Methodology for Estimating Emissions and Air Quality Impacts in Port Drayage

As electric trucks enter operations, companies are increasingly looking to quantify their impact for decision-making and reporting. However, differences in methodologies, assumptions, and data quality make it difficult to compare results across regions, partners, and projects.

This methodology outlines a practical, consistent approach to estimate and compare emissions from diesel and battery-electric drayage operations. It is designed to support companies across the value chain, shippers, carriers, and logistics providers, in evaluating opportunities, prioritizing deployment, and communicating impact with confidence.

Why drayage is a priority

Drayage operations are short-distance, high-frequency, and concentrated around ports, conditions well suited to electric trucks. Today, these operations are predominantly diesel-powered, making them a concentrated source of both greenhouse gas emissions and harmful air pollutants, directly affecting the health of port workers and surrounding communities.

Diesel trucks emit nitrogen oxides (NOx), particulate matter (PM), and black carbon (BC), all of which contribute to poor air quality, and greenhouse gases (GHGs), which contributes to climate change. Electric drayage eliminates tailpipe air pollutant emissions entirely. This means that, in addition to reducing CO_2 emissions, it can significantly improve local air quality, making it a decarbonization solution with both global climate benefits and immediate local health impacts.

Purpose of the analysis

This methodology provides a structured way to compare diesel and electric drayage impact across two dimensions:

- Greenhouse gas emissions (CO_2e) – reflecting climate impact
- Air pollutants (PM, NOx, BC) – reflecting local air quality impact

Air pollutants predominantly have local impacts, unlike GHGs which have a global impact. Results are expressed in grams of emissions per tonne-kilometer (tkm). This allows for consistent comparison across different operations, geographies, and vehicle types.

How this methodology is used

The methodology is designed as a screening-level analytical framework, meaning it provides reliable directional insights using standard assumptions and default values. The analysis:

- Provides a high-level overview of current conditions at the port
- Supports comparison across ports and regions
- Enables tracking of progress over time

The table below summarizes the minimum data required to apply this methodology.

Table 1. Data Requirements Overview

Emissions	Approach	Vehicle assumptions	Additional data
Air Pollutants	GLEC + Tier 1 method	Vehicle type, fuel type	tkm OR fuel consumed
	GLEC + Tier 2 method	Vehicle type, fuel type, vehicle emission standard	Distance
GHG Emissions	GLEC/ISO 14083	Vehicle type, fuel/energy type	Distance, transported load

It can be applied quickly across ports and projects, while still aligning with established frameworks such as the GLEC Framework and ISO standards. This methodology is intentionally designed to work with limited, aggregated data, reflecting the fragmented nature of port drayage operations. The results are indicative and based on minimum required data and assumptions, they are not intended for company-level emission reporting.

More granular approaches exist using different data inputs such as fuel consumption. Refer to the GLEC Framework and associated Air Pollutant Methodology for descriptions of these more detailed methods.

Air pollutant emissions – estimation approach

To calculate the estimated air pollutants produced by drayage operations, fuel emission factors are multiplied by fuel intensity. Fuel emission factors related to heavy-duty trucks from the Air Pollutant Emission Inventory Guidebook are considered. For electric trucks, fuel combustion is zero as there is no combustion process occurring at the tailpipe. Electric trucks have zero tailpipe air pollutant emissions, as no combustion occurs.

Table 2 Emissions of PM2.5, BC, and NOx per tkm travelled by a HDV truck

	Air pollutant emissions		
	PM 2.5 (g/tkm)	**BC (g/tkm)**	**NOx (g/tkm)**
Diesel trucks	**0.013**	**0.007**	**0.623**
Electric trucks	**0**	**0**	**0**

More detailed information on the two methodologies which can be used, depending on data input available can be found in Appendix I.I and I.II. The method to be used needs to be consistent across stakeholders.

GHG emissions – estimation approach

For diesel drayage trucks, total emissions come from both fuel production and fuel use. For battery-electric trucks, total emissions depend on how the electricity is generated. To compare GHGs for diesel and electric trucks, emissions from producing and delivering the fuel must therefore be considered (known as the well to wheel or WtW approach).

Estimated GHG emissions for electric trucks are calculated by multiplying the truck's energy used by the carbon intensity of the local electricity grid. The carbon intensity values for electricity (gCO_2e/KWh) can be found in the GLEC Framework v3.2 and represent regional averages and as such, results will vary by region. The table below has already included the fuel intensity of an assumed Artic Truck 34-40 t GVW and therefore presents the emissions as gCO2e/tkm.

Table 3 Emission Intensity in gCO_2e/tkm per region

	GHG emissions (gCO_2e/tkm)		
	United States	**Europe**	**China**
Diesel trucks	**96**	**101**	**81**
Electric trucks	**56**	**53**	**99**

The above table indicates that based on the average, consumed national grid, electric trucks produce more GHG emissions in comparison to diesel trucks in China. However, these are based on averages and when a direct source of renewable energy is used, the emission intensity factors for electric trucks become significantly more favorable. It is important that a transition to electric starts today, as the grid is only becoming more renewable over time. It also supports operational knowledge and the roll out of electric trucks at scale, even when the current outcome is that GHG savings are little to none.

Interpreting results at port level

The calculations above are based solely on default data. When comparing results in Europe, on average, electric trucks eliminate all air pollutants and ~47% of GHG emissions.

Table 4 Emission comparison of diesel vs electric trucks

	Air pollutants			**GHGs (Europe)**
	PM 2.5 (g/tkm)	**BC (g/tkm)**	**NOx (g/tkm)**	**(g CO2e /tkm)**
Diesel trucks	**0.013**	**0.007**	**0.623**	**101**
Electric trucks	**0**	**0**	**0**	**53**
Reduction	**100%**	**100%**	**100%**	**~47%**

For simplicity, the results are expressed per unit of activity (GHG and air pollutants per tkm), providing an initial overview of impacts. This calculation uses assumptions on vehicle type, for a more precise estimate of total emissions, the GLEC Framework and the included air pollutant methodology can be used.

To calculate the total impact of drayage trucks per port, total emissions at port level are estimated by applying emission factors to aggregated truck activity data. To do this accurately, port authorities and terminals will have to share the total tonne kilometers travelled within the port area. If this activity data is not known, it can be estimated using the distance travelled (km) within the port and the transported load (tonnes). Note empty running and load factor assumptions have already been built into the calculation To create a year-over-year comparison, these data will be collected and reported out on an annual basis.

Key assumptions and limitations

This methodology is designed to balance usability and consistency. As such, several simplifying assumptions are applied:

- Results are based on average vehicle performance and standard conditions
- Electricity emissions reflect regional averages, not specific charging profiles
- Operational variability (traffic, idling, routing) is not explicitly modeled
- Non-exhaust emissions (e.g. tire and brake wear) are not included

These assumptions ensure comparability across ports but may not fully reflect real-world conditions. More detail on these can be found in Appendix III and IV.
Where possible, companies are encouraged to use primary operational data to improve accuracy and relevance. The GLEC Framework and associated Air Pollutant Methodology can assist in applying these more granular methods.

From estimate to real-world impact

Quantifying emissions is a starting point, but real impact depends on how electrification is implemented and scaled and can be more accurately measured using primary operational data.

By combining this methodology with real operational data, organizations can:

- Track the growth and utilization of electric drayage operations
- Compare performance between diesel and electric deployment models
- Build credible, data-backed business cases for scaling

Replacing high-level assumptions with company-specific data enables:

- More accurate Scope 1 and Scope 3 emissions insights
- Better alignment between operations and reporting

Conclusion

This methodology provides a consistent, port-level view of emissions and air quality impacts from drayage operations. While based on high-level assumptions, it enables comparison across ports and supports year-over-year tracking of progress as electric truck adoption increases. Within the Electrifying Drayage Alliance (EDA), this approach is used to measure and demonstrate impact across priority ports over time, highlighting where progress is being made and where further action is needed. Organizations can build on this approach using their own operational data for more detailed analysis where relevant.

Appendix

Appendix I.I – Air Pollutant Emissions Calculation (Tier 1 Method)

Input data: total tkm within the port area

For heavy-duty diesel trucks (34 - 40 tonnes GVW), air pollutant emissions are estimated using EMEP/EEA Tier 1 emission factors [1]. The calculation, according to Equation B, determines the mass of pollutants emitted per tonne-kilometer (Table 1) [2].

To estimate air pollutant emissions in g/tkm, use Equation B, which is derived from Equation A.

$$Em_{k,f} = tkm_{v,f} \times FI_{v,f} \times EF_{k,f} \quad \text{(A)}$$

$$\frac{\boldsymbol{Em_{k,f}}}{\boldsymbol{tkm_{v,f}}} = \boldsymbol{FI_{v,f}} \times \boldsymbol{EF_{k,f}} \quad \text{(B)}$$

- FI = Fuel Intensity (GLEC Framework)– 0.024 kg/tkm (For articulated diesel trucks (34 - 40 tonnes GVW)
- EF = Emission Factors:
    - PM 2.5 Emission factors (EMEP/EEA) – 0.55 g/kg of fuel (HDVs)
    - BC Emission factors EMEP/EEA) – 0.2915 g/kg of fuel (HDVs)
    - NOx Emission factors EMEP/EEA) – 25.95 g/kg of fuel (HDVs)

Table 6 Emissions of PM2.5, BC, and NOx per tkm of a diesel truck

Air pollutant emissions		
PM 2.5 (g/tkm)	BC (g/tkm)	NOx (g/tkm)
0.013	0.007	0.623

To calculate the emissions produced by drayage operations, multiply the factors included in Table 1 by the total tkm within the port area, ensuring the tkm is calculated with the guidance of the GLEC Framework (equation A) [3]. Using real data improves accuracy and makes the results more reliable for decision-making.

Note: If fuel consumption data for the total port area is known, simple calculation steps can be provided.

For a more detailed description of the air pollutant calculation methodology and the emission factors applied for different energy carriers, please consult the full methodological report: Air Pollutants Emissions Methodology for the logistics sector. For greenhouse gas calculation, consult the GLEC Framework, both documents can be found in the Smart Freight Centre Library.

Appendix I.II – Air Pollutant Emissions Calculation (Tier 2 Method)

Input data: total vehicle km within the port area

If more granular data exists on the distance travelled within the port area by vehicle type, there are opportunities to use specific emission factors for air pollutants varied by the specific truck vehicle emission standards (Euro Classes).

To estimate air pollutant emissions in g/vehicle-km, use Equation C.

$$Em_{k,v,f,s} = km_{v,f,s} \times EF_{k,v,f,s} \quad \text{(C)}$$

- kmv,f,s = Distance travelled using vehicle type v, fuel f, and emission standard s (km)
- EFk,v,f,s= Emission factors specific to vehicle type v, fuel f, and vehicle emissions standard s (g/vehicle-km)

These emission factors can be found in the appendix of the Air Pollutants Emissions Methodology for the logistics sector.

The below table compares vehicle emission standards; Euro Classes 1-6 with US & Chinese equivalents and identifies the emission intensity factor for each truck class.

Table 5 Truck vehicle emission standards

Euro Standard	US Equivalent	China Equivalent	Notes
Euro I	EPA 1994 (approx.)	China I (2000)	First meaningful limits on NOx and PM; very high emissions by today's standards
Euro II	EPA 1998	China II (2003)	Incremental tightening; still relatively high NOx and PM
Euro III	EPA 2004	China III (2008)	Introduction of more advanced engine controls; noticeable NOx reductions
Euro IV	EPA 2007	China IV (2013)	Major PM reductions; introduction of after-treatment (e.g., SCR, early DPFs)
Euro V	EPA 2007-2010	China V (2017)	Significant NOx reductions; widespread SCR adoption
Euro VI	EPA 2010 (current standard)	China VI (2021)	Very low NOx and PM limits; includes real-world driving emissions (in EU/China), closest global alignment

Appendix III – Assumptions

To allow for a simplified methodology and consistency across emissions calculations at the various ports, the following is assumed:

- Air pollutants emission factor: Heavy-duty vehicle (HDV)
- GLEC Framework: Artic Truck 34 – 40 t GVW
- A standard energy use value is applied to all electric trucks to keep results comparable
- Electricity emissions are based on regional averages, not specific locations or times
- Diesel and electricity emissions are based on standard regional values (i.e. Europe, China and the US)
- Diesel and electric trucks are assumed to operate in similar conditions
- Results are provided in terms of g/tkm to allow calculation with transport activity data when available
- When calculating the total pollutants produced, it is expected that the transport activity data (either tkm or km) is calculated using GLEC methods

Appendix IV – In-Scope Pollutants

PM in this methodology includes both PM2.5 and PM10. Although the example only shows PM2.5, both PM2.5 and PM10 can be reported. In this case, the emission factors for PM2.5 and PM10 are the same because all PM is assumed to be PM2.5. Therefore:

- PM = PM10 = PM2.5

SOx is not included in this simplified methodology because it depends on the sulphur content of petrol and diesel, which has been very low since 2009. To keep the methodology simple and consistent, we focus on the pollutants most directly linked to drayage vehicle exhaust: PM, BC, and NOx.

For an expanded analysis, including additional pollutants such as SOx, organizations can refer to the complete Air Pollutants Methodology.

Appendix V – In-Scope Activities

Air pollutant emissions are assessed on a tank-to-wheel (TtW) basis and therefore reflect only emissions generated during vehicle operation. This approach is consistent with the objective of evaluating local air quality impacts within port environments, where tailpipe emissions directly affect workers and surrounding communities. Upstream emissions associated with fuel production, electricity generation, and energy distribution are excluded, as these occur outside the port boundary and are not directly linked to local air quality conditions at the point of vehicle operation.

We recognize the point about displacement risk: if electrification simply shifts air pollutant burden to communities near power plants, that is a fair concern. This could come in a future, optional module rather than embedding it in the core comparison. The reasons for this decision were:

- **Scope consistency:** This methodology aims to estimate local, port-level air pollutant emissions. GHG emissions have the same climate effect regardless of where they are released, so summing emissions across the full energy supply chain (well-to-wheel) makes sense. Air pollutants don't work this way: NOx and PM emitted at the port affect port workers and nearby communities, while the same pollutants from a distant power plant affect a different population. Combining these two scales would blur the local emissions picture within the boundary of this methodology.
- **Data reliability:** Grid electricity in most regions comes from a mix of sources that varies by hour, season, and year. Attributing air pollutant emissions to electricity would require a defensible grid mix assumption (average grid mix, marginal generation, time-matched sourcing) and pollutant-specific emission factors per generation source. At a screening level, this adds significant uncertainty and could fragment results in ways that are hard to interpret or compare across ports.

Appendix VI – Intensity Metrics

It is useful to report both total emissions and emissions intensity, as they provide different insights. Total pollutant emissions support the calculation of air quality and health impacts at the port level. Intensity metrics, such as g/tkm, help companies understand whether emission changes are linked to operational efficiency or business growth. This simplified methodology focuses on intensity metrics, allowing companies to assess performance and evaluate the benefits of electrification.

Where more detailed data is available, companies can refer to the complete Air Pollutant Methodology and report total air pollutant emissions in grams.

Appendix VII – Excluded Factors

Below factors can affect real emissions and should be considered in more detailed studies, e.g. when applied to own real-world operational data:

- Traffic, speed, road conditions, and load changes
- Idling time and stop/start driving
- Cold starts (important for short trips)
- Tire and brake wear emissions
- Weather and how pollution spreads
- Changes in electricity emissions depending on time and place

Appendix VIII – References

[1] European Environment Agency, “EMEP/EEA Air Pollutant Emission Inventory Guidebook 2023,” Copenhagen, Denmark, 2023. [Online]. Available: https://www.eea.europa.eu/publications/emep-eea-guidebook-2023

[2] Smart Freight Centre and Stockholm Environment Institute, “Air Pollutant Emissions Methodology for the Logistics Sector,” Amsterdam, Oct. 2025. [Online]. Available: https://smart-freight-centre-media.s3.amazonaws.com/documents/Report_AP.pdf

[3] Smart Freight Centre, “Global Logistics Emissions Council (GLEC) Framework v3.2,” 2025. Accessed: Apr. 01, 2026. [Online]. Available: https://smart-freight-centre-media.s3.amazonaws.com/documents/GLEC_FRAMEWORK_v3.2_21_10_25_1.pdf

[4] International Organization for Standardization, “ISO 14083:2023 — Greenhouse Gases: Quantification and Reporting of Greenhouse Gas Emissions Arising from Transport Chain Operations,” 2023. [Online]. Available: https://www.iso.org/standard/78864.html