American Carbon Registry

Methodology for the Quantification, Monitoring, Reporting, and Verification of Greenhouse Gas Emission Reductions

from

Re-Refining Used Lubricating Oils

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1.0 BACKGROUND AND APPLICABILITY

1.1 Summary Description of the Methodology

Lubricating oils are used to minimize friction and wear between mechanical parts in contact with each other and are essential to a wide variety of automotive, industrial, and marine applications. The lifecycle of lubricating oils is associated with environmental impacts including greenhouse gas emissions. The manufacture of lubricating oil is the most energy-intensive process in a crude oil refinery, and used lubricating oils are often burned in industrial or commercial boilers, releasing multiple pollutants including carbon dioxide.[1]

An alternative option exists for used lubricating oil: collection and re-refining. Used oil management programs have been developed throughout North America in order to reduce the amount of improperly disposed used oil and to encourage the recycle and reuse of used oil. Lubricating oil must be taken out of service when it no longer performs to expected specifications. This occurs when additive packages become depleted and the lubricant becomes contaminated. The base oil portion of the lubricant, however, does not break down during use. As a result, used engine oil and other lubricating oils can be re-refined to remove water, contaminants and additives to produce base oil of the same quality as the virgin base oil. Lubricants formulated using re-refined base oils in turn can meet the same performance standards as those using virgin basestocks.

The purpose of the Methodology is to quantify greenhouse gas (GHG) emission reductions associated with the re-refining of used lubricating oils. Re-refining used lubricating oils avoids GHG emissions associated with combustion and improper disposal of used oil at end of life. This Methodology provides the quantification and accounting frameworks, including eligibility and monitoring requirements, for the creation of carbon offset credits from the reductions in GHG emissions resulting from the re-refining of used lubricating oils.

1.2 Definitions and Acronyms

If not explicitly defined here, the current definitions in the latest version of the American Carbon Registry (ACR) Standard apply.

[1] Used lubricating oil is often improperly disposed, for example dumped into storm sewers or garbage bins, or burned in unregulated boilers. Burning used oil without proper controls releases harmful compounds into the atmosphere including Polycyclic Aromatic Hydrocarbons (PAHs) and heavy metals. Dumping used oil can impact both the environment and human health as contaminated oil migrates downward through soil and possibly into groundwater.

Table 1: Definitions

Term	Acronym (if applicable)	Definition
American Petroleum Institute	API	Organization which sets quality and performance standards for base oil and finished lubricants
Base oil		A lubrication-grade hydrocarbon initially produced from refining crude oil or chemical synthesis that is then mixed with additive packages to produce finished lubricant products. The API grades base oils based on how they are made: Group I (solvent refined), Group II (hydro-processed and hydro-cracked), Group III (severe hydro-cracked), Group IV (chemical reaction from polyalphaolefins), or Group V (all other synthetics)
Carbon Dioxide	CO_2	A chemical compound composed of two oxygen atoms and a single carbon atom. Can be used as a low-GWP refrigerant
Carbon dioxide equivalent	CO_2e	A standard unit of measure to express the impact of each different greenhouse gas in terms of the amount of CO_2 that would create the same amount of global warming
Carbon offset credits	Offsets	A carbon offset is a reduction in emissions of carbon dioxide or greenhouse gases made in order to compensate for or to offset an emission made elsewhere
Comprehensive take back program		Program that collects used lubricating oils directly from customers or at regional collection centers and distributes finished, re-refined lubricating oils directly back to customers.
Contaminants		Heavy metals, solvents, and particulate matter which are collected throughout the use phase of a lubricating oil
GHG Source, Sink, or Reservoir	SSR	1) GHG Source – Physical unit or process that releases a GHG into the atmosphere 2) GHG Sink – Physical unit or process that removes a GHG from the atmosphere 3) GHG Reservoir - Physical unit or component of the biosphere, geosphere or hydrosphere with the capability to store or accumulate a GHG removed from the atmosphere by a GHG sink or captured from a GHG source.

Term	Acronym (if applicable)	Definition
Global warming potential	GWP	An index that attempts to integrate the overall climate impacts of a specific action (e.g., emissions of CH_4, NO_x or aerosols). It relates the impact of emissions of a gas to that of emission of an equivalent mass of CO_2
Lubricating oil		A petroleum-derived or synthetic crankcase oil, engine oil, hydraulic fluid, transmission fluid, gear oil, heat transfer fluid, or other oil or fluid used for lubricating machinery or equipment
Mineral base oil		Base oil produced from the refining of crude oil
Project Proponent		The company or entity that is organizing and managing the project and is the owner of the emission reduction credits
Project Site/Re-refinery		A facility capable of re-processing used lubricating oil and producing base oil identical in quality to virgin base oil
Re-refined lubricating oil		Lubricating oil that is completely treated to the point that it has the same characteristics, functionality and life span as virgin lubricating oil. Re-refined oil meets the quality and technical performance standards for base oil per API standards
Synthetic base oil		Base oil that is produced from chemical synthesis. Group III base oils are mineral-based, but are sometimes classified as synthetic based on additional chemical processing steps. Group IV base oils are produced from the synthesis of polymers
Used lubricating oil		Lubricating oil which has been used in various applications including automotive, manufacturing, etc. and is collected; the input to the re-refining process
Virgin base oil		Base oil that is newly produced from either crude refining or chemical synthesis – as opposed to being re-refined – and that has not yet been combined with additives to formulate finished lubricant products
Virgin lubricating oil		Finished lubricant products that are formulated using virgin base oil and additives.

Term	Acronym (if applicable)	Definition
Volatile Organic Compound	VOC	An organic chemical compound whose composition makes it possible for it to evaporate under normal indoor atmospheric conditions of temperature and pressure

1.3 Applicability Conditions

Finished lubricants are produced by blending base oil with additives to control viscosity and achieve specific quality and performance targets. Under a project scenario, used lubricating oil is collected and re-refined into base oil with identical properties as base oil produced from crude. Base oils derived from crude oil refining, chemical synthesis, and the re-refining of used lubricating oil must meet the American Petroleum Institute (API) standards or equivalent standards to deliver the same performance.

This Methodology defines a set of activities designed to reduce GHG emissions through the re-refining of used lubricating oils. This methodology is applicable under the following conditions:

- The re-refined lubricating oils produced by the project activity in a re-refinery (hereafter referred to as "Project Site") are of the same quality as virgin lubricating oils, as evidenced by the fact that they can be used for the same purpose and meet all relevant product specifications.
- The Project Site is located in North America.
- Used lubricating oils eligible under this protocol are those included in the definition of used lubricating oils in the Definitions section.
- The Project complies with all local or national regulations related to proper treatment and disposal of contaminants.

1.4 Crediting Periods

The crediting period shall be ten years.

1.5 Periodic Reviews and Revisions

ACR may require revisions to this Methodology to ensure that monitoring, reporting, and verification systems adequately reflect changes in the project's activities. This Methodology may also be periodically updated to reflect regulatory changes, emission factor revisions, or expanded applicability criteria. Before beginning a project, the project proponent should ensure that they are using the latest version of the Methodology.

2.0 PROJECT BOUNDARIES

2.1 Geographic Boundary

The GHG assessment boundary, or offset project boundary, delineates the SSRs that must be included or excluded when quantifying the net changes in emissions associated with the re-refining of used lubricating oils.

The project boundaries, depicted by the dashed lines in Figure 1, include the physical and geographical sites where base oils are produced, as well as the locations where used lubricating oil is either burned as heating fuel, improperly disposed, or re-refined for further use.

For purposes of this assessment, the extraction and transport of crude oil, and the collection, aggregation, and transport of used lubricating oil to locations where it either burned as fuel or re-refined, and any associated GHG emissions, are not included in the project boundaries. The extraction and transport of crude oil has been excluded based on the assumption that extracted crude will most likely continue to be refined into other products despite adoption of lubricant re-refining processes. Avoided GHG emissions from displaced base oil production is also not included in this Methodology to prevent potential double-counting in jurisdictions with a GHG emission control program (either carbon tax or a cap-and-trade program). Also, the production of additives which are added to base oil to create finished lubricant products is not included.

Figure 1 illustrates the GHG assessment boundary for re-refining of used lubricating oils. All SSRs within the bold dashed line are included and must be accounted for under this Methodology.

Figure 1: Project Boundary Diagram for Re-refining Used Lubricating Oils

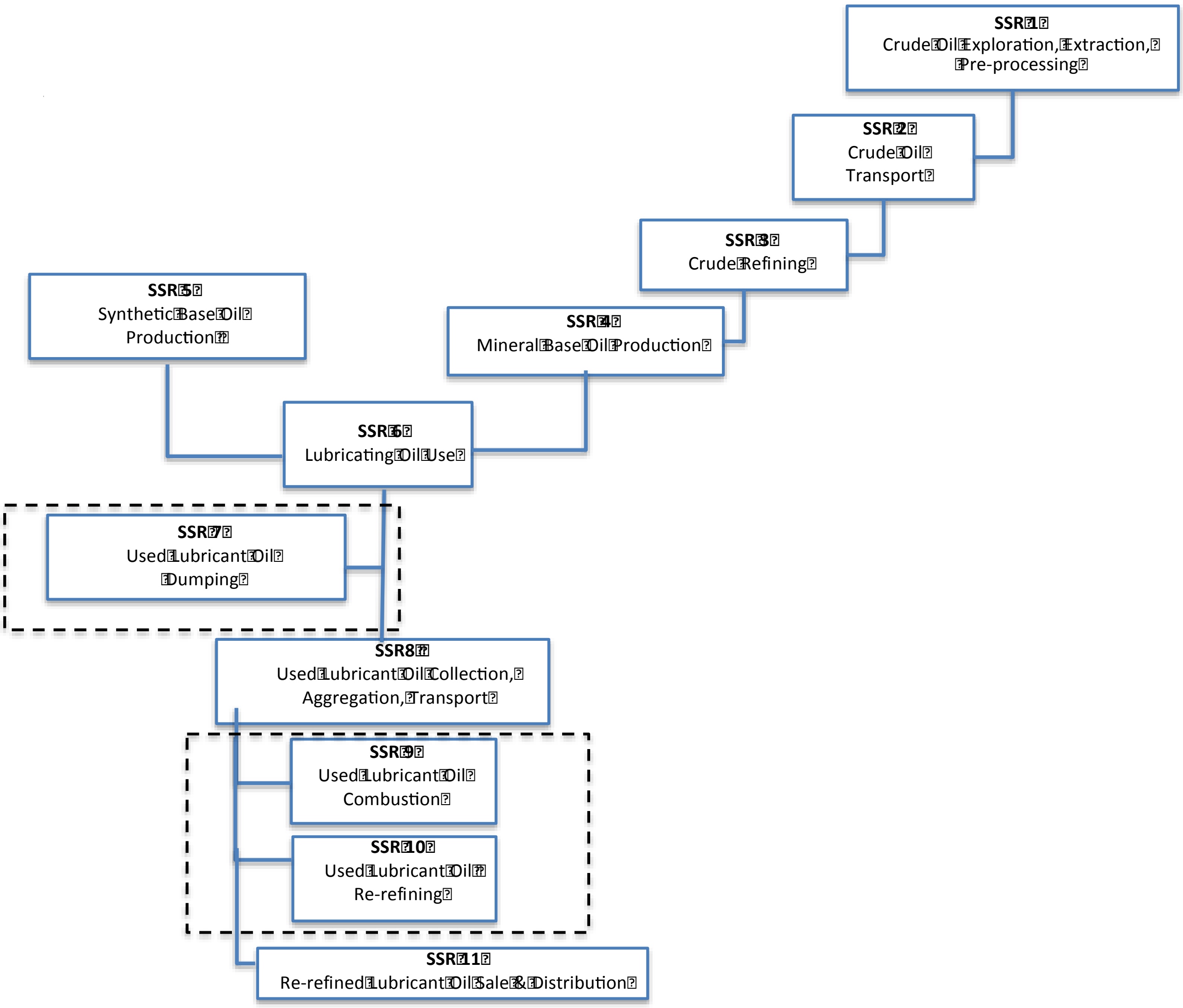

Table 2 lists the GHG sources included and excluded in the quantification under this Methodology, depending on whether the sources are within or outside project boundaries.

Table 2: Greenhouse Gases and Sources, Sinks and Reservoirs

SSR	Source Description	Gas	Included (I) or Excluded (E)	Quantification Method
1	Crude Oil Exploration, Extraction, Processing	CO_2	E	N/A
		CH_4	E	N/A
		N_2O	E	N/A
2	Crude Oil Transport	CO_2	E	N/A
		CH_4	E	N/A
		N_2O	E	N/A
3	Crude Refining	CO_2	E	N/A
		CH_4	E	N/A
		N_2O	E	N/A
4	Mineral Base Oil Production	CO_2	E	N/A
		CH_4	E	N/A
		N_2O	E	N/A
5	Synthetic Base Oil Production	CO_2	E	N/A
		CH_4	E	N/A
		N_2O	E	N/A
6	Lubricant Oil Use	CO_2	E	N/A
		CH_4	E	N/A
		N_2O	E	N/A
7	Used Lubricant Oil Dumping	CO_2	I	N/A
		CH_4	E	N/A
		N_2O	E	N/A
8	Used Oil Collection, Aggregation, Transport	CO_2	E	N/A
		CH_4	E	N/A
		N_2O	E	N/A
9	Used Lubricant Oil Combustion	CO_2	I	See Methodology
		CH_4	E	N/A
		N_2O	E	N/A
10	Used Lubricant Oil Re-Refining	CO_2	I	See Methodology
		CH_4	E	N/A
		N_2O	E	N/A
11	Re-Refined Lubricant Oil Sale and Distribution	CO_2	E	N/A
		CH_4	E	N/A
		N_2O	E	N/A

3.0 BASELINE DETERMINATION

The baseline scenario considers:

- the baseline rates of used lubricant collection, re-refining and combustion for energy recovery;
- the potential for increased re-refining to reduce improper disposal of used lubricating oil; and
- emission factors for combustion and improper disposal of used lubricating oil.

3.1 Baseline Rates of Re-refining and Combustion

The current rates by which lubricants are re-refined, burned as fuel, and improperly disposed in North America are accounted for in determining the baseline scenario. A 2010 industry survey by Kline & Company provides the most recent data on lubricant re-refining in North America (Kline & Company, 2010). These data, shown in Table 3, indicate the following:

- Of the 22.4 million tons of used oil that is collectable on an annual basis, 16.5 million tons were collected, with the balance (5.9 million tons or 26% of the total) lost to unknown end uses (this would include losses from improper disposal with some used oil being dumped in landfills, waterways, and groundwater);
- Of the used oil volume recovered, 12.87 million tons (78%) were combusted as fuel in asphalt plants, space heaters, industrial and utility boilers, steel mills, cement kilns, and other facilities.
- Of the used oil volume recovered, 2.64 million tons (16%) were re-refined and this total volume is split among re-refined basestocks and other uses such as production of diesel or naptha:
  - Re-refined basestocks is 61% of this volume or 1.62 million tons - yielding a re-refining to base oil rate of 7%;
  - Other re-refined products account for 39% of this volume or 1.02 million tons.

Table 3. Used Oil Collection, Combustion and Re-refining in North America

Oil Type	Quantity (millions of tons per year)
Collected Used Oil	22.4
Collected Used Oil	16.5
Collected/Combusted Used Oil	12.87
Collected/Re-refined Base Oil	2.64
Collected used oil re-refined to base oil	1.62
Collected used oil re-refined to other products	1.02

Based on the Kline and Company (2010) survey, it is assumed that for the baseline scenario, of the used lubricant oil collected across North America, 78% of the total collected oil is combusted for energy recovery, and 7% is re-refined to base oil[2]. The remaining proportion (6%) of lubricant that is collected (and not either re-refined or combusted for fuel) is incinerated due to contamination which prevents it from being re-refined.

3.2 Reduction in Improper Disposal of Used Oil

The Kline and Company (2010) data indicate that of the used oil in North America that is collectable, 26% was lost to unknown end uses, a portion of which would have been disposed of improperly through dumping into landfills, waterways, and groundwater. Under a scenario where GHG credits can be generated from collection and re-refinement of used lubricant oil, it is anticipated that businesses and individuals would have some additional incentive to participate in a used oil takeback program, thereby reducing the amount of used oil that is improperly disposed.

Across North America and around the world, there have been various government-sponsored programs to discourage illegal disposal and promote used oil collection. One of the most established programs is California's used oil recycling program, which certifies collection centers throughout the state that pays the public for every gallon of used motor oil, and conducts outreach to inform and motivate the public to recycle used oil[3]. Between 1994 and 2008, California's Department of Resources Recycling and Recovery (CalRecyle) reported that used oil collected in California by the public collection programs increased from 7.1 million gallons in 1994 to 23.5 million gallons in 2008, an increase of 330% over 14 years, or an average of 23.6% per year.

There is at least one private-sector sponsored takeback program in North America where a re-refiner/recycler of lubricating oils arranges to collect all used oil from specific customers so that the lubricating oil used by that customer is part of a comprehensive takeback program.[4] In a comprehensive takeback program, used lubricating oil is recovered and re-refined into base oil multiple times. Each time the original quantity of used lubricating oil is re-refined and subsequently re-used, some amount of improper disposal of used oil is reduced.

For the purposes of this Methodology, used oil that is collected as part of a comprehensive take back program and ultimately re-refined, reduces improper disposal of used oil from the customers within that program. For this type of program, every gallon of used oil that is re-refined will be credited to displace the improper disposal of used oil that would not otherwise be collected, as well as used oil combustion that would otherwise occur. Based on the results of the California used oil takeback program indicating a

[2] Note that this methodology only quantifies the GHG emissions benefit of re-refining to base oil and not re-refining to produce other products such as diesel or naptha.
[3] http://www.calrecycle.ca.gov/UsedOil/
[4] Safety-Kleen OilPlus™ Program; www.safety-kleen.com/products-services/oil-solutions/oilplus-oil-delivery

23.6% annual increase in used oil collection, it is assumed that a comprehensive take-back program would increase used oil collection within that program and reduce improper disposal by 3% per year.

3.3 GHG Emissions from Combustion and Improper Disposal of Used Lubricating Oil

GHG emissions from combustion and improper disposal of used lubricating oil are assessed in this Methodology. Default GHG emission factors for improper disposal (dumping) are from a lifecycle assessment conducted by Environ (2009) and, for combustion, the IPCC (2006).

These default factors do not account for GHG emissions from disposal of used synthetic oil. The embodied carbon content of synthetic oil is estimated to be 3.15 kg CO_2e/kg (Mulvaney, 2014) which is nearly 3 times higher than the range of comparable global warming potential estimates in the literature for lubricants (1.05 – 1.25 kg CO_2e/kg lubricant) (PE International, 2013). The relatively small percentage (1-2%) of total base oil production accounted for by purely synthetic base oil would translate into a negligible effect on an aggregated emission factor for disposal of both mineral and synthetic base oils. This exclusion adds a conservative element to this Methodology.

3.3.1 Combustion of Used Oil

Burning used lubricating oil for heat recovery results in direct CO_2 emissions. Most lubricating oils are made from heavier, thicker petroleum base stock, and are designed for lubrication rather than as fuel. The hydrocarbon composition of lubricating oil varies, especially for used oil that is frequently mixed with heavy oils to improve the quality of the fuel. As such, a wide range of values are reported in the literature for the energy content of lubricating oils and resulting CO2 emissions from combustion. This Methodology uses two default factors from the most recent IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006):

- The net calorific value for lubricants of 40.2 Terrajoules (TJ) per Gigagram (Gg) presented in Table 1.2 of IPCC (2006). The IPCC default factor is converted into units of BtU per gallons (see Appendix A).
- The CO_2 emission factor of 73,300kg CO_2 per Terrajoule for lubricant combustion presented in Table 1.4 of IPCC (2006). The IPCC default factor is converted into units of kgCO_2 per BtU (see Appendix A).

Burning used oil for heating may displace the burning of fossil fuels for the same heating value. However, these potential emission reductions are not included in the baseline quantification. This is to provide balance in the Methodology – as is the case in the calculation of project emissions, the contribution from additional fossil fuel combustion is also not accounted for.

3.3.2 Improper disposal of used oil

The Environ (2009) lifecycle assessment calculated an emission factor of 2.40 kgCO_2e per gallon. This calculation was based on an assumption that all of the carbon in used oil that is improperly disposed is converted to CO_2 during a 100-year timeframe. Because this Methodology uses a 10-year crediting period, the Environ emission factor is reduced by a factor of 10, i.e., to .24 kgCO_2e per gallon.

4.0 ADDITIONALITY ASSESSMENT

Emission reductions from the project must be additional, or deemed not to occur in the "business-as-usual" scenario. Assessment of the additionality of a project will be made based on passing the two tests cited below. These two tests require the project proponent to demonstrate that the project activity is surplus to regulations and reduces emissions below the level established in the Methodology.

1. Regulatory Surplus Test, and
2. Practice-Based Performance Standard

4.1 Regulatory Surplus Test

In order to pass the regulatory surplus test a project must not be mandated by existing laws, regulations, statutes, legal rulings, or other regulatory frameworks in effect as of the project start date that directly or indirectly affect the credited GHG emissions associated with a project. The project proponent must demonstrate that there is no existing regulation that mandates the project or effectively requires the GHG emission reductions associated re-refining used lubricating oil.

Currently, there are no such requirements in the U.S. or elsewhere in North America. Consumers are free to use virgin lubricating oil or re-refined lubricating oil in any amount. Likewise, there are no restrictions in North America on the quantities of re-refined lubricating oil that can be produced, imported, or used for any application.

4.2 Practice-Based Performance Standard

The second test is whether used lubricating oil is routinely re-refined under common business practice, instead of being combusted. The most recent available industry data indicate that only 7% of collected used oil in North America is re-refined to base oil (Kline & Company, 2010).

5.0 QUANTIFICATION OF GHG EMISSION REDUCTIONS

Quantification of project emission reductions requires calculation of baseline emissions and project emissions.

5.1 Baseline Emissions

Baseline emissions (BE) must be estimated by using Equation 1 and by summing the baseline emissions for all SSRs identified as included in the baseline in Table 2. Baseline emissions are the combined GHG emissions from the combustion of used lubricating oil that would be avoided by additional production of re-refined used lubricating oil and the avoided improper disposal of used lubricating oil.

Default values for the parameters needed to calculate baseline emissions are listed in Table 4.

Table 4. Default Values for Baseline Emissions

Parameter (Equation #)	Value	Source
Baseline rate of collected used lubricating oil re-refined to base oil in North America (Eq 2) LRR_{BL}	7%	Kline and Company (2010)
Baseline rate of collected used lubricating oil combusted for energy recovery in North America (Eq 2) *LC*	78%	
Reduction in improper disposal of used oil within a comprehensive take back program (Eq 3) *RID*	3%	Derived and discounted based on CalRecycle (2010)
Effective emission factor for lubricating oil combustion (Eq 2) EFC_{LO}	7.73 x 10^{-5} kgCO_2e/BTU*	IPCC (2006)[5], Table 1.4
Net Calorific Value of used oil (Eq 2) EC_{LO}	144,230 BtU/gal	IPCC (2006), Table 1.2
Emission factor for improper disposal (Eq 3) EFD_{LO}	0.24 kg CO_2e/gal	Environ (2009)

*Units were converted from 73,300 kg CO_2/TJ

<u>Equation #1: Total Baseline Emissions</u>

$$BE_y = (BE_{ULOC,y} + BE_{ULOD,y})$$

Where, Units

BE_y	=	Baseline emissions in year y	tCO_2e
$BE_{ULOC,y}$	=	Baseline emissions from the combustion of used lubricating oil (ULOC) that are avoided through re-refining in year y	tCO_2e

[5] IPCC (2006) Guidelines for National Greenhouse Gas Inventories, Volume 2 (Energy)

$BE_{ULOD,y}$	=	Baseline emissions from the improper disposal of used lubricating oil (ULOD) that are avoided through re-refining in year y	tCO_2e

The GHG emissions from combustion of used lubricating oil that would be avoided by additional production of re-refined lubricating oil can be calculated using the default emission factor for combustion of used lubricating oil in the following equation:

Equation #2: Baseline Emissions from Combustion of Used Lubricating Oil

$$BE_{ULOC,y} = \Sigma[(EC_{LO,y} * EFC_{LO}) * (LC * Q_{LOT,y} /1000) * (1 – LRR_{BL})]$$

Where,

			Units
$BE_{ULOC,y}$	=	Baseline emissions from the combustion of used lubricating oil (ULOC) that are avoided through re-refining in year y	tCO_2e
$EC_{LO,y}$	=	Energy content of used lubricating oil (LO) that is re-refined and that would otherwise be combusted in year y – see Table 4	BTU/gallon
EFC_{LO}	=	Emission factor for used lubricating oil combustion – see Table 4	$kgCO_2e/BTU$
LC	=	Percentage of used lubricating oil that is combusted for energy recovery	%
$Q_{LOT,y}$	=	Total quantity of used lubricating oil that is re-refined to base oil[6] in year y	Gallons
1000	=	Conversion from kilograms to metric tons	
LRR_{BL}	=	Baseline rate of used lubricating oil re-refining - see Table 4	%

The GHG emissions from disposal of used lubricating oil that would be avoided by additional production of re-refined lubricating oil can be calculated using the following equation:

Equation #3: Baseline Emissions from Improper Disposal of Used Lubricating Oil

$$BE_{ULOD,y} = \Sigma(EFD_{LO} * RID * Q_{LOTB,y})/1000$$

Where, Units

[6] This quantity shall only include the gallons of re-refined base oil and not the volume of other re-refined products that may be produced in the re-refining process.

$BE_{ULOD,y}$	=	Baseline emissions from the improper disposal of used lubricating oil (ULOD) that are avoided through re-refining in year y	tCO_2e
EFD_{LO}	=	Emission factor for used oil disposal – see Table 4	$kgCO_2e$/gallon
RID	=	Percentage reduction of used lubricating oil that is improperly disposed within a comprehensive takeback program – see Table 4	%
$Q_{LOTB,y}$	=	Total quantity of used lubricating oil that is re-refined to base oil[6], in year y, in comprehensive takeback programs only	Gallons
1000	=	Conversion from kilograms to metric tons	

5.2 Project Emissions

Project emissions are determined from energy requirements and emissions from the Project Site, i.e., the facility conducting re-refining.

As noted in Section 3.2.1, GHG emissions from the fossil fuel sources required to provide heat in place of the used lubricating oil which is re-refined as part of the project are not included. This is because the baseline quantification does not account for avoided GHG emissions associated with the burning of used lubricant oil that displaces combustion of fossil fuels for the same heat value. Also, as noted in Section 2.1, any project-related emissions from collection and transport of used lubricating oil and re-refined lubricating oil are considered to be outside the project boundary.

Project emissions can be calculated as follows:

Equation #4: Total project emissions

$$PE_y = PE_{elec} + PE_{ff}$$

Where,

			Units
PE_y	=	Project emissions in year y	tCO_2
PE_{elec}	=	Project emissions from the use of electricity at the refining facility	tCO_2
PE_{ff}	=	Project emissions from the combustion of fossil fuels used at the refining facility	tCO_2

Equation #5: Project emissions from the use of electricity at the refining facility

$$PE_{elec} = Q_{electricity,y} * EF_{EL} / 2204.62$$

Where,

			Units
PE_{elec}	=	Project emissions from the use of electricity at the refining facility	tCO_2
$Q_{electricity,y}$	=	Quantity of electricity used by the refining facility in year y	MWh
EF_{EL}	=	Carbon emission factor for grid electricity[7]	$lbCO_2/MWh$
2204.62	=	$lbCO_2/tCO_2$	

Equation # 6: Project emissions from the combustion of fossil fuels used at the refining facility

$$PE_{ff} = \sum y \left(FF_{y,y} * EF_y\right)/1000$$

Where,

			Units
PE_{ff}	=	Project emissions from the combustion of fossil fuels used for the refining facility	tCO_2
$FF_{y,y}$	=	Total quantity of fossil fuel,y, consumed in year y	Volume/mass of fuel
EF_y	=	Fuel specific emission factor for fuel, y [8]	kg CO_2/volume or mass of fuel
1000	=	Conversion from kilograms to metric tons	

5.3 Leakage

In GHG project literature, leakage is a term that refers to secondary effects associated where the GHG emission reductions of a project may be negated by shifts in market activity or shifts in materials, infrastructure, or other physical assets associated with the project. In cases where leakage occurs, it must be accounted for and subtracted from the reported net GHG emission reductions for the reporting period.

[7] Project proponents shall use the current version of the U.S. Environmental Protection Agency's Power Profiler (http://oaspub.epa.gov/powpro/ept_pack.charts) to determine what regional emission factor should be used in accordance with the Emissions & Generation Resource Integrated Database (eGRID) for EF_{EL}. eGRID emission factors are available at http://www.epa.gov/energy/egrid.

[8] See Appendix B.

In the case of re-refining used lubricating oil, all potential sources of emissions are accounted for in the project boundary and it is unlikely that any emissions would occur outside the project boundary. Thus, leakage does not need to be considered.

5.4 Total Emission Reductions

GHG emission reductions (ER) from a used lubricating oil re-refining project are quantified by subtracting the project emissions (PE) from the baseline emissions (BE) as shown in Equation 6.

Equation #7: Total Emission Reductions

$$ER_t = BE_t - PE_t$$

Where,

			Units
ER_t	=	Total quantity of GHG emission reductions during the reporting period, t	tCO_2e
BE_t	=	Total quantity of project baseline emissions during the reporting period, t	tCO_2e
PE_t	=	Total quantity of project emissions during the reporting period	tCO_2e

6.0 MONITORING AND DATA COLLECTION

Each project shall include a monitoring, reporting and verification plan sufficient to meet the requirements of the ACR Standard. The plan shall collect all data required to be monitored in a manner that meets the requirements for accuracy and precision of this Methodology.

6.1 Description of the Monitoring Plan

The project proponent must prepare a monitoring plan describing (for each separately) the following: a) project implementation; b) technical description of the monitoring task; c) data to be monitored and collected; d) overview of data collection procedure; e) frequency of the monitoring; f) quality control and quality assurance procedure; g) data archiving; and h) organization and responsibilities of the parties involved in all the above.

The rationale of monitoring project implementation is to document all project activities implemented by the project that could cause an increase in GHG emissions compared to the baseline scenario.

6.2 Data Collection and Parameters to be Monitored

For a specific quantity of used lubricating oil that is re-refined, the process for monitoring the emission reduction parameters includes:

- Documentation of the point of origin of the used lubricating oil including location, volume, and date of collection;
- Documentation of the delivery of used lubricating oil to the re-refining facility, including location, volume, and date of delivery;
- Documentation demonstrating that the used lubricating oil collected and delivered to the Project Site is well-mixed prior to entering the re-refining process to ensure uniform composition;
- Documentation demonstrating that the used lubricating oil received at the Project Site to undergo the re-refining process is tested and meets all required specifications of used lubricating oil suitable for reprocessing based on the technical capabilities of the Project Site;
- Documentation on the volume of re-refined lubricating oil that is produced;
- Documentation of the annual yield of re-refined lubricating oil[9];
- Documentation of the location where the re-refined lubricating oil is produced;
- Documentation demonstrating the Project Proponent's license to operate as a re-refiner;
- In regions where used oil is considered to be hazardous waste, documentation must be maintained to prove proper handling, processing, and disposal of contaminants and waste.

Re-refiners that participate in comprehensive take back programs with customers to support a closed-loop recycling program can use Equation 3 to quantify GHG reductions from reduced improper disposal of used oil. In order to demonstrate eligibility for this, the re-refiner must provide:

- Evidence of the agreement(s) with individual customers in the form of a contract, operating plan, or other formal documentation;
- Effective start date of the takeback program(s);
- Geographic scope of the takeback program(s);
- Aggregated volumes of used oil and re-refined oil that are transacted on an annual basis with individual customer(s).

[9] A stated above, this volume only includes the volume of re-refined base oil and not volumes of other re-refined products that may be produced.

Table 5. Parameters to be monitored

Parameter	Description	Data Unit	Calculated (C), Measured (M), Reference (R), Operating Records (O)	Measurement Frequency	Comment
$Q_{LOT,y}$	Total quantity of lubricating oil that is re-refined to base oil in year y	Gallons	M	Continuous; annual value determined once and recorded	On-site records
$Q_{LOTB,y}$	Total quantity of lubricating oil that is re-refined to base oil, in year y, within a comprehensive takeback program	Gallons	M	Continuous; annual value determined once and recorded	On-site records
$Q_{electricity,y}$	Quantity of electricity used by the refining facility in year y	MWh	M, O	Continuous	On-site records from utility bills
EF_{EL}	Carbon emission factor for grid electricity	$lbCO_2/MWh$	R	Annual value determined once and recorded	See footnote 7
$FF_{y,y}$	Total quantity of fossil fuel,y, consumed in year y	Volume or mass	M, O	Continuous or as delivered	On-site records from utility bills or fuel purchase
EF_y	Fuel specific emission factor for fuel, y	kg CO_2/volume or mass of fuel	R	Annual value determined once and recorded	See Appendix B

7.0 VERIFICATION

See the ACR Standard for guidance on project validation and verification requirements.

A re-refined used lubricating oil offset project requires only one site visit regardless of the number of re-refining events within that reporting period.

For the purpose of this Methodology, the site visit must include a visit to the re-refining facility. The site visit may also include a visit to the project proponent's office(s) where all project-related documents and data were produced, managed, and retained. The site visit may also include a visit to any facility in the chain of custody, such as an aggregation facility or other point of origin.

APPENDIX A: BASELINE DATA INPUTS & UNIT CONVERSIONS

In calculating baseline emissions, default values for the net calorific value for lubricants and the CO_2 emission factor for combustion of lubricants are used in Equation 2, and listed in Table 4. The default values in this Methodology for these two parameters are derived from values, in different units, listed in the IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006). The IPCC values are converted into units that correspond to the quantification protocol in this Methodology as follows:

1. Net Calorific Value for Lubricants

IPCC Default Value: 40.2 TJ/Gg (Table 1.2; IPCC, 2006)

Converted into 144,230 BtU per gallon using the following standard conversion factors:

- 9.478 e+8 BtU/TJ
- 1 Gg/10^6 kg
- 1.0 kg lubricant per Liter lubricant (Default value for average density of lubricant at room temperature and standard atmospheric pressure, from Table 2, CDP Guidelines for Conversion of Fuel Data (CDP, 2014)
- 3.78541 Liters/Gallon

2. Effective CO_2 Emission Factor for Lubricant Combustion

IPCC Default Value: 73,700 kg CO_2/TJ (Table 1.4; IPCC, 2006)

Converted into kgCO_2 per BtU using the standard conversion factor:

- 9.478 e+8 BtU/TJ

APPENDIX B: FOSSIL FUEL EMISSION FACTORS

To calculate PE_{ff}, project proponents shall use the below emission factors for EF_y which will be revised periodically based on updated information.

	CO_2 EF_y	
Fossil Fuel Type	**Kilograms (kg) CO_2**	**Per Unit**
Propane	5.76	Gallon
Butane	6.71	Gallon
Butane/Propane Mix	6.21	Gallon
Home Heating and Diesel Fuel	10.16	Gallon
Kerosene	9.75	Gallon
Coal (All types)	2,100.82	Short ton
Natural Gas	53.12	Thousand cubic feet
Gasoline	8.89	Gallon
Residual Heating Fuel (Businesses only)	11.79	Gallon
Flared natural gas	54.75	Thousand cubic feet
Petroleum coke	14.70	Gallon
Other petroleum & miscellaneous	10.02	Gallon
Source: U.S. Energy Information Administration, published February 2, 2016.		

APPENDIX C: REFERENCES

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