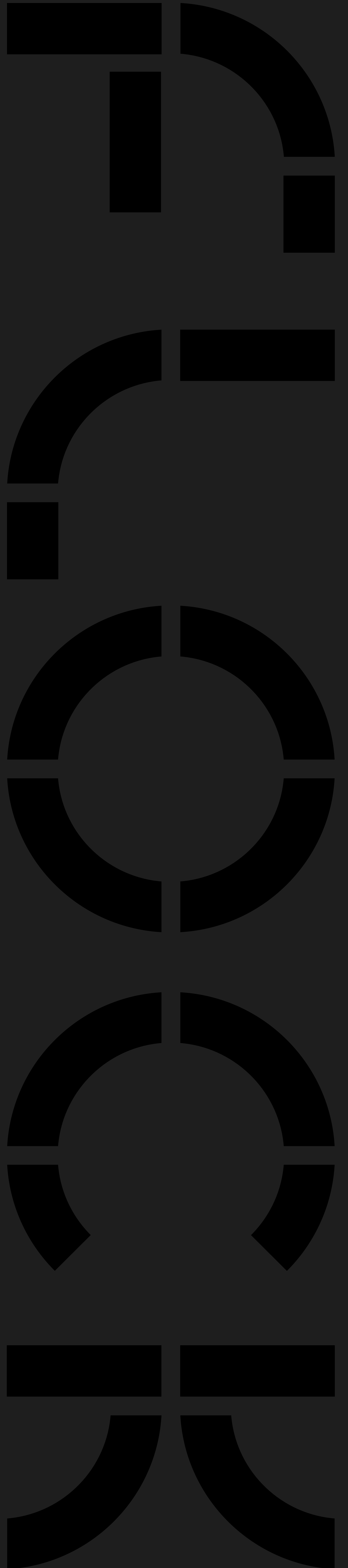




Flock Freight Emissions Framework Technical Documentation, in Conformance with GLEC v3.1 and ISO14083



Intro



Flock Freight's freight emissions calculations take a full life-cycle approach and are accredited annually by the [Smart Freight Centre](#), an independent third-party organization that ensures we provide accurate measurements in accordance with the [Global Logistics Emission Council \(GLEC\) Framework](#), [ISO14083:2023](#) and the [Greenhouse Gas Protocol](#). This document covers North American road transport activity.



**Smart Freight
Centre**



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I. Abbreviation & unit key



ABBREVIATION:	CO ₂ e
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 radiative forcing caused by carbon dioxide (derived from GLEC v3.1).
ABBREVIATION:	FTL
MEANING:	Full truckload
EXPLANATION:	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 ₂ e. CO ₂ e 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 ₂ e. CO ₂ e 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 v3.1](#)).

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 v3.1](#)).

II. Emissions formula



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

$$\text{TON-MILES} \times \text{EMISSIONS INTENSITY}$$

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 ₂ e / ton-mile) VALUES		
	WTT	TTW	WTW
FTL	24	115	139
STL	41	200	241
LTL	57	283	340
UTL	64	320	384

FIGURE 2

Source for FTL and LTL: GLEC Framework V3.1, Section 3, Module 2, Table 6, page 98. Converted to g/ton-mile using Section 4, Annex unit conversions.

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



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 v3.1 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 CO₂e 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.

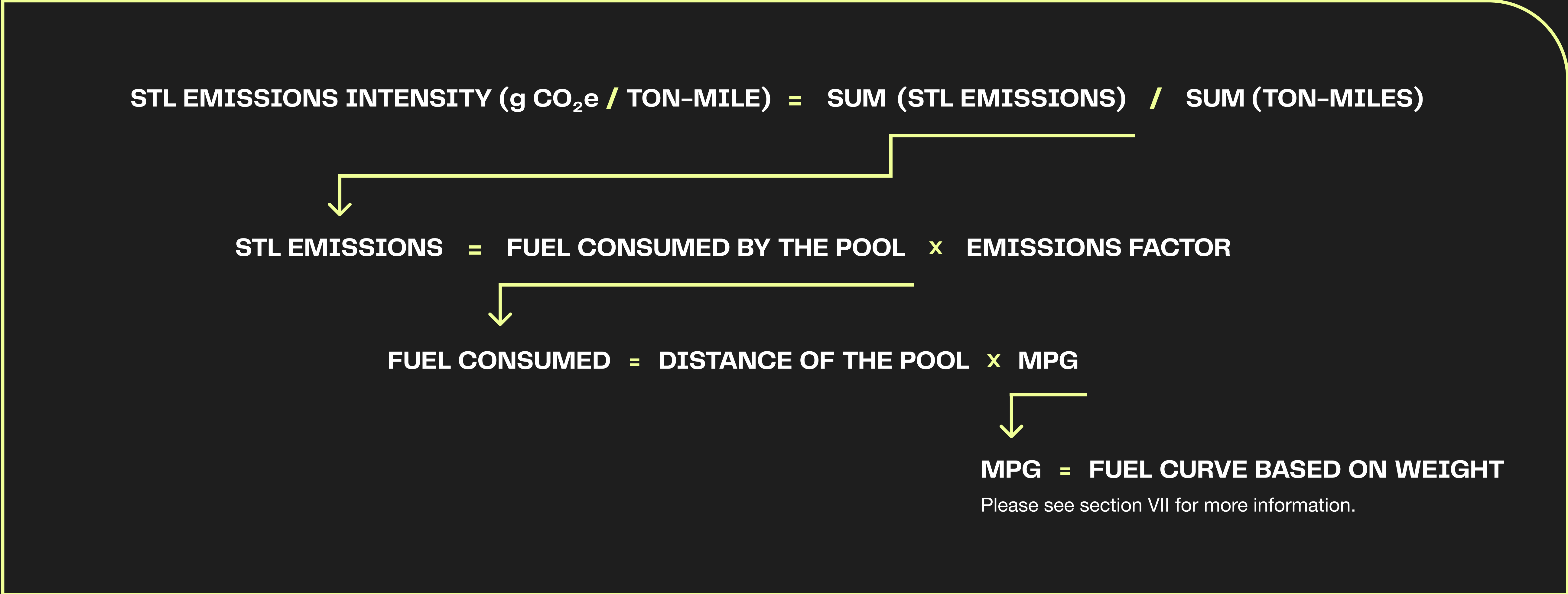


FIGURE 4

EMISSIONS FACTORS (kg CO ₂ e / kg FUEL) FOR DIESEL		
WTT	TTW	WTW
0.65	3.22	3.87

FIGURE 5

Source: GLEC Framework V3.1, 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 3.83% is added to the loaded distance to represent miles that the driver travels to the first shipment pickup with no freight loaded.
 - 3.83% is the average empty running factor tracked by Flock from 10/1/23 - 9/30/24 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 nearly half the trucks on the road (43%) are moving over half empty with 29 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 2024, and there were almost 2,000,000 freight carriers registered under the FMCSA in the US that year. There are presumably thousands, if not 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 2024 research study of 1,000 anonymous shippers, we found that 43% of the trucks on the road move over half empty with 29 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 22 linear feet. Had these shipments not moved in a Shared Truckload with other freight, the shipper would have 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.

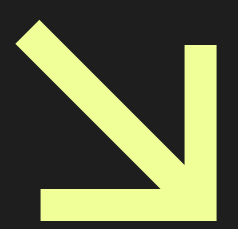
This portion of underutilized TLs in US trucking is not properly represented by SmartWay or GLEC in their truckload emissions intensity factor. This is why Flock is seeking to create a more realistic emissions intensity value for underutilized truckloads.

**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.
- +5.13% is added to the loaded distance as the average empty running factor tracked by Flock from 10/1/23 - 9/30/24 for truckloads.

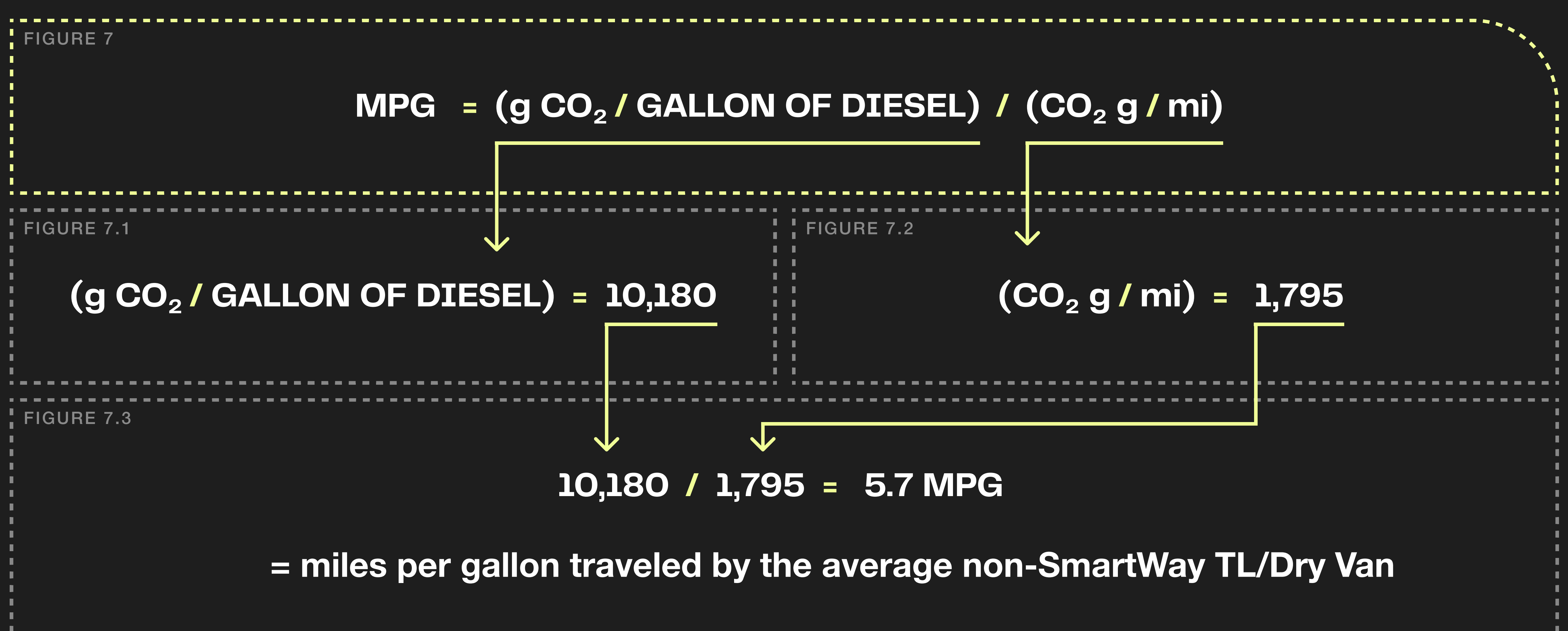
VII. Formula for STL and underutilized TL fuel efficiency



$$\text{MPG} = -4.75\text{e-}10 \times (\text{WEIGHT})^2 + 8\text{e-}6 \times (\text{WEIGHT}) + 7.2796$$

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.



Source: Figure 7.1, CO₂ 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 a pooled STL, and that same shipment had it moved using the most likely alternative service option of LTL or underutilized TL.

On average, STL shipments were 37% less emissions intensive per ton-mile than underutilized TL and 29% less emissions intensive than LTL based on Flock's calculations using one year of 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 a [research study](#) Flock conducted in 2024, where the mean LTL/FTL cut off point was 9.92 linear feet for a sample size of 843 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 × EMISSIONS INTENSITY VALUE = EMISSIONS

	MODE	WEIGHT (tons)	DISTANCE (miles)	TON-MILES	WTW EMISSIONS INTENSITY VALUE (g CO ₂ e / ton-mile)	WTW EMISSIONS (g CO ₂ e)
Shipment 1	LTL	.25	1,000	250	340	85,045
Shipment 2	FTL	18	1,000	18,000	139	2,496,600
Shipment 3	STL	5	1,000	5,000	241	1,205,000
Shipment 4	STL	2.5	1,000	2,500	241	602,500

FIGURE 8

Emissions avoidance (STL only)

STL EMISSIONS – ALTERNATIVE MODE EMISSIONS = EMISSIONS AVOIDANCE

	WTW STL EMISSIONS (g CO ₂ e)	LINEAR FEET	ALTERNATIVE MODE (IF STL WASN'T AN OPTION)	WTW ALTERNATIVE MODE EMISSIONS (g CO ₂ e)	EMISSIONS CHANGE BY MOVING THE SHIPMENT STL (g CO ₂ e)	% EMISSIONS CHANGE (AVOIDANCE)
Shipment 3	1,205,000	14	UTL	1,920,000	-715,000	-37%
Shipment 4	602,500	8	LTL	850,450	-247,950	-29%

FIGURE 9

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