Piloting Electric Vehicle Systems and Developing a Green Transportation Investment Roadmap for Bali, Indonesia:

Technical Study for E-Mobility in Jakarta and Bali, Indonesia

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ABBREVIATIONS

A/C	Air Conditioner
AC	Alternating Current
ADB	Asian Development Bank
APBD	Regional Revenue and Expenditure Budget
APBN	State Revenue and Budget
APM	Brand Holder Agent
APPI	Indonesia Finance Services Association
Bappeda	Regional Development Planning Agency
Bappenas	Ministry of National Development Planning
BAU	Business-as-usual
BBM	Oil-based Fuel
BBNKB	Motor Vehicle Title Transfer Fee
BEB	Battery Electric Bus
BEV	Battery Electric Vehicle
BLEZI	Bali Low Emission Zone Initiative
BLUD	Regional Public Service Agency
BMS	Battery Management System
BNI	Bank Negara Indonesia
BPKAD	Regional Financial and Asset Management Agency
BRI	Bank Rakyat Indonesia
BRIN	National Research and Innovation Agency
BRT	Bus Rapid Transit
BSI	Bank Syariah Indonesia
BSN	National Standardization Agency
BSS	Battery Swap Station
BST	Bersama Satu Tujuan (Cooperative)
BTS	Buy The Service
CAGR	Compound Annual Growth Rate
CBU	Completely Built-Up
CCS	Combined Charging System
CKD	Completely Knocked-Down
CNG	Compressed Natural Gas
CO2	Carbon Dioxide

CSR	Corporate Social Responsibility
DC	Direct Current
DIMA	Disabilitas Maju
DKI	Special Capital Region
E2W	Electric Two-Wheelers
E3W	Electric Three-Wheelers
E4W	Electric Four-Wheelers
E-bus	Electric Bus
EIB	European Investment Bank
EVs	Electric Vehicles
FCEV	Fuel Cell Electric Vehicles
FSA	Financial Service Authority
FTA	Free Trade Agreements
G20	The Group of Twenty (The premier forum for international economic cooperation)
GAUN	Gerakan Aksesibilitas Umum Nasional
GCC	Gross Cost Contract
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEDSI	Gender Equality, Disability and Social Inclusion
GERKATIN	Gerakan Untuk Kesejahteraan Tuna Rungu Indonesia
GHG	Green-House Gases
GIZ	The Deutsche Gesellschaft für Internationale Zusammenarbeit
GoI	Government of Indonesia
GoJ	Government of Jakarta
GPDLI	Gerakan Peduli Disabilitas dan Lepra Indonesia
GPIP	Good Practice Infrastructure Project
GR	Governor Regulation
GRDP	Gross Regional Domestic Product
GSEN	National Energy Grand Strategy
GVW	Gross Vehicle Weight
HDI	Human Development Index
HEV	Hybrid Electric Vehicles
HOV	High-Occupancy Lane
HWDI	Himpunan Wanita Disabilitas Indonesia
IBC	Indonesia Battery Corportation
ICCT	International Council on Clean Transportation
ICE	Internal Combustion Engine
ICLEI	International Council for Local Environmental Initiatives
IDR	Indonesian Rupiah
IFC	International Finance Corporation
IKD	Incompletely Knocked Down
INKA	PT Industri Kereta Api
IO	International Organization
ITDP	Institute for Transportation and Development Policy

ITMI	Ikatan Tunanetra Muslim Indonesia
ITMOs	Internationally Transferred Mitigation Outcomes
ITMS	Integrated Transport Management System
Jabodetabek	Aglomeration area of Jakarta, Bogor, Depok, Tangerang, and Bekasi
KBLBB	Battery-based Electric Motor Vehicles
KIAT	Indonesia Australia Partnership for Infrastructure
Km	Kilometer
KPI	Key Performance Indicators
kVa	Kilovolt-ampere
kW	Kilowatt
kWh	Kilowatt-Hour
LEZ	Low Emission Zone
LFP	Lithium Ferrophosphate
LKPP	Government Goods/Services Procurement Policy Agency
LPG	Liquified Petroleum Gas
LST	Luxury-Goods Sales Tax
LTO	Lithium Titanate Oxide
MAB	PT Mobil Anak Bangsa
MCC	Millennium Challenge Corporation
MIS	Management Information System
NDA	National Designated Authority
NDC	National Determined Carbon
NGO	Non-Governmental Organization
NMC	Nickle Manganese Cobalt Oxide
NMT	Non-motorized Transport
NPCI	National Paralympic Committee of Indonesia
OEM	Original Equipment Manufacturer
OJK	Financial Services Authority
PAD	Regional Original Income
PERTUNI	Persatuan Tunanetra Indonesia
PHEV	Plug-in Hybrids Electric Vehicles
PII	PT Penjaminan Infrastruktur Indonesia
PKB	Motor Vehicle Tax
PLN	Perusahaan Listrik Negara or State Electricity Company
PM2.5	Particulate Matter 2.5
PR	Presidential Regulation
PSA	Public Service Announcements
PSO	Public Service Obligation
PT	Public Transport
Puspadi Bali	Pusat Pemberdayaan Penyandang Disabilitas Bali
PwC	PricewaterhouseCoopers
QRIS	Quick Response Code Indonesia Standard
RAD	Regional Action Plan
RPJMN	National Medium-Term Development Plan

RPJP	Regional Long-Term Development Plan
RPTRA	Child-Friendly Integrated Public Space
RR	Regional Regulation
RUED	Regional General Energy Plan
RUEN	National Energy Master Plan
RUKN	National Electricity Master Plan
RUPTL	Electricity Supply Business Plan
SDG	Sustainable Development Goals
SGB	PT Sistem Ganti Baterai
Sistranas	National Transportation System
SMI	PT Sarana Multi Infrastruktur
SOP	Standard Operating Procedure
SPBKLU	Public Electric Vehicle Battery Exchange Stations
SPKLU	Public Electric Vehicle Charging Station
SPLU	Public Electric Charging Station
SPM	Service Level Agreement
SUMP	Sustainable Urban Mobility Program
TC	Traffic Count
TCO	Total Cost of Ownership
TKDN	Domestic Component Level
TRS	Trans Roda Sejati (Cooperative)
TTW	Tank-to-Wheel
TUMI	Transformative Urban Mobility Initiative
UITP	International Association of Public Transport
UK PACT	United Kingdom Partnering for Accelerated Climate Transitions
UNEP	United Nations Environment Programme
USD	United States dollar
VAT	Value-added Tax
WACC	Weighted Average Cost of Capital
WHO	World Health Organization
WRI	World Resources Institute
WTW	Well-to-wheel
YDKI	Yayasan Disabilitas Kreatif Indonesia

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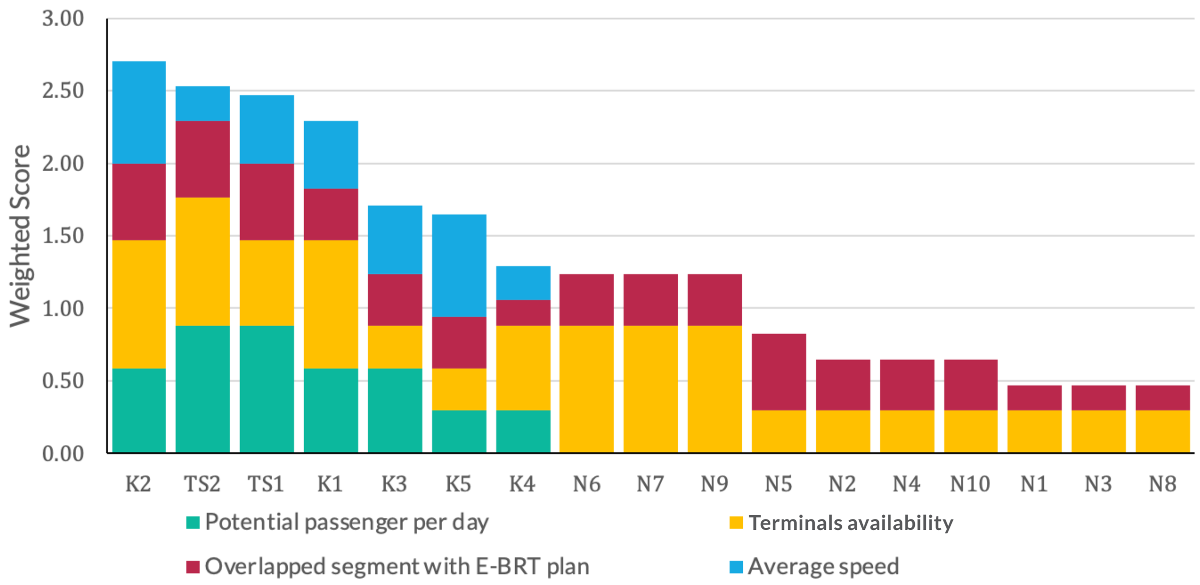
EXECUTIVE SUMMARY

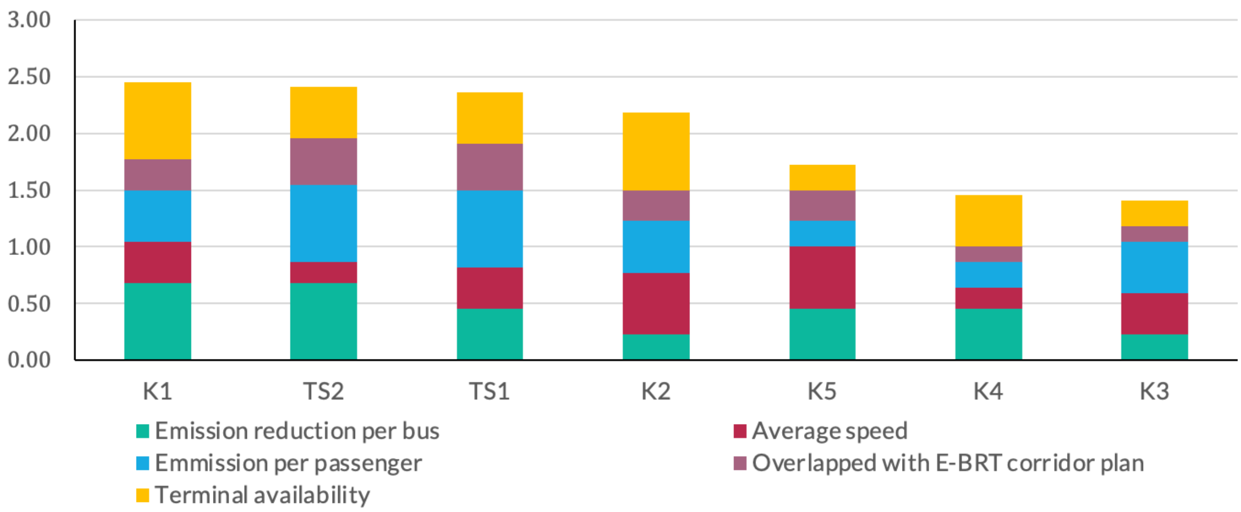
Through Presidential Regulation No. 55 of 2019, Indonesia prioritizes accelerating Battery Electric Vehicles (BEVs) for road transport, yet the adoption rate remains low, exemplified by Bali achieving less than 1% of its moderate regional target. Challenges such as a lack of charging infrastructure and high upfront costs remain the main barriers for implementation. This technical study aims to support the Government of Indonesia, particularly the Bali Provincial Government, in transitioning to sustainable transport by looking at several options that have the most potential to transition to electric thereby increasing investment opportunities and strengthening capacity involving public and private stakeholders. Focusing on Jakarta and Bali, the study also examines BEV adoption challenges and practices, while analyzing environmental and economic impacts, and offering policy and business model recommendations for BEV development and implementation.

This study also yields route options that can considered for the implementation of electric buses and their infrastructure. Based on desktop analysis results, field surveys, and workshop, there are several potential routes in addition to the existing routes that already have good operational data and characteristics. Therefore, the selection of these route options uses a two-stage multi-criteria analysis (MCA). Due to the limitation of this study, other potential routes could further develop and assessed as part of the next steps. The following are the results of the two-stage MCA based on criteria such as emission reduction per bus, emission per passenger, potential passengers per day, terminal availability, average speed, and overlapped segments with e-BRT.

Assessment Result from Multi Criteria Analysis Step 1



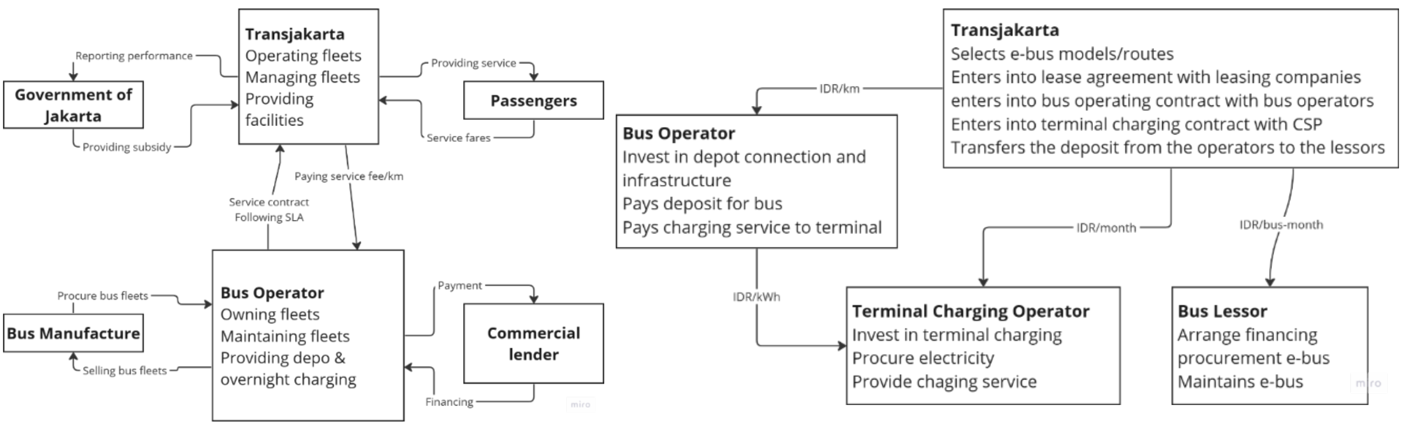
Assessment Result from Multi Criteria Analysis Step 2



Based on the results of the MCA analysis, the K1 route by Trans Metro Dewata has the highest score with an accumulated value of 2.45 due to its significant reduction in emissions and the availability of charging locations. This is followed by the Trans Sarbagita routes (TS1 and TS2), where a higher number of passengers results in lower emissions per capita, thus helping to reduce the city's carbon footprint. In contrast, Routes K3 and K4 score lower across all criteria, particularly in terms of average speed and terminal availability, resulting in a lower overall score.

The business model of electric bus implementation is also another aspect that is looked at in this study. The Bali Government can draw upon practices from Transjakarta, as a Regional-owned Enterprise operating Bus Rapid Transit (BRT) in Jakarta. Although Bali has currently formed an executing unit, it can be elevated to Badan Layanan Umum (BLU) or Badan Usaha Milik Daerah (BUMD) to meet the needs and flexibility of financial management. Here is the business model used by Transjakarta in managing its first 100 e-buses, and options for leasing mechanisms for another 26 e-buses.

The First and Second Business Model and Mechanism for 100 E-Bus by Transjakarta



Policy Recommendation

National Level

The government is pushing two and four-wheeler electrification as an ambition to lead the EV market. Despite incentives from PP No. 59/2019, the shift from fossil fuel to EV has been slow. Future policies should focus on alternative strategies to encourage immediate transition to EV both for public and businesses, such as, renewing the business license by encouraging ride-hailing and delivery companies using BEV modes, disincentivizing oil-fueled purchase and service life of ICE, increasing public campaign program for BEV, and exploring more financing mechanisms like leasing scheme for a long-term solution.

Prioritizing public transportation electrification shows government commitment and will maximize impacts. Key policies include clear guidelines for planning and implementation, aligning targets with GHG reduction goals, establishing regional institutional mechanisms, designing financing options, ensuring coordination between central and local governments, providing technical guidance for operators, and regularly reviewing contracts is needed for successful e-bus adoption. Additionally, financial concerns can be a challenge for cities to provide optimum public transportation, given this service is highly reliant from local fiscal budgets. The recent issuance of Government Regulation No. 35 of 2023 provides opportunity for cities as it stipulates at least 10% of revenue from vehicle tax must be allocated to improve public transport services and facilities. However, the national government needs to continuously monitor and evaluate the policy to achieve implementation.

Sub-National Level

As the region already has a strategic target to accelerate the implementation of BEVs, there are potential policies and steps that can be taken. This includes creating exclusive zones for EVs in urban centers and expanding to other areas, which would encourage vehicle rental companies to switch their fleet to EVs. In addition, offering tax incentives to companies can also be an effort to encourage the transition.

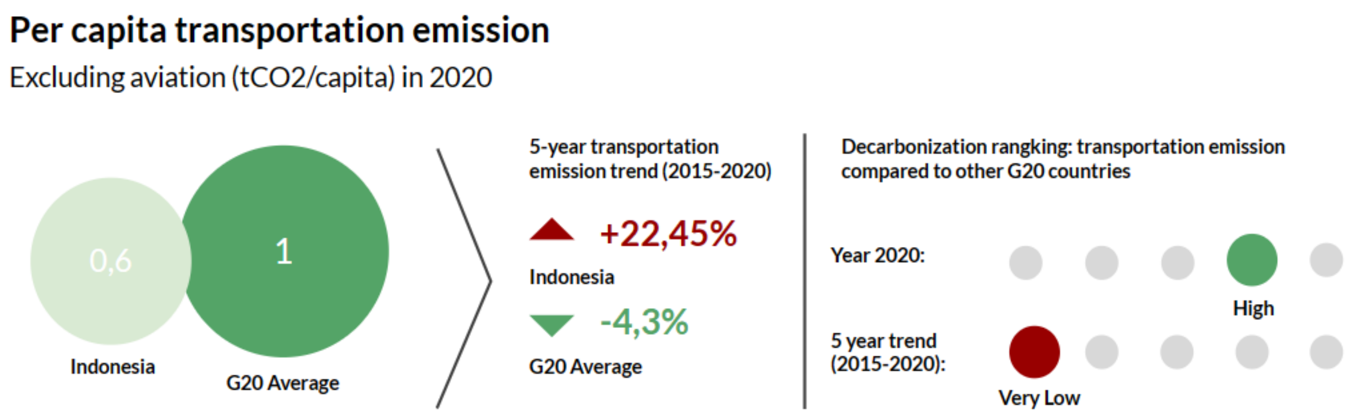
The Ministry of Transportation's Buy the Service programs aids to provides PT in the regions. However, this is a temporary measure and regions expected will continue this service. Government Regulation 35 of 2023 might mitigate financial concerns, yet various factors need to be considered such as, plans to include establishing a roadmap for public transport with measurable targets and phasing out fossil fuel vehicles. Regulations to encourage EV transition, including settings longer contracts for investment recovery, and fleet ownership rules. A clear financing mechanism for a cross-financing scheme from the vehicle tax. Additionally, developing green corridors for increased coverage; and addressing land issues for e-bus infrastructure by utilizing strategic locations like local assets or existing terminals.

1. INTRODUCTION

1.1 Current Status or Existing Situation

In 2019, Indonesia introduced Presidential Regulation No. 55 of 2019, focusing on accelerating the electric vehicle (EV) program for road transport and prioritizing electric vehicles. EVs are also a priority target in the National Medium-Term Development Plan, 2020-2024, as a key strategy for Indonesia to achieve its Nationally Determined Contribution Plan to reduce GHG (greenhouse gases) emissions by 32% by 2030 using its resources, or 43% with international assistance. According to data from the Net-Zero Summit 2023, emission profiles in Indonesia are predominantly influenced by the electricity and transportation sectors (42% and 23%, respectively). Additionally, the Climate Transparency Report 2021 for Indonesia states that per capita transportation emissions saw a significant increase (+22.45%) over the 5-year trend from 2015 to 2020, compared to the average of other G20 countries (-4.35%).[1] Electrification of the transportation sector, coupled with a high share of renewable energy in the electricity sector, is necessary to reduce emissions and stay within the limits of a 1.5-degree temperature increase.

Figure 1. Per Capita, Transportation Emission in Indonesia. *Climate Transparency Report (2021)*



1 Transparency climate. 2021. https://www.climate-transparency.org/wp-content/uploads/2021/11/Indonesia-Country-Profile-2021_Bahasa.pdf

The development of EVs in Indonesia has been progressing from year to year, with data from the Ministry of Transportation indicating a significant increase, especially in Electric Two-Wheelers (E2W) and Electric Four-Wheelers (E4W) from 2021 to 2022.[2] However, when compared to the National General Energy Plan (RUEN) and the National Energy Grand Strategy (GSEN), the adoption rates for both E2W and E4W are below 1.5% in both 2025 and 2030. For public transportation, as part of the effort to reduce GHG emissions from the transportation sector, adopting the Battery Electric Vehicle (BEV) Acceleration Program regulation is now defining targets for Indonesia. According to RUEN and the Ministry of Transportation's public transportation roadmap, the current objectives are set at 10% of vehicles by 2025 and an ambitious 90% by 2030.[3]

Figure 2. E2W and E4W Population in Indonesia. *IESR (2023)*

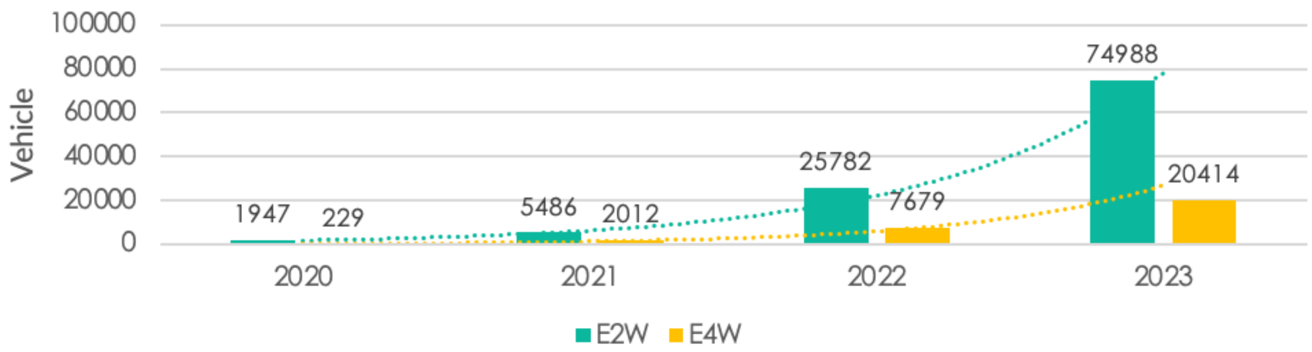


Table 1. Indonesia BEV Adoption Target and Status. *ITDP (2021)*

BEV Adoption Target	E2W	E4W	E-Bus
2025 National General Energy Plan (RUEN)	2.1-million-unit (1.6% from the total Internal Combustion Engine (ICE) 2W)	2,200 unit (0.01% from the total ICE 4W)	10% from the total fleet
2030 National Energy Grand Strategy (GSEN)[4]	13 million unit (10% from the total ICE 2W)	2 million unit 9.09% from the total ICE 4W)	90% from the total fleet (moderate target: 15.546 unit)
100% electrified target	100% in 2040[5]	100% in 2050[5]	100% in 2040[6]
Latest progress, October 2023[7]	74,988 unit (0.58% from the 2030 target)	20,414 unit (1.02% from the total 2030 target)	80 unit (0.51% from the moderate target in 2030)

2 ESDM. 2022. https://www.esdm.go.id/en/publication/handbook-of-energy-economic-statistics-of-indonesia-heesi

3 Yihao Xie, Francisco Posada, Adhi Triatmojo. 2023. Peta jalan kebijakan untuk percepatan elektrifikasi bus angkutan umum perkotaan di Indonesia.

4 ESDM. 2020. https://www.esdm.go.id/id/media-center/arsip-berita/sambut-era-kendaraan-listrik-pemerintah-lakukan-public-launcing-kendaraan-bermotor-listrik-berbasis-baterai

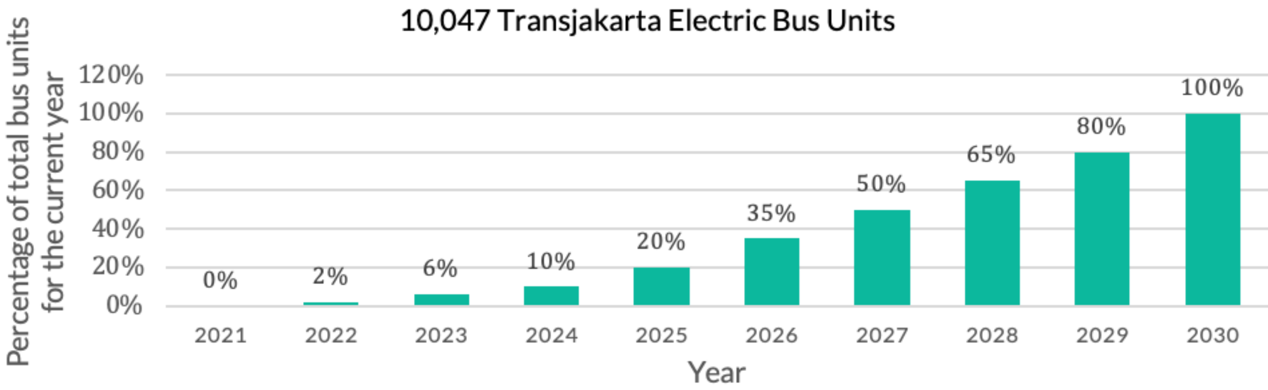
5 Indonesia National Energy Grand Strategy

6 The Ministry of Transportation's internal target

7 Detikoto (2023). Available at: Ternyata Segini Jumlah Kendaraan Listrik di Indonesia (oto.detik.com) (Accessed: Jan 2024)

At the regional level, The Provincial Government of Special Capital Region (DKI) Jakarta is actively promoting the acceleration of motor vehicle electrification for both public and private transportation. This is stated in Regional Regulation No. 90/2021, which emphasizes the need for public transportation electrification while also developing the necessary infrastructure to support EV in Jakarta. Transjakarta, as a Regional-owned Enterprise operating the first Bus Rapid Transit (BRT) system in Southeast Asia since 2004, has initiated a trial of 30 electric buses aiming for 50% by 2027 and complete electrification with 10,047 buses (100%) by 2030 as outlined in the Long-Term Company Plan 2020-2030.[8] In follow-up to this, in 2019, the Governor of DKI Jakarta signed the C40 Fossil Fuel Free Street declaration, stating that there will be no more procurement of conventional buses starting from 2025 and initiating the trial implementation of 100 electric bus fleets. By December 2023, all 100 electric bus fleets for the BRT service are already in operation.

Figure 3. Transjakarta Electrification Target, 2022-2030. *Transjakarta*



The Bali Provincial Government has also officially launched the Regional Action Plan (RAD) for Accelerating Battery Electric Vehicles 2022-2026. One of Bali's Government targets is to reduce carbon emissions by 41 thousand tons in 2026 through the deployment of 140 thousand E2Ws, 5719 E4Ws, and 50 e-buses. Currently, Bali has achieved less than 1%[9] of its moderate target, with a total of 1990 electric two-wheelers (E2W) and 319 electric four-wheelers (E4W) at the beginning of 2023, despite aiming for a year-on-year growth rate of 200%. This is attributed to various barriers, such as a lack of charging infrastructure, high upfront costs, limited driving range, and prolonged charging duration.[10] Based on a relatively similar case and situation in each city, a more strategic approach is needed to examine the issues and influencing factors more deeply. In particular, a wide range of options is required, such as choices that can be considered and how to provide a balance for public value (cost, benefit, and risk).

1.2 Global E-Mobility Market

Evaluating market conditions in the target area, encompassing global and national perspectives, is pivotal for effective e-mobility implementation. Globally, insights into manufacturers, models, and charging infrastructure offer a glimpse into cutting-edge technologies and potential collaborations.

8 ITDP. 2020. TUMI e-bus mission: Supporting and Building Capacity in Monitoring and Evaluating Pilot E-Bus Implementations

9 Land Transport Agency Bali. 2023

10 IESR. 2023. https://iesr.or.id/wp-content/uploads/2023/02/Indonesia-Electric-Vehicle-Outlook-2023.pdf

1.2.1 Global E2W Market

The global E2W market movement was valued at United States dollar (USD) 34.16 billion in 2022 and is projected to continue increasing to exceed USD 72.16 billion by the end of 2030, with a compound annual growth rate (CAGR) of 9.84%. Here is a list of key market players in the E2W industry: Zero Motorcycles, Energica Motor Company, Harley-Davidson, Yamaha, NIU Technologies, Ather Energy, Gogoro, Evoke Motorcycles, Super Soco, Segway-Ninebot, Arcimoto, Revolt Motors, E-bike and E-scooter Sharing Companies, Local Manufacturers, and Others.[11]

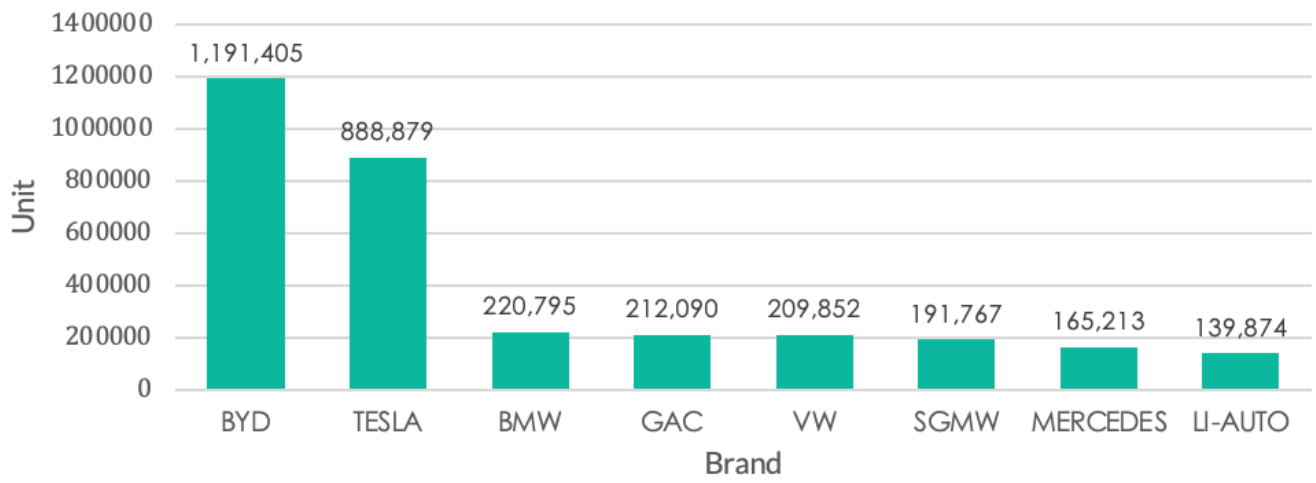
Table 2. Global E2W Market Brand Specification and Price Example

Brand/or model[12]	Battery Capacity	Charging Strategy	Plug-in (hours)	Batt. swap (hours)	Est. Range (km)	Vehicle Price
Honda EM1	29.4 Ah	Plugin and battery swap	6	N/A	41.1	USD 2,560
Yadea Trooper 1	48V 20Ah	Plugin	6	N/A	60	USD 1,999
Vida V1 Pro	3.94 kWh	Plugin and battery swap	6	N/A	110	USD 1,750
Yamaha E01	87.6 V, 56.2 Ah	Plugin	5	N/A	104	USD 1,400
Bajaj Chetak	2.9 kWh	Plugin	4.3	N/A	127	USD 1,737

1.2.2 Global E4W Market

The global electric vehicle market, or BEV, was valued at USD 209.71 billion in 2022 and is projected to reach USD 525.65 billion by 2028, with a CAGR of 18.6%. Here are some key market players in the global BEV market: General Motors Company, Mercedes-Benz Group AG, Volvo, Renault, Tesla, Nissan, BMW, Volkswagen, Stellantis, Ford, Hyundai, NIO, BYD, Rivia Automotive, Zhejiang Geely.[13]

Figure 4. Estimated Global Plug-in EV Sales in the First Half of 2023, by Brand. *Statistica (2023)*



11 Fact and Factors. Electric Two-wheeler (E2W) Market Size, Share Global Analysis Report, 2023-2030

12 CNN Indonesia (2022). Available at: 10 Merek Motor Terlaris di Dunia, Honda Dipepet Motor Listrik China (cnnindonesia.com) (Accessed: Jan 2024)

13 Research and Markets. Cars Dominate the Global Battery Electric Vehicle (BEV) Market, but Buspheves Set to Witness Fastest Growth, Driven by Sustainability Initiatives (2023)

Table 3. Global E4W Market Brand Specification and Price Example

Brand/or model[14]	Type	Battery Capacity	Charging (hour)	Est. Range (km)	Unit Sold (unit)	Vehicle Price
Tesla/Model Y	BEV	67.6-81 kilowatt-hour (kWh)	22 (3.6 kilowatt (kW)) 12 (7kW) 8 (22kW)	498	772,364	USD 46,990
Tesla/Model 3	BEV	60 kWh	22 (3.6kW) 12 (7kW) 8 (22kW)	549	435,059	USD 35,000
BYD/Atto 3	BEV	62 kWh	9	480	265,688	USD 46,118
BYD/Song Pro	BEV + PHEV	71 kWh	0,5 (30%-80%)	502	222,825	USD 19,500
BYD/Dolphin	BEV	60.4 kWh	26.5 (10A) 9.6 (16A)	426	160,693	USD 38,890

1.2.3 Global E-Buses Market

The global electric bus market is valued at USD 45 billion by 2024 and is expected to reach USD 116.46 billion by 2029, with a growing rate CAGR of 20.95% during the forecast period (2024-2029).[15] Meanwhile the market for e-bus charging infrastructure was USD 1.68 billion in 2021. It is projected to reach USD 6.63 billion by 2027, indicating a CAGR of approximately 16.4% during the forecast period (2022–2027). Some e-bus key players are Anhui Ankai Automobile, BYD Company Limited, King Long United Automotive Industry, Zhengzhou Yutong Group, and Zhongtong Bus.

China leads in the deployment of EV, contributing to the development and experience of Chinese brands in designing and manufacturing battery electric buses. For example, brands like BYD and Yutong are the most common and dominated electric bus on the market, offering products with various quality standards tailored to specific markets. These standards are classified as either China standard or European. Vehicles built with a China standard exclusively utilized local component (batteries, motors, control system), which more cost-effective and typically find export markets in developing countries with less strict standard for technical regulations. For instance, a 12m low floor city bus usually cost between USD 469,999 – USD 535,000, with the China standard vehicle being USD 134,000 – USD 201,000 cheaper.

The emergence of new players such as Hyundai, who recently introduced the Hyundai Elec City, and Tata Motors from India, which released the Urban 9/12, is a promising development. These new products have been designed to meet the changing needs of the global market, and there is a high probability that new advanced technologies will be introduced that offer advantages and improvements in the design, performance, and efficiency of electric buses. Hyundai's electric bus sector is following the successful global bus market penetration. In 2022, Hyundai exported USD 487 million worth of buses, ranking 10th in the world[16].

14 Neufeld (2023). Available at: Ranked: Electric Vehicle Sales by Model in 2023 (visualcapitalist.com) (Accessed: Jan 2024)

15 Modor Intelligence. Electric Bus Market Size & Share Analysis, (2024-2029)

16 The Observatory of Economic Complexity (oec.world)

Table 4. Global E-Bus Market Brand Specification and Price Example

Bus Type	Brand/model	Power (Kw)	Battery Size (kWh)	Range (km)	Passenger (pax)	Vehicle Price
Single Bus 9m-12m	Hyundai Elec City	240	290.4	290	50/51	USD 350,000
	BYD K9	180	324	251	37	USD 310,000
	Zhong Tong LCK6125EV	280	350	150	40	n/a
	Tata Urban 9/12	186	188	160	40	n/a
	Yutong	200	374	320	35	n/a
Medium Bus 6m-9m	Hyundai County EV	150	128	250	15-33	n/a
	Tata Ultra 9/9	254	124	150	31	n/a
	BYD K7	180	180	221	22	n/a
	Shenzhen BAK	165	175	200	20	USD 98,000

1.3 Objective and Scope of Works

The objective of this project is to support the Government of Indonesia (GoI), specifically the Bali Provincial Government, in transitioning to more sustainable transportation. This objective will be achieved by implementing a coherent and sustainable EV roadmap, increasing investment opportunities and commitments to accelerate the use of EVs and strengthening capacity and institutional framework involving public and private stakeholders.

This technical study will demonstrate the viability of financing and implementing an EV-based transportation system as well as to testing and learning to inform and guide the design of the larger green transportation system, and also a guidance to overlook of the Indonesian e-mobility roadmap. For the targeted areas of Jakarta and Bali, this study will describe the progress of electric bus trials conducted by Transjakarta, including its business model and obstacles faced. Specifically in Bali, the study will examine potential routes for e-buses based on field survey data, as well as the environmental and economic impacts in various scenarios. Furthermore, this study will provide policy recommendations for the development and implementation of BEV.

Table 5. Main Task and Output of Technical Study

Task A	Task B
• Institutional and policy paper list, functions, and stakeholders mapping • E-mobility related data • Site map and bus route map • Analytical report on the transport condition of the target area	• Environmental and economical assessment impact • Analytical report on e-mobility technology option • Recommendation
Output A	**Output B**
• Analysis of Sustainable Transport Regulations: Focus on E-Mobility and Marginalized Sectors • Review and analyse stakeholder mapping that has roles and influences on the implementation of EVs in Indonesia • Barriers and Funding models to Mass E-mobility Adoption • Target Area Overview: Review and Analysis of Geographic, Administrative, Population, and Socio-Economic Information • Data Collection on Vehicle fleet technology in Indonesia • Collecting public transport data • Exploring E-Mobility options	• Assessing Greenhouse Gas Emission Impacts: Transitioning from Conventional to E-Mobility Vehicles • Evaluating The Economic Impacts: Transitioning from Conventional to E-Mobility Vehicles • Potential impacts on the distribution grid from adding EV charging infrastructure • Analysing E-Mobility Business Models • Policy Recommendations

2. E-MOBILITY READINESS IN INDONESIA

As Indonesia grapples with increasing urbanization and population growth, the shift towards EV becomes paramount. Recognizing and understanding key stakeholders is essential for fostering collaboration and overcoming industry barriers. Moreover, a clear regulatory framework is vital to incentivize investments, research, and infrastructure development. The expeditious establishment of these foundations is crucial to propel Indonesia towards a sustainable and efficient e-mobility future.

2.1 Analysis of Sustainable Transport Regulations

National policies showcase a commitment to sustainability, while sub-national insights provide a localized perspective. This dual-level examination helps identify disparities, ensuring equitable access to e-mobility solutions. Additionally, scrutinizing fiscal and non-fiscal incentives at both levels is vital for gauging economic viability. This comprehensive analysis allows stakeholders to craft targeted strategies that promote sustainable transport while addressing diverse social and economic considerations, fostering an inclusive approach to e-mobility development.

2.1.1 National Level Documents and Policies for EV

In a national context, there are two policy regulations serving as the basis for the transition to EV, namely Presidential Regulation No. 22/2017 on the RUEN and Presidential Regulation No. 55/2019 on the Acceleration of the BEV Program for Road Transportation which has been amended by Presidential Regulation No. 79/2023.

In 2017, the initial plan outlined in the National Energy Plan had targets until 2025, including (1) 2.1 million electric or hybrid 2-wheelers, (2) 2,200 electric or hybrid 4-wheelers, and (3) electrification of EV amounting to 10% of the total public transportation in Indonesia. In 2019, the Government of Indonesia focused on the direction of BEV adoption by launched PR No. 55/2019 as stated in the PR No. 22/2017 targets, still acknowledging hybrid vehicles and providing a framework to accelerate adoption and enhance the domestic industry.

Table 6. **President Regulation No. 55/2019 Highlight**

No	Topic	Remarks
1	The acceleration of domestic BEV	1. Ministry of Industry to release the National Motorized Vehicle Industry Roadmap (Peta Jalan Pengembangan Industri Kendaraan Bermotor Nasional) through Ministry of Industry Regulation 6/2022, amended the previous Ministry of Industry Regulation 27/2020. 2. BEV manufacturers allowed limited-time (2025) import of Completely Built-Up (CBU) vehicles. 3. BEV component manufacturers permitted limited-time import of Incompletely Knocked-Down (IKD) or Completely Knocked-Down (CKD) components
2	General guideline for possible incentives	1. Incentives for import taxes 2. Waiver of luxury goods tax 3. Reductions or exemptions in national/local taxes 4. Incentives for manufacturing public charging infrastructure 5. Export financing support 6. Fiscal backing for research, development, and vocational studies in the BEV industry 7. Parking cost incentives determined by local governments 8. Tariff reductions for charging at public facilities 9. Financial assistance for establishing public charging facilities 10. Certification for professionals in the BEV industry 11. Certification for players in the BEV or BEV battery industry 12. Non-fiscal benefits 13. Exemptions from specific road access restrictions 14. Authorization for producing BEV-related technology 15. Security assistance for logistical or production operations in the industry
3	Charging infrastructure and regulation of electricity tariffs	1. National Electric Company (PLN) tasked with establishing public charging facilities nationwide. 2. Ministry of Energy and Mineral Resources to introduce a special electricity tariff for both public and private BEV charging facilities.
4	Environment protection	Recycling or treatment of BEV battery waste is mandatory, and its management is carried out by institutions or domestic players in the BEV or BEV component industry holding a waste management permit as per regulations
5	National BEV Acceleration Coordination Team	1. The National BEV Coordination Team, led by the Coordinating Ministry for Maritime Affairs and Investment, oversees, and accelerates the BEV adoption program. 2. The Team is supported by a Task Force established by its leader.

Demand-side policies aim to promote BEVs by offering consumer incentives, discouraging ICE use, or mandating a shift to BEVs. This key points also covers relevant policies on energy prices, subsidies, and public transport fleet taxes in Indonesia, impacting BEV operational costs. Moreover, the demand-side incentives are essential for accelerating EV adoption, however, relying solely on imported vehicles is not sufficient. The local industry must develop infrastructure and production facilities. The Indonesia Government has implemented specific incentives through Presidential Regulation (PR) 22/2017 and PR 55/2019 with directed several policies (demand and supply) to supporting BEV adoption, but many are yet to be issued. In more detail PR No. 55/2019, along with other policies addressing supply and demand, are listed in Table 62.

Table 7. Others National BEV Related Regulations

Policies	Remarks
Ministry of Transportation Regulation No. 65/2020	Every motorcycle with an internal combustion engine that has been registered and identified can be converted into a battery-based Electric Motorcycle.
Ministry of Transportation Regulation No. 15/2020	Same as Ministry of Transportation Regulation No. 65/2020 this regulation intended for the conversion of vehicles other than motorcycles.
President Instruction No. 07/2022	Regulates the use of Battery-Based Electric Motor Vehicles (KBLBB) as operational service vehicles and/or personal service vehicles for central government and local government agencies.
Ministry of Industry Regulation No. 21/2023	Assistance from the government for the purchase of E2W BEV, with an amount of 7 million Indonesian Rupiah (IDR) per purchase of 1 unit.

2.1.1.1 National Public Transport Electrification Roadmap

Nationally, the government, particularly Ministry of Transportation, has established a roadmap for the implementation and development of BEV-based public transportation. This initiative begins with the bus subsidy program by the ministry, namely Buy the Service (BTS). This program is a scheme for the central government to purchase services from the state budget (APBN) of the Ministry of Transportation to pay operators providing public transportation services through a bidding mechanism based on the Service Level Agreement (SPM) that has been established on specific routes in several cities in Indonesia. Currently, there are 10 regions in Indonesia that have been selected to receive this BTS program: Medan, Palembang, Banjarmasin, Makassar, Denpasar, Bandung, Banyumas, Yogyakarta, Surakarta, and Surabaya.

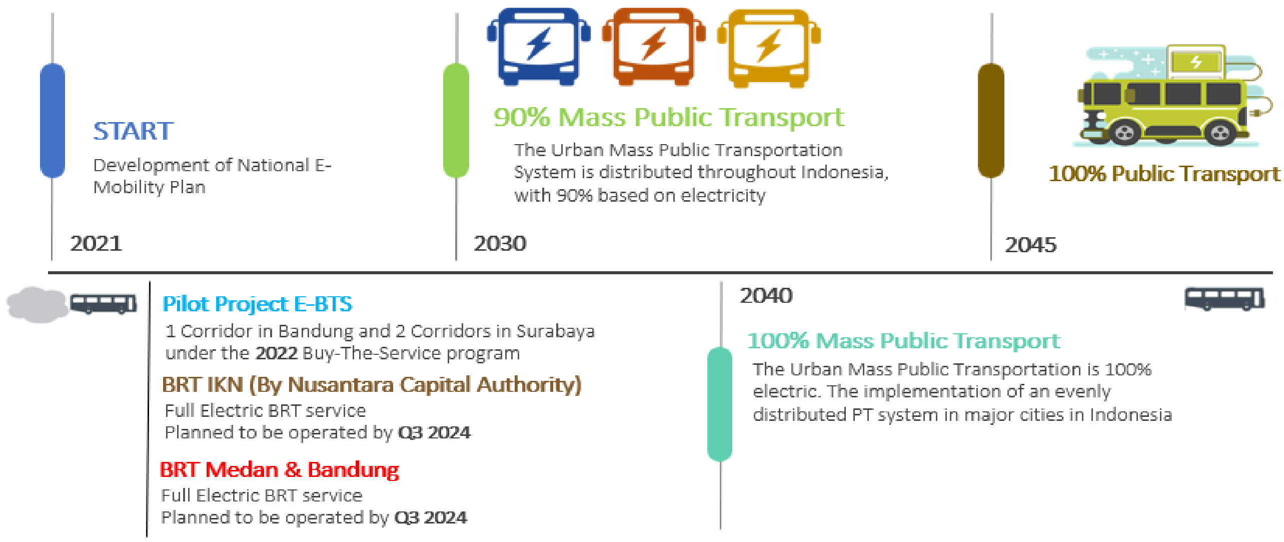
Table 8. BTS Challenges and Success Highlight. *ITDP (2022)*

Topic	Remarks
The highlight challenges faced by the local government in implementing the BTS	1. Conflict with the existing operator. 2. Low ridership. 3. Inaccessible infrastructure. 4. Limited funding to fund the operational and infrastructure. 5. Public transport reform: the reformation only provided for the bus system, meanwhile angkot/ paratransit are still exile from the system.

Topic	Remarks
Success story from Surakarta	1. The political aspirations and continuous commitment of the leaders of Surakarta City play a crucial role. 2. The institutional reform of existing public transportation operators in Surakarta City involves the formation of PT Bengawan Solo Trans as a bus operator, Bersama Satu Tujuan (BST) Cooperative, and Trans Roda Sejati (TRS) Cooperative as feeder operators. 3. Financial support from the government, providing certainty and decent income for Bersama Satu Tujuan feeder drivers, encourages them to operate feeder services according to Standard Operating Procedure/SOP) and SPM and supports the reform of integrated Batik Solo Trans service networks in Surakarta City. 4. The optimal performance of public transportation services will be achieved if institutional reform and Batik Solo Trans service network development are carried out comprehensively, both for buses and feeders. 5. The expansion of the Batik Solo Trans service network coverage area to Surakarta, Boyolali, Sukoharjo, Karanganyar, Wonogiri, Sragen, and Klaten (Subosukawonosraten) agglomeration area is necessary. 6. The implementation of the Batik Solo Trans program in Surakarta City has led to an increase in the use of urban public transportation services by Batik Solo Trans users and the welfare of the drivers. 7. The provision of supporting public transportation infrastructure, such as contra-flow bus lanes, bus stops including sub-terminals, shelters, bus stop, and comprehensive socialization programs, has led to an increase in the use of Batik Solo Trans services.

In addition, the government also conducts pilots and implements E-Bus fleets for the BRT system in urban areas. The electrification target is to reach 90% of public transport (bus system) by 2030, 100% by 2040, and all public transport (including feeder) by 2045. The bus deployment number and target for each city will be illustrated in Table 63. By 2023, apart from DKI Jakarta, Surabaya, and Bandung, there are no other cities or provinces that commercially utilize electric buses for urban public transportation. Some limited trials have been conducted in Aceh, Bali, Semarang, Medan.

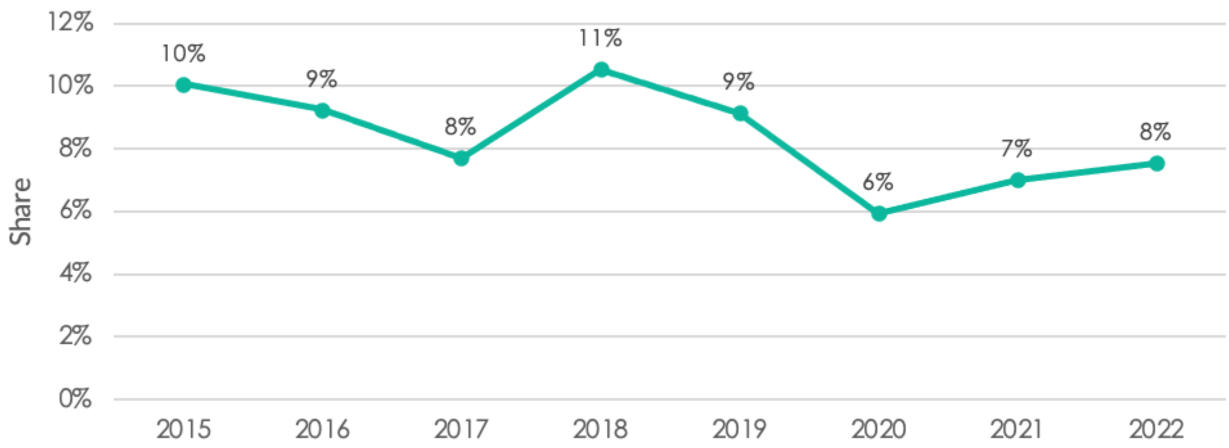
Figure 5. National Public Transport Electrification Roadmap. *Ministry of Transportation (2023)*



2.1.1.2 Fuel and Energy Price, Subsidies Policies in Indonesia

One factor supporting the global adoption of EV is reducing operational costs, meaning the total cost of ownership (TCO). Operational cost savings realized through the transition to EVs are closely related to the cost of electricity and fossil fuels in cities. In Indonesia, electricity tariffs and fossil fuel prices are regulated at the national level. Every year, the government carries out expenditures that include both energy and non-energy subsidies. In 2024, the targeted subsidy is IDR 186 trillion or around USD 13.29 billion out of which with 60% is allocated to Fuel Oil (BBM) and Liquified Petroleum Gas (LPG), and 40% to electricity subsidies.[17] Overall, energy subsidies constituted 8% of total government expenditures in 2022, approaching pre-pandemic levels (Figure 6).

Figure 6. The Percentage Proportion of Energy Subsidy to the Total Expenditures from Year to Year. *Portal Data APBN (2023)*

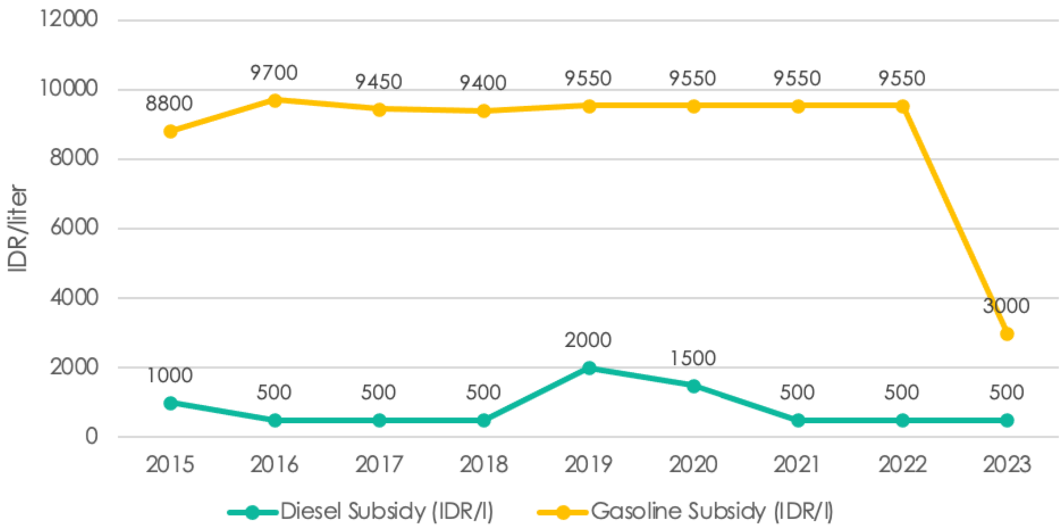


Gasoline and Diesel

Generally, oil-based fuels in Indonesia are divided into subsidized and non-subsidized categories, based on government budget assistance and their impact on quality. Subsidized fuels are currently supported using national government funds and are only categorized for gasoline with octane 90 and diesel with cetane 48, priced lower than the market rate. Although quotas are limited by the government, almost all road transport modes are eligible to purchase subsidized fuels, including public transport fleets.

17 Kementerian Ebergi dan Sumber Daya Mineral Republik Indonesia, Siaran Pers, (2024), https://www.esdm.go.id/id/media-center/arsip-berita/jaga-daya-beli-menteri-esdm-targetkan-alokasi-subsidi-energi-2024-rp1869-triliun-

Figure 7. Gasoline and Diesel Amount Subsidy Over the Years. *ITDP Desktop Research (2023)*



Compressed Natural Gas

The Indonesian government regulates compressed natural gas (CNG) prices and provides incentives, including free converter kits for government and public transport fleets.[18, 19] However, the adoption of CNG in the road transport sector remains limited in Indonesia. There are still many challenges in the lengthy transition to optimize CNG operations, as illustrated by Transjakarta operators whose CNG bus development is currently hindered due to the lack of refuelling infrastructure.

Electricity

Indonesia's electricity rates are governed by Ministry of Energy and Mineral Resources Regulation No. 28/2016 on Electricity Tariffs by PLN. Amended four times by 2021, it includes 37 tariff categories. The regulation for the bulk purchase tariff, used for public or private charging stations for public transport fleets, is as follows:

- The tariff is set at Q x IDR 707/kWh (IDR 817 if includes 10% income tax and 5% street lighting tax). The 'Q' value represents a differentiated tariff for commercial and non-commercial usage, ranging from 0.8 to 2, set by the Board of Directors of PLN.
- Bulk purchases: 40 (active hours) x connected power (kilovolt-ampere/kVa) x Agreed electricity tariff.

Table 9. Cost Comparison Between ICE and BEV per 100 km Trip. *ITDP Desktop Research (2024)*

Fuel/energy type	Motorcycle	Car	Bus
ICE	IDR 19,734	IDR 87,123	IDR 226,667
BEV	IDR 4,500	IDR 29,300	IDR 79,600

Notes:

- For ICE, the estimation using subsidize gasoline or diesel price
- For E2&4W using the electricity rate IDR 1.467/kWh (including the tax)
- For E-Bus using IDR 817/kWh with Q equal to 1.

18 Presidential Regulation No. 64/2012 on CNG Provision, Distribution, and Price Setting for Road Transportation

19 Presidential Regulation No. 125/2015 on the Amendment of Presidential Regulation No. 64/2012 on CNG Provision, Distribution, and Price Setting for Road Transportation

For further understanding, a ballpark calculation of the cost incurred by the electric vehicles compared to ICE vehicles per 100 km of travel distance is conducted. This calculation utilizes common fuel consumption factors, such as using a motorcycle with a 150 cc specification (50 km/liter) and a low-cost green car (20 km/liter). As for EV, the multiplier factor will use the kWh consumption per kilometer. Both factors are then multiplied by the subsidized gasoline price and the applicable electricity price to estimate the cost for covering a specific distance, in this case, 100 kilometers.

Generally, subsidize fuel prices are still relatively lower than non-subsidized prices in the market in 2023, at least 3,350/l for gasoline and 8,700/l for diesel, compared to the lowest non-subsidized prices. Despite the increase in Pertalite prices to 10,000/l in 2023, this price is still considered low compared to the buying values from the country and selling values retailed by private companies. To discourage the use of ICEs and promote EVs, such subsidies should be gradually phased out, or alternatively, an equivalent subsidy should be provided for EV-based vehicle or public transport, this has been supported by the comparison result of BEV costs, which are generally cheaper than ICE. Table 10 provides a summary of the fuel and energy comparisons and their corresponding prices.

Table 10. Fuel and Energy Price Comparison per 2023. *ITDP Desktop Research (2023)*

Fuel/energy type	Specification	Product name	Distributor/ retailer	Price (IDR)**
Gasoline	RON 90 (subsidize)	Pertalite	Pertamina	10,000/l
	RON 92	Pertamax		13,350/l
	RON 98	Pertamax Turbo		15,350/l
	RON 95	Pertamax Green*		13,500/l
Diesel	CN 48 (subsidize)	Solar/Bio Solar		6,800/l
	CN 48	Solar		18,200/l
	CN 51	Dexlite		15,500/l
	CN 53	Dex		16,200/l
CNG	n/a	n/a		3,500/Pertamax Turbo equivalent liter
Electricity	Bulk tariff***	n/a	PLN	817/kWh (including tax) x Q (0.8 – 2)

*) introduce in 2023, available only in Jakarta and Surabaya City

**) capped price in Jakarta area

***) based on Ministry of Energy and Mineral Resources regulation, the bulk tariff price is IDR 707 per kWh (before tax)

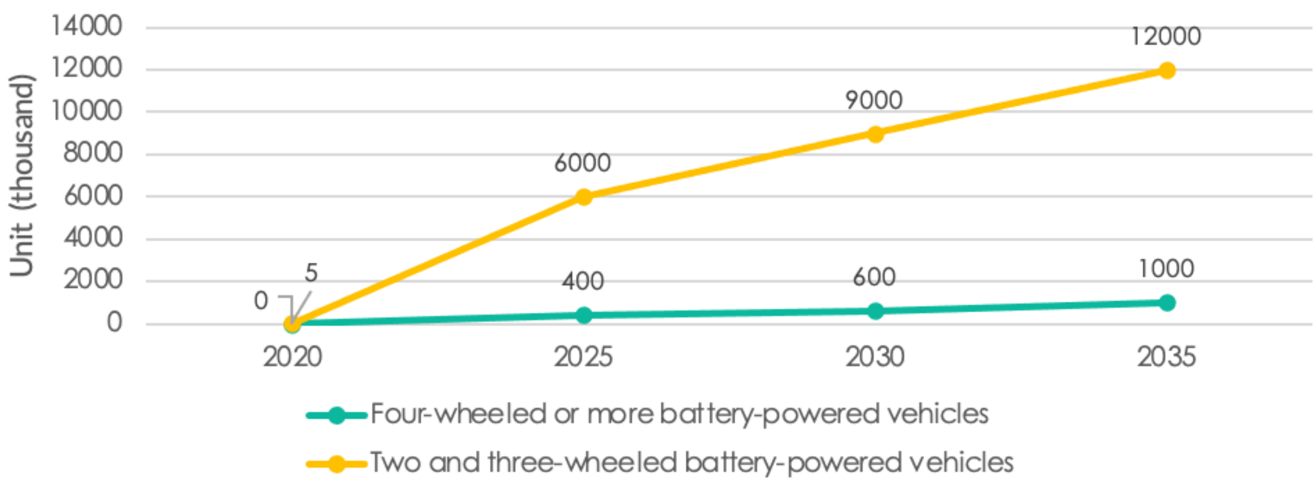
2.1.1.3 National Automotive Industry and BEV Industry Roadmaps

Ministry of Industry Regulation No. 06/2022 outlines roadmaps for the National Automotive Industry, including the BEV specifications and calculation components Industry. Key points of the Regulation are as follows:

Table 11. National Roadmap for the Battery-Based Electric Vehicle Industry

Key Point	Remark
Roadmap strategy	• Lowering the TCO • Infrastructure readiness 2020 – 2025 Supply development and technology after 2026
CBU, CKD, and IKD timeline	• Set of timelines to limit CBU and CKD import as to develop domestic industry. • The CKD import for HGV, 4W, and 2W is targeted until 2024, and IKD import until end 2026 (not applicable for two-wheelers) Domestic industry expected are fully established in 2027 onwards (2025 for two-wheelers)
BEV component timeline	• Develop the battery industry, including assembly, cells, BMS, materials, and recycling, from 2020-2031. • Start developing electric motors in 2022, moving from an 85% efficient non-permanent magnet-based motor to a 94% efficient permanent magnet-based motor. • Commence the development of converters/inverters in 2022, with >95% inverter efficiency. Prioritize the development of AC Level I and II chargers between 2021-2023, followed by DC fast charger/ ultra-charger beyond 2024.

Figure 8. Quantitative Target for the Development of Battery-Based Electric Motor Vehicle Industry. *Ministry of Energy and Mineral Resources*



2.1.1.4 Charging Infrastructure Provision Support Policies and Regulations

The table below provides an overview of key government regulations and initiatives regarding electric vehicle infrastructure and support in Indonesia.

Table 12. Mandated Charging Infrastructure Policies

Key Point	Remark
President Regulation No. 22/2017 on RUEN	
Public charging facilities	• Gradually develop units until 1,000 by 2025 (based on the GSEN, the Ministry of Energy and Mineral Resources targeted 30,000 units public charging, and 167,000 units battery swap stations available by 2030, however is not realized yet)
President Regulation No. 55/2019 on Acceleration of the Battery Electric Vehicles (BEV) Program for Road Transportation	
Manufacture incentives	• No issued yet
Financial support for establishment	• Incentive offers from PLN; up to 95% discount for power upgrade cost (home and public), discount for new grid installation, electricity subscription deposit fee incentive, and minimum account fee exemption.
Preferential tariff for BEV	• Bulk electricity tariff for public charging operators: Ministry of Energy and Mineral Resources Regulation No. 13/2020 provides a preferential electricity tariff (0.8 to 2 times the current bulk) for public and public transport charging facilities. • PLN provides a 30% discount for home charging users from 10 pm to 5 am.
Other fiscal or non-fiscal policies	• Ministry of Energy and Mineral Resources Regulation No. 5/2021 offers relaxation for public infrastructure permit, which no longer required approval from the local government.

2.1.2 Regional Level Documents and Policies for EV

2.1.2.1 Jakarta Province

Governor Regulation (GR) No. 1053/2022 provides guidelines for accelerating the adoption of BEVs within Transjakarta transportation services in Jakarta Province. The regulation aims to expedite the deployment of 10,047 BEVs by 2030, along with the procurement and financing to support this transition from conventional vehicles to BEVs. The regulation sets ambitious targets, aiming for 50% BEV adoption by 2027 and complete transition by 2030. In addition to these regulations, there are various other policies that govern the implementation of the EV ecosystem in Jakarta. These policies can be found in Table 64.

Table 13. Governor Decree No. 1053/2022 Highlight

Topic	Remarks
Governor Regulation No. 1053/2022 on Guidelines for Accelerating the Program of Using Battery Electric Vehicles Under the Transjakarta services	
Main Activities	• Accelerating the use of 10,047 (ten thousand forty-seven) battery electric buses in Transjakarta transportation services until 2030. • Procurement and/ or financing of activities to accelerate the program of BEV for public transport services in Jakarta Province. • Transitioning from conventional vehicles (diesel, petrol, and compressed natural gas fleets) to battery EV into Transjakarta Services gradually, starting in 2022.
Realization Target	• 50% (fifty percent) in 2027 relative to the number of Transjakarta fleets in operation that year; • 100% (one hundred percent) by 2030.
Charging Infrastructure	• Charging infrastructure will be provided for overnight charging, opportunity charging, or other types of charging technology at depots, terminals, or other locations in accordance with statutory provisions. • Potential charging locations will be inventoried on Regional-owned Enterprise assets or on other locations.

Topic	Remarks
Procurement and/ or financing	• Procurement and/ or financing of Transjakarta operator is carried out with the IDR per kilometer scheme. • Procurement and/ or financing of battery EV can be carried out by Transjakarta operators or with other financing schemes in accordance with the provisions of laws and regulations by ensuring the efficiency and effectiveness of the use of the revenue and expenditure budget of the Government of Jakarta. • Procurement and/ or financing for charging infrastructure of battery electric buses is carried out in accordance with the provisions of laws and regulations.

2.1.2.2 Bali Province

Governor Regulation No. 48/2019 on the use of Battery Based Electric Vehicles

GR No. 48/2019 outlines policies and strategies to facilitate the transition from ICE vehicles to BEV in Indonesia. The regulation includes initiatives to promote environmental sustainability, encourage infrastructure readiness for EV adoption, and accelerate the transition through incentives, fossil fuel control, and industry collaboration. Additionally, the regulation establishes acceleration committees to oversee the implementation of regional action plans and ensure an effective transition to BEVs. For more information on this governor regulation, please refer to Table 65.

Regional Action Plan (RAD)

As an extension of GR No. 48 of 2019 regarding battery based EVs, the RAD for accelerating BEV usage (2022-2026) has been developed as a detailed guideline for the holistic development of BEVs. The RAD covers directives, targets, strategies, and role distribution for expediting BEV adoption in Bali. The Bali EV Action Plan set out three main targets for EV adoption, which are (1) EV adoption target for 2W and 4W, (2) EV target for public transportation, and (3) GHG emission reduction target.

Table 14. EV Target Number in Bali 2022-2026. *Bali Regional Action Plan*

Scenario	2022	2023	2024	2025	2026
E2W					
Optimistic	15,715	40,924	93,529	180,642	287,056
Moderate	7,858	20,463	46,766	88,120	145,808
Pessimistic	1,179	2,465	3,827	6,610	10,481
E4W					
Optimistic	1,053	3,286	7,386	12,937	19,435
Moderate	527	1,096	1,706	3,530	5,719
Pessimistic	79	165	257	413	591
E-Bus					
Units	10	20	30	40	50
Carbon Emission Reduction (Ton Carbon Dioxide/CO2)					
Optimistic	5,429	12,908	29,413	55,882	88,017
Moderate	2,703	6,072	13,320	25,319	41,516
Pessimistic	410	752	1,172	2,003	3,136

To achieve the set targets, a multi-sectoral collaboration strategy is necessary. Therefore, it is divided into 5 sub-target pillars, strategies, and roles to facilitate the role allocation planning process, implementation, and monitoring. Details related to the 5 sub-pillars along with the targets envisioned in the Bali Action Plan (RAD) are addressed in Table 66. The RAD also provides estimates of funding and investment needs for BEV ecosystem for optimistic, moderate, and pessimistic scenarios, and also the estimate for government contribution, business entities, and third-party contributors.

Figure 9. Financing Needs per Pillar for Each Scenario. *Bali Regional Action Plan*

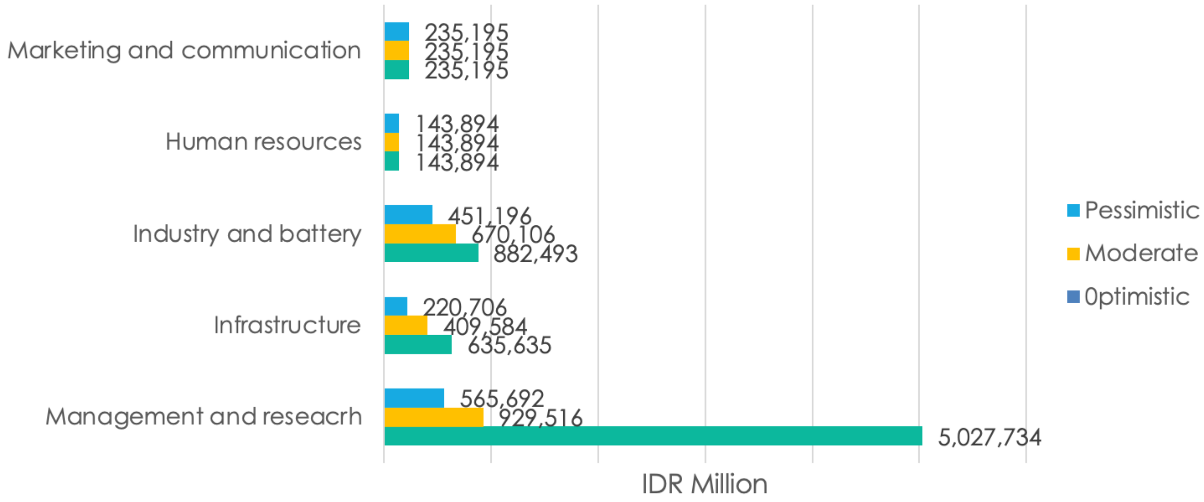


Figure 10. Financing Value According to Source of Funding in Each Scenario. *Bali Regional Action Plan*

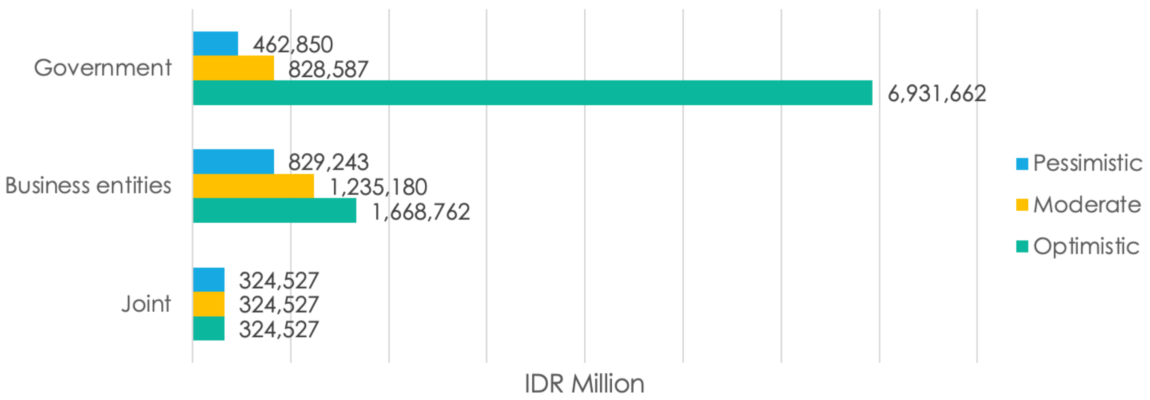


Table 15. Contribution of Each Funding Source. *Bali Regional Action Plan*

Funding source	Optimistic	Moderate	Pessimistic
Joint	4.7%	13.6%	20.1%
Business entities	24.1%	51.7%	51.3%
Government	71.2%	34.7%	28.6%

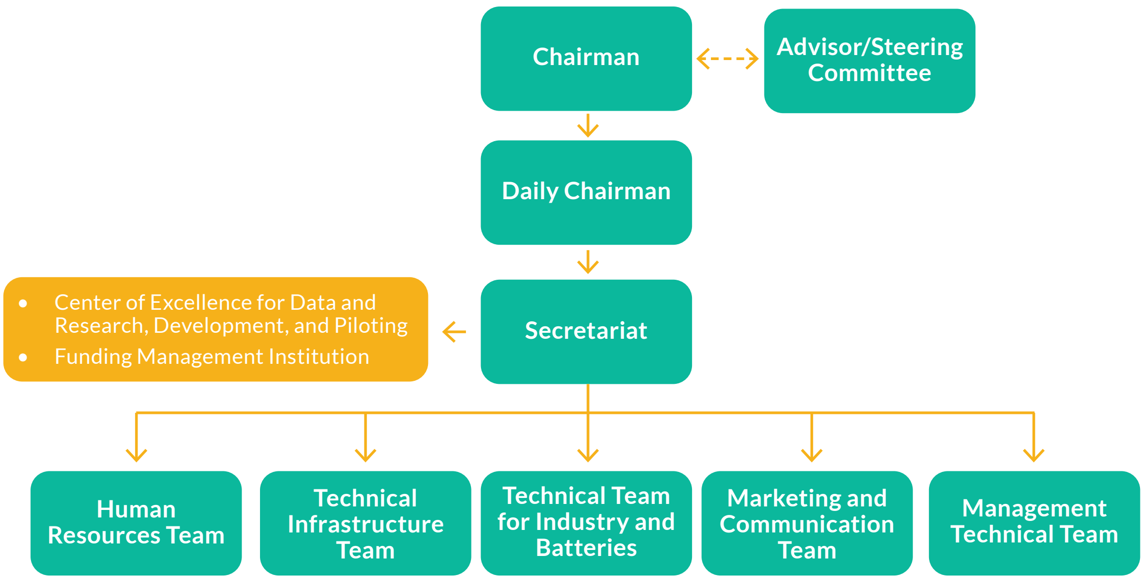
The funding source can be source from government budgets, business entities, and partnership, however, this cost estimate also identifies potential funding source that can be utilized. For example, other potential funding sources from the government could come from taxes, grants, foreign and domestic loans, and balance funds. Meanwhile, from non-government sources, funding could be formed through cooperation with business entities, business entity funding, corporate social responsibility (CSR), and philanthropy.

In this RAD, the committee/team to guide, monitor, and evaluate the BEV implementation is established, which involves other related parties on the ecosystem. This institution is also responsible for ensuring the goal achievement both for targets and sub-targets from each pillar. The committee consists of various stakeholders, including government entities, non-government organizations, academics, and private entities.

Table 16. Institutional Committee's Working Reference. *Bali Regional Action Plan*

Topic	Remarks
Output targets	Achievement of RAD's output targets and sub-targets based on timelines.
Activities/ strategies	• Identification of intervention and strategies needed. • Recommending and facilitating policy needs at regional level. Managing and facilitating resources from parties.
Monitoring and evaluation	• Monitoring, ensuring, and approving plans. • Assisting regional government in reporting.
Funding	• Seeking and developing innovative funding resources to implement BEV.
Coordination	• Managing, facilitating, and coordinating resource from relevant parties to assist RAD implementation

Figure 11. Committee Structure of Accelerating on the Use of BEV in Bali. *Bali Regional Action Plan*



Other Regional Related Policies

The sustainability policies in Bali Province aim to improve environmental quality and reduce carbon emissions. Provincial regulations, such as Regional Regulation (RR) No. 2 of 2019, No. 7 of 2022, and No. 45 of 2019, along with the Bali Province Medium-Term Development Plan and Regional Energy Development Plan, reaffirm the commitment to clean energy use and EVs. The programs encompass renewable energy management, energy diversification for EVs, and supportive infrastructure development. Table 67 provides a detailed analysis of these regulations or policies. Low-carbon development models exhibit an increase in carbon emissions without intervention. However, these steps can help address these challenges and promote sustainable growth in the future. Gender Equality, Disability and Social Inclusion (GEDSI)-related regulations

2.1.3 GEDSI-Related Regulation

In the planning and implementation of transportation systems, it is necessary to consider all aspects and diverse users to achieve a level of inclusivity that is just. In this regard, the perspective of GEDSI or needs to be considered for all aspects such as infrastructure, tariffs, and service areas. This section will review policies and regulations related to GEDSI on both national and regional scales to assess overall inclusivity aspects and the role within the scope of transportation.

2.1.3.1 National Framework

Table 17. GEDSI National Legal Framework

Policies	Remarks
Presidential Regulation No.9/2000 on Gender Mainstreaming in National Development	• All national-level government agencies must consider gender equality in their plans and actions. • Outlines ways to ensure fairness and equal opportunities for both men and women in development programs, from planning to evaluation.
Ministerial Regulation No. 67/2011, amending No. 15/2008	• Mandates sub-national governments to integrate gender perspectives into their development plans and activities. • Delineates responsibilities for gender mainstreaming at provincial and district levels, introducing tools like Gender Responsive Budgeting and Gender Analysis Pathways to support the development of gender-responsive policies.
Ministerial Regulation No. 6/2009 from the Ministry of Women's Empowerment and Child Protection	• Mandates the use of gender and children data systems for ministries/agencies and sub-national governments to incorporate disaggregated data into gender-responsive policymaking, planning, budgeting, and monitoring and evaluation. • The regulation was revised in 2014, leading to Ministerial Regulation No. 5/2014, which organizes the responsibility and management of gender and children data systems.
Bappenas, Ministry of Finance, Ministry of Home Affairs, and Ministry of Women's Empowerment and Child Protection Join Letter	• Outlining the national strategy to expedite gender mainstreaming through gender-responsive planning and budgeting. • The aim is to accelerate the achievement of gender equity and gender equality in Indonesia.
Disability Law No. 8/2016, replacing the 1997 law	• Outlining 22 rights for people with disabilities, adding 4 more for women. The law focuses on their human rights, including economic, political, civil, and cultural aspects. • Emphasizes mainstreaming disability issues across all government ministries, including transportation.
The Elderly Welfare Law No. 13/1998	• Safeguards the rights of senior citizens in Indonesia. • Provides financial and non-financial protection, encouraging them to stay active in an inclusive environment. • In public transport, the law ensures accessible, affordable, safe, and user-friendly transportation, with features like accessible bus stops, financial subsidies, and easy connectivity to essential destinations.

Policies	Remarks
Ministry of Transportation Regulation No. 98/2017 for Public Transport Accessibility replacing Ministerial Decision No. 71/1999 about Accessibility for Disability and Sick Individuals	• Outlining vulnerable users who needs facilities and special treatment: disability, elderly, children, pregnant women, and sick individuals. • Outlining mandatory 5 facilities and 15 infrastructures accessibility to support inclusiveness and needs for the vulnerable users.

2.1.3.2 Sub-national Framework (Jakarta)

Table 18. GEDSI Regional Legal Framework (Jakarta)

Policies	Remarks
Governor Regulation No. 37/2012 on Gender Mainstreaming, Governor Regulation No. 58/2012 on Gender-responsive Planning and Budgeting, Governor Regulation No. 170/2012 on Gender Mainstreaming Working Group	• These regulations extend the national gender mainstreaming guidelines to the provincial level, ensuring that all provincial policies and programs incorporate gender responsiveness. This involves implementing gender analysis in decision-making, planning, and budgeting processes across provincial agencies.
Governor Regulation No. 35/2014 on Minimum Service Standards for Transjakarta-Busway Service Units	• Focusing on Transjakarta Busway service units. • Considers gender-related aspects, ensuring affordable fares for vulnerable groups, equal treatment for passengers with special needs, priority seating for specific groups, and wheelchair accessibility within the fleet.
Governor Regulation No. 14/2019, aligning Regional Regulation No. 10/2011 on Disability Protection	• Emphasizing accessibility, non-discrimination, and reasonable accommodation. • Enhance accessibility in public facilities, including sidewalks and pedestrian bridges.
Governor Regulation No. 196/2015 (amended to No. 40/2016) on Guidelines for Child-Friendly Integrated Public Spaces	• Focuses on Child-Friendly Integrated Public Space (RPTRA) planning. • Supported by related documents, it emphasizes safe and affordable public transportation for children.

2.1.3.3. Sub-national Framework (Bali)

Table 19. GEDSI Regional Legal Framework (Bali)

Policies	Remarks
Bali's Governor Regulation No. 11/2020 about Gender Mainstreaming	Legal basis and the formulation of gender integration strategies through gender-responsive planning, implementation, monitoring processes, aiming to create gender justice, economic equality, and enhance the role and independence of institutions dealing with women's empowerment.

Policies	Remarks
Bali's Regional Regulation No. 09/2015 on Protection and Fulfilment of Rights for People with Disabilities	The fulfillment and protection of the rights of people with disabilities are all actions and/or activities aimed at ensuring and protecting the constitutional rights of people with disabilities in accordance with human dignity, preventing violence, and discrimination.
Governor Regulation No. 44 of 2018	Discusses the Implementation of Regional Regulation No. 9 of 2015 concerning the Protection and Fulfilment of the Rights of Persons with Disabilities.
Bali's Provincial Regulation No. 12 of 2023	Concerning the Implementation of Disaster Management. Article 47 of this Regulation specifically mentions the protection of persons with disabilities and other vulnerable people.

2.2 Review and Analyse Stakeholder Mapping

Generally, we can categorize stakeholders related to EV into four parts: national policy makers, regional levels, industry players, and think tanks or civil society institutions. National policymakers set the tone, regional insights address localized challenges, industry collaboration is essential for operations, and think tanks provide diverse perspectives. This strategic analysis enables tailored approaches that consider the specific roles and influences of each stakeholder segment, fostering a successful and holistic integration of EVs in Indonesia.

2.2.1 Policymaker on the National Level

Table 20. Policymaker on the National Level

Stakeholder	Remarks
President	• President has mandated the acceleration of the KBLBB through President Regulation No. 55/2019 • Set the direction and development priorities through the National Medium-Term Development Plan (RPJMN) and Strategic Priority Projects, determined the national energy plan, and actively regulated environmental protection and the operation of public transportation
Ministry of Transportation	• In the acceleration of KBLBB, the Ministry of Transportation, through the Directorate General of Land Transportation, actively assumes a crucial role as one of the coordinating team members. This includes managing public transportation and actively participating in formulating electrification plans and conducting vehicle testing types.
Coordinating Ministry for Maritime Affairs and Investment	• In accelerating the KBLBB program, the President actively leads the task force with the assistance from the Coordinating Ministry for Maritime Affairs and Investment as the team's chair and the Coordinating Ministry for Economic Affairs as the deputy chair.
Ministry of Industry	• Under the Directorate of Maritime Industry, Transportation Equipment, and Defence Equipment (IMATAP), the Ministry of Industry issues specifications, roadmaps, and regulations for calculation the Domestic Component Level (TKDN) for EV and their components.
Ministry of Finance	• Through the Fiscal Policy Agency, the Ministry of Finance issues various incentive regulations to support the acceleration of KBLBB. The head of the Fiscal Policy Agency serves as the National Designated Authority (NDA) for Indonesia for the Green Climate Fund (GCF), a funding program for green projects.
Ministry of Energy and Mineral Resources	• The Ministry of Energy and Mineral Resources formulates various regulations in the energy sector, including RUEN, and the Roadmap for Energy Transition toward Carbon Neutrality. • This includes setting targets for the use of EV. Moreover, the Ministry regulates the standardization of EV charging infrastructure and determines its electricity tariffs.

Stakeholder	Remarks
Ministry of Home Affairs	• The Ministry of Home Affairs provides guidelines for the development of programs and assesses them through Key Performance Indicators (KPI) for local government. This includes overseeing transportation programs and the provision of public transportation. Additionally, the Ministry of Home Affairs regulates several local taxes and levies, including Vehicle Tax (PKB) and Motor Vehicle Title Transfer Fee (BBNKB).
Ministry of Environment and Forestry	• Through the Fiscal Policy Agency, the Ministry of Finance issues various incentive regulations to support the acceleration of KBLBB. The head of the Fiscal Policy Agency serves as the NDA for Indonesia for the GCF, a funding program for green projects.
Ministry of Trade	• Ministry of Trade regulates the provisions for the import of used lithium batteries, which can serve as raw materials, for batteries in the context of KBLBB industry.
Ministry of State-Owned Enterprises	• Ministry of State-Owned Enterprises encourages several state-owned enterprises, including Indonesia Battery Corporation (IBC) Holding company for EV battery in Indonesia, consisting of Mind ID, PT Antam, PT Pertamina, and PLN, PT INKA, Damri, as well as state-owned banks and other financial institutions, to actively participate in the acceleration of the KBLBB program.
Ministry of Agrarian and Spatial Planning/National Land	• Ministry of Agrarian and Spatial Planning/National Land handles land-related matters, including mapping, registration, and spatial planning. For EV implementation, it collaborates with the Ministry of Transportation and oversees spatial policies in transportation, like terminal development locations. Additionally, it works with Bappenas to monitor regional spatial plans.
Bappenas/ Ministry of National Development Planning	• Bappenas designs government programs to determine the direction and prioritize urban public transportation. It also formulates strategies to achieve Net Zero Emission by 2060. Together with the Ministry of Agrarian and Spatial Planning/National Land Agency, Bappenas oversees and evaluates regional spatial plans.
Central Bank of Indonesia and Financial Services Authority (OJK)	• Central Bank of Indonesia facilitates down payment flexibility in the purchase of KBLBB, meanwhile the OJK regulates fiscal incentives provisions and provides funding and assesses credit quality for the implementation of EV.
National Research and Innovation Agency (BRIN)	• BRIN actively collaborates with Pertamina (state-owned company that produces and distributes gas, petroleum, and petrochemicals in Indonesia) in developing battery technology and EVs charging.
Government Goods/ Service Procurement Policy Agency (LKPP)	• LKPP actively facilitates the provisions of a procurement platform for public transportation service through an e-catalog. This platform is used to conduct auctions for the procurement of public transportation services by submitting procurement bids.
National Standardization Agency (BSN)	• BSN actively sets standards for EV components, batteries, and EV charging infrastructure.
National Police	• The Republic of Indonesia National Police actively maintains data on the quality and types of registered vehicles in Indonesia.
Government Organization, International Organization, NGO, Think Tank, and Research Institute	• Government Organization, International Organization (IO), Non-Governmental Organizations (NGOs) and Think Tanks will play a role in facilitating the implementation process by offering technical assistance to the national government, and the possibility to be a fund a e-mobility related project. Additionally, these organizations have the capacity to provide direct support to the industry in the deployment of EVs and the advancement of infrastructure. The identified stakeholders include the United Nations Development Programme (UNDP), and Green Infrastructure Initiative (GII)

2.2.2 Policymaker on the Sub-National Level

Generally, the formulation of policies at the regional level is conducted by the head of the region, the regional secretary, and supporting institutions involved to accelerate the KBLBB program. In this report, stakeholders involved in the implementation of electric buses in Jakarta will be outlined as a general overview, as well as the KBLBB committee structure which is currently available in Bali.

Table 21. Policymaker on the Regional Level

Stakeholder	Remarks
Regional Head	• The Regional Head has the authority to issue regulations at the regional level for the acceleration of KBLBB and the operation of public transportation
Regional Secretary	• Supporting the Regional Head (can be different for each region) • Bureau of Economic & State-Owned Enterprises Development Agency; focuses on the state-owned programs, regional investment, and regional public service agencies. • The Bureau of Goods and Services Procurement focuses on the procurement of goods and services, including the verification of vehicle operational costs.
Transport Agency	• Regulating the technical aspects of EV implementation, including routes, supporting facilities, the establishment of agencies or technical implementation units for city transportation, tariffs, subsidies, budgeting, driver, and staff training.
Regional Development Planning Agency (Bappeda)	• Incorporating electrification plans into Regional Long-Term Development Plan (RPJP), which includes work plans, budget plans, and determinations of Key Performance Indicators.
Human Settlement, Spatial Planning, and Land Agency	• Develop a regional/city-level guideline for land use and building to regulate charging infrastructure provision and cycling infrastructure network
Environment and Forestry Agency	• Oversees the processing of waste related to EVs, such as batteries and other components. They formulate action plans to reduce greenhouse gas emissions and develop strategies for controlling air pollution.
Department of Spatial Planning and Land Affairs	• Plays a role in formulating spatial utilization plans for the operation of electric buses, including the distribution of charging infrastructure and parking areas to avoid blank sports and backlogs.
Regional Financial and Asset Management Agency (BPKAD)	• Manage assets for the development of charging infrastructure and formulates regional budget policies for public infrastructure.

Main Industry Players on BEV Ecosystem

Table 22. Main Industry Players on BEV system

Stakeholder	Remarks
Original Equipment Manufacturer (OEM) and Brand Holder Agent (APM)	• Consecutive roles in the production/assembly and distribution/sales of electric buses
Bus Operator	• Such as Damri and Trans Satria Jaya play a role in providing public transportation by offering a fleet and electric charging facilities
Battery Provider	• Such as Swap, IBC, play a role to supplying battery for EVs options
Charging Infrastructure Supply Companies	• Role in supplying charging infrastructure devices and/or operating charging infrastructure • Such as PT. LEN Industri (Persero); develop and provide charging infrastructure, in collaboration with Ministry of Energy and Mineral Resources , BRIN, and PLN

Stakeholder	Remarks
Electricity Providers	• Such as PLN, play a role in supplying electricity for charging infrastructure
Commercial banks and other financial institutions	• State-owned banks including Bank Rakyat Indonesia (BRI), Bank Mandiri, Bank Nasional Indonesia (BNI), Bank Tabungan Negara (BTN), and Bank Syariah Indonesia (BSI) can provide development of the BEV ecosystem in terms of investment, financing, transaction & cash management, treasury & trade solutions
Vehicle Conversion Companies	• Role in converting conventional buses into electric buses

IO, NGO, Think Tank, and Research Institute

International Organizations (IO), NGOs and Think Tanks will play a role in facilitating the implementation process by offering technical assistance to the government in policy formulation. Additionally, these organizations have the capacity to provide direct support to the industry in the deployment of EVs and the advancement of infrastructure.

Table 23. **IO, NGO, Think Tank, and Research Institute**

Jakarta	Bali
• C40 Cities • German Development Cooperation (GIZ) • Global Green Growth Institute (GGGI) • Institute for Transportation and Development Policy (ITDP) • International Council for Local Environmental Initiatives (ICLEI) • The International Association of Public Transport (UITP) • The International Council on Clean Transportation (ICCT) • Transformative Urban Mobility Initiative (TUMI) • UK Partnering for Accelerated Climate Transitions (UK PACT) • United Nations Environment Programme (UNEP) • World Resources Institute (WRI)	• Global Green Growth Institute (GGGI) • Indonesia Australia Partnership for Infrastructure (KIAT) • Institute for Transportation and Development Policy (ITDP) • Millennium Challenge Corporation (MCC) • World Resources Institute (WRI)

Users

In the context of public transportation, public transport users play a decisive role, as they are the primary users in daily mobility. The perception of public transportation and policy measures provided by the government sometimes cannot meet the expectations of the users themselves. Therefore, it is very important to understand user perception and to identify specific variables that can influence them in making decisions to use public transportation.

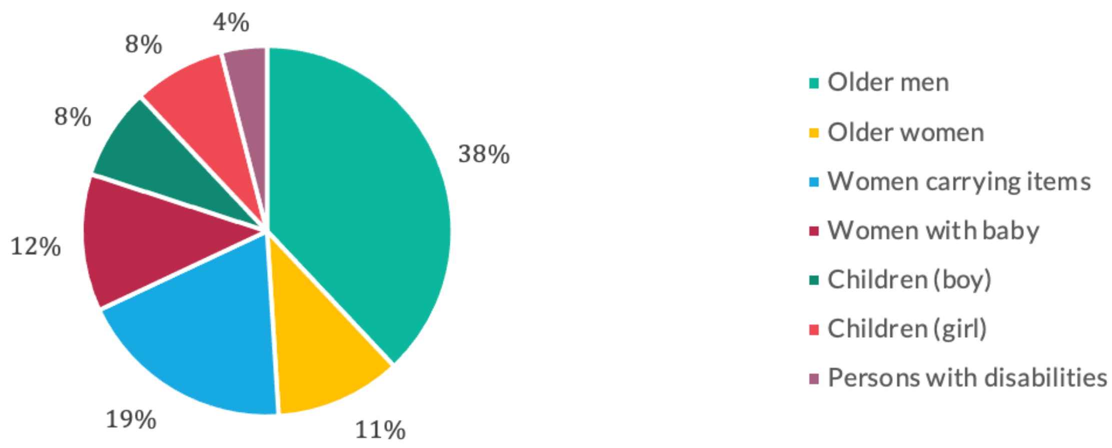
The Importance of Gender Mainstreaming and Social Inclusion in Urban Public Transportation Fleet Electrification

Gender equality, disability, and social inclusion, or GEDSI, are important topics in transportation because transportation users actively and public transportation is dominated by vulnerable groups. Specifically, vulnerable groups in the context of urban transportation can be defined as women, children, persons with disabilities, and older persons (sustainable development goals (SDGs) point 11.2). Vulnerable groups are often seen as at-risk commuters when utilizing public transportation. Therefore, it is crucial to underscore the necessity of these groups in the planning of public transportation electrification to mitigate potential undesirable impacts.

Improving inclusivity access in overall public transportation facilities and services can be initiated through electrification. As this process typically involves fleet replacement, incorporating universal design principles such as the minimum maneuvering space needed from the door to the designated wheelchair area inside the bus, wheelchair seating availability, luggage space availability, and other notes for electric buses is an opportunity to cater to the needs of vulnerable groups comprehensively. This consideration goes beyond factors like reliability and durability, ensuring a holistic approach to designing and building electric buses.

As much as 63% of the targeted electric bus fleet to operate by 2030 consists of small buses under the Mikrotrans service.[20] Mikrotrans significantly influences the daily mobility of users, particularly those from vulnerable groups such as the older persons and women. Therefore, in the planning of public transportation electrification, it is crucial to consider vulnerable groups in stakeholder mapping, and continuous participatory planning is essential for a thorough understanding of the needs of vulnerable groups in public transportation electrification, ensuring their ongoing involvement at every planning stage.

Figure 12. Users of Mikrotrans Services in Jakarta. *ITDP (2021)*



There are several efforts by the Jakarta government to enhance the inclusivity aspects of public transportation such as providing ramps, lifts, special toilets, journey planning applications, and dedicated buses and train cars for women. However, generally, there are still many challenges that arise in creating inclusive transportation, such as inadequate funding and resources, insufficient infrastructure, and a lack of appropriate regulations that do not consider the needs of vulnerable groups. Here are some examples of the problems faced by users in accessing public transportation:

Table 24. Inclusive Walking Tour Result. *ITDP (2021)*

Issue	Recommendation
Accessibility to Public Transportation	• Disability facility development can start from the village level to accommodate the origin and destination of travel. • Ensure universal principles, such as sidewalk width, ramp slope, and guide tile elevation.
Safety and ease of crossing roads	• Providing safe at-grade level crossings. • Crosswalk buttons, adequate duration, and provision of ramps to access sidewalks and stations/stops.

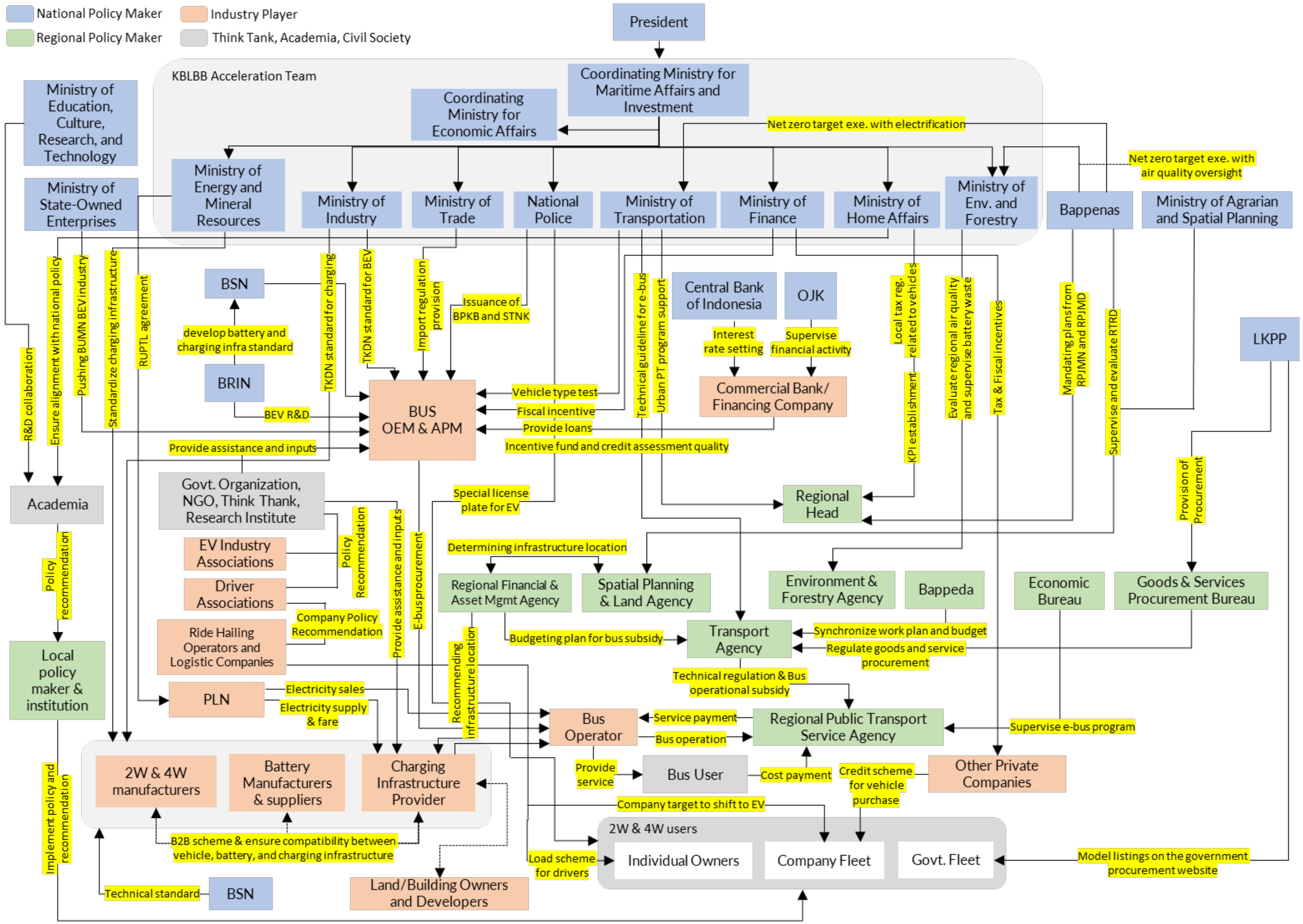
20 UK PACT. Building a Regulatory and Financial Basis for Transjakarta First Phase E-bus Deployment. 2023

Issue	Recommendation
Provision of information systems	• Provision of auditory and visual information ensuring availability and accuracy, including emergency information. • Personnel should be equipped with basic sign language skills.
Disability Card Services	• Ensure access to people with disabilities, including administrative processes. • Targeted socialization on usage, procedures, and service coverage.
Accessibility of Transjakarta Stations	• Having accessible gates wide enough to accommodate wheelchairs. • Portable ramps and personnel for boarding and alighting from public transportation are necessary.
Installation of guide tiles	• It is necessary to involve people with disabilities from the beginning in the planning process, not after the infrastructure built.
Presence of trained personnel	• Due to the smaller numbers, prioritizing accessible infrastructure is necessary to alleviate the burden on personnel.
Assurance of wheelchair and priority seating space in the fleet	• Inclusive fleet design; featuring priority seating, wheelchair spaces, and clear signage.
Additional Publication from ITDP: Women-only buses or train carriages	• The separation and exclusivity of space between men and women are considered as temporary solutions and not the way out to prevent harassment and sexual violence in public transportation spaces. Recommendation points: • Improving fleet frequency and reducing wait times to avoid density at the bus stop and fleet. • Formulating and implementing service operational standards for sexual harassment mitigation • Establishing task forces within inter-departmental cooperation and police involvement for reporting and handling • Transportation agencies issuing warnings and sanctions for public transport operators not implementing mitigation strategies. • Regular socialization, guidance, and training • Public awareness campaigns through printed and audio materials within fleets, stations, and stops. • Ensuring access to emergency services

Table 25. GEDSI Organization and Communities

Stakeholder	Issue Specialist
Organization	
United Nation (UN) Women	Women
ITMI (Ikatan Tunanetra Muslim Indonesia)	Visually Impaired Muslim
PERTUNI (Persatuan Tunanetra Indonesia)	Visually Impaired
HWDI (Himpunan Wanita Disabilitas Indonesia)	Women with Disabilities
GERKATIN (Gerakan Untuk Kesejahteraan Tuna Rungu Indonesia)	Hearing Impaired
Puspadi Bali (Pusat Pemberdayaan Penyandang Disabilitas Bali)	Physically Impaired
Community	
GAUN (Gerakan Aksesibilitas Umum Nasional)	Access & Mobility for Disabilities
DIMA (Disabilitas Maju)	Access & Mobility for Disabilities
YDKI (Yayasan Disabilitas Kreatif Indonesia)	Access & Mobility for Disabilities
GPDLI (Gerakan Peduli Disabilitas dan Lepra Indonesia)	Access & Mobility for Disabilities
Yayasan Tunanetra SWABYMA	Access & Mobility for Disabilities
NPCI (National Paralympic Committee of Indonesia)	Access & Mobility for People with disabilities in sports

Figure 13. EV Stakeholder Mapping in Indonesia



2.3 Barriers and Funding Models to Mass E-Mobility Adoption

The EV sector in Indonesia is growing rapidly, and this presents both a challenge and an opportunity for achieving sustainable and efficient mobility. Exploring obstacles in stakeholders adopting EV is critical for understanding and overcoming barriers to EV adoption in Indonesia. Looking closely at the e-bus sector, the fund channeling scheme employed in the Transjakarta E-Bus case study serves as a viable solution, showcasing effective funding mechanisms. By presenting this scheme as a solution, stakeholders gain valuable insights into addressing funding issues, promoting financial sustainability, and encouraging broader adoption of e-bus in the Indonesian context.

2.3.1 Barrier Identification of Current E2W and E4W Implementation

Research studies have highlighted the positive impact associated with the shift towards more sustainable transportation options, such as EVs. However, despite the potential societal benefits, electrifying 2W and 4W in Indonesia poses a considerable challenge. Various barriers stand in the way of the widespread adoption of electric 2W and 4W, and these impediments will further elaborate below.

Higher Acquisition Price

The primary obstacle to widespread electrification lies in the initial cost of EV, as individuals often opt for more economical alternatives when comparing functionalities. This cost disparity poses a significant hindrance to the adoption of electric motorcycles. Governments worldwide have tackled this challenge by providing incentives for EVs. In Norway, for instance, EV are exempt from vehicle registration tax and value-added tax, resulting in a substantial reduction of up to 50% in the acquisition price, making them price-competitive with conventional vehicles.

Charging Infrastructure Availability

A key obstacle to widespread EV adoption is the limited driving range, implying that more improvements are required from extending the capacity of EV batteries to deploying more extensive charging infrastructure. The term "range anxiety" encapsulates the concern that an EV lacks sufficient range to reach its destination. To alleviate this issue, increasing charging opportunities proves more effective than merely extending driving range.

According to a 2016 McKinsey survey targeting potential EV buyers in China, Germany, and the United States, limited access to charging stations ranks among the top three barriers to EV purchase, following price and driving range concerns[21]. Another study discovered a significant positive correlation between charging infrastructure and EV market share in 30 analyzed countries[22]. The study suggests that adding one charging station per 100,000 people has a more substantial impact on market share than providing customers with a $1,000 financial incentive market penetration rate compared to offering tax exemptions. This is crucial, given that the primary barrier for customers in Indonesia to switch to EVs is the lack of charging infrastructure[23].

Despite the emphasis on developing public charging infrastructure, access to home charging is vital in the early stages of EV adoption. Most EV consumers initially emerge from those with access to home charging. Therefore, a key takeaway is the need to enhance home charging capabilities by increasing the residential electricity capacity limit.

21 Charging Ahead: Electric Vehicle Infrastructure Demand. McKinsey & Company, 2018

22 The influence of financial incentives and other socio-economic factors on electric vehicle adoption. Energy Policy. 2014

23 https://www2.deloitte.com/content/dam/Deloitte/sg/Documents/strategy/sea-strategy-operations-full-speed-ahead-report.pdf

Limited Performance

On average, currently available EVs in the market have lower performance than typical ICE vehicles, top speed for instance. In Indonesia, electric two wheelers commonly have a top speed around 70 km/h, 30% lower than comparable gasoline based two wheelers, where in four wheelers the reduction of top speed is around 20% lower. The limitation performance of driving range is contributing to the range anxiety perceived by the users. Furthermore, high ambient temperature adversely affects the battery performance which leads to an even short driving range. The study shows that energy consumption rate is found to increase by around 20% to 25% at an ambient temperature of 300°C compared to the normal temperature at 20-260°C[24].

Lack of Supporting Policies

Tax reductions and financial incentives, such as subsidies, play a crucial role in boosting the adoption of EV. In certain Indonesian provinces, there are currently regulated tax incentives for electric two-wheelers, involving a reduction in BBNKB (ranging from 0% in Jakarta to 10% in Bali and 2.5% in West Java). Additional supportive regulations include a 75% reduction in fees for upgrading home electricity supply and a 30% lower charging tariff offered for night-time home charging.

However, to expedite the uptake of electric two-wheelers, it is imperative to consider several more robust regulations. One such regulation is the implementation of fuel economy standards, which has demonstrated a strong positive correlation with EV adoption. Another viable regulation option can be gleaned from China, which boasts the highest global market share for electric two-wheelers. China's success in promoting electric two-wheelers is primarily attributed to the government's prohibition on purchasing gasoline-based motorcycles[25]. The absence of a similar regulation is assumed to be a significant factor hindering the development of electric two-wheelers.

Low Public Awareness

Numerous EV brands and models are currently accessible in the market, complemented by tax incentives and supportive non-fiscal policies. However, the dissemination of this information to the public is somewhat inadequate. Consequently, the limited awareness among individuals about the available options, encompassing both electric two-wheelers and four-wheelers, contributes to a reluctance towards embracing this transformative technology. To address this issue, there is a pressing need for intensified promotional activities, campaigns, and other substantial initiatives aimed at raising awareness about EVs. This is particularly crucial in developing countries such as Indonesia, where the integration of EVs into the market is not as seamless. It becomes imperative for the government to take proactive measures in promoting awareness of the available incentives. Encouraging greater collaboration among the private sector, government entities, charging infrastructure developers, and EV OEMs is essential to collectively propel the growth and acceptance of EV. The China government has successfully demonstrated the benefits of EVs by combining incentives and public awareness campaigns. China launched extensive media campaigns promoting the environmental benefits of EVs, highlighting government policies, organizing EV test drives, exhibitions, and educational events to familiarize citizens with EV technology.

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24 Investigation of Energy Consumption Characteristics of Electric Passenger Car under High and Low Temperature Conditions. 2020 5th Asia Conference on Power and Electrical Engineering (ACPEE).

25 Mengembangkan Ekosistem Kendaraan Listrik di Indonesia Pelajaran dari Pengalaman Amerika Serikat, Norwegia dan Cina. IESR, 2020

2.3.2 Barrier Identification of Current E-bus Implementation

Based on the recent study by ITDP on the barrier to public transport integration in Indonesia, the barrier could be defined into several categories, as follows: government commitments and targets, funding and financing, technology and infrastructure, the current state of urban transportation in Indonesia, and lastly the industry development of e-bus domestic ecosystem. These identified barriers will further explain below.

Government commitments and targets

To establish a robust legal foundation, commitments, and targets need to be formalized under a specific regulatory framework, which can be set by both the central and local governments. These commitments and targets should also align with and prioritize other related goals. For instance, the target of using e-bus for urban public transportation should be incorporated into national and regional development plans, emphasizing socio-economic benefits that urban communities can experience, such as reducing GHG emissions and air pollution. Prioritizing alignment with other relevant aspects, like the plan for electric energy usage, and incorporating it into projections for the total number of electric buses alongside other vehicle types is essential for comprehensive planning.

The barrier of government commitments and targets could be separated into commitments and targets from national, and regional governments.

National Government

1. The targets and plans for the electrification of urban public transportation are not legally grounded.
    - The RPJMN, Strategic Priority Projects, and Bappenas' Blue Book have not yet considered plans for the electrification of urban public transportation.
    - Subsequent strategic planning documents need to explicitly mention the use of electric buses for urban public transportation, along with their quantitative targets.
    - Currently, there is no regulation that clearly states targets for the electrification of urban public transportation, either in percentage or numerical terms.
    - Ministry of Transportation's need for an electric bus fleet in forty-two cities/counties is still a rough estimate, considering the ratio of buses to the population and the planned headway.
    - The electrification targets by Ministry of Transportation under the BTS Teman Bus program has not yet been achieved. Only 2 BTS cities have ever used electric buses.
2. The lack of updates in the guidelines for the regulation and development of national transportation.
    - The National Transportation System (Sistranas), which was established more than 18 years ago, does not accommodate current advancements in transportation technology, including the use of e-bus.
    - The guidelines for transportation development need updating, and it should explicitly mention the use of e-bus for urban public transportation.
3. The presence of fragmented authority for the electrification of urban public transportation at the national level.
    - Fragmented authority has led to targets for the electrification of public transportation not aligned with other goals.
    - The targets for the electrification of urban public transportation need to be aligned with goals for

reducing GHG, as well as projections for the quantity of E-bus and electricity consumption in future planning documents such as RUEN, RUKN, and RUPTL.

Regional Government

1. Limited budget allocation from local governments for public transportation operations.
    - On average, each region allocates only 1% of its budget for the management of transportation affairs, including the provision of public transportation[26].
    - The minimal budget allocation has led to the absence of public transportation authorities and limited operational subsidies for public transportation.
2. Uncertainty in budget allocation for public transportation operations.
    - Funding through annually determined subsidies poses a risk to the sustainability of public transportation, as public transportation contracts typically span multiple years.
3. Few local governments have established public transportation plans.
    - Sustainable Urban Mobility Plans (SUMP) currently implemented in only Bandung, Medan, Denpasar, Semarang, Makassar, and Surabaya.
4. Few local governments have set targets for the electrification of public transportation.
    - There are only 4 provincial-level regions (DKI Jakarta, Bali, South Sumatera, East Java) and 1 city (Batam) in the nation that have committed to the use of e-bus.
    - Among these five regions, only DKI Jakarta and Bali have set targets for the electrification of public transportation.

Funding and Financing

Funding and financing are critical issues in the implementation of the e-bus, as they are linked to the availability of resources for acquiring necessary facilities and infrastructure, as well as ensuring the long-term sustainability of public transportation operations. Funding refers to specific-purpose financial resources owned by the government or specialized entities, while financing involves obtaining capital or money for specific needs, typically provided by financial institutions such as banks or other financial entities. The barriers to the e-bus adoption in terms of funding and financing are identified as follows:

1. High upfront cost
    - The investment cost for purchasing e-bus is significantly higher than conventional buses. The battery price accounts for 40% of the total electric bus cost.
    - Investment costs for public transportation electrification also include charging facilities and other electrical infrastructure.
    - Investment costs affecting the purchasing power of electric buses result in a low procurement scale.
2. Ineffectiveness of existing fiscal incentives in accelerating the adoption of e-bus
    - Several fiscal incentives aimed at accelerating e-bus program have been established under Presidential Regulation No. 55/2019.

26 Audience meeting with Ministry of Home Affairs, July 2023

- The fiscal incentives provided have not been highly effective in promoting e-bus adoption, mainly due to the relatively high-risk profile of public transportation electrification and limited financing guarantees.
- Detailed regulations regarding e-bus incentives are yet to be established, posing challenges for the electric bus industry to utilize the government-borne Value-Added Tax (VAT) incentive program effectively.
- The budget allocation for government-borne VAT incentive for e-bus is considerably smaller compared to electric motorcycles and cars.

3. Import duty regulations not fully supportive of TKDN.
    - Although the Ministry of Finance has set a 0% import duty for the import of electric chassis/engines for four-wheeled or more Battery Electric Buses (BEB), the import duty rates based on certain Free Trade Agreements (FTA) still support the purchase of electric buses as CBU units. The import duty rates for the CBU are 0-5% (PMK 43/2022), hence the CBU scheme under FTA is still considered more favorable as it does not require the cost of assembly and partnership with local bus body builders.
4. Limited sources and access to funding and financing
    - Funding for public transportation is predominantly derived from subsidies originating from the central and local government budgets (APBN/APBD).
    - The funding, primarily consisting of government subsidies, poses risks to the sustainability of the public transportation system due to the limitations in the fiscal capacity of local governments and the potential reduction of budgets for public transportation operations in subsequent years.
    - Alternative funding sources from the central government, such as general transfer funds and regional loans, are underexplored by local governments.
    - Facility provision still primarily focuses on operators with limited financial capacity and generally low bankability.
    - Limited options for funding and financing guarantees
    - Commercial banks face financial risks in providing loans for public transportation operations due to the lack of guarantees from local governments or relevant public transportation authority regarding operational sustainability and ability repay the capital and step-in procedures that burden banks in case of operator default.
    - Financial institutions that can provide financing guarantees, such as PT PII and PT Askrindo, have not been optimally utilized for public transportation electrification.
5. The existing business model for public transportation provision is rigid and lacks sustainability.
    - The operational business model for public transportation in Indonesia still heavily relies on the role of the government (providing subsidies) and operators (supplying assets and operating public transportation services).
    - Business models that emphasize the role of operators complicate collaboration with the private sector to reduce the risk profile of public transportation electrification.

- Asset separation, operational, and maintenance have been implemented under the Transjakarta service, but this model has not been widely adopted.
- Business certainty poses a constraint on the involvement of several financial institutions other than commercial banks interested in participating in public transportation electrification.

6. Uncertainty in the commercial benefits of alternative business models for e-bus
    - The conventional business model (e.g., Gross Cost Contract/GCC) has already demonstrated the proof of concept for the commercial benefits gained by public transportation providers and bus operators.
    - Alternative business models also have the potential to involve new financial institutions besides commercial banks.
    - Alternative business models, such as fully separating assets and operations, have not yet provided certainty for financial institutions.
7. Mismatch in the duration of public transportation operation contracts.
    - The duration of public transportation operation contracts must consider other legal regulations, such as the maximum age of public transportation fleets and public procurement rules.
    - A contract duration that is too short and mismatches with the battery warranty period results in a high cost per kilometer, the need for additional investment during the contract period.

Technology and Infrastructure

Securing safe and compatible technology and infrastructure is a distinct challenge in electrification due to the evolving nature of the technology and the need for different skill sets compared to conventional bus operation. Electrifying public transportation involves not only replacing conventional buses with electric ones but also addressing charging facilities, battery technology, Battery Management Systems (BMS), and related electrical infrastructure. Compatibility among chosen technologies and infrastructure is crucial. Obstacles to public transportation electrification related to technology readiness include:

1. E-bus technology is still rapidly growing.
    - The immature development of electric bus technology increases implementation and financing risks.
    - There is a knowledge and technical skills gap between operators and public transportation authorities.
    - Advancements in battery technology is needed, especially in denser batteries with longer ranges to enhance the economic value of batteries.
2. E-bus requires a higher Gross Vehicle Weight (GVW).
    - Electric buses, heavier than conventional buses, require industry players to adjust to meet GVW requirements.
    - Adjusting the battery weight may affect the range of electric buses, and reduced passenger capacity to accommodate the total weight of the bus.

3. Lack of domestic technical standardization related to the type, operation, and maintenance of e-bus.
    - The lack of technical standardization regarding safety in the repair and maintenance of e-bus can pose technical risks related to safety during repairs and maintenance, passenger safety, and the sustainability of electric bus programs.
4. Uncertainty of the end-of-use life (waste management, secondary market) of e-bus, batteries, and charging facilities.
    - The uncertainty regarding the end-of-life of electric buses, batteries, and charging facilities poses risks to financial aspects (uncertainty in salvage value) and environmental pollution risks due to battery waste.
5. Operator capacity and skillsets for technology transition are still low.
    - The limitations in human resource skills for maintaining electric buses hinder electrification.
    - In the case of Transjakarta electrification, stakeholders and industry players have a low skill level in aspects of electric bus repair and maintenance, as well as in Integrated Transport Management System (ITMS) and Management Information System (MIS).
6. Regulatory framework certainty and the scalability of conversion vehicles.
    - Ambiguity in the age of converted vehicles arises from the use of conventional vehicle chassis and new engines but with an old body.
    - Ownership of assets for electric buses resulting from conversion has not clearly defined.
    - There is no conversion workshop for EVs to manufacture electric buses on a large scale.
    - Limited certainty the reliability of technology in converted electric buses.
7. Limited charging infrastructure.
    - Operators prefer the charging infrastructure in their own depots over Public Electric Vehicle Charging Station (Stasiun Pengisian Kendaraan Listrik Umum/SPKLU) due to lower bulk tariffs and technology compatibility issues.
    - Operators currently undertaken the provision of charging infrastructure for urban public transportation.
    - The business model from the Ministry of Energy and Mineral Resources for SPKLU provision can only be implemented by businesses operating in more than one province, posing challenges for Regional-owned Enterprise operating in a single province.
    - The electrical network in Indonesia is not entirely stable, introducing technical risks in the provision of energy for electric bus operations.

The Current State of Urban Transportation in Indonesia

Indonesia's public transportation, especially informal options like city transport (Angkot), follows government regulations on routes, service standards, and infrastructure. Transport cooperatives manage operations under permits from local authorities, determining routes, fleet details, and even fare regulations. The system involves cooperatives, local governments, and individual fleet owners in a regulated framework.

1. The public transportation institutional framework is not robust yet.
    - Up until now, only Jakarta has a dedicated institution for public transportation like a Regional-owned Enterprise .
    - Only some cities have Regional Public Service Agency (BLUD) for public transportation.
    - The weak institutional structure of public transportation leads to inflexible urban public transportation business models, challenges in subsidy distribution, and a lack of operational monitoring and evaluation for electrification planning.
    - The institutional framework for inter-administrative region public transportation needs clarification to ensure roles and responsibilities at various government levels, along with a clear hierarchy in planning, decision-making, and fare determination.
2. The absence of a regulatory framework for alternative business models in urban public transportation.
    - The lack of a clear business scheme, uncertainty in cooperation and guarantee schemes hinder commercial banks, other financial institutions, and investors from providing loans to operators.
3. Limited operational data due to service uncertainty and weak monitoring and evaluation in operational, SPM, and fleet quality aspects.
    - The unclear operational schedule, headway, and fares result in uncertainty when determining the operational plan for electric buses, including the fleet, and supporting facilities needed.
    - Local governments only issue route permits to operators and set the basic city transport fare without guaranteeing SPM, causing uncertainty in determining the number of fleets needing refurbishment or replacing electric fleets.

The Industry Development of E-Bus Domestic Ecosystem

Accelerating the KBLBB aims to boost Indonesia's domestic electric bus industry. The government encourages local industry development through incentives and TKDN roadmap. The industry's readiness influences TKDN, impacting the pace of electric bus adoption for public transportation. Obstacles include the development of domestic industry.

1. Domestic production capacity is still low.
    - Current production capacity is relatively low to meet electrification targets, although some manufacturers have aimed to increase their production capacity.
    - Demand uncertainty is a key factor in the low domestic production capacity. Investment in additional production capacity requires strong justification.
2. E-bus produced or assembled by domestic manufacturers are not yet technically competitive.
    - Electric bus technology, although some can be assembled or obtained domestically, is still not reliable, as seen in issues such as battery overheating and battery energy efficiency.
3. Difficulty in finding partners for the development of electric bus technology.
    - Indonesia is not yet able to produce batteries and electric motor drive systems for e-bus, posing a challenge for the industry to improve TKDN values for certification, impacting the underutilization of government-borne VAT incentive.

3. DATA COLLECTION ON E-MOBILITY

Providing an overview of e-mobility data for target area is crucial for understanding the specific transportation conditions, market dynamics, and progress in these regions. This includes examining fleet technology, funding aspects, and identifying barriers. Offering examples of successful funding mechanisms presents replicable models, while the collection of e-bus data ensures informed decision-making for mass transit systems. In essence, this comprehensive documentation serves as a strategic guide for stakeholders aiming to navigate and effectively integrate e-mobility in these significant Indonesian locales.

3.1 Target Area Overview

Explaining the city context, including geographic, demographic, and socioeconomic factors, is crucial for tailoring e-mobility initiatives. Assessing the highest GHG and pollution emitters guides targeted interventions, reducing environmental impact. This comprehensive overview informs strategic and sustainable approaches aligned with the specific needs and challenges of the city.

3.1.1 DKI Jakarta Area Overview

DKI Jakarta is a vibrant city in Indonesia with an area of 662.33 km^2, consisting of six administrative divisions, namely Central Jakarta, South Jakarta, East Jakarta, West Jakarta, North Jakarta and Kepulauan Seribu. Although the national government is undergoing a transition period to move to a new capital city, at the time of this report, DKI Jakarta still has two crucial roles, namely as the center of national government and the center of business activities in Indonesia. According to the 2022 population statistics, Jakarta Province has a population growth rate of 0.66% and a density of 16,084 people per km^2, making it the most populous province in Indonesia. Furthermore, East Jakarta is the district with the highest population density in the province.

Table 26. DKI Jakarta Province Population by Municipality, 2022. *Jakarta Dalam Angka (2023)*

Regency/Municipality	Population	
	2021	2022
Kepulauan Seribu	28,240	28,925
South Jakarta	2,233,855	2,244,632
East Jakarta	3,056,300	3,083,883
Center Jakarta	1,066,460	1,079,995
West Jakarta	2,440,073	2,448,975
North Jakarta	1,784,753	1,793,550
DKI Jakarta	10,609,681	10,679,951

3.1.1.1 Jakarta's Socioeconomic Characteristics

In 2022, Jakarta's Gross Regional Domestic Product (GRDP) increased by 5.25% from the previous year, reaching approximately 3.2 quadrillion Rupiah. The Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles sector made the largest contribution, accounting for 17.44% of the total GRDP. This makes Jakarta the largest contributor to Indonesia's national Gross Domestic Product (GDP).[27]

DKI Jakarta's local revenue in 2022 came from three sources: regional original income (PAD) or the realization of local taxes amounting to 45 trillion Indonesian Rupiah, transfer income of 17 trillion Rupiah, and other legitimate income totaling 4.9 trillion Indonesian Rupiah[28]. However, despite this revenue, Jakarta faced a deficit of 824 billion Rupiah after incurring expenditures totaling 76 trillion Rupiah. The poverty line in Jakarta is 773,370 Rupiah per capita per month, with 4.61% of the population classified as poor. The Human Development Index (HDI) for Jakarta is 72.91, indicating a slight but consistent improvement over the past decade.

3.1.1.2 Jakarta's Transportation Landscape and Situations

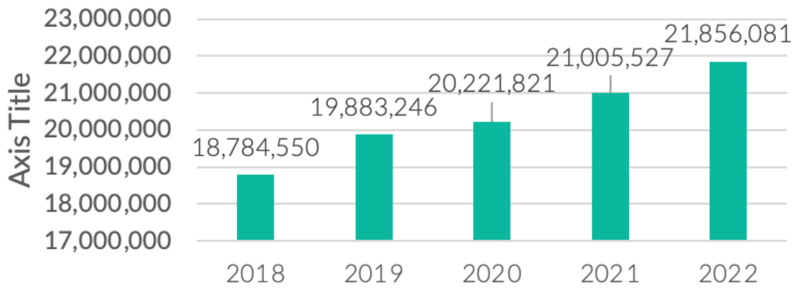
Jakarta has a dynamic transportation landscape and is facing challenges related to traffic congestion, rapid urbanization, and the need for sustainable transportation solutions in the future. According to a statement from the Jakarta Transportation Agency, Jakarta is globally recognized as one of the most congested cities, ranking 30th in 2023[29]. The total number of registered motorized vehicles in DKI Jakarta has reached 26,370,535 vehicles, with the largest proportion being motorcycles at 66%. It is assumed that this figure does not include vehicles from outside Jakarta (Jabodetabek) that commute daily in the city.

27 Statistica. 2024. https://www.statista.com/statistics/1426525/indonesia-grdp-jakarta/

28 PPID Jakarta. 2022. https://ppid.jakarta.go.id/assets/pdf/laporan-realisasi-anggaran-pemerintah-provinsi-dki-jakarta/Laporan%20Realisasi%20Anggaran%20Pemerintah%20Provinsi%20DKI%20Jakarta%20Tahun%202022.pdf

29 Tomtom. 2023. https://www.tomtom.com/traffic-index/

Figure 14. Jakarta's Motorized Vehicle Growth Trend (Left) and Motorized Vehicle Mode Share (Right). *Jakarta Dalam Angka (2023)*



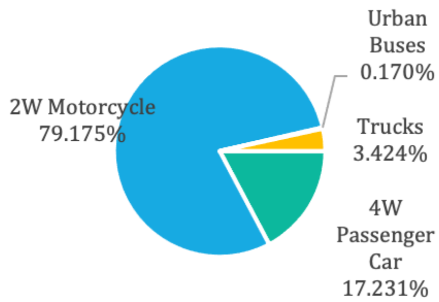


Table 27. Number of Registered Motor Vehicle (units) in DKI Jakarta Province, 2018-2022. *Jakarta Dalam Angka (2023)*

Vehicle type	2018	2019	2020	2021	2022
4W Passenger Car	3,082,616	3,310,426	3,365,467	3,544,491	3,766,059
2W Motorcycle	15,037,359	15,868,191	16,141,380	16,711,638	17,304,447
Urban Buses	33,419	34,905	35,266	36,339	37,180
Trucks	631,156	669,724	679,708	713,059	748,395
Total	**18,784,550**	**19,883,246**	**20,221,821**	**21,005,527**	**21,856,081**

Jakarta's Ride-hailing Service

The existence of ride-hailing services such as Gojek and Grab has changed the way people travel in Jakarta since their introduction around 2010. Quickly becoming favourites, they offer a simple and affordable solution to transportation challenges, especially in Jakarta. As of 2020, the number of users of these modes of transportation has reached 36 million, demonstrating the significant impact and rapid growth of this ecosystem. Although convenient, ride-hailing services in Jakarta mostly rely on conventional cars and motorcycles that run on ICE, making this mode of transportation unsustainable in terms of air pollution and traffic. The popularity of these services highlights the conflict between convenience, environmental concerns, and the broader picture of public transportation in Jakarta.

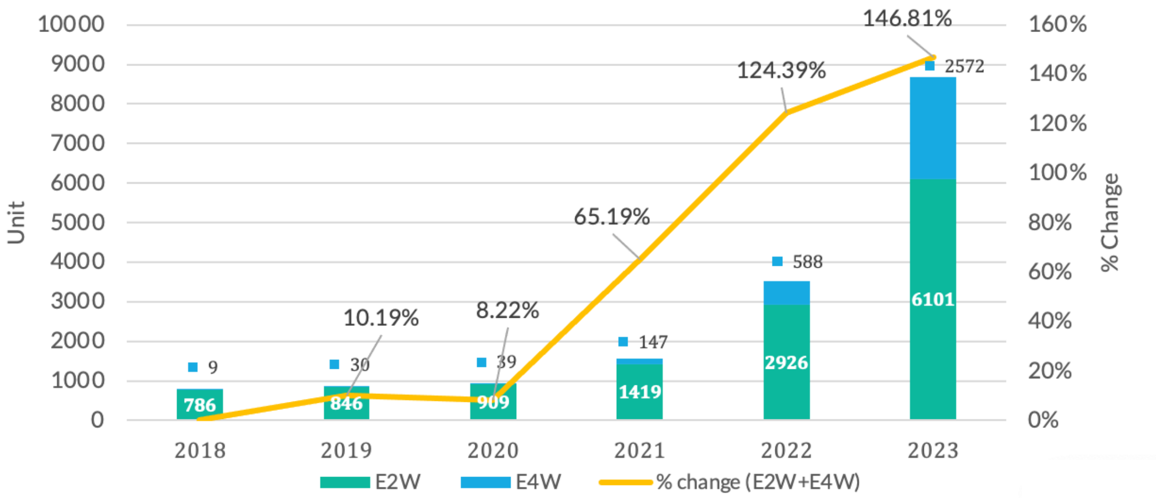
Jakarta's Non-motorized Transport (NMT)

In addition to the extensive development of pedestrian facilities since the implementation of the complete street concept in 2021, Jakarta has also introduced a sizable network of bicycle lanes since their construction in 2019. As of 2022, Jakarta has a total of 300 kilometers of bicycle lanes, with 50 kilometers of them offering physical protection, connecting administrative areas in Jakarta.

Jakarta's Progress on E-mobility E2Ws and E4Ws

The number of electric vehicles in Jakarta province continues to increase at a notable rate. Between 2018 and 2023, the number of electric vehicles in the province grew by 990.94%. However, the total remains relatively low. The largest increase occurred in 2023, with a 146.81% increase from the previous year, bringing the total number of electric vehicles in the province to 8,673. Most electric vehicles are two-wheeled, comprising 70.34% of the total units.

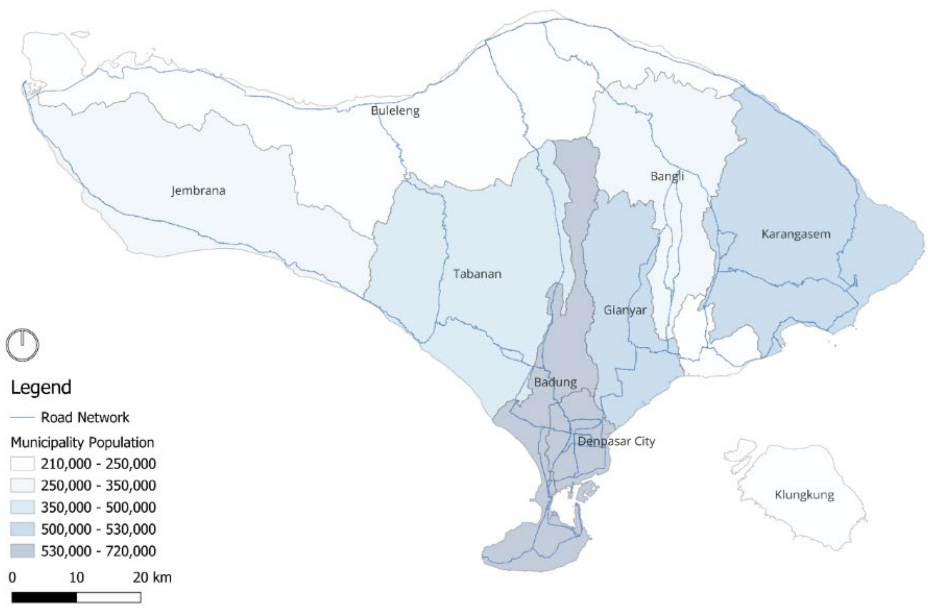
Figure 15. E2W and E4W Numbers in Jakarta Province over the years. *Bapenda (2023)*



3.1.2 Bali Province Area Overview

Bali, also known as the Bali Islands, is a province of Indonesia located between the islands of Java and Lombok. Administratively, the province of Bali is divided into eight regencies and one city: Jembrana, Tabanan, Badung, Gianyar, Karangasem, Klungkung, Bangli, Buleleng, and the city of Denpasar, which is the provincial capital[30]. According to the 2022 population statistics, the province has a population of 4.41 million people, with a 10-year growth rate of 1.01%.[31] Although Denpasar has the highest population density at 5,774 per km^2, Buleleng has the highest percentage of population distribution at 18.69%, followed by Denpasar at 16.46%. The smallest percentage is in Klungkung Regency at 4.85%.[32]

Figure 16. Population by Regency/Municipality in Bali Province, 2022. *Bali Provincial Statistics Agency (2022)*



30 Bali Public Works Agency. Available at: (Sekilas Bali – Sistem Informasi Wilayah dan Tata Ruang Bali (baliprov.go.id) (Accessed: Dec 2023).

31 The growth rate refers to the change of the population in 2020 (September) to the population in 2021 (June). Bali Province in Number 2023.

32 The result of Interim Population Projection 2020-2023 (mid year/June). Bali Province in Number 2023.

3.1.2.1 Balis's Socioeconomic Characteristics

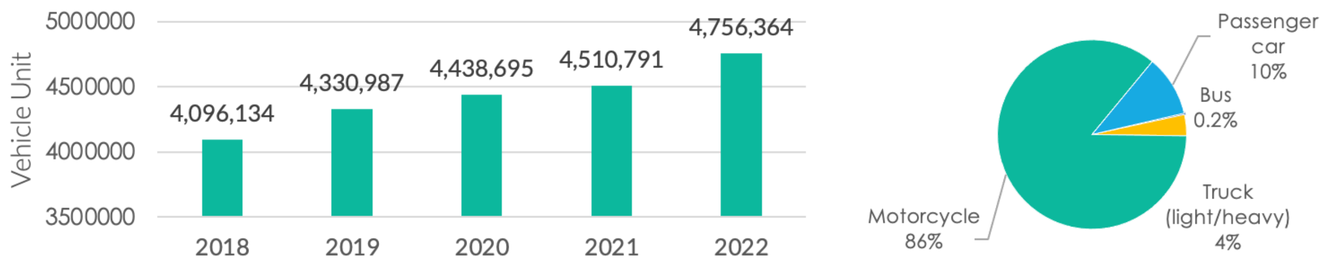
The economic condition of Bali Province is reflected in the GRDP contributed by each sector. In 2022, Bali's GRDP reached 245,233 billion rupiah, with a 4.84% economic growth from the previous year. The transportation and storage sector (+21.55%), electricity and gas procurement (+16.02%), and accommodation and food services (+13.84%) were the largest contributing sectors.[33] In terms of PAD, taxes remain the primary source of income for Bali Province and Denpasar City, contributing 84% and 78%.[34]

Most of this revenue is generated from motor vehicle taxes and transfer fees, totaling 700 billion Rupiah or approximately 45.2 million USD. Local expenditure exceeds 6% of local revenue, with the largest expenditures coming from the official sector[35] (46%), service sector[36] (45%), roads (43%), and land capital expenditures[37] (24%). The poverty gap index (P1) reached 0.625 against the poverty line, with a poverty severity index (P2) of 0.129 in 2022. Bali's human development index increased by 0.9% from the previous year from 75.69 in 2021 to 76.44 in 2022[38], in contrast to Indonesia's HDI in 2022 is 72.91.[39]

3.1.2.2 Bali's Transportation Landscape and Situation

Bali is a well-known tourist destination for both domestic and international visitors. As of the end of 2022, it had recorded 3.9 million domestic tourists and 2.3 million international tourists, which is approximately 36% of the pre-pandemic levels. However, the province faces various urban problems, particularly congestion, due to limitations in the public transportation network. In 2020, the number of motorized vehicles in Bali reached 4,756,364. with motorcycles dominating the market. This growth has averaged 10.01% over the past 12 years and driven by affordable down payments (around 1 to 2 million rupiah) and easy credit facilities. It is common for each household to own 4-5 motorcycles, and even school children use them as their primary means of transportation.

Figure 17. Bali's Motorized Vehicle Growth Trend (Left) and Motorized Vehicle Mode Share (Right). *Bali Dalam Angka (2023)*



33 BPS - Statistics of Bali Province; various census, survey, and other source. Bali Province in Number 2023.

34 PS-Statistics of Bali Province, Regional Financial Statistics Survey. Bali Province in Number 2023.

35 Employee expenses cover salaries, pensions, allowances, travel, and more for civil servants

36 Goods and services expenditure covers purchasing consumables for production and procurement for public sale, including travel costs

37 Budget expenses for land acquisition, including ownership transfer, lease, clearing, leveling, and preparation until ready for use

38 BPS-Statistics of Bali Province, Series of Press Release of Human Development Index

39 BPS-Statistic Indonesia. Indonesia's HDI in 2022. https://www.bps.go.id /en /pressrelease /2022 /11 /15 /1931 /indonesias-human-development-index-in-2022-reached-72-91--an-increase-of-0-62-points--0-86-percent--compared-to-previous-year--72-29-.html

Table 28. Number of Registered Motor Vehicles (units) in Bali Province. *Bali Dalam Angka (2023)*

Vehicle type	2018	2019	2020	2021	2022
Bus	8,643	9,088	9,205	8,911	11,257
Truck (light/heavy)	148,238	153,722	156,624	159,003	171,603
Motorcycle	3,516,415	3,718,636	1,811,957	3,877,595	4,079,617
Passenger car	422,838	449,541	460,909	465,282	493,887
Total	**4,096,134**	**4,330,987**	**4,438,695**	**4,510,791**	**4,756,364**

Bali's Private Hire Vehicles

The business of private hire vehicles is thriving in Bali, particularly to cater to the mobility needs of tourists. This business has developed from both offline and online rentals facilitated through various applications. Moreover, the growing partnerships between private entities and the government indicate that this business will continue to grow in the future. There is a diverse range of vehicle rentals, for both two-wheelers and four-wheelers, offering choices from standard to luxury vehicles[40].

Media reports indicate a 20-30% increase in demand for vehicle rentals (two- and four-wheeled vehicles) in Bali in 2023. For example, according to media reports, rental prices for cars commence from around IDR 900 thousand or USD 58 per 24 hours. Entrepreneurs in this industry can achieve a monthly revenue of up to IDR 70 million or USD 4,500 with 25 units of cars, excluding offline rentals and special seasonal prices such as holidays or the new year[41].

Figure 18. 2W Rental (Left) and 4W Rental (Right). *Motorbalirental and Adityabalitours*

Bali's Ride Hailing Services

Since its introduction in 2015, the ride-hailing situation in Indonesian cities, including Bali, has been controversial due to the presence of two major operators, Grab and Gojek. Business competition persists, particularly between online ride-hailing (app-based) and local ride-hailing, which often leads to conflicts in certain locations, such as airports and high-demand zones dominated by local players. Although controversial, these services are considered to contribute to the creative economy and increase employment opportunities. This is illustrated by the existence of locally initiated app-based ride-hailing services in Bali, currently operated by five operators: APPKEY, Timedoor Bali, Bali Mobi, Fastwork Bali, and Kojek Bali.

40 Arini (2023). Available at: Okupansi Penyewaan Mobil di Bali naik 90 Persen Jelang Nataru, Masuk Peak Season - Tribun-bali.com (tribunnews.com) (Accessed: Dec 2023).

41 Ahmad (2022). Available at: Usaha Rental Mobil di Bali Mulai Bangkit, Bisa Puluhan Juta Sebulan Lewat Aplikasi Trevo - Wartakotalive.com (tribunnews.com) (Accessed: Dec 2023).

Figure 19. Electric 2W Ride-Hailing (Left) and E4W Ride-Hailing (Right). *Mobil123 and Transonlinwatch*

Bali's Future Sustainable Mobility Program

In 2023, the Bali Government is preparing the development of the BRT system and the Bali Low Emission Zone Initiative (BLEZI) to support the sustainable mobility program. The proposed BRT corridor will operate from North-South and East-West, aligning with the EV adoption program based on the study of the Sustainable Urban Mobility Program (SUMP). On the other hand, the government is also developing BLEZI, which will promote Pedestrian Oriented Development at seven locations: Kuta, Nusa Dua, Sanur, Ubud, Nusa Penida, Denpasar, and Besakih. Additionally, the Government of Bali is also working on the feasibility study of EV charging stations with MCC. Table 68 outlines the various incentive and disincentive policies aimed at implementing Bali's Low Emission Zone.

Figure 20. BRT and BLEZI Plan in Bali. *WRI and KIAT (2023)*

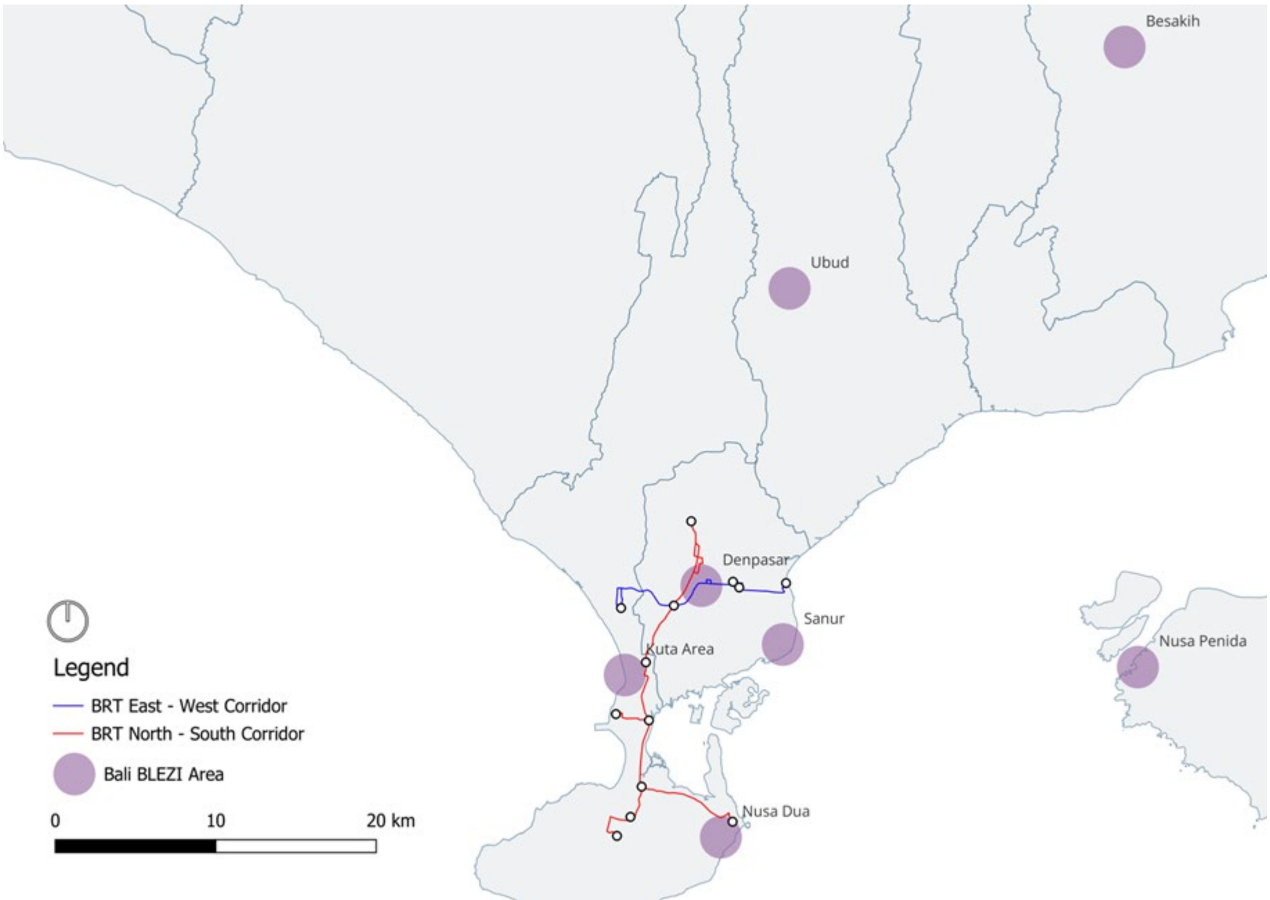


Table 29. BRT Corridor Route Plan. *KIAT (2023)*

Vehicle Type	2018
BRT East – West Corridor	Sanur Port – Seminyak Area
BRT Noth – South Corridor	Ubung Bus Terminal – Garuda Wisnu Kencana (GWK) – Nusa Dua – Ngurah Rai Airport

Figure 21. BLEZI, Electrification, and Bus Rapid Transit (BRT): Framework. *WRI Indonesia (2023)*

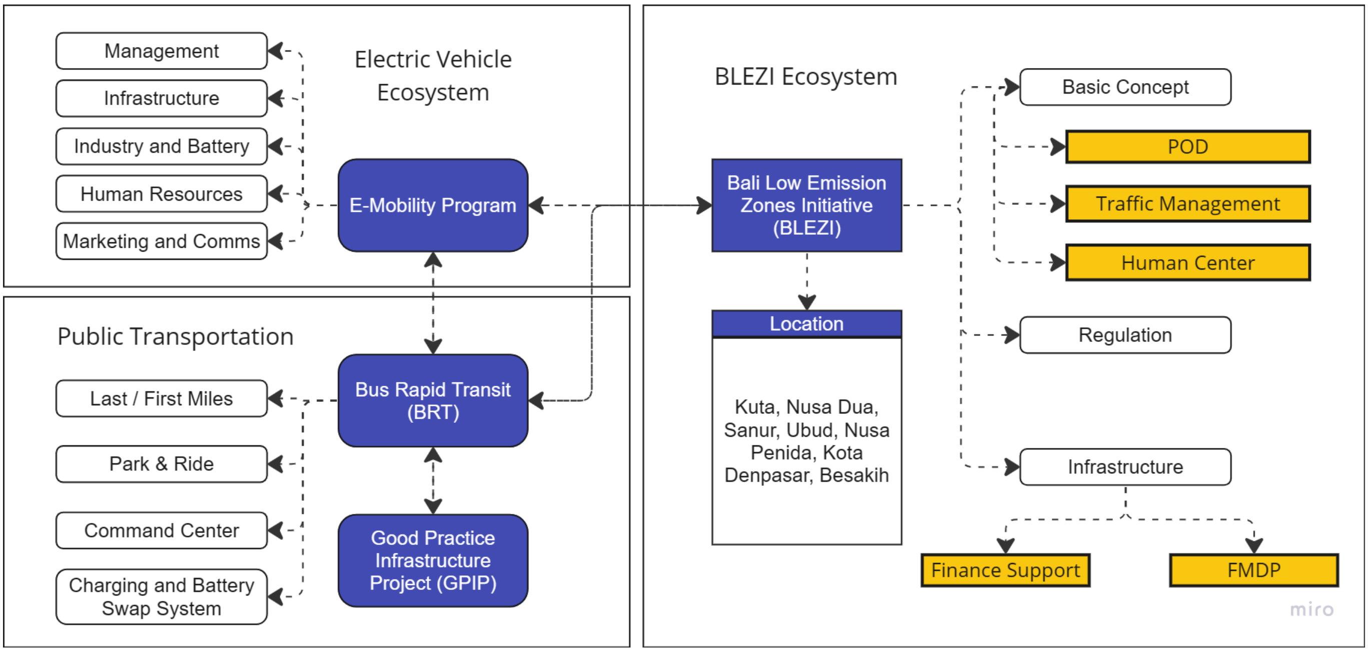


Table 30. BEV Studies or Project Related in Bali. *WRI Indonesia (2023)*

Name of Study/Project	Remark 1
E-BRT Feasibility Study	Promoted by KIAT and executed by ARUP, this project will focus on the development and operation plans of e-BRT in the Sarbagita region based on the Sarbagita SUMP
Bali Low Emission Zone Initiatives (BLEZI) Study	Implemented by WRI Indonesia, this study provides detailed analysis on the delineation, implementation timeline, and supporting policies for the planned BLEZI areas in Bali Province
Good Practice Infrastructure Project (GPIP) Option and Feasibility Study - Electric Vehicle Charging Point	Funded by MCC, and the PwC Indonesia as a consortium teams, providing Feasibility Study, root cause and evaluation option should be deployed

Bali's Progress on E-mobility E2Ws, E4Ws, E-buses, Commercial and Private

The development of the EV market in Bali continues to increase each year. Bali stands out as the only province to follow up on Presidential Regulation No. 55/2019 in accelerating EV adoption by adopting a regional regulation governing its usage (Bali Government Regulation 48/2019). The growth of EVs in Bali in 2023 has almost reached 4,000 vehicles for both two and four-wheelers, compared to last year, which the number reached 1,602. However, this number represents that the current adoption is shortfall from the moderate target in 2023 by 18.5%. This growth excludes taxis, which the number around 30 vehicles and are targeted to reach 50 vehicles in 2023, around 60 light transport modes such as auto-rickshaws or 3-wheelers and government official vehicles, which have been actively promoted since the G20 event in Bali.

Figure 22. E2W and E4W Numbers in Bali Province Over the Years. *Bali Land Transport Agency (2023)*

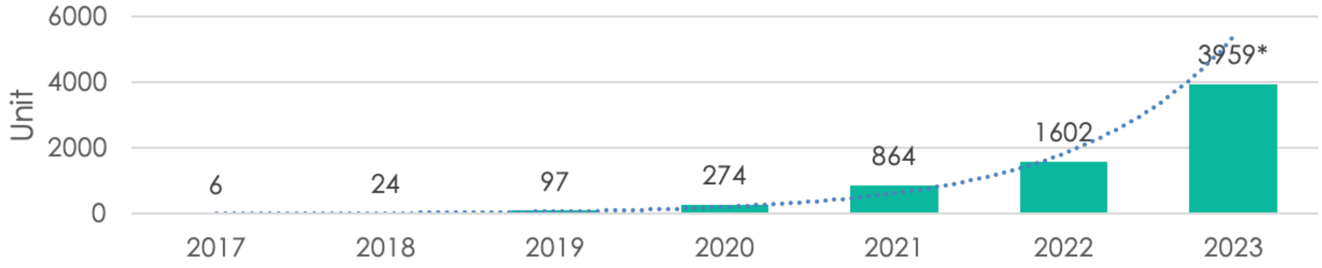
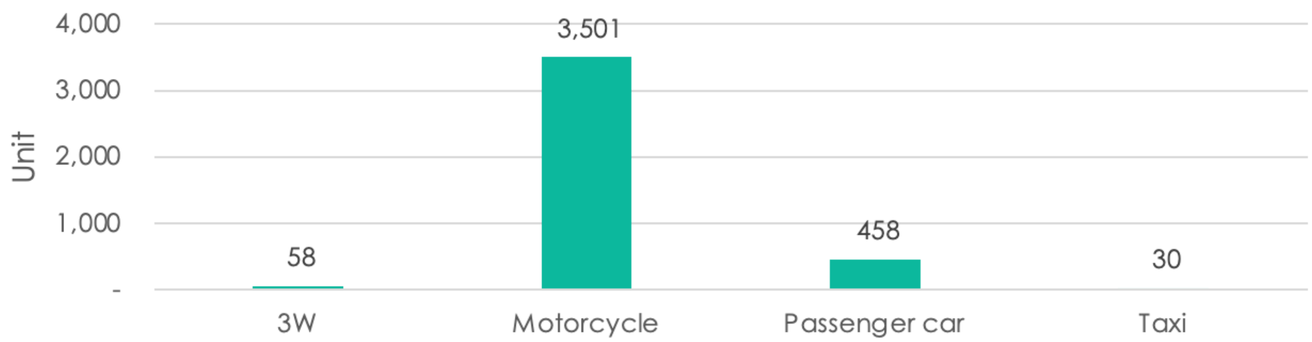
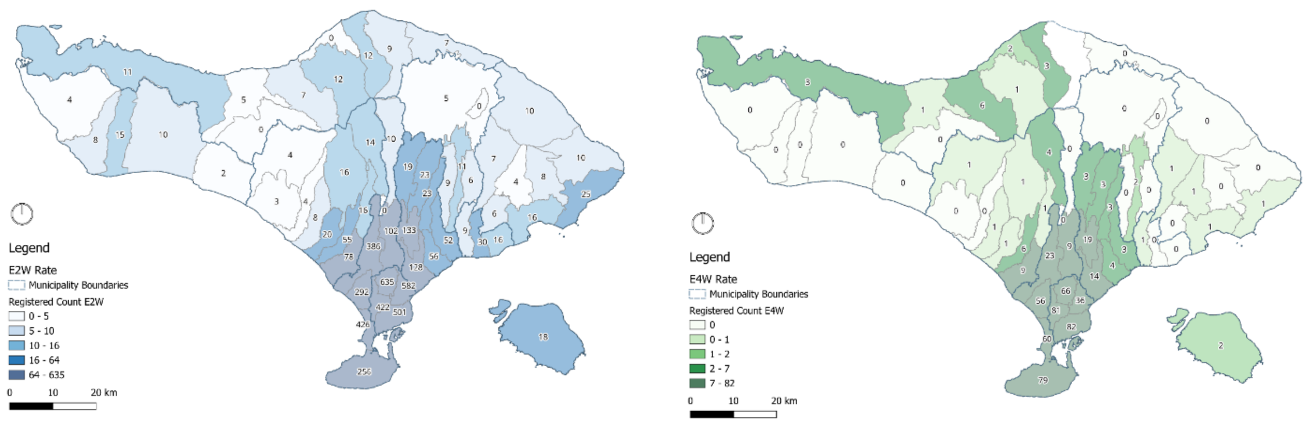


Figure 23. Bali BEV Population, 2023. *Bali Land Transport Agency (2023)*



To understand the ownership and distribution, here is the BEV registration data obtained from the Regional Revenue Agency of Bali Province. Based on the ownership proportions in 2023, BEVs, both for E4W and E2W are predominantly concentrated in the Sarbagita area or the metropolitan region in the Bali Province, consisting of Denpasar City, Badung Regency, Gianyar Regency, and Tabanan Regency. For E4W ownership, it is evident in the darkest areas, with ownership ranges from 7 to 82 vehicles per sub-district. In contrast, E2W ownership is more abundant and spread across Bali, although it still exhibits a similar concentration with a range of 64 to 634 vehicles per sub-district.

Figure 24. Registered Count E4W (Left) and E2W (Right) Based on Sub-District. *Regional Revenue Agency of Bali*



3.1.3 Initial Assessment of the GHG and Air Pollution Emitter

Assessing environmental impact indicators is crucial for maintaining a sustainable ecosystem. According to the World Health Organization (WHO), PM2.5 and GHG indicators have indirect effects on environmental factors, climate change, and public health. PM2.5 is used to evaluate air quality because these particles can enter the human respiratory system. CO2 is the primary indicator of the greenhouse effect and climate change, which results from burning fossil fuels. In this study, calculations of PM2.5 and CO2 emissions were conducted on motorized vehicle segments, specifically 4W, 2W, and buses, to identify the largest contributions from each mode. Subsequently, using baseline data from the year 2022, calculations were extended to assess the long-term impacts until 2030, mainly using TTW (Tank-to Wheel) parameters to see the direct impact of emission production from all vehicle segments.

Methodology

The estimation or projection of these emissions is calculated using supporting data, starting from the number of motorized vehicles, emission factors, and assumptions about vehicle kilometers traveled to assess the annual impact. The data on the number of motorized vehicles used for Jakarta and Bali is based on the 2022 baseline because the most complete data is currently available. For example, in addition to the required number of registered motorized vehicles, data on the proportion of vehicles based on fuel type and energy are also included in the modeling, such as gasoline, diesel, CNG, and EV. Each of these proportions can have different emission outputs. Once the data on the number and proportion of vehicles is obtained, it is multiplied by air emission factors and the annual mileage to determine the annual emission output in tons.

3.1.3.1 Jakarta Emission Projection

Based on the modeling results using the methods mentioned in the previous paragraph, Jakarta produces a total of 25,577,743 tons of CO2 TTW and 2,913 PM2.5 emissions from motorized vehicles, specifically 4W, 2W, and Urban Buses in the year 2022. In its segmentation, 2W generates the highest proportions of CO2 TTW and PM2.5 at 56% and 61%, respectively. Similar to Bali, 4W contributes as the second-largest emitter of CO2 after 2W (30%). However, concerning PM2.5 proportions, Urban Buses have the second-largest share (28%), even though the number of Bus fleets is smaller than 4W (0.2% and 17.8%) of the total motorized vehicles in Jakarta. For the CO2 TTW projections, based on year 2022, Jakarta is projected to have a total of 29.6 million tons, in 2025, and 38 million tons in 2030.

Figure 25. Jakarta GHG and Air Pollution Emission from Transport by Vehicle Segment 2022 Under BAU Scenario

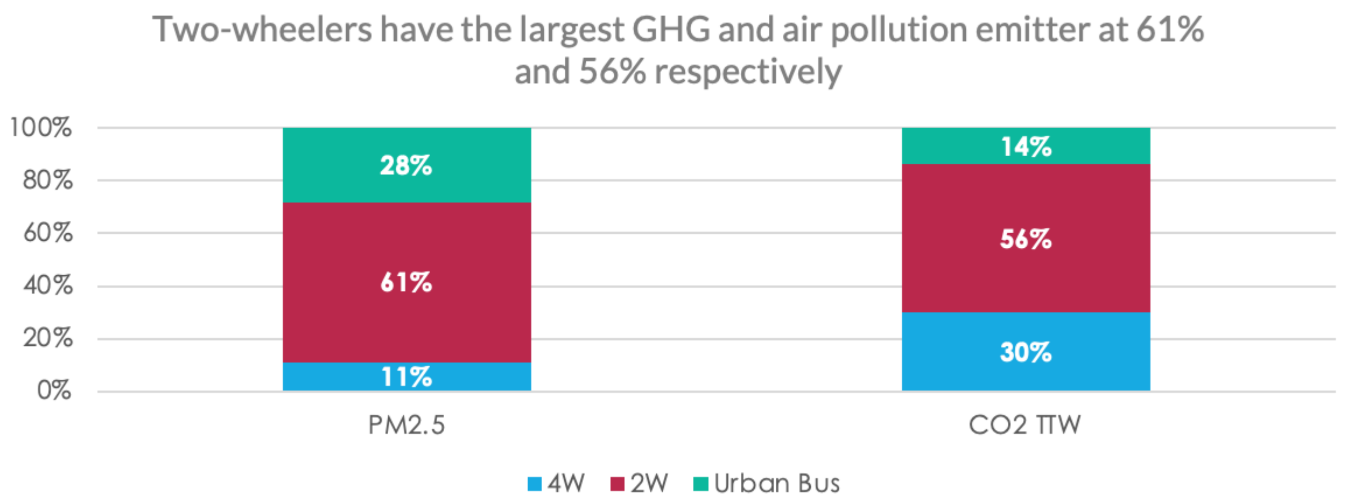
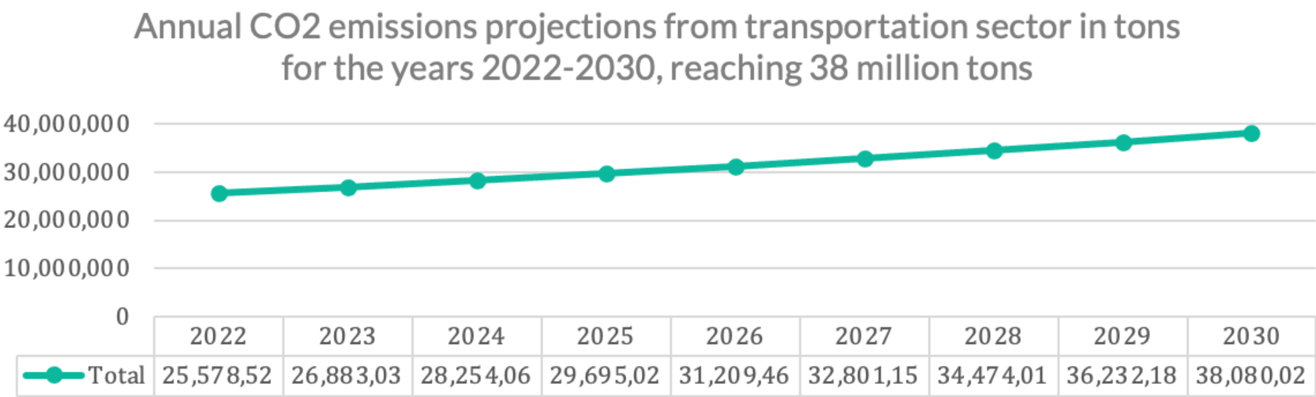


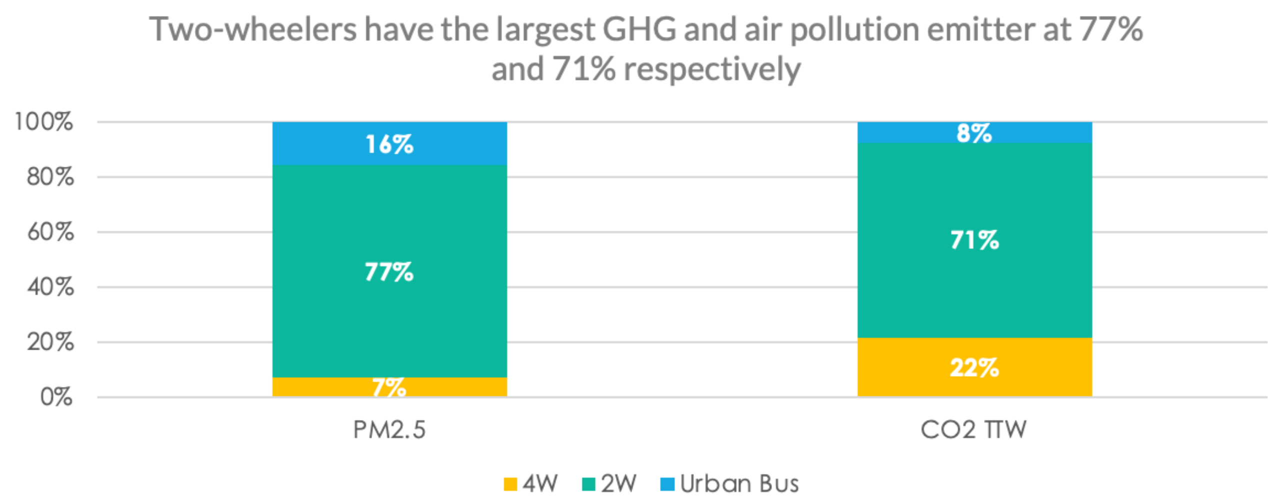
Figure 26. Jakarta GHG Transport Emission TTW and Projection



3.1.3.2 Bali Emission Projection

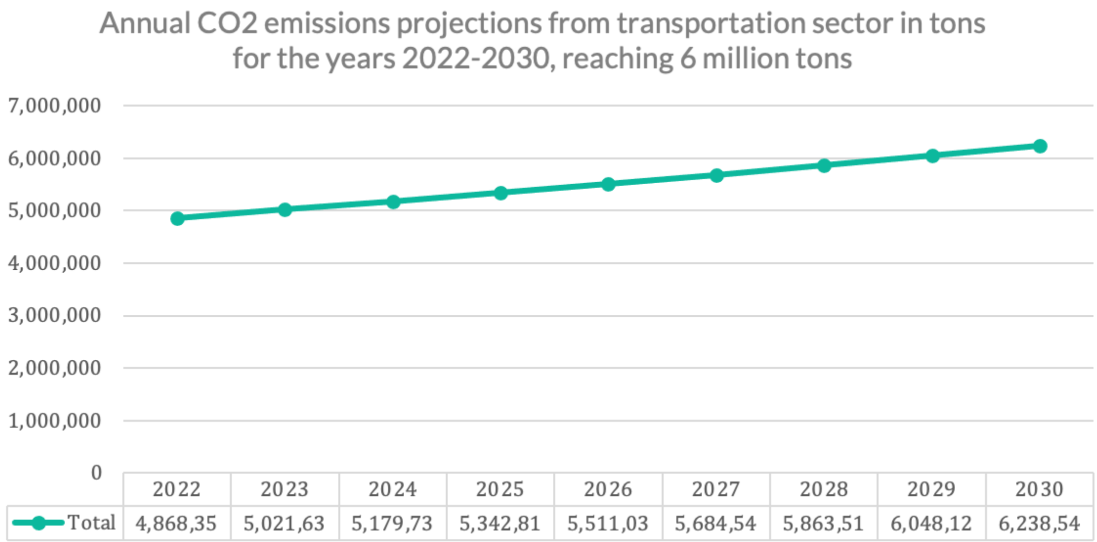
Based on the analysis results, Bali produces a total of 5,158,174 tons of CO2 TTW and has a total of 301.6 tons of PM2.5 emitted by 4W, 2W, and Urban buses in the year 2022.[42] Same like Jakarta, the GHG data is represented by the CO2 TTW cycle to identify the direct emission from the tailpipe vehicle. In terms of proportions, the 2W mode generates the highest CO2 and PM2.5 emissions compared to other modes (71% and 77%, respectively). 4W has the second-largest proportion of CO2 emissions, followed by Urban Buses. However, when considering PM2.5 emissions, Urban Buses produce the second-largest proportion after 2W, even though the number of Urban Buses is smaller compared to 4W in the total motorized vehicles in Bali (0.2% and 10%, respectively). Furthermore, for the CO2 TTW projection, Bali produced 4 million tons in 2022, followed by 4.4 million tons in 2025, and reaching 5.1 million by the end of 2030. This projection is linear and does not consider fundamental economic factors such as recessions or pandemics.

Figure 27. Bali GHG and Air Pollution Emission from Transport by Vehicle Segment 2022 Under BAU Scenario



42 Direct GHG emission are calculated for the fossil fuels based on the quantity of fuel used, the Net Caloric Value (NCV) of the fuel and the CO2 emission factor. Same applied for PM2.5, which using EF from COPERT (EU emission modelling).

Figure 28. Bali GHG Transport Emission TTW and Projection



3.1.4 Current E-Mobility Market in the Target Areas

Nationally, understanding local manufacturers, available models, and pricing information provides a nuanced view of the market's readiness for EVs. This comprehensive assessment informs stakeholders about emerging trends and economic considerations, guiding strategic decisions. In essence, the data collected on manufacturers, models, charging equipment, and pricing is instrumental in developing tailored strategies for the successful and sustainable integration of e-mobility solutions in the specific target area.

3.1.4.1 National E2W Market

The Indonesian E2W market was valued at over USD 364.42 million in 2019 and is expected to grow at an annual rate of 20.96%, reaching USD 816.22 million by 2025. Although the market size for three-wheel electric bicycles (E3W) is unknown due to lack of interest and data, the Ministry of Transportation reports that the current number of E2W units is around 85,838[43], which is far from the target of 13 million by 2030. This indicates low adoption of E2W in Indonesia. The expected growth will exceed this figure, but it is highly dependent on ambitious support from the government, especially through incentives for users and manufacturers. The provided illustrates that the price and capacity of E2W batteries are generally lower than those of E3W batteries before subsidies from the central government. In general, E2W exhibits lower battery capacity compared to E3W, ranging from 0.3 to 2 kWh. Related market data by production base can be seen in Table 68.

3.1.4.2 National E4W Market

Similar to E2W, the sales of E4W in Indonesia continue to experience annual growth. Sales data for the year 2022 records 7,600 BEV, with an estimated increase 57% (year-on-year) in 2023[44]. However, it is forecasted to the 2030 target of 600,000 units, the estimated sales achievement for E4W remains below the target, reaching only around 81,000 units, excluding Hybrid Electric Vehicles (HEV) in 2030[45]

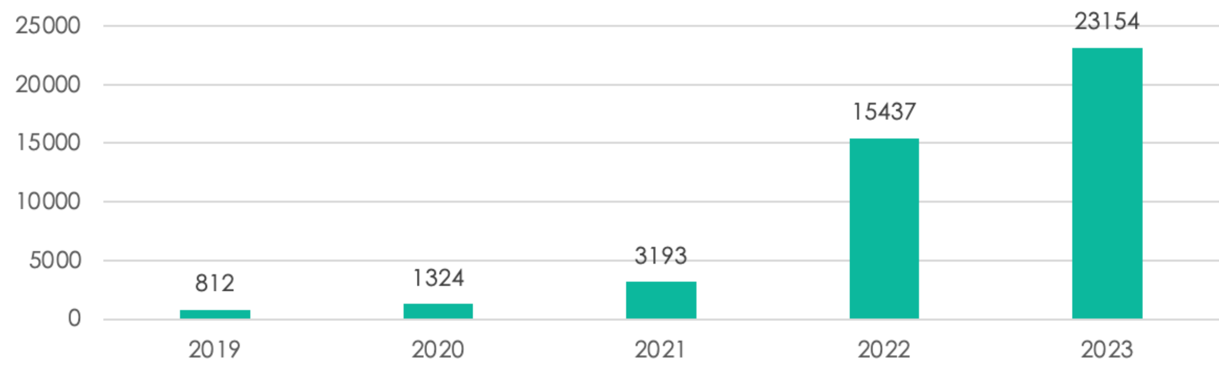
43 Indonesia Electric Two-wheeler Market (2021). Available from: Research and Market (Accessed: Dec 2023).

44 Kompas (2023). Available at: Jumlah Kendaraan Listrik di Indonesia Diklaim Terus Meningkat (kompas.com) (Dec 2023).

45 Unleashing Indonesia's electric mobility potential | Arthur D. Little (adlittle.com)

The following is the development of total sales of 4W BEV in Indonesia, which continues to increase every year. Additionally, here is the data on the most-selling BEVs by brand in Indonesia to illustrate the market and public interest in 4W BEVs. Based on the 2023 data, Wuling and Hyundai emerge as the top selling BEVs, surpassing Japanese OEMs even though they have a dominant ICE market in Indonesia[46]. Refer Table 70 to for information on the sales achievements of each brand and the types of models being sold.

Figure 29. Total BEV Sales Over the Years in Indonesia. *Goodstat (2023)*



3.1.4.3 National E-buses Market

Based on the market share of electric buses entering Indonesia, especially in the city of Jakarta as the first to implement electric buses, the type of model used is an average 12m medium bus. A variety of local OEMs such as Mobil Anak Bangsa (MAB) and INDY, and non-local (imported) such as BYD, Zhongtong, and Skywell are used to facilitate the electric bus ecosystem in Indonesia. Refer to Table 71 for additional information on the different types of electric buses registered by Ministry of Transportation in Indonesia and their specifications.

3.2 Data Collection on Vehicle Fleet Technology in Indonesia

Evaluating EV technology in Indonesia is essential for tailoring solutions to diverse fleet classifications and addressing unique charging challenges. Understanding the current fleet and charging technology informs strategic interventions, positioning Indonesia for a seamless transition to sustainable mobility. This assessment is crucial for fostering environmental benefits and technological innovation in the country's evolving EV landscape.

3.2.1 Global Fleet Classification on E2W, E4W, and E-bus

3.2.1.1 E2W and 3W Classification

Due to the various models available in the market, classification is needed to observe the differences and the general landscape of the E2W and 3W market. In general, OEMs in Indonesia focus on producing one type of vehicle. For example, it is rare for an OEM to mass-produce both types of 2W and 3W. However, there are two major OEMs currently producing a diverse range of fleet types, such as Viar Motor and Selis. The products they manufacture vary, ranging from electric bicycles, e-mopeds, e-motorcycles/scooters, e-tricycles, to e-rickshaws. Table 73 shows the classification and specification characteristics of each E2&3W available in the Indonesian market.

46 (Kata Data, 2023)

3.2.1.2 E4W Classification

Table 74 presents the various types of EV, ranging from BEV that fully utilize rechargeable batteries as a power source to Plug-in Hybrids Electric Vehicle (PHEV), which are a variation of HEV that allow the vehicle to be charged directly. Battery prices and capacities vary among vehicle types, with prices ranging from $23,000 to $200,000 and battery capacities ranging from 0.5 kWh to 100 kWh.

3.2.1.3 E-Bus Classification

Figure 30 and Table 75 present the various types of electric buses and OEM companies, along with the corresponding battery capacities used, based on ITDP's desktop research of 2022. The bus types include high-deck single buses, low-door single buses, articulated buses, medium buses, microbuses, and double-decker buses. The dimensions and battery capacity vary for each bus type, ranging from 42 kWh for microbuses to 676 kWh for double-decker buses. Special attention is given to single low-entry buses, where the battery capacity can reach 400 kWh to meet higher energy demands. Additionally, the table mentions that there are currently no high-deck articulated e-bus models deployed globally, while for medium buses, research is underway to use higher-capacity batteries to extend the range, in accordance with current vehicle weight regulations.

Figure 30. Product range and market presence matrix. *ITDP (2022)*

3.2.2 Charging Technologies on E2W, E4W, and E-bus

3.2.2.1 E2W Charging Technology

Most charging technologies for E2W divided into two types: plug-in and battery swapping. Each of these technologies has advantages and disadvantages, such as plug-in technology which is more cost efficient than swapping. However, the development of swapping technology is now increasingly developed because it offers higher benefits such as mitigating range anxiety, improving battery life because professionals manage it, and can be developed into attractive payment schemes such as subscriptions. The selection needs to consider based on convenience, cost, infrastructure, and personal or business needs.

Table 31. Pros and cons of E2W Charging Types

No	Type of Charging	Remarks	Pros	Cons	Estimate Capital Cost	Estimate Installation Cost
1	Plugin Charging	Charging by connecting a plug from the infrastructure to the vehicle's port	▪ Can be charge at home or outside station ▪ Battery ownership ▪ Wider infrastructure; more common and widespread	▪ Longer charging time; depending on the electrical outlets ▪ Reduced flexibility	USD 780 – 2,470[47]	USD 78 – 247*
2	Battery Swapping	Quickly replace a depleted battery with a fully charged one at swapping stations	▪ Reduce range anxiety ▪ Reduce vehicle upfront cost ▪ Efficient charging arrangement ▪ Quick battery replacement ▪ Mitigate residual value of battery degradation	▪ Lack of standard; battery compatibility ▪ Safety issues ▪ Requires a network of swapping station	9,032[48]	903.2*
The need of standardization for swapping[49]			▪ Reduce expensive charging infrastructure investment (from both government and industry for common interoperability ▪ Can aggregate enough demand on e2w battery for industrial investment ▪ Can guide E2W industry for faster development			

**) Assumption of installation costs up to 10% of the total price*

Figure 31. Plug-in Charging System (Left) and Battery Swapping System. *Search Engine (2023)*

47 https://cleartax.in/s/ev-charging-station-in-india

48 https://m.indiamart.com/proddetail/electric-vehicle-battery-swapping-machine-2849824868148.html

49 Battery swapping regulations and standards in ASEAN. Nuwong Chollacoop. ENTEC. 2023.

3.2.2.2 EV and E4W Charging Technology

The technology for E4W, especially for BEVs, is almost the same as E2W but modified with greater power and different usage patterns. For example, battery swapping is difficult because the E4W battery is larger than the E2W. However, safety and convenience factors continue to be developed by private parties such as the Vinfast company which currently offers a subscription scheme for electric cars.

Table 32. E4W Power Source and Grid Requirement. *ITDP desktop research (2023)*

No	Type	Power Source	Includes an internal combustion engine or generator	Grid Connected (Plug-in)
1	BEV	Batteries (home or station)	No	Yes
2	FCEV	Hydrogen fuel	No	No
3	HEV	Primarily gasoline	Yes	No
4	PHEV	Gasoline, batteries (home or station)	Yes	Yes
5	EREV	Gasoline, batteries (home or station)	Yes	Yes

Table 33. EV and E4W Charging Level and Specs. *ITDP desktop research (2023)*

No	Level	Volt	Power Delivery	Range Added Per Hour	Charging Duration
1	1	120	1 – 1.4 kW	4 – 8 km	30 – 40 hours
2	2	208 - 240	3.9 – 19.2 kW	20 – 130 km	2.5 – 4.5 hours
3	3	400 - 900	24 – 300 kW	120 – 1900 km	30 – 40 minutes

Table 34. EV and E4W Charging Level and Plug Types

Level	Remarks	Location	Plug Type	Estimate Capital Cost[50]	Estimate Installation Cost[51]
1	Common household outlet. Slowest way to charge an EV. Suitable for PHEV due to smaller batteries size	Home, Workplace & Public	J1772, CHAdeMO,	USD 300 – 600	USD 300 – 1,500
2	Most suitable for BEV. 10 times faster than Level 1 charging.	Home, Workplace & Public	J1772, CHAdeMo, CCS Type 1, CCS Type 2	USD 600 – 1,000	USD 400 – 3,000
3	DC Fast Charge & Supercharging. Fastest type of charging.	Public	CCS Type 1, CCS Type 2, Supercharger	USD 10,000 – 40,000	USD 10,000 – 40,000

50 https://energy5.com/ev-charging-stations-capital-and-maintenance-costs-explained

51 https://energy5.com/ev-charging-stations-capital-and-maintenance-costs-explained

Figure 32. Types of EV Plugs[52]

Current Type	Region				
	Japan	America	Europe, rest of world	China	Supercharge
AC					
Plug Name:	J1772 (Type 1)	J1772 (Type 1)	Mennekes (Type 2)	GB/T	
DC					
Plug Name:	CHAdeMo	CCS 1	CCS 2	GB/T	

miro

3.2.2.3 E-Bus Charging Technology

The availability of power, especially for producing green energy, is a key factor in maintaining the e-bus ecosystem. Although the current mode already achieves zero emissions, it still involves the use of fossil fuel for power generation in a well-to-wheel cycle. This requires macro-level involvement and coordination. Generally, the provision of power generation and charging equipment is operated by different operators, but typically, they have power generators, distribution, and charging machines from the same OEM, such as but not limited to Siemens, GE, and ABB-Hitachi.

The charging market is extensive and varied, between Alternating Current (AC) and Direct Current (DC) charging equipment, ranging from slow to ultra-fast charging (50->500 kWh), and presented in various formats, including plug-in Combined Charging Station (CCS) dispensers, pantograph hoods, and pantograph masts. Space availability in depots or stations is a key constraint. The size of the equipment varies depending on the available space and vice versa. Some large-scale electrification projects have seen 10-20% parking space reduction due to the necessity of equipment placement.

Figure 33. CCS Wall Mounted Box (Left), Panto Down (Middle), and Panto Up (Right). *ABB*

52 Every EV Charging Standard and Connector Type Explained (lifewire.com)

Table 35. Typical Type of E-Bus Charging[53]

No	Type	Power	Remarks
1	CCS wall mounted	Up to 300 A and 24 kW power charging	Flexible, can placed on wall, pedestal, or cart
2	CCS ground mounted	Up to 400 A and 50 – 180 kW power charging	Offers more variation, some model can charge four buses simultaneously
2	Pantograph-down	Up to 1000 A and fast charging 150 – 450 kW (voltage range 150 – 850 V)	Enables multiple vehicles to leverage the same charging infrastructure reducing the cost per vehicle
3	Pantograph-up	Up to 1000 A and fast charging 320 – 480 kW (voltage range 150 – 850 V)	Offers redundancy and high fleet uptimes

Identification of the Current Charging Technologies in Indonesia

Before examining the state of charging technology in Indonesia, it is first necessary to provide an explanation of the types of infrastructure that are applicable in Indonesia. This will provide a clearer understanding of the context within which the technology is developed.

SPLU – Public Electric Charging Station

The SPLU is a facility for recharging or accessing electrical energy supply provided by the government for the public. Anyone in need of electrical energy can utilize SPLU by paying according to the amount of power used. The SPLU is mainly used for home supply and street-side vendors. However, in general, they can also be used for charging 2W batteries (slow charging) and some certain types of E4W, since it only delivers a power range between 5,500 VA to 22,000 VA.[54] There are four types of SPLU that are available for the public, starting from standing/tower, hook/pole mount, hang/wall mount, and stall/pedestal.

Figure 34. SPLU Hook and Wall Mount Type. *Search Engine (2023)*

53 9AKK108467A8434 Charging solutions for eBuses - 06 2023_Rev B (abb.com)

54 Kompas (2019). Available at: https://otomotif.kompas.com/read/2019/09/11/082200715/apa-perbedaan-splu-dengan-spklu-buat-kendaraan-listrik-. Accessed (Dec 2023).

SPKLU - Public Electric Vehicle Charging Station

Figure 35. SPKLU by PLN. *ITDP (2024)*

On the other hand, for SPKLU, it has the same function as SPLU but with higher power, ranging from 22 kW to 150 kW. The development of SPKLU in Indonesia is also carried out by private companies, commonly known as non-PLN SPKLU. The BEV charging rate in Indonesia is classified nearly the same as in the global market, which differentiated by both power and charging time. Currently, there are 3 types of SPKLU plug socket-outlets proposed in the Ministerial Regulation Draft, namely Type 2 AC Charging, DC Charging CHAdeMo, and DC Charging Combo Type CCS2[55].

Table 36. BEV Level Charging in Indonesia[56]

Description	Level 1 (Slow Charging)	Level 2 (Moderate Charging)	Level 3 (Fast Charging)	Level 4 (Super-Fast Charging)
Location	Home installation	Office installation	SPKLU	SPKLU
Maximum output current (A)	16 AC	63 AC	100 AC/250 DC	300 AC/500 DC
Output power	< 3.7 kW	< 22 kW	< 50 kW	< 150 Kw
Type of pug-in connector	Type 1 and 2 (EC 62196-2)	Type 2 (EC 62196-2)	Combine type charging CCS and CHAdeMO (EC 6196-3)	Combine type charging CCS 2 and CHAdeMO (ICE 62196-4)
Charging time*	8 hours	4 hours	30 min	15 min

**) The appropriate charging time may vary depending on the vehicle battery capacity and the battery's condition at the beginning of the charging process*

55 (Kementerian Energi dan Sumber Daya Mineral, 2020)

56 Dharmawan et al (2021). Perkembangan Infrastruktur Pengisian Baterai Kendaraan Listrik di Indonesia.

SPBKLU - Public Electric Vehicle Battery Exchange Stations

SPBKLU or battery swap station (BSS) is a facility designed for quickly exchanging the depleted battery of BEV with a full charge, which typically can be done in a matter of minutes. This approach aims to reduce the time required for charging, and improve convenience, especially for long-distance travel. In general, battery swapping facilities in Indonesia typically handle batteries with nominal voltages of 48 volts, 60 volts, or 72 volts, where the nominal capacity of these batteries is at least around 20 ampere-hours (Ah). The selection of nominal voltage and capacity is based on SNI 8289:2020.

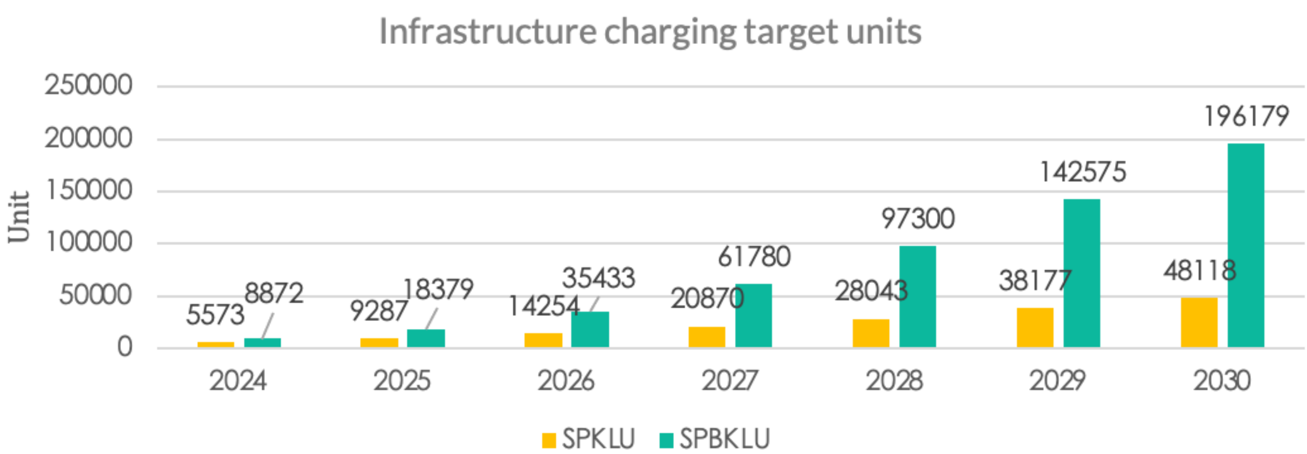
Table 37. Specifications of Nominal Voltage, Nominal Capacity, and Standard Battery Pack Size

Nominal Voltage (V)	Capacity Voltage Minimum (Ah)
48	12/20
60	20
72	20

Progress of Charging Infrastructure Implementation

Based on data from the Ministry of Energy and Mineral Resources in 2023, there are currently a total of 842 Public Charging Station (SPKLU) and 1,346 Public Electric Vehicle Battery Exchange Stations (SPBKLU) located in public areas. These figures do not include charging units provided by private operators in Indonesia. However, when compared to the 2024 plan, the adoption of SPKLU is lagging by 91%, and 85% for SBPKLU on a national scale. Refer Table 76 to for further details on the distribution and types of data charging stations in all Indonesian cities.

Figure 36. National Development Plan for SPKLU and SPBKLU. *Ministry of Energy and Mineral Resources (2023)*



In its implementation, several regulations have been developed to facilitate the acceleration of BEV charging infrastructure development. These regulations address the ease and certainty for businesses intending to build SPKLU and SPBKLU. They also cover cost determination and the need for a single gateway system to streamline integrated information systems at both national and sub-national levels.

Table 38. Ministry of Energy and Mineral Resources Regulation to Accelerate Adoption BEV Charging Facility

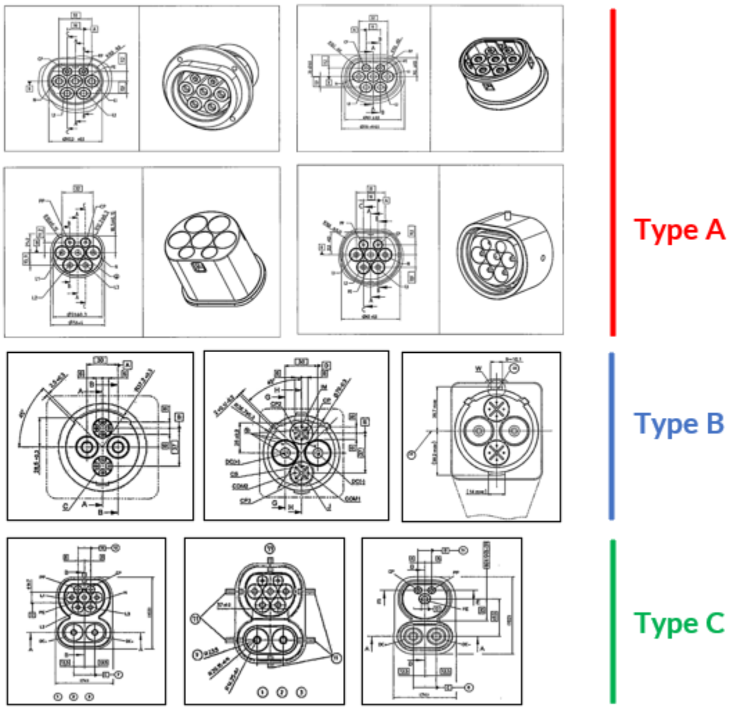
Policy	Remarks
Ministry of Energy and Mineral Resources Regulation No. 1/2023 on Provision of Electric Charging Infrastructure for BEV	• Applied for public electric vehicle charging station, battery swap station, and private electric installation. • The SPKLU licensing process is facilitated through the online single submission system. • Business scheme o Electric supply business license and business area o State-own energy companies and/or other business entities. o Initial assignment for PLN o PLN can collaborate with state-own enterprise and/or business entities. • Connector types, charging types, mapping location, and charging technology. • Obligation to have an online application connected to the single gateway of Ministry of Energy and Mineral Resources • Electricity tariffs o Battery rental fee = recharge cost + SPBKLU investment o TTL (based on certain classification) = maximum IDR 1,644.5/kWh, maximum IDR 2,467/kWh + special service fee for fast/ultra-fast charging • Incentives for business operation and installations • Electrical safety o Charging stations must comply with the Electrical Safety Regulations o Operation Safety Certificate from the charging station by the Technical Inspection Institution o Product standard compliance of the charging station by the Product Certification Institution
Ministry of Energy and Mineral Resources decision letter No.182, K/TL.04/MEM.S/2023 on Charging Service Fees for Public EV	• SPKLU that utilizing fast charging technology are priced at a maximum of IDR 25,000 • SPKLU that utilizing ultra-fast charging technology are priced are maximum of IDR 57,000
Ministry of Energy and Mineral Resources Single Gateway System[57]	• Providing information related to SPKLU, including the location and coordinates of SPKLU, connector types and charging specifications, as well as electricity tariff details, aims to facilitate the public in charging their EV

Slow charging technology, at the very least, consists of recharging alternating current using a type 2 connector (type 2 series). Medium charging technology, fast charging technology, and ultrafast charging technology, at the very least, consist of:

- Recharging alternating current (alternating current charging system) using a type 2 connector; (A)
- Recharging direct current (direct current charging system) using a connector with AA series configuration; (B)
- Recharging a combination of alternating current and direct current (combined charging system) using a connector with FF series configuration. (C)

57 sistem informasi pengawasan dan evaluasi spklu & spbklu. SPKLU-SPBKLU (artristik.co.id)

Figure 37. Type of Charging Port Regulated in Indonesia. *Ministry of Energy and Mineral Resources (2023)*



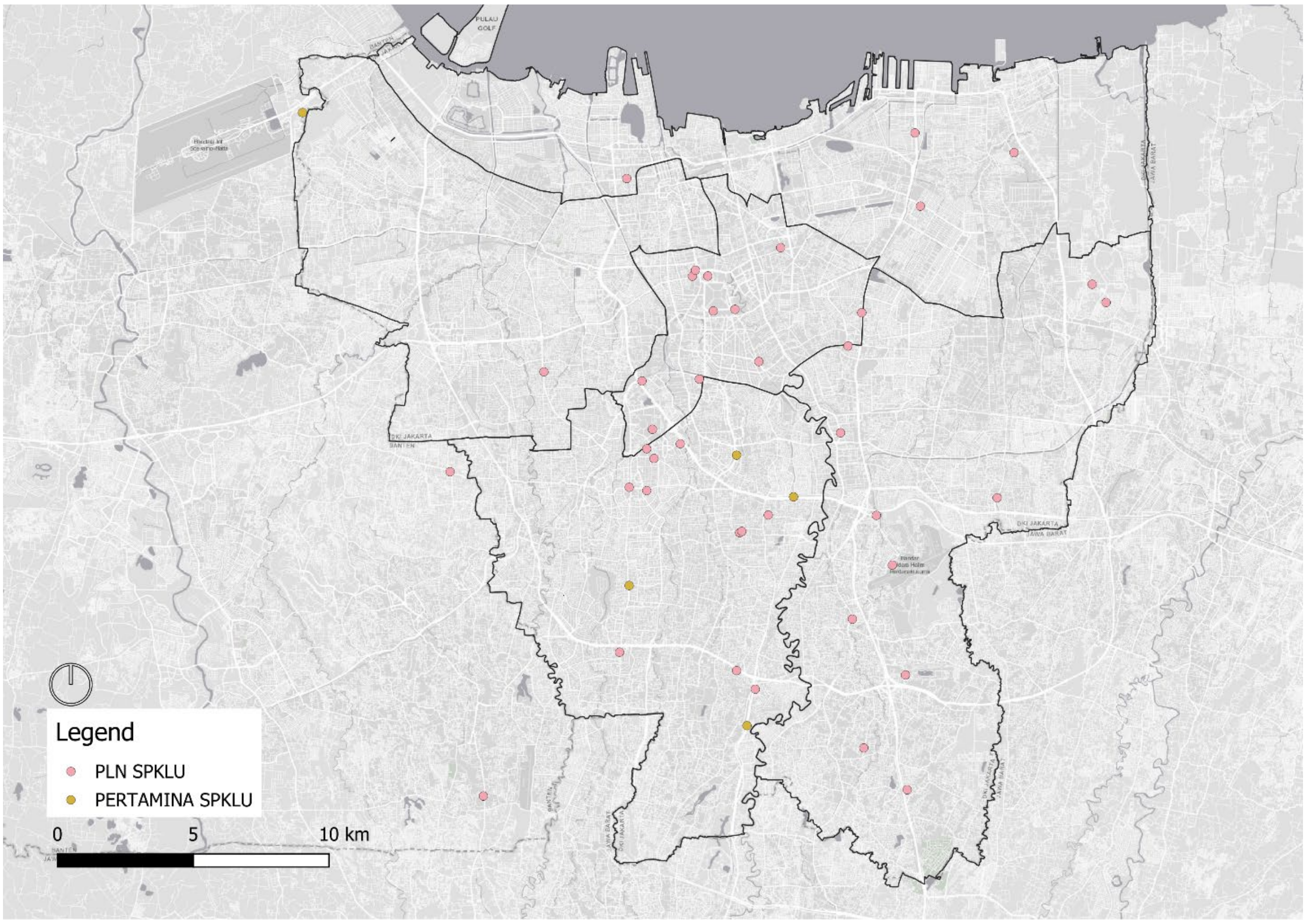
3.2.2.4 Jakarta Context

Just like the ecosystem in general, electric charging stations in Jakarta can be divided into 3 categories: SPLU, SPKLU, and SPBKLU. For SPKLU, based on 2023 data, there are a total of 136 charging locations with a total of 258 charging units. In addition to PLN and Pertamina as energy companies in DKI Jakarta, SPKLU units are also managed by private companies with various types of technology ranging from slow charging to ultra-fast charging. The following is a list of SPKLU managers and information on the number of units:

Table 39. List of Owner Operator and Units SPKLU in DKI Jakarta

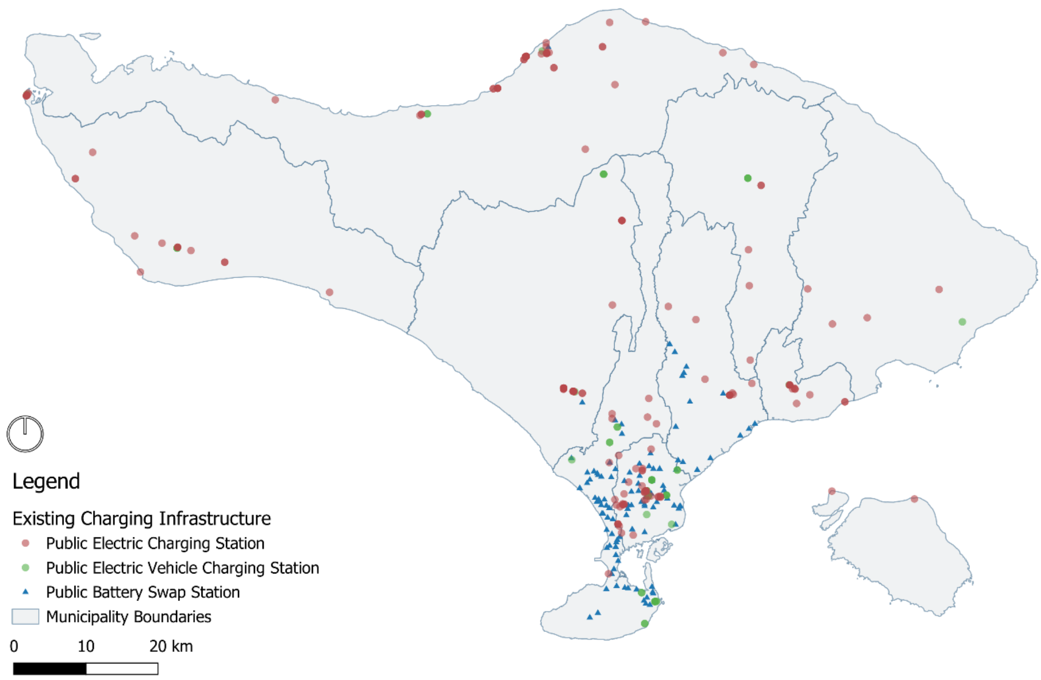
Owner/operator Name	Unit	Owner/operator Name	Unit
PLN	113	EVCuzz Indonesia	4
Pertamina	7	Astra OtoPower	3
BPPT	1	Mitsubishi	13
Blue Bird	15	Hyundai	38
Shell Indonesia	3	Mercedes-Benz	1
Medco Energi	1	BMW	2
Stravo Indonesia	57		

Figure 38. The Distribution Map of SPKLU Managed by PLN and Pertamina. *Disnakertransgi (2023)*



3.2.2.5 Bali Context

Figure 39. Existing Charging Infrastructure Distribution in Bali Area, 2023. *Land Transport Agency Bali and PLN (2023)*



The development of charging infrastructure in Bali continues to experience improvement every year. In its development, the existence of SPLU has been widely provided by PLN as a common electricity supply since early times, mainly on the islands of Java and Bali. This was then expanded with the establishment of SPKLU and SPBKLU to support the BEV ecosystem. Additionally, in 2022, the President inaugurated the first 60 ultra-fast charging SPKLU in Indonesia, along with 21 fast charging SPKLU, and 150 home charging units in Bali area, as part of the promotion during the G20 Summit event to accelerate the adoption of BEVs.

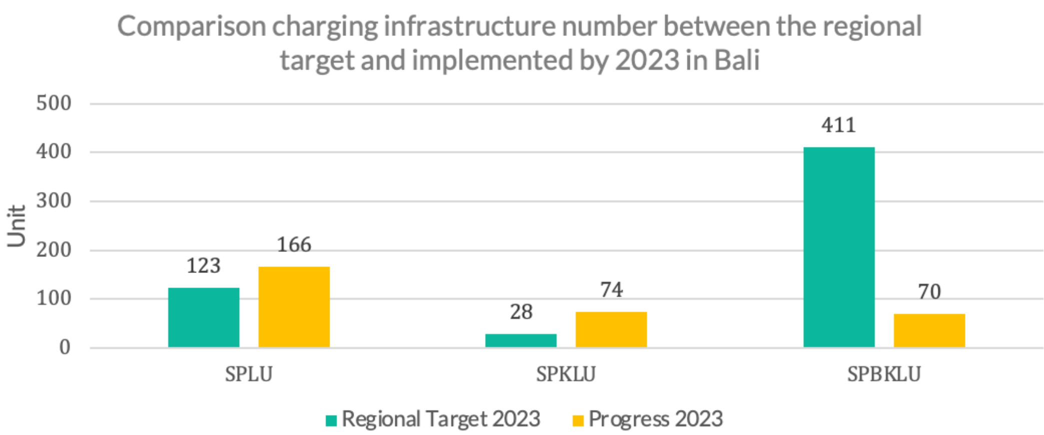
In 2023, Bali has approximately 74 SPKLU and 70 units of SPBKLU. These SPBKLU locations are mainly found in convenience stores but are also available in other places such as shopping centers, restaurants, and banks. Through collaborations with the government, the infrastructure providers in Bali are predominantly managed and developed by private operators, namely Swap and Oyika, Kilats, and Sistem Ganti Baterai (SGB).

Figure 40. BSS by Swap and Oyika Company. *Search Engine (2023)*

Targets and Realization

In its realization, the number of charging infrastructure facilities for BEV in Bali has exceeded the moderate target for 2023 (both for SPLU and SPKLU). However, the number of SPBKLU is still a quarter of the planned target[58].

Figure 41. Regional Action Plan Moderate Targets and Implemented Charging Infrastructure, 2023



58 PLN UID Bali. 2024. Pembangunan Stasiun Pengisian Listrik Umum (SPKLU) untuk Percepatan KBL BB di Bali.

3.3 Collecting Public Transport Data

Collecting and assessing public transport data in Jakarta and Bali, including fleet numbers, targets, realization, and operating plans, is essential for optimizing and advancing sustainable transportation. These data points offer insights into the current state of public transport. Fleet numbers offer a snapshot of existing infrastructure, while targets and realization metrics gauge progress towards sustainable transport goals. Examining operating plans, especially for e-buses, informs interventions for enhanced efficiency. This thorough data collection and assessment contributes to strategic planning, aligning public transport systems with environmental, social, and economic objectives in the target area.

3.3.1 Jakarta Public Transport Data

3.3.1.1 Target and Realization

As of December 2023, Jakarta has operated 100 e-buses, all the e-buses deployed at the non-BRT routes. The e-bus operation has been running since March 2022 with 4 buses and gradually increased until completed the target to operates 100 e-buses by the end of 2023. Jakarta has committed to electrify 50% of Transjakarta's fleet by 2027 and 100% by 2030, equivalent to 10,047 fleets. The plan has been formalised in a Governor Decree No. 1053/ 2022 on Guidelines for the Acceleration Program for the Use of BEV under Transjakarta Transportation Services. Previously, Transjakarta had committed to electrifying their fleets on their Long-Term Corporate Plan. Under the Fossil-Fuel-Free-Streets Initiative by C40 Cities, The Government of Jakarta has also committed to only procure zero emission buses starting in 2025 and run e-bus pilot.

3.3.1.2 Existing and Planned Operating Plans

The public transportation network in Jakarta is divided into rail-based and road-based systems. The road-based network is served by the BRT system (Transjakarta), which operates a fleet of buses and minibusses. The Transjakarta system has been in operation since 2004 and has gradually expanded to include 13 corridors as of 2023. The BRT system is complemented by direct services through non-BRT feeder buses and angkot/ paratransit managed by cooperatives. Starting from 2018, some regular angkot services are integrated with Transjakarta service under the name Mikrotrans (microbus) through a system called JakLingko to enhance an integrated multimodal system and increase public transportation usage in Jakarta.

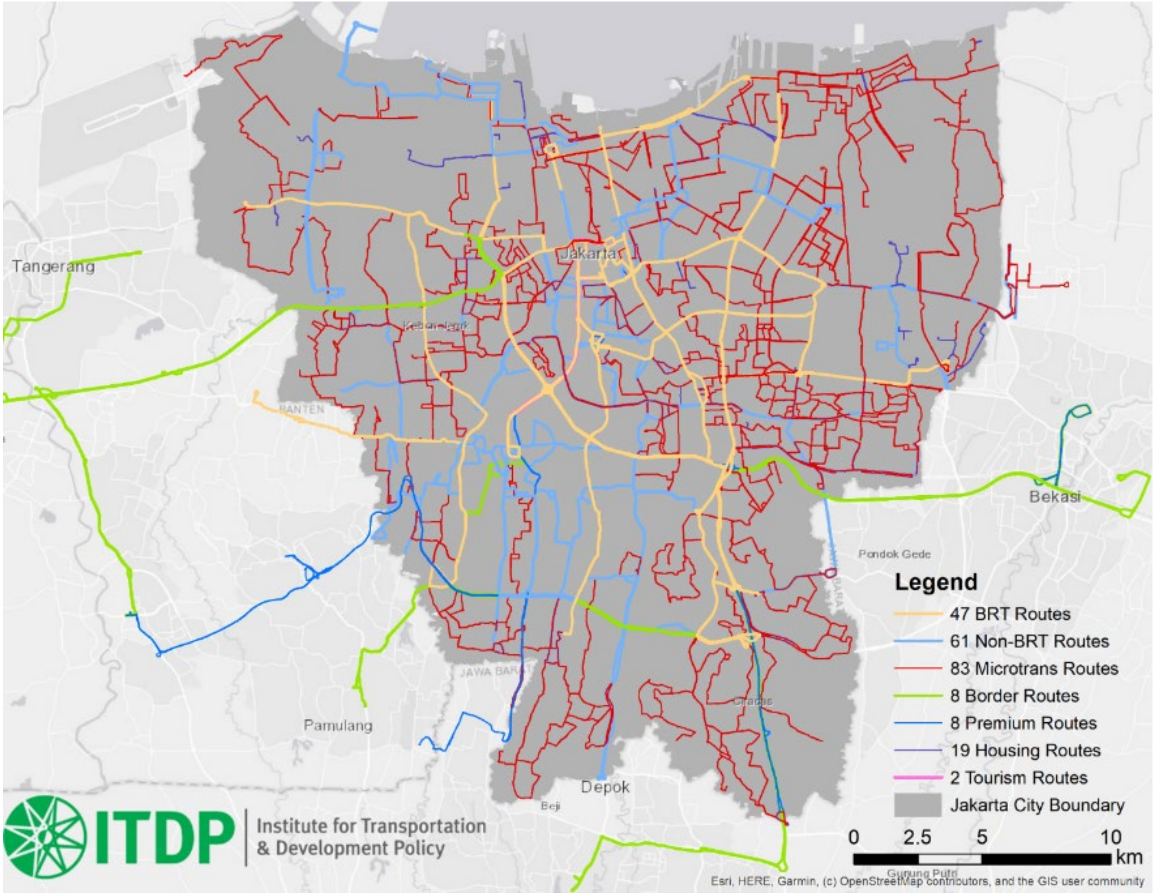
Transjakarta

Transjakarta currently operates seven services under different services to accommodates different characteristics based on the fleet, infrastructure, and targeted passengers. The services are as below.

1. BRT Services: Operates on segregated (physical) lanes, with a proportion of 20.6% of the total route.
2. Direct Service: Operates on and off corridors, catering demand on the narrower streets in the residential areas. Proportion of 26.8% of the total route.
3. Royaltrans: Premium service (non-subsidy) services, equipped with premium facilities onboard, such as free Wi-Fi, TV, CCTV, and charging sockets. This service consists proportion of 20.6% of the total route.
4. Border Route: Operates on agglomeration cities around Jakarta such as Depok, Tangerang, and Bekasi, and is integrated with BRT services. This service consists proportion of 3.5% of the total route.
5. Affordable Housing Route: One of the access routes connecting the residents of subsidized housing in Jakarta with the city centres with a proportion of 8.3% of the total route.
6. Tourism Route: Service operates in tourism areas and city landmarks in Jakarta with a free charge. This service consists proportion of 0.9% of the total route.

7. Mikrotrans: using a 4-meter fleet, the service runs around 72 routes that connect people from residential areas to the city centre and public transport with free charge. This service consists of 36.4% of the total route.

Figure 42. **Entire Transjakarta Services.** *Transjakarta (2023)*



Bus Regular Services (Angkutan Kota/ Angkot)

Aside from the Transjakarta services, the road-based public transport services in Jakarta are also covered by the regular services operated by private operator by obtaining the routes permit from the Jakarta Transport Agency. Based on the Jakarta Provincial Open Data Resource (2018) [59], there are more than hundreds of angkot routes, and starting from 2018 most of the angkot lines are gradually integrated under the Mikrotrans services under Transjakarta. The remaining angkot lines are hard to trace as those data are not publicly available. For an example of angkot lines in 2018 can be seen in Table 77.

School Bus

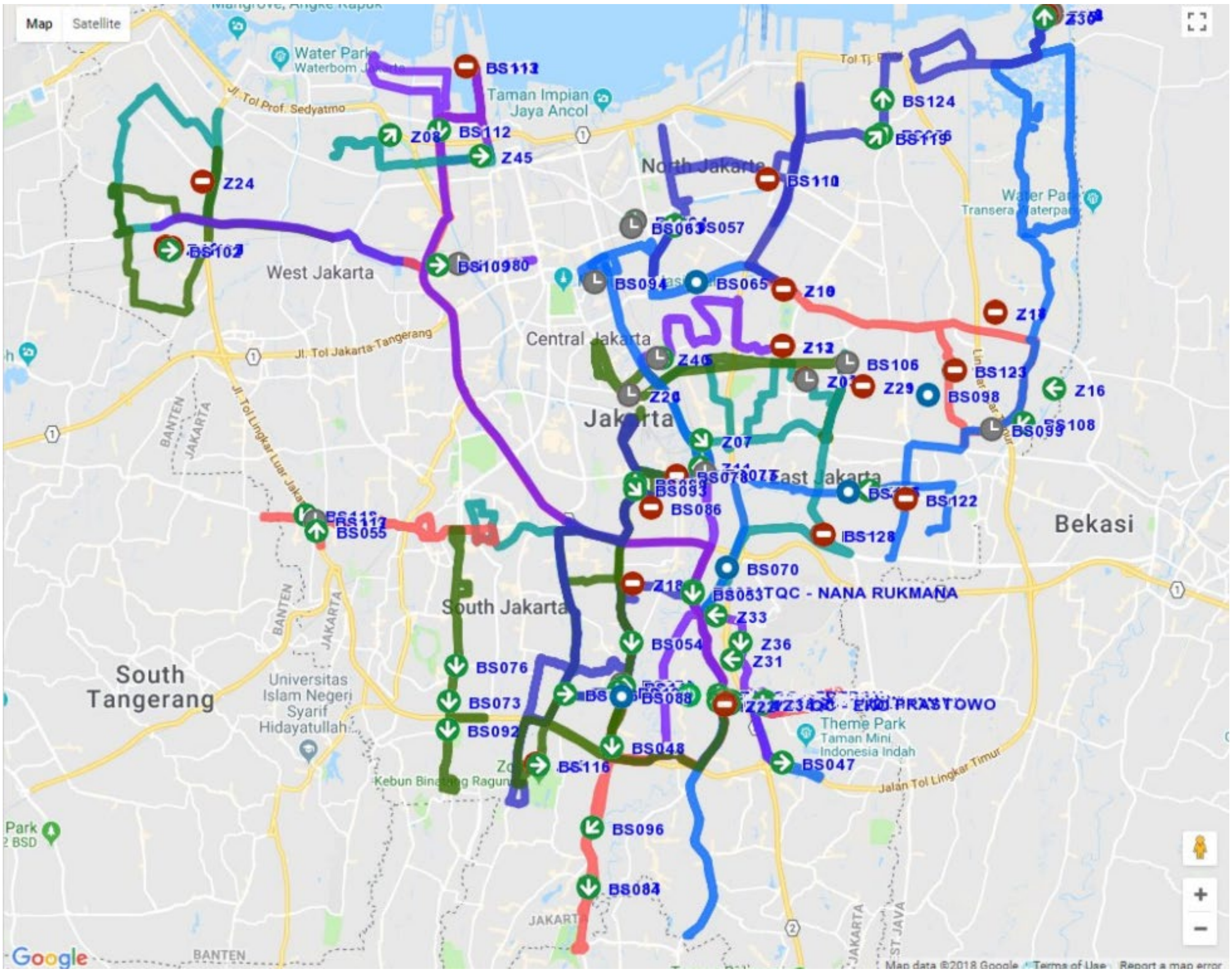
The school bus serves as a government-provided mode of transportation designed to ensure convenience, efficiency, and comfort for students using public transportation. Implementing school buses can be a viable alternative to educate students on utilizing public transportation facilities and discourage reliance on private vehicles, particularly two-wheelers which are associated with lower safety standards.

Based on the publication data on School Bus Jakarta Official Account[60], there are 41 routes, and the route visualization could be seen in the picture below.

59 https://data.jakarta.go.id/dataset/daftartrayekangkutanumum

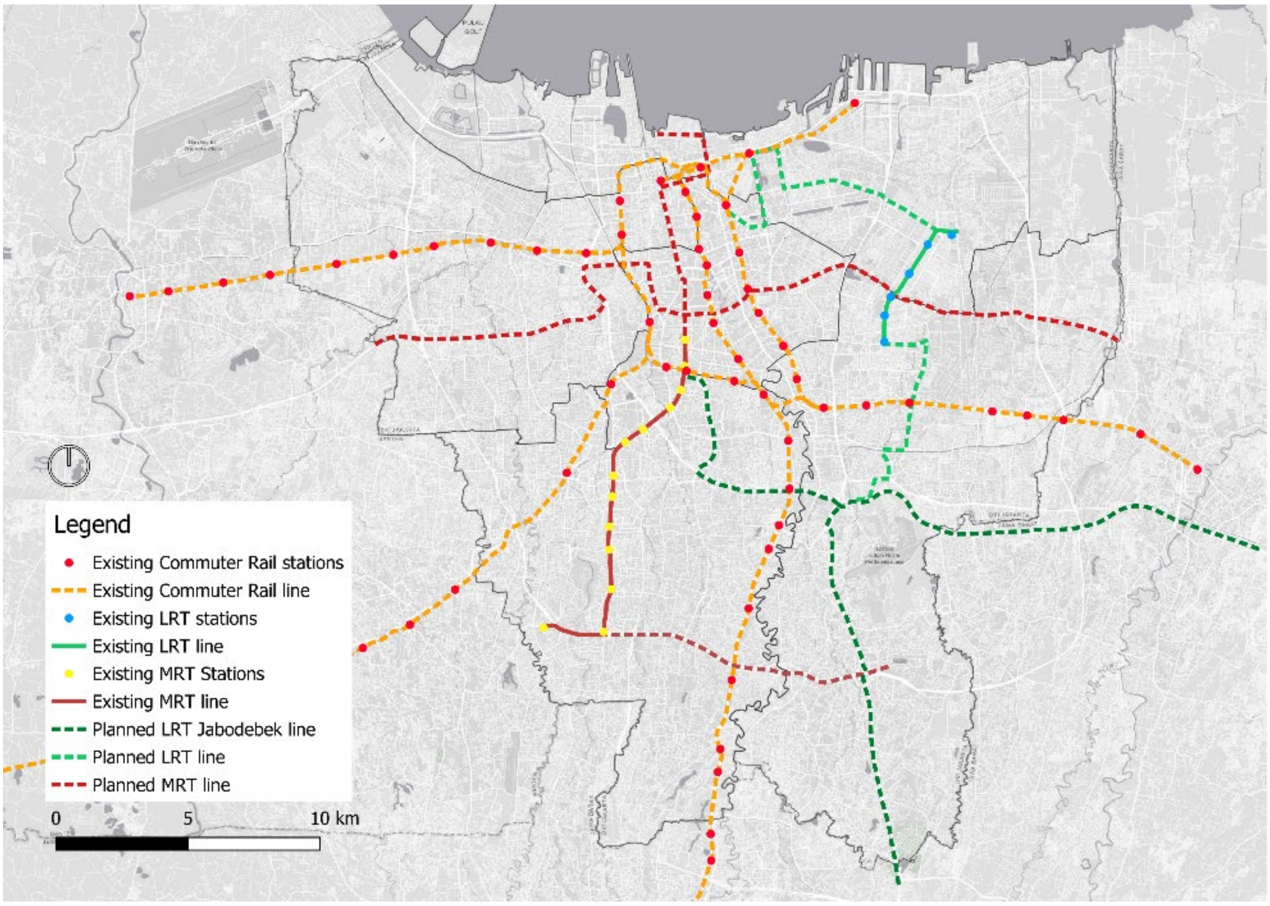
60 https://twitter.com/bussekolah_dki/

Figure 43. Jakarta School Bus Network



For the rail-based network, Jakarta is served by KRL Commuter Line, MRT Jakarta, LRT Jakarta, and LRT Jabodetabek. The Commuter Line plays a vital role in supporting the mobility of the surrounding cities of Bogor, Depok, Tangerang, and Bekasi (Bodetabek) to reach Jakarta, consisting of 5 main lines and 7 connection lines. MRT Jakarta, LRT Jakarta and LRT Jabodebek, on the other hand, are relatively newer services that focus on the urban area. The rail-based transport will not be elaborated further as the rail-based transport is not the main scope of the study.

Figure 44. Jakarta's Rail-base Public Transportation

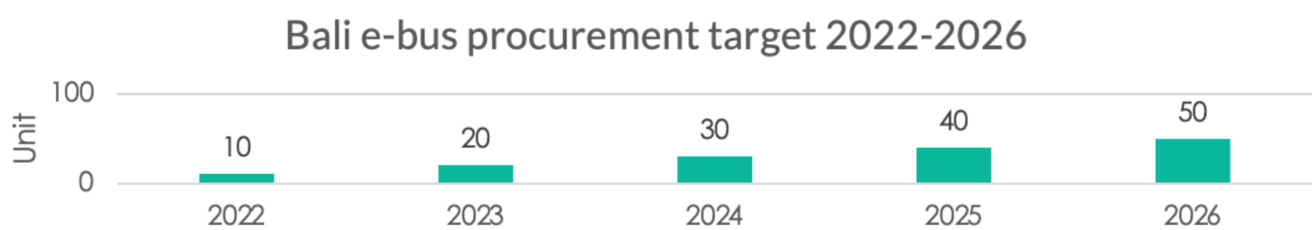


3.3.2 Bali Public Transport Data

3.3.2.1 Target and Realization

The Bali government's commitment has put through the Bali EV Action Plan. This document not only highlights the commitment but also the diverse partners to foster sustainable and forward-thinking transportation solutions for the province. Public transportation target under the Bali EV Action Plan binds the target of e-bus adoptions for 2022 to 2026 by the target for each year as follows:

Figure 45. Bali E-Bus Target. Bali EV Action Plan



In 2022, when Indonesia took on the role of hosting the G20 summit in Bali, the Indonesian Government undertook a commendable initiative. They made 41 fleets of e-buses accessible for the entire delegation, providing sustainable transportation solutions throughout the event. Following the summit's conclusion, these electric buses were repurposed for trial runs in Bandung and Surabaya, allowing authorities to assess their performance in different urban settings.

Despite these trials in other cities, it is notable that Bali, where the G20 event took place, has not yet implemented commercial operations for e-buses. The transition from trial phases to full-fledged commercial use often involves careful consideration of various factors, including infrastructure readiness, public reception, and logistical challenges. The absence of commercially operational e-buses in Bali suggests that further steps or considerations may be underway before embracing electric buses as a regular mode of public transportation in the region.

3.3.2.2 Existing and Planned Operating Plans

In addition to the EV target and its implementation, Bali offers a range of conventional public transport services provided by various stakeholders, including the National, Provincial, City Governments, and the private sector. Among the available options are Trans Metro Dewata, Trans Sarbagita, School Bus, Angkot, and Kura-Kura Bus.

Trans Metro Dewata

In September 2020, the Bali Provincial Government received funding for the BTS program as a subsidy from the Central Government to pay operators in providing public transport service. Based on the first contract, the service contract is for a duration of 5 years and will conclude by the year 2025. The public transport service consists of 5 corridors for Trans Metro Dewata, with PT Satria Trans Jaya as the operator, a consortium of 4 existing public transportation companies: PT Gunung Harta, PT Dewata Tourism, PT Restu Mulya, and PT Merpati Transport. The operation for this corridor utilizes 8-meter medium bus (high deck with low entry) with a capacity around 39 pax (19 seating capacity including the priority seat and 20 handrails for standing passenger).

Figure 46. Trans Metro Dewata Bus Stop (Left) and Bus Pole (Right)

The BTS program is a government initiative in which urban public transportation services are procured by the central government through the Ministry of Transportation. This involves the acquisition of urban public transportation services from established operators through a bidding mechanism based on a predetermined SPM. The service purchase is calculated based on the operational cost formulation of the vehicles, resulting in a cost per kilometer in IDR (the rate per kilometer is approximately IDR 9,000). Consequently, the operator is compensated according to the distance traveled in kilometers. The BTS program operates under a gross-cost contract for public transportation system.

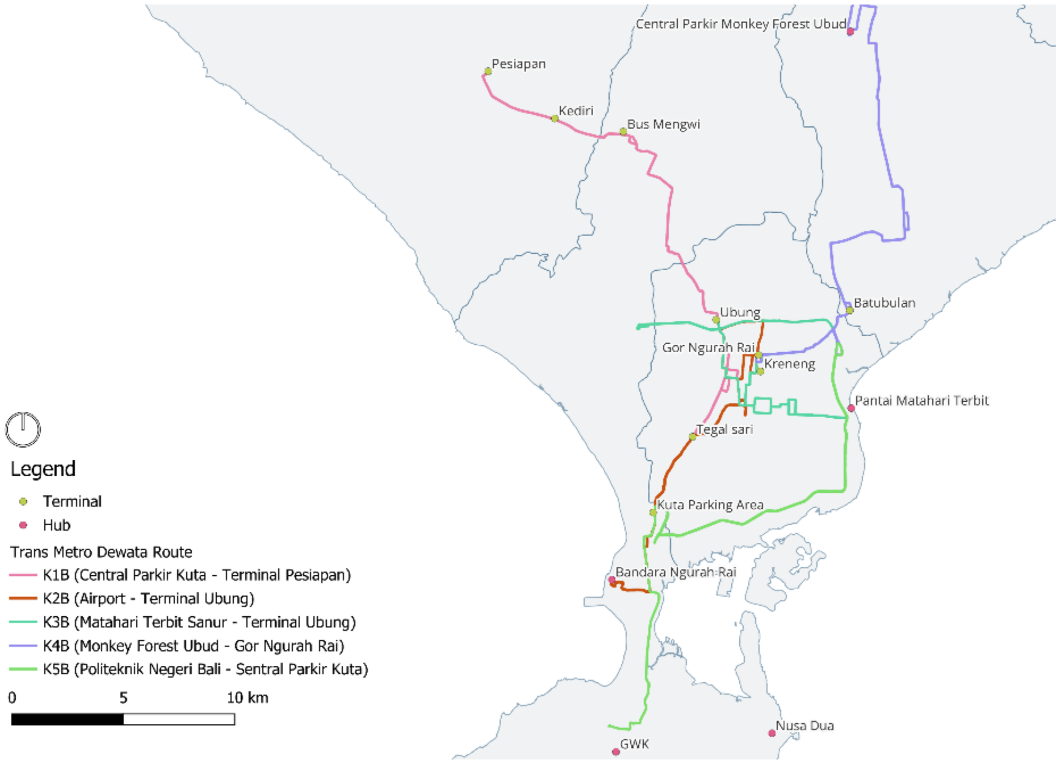
Trans Metro Dewata was introduced to replace the pre-existed Trans Sarbagita service, due to the occurrence of corridor inactivity from the Trans Sarbagita service. The service route of Trans Metro Dewata are represented in the figure and table below.

The fare cost of Trans Metro Dewata is governed by the Ministry of Finance, through the Ministry of Finance Regulation 55/2023, as this program is initiated by the national government. The fare cost was set at IDR 4,400/trip with only to the smart payment (QR and Card). The operation of Trans Metro Dewata has been improved compared to the regular bus service, which it only serves people at the designated bus stop (high floor) and bus pole (low floor).

Table 40. **Trans Metro Dewata Service Routes.** ***ITDP desktop research (2023)***

No	Corridor	Length (Km)	Fleet Number	Bus Daily Kilometer Traveled (km)	Bus Type
1	Sentral Parkir Kuta Badung – Terminal Persiapan Tabanan	61.0	24	251.3	8-meter medium bus (high deck-low entry) with 39 pax of capacity
2	GOR Ngurah Rai – Bandara Ngurah Rai	32.5	17	200.9	
3	Terminal Ubung – Pantai Matahari Terbit	33.0	17	203.9	
4	Gor Ngurah Rai – Monkey Forest	63.0	24	254.2	
5	Sentral Parkir Kuta – Politeknik Negeri Bali	69.0	23	284.3	

Figure 47. **Trans Metro Dewata Service Routes. ITDP desktop research (2024)**



Trans Sarbagita

Trans Sarbagita was introduced in mid-August 2011 by the Bali Provincial Government to provide public bus transit services. Initially, the buses were provided as a grant from the National Government and operated by PERUM PPD funded by the Bali Transport Agency's allocated budget which comes from APBD. These buses were high-deck 8-meter buses with 35 pax of passenger capacity, this service offers a fare of IDR 3,500 per person per trip and free fare specific only for the student. Since 2020, Trans Sarbagita has enabled the smart payment system using QRIS (Quick Response Code Indonesia Standard), to support the transition into digitalisation and increasing the payment efficiency. Due to the high-deck design, Trans Sarbagita stations utilize high-floor platforms for boarding and alighting. Trans Sarbagita was planned to operate in 17 corridors[61] with a total length of 859.6 km.

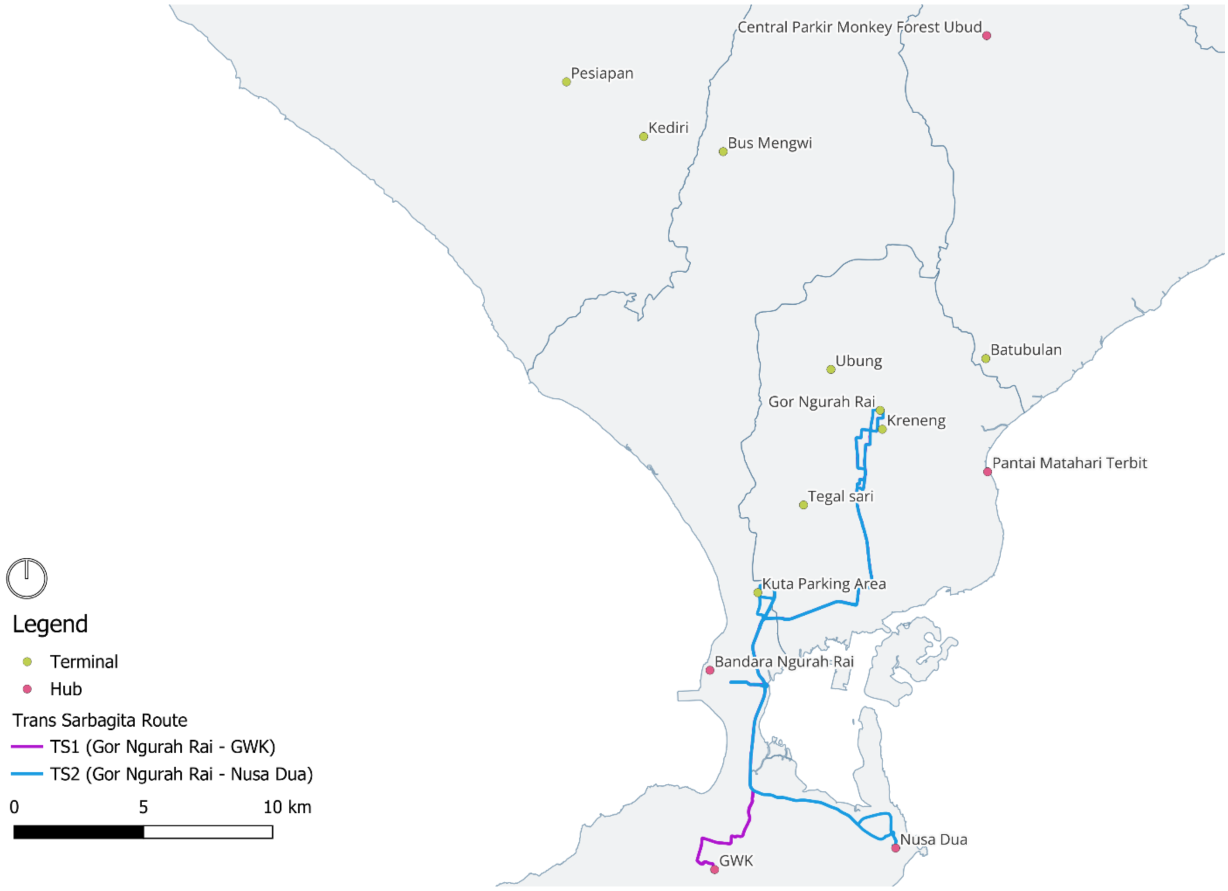
Figure 48. Trans Sarbagita Bus and Shelter

The Sustainable Urban Mobility Baseline Assessment study for the Sarbagita Metropolitan Area revealed that the planned fleet for Trans Sarbagita was intended to consist of 177 buses. However, the actual number in operation per 2023 is only 10 buses. This significant shortfall in the bus fleet made it nearly impossible to adhere to the planned headway, resulting in reliability issues and increased average wait times for passengers.

61 I Nyoman Budiartha R.M., Putu Asih Anggarini, Eka Tamar Agistini, Nyoman Gery Arishandi and Dyah Ayu Lestari (2014), Analisis Kelayakan Finansial Pengoperasian Bus Trans Sarbagita Koridor Vi, The 17th FSTPT International Symposium, Jember University, August 23, 2014

On average, passengers experienced a waiting time of around 1 hour for Trans Sarbagita services, making it less attractive than private transportation modes. The discrepancy between the planned and actual fleet size had a tangible impact on the efficiency and appeal of the public transportation system in the area. Currently, Trans Sarbagita operates in two corridors: Corridor 1 (Kota-GWK) and Corridor 2 (Kota-Nusa Dua), the representative image are as below.

Figure 49. Trans Sarbagita Service Routes. *Bali Transport Agency (2023)*



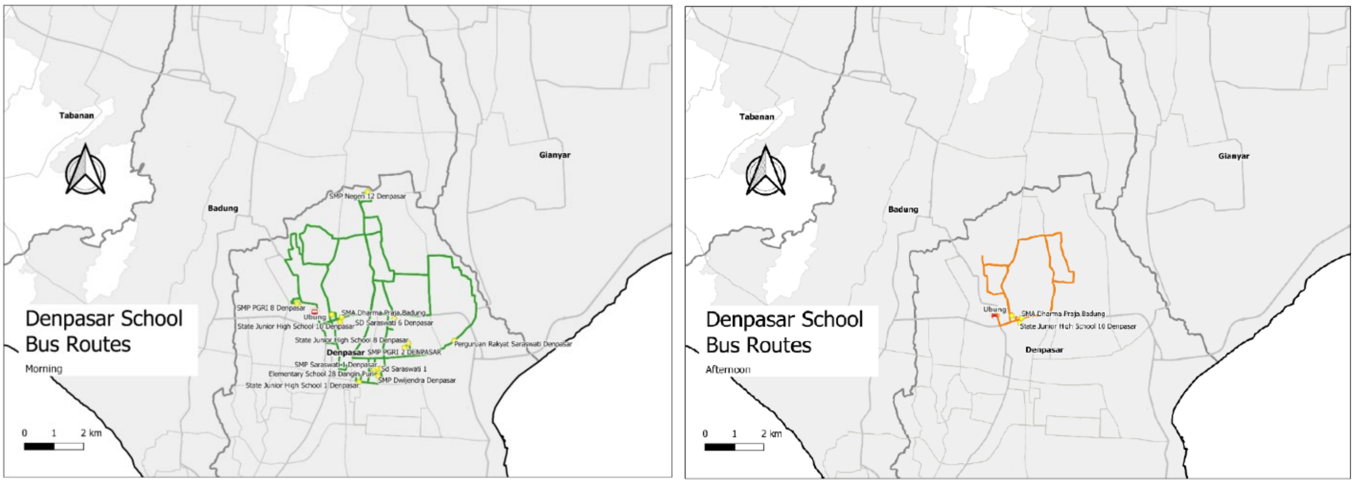
School Buses

The school bus serves as a government-provided mode of transportation designed to ensure convenience, efficiency, and comfort for students using public transportation. Implementing school buses can be a viable alternative to educate students on utilizing public transportation facilities and discourage reliance on private vehicles, particularly two-wheelers which are associated with lower safety standards.

School buses are utilizing minibus with the capacity of 25 pax, equipped with many features like Air Conditioner (A/C), Wi-Fi, CCTV, Mobile apps tracker, Power Outlet, etc. These features are aimed to attract students to leave their private vehicles and shift to the school buses. According to the Denpasar Transport Agency, in 2021 the number of school buses are 13 fleets[62]. In Denpasar, school buses are made available to cater Secondary School and Junior High School. The school bus routes are represented in the figure and table below. The figure below displays the school bus routes, while Table 78 in the appendix provides details on each route's distance.

62 Bus Sekolah DPS Official Account

Figure 50. Denpasar School Bus Network Morning (Left) and Afternoon (Right)

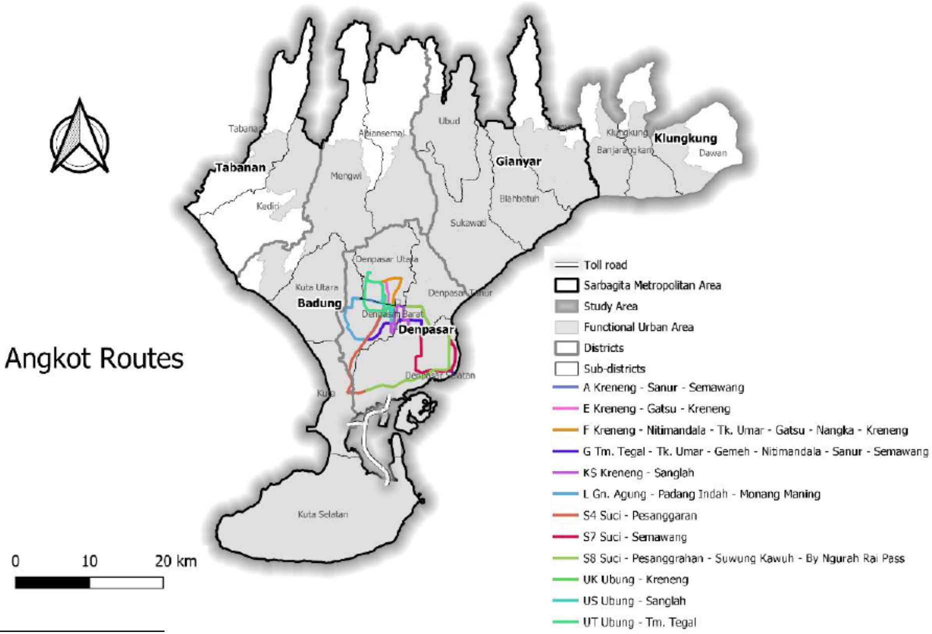


In addition to Denpasar, other cities in Bali, specifically Gianyar and Tabanan, have implemented a commendable initiative by introducing free school bus services within their regions. This strategic move aims to enhance the safety and convenience of student transportation. The provision of these buses ensures a reliable means for students to be picked up from and dropped off at designated locations, contributing to the overall efficiency and well-being of the educational system in these areas.

Angkutan Kota (Angkot)/ Bemo

Like many other regions in Indonesia, Bali offers Angkot, or known as "Bemo", as a public transport option. However, the demand for Angkot has steadily declined, primarily influenced by people's reliance on private modes of transportation. Consequently, the Angkot industry is gradually collapsing, as evidenced by the decreasing number of fleets over the past five years. This condition is well reflected by the number of Angkot fleets decreasing during the past 5 years. According to the data from Denpasar Transit Agency[63] the Angkot fleets numbered 285 units in 2020, but this figure dwindled to 37 units in 2021. Subsequently, the number further decreased to 26 fleets in 2022 and a mere 17 fleets in 2023. Even among the 17 fleets in 2023, only 2 are considered roadworthy.

Figure 51. Angkot Network. *KIAT (2023)*



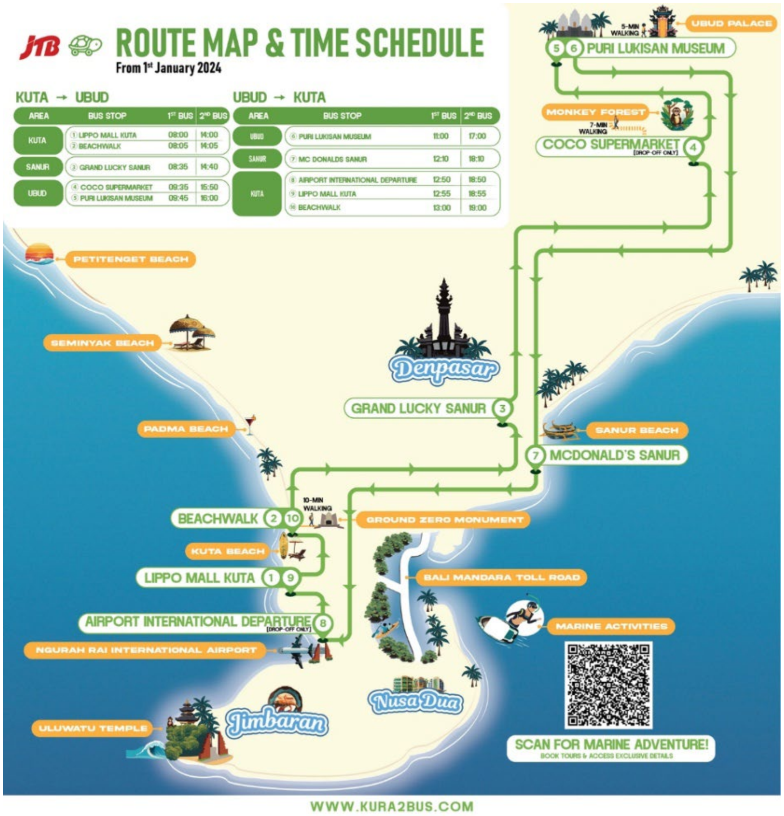
63 Denpasar Cuma Punya 2 Angkot Layak Jalan Tahun Ini (Kompas.com)

Kura-Kura Bus

The Kura-Kura Bus, a public shuttle bus service managed by a private company, operates daily in popular tourist destinations such as Kuta, Legian, Seminyak, Nusadua, Jimbaran, Sanur, and Ubud. Established in 2015 through the collaboration between PT JTB INDONESIA and Koperasi Wahana Dharma Organda Bali, the Kura-Kura Bus aims to provide safe, comfortable, reliable, and affordable shared transportation facilities in Bali.

The services utilize 12 to 15 seats minibus on one route: Kuta-Ubud (round trip), where previously, back in October 2019, the service was operated on 5 routes. This is due to the service being heavily impacted by the COVID-19 travel restriction, as the Kura-Kura bus target market is the tourists for accessing the popular tourist destinations. Related to the Kura-Kura Bus schedule along with the details of its stops can be seen in Table 79 in the annex.

Figure 52. Kura-Kura Bus Network. *Kura-kura Official Website (2024)*



3.4 Exploring EV Options

Specifically for the Bali area, EV options activities were conducted in line with stakeholder engagement activities to provide more focused output results. During the stakeholder engagement, the targets, outputs, and scenario models to be carried out in this study were determined. To complete the required data, the team conducted a field survey in Bali on 4-5 March 2024, specifically to collect data on public transportation and transportation conditions. With a disclaimer, stating that this survey was conducted during the Balinese holidays of Galungan and Kuningan (28th Feb and 9th March) and Nyepi (11th March), hence schools are still on vacation during this period. This will have an impact on the survey results.

3.4.1 Key Points Summary from the Stakeholders Consultations

The Bali government expressed support and high interest in the scheme provided by this study. The electrification scheme prioritized on public transportation, especially Trans Metro Dewata and Trans Sarbagita, is expected to provide momentum to improve public transportation services in Bali and have a good impact on the environment and social economy in the future. As a follow-up, a field survey was conducted in Bali to collect mobility data. Especially on public transportation services, as follows:

Boarding Alighting Survey

This survey is intended to determine the highest boarding and alighting locations at stops or terminals in the service. In addition, the output of boarding alighting survey can also be analyzed for further route development. This survey uses an onboard approach to calculate the passenger number that boards and alights on each station. For all public transport route (Trans Sarbagita and Trans Metro Dewata) the team observe the demand at morning and afternoon peak hour. Based on the survey results, passenger boarding and alighting points focus on points that accommodate a variety of mobility such as residents and for tourists. In addition to terminals, deposition points such as Sentral Parkir Kuta and Gor Ngurah Rai have the highest transfer points and locations for users to transfer to another mode of transport, or even to change the corridor route. These locations can be improved as further integration points.

Figure 53. Boarding Alighting Patterns on Trans Sarbagita and Trans Metro Dewata Service

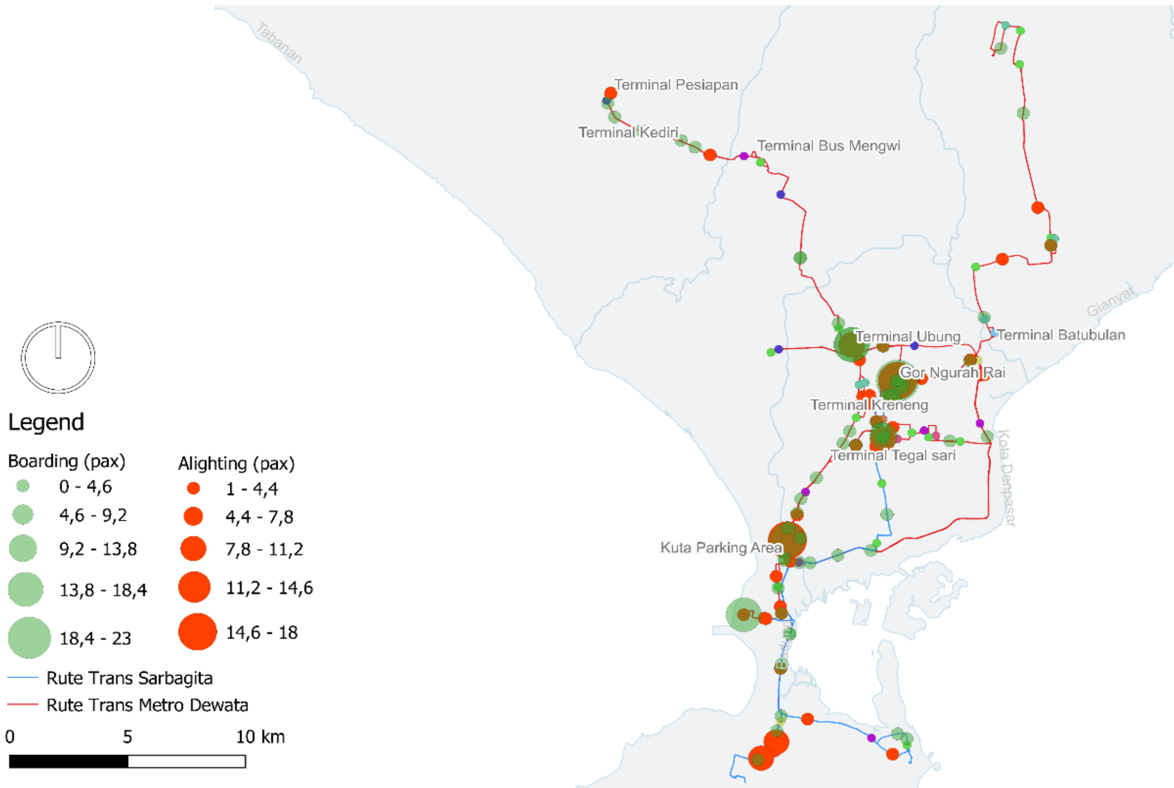


Table 41. Five Stations or Location with the Highest Boarding and Alighting Numbers

Station name/terminal	Boarding	Alighting	Total
Gor Ngurah Rai	23	15	38
Sentral Parkir Kuta	15	18	33
Terminal Ubung	17	9	26
Ngurah Rai Airport	14	2	16
Sudirman 2 Bus Stop	12	0	12

Frequency and Visual Occupancy Survey

This survey aims to understand the level of bus availability by recording the bus frequency at several busiest street points and visual observation on passenger that boards the bus to capture the fluctuations over time. This FVO survey was conducted during the morning and afternoon operational peak hours, based on the survey results, the frequency of buses at peak hours served an average of 7-8 buses per hour, with the highest frequency belonging to Corridor K2 (Airport - Terminal Ubung). Although the current service has a fixed departure timetable, the service route in the field varies due to traffic impacts or congestion factors. Passenger occupancy during peak hours carries an average of 25 people, with the highest passengers belonging to Corridor TS1 (Gor Ngurah Rai - Garuda Wisnu Kencana) and K2 for Trans Metro Dewata services.

Figure 54. Bus Frequency on Peak Hour Service

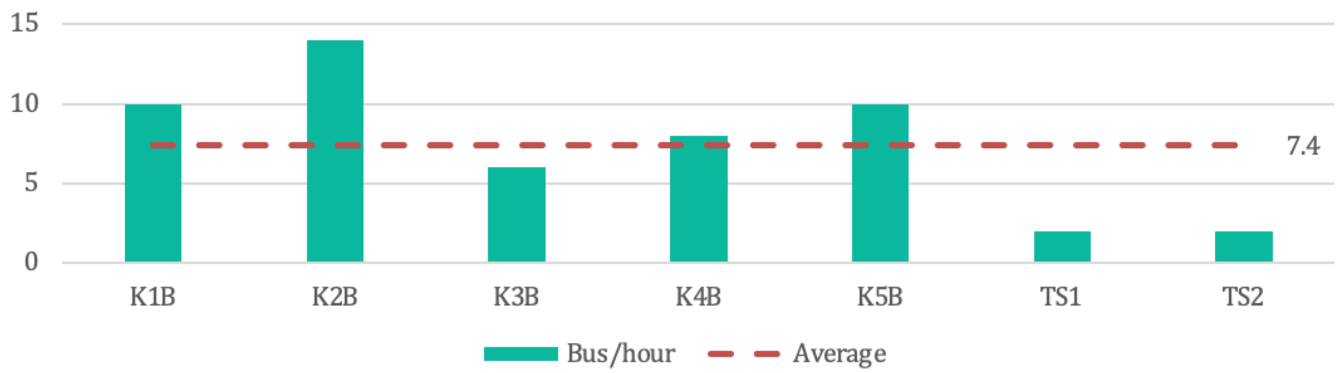
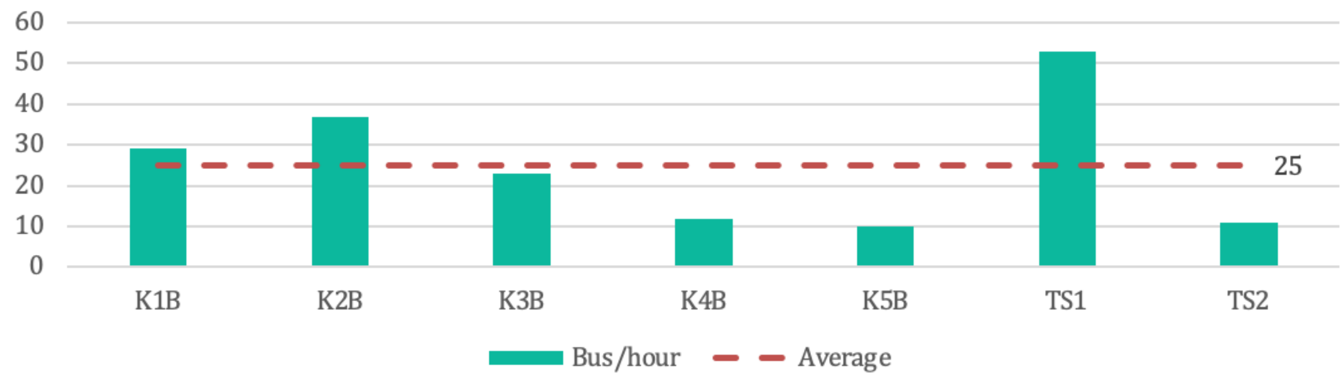


Figure 55. Bus Occupancy on Peak Hour Service

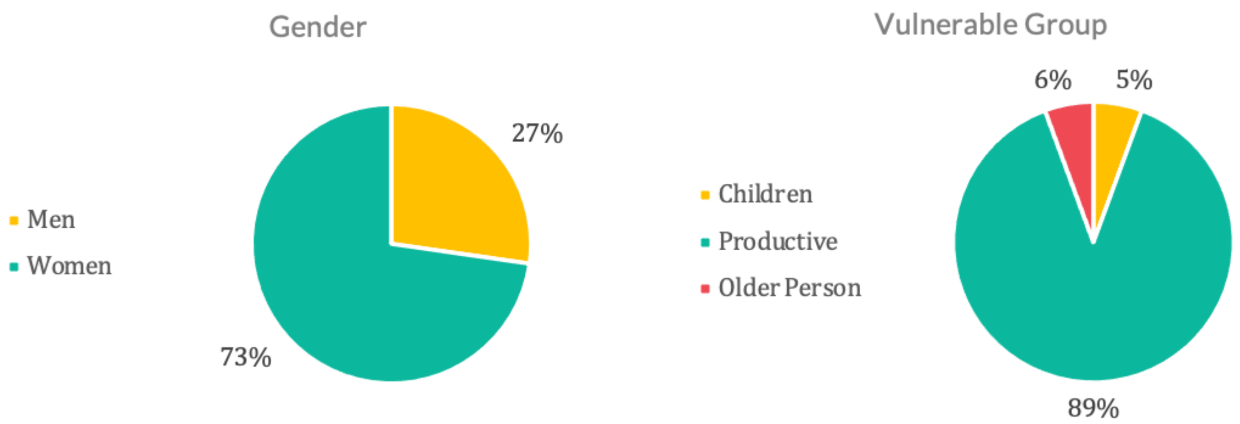


Passenger Profile Survey

While the team was conducting the boarding and alighting survey, by using an onboard approach, the team also identified the passenger profiles in parallel. Noted during the observation was the gender profile and grouping of vulnerable groups. Based on the results of the survey conducted over 2 days, most public transportation service users in Bali are women. Moreover, the profiles of elderly passengers and children (mostly accompanied by mothers/parents) were also found. This finding proves that the level of vulnerable groups among public transportation users in Bali is quite high.

Additionally, there was one person with temporary disability (someone who uses walking aids) who utilized the bus service during the survey. According to our team's observation, access to Trans Sarbagita and Trans Metro Dewata bus stops is insufficient to accommodate people with disabilities (due to the lack of sidewalks and inadequate ramp access due to steepness). This is strengthened by informal interviews with bus drivers, where they mentioned that no individuals with wheelchairs utilize our bus service due to poor accessibility. However, sometimes other people with disabilities (such as physical and hearing impairments) are still seen using the service, and they commute around independently without assistance from anyone.

Figure 56. Public Transport Passenger Profile and Segregation in Bali



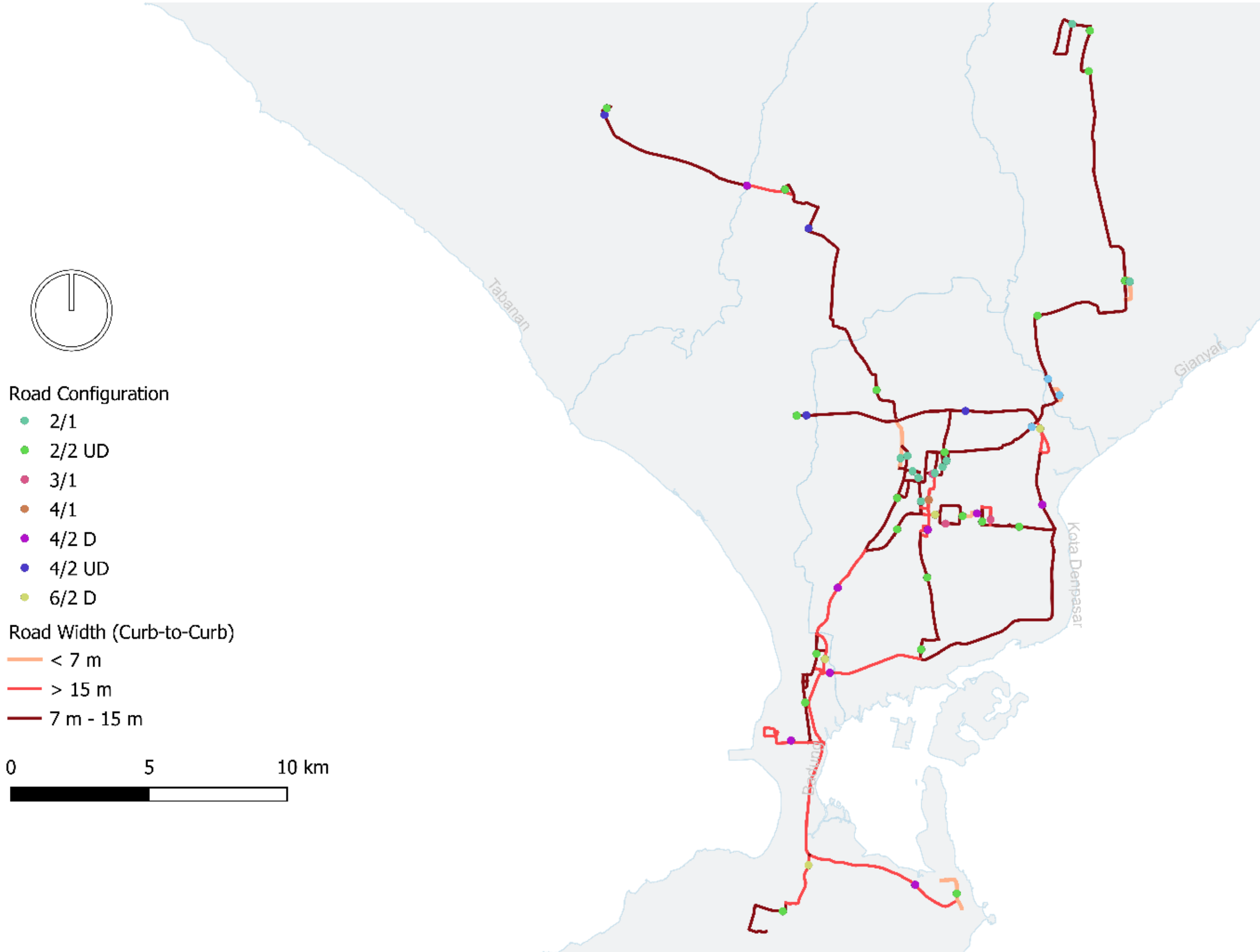
Cross-Section Survey

A road measurement survey was conducted to identify road space and potential conflicts with future trolleybus operations. Based on geometric requirements, the longer the bus, the greater the turning radius needed to maneuver, this will have an impact on traffic mobility and the potential for road delays if long dimension buses pass through narrow roads. With the cross-section survey, the minimum width of the road traveled by each service route will be identified. For future studies, this data can be used to determine alternative routes.

Table 42. Existing Road Geometric Condition per Service Route

Code	Route	Minimum width (m)	Average width (m)
TS1	Gor Ngurah Rai – GWK	6.1	12
TS2	Gor Ngurah Rai – ITDC Nusa Dua	6.1	11.3
K1	Sentral Parkir Kuta – Terminal Persiapan	4.9	12.1
K2	Terminal Ubung – Bandara Ngurah Rai	6	9.4
K3	Terminal Ubung – Matahari Terbit	7.5	13
K4	Gor Ngurah Rai – Monkey Forest	7.18	14.5
K5	Sentral Parkir Kuta – Politeknik Negeri Bali	6.2	14.1

Figure 57. Type of Road Classification and its Location



Note: 2/1 means lane/direction, or 2 lane and 1 direction

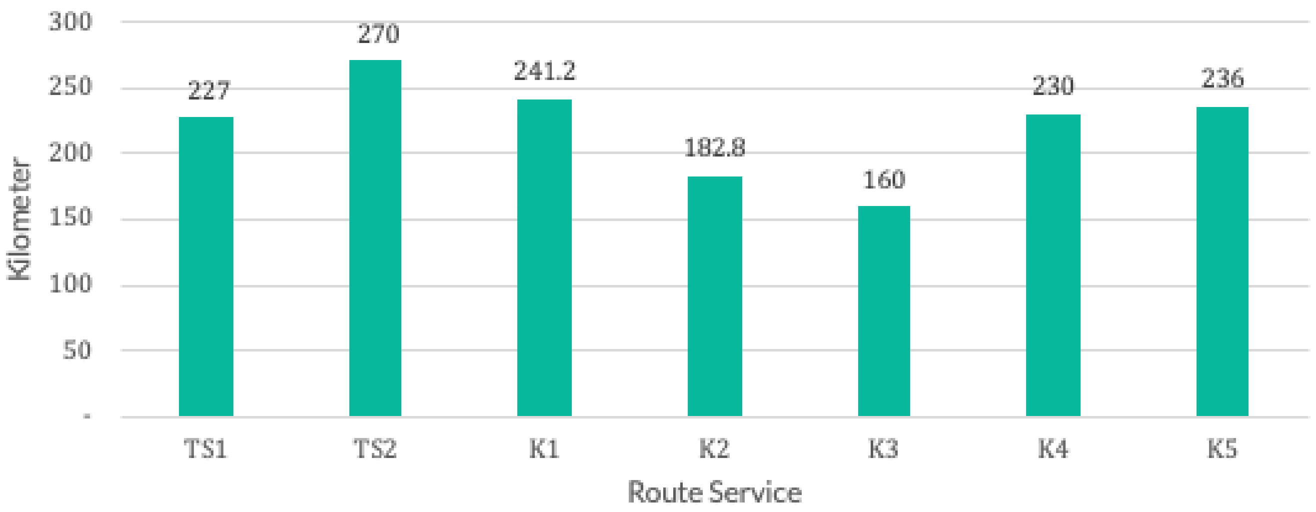
The results of the geometric conditions of the roads in Bali through which this corridor passes have varying widths, but there are some relatively narrow spots in the city center to accommodate larger than current bus maneuvers. Accommodating larger than current buses (>8m) would potentially require road widening and land acquisition as the average sidewalk facility is currently relatively narrow or below the minimum standard (1.5m).

PT Operational Data

For public transport operational data, data is taken not only from field surveys but also from managers or governments. In general, Trans Sarbagita's operational fleet is lower than Trans Metro Dewata, yet it has the highest number of passengers on route TS1 and the longest corridor on TS2. The current operational conditions of Trans Sarbagita also do not have a complete standard operational procedure (SOP) and service level agreement compared to Trans Metro Dewata. This has an impact on service operations, such as not requiring stops at every stop and low headways. Below is some of the operational data collected:

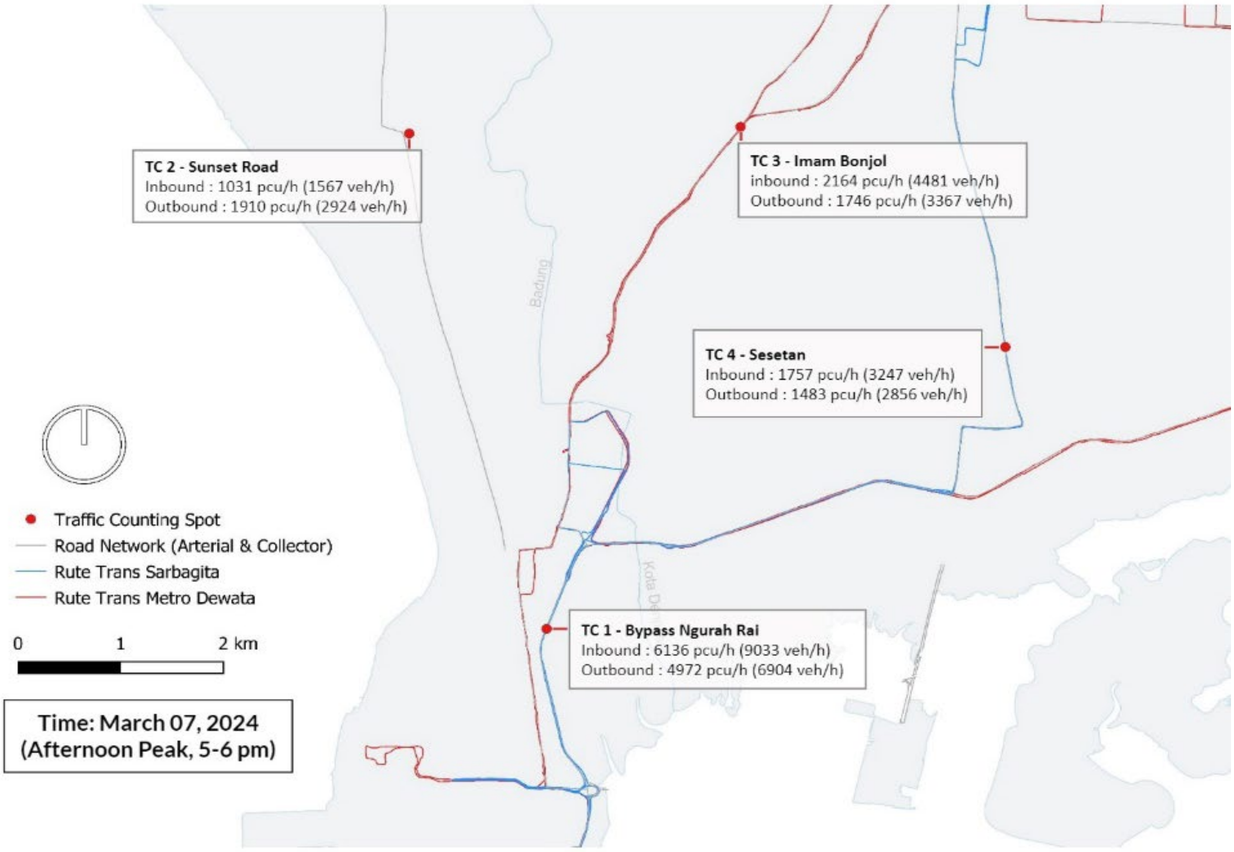
Figure 58. Operated Fleet per Route Service

Figure 59. Daily Mileage per Route Service



Other operational data obtained from the agency is ballpark and only used for economic calculation purposes in modeling, bus capex, amount of insurance value, residual value, vehicle operational cost, staff cost, route length, daily roundtrip, fuel consumption per day, fuel cost, daily mileage, operational days, bus service life, and maintenance cost.

Figure 60. Traffic Counting Location



Having a clear understanding of the traffic pattern in Bali is essential at the earliest stage, as this could determine the effectiveness of the proposed bus lines. The survey could also provide some key insights, for instance, morning and afternoon peak hours, vehicle majority directions at specific time, and routes with most potential demand.

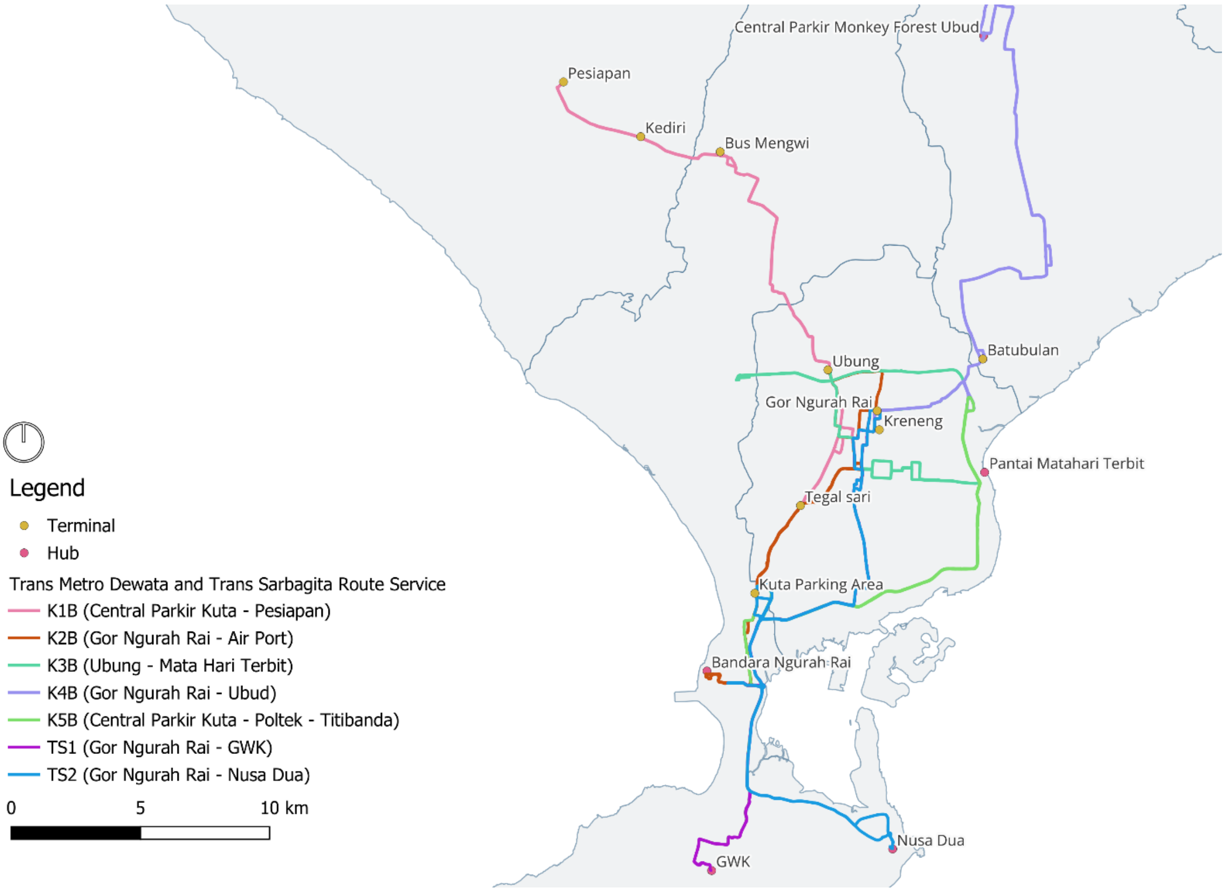
The survey location was selected according to the existing lines of Trans Sarbagita and Trans Metro Dewata. In Bypass Ngurah Rai (TC-1) and Sesetan (TC-4) it passed by the Trans Sarbagita Corridor 1 and 2, while in Imam Bonjol (TC-3) it passed by the Trans Metro Dewata Corridor 1 and 2. One additional spot in Sunset Road (TC-2) targeted to the tourism access road which still does not have an existing bus route yet. Based on the survey result on weekdays, the afternoon peak gives higher vehicle volumes than morning peak, with the directions are mostly heading towards the Denpasar area (Inbound).

3.4.2 Recommended EV options of EV technology

Possible Route Development for E-Bus Corridor

Currently, the Trans Sarbagita and Trans Metro Dewata routes serve a total length of approximately 400 kilometers in Bali area. Based on the data collection using GPS and manual measurements technology, information on the characteristics of each route was obtained including information on the operational, geometric, and e-bus characteristic when using the existing operational state.

Figure 61. Public Transport Route Service in Bali



In addition, to the seven route options mentioned above, there are several other options for selecting e-bus routes that can be developed to expand the public transport service and meet mobility demand as well as leverage the positive impacts of e-buses deployment. During the workshop session, several proposed routes were suggested, particularly those accommodating both tourism and non-tourism travel. In the context of tourism, Bali has a high number of both domestic and international tourists, contributing 40% of the total international tourism revenue in the country.[64] The growth of tourists coming to Bali was recorded at 5.2 and 9.8 million in 2023.[65] Based on our field survey, the K2 route is the only public transportation route within the Trans Metro Dewata system that can aid tourist mobility and has the highest occupancy rate compared to other corridors.

A direct/shuttle route was recommended during the workshop to accommodate tourist routes from the airport to several points of interest (POIs). With this route, it is expected to handle high loads, allowing passengers to transit directly without needing to stop at every station (as per the minimum TMD requirements). Additionally, for non-tourism routes, it was recommended that public transportation routes accommodate areas such as Gianyar and Klungkung, as there is significant potential for mobility among workers and non-workers, such as students.

Based on the results of stakeholder consultations and our analysis, we have attempted to map out the POIs (Points of Interest) or areas via desktop analysis based on possibility of the potential routes. The following table shows options for the e-bus pilot in the Bali Province:

64 Tourism-induced poverty impacts of COVID-19 in Indonesia. https://doi.org/10.1016/j.annale.2022.100069

65 Provinsi Bali Dalam Angka 2024

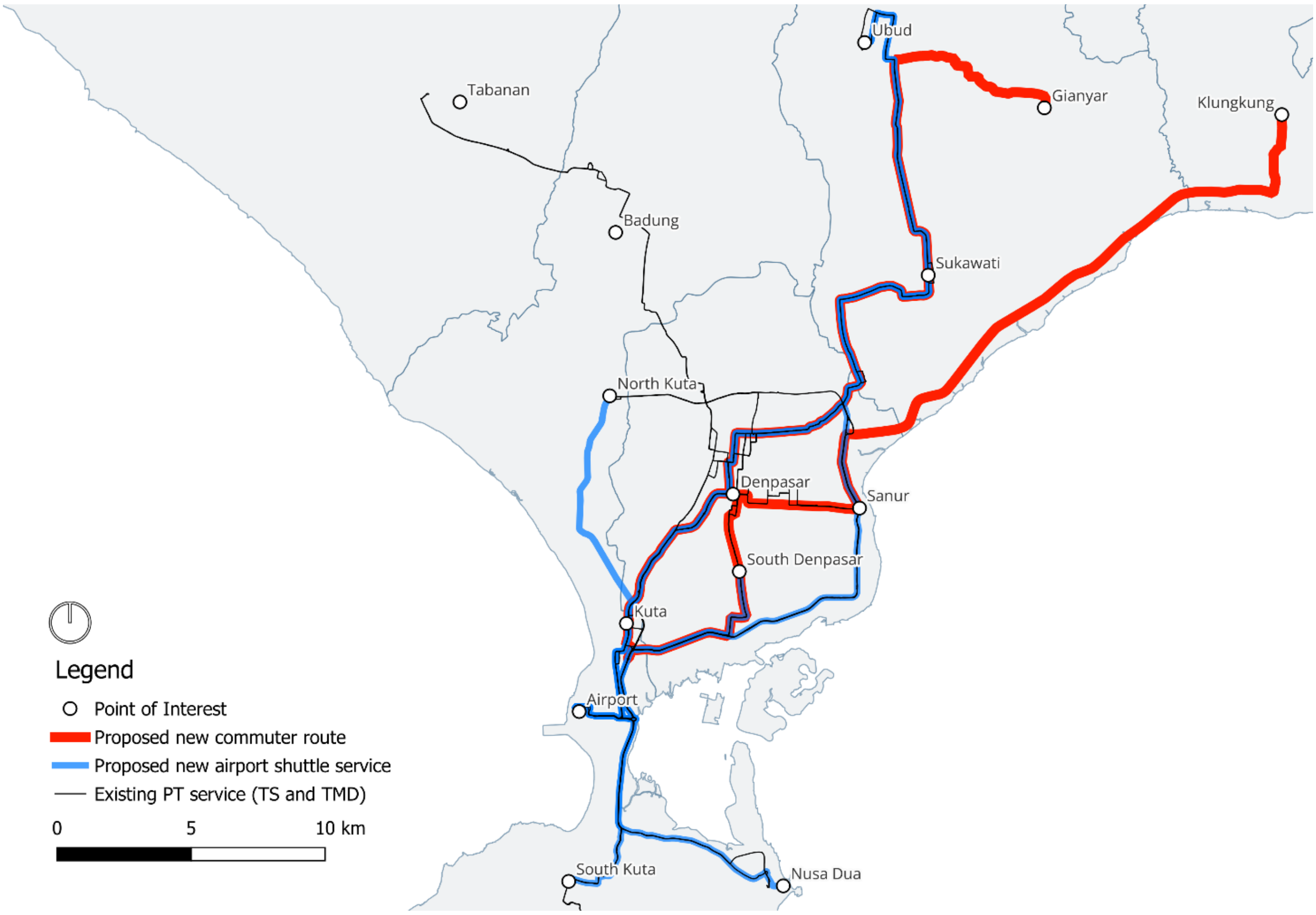
Table 43. Proposed New Airport Shuttle and Commuter Route Characteristics

Type of Route	Remarks	New Route Code	Length (km)	Max Slope (%)
Airport Shuttle	Airport - Kuta	N1	6	6.9
	Airport – South Kuta	N2	11	12
	Airport – North Kuta	N3	15.6	5.9
	Airport – South Denpasar	N4	12.2	8.3
	Airport – Nusa Dua	N5	14.2	3.5
	Airport – Sukawati	N6	28.4	8
	Airport – Denpasar - Ubud	N7	40.8	5.3
	Airport – Sanur - Ubud	N8	42.8	5.1
Commuter	Kuta – Denpasar – Sukawati - Gianyar	N9	37.7	12.7
	Kuta – South Denpasar – Denpasar – Sanur - Klungkung	N10	42.1	8.6

However, to explore the feasibility of implementing these routes, further consideration should be taken, such as:

- Demand assessment
- Technology and charging strategy
- Analysis of multiple TCO scenarios based on contract duration
- Environmental impact and power grid analysis along the proposed route
- Other route characteristic: road width, average slope, terminal location, depot location, and maintenance location

Figure 62. Proposed New Shuttle Service and Commuter Route



Vehicle weight data must also be considered. Since the weight of the vehicle affects the weight of the battery, the GVW (including the total weight of the passengers) may vary from route to route. For the selection of medium buses, due to the relatively narrow roads in the corridor, the energy consumption and range may vary from route to route. Below is an example of a medium e-bus model and its gross weight:

Table 44. **Medium E-Bus Models and GVW Information**

Model Name	Bus Length (m)	Seating Capacity	GVW (kgs)
BYD K7[66]	9	22 + 1D	13,500
Golden Dragon Polestar[67]	8.5	16 - 27	8650
Tata Ultra 9/9[68]	9	31 + 1D	10,200 +/- 300
MNGT - BEVB[69]	8.5	18 +1D	13,500
Eicher Skyline Pro E9M[70]	9	32+D	12,800

Battery Chemistry

Over the years, the battery used in EV has improved. Currently there are two types of battery called Lithium Iron Phosphate (LFP) and Lithium Nickle Manganese Cobalt Oxide (NMC), which mostly used in electric battery ecosystem.

LFP batteries are known for the most reliable charging chemistry. They work well with slow chargers with a charging rate of not more than 1.5C. LFP battery offers slower battery degradation and longer life cycle when handled properly.

Meanwhile NMC battery offers fast charging rate, with up to 3C rate as well as largest capacity and suitable for both opportunity and overnight charging. Lithium Titanate Oxide (LTO) offers thermal stability and safety. However, it has lower energy density than NMC and LFP, hence low capacity. Here are the battery chemistry and capacity from the previous model mentioned:

Table 45. **Medium E-Bus Models with Battery Chemistry and Capacity**

Model Name	Battery Chemistry	Battery Capacity (kWh)
BYD K7	LFP	180
Golden Dragon Polestar	LFP	180
Tata Ultra 9/9	LFP	124
MNGT - BEVB	LFP	174.7
Eicher Skyline Pro E9M	LFP	204

Charging Strategy

The ecosystem of e-bus adoption relies heavily on charging infrastructure, or charging solution, and power/grid infrastructure. The distance between the bus route origin and destination were not a concern due to diesel bus's ability to travel long range and the availability of refilling stations. However, with e-buses, range anxiety

66 BYD K7. 4504-byd-transit-cut-sheets_k7-30-lr.pdf

67 Golden Dragon Polestar. Polestar Electric Bus-Golden Dragon Bus-China Top Bus Manufacturer

68 Tata Ultra 9/9. TATA MOTORS BUSES | Ultra 9/9m AC Electric Bus Specs | Tata Motors Buses

69 MNGT BEVB. 8.5 meters electric city bus China Manufacturer (main-newenergy.com)

70 Eicher Skyline Pro E9M. Eicher Skyline Pro E 9m - Price, Specifications & Gallery | Eicher (eichertrucksandbuses.com)

arises due to limited battery capacity. While larger battery packs could be adopted, it increases procurement cost and charging demand, bigger battery pack also makes weight higher which potentially reduces the mileage, hence require more frequent charging.

Charging is essential for replenishing used charge, primary utilize conductive methods (plug-in and pantograph). For medium e-bus model, plug in charging is more suitable due to smaller battery size. Plug-in charging involves inserting the plug of a charging gun or outlet into the socket or inlet of an e-bus and is currently the most widely used method worldwide. Chargers can output either AC or DC power, with DC offering faster charging rates due to on-site power conversion.

Table 46. **Medium E-Bus Models with Charger Type and Power**

Model Name	Charger Type	Charger Power (Kw)
BYD K7	AC Synchronous	80
Golden Dragon Polestar	DC Charging	120
Tata Ultra 9/9	Fast Charging	n/a
MNGT - BEVB	DC Charging	n/a
Eicher Skyline Pro E9M	DC Fast Charging	n/a

3.5 Assessment of Public Transportation Routes in Bali: Multi-Criteria Analysis Step 1

To achieve the objective of this project, which is to select service routes to be operated using 10 electric buses in the Province of Bali, a multi-criteria analysis is conducted. This analysis encompasses all routes, including both existing and potential ones (see Table 43). The multi-criteria analysis is conducted in a hierarchical system thus divided into two stages. This approach is taken to provide a more comprehensive assessment based on the available data. The initial stage of the analysis encompasses several criteria, including potential demand or the number of passengers on the route, terminal availability, overlap with the planned E-BRT segments, and the average speed of buses on each route. Each selected criterion is assigned a weight that reflects its relative importance to the overall sustainability of the project. The greater the importance of a criterion, the higher the weight assigned (expressed in a raw value range of 1-5). In this analysis, the two criteria with the highest weights are the potential demand or number of passengers on the route and terminal availability.

Table 47. **Selected Criteria for Multicriteria Step 1 and its Weighting Value**

No	Criteria	Remark	Raw Weighting (1-5, less important-neutral-most important)	Weighting
1	Potential passenger per day	Number of potential passengers per day	5	29.41%
2	Terminal availability as a potential charging location	The number of terminals that pass by or are within the range of the bus service route. These terminals can potentially serve as charging stations	5	29.41%
3	Future e-bus deployment potential (overlapped segment)	The percentage of overlap of route segments of the existing bus service corridor with the planned E-BRT corridor. If a certain route is more likely to be chosen for electrification, that route should be chosen for the pilot	3	17.65%

No	Criteria	Remark	Raw Weighting (1-5, less important-neutral-most important)	Weighting
4	Average speed (km/hour)	The average speed of buses on a route. The lower the speed, assumed that traffic volume is dense, hence the emissions that can be saved are also greater	4	23.53%
Total			**17**	**100%**

Each criterion evaluated against each existing route. To simplify the analysis, the range of ratings categorized into low, medium, and high, expressed with scores from 1 to 3. Since all criteria are quantitative, the categories divided as follows:

- 25th Percentile: Divides the data such that one-third of the data values fall into the low category.
- 75th Percentile: Divides the data such that two-thirds of the data values fall into the low and medium categories, with the remaining one-third in the high category.

This approach allows each route to be evaluated consistently based on the distribution of quantitative values, facilitating a more structured and objective assessment.

Potential Passenger per Day

This criterion relates to the number of individuals utilizing the bus service on a particular route over the course of a day. This provides an overview of the usage level of the bus service on that route. The table below presents the potential number of passengers per day, along with the scoring results. It should be noted that **this potential passenger data is based on the operations of existing buses, and thus, there is no demand data for potential routes, as there are no buses operating on those routes**. The potential passenger data per hour was obtained from ITDP's survey in 2024, and this data was then multiplied by the operational hours of each operator. Trans Metro Dewata operates for 13.5 hours a day (04:30–18:00 WITA), while Trans Sarbagita operates for 11 hours a day (06:30–17:30 WITA). The 25th percentile is represented by a value of 675 passengers per day, while the 75th percentile is represented by a value of 1,760 passengers per day. As there is no data available for potential routes (N1-N10), the score assigned is 0. The conditional formatting data for this criterion includes the following:

- Score 1 for data below or equal to 675 passengers per day
- Score 2 for data between 675 passengers and 1,760 passengers per day
- Score 3 for data above or equal to 1,760 passengers per day

Table 48. Scoring Criteria for Potential Passenger per Day of Each Route

Code route	Potential passenger per hour	Potential passenger per day	Score
TS1	160	1,760	3
TS2	406	4,466	3
K1	72	972	2
K2	64	864	2
K3	120	1,620	2
K4	50	675	1
K5	24	324	1
N1	0	0	0
N2	0	0	0
N3	0	0	0

Code route	Potential passenger per hour	Potential passenger per day	Score
N4	0	0	0
N5	0	0	0
N6	0	0	0
N7	0	0	0
N8	0	0	0
N9	0	0	0
N10	0	0	0

Terminal Availability

The availability of terminals is a crucial factor as a criterion. Terminal locations can serve as charging stations, which can help optimize routes and schedules for electric buses. Furthermore, the accessibility of terminals can result in reduced operational costs, as it reduces the necessity for additional infrastructure and provides sufficient charging capacity for larger bus fleets. Figure 63 illustrates the locations of terminals traversed by buses on each public transportation route. It is evident that Corridor 1 of the Trans Metro Dewata service traverses the most terminals. The 25th percentile data shows one terminal, while the 75th percentile data shows four terminals. Consequently, conditional formatting is as follows:

- Score 1 for number of terminals below two
- Score 2 for number of terminals between one and four
- Score 3 for number of terminals above or equal to four

Figure 63. Existing and Potential Routes of Bus Public Transportation Services and Distribution of Bus Terminal's Location

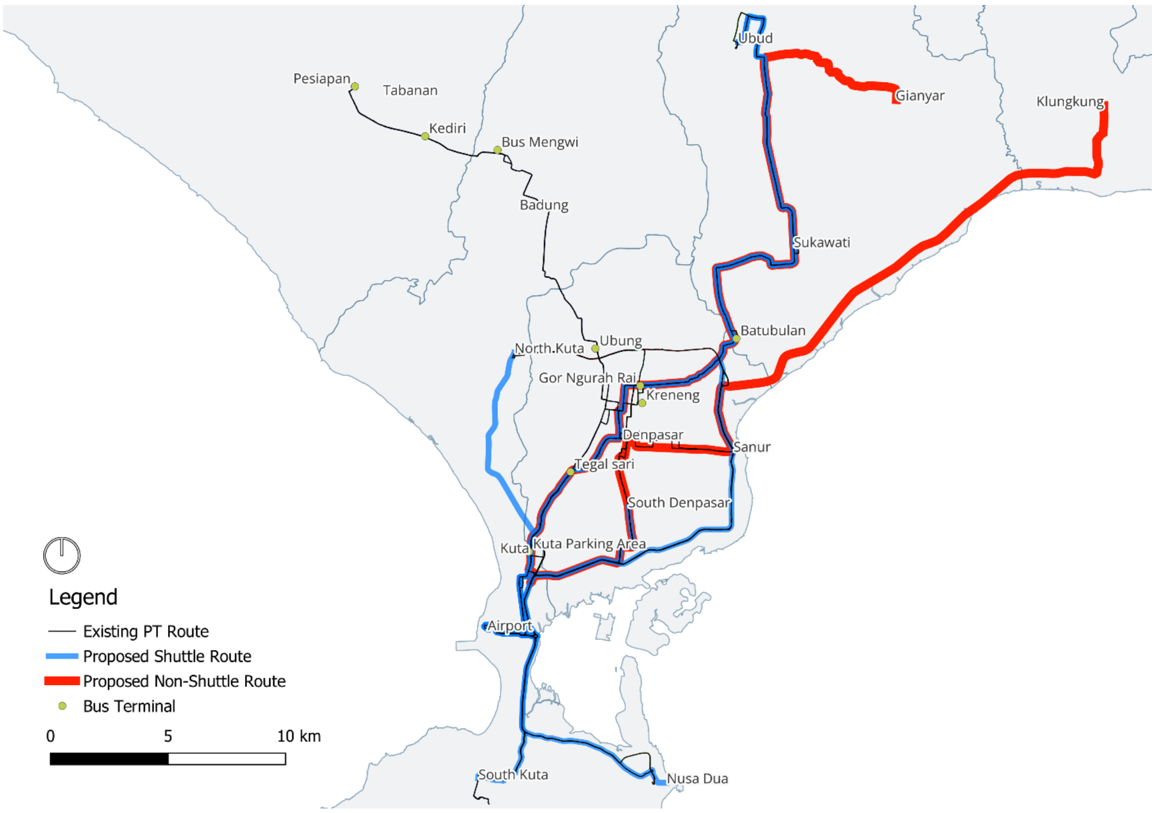


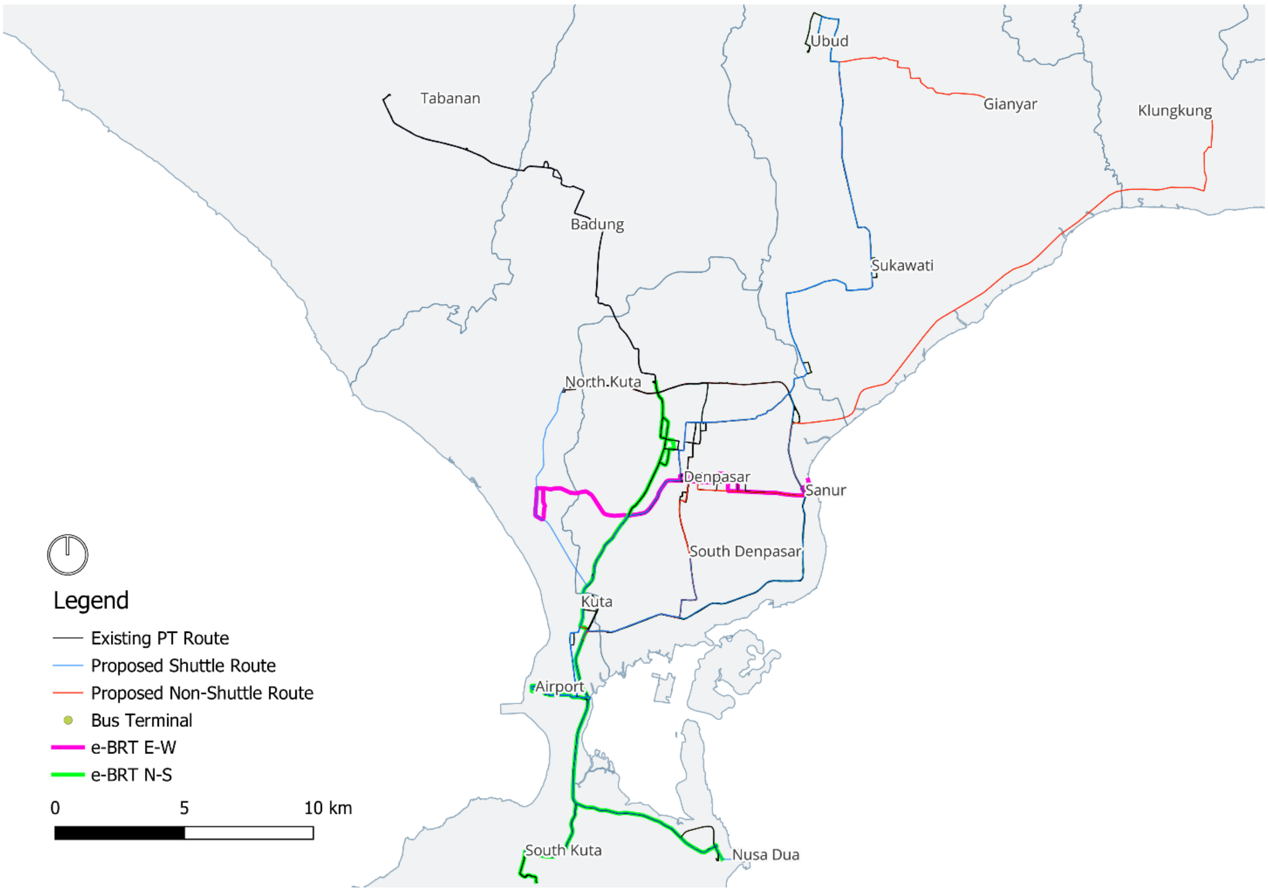
Table 49. Scoring of Criteria for Terminal Availability of Each Route

Code route	Terminals availability	Score
TS1	3	2
TS2	4	3
K1	6	3
K2	5	3
K3	1	1
K4	2	2
K5	1	1
N1	1	1
N2	0	1
N3	1	1
N4	0	1
N5	0	1
N6	4	3
N7	4	3
N8	1	1
N9	4	3
N10	1	1

Overlapped Segment with E-BRT Plan

A study conducted by KIAT in 2023 revealed that the Sarbagita area is planned to have BRT corridors using electric buses. The proposed E-BRT corridors are to comprise two routes, namely the south-north route and the east-west route (see Figure 64). The selection of routes for the operation of the 10 electric buses must be aligned with the E-BRT plan. This is being done as a pilot study to assess the performance of the routes planned for the E-BRT corridor. Furthermore, integrating with the planned E-BRT corridor allows the use of already planned or under-construction infrastructure, such as charging stations, dedicated lanes, and maintenance facilities. This will result in a reduction of the additional costs required to build new infrastructure. Therefore, existing routes that overlap with the planned E-BRT corridor are included as variables in this MCA analysis.

Figure 64. Proposed e-BRT Corridor Routes from KIAT Study Compared to Existing and Potential Routes of Bali's Public Transportation Services



It is evident that Corridor 2 of the Trans Sarbagita service has the highest percentage of overlap with the planned E-BRT corridor, followed by Corridor 1 of Trans Sarbagita. Meanwhile, Corridor 4 of the Trans Metro Dewata service does not intersect with the planned E-BRT corridor at all. The 25th percentile data is 10.05% of overlap, and the 75th percentile data is 24.68% of overlap. Consequently, the conditional formatting is as follows:

- Score 1 for a percentage of overlap below or equal to 10.05%
- Score 2 for a percentage of overlap between 10.05% and 24.68%
- Score 3 for a percentage of overlap above or equal to 24.68%

The results of scoring each route concerning the criterion of overlapping with the planned E-BRT corridor route are shown in Table 50.

Table 50. Scoring Criteria for Overlap with e-BRT Corridor Plans

Code route	Overlapped segment with E-BRT plan	Score
TS1	27.00%	3
TS2	32.00%	3
K1	24.00%	2
K2	26.00%	3
K3	16.00%	2
K4	0.00%	1
K5	18.00%	2
N1	5.63%	1

Code route	Overlapped segment with E-BRT plan	Score
N2	20.15%	2
N3	9.95%	1
N4	10.14%	2
N5	25.35%	3
N6	18.97%	2
N7	17.84%	2
N8	9.77%	1
N9	12.77%	2
N10	10.20%	2

Average Speed in Each Route

The average speed of buses on a route is employed as a criterion for determining the route, on the assumption that this speed reflects the traffic volume conditions on that route. Conversely, the lower the average speed of the bus, the higher the traffic volume on that route, and vice versa. The reduction of emissions is more feasible on routes with high traffic volumes if the buses in operation are electric. Additionally, on roads with high traffic volumes, the increased exposure to electric buses is expected to raise awareness of their existence and benefits. Nevertheless, this does not guarantee a shift in mode share to electric buses.

The table below presents the average speed data for each bus route, accompanied by the corresponding evaluation scores. This data was obtained from a bus service survey conducted by ITDP Indonesia in 2024. **It should be noted that this data is based on the operations of existing buses, so there is no data for potential routes as there are no buses operating on those routes.** Therefore, the score for the potential routes is 0 (zero). Corridor 2 of the Trans Metro Dewata service is known to have the lowest average speed among all routes, indicating high traffic volume. The 25th percentile speed is 17.90 km/h, while the 75th percentile speed is 24.10 km/h. Consequently, the conditional formatting is as follows:

- Score 1 for speeds above or equal to 24.1 km/h
- Score 2 for speeds between 17.9 km/h and 24.1 km/h
- Score 3 for speeds below or equal to 17.9 km/h

Table 51. Scoring Criteria for Average Speed of Each Route

Code route	Average speed	Score
TS1	19.20	2
TS2	26.10	1
K1	22.10	2
K2	17.30	3
K3	18.70	2
K4	24.10	1
K5	17.90	3
N1	0.00	0.00
N2	0.00	0.00
N3	0.00	0.00
N4	0.00	0.00

Code route	Average speed	Score
N5	0.00	0.00
N6	0.00	0.00
N7	0.00	0.00
N8	0.00	0.00
N9	0.00	0.00
N10	0.00	0.00

Assessment of Multi Criteria Analysis Step 1

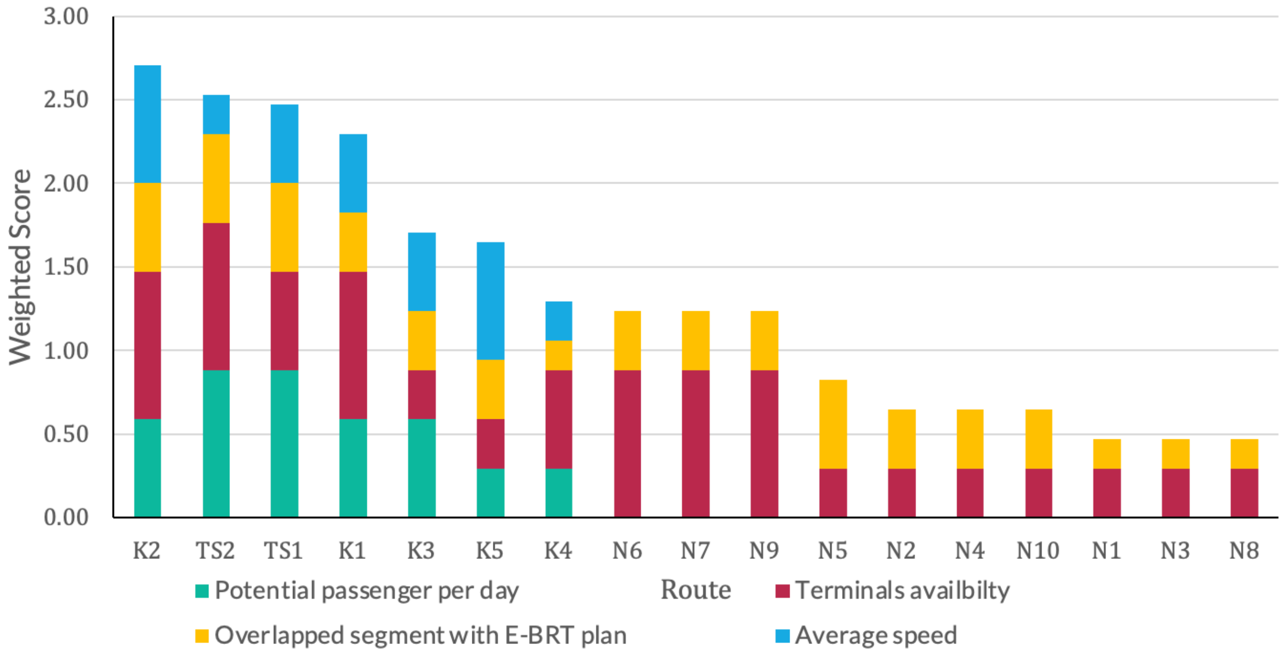
Once all routes have been evaluated according to the specified criteria, the initial stage of multi-criteria analysis can be conducted. Table 52 illustrates the results of the multi-criteria assessment analysis for each route. In this process, each score on a particular criterion is multiplied by a predetermined weight, and the resulting values are summed up to obtain a total assessment value. The assessment results indicate that route K2 is the most optimal route, with a total score of 2.71. This is due to its high scores on the terminal availability criteria, compatibility with the E-BRT segment, and good average speed. TS1 and TS2 also demonstrate good performance, with total assessment scores of 2.41 and 2.53, respectively.

Table 52. Assessment of Multi Criteria Analysis Step 1 of Each Route

Code Route	Potential Passenger per Day	Terminals Availability	Overlapped Segment with E-BRT Plan	Average Speed	Total Assessment
Weighting	29.41%	29.41%	17.65%	23.53%	100%
TS1	3	2	3	2	2.47
TS2	3	3	3	1	2.53
K1	2	3	2	2	2.29
K2	2	3	3	3	2.71
K3	2	1	2	2	1.71
K4	1	2	1	1	1.29
K5	1	1	2	3	1.65
N1	0	1	1	0	0.47
N2	0	1	2	0	0.65
N3	0	1	1	0	0.47
N4	0	1	2	0	0.65
N5	0	1	3	0	0.82
N6	0	3	2	0	1.24
N7	0	3	2	0	1.24
N8	0	1	1	0	0.47
N9	0	3	2	0	1.24
N10	0	1	2	0	0.65

In contrast, potential routes (N1 to N10) have comparatively low scores in comparison to existing routes (Trans Sarbagita and Trans Metro Dewata services) due to a lack of data on potential passengers per day and average speed. Based on the accumulated score among the new routes, routes N6, N7, and N9 have the highest score of 1.24. This is due to their advantage of having terminals with an optimal score. Conversely, the lowest score is observed for routes N1, N3, and N8, with a value of 0.47, due to the limited number of terminals passed on the route. The overall ranking of each route, both existing and potential, resulting from this multicriteria analysis is presented in Figure 65.

Figure 65. Comparison and Ranking Result from MCA Step 1



The limited data on the new routes, due to the absence of an operating bus service, prevented further analysis at this stage. In the further analysis discussed in Chapter 4, the environmental and economic impacts of each route will be evaluated. The results of the environmental and socio-economic impact analysis on existing routes such as the Trans Sarbagita and Trans Metro Dewata services will then be considered in the second stage of the multi-criteria analysis. The objective is to obtain a more comprehensive comparison and rank the routes based on overall performance. This evaluation is expected to provide a completer and more in-depth picture of the effectiveness and efficiency of each route.

This section will explain the environmental and economic impacts of the two target areas, Jakarta dan Bali. Specifically for Jakarta, the analysis will only focus on environmental impact, comparing two-wheeled, four-wheeled, and bus modes of transportation. **For Bali, the calculations will be conducted specifically for the existing public transportation system**, examining the economic impact on the planned investment in addition to the environmental impact. The environmental and economic impact modeling will look generally at whether the investment with the specified scenario can create good results for both target areas.

4. ENVIRONMENTAL AND ECONOMIC IMPACTS

4.1 Environmental Impacts

This activity will assess the environmental impact based on the selected option, particularly focusing on the amount of GHG emissions and air pollution (PM2.5 and NOx) produced compared to ICE modes. This rapid assessment will consider available e-mobility targets or programs to illustrate demand and impacts in the future. Adjustments to the scenario can be developed to achieve optimum EV impacts.

4.1.1 Key Parameters and Methodology

The methodology employed in this modeling generally compares the impacts of EV and ICE implementation on GHG and air pollution. This modeling can also identify which modes of transportation have the highest impact in reducing GHG and air pollution. By estimating the growth of both ICE and EV investments annually or based on planned targets, the potential annual reduction in GHG and air pollution due to EVs can be determined.

For DKI Jakarta, environmental impact estimation calculations will conduct for 2-wheelers, 4-wheelers, and urban buses in general. Assuming a scenario where EV growth reaches 30% by 2030. Due to data limitations in 2024, the baseline analysis data obtained from 2022 statistical data and projected until 2030 by comparing BAU (business-as-usual) scenarios and EV scenarios annually.

For the Bali region, environmental impact estimation calculations will focus on public transportation services, especially existing services in Bali, namely Trans Metro Dewata and Trans Sarbagita. These environmental impact calculations will examine the potential reduction in GHG and air pollution from each service route. The data used is operational data from the operators and based on the results of field surveys conducted by the team.

These environmental impact calculations are conducted using modeling calculations and require parameters to support more accurate calculation results. These parameters include:

City Input Parameter

Data such as electricity grid factor, GDP growth rate projection, city population, and motor vehicle numbers (both ICE and EV shares) are utilized to calculate annual growth projections up to the specified year.

Table 53. Jawa, Madura, Bali (Jamali) Grid Carbon Intensity to Calculate EV GHG Impact. *RUPTL (2021-2030)*

JAMALI	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
% Coal	74.38%	73.36%	72.98%	72.72%	67.45%	69.19%	69.06%	67.33%	66.95%	66.65%
% NG	16.17%	16.66%	16.88%	16.25%	15.27%	14.47%	14.93%	16.71%	16.84%	17.08%
% Oil	0.99%	0.96%	0.13%	0.13%	0.15%	0.18%	0.18%	0.18%	0.19%	0.19%
% Renewables	8.46%	9.02%	10.01%	10.90%	17.13%	16.15%	15.82%	15.78%	16.02%	16.07%
Carbon Intensity (gCO2/kWh)	**885.8**	**877.3**	**862.2**	**856.1**	**795.5**	**809.9**	**811.1**	**802.5**	**799.4**	**797.5**

Emission City Calculation

To calculate the existing emissions produced by each vehicle, key parameters such fuel consumption, distance driven, and emission factors for each type of vehicle being assumed and calculated. These factors will be multiplied by the proportion of motor vehicles to determine the number of emissions from each type. In this modeling, the output on GHG will be differentiated into TTW (tank-to-wheel) to observe emissions generated based on vehicle operation, and WTW (well-to-wheel) to observe the comparison of emissions generated from the production source (coal-generated); this type of cycle fuel is considered by the possibility BEV shares on the existing numbers and to compare impact with the BEV. Additionally, calculations are also performed on air pollution and other concentrations such as PM2.5 and NOx.

Table 54. Example of Emission Factor for Each Air Pollution

Vehicle category	Fuel type	Fuel consumption	NO_x	$PM_{2.5}$	CO_2 TTW	BC	CO_2 WTW incl. BC
4W Private use	Gasoline	7.6	0.071	0.001	173	0	206
4W Private use	Diesel	6	0.697	0.034	177	26	244

Table 55. Example of Daily Mileage per Vehicle Segment Estimation. *ITDP. Desktop and Field Survey (2024)*

Vehicle Segment	Daily Mileage (km)	Operational day/year	Annual Mileage (km)
4W Private use	30	312	9,360
2W Private use	30	312	10,950
Urban buses Transjakarta	200	300	73,000
Urban buses Trans Metro Dewata	225	365	82,125

GHG and Air Pollution Reduction due to EV

To calculate the reduction of GHG and air pollution due to EVs, it is necessary to project the annual growth of ICE and EV vehicles until the target year. As an example, a model specific to Jakarta will be used, which implements the 30@30 policy until 2030. Once the annual BEV growth targets are determined, the growth in ICE vehicles can be calculated based on the stock of EVs implemented. After determining these numbers, the EV stock will be multiplied by a factor adjusted to the annual operational characteristics and the lifetime of each mode, both for ICE and BEV. This calculation will be based on the respective city's fuel mix and electricity grid factor.

Table 56. **Example of Impact per Vehicle per Annum and Over Vehicle Lifetime**

Vehicle: 4W Passenger Car	SO_2 in kg	NO_x in kg	$PM_{2.5}$ in kg	CO_2 TTW in tons	CO_2 WTW incl. BC in tons	GHG reduction in tons (WTW)	GHG reduction as % (WTW)
Fossil average vehicle per annum	0.01	1.25	0.04	1.62	1.96		
EV per annum	0.00	0.00	0.00	0.00	1.13	0.83	42%
Fossil average vehicle lifetime	0.05	12.52	0.42	16.23	19.64		
EV lifetime	0.00	0.00	0.00	0.00	11.32	8	42%

Table 57. **Example of EV Impact Calculation Throughout Year**

4W Passenger Car	2022	2023	2024	2025	2026	2027	2028	2029	2030
Target share of EVs in new vehicles	3%	7%	10%	13%	17%	20%	23%	27%	30%
Passenger car stock all vehicles	3,755,986	3,947,541	4,148,866	4,360,458	4,582,841	4,816,566	5,062,211	5,320,384	5,591,724
Replacement passenger car	228,400	240,049	252,291	265,158	278,681	292,894	307,832	323,531	340,031
New purchased passenger car	419,956	441,373	463,883	487,541	512,406	538,539	566,004	594,871	625,209
EV passenger car fleet new	12,599	30,896	46,388	63,380	87,109	107,708	130,181	160,615	187,563
EV passenger car fleet stock	12,599	43,495	89,883	153,264	240,373	348,080	478,261	638,876	826,439
EV fleet as % of stock	0%	1%	2%	4%	5%	7%	9%	12%	15%
GHG reduction due to EV (WTW incl. BC) in tons	10,480	36,181	74,770	127,493	199,956	289,553	397,845	531,454	687,480
$PM_{2.5}$ reduction due to EV in tons	0.53	1.84	3.80	6.49	10.17	14.73	20.24	27.04	34.98
NO_x reduction due to EV in tons	15.8	54.5	112.6	191.9	301.0	435.9	598.9	800.0	1,034.9
Electricity usage EVs in MWh per annum	17,765	61,331	126,742	216,114	338,944	490,820	674,386	900,865	1,165.343

After that, the reduction of each type of air pollution can be calculated by multiplying the number of BEVs by their respective reduction factors. Additionally, the electricity usage of EVs in MWh per annum can also be calculated by multiplying the number of BEVs by their annual electricity usage.[71]

71 Annual electricity usage: electricity consumption devided by the annual milage

Comparing the GHG Impact between ICE and BEV

Since EVs do not produce emissions, comparing TTW (Tank-to-Wheel; direct impact of emission production from vehicle segments) between ICE and EV becomes not relevant. Therefore, the comparison will use the WTW (Well-to-Tank; indirect emission), which include extraction, refinery, and transportation of fossil fuel; upstream emission-based default mark-up factor). The Black Carbon emission converted to CO2 based on PM2.5 fraction in BC and Global Warming Potential.

Calculating Cost per Ton of Emission

After the emission reduction amounts have been calculated, the cost per ton for each mode can be determined. This is done by multiplying the total reduced emissions (in tons) by their respective cost factors.[72]

Table 58. Cost per Ton of Emission (USD 2018)

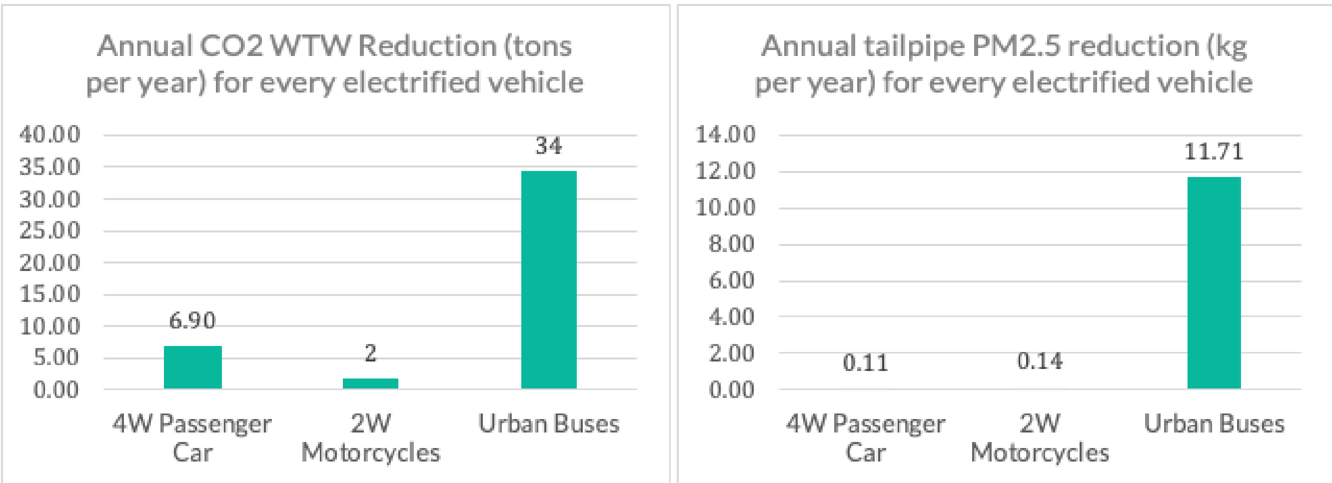
SO_2	3,199
NO_x	665
$PM_{2.5}$	89,884
CO_2	50

4.1.2 GHG and Air Pollution Impact

DKI Jakarta Area

The initial step in calculating the EV scenario involves assuming or replacing ICE vehicles EV (2W, 4W, and Bus) of a specific model according to the prevailing market in the target area. Specifically for buses, the assumption is that electric buses used have specifications of 12m, like the type or model of electric buses currently used in DKI Jakarta. Based on the criteria of distance traveled and vehicle specifications, assumptions are made regarding the reduction in emissions per vehicle for both GHG and PM2.5.

Figure 66. Annual CO2 WTW and Tailpipe PM2.5 Potential Reduction per Year for Every Electrified Vehicle. *Modelling Calculation (2024)*



72 US Social Cost of Carbon

The next step is to measure the impact of the EV based on the predetermined target. Since Jakarta does not yet have a specific target for EVs in general, this study will use the initiative of 30@30 policy. EV30@30 is a global campaign to support the development of the EV market with the goal of achieving a 30% sales share for EV by 2030[73].

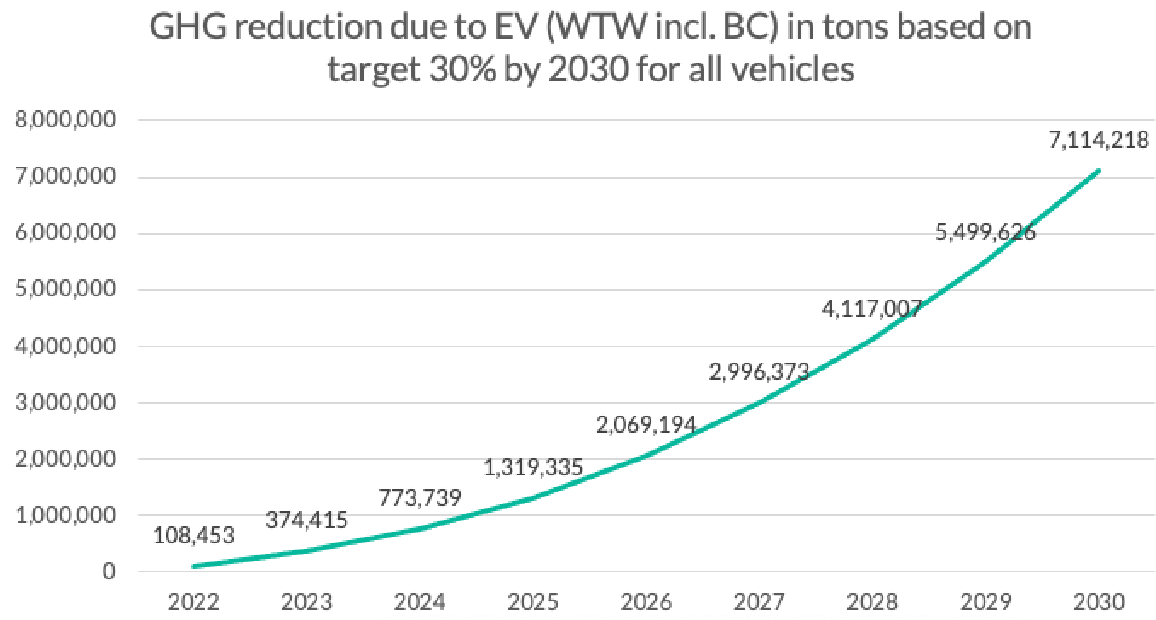
Based on the data of EV population in 2022, the penetration rate is only below 1% of the total of 2W and 4W vehicles.[74] With a target of 30% by 2030, it is necessary to determine the target for each year incrementally from 2022 to 2030. The assumption of annual EV share with a growth target of 3.7% each year can be seen in the table below.

Table 59. **Electrification Target Year-on-Year 2022-2030.** *Modelling calculation (2024)*

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
Electrification target	3%	7%	10%	13%	17%	20%	23%	27%	30%

This projection also considers the growth parameters of ICE vehicles each year. However, every year there is a development in the number of EVs (based on the determined annual targets) that will replace the number of ICE vehicles. After that, the potential reduction in GHG emissions by 2030 can be calculated, amounting to as much as seven million tons or a reduction of 17.5% compared to the total emissions of 40.5 million tons.

Figure 67. **Potential GHG Reduced Due to EV (WTW) including Black Carbon.** *Modelling Calculation (2024)*



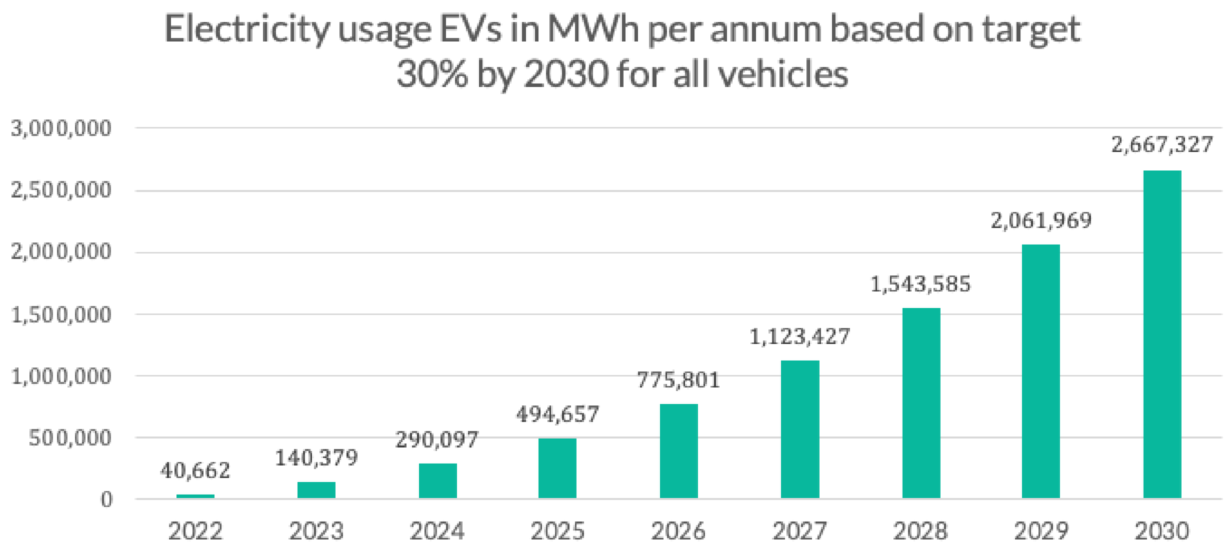
WTW: Well to Wheel; The emissions produced from fuel source/production and vehicle operation.

Black Carbon: component of fine particulate matter (PM2.5), and often exhibit similar health effects as exposure to PM2.5

73 EV30@30 campaign | Clean Energy Ministerial

74 Bapenda DKI Jakarta. 2024.

Figure 68. Electricity Usage by EV in MWh per Year. *Modelling Calculation (2024)*



By calculating the electricity consumption per kilometer and the lifespan mileage of a vehicle, the electricity consumption of each vehicle per year can be calculated in MWh. Figure 69 illustrates the required electricity consumption each year based on the number of fleet investments. Assuming a constant electricity production capacity of 34,578, the share of net electricity is determined.

Table 60. EV as Share of Net Electricity Production 2022. *Modelling Calculation (2024)*

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
EV Share of net electricity production 2022	0.12%	0.41%	0.84%	1.43%	2.24%	3.25%	4.46%	5.96%	7.71%

Figure 69. Emission Comparison Between BAU and EV Scenario. *Modelling Calculation (2024)*

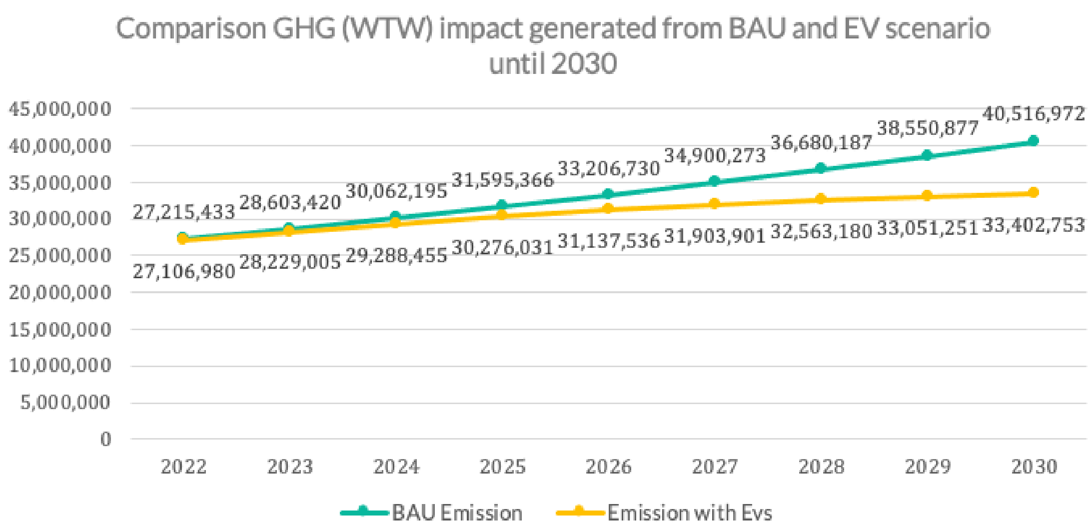
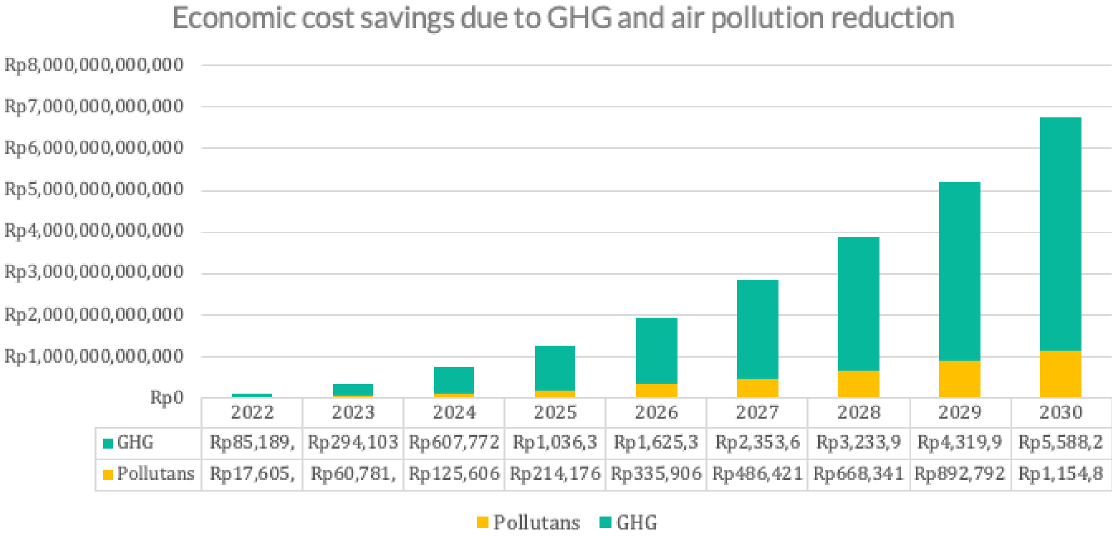


Table 61. Emission Reduction Over the Year for All Vehicles

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
GHG	108,453	374,415	773,739	1,319,335	2,069,194	2,996,373	4,117,007	5,499,626	7,114,218
$PM_{2.5}$	9.56	33.00	68.20	116.29	182.39	264.12	362.90	484.77	627.09
NO_x	393.1	1,357.1	2,804.5	4,782.1	7,500.1	10,860.8	14,922.7	19,934.2	25,786.5

After the GHG reduction figures are calculated, the annual emission reduction can be determined by subtracting the previous BAU emission figures, as shown in the figure above. Subsequently, the cost per ton value can also be calculated. Reduction of up to 7 million tons of CO2 for GHG emissions, the reduction amounts for PM2.5 and NOx are also calculated at 627 and 25,786 tons respectively in 2030. Thus, the economic cost savings can be calculated totaling IDR 1.1 trillion for air pollution alone, and IDR 6.7 trillion if GHG emissions are included.

Figure 70. Economic Cost Saving due to Emission Reduction from 2022 until 2030



Bali Province

For Bali modeling, the environmental impact calculations will focus on the public transport services Trans Sarbagita and Trans Metro Dewata. Currently, Trans Sarbagita serves two routes (TS1 and TS2) with 5 total operating bus fleet per route. Meanwhile Trans Metro Dewata consists of five routes (K1, K2, K3, K4, and K5) with 95 operational bus fleet in total. The total GHG and air pollution produced from this existing service can be seen in the graph below. For this study, the electrification scenario will involve the use of 10 planned e-bus fleets that are planned to be operational in the future. Therefore, in this model, the impact of 10 units of e-buses on each route will be evaluated.

Table 62. E-Bus Impact on Each Public Transport Route

Segment	Operated Fleet	Daily Mileage (km)	Operational day/year	Annual Mileage (km)	*Source*
TS1	5	227	365	82,928	*Trans Sarbagita*
TS2	5	270	365	98,696	*Trans Sarbagita*
K1	22	241,2	365	88,038	Survey
K2	15	182,8	365	66,722	Survey
K3	15	160	365	58,400	Survey
K4	22	230	365	83,950	Survey
K5	21	236	365	86,140	Survey

With the operational data gathered from surveys and stakeholder information, the emissions per route calculated by multiplying the fleet's operational count by the emission factor.

Table 63. Emission per Bus Route per Annum

PT Route	SO_2	NO_x	$PM_{2.5}$	CO_2 TTW	BC	CO_2 WTW incl. BC
TS1	0.012	1.688	0.059	381	37.239	506
TS2	0.014	2.009	0.070	454	44.320	603
K1	0.055	7.886	0.276	1,782	173.949	2,365
K2	0.028	4.075	0.143	921	89.886	1,222
K3	0.025	3.567	0.125	806	78.674	1,070
K4	0.052	7.519	0.263	1,699	165.872	2,255
K5	0.051	7.365	0.258	1,664	162.463	2,209

Trans Sarbagita: TS1, TS2
Trans Metro Dewata: K1, K2, K3, K4, K5
TTW: Tank-to-Wheel; Tailpipe emissions that are produced when the vehicle is driven.

Figure 71. Annual GHG Emission (TTW) Produced from the Current Service

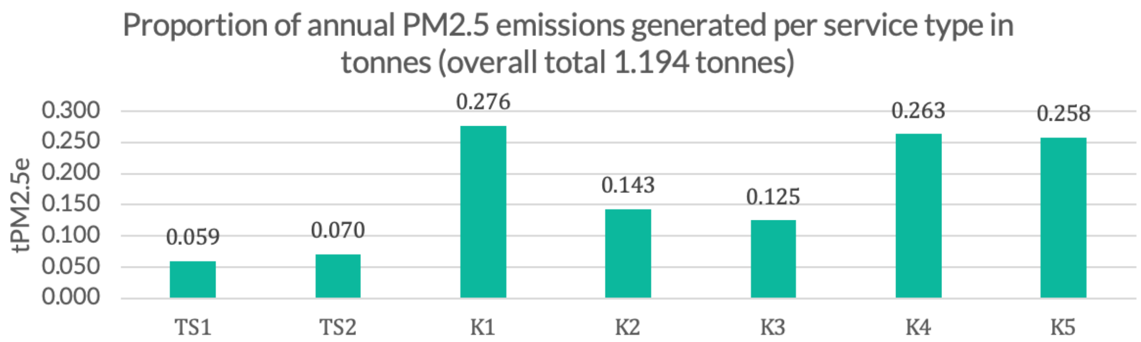
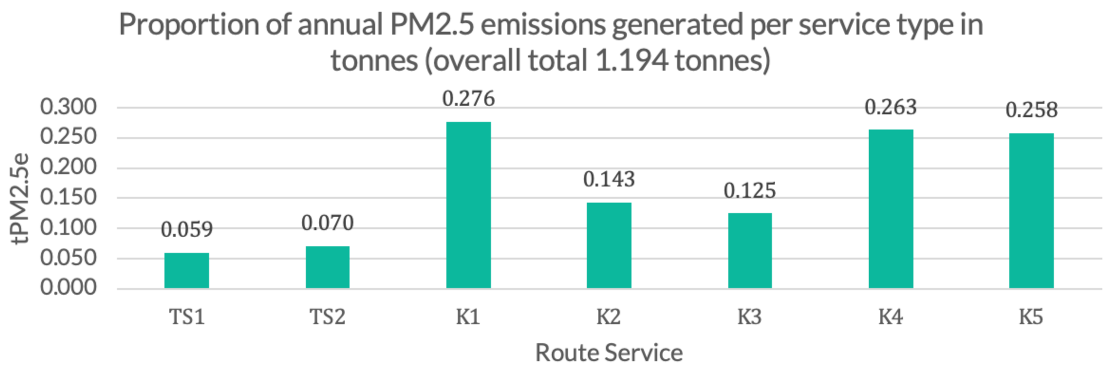
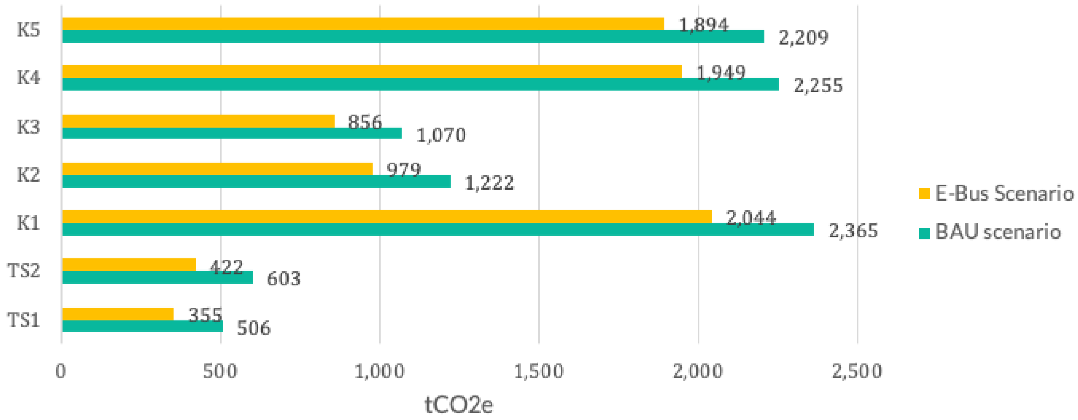


Figure 72. Annual PM2.5 Emission Produced from the Current Service



Moreover, to examine the impact in more detail, calculations will be conducted by observing the impacts of the 10 e-buses on the existing operational routes. Assuming that routes with more than 10 fleet operations, 10 buses will be replaced by e-bus and the rest of bus will stay ICE, whereas routes with fewer than 10 fleets (example: 5 buses) will be completely replaced with e-buses. This calculation is carried out to determine which routes have the most significant impact or potential for the largest reduction in GHG emissions based on existing operational characteristics.

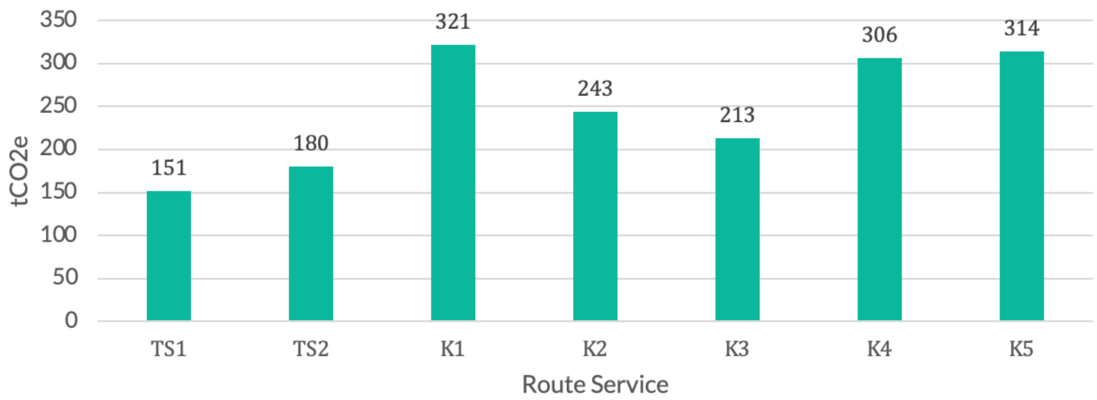
Figure 73. Comparison of GHG Emission Between BAU and the Replacement of 10 E-Buses on Existing Route



WTW: Well to Wheel; The emissions produced from fuel source/production and vehicle operation.
Black Carbon: component of fine particulate matter (PM2.5), and often exhibit similar health effects as exposure to PM2.5

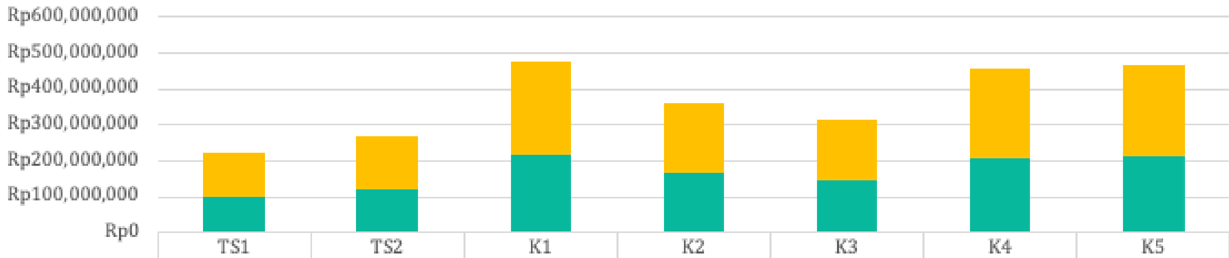
By using the same calculation method as before, the GHG reduction due to the impact of 10 e-buses calculated for each route. However, this calculation does not use a projection; instead, it uses a one-year operational profile based on data we collected from the stakeholders and our field survey.

Figure 74. GHG Reduction Due to E-Bus (WTW incl. BC) on Each Service Route in Tons



Based on the graph above, with the replacement of 10 e-buses on existing routes, routes K1 and K5 have the highest potential reduction compared to other routes, which are 321 and 314 tons of CO2, respectively. This impact occurs because K1 and K5 have higher mileage compared to other routes. Conversely, the Trans Sarbagita route has the lowest reduction due to the fleet operating fewer than 10 buses (only 5 buses per route). However, assuming 10 e-bus fleet operations on the Trans Sarbagita service, this route would have a higher impact, up to 360 tons of CO2 in one year of operation. Based on the cost savings value, Route K1 also has the highest impact, with Route K5 being the second highest. The total savings (GHG + air pollution) are IDR 476 million and IDR 466 million, respectively, in one year of operation.

Figure 75. Annual Economic Cost Saving Value Due to Emission Reduction



	TS1	TS2	K1	K2	K3	K4	K5
GHG	Rp122,319,226	Rp145,577,107	Rp259,713,004	Rp196,830,585	Rp172,280,600	Rp247,653,362	Rp254,113,885
Pollutant	Rp102,011,052	Rp121,407,519	Rp216,593,888	Rp164,151,587	Rp143,677,538	Rp206,536,460	Rp211,924,368

4.2. Economic Impacts

This segment evaluates the socio-economic cost-benefit analysis, a quantitative assessment that predicts the effect of the project on economic aspects. The objective of the analysis is to determine the economic impact of replacing 10 units of ICE buses with 10 units of electric buses on each existing route, namely the Trans Metro Dewata and Trans Sarbagita routes.

4.2.1. Key Parameters and Methodology

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. The ENPV is calculated using the following formula:

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

Bt is the quantified benefits at time t, ***Ct*** is the quantified costs at time t, and ***sc*** is the social discount rate. A project could be said to bring greater goods for society when ENPV is greater than zero. The Internal Rate of Return (IRR) is one of the crucial financial metrics in evaluating investments. IRR estimates the discount rate at which the net present value (NPV) of all cash flows associated with an investment project becomes zero. In this context, emphasis on the economic aspects of IRR is related to the analysis of externalities arising from the transition to electric bus technology, including potential environmental and social implications. The economic IRR can be calculated using the following formula:

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

Benefit cost ratio (BCR) summarizes 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 society. The formula to calculate BCR is as follow:

$$BCR = \frac{|PV[Benefits]|}{|PV[Cost]|} = \frac{\sum_{t=1}^{T} \frac{|B_t|}{(1+sc)^t}}{\sum_{t=1}^{T} \frac{|C_t|}{(1+sc)^t}}$$

Economic parameters assumed in the analysis include an inflation rate of 2.95% (average inflation from 2018 to 2023) and a discount rate of 6.82%. Other parameters adjusted based on the targeted areas in this study. The cost-benefit analysis in this target area will look at the impact of electrifying 10 existing ICE buses into 10 electric bus units on each existing route. The identified benefit components include fuel subsidy reduction resulting from the transition to EV, operational and maintenance cost savings, and environmental benefits comprising GHG reduction and air pollution reduction benefits. Meanwhile, the selected cost components include infrastructure maintenance costs, electricity consumption costs for electric buses and capital costs consisting of bus procurement costs, charging equipment procurement costs, and charging equipment installation costs. Other assumptions from this analysis shown below.

Table 64. List of Assumptions

Aspect	Unit of Measurement	Data	Remarks
Electric bus price	Million Rupiah	Rp 3,418	Using examples of official prices for electric bus procurement (tax included)[75]
Charging facility	Million Rupiah	Rp 957.26	Using Hitachi ABB PowerGrid + 10% tax
Charging-bus ratio	Ratio	0.2	Assumption for each charger serving 5 buses
Installation cost	%	10%	From total capital cost
Battery cost	%	40%	From total capital cost bus
Operational days	Days	365.5	Average operational days from existing services
Daily mileage	Km	239.25	Average mileage based on existing bus trips
Energy consumption	kWh/Km	1	Energy required for each kilometre
Energy cost	Rp/kWh	Rp 817	Based on the bulk price from PLN (including 10% income tax and 5% street lighting tax)

4.2.2. Assessment of Cost-Benefit-Analysis

Quantifiable Benefits

As explained in Chapter 2, the government provides subsidies for certain types of oil fuels, including diesel fuel used by public transportation services. The subsidy amount for cetane 48 diesel is Rp 500 per liter, which can be sourced from the local government budget. Transitioning to EV can help alleviate the budget allocation for fuel subsidies. Energy consumption calculated based on the parameters of the existing bus, as presented in the table below. These parameters obtained through interviews with relevant operators.

Table 65. Energy Consumption Parameters of the Existing Bus

Aspect	Unit of Measurement	Trans Metro Dewata	Trans Sarbagita
Fuel consumption	L/Km	0.22	0.23
Operational days	Days	365	366

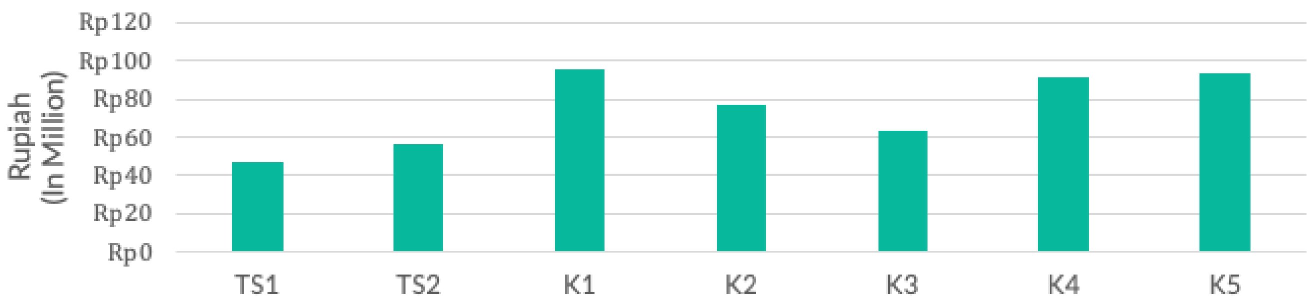
The replacement of 10 diesel buses with electric buses results in the loss of the subsidy allocated to the diesel buses. This loss can be considered a saving. To calculate the total cost savings of subsidies based on the provided table, it is obtained by multiply the number of ICE buses replaced by the fuel consumption per kilometer, daily mileage, annual operational days, and the diesel subsidy, which is 500 rupiah per liter. Based on the calculations shown in Table 66, the highest cost of fuel subsidy savings occurred in the Trans Metro Dewata service on corridor route 1 (K1), followed by corridor routes 5 (K5) and 4 (K4).

75 https://e-katalog.lkpp.go.id/katalog/produk/detail/75615180?lang=id&type=general

Table 66. Calculation of Fuel Subsidy Savings

Code route	Number of ICE buses replaced	Fuel consumption (L/km)	Daily mileage (Km)	Annual operational days	Total fuel subsidy saved (Million Rupiah)
TS1	5	0.23	227	366	Rp 47.40
TS2	5	0.23	270	366	Rp 56.38
K1	10	0.22	241.2	365	Rp 95.69
K2	10	0.22	192.8	365	Rp 76.49
K3	10	0.22	160	365	Rp 63.48
K4	10	0.22	230	365	Rp 91.25
K5	10	0.22	236	365	Rp 93.63

Figure 76. Estimate of Fuel Subsidy Cost Savings on Each Route



The transition from using buses with internal combustion engines (ICE) to electric buses also can result in reduced vehicle operating costs. This reduction arises from the higher efficiency of using electric energy compared to using gasoline fuel. This assumption is made by considering that there is no change in staff costs or other overhead costs when using electric buses. In addition, previous studies have shown that most electric bus maintenance costs are around 1,097 Rupiah per kilometer[76]. The following table (Table 67) presents a comparison of operational and maintenance data for ICE and electric buses at each operator, which is used to calculate operational and maintenance cost savings. For the operational data components, the data is elaborated into several components, including staff costs, energy, and other operational costs, other than staff and energy costs. These generally include overhead costs as well as expenses for taxes and administration.

Table 67. Comparison of Operational and Maintenance Data on the Use of ICE Buses and Electric Buses at Each Operator

Aspect	Unit of Measurement	Trans Metro Dewata		Trans Sarbagita	
		ICE Bus	E-Bus	ICE Bus	E-Bus
Operational cost	Rp/km	Rp 10,000	Rp 9,480.04	Rp 4,815	Rp 4,080.03
Staff cost		Rp 700	Rp 700	Rp 1,976.76	Rp 1,976.76
Energy cost		Rp 1,336.96	Rp 817	Rp 1,551.97	Rp 817
Other operational cost exc. staff and energy		Rp 7,963.04	Rp 7,963.04	Rp 1,286.27	Rp 1,286.27
Maintenance cost		Rp 3,400	Rp 1,097	Rp 738.90	Rp 1,097
Operational days	Days	365		366	

76 GFA. (2020). Financial Feasibility Study. Berlin: GIZ

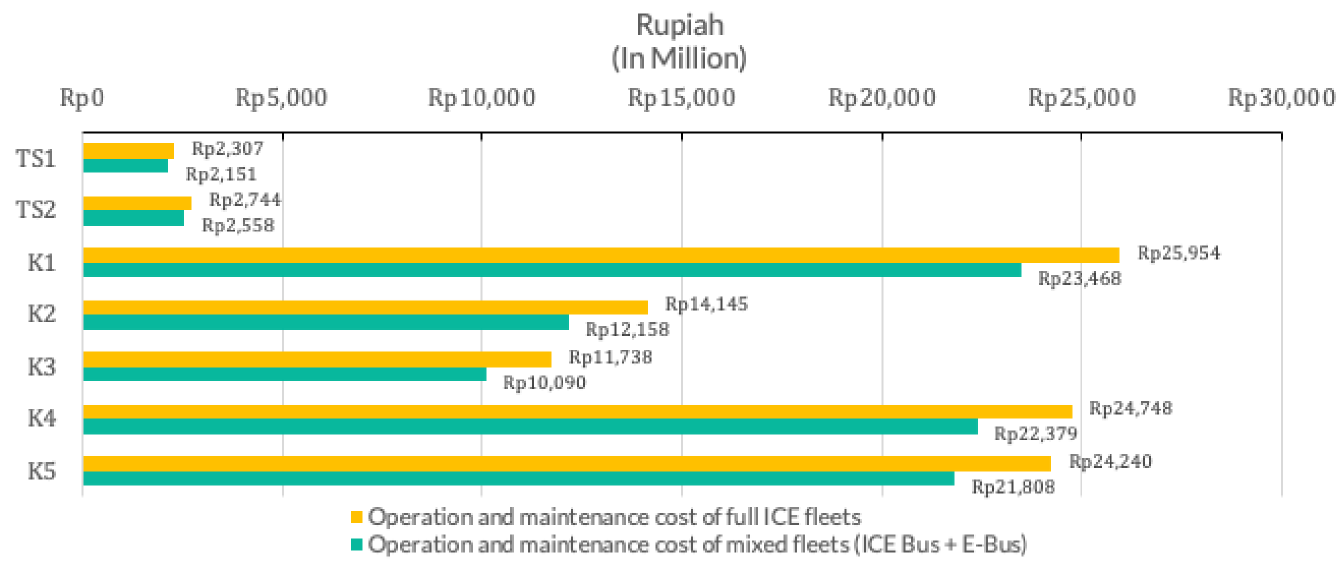
To calculate the value of operational and maintenance cost savings when using electric buses, it is necessary to conduct a comparison between the annual operational and maintenance costs for a full fleet of Internal Combustion Engine (ICE) buses and a mixed fleet consisting of both ICE and electric buses. The annual operational cost is calculated by multiplying the operational cost per kilometer by the average daily mileage and the number of operating days in a year. In parallel, the annual maintenance cost is calculated by multiplying the maintenance cost per kilometer by the average daily mileage and the number of operating days in a year. The difference between the annual operational and maintenance costs of the ICE bus fleet and the mixed fleet is then calculated to identify the savings value.

The calculations presented in Table 68 demonstrate that several routes have the potential to achieve considerable savings in annual operational and maintenance costs using electric buses. Notably, in the Trans Sarbagita service, where the number of buses operating on each route is limited to 5 units. With an allocation of 10 electric buses, this service can fully replace the entire fleet with electric buses (TS1 and TS2), resulting in optimal percentage savings compared to the Trans Metro Dewata service, which utilizes a mixed fleet (ICE + Electric Bus). Nevertheless, in terms of quantity, the greatest savings are observed in the Trans Metro Dewata service on corridor 1 (K1), due to the number of transitions to electric buses and the longest daily mileage.

Table 68. Calculation of Operational and Maintenance Cost Savings on Each Service Route

Code Route	Number of existing buses	Number of electric buses	Daily mileage (Km)	Annual operational cost (Million Rupiah)		Annual maintenance cost (Million Rupiah)		Annual operational and maintenance cost savings
				Full ICE Bus	Mixed fleets (ICE Bus + E-Bus)	Full ICE Bus	Mixed fleets (ICE Bus + E-Bus)	
TS1	5	5	227	Rp2,000.20	Rp1,694.88	Rp306.94	Rp455.70	Rp156.55
TS2	5	5	270	Rp2,379.09	Rp2,015.94	Rp365.09	Rp542.03	Rp186.21
K1	22	10	241.2	Rp19,368.36	Rp18,910.60	Rp6,585.24	Rp4,557.73	Rp2,485.27
K2	15	10	192.8	Rp10,555.80	Rp10,189.90	Rp3,588.97	Rp1,968.30	Rp1,986.57
K3	15	10	160	Rp8,760.00	Rp8,456.35	Rp2,978.40	Rp1,633.45	Rp1,648.61
K4	22	10	230	Rp18,469.00	Rp18,032.50	Rp6,279.46	Rp4,346.09	Rp2,369.87
K5	21	10	236	Rp18,089.40	Rp17,641.51	Rp6,150.40	Rp4,166.59	Rp2,431.69

Figure 77. Comparison of Operational and Maintenance Costs between a Full Fleet of ICE Buses and a Mixed Fleet Consisting of ICE Buses and e-Buses



Cost Component

The implementation of electric vehicles (EVs) undoubtedly requires a considerable amount of investment. This investment comprises two main components: buses and charging infrastructure. Based on the selected model, the price of one bus unit is estimated at 3.4 billion Indonesian rupiah[77], while the unit cost for the charging facility is IDR 957 million, both prices including taxes. Furthermore, it is assumed that the installation cost of the charging facility is 2.5% of its unit price, resulting in an estimated installation cost of Rp 23.9 million for each charger unit.

In addition to capital costs, it is crucial to ensure the allocation of sufficient resources for the routine maintenance of electric vehicle (EV) infrastructure to guarantee a seamless charging process. In general, the funds allocated for the maintenance of charging infrastructure contribute 2.5% of unit cost[78]. The estimated price of the charging infrastructure, based on the model utilized (Hitachi ABB PowerGrid), is 957.26 million Rupiahs, which already includes a 10% tax. It is also important to consider the cost of energy consumption in this analysis. The selected bus model is assumed to consume 1 kWh per kilometer, and the current electricity price is 817 Rupiahs per kWh (including a 10% income tax and a 5% street lighting tax).

Table 69. Assumed Parameters for Cost Component Calculation

Component	Unit of Measurement	Value
Electric bus price	In million Rp	Rp 3,418
Unit cost for charging facility	In million Rp	Rp 957.26
Installation cost	%	10%
Infrastructure maintenance allocation	%	2.5%
Energy consumption	kWh/km	1
Energy cost	Rp/kWh	817

The Trans Sarbagita service operates with a fleet of only five buses per route, which allows for the conversion of these routes to electric buses. Meanwhile, on the Trans Metro Dewata service, each route can only partially electrify the buses, with 10 units being electric and the remainder still using ICE buses. The charging ratio is assumed to be 1:5, where one charging device can serve five electric bus units. Consequently, each Trans Sarbagita route requires only one charging unit, while on the Trans Metro Dewata route, two charging devices are required for each route.

The infrastructure maintenance cost is obtained by multiplying the maintenance allocation percentage (2.5%) by the total charging infrastructure cost, which amounts to 957.26 million Rupiah, and the number of charging facilities. Furthermore, to estimate the annual energy consumption cost, the number of kilowatt-hours (kWh) consumed per kilometer (1 kWh/km) is multiplied by the average daily mileage and the number of operational days in a year for each route. The result is then multiplied by the energy cost per kilowatt-hour (Rp 817/kWh) to obtain the total annual energy consumption cost. Based on the calculation table below, it is known that corridor 1 of the Trans Metro Dewata service (K1) has the highest cost component compared to all existing service routes.

77 https://e-katalog.lkpp.go.id/katalog/produk/detail/75615180?lang=id&type=general

78 Grutter Consulting. (2019). Bus listrik for BRT Corridors 1 and 6 of Transjakarta. Leysin: Grutter Consulting

Table 70. Summary of the Calculation of Cost Components on Each Route

Code Route	Number of E-buses	Number of charging facility	Daily mileage (Km)	Bus procurement (Million Rupiah)	Procurement of charging facilities (Million Rupiah)	Installation cost (Million Rupiah)	Infrastructure maintenance cost (Million Rupiah)	Annual energy consumption cost (Million Rupiah)
TS1	5	1	227	Rp 17,088.31	Rp 957.26	Rp 95.73	Rp 23.93	Rp 339.39
TS2	5	1	270	Rp 17,088.31	Rp 957.26	Rp 95.73	Rp 23.93	Rp 403.68
K1	10	2	241.20	Rp 34,176.62	Rp 1,914.52	Rp 191.45	Rp 47.86	Rp 719.27
K2	10	2	192.80	Rp 34,176.62	Rp 1,914.52	Rp 191.45	Rp 47.86	Rp 574.94
K3	10	2	160	Rp 34,176.62	Rp 1,914.52	Rp 191.45	Rp 47.86	Rp 477.13
K4	10	2	230	Rp 34,176.62	Rp 1,914.52	Rp 191.45	Rp 47.86	Rp 685.87
K5	10	2	236	Rp 34,176.62	Rp 1,914.52	Rp 191.45	Rp 47.86	Rp 703.76

4.2.3. Cost-Benefit Analysis

After considering all the benefit and cost components, the benefit-cost ratio (BCR) calculation can be performed. A summary of the quantifiable benefits and cost components previously identified is presented in Table 71. It can be observed that the trend of greater values occurs on all Trans Metro Dewata service corridor routes, both in terms of benefits and costs. This can be attributed to the highest transition towards the use of electric buses in the operation of the Trans Metro Dewata corridor routes, in contrast to the situation on the Trans Sarbagita service corridor routes, which only operate five bus units in each corridor. In terms of the overall accumulated benefits, it can be observed that corridor 1 of the Trans Metro Dewata service generates the largest benefits in comparison to other routes. Although the cost of capital component has a very large value, it only appears in the first year and does not reappear in subsequent years.

Table 71. Summary of Quantifiable Benefits and Cost Component

Code Route	Benefit (In Million Rupiah)				Cost (In Million Rupiah)		
	Fuel subsidy savings	Operational and maintenance cost savings	GHG Reduction Benefit	Air Pollution Reduction Benefit (SOx, NOx, and PM2,5)	Capital cost (procurement of buses, charging facilities and installation cost)	Infrastructure maintenance cost	Annual energy consumption cost
TS1	Rp 47.40	Rp 156.55	Rp 122.32	Rp 102.01	Rp 18,141.30	Rp 23.93	Rp 339.39
TS2	Rp 56.38	Rp 186.21	Rp 145.58	Rp 121.41	Rp 18,141.30	Rp 23.93	Rp 403.68
K1	Rp 95.69	Rp 2,485.27	Rp 259.71	Rp 216.59	Rp 36,282.59	Rp 47.86	Rp 719.27
K2	Rp 76.49	Rp 1,986.57	Rp 196.83	Rp 164.15	Rp 36,282.59	Rp 47.86	Rp 574.94
K3	Rp 63.48	Rp 1,648.61	Rp 172.28	Rp 143.68	Rp 36,282.59	Rp 47.86	Rp 477.13
K4	Rp 91.25	Rp 2,369.87	Rp 247.65	Rp 206.54	Rp 36,282.59	Rp 47.86	Rp 685.87
K5	Rp 93.63	Rp 2,431.69	Rp 254.11	Rp 211.92	Rp 36,282.59	Rp 47.86	Rp 703.76

The results of the calculated benefits and costs identified above were then projected until 2030 with an inflation rate of 2.95% to provide a clearer comparison of the cost-benefit ratio. The projection results are shown in Figure 78. It should be noted that the initial capital cost is not included in the graph, due to its very significant value. However, a detailed version of this information can be found in Table 103 in the annex section. It was found that the savings from operational and maintenance costs constitute the largest proportion of the total measurable benefits, followed by environmental benefits such as greenhouse gas reduction and air pollution reduction. In terms of cost components, the largest proportion apart from capital costs is attributable to the energy consumption cost of the electric bus. While the overall benefits generated by the Trans Metro Dewata service are generally greater, this is also proportional to the cost components incurred.

Figure 78. **Projected Benefit-Cost Components for Each Route Exclude Initial Capital Costs**

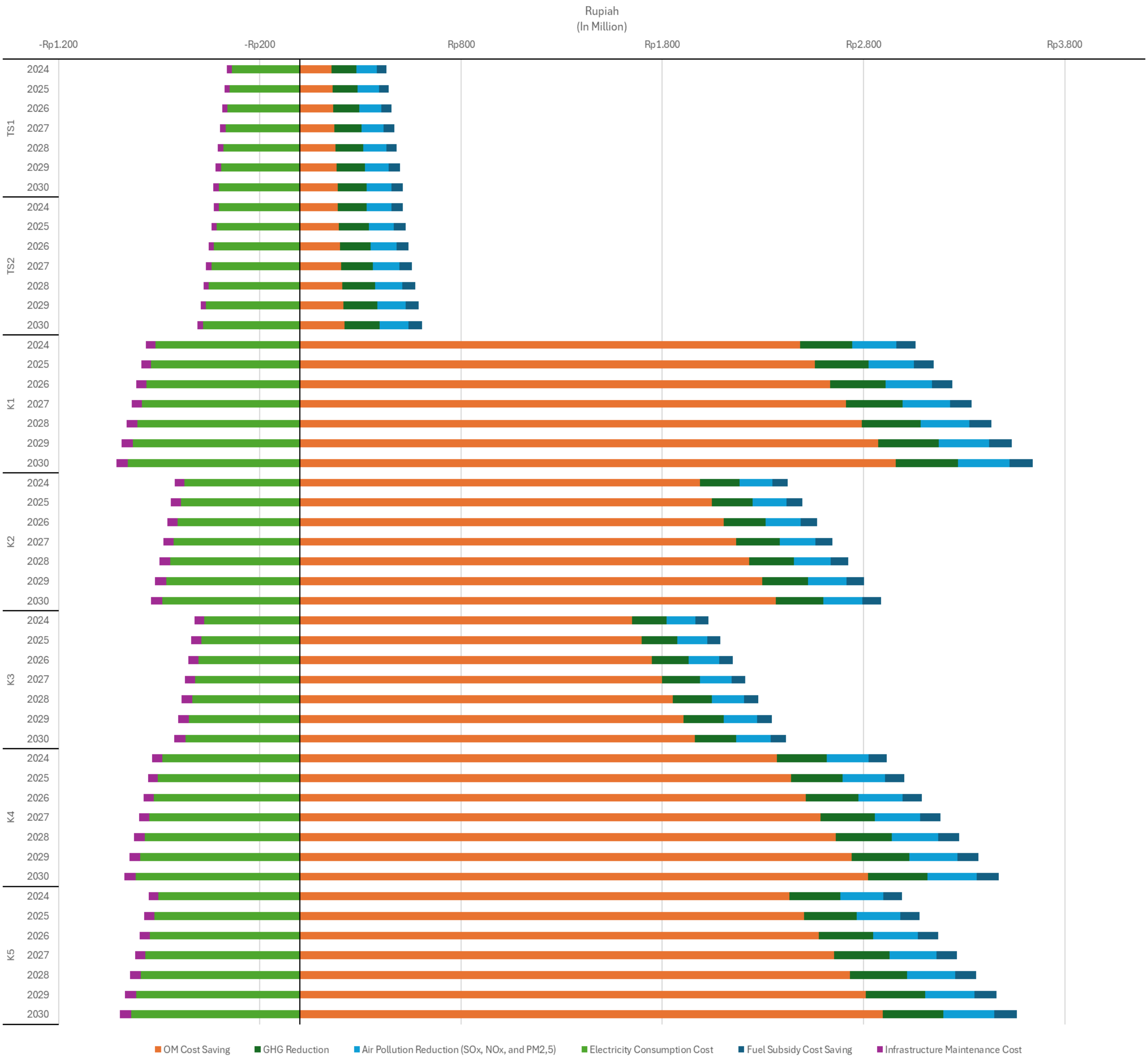


Table 72 summarizes the calculation results of present value each component, along with the corresponding benefit-cost ratio (BCR) values. It is known that all routes show low parameter results. The negative values of both the economic net present value (NPV) and economic internal rate of return (EIRR) indicate that the potential benefits that may be derived from replacing 10 electric buses within the specified time (6 years) period are still insufficient in comparison to the costs incurred. This finding is in line with the results of the Benefit-Cost Ratio (BCR), which indicate that all routes exhibit a ratio below one. This suggests that the expected benefits are not worth the costs, as the ratio does not demonstrate economic profitability. Furthermore, it was observed that the Benefit-Cost Ratio (BCR) value of the Trans Metro Dewata service tends to be higher than that of the Trans Sarbagita service. Among the other routes, the BCR value of corridor 1 exhibited the largest ratio.

Table 72. Summary of the Calculation Cost-Benefit Components from 2024 to 2030

Code route	PV of benefits (Million Rupiah)	PV of cost (Million Rupiah)	Economic NPV (Million Rupiah)	Benefit-cost ratio	Economic IRR
TS1	Rp 2,691.16	Rp 20,424.23	-Rp 17,733.07	0.13	-58.63%
TS2	Rp 3,201.94	Rp 20,828.19	-Rp 17,626.25	0.15	-56.75%
K1	Rp 19,210.38	Rp 41,102.88	-Rp 21,892.49	0.47	-23.88%
K2	Rp 15,231.48	Rp 40,195.97	-Rp 24,964.49	0.38	-28.31%
K3	Rp 12,743.20	Rp 39,581.37	-Rp 26,838.17	0.32	-31.35%
K4	Rp 18,318.36	Rp 40,893.01	-Rp 22,574.66	0.45	-24.82%
K5	Rp 18,796.23	Rp 41,005.44	-Rp 22,209.21	0.46	-24.31%

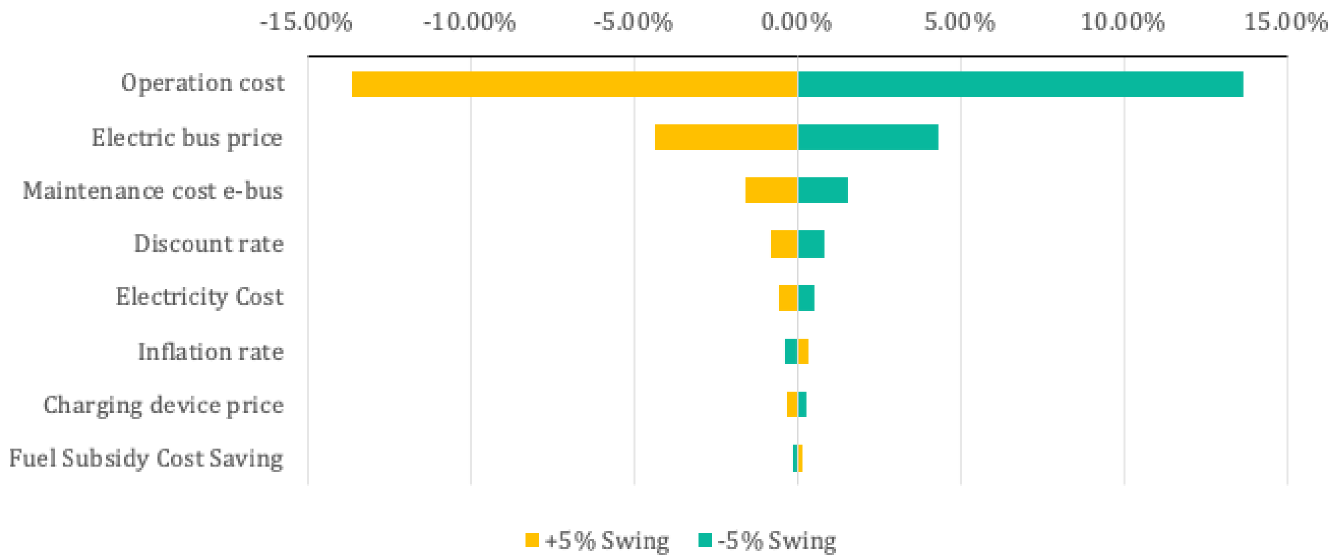
Sensitivity analysis is conducted to identify which variables have a significant impact on the benefit-cost ratio (BCR). For this study, a range of changes up to 5% serves as the sensitivity indicator, used to assess how changes in variables affect the overall BCR value. For the sensitivity analysis using the example of parameter changes in corridor 1 of the Trans Metro Dewata service (K1). There are 8 variables selected to assess the impact of changes on the BCR calculations and results of this sensitivity analysis are presented in Table 73. For example, the base electricity cost is Rp 817. When it decreases to Rp776.15 (-5% swing), the BCR value increases by 0.55%. Conversely, if the electricity cost increases to Rp857.85 (+5% swing), it results in a decrease in the BCR value by -0.55%

Table 73. The Results of the Sensitivity Analysis Calculation on Corridor 1 Trans Metro Dewata (K1)

Parameter	Base Case	-5% swing	+5% swing	Percentage change in BCR value after -5% swing	Percentage change in BCR value after +5% swing
Operation cost	Rp 9,480.04	Rp 9,006.04	Rp 9,954.05	13.65%	-13.65%
Electricity Cost	Rp 817	Rp 776.15	Rp 857.85	0.55%	-0.55%
Maintenance cost e-bus	Rp 1,097	1042.15	1151.85	1.58%	-1.58%
Inflation rate	2.95%	2.80%	3.10%	-0.36%	0.36%
Discount rate	6.82%	6.48%	7.16%	0.81%	-0.81%
Fuel Subsidy Cost	Rp 500	Rp 475	Rp 525	-0.16%	0.16%
Electric bus price	Rp 3,417,661,733	Rp 3,246,778,646	Rp 3,588,544,819	4.34%	-4.34%
Charging device price	Rp 957,261,696	Rp 909,398,611	Rp 1,005,124,780	0.29%	-0.29%

The results of the sensitivity analysis indicate that the operational cost variable exerts the greatest influence on the BCR value, with an impact on the BCR value by ±13.65%. This may be due to the continuous and significant nature of operating costs compared to other variables. When the operating cost decreases, it results in higher savings compared to the ICE bus, thus increasing the BCR value. Conversely, as the operating cost increases, the difference in savings with the operating cost of an ICE bus becomes smaller, and as a result, the BCR value also decreases. Furthermore, it is found that the variables of fuel subsidy cost and inflation rate have a positive relationship with the BCR value, indicating that a decrease in both variables leads to a decrease in the BCR value. In contrast, the other selected variables show a negative correlation.

Figure 79. Sensitivity Analysis of the Benefit-Cost Ratio Value



4.3 Assessment of Public Transportation Routes in Bali: Multi-Criteria Analysis Step 2

In the second step, a further multi-criteria analysis (MCA) was conducted to gain a deeper insight into the comparisons between the routes, with the potential conversion to 10 electric buses. The criteria selected for the ranking of the routes include emissions reduction per bus, average speed on the route, emissions per passenger, overlap with E-BRT plans, and terminal availability. To provide a more equitable assessment of each route, the criteria of terminal availability, average speed, and overlap with E-BRT corridor plan segments were once again employed. In conducting the multi-criteria assessment, each selected criterion is assigned a weight that reflects its relative importance to the overall sustainability of the project. In this analysis, the criteria with the highest weights were emissions reduction per bus, emissions per passenger, and the availability of terminals as potential charging locations.

Table 74. Selected Criteria and its Weighting Value

No	Criteria	Remark	Raw Weighting (1-5, less important-neutral-most important)	Weighting
1	Emission reduction per bus (ton/year)	Emissions saved when using electric buses. The amount of emissions is adjusted according to the length of the route.	5	22.73%
2	Average speed (km/hour)	The average speed of buses on a route. The lower the speed, it is assumed that traffic volume is dense, hence the emissions that can be saved are also greater.	4	18.18%
3	Emissions per passenger (kg/pax)	The amount of emissions borne by each individual. More passenger route is preferred.	5	22.73%

No	Criteria	Remark	Raw Weighting (1-5, less important-neutral-most important)	Weighting
4	Future e-bus deployment potential (overlapped segment)	The percentage of overlap of route segments of the existing bus service corridor with the planned E-BRT corridor. If a certain route is more likely to be chosen for electrification, that route should be chose for the pilot.	3	13.64%
5	Terminal availability as a potential charging location	The number of terminals that pass by or are within the range of the bus service route. These terminals can potentially serve as charging stations	5	22.73%
Total			**22**	**100%**

Emission Reduction per Bus

The reduction of emissions per bus is an important indicator for evaluating the effectiveness of policies or changes in the transportation system. This criterion helps to assess how well a route or transportation service contributes to the reduction of greenhouse gas emissions. Table 75 shows the results of the calculation of wheel-to-wheel greenhouse gas reduction for each route due to the use of electric buses. It is known that corridor 2 of Trans Sarbagita produces the largest emission reduction, with a total of 36.02 tons per year. The 25th percentile data is 24.35 tons per year, while the 75th percentile data is 32.13 tons per year. Consequently, the conditional formatting for evaluating this criterion is as follows:

- Score 1 for data above or equal to 24.35 ton per year
- Score 2 for data between 24.35 ton per year and 32.13 ton per year
- Score 3 for data below or equal to 32.13 ton per year

Table 75. Scoring of Criteria for Emission Reduction per Bus (Wheel-to-Wheel)

Code route	Emission reduction per bus WTW (ton/year)	Score
TS1	30.26	2
TS2	36.02	3
K1	32.13	3
K2	24.35	1
K3	21.31	1
K4	30.64	2
K5	31.44	2

Average Speed in Each Route

In order to provide a more equitable assessment, the average speed of buses on each route was once again employed as a criterion in the analysis. This criterion assumes that the average speed is indicative of the traffic volume conditions on the route. It is more feasible to reduce emissions on routes with high traffic volumes if the buses are electric. While greater exposure to electric buses in traffic may enhance awareness of the existence and benefits of electric buses, it does not guarantee a mode share shift to electric buses. The conditional formatting is as follows:

- Score 1 for speeds above or equal to 24.1 km/h
- Score 2 for speeds between 17.9 km/h and 24.1 km/h
- Score 3 for speeds below or equal to 17.9 km/h

Table 76. Scoring of Criteria for Average Speed of Each Route

Code route	Average speed (km/hour)	Score
TS1	19.2	2
TS2	26.1	1
K1	22.1	2
K2	17.3	3
K3	18.7	2
K4	24.1	1
K5	17.9	3

Emission per Passenger

In addition to measuring emission reductions per bus, measuring emissions per passenger can provide a clearer and more equitable comparison between various routes. It can be observed that routes that serve a greater number of passengers produce lower emissions per capita, thereby contributing to the reduction of the city's carbon footprint. The table below presents the results of the calculation of emissions per passenger, based on the potential passenger data per hour obtained from survey results. This data is then multiplied by the operational hours of each operator. Trans Metro Dewata operates for 13.5 hours a day (04:30–18:00 WITA), while Trans Sarbagita operates for 11 hours a day (06:30–17:30 WITA). Subsequently, the daily wheel-to-wheel CO_2 emission variable is divided by the potential number of passengers per day, resulting in emissions per passenger (kg/pax). The 25th percentile is represented by a value of 0.55 kg/pax, while the 75th percentile is represented by a value of 2.92 kg/pax. Consequently, the conditional formatting data for this criterion encompasses the following:

- Score 1 for data below or equal to 0.55 kg/pax
- Score 2 for data between 0.55 kg/pax and 2.92 kg/pax
- Score 3 for data above or equal to 2.92 kg/pax

Table 77. Scoring Criteria for Emissions Per Passenger

Code route	Emission CO^2 WTW/ day	Potential passenger boarding/hour	Potential passenger per day	Emission per passenger (kg/pax)	Score
TS1	0.97	160	1760	0.553	3
TS2	1.16	406	4466	0.259	3
K1	2.06	72	972	2.124	2
K2	1.56	64	864	1.811	2
K3	1.37	120	1620	0.845	2
K4	1.97	50	675	2.917	1
K5	2.02	24	324	6.235	1

Overlapped segment with E-BRT plan

In addition, routes that overlap with segments of planned E-BRT corridors are also included as criteria. The integration of planned E-BRT corridors allows for the utilization of existing infrastructure, such as charging stations, dedicated lanes, and maintenance facilities, that have already been planned or are currently under construction. This will result in a reduction of the additional costs required to build new infrastructure. It is evident that Corridor 2 of the Trans Sarbagita service exhibits the highest degree of overlap with planned E-BRT corridors, followed by Corridor 1 of Trans Sarbagita. In contrast, Corridor 4 of the Trans Metro Dewata service does not intersect with any planned E-BRT corridors. The results of the assessment of each route in terms of overlap with the planned E-BRT corridor routes are presented in Figure 63.

Table 78. Scoring Criteria for Overlap with E-BRT Corridor Plans

Code route	Overlap with E-BRT plan	Score
TS1	27.00%	2
TS2	32.00%	3
K1	24.00%	2
K2	26.00%	2
K3	16.00%	2
K4	0.00%	1
K5	18.00%	2

Terminal Availability as a Potential Charging Location

Terminal availability is crucial in this analysis as they can function as charging stations for electric buses, optimizing routes and schedules. Accessible terminals can reduce operational costs by eliminating the need for additional infrastructure and providing ample charging capacity. Figure 63 shows terminal locations along public transportation routes, with Corridor 1 of the Trans Metro Dewata service having the closest terminal. The 25th percentile data indicates one terminal, while the 75th percentile data indicates five terminals. Scoring is as follows: Score 1 for less than two terminals, Score 2 for one to five terminals, and Score 3 for five or more terminals.

Table 79. Scoring Criteria for Terminal Availability

Code route	Terminal availability	Score
TS1	3	2
TS2	4	2
K1	6	3
K2	5	3
K3	1	1
K4	2	2
K5	1	1

Assessment of Multi Criteria Analysis Step 2

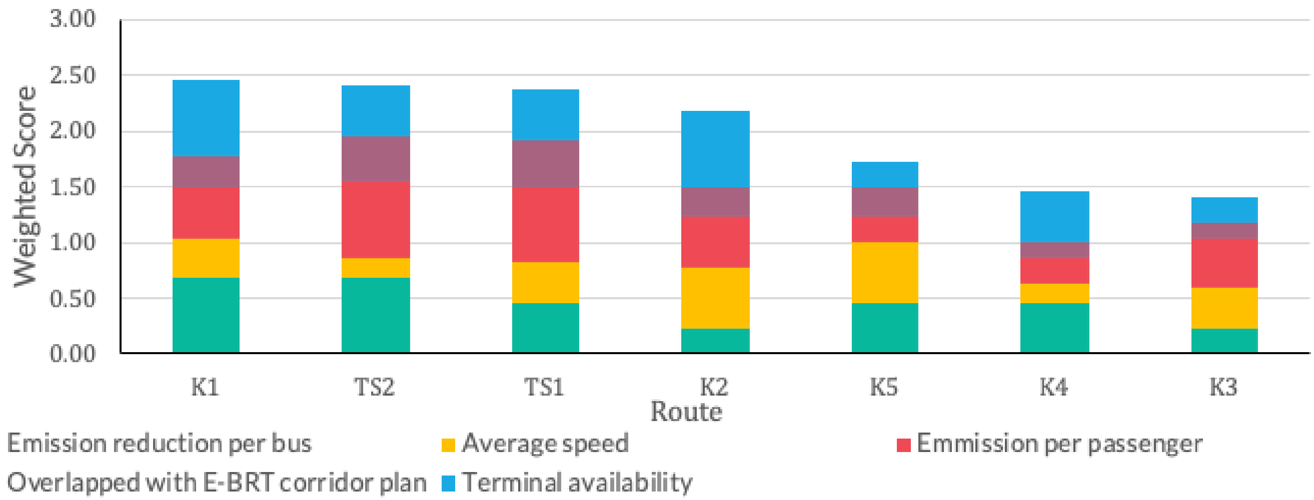
In Stage 2, multicriteria analysis can be conducted after all routes have been scored on each criterion. The summary of the assessment for each route from this analysis is shown in Table 80. The scores for each route were multiplied by the respective criterion weights, and the resulting values were summed to obtain the total assessment value. It was determined that emission reduction per bus and terminal availability were the primary factors influencing the high scores on routes K1, TS1, and TS2. Route K1 stands out with significant contributions from reduced emissions per bus and terminal availability, while Route TS2 shows a good balance between reduced emissions per bus and emissions per passenger.

Table 80. Multicriteria Analysis Assessment of Each Route

Code Route	Emission reduction per bus (ton/year)	Average speed (km/hour)	Emissions per passenger (kg/pax)	Future e-bus deployment potential (overlapped segment)	Terminal availability as a potential charging location	Total assessment
Weighting	23%	18%	23%	14%	23%	100%
TS1	2	2	3	3	2	2.36
TS2	3	1	3	3	2	2.41
K1	3	2	2	2	3	2.45
K2	1	3	2	2	3	2.18
K3	1	2	2	1	1	1.41
K4	2	1	1	1	2	1.45
K5	2	3	1	2	1	1.73

The ranking based on the value of the multicriteria analysis step 2 is shown in the figure below. It is found that the largest score is on corridor 1 of Trans Metro Dewata, with an accumulated value of 2.45, followed by routes on corridors 1 and 2 of the Trans Sarbagita service. On the other hand, Routes K3 and K4 have lower contributions from all criteria, especially on average speed and terminal availability, which contribute to a lower total score.

Figure 80. Route Ranking Based on Scores from Multicriteria Analysis



5. BUSINESS MODEL & POLICIES RECOMMENDATION

This segment will assess the current EV business model and propose policies to optimize EV implementation in the target area, considering economic viability, regulations, and strategic approaches for sustainable integration.

5.1 Business Models

This activity will gather insights from the previous business model case study of Transjakarta and assess the applicability of the recommended business model to the target area. The assessment will also explore proposed policies or targets that have the potential for EV implementation in the designated area.

5.1.1 Potential Financing Schemes and Business Model: Transjakarta Study Case

Transjakarta is taking the first step towards introducing electric buses by initiating a pilot program that aims to deploy 100 e-buses by the end of 2023. In most of the pilot phases, the business model mirrors that of conventional diesel buses. The delivery of bus services to the public is a vital responsibility of the Government of Jakarta. To offer financial support to Transjakarta, the government extends a subsidy known as Public Service Obligation (PSO).

Table 81. Transjakarta 100 E-Bus Operator and Information. I*TDP desktop research (2023)*

Operator Name	Bus Model	Bus Type	Passenger Capacity (pax)	Range (km)	Number of Fleet (unit)
Mayasari Bakti	BYD K9	12 m (low floor)	43	250 km[79]	52
Bianglala Metropolitan	Golden Dragon (SAG)	12 m (low floor)	60	250 km[80]	22

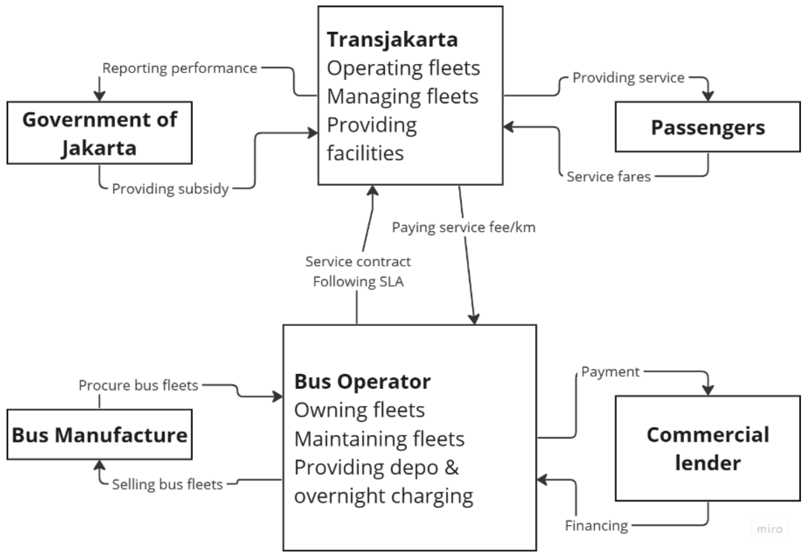
79 K9 12m specs information. www.sg.byd.com

80 Transjakarta uji coba tiga merek bus listrik. Kompas.www.otomotif.kompas.com

Operator Name	Bus Model	Bus Type	Passenger Capacity (pax)	Range (km)	Number of Fleet (unit)
Damri	Skywell	12 m (low floor)	50	250 km[81]	26

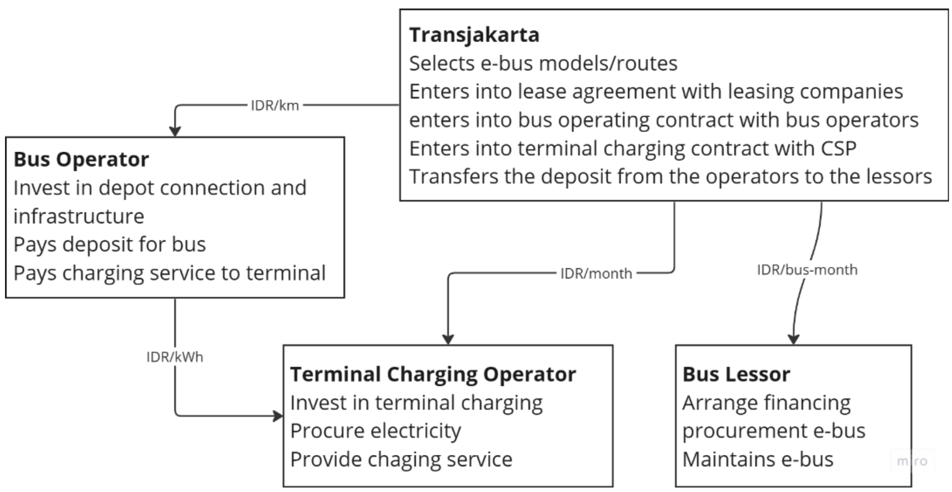
In exchange for this assistance, Transjakarta is required to furnish the Government of Jakarta (GoJ) with regular reports encompassing the level of service achievement, financial details, and management aspects of the bus services. The designated operator is responsible for procuring and maintaining the electric buses, along with the task of establishing and maintaining the necessary charging infrastructure and depot facilities. To ensure adherence to standards, Transjakarta has set a service level agreement (SLA) that outlines the criteria the bus operators must meet. In return for their services, operators receive payment in the form of a service fee per kilometer traveled.

Figure 81. Business Model for 74 E-Bus Pilot by Transjakarta. *ITDP research (2023)*



To accelerate the transition to the larger scale of the electrification, Transjakarta has accommodated the new scheme of business model through the bus leasing mechanism. In this scheme it enables the bus ownership to fall into the Bus Lessor and the bus operator only responsible for the daily operations.

Figure 82. Business Model for Recent 26 E-Bus Pilot by Transjakarta. *ITDP research (2023)*



81 DKI punya 26 bus listrik baru CNBC Indoneia. www.cnbcindonesia.com

According to Transjakarta's rough estimation, the investment needed for acquiring 10,047 e-buses by the year 2030 would exceed USD 2.45 billion. Transjakarta heavily relies on annual subsidy from The Government of Jakarta to meet the cost operating gap. The 2019, 2020, and 2021 figures show that 78.3%, 88.7%, and 90.2% of Transjakarta's revenue streams come from public transport services subsidies (PSO).

Table 82. **Transjakarta Revenue Source.** ***Transjakarta***

Source	2017	2018	2019	2020	2021
Ticket	25.5%	20.1%	20.4%	9.9%	7.7%
Subsidize	73.9%	79.5%	78.3%	88.7%	90.2%
Sponsorship	0.6%	0.4%	0.3%	0.4%	0.3%
Non-Transport Revenue	0.1%	0.0%	0.95%	1.0%	1.8%

Business-As-Usual approach will not suffice to help Transjakarta electrify its bus fleet. Therefore, alternative funding options are necessary to support the implementation of the electric bus system. For instance, government agency grants, private financing, or public-private partnerships may have varying costs. However, the fund channeling scheme for Transjakarta should be based on a proof-of-concept scheme that exhibits the following characteristics:

- Procurement model that can replicated and scaled
- Attract various types and sizes of private capital/investors
- Add flexibility
- Based on Government Decree 1053/ 2022 on Transjakarta's BEV acceleration program, the service contract between Transjakarta and bus operators will still be in the form of Rp/km
- The fund channeling schemes aim to reduce the dependency of public service obligation from The Government of Jakarta

A recent study conducted by ITDP identified various options for channeling funds, as shown in Table 60, categorized into public and private sectors. Each option includes a simulation of Weighted Average Cost of Capital (WACC) calculations to ensure efficient resource allocation and the selection of the most financially viable options. An SPV or special purpose vehicle is a legal entity formed to isolate financial risks associated with the electrification program. This may be a newly established company or a subsidiary of Transjakarta. The reason for introducing a Special Purpose Vehicle (SPV) in this context is due to Transjakarta's aspiration to avoid owning or managing assets. Therefore, this responsibility is transferred to the SPV.

Table 83. **Various Options for Fund Channeling by Transjakarta.** ***ITDP research (2023)***

Source of fund/ financing	Scheme	Description	Gov. Guarantee Letter	Special Purpose Vehicle	Other financing instrument	WACC Simulation Result
Public Sector	A-1	PT Sarana Multi Infrastruktur/SMI provides regional loans to the Gov of Jakarta	No	Yes	No	7.21%
	A-2	The combination of regional loans and financing products (PT. SMI)	No	Yes	Yes	7.39%
	A-3	Development Financial Institution (DFIs) or Export Credit Agencies (ECAs) loan to Gov (2-step loan)	Yes	Yes	No	6.86%

Source of fund/ financing	Scheme	Description	Gov. Guarantee Letter	Special Purpose Vehicle	Other financing instrument	WACC Simulation Result
Private Sector	B-1	Loan from local and foreign commercial banks including ECA and DFI	No	No	No	10.08%
	B-1A	Loan from commercial foreign banks to private sector (BaU)	No	No	No	10.18%
	B-2	Bond as investment instrumental to raise capital	No	Yes	Yes	11.32%
	B-2, Alt 1	Utilizes limited participation mutual funds (reksa dana penyertaan terbatas, "RDPT") as the investment instrument, SPV as the asset owner	No	Yes	Yes	9.89%
	B-2, Alt 2	Utilises RDPT, finance lease to operators	No	Yes	Yes	10.03%
	B-2, Alt 3	Utilises RDPT, leverage lease agreement between SPV and leasing company	No	Yes	Yes	10.54%

While a smaller simulated WACC value may seem financially attractive, the decision on the funding scheme depends on various factors, including project objectives, financial conditions, risks, and the preferences of the government or entities involved. Furthermore, a comprehensive evaluation includes analyzing the interest rate, duration, security, and overall impact on the project and related entities before deciding on the most suitable funding.

Regarding the province of Bali, WACC simulations based on fund channeling options for Transjakarta cannot be replicated for public transportation funding in Bali. This is due to differences in regional fiscal conditions, availability of funding instruments that meet requirements and obtain approval from relevant financial institutions, as well as legal and regulatory aspects. Since public transportation services in Bali are already operational, the Bali government can consider using a scheme based on actual conditions or business as usual.

This scheme is like schemes B-1 and B-1A. It allows the private sector to sell or lease assets directly to bus operators without having to establish an SPV, as well as providing maintenance services. The local government will provide subsidies to bus operators, and bus operators will provide monthly payments for service operational to bus operators based on a Rp/km tariff. However, further feasibility studies to address fiscal, legal, or regulatory issues and government preferences are still needed before deciding to adopt this scheme.

5.1.2. Other Form of Fundings

In the international context, there are funding options for financing e-bus infrastructure such as through Article 6 of the Paris Agreement, which is a key component of countries voluntarily cooperating to achieve the emission reductions specified in the National Determined Carbon (NDC).

As a best practice example, the Bangkok E-bus program supported by the Klik Foundation is the first in Asia to be authorized under Article 6. With the aim of reducing GHGs and air pollution, financial viability is ensured through the trading of Internationally Transferred Mitigation Outcomes (ITMOs), which are carbon credits earned from emission reductions.

The principles of Article 6 of the Paris Agreement can be applied at the regional level with cooperative approaches and various mechanisms such as carbon markets or non-market approaches. Regions can develop projects that reduce emissions, such as transitioning to electric buses, and then use the resulting ITMOs to meet their NDCs or even trade them with others. This can be particularly effective in regions where multiple jurisdictions share common environmental goals and can benefit from common resources and infrastructure.

5.2 Policy Recommendations

This section presents policy recommendations for the implementation of EV, including in public transportation. The recommendations are based on the results of a desktop study, which identified barriers as described in the previous chapter, and consider inputs from focus group discussions with relevant stakeholders. The recommendations are divided into two levels: national and regional.

5.2.1. National Level

5.2.1.1. E2W and E4W Policy

The national government is committed to accelerating the transition process towards vehicle electrification, including both two-wheelers and four-wheelers. This is part of the country's efforts to adopt clean energy and become a market leader in the EV ecosystem. The realization of this vision began with the issuance of Presidential Regulation No. 55/2019, followed by a series of derivative regulations from various ministries (listed in Table 8), as well as regional level policies outlined in section 2.1.2.

However, despite the incentives offered in Presidential Regulation 55/2019, there has been no significant impact in encouraging users to switch from fossil fuel vehicles to EV. The barriers described in section 2.3.1 provide a clear picture of the current situation. This applies not only to users but also to local business entities who are still hesitant to provide charging facilities as they do not find it financially attractive.

Considering the current situation, providing additional subsidies to businesses to switch to EV is not deemed appropriate, as they are already benefiting from existing incentives. Therefore, future policies should prioritize alternative approaches. The recommended effort is to push the public and businesses to switch to EV immediately. This can be achieved through various measures, as implemented in other countries:

- To renew their business license, online ride-hailing services are required to increase their usage of electric fleets. This regulation has been successfully implemented in the United States, particularly in California, and has encouraged companies like Uber and Lyft to increase their use of EV. It is expected that there will be a 2% increase in total vehicle miles traveled by 2023[82]. This measure does not require companies to provide additional EV, but rather incentivizes the increased use of EV on the road. Therefore, ride-hailing and delivery companies will no longer be able to use the excuse of not having EV.
- To encourage a gradual transition to the use of EV, the purchase of oil-fueled vehicles should be disincentivized and the service life of ICE vehicles should be reduced. This strategy is currently being implemented in China, where the government has made it difficult to purchase ICE vehicles[83].
- Establish public campaign programs to mainstream information on EV. This can be achieved through several steps. Firstly, develop an accessible one-stop informational website in collaboration with industry players, as seen in India. As part of the accelerated adoption of EV, the national government has launched a website

82 Clean Miles Standard | California Air Resources Board

83 Mengembangkan Ekosistem Kendaraan Listrik di Indonesia Pelajaran dari Pengalaman Amerika Serikat, Norwegia dan Cina. IESR, 2020

facilitating connectivity between OEMs and assisting end-users in staying informed about the FAME II scheme. Secondly, organize and sponsor offline E2&4W events, like the approach taken in the UK with the EV Energy Taskforce's 'Charging the Future Conference.' Lastly, develop public service announcements (PSAs)

- Depending solely on tax exemptions may not be a sustainable long-term solution. To address this issue, it may be beneficial to explore alternative financial mechanisms, such as leasing schemes. According to a 2012 study by Vandezande, leasing schemes have effectively increased the demand for EV. This trend is also noticeable in the electric motorcycle sector, where models like the Honda PCX Electric in Japan are exclusively available through leasing arrangements. Although specific details regarding leasing costs and actual sales figures are not readily available, this statement highlights the proactive measures taken by private companies to promote the wider use of EV.

Most urban residents use electric motorcycles that can be fully charged at home for daily use. According to the Asian Development Bank (2023), battery swapping is more common among long-distance riders. Uniform battery specifications are not recommended as they have the potential to stifle competition and reduce innovation. While uniform battery technology can make interchangeability easier and reduce initial costs, it may also limit further technological development[84].

5.2.1.2. E-Bus Policy

Presidential Regulation 55/2019 regulates the status of public transportation, setting a target of 10% of the total fleet in Indonesia to be electric vehicles. However, the RPJMN prepared by Bappenas does not include the public transport electrification program. Nevertheless, the national government, through the Ministry of Transport, has established a plan to electrify public transport. The initiative began with the BTS program, which piloted the use of electric buses in several corridors in various cities as a pilot project.

The electrification of public transportation should be prioritized as the first step towards vehicle electrification. This not only demonstrates the government's commitment but also maximizes the impact due to the longer daily distance traveled by public transportation compared to private vehicles. Additionally, the large number of buses in a public transportation fleet managed by an agency allows for a more focused electrification program or incentives. Therefore, it is important to prepare notes for the policy towards electric buses:

- The guidelines for transportation planning should be revised to explicitly include the use of electric buses for urban public transportation. Additionally, clear, and measurable targets for each city should be established.
- Targets for electrification of urban public transportation should be aligned with greenhouse gas emission reduction goals, as well as projections of the number of electric buses and electricity consumption in future planning documents such as RUEN, RUKN, Regional General Energy Plan (RUED), and RUPTL.
- The national government should establish institutional mechanisms for each region that wishes to operate public transportation services, along with measurable targets.
- The high cost of initial investment is a significant barrier for operators in this industry. It is crucial for the government to design policies that consider financing options and sustainable business models.
- Coordination between central and local governments is especially important in contexts where assets may provide as grants. Effective communication is essential for successful map planning. It is important to ensure that complex administrative processes do not impede the flow of information and decision-making.

84 https://www.adb.org/publications/electric-motorcycle-charging-infrastructure-indonesia

- Technical guidance is necessary to develop the capacity of operators who are transitioning to using electric buses in their operations.
- The duration of the contract between operator and government must reviewed, considering other legal regulations such as the maximum age limit of public transportation fleets and public procurement rules.

Furthermore, financial concerns pose a significant challenge for cities seeking to provide public transportation, given that such services are heavily reliant on subsidies from local fiscal budgets. The recent issuance of Government Regulation 35 of 2023 on General Provisions of Regional Taxes and Retributions provides a welcome opportunity for cities seeking to improve their public transportation services. Article 25 stipulates that at least 10% of the revenue from vehicle tax must be allocated to the construction and/or maintenance of roads and improvement of public transportation modes and facilities. However, the national government must continue to monitor and evaluate the process to meet the targets set in the regulation.

5.2.2. Regional Level

5.2.2.1. E2W and E4W Policy

The issuance of Presidential Regulation No. 55/2019 has resulted in a series of regional regulations that also cover EV as a derivative of the presidential regulation. Regions also can design strategic plans as a cohesive response to central government initiatives, as shown by Bali Province in their regional action plan. Regions can support in the way of "push policies" to EV through regulations, as financial incentives typically provided by the national government. Steps to consider includes:

- Exclusive zones for EV gradually expanded, starting with some roads in urban centres and then expanding to other areas.
- In the commercial sector, measures to restrict zones exclusively for EV can also be gradually implemented. For instance, vehicle rental companies can be encouraged to switch their fleets to EV. In addition, offering tax incentives to companies that operate EV can also be an effort to encourage the transition to environmentally friendly vehicles.

Local governments can establish special teams to inform the public about the transition to EV. Encouraging greater collaboration among the private sector, government entities, charging infrastructure developers, and EV original equipment manufacturers (OEMs) is essential to collectively propel the growth and acceptance of EV. For instance, Bali Province has implemented this measure in their local action plan.

5.2.2.2. E-Bus Policy

The Buy the Service program, administered by the Ministry of Transportation, is a helpful initiative for regions in need of public transportation services. However, it is important to note that the BTS program is only a temporary stimulus from the national government. It is expected that regions will continue providing these services independently in the future. The issuance of Government Regulation Number 35 of 2023 has addressed regional concerns regarding financial issues related to providing public transportation. However, when providing public transportation, regions must consider several factors, particularly in the electrification of public transportation. These factors include:

- Establish a roadmap for public transportation planning that includes measurable electrification targets. Additionally, include a clear plan for phasing out fossil fuel vehicles manufactured to old standards (up to EURO IV). This will enable governments and operators to conclude large multi-year procurement contracts with manufacturers and organize charging infrastructure arrangements accordingly.

- Establishing regulations that encourage operators to transition to EV. This can be done by:
  - EVs can be allowed to operate without age restrictions as long as they remain roadworthy and safe to operate.
  - Setting contracts with longer durations of up to 20 years to fully recover additional investments made in electric buses, depots, charging infrastructure, etc.
  - Regulating fleet ownership by third parties including payment security mechanisms, protection of investments in case of termination, reassignment of vehicles to other operators, etc.
- Establish a clear financing mechanism for the cross-financing scheme from vehicle tax revenues, as derived from Government Regulation No. 35 of 2023. This mechanism may include initial capital financing or an interest subsidy program to support part of the interest/principal payments to national banks, if feasible.
- Like the effort to enforce EV-only restricted zones, the government can plan green corridors designated for electric buses. This plan could be implemented in phases to increase coverage across the city.

Regarding charging station infrastructure, one of the main challenges in implementing electric buses is land availability. Local governments can establish strategic locations, starting with utilizing local assets as charging stations. This requires intense communication between institutions, so inter-institutional integration may be an option. The availability of a charging network will help increase the daily operational range of electric buses and reduce the PSO subsidy burden.

5.3 Stakeholder Mapping

Stakeholder mapping is essential because it provides a strategic overview of all key players involved and affected in the EV adoption ecosystem project. It helps organizations identify and understand the interests, influences, and interrelationships of different stakeholders. This understanding is crucial for effective communication, managing expectations, and building cooperation among stakeholders. by knowing and addressing the needs of each stakeholder group and organization, it can mitigate risks, leverage opportunities, and ensure smooth progress and success of this project. The following is a summary of stakeholder mapping listed by role and function in the previous chapter, which is grouped based on the theme of the electric bus ecosystem.

Table 84. List of Stakeholder Mapping and Key Function

Topics	Remarks	Stakeholders
Government bodies	Policy makers, regulatory agencies, and local authorities who sets regulations and incentives.	National: President, Ministry of Transportation, Coordinating Ministry for Maritime & Investment Affairs, Ministry of Finance, Ministry of Energy and Mineral Resources, Ministry of Home Affairs, Ministry of Environment and Forestry, Ministry of Commerce, Ministry of State-Owned Enterprises , Ministry of Agrarian Affairs and Spatial Planning/ National Land Agency, Bappenas, Central Bank of Indonesia, OJK, BRIN, LKPP, BSN, Polri Regional: Regional Head/City Mayor, Provincial Transportation Agency, Bappeda, BPKAD, Public House and Public Housing Agency, Environment and Forestry Agency
Vehicle manufactures	Companies that design and produce EV	INVI, INDIKA, MAB
Battery manufactures	Suppliers of the batteries	IBC, Swap
Charging infrastructure providers	Entities that install and maintain charging stations	PT. LEN Industri (Persero), Medco Energy, PT Tri Energi Berkarya
Energy suppliers	Utilities and renewable energy providers that supply electricity	PLN, Pertamina, Shell, British Petroleum
Transport operators	Public and private organizations that operate vehicle fleet	DAMRI, PT Trans Satria Jaya, UPTD Trans Sarbagita, PT Mayasari Bakti, PT Bianglala Metropolitan, PT Lestari Surya Gema Persada, Koantas Bima, Koperasi Wahana Kalpika, Koperasi Mikrolet Jakarta Raya
Business entities	Commercial entities	Goto, Grab, Bluebird, Kerthi Bali Santhi
Financial institutions	Banks and investor that fund EV initiatives and infrastructure	State and Regional Owned Banks (BRI, Mandiri, Bank DKI etc), Private Banks (Bank Central Asia, Oversea-Chinese Banking Corporation, etc), Exporting Credit Agencies such as UKExport Finance (UKEF), Development Financial Institutions (Asian Development Bank (ADB), European Investment Bank (EIB), Sarana Multi Infrastruktur (SMI), and International Finance Corporation (IFC), Central Bank of Indonesia, OJK, Indonesia Finance Services Association (APPI)
NGOs	Group that influences public opinion and policy on EVs	C40, UNEP, UK PACT, TUMI, ICCT, UITP, ICLEI, GIZ, WRI, ITDP, KIAT, MCC, KIAT

APPENDIXES

A. E-Mobility Readiness in Indonesia

Table 85. Demand and Supply-side Policies and Regulation

Topic	Remarks
President Regulation No. 22/2017 on National Energy Plan (RUEN) – demand side	
Road map	• The Ministry of Transportation has developed a public transport electrification roadmap. However, no ministerial regulation has been issued yet. • Law No. 7/2021 on Tax Regulation establishes the legal foundation for implementing carbon tax, yet a detailed roadmap for its implementation is pending.
Acceleration	• Acceleration of electricity for mass public transport reach 2.3 TWh by 2025 (not yet included in Ministry of Transportation's Strategic Plan 2020-2024). • Gradually increase EV in public transport fleet by 10% of urban public transport fleet pop by 2025 (not yet included in Ministry of Transportation's Strategic Plan 2020-2024).
Savings	• Conduct fossil fuel savings in the transportation sector to reach 75. kl/year by 2025 (no clear action plans as a measure to reduce fossil fuel consumption in Ministry of Transportation's Strategic Plan 2020-2024)
Incentive or disincentive	• Policies on fossil fuel excise or other fiscal disincentives (not yet issued). • Incentives for electric public transportation (not yet issued).
President Regulation No. 22/2017 on National Energy Plan (RUEN) – supply side	
Supply chain	• Hybrid and EV, along with their components, are prioritized in Government Regulation No. 14/2015 for the National Industry Development Master Plan 2015-2035: general automotive component, engine, and power train
Guideline	• Ministry of Industry Regulation No. 06/2022 outlines the roadmap for EV industry from 2020 to 2031, specifying BEV specifications and TKDN calculations.
Fiscal Incentives	• Tax holiday of up to 20 years for EV, • EV components, and battery industries, Ministry of Finance Regulation No. 130/2020 and Ministry of Investment Regulation 7/2020 • Tax allowance, as outlined in Ministry of Industry Regulation No. 47/2019, is applicable to parts, accessories, and motorized vehicle components industries, including those ineligibles for a tax holiday. This incentive also covers the Internal ICE vehicle industry.
Prototypes	• EV technology, propulsion, and charging research is part of the 2017-2045 National Research Master Plan, with a budget of IDR 923 billion allocated in the 2020-2024 RPJMN.

Topic	Remarks
President Regulation No. 55/2019 on Acceleration of the Battery Electric Vehicles (BEV) Program for Road Transportation – demand side	
Vehicle tax	• Ministry of Home Affairs Regulation No. 1/2021 (amended to No. 40/2021) reduces taxes for public transport fleets to a maximum of 10%, while taxes for ICE fleets remain at a maximum of 30%
Luxury good tax (LST)	• BEVs and FCEVs are LST-exempt, while HEVs and PHEVs will see increased LST after the domestic BEV industry is established. Public transport fleets remain LST-exempt
Other exemptions	• Exemptions from specific road access limitations (various local-level policies have been enacted)
Other fiscal or non-fiscal policies	• Zero down payment and low-interest financing for BEVs under Central Bank of Indonesia Regulation No. 22/13/PBI/2020.
President Regulation No. 55/2019 on Acceleration of the Battery Electric Vehicles (BEV) Program for Road Transportation – supply side	
BEV Specifications	• Ministry of Industry Regulation No. 06/2022 provides specifications for 4W and 2/3W BEVs, including industry roadmap and TKDN calculation.
Industry roadmap	• Ministry of Industry Regulation No. 06/2022 details the 2020-2031 roadmap for the BEV and BEV components industry, integrated into the national automotive industry roadmap.
Domestic content level (TKDN)	• Ministry of Industry Regulation No. 06/2022 outlines the TKDN calculation formula, detailing requirements for each BEV component and their contributions to the total TKDN rate. • Gradual minimum implementation (adjusted on the new President Regulation No. 79/2023) o 2W: 40%, 50%, 60% (years: 2019-2023, 2024-2025, 2026 and beyond) o 4W: min 35%, min 40%, min 60%, 80% (years: 2019-2021, 2022-2026, 2027-2029, 2030 and beyond) o TKDN prioritization does not apply to BEV resulting from conversion workshops.
Import tax for IKD and CKD	• Ministry of Industry Regulation No. 28/2020 allows the import of CKD and IKD BEV components to accelerate domestic industry growth, with some exceptions
Import CBU (adjusted on PR No. 79/2023)	• BEV Industry Companies that produce BEV origination from imports in CBU condition may be eligible for incentives. • BEV Industry Companies that can expedite the assembly process domestically within the importation period in CBU condition until the end of 2025, may be eligible for incentives.
Import materials	• Ministry of Finance Reg. No. 188/2015 grants a 3-year import tax exemption for machinery and raw materials, supporting investments.
Export financing	• No export financing incentive has been issued yet for BEVs and BEV components.
Fiscal research	• Ministry of Finance Reg. No. 153/2020 offers up to 300% 'Super Tax Deduction' for R&D, including EVs, ICE vehicles, and components in Indonesia
Professional certification	• The Ministry of Energy and Mineral Resources is updating professional programs and certification schemes in the electricity sector, in collaboration with Ministry of Education, Culture, Research, and Technology, Ministry of Manpower, and BSN, to include new EV-related professions
Technical/ product certification	• BSN has released 34 EV-related national standards, including those for EV batteries and public charging infrastructure, following IEC/ISO guidelines.
Spec and classification	• Ministry of Transportation Reg. No. 86/2020 and No. 44/2020 set technical specifications EV Type Tests, while No. 87/2020 specifically addresses BEV Type Tests.

Topic	Remarks
Other fiscal or non-fiscal policies	• GOI prohibited raw nickel export through Ministry of Energy and Mineral Resources Regulation No. 11/2019 to secure raw material supply. • OJK, offers several incentives: o Banks/financial institutions offer financing for BEV purchases and associated battery and components industry. o Loan for BEV or BEV component production is exempt from the maximum credit limit. o For loans up to IDR 5 billion, eligibility is assessed based on the timely payment of principal and/or interest. o For individual/micro-small enterprises applying for loans, the credit risk level can be set at 75%, below the default 100%.

Table 86. Electric Bus Needs in Each City in Indonesia

No	City	Number of Electric Buses with Various Scenarios			No	City	Number of Electric Buses with Various Scenarios		
		Ideal	Medium	Minimum			Ideal	Medium	Minimum
1	Jakarta	10,000	5,000	1,000	22	Pontianak	647	194	66
2	Surabaya	2,806	842	180	23	Balikpapan	616	185	66
3	Bandung	2,471	741	180	24	Jambi	604	181	66
4	Bekasi	2,381	714	120	25	Surakarta	510	153	66
5	Medan	2,211	663	180	26	Mataram	441	132	66
6	Palembang	1,708	513	112	27	Kupang	435	130	66
7	Depok	1,632	490	90	28	Ambon	428	128	66
8	Semarang	1,595	479	150	29	Manado	428	128	66
9	Tangerang	1,566	470	75	30	Yogyakarta	423	127	112
10	Makassar	1,470	441	150	31	Palu	368	110	44
11	Tangerang Selatan	1,219	366	90	32	Bengkulu	329	99	44
12	Batam	1,037	311	112	33	Pangkal Pinang	327	98	44
13	Pekanbaru	1,005	302	112	34	Jayapura	316	95	44
14	Bogor	982	295	112	35	Mamuju	293	88	44
15	Padang	915	274	112	36	Palangkaraya	281	84	44
16	Denpasar	897	269	112	37	Banda Aceh	268	80	44
17	Bandar Lampung	880	264	112	38	Sorong	254	76	27
18	Samarinda	813	244	112	39	Gorontalo	194	58	27
19	Malang	809	243	112	40	Manokwari	107	32	27
20	Banjarmasin	701	210	98	41	Tanjung Selor	52	18	18
21	Serang	667	200	66	42	Sofifi	18	18	18
Total		**45,104**	**15,545**	**4,452**					

Table 87. Jakarta's Other BEV Related Policies, Targets, and Programs

Policies/Targets	Remarks
Governor Instruction No. 66/2019 on Air Quality Control	Includes an instruction to accelerate public transport fleet renewal and to implement a more stringent emission standard for public transport fleet
Governor Regulation No. 90/2021 on Local Low Carbon Development Plan	Electric bus deployment at BRT system, BEV adoption in government fleets, and charging infrastructure development are included as the detailed action plan to shift the transport sector to a more environmentally friendly fuel source.
C40 Fossil Fuel Free Street Declaration (2019)	Pledge to implement 100 E-Buses by 2020, to have 50% Transjakarta fleet electric by 2025, and to only procure zero-emission buses by 2025, and to implement two low emission zones by 2021 as well as other "push" policy measures such as increased parking fare and congestion pricing by 2020.
Transjakarta's Long Term Corporate Plan 2020-2030	Targets to operate more than 10,000 E-Buses, or 83% of their total fleet, by 2030

Policies/Targets	Remarks
Governor Regulation No. 29/2023 on Regional Tax Incentive in the form of a Rate Imposition of 0%	The Governor provides a regional tax incentive in the form of a BBNKB imposition for Second and Subsequent Deliveries at a rate of 0% of the BBNKB imposition base (only applied for BEV).
Governor Regulation No. 03/2020 on Tax Incentives for Motor Vehicle Ownership Transfer Tax on BEV for Road Transportation	Tax incentives are provided, exempting the motor vehicle ownership transfer tax.
Governor Regulation No. 88/2019 amendments to 155/2018 on Traffic Restriction with the Odd-Even System	The odd-even policy in Jakarta Area does not apply to BEV.
SPKLU obligation for buildings	Proposed
Government official vehicles	Proposed
Low emission zone (LEZ)	Jakarta has implemented all-day LEZ policy in the" Kota Tua" of Old Town area from 2021. An exemption is made for vehicles that have passed the emission test, which allows BEV could access the zone.
Transjakarta Pilot E-Bus	By 2020, the Government of DKI, Jakarta has approved a pilot E-bus project for 100 large buses which is being implemented by Transjakarta.
Buy The Service	The Government of DKI, Jakarta has also increased the maximum contract period for BTS contracts for Transjakarta from 7 years to 10 years to reduce the cost of operating the Evs.

Table 88. Governor Regulation No. 48/2019 Highlight

Topic	Remarks
Policies direction and strategy	• Preserving environmental sustainability, supporting government programs for energy efficiency and pollution reduction. • Promoting infrastructure readiness for the transition from ICE to EV. • Implementing acceleration strategies, including the use of BEVs by government agencies, local content adoption in the industry, incentives for owners and industry, fossil fuel control, and committee formation.
Action plan	• Regional action plan: mandating government and public transport companies to adopt BEV, staging and action plan for mass public transport system, incentives value (for users, institution, and industry, and staging or scenario for fossil fuel management. • Thematic action plan: determination on staging and timeline, local content, recycling, waist, and incentive value.
Industry plan	• Prioritize the use of goods & service by 15%. • Local workers for 10%, 40%, and 70% for the industry age start from below 5 years, 5 years, and 10 years above respectively. • Has minimum contract at least 5 years with the state own company or local company
Infrastructure supply	• Access and installation support. • Criteria: accessible, mandatory parking space, meet safety standard, minimum impact on traffic. • Public location; public fuel and gas stations, government and regional offices, shopping places, and public roadside. • Private location; central and regional offices, and residence/housing.

Topic	Remarks
Incentives	• Receivers; individuals/agencies/companies using BEV, companies renting battery, industries accelerating production and providing infrastructure, companies managing battery waste, and companies providing charging infrastructure. • Fiscal incentives; exemption PKB and/or BBNKB • Non-fiscal incentives; exemption specific road usage restriction, exemption parking fees and electric fee reduction on public charging stations, financial support for charging infrastructure development, professional competency certification for human resource BEV industry, security/operational safety guidance for sustainability/logistics, product certification and/or technical standard for BEV vehicle and component production companies.
Types and operational requirement	• Covering 2W, 3W, 4W or more shall comply with applicable legal provisions. • The vehicle must meet technical requirement, pass type approval, periodic test, and obligatory registered and roadworthy
Fossil fuel use management	• Restriction; corridor, tourism area, office area, and sacred area. • Methods; ICE restriction to the area except resident or emergency vehicle, on-street parking restriction, park, and ride, NMT and BEV modes on the service area.
Environment protection	• Battery must be managed through recycling/proper disposal. • Companies must hold permits for managing battery waste that comply prevailing laws and regulation.
Partnership	• Collaboration between Provincial Government, other regions, local authorities, and/or third parties is allowed to accelerate the adoption of BEV.
Acceleration committee	• Comprising various government and community representatives, tasked with formulating regional action plans, reviewing thematic action plans, and ensuring the implementation of the action plans set by the Governor.

Table 89. Five Pillars Sub-Target to Achieve EV Adoption Targets. *Bali Regional Action Plan*

Pillar	Topic	Remarks
Pillar 1	Management and research	• Qualitative approach and provides component requirements needed on the BEV ecosystem management, which categorized into six parts: • Policies, research, development, and piloting. • Zoning BEV area development. • Business model and funding. • Database and monitoring system development. • Information system development BEV institutions.
Pillar 2	Infrastructure	• Establish target related to the availability of BEV charging infrastructure (total cumulative in 2026: optimistic, moderate, and pessimistic). • Public electric charging stations; 1,723/876/64 units. • Public EV charging stations; 487/145/16 units. • Public electric battery swap stations; 5,745/2,920/212 units. • Electric bus charging facilities; 14 slots. • Private installation or household charging; 19,435/5,719/519 units. • Renewable energy electric power capacity; 251.6/165.8/133.8 MW.

Pillar 3	Industry and battery	• Establish target related to production, maintenance, and collection of BEV battery (total cumulative in 2026: optimistic, moderate, and pessimistic). • Number of BEV 2W assembly facilities; 2 units. • Number of BEV 2W conversion facilities; 115/67/2 units. • Number of BEV 2W maintenance facilities; 59/29/3 units. • Number of BEV 4W maintenance facilities; 21/7/2 units. • Number of BEV batteries collecting locations; 2 units.
Pillar 4	Human resources	• Establish targets for development BEV human resource capacity in 2026. • Number of vocational high school (SMK) with BEV lessons and practical training; 28 school • Number of polytechnics with BEV lessons and practical training; 2 polytechnics. • Number of higher education institutions with BEV lessons and practical training; 2 polytechnics. • Number of short-term training sessions; 140 sessions. • Number of BEV entrepreneurial incubators or mentoring; 11 incubators. • Number of self-learning materials; 14 material packages. • Number of BEV technician certification institutions; 4 units.
Pillar 5	Marketing and communication	• Establish targets and strategies related to the promotion of BEV. • Economic benefit awareness; 55%. • Environmental benefit awareness; 71.25%. • Understanding of BEV usage; 80.25%. • Positive assessment of BEV; 81%. • Trust in BEV reliability; 50.5%. • Desire to purchase BEV; 63.75%.

Table 90. **Bali's Other BEV Related Policies**

Policies	Remarks
Regional Regulation of Bali Province No. 2 of 2019 Regarding Bali Spatial Planning 2005-2025	The establishment of the mission "Developing the way of life of the Balinese people, organizing the region, and creating a green, beautiful, and clean environment."
Regional Regulation of Bali Province No. 7 of 2022 Regarding Bali Medium-Term Development Plan 2018-2023	In line with the mission, there are directives for the improvement of environmental quality indicators, including the enhancement of air quality indices and the utilization of Renewable Energy Sources.
Regional Regulation of Bali Province No. 9 of 2020 Regarding General Plan for Regional Energy	One of the energy policy strategies in Bali Province is the development of infrastructure to achieve energy self-reliance, with a focus on clean energy. This will be accomplished through energy diversification for the use of electric cars and motorcycles.
Governor Regulation of Bali No. 30 of 2022 Regarding Bali Regional Medium-Term Development Plan for 2023	There is a program for the management of renewable energy implemented through energy conservation in the Bali Province region.
Governor Regulation of Bali No. 45 of 2019 Regarding Clean Energy in Bali	One of the goals of providing and utilizing clean energy is the optimization of efficiency and sustainable energy conservation in the transportation sector, including the development of supporting infrastructure.
Sarbagita Metropolitan Area Sustainable Urban Mobility Plan	The use of BEV, including electric bicycles, electric motorcycles, electric cars, electric buses, and electric trucks, is one of the sustainable urban mobility strategies mentioned in the Sarbagita Metropolitan Area SUMP document, specifically under the mobility improvement measures component.

Policies	Remarks
Low Carbon Development Plan of Bali Province	The results of the LEAP modeling indicate a continuous increase in carbon emissions in the energy and transportation sectors in Bali, reaching 19.5 million tons by 2030, or three times the annual emissions in 2010 without any interventions (business-as-usual). Emissions from land transportation contribute to 80% of the total emissions in the transportation sub-sector. There are targets for the use of KBL BB for two-wheeled, four-wheeled, and public transportation segments from 2021 to 2025, starting with two-wheeled vehicles such as electric motorcycles and electric bicycles, followed by mass transit/taxi buses, and then private vehicles.

B. Data Collection on E-Mobility

Table 91. Targeted Policy for Implementing Bali Low Emission Zone. *WRI Indonesia (2023)*

Scope	Incentive Policy	Disincentive Policy
General	• Development of electric buses and shuttles in the designated area • Incentives for EV conversion from ICE vehicles • Support for e-bike and e-motorcycle rental businesses. • Organize the distribution of SPKLU, Public Electric Vehicle Battery Exchange Stations (Stasiun Penukaran Baterai Kendaraan Listrik Umum/SPBKLU), and used battery collection point. • Park and ride facilities • Discounted parking rates for EV • Payment gateway • Zone signage and EV support facilities	• Restriction of high-emission vehicles entering low-emission zones • Enforcing electric road pricing for ICE vehicles • Imposing disincentives under specific conditions (certain hours, specific license plate) • Other traffic regulation to control access
Public Transportation	• Expanded service area make public transit accessible and feasible for wider population. • Reliability, timely, and well-maintained, transit services foster commuter trust and usage. • Seamless connections between buses, bikes, and pedestrian paths ease and expedite transit. • Appropriate transit hub design: well-placed, amenity rich transit hubs with safety and accessibility features enhance passenger experiences and facilitate transfer	• High cost of private vehicle parking and tax • High-occupancy vehicle (HOV) lanes
Non-Motorized Transportation	• Improving bicycle infrastructure such as bike lanes • Pedestrian infrastructure improvement • Provide enhance safety features for pedestrians. • Segregate the bicycle traffic from pedestrian traffic	• Speed bumps, road narrowing, share street. • Fees for congestion charging for vehicles entering busy urban areas

Table 92. Current Indonesia E2&3W Market Based on Production Base, Model, and Price. *Modified from ICCT (2021)*

No	Brand and/ or Model	Domestic/ foreign	Battery Capacity	Charging Strategy	Plug-in charging (hours)	Battery Swap (seconds)	Est - Travel Range (km)	Vehicle Price
1	Q1 - Viar	Domestic	2 kWh	Plugin and battery swap	3-4	30	50 - 70	IDR 16.2 million
2	Gesit E-Motorcycle	Domestic	1.98 kW	Plugin and battery swap	4-5	30	60 - 70	IDR 15 million
3	Smoot Tempur	Domestic	1.44 kWh	Plugin and battery swap	3-4	9	50 - 70	IDR 39.8 million
4	Selis E-motorcycle	Domestic	Eagle Prix: 0.96 kWh Agats: 1.4 kWh Jalak Pro: 1.2 kWh E-max: 1.2 kWh	Plugin and battery swap	5-7	9	55 - 65	Eagle Prix : IDR 15 Million Agats : IDR 19.9 Million Jalak Pro: IDR 18 million E-max: IDR 16.9 million
5	Selis PMD	Domestic	Kid scooter: 0.288 kWh K-Bike: 0.316 kWh Auto Folding: 0.252 kWh	Plugin	5-7	N/A	15-20	Kid scooter: IDR 3.8 Million K-Bike: IDR 15.3 Million Auto Folding: IDR 18.5 Million
6	Seliv SPV	Domestic	New Robin: 0.96 kWh Pujasera: 0.42 kWh urban Trike: 0.96 kWh Cargo Bike: 0.96 kWhn	Plug in	5-7	N/A	30 - 35	New Robin: IDR 18.6 Million Pujasera: IDR 15 Million Urban Trike: IDR 28.5 Million Cargo Trike: IDR 25 Million

No	Brand and/ or Model	Domestic/ foreign	Battery Capacity	Charging Strategy	Plug-in charging (hours)	Battery Swap (seconds)	Est - Travel Range (km)	Vehicle Price
7	Selis E-moped	Domestic	Murai: 0.576 kWh Mandalika: 0.432 kWh Butterfly Trike: 0.432 kWh Rinjani: 0.432 kWh	Plug in	5-7	N/A	35	Murai: IDR 7.85 Million Mandalika : IDR 5.4 Million Butterfly: IDR 8.4 million Rinjani: IDR 8.5 million
8	Selis E-bike	Domestic	IOI Pro carrier: 0.576 kWh Swan: 0.3744 kWh Storm: 0.3744 kWh Tornado: 0.3744 kWh Roadmaster 2: 0.3744 kWh SOI: 0.316 kWh	Plug in	5-7	N/A	20 - 25	IOI Pro Carrier: IDR 7.5 Million Swan: IDR 15 million Storm: IDR 55 million Tornado: IDR 25 million Roadmaster IDR 15 Million SOI: IDR 14.5 million
9	MIGO 2	Domestic	Migo 2: 1.4 kWh	Plug in	3-4	N/A	45 - 55	Migo 2: IDR 12.7 million
10	United T1800 E-motorcycle	Domestic	T1800: 1.68 kWh	Plug in	3-4	N/A	45 - 64	T1800: IDR 27 million
11	Tomara Semar E-motorcycle	Domestic	Semar: 1.9 kWh	Plug in	7	N/A	50 - 65	Semar: IDR 32 million
12	ECGO 2	Foreign	ECGO 2: 1.25 kWh	Plug in	3-4	N/A	45 - 55	IDR 6.9 million

No	Brand and/ or Model	Domestic/ foreign	Battery Capacity	Charging Strategy	Plug-in charging (hours)	Battery Swap (seconds)	Est - Travel Range (km)	Vehicle Price
13	Volta	Domestic	E-Bikes Volta 100: 0.4 kWh Volta 202: 0.4 kWh Volta 203: 0.4 kWh	Plug in and battery swap	3-4	9	20 - 25	
14	Volta E-motorcycle	Domestic	Volta 301: 0.4 kWh Volta 302: 0.4 kWh	Plug in and battery swap	3-4	9	25 - 35	Volta 301: IDR 6 million Volta 302: IDR 7.8 million
15	Volta 501 E3W	Domestic	Volta 501: 3.5 kWh	Plug in and battery swap	3-4	9	65 - 70	IDR 17 Millio
16	Sun race E-motorcycle	Domestic	Jupiter: 1.4 kWh F1: 1.4 kWh Stylish: 0.6 kWh & 0.9 kWh	Plug in	3-4	N/A	45 - 65	Jupiter: IDR 14 million F1: IDR 14.5 million Stylish: IDR 5.5 Million
17	Artas Motorcycle (Rakata Motor)	Foreign	NX8: 3.6 kWh NX3: 1.82 kWh X5: 1.2 kWh S9: 1.2 kWh	Plug in	4.5-6	N/A	55 - 75	NX8: IDR 54.75 Million NX3: IDR 41.1 Million X5: IDR 22.1 million S9: IDR 17 million
18	Gelis Cargo E3W	Domestic	Cargo: 3 kWh	Plug in	5	N/A	65 - 70	IDR 28 million
19	Beneli Divo E-motorcycle	Foreign	Divo: 1.56 kWh	Plug in	4	N/A	54 – 66	IDR 39.8 million
20	Keeway E-motorcycle	Foreign	E-Zi: 1.2 kWh	Plug in		N/A	53 - 60	IDR 43 million
21	Piaggio Ape E3W	Foreign	Ape: 7.5 kWh	Plug in	4	N/A	80 – 100	IDR 115 million
22	Kymco Nice E-motorcycle	Foreign	Nice 100 EV: 1.5 kWh	Plug in	3-4	N/A	55 – 65	IDR 14.8 Million

Table 93. BEV 4W Highest Wholesale in Indonesia 2023. *ITDP desktop research (2024)*

No	Brand	Model	Type	Battery Capacity	Charging Duration (hour)	Est – Travel Range (km)	Unit Sold (unit)[85]	Vehicle Price
1	Hyundai	Ioniq 5 Signature Extended	BEV	72.6 kWh	57 min	451	6,334	IDR 895 million
2	Wuling	Air EV Long Range	BEV	26.7 kWh	4	300	3,461	IDR 299 million
3	Wuling	Air EV Lite	BEV	17.3 kWh	8.5	200	1,208	IDR 206 million
4	Wuling	Air EV SR	BEV	17.3 kWh	8.5	200	906	
5	Wuling	Binguo EV 410	BEV	37.9 kWh	-	410	827	IDR 408 million
6	BMW	IX Xdrive 40 AT	BEV	76.6 kWh	-	390	615	IDR 2.4 billion
7	Wuling	Binguo EV 333	BEV	37.9 kWh	-	333	566	IDR 358 million
8	Hyundai	Ioniq 5 Prime Extended	BEV	72.6 kWh	57	481	488	IDR 823 million
9	Toyota	BZX4	BEV	71.4 kWh	-	550	479	IDR 1.2 billion
10	Hyundai	Ioniq 5 Signature Reguler	BEV	58 kWh	46	384	298	IDR 845 million

85 Anshary (2023). Available at: Rapor Penjualan Mobil Listrik RI pada 2022, Meroket 383 Persen! (bisnis.com) (Accessed: Dec 2023)

Table 94. E-bus in Indonesia (Active Manufacturer and Registered Through Ministry Industry)-Part I. *ITDP desktop research (2024)*

No	OEM	Domestic/ Foreign	Buss Model	Year Operation	Operator	Place of Operation	Dimension (W×H× L)	Passenger Capacity	Charging Duration (hour)	Travel Range (km)	Battery Capacity (kWh)	Price Range (billion rupiah)	Buss Illustration
1	Mobil Anak Bangsa[86]	Domestic	MD 12E LE	Planned	n/a	n/a	2,490×3,430×12,000	80 (seating + standing)	3	250	315,85	5.3[87]	
2	Skywell[88]	Foreign	NL6126BEV	2023	Transjakarta	Jakarta	2,550×3,200×11,990	50 (seating + standing)	1.5-2	280 -423	322	4.6-5 or more than 5[89]	
3	INKA[90]	Domestic	E-INOBUS	Planned	n/a	n/a	2,500×3,250×12,000	50 (seating)	3-4	250	335		
4	Higher[91]	Foreign	KLQ6125GEV1	Planned	n/a	Jakarta	2,480×3,370×12,000	34 (seating)	3-4	400	385		

86 https://www.mabindonesia.com/md-12e-le-low-entry-city-bus

87 https://kumparan.com/kumparanoto/inilah-bus-listrik-dengan-panjang-12-meter-karya-pt-inka-jarak-tempuhnya-250-km-1yx4glo4Dlm/full

88 https://en.skywellev.com/v2/overview?type=2&id=35 https://oto.detik.com/berita/d-6490288/spesifikasi-bus-listrik-skywell-yang-bakal-digunakan-transjakarta

89 https://kumparan.com/kumparanoto/inilah-bus-listrik-dengan-panjang-12-meter-karya-pt-inka-jarak-tempuhnya-250-km-1yx4glo4Dlm/full

90 https://kumparan.com/kumparanoto/inilah-bus-listrik-dengan-panjang-12-meter-karya-pt-inka-jarak-tempuhnya-250-km-1yx4glo4Dlm/full

91 https://www.higer.co.id/product

Table 95. E-bus in Indonesia (Active Manufacturer and Registered Through Ministry Industry)-Part II. *ITDP desktop research (2024)*

No	OEM	Domestic/ Foreign	Buss Model	Year Operation	Operator	Place of Operation	Dimension (W×H× L)	Passenger Capacity	Charging Duration (hour)	Travel Range (km)	Battery Capacity (kWh)	Price Range (billion rupiah)	Buss Illustration
5	Zhongtong[92]	Foreign	Zhongtong LCK6125EV	Planned	n/a	n/a	2,490×3,265 ×12,000	62 (seating + standing)	1.5-2	250	350	4.6-5 or more than 5[93]	
6	Golden Dragon[94]	Foreign	XML6125JEVJ0C3	2023	Transjakarta	Jakarta	2,540×3,120 × 12,000	60 (seating + standing)	1	250	326		
7	BYD[95]	Foreign	BYD K9	2022	Transjakarta	Jakarta	2,500×3,400× 12,000	33 (seating + standing)	1.5-2	250	342		
8	INVI[96]	Domestic	KG Mobility 12 M	Planned	n/a	n/a	2,495×3,265 × 11,805	34 (seating)	1	450	320		

92 https://otomotif.kompas.com/read/2021/04/09/092200415/kapasitas-dan-pernak-pernik-interior-bus-listrik-zhongtong

93 https://kumparan.com/kumparanoto/inilah-bus-listrik-dengan-panjang-12-meter-karya-pt-inka-jarak-tempuhnya-250-km-1yx4glo4Dlm/full

94 https://kabaroto.com/post/read/kenalan-dengan-bus-sag-golden-dragon-bus-ev-transjakarta#:~:text=Bus%20SAG%20yang%20digunakan%20adalah%20XML6125JEVJ0C3%2C%20memiliki%20panjang,mm%20di%20belakang%2C%20serta%20bobot%20totalnya%2017.800%20kg.

95 https://mobilkomersial.com/2022/03/11/intip-spesifikasi-bus-listrik-byd-k9-milik-transjakarta/

96 https://otomotif.bisnis.com/read/20230812/46/1684267/indika-energy-indy-luncurkan-bus-listrik-invi

Table 96. E2W&3W Classification on Indonesia Market. *ITDP desktop research (2024)*

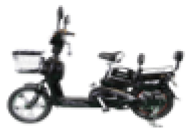
No	Type	Operation	Weight (kg)	Operational Speed (km/h)	Battery Capacity (kWh)	Price Range (In IDR)	Vehicle Illustration
1	E-Bikes	Pedal-assisted	< 30	< 25	0.2 - 0.37	6.5– 55 million	
2	Moped	Pedal-assisted and/or throttle	56 - 110	< 25	0.4 - 0.6	5,4 – 12,7 million	
3	Kick Scooter	Throttle or foot-kick	13 - 18	< 25	0.2 - 0.3	3,8 – 18,5 million	
4	Scooter/ Motorcycle	Throttle	85 - 95	40 - 70	0.4 - 2	15 – 43 million	
5	E-Rickshaw	Throttle	30 - 380	40 - 70	2.7 – 7.5	17 – 115 million	
6	E-Tricycle	Pedal-assisted and/or throttle	150 - 200	< 25	0.42 – 0.96	11,6 – 28,5 million	

Table 97. E4W Classification and Specification. *ITDP desktop research (2024)*

No	Type	Remarks	Battery Capacity (kWh)	Price Range (USD)	Vehicle Example and Illustration
1	Battery Electric Vehicles (BEV)	Pure EV and use rechargeable battery as a power source. They can charge at home of using charging station	16 – 100	30,000 – 187,000	
2	Fuel Cell Electric Vehicles (FCEV)	Instead of rechargeable batteries, it uses fuel cells to generate electricity. The refueling use a hydrogen charging station	10 – 17	50,000 – 60,000	Toyota Mirai (2023) 
3	Hybrid (HEV)	Vehicles use both electric motor and ICE that run on gas. The vehicle cannot be plugged to charge, instead the battery is charged by gas engine and regenerative braking	0.65 - 1.8	23,000 – 200,000	Toyota Prius 
4	Mild Hybrid (MHEV)	Same as HEV but using diesel power	0.5 - 1	33,990 – 149,400	Toyota Hilux 48v 
5	Extended Range Hybrid (EREV)	Run entirely on the electric motor and do not include a traditional ICE. Instead, they have gasoline generator that can provide electricity to extend overall range	Up to 32	40,000 – 50,000	Chevrolet Volt 
6	Plug-in Hybrid (PHEV)	HEV variation that's allow the vehicle plugged in to charge	4.4 - 34	26,000 – 200,000	Toyota RAV4 (2024) 

Table 98. E-Bus Classification and Battery Capacity. *ITDP desktop research (2024)*

	Type of E-bus*	Dimension	Battery Capacity	Vehicle Illustration
1	Single bus (high deck)	12 m	324 kWh	
2	Single bus (low entry)	12 - 14 m	324 kWh – 400 kWh	
3	Articulated bus	18 m	450 kWh**	
4	Medium bus	7 m	135 kWh***	
5	Microbus	4 m	42 kWh	
6	Double decker bus	13 m	676 kWh[97]	

**) referred from e-bus model used by Transjakarta*

***) In the worldwide market, no high-deck articulated e-bus models have deployed*

****) Higher-capacity batteries to extend the range of medium buses complying with the current GVW regulations are being explored in the market*

97 Van Hool TDX25E | ABC Companies (abc-companies.com)

Table 99. SPKLU and SPBKLU Progress in Indonesia. *Ministry of Energy and Mineral Resources (2023)*

City	Charging Technology				
	SPKLU				SPBKLU
	Slow	Medium	Fast	Ultrafast	
DKI Jakarta	5	100	10	5	429
East Java, Bali Nusra	248	67	23	2	170
Centre Java, DIY	14	26	6	4	41
West Java	4	142	4	21	282
Banten	3	30	4	0	249
Sumatera	5	31	25	0	115
Kalimantan	0	11	6	0	12
Sulawesi	2	21	8	0	48
Maluku	0	1	2	0	0
Papua	0	0	2	0	0
Total	**290**	**429**	**91**	**32**	**1,346**

Table 100. List of Angkot Routes Samples

No.	Route Code	Origin - Destination	Routes
1	B80	Kalideres - Grogol	Term. Kalideres -- Pesing -- Daan Mogot -- Tubagus Angke -- Jembatan V -- Roxy -- Kiai Tapa -- Term. Grogol
2	B82	Grogol - Kalideres	Term. Grogol -- Daan Mogot -- Pesing -- Jembatan Genit -- Kapuk -- Kamal Raya -- Term. Kalideres
3	B02	Kota - Warung Gantung	Term. Kota -- TB. Angke -- Pesing -- Cengkareng -- Warung Gantung
4	M01	Term. Kampung Melayu - Senen	Term. Kampung Melayu -- Jatinegara Barat -- Matraman Raya -- Salemba Raya -- Kramat Raya -- Naik Fly Over Senen -- Senen Raya 3 -- Senen Raya -- Dr. Wahidin -- Gunung Sahari -- Term. Senen-Kemayoran -- Bungur -- Kepu -- Garuda-Kemayoran Gempol
5	B91	Tanah Abang - Batusari	Jatibaru -- Cideng -- Roxi -- Kyai Tapa -- S. Parman -- TG. Duren -- Kemanggisan -- Batusari
6	B92	Tanah Abang - Ciledug	Tanah Abang -- Jatibaru -- Cideng -- Roxi -- Kyai Tapa -- Daan Mogot -- Pesing -- Kedoya -- Joglo -- Term. Ciledug
7	S60	Kp. Melayu - Manggarai	Term. Kp. Melayu -- Jatinegara Brt -- Bkt Duri Tjk -- Tebet UtaraT-- Tebet Utara --Tebet Barat -- Dr. Supomo -- Dr. Sahardjo -- Minangkabau -- Term. Manggarai
8	S61	Manggarai - Kp. Melayu	Term. Manggarai -- St. Manggarai -- Manggarai Utara -- Bk. Duri Puteran --Slamet Riyadi -- Matraman Raya -- Jatinegara Tmr -- Term. Kp. Melayu
9	S62	Manggarai - Tg. Barat	Term. Manggarai -- Sahardjo -- Supomo -- Pancoran -- Raya Ps. Minggu -- Raya Lt. Agung -- Raya Tj Barat -- Poltangan Raya -- Ptangan R.J.Brt -- Jl. Nangka -- Tanjung Barat
10	M14	Tanjung Priok - Cilincing	Term. Tanjung Priok -- Jl. Enggano -- Jl. Enim -- Jl. Bugis -- Yos Sudarso -- Jl. Berdikari -- Jl. Jepara -- Jl. Cilincing -- Jl. Baru -- Jl. Kosambi -- Jl. Kelapa Dua -- Raya Cilincing
11	M15	Tanjung Priok - Kota	Term. Tanjung Priok -- RE. Martadinata -- Kampung Bandan -- Jl. Kunir -- Stasiun Kota -- Pintu Besar Utara -- Jl. Bank -- Kalibesar -- Term. Kota
12	M15A	Tanjung Priok - Kota/ Mangga Dua	Term. Tanjung Priok -- RE. Martadinata -- Gunung Sahari -- Mangga Dua Raya -- Semangat -- Mangga Dua Plaza -- Mangga Dua Raya -- Jembatan Batu -- Pintu Besar Utara -- Jl. Bank -- Kalibesar Timur -- Term. Kota

No.	Route Code	Origin - Destination	Routes
13	M16	Kampung Melayu - Pasar Minggu	Term. Kampung Melayu -- Jatinegara Barat -- Matraman Raya -- Jatinegara Timur -- Otista Raya -- Dewi Sartika -- Kalibata -- Raya Pasar Minggu -- Pejaten -- Sawo Manila -- Jl. Ragunan -- Term. Pasar Minggu

Table 101. School Bus Routes in Denpasar. *KIAT (2023)*

No.	Route	Length (km)
Morning: Total 162.4 Km		
1	Terminal Ubung – SMPN 12 Denpasar	7.8
2	SMPN 12 Denpasar–SMPN 5 Denpasar	9.7
3	Terminal Ubung – SMPN 1 Denpasar	19.9
4	Terminal Ubung – SMPN 12 Denpasar	9.2
5	Terminal Ubung – SMP Dwijendra	11.5
6	Terminal Ubung – SD Saraswati 5 Denpasar	12.0
7	Terminal Ubung – SD Saraswati 2	15.7
8	Terminal Ubung – SMP Dwijendra	16.1
9	Terminal Ubung – SD 1 dan 2 Saraswati	14.8
10	Terminal Ubung – SMPN 5 Denpasar	9.7
11	Terminal Ubung – SMPN 12 Denpasar	7.8
12	Terminal Ubung – SMP PGRI 2 Denpasar	13.9
13	Terminal Ubung – SD 6 Saraswati	14.3
Afternoon: Total 25.9 Km		
14	Terminal Ubung – SDN 17 dauh Puri	6.9
15	Terminal Ubung – SMP Dharma Praja	10.2
16	Terminal Ubung – SDN 17 Dauh Puri	8.8

Table 102. Kura-Kura Bus Time Schedule

Area	No.	Bus Stop	1st Bus	2nd Bus
To Ubud				
Kuta	1	Lippo Mall	08:00	14:00
Kuta	2	Beachwalk	08:05	14:05
Sanur	3	Grand Lucky Sanur	08:35	14:40
Ubud	4	Coco Supermarket Ubud	09:35	15:50
Ubud	5	Puri Lukisan Museum	09:45	16:00
From Ubud				
Ubud	6	Puri Lukisan Museum	11:00	17:00
Sanur	7	Mc Donald Sanur	12:10	18:10
Kuta - Airport	8	Drop Off Zones Ngurah Rai Airport	12:50	18:50
Kuta	9	Lippo Mall	12:55	18:55
Kuta	10	Beachwalk	13:00	19:00

C. Environmental and Economic Impacts

Table 103. Detailed calculation of benefit cost analysis.

TS1 (Gor Ngurah Rai – GWK)							
Benefit	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Fuel Subsidy Cost Saving	Rp47.40	Rp48.80	Rp50.24	Rp51.73	Rp53.25	Rp54.82	Rp56.44
OM Cost Saving	Rp156.55	Rp161.17	Rp165.93	Rp170.82	Rp175.86	Rp181.05	Rp186.39
GHG Reduction	Rp122.32	Rp125.93	Rp129.64	Rp133.47	Rp137.40	Rp141.46	Rp145.63
Air Pollution Reduction (SOx, NOx, and PM2,5)	Rp102.01	Rp105.02	Rp108.12	Rp111.31	Rp114.59	Rp117.97	Rp121.45
Cost	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Capital cost	Rp18,141.30						
Infrastructure Maintenance Cost	Rp23.93	Rp24.64	Rp25.36	Rp26.11	Rp26.88	Rp27.68	Rp28.49
Electricity Consumption Cost	Rp339.39	Rp349.40	Rp359.71	Rp370.32	Rp381.25	Rp392.49	Rp404.07
PV Benefits	Rp428.29	Rp412.77	Rp397.82	Rp383.41	Rp369.52	Rp356.13	Rp343.23
PV Costs	Rp18,504.62	Rp350.16	Rp337.47	Rp325.25	Rp313.46	Rp302.11	Rp291.16
Net Benefit-Cost	-Rp18,076.33	Rp62.61	Rp60.35	Rp58.16	Rp56.05	Rp54.02	Rp52.06
Benefit-Cost Ratio	0.13						
NPV	-Rp17,733.07						
EIRR	-58.63%						
TS2 (Gor Ngurah Rai – ITDC Nusa Dua)							
Benefit	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Fuel Subsidy Cost Saving	Rp56.38	Rp58.05	Rp59.76	Rp61.52	Rp63.34	Rp65.21	Rp67.13
OM Cost Saving	Rp186.21	Rp191.70	Rp197.36	Rp203.18	Rp209.18	Rp215.35	Rp221.70
GHG Reduction	Rp145.58	Rp149.87	Rp154.29	Rp158.84	Rp163.53	Rp168.35	Rp173.32
Air Pollution Reduction (SOx, NOx, and PM2,5)	Rp121.41	Rp124.99	Rp128.68	Rp132.47	Rp136.38	Rp140.40	Rp144.55
Cost	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Capital cost	Rp18,141.30						
Infrastructure Maintenance Cost	Rp23.93	Rp24.64	Rp25.36	Rp26.11	Rp26.88	Rp27.68	Rp28.49
Electricity Consumption Cost	Rp403.68	Rp415.59	Rp427.85	Rp440.47	Rp453.46	Rp466.84	Rp480.61
PV Benefits	Rp509.58	Rp491.12	Rp473.33	Rp456.18	Rp439.65	Rp423.72	Rp408.37
PV Costs	Rp18,568.91	Rp412.12	Rp397.19	Rp382.80	Rp368.93	Rp355.56	Rp342.68
Net Benefit-Cost	-Rp18,059.33	Rp79.00	Rp76.14	Rp73.38	Rp70.72	Rp68.16	Rp65.69
Benefit-Cost Ratio	0.15						
NPV	-Rp17,626.25						
EIRR	-56.75%						
K1 (Sentral Parkir Kuta – Terminal Persiapan)							
Benefit	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**

Fuel Subsidy Cost Saving	Rp95.69	Rp98.52	Rp101.42	Rp104.41	Rp107.49	Rp110.67	Rp113.93
OM Cost Saving	Rp2,485.27	Rp2,558.59	Rp2,634.07	Rp2,711.77	Rp2,791.77	Rp2,874.13	Rp2,958.91
GHG Reduction	Rp259.71	Rp267.37	Rp275.26	Rp283.38	Rp291.74	Rp300.35	Rp309.21
Air Pollution Reduction (SOx, NOx, and PM2,5)	Rp216.59	Rp222.98	Rp229.56	Rp236.33	Rp243.31	Rp250.48	Rp257.87
Cost	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Capital cost	Rp36,282.59						
Infrastructure Maintenance Cost	Rp47.86	Rp49.28	Rp50.73	Rp52.23	Rp53.77	Rp55.35	Rp56.98
Electricity Consumption Cost	Rp719.27	Rp740.49	Rp762.33	Rp784.82	Rp807.97	Rp831.81	Rp856.35
PV Benefits	Rp3,057.27	Rp2,946.51	Rp2,839.76	Rp2,736.88	Rp2,637.73	Rp2,542.16	Rp2,450.06
PV Costs	Rp37,049.73	Rp739.34	Rp712.56	Rp686.74	Rp661.86	Rp637.88	Rp614.77
Net Benefit-Cost	-Rp33,992.45	Rp2,207.17	Rp2,127.21	Rp2,050.14	Rp1,975.87	Rp1,904.28	Rp1,835.29
Benefit-Cost Ratio	0.47						
NPV	-Rp21,892.49						
EIRR	-23.88%						
K2 (Terminal Ubung – Bandara Ngurah Rai)							
Benefit	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Fuel Subsidy Cost Saving	Rp76.49	Rp78.75	Rp81.07	Rp83.46	Rp85.92	Rp88.46	Rp91.07
OM Cost Saving	Rp1,986.57	Rp2,045.17	Rp2,105.51	Rp2,167.62	Rp2,231.56	Rp2,297.40	Rp2,365.17
GHG Reduction	Rp196.83	Rp202.64	Rp208.61	Rp214.77	Rp221.10	Rp227.63	Rp234.34
Air Pollution Reduction (SOx, NOx, and PM2,5)	Rp164.15	Rp168.99	Rp173.98	Rp179.11	Rp184.40	Rp189.84	Rp195.44
Cost	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Capital cost	Rp36,282.59						
Infrastructure Maintenance Cost	Rp47.86	Rp49.28	Rp50.73	Rp52.23	Rp53.77	Rp55.35	Rp56.98
Electricity Consumption Cost	Rp574.94	Rp591.90	Rp609.36	Rp627.34	Rp645.84	Rp664.90	Rp684.51
PV Benefits	Rp2,424.04	Rp2,336.22	Rp2,251.58	Rp2,170.01	Rp2,091.39	Rp2,015.62	Rp1,942.60
PV Costs	Rp36,905.40	Rp600.24	Rp578.49	Rp557.53	Rp537.34	Rp517.87	Rp499.11
Net Benefit-Cost	-Rp34,481.35	Rp1,735.98	Rp1,673.09	Rp1,612.48	Rp1,554.06	Rp1,497.76	Rp1,443.49
Benefit-Cost Ratio	0.38						
NPV	-Rp24,964.49						
EIRR	-28.31%						
K3 (Terminal Ubung – Matahari Terbit)							
Benefit	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Fuel Subsidy Cost Saving	Rp63.48	Rp65.35	Rp67.28	Rp69.26	Rp71.31	Rp73.41	Rp75.58
OM Cost Saving	Rp1,648.61	Rp1,697.24	Rp1,747.31	Rp1,798.85	Rp1,851.92	Rp1,906.55	Rp1,962.80
GHG Reduction	Rp172.28	Rp177.36	Rp182.60	Rp187.98	Rp193.53	Rp199.24	Rp205.11

Air Pollution Reduction (SOx, NOx, and PM2,5)	Rp143.68	Rp147.92	Rp152.28	Rp156.77	Rp161.40	Rp166.16	Rp171.06
Cost	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Capital cost	Rp36,282.59						
Infrastructure Maintenance Cost	Rp47.86	Rp49.28	Rp50.73	Rp52.23	Rp53.77	Rp55.35	Rp56.98
Electricity Consumption Cost	Rp477.13	Rp491.20	Rp505.69	Rp520.61	Rp535.97	Rp551.78	Rp568.06
PV Benefits	Rp2,028.04	Rp1,954.57	Rp1,883.76	Rp1,815.51	Rp1,749.73	Rp1,686.34	Rp1,625.25
PV Costs	Rp36,807.58	Rp505.97	Rp487.64	Rp469.97	Rp452.95	Rp436.54	Rp420.72
Net Benefit-Cost	-Rp34,779.54	Rp1,448.60	Rp1,396.12	Rp1,345.54	Rp1,296.79	Rp1,249.81	Rp1,204.53
Benefit-Cost Ratio	0.32						
NPV	-Rp26,838.17						
EIRR	-31.35%						
K4 (Gor Ngurah Rai – Monkey Forest)							
Benefit	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Fuel Subsidy Cost Saving	Rp91.25	Rp93.94	Rp96.71	Rp99.57	Rp102.50	Rp105.53	Rp108.64
OM Cost Saving	Rp2,369.87	Rp2,439.78	Rp2,511.76	Rp2,585.85	Rp2,662.14	Rp2,740.67	Rp2,821.52
GHG Reduction	Rp247.65	Rp254.96	Rp262.48	Rp270.22	Rp278.20	Rp286.40	Rp294.85
Air Pollution Reduction (SOx, NOx, and PM2,5)	Rp206.54	Rp212.63	Rp218.90	Rp225.36	Rp232.01	Rp238.85	Rp245.90
Cost	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Capital cost	Rp36,282.59						
Infrastructure Maintenance Cost	Rp47.86	Rp49.28	Rp50.73	Rp52.23	Rp53.77	Rp55.35	Rp56.98
Electricity Consumption Cost	Rp685.87	Rp706.10	Rp726.93	Rp748.38	Rp770.46	Rp793.19	Rp816.58
PV Benefits	Rp2,915.31	Rp2,809.69	Rp2,707.90	Rp2,609.79	Rp2,515.24	Rp2,424.12	Rp2,336.29
PV Costs	Rp37,016.33	Rp707.15	Rp681.53	Rp656.84	Rp633.04	Rp610.11	Rp588.01
Net Benefit-Cost	-Rp34,101.02	Rp2,102.54	Rp2,026.37	Rp1,952.95	Rp1,882.20	Rp1,814.01	Rp1,748.29
Benefit-Cost Ratio	0.45						
NPV	-Rp22,574.66						
EIRR	-24.82%						

K5 (Sentral Parkir Kuta – Politeknik Negeri Bali)							
Benefit	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Fuel Subsidy Cost Saving	Rp93.63	Rp96.39	Rp99.24	Rp102.16	Rp105.18	Rp108.28	Rp111.47
OM Cost Saving	Rp2,431.69	Rp2,503.43	Rp2,577.28	Rp2,653.31	Rp2,731.58	Rp2,812.17	Rp2,895.12
GHG Reduction	Rp254.11	Rp261.61	Rp269.33	Rp277.27	Rp285.45	Rp293.87	Rp302.54
Air Pollution Reduction (SOx, NOx, and PM2,5)	Rp211.92	Rp218.18	Rp224.61	Rp231.24	Rp238.06	Rp245.08	Rp252.31
Cost	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Capital cost	Rp36,282.59						
Infrastructure Maintenance Cost	Rp47.86	Rp49.28	Rp50.73	Rp52.23	Rp53.77	Rp55.35	Rp56.98
Electricity Consumption Cost	Rp703.76	Rp724.52	Rp745.90	Rp767.90	Rp790.56	Rp813.88	Rp837.89
PV Benefits	Rp2,991.36	Rp2,882.99	Rp2,778.54	Rp2,677.88	Rp2,580.86	Rp2,487.36	Rp2,397.24
PV Costs	Rp37,034.22	Rp724.40	Rp698.15	Rp672.86	Rp648.48	Rp624.99	Rp602.34
Net Benefit-Cost	-Rp34,042.86	Rp2,158.59	Rp2,080.39	Rp2,005.02	Rp1,932.38	Rp1,862.37	Rp1,794.90
Benefit-Cost Ratio	0.46						
NPV	-Rp22,209.21						
EIRR	-24.31%						

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