FLOCK

# Flock Freight Emissions Framework Technical Documentation, in Conformance with GLEC v3.2 and ISO14083

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# Intro
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Flock Freight’s freight emissions calculations take a full life-cycle approach and are certified annually by the Smart Freight Centre, an independent third-party organization, to be generally suited to deliver results aligned with  the Global Logistics Emission Council (GLEC) Framework, ISO14083 and the Greenhouse Gas Protocol. This document covers North American road transport activity.

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# I. Abbreviation & unit key

| | |
|---|---|
| **ABBREVIATION:** | **$CO_2e$** |
| **MEANING:** | Carbon dioxide equivalent |
| **EXPLANATION:** | Carbon dioxide equivalent is a unit that describes the collective impact of different greenhouse gases as a single measure related to the overall global warming potential (GWP). caused by carbon dioxide (derived from GLEC v3.2). |

| | |
|---|---|
| **ABBREVIATION:** | **FTL** |
| **MEANING:** | Full truckload |
| **EXPLANATION:** | Sometimes referred to as “truckload” in the freight industry, one shipment from a single shipper is transported on one truck. FTLs are assumed to be full through weight (weighing out) or volume (cubing out). |

| | |
|---|---|
| **ABBREVIATION:** | **g** |
| **MEANING:** | gram |
| **EXPLANATION:** | Unit of mass. GLEC emissions intensity variables are sometimes presented in grams of $CO_2e$. $CO_2e$ output values may be converted to other units such as metric tons or pounds. |

| | |
|---|---|
| **ABBREVIATION:** | **kg** |
| **MEANING:** | kilogram |
| **EXPLANATION:** | Unit of mass. GLEC emissions factors are sometimes presented in kilograms of $CO_2e$. $CO_2e$ output values may be converted to other units such as metric tons or pounds. |

| | |
|---|---|
| **ABBREVIATION:** | **lbs** |
| **MEANING:** | pounds |
| **EXPLANATION:** | Unit of mass. Flock measures shipment weight in pounds and converts to other units when necessary. |

| | |
|---|---|
| **ABBREVIATION:** | **LTL** |
| **MEANING:** | Less than truckload |
| **EXPLANATION:** | Shipment mode where smaller shipments, often 10 linear feet or less, share truck space and move through the hub-and-spoke system. Shipments are dropped off at terminals, consolidated with similarly-routed shipments, and picked back up. This continues until the shipment reaches its destination. |

| | |
|---|---|
| **ABBREVIATION:** | **mpg** |
| **MEANING:** | miles per gallon |
| **EXPLANATION:** | Flock measures fuel efficiency in mpg and converts to other units when necessary. |

| | |
|---|---|
| **ABBREVIATION:** | **MS TL** |
| **MEANING:** | Multi-stop truckload |
| **EXPLANATION:** | Multiple shipments from one shipper share space on a truck, often with the same pickup location, but different drop off locations or vice versa. |

| | |
|---|---|
| **ABBREVIATION:** | **PTL** |
| **MEANING:** | Partial truckload |
| **EXPLANATION:** | Shipments too large for LTL but too small for the shipper to rationalize paying for a truckload. These shipments are often manually combined with other loads by the carrier, but the shipper and logistics provider have no visibility into how these loads are combined or moved. |

| | |
|---|---|
| **ABBREVIATION:** | **STL** |
| **MEANING:** | Shared Truckload |
| **EXPLANATION:** | A tech-enabled freight mode that allows several shippers, typically between two and four, to share trailer space on one truck. This process is sometimes referred to as “pooling” shipments together. Freight does not leave the truck until delivery and moves on a pre-determined terminal-free route to its destination. |

| | |
|---|---|
| **ABBREVIATION:** | **ton-mile** |
| **MEANING:** | US short ton-mile |
| **EXPLANATION:** | Weight of a shipment in US tons multiplied by the distance of a shipment in miles. |

| | |
|---|---|
| **ABBREVIATION:** | **TTW** |
| **MEANING:** | Tank to wheel |
| **EXPLANATION:** | The portion of greenhouse gases emitted when fuel is burned to power a vehicle, also known as tailpipe emissions. |

| | |
|---|---|
| **ABBREVIATION:** | **UTL** |
| **MEANING:** | Underutilized truckload |
| **EXPLANATION:** | Referred to as “truckload” in the freight industry, one shipment from a single shipper is transported on one truck. In a UTL, the shipment does not fill the space of the trailer by weight or volume. |

| | |
|---|---|
| **ABBREVIATION:** | **VLTL** |
| **MEANING:** | Volume LTL |
| **EXPLANATION:** | Just like LTL, but with loads that are larger and incur fees for their size. |

| | |
|---|---|
| **ABBREVIATION:** | **WTT** |
| **MEANING:** | Well to tank |
| **EXPLANATION:** | The portion of greenhouse gases from the fuel’s life cycle from the initial process of extraction to the moment fuel is supplied to the vehicle (derived from GLEC v3.2). |

| | |
|---|---|
| **ABBREVIATION:** | **WTW** |
| **MEANING:** | Well to wheel |
| **EXPLANATION:** | Refers to the full fuel life cycle; i.e. the summation of the WTT and TTW phases (derived from GLEC v3.2). |

# II. Emissions formula

All modes use the following basic format for calculating emissions, with different emissions intensity values for each:

**TON-MILES X EMISSIONS INTENSITY**

FIGURE 1

- Weight of a shipment is provided by the shipper at time of booking.
- Distance between dispatch and drop off is calculated by Flock Freight using Google Directions API, MapBox, and OpenStreetMaps (OSM).

# III. Emissions intensity chart

| MODE | EMISSIONS INTENSITY (g $CO_2e$ / ton-mile) VALUES | | |
|---|---|---|---|
| | WTT | TTW | WTW |
| FTL | 24 | 112 | 136 |
| STL | 42 | 201 | 243 |
| LTL | 55 | 263 | 318 |
| UTL | 66 | 328 | 394 |

FIGURE 2

Source for FTL and LTL: GLEC Framework v3.2, Section 3, Module 2, Table 6, page 99. Converted to g/ton-mile using Section 4, Annex unit conversions, Table 2, page 174.

Source for STL and underutilized TL explained in sections V - VII.

Shipments that were picked up in the 2025 calendar year or prior will use emissions intensity values from our 2025 technical document. This document can be provided upon request.

# IV. Corresponding emissions intensities for Flock Freight service options ↘

| FULFILLMENT MODE | EMISSIONS INTENSITY |
|---|---|
| FTL | FTL |
| LTL | LTL |
| VLTL | LTL |
| MS TL | STL |
| PTL | STL or UTL* |
| STL | STL |

FIGURE 3

*We assume a PTL either moves solo in a truck (using the UTL emissions formula) or is matched with other freight (using the STL emissions formula) based on the price we pay the carrier. PTL uses the UTL formula when we pay the carrier more than 90% of the estimated truckload cost, and uses the STL formula when we pay the carrier 90% or less than the estimated FTL cost. The truckload cost is calculated by Flock Freight and represents what we would expect to pay a carrier to move a single load in a trailer without other freight onboard.

# V. Shared Truckload emissions intensity

GLEC v3.2 does not have an emissions intensity value to represent Shared Truckload, which is why Flock has created its own alongside Smart Freight Centre. The inputs are based on annual Shared Truckload data.

Logic behind the emissions intensity value for STL:

1. Calculate the total emissions for one year of Shared Truckload pools run by Flock Freight.

2. Calculate the ton-miles for one year of Shared Truckload pools and add the values together.

3. Dividing the total emissions by the total ton-miles yields an emissions intensity value in grams of $CO_2e$ per ton-mile that can be applied to individual STL shipments to find their emissions.

The methodology for calculating the emissions intensity of Shared Truckload applies the following formulas to one year of data.

**STL EMISSIONS INTENSITY (g $CO_2e$ / TON-MILE) = SUM (STL EMISSIONS) / SUM (TON-MILES)**

**STL EMISSIONS = FUEL CONSUMED BY THE POOL x EMISSIONS FACTOR**

**FUEL CONSUMED = DISTANCE OF THE POOL x MPG**

**MPG = FUEL CURVE BASED ON WEIGHT**

Please see section VII for more information.

FIGURE 4

| EMISSIONS FACTORS (kg $CO_2e$ / kg FUEL) FOR DIESEL | | |
|---|---|---|
| WTT | TTW | WTW |
| 0.65 | 3.22 | 3.87 |

FIGURE 5

Source: GLEC Framework v3.2, Module 1, Section 3, “Emissions factors: North American Sources”, page 79

# Assumptions:

1. All trucks for STL transport run on diesel and are in EPA class 8b.

2. An empty running (deadhead) factor of +3.82% is added to the loaded distance to represent miles that the driver travels to the first shipment pickup with no freight loaded.
   - 3.82% is the average empty running factor tracked by Flock from 1/1/25 - 12/31/25 for Shared Truckloads.
   - We calculate the empty running factor as the distance between truck dispatch location and first pickup location divided by loaded trip miles.

3. We assume the total distance value calculated by Flock is the shortest feasible distance. To account for route deviations, we add a 5% uplift on the total distance aligned with ISO requirements.

4. Fuel efficiency is based on a fuel curve dependent on weight of the equipment + payload. Please see section VII for more information.

# VI. Underutilized truckload emissions intensity

## Why is an underutilized TL emissions intensity value necessary?

**SUMMARY:** Flock proposes that the GLEC FTL emissions intensity factor, derived from EPA SmartWay data, represents the movement of fully utilized FTLs, and does not represent the emissions of underutilized TLs. We've found that over half the trucks on the road (58%) are moving over half empty with 34 linear feet of unused deck space. If the GLEC FTL emissions factor is applied to underutilized truckloads, we believe it underestimates emissions per ton-mile. The gap in emissions intensity variables is related to the voluntary nature of emissions reporting in the freight industry today, and does not degrade the quality or rigor of SmartWay or GLEC.

**DETAILS:** GLEC derives its FTL emissions intensity factor from EPA SmartWay partner data. In the 2024 SmartWay Online Truck Tool, the average payload load size recorded for TL/Dry Van carriers is 18.46 tons, or 36,920 lbs. Assuming most class 8b tractor-trailers can accept about a 40,000 lb payload, these trucks are reported to be nearly full. This data was collected from 929 class 8b carriers. Flock alone used over 8,000 carriers in 2025, and there were over 2,000,000 freight carriers registered under the FMCSA in the US that year. There are presumably hundreds of thousands of class 8b TL/Dry Van carriers who don't report to SmartWay. This means their payloads and distances are unaccounted for in emissions outcomes.

In our 2025 research study of 1,000 anonymous shippers, we found that 58% of the trucks on the road move over half empty with 34 linear feet of unused deck space. To further support the external research and add a weight component, Flock analyzed over 50,000 of our own shipments that measured over 10 linear feet and moved in Shared Truckloads. The average weight of these shipments was just under 10,000 lbs and 24 linear feet. Had these shipments not moved in a Shared Truckload with other freight, the shipper would have most likely paid for the freight to move solo in a truck.

There is a chance a carrier would manually locate more freight to add on board, but it isn’t tracked or accounted for by the shipper and often happens without their knowledge.

This portion of underutilized TLs in US trucking is not properly represented by SmartWay or GLEC in their truckload emissions intensity factor. This is why Flock is seeking to create a more realistic emissions intensity value for underutilized truckloads.

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**HOW IT’S CALCULATED:**

We calculated the emissions intensity of underutilized truckloads using STL shipments larger than 10 linear feet over the course of one year.  Based on our research and customer feedback, the assumption is that if these loads had not been run in an STL, they would have moved solo on a truck. **We used the same methodology as calculating the emissions intensity for Shared Truckloads, with a few key differences**

- The calculation assumes no shipments were pooled together, and instead each shipment moved on its own truck in an underutilized truckload. This means weight per truck is lower for similar distances. This is because truck space wouldn't be shared in the underutilized TL scenario.
- +4.6% is added to the loaded distance as the average empty running factor tracked by Flock from 1/1/25 - 12/31/25 for truckloads.

# VII. Formula for STL and underutilized TL fuel efficiency ↘

**MPG = -4.75e-10 x (WEIGHT)^2 + 8e-6 x (WEIGHT) + 7.2796**

FIGURE 6

1. We used the fuel curve in Eq. 1 & Fig. 34 from the ORNL's Effect of Weight and Roadway Grade on the Fuel Economy of Class-8 Freight Trucks and revised it to be more conservative, adjusting it down using an MPG value and payload derived from SmartWay.

2. The revision follows: A class 8 truck carrying a 32,700 lb payload has an average MPG of 5.7 MPG instead of ORNL's 8.09 MPG.

FIGURE 7

**MPG = (g $CO_2$ / GALLON OF DIESEL) / ($CO_2$ g / mi)**

FIGURE 7.1

**(g $CO_2$ / GALLON OF DIESEL) = 10,180**

FIGURE 7.2

**($CO_2$ g / mi) = 1,795**

FIGURE 7.3

**10,180 / 1,795 = 5.7 MPG**

**= miles per gallon traveled by the average non-SmartWay TL/Dry Van**

Source: Figure 7.1, $CO_2$ Factors by Fuel Type, Fuel type = Diesel from the 2024 SmartWay Online Truck Tool: All Carriers Technical Documentation.
Figure 7.2, Non-SmartWay Truck Carrier Performance Metrics, Category = TL/Dry Van from the 2024 SmartWay Online Logistics Tool: Technical Documentation.

3. We take the weight of an average TL/Dry Van from table 4, Default “Miles Only” Payload Values from the 2024 SmartWay Online Logistics Tool: Technical Documentation.

   A. Tons = 16.35

   B. Pounds conversion = 32,700

4. Our payload assumption is a more conservative approach compared to using the average payload of a class 8b SmartWay carrier (18.46 tons) from Table 5, Average, Min and Max Payloads (short tons) by Truck Class/SmartWay Category in the 2024 SmartWay Online Truck Tool: All Carriers Technical Documentation.

5. It’s worth noting that the ORNL study was released in October 2011. We are open to updating this fuel curve in future editions of our methodology if we find better-aligned research on the effect of payload on fuel efficiency.

# VIII. Emissions avoidance

Emissions avoidance is the difference between a shipment that moves in an STL, and that same shipment had it moved using the most likely alternative service option of LTL or UTL.

On average, STL shipments were 38% less emissions intensive per ton-mile than underutilized TL and 24% less emissions intensive than LTL based on Flock's calculations using 2025 shipment data.

STL is typically less emissions intensive than underutilized TL or LTL because it fills more space on the truck and doesn't involve transloading or the hub-and-spoke system.

To calculate emissions avoidance, we first measure the emissions of a shipment that moved in a Shared Truckload. Next, we measure the emissions of that same shipment had it moved in an underutilized TL or LTL. The difference between these calculations gives us the emissions avoided.

**We use 10 linear feet as the LTL / TL cut off to decide the alternative mode.** If a load measures 10 linear feet or less, we place it in the LTL category for this calculation. If a load measures more than 10 linear feet, we place it in the underutilized TL category. The cut off point of 10 linear feet is based on Flock's 2025 research study, where the mean LTL/FTL cut off point was 9.81 linear feet for a sample size of 715 shippers.

Please note this linear foot cutoff is solely used for the purpose of the emissions avoidance exercise at Flock. Flock agrees on service options with our shippers at the time of booking, and not based on this linear foot cutoff.

# IX. Examples ↘

## Total emissions per shipment

**TON-MILES x EMISSIONS INTENSITY VALUE = EMISSIONS**

| | MODE | WEIGHT (tons) | DISTANCE (miles) | TON-MILES | WTW EMISSIONS INTENSITY VALUE ($g\ CO_2e$ / ton-mile) | WTW EMISSIONS ($g\ CO_2e$) |
|---|---|---|---|---|---|---|
| Shipment 1 | LTL | .25 | 1,000 | 250 | 318 | 79,570 |
| Shipment 2 | FTL | 18 | 1,000 | 18,000 | 136 | 2,444,040 |
| Shipment 3 | STL | 5 | 1,000 | 5,000 | 243 | 1,215,000 |
| Shipment 4 | STL | 2.5 | 1,000 | 2,500 | 243 | 607,500 |

FIGURE 8

## Emissions avoidance (STL only)

**STL EMISSIONS - ALTERNATIVE MODE EMISSIONS = EMISSIONS AVOIDANCE**

| | WTW STL EMISSIONS ($g\ CO_2e$) | LINEAR FEET | ALTERNATIVE MODE (IF STL WASN'T AN OPTION) | WTW ALTERNATIVE MODE EMISSIONS ($g\ CO_2e$) | EMISSIONS CHANGE BY MOVING THE SHIPMENT STL ($g\ CO_2e$) | % EMISSIONS CHANGE (AVOIDANCE) |
|---|---|---|---|---|---|---|
| Shipment 3 | 1,205,000 | 14 | UTL | 1,970,000 | -755,000 | -38% |
| Shipment 4 | 602,500 | 8 | LTL | 795,700 | -188,200 | -24% |

FIGURE 9

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