Unified Mining Technical Report

Truck–Shovel vs Dragline — Cost & ESG Evaluation

Date: 2025-08-18

Scope: Equipment productivity, ownership & operating cost modeling, carbon intensity, and integrated cost-with-carbon assessment.

Disclaimer: This is an indicative model. Actual project decisions require detailed geotechnical, operational, and financial due diligence.

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1. Executive Summary

Leader: Dragline. TS total unit cost: 0.6 €/m^3 (carbon 0.049 €/m^3); DL total unit cost: 0.34 €/m^3 (carbon 0.016 €/m^3). Annual production TS 3,981,312 m^3 vs DL 4,120,658 m^3. Carbon intensity TS 0.814 kg/m^3 vs DL 0.262 kg/m^3. Annual CO, TS 3,241.73 t vs DL 1,080.58 t.

1.1 Key KPIs

Metric	Truck–Shovel	Dragline
Annual Production (m^3 LCM)	3,981,312	4,120,658
Unit Cost incl Carbon (€/m^3)	0.6	0.34
Carbon Intensity (kg CO,/m^3)	0.814	0.262
Carbon Tax (€/m^3)	0.049	0.016
Bottleneck	Truck-bound	—
Matching Factor	1.04	—

1.2 Recommendation Overview

DATA-DRIVEN RECOMMENDATION

Leader: Dragline
Cost ”: 75.3% | Carbon Intensity ”: 210.5%

TS COST €/M^3
0.6
DL COST €/M^3
0.34
TS KG/M^3
0.814
DL KG/M^3
0.262
TS CTAX
0.049
DL CTAX
0.016
TS SCORE
2.429
DL SCORE
1.000
TS ANNUAL M^3
3,981,312
DL ANNUAL M^3
4,120,658

Composite score equally weights economic and carbon efficiency. Adjust for strategic decarbonization vs cost priorities. Carbon tax shifts margin if intensity divergence exceeds unit cost gap threshold.

2. Equipment Inputs

2.1 Truck–Shovel Fleet

Parameter	Value
Shovels (units)	1
Shovel bucket (m^3 BCM)	5.4

Parameter	Value
Shovel cycle (s)	27
Trucks (units)	2
Truck body (m^3 BCM)	60
Truck payload (t)	—

2.2 Dragline

Parameter	Value
Draglines (units)	1
Bucket (m^3 BCM)	10.8
Cycle (s)	54

3. Material, OEE & Calendar

Parameter	Value
Density (t/m^3)	1.6
Swell Factor	1.2
Fill Factor	1.15
M Factor TS	1.0
M Factor DL	1.0
Availability A	0.9
Utilization U	0.8
Hours/shift	8
Shifts/day	3
Days/year	240
Annual Hours	5,760

4. Truck–Shovel Cycle Analysis

Load 324.0s | Haul 72.0s | Dump 52s | Return 48.0s | Wait 125s !' Total 621.

Passes: 12

Cycle efficiency influences truck queueing & idle fractions. Matching Factor (MF) close to 1 indicates balanced fleet utilization.

5. Production (LCM Basis)

Metric	TS	Dragline
m^3/h (Constraint / Direct)	691.2	715.39
Monthly m^3	331,776	343,388.16
Annual m^3	3,981,312	4,120,657.92

6. Total Cost of Ownership

Ownership covers depreciation plus investment interest / tax factor on average deployed capital. OPEX integrates energy, lube, maintenance, breakdown allowance, and labour.

System	Ownership €/y	OPEX €/y	Total €/y

System	Ownership €/y	OPEX €/y	Total €/y
Truck–Shovel	376,573.53	1,818,421.18	2,194,994.71
Dragline	637,106.9	708,924.07	1,346,030.98

6.1 TS Ownership Breakdown

Component	Shovel	Trucks
Ownership €/y	127,750	248,823.53
OPEX €/y	609,160	1,209,261.18

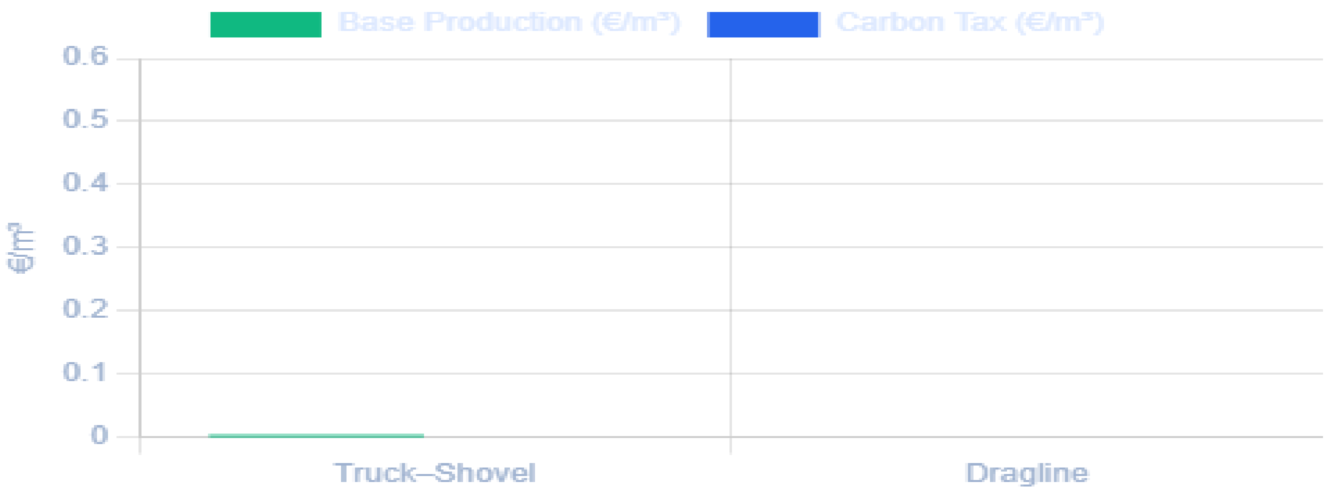
7. ESG & Carbon Economics

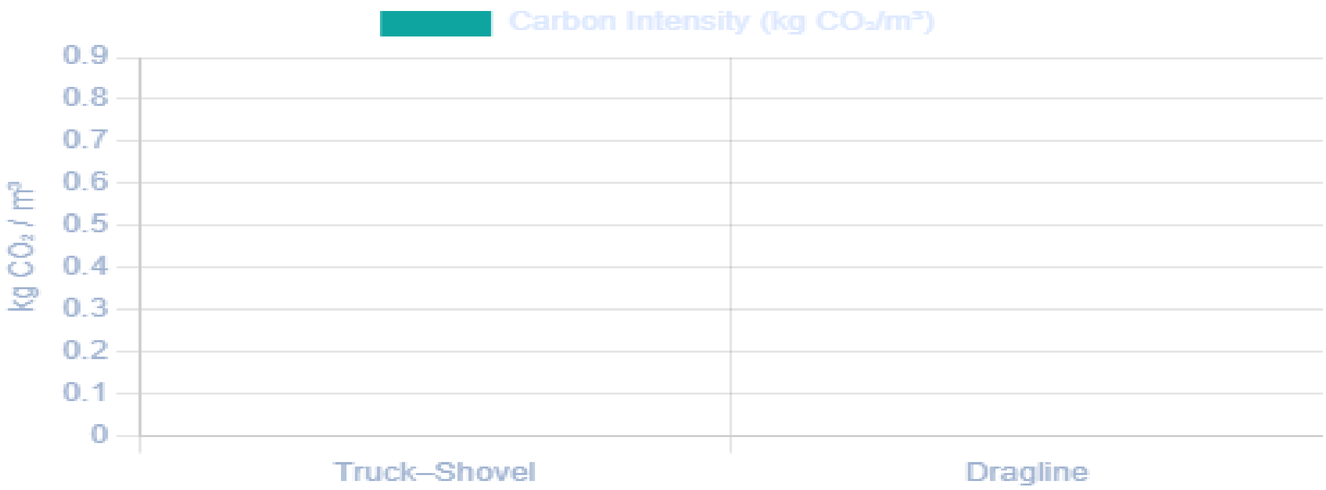
Metric	TS	Dragline
Fuel L/h	210	70
CO_2 kg/h	562.8	187.6
Annual CO_2 t	3,241.73	1,080.58
Carbon Intensity kg/m³	0.814	0.262
Carbon Tax €/m³	0.049	0.016
Unit Cost €/m³ (prod)	0.55	0.33
Total Unit Cost €/m³ (incl carbon)	0.6	0.34

Emission factor applied uniformly. Overrides allow alignment with measured site fuel data. Carbon pricing alters competitive positioning when intensity gap is significant.

8. Visual Analytics

Stacked cost bars show carbon tax contribution; carbon intensity chart contextualizes decarbonization leverage.





9. Methodology & Formulae

Model hierarchy: (1) Physical capacity derivation (cycle-based), (2) Cost lay
overlay (fuel-driven emissions), (4) Integrated economic + carbon scoring. All volumes in LCM unless stated.

9.1 Core Equations

Shovel LCM/h = (3600 / cycle_s) * bucket_BCM * Fill * Swell * M_TS * Units * A * U
Truck LCM/h = (3600 / truckCycle_s) * body_BCM * Fill * Swell * Units * A * U
TS Capacity = min(Shovel LCM/h, Truck LCM/h)
Dragline LCM/h = (3600 / cycle_s) * bucket_BCM * Fill * Swell * M_DL * Units * A * U
Annual Hours = h/shift * shifts/day * days/year
Ownership €/y = (Depreciation + IIT) * Units
OPEX €/y = Energy + (Lube%×Energy) + (Maint%×Dep) + (Break%×Cost) + Labour
Unit Cost (€/m³) = Annual Cost / Annual LCM
CO, kg/h = Fuel L/h × EF kg/L
Carbon Tax €/m³ = ((CO, kg/h × Hours_y)/1000 × CarbonCost €/t)/Annual LC
Composite Score = 0.5*(Cost/MinCost)+0.5*(CI/MinCI)

9.2 Assumptions & Limitations

Simplifications: deterministic cycles (no stochastic queuing), homogeneous material, single pit profile, uniform shift efficiency (A·U). Dragline energy modeled identical to diesel for demonstration if no separate electricity factor. Real operations require time-distribution of delays, ramp/grade corrections, and maintenance downtime modeling.

10. Data-Driven Recommendation

DATA-DRIVEN RECOMMENDATION

Leader: Dragline
C o s t ": 7 5 . 3 % | C a r b o n I n t e n s i t y ": 2 1 0 . 5 %

TS COST €/M³
0.6
DL COST €/M³
0.34
TS KG/M³
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Composite score equally weights economic and carbon efficiency. Adjust for strategic decarbonization vs cost priorities. Carbon tax shifts margin if intensity divergence exceeds unit cost gap threshold.

11. Disclaimer

This document is for preliminary comparative analysis only. It should not be construed as a feasibility-level study. Sensitivity to fuel price, carbon pricing, haul distance variability, equipment reliability, and ore/waste blending is recommended before investment decisions.