Life Cycle CO2 emissions for commuting in Jakarta Indonesia

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Presented By

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1. Introduction

My transportation in Jakarta, Indonesia, for commuting, is divided into 4 parts: Walking, Moped Taxi, Taxi and Bus(Ojek, passenger cars and Trans Jakarta). In this study, I would use my commuting path of 11.2 km a day to analyze carbon emissions.

Therefore, commuting with different Internal Combustion Engine Vehicles (ICEV), and Electric Vehicles (EV) transportation would be analyzed. Consequently, manufacturing emissions, shipping emissions, end-of-life emissions and fuel emissions will be considered.

Furthermore, will be contrasted altogether to assess the less polluting transportation method for a single commuter. Finally, it will be addressed in developing countries the preference of people for the use of individualized transportation which is a reason for high air pollution in the cities.

2. Cradle-to-gate CO2 assessment of transportation methods in Jakarta

2.1. Commuting Parameters

Table 1 calculates the extra idling times of cars and motorcycles due to traffic jams according to the World Traffic Conjection rank and an average traffic jam congestion magnitude of 31% for commuting at 12:00 pm and 9:00 pm. As a motorcycle requires 1/6 of an area of a car then the extra traffic time will be reduced from 31% to 5% and as Trans Jakarta has an exclusive lane it will be assumed to be 0%.

Table 1. Driving Parameter

Parameter	Bus	Moped Taxi	Car
Total distance (m)	5600	5600	5600
Bus stops	6	0	0
Idling time per bus stop (s)	60	0	0
Assumed traffic lights	6	6	6
Idling time per traffic light (s)	90	90	90
Traffic Jam percentage avg 31%	0%	5%	31%
Assumed city speed (m/s)	15	15	15
Total Iddling time	900	558.6666667	655.73333

2.2. Well-to-tank and tank-to-wheel emission factors

Well-to-tank (WTT) emissions are the emissions of fuel production and its supply, as shown in **Table 2.** Preceding the WTT Emissions, the Tank-to-Wheel (TTW) emissions are the direct emissions of the fuel consumption of the transportation method, which assists in estimating the fuel cycle emissions. The heating value of diesel and gasoline is 42-46 MJ/kg so it will be similar for both for the TTW emission factor.

Table 2. Table of Emission Factors [1] [2]

Unit	Emission factor
Electricity in Indonesia ($kgCO_2/kWh$)	0.71
EU WTT diesel approximated to Indonesian energy mix ($kgCO_2/l$)	1.59
EU WTT gasoline approximated to Indonesian energy mix ($kgCO_2/l$)	1.33

[1] Carbonfootprint. (2022). COUNTRY SPECIFIC ELECTRICITY GRID GREENHOUSE GAS EMISSION FACTORS.
[2] Edwards,R. (2014). WELL-TO-WHEELS ANALYSIS OF FUTURE AUTOMOTIVE FUELS AND POWERTRAINS IN THE EUROPEAN CONTEXT. *European Comission*

TTW ($kgCO_2/l$)	2.67

2.3. Bus

2.3.1. Manufacturing

TransJakarta buses utilize Volvo, Scania, Mercedes-Benz and Ankai for Internal Combustion Engine Vehicles (ICEV). Utilizes BYD K9 for Electrical Vehicle (EV) buses in **Table 3**. The lifespan of the buses is important to assess the cycle, as shown in **Table 4**.

Table 3. Emissions for different Bus manufacturing and End of Life

Lifetime emissions	ICEV	EV	Source
Emissions $tonCO_2$/vehicle	112 (Volvo 7900)	142 (Volvo 7900)	Lie, K. et al. (2021)[3]
Emissions $tonCO_2$/vehicle	93.9276 (Volvo B8RLE)	131.9198 (BYD K9)	Zhao E. et al. (2021). [4]
Emissions $tonCO_2$/vehicle	93.6975 (Volvo bus 8908RLE)	-	Lindholm & Lorentzon (2019).[5]
Emission ton CO_2/vehicle	-	124.8 (Avg EU Bus)	O'Connell A. et al. (2023). [6]
Average $tonCO_2$/vehicle emissions	99.87503333	132.9066	

Table 4. Lifespan of a Bus

Bus	ICEV	EV
Lifespan (km) [7]	780000	780000
Lifespan (km)[8]	714570	714570

2.3.2. Shipping

[3] Lie, k. et al. (2021). The Carbon Footprint of Electrified City Buses: A Case Study in Trondheim, Norway. *Energies* 2021, 14, 770.
[4] Zhao, E. et al. (2021). Emissions life cycle assessment of diesel, hybrid and electric buses. *Proceedings of the Institution of Mechanical Engineers Part D Journal of Automobile Engineering*. 236(504):095440702110343.
[5] Lindholm, E. & Lorentzon, L. (2019). Managing life cycle assessment of buses. [Master's Thesis]. C*HALMERS UNIVERSITY OF TECHNOLOGY.*
[6] O'Connell A. et al. (2023). A COMPARISON OF THE LIFE-CYCLE GREENHOUSE GAS EMISSIONS OF EUROPEAN HEAVY-DUTY VEHICLES AND FUELS. *ICCT*
[7] Lie, k. et al. (2021). The Carbon Footprint of Electrified City Buses: A Case Study in Trondheim, Norway. *Energies* 2021, 14, 770.
[8] Cooney, G. (2011). LIFE CYCLE ASSESSMENT OF DIESEL AND ELECTRIC PUBLIC TRANSPORTATION BUSES. [Master's Thesis]. *University of Pittsburgh*

The shipping of the ICEV and EV bus is calculated as shown in **Table 5** with a well-to-tank and a tank-to-propeller scope assuming it is with a 47000 dWT ship[9]. The ICEV bus will have a distance from Sweden to Jakarta. On the other hand, the shipping of the EV bus will be from Guangzhou to Jakarta.

Table 5. Well-to-propeller emissions from the fuel of shipping one ICEV and one EV Bus

Parameters	ICEV Bus	EV Bus
Ship (DWT)	47000	47000
Bus weight (ton)	15	14.40
Distance (NM)	9796.43	4215
Shipping speed (knots)	15.1	15.1
Time (d)	27.03	11.63
Shipping total fuel consumption (ton)	975.85	419.87
Well-to-Tank Emission Factor (tCO_2e/tfuel)	0.43	0.43
Well-to-Tank Emissions of 1 Bus (tCO_2e)	0.13	0.06
Tank-to-Propeller Emission Factor (tCO2e/tfuel)	3.14	3.14
Tank-to-Propeller Emissions of 1 bus (tCO_2e)	0.98	0.40
Well-to-Propeller Emissions of 1 ICEV bus (tCO_2e)	1.11	0.46

2.3.3. Fuel and electricity consumption

2.3.3.1. ICEV Bus Diesel consumption

Literature from fuel consumption of TransJakarta is limited as shown in **table 6**, therefore we would use a Vehicle Specific Power (VSP) approach from Yu, Q. et al. [10] . Assuming TransJakarta lane is exclusive for the transit of the bus, assuming there are 6 red lights in between the commute. Considering the 6 bus stops of the commute.

Table 6. Transjakarta Fuel economy[11]

Bus type	Fuel economy
Diesel Bus (l/km)	0.5
CNG Bus (l/km)	0.6
Electric Bus (kWh/km)	1

$$\mathrm{VSP} = \frac{\mathrm{Power}}{\mathrm{Mass}} = \frac{\mathrm{F_t v}}{\mathrm{m}} = \frac{(\mathrm{F_f} + \mathrm{F_w} + \mathrm{F_j})\mathrm{v}}{\mathrm{m}}$$

$$= \frac{[\mathrm{mgfcos}\alpha + 0.5\rho_{\mathrm{air}}\mathrm{C_D A} \cdot (\mathrm{v} + \mathrm{v_m})^2 + \mathrm{mgsin}\alpha + (1 + \varepsilon_\mathrm{i})\mathrm{ma}]\mathrm{v}}{\mathrm{m}}$$

$$= \mathrm{v}[\mathrm{g} \cdot \mathrm{f} + \mathrm{g} \cdot \sin\alpha + (1 + \varepsilon_\mathrm{i}) \cdot \mathrm{a}] + 0.5\rho_\mathrm{a} \frac{\mathrm{C_D A}}{\mathrm{m}} (\mathrm{v} + \mathrm{v_m})^2 \mathrm{v}$$

9 MAN Diesel & Turbo. (2012). Propulsion of 46,000-50,000 dwt Handymax Tanker.

10 Yu, Q. et al. (2016). Improving urban bus emission and fuel consumption modeling by incorporating passenger load factor for real world driving. *Applied Energy*, 161. 101 - 111. ISSN 0306-2619

11 Sufa, F. (2012). Low-to-No Emissions Journey of TransJakarta BRT System. *ITDP*.

Parameters are based on Heavy-Duty Diesel literature to consider the effect of mass and road grade and Scania Urban Bus information[12] [13] [14] as shown in **Table 7**. Driving distance parameters and speed of the commute are described in **Table 8**.

Table 7. VSP Parameters for Bus

Parameters	value	unit
air density, ρ_{air}	1.2	kg/m3
bus front area, A	5.4	m2
drag coefficient, C_d	0.65	n/a
roll resistance coefficient, f (A)	0.008	n/a
curb weight of bus	15000	kg
assumed weight per passenger	68	kg
Passenger capacity	100	person
road grade (**Figure 1**), α	1.5	degree
specific fuel consumption, *SFC*	242	g/kW
diesel fuel density, ρ_{diesel}	0.85	kg/l
Bus Avg speed, v	4.6	m/s
Headwind, v_m	0	m/s
Acceleration of gravity, g	9.807	m/s2
Mass factor, ε_i	0.1	n/a
Bus average acceleration	1	m/s2

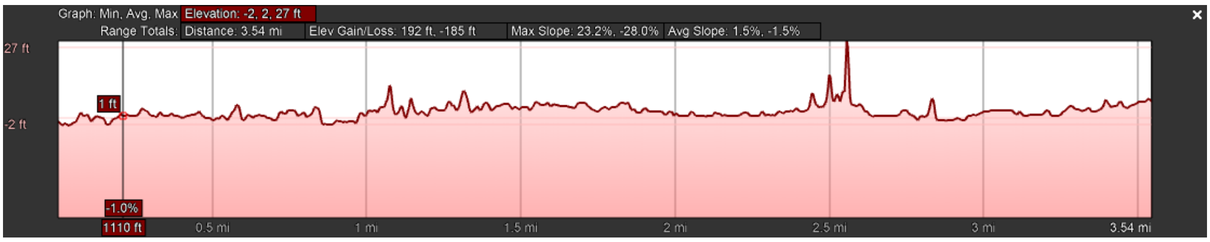

Figure 1. Avg Slope of Bus commuting

[12] Nam, E. et al. (2005). Heavy-Duty Diesel Vehicle Fuel Consumption Modeling Based on Road Load and Power Train Parameters. *US EPA*.
[13] Nam, E & Gianelli, R. (2005). Fuel Consumption Modeling of Conventional and Advanced Technology Vehicles in the Physical Emission Rate Estimator (PERE). *US EPA*.
[14] Barth, M et al. (2005). Development of a Heavy-Duty Diesel Modal Emissions and Fuel Consumption Model. *US EPA*.

The fuel consumption for a commute is compared from the literature as shown in **Table 8**. The driving patterns are divided into 2 main VSP bins which are Iddling and Cruising as shown in **Figure 2.** And the final fuel consumption will be described in **Table 9.**

Table 8. Average fuel consumption by VSP

VSP Mode	g/s	g/s	g/s	Average
Idling	1.02	1.02	1.02	1.02
VSP at 0% slope fuel consumption	5.8	5	6	5.6
VSP at 1.5% slope fuel consumption	6.2	5.8	7	6.3
VSP at 5.5% slope fuel consumption	7	6.6	8	7.2
Source	Śmieszek, M. and Mateichyk, V. (2021)[15]	Sun, R. et al. (2021). [16]	Frey, C. et al. (2007). [17]	-

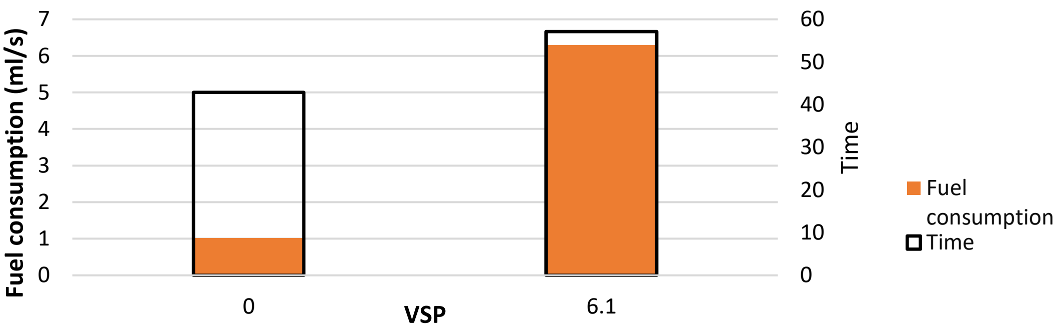

Figure 2. Diesel consumption by the time difference, 1.5% slope avg.

Table 9. Bus diesel consumption y commute

Mode	Diesel (ml)
Driving	7560
Idling	918
Total	8478

[15] Śmieszek, M. & Mateichyk, V. (2021). Determining the fuel consumption of a public city bus in urban traffic. IOP Conf. Ser.: Mater. Sci. Eng. 1199 012080.
[16] Sun, R. et al. (2021). Hybrid electric buses fuel consumption prediction based on real-world driving data. *Transportation Research Part D: Transport and Environment*. Volume 91, February 2021, 102637
[17] Frey, C. et al. (2007). Comparing real-world fuel consumption for diesel- and hydrogen-fueled transit buses and implication for emissions. *Transportation Research Part D: Transport and Environment*. Volume 12, Issue 4, June 2007, Pages 281-291

2.3.3.2. EV Bus electricity consumption

The prediction model from Abdelaty, H. and Mohamed, M. (2021)[18] will be utilized as follows. And the parameters to obtain the prediction are described in **Table 10.** Furthermore the idling consumption is added in **Table 11**.

$$E_C = -0.782 + 0.380GR + 0.0124SoC_i + 0.260R_C + 0.036HVAC + 0.005P_L + 0.065D_{Agg} + 0.128S_D + 0.007V_a + \varepsilon$$

Table 10. Electric Bus Parameters for Abdelaty, H. and Mohamed, M. electricity consumption prediction model

Parameter	Value	Unit
Air density	1.2	kg/m3
Bus front area	8.772	m2
Drag coefficient	0.65	n/a
Roll resistance coefficient	0.0092	n/a
Curb weight of bus	14400	Kg
Assumed weight per passenger	68	Kg
Passenger capacity	75	Person
Road grade (**Figure 1.**),	1.5	Degree
Bus Avg speed, v	4.6	m/s
Headwind,	0	m/s
Bus average Acceleration	1	m/s2
Initial state of Charge, SoCi	79.667	%
Bus average deceleration,	-2	m/s2
HVAC	13.5	kW
Driver aggressiveness DA	2	Level
Road condition RC	2	Level
Consumption	1.5971828	kWh

Table 11. EV bus adding the idling energy consumption

Parameter	Amount
Total kilometer traveled day (km/day)	11.2
Fuel consumption (l/km)	1.5971828
Fuel consumption per commute (l)	17.88844736
Idling time (h)	0.25
Idling time fuel consumption (l/h or kWh)	0.15[19]
extra fuel during car jam (l)	0.0375
Total fuel or electricty	17.92594736

[18] Abdelaty, H. and Mohamed, M. (2021). A Prediction Model for Battery Electric Bus Energy Consumption in Transit.

[19] Hussein Basma, Charbel Mansour, Marc Haddad, Maroun Nemer, Pascal Stabat. Comprehensive energy assessment of battery electric buses and diesel buses. 32nd International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems, Jun 2019, Wroclaw, Poland. ffhal-02169856

2.3.3.3. Fuel and electricity consumption

Table 12. ICEV and EV bus fuel and electricity consumption per km and total commute

Parameter	ICEV bus	Evbus
Total kilometre travelled day (km/day)	11.2	11.2
Diesel or electricity consumption (l/km or kWh/km)	0.675	0.04
Diesel or electricity consumption per commute (l or kWh)	7.56	0.448
Idling time (h)	0.25	0.25
Idling time fuel consumption (lh or kWh)	3.6	0.15
Extra fuel during iddle (l)	0.9	0.0375
Total fuel or electricity (l or kW)	8.46	0.4855

2.1.3. ICEV and EV bus emissions comparison

The emissions per person per 11.2km will be based on the bus's lifetime and will be calculated assuming that the ICEV and EV bus is carrying 50% of its capacity (100 and 75 people respectively) as shown in **Table 13** and **Figure 3**.

Table 13. Emissions per person on an 11.2km bus commute (50% capacity)

Parameter	ICEV bus	EV bus
Manufacture $kgCO_2e$	0.029	0.052
Shipping $kgCO_2e$	0.00032	0.00018
WTT Fuel $kgCO_2e$	0.27	0.34
TTW Fuel $kgCO_2e$	0.45	0

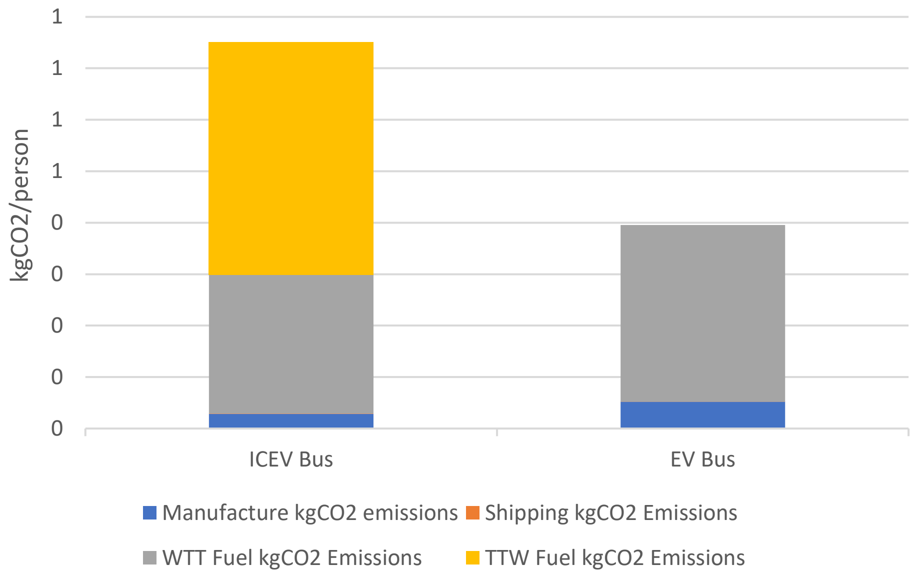

Figure 3. Emissions per person in an 11.2km bus commute

2.4. Moped taxi

2.4.1. Manufacturing

The Manufacture and lifetime is shown in **Table 14** and **15**, and calculated in **Table 16**.

Table 14. Life Cycle Assessment for the manufacture of an ICEV and an EV moped[20 21]

Life-cycle assessment	ICEV Moped	EV moped
$kgCO_2e$	382	615
$kgCO_2e$	674	545
Avg. $kgCO_2e$	528	580

Table 15. Vehicle lifetime

Vehicle	Lifespan (km)
ICEV Moped	80000
EV Moped	65000

[20] Schneider, F. et al. (2023). Comparative Life Cycle Assessment (LCA) on battery electric and combustion engine motorcycles in Taiwan. *Journal of Cleaner Production*, Volume 406, 137060.
[21] Carranza, G. et al. (2022). Life cycle assessment and economic analysis of the electric motorcycle in the city of Barcelona and the impact on air pollution. *Science of The Total Environment*,
Volume 821, 153419.

Table 16. Manufacture life cycle

Parameter	ICEV Moped	EV Moped
Back and forth Daily commute (km)	11.2	11.2
Lifespan of a moped (km)	80000	65000
Daily commute/Bus Lifespan ratio	0.00014	0.00017
Manufacture CO2 emissions of 1 moped ($kgCO_2$)	528	582.87
Manufacture CO2 emissions of 1 moped/11km commute ($kgCO_2$)	0.073	0.100

2.4.2. Shipping

Assuming the ICEV moped is made in Japan and the EV Moped is made in China the shipping is compared in **Table 17**

Table 17. Shipping of an ICEV and EV moped

Shipping Parameters	ICEV Moped	EV Moped
Ship (DWT)	47000	47000
moped weight	0.09	0.09
Distance (NM	3564	4215
Shipping speed (knots)	15.1	15.1
Time (d)	9.834437086	11.6307947
Shipping total fuel consumption (t)	355.0231788	419.8716887
Well-to-Tank Emission Factor (tCO_2/tfuel)	0.4311	0.4311
Well-to-Tank Emissions of 1 moped (tCO_2)	0.000293075	0.000346609
Tank-to-Propeller Emission Factor (tCO_2/tfuel)	3.14	3.14
Tank-to-Propeller Emissions of 1 moped (tCO_2)	0.002134671	0.00252459
Well-to-Propeller Emissions of 1 moped (tCO_2)	0.002427747	0.002871199

2.4.3. Fuel and electricity consumption

2.4.3.1. ICEV Moped Gasoline consumption

Table 18. Fuel economy from Ojek[22]

Parameter	Amount
Total distance travelled (km/day)	11.2
Fuel consumption (l/km)	0.082959641
Fuel consumption per commute (l)	0.929147979

[22] Nugrohono, S. et al. (2011). Empirical study on Fuel Consumption of Paratransit in Jakarta city. *Hiroshima University*

2.4.3.2. EV Moped electricity consumption

Table 19. Electricity economy from electric motorcycle taxis[23]

Parameter	Amount
Total distance travelled (km/day)	11.2
electricity consumption (kWh/km)	0.04
electricity consumption per commute (kWh)	0.448

2.4.3.3. Fuel and electricity consumption

Table 20. ICEV and EV moped fuel and electricity consumption per km and total commute.

Parameter	ICEV moped	EV moped
Total kilometer traveled day (km/day)	11.2	11.2
Fuel consumption (l/km)	0.083	0.04
Fuel consumption per commute (l)	0.93	0.45
Idling time (h)	0.16	0.16
Idling time fuel consumption (l/h or kWh)	0.21	0.1
Extra fuel during car jam (l)	0.033	0.016
Total fuel or electricity in the commute (l or kW)	0.978	0.46

2.4.4. ICEV and EV moped emissions comparison

The emissions per person per 11.2km will be based on the moped's lifetime as shown in **Table 21** and **Figure 4**.

Table 21. Emissions per person on an 11.2km moped taxi commute

Parameter	ICEV moped	EV moped
Manufacture kgCO_2e	0.074	0.100
Shipping kgCO_2e	0.00034	0.00049
WTT Fuel kgCO_2e	1.28	0.33
TTW Fuel kgCO_2e	2.57	0

[23] Vanatta, M. et al. (2022). Emissions impacts of electrifying motorcycle taxis in Kampala, Uganda. *Transportation Research Part D* 104 (2022) 103193.

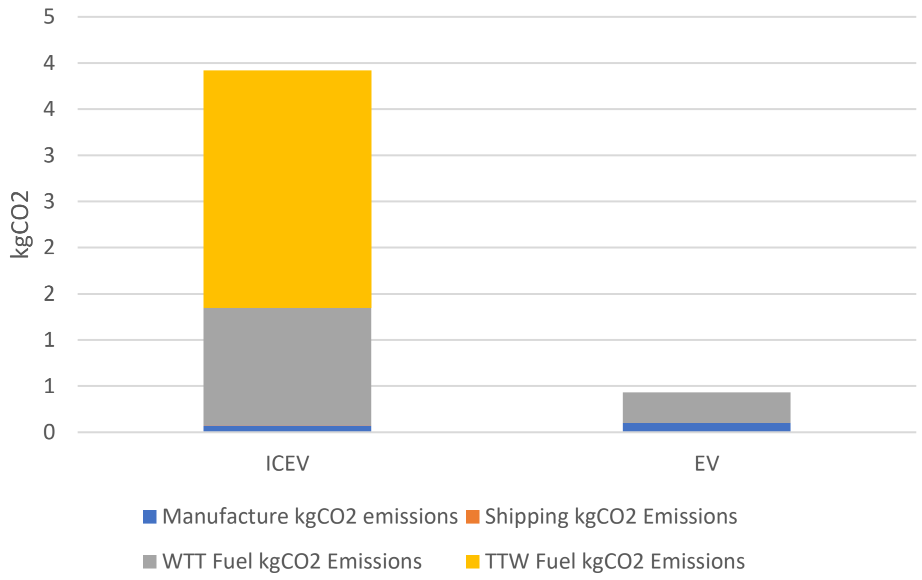

Figure 4. Emissions per person in an 11.2km moped taxi commute

2.5. Passenger vehicles

We will consider country-specific electricity grid emission factors for the manufacture of Japanese cars. The energy consumption from the vehicle manufacturing phase is obtained from the GREET 2 2022 model.

2.5.1. Manufacturing

The Manufacture is shown in **Table 22** with its life time in **Table 23**, and finally calculated in **Table 24**.

Table 22. Life Cycle Assessment for the manufacture of an ICEV and an EV car

CAR type	Components	Assembly, Dispose and Recycling	Batteries	Fluids	Total
ICEV $kgCO_2e$	9714.12	1949.71	101.86	1618.20	13383.89
EV $kgCO_2e$	8876.68	1949.72	11931.78	381.94	23139.98

Table 23. Vehicle lifetime

Vehicle	Lifespan (km)

ICEV car	278659.52
EV car	278659.52

Table 24. Manufacture life cycle

Parameter	ICEV Moped	EV Moped
Back and forth Daily commute (km)	278659.52	278659.52
Lifespan of a moped (km)	4.01924E-05	4.01924E-05
Daily commute/Bus Lifespan ratio	0.00014	0.00017
Manufacture CO_2 emissions of 1 moped ($kgCO_2$)	13383.89	23139.98
Manufacture CO_2 emissions of 1 moped/11km commute ($kgCO_2e$)	0.53	0.93

2.5.2. Shipping

Assuming both the ICEV and EV car are made in Japan as shown in **Table 25**

Table 25. Shipping of an ICEV and EV car

Parameters	ICEV	EV
Ship (DWT)	47000	47000
Car weight	1.59	1.42
Distance (NM	3564	3564
Shipping speed (knots)	15.1	15.1
Time (d)	9.83	9.83
Fuel consumption (t/day)	36.1	36.1
Shipping total fuel consumption (t)	355.02	355.02
Well-to-Tank Emission Factor (tCO_2/tfuel)	0.43	0.43
Well-to-Tank Emissions of 1 car (tCO_2)	0.01	0.00
Tank-to-Propeller Emission Factor (tCO2/tfuel)	3.14	3.14
Tank-to-Propeller Emissions of 1 car (tCO_2)	0.038	0.034
Well-to-Propeller Emissions of 1 car (tCO_2)	0.043	0.038

2.5.3. Fuel and electricity consumption

The GREET2 model includes the fuel and electricity consumption.

2.5.3.1. Fuel and electricity consumption

Table 26. ICEV and EV car fuel and electricity consumption per km and total commute.

Parameter	ICEV car	EV car

Total kilometer traveled day (km/day)	11.2	11.2
gasoline or electricity consumption (l/km or kWh/km)	0.068	0.22
gasoline or electricity consumption per commute (l or kWh)	0.76	2.46
Idling time (h)	0.18	0.18
Idling time fuel consumption (l/h or kWh)	0.6	0.24
extra fuel during car jam (l)	0.11	0.044
Total fuel or electricity	0.87	2.51

2.5.4. ICEV and EV car emissions comparison

The emissions per person per 11.2km will be based on the moped's lifetime as shown in **Table 27** and **Figure 5**.

Table 27. Emissions per person on an 11.2km car commute

Parameter	ICEV moped	EV moped
Manufacture $kgCO_2e$	0.538	0.930
Shipping $kgCO_2e$	0.00173	0.00154
WTT Fuel $kgCO_2e$	1.16	1.80
TTW Fuel $kgCO_2e$	2.03	0

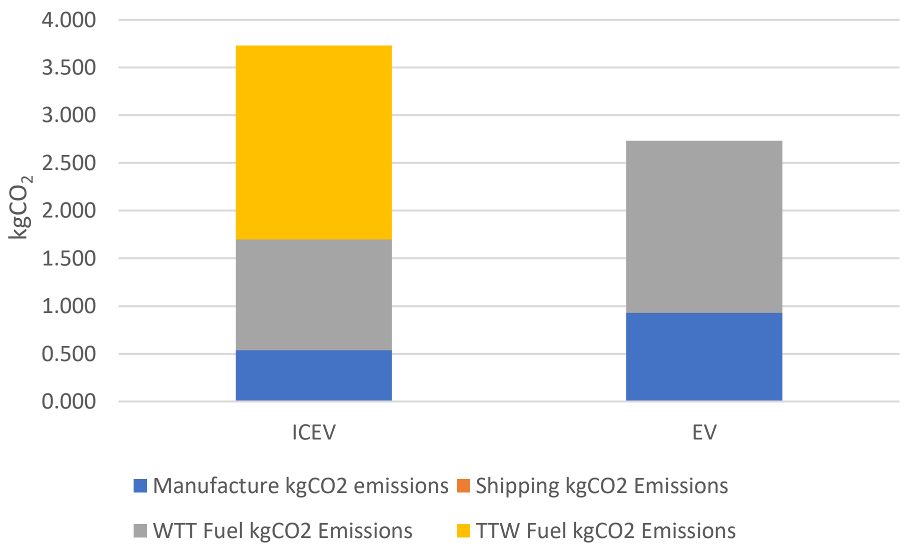

Figure 5. Emissions per person in an 11.2km car commute

3. Results

In **Table 28** and **Figure 6** transportation by both ICEV and EV bus shows promising reductions in CO_2 for my commute, which is an instant and reachable solution. The EV bus shows the least emissions of all the methods. EV mopeds show a promising reduction of CO_2 emissions for the actual situation with ICEV moped taxis in Jakarta, which is encouraging for the update of Ojek to reach Indonesia's carbon reduction objectives. The ICEV motorcycle shows the highest emissions due to its fuel usage (obtained from literature on Ojek transportation) and its shorter life cycle than all the transportation methods.

Due to the electricity emission factor of Indonesia, and the individuality of an EV car, it shows a not promising comparison against the EV bus.

Finally, transportation and working conditions are not equal worldwide as shown in **Table 29**. Therefore we intend to recognize that problems in third-world countries such as increasing safety, transportation methods, comfort and efficiency should be focused on first to increase the minimal quality of life for citizens. We recognize that lack of investments in public transportation, safety, efficiency, and climate conditions are one of the main reasons why people in third-world countries would prefer to utilize individualized transportation methods.

Table 28. $kgCO_2$ emissions per person per Km

Parameter	EV bus	Shoes[24]	EV moped	ICEV bus	EV car	ICEV car	ICEV moped
Manufacture $kgCO_2$ emissions	0.005	0.04	0.01	0.003	0.08	0.05	0.007
Shipping $kgCO_2$ emissions	1.61E-05	6.10E-08	4.42E-05	2.85E-05	1.37E-04	1.54E-04	3.03E-05
WTT Fuel $kgCO_2$ emissions	0.03	0	0.03	0.02	0.16	0.10	0.11
TTW Fuel $kgCO_2$ emissions	0	0	0	0.04	0	0.18	0.23
Total $kgCO_2$ emissions	0.0353	0.0356	0.0387	0.0671	0.2439	0.3332	0.3501

[24] Azofeifa. F. (2023). Life Cycle CO2 Emissions of Running Shoes. *Cyclocarpum*

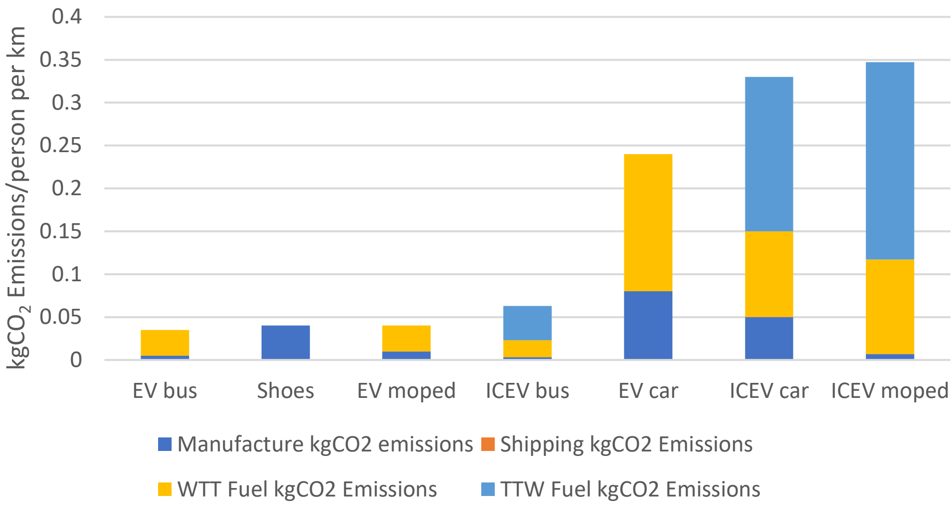

Figure 6. $kgCO_2$ emissions per person per Km

Table 29. Urban topics for commuting in Jakarta, Indonesia

Topic	Place	Other data
World traffic Conjection rank[25]	46/404	
City Crime rank[26]	139/416	
Public transit ranking[27]	38/60	
Traffic-Time index ranking[28]	16/239	Jakarta avg. (one way) 51.7 mins.
Precipitation[29]	11-18 days/ month (wet season)	
Floods[30]	135/ month (wet season)	815 floods year (wet season)
Temperature	28-30 C (11:00-12:00)	
AQI ranking	27/100[31]	pm2.5>50 avg. 20.75 days/month[32]

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[26] Anonymous. (2023, January 27). Crime Index by City 2023. *NUMBEO*. https://www.numbeo.com/crime/rankings.jsp
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