This document will explain the impact of two wheelers ride hailing fleets electrification in Greater Jakarta, seen from environmental, social, economic, and GESI aspects.

Road Map and Timetable of Two-Wheeler Electrification in Greater Jakarta

Two Wheelers Ride Hailing Impact Analysis Document

31/01/2022

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1. Introduction

This report will elaborate the impact of the 2W ride hailing electrification roadmap that has been produced on the previous report, which is the Timetable and Roadmap for Ride Hailing Fleet Electrification. There are 3 aspects that would be explained in this report, which are the environmental impact, social and economic impact, and GESI impact. Quantitative analysis could be made on environmental, social, and economic impact. However, a qualitative analysis would be made on the GESI impact instead, due to limitations on references.

2. Environmental Impact Analysis

The main environmental impacts from electric two wheelers (2W) adoption can be divided into two, that is greenhouse gas (GHG) emission reduction and air pollution reduction. Traffic noise reduction could also be an advantage of electric vehicles in general. However, some analysis shows that the noise reduction only occurs during low velocity. Furthermore, due to limited data in Indonesia, it is not analysed further.

In order to understand the full picture of environmental benefits of electric 2W, the estimation is based on life cycle assessment, which includes both vehicle and fuel cycles. The system boundary for the assessment is given below.

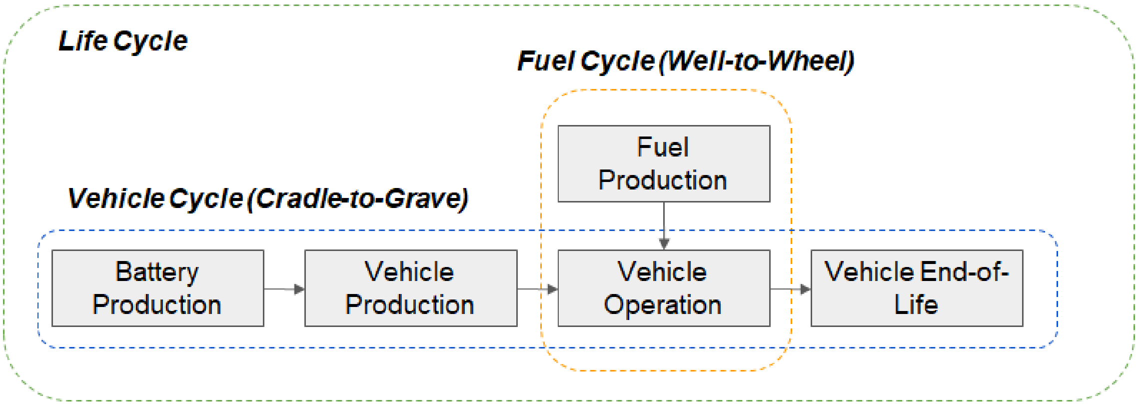


Figure 1 System Boundary of Vehicle Life Cycle Assessment

Each segment in the life cycle analysis above includes other sub-segments that might be on the upstream or downstream level depending on the assumptions. The assumptions and analysis for each segment is separated into two parts, for electric and conventional 2W. For this analysis, the general assumption is that the lifetime taken for electric and conventional 2W is 10 years.

2.1. Battery Production

The battery production stage is included in the vehicle cycle, but it is only applicable for electric 2W. Other vehicle components are integrated into the Vehicle Production stage. The battery type investigated is Lithium-ion battery. Currently, there is no complete domestic Li-ion battery production in Indonesia. Therefore, it is presumed that the battery used by electric 2W is imported. Since China holds the biggest market share for Li-ion batteries globally, it is assumed that the batteries in Indonesia are mainly imported from China. For this case, it is taken that NMC (Nickel-Manganese-Cobalt) is the Li-ion battery type used for electric 2W. This assumption is based on the knowledge that Gesits – one of the electric 2W manufacturers with the biggest market share – uses this battery type for its 2W. The emissions factors for the NMC battery are gathered as below from Hao et al. (2017), using the electricity mix in China that has an average grid emission factor of 869 grCO2/kWh.

Table 1 Emission Factor for Li-NMC Battery Production in China

NMC production stage & components	Emission Factor (kgCO2/kWh)
Battery components manufacturing	
Anode active materials	63
Graphite	3
Binder	1
Copper	4
Wrought Al	20
Electrolyte: LiPF6, DMC, EC	2
Plastic: PP, PT, PET	1
Steel	2
Fibreglass	0
Coolant: Glycol	1
BMS	8

NMC production stage & components	Emission Factor (kgCO2/kWh)
Battery cell production & assembly	**2**
TOTAL	**107**

When ten years is used as the lifetime of the 2W in Indonesia, at minimum, three batteries are needed for each electric 2W (the battery is replaced every 3-5 years). Taking Gesits model as the base case, each battery has 1.4 kWh of capacity, thus 4.2 kWh will be needed in total for the entire lifetime. Multiplying the capacity to the total emission factor above, it is found that **898.8 kgCO2** will be generated to produce three batteries.

The figure above needs to be added with the battery shipping emission. It is assumed that the transportation of batteries is done by airplane from Beijing to Jakarta. This translates to a distance of around 5,240 km. From Peshin et al. (2021), it is also reported that long-haul cargo flight emission generates 375-950 grCO2/ton-km according to IPCC. Therefore, to calculate the flight emission, the average value is taken, which is 662.5 grCO2/ton-km. One battery weighs about 8 kg for Gesits electric 2W, thus 24 kg will be required for the lifetime of the vehicle. Multiplying the three variables mentioned gives the total emission of **83.3 kgCO2** for transporting three batteries.

2.2. Vehicle Manufacturing

In this stage, the steps included are raw materials extraction, processing, vehicle parts production, vehicle assembly, painting and welding. The materials used are taken from Indian 2W manufacturing data, obtained from Peshin et al. (2021).

Table 2 Materials Mix for 2W Production in India

Material	Percentage (%)
Steel	46.5
Plastic	27.0
Lead	26.1
Fluid	7.5
Copper	6.1
Rubber	2.2

Material	Percentage (%)
Aluminium	1.0
Glass	0.3

The energy consumed during the whole production process (from raw materials extraction until vehicle assembly) of electric and conventional 2W are also estimated based on the manufacturing of the vehicles used in India.

Table 3 Energy Consumption of Electric and Conventional 2W Production in India

Two-Wheeler Type	Energy Consumption (MJ)	Curb weight (kg)
Photon (electric)	10,124	87
Activa 5G (conventional)	12,684	109

Assuming that the technology and process used are similar to Indonesia, the energy consumption is adjusted based on the curb weight of the vehicles. Hence, the energy consumption of 2W in Indonesia is calculated.

Table 4 Energy Consumption of Electric and Conventional 2W Production in Indonesia

Two-Wheeler Type	Energy Consumption (MJ)	Curb weight (kg)
Gesits (electric)	10,997	94.5
Honda Beat (conventional)	10,822	93

The energy sources mix to fulfil the requirement according to the study above is listed below.

Table 5 Energy Sources Mix to Manufacture Electric and Conventional 2W

Energy Source	Percentage Mix
Electricity	45%
Natural gas	52%
Fuel oil	3%

In order to calculate the emissions in the production stage, the emission factor for each energy source needs to be determined first. Both natural gas and fuel oil factors are taken from Peshin et al. (2021) since there is limited information found in Indonesia. Natural gas burning will emit 0.0561 kgCO2/MJ and fuel oil will contribute 0.0774 kgCO2/MJ. As for electricity, the carbon intensity varies depending on the energy mix used to generate the power. The carbon intensity from 2021-2030 is found by gathering data of emission and energy mix as projected in RUPTL 2021 (PLN, 2021).

Table 6 RUPTL 2021 Carbon Intensity (tonCO2/MWh) for Jamali Grid

Energy Source	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gas	0.445	0.429	0.421	0.420	0.419	0.418	0.416	0.418	0.421	0.432
Coal	1.096	1.083	1.080	1.079	1.081	1.075	1.073	1.070	1.068	1.068
Oil	0.740	0.737	1.007	0.980	1.087	1.096	1.037	1.016	1.113	1.071
TOTAL	**0.894**	**0.873**	**0.861**	**0.854**	**0.795**	**0.806**	**0.805**	**0.792**	**0.788**	**0.788**

Converted into MJ, the carbon intensity for Jamali grid from 2021-2030 is given as below.

Table 7 RUPTL 2021 Carbon Intensity (kgCO2/MJ) for Jamali Grid

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Carbon Intensity	0.248	0.243	0.239	0.237	0.221	0.224	0.224	0.220	0.219	0.219

2.3. Fuel Production

The fuel production stage consists of gasoline production for the case of conventional 2W and electricity generation for electric 2W. As described before, the electricity grid emission factors are calculated from RUPTL 2021 with the energy sources mix as follows.

Table 8 RUPTL 2021 Electricity Mix (%) for Jamali Grid

Energy Source	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Renewables	8.5	9.0	10.0	10.9	17.1	16.2	15.8	15.8	16.0	16.1

Energy Source	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Natural gas	16.2	16.7	16.9	16.3	15.3	14.5	14.9	16.7	16.8	17.1
Oil	1.0	1.0	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
Coal	74.4	73.4	73.0	72.7	67.4	69.2	69.1	67.3	67.0	66.7

Using the energy mix and total emissions found from RUPTL, the carbon intensities are estimated for every year until 2030.

Table 9 RUPTL 2021 Carbon Intensity (tonCO2/MWh) for Jamali Grid

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Carbon Intensity	0.894	0.873	0.861	0.854	0.795	0.806	0.805	0.792	0.788	0.788

For gasoline production, the process of crude oil extraction, gasoline refining, and the transportation in between are considered. According to Restianti and Gheewala (2012), crude oil extraction in Indonesia yields 0.057 kgCO2/L and gasoline refining generates 0.153 kgCO2/L of emissions. The transportation occurs from after the refinery all the way to gasoline fuelling stations, which encompass pipeline, train and tanker as the transport modes. Overall, the transportation contributes to 0.045 kgCO2/L of emission. Therefore, in total, gasoline production produces 0.255 kgCO2/L.

The emission factor above is then converted into distance basis by dividing it to the fuel economy used of conventional 2W. The fuel economy is obtained by averaging the fuel economy of several most popular conventional 2W used by ride-hailing drivers in 2021: Yamaha Mio, Honda Beat, Honda Vario and Yamaha Nmax. Furthermore, it is assumed that the fuel efficiency will improve 0.5% annually (ERIA, 2018).

Table 10 Fuel Economy and Gasoline Production Emission Factor for Conventional 2W

Variable	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Fuel economy (km/L)	24.6	24.72	24.85	24.97	25.10	25.22	25.35	25.47	25.60	25.73

Variable	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Emission factor* (kgCO2/km)	0.0104	0.0103	0.0103	0.0102	0.0102	0.0101	0.0101	0.0100	0.0100	0.0099

**Note: Calculated by dividing emission from gasoline production, which is 0.255 kgCO2/L, by fuel economy. Emission factor = emission from gasoline production/fuel economy*

2.4. Vehicle Operation

This segment only involves tailpipe emissions coming from conventional 2W, since the electricity use for electric 2W is already counted in the fuel production (electricity generation) stage and they produce zero tailpipe emission. The emission factor data for gasoline burning for conventional 2W is derived from the Ministry of Environment and Forestry Regulation No. 12/2010 and is in kg/km unit. The data is then converted to kg/l units using fuel economy that is sourced from the same regulation (28 km/l).

Table 11 Emission Factor of Gasoline Burning for Conventional 2W (MoEF, 2010)

Compound	Amount (kg/l)
Carbon Monoxide (CO)	0.392
Nitrogen Oxide (NO_x)	0.00812
Particulate Matter (PM_{10})	0.00672
Sulphur Dioxide (SO_2)	0.000224
Carbon Dioxide (CO_2)	2.4168

Using previous data for fuel economy and fuel economy improvement (0.5%/annum), the emissions factors are as follows.

Table 12 Emission Factors of Gasoline Burning from 2021-2030 (in kg/km)

Compound	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CO	0.0159350	0.0158557	0.0157768	0.0156983	0.0156202	0.0155425	0.0154652	0.0153882	0.0153117	0.0152355

Compound	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
NO_x	0.0003301	0.0003284	0.0003268	0.0003252	0.0003236	0.0003220	0.0003203	0.0003188	0.0003172	0.0003156
PM10	0.0002732	0.0002718	0.0002705	0.0002691	0.0002678	0.0002664	0.0002651	0.0002638	0.0002625	0.0002612
SO_2	0.0000091	0.0000091	0.0000090	0.0000090	0.0000089	0.0000089	0.0000088	0.0000088	0.0000087	0.0000087
CO_2	0.0982439	0.0977551	0.0972688	0.0967849	0.0963033	0.0958242	0.0953475	0.0948731	0.0944011	0.0939315

2.5. Vehicle End-of-Life

Since there is not yet a recycling facility in Indonesia, for vehicles and batteries. It is assumed that in the end, the mechanical parts of the 2W will be discarded. The emissions caused are taken as similar for both electric and conventional, since it is incinerated. However, the amount of emission does differ based on the weight of the vehicles.

For vehicle disposal, the data from Peshin et al. (2021) is taken. This is based on GREET energy consumption data and multiplied by India specific emissions factors. Furthermore, these factors are multiplied with the weight of 2W to provide emissions.

Table 13 Emission Factors of Vehicle Disposal

Compound	Emission Factor (kg/kg)
CO_2	0.852
CO	0.000044
NO_x	0.001168
PM10	0.000524

Using the curb weight of each type of 2W as indicated in Table 4 above, the total emissions could be estimated and given below.

Table 14 Total Emission of Electric and Conventional 2W for Each Compound in 10 Years

Compound	Electric Two-Wheeler Emission (kg)	Conventional Two-Wheeler Emission (kg)
CO_2	80.514	79.236
CO	0.0041	0.004
NO_x	0.1103	0.1086
PM10	0.0495	0.0487

2.6. Life Cycle CO2 Emission Reduction

Using Scenario 2 on our previous report of Timetable and Roadmap for Ride Hailing Fleet Electrification, that is electric 2W adoption projection until 2030, the total life cycle emission is calculated for both electric and conventional 2W in the scenario. The life cycle emission is taken as an average annual basis, thus the emissions coming from battery production, vehicle production and vehicle end-of-life is divided by 10 years to arrive with an average annual figure. However, since fuel production and vehicle operations emissions are given in the kgCO2/km basis, it is then multiplied by the total annual distance travelled to estimate the annual emissions. The general assumptions taken are that the daily distance travelled is equal to 76.3 km (average for all electric 2W ride-hailing functions) and the total working days is equal to 313 days (assuming drivers take 1 day off per week). In order to estimate the total emission for fuel production, it is assumed that the electric 2W will use 3.64 kWh on average daily in 2022. Assuming that fuel economy for electric 2W improves 0.67% annually (Anup et al., 2021), the total daily electricity consumption is given by Table 15 below. Hence, the annual electricity consumption equals to electricity consumption (kWh/day) multiplied by 313 days/year.

Table 15 Fuel Economy Improvement for Electric 2W from 2022-2030

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
Daily kWh Needed	3.64	3.62	3.59	3.57	3.54	3.52	3.50	3.47	3.45
Fuel economy (km/kWh)	20.96	21.10	21.24	21.39	21.53	21.67	21.82	21.96	22.11

Table 16 Life Cycle Emission of Electric 2W per Year Using Scenario 2 (in kgCO2)

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cumulative Electric Fleet Size	7,348	25,719	132,270	235,146	484,989	734,832	984,674	1,234,517	1,469,663
Battery Production	721,659	2,525,904	12,990,448	23,094,065	47,631,546	72,169,026	96,706,409	121,243,890	144,337,955
Vehicle Production	1,157,471	3,977,066	20,235,433	35,747,739	69,796,455	106,863,337	143,061,390	177,154,550	210,090,184
Fuel Production	7,308,702	25,061,903	126,991,883	208,766,781	433,634,206	651,839,201	853,638,744	1,057,741,854	1,250,835,812
Vehicle Operation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vehicle End-of-Life	59,162	207,074	1,064,959	1,893,255	3,904,840	5,916,426	7,928,004	9,939,590	11,832,845
Total	**9,246,994**	**31,771,947**	**161,282,723**	**269,501,840**	**554,967,047**	**836,787,991**	**1,101,334,547**	**1,366,079,884**	**1,617,096,795**

Table 17 Life Cycle Emission of Conventional 2W per Year Using Scenario 2 (in kgCO2)

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cumulative ICE Fleet Size	943,052	977,903	927,556	884,029	696,860	513,201	333,248	157,209	0
Battery Production	0	0	0	0	0	0	0	0	0
Vehicle Production	143,513,359	147,229,525	138,771,127	125,203,359	99,731,924	73,377,930	47,062,043	22,116,347	0
Fuel Production	232,296,961	239,683,205	226,212,137	214,524,162	168,263,213	123,300,567	79,667,111	37,395,803	0
Vehicle Operation	2,201,628,606	2,271,632,825	2,143,958,795	2,033,184,291	1,594,739,342	1,168,599,252	755,056,760	354,424,220	0

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
Vehicle End-of-Life	7,472,367	7,748,512	7,349,583	7,004,692	5,521,640	4,066,399	2,640,524	1,245,661	0
Total	**2,584,911,292**	**2,666,294,067**	**2,516,291,642**	**2,379,916,504**	**1,868,256,119**	**1,369,344,148**	**884,426,438**	**415,182,031**	**0**

As can be seen from the above tables, electric 2W still contribute to carbon emission. This mainly comes from the fuel production stage, which is electricity generation. However, compared to conventional 2W, it is already a significant reduction.

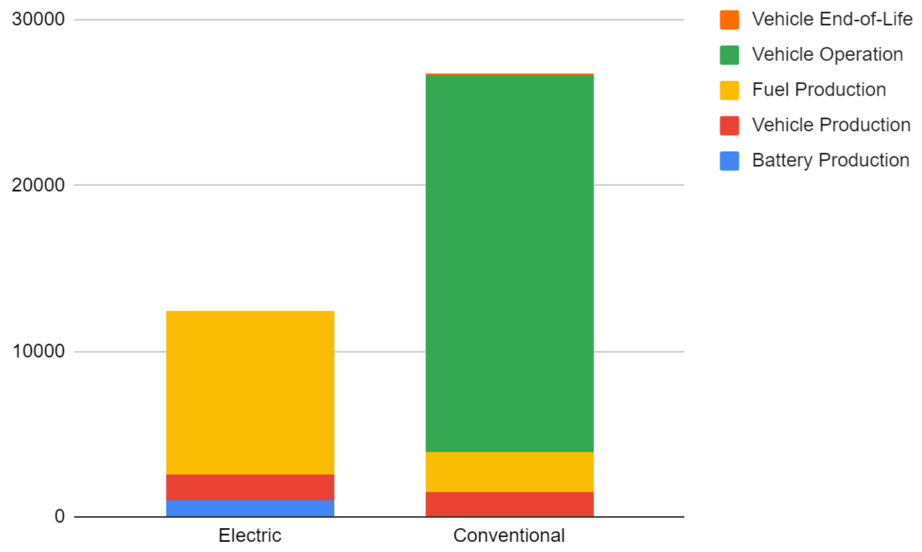


Figure 2 Life Cycle Emission (10-Year Basis) for an Electric and Conventional 2W In Indonesia (in kgCO2)

On the contrary, conventional 2W mainly emit CO2 from the vehicle operation stage, that is tailpipe emission.

The Scenario 2 emission is then compared to the emission when using only conventional 2W until 2030.

Table 18 Life Cycle Emission of Conventional 2W per Year Using Only Conventional Scenario (in kgCO2)

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cumulative ICE Fleet Size	950,400	1,003,622	1,059,825	1,119,175	1,181,849	1,248,033	1,317,923	1,391,726	1,469,663

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
Battery Production	0	0	0	0	0	0	0	0	0
Vehicle Production	144,631,575	151,101,684	158,559,817	158,506,643	169,141,685	178,444,855	186,120,095	195,789,651	206,753,920
Fuel Production	234,106,954	245,986,911	258,469,869	271,586,202	285,368,237	299,849,720	315,066,010	331,054,271	347,854,122
Vehicle Operation	2,218,783,086	2,331,377,119	2,449,686,197	2,573,998,171	2,704,619,432	2,841,869,814	2,986,084,448	3,137,615,540	3,296,838,593
Vehicle End-of-Life	7,530,589	7,952,299	8,397,629	8,867,895	9,364,499	9,888,914	10,442,695	11,027,480	11,645,022
Total	**2,605,052,205**	**2,736,418,013**	**2,875,113,513**	**3,012,958,912**	**3,168,493,852**	**3,330,053,303**	**3,497,713,248**	**3,675,486,943**	**3,863,091,656**

The figures above are then deducted with the total of electric and conventional 2W emissions from Scenario 2. The total emission reduction results as follow.

Table 19 Average Annual Life Cycle Emission Reduction (in kgCO2)

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
Scenario 100% conventional	2,605,052,205	2,736,418,013	2,875,113,513	3,012,958,912	3,168,493,852	3,330,053,303	3,497,713,248	3,675,486,943	3,863,091,656
Scenario 2	2,594,158,286	2,698,066,014	2,677,574,365	2,649,418,344	2,423,223,166	2,206,132,139	1,985,760,985	1,781,261,915	1,617,096,795
Emission reduction	**10,893,919**	**38,351,999**	**197,539,148**	**363,540,567**	**745,270,686**	**1,123,921,164**	**1,511,952,262**	**1,894,225,028**	**2,245,994,862**
Emission reduction (%)	0.42	1.40	6.87	12.07	23.52	33.75	43.23	51.54	58.14

Each year, there is a growing potential of CO2 emission reduction from 0.42% to 58.14% once scenario 2 is implemented to replace conventional scenario.

2.7. Air Pollution Reduction

Four compounds i.e., Carbon Monoxide (CO), Nitrogen Oxide (NOx), Particulate Matter (PM10), and Sulphur Dioxide (SO2) are included in the analysis of air pollution impact from both electric and conventional 2W. The approach taken to calculate air pollution reduction for each compound is similar to the one that is used for CO2 emission reduction calculation. Therefore, scenario 2 of Task 3.3 also serves as a basis of electric 2W adoption projection until 2030. However, due the limited data availability, the calculation only covered vehicle operation and vehicle-end of life stage. Since electric 2W do not emit any pollution, hence, the air pollution for each compound comes merely from the vehicle disposal, as can be seen at table below.

Table 20 Vehicle Disposal Emission of Electric 2W per Year Using Scenario 2 for Each Compound (in kg)

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
CO	3	11	55	98	202	306	409	513	611
NO_x	81	284	1,460	2,595	5,353	8,111	10,868	13,626	16,222
PM10	36	127	655	1,164	2,402	3,639	4,876	6,113	7,277
SO_2*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

**Data is not available*

Meanwhile, conventional vehicles cause air pollution primarily by burning gasoline. Total conventional vehicle emissions for each compound are summarised in the table below.

Table 21 Tailpipe and Vehicle Disposal Emission of Conventional 2Wper Year Using Scenario 2 for Each Compound (in kg)

Year		2022	2023	2024	2025	2026	2027	2028	2029	2030
CO	Vehicle Operation	347,492,457	358,541,522	330,151,984	313,093,624	245,576,715	175,838,801	113,613,178	53,330,113	0
	Vehicle End-of-Life	386	400	380	362	285	210	136	64	0
	Total	**347,492,843**	**358,541,922**	**330,152,364**	**313,093,986**	**245,577,000**	**175,839,011**	**113,613,315**	**53,330,177**	**0**
NO_x	Vehicle Operation	7,198,058	7,426,932	6,838,863	6,485,511	5,086,946	3,642,375	2,353,416	1,104,695	0

Year		2022	2023	2024	2025	2026	2027	2028	2029	2030
	Vehicle End-of-Life	10,244	10,622	10,075	9,603	7,570	5,575	3,620	1,708	0
	Total	**7,208,302**	**7,437,554**	**6,848,938**	**6,495,113**	**5,094,516**	**3,647,950**	**2,357,036**	**1,106,403**	**0**
PM10	Vehicle Operation	3,685,624,769	3,840,938,184	3,752,766,861	3,594,545,783	2,847,666,367	2,156,976,893	1,407,640,041	667,371,302	0
	Vehicle End-of-Life	4,596	4,766	4,520	4,308	3,396	2,501	1,624	766	0
	Total	**3,685,629,365**	**3,840,942,949**	**3,752,771,381**	**3,594,550,091**	**2,847,669,763**	**2,156,979,394**	**1,407,641,665**	**667,372,068**	**0**
SO_2	Vehicle Operation	122,854,159	128,031,273	125,092,229	119,818,193	94,922,212	71,899,230	46,921,335	22,245,710	0
	Vehicle End-of-Life*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Total	**122,854,159**	**128,031,273**	**125,092,229**	**119,818,193**	**94,922,212**	**71,899,230**	**46,921,335**	**22,245,710**	**0**

**Data is not available*

For each compound, total emission based on Scenario 2 for both types of vehicles is then compared to the emission when using only conventional 2W, as can be seen on the table below.

Table 22 Tailpipe and Vehicle Disposal Emission of Conventional 2W per Year Using Only Conventional Scenario for Each Compound (in kg)

Year		2022	2023	2024	2025	2026	2027	2028	2029	2030
CO	Vehicle Operation	350,200,022	367,971,220	377,231,485	396,374,504	416,489,102	427,615,352	449,315,288	472,116,129	485,406,714
	Vehicle End-of-Life	389	411	434	458	484	511	539	569	601
	Total	**350,200,411**	**367,971,630**	**377,231,918**	**396,374,962**	**416,489,585**	**427,615,863**	**449,315,827**	**472,116,698**	**485,407,316**
NO_x	Vehicle Operation	7,254,143	7,622,261	7,814,081	8,210,615	8,627,274	8,857,747	9,307,245	9,779,548	10,054,853

Year		2022	2023	2024	2025	2026	2027	2028	2029	2030
	Vehicle End-of-Life	10,324	10,902	11,512	12,157	12,838	13,557	14,316	15,117	15,964
	Total	**7,264,467**	**7,633,163**	**7,825,593**	**8,222,772**	**8,640,112**	**8,871,303**	**9,321,561**	**9,794,666**	**10,070,817**
PM10	Vehicle Operation	3,714,342,136	3,941,955,451	4,287,909,450	4,550,671,728	4,829,537,709	5,245,465,895	5,566,908,688	5,908,045,931	6,407,888,710
	Vehicle End-of-Life	4,631	4,891	5,165	5,454	5,759	6,082	6,423	6,782	7,162
	Total	**3,714,346,768**	**3,941,960,342**	**4,287,914,615**	**4,550,677,182**	**4,829,543,468**	**5,245,471,977**	**5,566,915,110**	**5,908,052,713**	**6,407,895,872**
SO_2	Vehicle Operation	123,811,405	131,398,515	142,930,315	151,689,058	160,984,590	174,848,863	185,563,623	196,934,864	213,596,290
	Vehicle End-of-Life*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Total	**123,811,405**	**131,398,515**	**142,930,315**	**151,689,058**	**160,984,590**	**174,848,863**	**185,563,623**	**196,934,864**	**213,596,290**

**Data is not available*

The air pollution reduction is derived from the deduction between total emission of scenario 100% conventional vehicles with total emission from both electric and conventional 2W emissions from Scenario 2 for each compound. The results of total air pollution reduction for each compound are as follows.

Table 23 Average Annual Emission Reduction for Each Compound (in kgCO2)

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
CO	2,707,565	9,429,697	47,079,499	83,280,879	170,912,383	251,776,546	335,702,103	418,786,008	485,406,705
NO_x	56,084	195,325	975,195	1,725,063	3,540,243	5,215,243	6,953,657	8,674,637	10,054,596
PM10	28,717,367	101,017,266	535,142,579	956,125,926	1,981,871,304	3,088,488,944	4,159,268,569	5,240,674,532	6,407,888,594

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
SO_2	957,246	3,367,242	17,838,086	31,870,865	66,062,378	102,949,633	138,642,288	174,689,154	213,596,290
Average emission reduction (%)	0.8	2.6	12.5	21.0	41.0	58.9	74.7	88.7	100.0

The percentage of annual emission reduction for each compound is similar given the same approach and scenario applied for each of them. This analysis found that the air pollution coming from CO, NOx, PM10, and SO2 are potentially reduced gradually each year to almost zero by 2030 if scenario 2 is implemented. Zero air pollution in 2030 is reasonable owing to no conventional vehicle share being assumed in that year and total emission from vehicle disposal of electric 2W is negligible. Further assessment covering the whole life cycle of 2W is required to produce a more accurate and comprehensive result.

3. Social and Economic Impact Analysis

Socio-Economic Benefit-Cost Analysis is a quantitative exercise forecasting the impact of the project on all economic actors. The purpose of this analysis is to verify that socio-economic benefits are larger than costs. Bollati (2016) mentioned some main principles of developing a socio-economic benefit-cost analysis are:

- Incremental approach: Cost Benefit Analysis (CBA) compares a scenario with-the-project with a counterfactual baseline scenario without-the-project (Business as Usual/BAU).
- Discounted cash flows: Depreciation, reserves and other accounting items are excluded
- Opportunity cost: Defined as the potential gain from the best alternative forgone.
- Long-term perspective: Ranging from a minimum of 10 to 30 years (could be adapted in case of concessions, very long-term projects).

3.1. Direct Benefit

There are several benefits that could be obtained directly from the electrification program on the 2W ride hailing industry. The direct benefit calculated in this socio-economic benefit-cost analysis is reduction on purchasing cost, reduction on operation and maintenance, reduction on fuel subsidy, and increasing tax revenue from BEV industry.

3.1.1. Reduction on Purchasing Cost of Electric 2W

According to Bank Indonesia Regulation No. 17/10/PBI/2015, the Loan-to-Value (LTV) ratio for purchasing conventional 2W is 20%. The typical loan is applicable for 3 years of tenor, with 5.7% interest rate per year (Average loan interest rate from several banks in Indonesia, i.e., BNI, BCA, and Mandiri). Bank Indonesia Regulation No. 22/13/PBI/2020 has amended the previous Bank Indonesia Regulation No. 20/8/PBI/2018 regarding the LTV ratio for purchasing environmentally friendly vehicles, including electric vehicles. In Article No. 23A, it was stated that customers could make a 0% down payment to purchase environmentally friendly vehicles. This means that there would be a reduction in people's expenses related to down payment due to the electrification program as banks could fully finance the purchase of electric vehicles. However, this policy will only be effective for half of the conversion program period as the average price of electric 2W is a little bit higher (IDR 23,490,000) compared to the average price of conventional 2W (IDR 20,989,250)[1] . The savings from down payment would eventually be cancelled out by the increase of the instalment payment (assuming that both conventional and electric 2W were purchased using credit scheme, with 5.7% interest rate for 3 years). The comparison of purchasing cost between conventional and electric 2W are depicted in Figure 3. The reduction on purchasing cost until 2030 can be seen in Figure 4.

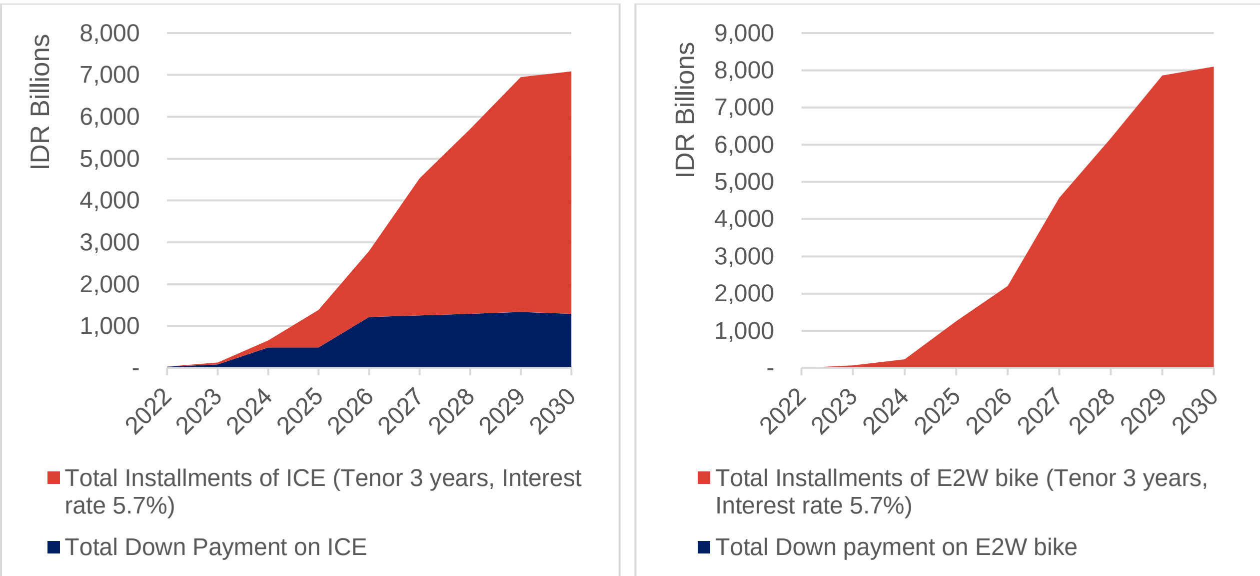


Figure 3 Purchasing Cost of Conventional (left) and Electric 2W (right)

[1] Referring to data list of both electric and conventional 2W in previous report (Timetable and Roadmap for Ride Hailing Fleet Electrification). However, Selis Mandalika is excluded in the electric 2W price calculation since it was considered not suitable to carry passengers. On the other hand, the calculation of average price for conventional 2W includes Honda Beat, Yamaha Mio, Honda Vario, and Yamaha Nmax since they are the models that are commonly used by ride hailing drivers.

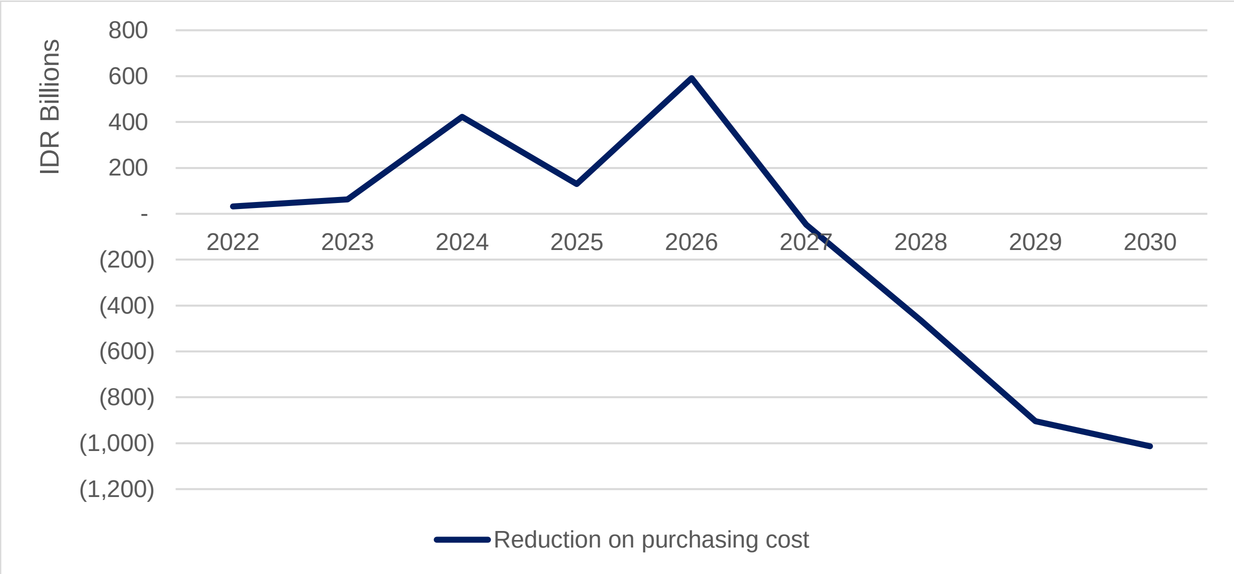
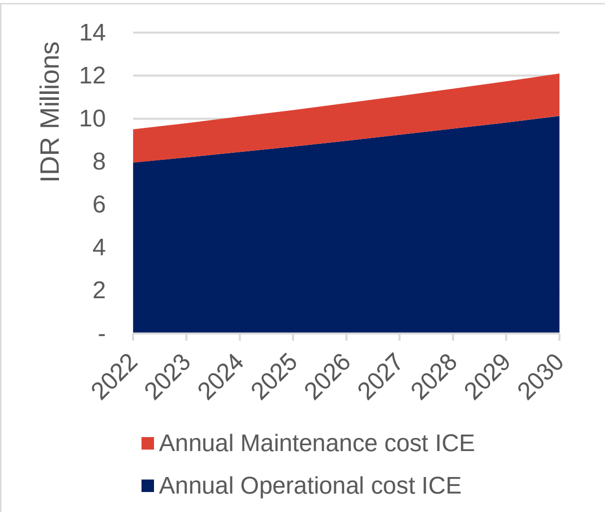


Figure 4 Annual Purchasing Cost Savings from 2W Electrification Program

3.1.2. Reduction on Operation and Maintenance Costs

As explained in the previous report, the overall operation and maintenance costs of electric 2W are far less expensive than conventional 2W. Taking the numbers from TCO calculation, the annual operational cost of electric 2W is IDR 2,832,769 whereas the annual operational costs of conventional 2W are IDR 7,710,612. Therefore, there will be an annual savings of IDR 4.88 million for every converted vehicle. In addition, the average annual maintenance costs of conventional 2W are IDR 1,504,380 compared to electric 2W IDR 637,899. Multiplying these savings with the total population of 2W ride hailing fleets, the total potential savings from operation and maintenance costs will reach IDR 43.51 billion in 2022 to IDR 11.08 trillion in 2030. See the comparison and the reduction on Figure 5 and Figure 6 respectively.



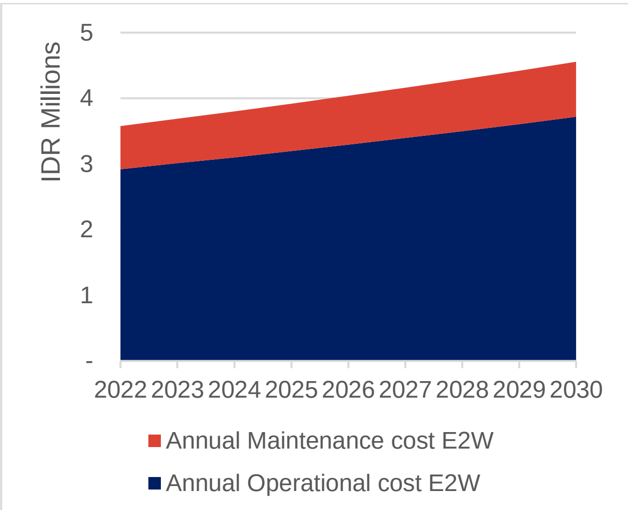


Figure 5 Annual Operation and Maintenance Cost of Conventional (left) and Electric 2W (right)

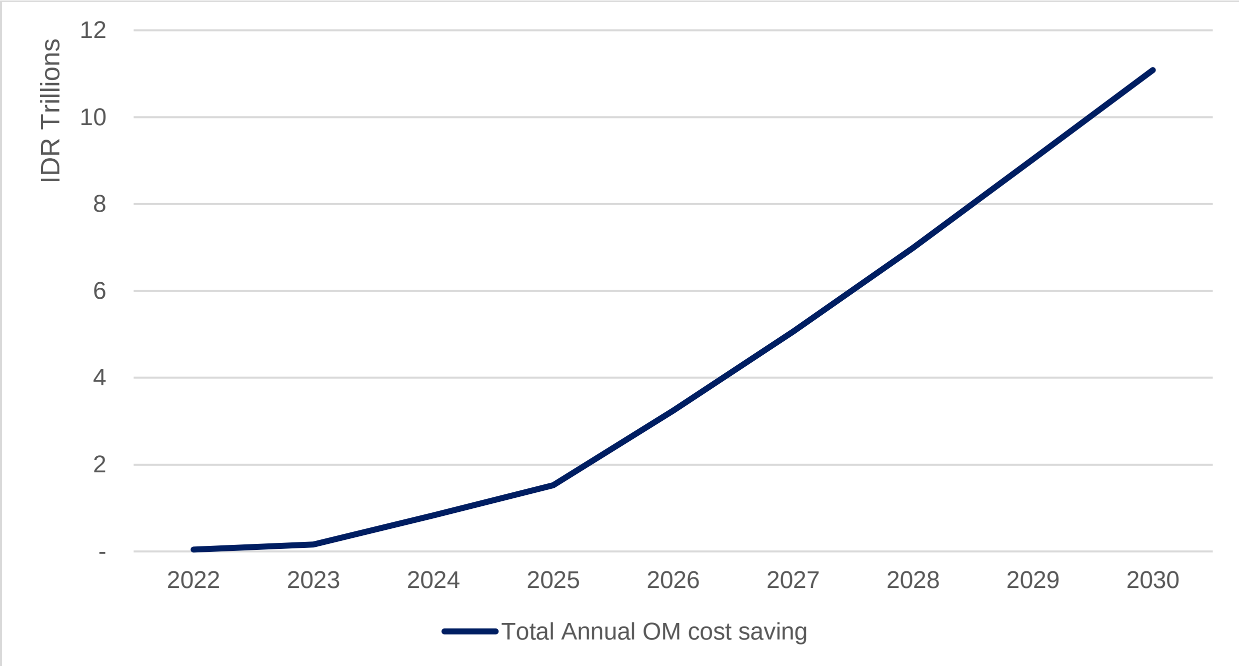


Figure 6 Annual Operation and Maintenance Cost Savings from 2W Electrification Program

3.1.3. Reduction on Fuel Subsidy

As reported in the Annual Tax Expenditure Report by the Ministry of Finance (2021), the Government of Indonesia (GoI) spent around IDR 60 trillion on fuel subsidy. Pertamina (2021), the state-owned oil and gas company, stated that the consumption of subsidised gasoline is around 7,976,023 KL in 2020. Using the fuel consumption calculation shown in Table 24, the calculated average subsidy per 2W is around IDR 320,000.

Table 24 Fuel Consumption Calculation in 2020

Vehicle	Population	Fuel Economy (km/L)	Average Yearly Distance (km)	Average Yearly Fuel Consumption (L)	Total Fuel Consumption (KL)	Proportion
Car	15,797,746	10.97	20,000	1,822.61	28,793,068	33.58%
Motorcycle	115,023,039	56.13	27,792	495.10	56,947,931	66.42%

Notes: Own calculation using data from BPS-Statistics Indonesia (2021).

While ride hailing drivers are projected to grow 5.6% per year, the number of conventional 2W is assumed to be decreased as they will be replaced by electric 2W, so that in 2030 there would be no more conventional 2W to be used for ride hailing services. Because of this, it is estimated that there would be an additional savings from fuel subsidy expenses by the government. The estimated fuel subsidy savings can be seen in Figure 7 below.

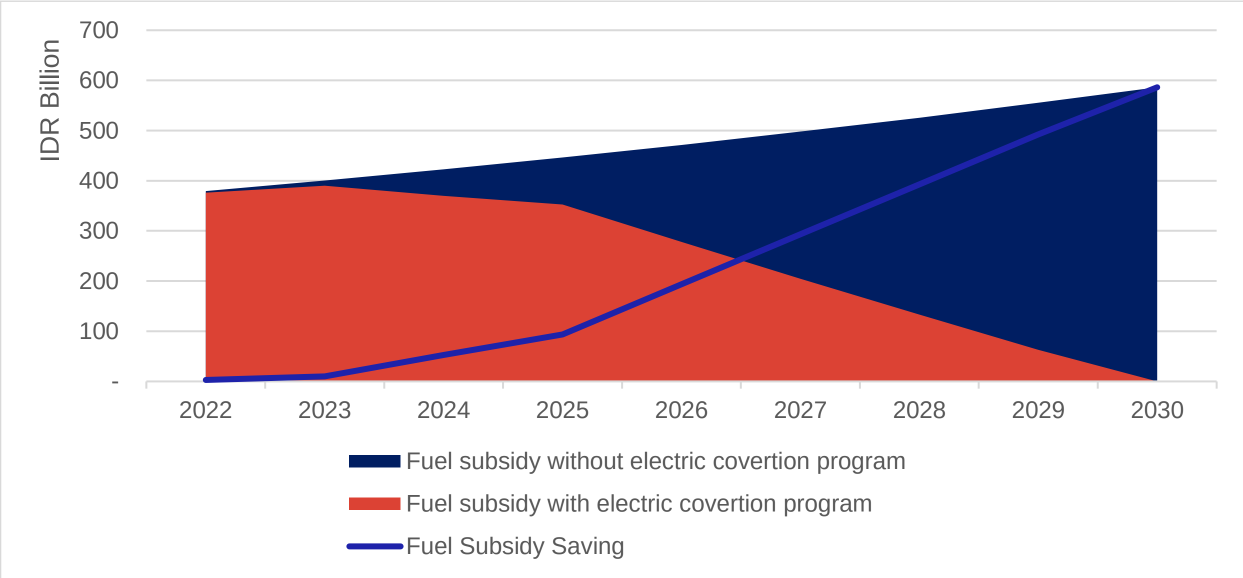


Figure 7 Reduction on Fuel Subsidy

3.1.4. Increasing Tax Revenue from BEV Industry

Based on the previous report, the average price of electric 2W sold in Indonesia is around IDR 23.49 million. Assuming that the average Indonesia YoY inflation rate is 3.07% (Bank Indonesia, 2022), and the projected number of electric 2W is aligned with Scenario 2 on the previous report (full electrification by 2030), it is estimated that the additional sales revenue is IDR 177.91 billion in 2022, which will also increase to IDR 7.25 trillion in 2030. This will bring additional tax revenue from companies in the BEV industry. According to Law No. 2/2020, the government would impose a 22% corporate tax rate starting from 2022, before being decreased into 20% from 2025 onward. This tax rate would be imposed to the profit gathered from their revenue. Based on the report by BPS-Statistics Indonesia (2022a), the average operating profit margin for the automotive industry is 59.66%. The additional corporate tax revenue on the BEV industry could be seen in Figure 8 below.

In addition, the government would also obtain an increased personal income tax revenue. In the socio-economic benefit-cost analysis, the remuneration is assumed to be a variable cost. The argumentation is that the remuneration (in terms of bonus and allowance) will increase if the sales increase and vice versa. The average remuneration ratio in the automotive industry is 4,58% (BPS-Statistics Indonesia, 2022b) and assuming that on average the workers' wages belong to a 15% tax bracket, the estimated personal income tax revenue could also be seen in Figure 8 below.

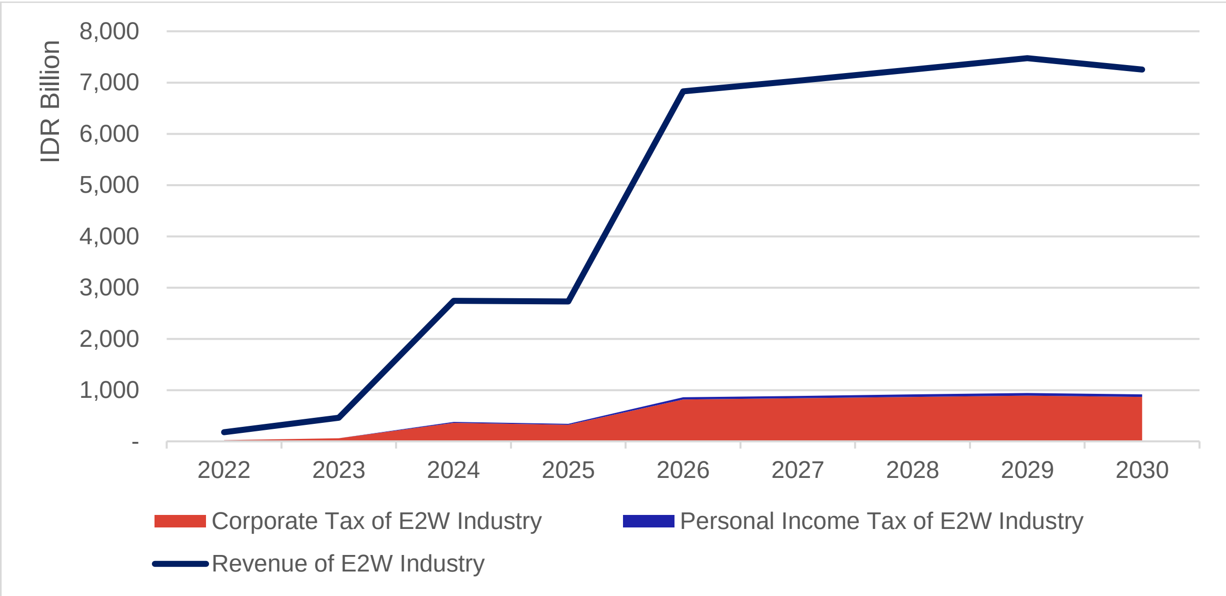


Figure 8 Increasing Tax Revenue from BEV Industry

3.2. Indirect Benefit

The indirect benefit from the 2W ride hailing electrification program that would be elaborated further in this report are the pollution damage cost reduction and the economic multiplier benefit.

3.2.1. The Social Cost of Carbon Reduction

The social cost of carbon is defined as the monetary value of the first partial derivative of global, net present welfare to current carbon dioxide emissions. In other words, the social cost of carbon is the incremental impact of emitting an additional tonne of carbon dioxide, or the benefit of slightly reducing emissions (Tol, 2019). Tol (2019) has calculated that the global Social Cost of Carbon is equal to USD 24 per ton of Carbon in 2019. However, in that study, it was explained that the global social costs of carbon were accumulated from each nation's social cost of carbon, where developed countries contributed a larger portion of the global social cost. Therefore, it is suggested that the social cost contributed by Indonesia is around USD 0.85 per ton of carbon. Using the USD/IDR exchange rate in 2022, which was at IDR 14.600 per USD, Indonesia's social cost of carbon value is then projected by adjusting the exchange rate with inflation in Indonesia and the US. By multiplying the social cost of carbon in Indonesia with the carbon reduction in Table 19 above, the estimated total reduction on social cost of carbon can be seen in Figure 9 below.

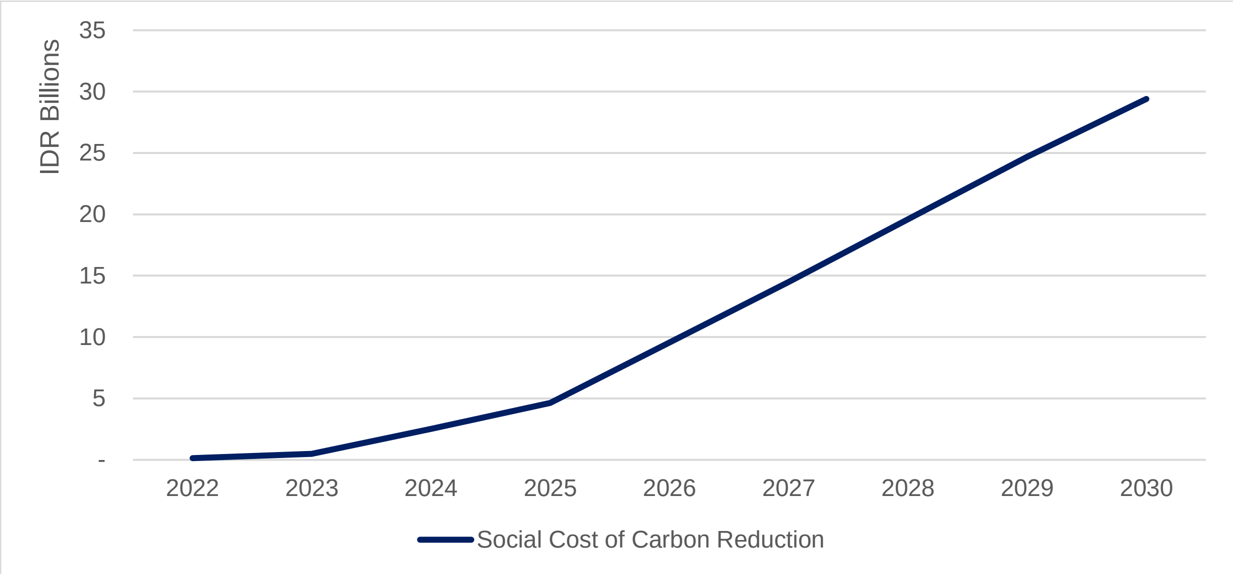


Figure 9 Reduction on Social Cost of Carbon

3.2.2. Economic Multiplier Benefit

In his 1936 book, "The General Theory of Employment, Interest, and Money," Keynes proposed that for any level of income, people would spend a fraction and save/invest the remainder. He further defined the marginal propensity to save and the marginal propensity to consume, using these theories to determine the amount of a given income that is invested. Keynes also showed that any amount used for investment would be consumed or reinvested many times over by different members of society, thus increase/decrease of income in one sector would create a multiplier effect in the general economy.

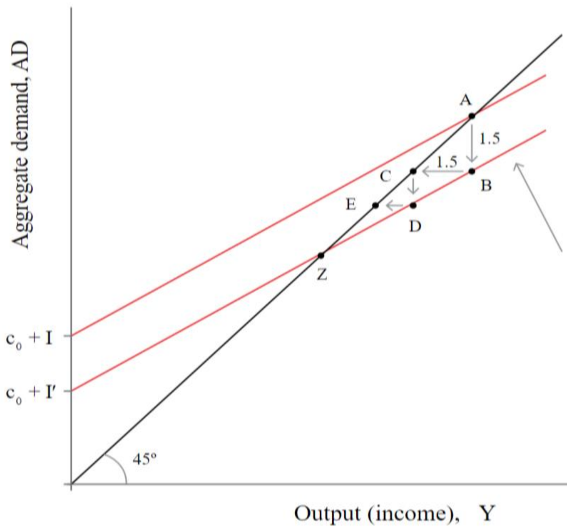


Figure 10 Keynesian Multiplier Effect

In the Keynesian Multiplier Model shown in Figure 10, the decrease of demand in a particular sector (arrow A-B) would cause a decrease of income in those particular sectors (arrow B-C). This would further decrease the demand in the related sectors (arrow C-D) and further decrease the income of those related sectors (arrow D-E). This process will proceed continuously thus the overall income would decrease from point A to point Z. The overall change in income can be calculated by the following formula.

$$\Delta Y = \frac{1}{1 - MPC} \Delta Aggregate\ Demand$$

Where ΔY is aggregate change in income and MPC is the marginal propensity to consume. The term $\frac{1}{1-MPC}$ reflects the economic multiplier.

The reduction on purchasing cost, reduction on operational and maintenance cost, reduction on fuel subsidy, additional revenue in the electric 2W industry[2], and reduction of pollution damage cost will increase the overall society's income. Using the economic multiplier value of 3.15 (Kuncoro, 2021), the estimated economic multiplier benefit can be seen in Figure 11.

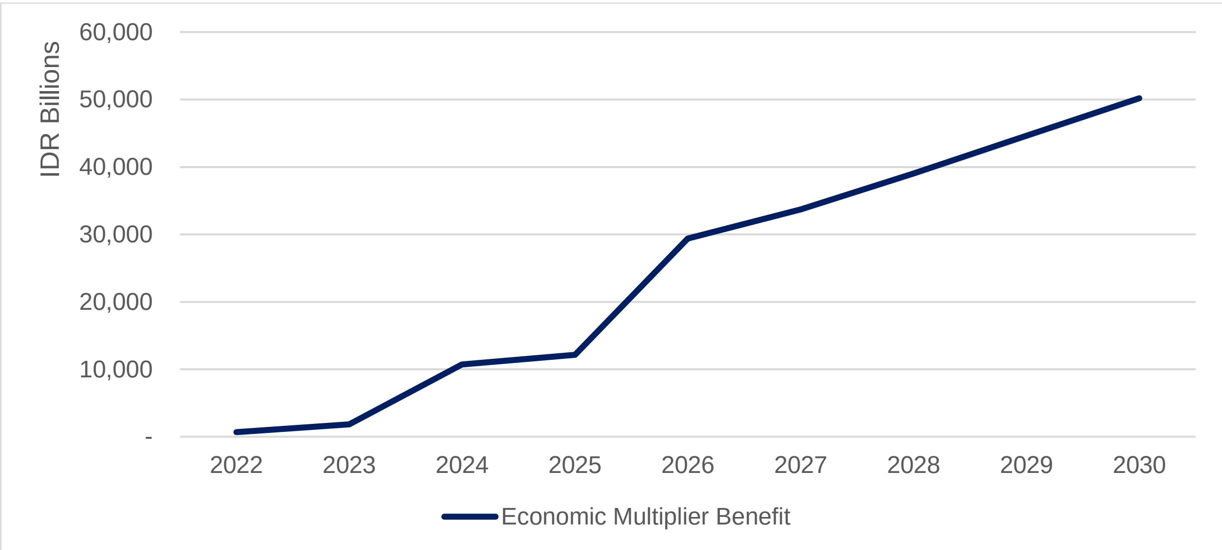


Figure 11 Economic Multiplier Benefit

[2] Personal income and tax revenue sourced from the electric 2W industry are excluded from this calculation to avoid redundancy. Personal income and government tax revenue are sourced from remuneration payment and tax payment by the electric 2W industry. Thus, those were considered as expenses from the electric 2W industry point of view. The revenue of electric 2W industry has considering the values added of final goods consumed in the market, which included the additional values from workers (in terms of remuneration payment) and government (in terms of tax payment)

3.3. Direct Cost

3.3.1. Increasing Transfer Fee Tax Subsidy Cost

Government of Indonesia has stipulated some subsidies or incentives to stimulate the demand of electric vehicles and to support the electric vehicles industry in general. However, some incentives are only applicable to the electric cars industry. For example, incentives in the form of luxury goods tax (PPN-BM) exemption are not applicable for electric 2W as 2W themselves are not subjected to PPN-BM in the first place. Other incentives that were not applicable for the majority of industry players are the import tax subsidy, as it would only be applicable for companies that are willing to develop their own electric vehicles factory in Indonesia prior to 2025. Therefore, subsidies that would be calculated in this report are the one that would be imposed for all electric 2W, which are the exemption on transfer fee tax (BBN-KB). Based on the Jakarta Province Governor Regulation No. 3/2020, electric vehicles, including electric 2W, received BBN-KB exemption which amount to up to 12.5% of the price of the vehicle. The calculation of the BBN-KB subsidy for electric 2W is depicted in Figure 12 below.

Figure 12 Transfer Fee Tax Subsidy for Electric 2W

3.3.2. Decreasing Tax Revenue from Conventional 2W Industry

Electrification programs for 2W ride hailing fleets will obviously decrease the number of conventional 2W used by the ride hailing drivers. Thus, it will decrease the annual revenue of conventional 2W industry players. With the scheduled conversion of conventional 2W into electric 2W as calculated in the previous section, using the average price of conventional 2W in Indonesia that has been mentioned previously, which is around IDR 20.99 million, and using the average inflation rate of 3.07%, it is estimated that the decreased revenue for conventional 2W industry will increase from IDR 158.97 billion in 2022 to IDR 6.47 trillion by 2030. Using the same parameters used in calculating increasing tax revenue from electric 2W industry mentioned previously, such as average operating profit margin, corporate tax rate, average remuneration ratio, and personal income tax rate, the non-captive tax revenue in conventional 2W industry is estimated as shown in Figure 13.

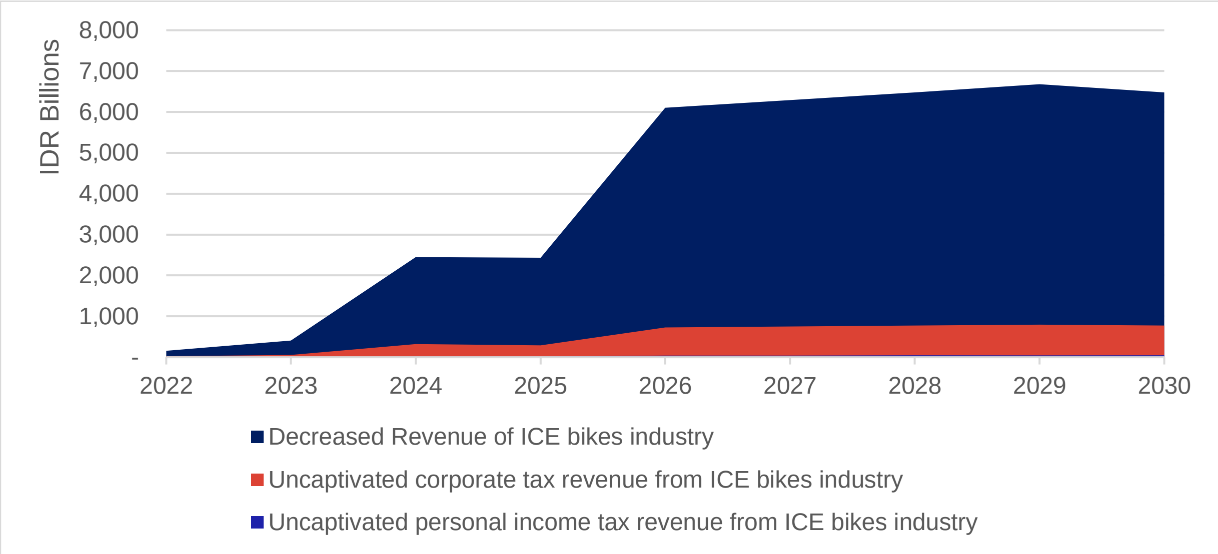


Figure 13 Non-Captive Tax Revenue in Conventional 2W Industry

3.4. Indirect Cost

3.4.1. Economic Multiplier Cost

Similar to the growth of the electric 2W industry that would create new opportunities and multiple impacts to the economy, the shrinking conventional 2W industry will also have a multiplier effect to the economy. The decreasing revenue on conventional 2W industries will also reduce income of their employees, investors, and other related industries, which will eventually create a vicious cycle in the economy. Using the similar economic multiplier value of 3.15, the calculation on the economic multiplier cost can be seen in Figure 14.

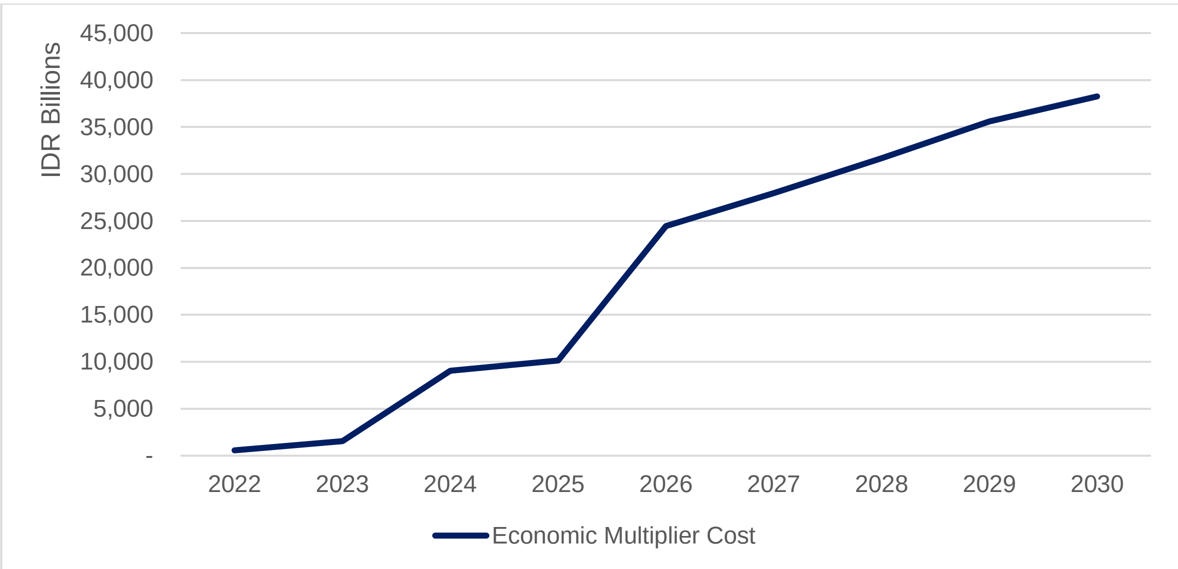


Figure 14 Economic Multiplier Cost

3.5. Benefit-Cost Analysis

The benefit-cost analysis is conducted by looking at three parameters, which are Economic Net Present Value (ENPV), Economic Internal Rate of Return (EIRR), and Benefit-Cost Ratio (BCR). The ENPV is the difference between the present value of quantified benefits and the present value of quantified costs over a period of time. The ENPV is calculated using the following formula:

$$ENPV = \sum_{t=}^{T} \frac{(B_t - C_t)}{(1 + sc)^t}$$

B_t is the quantified benefits at time t, C_t is the quantified costs at time t, and sc is the social discount rate. A project could be said to bring greater goods for the society when ENPV is greater than zero.

EIRR is a metric used to estimate the profitability of potential investments. EIRR is a discount rate that makes the present value of all net benefits equal to zero in a discounted cash flow analysis. In other words, it is the annual return that makes the ENPV equal to zero. A project is said to bring greater goods for the society when EIRR is greater than the social discount rate. The EIRR can be calculated using the following formula:

$$0 = \sum_{t=}^{T} \frac{(B_t - C_t)}{(1 + EIRR)^t}$$

BCR summarises the overall relationship between the relative costs and benefits of a proposed project. BCR can be expressed in monetary or qualitative terms. If a project has a BCR greater than 1.0, the project is expected to deliver a positive net present value to the society. The formula to calculate BCR is as follow:

$$BCR = \frac{\sum_{t=1}^{T} \frac{B_t}{(1 + sc)^t}}{\sum_{t=1}^{T} \frac{C_t}{(1 + sc)^t}}$$

Considering all the benefits and costs, it is clearly understood that the electrification program for 2W ride hailing fleets in Greater Jakarta will create overall benefit to the society. The Benefit-Cost Ratio is 1.3, whereas, assuming a 10% social discount rate, the ENPV is IDR 36.23 trillion. Both BCR and ENPV calculation shows that the electrification program in general brings more benefits than costs to the society. In fact, as shown in Table 25 below, the net benefit of this program will be positive since the beginning year of the program and will keep increasing to the end of the program. Therefore, the Economic IRR cannot be calculated. The complete calculation of socio-economic impact can be seen in Table 26.

Table 25 Social Cost Benefit Analysis (SCBA) Summary

Parameter	Value
Social Discount Rate[3]	10%
ENPV (IDR Million)	36,230,866
EIRR*	N/A
BCR	1.31

**Note: The EIRR cannot be calculated since the net benefits are always positive*

[3] http://greengrowth.bappenas.go.id/wp-content/uploads/2018/05/20151020214307.Green_Growth_Training_Toolkit_ENGLISH.pdf

Table 26 Benefit-Cost Analysis (in IDR Million)

	2022	2023	2024	2025	2026	2027	2028	2029	2030
BENEFITS									
Direct Benefits									
Decrease in purchasing cost	31,794	63,050	422,244	129,123	591,257	-46,916	-464,060	-904,343	-1,013,097
E2W operational cost saving	43,505	156,949	831,950	1,524,424	3,240,651	5,060,818	6,989,681	9,032,215	11,082,742
Decrease in Fuel Subsidy	2,931	10,260	52,766	93,807	193,476	293,146	392,815	492,485	586,292
Increase in Tax Revenue from E2W Industry									
Corporate Tax	23,350	60,168	359,690	325,407	814,537	839,543	865,317	891,882	865,189
Personal Tax	1,223	3,151	18,840	18,749	46,930	48,371	49,856	51,386	49,848
Indirect Benefits									
Pollution Damage Reduction	137	485	2,512	4,645	9,569	14,500	19,601	24,677	29,402
Economic Multiplier Benefit	677,134	1,828,494	10,727,304	12,151,414	29,402,992	33,697,232	39,029,736	44,646,138	50,186,364

	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total Benefits	**780,075**	**2,122,558**	**12,415,306**	**14,247,568**	**34,299,411**	**39,906,694**	**46,882,947**	**54,234,440**	**61,786,739**
COSTS									
Direct Costs									
Increase in Transfer Fee Subsidy	22,237.93	80,225.36	425,256.75	779,219.35	1,656,480.39	2,586,870.85	3,572,822.43	4,616,877.09	5,665,017.75
Decrease in Tax Revenue from ICE Industry									
Corporate Tax	20,864.56	53,762.76	321,396.99	290,764.53	727,821.01	750,165.12	773,195.19	796,932.28	773,080.57
Personal Tax	1,093	2,816	16,834	16,753	41,934	43,221	44,548	45,916	44,542
Indirect Costs									
Economic Multiplier Cost	570,807	1,543,037	9,053,211	10,130,849	24,432,699	27,953,323	31,667,074	35,582,516	38,254,463
Total Costs	**615,002**	**1,679,841**	**9,816,699**	**11,217,585**	**26,858,934**	**31,333,580**	**36,057,640**	**41,042,241**	**44,737,103**
Net Benefit	**165,073**	**442,717**	**2,598,607**	**3,029,982**	**7,440,476**	**8,573,113**	**10,825,307**	**13,192,199**	**17,049,636**

	2022	2023	2024	2025	2026	2027	2028	2029	2030
Accumulated Net Benefit	165,073	607,790	3,206,397	6,236,379	13,676,856	22,249,969	33,075,276	46,267,475	63,317,111

4. GESI Impact Analysis

4.1. Existing Vulnerable Groups Participation and Profile in Ride-Hailing

4.1.1. Overall Ride-Hailing Drivers' Profile

Based on the survey in 2019, there were 900,000 drivers participating in ride-hailing companies in Greater Jakarta. This number is getting bigger with an average growth of 5.6% per year. Among the driver population, women and PWD are taking part. Alia and Bestari in 2018 estimated there were 10% female participation in the system within the Greater Jakarta area. On the other hand, there is no specific data related to the size of PWD act as ride-hailing drivers in Greater Jakarta. However, based on the press release of Grab in 2019, they mentioned that there were more than 90 deaf drivers joining Grab in Jakarta, Bandung, Medan and Surabaya. Meanwhile in January 2022, based on interviews with the deaf driver and its community, 120 people with hearing impairments were recorded as Gojek's drivers in Greater Jakarta.

4.1.2. Female Drivers

As delivered in previous reports, female participation in ride-hailing systems may enable them to improve their socio-economic status. In terms of 2W electrification, women also can be seen as a person who may get numerous benefits throughout the process. Nastiti, cited in Keban et al. (2021), mentioned in her study that ride hailing jobs dominated the women's occupations in the gig economy.

Based on the collected data, these female drivers decided to join the ride hailing companies to raise their daily revenue in supporting the family (44%) and the flexibility on time and type of work offered by the system (32%). Furthermore, the behaviour of female drivers show that they may tend to avoid conflict (e.g. a risk to be harassed by passengers and other safety-security issues) rather than maximise the profit (by considering distance and needed time) while taking orders. This can be seen from the proportion of 82% female respondents choosing food delivery over goods and passenger services.

According to the respondents' marital status, married women are dominant with 70% followed by single women (20%), and single mothers (10%). In which 16% of female drivers work almost every day with 11.5 working hours on average per day in 2 or 3 companies. Single mothers contribute the highest percentage (37.5%) in the female population who work in 2 or 3 companies with 11.3 working hours per day on average.

4.1.3. Drivers with Disabilities

During the data collection, there were 13 deaf drivers participating in the surveys and it contributed 2.5% of the total respondents. Relying on the results, the deaf drivers tend to maintain the work efficiency. Waiting time is considered as the most important factor while taking orders. On the other hand, distance and possibility of avoiding contacts and/or communication with clients come after the waiting time.

10 out 13 deaf drivers put this job as their main source of revenue. 38.5% deaf drivers work in 2 companies due to economic reasons. Meanwhile there is a respondent working in 3 companies since he has 3 family members to be fed.

4.2. Expected Increase of Vulnerable Groups Participation in Ride-Hailing

4.2.1. The Given Growth

Following the Covid-19 situation in Greater Jakarta, the number of people joining the informal sector is increasing due to lack of access to formal jobs and huge number of work termination. In 2020, there was a huge increase up to 76% in the number of unemployed women over 15 years old (BPS-Statistics of DKI Jakarta Province, 2021).

In accordance with the given profile of female drivers, single mothers and/or female head of household have the highest potency to grow up to 224.8% in 2030 or may contribute 16.84% shares from total drivers. This persona is more likely to join the job opportunity as a result of the consideration of age, education background, marital status, and job training as stated by Wandaweka and Purwanti (2021). These circumstances adjust the average 0.57% growth per annum of female head of household joining informal jobs (BPS-Statistics of DKI Jakarta Province, 2019; BPS-Statistics of DKI Jakarta Province, 2020) and will be limited to 747,876 people due to the number of female head of household in Jakarta 2020 (BPS-Statistics of DKI Jakarta Province, 2020).

Table 27 Expected Female Ride Hailing Drivers Growth in Greater Jakarta

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
# of drivers	849,600	900,000	950,400	1,003,622	1,059,825	1,119,175	1,181,849	1,248,033	1,317,923	1,391,726	1,469,663	1,551,964	1,638,874
% of female drivers	10%	10.57%	11.14%	11.71%	12.28%	12.85%	13.42%	13.99%	14.56%	15.13%	15.70%	16.27%	16.84%
# of female drivers	84,960	95,130	105,875	117,524	130,147	143,814	158,604	174,600	191,890	210,568	230,737	252,505	275,986
# of additional single mothers and/or	n/a	10,170	10,745	11,650	12,622	13,668	14,790	15,996	17,290	18,679	20,169	21,767	23,482

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
female head of household													

This increase of this persona may have happened considering Grab, one of the companies, launched a program in 2020 offering big opportunities for single mothers to join as female drivers. On the other hand, the easy requirements and other supportive programs dedicated to female drivers (e.g. women @gojek, road safety training, #amanbersamagojek, lady grab, and martial arts training) attracts more and more female drivers.

During the data collection, PWD drivers joined the survey, contributed 2.5% of the total sample or it is 13 respondents and consisted of deaf and mute drivers. However, due to the absence of data on the actual proportion of PWD drivers joining the ride hailing system and type of disabilities, the projected PWD drivers will only consider the opportunities given by the companies. As stated by Grab in 2019, through collaboration with numerous communities which have concern in people with disabilities issues, the company may double the size of PWD drivers in the system (Rahman, 2019). Marking the statement as a promising increase per year, total PWD drivers may grow up and finally share 0.26% from total drivers in 2030.

However, this projection may be limited to 4,181 people. This number is in line with given data in 2018. There were 6,690 deaf, mute and physically impairment people living in Jakarta (JCISA, 2020). It was estimated that 62.5% of the population were in productive age aligned with the national survey (Susenas BPS) in 2018. As a consequence of the absence of supporting data to project the size of people with disabilities in 2030, hence this number will be kept as the goal to be achieved in 2030.

Table 28 Expected PWD Ride Hailing Drivers Growth in Greater Jakarta

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
# of drivers	849,600	900,000	950,400	1,003,622	1,059,825	1,119,175	1,181,849	1,248,033	1,317,923	1,391,726	1,469,663	1,551,964	1,638,874
# of PWD drivers	n/a	n/a	n/a	n/a	n/a	33	65	131	261	523	1,045	2,091	4,181
% of PWD drivers	n/a	n/a	n/a	n/a	n/a	0.00%	0.01%	0.01%	0.02%	0.04%	0.07%	0.13%	0.26%
% of additional PWD	n/a	n/a	n/a	n/a	n/a	n/a	100%	100%	100%	100%	100%	100%	100%

4.2.2. Opportunity Growth

Following the ride hailing electrification scheme, female and PWD drivers will be impacted. By maintaining as closely as possible a 50:50 distribution between male and female drivers on new electric 2W fleets being deployed annually, this scheme can further boost growth of female ride hailing drivers. This growth can be addressed as the opportunity growth over the given opportunities given to the female drivers. However, it should be noted that drivers have their own preferences of type of services, as captured through the driver interview survey explained in the previous report. Assuming that female drivers get prioritised over 50% of new electric 2W being deployed, no changes in female drivers' preferences on type of services, and additional electric 2W per year was deployed based on scenario 2 on the previous report, the number of female drivers accumulated from given growth and opportunity growth could be as much as 790,000 drivers in 2030, accounted for 48.22% of all ride hailing drivers in Greater Jakarta.

Table 29 Opportunity Growth for Female Ride Hailing Drivers in Greater Jakarta

	2022				2023				2024				2025				2026				2027				2028				2029				2030			
# of additional electric vehicles	7,348				18,371				106,551				102,876				249,843				249,843				249,843				249,843				235,146			
	food	goods	combination	passenger	food	goods	combination	passenger	food	goods	combination	passenger	food	goods	combination	passenger	food	goods	combination	passenger	food	goods	combination	passenger	food	goods	combination	passenger	food	goods	combination	passenger	food	goods	combination	passenger
# of EV per type of services	3,307	3,307	367	367	8,267	8,267	919	919	42,620	42,620	10,655	10,655	36,007	36,007	15,431	15,431	74,953	74,953	49,969	49,969	74,953	74,953	49,969	49,969	74,953	74,953	49,969	49,969	62,461	62,461	49,969	74,953	47,029	47,029	70,544	70,544
# of prioritized EV for female drivers	2,508	184	-	367	6,280	460	-	919	42,620	3,119	-	6,237	36,007	2,635	-	5,269	74,953	5,484	-	10,969	74,953	5,484	-	10,969	74,953	5,484	-	10,969	62,461	4,570	-	9,141	47,029	3,441	-	6,882
# of additional female drivers	3,058				7,658				51,976				43,911				91,406				91,406				91,406				76,172				57,352			

In contrast with the available data to project female opportunity growth, the PWD's participation cannot be calculated due to the unknown size of population. Nevertheless, the given growth can be met with the number of additional electric vehicles to suggest allocated PWD drivers per type of services as shown by this table.

Table 30 Opportunity Growth for PWD Ride Hailing Drivers in Greater Jakarta

	2022				2023				2024				2025				2026				2027				2028				2029				2030			
# of additional electric vehicles	7,348				18,371				106,551				102,876				249,843				249,843				249,843				249,843				235,146			
	food	goods	combination	passenger	food	goods	combination	passenger	food	goods	combination	passenger	food	goods	combination	passenger	food	goods	combination	passenger	food	goods	combination	passenger	food	goods	combination	passenger	food	goods	combination	passenger	food	goods	combination	passenger

	2022				2023				2024				2025				2026				2027				2028				2029				2030			
# of EV per type of services	3,307	3,307	367	367	8,267	8,267	919	919	42,620	42,620	10,655	10,655	36,007	36,007	15,431	15,431	74,953	74,953	49,969	49,969	74,953	74,953	49,969	49,969	74,953	74,953	49,969	49,969	62,461	62,461	49,969	74,953	47,029	47,029	70,544	70,544
# of prioritized EV for PWD drivers	n/a	n/a	n/a	n/a	8	17	-	8	8	18	-	8	15	35	-	15	30	71	-	30	60	141	-	60	120	282	-	120	240	564	-	240	481	1,129	-	481
# of additional PWD drivers	n/a				33				33				65				131				261				523				1,045				2,091			

To be noted, this growth will only be achieved if these requirements are met:

a. Both female and PWD drivers are having adequate knowledge about electric vehicles. It includes the benefits, risks and mitigation while driving with the electric 2W. The understanding of the charging process is also part of the knowledge that should be mastered by the drivers. If this condition is attained, it will tackle doubts given by 27% female and PWD drivers.

b. Rented electric 2W should be provided by the companies and/or available as an option to run the business. By providing the possibilities to rent e-vehicles and/or the batteries, may eliminate the hesitation given by 17.5% female and PWD drivers to shift to electric 2W.

c. Increase and/or ensure the drivers safety by conducting periodic training and/or assessments.

4.3. Impact of The Participation Growth

4.3.1. Induce The Use of Electric 2W and Its Infrastructure in General

Enabling women participation in electric ride hailing is expected to increase women's bargaining power in the family as aligned with the study from Bittman et al. (2003) and Brines (1994). Regardless, with or without income, Pepin (2017) affirmed that family decisions are predominantly believed as part of women's responsibility. As the electric 2W will attract more female drivers, this will also impact other family-related decisions such as:

a. Preference on buying electric vehicles as the second and/or third assets;

b. Affirmation on safety concerns by word of mouth; and

c. Lead to the possible economic opportunities increase related to electric vehicles (e.g. electric vehicle and battery rental).

On the other hand, accommodating this potential growth of female and PWD drivers, the available options of women and PWD friendly 2W's specification will be generated. This type of intervention will support the shift from conventional toward electric vehicles.

4.3.2. Safe Cities

In line with a current program initiated by Gojek, the location of safe zones could be expanded to accommodate the growing number of female drivers. By projecting a development of safe zones, both female drivers and passengers could interpret cities as the safe place day and night. The sense of security and safety will increase along with the expansion of female representatives in the system.

4.3.3. Road Safety and Vulnerability

Looking at the opportunities offered by the electric 2-wheelers, road safety and vulnerability on the street should be concerned. The additional number of vehicles in future may conflict with the street design and/or even invite inevitable bad impacts such as increasing the vulnerability of pedestrians and cyclists.

These possible negative impacts should be mitigated by implementing:

a. Speed limitation - in terms of allowing the electric 2-wheelers to access the streets the speed limitation is needed. The maximum speed will ensure the safety of other road users, especially cyclists and pedestrians who may share spaces with electric 2W in many streets.

b. Strict driver licences - police, cities' transport agencies and ride-hailing companies should work together to ascertain driver's licences (SIM C and SIM D) are obtained through a verified legal system. Periodic training and assessment should be conducted and/or scheduled to assure that.

c. Advance complete street design - the shifts should be assessed and addressed on the future street designs. Typologies to define the allocated spaces per type of road users can answer the doubt of pedestrians and cyclists from previous study on welcoming the additional (electric) 2W.

5. References

Alia, S. S. and Bestari, N. P. 2018. 5 Fakta Driver Perempuan Grab, Terakhir Bikin Miris. *Viva*. [Online]. 19 April 2018. [Accessed in January 2022]. Available from: https://www.viva.co.id/digital/startup/1027928-5-fakta-driver-perempuan-grab-terakhirbikinmiris

Anup, S., Deo, A., and Bandivadekar, A. 2021. Fuel Consumption Reduction Technologies for The Two-Wheeler Fleet in India. *Institute Council on Clean Transportation (ICCT)*. [Accessed in February 2022]. Available at: https://theicct.org/sites/default/files/publications/2w-fuel-reduction-india-mar2021-1.pdf

Bank Indonesia. 2022. *Inflation Data: January 2016 – February 2021*. [Online]. [Accessed in February 2022]. Available from: https://www.bi.go.id/en/statistik/indikator/data-inflasi.aspx

Bittman, M., England, P., Sayer, L., Folbre, N., and Matheson, G. 2003. When Does Gender Trump Money? Bargaining and Time in Household Work. *American Journal of Sociology*. **109**(1), pp.186-214.

Bollati, J. 2016. *Preparation of Cost Benefit Analysis*. MoS Workshop, 28 September, Brussels.

BPS-Statistics Indonesia. 2021. *Land Transportation Statistics 2020*. [Online]. [Accessed in January 2022]. Available from: https://www.bps.go.id/publication/2021/11/29/4f0914ee631f397e1e6ad858/statistik-transportasi-darat-2020.html

BPS-Statistics Indonesia. 2022a. *Value of Gross Output of Large and Medium Manufacturing by Subsector [KBLI 2009] (Billion Rupiahs), 2010-2019*. [Online]. [Accessed in January 2022]. Available from: https://bps.go.id/indicator/9/737/4/nilai-output-ibs-menurut-kbli-2-digit-kbli-2009-.html

BPS-Statistics Indonesia. 2022b. *Labour Cost for Workers of Large and Medium Manufacturing by Subsector [KBLI 2009] 2017-2019*. [Online]. [Accessed in January 2022]. Available from: https://bps.go.id/indicator/9/735/1/pengeluaran-untuk-tenaga-kerja-industri-besar-dan-sedang-menurut-sub-sektor-kbli-2009-.html

BPS-Statistics of DKI Jakarta Province. 2019. *DKI Jakarta Province in Figures 2019*. [Online]. [Accessed in January 2022]. Available from: https://jakarta.bps.go.id/publication/2019/08/16/eea4f4b387c3024bb4a3a7fc/provinsi-dki-jakarta-dalam-angka-2019.html

BPS-Statistics of DKI Jakarta Province. 2020. *DKI Jakarta Province in Figures 2020*. [Online]. [Accessed in January 2022]. Available from: https://jakarta.bps.go.id/publication/2020/04/27/20f5a58abcb80a0ad2a88725/provinsi-dki-jakarta-dalam-angka-2020.html

BPS-Statistics of DKI Jakarta Province. 2021. *DKI Jakarta Province in Figures 2021*. [Online]. [Accessed in January 2022]. Available from: https://jakarta.bps.go.id/publication/2021/02/26/bb7fa6dd5e90b534e3fa6984/provinsi-dki-jakarta-dalam-angka-2021.html

Brines, J. 1994. Economic Dependency, Gender, and the Division of Labor at Home. *American Journal of Sociology*. **100**(3), pp.652-688.

Economic Research Institute for ASEAN and East Asia (ERIA). 2018. *An Analysis of Alternative Vehicles' Potential and Implications for Energy Supply Industries in Indonesia*. [Online]. [Accessed on January 2022]. Available from: https://www.eria.org/uploads/media/ERIA_RPR_2017_15.pdf

Grab. 2019. Grab Kembangkan Program 'Mendobrak Sunyi' untuk Melayani Lebih Banyak Komunitas Penyandang Disabilitas. *Grab Indonesia*. [Online]. 3 December 2019. [Accessed in January 2022]. Available from: https://www.grab.com/id/en/press/social-impact-safety/grab-kembangkan-program-mendobrak-sunyi-untuk-melayani-lebih-banyak-komunitas-penyandang-disabilitas/

Hao, H., Mu, Z., Jiang, S., Liu, Z., and Zhao, F. 2017. GHG Emissions from the Production of Lithium-Ion Batteries for Electric Vehicles in China. *Sustainability*. **9**(4).

Jakarta Communications, Informatics, and Statistics Agency (JCISA). 2020. *Data Jumlah Disabilitas Berdasarkan Jenis Disabilitas dan Jenis Kelamin di Provinsi DKI Jakarta Tahun 2018*. [Online]. [Accessed in January 2022]. Available from: https://data.jakarta.go.id/dataset/data-disabilitas-dki-jakarta-berdasarkan-jenis-disabilitasnya/resource/5ca02147-f578-4176-a68b-56e64e074a2c

Keban, Y.T., Hernawan, A., and Novianto, A. 2021. *Menyoal Kerja Layak dan Adil dalam Ekonomi Gig di Indonesia*. Yogyakarta: IGPA Press.

Keynes, J.M. 1936. *The General Theory of Employment, Interest, and Money*. London: Palgrave Macmillan.

Kuncoro, A. 2021. Perilaku Konsumsi dan Tabungan. *Kompas*. [Online]. 2 February 2021. [Accessed in January 2022]. Available from: https://www.kompas.id/baca/ekonomi/2021/02/02/perilaku-konsumsi-dan-tabungan

Ministry of Finance (MoF). 2021. Tax Expenditure Report 2020. *Ministry of Finance Republic of Indonesia*.

Pepin, J.R. 2017. *Revisiting Measurements of Gender Inequality: Is Family Decision Making Power?* American Sociological Association Annual Meeting, August, Montréal, QC.

Pertamina. 2021. Kuota Dan Realisasi Premium Pertamina per Kota Kabupaten Tahun 2021 - Update September 2021. [Online]. [Accessed in January 2022]. Available from:

https://www.pertamina.com/id/Kuota-Dan-Realisasi-Premium-Pertamina-per-Kota-Kabupaten-Tahun-2021-Update-September-2021

Peshin, T., Sengupta, S., and Azevedo, I., 2021. Should India move towards vehicle electrification? Assessing life-cycle greenhouse gas and criteria air pollutant emissions of alternative and conventional fuel vehicles in India. *ChemRxiv*.

Rahman, A.F. 2019. Grab Ingin Tingkatkan Jumlah Driver Tuna Rungu Dua Kali Lipat. Detikinet. [Online]. 24 September 2019. [Accessed in January 2022]. Available from: https://inet.detik.com/cyberlife/d-4719943/grab-ingin-tingkatkan-jumlah-driver-tuna-rungu-dua-kali-lipat

Restianti, Y.Y. and Gheewala, S.H. 2012. Life cycle assessment of gasoline in Indonesia. *The International Journal of Life Cycle Assessment*. **17**(4), pp.402-408.

State-Owned Utility Company (PLN). 2021. *Rencana Usaha Penyediaan Tenaga Listrik (RUPTL) PT PLN (Persero) 2021-2030*. [Online]. [Accessed in January 2022]. Available from: https://web.pln.co.id/statics/uploads/2021/10/ruptl-2021-2030.pdf

Tol, R.S.J. 2019. A social cost of carbon for (almost) every country. *Energy Economics*. **83**, pp.555-566

Wandaweka dan Purwanti. 2021. Determinan Partisipasi Kerja Perempuan dalam Sektor Informal di Indonesia Tahun 2019. *Seminar Nasional Official Statistics 2021*. **2021**(1), pp.652-661

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