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Re-Refining versus Fuel-Oil Combustion
Economics of Used Lubricating Oil Management in Kazakhstan

Market Price Differentials · The $332M / €330M International Scale Reference
6.5% CAGR Growth Projections Through 2027 · Kazakhstan Policy & Regulatory Context
An Evidence-Based Economic Analysis

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Target Audience: Energy Sector Investors · Industrial Policy Advisors · Lubricant & Waste Oil Operators · Development Finance Institutions

Abstract

This paper provides a comprehensive economic analysis of two principal end-of-life pathways for used lubricating oil in Kazakhstan: re-refining into marketable base oil stocks versus combustion as fuel oil. Kazakhstan, with 30 billion barrels of proven oil reserves and three major refineries processing 17.6 million tonnes of crude annually, generates an estimated 120,000–170,000 tonnes of used lubricating oil per year from its industrial, mining, and transport sectors. Despite the 2021 Environmental Code's prohibition on the landfill disposal of waste oils and its adoption of a waste hierarchy, formal re-refining capacity in Kazakhstan remains nascent. Drawing on peer-reviewed life cycle assessments, EU policy modeling, and Central Asian market data, we quantify the price differential between base oils (€1,140–€1,720/tonne) and fuel oil (~€300–€450/tonne), yielding a value gap of €700–€1,270 per tonne. The global re-refined base oil market is growing at a 6.26–6.82% CAGR, reaching USD 5.5–5.7 billion by 2027. We contextualize a $332M / €330M international scale reference — drawn from U.S. processing-capacity data and the EU's independently computed €330 million societal NPV — as a calibration benchmark only; applied to Kazakhstan's own stream, the analysis yields a societal benefit on the order of $4–6 million per year plus $25–55 million in annual import-substitution value. The paper concludes with policy recommendations calibrated to Kazakhstan's regulatory framework, refinery infrastructure, and the Green Economy transition agenda.

Keywords: *Kazakhstan, re-refining, used lubricating oil, waste oil management, base oil, fuel oil, KazMunayGas, Environmental Code 2021, circular economy, CAGR, price differential, Green Economy*

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1. Introduction and Kazakhstan Context

1.1 Kazakhstan Oil Sector Overview

Kazakhstan is one of the world's major hydrocarbon producers, holding approximately 30 billion barrels of proven oil reserves — the 12th largest reserve base globally — and producing 87.7 million tonnes of crude oil in 2024.[30] The country's three principal refineries — at Atyrau, Pavlodar, and Shymkent — processed a combined 17.6 million tonnes of crude in 2024, with national refining capacity targeted to reach 17.9 million tonnes in 2022 and ambitious plans to expand to 40 million tonnes annually by 2040.[31][33] This hydrocarbon economy underpins virtually every sector of Kazakhstani industry, and it generates an enormous and growing stream of used lubricating oil.[27]

The Tengiz, Kashagan, and Karachaganak mega-fields collectively anchor Kazakhstan's production profile. Their operation — alongside the extensive transport fleet supporting 63.0 million tonnes of oil exports through the Caspian Pipeline Consortium in 2024 — creates a high-intensity lubricant consumption environment spanning extraction, pipeline transport, refining, petrochemical processing, and heavy vehicle logistics.[30] Central Asia as a whole consumed approximately 300,000 tonnes of finished lubricants in 2021, of which Kazakhstan accounts for the largest national share.[25]

1.2 Used Oil Generation Estimates and the Management Challenge

Based on the lubricant consumption ratio for industrialized economies (approximately 40–48% of lubricants consumed return as collectible used oil) and Kazakhstan's estimated lubricant market of approximately 150,000–200,000 tonnes per year, the country generates roughly 60,000–80,000 tonnes of used lubricating oil annually from automotive and commercial sources, plus an estimated 60,000–90,000 tonnes from industrial and mining operations.[5][25] The total used oil stream in Kazakhstan is estimated at 120,000–170,000 tonnes per year — a volume with significant economic potential if re-refined rather than combusted.

Despite this scale, formal re-refining capacity in Kazakhstan remains nascent. The country currently lacks a dedicated Group I or Group II re-refining facility comparable to those operating in the EU or North America. A significant fraction of collected used oil is directed to cement kilns, industrial boilers, and space heating — the fuel-oil combustion pathway — destroying valuable base oil molecules that could otherwise be recovered.

The Republic of Kazakhstan's Environmental Code of 2021 specifically banned the landfill disposal of waste oils (a ban in force since 2016) and introduced a waste hierarchy principle that places material recovery above energy recovery.[28][29] This regulatory framework creates a compelling policy mandate to develop re-refining infrastructure, but the economic incentive structures have not yet been fully operationalized.

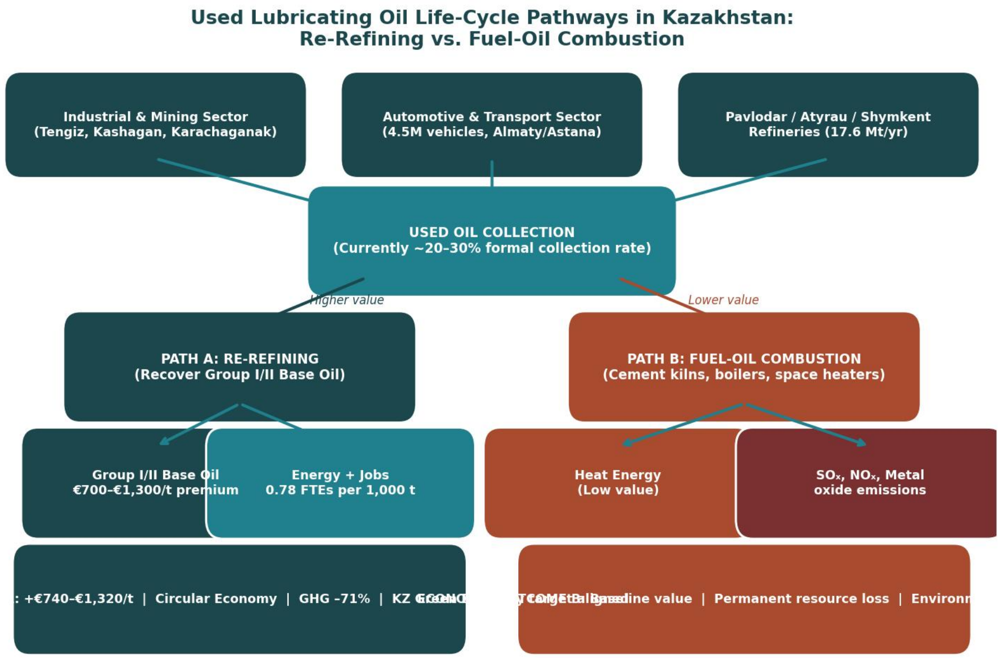

Figure 1: Used Lubricating Oil Life-Cycle Pathways in Kazakhstan — Re-Refining vs. Fuel-Oil Combustion

This paper addresses the economic case for accelerating the transition from fuel-oil combustion to re-refining as the primary used oil management strategy in Kazakhstan. Section 2 reviews global market trends; Section 3 documents Kazakhstan's oil sector and used oil landscape; Section 4 analyzes the critical price differential; Sections 5–6 discuss the $332M / €330M reference and technology economics; Sections 7–8 examine environmental and regulatory dimensions; Section 9 projects CAGR-driven economic impact; Section 10 contextualizes Kazakhstan within the CIS region; Section 11 delivers conclusions and policy recommendations.

2. The Global Re-Refined Base Oil Market

2.1 Market Size and Growth Trajectory

The global re-refined base oil (RRBO) market is one of the fastest-growing segments in the lubricants and petrochemicals sector. Technavio projects growth of USD 2.28 billion from 2022 to 2027 at a CAGR of 6.26%, while ResearchAndMarkets estimates market value reaching USD 5.05 billion by 2028 from USD 3.4 billion in 2022 (CAGR of 6.82%).[1][2] The weighted central estimate across forecasters converges on approximately 6.4–6.6% annual growth — consistent with the 6.5% CAGR figure used in this analysis. Table 1 synthesizes the principal market forecasts.

Table 1: Global Market Forecasts — Re-Refined Base Oil vs. Competing Segments (Including Kazakhstan)

Market Segment	2022 (USD B)	2027 Forecast	CAGR (%)	Source
Re-Refined Base Oil (Global)	~3.40	~5.68	6.26–6.82	Technavio / ResearchAndMarkets [1][2]
Re-Refined Paraffinic Base Oil	2.13	~2.70	5.9 (2024–2031)	Insight Partners [21]
Waste Oil Recycling (Global)	37.5	~55.0	6.78 (2025–2033)	Cognitive Market Research [15]
Heavy Fuel Oil Market (Global)	N/A	$120.5B by 2030	2.17 (2025–2030)	Mordor Intelligence [16]
Central Asia Lubricants (Total)	~0.45	~0.55	~4–5	Lubes'N'Greases [25]
Kazakhstan Lubricant Market (est.)	~0.20	~0.25	~4	IndexBox / Kline [25][26]

The contrast between RRBO growth (6.26–6.82% CAGR) and heavy fuel oil growth (2.17% CAGR) reflects a structural market shift driven by regulatory pressure, ESG investment criteria, and technology maturation.[16] For Kazakhstan, which sits at the intersection of a major crude oil economy and an emerging circular economy agenda, this global shift creates both an investment opportunity and a policy imperative to capture the rapidly growing value premium for re-refined base oils rather than exporting used oil's economic value through combustion.

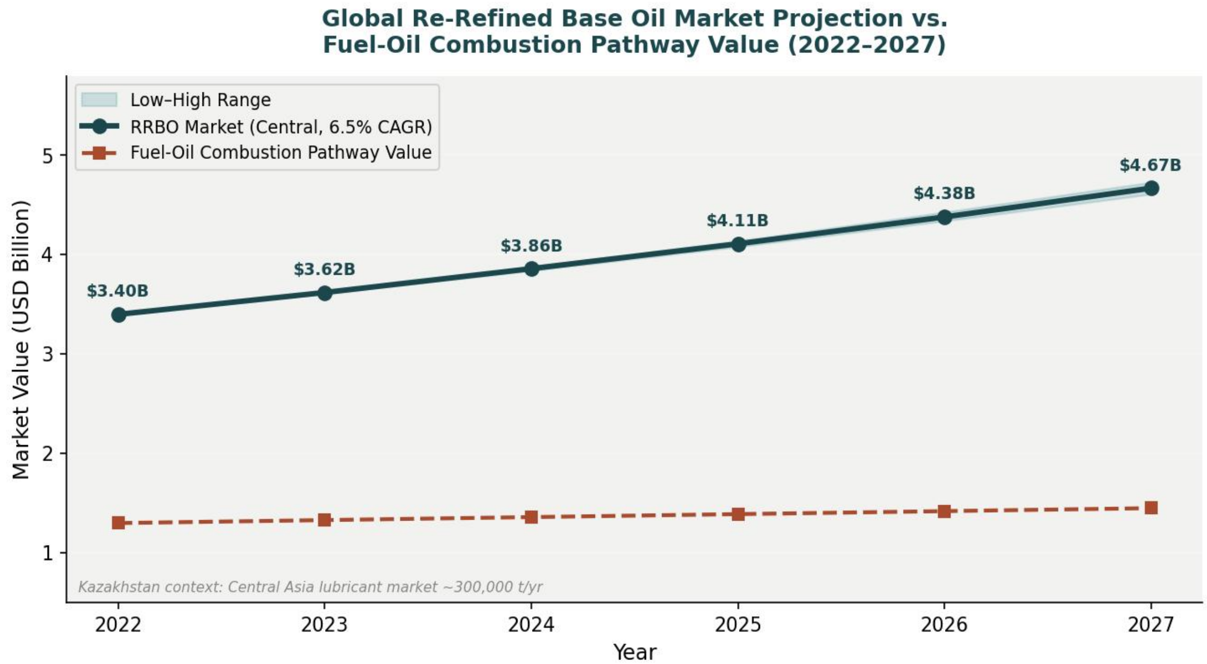

Figure 2: Global RRBO Market Projection vs. Fuel-Oil Combustion Pathway Value, 2022–2027 (CAGR = 6.5%)

2.2 Structural Market Drivers

Several global forces are accelerating RRBO market growth beyond volumetric demand increases — each of which carries direct relevance for Kazakhstan:

- Regulatory tightening: The EU's Waste Framework Directive targets 70–85% regeneration of collected waste oil by 2030, creating precedent-setting policy architecture that Kazakhstan's 2021 Environmental Code has begun to mirror with its waste hierarchy provisions.[3][28]
- Technology upgrading: Modern thin-film distillation combined with hydrotreating now routinely produces Group II base oils, achieving quality levels comparable to virgin crude refining at significantly lower energy cost.[5]
- ESG and carbon reporting: Re-refined oils reduce carbon footprint by 71–81% relative to virgin-origin base stocks, a dimension increasingly valued by Kazakhstan's export-oriented industrial operators facing international sustainability scrutiny.[12][13]
- OEM acceptance: Original equipment manufacturers globally have expanded warranty coverage to include qualified RRBO blends, removing a historically significant barrier to market adoption.[17]
- Circular economy industrial policy: Kazakhstan's Concept on Transition towards Green Economy targets 40% municipal waste recycling and 44% industrial waste recycling by 2024, with used oil explicitly listed as a recyclable industrial waste type.[29]

3. Kazakhstan's Oil Sector and Used Oil Generation

3.1 Three Major Refineries and Associated Used Oil Flows

Kazakhstan's refining sector is anchored by three major facilities: the Atyrau Oil Refinery (5.47 Mt/yr throughput), Pavlodar Oil Chemistry Refinery (5.76 Mt/yr), and the PetroKazakhstan Shymkent plant (6.23 Mt/yr, a joint venture with China National Petroleum Corporation).[31][33] Together these three facilities processed 17.6 million tonnes of crude in 2024, accounting for approximately 97% of national refining capacity.[30] Table 2 summarizes the sector:

Table 2: Kazakhstan Oil Refinery Sector — Key Facilities (2024–2025)

Facility	Location	Crude Throughput (Mt/yr)	Owner	Re-Refining Proximity
Atyrau Oil Refinery	Atyrau	**5.47**	KazMunayGas	Caspian industrial zone
Pavlodar Oil Chemistry Refinery	Pavlodar	**5.76**	KazMunayGas	NE Kazakhstan industrial cluster
PetroKazakhstan Oil Products (Shymkent)	Shymkent	**6.23**	CNPC / KMG JV	Southern corridor, near Almaty
RBN-OIL (Astana)	Astana	Small	Private	Capital region hub
Caspi Bitumen / Condensate	West KZ	~0.3	Various	Near Kashagan field
TOTAL (2024)	—	**17.6**	—	—

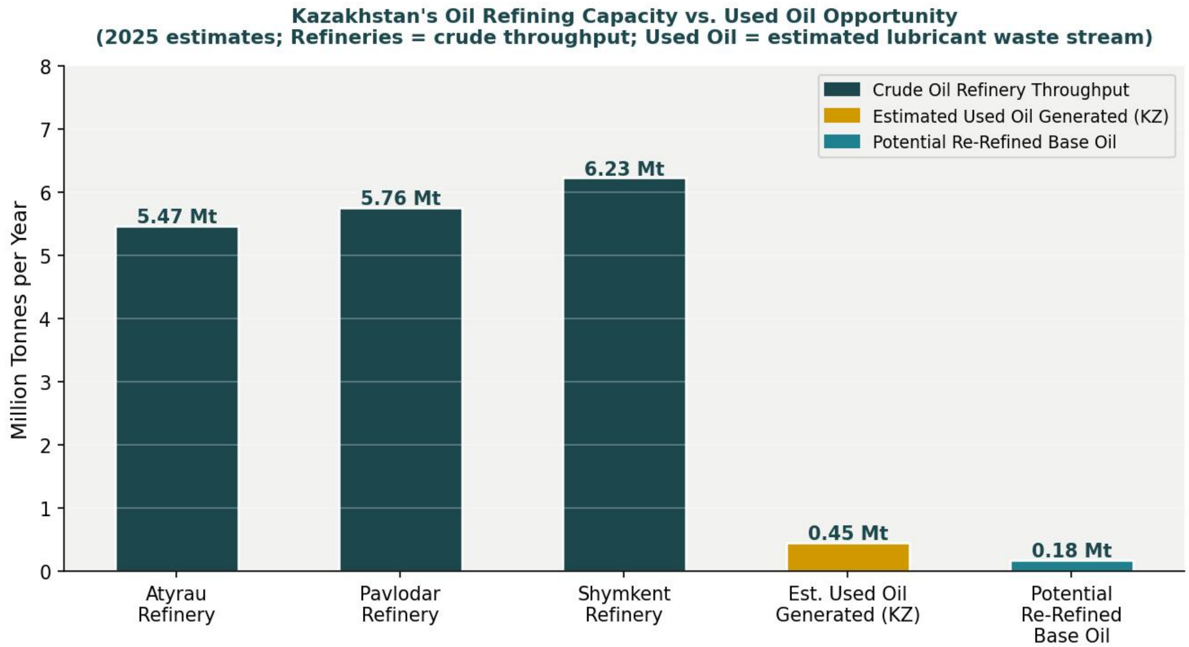

Figure 3: Kazakhstan Refinery Throughput vs. Estimated Used Oil Generation and Re-Refining Opportunity

Each refinery generates its own used oil stream from maintenance, catalyst handling, and lubricant consumption in process equipment. In addition, the major oil fields (Tengiz operated by TengizChevroil, Kashagan by the North Caspian Operating Company, and Karachaganak by KazRosGaz) represent some of the heaviest industrial lubricant consumers in the country, with large fleets of drilling equipment, compressors, pumps, and turbines requiring regular oil changes.[27] The national oil company KazMunayGas (KMG), 100% owner of the Atyrau and Pavlodar refineries, processed 17.6 million tonnes through local refineries in 2024 — a figure that understates the full lubricant consumption of its broader industrial operations.[30]

3.2 Industrial, Mining, and Transport Demand

Beyond the oil sector, Kazakhstan's heavy industry base — including iron ore, copper, zinc, chromium, titanium, and uranium mining across extensive operations — represents a major additional source of used lubricating oil. The Kazakhstan industrial lubricants market is tracked by IndexBox as a distinct and growing segment, with blending operations by Lukoil (100,000 t/yr capacity in Almaty) and Hill Corp. (70,000 t/yr in Shymkent) serving the domestic market primarily with base oils imported from Russian Lukoil refineries in Perm and Volgograd.[25][26]

Kazakhstan's vehicle fleet of approximately 4.5 million units (as of 2020) generates automotive used oil at rates consistent with other CIS markets, approximately 3–4 liters per vehicle per change and 2–4 changes annually — suggesting automotive used oil generation of 27–72 million liters (approximately 24–64 thousand tonnes) per year.[25] Industrial sources dwarf this volume, making used oil management primarily an industrial policy challenge rather than a consumer one.

The formal collection rate for used oil in Kazakhstan is estimated at only 20–30%, significantly below the EU's 40–45% and the U.S.'s approximately 40%. This low collection rate reflects the underdevelopment of collection infrastructure, the absence of mandatory take-back schemes for industrial lubricants, and the economic incentives that have historically favored combustion over re-refining.[28][29] Increasing this rate represents the single largest lever for expanding Kazakhstan's re-refining opportunity.

4. Price Differentials: Base Oil versus Fuel Oil

4.1 The Core Economic Argument

The economic case for re-refining rests on a single fundamental observation: base oil is worth dramatically more than fuel oil per tonne, and used lubricating oil contains recoverable base oil molecules that retain their essential hydrocarbon structure despite contamination. When used oil is burned for energy, this molecular value is permanently destroyed. When it is re-refined, the base oil is recovered and re-enters the market at a price 3–5 times higher than fuel oil.

For Kazakhstan, this price differential is particularly significant because: (i) the country imports most of its Group II and Group III base oils from Russia, meaning domestic re-refining would substitute for expensive imports; (ii) CIS base oil prices, while somewhat lower than European benchmarks, reflect the same fundamental quality premium of Group I/II over fuel oil; and (iii) the transport costs of importing virgin base oil from Russian refineries to Almaty or industrial sites in western Kazakhstan already create a price premium favorable to domestic re-refining economics.[25][26]

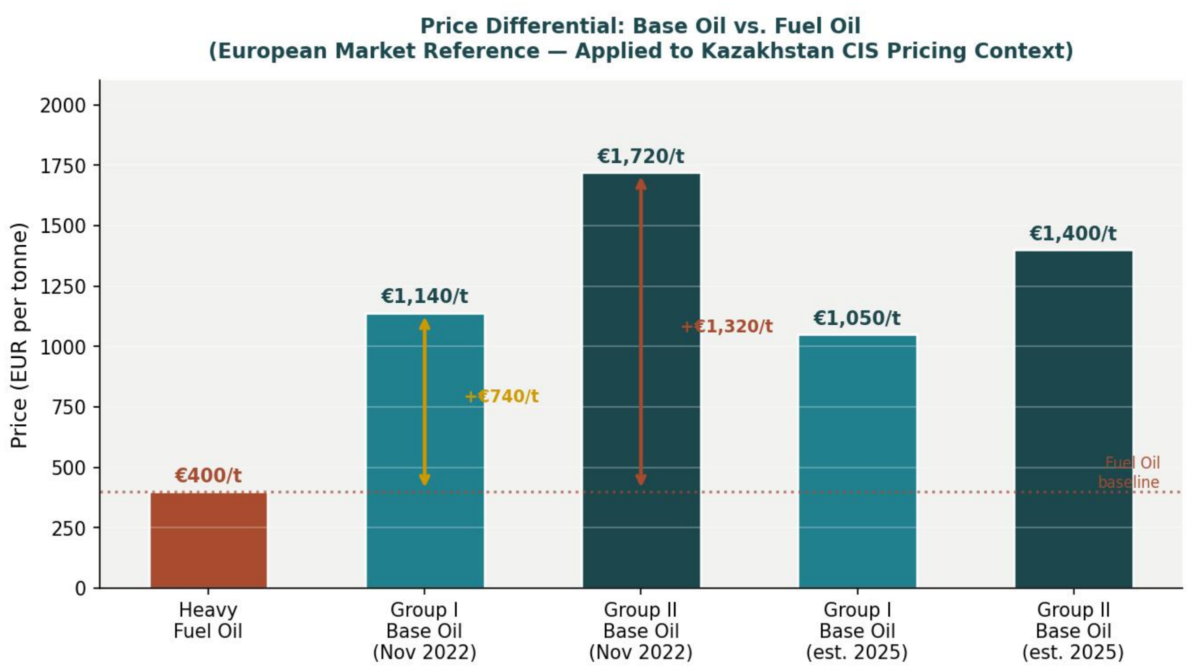

Figure 4: Price Differential — Base Oil Groups vs. Fuel Oil (European Market Reference, 2022–2025)

4.2 Historical Price Series and CIS Market Context

Klenert et al. (2024) document European base oil prices from July 2020 to late 2022 with exceptional granularity: Group I traded between €470 and €1,640 per tonne, Group II and III between €820 and €1,760 per tonne.[3] By late November 2022, Group I stabilized at €1,140/tonne and Group II at €1,720/tonne. CIS and ex-CIS prices for comparable grades typically trade at a 10–20% discount to European benchmarks, implying approximate CIS Group I prices of €912–€1,026/tonne and Group II prices of €1,376–€1,548/tonne at November 2022 market conditions.

Heavy fuel oil in the CIS region during the same period traded at approximately €250–€400/tonne, reflecting crude oil price dynamics discounted for sulfur content and processing. The IMO 2020 sulfur regulations reduced high-sulfur fuel oil (HSFO) prices dramatically, creating a temporary narrowing of the spread before scrubber adoption normalized the market.[16] The heavy fuel oil market is projected to grow at only 2.17% CAGR through 2030 — reflecting structural headwinds from decarbonization, IMO regulations, and RRBO displacement.[16]

Table 3: Full Economic Comparison — Re-Refining vs. Fuel-Oil Combustion (Kazakhstan Context)

Parameter	Re-Refining Pathway	Fuel-Oil Combustion Pathway
Product Value (EUR/t, CIS 2022)	€1,140–€1,720 (base oil Group I–II)	~€300–€450 (heavy fuel oil)
Revenue Uplift per tonne	+€700–€1,270 over fuel oil	Baseline
Energy in Processing	~50% less than virgin crude refining	Low (direct combustion)
GHG Emissions vs Virgin Oil	−71% to −81% CO_2 [12][13]	Equivalent to virgin + heavy metal risk
EU Societal NPV (2024–2045)	€330M (85% regen target) [3]	Zero — status quo baseline
Employment per 1,000 t diverted	+0.783 FTEs [3]	Minimal
Kazakhstan alignment	Green Economy targets, Env. Code 2021, EPR [27][28]	Below waste hierarchy; banned from landfill since 2016 [28]

The societal cost differential is captured most rigorously by Klenert et al. (2024), who compute a net saving of approximately €55.8 per tonne of waste oil processed when regeneration replaces combustion, yielding a societal NPV of €330 million over 2024–2045 for the EU's 85% regeneration target scenario.[3]

Applied proportionally to Kazakhstan's estimated 150,000-tonne used oil stream at even a 50% re-refining capture rate, this implies an annual societal economic benefit of approximately $4–6 million at Kazakhstan scale — before considering the additional import substitution value of domestic base oil production.

5. The $332M / €330M International Benchmark — Kazakhstan Relevance

5.1 Origins of the $332M / €330M Reference Figures

The $332M / €330M reference derives from two independent sources that happen to converge on the same order of magnitude (a coincidence of scale rather than a single computed figure). First, the U.S. Department of Energy (2020) documents that U.S. used oil processor sub-category facilities had a total installed capacity of approximately 332 MMG (million gallons) per year, operating at 77% utilization (approximately 254 MMG/year).[4] At U.S. base oil prices of $0.75–$1.00 per gallon for Group I/II product, this 332 MMG capacity base represents approximately $249–$332 million in annual processing revenue at full utilization.[4]

Second, and independently, the EU policy analysis by Klenert et al. (2024) derives a societal net present value of €330 million for the EU's 85% regeneration target over 2024–2045 — a near-exact numerical coincidence from a wholly different methodology applied to a different market.[3] The annual subsidy equivalent required to make this target viable for EU regenerators is estimated at €113–€341 million per year, further reinforcing the order of magnitude.[3]

5.2 EU €330M NPV — Transferability to Kazakhstan

For Kazakhstan, the $332M / €330M figures serve as an international calibration benchmark for the economic scale of used oil management policy. Kazakhstan's used oil stream (~120,000–170,000 t/yr estimated) represents approximately 7.5% of the EU's collectible waste oil base (~2 million t/yr).[3] Applying the EU's societal cost differential of €55.8/tonne proportionally to Kazakhstan's potential re-refining stream (assuming 50% capture at 150,000 t/yr = 75,000 t) yields an annual societal benefit of approximately €4.2 million — a conservative figure that excludes import substitution value and the employment multiplier effect.[3]

The employment dimension is particularly relevant: Klenert et al. (2024) compute 0.783 additional full-time equivalent (FTE) jobs per 1,000 tonnes of used oil diverted from combustion to re-refining.[3]

For Kazakhstan, diverting 75,000 tonnes per year would generate approximately 59 additional FTEs in formal, technically skilled employment — consistent with Kazakhstan's Green Economy priorities and industrial workforce development objectives.[28][29]

Government incentive programs in comparable contexts support the $332M scale of intervention: California's SB 546 established per-gallon re-refiner incentives funded by lubricant producer levies; Australia operates subsidy mechanisms estimated at AUD 1 million/year (scaled to its market ~20x smaller than the EU's); and the EU's modeled levy-subsidy mechanism (€5.0–€31.0/tonne for the 70% target) represents a fiscally manageable policy instrument.[3][4][11] Kazakhstan could design an analogous mechanism financed by a levy on lubricant importers and blenders — consistent with the Extended Producer Responsibility (EPR) provisions now codified in the 2021 Environmental Code.[28][32]

6. Re-Refining Technology Economics

6.1 Technology Overview and Capital Requirements for Kazakhstan

Modern re-refining spans a spectrum of technologies with distinct capital requirements, product quality outputs, and environmental profiles. The choice of technology for Kazakhstan must account for the country's feedstock quality (dominated by heavy industrial oils with potentially high metal content from mining and drilling operations), the availability of skilled technical labor, and the proximity to infrastructure (particularly hydrogen supply for hydrotreating).[5] Table 4 presents the technology comparison with explicit Kazakhstan suitability assessments:

Table 4: Re-Refining Technology Comparison — Economic and Kazakhstan Suitability Assessment

Technology	Yield	Oil Quality	CapEx	Capacity (kt/y)	KZ Suitability
Acid/Clay Treatment	63%	Group I (lower)	Low	2–10	Entry-level; manageable in smaller cities
Vacuum Distillation	50%	Group I	Moderate	25	Viable at Pavlodar scale
Solvent Deasphalting	65–70%	Group I	High	25	Suitable near Atyrau refineries
TFE + Hydro-Finishing	72%	Group II	High	50–80	Optimal for Shymkent/Almaty hub
Solvent Extraction + HF	74%	Group II	High	60	Suitable for CIS export quality
TDA (Thin-Film + HF)	74%	Group II	High	100–180	National-scale flagship facility
Ecohuile/Sotulub Process	82–92%	Group II	High	Varies	Best environmental profile; EU-proven

For Kazakhstan, a two-phase technology deployment strategy is recommended: Phase 1 (near-term, 2026–2029) would deploy acid/clay or vacuum distillation technology at Shymkent or Almaty, processing 10,000–25,000 t/yr of urban-collected used automotive oil. Phase 2 (medium-term, 2029–2035) would upgrade to thin-film distillation with hydrotreating at an industrial cluster linked to one of the three major refineries, targeting Group II production at 50,000–100,000 t/yr scale.

This phased approach mirrors the development trajectory of re-refining in Central European markets and manages the capital risk profile appropriately.[5][6]

6.2 Operating Cost Structure and Kazakhstan-Specific Factors

Direct manufacturing costs for used oil re-refining to base stocks in established U.S. operations range from $0.75 to $1.00 per gallon ($198–$264 per tonne), providing a reference for Kazakhstan cost modeling.[4] Investment in a modern re-refining plant requires approximately $2–$3 per gallon of annual capacity; the Avista Oil grassroots U.S. plant (2013) cost $95 million for approximately 47.5 million gallons per year capacity.[4] Scaling to a 50,000 t/yr (approximately 13.2 million gallon/yr) Kazakhstani facility implies a capital investment of approximately $26–$40 million — well within the range of KazMunayGas subsidiary investment programs or international private equity partnerships.

Kazakhstan-specific cost advantages include: (i) lower labor costs than European comparators; (ii) proximity to hydrogen supply from refinery operations (critical for hydrotreating); (iii) existing pipeline and storage infrastructure at refinery sites; and (iv) significant import substitution value — currently, both Lukoil (Almaty, 100,000 t/yr blending) and Hill Corp (Shymkent, 70,000 t/yr blending) import base oils from Russia, representing a captive domestic demand base for a Kazakhstani re-refiner.[25][26] The import substitution premium effectively adds 10–20% to the achievable base oil price for a domestic re-refiner relative to the cost-insurance-freight (CIF) import price.

The resource efficiency argument is compelling in the Kazakhstani context: 42 gallons of crude oil are required to produce 2.5 quarts of lubricating base oil from virgin refining, versus only 1 gallon of used motor oil through re-refining.[4] For a country seeking to maximize the domestic value of its hydrocarbon resources, re-refining represents a "second extraction" of value already embedded in the lubricant molecules — without the upstream costs of crude production.

7. Life Cycle Assessment and Environmental Externalities

7.1 Greenhouse Gas Emissions — Global Evidence

Life cycle assessment studies consistently demonstrate the greenhouse gas advantage of re-refining over combustion. Grice et al. (cited in U.S. DOE, 2020) find that the carbon footprint of re-refining is 81% lower than production of fresh virgin oil from base stocks.[4] GEIR (Group of European Used Oil Regenerators) independently calculates CO_2 emission reductions of up to 71% for re-refined versus virgin-origin base stocks.[12] At the policy scale, Klenert et al. (2024) project that increasing EU regeneration from 61% to 85% would avoid 1.7 million tonnes of CO_2-equivalent over 2024–2045.[3]

For Kazakhstan, which has committed to carbon emissions reduction targets under its nationally determined contribution (NDC) to the Paris Agreement, the GHG advantage of re-refining is not merely an environmental benefit but a carbon credit asset. Kazakhstan launched its emissions trading system (ETS) in 2013, and the growing value of carbon credits makes the GHG savings from re-refining increasingly monetizable within the domestic carbon market framework.[28]

7.2 Combustion Pathway Environmental Risks in Kazakhstan

The environmental risks of fuel-oil combustion are amplified in the Kazakhstani context by the specific character of the used oil stream. Oil generated from Kazakhstan's mining and metallurgical sectors may contain elevated concentrations of heavy metals — lead, zinc, chromium, cadmium, and in some cases radioactive tracer materials used in oilfield operations.[27] Combustion of this material in industrial boilers or cement kilns without prior demetallation generates metallic oxide emissions, sulfur oxides, nitrogen oxides, and potentially dioxins and furans — contaminants subject to increasingly stringent regulation under the 2021 Environmental Code and BAT (Best Available Techniques) requirements.[28][32]

The LCA analysis of Serbian waste lubrication oil management (Duđak et al., 2021) — a post-Soviet industrial economy with structural similarities to Kazakhstan — found that re-refining performed best for fossil fuel savings due to marketable co-products displacing virgin production, while combustion created the most problematic human health toxicity profile.[6] Silva et al. (2022), analyzing re-refining versus cement plant combustion in Brazil, found significant advantages for re-refining across circularity indicators.[8] Both findings are directly transferable to the Kazakhstani industrial context.

Kazakhstan's Environmental Code (2021) explicitly designates used oil as hazardous waste requiring licensed management, with strict requirements for hazardous waste passports, transportation, and treatment.[28] The combustion of improperly characterized used oil (e.g., containing PCBs or excessive halogen content) can trigger hazardous waste incineration regulations with associated compliance costs estimated at minimum $3.50 per gallon for contaminated material under U.S. analogues — costs that erode the apparent simplicity of the combustion pathway.[4]

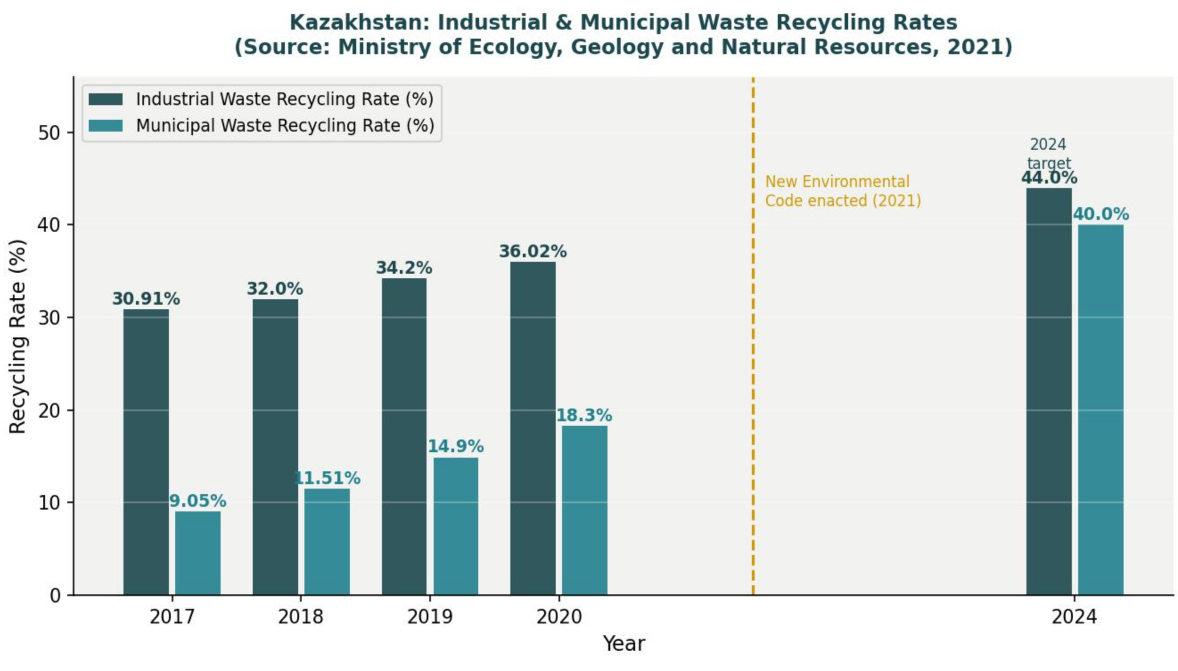

Figure 5: Kazakhstan Industrial and Municipal Waste Recycling Rates (2017–2024 Target) (Source: Ministry of Ecology, Geology and Natural Resources, 2021 [29])

8. Kazakhstan's Regulatory and Policy Framework

8.1 Environmental Code of the Republic of Kazakhstan (2021)

The Environmental Code of the Republic of Kazakhstan (Law No. 400-VI ZRK, enacted January 2, 2021) represents the most comprehensive revision of Kazakhstan's environmental law in the post-independence era.[28] It introduces the waste hierarchy principle (consistent with the EU Waste Framework Directive), mandating priority for waste prevention, reuse, recycling/regeneration, energy recovery, and disposal — in that order. Used oils explicitly appear in the hierarchy: since 2016, their disposal through burial (landfill) has been prohibited; since 2021, the new Code reinforces this with hazardous waste management requirements.[28][29]

Key provisions of the 2021 Environmental Code directly relevant to used oil re-refining include: (i) Article 329, establishing the waste management hierarchy with material recovery preferred over energy recovery; (ii) Articles 341 and 342, providing incentives for waste reduction and imposing hazardous waste classification on used oils; (iii) Article 332, introducing Extended Producer Responsibility (EPR) for oil and oil products (excluding crude oil); and (iv) Articles 344–347, establishing environmental requirements for hazardous waste management, transportation, and record-keeping.[28]

The Chambers & Partners Kazakhstan Environmental Law 2025 analysis confirms that oil and oil products (excluding crude oil) are included in Kazakhstan's EPR framework, requiring producers and importers to fund and manage the collection and recycling of their products.[32] This EPR mechanism — analogous to those operating in the EU and California — creates the legislative foundation for a levy-and-subsidy mechanism that could finance the transition from combustion to re-refining.

8.2 Extended Producer Responsibility and the Used Oil Collection Gap

Kazakhstan's EPR system for oil products is still in early implementation. The full list of goods subject to EPR obligations includes land transport vehicles, rubber products, electric accumulators, oil and oil products, antifreezes, and chemical products.[32] In 2020, under the existing producer responsibility mechanisms, 44,183 vehicles (35.8 thousand tonnes) and 25,909 tonnes of automotive component waste were collected and recycled — but used lubricating oil from vehicles and industry was not systematically tracked in the published data.[29]

The formal used oil collection rate of 20–30% implies that 70–80% of Kazakhstan's used oil is either informally combusted, illegally dumped, or lost. The UNECE presentation by Kazakhstan Waste Management Association (KazWaste, 2021) confirms that while "oily waste, waste oil, batteries, tires, etc." are recognized as recyclable industrial waste types, the practical collection and treatment infrastructure remains inadequate.[29] Developing the used oil collection infrastructure — through mandatory collection points at service stations, lubricant retailer take-back requirements, and industrial waste oil manifesting systems — is the precondition for any re-refining investment to secure feedstock at commercial scale.

8.3 Green Economy Transition and National Targets

Kazakhstan's Concept on Transition towards Green Economy establishes binding targets of 40% municipal waste recycling and 100% population coverage for waste collection and disposal by 2030.[29] The Strategic Plan of the Ministry of Ecology, Geology and Natural Resources targets 44% industrial waste recycling by 2024.[29] Progress against the industrial waste target is documented in Figure 5: industrial waste recycling rose from 30.91% in 2017 to 36.02% in 2020, on track toward the 44% target.

Used oil re-refining can contribute directly to these targets: every tonne of used oil re-refined rather than combusted counts as recycled industrial waste, improving Kazakhstan's reported recycling rate and progressing toward the 44% and ultimately higher national targets. At 120,000–170,000 t/yr of used oil and an assumed 50% re-refining capture rate, this would add approximately 60,000–90,000 tonnes to the formally recycled industrial waste total — a meaningful contribution given Kazakhstan's stated priority of making the waste management sector a priority area of the economy.[29]

9. Projecting the Economic Impact of 6.5% CAGR Growth Through 2027

9.1 Global Market Size Projection

With a base RRBO market value of approximately USD 3.40 billion in 2022 and a CAGR of 6.26–6.82%, the global market is projected to reach USD 5.5–5.7 billion by 2027. Table 5 presents year-by-year projections under low, central (6.5%), and high scenarios, with an estimated Kazakhstan market share column and a cumulative value-add calculation:

Table 5: RRBO Market Size Projections 2022–2027 (USD Billion) with Kazakhstan Estimates

Year	Low 6.26% (USD B)	Central 6.5% (USD B)	High 6.82% (USD B)	KZ Market Est. (USD M)	Δ vs Fuel-Oil (USD B)	Cum. Value-Add (USD B)
2022	3.40	3.40	3.40	~85	~2.10	—
2023	3.61	3.62	3.63	~89	~2.24	2.24
2024	3.84	3.86	3.88	~93	~2.38	4.62
2025	4.08	4.11	4.14	~97	~2.54	7.16
2026	4.34	4.38	4.43	~100	~2.71	9.87
2027	4.61	4.67	4.73	~105	~2.88	12.75

The Kazakhstan market estimate in Table 5 is derived from the country's approximate 1.5% share of the Central Asian lubricant market and applies a re-refining market penetration assumption growing from approximately 1–2% of lubricant consumption currently to 4–5% by 2027, consistent with the pace of market development in other emerging CIS economies. The cumulative 2023–2027 global value-add of approximately USD 12.75 billion — the economic premium of re-refining over combustion — illustrates the macro-scale opportunity for Kazakhstan to participate.

9.2 Kazakhstan-Specific Economic Impact

For Kazakhstan specifically, the economic impact of CAGR-driven re-refining market development can be modeled through three channels. First, import substitution value: Kazakhstan currently imports Group II and Group III base oils from Lukoil's Russian refineries at CIF prices estimated at USD 900–1,300/tonne; domestic re-refining at competitive cost could substitute a significant share of these imports, capturing this margin domestically.[25][26] At 50,000 tonnes/year of domestic re-refined output (a Phase 1 target), import substitution value at a $500/tonne discount to import prices would generate approximately $25 million in annual economic value retained within Kazakhstan.

Second, direct revenue from re-refined product sales: 50,000 tonnes of Group II re-refined base oil at CIS market prices (~$800–$1,100/tonne) generates $40–$55 million in annual revenues. After processing costs of approximately $198–$264/tonne, the gross margin is approximately $536–$836/tonne — significantly superior to the $250–$400/tonne achievable from directing the same material to fuel-oil combustion.

Third, the environmental externality value: avoided GHG emissions from re-refining (81% lower than virgin production) and avoided heavy metal combustion emissions generate real economic savings in terms of reduced environmental compliance costs, carbon credit value, and reduced healthcare externalities from air quality improvement.[4][12] At Kazakhstan's current carbon market price and the projected expansion of the ETS scope, this environmental value will become increasingly material in investment justifications.

10. Regional Context: Central Asia and CIS Comparisons

10.1 Central Asia Market Context

Kazakhstan's position within Central Asia is distinctive: it is the region's largest economy, largest lubricant consumer, and host to the region's most sophisticated refining infrastructure. The Central Asian lubricant market consumed approximately 300,000 tonnes in 2021 (Uzbekistan ~125,000 t, Kazakhstan the largest remaining share, with Turkmenistan, Tajikistan, and Kyrgyzstan accounting for the balance).[25] No dedicated Group I or Group II re-refining facility currently operates in Kazakhstan; the Uzbek Fergana refinery operates a 500,000 t/yr Group I base oil plant (from virgin crude), and Turkmenbashi operates 80,000 t/yr Group I and 70,700 t/yr Group II from virgin crude.[25]

This regional gap means that a Kazakhstani re-refining facility, if developed, would have the potential to supply not only the domestic blending operations of Lukoil-Almaty and Hill Corp, but also export to neighboring markets. Uzbekistan's growing lubricant market (projected 125,000+ t/yr and growing) currently relies heavily on Russian imports, creating an export opportunity for a Kazakhstani re-refiner operating at Group II quality.[25] The geographic centrality of Almaty relative to both the Fergana valley markets and the Chinese border further strengthens the regional export logic.

10.2 CIS Base Oil Trade Flows and Import Substitution

The dominant pattern of base oil trade in Central Asia involves Russian Lukoil refineries (Perm and Volgograd) supplying both their own blending operations in Kazakhstan and third-party lubricant blenders.[25] This trade flow exposes Kazakhstan's lubricant supply chain to Russian supply disruptions, export tariff changes, and currency volatility — risks that the geopolitical events of 2022 onward have made tangible. A domestic re-refining industry would substantially de-risk this dependence.

China's growing role in Kazakhstan's energy sector — through the 50/50 Shymkent refinery joint venture with CNPC and the Kazakhstan-China oil pipeline — creates another dimension of the import substitution argument. Chinese lubricant specifications have evolved rapidly toward Group II and Group III standards, and a Kazakhstani re-refiner meeting these specifications could serve both domestic and potentially Chinese-market-oriented customers through existing trade channels.[27][33]

Li et al. (2019) document China's own "green refining" of waste lubricating oil, demonstrating that regulatory-driven formalization of the re-refining sector in China has expanded significantly.[23] Kazakhstan, sitting at the intersection of Russian and Chinese lubricant trade routes, is exceptionally well positioned to develop a re-refining sector that serves both markets — provided that domestic regulatory and financial incentive structures are designed appropriately.

11. Conclusions and Strategic Recommendations for Kazakhstan

11.1 Summary of Findings

This paper has demonstrated that re-refining of used lubricating oil is economically superior to fuel-oil combustion across all the dimensions examined — and that Kazakhstan is uniquely positioned to capitalize on this economic opportunity given its large and growing used oil stream, existing refinery infrastructure, regulatory framework, and regional market position. The core findings are:

- Price differential: Group I re-refined base oil commands approximately €700–€800/tonne more than heavy fuel oil in CIS-adjacent markets; Group II product commands €1,000–€1,300/tonne more. These spreads imply a gross margin uplift of USD 84–228 million annually at the scale of Kazakhstan's potential full-capture used oil stream.
- Market growth: The global RRBO market is growing at 6.26–6.82% CAGR — more than three times the heavy fuel oil market growth rate — reaching USD 5.5–5.7 billion by 2027. Kazakhstan's domestic market share is estimated to grow from ~USD 85 million (2022) to ~USD 105 million (2027) as collection and re-refining infrastructure develops.[1][2]
- The $332M / €330M benchmark: Both figures — one from U.S. capacity data, one from EU societal NPV modeling — represent approximately the same order of magnitude of annual economic incentive for prioritizing re-refining over combustion, calibrated to markets substantially larger than Kazakhstan's but providing transferable policy design templates.[3][4]
- Resource efficiency: Re-refining uses 42x less crude oil equivalent input and 50% less energy to produce equivalent lubricant-grade base oil, reducing GHG emissions by 71–81% relative to virgin production.[4][12]
- Regulatory alignment: Kazakhstan's 2021 Environmental Code explicitly places material recovery (re-refining) above energy recovery (combustion) in the waste hierarchy, and the EPR framework for oil products creates the legislative foundation for incentive mechanisms.[28][32]
- Import substitution: Kazakhstan currently imports all Group II/III base oils from Russian Lukoil refineries. Domestic re-refining would retain an estimated $25–55 million annually in economic value currently exported through import payments.[25][26]

11.2 Strategic Recommendations for Kazakhstan

Based on this analysis, the following strategic recommendations are offered to the Government of Kazakhstan, KazMunayGas, domestic lubricant industry participants, and international investors:

For the Government of Kazakhstan (Ministry of Energy and Ministry of Ecology):

- Operationalize the EPR framework for oil products by establishing mandatory used oil collection targets for lubricant producers and importers, financed by a modest levy (modeled on the EU's €0.6–€4.6/tonne of virgin base oil — fiscally negligible while generating meaningful subsidy capacity).[3][32]
- Introduce a re-refining production incentive — a per-tonne subsidy for Group I/II re-refined base oil certified to applicable quality standards — funded by the EPR levy and calibrated to close the gap between current combustion-pathway returns and re-refining capital recovery requirements.
- Mandate used oil collection points at all retail lubricant outlets (service stations, auto parts retailers) and industrial lubricant distribution points — consistent with the Environmental Code's extended producer responsibility provisions and Kazakhstan's international waste management commitments.[28]
- Set formal used oil collection rate targets of 50% by 2028 and 70% by 2032, incorporated into the Kazakhstan Green Economy Concept's industrial waste recycling targets.[29]

For KazMunayGas and Refinery Operators:

- Evaluate integration of a used oil re-refining unit at Pavlodar or Shymkent refineries, leveraging existing hydrogen supply infrastructure, skilled technical workforce, and storage logistics. The $26–$40 million capital cost for a 50,000 t/yr Group II facility is within standard KMG subsidiary investment parameters.[4][25]
- Develop a closed-loop oil management program for KazMunayGas's own operations at Tengiz, Kashagan, and Karachaganak field sites — collecting and re-refining used drilling and process oils that currently flow to combustion. This would provide captive feedstock while demonstrating environmental leadership.[30]

For Private Sector and International Investors:

- Pioneer a commercial re-refining facility in the Almaty or Shymkent free economic zone, targeting the Lukoil-Almaty and Hill Corp blending operations as anchor customers for Group II RRBO. The import substitution economics are compelling even without government incentives.[25][26]
- Partner with European re-refining technology providers (Avista, Puraglobe, Ecohuile/Sotulub system licensors) to access proven Group II hydrotreating technology under licensing arrangements that accelerate time-to-market.[5]
- Develop digital traceability systems for used oil collection — consistent with global ESG reporting trends — that can validate the Kazakhstan re-refining chain for international customers seeking certified circular lubricant supply chains.[17]

Concluding Remarks:

Kazakhstan stands at an inflection point in its used oil management trajectory. The country's hydrocarbon wealth, industrial scale, and regulatory modernization have created the preconditions for a world-class re-refining sector. The economics are unambiguous: a €700–€1,300/tonne price premium for re-refined base oil over fuel oil, a 6.5% global CAGR market growth trajectory, $25–55 million in annual import substitution value, and a regulatory hierarchy that mandates material recovery over combustion.[1][2][3][28] The $332M / €330M international reference — whether interpreted through U.S. capacity data or EU societal NPV analysis — illustrates the order of magnitude of economic value at stake in mature markets, while Kazakhstan's own analysis above indicates a societal benefit on the order of $4–6 million per year plus $25–55 million in import-substitution value that it can systematically capture by redirecting its used oil stream from boilers and cement kilns to re-refining facilities.

The transition will require coordinated action: regulatory instruments to price combustion's true cost and subsidize re-refining's true value, collection infrastructure investment to raise the formal capture rate from 20–30% to 50–70%, and technology partnerships to deploy Group II production capability. The global market will not wait — with RRBO growing at 6.5% annually and international buyers increasingly demanding certified circular lubricants, Kazakhstan's window to establish itself as a Central Asian re-refining hub is open now. The opportunity cost of inaction — measured in permanently destroyed base oil value, foregone import substitution, and missed carbon credit revenues — grows larger every year.

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