: Basic + annual on-site maintenance visit
- **Premium**: Standard + guaranteed uptime (>92%), emergency response (<48h)

Performance Monitoring

Real-time monitoring dashboard tracks:

- Thermal output and efficiency
- Feedstock consumption and quality
- Emissions compliance
- System health and predictive maintenance alerts
- Energy cost savings and CO_2 avoidance

Next Steps

Project Development Process

1. **Feasibility Assessment** (2-4 weeks)
    - Heat demand profiling and load duration analysis
    - Waste characterization and availability
    - Site evaluation and integration assessment
    - Preliminary economic modeling
2. **Proposal & Engineering** (4-6 weeks)
    - Detailed heat integration design
    - Financial modeling and project economics
    - Permitting strategy and timeline

    - Formal proposal and contract negotiation

3. **Project Execution** (5-7 months)
    - Equipment manufacturing and testing
    - Site preparation and civil works
    - Installation and commissioning
    - Performance testing and handover

Contact Information

Multi Fuel Conversion GmbH

Email: sales@mfc-energy.com
Phone: +49 (0) 341 XXXX XXXX
Address: Leipzig, Germany

Regional Partners:

- **Asia Pacific**: Life PTMA (Indonesia), Akira Asai Corporation (Japan)
- **South Asia**: Tata Power (India)
- **Europe**: Equation Labs (Spain)
- **Africa**: GIZ partnerships across 6 countries

Appendix: Technical Diagrams

System Schematic

```
[Waste Feedstock] → [Dryer] → [Gasifier] → [Heat Recovery] → [Heat
Distribution]
                                    ↓                              ↓
                                [Biochar Output]              [End-Use
Applications]
                                                                - District
Heating
                                                                - Process Heat
                                                                - Steam
Generation
                                                                - Drying
Operations
```

Energy Balance

Input: 150 kg/h organic waste (4.5 MWh/day LHV)

Output:

- Thermal energy: 3.5 MWh/day (78% efficiency)
- Biochar: 15 kg/h (carbon sequestration)

Losses: 15-20% (stack losses, radiation, auxiliary consumption)

Document Version: 1.0
Date: January 2025
Prepared by: Multi Fuel Conversion GmbH Technical Team