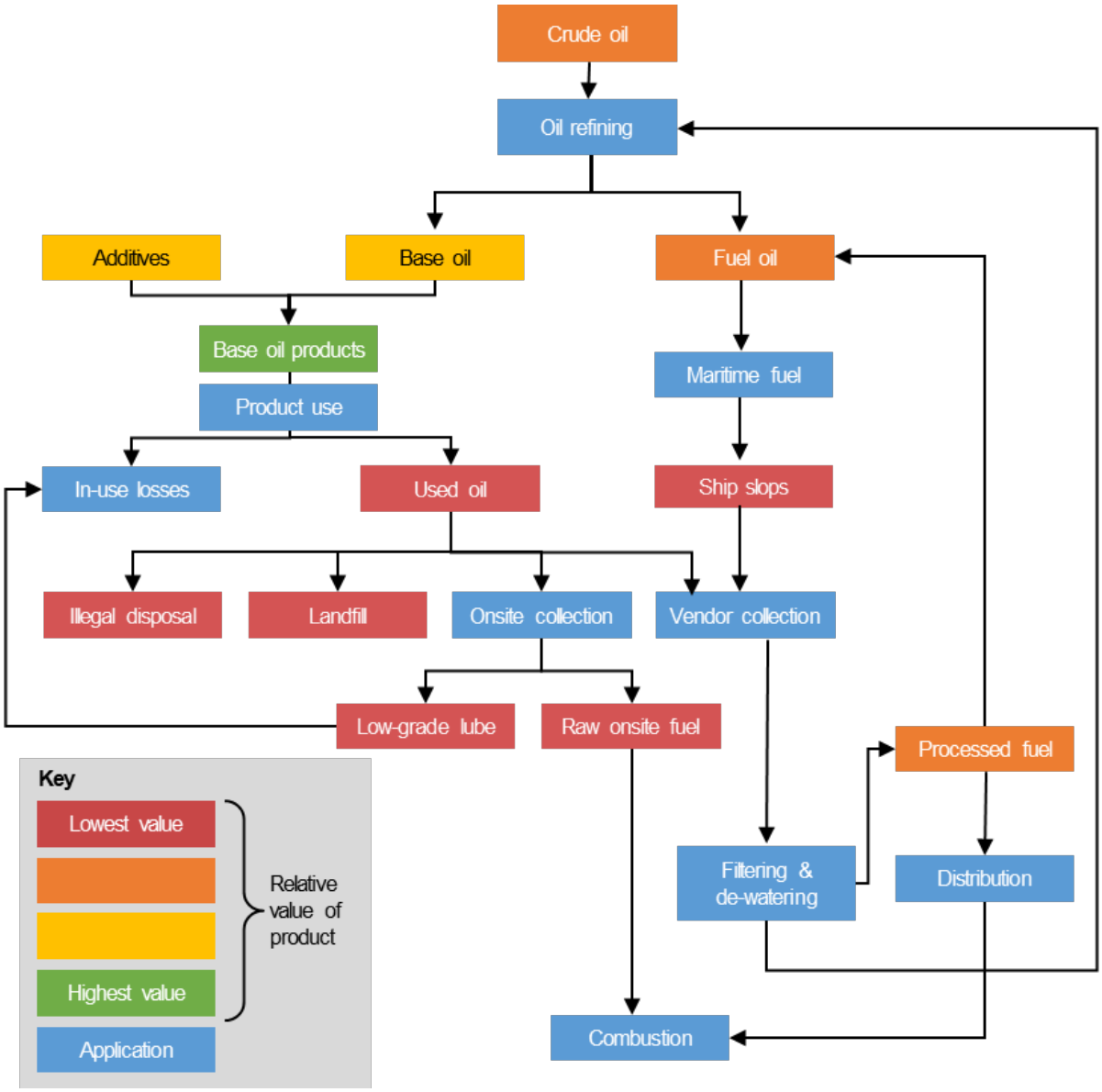
1. WHAT IS "USED OIL"?

"Used oil", sometimes called "waste oil", refers principally to petroleum-based oils that are at the end of their life as premium non-fuel products, such as lubricants. The term can however also be applied to describe used cooking oils and oils accumulated on shipping slop tanks (called "ship slops"). These oils are typically longer chain hydrocarbons (usually >20 carbon atoms) which have viscosities and flashpoints that are similar to heavier grade fuel oils (>8 mm^2/s at 100°C viscosity and 60°C+ respectively).

As used oils retain much of their original chemical characteristics it is possible for them to be recycled back into a base oil feedstock or, as is more common around the world, to enter the fuel supply chain. In New Zealand, petroleum-based used oils, whether processed or unprocessed by third party collectors, are largely combusted as a fuel to be used locally or exported to be used as fuel abroad.

Figure 1: Used oil supply chain and relative product values



Source: Enerlytica

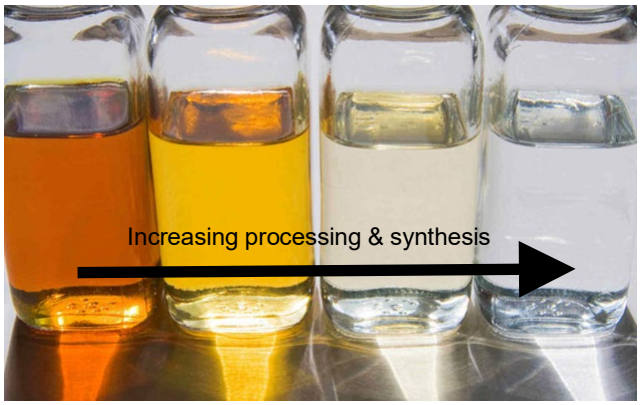
Due to differences in how they are sourced and their final applications, the major sources of used oils can be classified into petroleum-sourced base oil products including ship slops and vegetable and animal-based oils. In this study we focus principally on petroleum-based used oils.

1.1 Base oils

Base oils are petroleum oils, typically of 26 to 40 carbon atoms, that go through processes of de-asphalting, solvent extraction, dewaxing, hydro-finishing and further processes to become feedstock for a range of lubricants, hydraulic oils, transformer oils and more. Some base oils undergo even further chemical modification to become what is described as “synthetic” oils with more desirable and uniform lubrication properties compared to conventional mineral oils.

The use of base oils as lubricants, hydraulic fluids, and other specialist products is enabled by the addition of additives that enhance lubricity, viscosity, and other characteristics. It is the gradual oxidation of the oils and their additives plus gradual contamination by water and solids that requires that base oil products be replaced in applications such as motor vehicles, heavy machinery and transformers. Most used base oil products originate from the automotive sector where mechanics will collect used oil from changes of automotive fluids such as engine oil, transmission oil and brake oil.

Figure 2: Base oil samples



Source: Stock image, Enerlytica

1.2 Ship slops

Ship slops, sometimes also known as “ship sludges”, are waste liquids, including oils, generated from within larger maritime vessels and is collected in machinery drip trays, oily ballast water, the cleaning of oil product tankers and the filtration of fuel lines. Because ship slops are sourced from a wide range of port traffic it can be highly variable in composition and may include non-oil substances and heavier fuel oils with 50 or more carbon atoms.

As a result, ship slops are frequently treated as a separate processing stream to other used oils with the resulting processed product typically more suited to re-entering the maritime heavy fuel oil supply chain than onshore process heat applications.

1.3 Vegetable oils

Vegetable oils, animal fats, and tree resins can also enter the wider used oil processing stream however their renewability, low carbon emissions and greater biodegradability mean they are typically treated and managed separately from used base oil products and ship slops so as to be able to present a “green” price premium over petroleum oils.

The largest source of renewable used oils is spent cooking oil from the food and restaurant industry. Other sources include from forestry, tunnelling operations and marine industries where they are used as biodegradable lubricants. Used cooking oil (UCO) is a major source of biofuels for which there is significant demand in Europe and, increasingly, North America where highly supportive climate change policies have driven uptake. Given their biodegradability, UCO can also be processed into biodegradable lubricants and dust suppressants.

Figure 3: UCO being emptied into containers for collection

Source: Stock image

2. VOLUME ESTIMATES & FORECAST

2.1 Base oil products

The closure in 2022 of New Zealand's only oil refinery means that almost all petroleum-sourced base oil products that can become available to use in New Zealand must first be imported. Stats NZ data suggests that supply of oil products into New Zealand totalled nearly 54 million litres in 2023. The notable domestically supplied base oil product is 600,000 litres of transformer oil that is collected and recycled within the country and therefore feeds the supply stream although this does not meet all transformer oil demand in New Zealand.

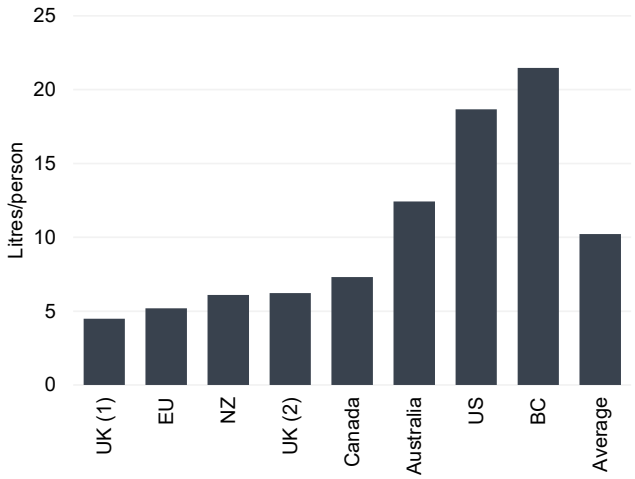
Automotive

Of the 54 million litres of imported base oil products lubricating preparations made up 87%, or around 46 million litres. This volume is largely comprised of engine, transmission and gear oils for the automotive transport sector. Our analysis using New Zealand Transport Agency data suggests this sector accounted for 38.1 million litres in 2023. Hydraulic oils make up 4.1 million litres of imports or 8% of imported base oil supply with an estimated further 1.5 million litres being brake fluid or similar product used by the automotive transport sector. In aggregate, the automotive transport sector therefore accounts for around 40 million litres of base oil product imports. The used oils from this sector are collected from mechanic workshops and garages that recover and retain the oils when carrying out vehicle servicing.

Our forecasts, based on assumptions presented in the Appendix to this report which applies data from the New Zealand Transport Authority data on vehicle fleet composition, Stats NZ population projections and assumptions on the annual mileage of New Zealand's fleet and the share of EVs, expect the volume of base oil products sold to the automotive sector in New Zealand to decline from 40 million litres pa in 2023 to as low as 3 million litres pa by 2050. Assuming a 60% recovery factor infers a volume of 1.8 million litres pa of used oil being recoverable from the automotive sector by 2050.

This declining supply of automotive oils reflects a progressive transition to fully electric vehicles (EVs). We expect EVs to occupy 99% share of the light vehicle and motorcycle fleet, 95% share of the bus fleet, and 80% share of New Zealand's trucking fleet by 2050. With no internal combustion engine (ICE), fewer moving parts in the transmission, and electrical power steering, EVs require minimal fluid changes. When fluids do require changing it is typically the battery coolant which falls beyond the scope of used oils. The only fluid of relevance to the used oil supply chain that needs regular changing in EVs is brake fluid. Current published advice on brake fluid changes for EVs is similar to ICE vehicles in that they should be checked every two years or 50,000 km although this could lengthen given that EVs have regenerative braking systems that reduce the use of hydraulic braking.

Figure 4: Used oil supply per capita in New Zealand vs peer country / regions



Note: Methodologies behind annual consumption figures is largely unknown and may lead to variance as seen in UK figures which come from two separate sources. Our observation is that differences are likely to result from inclusion or not of non-automotive oils.

Source: Enerlytica

It is the transport sector that largely explains how the amount of used oil generated in New Zealand compares to other jurisdictions. On a per capita basis and depending on the source, New Zealand sits above European countries and below Canada, Australia, and the US. This reflects New Zealand's high relative rate of car ownership of 1.1 motor vehicles per person, the 5th highest in the world, while the US, Canada, and Australia are ranked 8th, 10th, and 15th respectively. However, the average mileage of a New Zealand light vehicle at around 10,000 km per year is relatively low compared to these nations. For example, the average annual mileage of a light vehicle in the US is more than double this, meaning fluid changes there occur at twice the rate as in New Zealand. This difference in mileage likely reflects geographical factors including country size and greater degrees of urban sprawl.

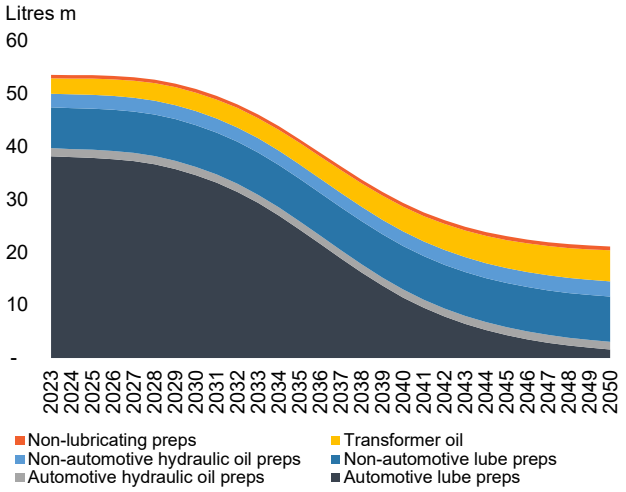
Industrial

Another reason behind differing levels of demand for base oil products is activity involving heavy machinery and industry. For example, the US, Canada and Australia all have larger mining sectors relative than New Zealand and Europe, which likely serves as another major source of demand for base oil products in those countries.

In New Zealand, large industrial sites such as steel works and forestry operations were estimated to be largely responsible for the import and usage of 7.7 million litres of lubricating preparations and 2.6 million litres of hydraulic oils in 2023. We expect industrial activity in New Zealand to grow with population but at a slower rate. This reflects that since the turn of the century New Zealand's industrial energy demand growth has decoupled from wider economic and population, registering a CAGR of 0.4% versus 2.9% for GDP and 1.3% for population.

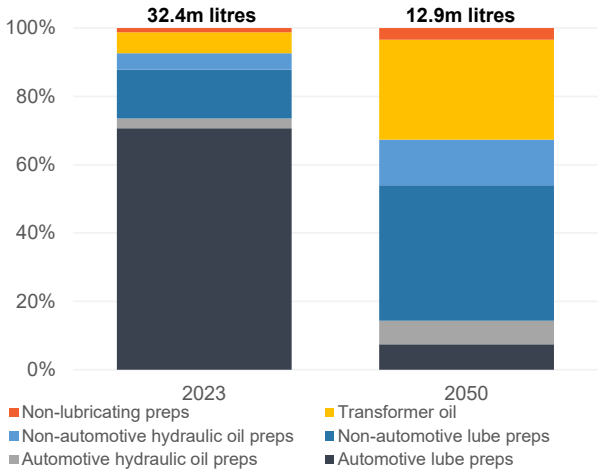
Long-term forecast population growth remains at around 1.2% pa which underpins our assumption that industrial energy demand, and thereby industrial demand for base oil products, will continue to grow at a similar rate of 0.4% pa. Demand for base oil products from this sector is therefore expected to grow from its current 10.9 million litres pa to 12.1 million litres by 2050, equating to 6.5 million litres pa of recoverable used oil from these sources in 2023 to 6.8 million litres pa in 2050.

Figure 5: Forecast New Zealand demand for base oil products



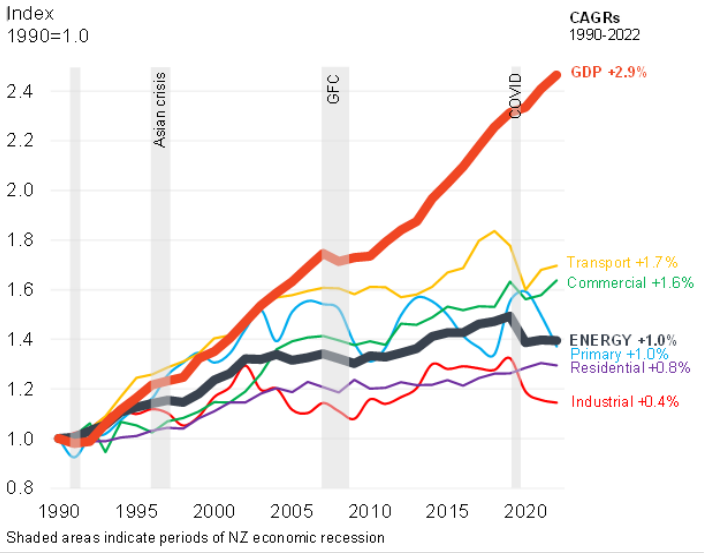
Note: including lubricants, hydraulic oils, transformer oils, and non-lubricating preparations
Source: NZTA, Stats NZ, Enerlytica

Figure 6: Forecast change in source mix of recoverable New Zealand used oil



Source: NZTA, Stats NZ, Enerlytica

Figure 7: New Zealand GDP vs energy demand growth



Source: Stats NZ, MBIE, Enerlytica

Transformer oils

2.3 million litres, or 4% of total base oil product imports, are transformer oils for the electricity sector. Industry sources suggest 16-20 million litres of transformer oil is present in New Zealand at any one time with Transpower operating 30% of the New Zealand's transformer fleet and single lines companies potentially holding up to half a million litres of transformer oil in their transformers at any one time. Individual generation units and similar assets are also likely to maintain large quantities of oil, with the largest likely being the HVDC cable which holds 650,000 litres.

Transformer oil volumes are expected to grow as the New Zealand economy electrifies. Indexing transformer oil imports to forecasts of electricity generation capacity growth as outlined in the Appendix, we estimate that the total volume of transformer oil imports into New Zealand will grow to 5.4 million litres by 2050. Assuming 60% of this is recoverable and adding the 600,000 litres that is already recycled each year in the country suggests that from 2030 to 2050 the volume of recoverable used transformer oil will increase from 2 million litres to 3.8 million litres pa.

Recovery rates

The estimates of the percentage of oil recoverable from the above applications varies between 50-70%. In other words, 30-50% of these volumes are lost through oxidation, leaks and applications that do not allow for recovery. Applying that to our estimate for New Zealand volumes including a small amount of other non-lubricating oils that make up the final 1% of imports and adjusting for recycled transformer oil suggests that around 32 million litres of used oil is currently recoverable in New Zealand.

Imports

As well as locally sourced used oil, New Zealand collection businesses import used oil from a number of Pacific islands including Tahiti, New Caledonia and Fiji. Stats NZ data suggests 2.8 million litres of waste oil was imported into New Zealand in 2023. We assume that Pacific Island demand for base oil products will decline at a similar rate to New Zealand's total demand albeit with a 10 year delay which reflects expected barriers to electrification on the islands such as the better range and variety of ICE boats and ships available, which is better suited to interisland traffic. As such, we expect the total volume of imported used oils to decrease from its current level of 2.8 million litres pa to 1.4 million litres pa in 2050.

Note that exports of used oil product is also possible (see section 4).

2.2 Ship slops

Ship slop volumes collected in New Zealand are difficult to quantify for several reasons including that:

- only a small number of companies are currently collecting ship slops and when they do they are simultaneously handling ship slops from Pacific Islands.
- commercial sensitivities surrounding the disclosure of processed slops volumes.
- reported volumes likely include water also collected in slop tanks and there is significant variance in the oil to water ratio that ships can deliver.

For example, ship slops collected in ports that have more coastal, diesel-fuelled shipping traffic can have up to a 95% water cut in their slops while long distance shipping traffic which uses heavier fuel oils may only have a 25% water cut. A review of customs codes, MBIE data and theorised volumes by former industry participants suggest the onshore collection of ship slops and their collection from the Pacific islands may not be captured by customs data or otherwise be readily quantifiable.

Best estimates suggest that up to 20 million litres pa of ship slops is processed in New Zealand although volumes collected from within New Zealand are understood to be in significant decline due to:

- the imposing of cleaner fuel standards by the International Maritime Organisation (IMO) resulting in long-distance shipping traffic visiting New Zealand increasingly being fuelled with lower sulphur, lighter and higher quality fuel oils that produce lighter oil residue.
- domestic shipping increasingly being fuelled with diesel or diesel equivalents which yield mostly water into their ship slops.
- cheaper costs to dispose of ship slops in other ports outside of New Zealand.

Industry sources suggest that imported ship slops are typically heavier than most base oil products and are in line with number 6 bunker oil which is known for its viscous composition. As such, much of the ship slops processed outside of the South Island are re-exported back to Pacific islands where they are recovered and fed into power generation facilities and ships fuelled by heavy fuel oil. Within the South Island, Gloriavale is known to consume some ship slop volumes although exact amounts are difficult to estimate for, but are also expected to be in decline.

Figure 8: Number 6 bunker oil sample

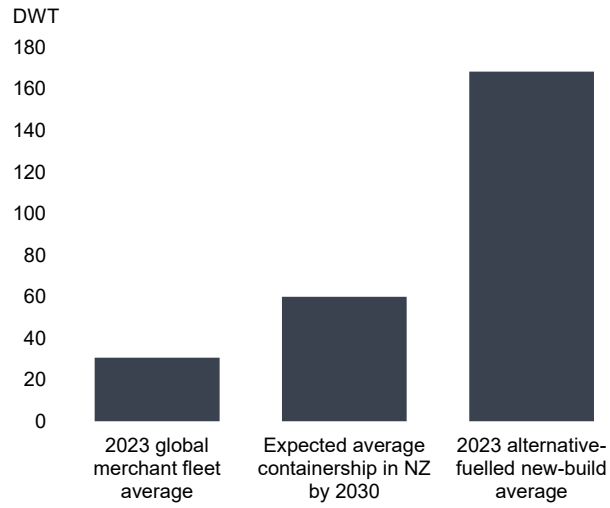
Source: Stock image

Looking ahead, the IMO is leading a move away from the use of heavier fuel oils by shipping operators. This should see the amount of oil captured in ship slops and imported to New Zealand from the Pacific islands decrease over time. The shipping industry is however notoriously cost-sensitive, difficult to regulate and to decarbonise. That said, the IMO has already successfully implemented policy (known as the IMO 2020 regulations) to require operators to reduce the sulphur content in fuel oil from 5% by mass to 0.5% across most nations, with some emission control areas (ECAs) going further to require a limit of 0.1% by mass.

The IMO has also separately set a target to reach 5% of energy used by the international shipping industry to come from lower carbon fuels by 2030, with an aspirational target of 10%. Lower carbon fuels currently available are LNG, LPG, methanol and battery/hybrid technologies with ammonia likely to become available soon. Presently only 1.2% of vessels and 5.5% of shipping tonnage in service are alternatively fuelled and this total is overwhelmingly composed of LNG carrier vessels which can use their cargo as fuel.

To meet these targets it is in the interest of the shipping industry to move the largest ships to alternative fuels to drive more rapid decarbonisation. As such, the average deadweight tonnage (DWT, the weight of cargo a ship can carry) of all alternatively fuelled vessels currently being built is 168,000 DWT. By contrast, the larger ships that regularly visit the waters of New Zealand and the Pacific Islands are between 30,000 and 60,000 DWT. The prospect of significant reduction in fuel oils from ship slops out to 2050 is therefore likely to be slow and relatively immaterial to the New Zealand market for used oils.

Figure 9: Vessel size benchmarks



Source: UNCTAD, Enerlytica

2.3 Cooking oils

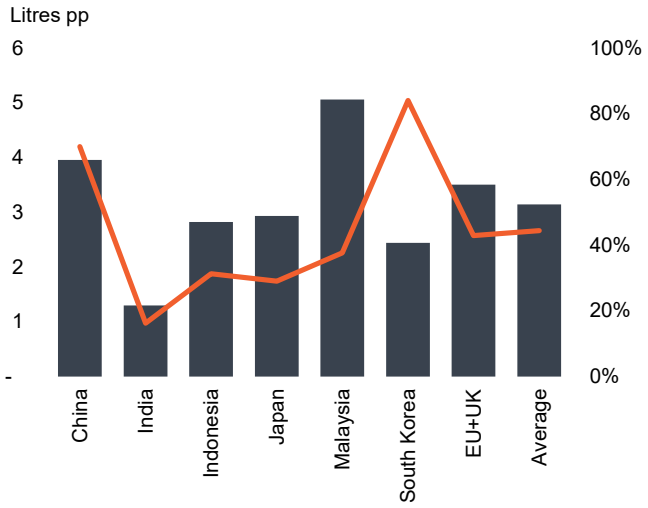
Industry estimates suggest that somewhere in the region of 12-15 million litres of UCO are collected in New Zealand each year. This is in line with an estimate of total UCO available in New Zealand derived from applying the average UCO potential per capita in 2022 from across several other peer countries.

Using the median of the sample peer country average and weighted average UCO supply, we infer a benchmark of 3.2 litres of UCO generated per capita per year in New Zealand, thereby totalling an aggregate 16.7 million litres pa.

Figures from other countries assume that almost all UCO available from food processors and restaurants is collected while collection from urban households is 50% or lower. Our discussions with UCO collectors in New Zealand suggest very little household UCO is collected locally and that local food processors leave a significant portion of residual oil in their produce. It is possible that the quantity of restaurants and number of food processing businesses in New Zealand are higher than in the peer jurisdictions we sampled, therefore keeping New Zealand quantities of UCO supply in line with that of the peer country sample.

Looking ahead, assuming our estimate for UCO volumes increases in line with forecast population growth infers that by 2050 New Zealand is expected to produce more than 21 million litres of recoverable UCO.

Figure 10: Per capita UCO availability in peer countries

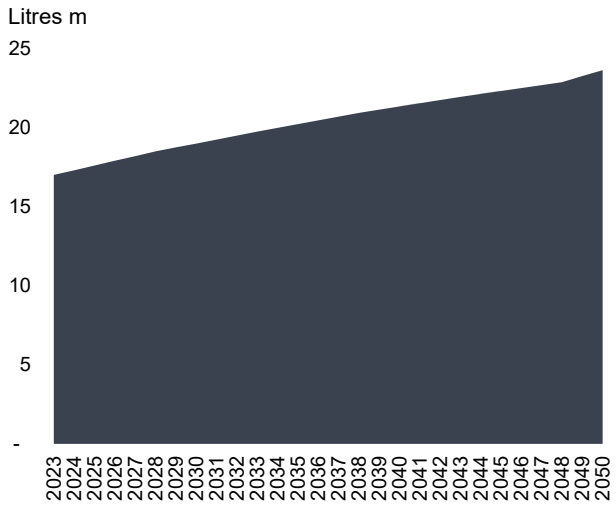


Note: Median of sample average and sample weighted average of UCO per capita were used to estimate total NZ supply.
Source: International Council on Clean Transportation (ICCT), CE Delft, Enerlytica

Data on volumes collected by region are not complete but it is understood that the Canterbury region alone produces around 2.5 million litres pa which, with a population of 600,000 people, suggests a UCO availability per capita of close to 4.2 litres. This is >30% above the 3.2 litre per person benchmark we used to calculate our estimate for national quantity of available UCO per annum. This could suggest that actual UCO volumes produced nationally are higher than our initial estimate and this may be the case given that, if we accept the industry estimate of 12-15 million litres being collected annually, New Zealand's collection rate is between 70-90%. This is in line with South Korea at 92%, the highest-ranking country in our peer country sample in terms of UCO recovery.

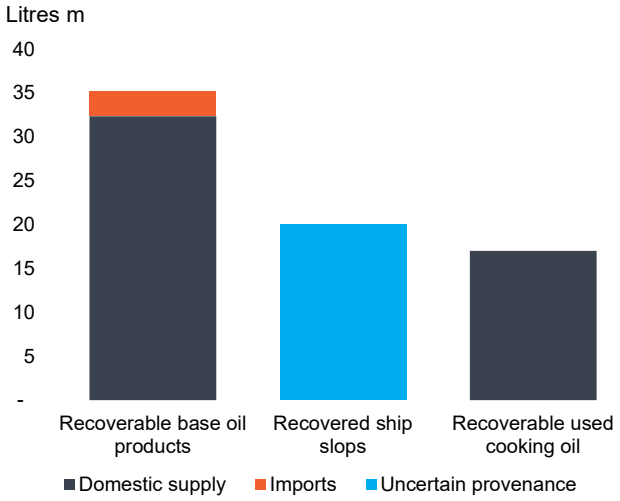
Our discussions with UCO collectors suggest however that it is likely that, outside of households, more than 90% of UCO available for collection is indeed being collected. This likely reflects that the residual value of the oils is high and that suppliers of UCO are sought out and compensated with multi-year contracts at attractive prices.

Figure 11: New Zealand UCO supply forecast



Note: Forecast assumes per capita UCO supply is constant and total supply is in line with population growth as forecast by Stats NZ.
Source: Stats NZ, ICCT, Enerlytica

Figure 12: New Zealand used oil sources in 2024



Source: Enerlytica, Stats NZ