International Transport Forum

IKI INTERNATIONAL CLIMATE INITIATIVE

Decarbonising Transport Initiative

Overview of the ITF Transport Life-cycle Assessment Tool: the process, challenges and lessons learnt

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OECD Wuppertal Institut NDC TRANSPORT INITIATIVE FOR ASIA giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH WORLD RESOURCES INSTITUTE icct THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION Agora Verkehrswende SLOCAT Partnership on Sustainable, Low Carbon Transport REN21

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What is LCA?

Evaluation of the potential environmental impacts of any product or service during its entire lifetime.

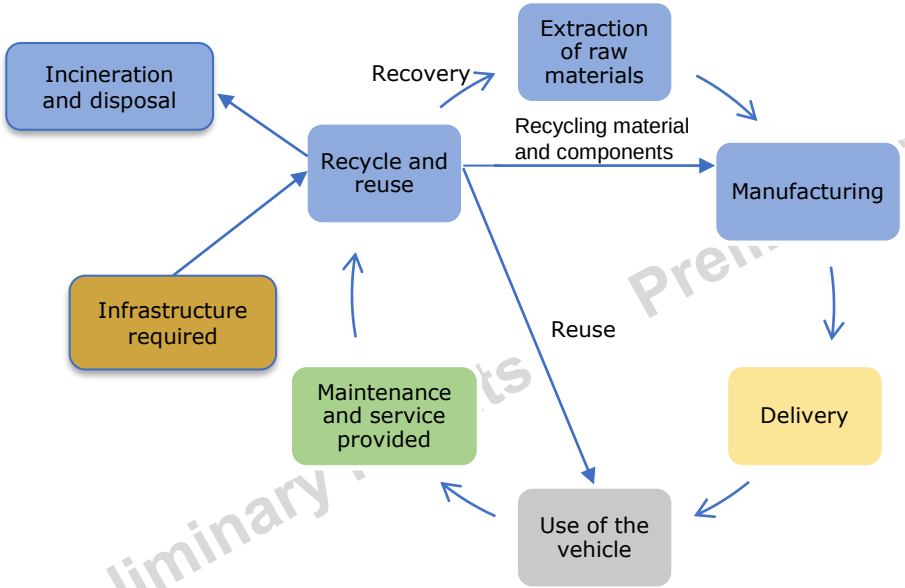


Fig 1: Life-cycle stages of a vehicle

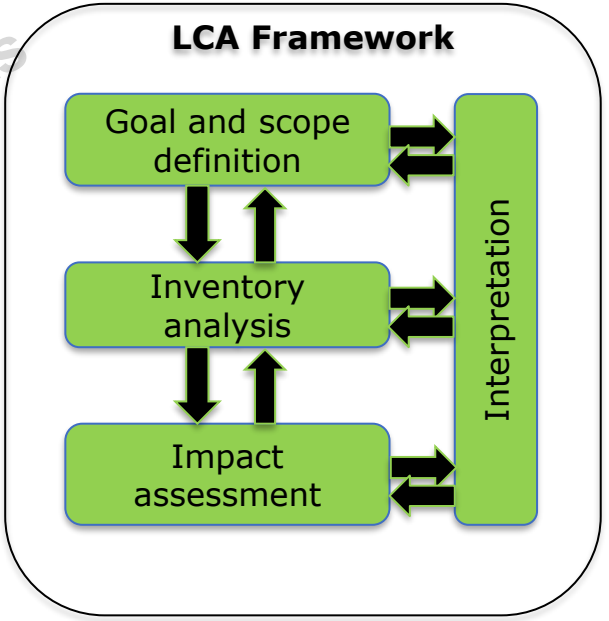


Fig 2: Framework of LCA

Why LCA in Transport?

- Provides a comprehensive evaluation of the environmental performance of different types of vehicles.
- Can be used to assess alternative fuels, considering the energy sources of the electricity grid used to charge EVs.
- It can account for the empty running of ride-sourcing vehicles/taxis between passengers.
- It can also include operational services required to charge and distribute shared fleets.

General Information about the LCA India Tool v1.0

The tool provides a holistic assessment of 26 modes of passenger transport options, accounting for energy use and GHG emissions (per passenger kilometer, vehicle kilometer, and vehicle level) that occur in different phases of the life of the vehicles, including:

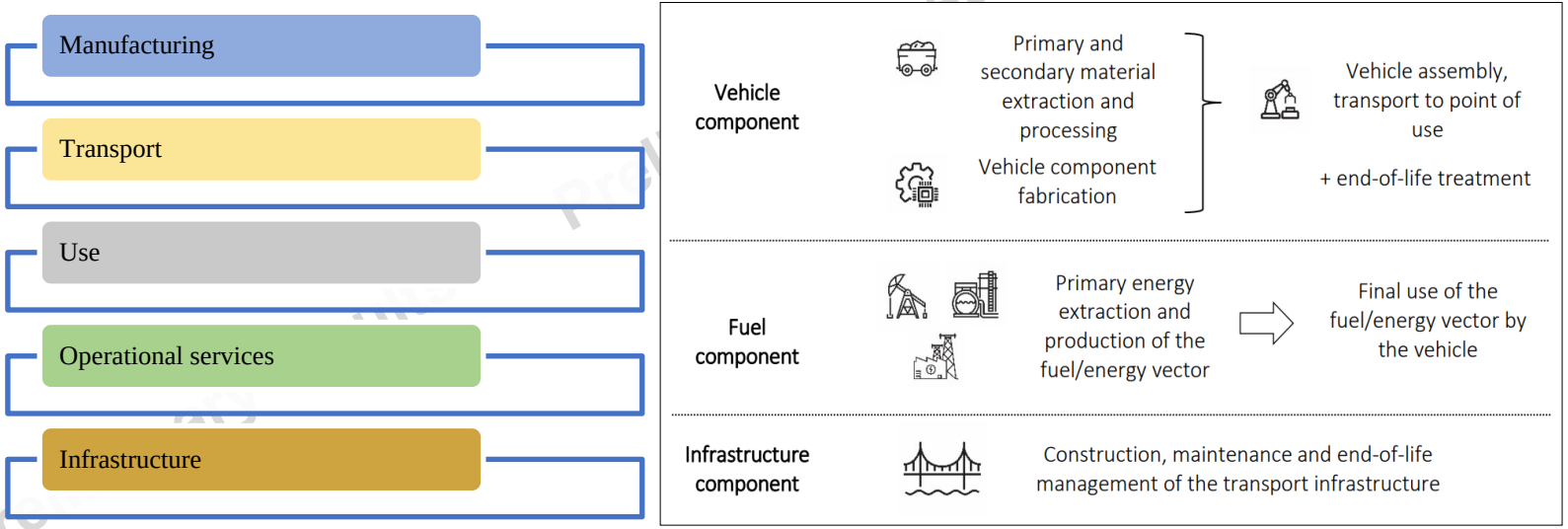


Fig 3: Stages considered in the LCA India tool

LCA India Tool v1.0

Workbook structure

Input sheets

Base input
- Users can define input values or choose to maintain default values

EM
- Users define electricity grid evolution scenarios

Phase sheets

Vehicle manufacturing
- Calculations associated with manufacturing of the vehicle including the assembly and disposal

Transport
- Calculations associated with transport of the vehicle from production point to purchase point

Use
- Calculations associated with the use of the vehicle

Operational services
- Calculations associated with operational service needed by specific vehicles

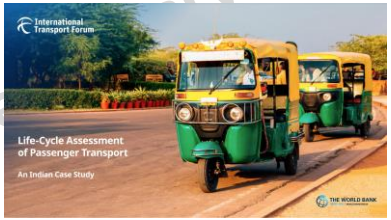
Infrastructure
- Calculations associated with operational service needed by specific vehicles

Result sheets

Summary
- Tabular summary showing energy consumption and GHG emissions, per passenger kilometer, vehicle kilometer, and vehicle, in each phase

Graphs
- Graphical representation of results in "Summary" sheet

Used to evaluate urban passenger modes



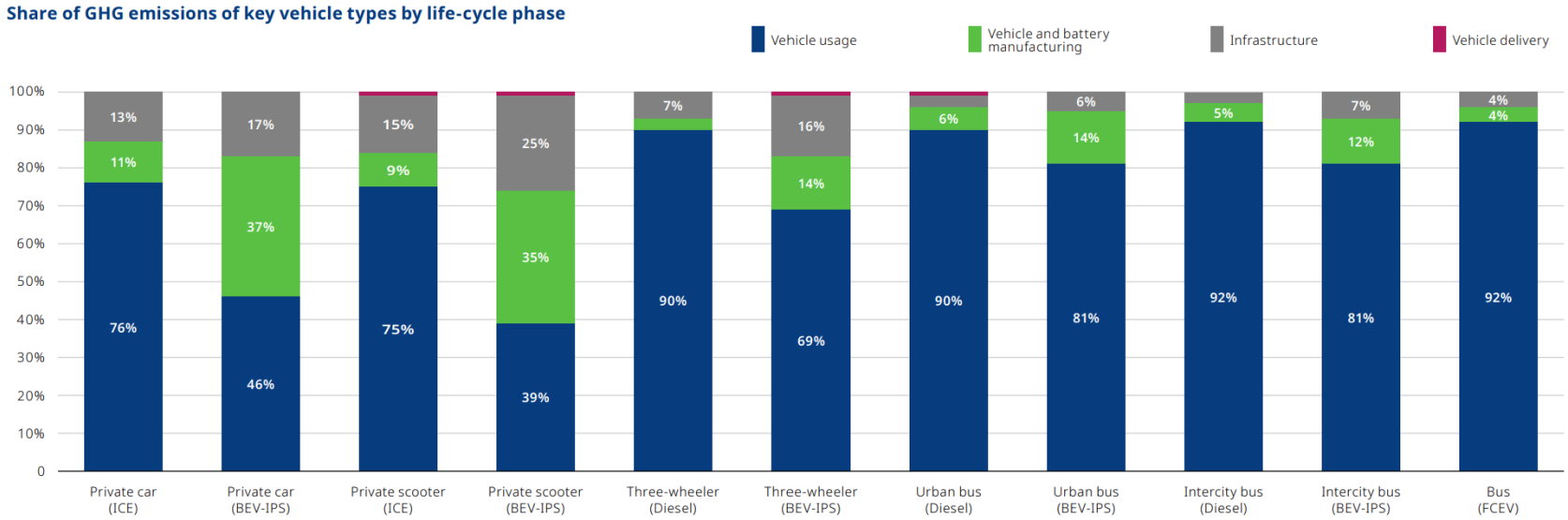


Fig 4: Share of GHG emission of key vehicle types by life –cycle phase

What next? The importance of freight

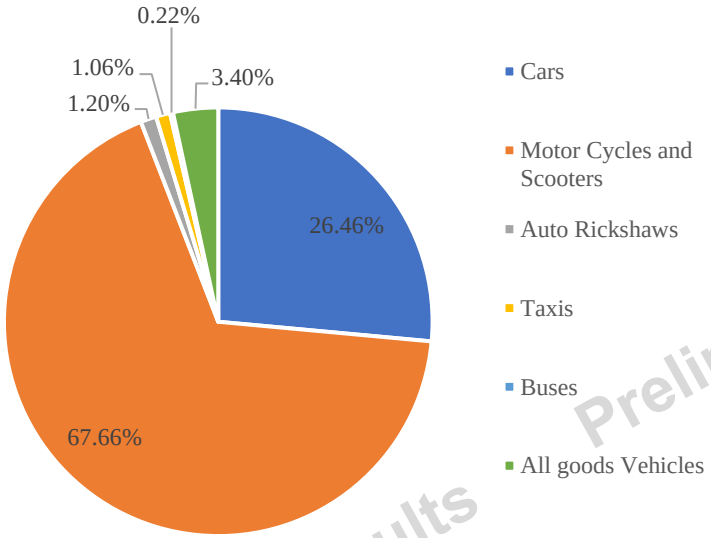


Fig 5: Percentage of different vehicle types in Delhi (2022-23)

- Third highest share in the road transport sector
- Lack of data availability for freight vehicles
- Comparison in passenger and goods vehicles

Addition of New Vehicles types (v2.0)

- Six Freight vehicle categories have been newly added.

➢ Light commercial vehicle Four-wheeler (ICE and BEV): GVW less than 3.5 ton

➢ Light commercial three-wheeler (ICE and BEV): GVW less than 3.5 ton

➢ Medium commercial vehicle (ICE): GVW more than 3.5 ton but less than 12 ton

➢ Heavy commercial vehicle (ICE): GVW more than 12 ton

Classification of cities

		Light Commercial vehicle four-wheeler- ICE (N1 category) [GVW <3.5T]	Light Commercial vehicle four-wheeler- BEV (N1 category) [GVW <3.5T]	Light commercial vehicle three-wheeler ICE(N1 category) [GVW <3.5T]	Light commercial vehicle three-wheeler BEV (N1 category) [GVW <3.5T]	Medium Commercial vehicle - ICE (N2 category) [3.5T<GVW <12T]	Heavy Commercial vehicle - ICE (N3 category) [GVW >12T]
City characteristics							
Classification of the city (By population density)		High density	High density	gh density	High density	High density	High density
Vehicle characteristics							
Fluid technology		ICE	BEV	ICE	BEV	ICE	ICE
Use of fuel/km							
Fuel type		Natural Gas (fossil, EU mix)		Natural Gas (fossil, EU mix)		Diesel (Oil)	Diesel (Oil)
Gasoline (Oil)	[km/l]						
Diesel (Oil)	[km/l]					10.3	5.4
Natural Gas (fossil, EU mix)	[km/kg]	16.8		17.8			
Electricity	[kWh/km]		No default available		0.10		
Hydrogen	[km/kg]						

Fig 6: Classification of cities

- Operational data differs based on city.
- Classification of cities has been given as user input.
- The user can select three given city types or choose “User input” to input other values.
- The cities are classified based on population density

Classification of cities

Population classification	Population Density (Population/ square kilometer)	Study Areas
High density	10,000 and above	Delhi
Medium density	1,000 to 10,000	Dhanbad
Low density	Less than 1,000	Bokaro

Delhi: National capital of India

Dhanbad: Coal capital of India (Mining region)

Bokaro: Steel city of India (Industrial belt)

Survey Locations

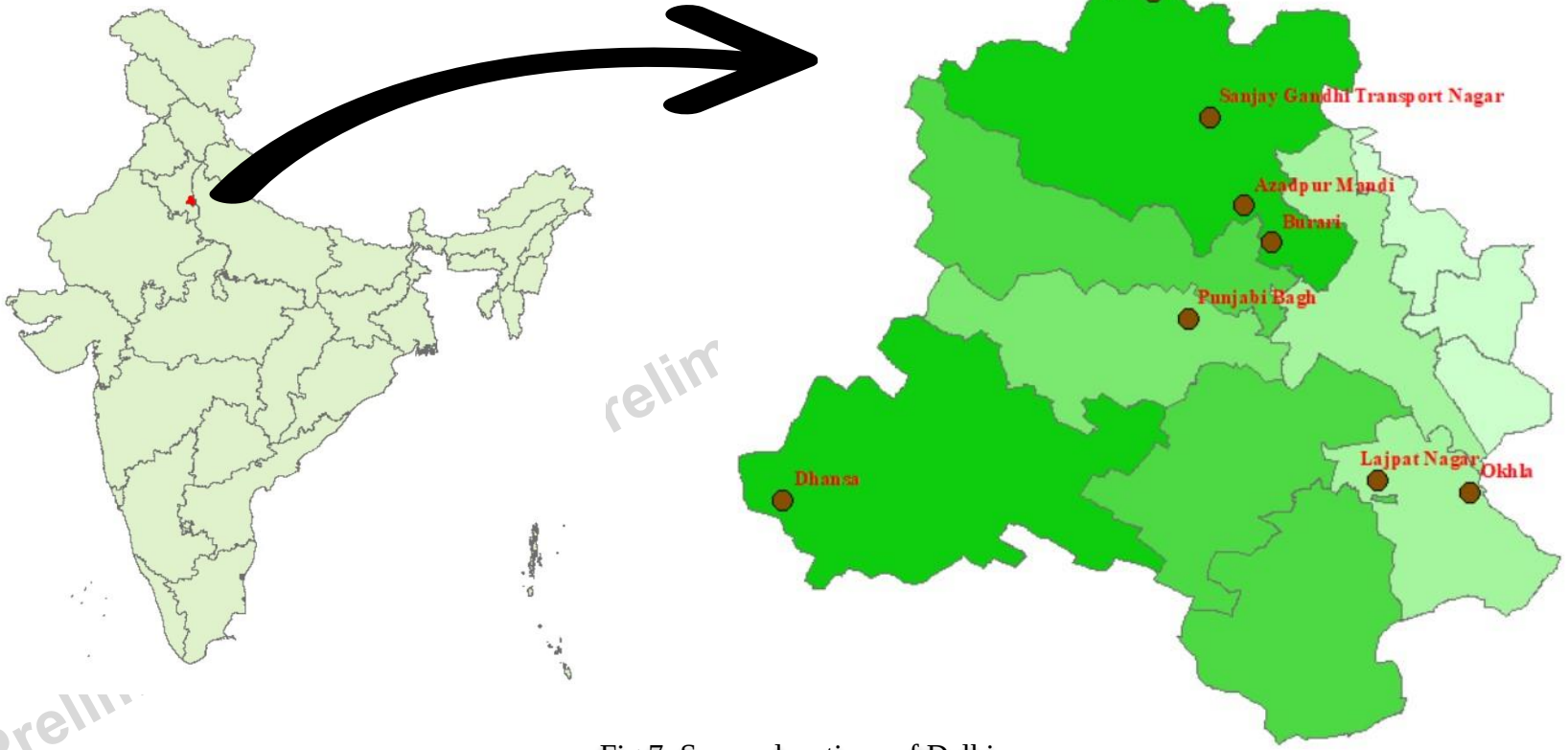


Fig 7: Survey locations of Delhi

Survey Locations

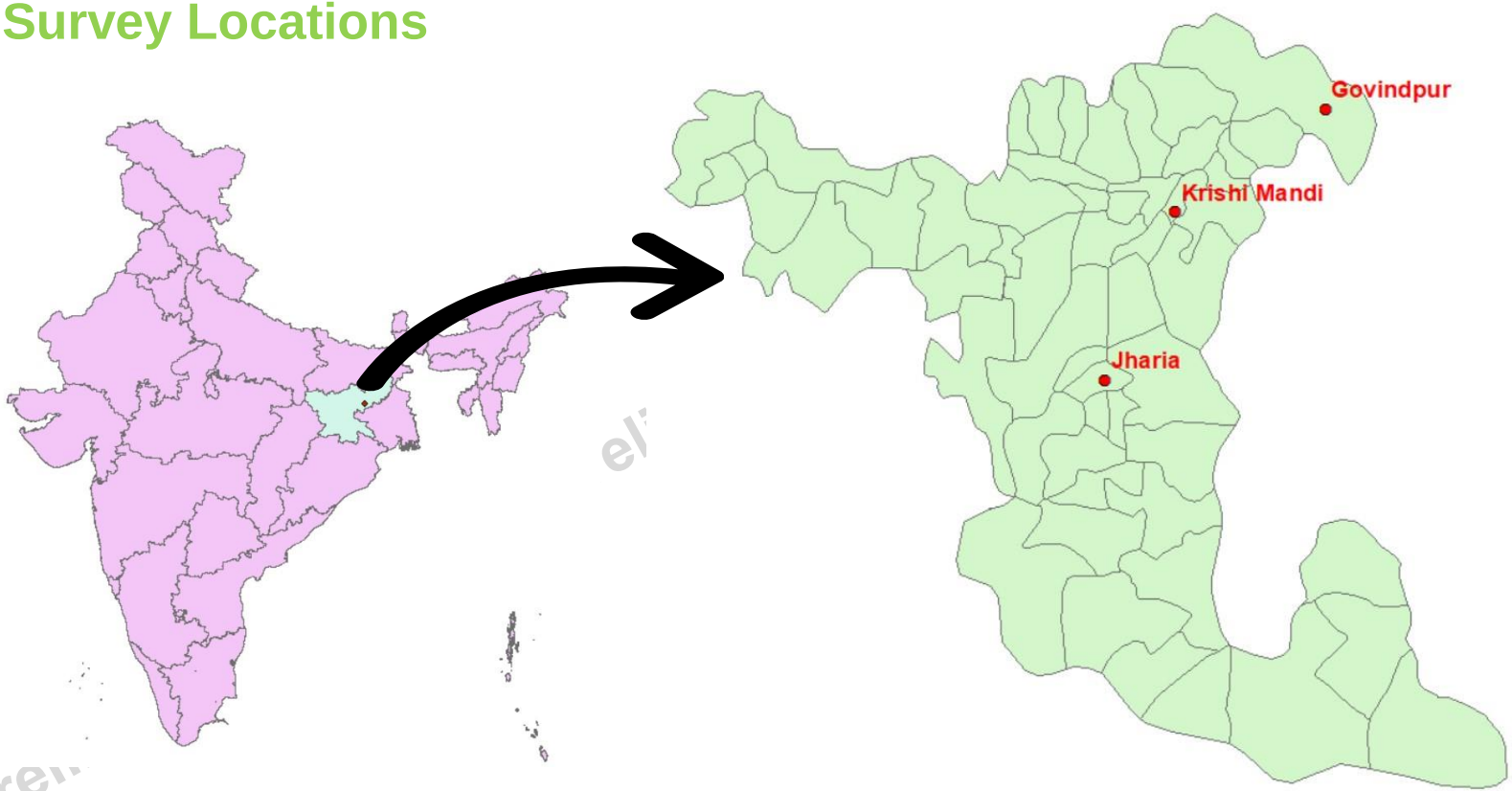


Fig 8: Survey locations of Dhanbad

Survey Locations

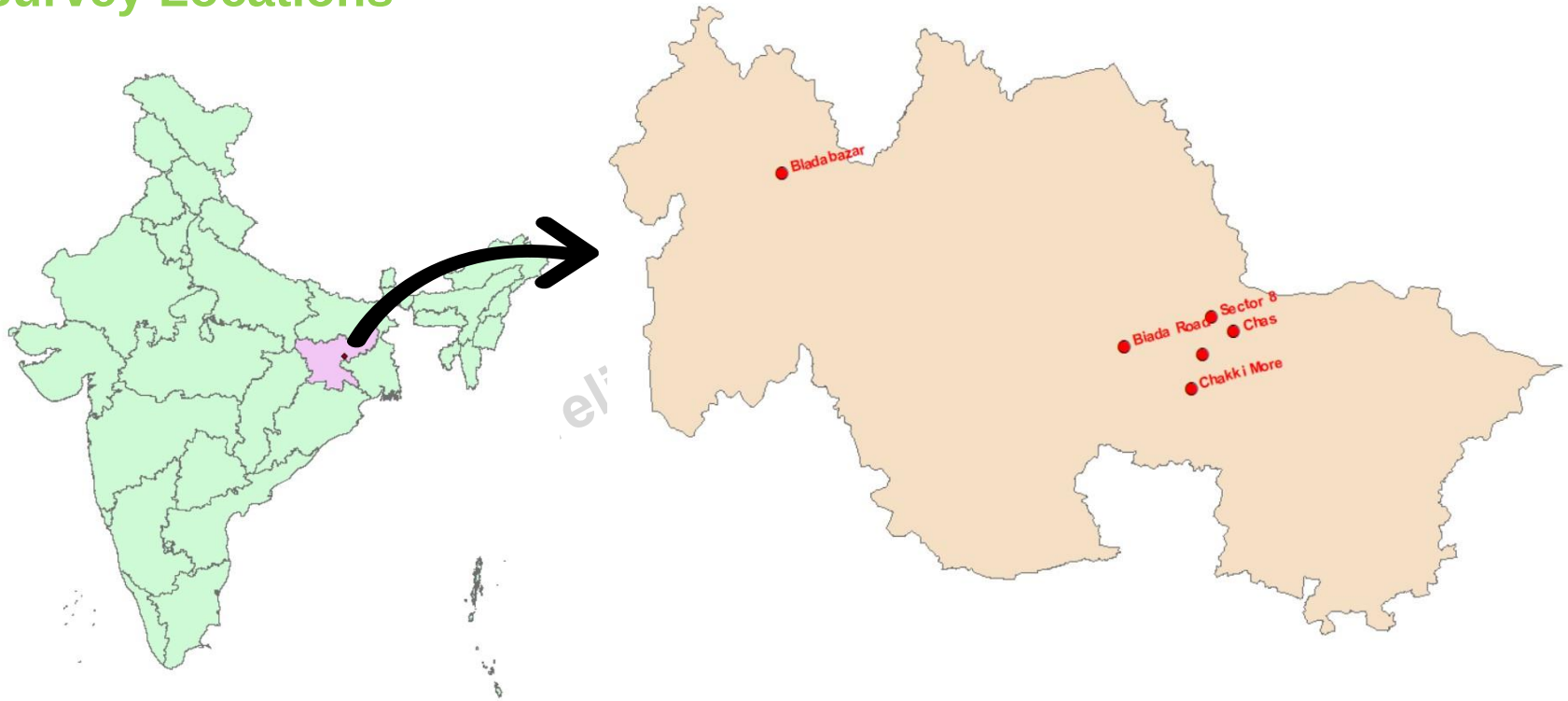


Fig 9: Survey locations of Bokaro

Operational data collected

Interviewer observation

- Registration number

- Age of the vehicle
- Fuel used

Questionnaire

- Fuel economy
- Daily distance covered
- Average payload

Travel diary

- Travel diary
- Origin and destination

Sample size

- The formula used for sample size calculation is

$$n = \frac{CV^2[Z(\alpha)]^2}{E^2}$$

- N is the sample size
- CV is the coefficient of variation
- Z(α) is the standard normal distribution quantile value for the confidence level (α)
- E is the level of accuracy (the margin of error for the estimate of the mean of the population).

Sample size of data collected

Sample size	N1(<3.5T)							N2 (3.5T<N2<12T)			N3(>12T)		
	ICE						BEV	ICE			ICE		
	Three-wheeler			Four-wheeler									
	CNG	Diesel	Petrol	CNG	Diesel	Petrol		CNG	Diesel	Petrol	CNG	Diesel	Petrol
Delhi	**109**	NA	NA	**114**	NA	NA	**9**	NA	**48**	NA	NA	**13**	NA
Dhanbad	NA	**63**	NA	NA	**75**	NA	**10**	NA	**34**	NA	NA	**79**	NA
Bokaro	NA	**40**	NA	NA	**82**	NA	**18**	NA	**15**	NA	NA	**29**	NA

Share of different vehicle categories

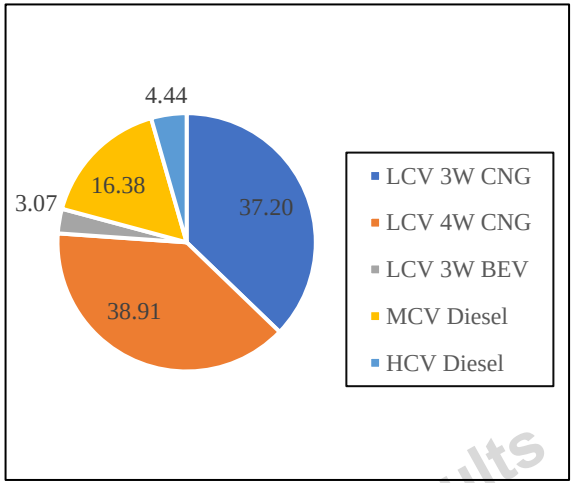


Fig 10: Percentage of different categories of vehicles surveyed in Delhi

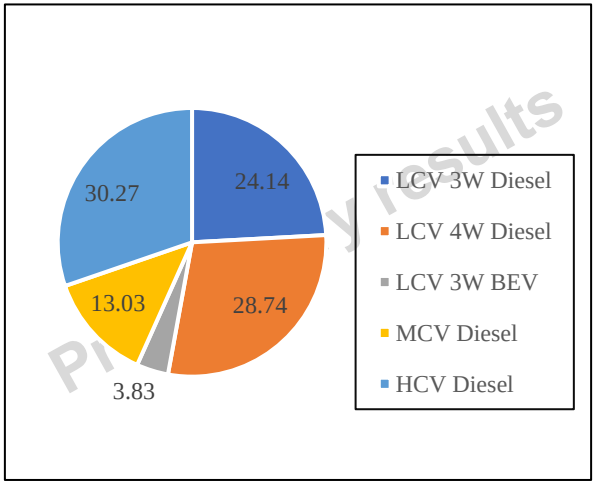


Fig 11: Percentage of different categories of vehicles surveyed in Dhanbad

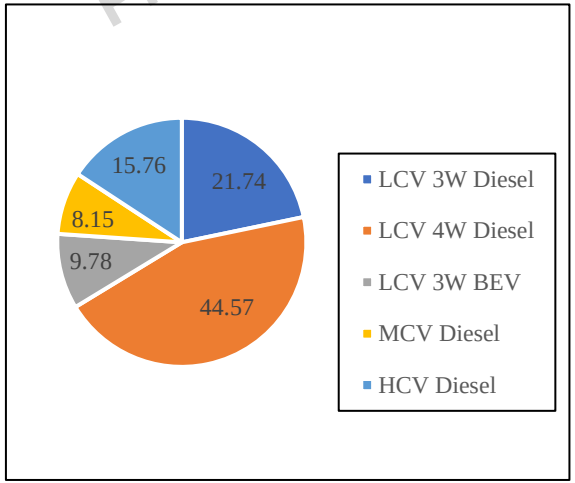


Fig 12: Percentage of different categories of vehicles surveyed in Bokaro

Daily distance travelled

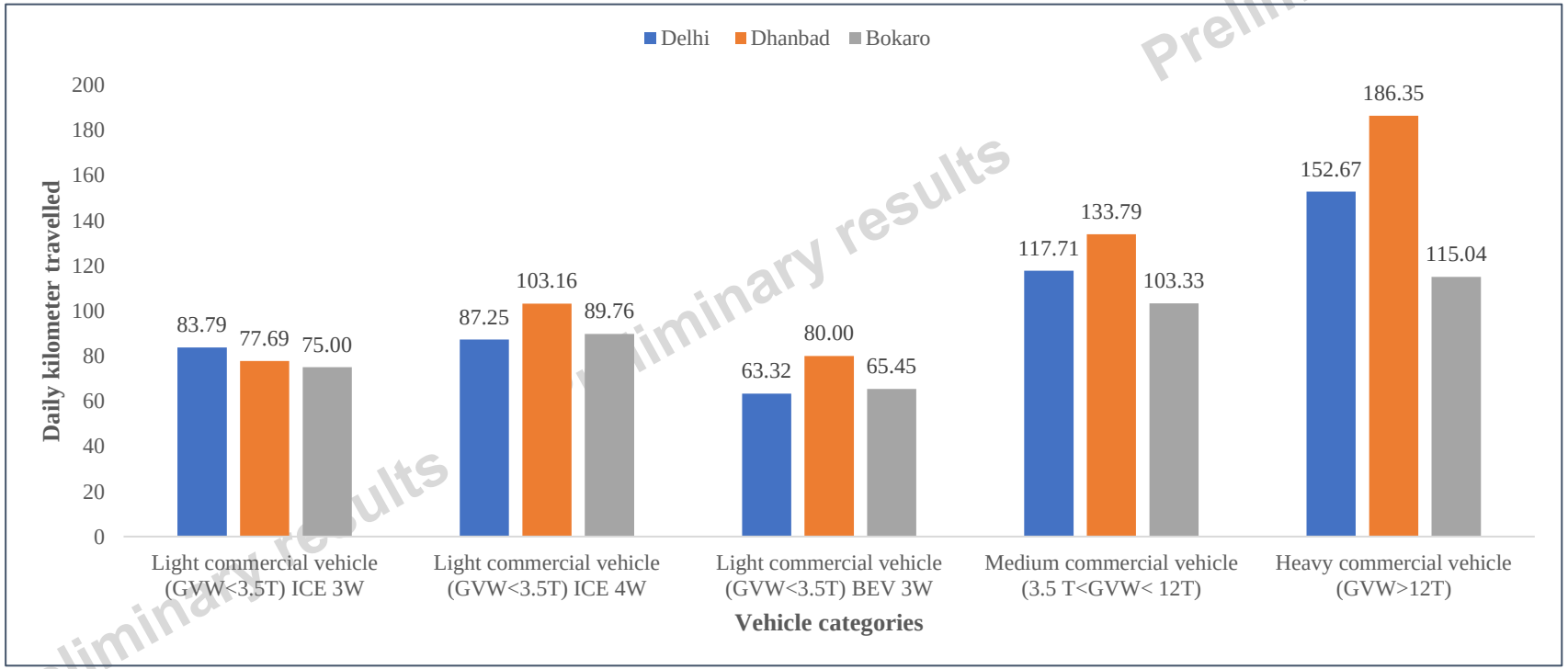


Fig 13: Daily kilometers travelled by different truck categories in surveyed cities

Fuel economy/ Range

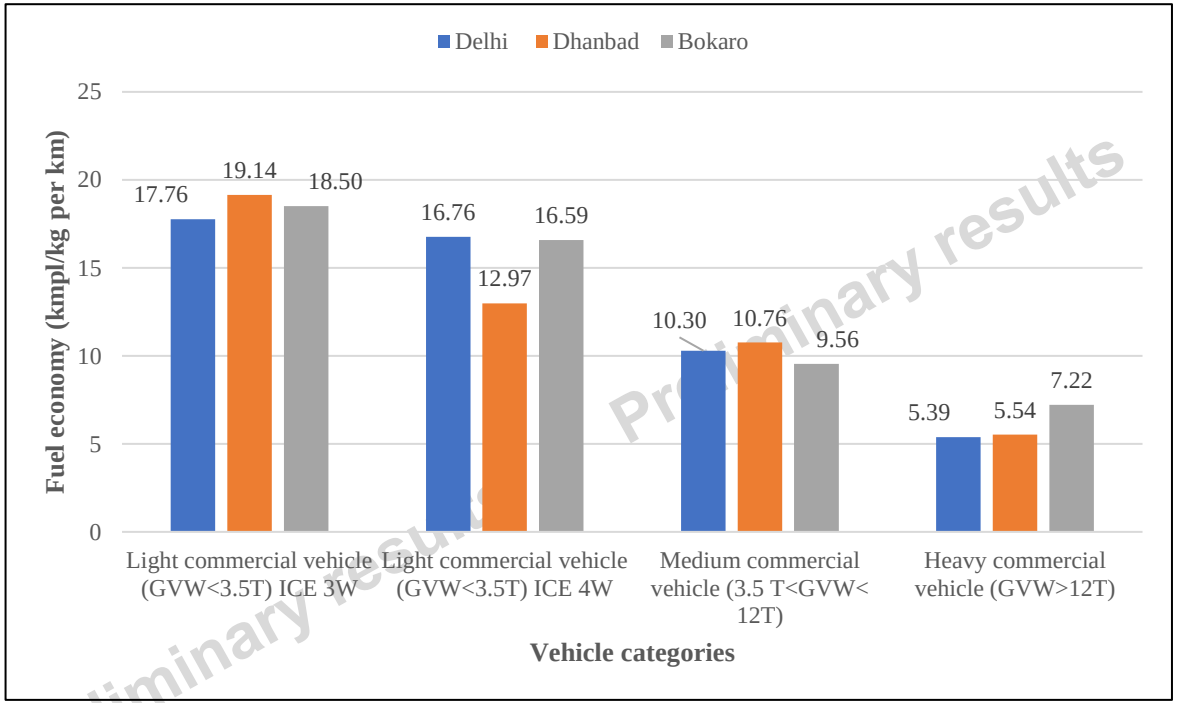


Fig 14: Fuel economy of different truck categories in surveyed cities

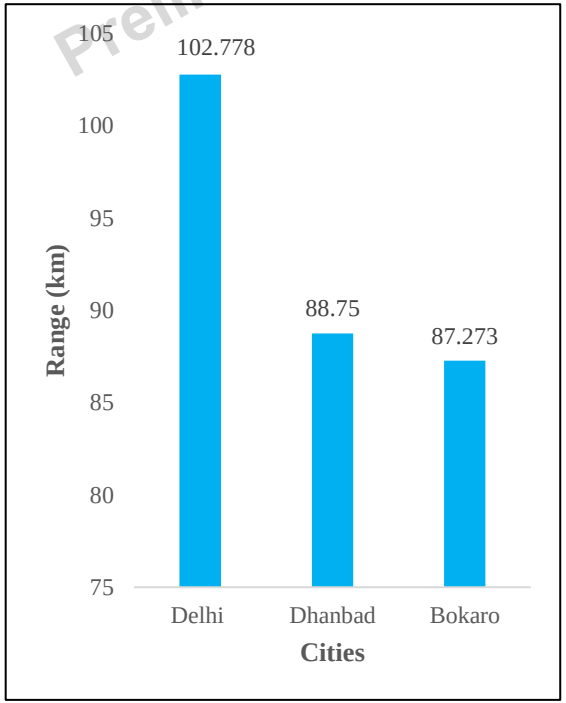
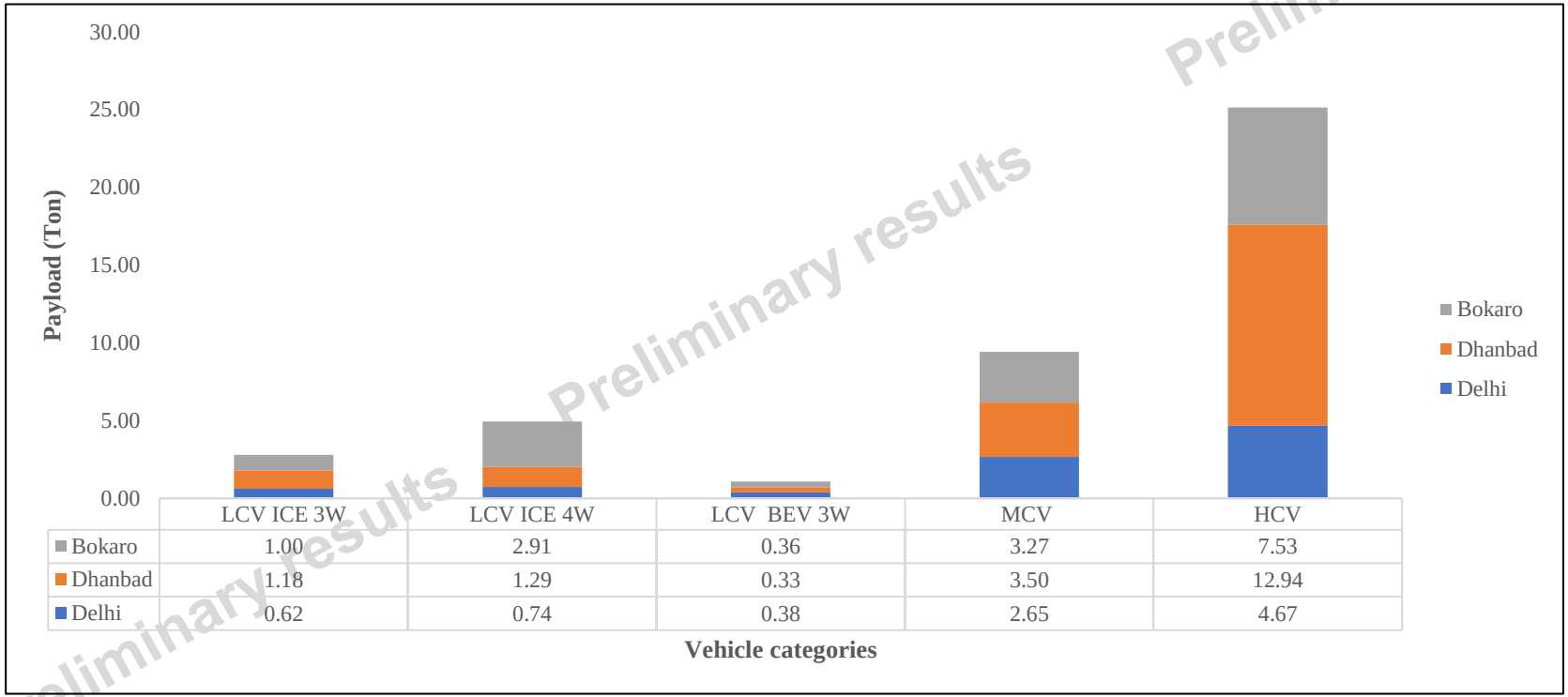


Fig 15: Range of 3W BEV

Payload



	LCV ICE 3W	LCV ICE 4W	LCV BEV 3W	MCV	HCV
Bokaro	1.00	2.91	0.36	3.27	7.53
Dhanbad	1.18	1.29	0.33	3.50	12.94
Delhi	0.62	0.74	0.38	2.65	4.67

Fig 16: Average payload carried by different truck categories in surveyed cities

Current data limitations

Operational data collected

- Only CNG fuel vehicles were encountered during the survey in the LCV category in Delhi.
- All the freight vehicles except LCV in Delhi were Diesel-fueled in the ICE category.
- LCV BEV 3W penetration is very low in Delhi. No LCV BEV 3W vehicle was encountered in Dhanbad and Bokaro during the survey.
- In Dhanbad and Bokaro, some passenger BEV 3Ws are used for carrying goods.
- No LCV BEV 4W was encountered in any of the three cities during the survey.

Current data limitations

Vehicle/battery data

- Relying on European/South American data for freight BEV battery due to lack of data availability.
- Weight of materials data for light commercial vehicles three-wheeler (ICE & BEV) is not currently available.
- Electricity usage for light commercial vehicles four-wheeler (BEV) is not currently available.

Preliminary Results: GHG Emission of Freight Vehicles per Vehicle

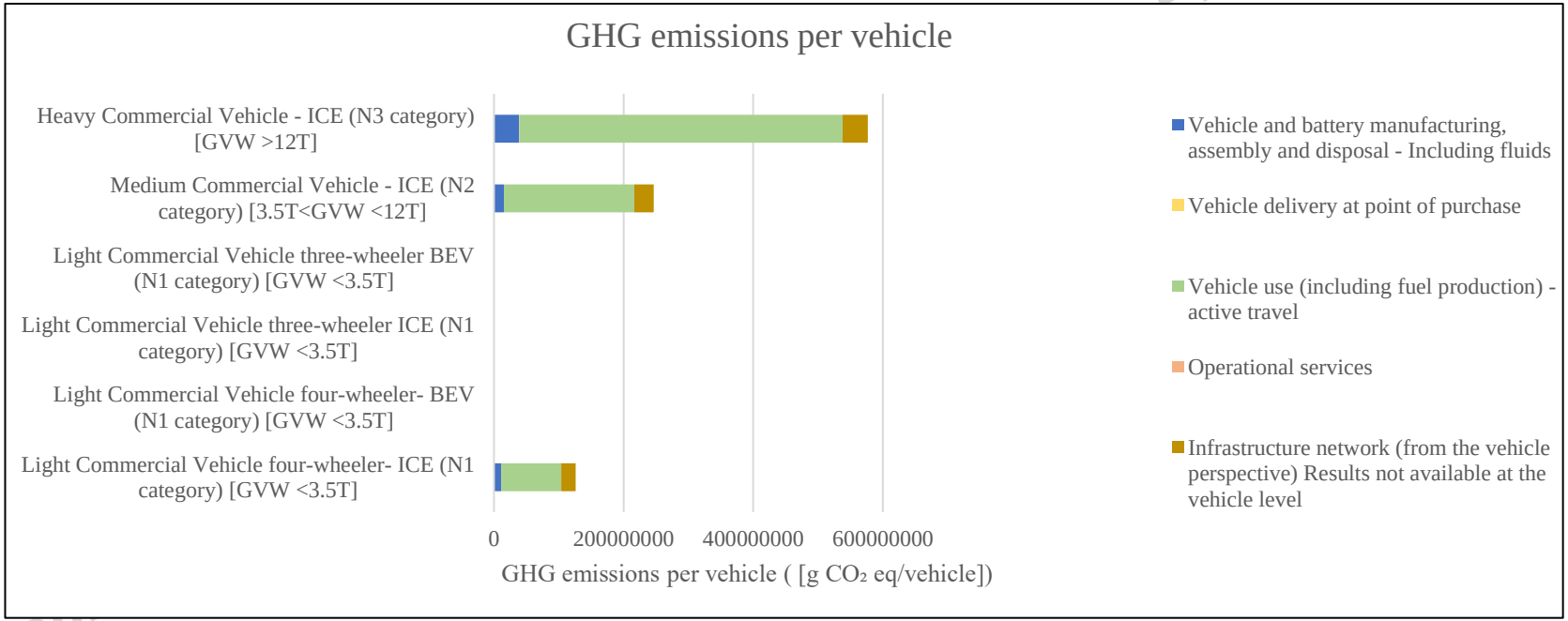


Fig 17: GHG emission per vehicle in high density city

GHG Emission of Freight Vehicles per tkm

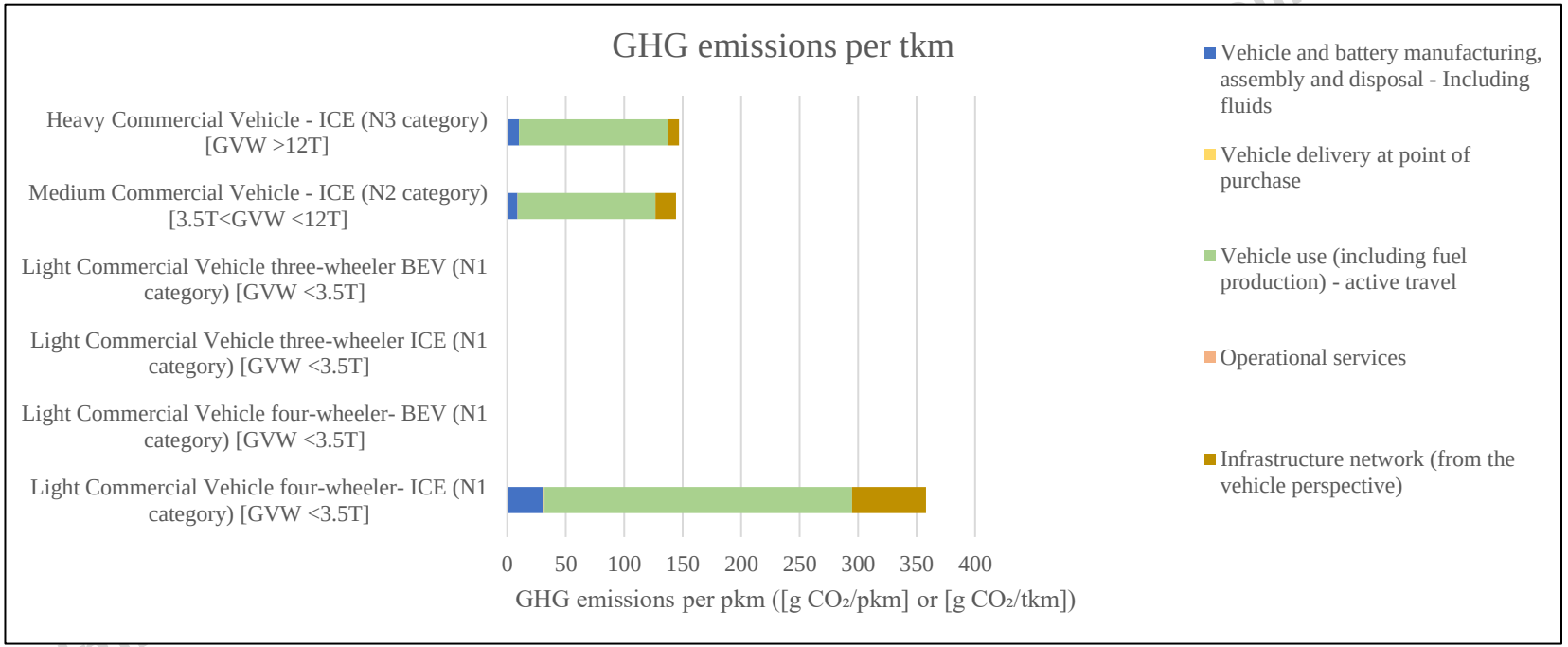


Fig 18: GHG emission per tkm in high density city

Preliminary results: City-wise Comparison of Energy Consumption

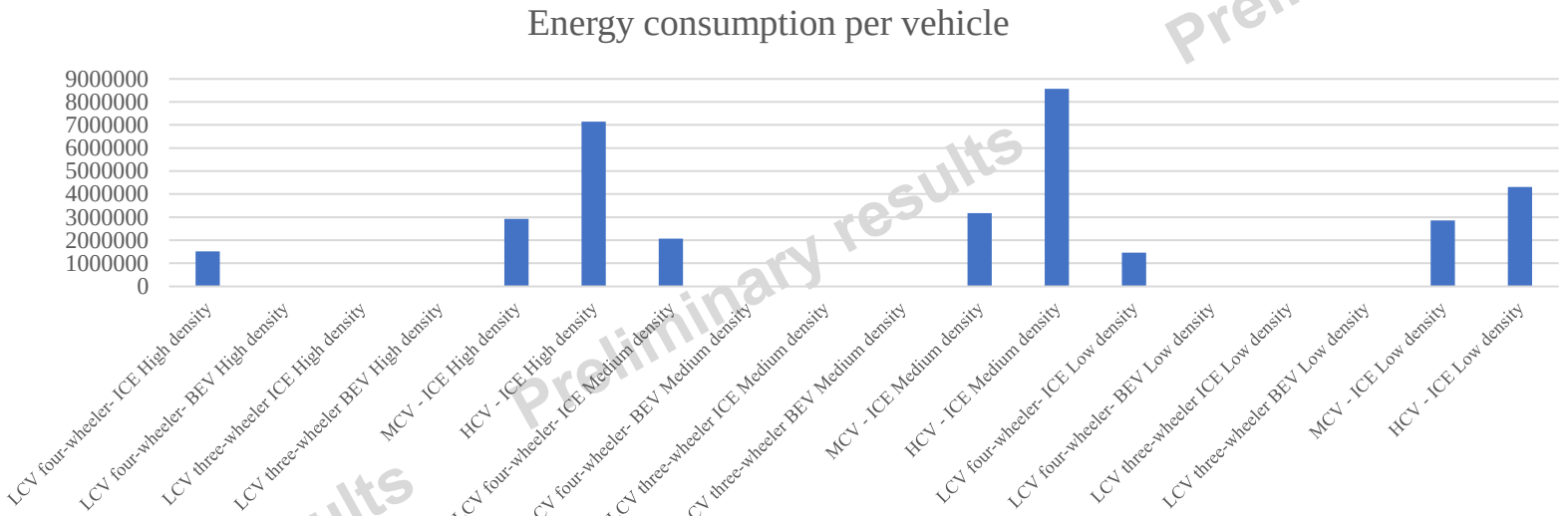


Fig 19: Energy consumption per vehicle in MJ

Preliminary results: City-wise Comparison of Energy Consumption

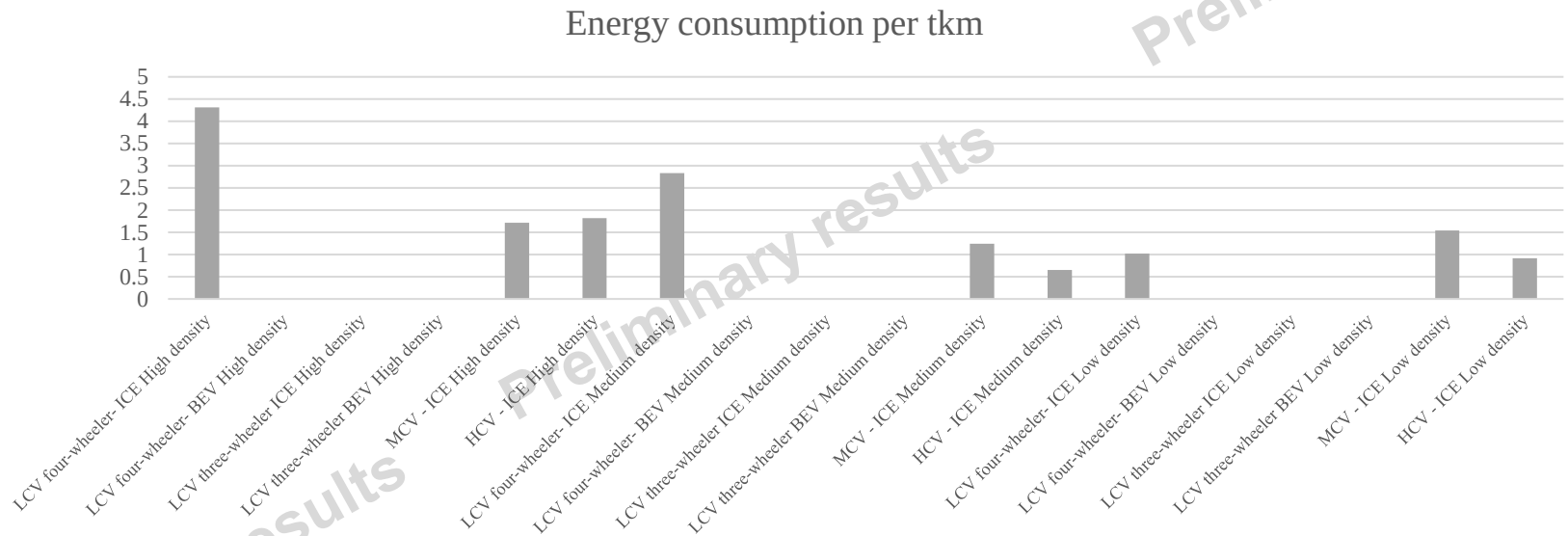


Fig 20: Energy consumption per tkm in MJ

Preliminary results: City-wise Comparison of GHG Emission

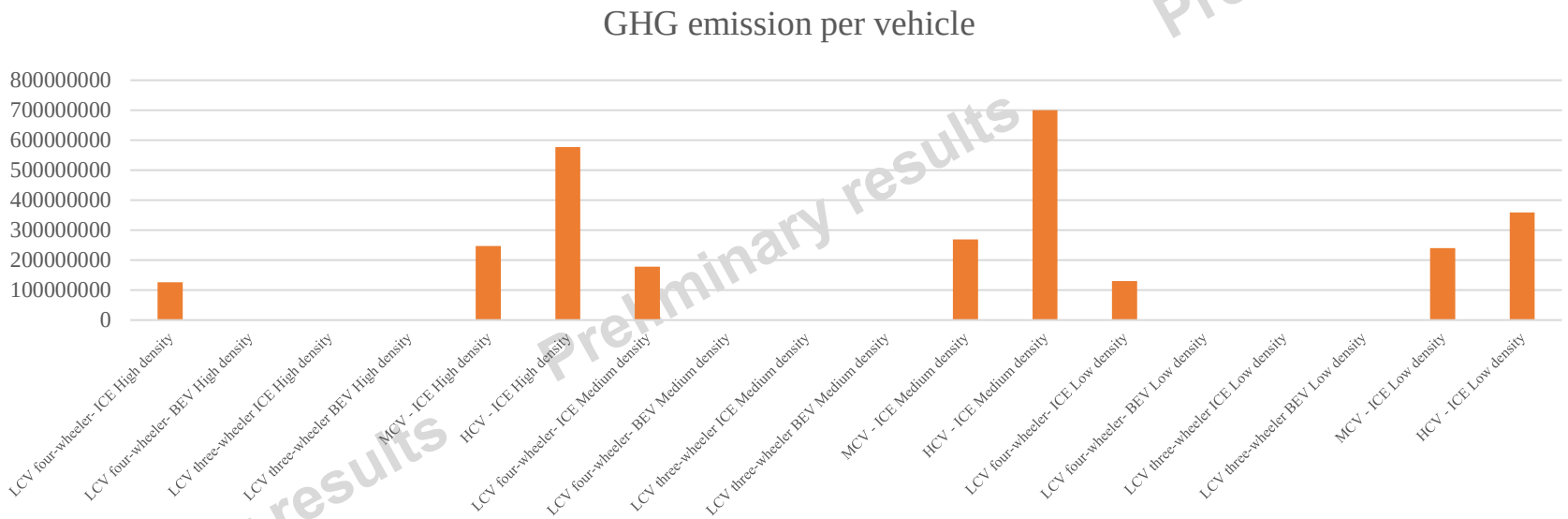


Fig 21: GHG emission per vehicle in g CO_2 eq.

Preliminary results: City-wise Comparison of GHG Emission

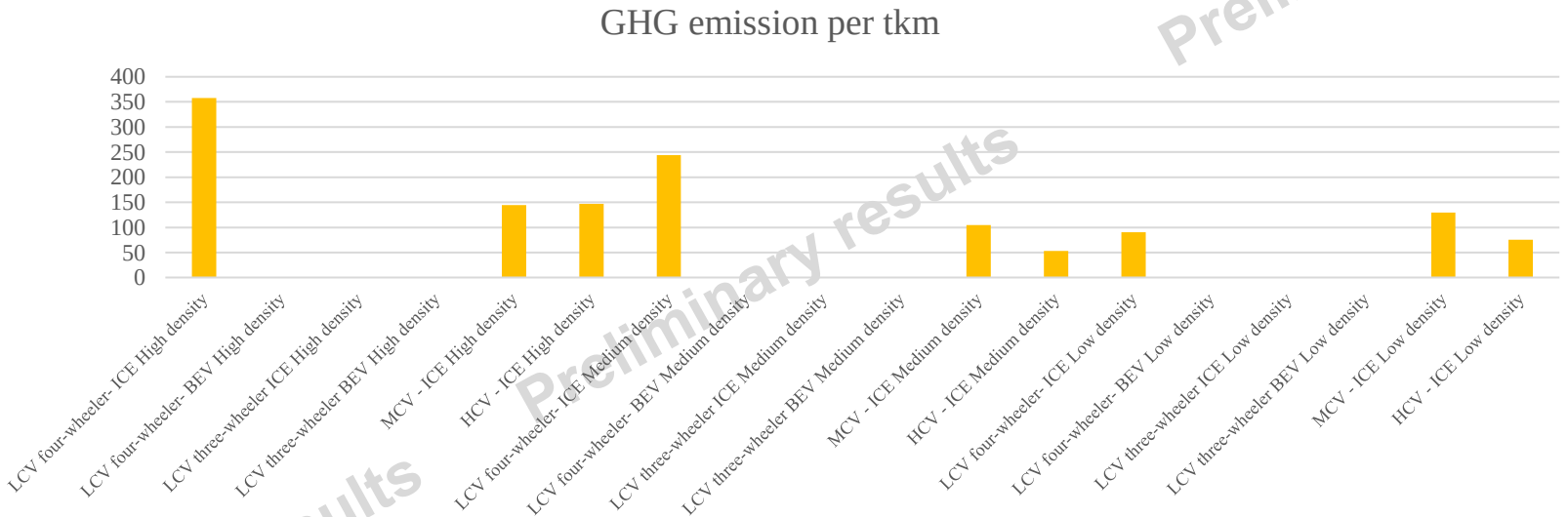


Fig 22: GHG emission per tkm in g CO_2 eq.

Preliminary Findings and Next Steps

- The majority of the LCVs surveyed in three Indian cities had a very low payload capacity.

- LCVs are less efficient than MCVs and HCVs in case of energy emission/ GHG emission per tkm when operating with very low payloads, but carry higher volume parcels (compared to their weight).

Next steps

- Q2 release of ITF Transport Life-cycle Assessment Tool for India v2.0 BETA

- Open to feedback and data

Thank You