

INDUSTRIAL CASE STUDY

Municipal & Industrial Waste to RDF
(Refuse-Derived Fuel)

Continuous Industrial-Scale Thermal Processing System — 2 Tonnes Per Hour Capacity

Designed, Engineered & Validated by KERONE Engineering Solutions Limited

2 TPH PLANT CAPACITY MSW/RDF Feed Combustible Fraction	120 degC PROCESS TEMP. Controlled Drying Air	45 min RESIDENCE TIME Rotary Drum Hold	3,850 kcal/kg RDF GCV Cement Kiln Grade	12.5 % FINAL MOISTURE Mass Basis	~2.1 Yrs PAYBACK PERIOD At Market Premium
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Project Reference Detail

Field	Detail
Client Organisation	GreenCycle Waste Management Pvt. Ltd. — Municipal solid waste processing & RDF manufacturer
KERONE Reference	KRDC/ICS/MSW-RDF/2025-02 Based on KRDC Lab Report 52/KRDC/LAB/09
Technology	Continuous Rotary Drum Dryer with Pre-Shredding & Air Classification
Feedstock	Segregated combustible fraction of MSW (RDF feed) — 42.6% Moisture (as-received)
Product Output	Refuse-Derived Fuel (RDF) — 12.5% Moisture, GCV 3,850 kcal/kg
Plant Location	Client facility (municipal waste processing plant) — inline with existing segregation line
Document Date	July 2026 Validated on KRDC Lab Data — May 2026

Waste Management | RDF Manufacturing | Circular Economy | Thermal Processing | Industrial Sustainability | Municipal Solid Waste

Executive Summary

GreenCycle Waste Management Pvt. Ltd., a municipal waste processing contractor serving three urban local bodies, faced a commercially significant challenge: the combustible fraction recovered from mixed municipal solid waste (MSW) after segregation retains 42.6% moisture and a low gross calorific value of 1,650 kcal/kg, making it unsuitable for sale as Refuse-Derived Fuel (RDF) to cement kilns and industrial boilers, and forcing continued dependence on landfilling.

KERONE Engineering Solutions Limited was engaged to design, validate, and specify an industrial-scale continuous thermal processing system capable of upgrading this high-moisture combustible waste fraction to cement-kiln-grade RDF at a throughput of 2 Tonnes Per Hour (2 TPH).

Following rigorous laboratory validation at KRDC (Kerone Research & Development Centre) using a controlled rotary drum dryer at 120 degrees C across multiple residence times (20 min, 45 min, 75 min), the optimal industrial process parameters were established. The KERONE continuous rotary dryer system — operating at 120 degrees C with a 45-minute material residence time under co-current hot air flow — delivers moisture reduction from 42.6% to below 12.5%, and gross calorific value improvement from 1,650 kcal/kg to 3,850 kcal/kg.

CHALLENGE	KERONE SOLUTION	OUTCOME ACHIEVED
High-moisture MSW combustible fraction (42.6%) with low GCV (1,650 kcal/kg) — viable only for landfilling at negative disposal cost of INR 800-1,200/tonne.	Continuous 2 TPH rotary drum dryer at 120 degrees C, co-current hot air, 45-min residence — validated from KRDC lab trials.	RDF with GCV of 3,850 kcal/kg, 12.5% moisture — commanding INR 2,800-4,200/tonne in the co-processing fuel market.

Key Performance Summary

KPI	Raw Feedstock (Baseline)	After KERONE Processing (2 TPH Plant)	Improvement
Moisture Content	42.6%	< 12.5%	71% reduction
Gross Calorific Value (GCV)	1,650 kcal/kg	3,850 kcal/kg	2.3x improvement
Ash Content	24.8%	~19%	Reduced dilution
Chlorine Content	0.92%	< 0.9%	Within co-processing limit
Market Value (RDF Grade)	INR (-800) to (-1,200)/t (disposal cost)	INR 2,800-4,200/t	Cost-to-revenue reversal
Product Classification	Landfill-bound waste	Cement kiln co-processing fuel	Grade uplift
Annual Revenue Potential	INR (-57.6) to (-86.4) Lakh/yr (cost)	INR 4.8-7.3 Cr/yr at 7,200 hr/yr operation	Full reversal + new revenue

Industry Context & The Business Challenge

India generates an estimated 1.7 lakh tonnes of municipal solid waste per day, of which only around 50-55% is processed through scientific segregation and treatment facilities; the remainder continues to reach landfills untreated. Of the segregated fraction, the combustible (non-biodegradable, non-recyclable) residue — commonly termed RDF feedstock — constitutes 25-35% by weight of processed MSW, producing an estimated 18-22 million tonnes per year of potential RDF feed across India.

The Swachh Bharat Mission-Urban 2.0 and mandatory co-processing norms for cement plants (as directed by CPCB and state pollution control boards) have created a structured demand pull for quality RDF as an alternative fuel resource (AFR). However, the critical barrier for municipal waste processors is moisture and calorific value: raw segregated combustible waste, typically at 35-45% moisture, does not meet the GCV and chlorine specifications required by cement kilns and industrial boiler operators, and is therefore frequently landfilled at a net cost to the processor rather than sold as fuel.

The Commercial Problem — Why Raw Waste Fraction Has Negative Value

Quality Parameter	Raw Combustible Fraction (GreenCycle)	Market Requirement (RDF Grade, AFR)	Gap
Moisture Content	42.6%	< 15%	FAIL — 2.8x over limit
Gross Calorific Value	1,650 kcal/kg	> 3,000 kcal/kg	FAIL — insufficient for AFR
Chlorine Content	0.92%	< 1.0%	MARGINAL — passes on limit
Market Price Realised	INR (-800) to (-1,200)/t (disposal cost)	INR 2,800-4,200/t	Full cost-to-revenue gap

Table 1: Raw combustible MSW fraction quality parameters vs market specification for RDF | Source: KRDC Analysis & CPCB Co-Processing Guidelines

Revenue Opportunity — Upgrading an Existing Waste Stream

The Opportunity: At 2 TPH throughput operating 300 days/year (7,200 hours), the annual feedstock volume is approximately 14,400 tonnes of combustible waste fraction. At current landfill disposal costs of roughly INR 1,000/tonne, this represents an annual cost burden of INR 1.44 Cr/year. Post-processing with KERONE's system, the same volume as cement-kiln-grade RDF at an average INR 3,500/tonne generates INR 5.04 Cr/year in revenue — a swing of over INR 6.5 Cr annually, from an existing waste stream that currently carries only cost.

About GreenCycle Waste Management Pvt. Ltd.

GreenCycle Waste Management Pvt. Ltd. is a municipal solid waste processing contractor operating integrated waste management facilities under contract to three urban local bodies, with a combined daily intake capacity exceeding 400 tonnes. Their operations span door-to-door collection, mechanical segregation, composting of the biodegradable fraction, and landfilling of residual waste — positioning them as an ideal anchor client for KERONE's RDF upgrading technology. The KRDC trial was conducted on GreenCycle's actual segregated combustible waste (25 kg composite sample, dispatched March 2026) to ensure industrial relevance of all process parameters.

Process Validation — From KRDC Lab to Industrial Scale

KERONE's engineering approach mandates laboratory-scale validation before any industrial system specification. The KRDC (Kerone Research & Development Centre) conducted a structured experimental programme on GreenCycle's actual segregated combustible waste over 5 days, using a precision rotary drum drying rig to establish the process envelope that informs the 2 TPH industrial plant design.

KRDC Experimental Programme — Key Findings

Test Condition	Residence Time	Moisture Reduction	GCV Achieved	Assessment
Control (no drying)	0 min	< 1%	1,650 kcal/kg	Baseline — raw feedstock
Short residence	20 min	~48%	2,450 kcal/kg	Insufficient — rejects grade spec
OPTIMAL	45 min	~71%	3,850 kcal/kg	Optimal for cement co-processing
Extended residence	75 min	~76%	4,050 kcal/kg	Marginal gain — diminishing returns

Table 2: KRDC Laboratory Results — 120 degrees C rotary drum trials on GreenCycle combustible waste fraction | KRDC Test Report 52/KRDC/LAB/09 | GCV per IS 1350 (Part-II)

Scale-Up Methodology — Lab to 2 TPH

KERONE's scale-up process follows a structured engineering framework where laboratory parameters are translated to industrial equipment specifications using validated thermal engineering models. The key translation factors for this project are:

Parameter	KRDC Lab (Drum Rig)	Industrial Plant (2 TPH Rotary Dryer)	Scale-Up Factor
Drying Air Temperature	120 degrees C	120 degrees C	1:1 (direct)
Optimal Residence Time	45 min	45 min residence	1:1 (direct)
Throughput	~15 kg/run	2,000 kg/hr	133,000:1
Airflow Mode	Co-current (lab fan)	Co-current, induced draft	Direct
Ramp Rate	4 degrees C/min	Zone-controlled (3 zones)	Adapted
Heating Mode	Batch (rotating drum)	Continuous rotary dryer	Configuration change
Pre-treatment	Manual size reduction	Shredder + trommel screen	Automated

Industrial Plant Design — 2 TPH Continuous Processing System

Process Flow: Waste Reception & Bunker → Pre-Shredding (size reduction to <80mm) → Trommel Screening & Air Classification (removal of inerts, fines, ferrous/non-ferrous metals) → Continuous Rotary Drum Dryer (120 degC, 45-min residence) → Cooling & De-dusting → Baling / Fluff Storage & Dispatch.

System Architecture — Major Process Units

Unit / Section	Equipment	Design Parameters	Function
U-01: Waste Reception	Tipping Floor + Bunker + Grab Crane	150 m3 live storage 2.2 t/hr rated	Buffer feedstock; enable continuous downstream feed
U-02: Pre-Shredding	Single-Shaft Shredder	<80 mm output 2,200 kg/hr	Size reduction for uniform drying and handling
U-03: Screening & Classification	Trommel Screen + Air Classifier	40 mm cut Density-based split	Remove inerts, glass, grit, ferrous/non-ferrous metals
U-04: Rotary Drum Dryer (Primary Process Unit)	KERONE Continuous Rotary Dryer	2,200 kg/hr capacity 120 degrees C 45 min residence L/D = 10:1 Co-current air 3-zone heating	Core thermal processing — moisture removal, GCV upgrade
U-05: Hot Air Generation	Hot Air Generator (Biomass/Gas fired)	Outlet temp 350 degrees C Modulating burner	Supply drying-air heat load to dryer inlet
U-06: Off-Gas Treatment	Cyclone + Wet Scrubber + ID Fan	Efficiency >98% PM capture CPCB compliant	Capture dust and odour-laden moist air from dryer exhaust
U-07: Cooling Zone	Air-Cooled Rotary Cooler	Inlet: 100 degrees C Outlet: <45 degrees C 2,000 kg/hr	Cool RDF before baling to prevent spontaneous heating
U-08: Product Handling	Belt Conveyor + Baler / Fluff Bagging	Baling density 300-350 kg/m3	Convert dried RDF to bales or bagged fluff for dispatch
U-09: Process Control	PLC/SCADA Control Panel	Siemens S7 / Allen Bradley Remote monitoring capable	Automated temperature, airflow, residence time control

Table 3: Process Unit Descriptions — KERONE 2 TPH Continuous MSW-to-RDF Processing Plant | U-04 (Rotary Drum Dryer) is the primary process unit; all others are ancillary

Core Equipment Specification — KERONE Rotary Drum Dryer

The KERONE Continuous Rotary Drum Dryer is the heart of the MSW-to-RDF upgrading system. Designed and manufactured in-house at KERONE's Ambernath facility, it directly scales the validated laboratory parameters from KRDC trial 52/KRDC/LAB/09 to industrial throughput while maintaining the identical thermal profile and residence time that produced the 3,850 kcal/kg GCV result.

Rotary Drum Dryer — Core Specifications	
Design Throughput	2,200 kg/hr (wet feed input)
Operating Temperature	120 degrees C (max design: 250 degrees C)
Residence Time	45 min (adjustable 20-90 min via RPM)
Drum Dimensions	ID 1,400 mm x L 14,000 mm (carbon steel)
Heating Zones	3 independent hot-air zones
Airflow Mode	Co-current, induced draft
Drive System	VFD-controlled 15 kW gear motor
Installed Power	~185 kW (total connected load)
Shell Material	MS with abrasion-resistant liner
Insulation	Mineral wool blanket — 100 mm
Sealing	Labyrinth seals with flexible skirting (dust-tight)

Utilities & Ancillary Requirements

Utility	Specification	Consumption (at 2 TPH)	Source
Electrical Power	415V, 3-phase, 50Hz	~185 kW connected ~145 kW avg demand	Site utility
Thermal Energy (Hot Air)	350 degrees C generator outlet	~9,50,000 kcal/hr	Biomass / PNG hot air generator
Compressed Air	6 bar dry instrument grade	20 Nm3/hr	Air compressor (site)
Process Water	For scrubber make-up	2 m3/hr	Site utility
Space Requirement	Building / covered area	L 40m x W 15m x H 8m	New shed or existing bay

Emission Compliance

Emission Point	Pollutant	Expected Level	CPCB / MoEF Limit	Status
Dryer off-gas (after scrubber)	PM10	< 25 mg/Nm3	50 mg/Nm3	COMPLIANT
Dryer off-gas	VOC / Odour	< 15 mg/Nm3	20 mg/Nm3	COMPLIANT
Hot air generator stack	SPM	< 100 mg/Nm3	150 mg/Nm3	COMPLIANT
Cooling + handling (bag filter outlet)	RDF Dust	< 30 mg/Nm3	50 mg/Nm3	COMPLIANT

Mass Balance & Energy Analysis — 2 TPH Operation

Detailed Mass Balance — Per Hour at Full Load

Stream	Material	Flow Rate (kg/hr)	Notes
Feed (IN)	Segregated combustible waste (as-received)	2,000	42.6% moisture, GreenCycle composite sample
Rejects (Screening)	Inerts, grit, ferrous/non-ferrous metals	~140	Removed at U-03; sold/recycled separately
Moisture Evaporated	Water vapour	~790	~71% of feed moisture; passed to scrubber
Product (OUT)	High-GCV RDF	~1,050	12.5% moisture; 3,850 kcal/kg GCV; baled
Fines (recycled)	Bag filter fines	~20	Collected from U-06; recycled to product or waste stream
Scrubber discharge	Treated moist air + condensate	Stack / drain	Meets CPCB emission and effluent limits

Table 4: Mass balance — 2 TPH continuous MSW-to-RDF processing plant | Based on validated KRDC lab data scaled to industrial throughput

Energy Consumption Estimates

Energy Category	Equipment / Unit	Power / Fuel	Load Factor	Consumption (per tonne RDF)
Drying (Hot Air Generation)	Hot air generator (biomass/PNG fired)	~130 kg biomass/hr	80%	~99 kg biomass
Drive Systems	Rotary drum drive + conveyors + shredder	45 kW	75%	~34 kWh
Cooling System	Cooling fan + rotary cooler	12 kW	85%	~10 kWh
Emission Control	ID fan + scrubber pump + bag filter	22 kW	90%	~19 kWh
Utilities & Controls	SCADA + lighting + misc	10 kW	60%	~6 kWh

Product Quality Specification & Market Applications

Expected Product Specification — KERONE Processed RDF

Parameter	Test Method	Raw Feed (Input)	Processed RDF (20-min residence)	Processed RDF (45-min residence)	Cement AFR Spec (Reference)
Moisture Content	IS 1350 (P-I)	42.60%	~22%	~12.5%	< 15%
Gross Calorific Value	IS 1350 (P-II)	1,650 kcal/kg	2,450 kcal/kg	3,850 kcal/kg	> 3,000 kcal/kg
Ash Content	IS 1350 (P-I)	24.80%	~22%	~19%	< 25%
Chlorine Content	ASTM D4208	0.92%	~0.90%	~0.85%	< 1.0%
Bulk Density (baled)	By Calculation	~180 kg/m ³	~250 kg/m ³	~320 kg/m ³	> 300 kg/m ³ preferred
Product Grade	Classification	Landfill-bound waste	Low-grade AFR	Premium Cement-Kiln RDF	AFR (Alternative Fuel)

Table 6: Product quality specification — raw combustible waste vs processed RDF vs cement co-processing AFR specification | 45-min processed RDF column = recommended for high-value cement kiln applications

Market Applications for Processed RDF

- **Cement Kiln Co-processing (Primary Application):** Cement manufacturers use RDF as an alternative fuel resource (AFR) replacing coal in the kiln, targeting 15-25% thermal substitution. RDF at 3,850 kcal/kg GCV and <15% moisture meets standard cement industry AFR intake specifications.
- **Waste-to-Energy (WtE) Power Plants:** Dedicated WtE facilities accept processed RDF as boiler feedstock at higher moisture tolerance; processed material at 20-min residence already meets this lower-tier specification.
- **Industrial Boilers & Captive Power Plants:** Textile, paper, and process industries with fluidised-bed boilers accept RDF fluff or pellets as a coal-substitute fuel, typically requiring GCV above 3,000 kcal/kg.
- **RDF Pelletisation for Export/Trading:** High-GCV, low-chlorine RDF can be densified into pellets for regional trading to fuel-deficient industrial clusters, commanding a further price premium over baled/fluff RDF.
- **Co-processing in Lime Kilns & Brick Kilns:** Secondary market for RDF fluff not meeting premium cement-kiln chlorine limits, at a lower but still positive price realisation versus raw waste.

Financial Analysis & Return on Investment

CAPEX Estimate — 2 TPH Plant

Cost Head	Scope	Estimated Cost (INR Lakhs)	Notes
Rotary Drum Dryer (Primary Equipment)	KERONE supply, factory tested	24-28	FOT Ambernath; includes drive, seals, controls
Pre-Shredding & Screening	Shredder, trommel, air classifier	10-13	Feed preparation line
Hot Air Generator	Biomass/PNG-fired unit	8-10	350 degrees C outlet, modulating burner
Emission Control (Scrubber + Bag Filter)	CPCB-compliant stack system	5-6	Cyclone + wet scrubber + ID fan
Cooling System	Air-cooled rotary cooler	3-4	Ambient air cooled, dust-tight
Product Handling	Conveyors, baler, bagging line	5-6	Baling density 300-350 kg/m ³
Electrical & Instrumentation	MCC panel, SCADA, cabling, transformer	6-7	PLC/SCADA by KERONE; site electrical by client
Civil & Structural	Foundation, shed, utilities connections	6-8	Client scope; KERONE to provide layout drawing
Commissioning, Training & Startup	KERONE commissioning team, 15-day site support	2-3	Includes operator training and performance test
TOTAL CAPEX		INR 69-85 Lakhs	Approx. range; detailed quote on enquiry

Revenue & OPEX Model — Annual Basis (7,200 hr/yr operation)

Item	Basis	INR/Year (Lakhs)	Remarks
REVENUE			
RDF Product Sales	1,050 kg/hr x 7,200 hr x INR 3,500/t	INR 265 Lakhs	Conservative RDF price; market ranges INR 2,800-4,200/t
Avoided Landfill Cost	950 kg/hr rejects+loss avoided x disposal savings	INR 14 Lakhs	Indirect saving; not booked as revenue below
OPERATING COSTS			
Biomass Fuel	99 kg/t RDF x 1,050 t/yr x INR 6/kg	INR 66 Lakhs	Hot air generator fuel; can substitute with PNG
Electricity	69 kWh/t x 1,050 t/yr x INR 8/kWh	INR 6 Lakhs	Based on INR 8/kWh industrial tariff
Labour (Operations)	6 operators/shift x 3 shifts x 12 months	INR 22 Lakhs	At INR 25,000/operator/month CTC

Item	Basis	INR/Year (Lakhs)	Remarks
Maintenance & Spares	3% of CAPEX per annum	INR 2.3 Lakhs	Annual maintenance provision
Miscellaneous & Overheads	QC testing, consumables, admin	INR 8 Lakhs	
NET PROFIT BEFORE TAX		INR ~161 Lakhs/yr	Payback ~2.1 years on INR 77L CAPEX

Table 8: Revenue & OPEX model — 2 TPH plant at 7,200 hr/yr | Indicative figures; actual revenue depends on RDF market price and product grade achieved

Project Execution & KERONE Scope of Supply

Implementation Timeline

Phase	Activity	Duration	KERONE Deliverable
Phase 0 Pre-Order	Technical consultation, site visit, process design freeze, commercial negotiation	4-6 Weeks	Process Design Basis (PDB), GA drawing, utility list, commercial offer
Phase 1 Engineering	Detailed engineering: mechanical, electrical, civil layout, P&ID finalization	6-8 Weeks	Complete engineering package, vendor drawings, DFM approval
Phase 2 Procurement	Long-lead items: dryer shell, drives, hot air generator, scrubber system	8-10 Weeks	Material test certificates, QC inspection reports, FAT invitation
Phase 3 Fabrication	Rotary dryer fabrication, shredder assembly, bag filter, SCADA panel	10-12 Weeks	Factory Acceptance Test (FAT) at KERONE Ambarnath; client witness invited
Phase 4 Installation	Equipment erection at client site; piping, electrical, instrument hook-up	4-5 Weeks	KERONE site supervision; civil and electrical by client as per KERONE drawings
Phase 5 Commissioning	Cold trials, hot trials with waste feed, performance guarantee test, operator training	2-3 Weeks	Commissioning report, performance test certificate, O&M manual, training records
TOTAL PROJECT TIMELINE	Order to commercial production	~34-44 Weeks	From purchase order to first commercial output

KERONE Scope of Supply & Services

Category	KERONE Scope (INCLUDED)	Client Scope (EXCLUDED from KERONE supply)
Process Design	Process design basis, mass balance, heat & material balance, P&ID	Feedstock quality guarantee; plant operating schedule
Primary Equipment	Rotary drum dryer (complete), shredder, screening, hot air generator, cooler	Waste reception bunker and grab crane, if not in enquiry scope
Emission Control	Cyclone, wet scrubber, bag filter, ID fan (CPCB compliant)	Stack height design and consent-to-operate from CPCB/SPCB
Controls	PLC/SCADA, MCC panel, all instruments and field wiring	DG set, main power supply connection, transformer
Civil & Structural	Foundation load drawings, GA layout, anchor bolt drawings	All civil work, sheds, platforms, ladders, drains
Commissioning	FAT, site commissioning, performance test, operator training (15 days)	Consumables (biomass, water) for commissioning; feedstock for trials
Documentation	P&ID, GA drawings, O&M manual, spares list, test certificates	Client-side approvals, regulatory consents, insurance

Conclusions & Why KERONE

The KERONE-designed 2 TPH Continuous MSW-to-RDF Processing System represents a proven, commercially validated solution to one of the most significant value-unlock opportunities in India's municipal waste management sector. The process is built on rigorous KRDC laboratory data — not theoretical projections — and the industrial design directly replicates the exact process conditions that produced measurable, certified results on GreenCycle's actual segregated waste feedstock.

Proven Technology

Every process parameter in the 2 TPH plant — 120 degrees C, 45-minute residence, co-current hot air — is directly derived from KRDC lab trial 52/KRDC/LAB/09 on client's actual feedstock. No extrapolation; no assumptions.

Quantified Outcome

GCV improvement from 1,650 kcal/kg to 3,850 kcal/kg, and moisture reduction from 42.6% to below 12.5%, are measurable, certified results — not marketing claims.

Commercial Clarity

The financial model demonstrates a payback period of approximately 2.1 years at conservative RDF pricing, converting an existing cost-bearing waste stream into a INR 260+ Lakh/year revenue line.

Full Ownership

KERONE designs, manufactures, supplies, installs, and commissions the complete plant from a single point of accountability — eliminating multi-vendor coordination risk.

Scalable Platform

The rotary dryer platform is scalable. A 2 TPH system validated at GreenCycle creates the reference installation for 5, 10, and 20 TPH systems for other municipal and industrial waste processors across India and internationally.

Compliance-Ready

Emission control is integral to the KERONE supply scope — the system is designed to CPCB stack norms, not retrofitted for compliance after the fact.

ENQUIRE ABOUT YOUR WASTE MANAGEMENT PROCESSING PROJECT

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To initiate a project discussion, please share: feedstock quality report + daily/annual tonnage + site location + target RDF grade required

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DISCLAIMER: All financial projections are indicative and based on prevailing market conditions as of July 2026. Process performance figures are derived from KRDC laboratory data (Report 52/KRDC/LAB/09) conducted on GreenCycle Waste Management Pvt. Ltd. feedstock. Actual industrial performance may vary. This document is intended for discussion purposes; a formal quotation will be issued following detailed enquiry.