

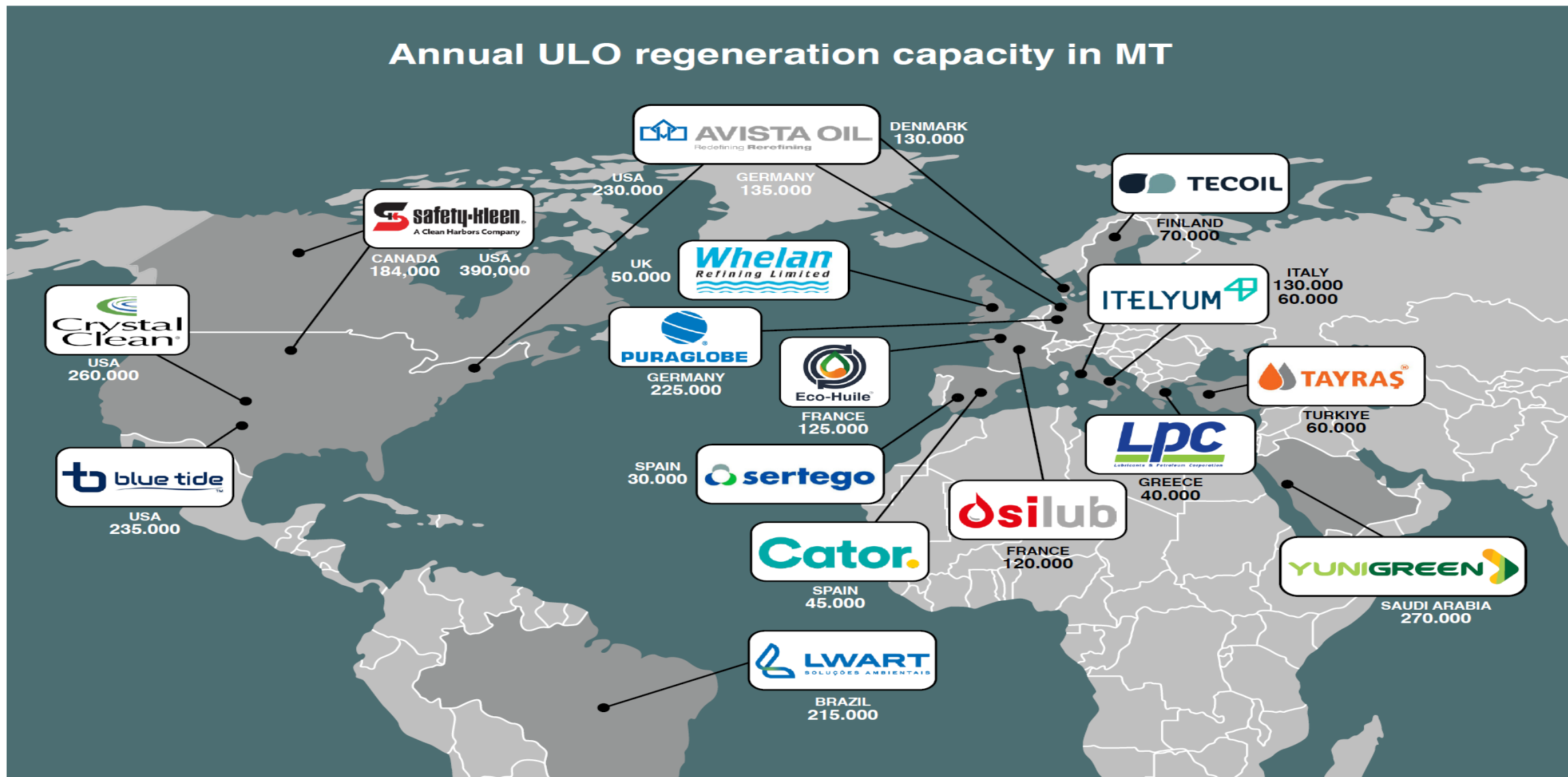


ADVANCING THE APPLICATION OF RE-REFINED BASE OILS

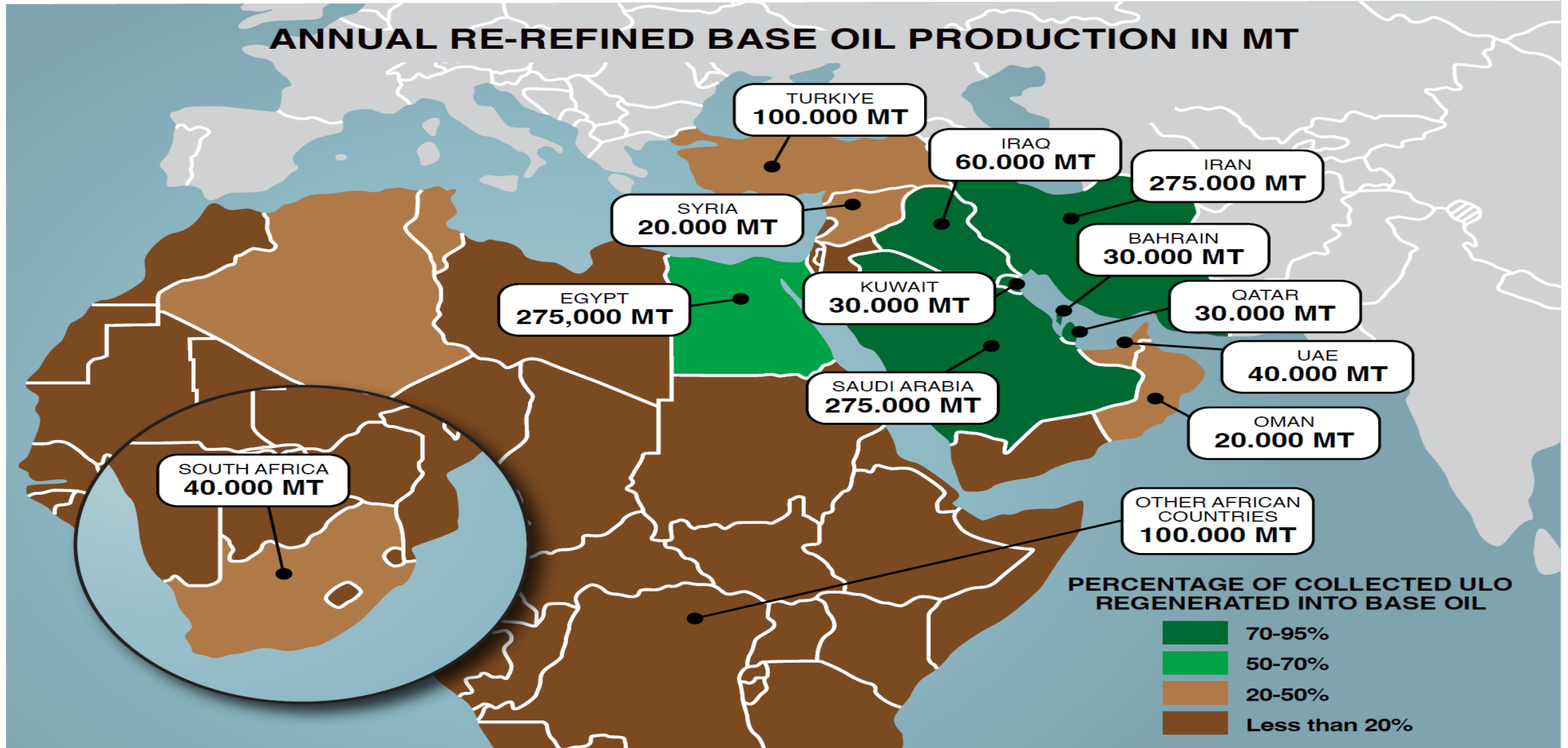
Presented By: **Antwan Osta**, Managing Director-CEO, Yanbu United Company (YUNIGREEN)



Major Re-Refined Base Oil Producers in the world



► Collected Oil Is Re-Refined Or Recycled Into Base Oil:



Product Carbon Footprint (PCF) Of RRBO

ifeu Study Of The Life Cycle Assessment For Regeneration of Waste Oil To Base Oil:

According to GEIR / ifeu 2022 LCA report LCA for regeneration of waste oil to base oil, The Greenhouse Gas (GHG) emissions for re-refining used lubricating oil are:

- **Average** burden (direct CO₂ emissions = 454 kg CO₂ per ton of waste oil processed (Range from 216 – 779 kg CO₂ –eq/t depending on technology).
- **Comparing** to virgin base oil production Group I, typically emits 1,200-1700 kg CO₂-eq per ton of base oil.
- **Re-refining** emits only 400 – 500 kg CO₂-eq per ton, reducing life cycle GHG emissions by about 60-75%.

Process	CO ₂ Emissions (kg CO ₂ -eq / t oil)	Relative Impact
Virgin Base Oil (Group I)	1,270 - 1,570	100%
Re-refining (Average)	450 +/- 200	25 - 35%
Net Saving	800 - 1,100 kg CO ₂ -eq / t oil	65 - 75% Lower


INSTITUT FÜR ENERGIE-
UND UMWELTFORSCHUNG
HEIDELBERG

Updated LCA for regeneration of waste oil to base oil – Final Report

Nabil Abdalla, Horst Fehrenbach, Stefanie Theis
Heidelberg, 27. July 2022



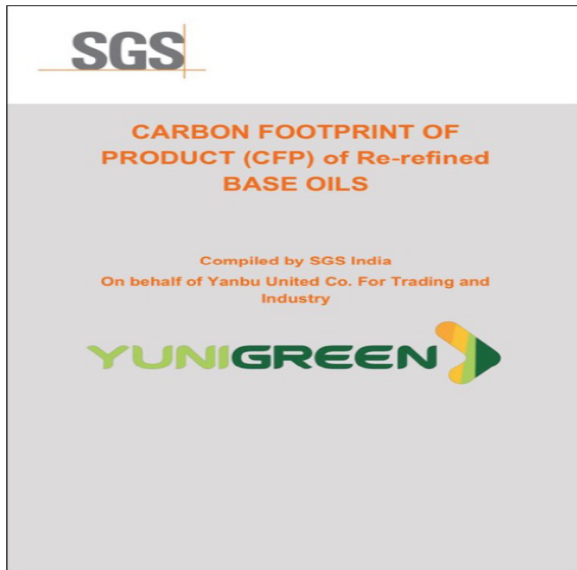
ifeu Wilckenstraße 3 D - 69120 Heidelberg Telephone +49 (0)6 221. 47 67 - 0 Fax +49 (0)6 221. 47 67 - 19 E-Mail ifeu@ifeu.de www.ifeu.de

Product Carbon Footprint (PCF) Of RRBO

Yanbu United Company Study:

According to SGS study Carbon Footprint Of Product Of Re-refined Base Oil Produced in Yanbu United Company:

- **Every one ton** of re-refined base oil produced at YUNIGREEN emits about 0.45 – 0.5 t CO₂–eq / t Base Oil
- **SN 150** emits 0.46 CO₂–eq / t Base Oil
- **SN 300** emits 0.49 CO₂–eq / t Base Oil



Used Lubricating Oil Collection

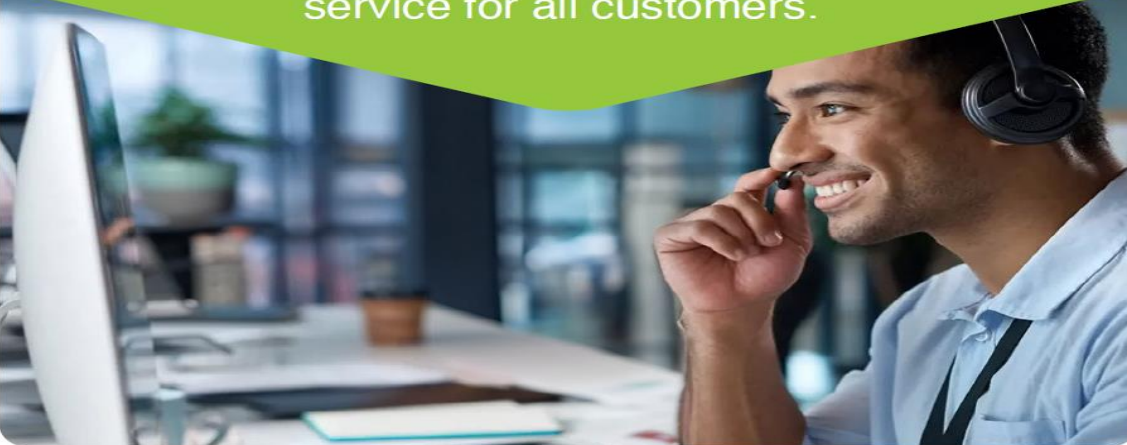
1. State-of-the-Art Oil Collection Sites

YUNIGREEN oil collection sites are developed in full compliance with international standards and local regulations, applying best practices and proven expertise. Each site is equipped with modern laboratories to ensure quality, safety, and environmental excellence at every stage of operation.



3. Dedicated Customer Service

YUNIGREEN specialized customer service team is ready to handle client calls, process oil collection requests, and manage contracts efficiently, delivering fast, reliable, and seamless service for all customers.



2. Smart Applications for Efficient Management

YUNIGREEN provides innovative smart applications to receive collection requests, digitally document transactions, and manage operations seamlessly, ensuring efficiency, transparency, and reliability throughout the process.



Used Lubricating Oil Quality In The GCC 2012-2026

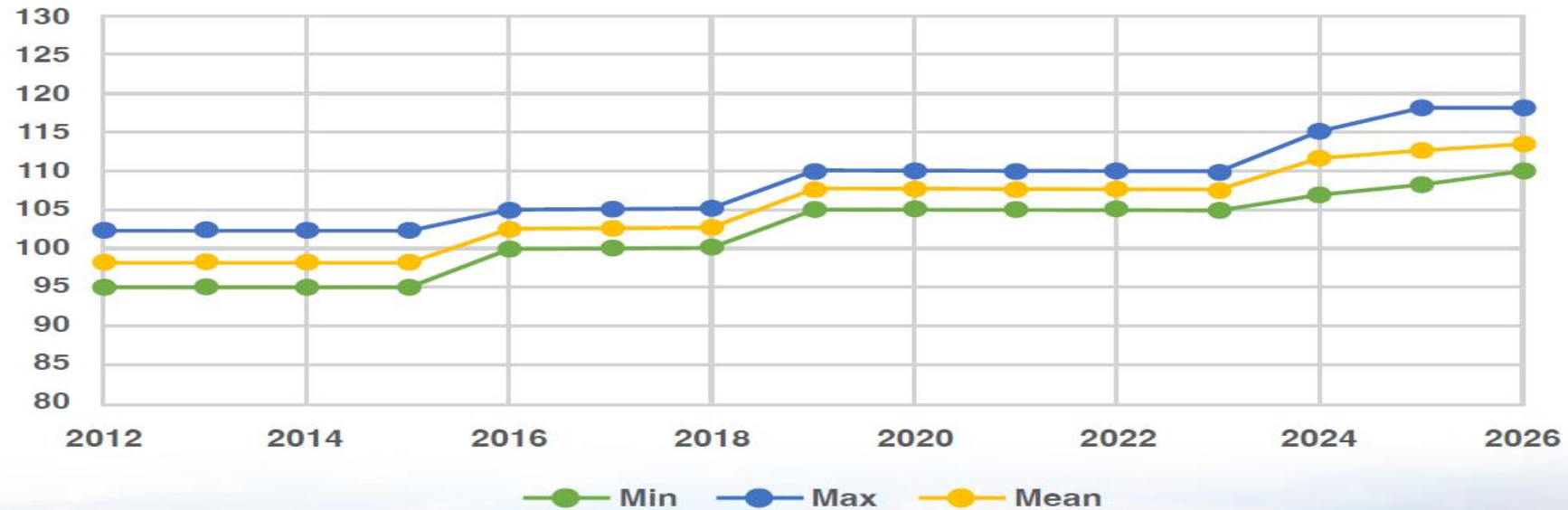
Used Lubricating Oil Density @-15c In The GCC
(ASTM D-1298)





Re-Refined Base Oil Quality In Saudi Arabia 2012-2026

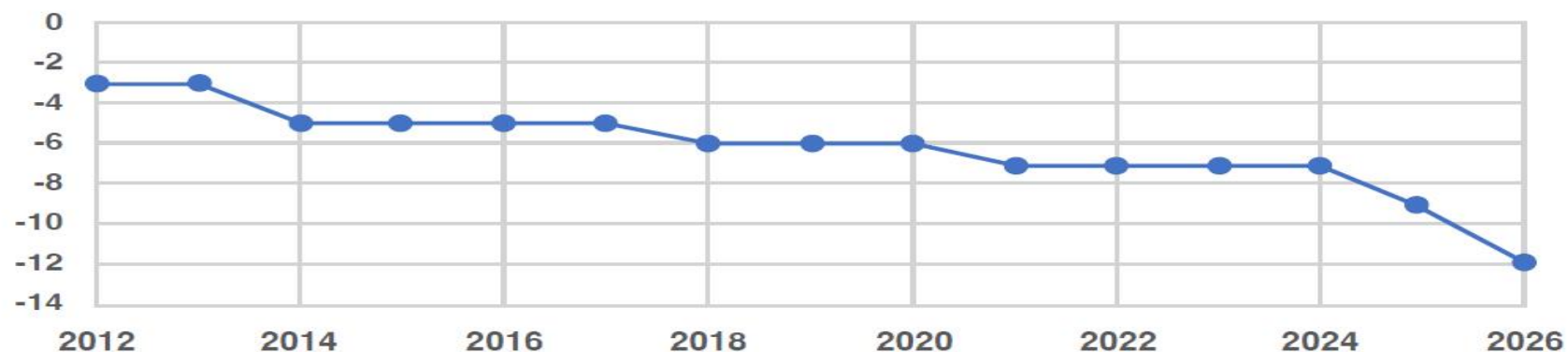
Viscosity Index Of RRBO In KSA
(ASTM D-2270)





Re-Refined Base Oil Quality In Saudi Arabia 2012-2026

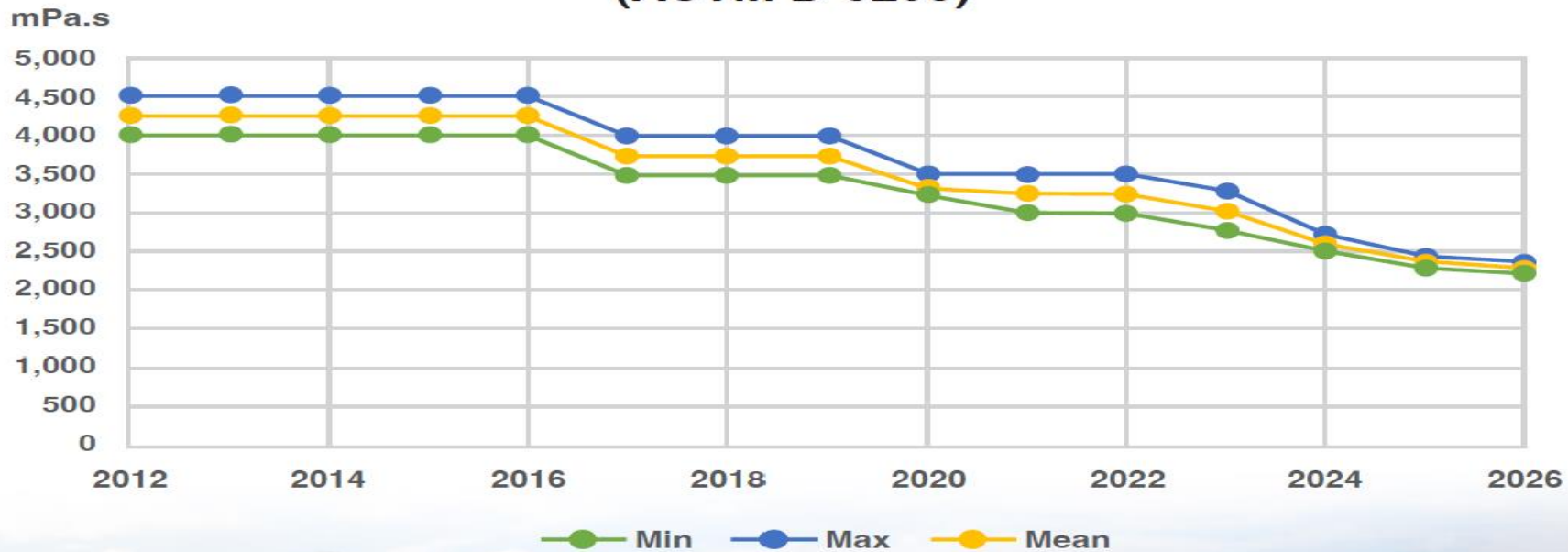
Average Pour Point
(ASTM D-97)





Re-Refined Base Oil Quality In Saudi Arabia 2012-2026

Cold Crancking Simulator (CCS) @-25c
(ASTM D-5293)





Different Grades Of Recycled and Re-Refined Base Oils

Used Lubricating Oil

Recycling

**Group I
(Off-spec.)**

Used Lubricating Oil

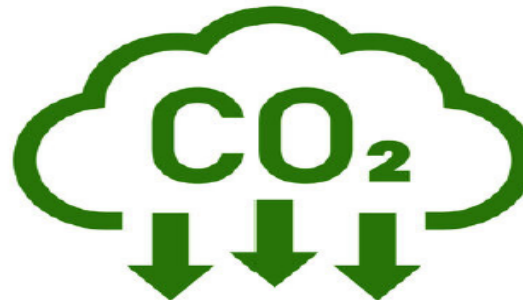
**Re-Refining
+ Traditional Finishing**

Group I/I+

Used Lubricating Oil

**Re-Refining + Advanced
Finishing Technology**

Group II/I+





How to improve the Quality of Re-Refined Base Oil?

1- Feedstock Quality Control – Self-Collection

- In-house used oil collection system
- Dedicated fleet and transfer stations
- Segregation by oil type
- Traceability and quality screening

2- Advanced Re-Refining Technologies

- Removal of sulfur, nitrogen, heavy metals, PAHs
- Optimized Distillate Fractionation for viscosity control
- Improved color, odor, oxidation stability

3- Research & Development Excellence

- Process optimization
- Laboratory testing and benchmarking
- Collaboration with additive suppliers

4- Closed-Loop Quality Improvement

- Higher-quality finished lubricants
- Cleaner used oil feedstock
- Long-term sustainability benefits

Key Takeaway

Quality excellence achieved by controlling the full re-refining value chain



Base Oil Specifications

Table (1)
Base Oil Specifications Group (I)

Property	Unit	Limit	Base Oil Grade									Test Methods
			70SN	100 SN	110SN	150 SN	300 SN	500 SN	600 SN	700 SN	150 BS	
Appearance	-	-	----- Bright & Clear -----									Visual, ASTM D4176
Color	Rating	Max.	1.0	1.0	1.0	1.5	2.0	3.0	3.5	3.5	5.0	GSO ISO 2049, ASTM D1500
Density at 15 °C	g/ml	-	Report	Report	Report	Report	Report	Report	Report	Report	Report	GSO ISO 3675 or ASTM D4052, ASTM D1298
Flash Point, COC	°C	Min.	Report	180	190	200	218	227	240	240	280	ASTM D92
Pour Point	°C	Max.	-19	-18	-16	-12	-9	-6	-6	-6	-6	GSO ISO 3016 or ASTM D7346 or ASTM D6749 or ASTM D97, ASTM D5949, ASTM D5950
Viscosity at 40°C	mm ² /s	Min.	10	18.0	21.0	28.0	55	85	Report	Report	Report	GSO ISO 3104, ASTM D445
		Max.	-	23.0	26.0	32.5	61	101	-	-	-	
Viscosity at 100°C	mm ² /s	Min.	Report	Report	Report	Report	Report	10.5	11.0	Report	29.5	GSO ISO 3104, ASTM D445
		Max.	-	-	-	-	-	-	12.5	-	34	
Viscosity Index	-	Min.	95	95	95	95	95	95	95	95	92	GSO ISO 2909, ASTM D2270
Ash Content	Wt. %	Max.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	GSO ISO 6245, ASTM D482
Sulfur	% mass	Max	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	GSO ISO 20884 or ASTM D4294
Water	mg/l	-	Report	Report	Report	Report	Report	Report	Report	Report	Report	GSO ISO 12937, ASTM D6304
Saturates	% mass	-	<90	<90	<90	<90	<90	<90	<90	<90	<90	ASTM D2007 or ASTM D7419 or IP 368



Base Oil Specifications

Table (2)
Base Oil Specifications Group (II)

Property	Unit	Limit	Base Oil Type										Test Method
			2cSt	3cSt	70 N	100N	110N	150N	220N	230N	500N	600N	
Appearance	--	--	----- Clear and Bright-----										Visual, ASTM D4176
Color	Rating	Max.	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.5	1.5	GSO ISO 2049, ASTM D1500
Color, Saybolt	Scale	-	Report	Report	Report	Report	Report	Report	Report	Report	Report	Report	ASTM D156
Density at 15°C	g/ml	-	Report	Report	Report	Report	Report	Report	Report	Report	Report	Report	GSO ISO 3675 or ASTM D4052, ASTM D1298
Copper Corrosion, 3hr at 100 °C	-	Max.	1	1	1	1	1	1	1	1	1	1	ASTM D130
Acid Number	mgKOH/g	-	Report	Report	Report	Report	Report	Report	Report	Report	Report	Report	ASTM D664
Flash Point, COC,	°C	Min.	155	170	175	200	200	200	220	220	230	240	ASTM D92
Pour Point,	°C	Max.	-21	-15	-15	-12	-12	-12	-12	-12	-12	-12	ASTM D97 or ASTM D7346 or ASTM D6749, ASTM D5949, ASTM D5950
Viscosity at 40°C	mm ² /s	Min.	Report	Report	Report	18.0	21.0	Report	Report.	42.5	Report	Report	ASTM D445
		Max.				22.0	25			46.0			
Viscosity at 100°C,	mm ² /s	Min.	2.0 – 2.3	2.9-3.5	2.8	Report	Report	5.0	6.0	Report	10.0	11.7	ASTM D445
		Max.			3.3			5.5	7.5		11.7	13.0	
Viscosity Index		Min.	100	100	80	95	95	95	95	95	95	95	GSO ISO 2909, ASTM D2270
Apparent Viscosity by CCS @ -25°C or -30°C	mPa.s	Max.	Report	Report	Report	Report	Report	Report	Report	Report	Report	Report	ASTM D5293
Evaporation Loss, Noack Method	mass %	Max	Report	Report	Report	20.0	17.0	15.0	12.0	8.0	Report	Report	ASTM D5800, Pro B
Sulfur	ppm w	Max.	100	100	100	100	100	100	100	100	100	100	GSO ISO 20884 or ASTM D4294 or ASTM D6481 or ASTM D5453, ASTM D2622, ASTM D7039
Saturates	mass%	Min.	≥90	≥90	≥90	≥90	≥90	≥90	≥90	≥90	≥90	≥90	ASTM D2007 or ASTM D7419 or IP 368
Aromatics	mass %	-	Report	Report	Report	Report	Report	Report	Report	Report	Report	Report	
Water	mg/L	-	Report	Report	Report	Report	Report	Report	Report	Report	Report	Report	GSO ISO 12937, ASTM D6304

THANK YOU

