EXOLINE OIL STOP
CASE STUDY

Circular Economy Model

Oil-Contaminated Waste Briquetting
Energy Recovery & Waste Reduction

Exoline Ltd.
Sustainable Waste Management
www.exoline.co.uk
January 2025

EXECUTIVE SUMMARY

Oil-contaminated waste management (soil, debris, sludge, dust) is one of the most expensive environmental tasks. The traditional solution - hazardous waste landfill disposal - is extremely costly (€200-400/tonne), environmentally harmful (carbon footprint), and creates no value. The EU Circular Economy Action Plan states: waste is NOT an end product, but a RESOURCE.

Exoline Oil Stop briquetting technology offers an innovative solution: **the oil-Exoline-$CaCO_3$ mass remaining after Exoline remediation can be mixed with biomass additives (sawdust, agricultural by-products) and transformed into ENERGY BRIQUETTES. This process simultaneously reduces waste volume (landfill avoidance), recovers energy (15-20 MJ/kg heating value), and utilizes residual $CaCO_3$ ash for agricultural liming.**

CIRCULAR MODEL: Exoline technology creates value THREE TIMES: (1) Primary remediation (oil stabilization, biodegradation support), (2) Secondary energy recovery (briquette combustion → heating, electricity), (3) Tertiary agricultural utilization ($CaCO_3$ ash → liming). This aligns with EU Waste Hierarchy: prevention > reuse > recycling > energy recovery > disposal.

Key Benefits

- Waste reduction: 85-95% landfill avoidance (briquetting → ash)
- Energy recovery: 15-20 MJ/kg heating value (similar to coal briquette)
- Cost savings: Hazardous waste €300/t → Briquette revenue €50-80/t
- Carbon-neutral ash: $CaCO_3$-rich ash with low environmental impact, suitable for agricultural liming and soil pH improvement.
- EU Circular Economy compliance: Waste-to-Energy model
- Carbon footprint reduction: Local energy production vs. transport/landfill

1. CIRCULAR ECONOMY AND EU REGULATIONS
1.1. EU Circular Economy Action Plan

The European Union updated its Circular Economy Action Plan in 2020, placing the Waste

Hierarchy at center stage:

1. Prevention: Reduce waste generation
2. Reuse: Second use of products
3. Recycling: Material recovery into production
4. **Energy Recovery: Waste-to-Energy technologies**
5. Disposal: Landfill only as last resort

The Exoline briquetting model operates at Level 4 (Energy Recovery), which is MUCH BETTER than traditional Level 5 (disposal).

1.2. Traditional Oil Waste Treatment Problems

Method	Cost	Environmental Impact	Problem
Hazardous waste landfill	€250-400/tonne	Soil/groundwater contamination risk, methane emission	Long-term liability, no value
Cement co-incineration	€150-250/tonne	High transport carbon footprint	Geographic limit, capacity constraint
Thermal destruction (incineration)	€200-350/tonne	High CO_2 emission, energy waste (if no recovery)	Expensive, not always available
Bioremediation (conventional)	€80-150/tonne	Slow (years), uncertain efficiency	Long duration, residual waste

CRITICAL: Common problem of traditional methods: ONLY COST, NO VALUE. Waste remains a 'problem', doesn't become a 'resource'.

2. EXOLINE BRIQUETTING TECHNOLOGY
2.1. Briquetting Process Overview

Exoline briquetting is a three-phase process transforming the oil-Exoline-$CaCO_3$ mass remaining after Exoline remediation into energy briquettes:

PHASE 1: Exoline Remediation and Oil Stabilization (30-90 days)

- Exoline Oil Stop application to contaminated soil, sludge, debris
- Oil adsorption onto Exoline surface → mobile oil immobilization
- Partial biodegradation: $CaO_2 \rightarrow O_2 \rightarrow$ aerobic degradation (20-40% TPH reduction)
- Result: Stable Exoline-oil-$CaCO_3$ mass (~10-20% residual oil)

PHASE 2: Extraction and Biomass Mixing (1-2 weeks)

- Exoline-oil mass extraction: Mechanical sieving or controlled soil excavation
- Biomass additive addition: Sawdust, straw, corn stalks, sunflower husks (35-50%)
- Binder (optional): Ligno-cellulose binder for stability increase
- Moisture adjustment: 8-12% (optimal for briquetting)

PHASE 3: Briquetting and Energy Utilization (continuous)

- Mechanical pressing: High-pressure briquette press (150-300 bar)
- Briquette forming: Cylindrical briquette (50-100 mm diameter)
- Energy utilization: Combustion in industrial boilers, biomass power plants
- **Ash utilization: $CaCO_3$-containing ash → agricultural liming**

2.2. Briquette Composition and Properties

Component	Ratio (%)	Function
Exoline-oil mass	40-55%	Heating value (residual oil) + $CaCO_3$ binding
Biomass (sawdust, straw)	35-50%	Heating value increase, structural integrity
Binder (ligno-cellulose)	3-8%	Mechanical stability, reduce crumbling
Moisture	8-12%	Optimal pressability

Parameter	Value	Comparison
Heating Value (LHV)	15-20 MJ/kg	Coal briquette: 18-22 MJ/kg, Wood waste: 12-16 MJ/kg
Density	800-1,100 kg/m³	Coal briquette: 900-1,200 kg/m³
Ash Content	12-18%	Coal briquette: 8-15%, Biomass: 5-10%
Moisture	8-12%	Coal briquette: 8-15%
Mechanical Strength	High (no crumbling)	Similar to commercial briquette

Result: Exoline briquette heating value SIMILAR to commercial coal briquette, but with RENEWABLE biomass content and $CaCO_3$ ash.

3. PRACTICAL CASE STUDY: AGRICULTURAL CONTAMINATION BRIQUETTING

3.1. Project Background

Location: Agricultural area, old machinery storage and fuel station vicinity, diesel and machine oil contamination.

Parameter	Value
Contaminated soil quantity	~850 tonnes (0-1.2m depth)
TPH concentration	3,500-8,200 mg/kg (average: 5,500 mg/kg)
Contaminant type	Diesel (60%), machine oil-lubricant (30%), other (10%)
Exoline application	18 kg/m³ average dosage
Total Exoline	~15.3 tonnes
Stabilization time	60 days
TPH reduction via biodegradation	5,500 mg/kg → 3,300 mg/kg (40% reduction)

3.2. Results

Component	Quantity	Note
Exoline-oil mass (extracted)	~42 tonnes	Clean mass after sieving
Of which: Exoline + $CaCO_3$	~18 tonnes	$CaO_2 \rightarrow CaCO_3$ converted
Of which: Residual oil	~24 tonnes	60% of original oil (after biodegradation)
Clean soil (replaced)	~808 tonnes	95% soil recoverable
Biomass additive	~33 tonnes	Wheat straw, corn stalks, sunflower husks
Briquette output (net)	~65 tonnes	Cylinder 80mm diameter
Briquette heating value (LHV)	17.5 MJ/kg	Lab measured
Total energy content	1,138 GJ = 316 MWh	~30,500 m³ natural gas equivalent
Ash generated	~9.8 tonnes	15% ash content
Agricultural liming equivalent	~7.3 tonnes limestone	Treatable area: ~15 hectares

Result: 65 tonnes energy briquettes produced from 850 tonnes contaminated soil. 95% soil recoverable, 5% briquette + energy.

4. ENERGY UTILIZATION & COMBUSTION

Exoline briquettes suitable for biomass power plants, industrial boilers, and cement kilns. Emissions fully comply with EU Industrial Emissions Directive (IED):

Emission	Exoline Briquette	EU IED Limit	Compliance
CO (carbon monoxide)	45 mg/Nm³	100 mg/Nm³	✓ Compliant
NOx (nitrogen oxides)	180 mg/Nm³	200 mg/Nm³	✓ Compliant
SO_2 (sulfur dioxide)	12 mg/Nm³	50 mg/Nm³	✓ Well below limit
Dust (particulates)	8 mg/Nm³	20 mg/Nm³	✓ Compliant
TOC (organic carbon)	5 mg/Nm³	10 mg/Nm³	✓ Compliant

Ash Utilization: $CaCO_3$-rich ash (65-75%) suitable for agricultural liming, providing pH improvement on acidic soils plus K, P, Mg micronutrients. Ash value: €365-585 equivalent to commercial limestone.

5. ECONOMIC ANALYSIS & CIRCULAR VALUE

Aspect	Traditional (Landfill)	Exoline Briquetting
Waste quantity	850 t contaminated soil → 850 t landfill	850 t soil → 808 t recovered + 65 t briquette → 9.8 t ash
Landfill requirement	850 t hazardous waste	0 t (briquette energy, ash liming)

Waste reduction	0%	95% (9.8 t ash vs. 850 t original)
Energy recovery	0 (wasted)	1,138 GJ = 316 MWh electricity
By-product value	None	Ash liming €365-585 value
EU Waste Hierarchy level	5. Disposal (worst)	4. Energy recovery + 3. Recycling (ash)

Environmental footprint comparison indicates up to 93% CO_2 emission reduction compared to traditional hazardous waste landfill disposal, with full landfill avoidance through energy recovery and partial fossil fuel replacement, based on project-level calculations.. This represents a practical and verifiable circular economy model aligned with EU policy objectives.

6. EU REGULATORY COMPLIANCE

Exoline briquette energy utilization is designed to comply with applicable EU Waste-to-Energy and Industrial Emissions regulations, subject to local permitting and operational conditions.

- Industrial Emissions Directive (2010/75/EU): Emission limits met
- Waste Framework Directive (2008/98/EC): Waste Hierarchy Level 4
- Renewable Energy Directive (2018/2001/EU): Biomass content (35-50%) → renewable energy
- End-of-Waste criteria: Briquette quality specifications met

End-of-Waste Status: Exoline briquettes may achieve End-of-Waste (EoW) status once quality criteria are met and approval is granted by the relevant local regulatory authority, enabling commercial utilization..

7. INDUSTRIAL SCALING & BUSINESS MODEL

Plant Size	Input (year)	Briquette Output (year)	Investment
Small (mobile)	500-2,000 t soil	40-160 t briquette	€200k-400k
Medium (local)	2,000-10,000 t soil	160-800 t briquette	€600k-1.2M
Large (regional)	10,000-50,000 t soil	800-4,000 t briquette	€2M-5M

Business Model Options: (1) Remediation Service + Briquette Sales, (2) Integrated Waste-Energy Company with own boiler, (3) Franchise/License Model for regional partners.

8. SUMMARY & FUTURE VISION

Exoline Oil Stop briquetting technology is not just a waste treatment solution, but a COMPLETE CIRCULAR ECONOMY MODEL meeting the highest expectations of the EU Circular Economy Action Plan.

Category	Exoline Briquetting Advantage
Waste reduction	95% landfill avoidance (850 t → 9.8 t ash)
Energy recovery	1,138 GJ = 316 MWh electricity

Fossil fuel replacement	~30,500 m³ natural gas
Agricultural utilization	9.8 t $CaCO_3$ ash → 15 ha liming
CO_2 footprint	93% reduction vs. traditional landfill
EU compliance	Waste Hierarchy Level 4 + IED compliance
Commercial value	Briquette + ash sales €3,500-6,000

CONCLUSION: Circular economy is not a future vision, but **CURRENT NECESSITY. The EU aims to be climate-neutral by 2050, which is only possible if all waste BECOMES RESOURCE.** Exoline briquetting technology proves: Oil-contaminated waste can be transformed into a controlled and valuable resource within a regulated circular economy framework, enabling energy recovery and secondary material utilization.. **The END of waste is not the landfill, but the NEW BEGINNING.**

CONTACT & ADDITIONAL INFORMATION

Exoline Ltd.

Circular Economy & Sustainable Waste Management

Website: www.exoline.co.uk
Email: info@exoline.co.uk
LinkedIn: linkedin.com/in/ferenc-sári
X (Twitter): @exoline_uk

Published: January 2025