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A Review and Evaluation of Emission Intensity Factors for Road Freight Transport

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Photo by Martin du Plessis

Agenda

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- Road Freight Transport Importance
- Emissions of Road Freight Transport
- Calculating Emissions of Road Transport
- Emission Intensity Factors – An Overview
- Accuracy of Factors
- Action Plan – SRF South Africa and Factors for Africa

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Road Freight Transport Importance

- Important in all supply chains – **growing dependance on the mode.**
- ±**120 trillion tonne-kilometre** (t-km) in 2017[1].
- In the **USA 59.3%**[2] and **EU 77.4%**[3] of all freight is moved by road transport vehicles.
- Developing countries even higher: **South Africa >90%**[4] of all freight is transported by road.

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Road Freight Transport and Emissions

- IEA states ±**17 million barrels** of crude oil per day in 2015[5].
- **20%** of global oil consumption and **50%** of global diesel demand[5].
- Road freight transport responsible for **35%[5] of transport-related emissions.**

Calculating Emissions of Road Freight

Activity-based approach

Emission intensity factors
g CO_2e/t-km, g CO_2e/TEU-km, kg CO_2e/pallet-day, kg CO_2e/container handled...

Distribution activity data
cargo weight, distance transported, vehicle description, storage duration...

Emissions of activity (kg CO_2e) = Emission intensity factor x distribution activity data

Accurate gCO_2e/t-km factors needed

Fuel-based approach

Fuel emission factors
kg CO_2e/ℓ diesel, kg CO_2e/kWh, kg CO_2e/t bunker fuel, kg CO_2e/kg LNG...

Fuel usage data
total ℓ/tonnes/kWh of fuel consumed

?

Complex...

Need actual data...

Total emissions of facility or transport vehicle (kg CO_2e) = Fuel emission factor x total fuel usage

Proportional contribution to total emissions

?

Emissions of activity (kg CO_2e) =Total emissions of facility or transport service x proportional contribution of activity to total emissions

Emission Intensity Factors for Road Freight Transport

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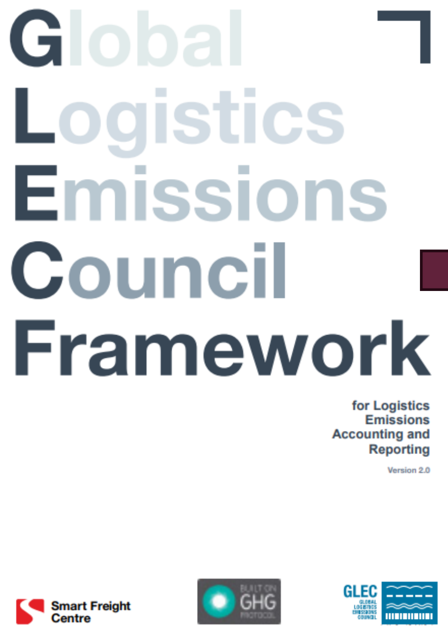
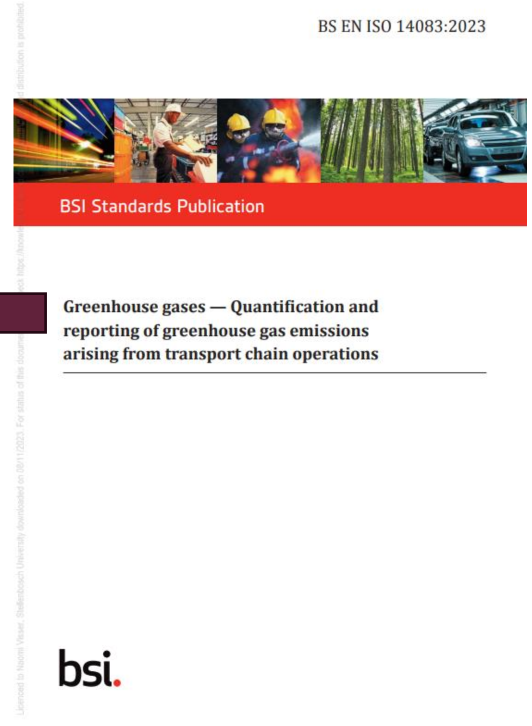


GLEC Framework V2



ISO 14083

Regions in GLEC Framework

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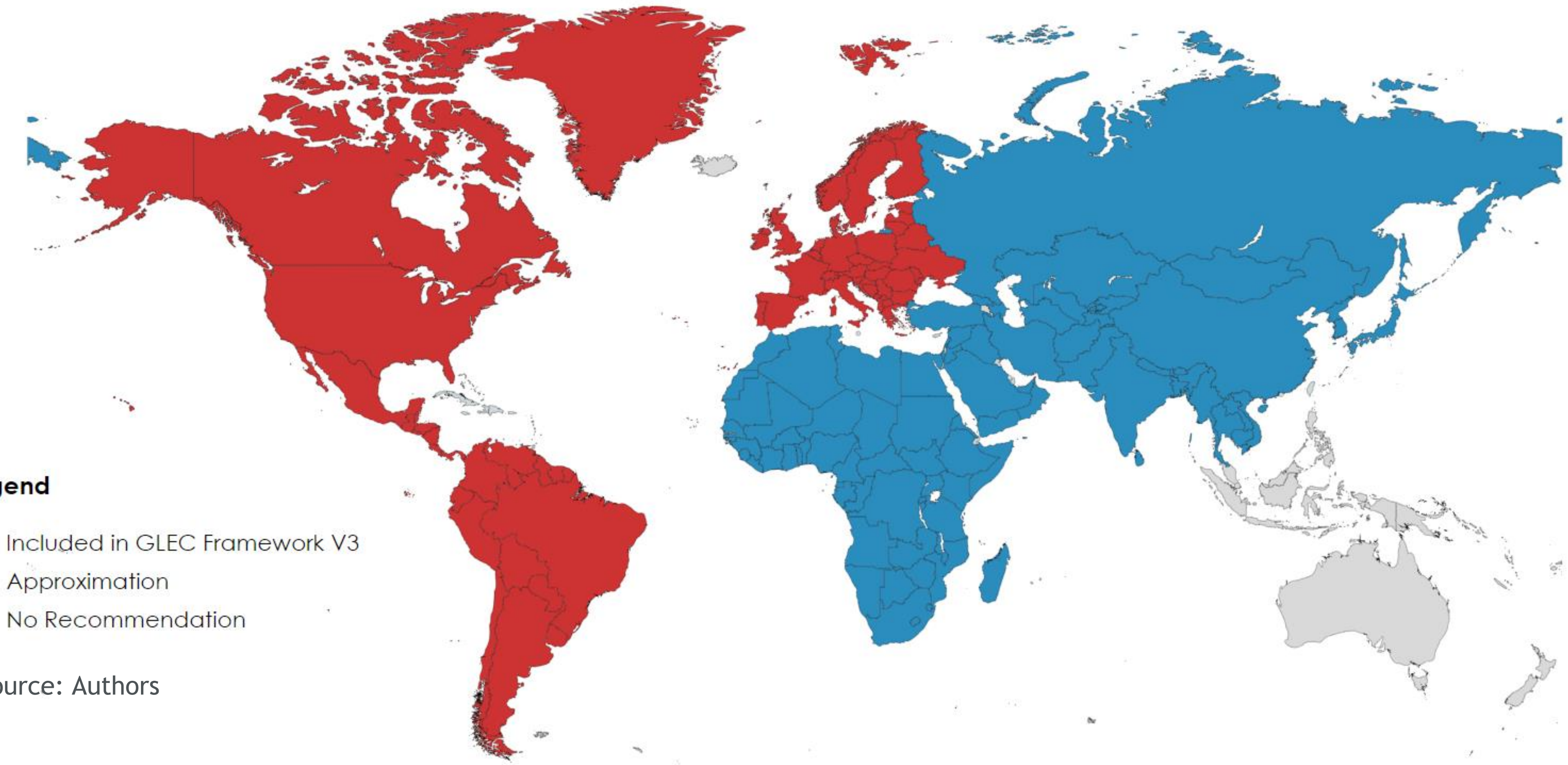

Legend

Included in GLEC Framework V3

Approximation

No Recommendation

Source: Authors

What approximation for blue regions? Source: GLEC

Ambient factors:	Africa & Asia = Red regions + 22%
Refrigerated factors:	Africa & Asia = Red regions + 22% +15%

Accuracy of Factors - South Africa as Example

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Calculating Fuel Usage and Emissions for Refrigerated Road Transport Using Real-World Data

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ABSTRACT

Road freight transportation is and will become increasingly important in all distribution chains. However, little research has analysed actual logistics service provider (LSP) data on a transport service level to determine fuel use and emissions in real-world scenarios. Subsequently, this article analyses 147 long-distance trips during which nearly 200 000 km were travelled, 3 693 tonnes of cargo were moved, and 84 588 litres of diesel fuel were burnt. In addition, 23 250 hours of refrigeration data were assessed. Based on the assessed data, a novel formula was developed that estimates the total fuel use (ℓ) of a transport service by incorporating the trailer type, route, load weight, empty distance, loaded distance and use and time duration of refrigeration with an average error of 6.7 %. This formula enables estimation of the total fuel use (ℓ), GHG emissions (kg CO_2e), carbon footprint (kg CO_2e/t cargo) and emission intensity factor (g CO_2e/t-km).

1. Introduction

Road freight transportation has evolved to become an indispensable part of all freight transportation systems (IEA, 2017). According to the Global Fuel Economy Initiative (2016), more goods are transported by heavy goods vehicles (HGVs) than ever – an estimated 120 trillion tonne-kilometre (t-km) in 2017 alone (SLOCAT, 2021). In the USA and EU, respectively 59.3 % and 77.4 % of all freight is moved by road transport vehicles (US Bureau of Transportation Statistics, 2020; Eurostat, 2022). However, in developing countries such as South Africa, up to 90 % of all freight is moved by road (DoT, 2018).

Road transportation will remain an essential part of the vast majority of all supply chains worldwide for the foreseeable future. Nearly all goods, products and raw materials are transported by road during some parts or the entire distribution process. This is due to the flexibility, speed, cost, low capital investment in infrastructure and equipment, and ease of using road transport compared to other modes. However, logistics is entering a new age – from the enabler of international trade to the kingpin of universal sustainability (Havenga, Witthöft, De Bod & Simpson, 2020).

According to the IEA (2017), the road freight industry consumed nearly 17 million barrels of crude oil per day in 2015 alone, representing nearly 20 % of the global oil demand and half of the global diesel consumption. Growth in the road freight industry is

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DEVELOPMENT OF EMISSION INTENSITY FACTORS FOR A SOUTH AFRICAN ROAD-FREIGHT LOGISTICS SERVICE PROVIDER

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ABSTRACT

The Global Logistics Emissions Council (GLEC) framework developed logistics emission factors to be used uniformly in North America and Europe. It included an approximation for African countries; however, actual South African emissions were not accurately reflected. Therefore, in this study, carbon emissions factors were calculated using calculated tonne-kilometres and the energy-based methodology. The authors obtained several datasets from a logistics service provider (LSP) consisting of vehicle routes, refuelling data, and freight load data. The project developed factors for each individual trip, for similar repetitive trips, and for the entire data set. These different sets of factors were developed to allow the use of different emission calculation and reporting standards. The LSP could use these emission intensity factors to estimate carbon emissions using the activity-based approach, report emissions according to legislation, and predict how much carbon emissions would be emitted to move a customer's shipment.

OPSOMMING

Die *Global Logistics Emissions Council (GLEC)* raamwerk het logistieke emissiefaktore ontwikkel vir eenvormige gebruik in Noord-Amerika en Europa. Alhoewel dit 'n benaderde skatting vir Afrika-lande insluit, word die werklike Suid-Afrikaanse emissies egter nie akkuraat weerspieël nie. In hierdie studie word koolstofvrystellingsfaktore bereken deur die gebruik van berekende ton-kilometer sowel as energie-gebaseerde metodologie. Die outeurs het verskeie datastelle van 'n logistieke diensverskaffer verkry wat bestaan uit die roetes gebruik deur hul voertuie, brandstofdata sowel as vrag data. Die projek het faktore ontwikkel vir individuele vragverskuiwings, vir soortgelyke herhalende vragte, en vir die datastel in sy geheel. Hierdie verskillende stelle faktore is ontwikkel om die gebruik van verskillende emissieberekeninge en verslagdoeningstandaarde moontlik te maak. Die logistieke diensverskaffer kan nou hierdie emissie-intensiteitsfaktore gebruik om koolstofvrystellings te skat deur die aktiwiteitsgebaseerde benadering te gebruik. Hierdie emissie-intensiteitsfaktore kan ook gebruik word om emissies te rapporteer soos vereis word deur wetgewing, en om te voorspel hoeveel koolstof vrygestel sal word om 'n kliënt se vrag te verskuif.

1. INTRODUCTION

Terms such as 'greenhouse gases' (GHGs), 'emissions', and 'carbon footprint' have become common buzzwords in modern society [1], [2]. Owing to increased pressure, governments, organisations, and individuals often use these terms to create an illusion of environmental sustainability [2], [3]. In most cases, unfortunately, this is only done to advance economic or political interests [4]. Despite a lack of understanding of the sources or size of emissions, ambitious emission reduction goals or targets are still set. Ideally, before organisations set emission reduction targets, a good starting point would be to quantify

15

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Accuracy of Factors - South Africa as Example

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Vs

Vehicle description	Description of factor			Emission intensity factor (g CO_2e/t-km)	
	Load type	Empty Running	Load factor	Dry	Refrigerated
4x2 Rigid (GVM:±14 t, max payload:±8 t)	Pallets	45%	55%	150	171
			85%	107	128
6x4 Rigid (GVM:±24 t, max payload:±15 t)	Pallets	45%	55%	121	143
			85%	86	100
4x2 truck tractor and tandem semi-trailer (GCM: ±34 t, max payload: ±15 t)	Pallets	10%	55%	174	184
			85%	116	122
6x4 truck tractor and tridem semi-trailer (GVM: ±49.5 t, max payload: ±32 t)	Pallets	10%	55%	87	91
			85%	59	62
		50%	55%	148	157
			85%	99	105
6x4 truck tractor and tridem semi-trailer loaded with 40-foot reefer container (GCM: ±49 t, max payload excl. container: ±28 t)	Container	10%	55%	98	103
			85%	66	70
		50%	55%	168	173
			85%	112	115
Standard interlink tautliner - 6x4 truck tractor with tandem- tandem trailer (GCM: ±56 t, max payload: ±36 t)	Pallets	10%	55%	99	-
			85%	67	-

Accuracy of Factors - South Africa as Example

	GLEC Framework	Authors
	Articulated truck: GVM < 60 tonnes	
Load Factor (%)	60%	85%
Empty Running (%)	17%	10%
	Dry or Ambient Road Transport	
Emission intensity factor (g CO_2e/t-km)	76,8	59,0
Difference	30,3% Overestimate	
	Refrigerated Road Transport	
Emission intensity factor (g CO_2e/t-km)	86,1	62,0
Difference	38,8% Overestimate	

Significant work is needed for different:

- Commodity groups (refrigerated, dry-bulk, palletised goods and liquids);
- Configurations of vehicles (rigid trucks, semi's, interlinks, etc.);
- Vehicle sizes (heavy vehicles, light vehicles, motor cycles, etc.)
- Various loading conditions (load factor%) and;
- Proportional empty runnings (percentage empty running).

Emission Intensity Factors - The Need

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- **Road freight transport system** unique in each **geographical region;**
- Emission intensity factor a function of:
  - **Type** and **age** of assets,
  - **Technology**,
  - Transport **infrastructure** such as roads, ports and other logistical facilities,
  - **Customs** and **regulatory complexities**,
  - **Geography and landscape**,
  - **Miscellaneous** such as workforce, maintenance, etc.
- **Regional emission intensity factors needed**;

SRF South Africa Proposal for African Factors

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2024/25

Project Proposal:

Sustainable Freight Logistics in Southern- and Eastern Africa

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Prepared For:
Smart Freight Centre by Stellenbosch University

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Road freight transport in Southern- and Eastern Africa:

Goal is to establish:

i) fuel consumption values (ℓ/t-km);
ii) emission intensity factors (g CO_2e/t-km);

for different configurations of vehicles:

- dry bulk (side tippers);
- liquids (tankers);
- vehicle carriers;
- refrigerated goods (reefers) and,
- break-bulk (tautliners and flat-decks).

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