Smart Freight Centre India

India Default GHG Emission Values V1.0– Complementing GLEC Framework v3.01

A brief description of India's transport-related emission factors and GHG emission intensity values

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Introduction

The purpose of this document is to show the current development of the fuel emission factors and GHG 8 emission intensity values for the transport sector in India. There are existing default emission intensity values and fuel emission factors for Europe, North America and China in the GLEC Framework v3.1 that were updated from e.g., Ecoinvent, GREET, HBEFA, SmartWay program, etc. India accounts for a large share of the world's freight emissions, using local emission intensity values aligned with ISO 14083 and the GLEC Framework is needed for companies looking to account and report Logistics GHG emissions in India. The purpose is to help companies use local Indian values as much as possible. This document is co-developed by Smart Freight Centre and the TCI-IIMB Supply Chain Sustainability Lab at IIM Bangalore.

Framework principles

Calculation methodologies comply with **ISO 14083 and GLEC Framework v3.1:**
The GLEC default emission intensity values are useful to provide estimates as a first step on a company's journey to inclusive, high-quality GHG emission reporting.

Methodology

The Indian values in this document include fuel emission factors and GHG emission intensity values for Road and Rail. Fuel emission factors are divided into "well-to-tank" (WTT) energy provision emissions and "tank-to-wheel" (TTW) operational emissions. The "well-to-wheel" (WTW) emissions, also referred as fuel life-cycle emissions, is sum of WTT and TTW emissions.

For diesel, gasoline, CNG and Ethanol the calculation of fuel emission factors first considers the emissions of CO2, CH4, and NO2 from vehicle fuel combustion (TTW). The emission factors for corresponding energy sources are mainly calculated based on relevant official and IPCC default values. To calculate the TTW CO2e emission intensity the fuel efficiency of different vehicle types (in L/100km) when empty and full was used and then converted it into emission intensity values expressed in g CO2e/tonne-km by considering the average load and empty running factor. CH4 and NO2 emissions are calculated based on IPCC emission factors and converted to CO2e based on IPCC AR6 GWP100.

For electricity, we referred to grid emission factors from the report "CO2 Baseline Database for the Indian Power Sector" released by the Central Electricity Authority, Ministry of Power (in kgCO2e/kWh). With the combination of vehicle electricity consumption (kWh/100km), load factor, and empty running rate, we then obtained the emission intensity (in gCO2/ tkm).

We used the European fuel emission factor (i.e., the TTW to WTW ratio) from GLEC Framework v3.1 to uplift TTW to WTW for India in this document.

Fuel Emission Factors

		IPCC - Kg of greenhouse gas / TJ on Net Calorific Basis									
	Common UOM in India	CO2	CH4	NO2	CO2e	IPCC Net calorific value (TJ/Gg)	Kg CO2e / Kg of Fuel (TTW)	Density - BPCL Conversion from Litre/kg	Kg CO2e / litre of Fuel (TTW)	Uplift Factor	Kg CO2e / litre of Fuel (WTT)
		A	B	C	D=A +27.9*B +273*C					TTW / WTW Ratio	
Road Transportation											
Diesel	Litre	74100	3.9	3.9	75,273.5	43	3.237	1.21	2.675	1.301	0.8058
Petrol	Litre	69300	33	3.2	71,094.3	44.3	3.149	1.411	2.232	1.320	0.7137
CNG	Kg	56100	92	3	59,485.8	48	2.855			1.373	1.0656
Ethanol	Litre	70800	260	41	89,247.0	27	2.410	1.411	1.708		
Rail Transportation											
Diesel	Litre	74100	4.15	28.6	82,023.6	43	3.527	1.21	2.915	1.301	0.878

Key sources: *The fuel emission factor calculations are based on various official sources:*

- The fuel conversion factors have been derived from BPCL Fuel conversion Factors available at https://www.bharatpetroleum.in/our-businesses/industrial-and-commercial/conversion-table.aspx.
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories - Chapter 1, 2 and 3 https://www.ipcc.ch/report/2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/

Electricity Emission Factors

The electricity emissions factors are derived from the report "CO2 Baseline Database for the Indian Power Sector" released by Central Electricity Authority, Ministry of Power.

Year	Emission Factors (Kg CO_2/kWh)
2015-16	0.82
2016-17	0.83
2017-18	0.82
2018-19	0.82
2019-20	0.80
2020-21	0.79
2021-22	0.81
2022-23	0.82

**Sources: This document used version 19 released in December 2023. (page 21)*

Rail Emission Intensity Values

In India, Railway locomotives are generally of one of two types: Diesel or Electric.

The calculation of the railway emission factors has been derived from Chapter 3 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

The emission per tonne-km derived for the five years is averaged out to arrive at the final emission per tonne-km. The final emission values are given in the following table.

Year	WTT Emission Intensity in CO2e in kg/Tonne-km (A)	TWT Emission Intensity in CO2e in kg/Tonne-km (B)	Tota; Emission Intensity in CO2e in kg/Tonne-km (C)= (A)+(B)
Emission Intensity	0.0064	0.0041	0.0106

Key Data Sources

All the data for rail transportation is being maintained by the Ministry of Railways. This study has used the data published in the annual reports of the Ministry of Railways. The fuel emissions factors used in this calculation are based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories as derived in the chapter above.

Fuel consumed Diesel & Electricity by Indian Railways during the period 2015-16 to 2019-20

Year	Goods Tonnes originating (000's)	Goods - Net Tonne kms. (millions)	Total Fuel consumed - Diesel oil (000 kilolitres)	Total Fuel consumed Electricity (Million kWh)	Fuel consumed - Diesel oil (000 kilolitres)- Goods	Fuel consumed Electricity (million kWh)- Goods
	A	B	C	D	E	F
2019-20	12,12,224.00	7,08,034.00	2,380.00	18,409.00	876.45	4,486.21
2018-19	12,25,287.00	7,38,923.00	2,749.00	12,062.00	1,011.02	4,442.50
2017-18	11,62,639.00	6,93,281.00	2,778.00	12,408.00	979.71	4,239.57
2016-17	11,10,899.00	6,20,856.00	2,793.00	12,062.00	944.31	4,016.52
2015-16	11,08,617.00	6,55,605.00	2,874.00	12,408.00	998.89	4,869.62

**Source for Freight Carried by Indian Railway in the below period*

Year	Source (Column C & D)	Link to source	Page Number	Source (Column E & F)
2019-20	Indian Railways Annual Report & Accounts 2019- 2020	https://indianrailways.gov.in/railwayboard/uploads/directorate/stat_econ/Annual- Reports-2019- 2020/Indian-Railways- Annual%20-Report- Accounts%20-2019- 20-English.pdf	171	RTI from Indian Railways RTO No: CRAIL / R? E/23/00690
2018-19	Indian Railways Annual Report & Accounts 2018- 2019	https://indianrailways.gov.in/railwayboard/uploads/directorate/stat_econ/Year_Book/Indian%20Railways%20Annual%20Report%20%26%20Accounts%20English%202018-19.pdf	169	
2017-18	Indian Railways Annual Report & Accounts 2017- 2018	https://indianrailways.gov.in/railwayboard/uploads/directorate/stat_econ/downloads/IRSP-2017-18/Annual_Report_2017-18_English.pdf	169	
2016-17	Indian Railways Annual Report & Accounts 2016- 2017	https://indianrailways.gov.in/railwayboard/uploads/directorate/stat_econ/IRSP_2016-17/Facts_Figure/Indian%20Railways%20Annual%20Report_Accounts%20English%202016-17.pdf	157	
2015-16	Indian Railways Annual Report & Accounts 2015- 2016	https://indianrailways.gov.in/railwayboard/uploads/directorate/stat_econ/2015-2016/Annual%20Report%20English_2015-16.pdf	149	

Road Emission Intensity Values

The following are the final emission intensity values obtained for all vehicle categories based on the fuel type: The emission factors have been derived on a Kg CO2e per tonne-km basis. The emission factor is the sum of WTT and TTW Emissions as calculated above.

The distance between the origin and destination is calculated using the Google distance matrix API, with the travel mode being driving, additionally a DAF uplift of 5% is considered for out of route deviation.

SL No	Vehicle Type	Fuel Type	Load Characteristics	Empty Factor	Average Utilization of Vehicles in %	Fuel Efficiency (Average Fuel Consumed in Litres Per Km of Trip (Average Laden)	Emission Intensity (gCo2e/tkm) WTT	Emission Intensity (gCo2 e/ tkm) TTW	Emission Intensity (gco2e/ tkm) WTW
1	Small Commercial Vehicles | GVW < 3.5 MT | Payload Capacity 0.5 to 2 MT	Diesel	Average	10.9%	83.0%	0.0841	0.0879	0.2916	0.3795
		Petrol	Average	10.9%	83.0%	0.0813	0.0999	0.3124	0.4124
		CNG	Average	10.9%	83.0%	0.0855	0.1337	0.3583	0.4920
2	Medium Commercial Vehicles -1 |GVW 3 to 5 M| Payload Capacity 2 to 3.5 MT	Diesel	Average	10.9%	82.7%	0.1193	0.0514	0.1707	0.2222
3	Medium Commercial Vehicles -2 |GVW 5 to 12 MT | Payload Capacity 3.5 to8 MT	Diesel	Average	10.8%	78.8%	0.1494	0.0324	0.1075	0.1400
		CNG	Average	10.8%	78.8%	0.1497	0.0459	0.1229	0.1689
4	Heavy Commercial Vehicles -1 |GVW 12 to 20 MT | Payload Capacity 8 to12 MT	Diesel	Average	12.4%	76.8%	0.17317	0.0209	0.0692	0.0902
5	Heavy Commercial Vehicles - 2 | GVW 20 to 30 MT | Payload Capacity 12 to 20 MT	Diesel	Average	12%	69.4%	0.2823	0.0191	0.0632	0.0823
6	Heavy Commercial Vehicles - 3 | GVW 30 to 50 MT | Payload Capacity 20 to 40 MT	Diesel	Average	14.4%	68.3%	0.2988	0.0154	0.0509	0.0663
7	Tractor Trailer Commercial Vehicles - Trailers | GVW 30 to 60 MT | Payload Capacity 20 to 50 MT	Diesel	Average	13.3%	67.21%	0.3080	0.0128	0.0423	0.0551

Key Data Sources

The main source of the fuel efficiency and transport activity and performance data (e.g., distance, load factor, empty running rate) is based on Preliminary Investigation and Research on Indian Freight Industry by "TCI-IIMB Supply Chain Sustainability Lab at IIM Bangalore. The calculation of road emission intensity factors follows mainly the 2006 IPCC Guidance, GHGP, and GLEC Framework

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