UK PACT


*This document outlines the business case of Transjakarta's first phase e-bus deployment*

# Building a Regulatory and Financial Basis for Transjakarta First Phase E-bus Deployment

## Task 4.7: Transjakarta First Phase E-Bus Deployment Business Case

31 March, 2023

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## List of Abbreviations

| | |
|---|---|
| AB | Articulated Bus |
| ACC | Annual Capital Costs |
| AOCC | Average Annual Operating Costs |
| APIC | Additional Paid in Capital |
| BAU | Business-As-Usual |
| BEV | Battery Electric Vehicle |
| BRT | Bus Rapid Transit |
| BUMD | *Badan Usaha Milik Daerah* (Regional-Owned Company) |
| CAGR | Compound Annual Growth Rate |
| CAPEX | Capital Expenditure |
| CBD | Central Business District |
| CBU | Complete Build Unit |
| CFF | Cities Finances Facility |
| CNG | Compressed Natural Gas |
| CRF | Capital Recovery Factors |
| DD | Double Decker Bus |
| DKI | *Daerah Khusus Ibukota* (Special Capital Region of Jakarta) |
| E-bus | Electric Bus |
| EIRR | Economic Internal Rate of Return |
| EV | Electric Vehicle |
| GESI | Gender Equality and Social Inclusion |
| GVW | Gross Vehicle Weight |
| ICE | Internal Combustion Engine |
| IDR | Indonesian Rupiah |
| ITDP | Institute for Transportation and Development Policy |
| kg | kilogram |
| km | kilometre |
| kW | kilowatt |
| kWh | kilowatt per hour |
| kWp | kilowatt peak |
| LE | Low Entry Bus |
| LFP | Lithium Iron Phosphate |
| m | metre |
| MB | Medium Bus |
| MoU | Memorandum of Understanding |
| NMC | Nickel Manganese Cobalt |
| NPV | Net Present Value |
| OEM | Original Equipment Manufacturer |
| OPEX | Operating Expense |

| | |
|---|---|
| PLN | *Perusahaan Listrik Negara* (State Electricity Company) |
| PSO | Public Service Obligation |
| PT | *Perseroan Terbatas* (Limited Company) |
| PV | Photovoltaics |
| Rp | Rupiah |
| SB | Single Bus |
| SKD | Semi Knocked Down |
| SoC | State of Charge |
| TCO | Total Cost Ownership |
| TJ | Transjakarta |
| UK PACT | UK Partnering for Accelerated Climate Transitions |
| UMP | *Upah Minimum Provinsi* (Province Minimum Wage) |
| UNEP-CTCN | United Nation Environment Programme-Climate Technology Centre and Network |
| USD | United States Dollar |

# Executive Summary

Transjakarta aims to electrify 100% of its fleets by 2030, which amounts to 10,047 fleets. ITDP Indonesia has developed a long-term year-on-year electrification plan that considers factors such as technology readiness, investment needs, regulatory support, and GESI aspects. The electrification plan is divided into phases to accommodate the constraints on budget and operational changes. In addition, financing institutions have expressed interests to invest in the program hence a comprehensive implementation plan is required to inform these institutions. A business case document, including a detailed technical plan, is needed to select routes, technology, charging locations, and assess the impacts of partial electrification on Transjakarta's operations.

In order to simplify the scope, based on funding mechanism using a Limited Participation Mutual Funds/ "RDPT" issuance and discussions with investment manager, the most viable funds that can be raised in one issue of such mutual funds is equal to around 840 e-bus, which can be deployed between 2023 - 2025. As such, the business case covers this phase only. The plan focuses on facilities and infrastructure directly related to electrification, such as e-bus fleets, charging facilities, and charging locations. The project also assumes all electric bus deployed in 2023 – 2025 is for fleets replacement and no fleets augmented in the selected routes. No additional routes are assumed to be deployed for electric bus between 2023 – 2025. Moreover, the study utilises the existing contractual schemes between Transjakarta and operators.

**Routes Selected for Electrification**

Routes selection was done by ranking the Transjakarta routes. The route ranking was developed for BRT routes (single and articulated bus), non-BRT medium bus, and microbus. All routes were ranked based on Route level TCO/km, Number of buses, Ridership or fleets visibility and usability (based on zoning from the potential traffic restriction area) and Charging strategy.

The final selection of routes for the first phase implementation is based on all of the factors mentioned above. The following table shows the total number of fleets to be electrified in each year from 2023 to 2025, based on the implementation phase developed before.

*Table 1. Total number of fleet to be electrified from 2023-2025*

| Electric buses | Start year of Implementation | | |
|---|---|---|---|
| | 2023 | 2024 | 2025 |
| Articulated Bus (AB) | 0 | 0 | 111 |
| Single Bus (SB) | 100 | 150 | 31 |
| Medium Bus (MB) | 100 | 0 | 50 |
| Microbus | 0 | 100 | 200 |

Based on the table above, the route ranking, the routes selected for BRT, non-BRT, and microbus are as follows:

For the BRT routes with single buses and articulated buses, routes ranking from 1 to 6 have been selected. Route 19C is included in the route selection as it shares the terminal Pinang Ranti with route number 9 and route no. 13C is excluded from the selection.

*Table 2. Route Selected for BRT Routes*

| Route Code | Route Name | Terminus 1 | Terminus 2 | Number of SB* | Number of AB | Start of Electrification | % Electrification |
|---|---|---|---|---|---|---|---|
| 1 | Blok M – Kota | Blok M | Kota | 100 | | 2023 | 71% |
| 1 | Blok M – Kota | Blok M | Kota | 70 | | 2024 | 100% |
| 9 | Pinang Ranti – Pluit | Pinang Ranti | Pluit | 80 | | 2024 | 65% |
| 1 | Blok M – Kota | Blok M | Kota | | 41 | 2025 | 100% |
| 3 | Kalideres – Pasar Baru | Kalideres | Pasar Baru | 33** | 24 | 2025 | 71% |
| 9 | Pinang Ranti – Pluit | Pinang Ranti | Pluit | 5** | 39 | 2025 | 100% |
| 9C | Pinang Ranti – Bundaran Senayan | Pinang Ranti | Bundaran Senayan | | 9 | 2025 | 45% |
| 8 | Lebak Bulus – Harmoni | Lebak Bulus | Harmoni | **63**** | | 2025 | 78% |

**Includes number of maxi buses as an equivalent number of single buses (conversion factor 1.3).*

*** reallocated from Corridor 1 to Corridor 8 in 2025 to account for replaced articulated buses in 2024 from Corridor 1.*

For the non-BRT medium bus routes, routes ranking from 1 to 15 are chosen. The selected routes will undergo full electrification.

*Table 3. Routes selected for Non-BRT Medium Bus Routes*

| Route Code | Route Name | Terminus 1 | Terminus 2 | Number of MB | Nearest Terminal | Start year of Electrification |
|---|---|---|---|---|---|---|
| 6C | Stasiun Tebet - Karet | Stasiun Tebet | Karet | 7 | Kampung Melayu | 2023 |
| 1E | Pondok Labu - Blok M | Pondok Labu | Blok M | 10 | Blok M | 2023 |
| 5N | Kampung Melayu - Ragunan | Kampung Melayu | Ragunan | 9 | Kampung Melayu | 2023 |
| 6N | Ragunan - Blok M | Ragunan | Blok M | 10 | Blok M | 2023 |
| 1C | Pesanggarahan - Blok M | Pesanggarahan | Blok M | 8 | Blok M | 2023 |
| 8D | Joglo - Blok M | Joglo | Blok M | 8 | Blok M | 2023 |
| 3E | Puri Kembangan - Sentraland Cengkareng | Puri Kembangan | Sentraland Cengkareng | 17 | Kalideres | 2023 |
| 8E | Bintaro - Blok M | Bintaro | Blok M | 7 | Blok M | 2023 |
| 1Q | Rempoa - Blok M | Rempoa | Blok M | 7 | Blok M | 2023 |
| 11D | Pulogebang - Pulogadung 2 | Pulogebang | Pulogadung | 14 | Both Terminus | 2023 |
| 7P | Pondok Kelapa - BKN | Pondok Kelapa | BKN | 9 | Kampung Melayu | 2023 |
| 11Q | Kampung Melayu - Pulo Gebang | Kampung Melayu | Pulo Gebang | 7 | Both Terminus | 2025 |
| 9H | Cipedak - Blok M | Cipedak | Blok M | 15 | Blok M | 2025 |
| 8K | Batusari - Tanah Abang | Batusari | Tanah Abang | 13 | Grogol | 2025 |
| 1M | Meruya - Blok M | Meruya | Blok M | 13 | Blok M | 2025 |

For microbus routes, routes ranking from 1 to 15 are chosen. Routes with at least one terminal end are given priority, which results in 9 routes to be selected. The selected routes will undergo full electrification.

*Table 4. Routes Selected for Microbus Routes*

| Route Code | No. of Buses | Terminal | Start year of Electrification |
|---|---|---|---|
| JAK.53 | 43 | Grogol | 2024 |
| JAK.56 | 30 | Grogol | 2024 |
| JAK.30 | 30 | Grogol | 2024 |
| JAK.31 | 30 | Blok M | 2025 |
| JAK.46 | 41 | Pasar Minggu | 2025 |

| | | | |
|---|---|---|---|
| JAK.54 | 27 | Grogol | 2025 |
| JAK.15 | 48 | Tanjung Priok | 2025 |
| JAK.19 | 42 | Pinang Ranti | 2025 |
| JAK.84 | 31 | Kampung Melayu | 2025 |

**Terminals Selected for Charging Infrastructure**

Based on route ranking result, routes which ranks higher will be assigned to nearest terminals to carry out opportunity charging. The selection of the terminals has principles to minimise the dead kilometres hence to increase cost-effectiveness of the electrification. Routes that can be covered with overnight charging are assumed to be charged at the depots or other locations. Given that Transjakarta already has 122 layover areas across Greater Jakarta, installing charging equipment at each one may not be necessary in the initial phase of electrification. Instead, route grouping can help ensure mileage efficiency by avoiding the need for buses to travel to the farthest depot for charging.

Based on BRT and non-BRT route selected, terminal charging locations are selected as follows:

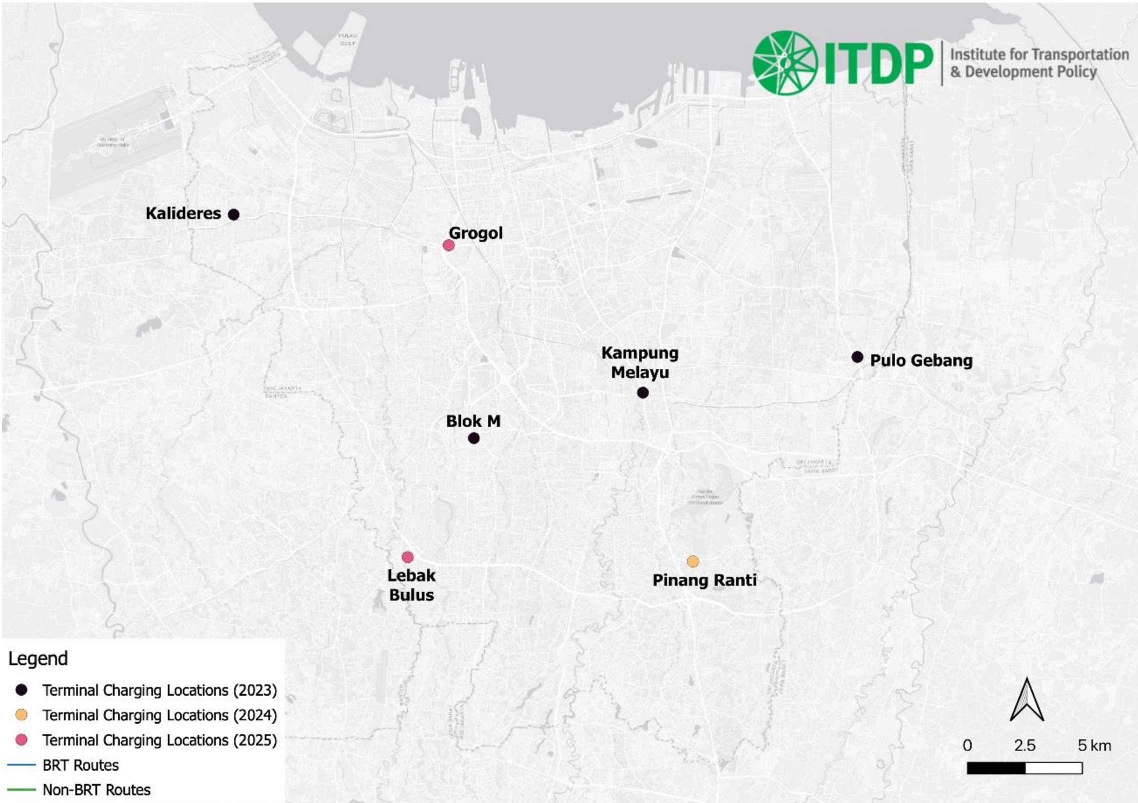


*Figure 1. Terminal charging location points*

**Type of Technology Proposed**

*Fleets' Technology Readiness and Fleets Typology*

Given that Transjakarta has several types of services with different bus types, typologies of electric buses need to be identified that are suitable to replace the counterpart of diesel bus types considering the bus specifications, passenger capacity and gross vehicle weight limits.

The study used market research and findings from previous studies to select bus typologies that include 12-m single buses, 12-m low entry buses, 7-m medium buses, 18-m articulated buses, and 4-m microbuses. The battery sizes were selected based on standard models available to avoid customization and longer procurement lead times. The business case excludes double decker buses, Royaltrans buses, and 13.5-m maxi buses as they are not part of Transjakarta's electrification plan. Table below presents the selected bus typologies and serves as a baseline for the e-bus technology assumptions based on market availability.

*Table 5. Transjakarta's fleets typology*

| Bus typology | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Bus Type | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Type of Bus | **Single Bus (12-m)** | | **Medium Bus (7-m)** | | **Articulated (18-m)** | **Low Entry (12-m)** | | **Microbus (4-m)** |
| Max GVW (kg) | 16,000 | | 8,000 | | 26,000 | 16,000 | | 5,000 |
| Service Type | BRT, non-BRT | | Non-BRT, affordable housing routes | | BRT | Non-BRT | | Mikrotrans, Transcare |
| Battery (kWh) | 324 | 180* | 135 | 150** | 450 | 324 | 180* | 42 |
| Energy consumption, including factors such as AC usage (kWh/km) | 1.2 | 1 | 1 | 1 | 1.8 | 1.2 | 1 | 0.15 |
| Full battery range (km) | 270 | 180 | 135 | 150 | 250 | 270 | 180 | 280 |
| SoC reserve | 20% | 20% | 20% | 20% | 20% | 20% | 20% | 20% |
| Estimated range with 20 %SoC reserve (km) | 216 | 144 | 108 | 120 | 200 | 216 | 144 | 225 |
| Battery degradation by year 8 | 20% | 20% | 20% | 20% | 20% | 20% | 20% | 20% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Range at year 8 after degradation (km) | 173 | 115 | 86 | 96 | 160 | 173 | 115 | 180 |

** For single bus and low entry bus, a 324-kWh battery will be selected*

*** The 150-kWh battery has not yet met the Gross-Vehicle Weight requirement; therefore, the medium bus will use a 135-kWh battery for further analysis.*

*Charger Technology Readiness & Charging Facilities*

The implementation of e-buses involves several factors, such as battery technology, charging infrastructure, charger power, and fleet provision options. The report recommends LFP battery technology in the initial phases due to its availability in the Asian market, but also notes the increasing market share of advanced chemistries such as NMC. The charging technology and the number of charging stations are estimated based on the charger-to-bus ratio for each bus type and type of charging. The report provides an analysis of the charging technology, charger capacity, and the number of charging stations required for each type of electric bus, categorised based on the number of electric bus fleets. The charger-to-bus ratio serves as an initial evaluation of the required number of chargers, with further analysis required to determine the most efficient number of chargers to support the electric buses.

- **12-m single electric bus (high-deck or low entry)**

The 12-m single buses both high-deck and low entry with 324 kWh LFP battery can have slow plug-in chargers up to 100 kW with a charging time of about 3.5 hours for 0% to 100% SoC and fast chargers up to 200 kW with a charging time of 1.25 hours for 10% to 80% SoC. For these bus types, double gun chargers at 200 kW recommended for overnight depot charging and terminal opportunity charging. It is assumed that each charger can charge two buses in succession for overnight charging, and the depot charger to bus ratio is estimated as 1:4. For opportunity charging, the terminal charger to bus ratio is 1:10. As battery technology improves, faster charging options may be explored in the future.

- **18-m articulated bus**

The recommended charging options for articulated buses include fast charging with a charger power of up to 400 kW, taking about 1.5 hours to charge from 10% to 80% SoC, and overnight charging with 200 kW plug-in chargers, taking about 3 hours to charge from 0% to 100% SoC. The overnight charger to bus ratio is 1:2, and for terminal charging, it is estimated as 1:10, taking into account the opportunity charge requirement and fast charger power.

- **7-m medium buses**

The medium buses currently used in Indonesia are limited by the gross weight restrictions, one examples of suitable model for now is the BYD C6 with a battery size of 135 kWh. However, in future phases, buses with a higher battery capacity of 150 kWh and lighter weight may be developed. A 100-kW charger is recommended for both overnight and terminal charging, with a charging time of 1.3-1.5 hours for different battery sizes. Respectively for 135kWh and 150 kWh battery sizes, charger to bus ratios are estimated at 1:5 and 1:4 for overnight charging and 1:3 for terminal charging based on the charger power and opportunity charging requirement.

- **4-m microbuses**

The Gelora EV from DFSK, equipped with a 42 kWh LFP battery and 22 kW charger, is the recommended model for electric microbuses in the current market based on TCO/km analysis conducted in the previous phase of the project. The charger to bus ratio is estimated at 1:10, with a charging time of 1.3 hours for 10% to 80% SoC, to account for opportunity charging or contingencies.

**Alternative Fund Channelling Schemes and Business Models**

The current Transjakarta business model does not allow for new players to participate due to lack of flexibility and upfront costs. The study recommends implementing different business models for large/medium buses and microbuses, such as concessional financing and leasing. The study also suggests that there is a need to separate the business models between large/medium buses and microbuses as the operation of the 2 bus types are significantly different where the microbuses do not have depot to locate the charging infrastructure and they are also operated by individuals.

Concessional financing for large/medium buses involves Transjakarta acquiring and allotting e-buses to operators, with Transjakarta paying for maintenance and operators investing in depot charging infrastructure. Terminal charging infrastructure is arranged through Public Private Partnership (PPP) with Charging Service Provider (CSP) where they would get paid by Transjakarta for the initial investment and by operators for the energy used. The operators would keep getting paid on the basis of Rupiah/km for the public bus services. The leasing model is similar, but Transjakarta does not own the buses and instead acquires them from a lessor and allots them to operators. Lessor would then arrange the maintenance contract with APM/OEM. Similar to concessional financing, operators would also need to invest in the depot charging and Transjakarta in terminal charging through PPP with CSP. In this case, Transjakarta would need to pay for the lease of the buses to the Lessor and to CSP for the initial investment.

For microbuses, cooperatives' role is shifted to a leasing company that arranges procurement, financing, charging, and maintenance. Transjakarta would enter into a framework agreement with lessors through a competitive process, specifying operational aspects, bus quality requirements, escrow arrangements, targeted fleet deployment, and provision for substitution of operators in case of poor performance.

Furthermore, the study suggests using fund channelling schemes to improve financing access and address financing challenges. These schemes are designed to be replicable, scalable, flexible, and attract various private investors. The goal of the schemes is to provide proof of concept where the costs of fund of each scheme are evaluated to provide confidence on the schemes. The schemes are divided into two sources of financing: public and private loans. Schemes A-1, A-2, and A-3 maximize regional loans and require government support, while the rest utilize private sector loans. Scheme B-1 will be implemented using loans from foreign commercial banks to also allow the option of having ECAs/DFIs participation in the scheme. Loan from commercial bank could also be exploited in the same scheme. Scheme B-2 uses Limited Participation Mutual Funds (RDPT) as securities, which are easier to implement than bonds or stocks.

Transitioning to an electric bus fleet is a complex problem that involves changing the transportation infrastructure, vehicle supply, and personnel training, among other associated costs. Social considerations such as the impact on bus riders and the community must also be taken into account. To fully deploy electric buses, further assessment of the business model and fund channelling scheme, deeper collaboration with stakeholders, and technical assessments are necessary.

The TCO analysis, discounted all costs to a prevent value, found that the **Total Cost of Ownership of electric microbuses is already 25% lower than the comparable petrol buses** but with or without the environment costs and are ready for large scale deployment. The deployment cost of single electric buses is 6% lower than diesel buses. The TCO for electric articulated buses is similar to diesel buses and with further optimisation, can be the same. Retrofitted single buses were not found to be as effective as the new (procured) single buses, but further analysis is needed. TCO for electric medium buses is still higher than diesel and exploring lighter, higher range models is recommended. Recent government fuel price increases are expected to further improve the TCO of electric buses compared to ICE.

Adoption of 100% electric buses by Transjakarta is expected to require a total investment of IDR 22 T between 2024 and 2030 as compared to a business-as-usual scenario investment of IDR 15 T during the same period i.e., 45% higher.

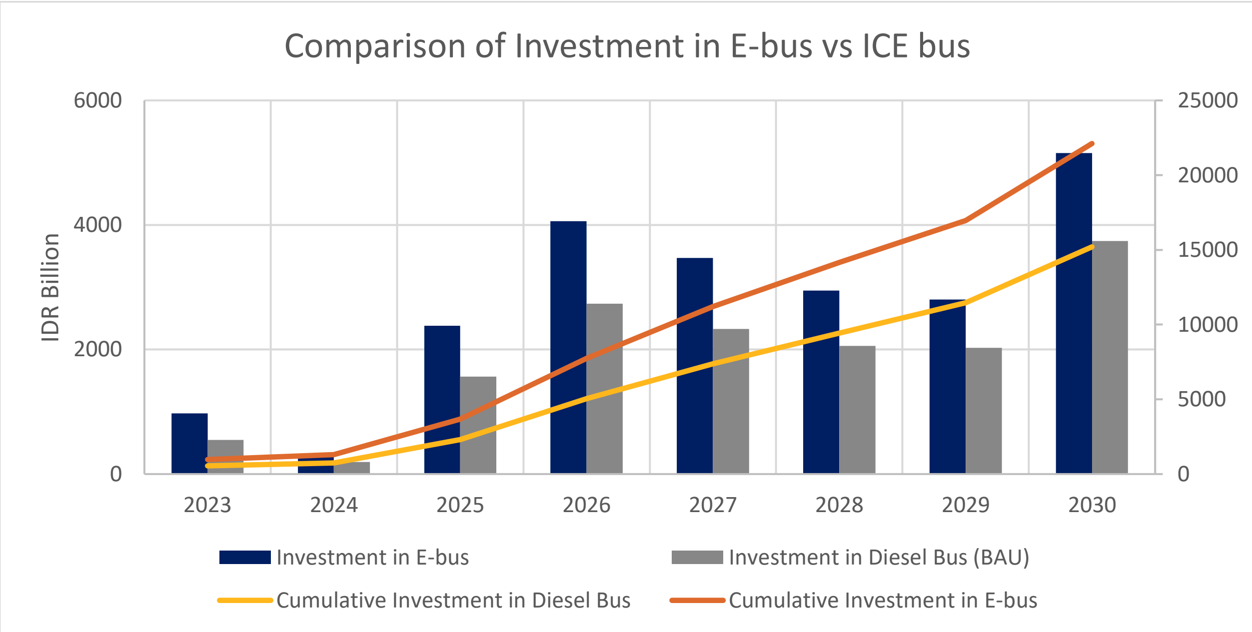


*Figure 2. Estimated Total Cost of Investment (Present Cost)*

Financial feasibility using Net Present Value for different investment options for deploying electric buses is being evaluated, compared to Business as Usual where the same number of fleets are deployed but it's all ICE buses. Options include direct procurement by operators, leasing from Transjakarta/SPV to operators, and lease financing. A combination of options for different bus types is recommended. The analysis includes fees, loan instalments/interest, insurance, and asset management costs, but excludes fare collection and Transjakarta's administrative and general overheads. Maxi buses and Royal Trans/tourism services are excluded. The electrification options also include BTS fees for the diesel fleet yet to be replaced.

Accordingly, the summary of the financial feasibility analysis is presented below:

*Table 6. Difference in NPV from BaU*

| Type of Bus/Option | Option 1 | Option 2 | Option 3 | Option 4 |
|---|---|---|---|---|
| Articulated Buses | -126 | 376 | -188 | 376 |
| Low Entry Buses | 115 | 299 | 0 | 115 |
| Single Buses | 399 | 943 | -358 | 399 |
| Medium Buses | 723 | 990 | 391 | 723 |
| Microbus | 3115 | 5583 | 5134 | 5134 |
| **Total** | **4225** | **8191** | **4978** | **6747** |
| %age of BAU NPV | 10.6% | 20.6% | 12.5% | 16.9% |

*(Figures in Rp Billion)*

The estimated year-wise increase (negative value) or decrease (positive value) in PSO requirements as compared to BaU scenario for various Options for electrification is shown in the table below.

*Table 7. Reduction in Operating Subsidy*

| | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Option 1 | -11 | -15 | -23 | -13 | 63 | 212 | 457 | 823 | 948 | 1073 | 1235 |
| Option 2 | -13 | -11 | 6 | 58 | 172 | 391 | 754 | 1309 | 1602 | 1902 | 2112 |
| Option 3 | -32 | -49 | -63 | -87 | -31 | 112 | 394 | 811 | 1078 | 1352 | 1511 |
| Option 4 | -11 | -13 | -2 | 41 | 144 | 337 | 659 | 1143 | 1405 | 1674 | 1985 |

*(Figures in Rp Billion)*

In case The Government of Jakarta/Transjakarta decides to pursue option 2, the net funding required is shown below.

*Table 8. Net Funding Required from Transjakarta in Option 2*

| Yearly Funding Requirement | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | Total |
|---|---|---|---|---|---|---|---|---|---|
| Articulated Buses | | | 889 | 1321 | 152 | 175 | 182 | 190 | 2909 |
| Low Entry Buses | 113 | | | | | 817 | 419 | 90 | 1439 |
| Single Buses | 435 | 651 | 134 | 969 | 1138 | 486 | 471 | 1600 | 5883 |
| Medium Buses | 193 | | 96 | 391 | 476 | 482 | 495 | 760 | 2894 |
| Microbus | | 45 | 87 | 176 | 267 | 485 | 777 | 935 | 2773 |
| **Total Investment Cost** | **741** | **695** | **1207** | **2857** | **2033** | **2446** | **2345** | **3575** | **15899** |

*(Figures in Rp Billion)*

Overall, all the four options considered are found to be financially feasible as compared to the Business-as-Usual scenario of using ICE buses. **However, it should be noted that the absolute amount of PSO requirement will still increase as compared to current levels due to expansion of the fleet by 2.5 times by 2030 and increase in cost components. This analysis only confirms that the overall cost will be lower with electric buses than with ICE buses.**

Scenario analysis was carried out to ascertain the financial robustness of the various options considered. It is seen that, despite various adverse scenarios assumed, the NPV of electrification remains positive in all options except when electric buses imported from Europe are considered. option 2 remains the most favourable of all options followed closely by option 4. It is also seen that the financial feasibility is most sensitive to changes in Capex associated with the e-buses and is low to moderate sensitive towards changes in electricity prices, maintenance costs or cost of funds. Also, it is seen that the alternate roadmap which accelerates the e-bus deployment has a higher NPV as compared to the base case scenario.

The social cost benefits analysis shows that electrification of Transjakarta's fleet will result in reduction of GHG emissions, noise pollution, and SOx/NOx/$PM_{2.5}$ emissions within the Jakarta city due to reduction in combustion of fossil fuels, foreign exchange outgo in importing motor fuels, as well as reduction in public transport fuel subsidy burden on Government of Indonesia. However, these benefits are offset to an extent by the increased GHG and SOx/NOx/$PM_{2.5}$ emissions from electricity generating plants using fossil fuels. In order to maximise the benefit of electrification of the buses, there needs to be integration of renewable energy sources for charging of the buses. The Government of Indonesia also needs to bring down emissions from the coal-based power plants at least to the level of similar Asian Countries like China or India.

The social cost/benefit of electrification is summarised in the table below.

*Table 9. Social Cost-Benefit of Electrification*

| Parameter | Unit | 2031 | (2024-2034) |
|---|---|---|---|
| Reduction in GHG Emissions | '000 Tons | 288 | 1779 |
| Reduction in SOx Emissions | Tons | (154) | (1160) |
| Reduction in NOx Emissions | Tons | 2657 | 17,800 |
| Reduction in $PM_{2.5}$ Emissions | Tons | (9.7) | (69.3) |
| Reduction in Foreign Exchange Outgo | USD Million | 75 | 457 |
| Reduction in Fuel Subsidy | IDR Billion | 1089 | 6760 |
| Economic IRR | | 34% | |
| Cost Benefit Ratio | | 2.41 | |

Overall, it is concluded that the electrification roadmap of Transjakarta is both financially and economically viable and needs to be implemented promptly to maximise the benefits. Integration of renewable energy in charging of e-buses and reduction of pollution from coal power plants will further increase the social benefits of this conversion. It is recommended that Transjakarta pursues different business/financing models for different types of buses as shown below:

*Table 10. Financial models for different type of buses*

| Bus Type | Responsibility | Financial Model |
|---|---|---|
| Articulated Buses | Transjakarta | Self-financing through (Government Funding/Loans) or Leasing |
| Single/Low Entry Buses/Medium Buses | Operator (Loans/Leasing) | Own Equity + Bank Loans/Leasing |
| Microbus | Operator | Leasing (facilitated by Transjakarta)/Own Funds |

# 4. Introduction

## 4.1. Project Context

The Indonesian government has set a bold target to combat the perilous effects of climate change. The aim is to reduce greenhouse gas emissions by 58% in 2050, compared to Business-As-Usual, which is equivalent to 2,726 MtCO2eq. The adoption of battery electric vehicles has been identified as one of the strategies to mitigate the problem. At the provincial level, the Government of Jakarta has signed the C40 Fossil-Fuel-Free Street Declaration, committing to achieving net-zero emissions by 2030 through initiatives such as implementing 100 electric buses in pilot projects, attaining a 50% electric bus share by 2025, and establishing two Low Emission Zones (LEZ) within the city limits.

Transjakarta, which operates as a regionally owned enterprise (BUMD) with the Government of Jakarta as a major stakeholder, has the most comprehensive BRT system globally. With corridors spanning approximately 230 km throughout Jakarta's roads and surrounding areas, Transjakarta plays a crucial role in accelerating and enhancing the quality of bus public transport services in the Jakarta region.

## 4.2. Background

Transjakarta has set an ambitious goal to completely electrify its fleet, which is made up of 10,047 buses, by the year 2030. This objective has been strongly encouraged and required by Governor Decree 1053/2022, which provides guidelines for the Battery Electric Bus Deployment Acceleration Program under Transjakarta Services. In addition, the Governor Decree states that the electrification of 50% of the fleet should be accomplished by 2027, with yearly targets for electric bus usage from 2022 to 2030.

Through the UNEP-CTCN study, the ITDP has devised a phase for the deployment of 1,724 large and medium electric buses. Moreover, under the UK PACT study's first year, the ITDP has created an implementation phase for 3,300 microbuses. However, the large and medium bus electrification program from the UNEP study only takes into account current fleet numbers, without projecting to 2030. Additionally, the microbus implementation plan from the previous study used outdated figures that are now being superseded by Transjakarta's current targets. Furthermore, according to the Head of Jakarta Transport Agency decree, which mandates quotas for large, medium, and small buses, there has been a significant shift in the number of electric microbuses that must be deployed by 2030.

The UK PACT study's second year focuses on the electrification of 10,047 Transjakarta electric bus fleets until 2030, covering aspects such as regulations, technical requirements, business models, financing mechanisms, financial and economic analysis, as well as cost-benefit analysis. Therefore, this business case report aims to provide a comprehensive analysis and justification for the transition from traditional fossil-fuel-powered buses to electric buses present the study’s findings and recommendations to gain a better understanding of the context surrounding the large-scale electrification of Transjakarta, particularly in the first phase after the pilot program, which is planned to take place between 2023 and 2025. The business case document serves as a tool for decision-makers to evaluate the feasibility of transitioning to electric buses and to make informed decisions about the future of Jakarta’s road-based public transportation under the Transjakarta services.

# 5. Overview of Transjakarta

## 5.1. General Overview of The Transjakarta Service

Transjakarta's current operations include eight types of services along with seven types of bus fleets. A majority of these are owned and operated by several operators with a few buses and routes owned and operated by Transjakarta. Each route can compromise of multiple fleet types which depend on several factors such as demand, road characteristics, type and width of the road, and safety aspects, taking the bus GVW and turning radius into consideration. The 8 types of Transjakarta services are listed as follows:

1. BRT (Bus Rapid Transit): This service runs on a dedicated lane. There are currently 13 BRT corridors with 50 routes under the Transjakarta service, spanning over 251.2 kilometres.
2. Integration routes: The integration routes, sometimes called non-BRT, are Transjakarta regular routes which run fully outside the BRT system or in-and-out the BRT system (direct services). There are currently 52 integration routes operated.
3. Border routes: The Border or Transjakarta service operates between cities in the Greater Jakarta Area ("Jabodetabek") and is integrated with the BRT service. There are currently 8 routes within this service.
4. Affordable housing routes: This service is aimed for affordable housing residents, providing them direct access to Transjakarta BRT corridors. There are 18 routes.
5. Mikrotrans: The Mikrotrans service is Transjakarta's feeder system using microbuses. This service highly increases the coverage of Transjakarta's service area. There are currently 80 Mikrotrans routes under Transjakarta service.
6. Royaltrans: Royaltrans service is a premium shuttle service for Greater Jakarta commuters. Different from other Transjakarta services, Royaltrans is not subsidised. There are currently 8 Royaltrans routes under the Transjakarta service.
7. Tourism routes: There are currently 2 tourism routes under Transjakarta service, using double-decker fleets.
8. Transcare: This is a special microbus service catered to serve people with disabilities with 26 buses under operation with no fixed routes.

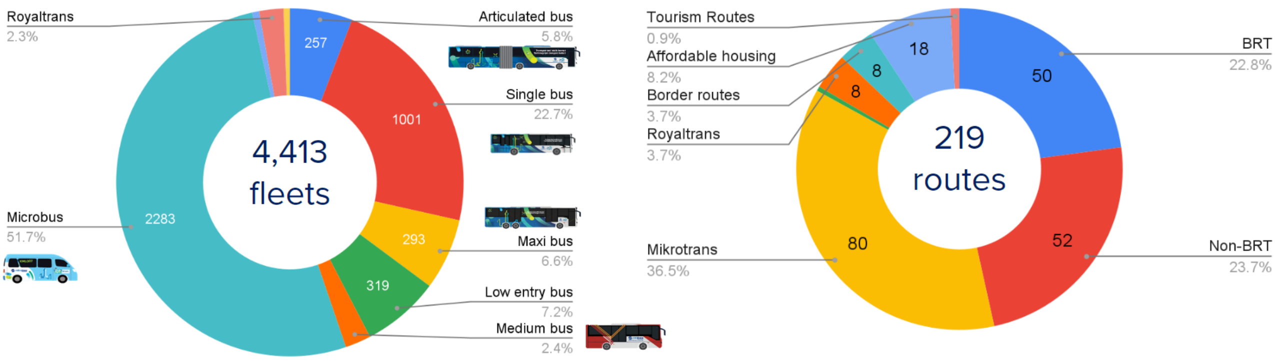


*Figure 3. Transjakarta's current number of fleets and number of routes*

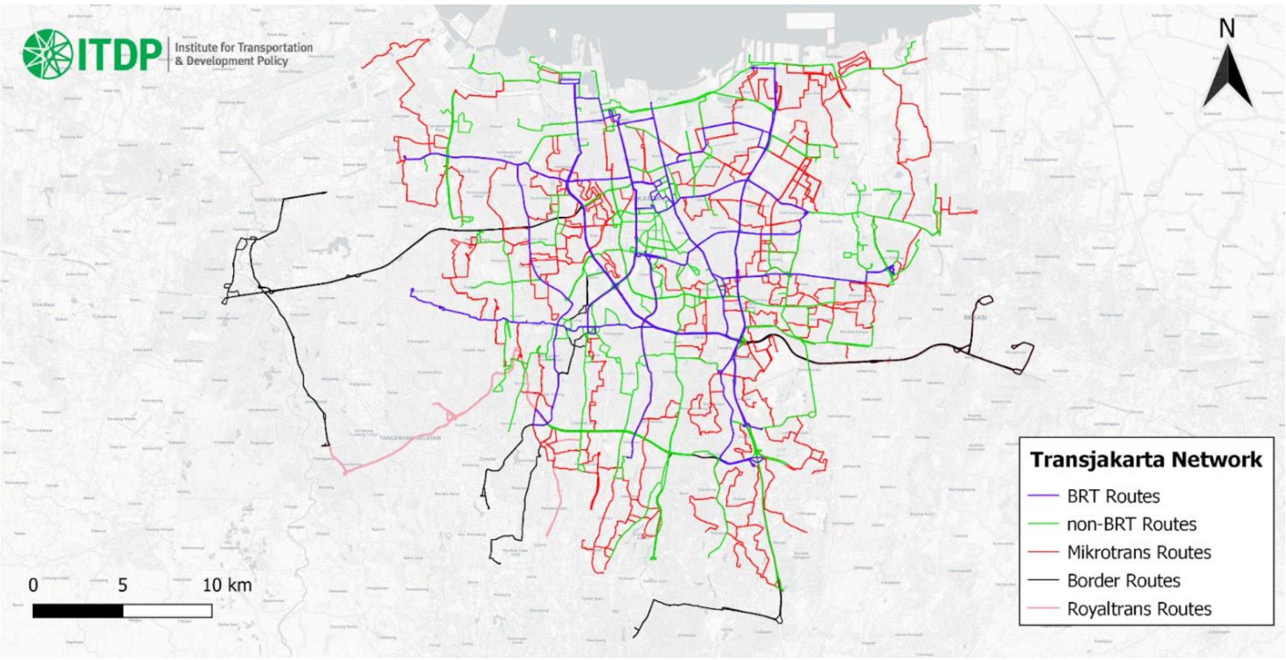


*Figure 4. Current Transjakarta's network*

Overall, Transjakarta has 4,413 buses, 18 operators, 219 routes, 8 service categories, demonstrated on the table below:

*Table 11. Transjakarta's service based on bus type*

| Bus type & length | Number of buses | Service |
|---|---|---|
| Medium Bus (7-m) | 268 | Non-BRT, Affordable Housing |
| Single Bus (12-m) | 965 | BRT, Non-BRT Integration, Border Routes, Affordable Housing |
| Single low Entry (12-m) | 319 | Non-BRT, Border Routes |
| Maxi Bus (13.5-m) | 293 | BRT, Non-BRT, Border Routes |
| Double Decker | 28 | Tourism Routes |
| Articulated (18-m) | 257 | BRT |
| Microbus (4-m) | 2129 | Mikrotrans, Transcare |

## 5.2. Current Contractual and Procurement Scheme, and Source of Revenue

As of December 2022, Transjakarta provides BRT, Non-BRT, and other services owned mainly by the bus operators under a "Buy the service" (BTS) scheme. The operators procure the buses by making a down payment of 20-30% of the bus commercial price and the remaining amount is financed through a bank loan typically for a 5-year duration. The depot is either owned or leased by the operator that is typically located outside the city centre area.

The contract for conventional bus is for 7 years and could be extended by 10 years for articulated buses in case the kilometres production is not achieved by the end of year 7. Excluding the 10% of the reserve buses, the targeted daily operating kilometres varies depending on the type of bus, for example 237 km for single/maxi buses, 200 km for microbus etc. for 335 days in a year. Thus, the agreed volume is 237 x 335 x 7 kms per bus during the contract period.

Transjakarta provides the schedule of operations to operators based on the contracted number of buses and operational requirements. In the case that Transjakarta is unable to utilise the agreed volume during the contract period, the contract is then extended until the remaining kms are utilised. However, Transjakarta must utilise or pay for at least 100 kms/bus/day. Transjakarta also has to pay for the dead kms (depot to starting point of route and vice-versa) but only limited to 20 km/day/bus.

Although the prices for the BTS is competitively determined, Transjakarta must only utilise the services of the operators who have a sanctioned and unfulfilled quota from the Jakarta Transport Agency (*Dinas Perhubungan DKI Jakarta, "Dishub"*). This puts restrictions on whom Transjakarta contracts with. For example, the medium and microbus services quotas are allocated to cooperatives which are owned by individuals who procure buses on their own and deploy them under the contract of the cooperative either themselves or through drivers appointed by them. The cooperatives find it difficult to get bank financing as well as to raise their own down payments due to their limited financial capacity. Due to this reason the quotas of most cooperatives remain unutilised and Transjakarta is unable to expand the services despite having approval from the Dishub.

Considering that the electric buses cost more than the diesel buses and further investments are needed for charging infrastructure, the cooperatives and operators who do not have financial strength will find it difficult to procure and operate the e-buses. Hence the current business model for diesel buses is not suitable for the e-bus adoption planned by Transjakarta/Dishub.

On the other hand, large institutional investors, who may want to invest in providing the e-buses and necessary infrastructure, look for bankability and payment security. Transjakarta meets over 80% of its annual expenses from the subsidies granted by the Government of Jakarta which are agreed annually in advance and disbursed in instalments during the year.

*Table 12. Subsidy for Public Transport Service*

| Subsidy | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|
| Subsidy for Public Transport Service (in IDR billion) | 1,291,088 | 2,078,093 | 2,588,066 | 2,723,417 | 2,764,842 |
| % Subsidy for Public Transport Service | 73.9% | 79.5% | 78.3% | 88.7% | 90.2% |

*Source: Financial Statement of Trans Jakarta, ITDP Analysis*

For diesel buses which do not cost as much as the e-buses and have ready alternate markets, this is not a big concern. However, for e-buses where the initial investment is significantly higher and there is high cost and risk of alternate deployment and uncertain residual value in case the contract fails, the investors would like to have a contract with a bankable counterparty which has adequate financial strength and is not dependent on government subsidies which are also not guaranteed beyond one year.

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# 6. Transjakarta Electrification Context

## 6.1. Deployment Plan and Stages

### 6.1.1. E-Bus Implementation Plan

Accordingly, Transjakarta has developed the procurement plan for electric buses. The target is not based on the number of e-bus to be deployed each year, giving a very dynamic fleets' realisation but rather based on the percentage of e-buses operating each year compared to the number of fleets. For example, if Transjakarta will have 5,000 fleets by 2023, with a 6% deployment target, Transjakarta has to have 300 e-bus fleets operating. Figure 5 demonstrates the Transjakarta e-bus share target from 2022 to 2030. As mentioned in the previous part, The Governor Decree only put milestones in the year of 2027 and 2030, which is 50% and 100% respectively – meaning the other years are relatively flexible.

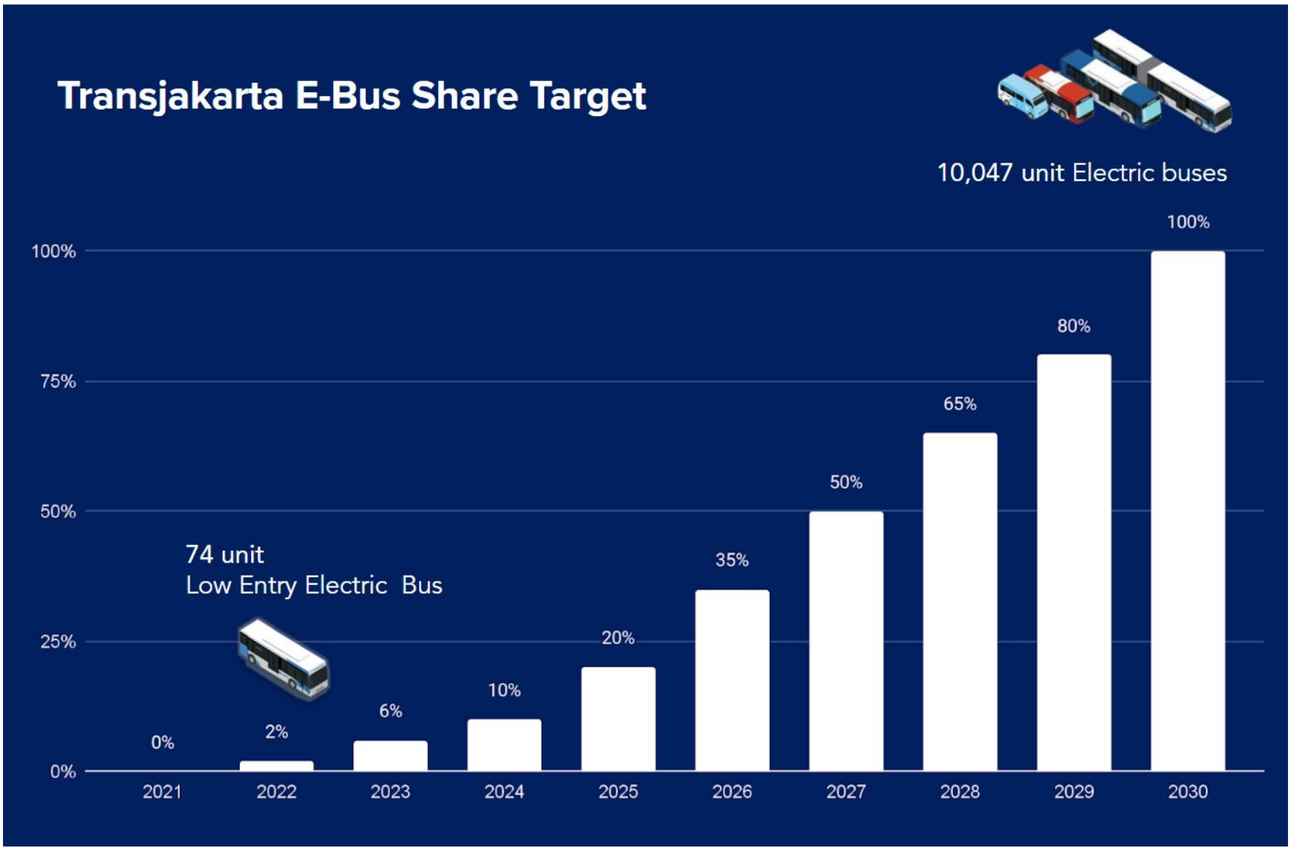



*Figure 5. Transjakarta's E-bus share target*

The following table shows Transjakarta's electrification plan until 2025 by bus-type.

*Table 13. Transjakarta's electrification strategy*

| 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|
| Single low entry bus 12-m<br><br>*Depot overnight charging* | Medium bus 8-m<br><br>*Depot overnight charging* | Medium bus 8-m<br><br>*Terminal opportunity charging & depot overnight* | Medium bus 8-m<br><br>*Terminal opportunity charging & depot overnight charging* |
| | Single Bus BRT 12-m<br><br>*Terminal opportunity charging & depot overnight charging* | Mikrotrans 4-m<br><br>*Overnight charging* | Articulated bus 18-m<br><br>*Terminal opportunity charging & depot overnight charging* |

#### 6.1.2. E-bus implementation Phase(s)

Typically, Transjakarta conducts three phases of electrification:

**1. Pre-trial phase**

Transjakarta conducted a pre-trial of e-buses on road from 2019 with BYD K9 (low-floor 12-m) and C6 model and other e-bus models follow afterwards. E-bus pre-trial is conducted for each e-bus model for 3-months before being commercially operated. Transjakarta obtained information on the level of battery consumption in the field and the conformity of each e-bus model with their needs from this phase. So far, 7 e-bus models have conducted pre-trial — 5 of them are low entry 12-m e-buses, 1 medium high deck low entry and 1 high deck BRT.

**2. Pilot phase**

In the pilot phase, the e-bus has been commercially operated and carried out for 2 years. At the end of year 2, a review of the cost of maintenance and operation is conducted. Transjakarta set targets to electrify 100 low entry, 12-m e-bus starting in 2021. Currently, 30 low entry e-bus have been deployed, with another 70 already in the pipeline.

**3. Full Implementation**

The full implementation phase continues the pilot phase that has been developed, with the cost of maintenance and operation that has been reviewed and adjusted.

ITDP has developed a year-on-year implementation phase based on several factors, such as:

- Transjakarta's latest plan of electrification, as presented in section 4 of this report.
- Quota for each bus type in 2030.
- Contract replacements.

The year-on-year implementation phase is demonstrated on **Error! Reference source not found.**Table 14 below.

*Table 14. Number of Electric Buses Acquired Year-on-Year*

| | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|
| **Articulated Bus** | | 0 | 0 | 111 | 165 | 19 | 22 | 23 | 24 |
| **Low Entry** | 74 | 26 | 0 | 0 | 0 | 0 | 190 | 98 | 21 |
| **Single Bus** | | 100 | 150 | 31 | 224 | 264 | 113 | 110 | 375 |
| **Medium bus** | | 100 | 0 | 50 | 204 | 250 | 253 | 260 | 401 |
| **Microbus** | | 0 | 100 | 200 | 400 | 600 | 1129 | 1800 | 2160 |
| **Total e-buses added** | **74** | **226** | **250** | **392** | **993** | **1133** | **1707** | **2291** | **2981** |
| **Cumulative** | 74 | 300 | 550 | 942 | 1935 | 3068 | 4775 | 7066 | 10047 |
| **Percent Electric** | 2% | 7% | 14% | 24% | 38% | 51% | 69% | 85% | 100% |

## 6.2. Current Progress and Technology Selection of E-Bus Pilot

As part of the 100 electric buses target for the pilot phase, currently 30 electric buses have been procured and are being operated by an operator, Mayasari Bakti. The procurement process for the rest of 70 electric buses is currently underway, divided into several procurement packages, each of the packages contains around 20 e-bus.

The tables below present some of the operating parameters of the electric bus.

*Table 15. Pilot E-bus specification*

| | |
|---|---|
| Battery capacity | 324 kWh |
| Range | 250 km |
| Model | BYD K9 12-m Low floor |
| Peak motor torque | 1100 Nm |
| Passenger capacity | 31 (seating) + 12 (standing) |

*Table 16. Pilot E-bus operational parameters*

| | |
|---|---|
| Daily km per bus | 200-250 km |
| Dead kms | 50 km |

| | |
|---|---|
| No of round trips/ bus | 7-8 |
| Fuel efficiency | 1 kWh/km |
| SoC reserve | 20% |
| Charging strategy | Overnight only |
| Charger power | 2 x 100 kW (double gun EVC) |
| Charging time | 1.5 hours (0-100%) |
| Dead kms/day | ~30-50 km |

Since the buses have been running for a limited time, there have been no downtime or failure issues recorded yet. The pilot e-buses performance efficiency is evaluated based on the distance travelled with the amount of energy consumed or illustrated by km/SoC and km/kWh.

It is seen from the pilot results that the dead kms are much higher than estimated and this will cause a significant impact on the range and charging pattern for the electric buses. While overnight charging will happen at the depots, as the battery capacity decreases over time, daytime opportunity charging at depots may not be feasible as it will increase the dead kms and also loss of time available for charging during off peak hours. Opportunity charging at terminals or other charging locations should be considered taking into account the terminal space availability and grid accessibility.

The pilot fleet can be gradually implemented based on availability of charging infrastructure. The timelines for procurement and operation of electric buses are also longer than the diesel buses ranging from 1 to 2 years. This timeline also depends on the lot size and scale of procurement and has to be considered in the implementation plan.

### 6.3. Contractual Scheme for Electrification

Transjakarta conduct gross-cost contract (service-based payment) with operator, for a certain number of fleets, for a certain type of fleets. The operators have to procure the fleets, chargers, and depots. This will imply to:

- Operators that will operate the electric bus on certain routes remain unknown as the operators are selected based on tenders.
- One route could be deployed by multiple operators. For example, in July 2022, Corridor 1 (Blok M – Kota) is operated by Mayasari Bakti, PPD, and Steady Safe. Swakelola,

Transjakarta's self-owned electric bus, also operates on the corridor. There are a total of 127 fleets operating in the routes. The multiple operators operating in one route enables a route being served both by electric bus and diesel bus.

- Specific routes selected to be served by electric buses are usually determined later and not directly associated with the tender of fleets.

## 6.4. Routes Selected

By the time the analysis conducted, the E-bus are currently being operated on 3 routes, which are 1P: Blok M - Terminal Senen, 1N: Blok M - Tanah Abang.  Out of the 30 e-buses, 11 buses are operating on route 1N (Tanah Abang - Blok M terminal), 16 buses are operating on route 1P (Senen Terminal - Blok M Terminal) and 3 buses reserved as spare buses. Just recently, Transjakarta added a new route for electric buses, namely 6D Stasiun Tebet – Bundaran Senayan.

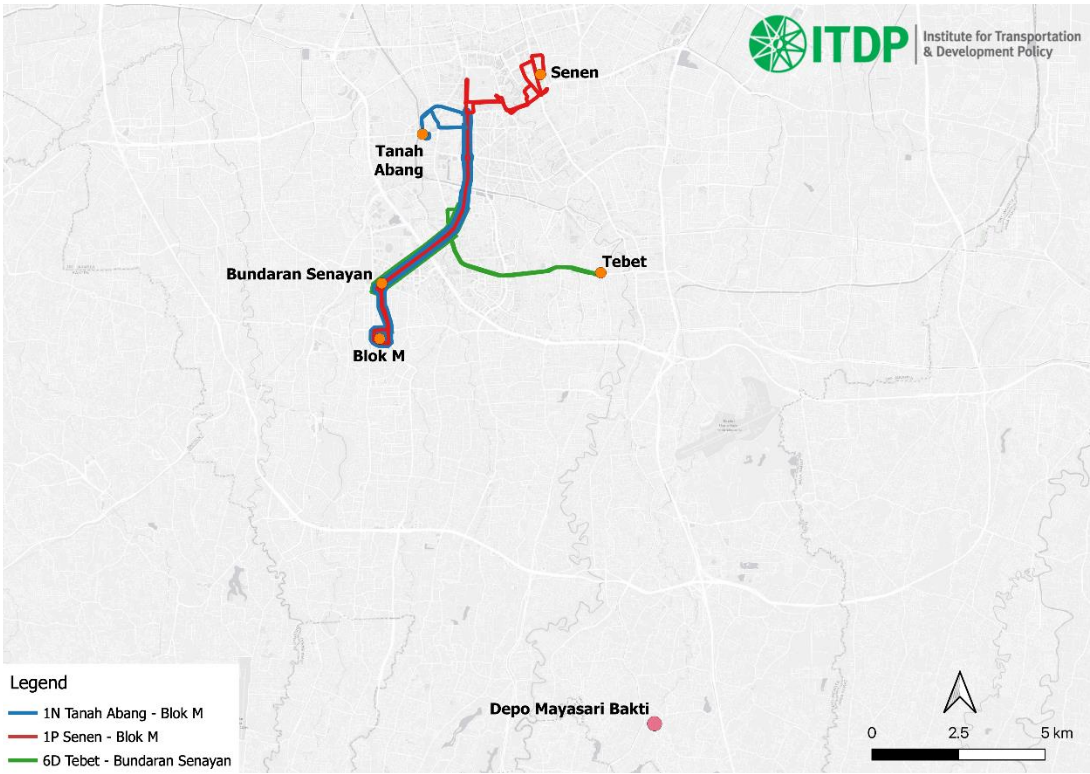



*Figure 6. Transjakarta electric bus route map.*

# 7. Business Case Formulation

## 7.1. Detailed Technical Plan

Detailed technical plans will be developed for the first phase of large-scale electrification of Transjakarta, between 2023 and 2025. The detailed technical plan is one of the most crucial aspects to develop properly, as it will affect the rest of the analysis that will be developed. The detailed technical plan covers ranking of all Transjakarta routes to be electrified, grouping the routes for terminal charging activities and selecting the terminals, developing the detailed charging strategy, developing the charging infrastructure planning on selected charging locations, grid impacts on electrification, renewable energy integration, and partial electrification impacts.

## 7.2. Business Models and Structured Financing Options

A business model is broadly defined as a way or framework for a company to make revenue and profit. It also dictates how one organisation creates and delivers its values to the general market in a social and economic context. In this study, for the Transjakarta context, the business model refers to the commercial arrangements and provision of assets for the electrification program. The current business model within Transjakarta service is that all assets are arranged and owned by the operators, and they are paid in the form of Rupiah/km that is pre-arranged in the contract. Due to the high upfront costs, this model will be challenging to implement in electrification. As a result, the business model will affect the contractual framework between all parties involved in the model. Hence, a modification to the business model also translates to an amendment of the contractual framework.

In addition to the business model, this section will be equipped with asset ownership and separation arrangements and structured financing options. Each option offers different benefits and drawbacks and should be carefully evaluated to determine the best option for a particular project.

## 7.3. Economic and Financial Analysis

Three analyses related to economic and financial analysis are developed in this study. The first analysis is TCO/km analysis of each type of bus. Evaluating the financing and economic aspects concerning the e-bus long-term implementation will involve the calculation of TCO/km to assess the readiness of each type of e-bus from the cost perspective. The TCO/km of each type of e-bus model will be compared to that of the conventional bus. The TCO/km calculation will become the consideration for ramping-up certain fleet models to be electrified.

The total investment cost each year will then be estimated using TCO/km as the input. The impacts of the implementation on the PSO will also be estimated, looking at the current financial capability of Transjakarta. To conclude the steps, the implementation phase will be fine-tuned considering other factors' readiness.

The second analysis is the financial analysis which consists of financial feasibility analysis and a social cost-benefit analysis. The financial feasibility analysis is conducted to determine the actual impact on the year-to-year financial outgo for Transjakarta and the quantum of PSO needed, while the social cost-benefit analysis will consider the non-financial aspects of the project.

Lastly, the sensitivity analysis is developed as part of the third analysis. The objective of this analysis is to check the sensitivity of various assumptions on the financial feasibility and to identify the key parameters which must be watched carefully to ensure the continued financial feasibility of the electrification of the fleet.

## 7.4. Potential Economic Benefit of the Project

The Government of Jakarta has initiated the electrification of Transjakarta fleet on account of the environmental and social benefits. This section assesses various social costs and benefits of electrification of the fleet on account of various aspects of the operation of e-buses. Some of the beneficial effects of electrification are monetarily quantifiable while some are non-quantifiable benefits. Quantifiable benefits that will be discussed consist of GHG emissions, air pollution (SOx/NOx/PPM) and their social costs. While non-quantifiable benefits will discuss noise pollution and reduction in foreign exchange outgoing.

## 7.5. Project Implementation Risk

Various business model options can be implemented for the Transjakarta electrification project. Each option offers different benefits and drawbacks and should be carefully evaluated to determine the best option for a particular project. Ultimately, the most financially sound BRT electric bus system is tailored to the local community's specific needs and the local authorities' financial capabilities.

Depending on the specific needs and goals of the project, the best option should be chosen to ensure that the system is both cost-effective and financially sustainable in the long run. Additionally, long-term financing options such as bonds and loans can be used to ensure that the project is able to continue providing service in the future. Ultimately, it is important to use the right mix of financing tools to ensure that the project is cost-effective and financially sustainable in the long run. Therefore, the identification of potential financial risks and their mitigation is needed to make the transition to e-bus financially doable and feasible. Identifying these potential risks can also provide further information to the actors involved regarding the risks that may occur so that further preventive actions and solutions can be taken.

## 7.6. Gender Impact Assessment

Analysing Transjakarta E-bus implementation plan from GEDSI perspective is important and crucial at this stage of the electrification program. Gender Impact Assessment (GIA) will be performed to assess the impact of the analysis performed (market analysis, implementation plan, technical plan, business models and financing, and financial analysis) on vulnerable groups—not only women in general, but also children, elderly, and people with disabilities. ITDP also conducted an on-board and off-board survey to portrait the existing conditions on the facilities.

Furthermore, the project team conducted a series of FGDs and participatory workshop with equity organisations and women-led advocacy groups to gather comprehensive inputs and information from the marginalised and vulnerable groups. Considering bus operators as one of the most vulnerable institutions in the proposed business models, consultation with them were conducted in order to gather input, ensuring no one left behind and the business models for Transjakarta electrification is socially exclusive.

# 8. Detailed Technical Plan

## 8.1. Routes Selected for Electrification

Route selection is made by ranking the Transjakarta routes. The route ranking will be developed for BRT routes (single and articulated bus), non-BRT medium bus, and microbus.

All routes will be ranked based on:

- Route level TCO/km
- Number of buses
- Ridership or fleets visibility and usability (based on zoning from the potential traffic restriction area)
- Charging strategy

The final selection of routes for the first phase implementation is based on all of the factors discussed above. The following table shows the total number of fleets to be electrified in each year from 2023 to 2025, based on the implementation phase developed before.

*Table 17. Total number of fleets to be electrified from 2023-2025*

| Electric buses | Start year of Implementation | | |
|---|---|---|---|
| | 2023 | 2024 | 2025 |
| Articulated Bus | 0 | 0 | 111 |
| Single Bus | 100 | 150 | 31 |
| Medium Bus | 100 | 0 | 50 |
| Microbus | 0 | 100 | 200 |

Based on the table above, and the route ranking, the routes selected for BRT, non-BRT, and microbus are as follows:

For the BRT routes with single buses and articulated buses, routes ranking from 1 to 6 have been selected. Route 19C is included in the route selection as it shares the terminal Pinang Ranti with route number 9 and route no. 13C is excluded from the selection.

*Table 18. Route Selected for BRT Routes*

| Route Code | Route Name | Terminus 1 | Terminus 2 | Number of SB* | Number of AB | Start of Electrification | % Electrification |
|---|---|---|---|---|---|---|---|
| 1 | Blok M – Kota | Blok M | Kota | 100 | | 2023 | 71% |
| 1 | Blok M – Kota | Blok M | Kota | 70 | | 2024 | 100% |
| 9 | Pinang Ranti – Pluit | Pinang Ranti | Pluit | 80 | | 2024 | 65% |
| 1 | Blok M – Kota | Blok M | Kota | | 41 | 2025 | 100% |
| 3 | Kalideres – Pasar Baru | Kalideres | Pasar Baru | 33** | 24 | 2025 | 71% |
| 9 | Pinang Ranti – Pluit | Pinang Ranti | Pluit | 5** | 39 | 2025 | 100% |
| 9C | Pinang Ranti – Bundaran Senayan | Pinang Ranti | Bundaran Senayan | | 9 | 2025 | 45% |
| 8 | Lebak Bulus – Harmoni | Lebak Bulus | Harmoni | **63**** | | 2025 | 78% |

**Includes number of maxi buses as an equivalent number of single buses (conversion factor 1.3).*

*** reallocated from Corridor 1 to Corridor 8 in 2025 to account for replaced articulated buses in 2024 from Corridor 1.*

For the non-BRT medium bus routes, routes ranking from 1 to 15 are chosen. The selected routes will undergo full electrification.

*Table 19. Routes selected for Non-BRT Medium Bus Routes*

| Route Code | Route Name | Terminus 1 | Terminus 2 | Number of MB | Nearest Terminal | Start year of Electrification |
|---|---|---|---|---|---|---|
| 6C | Stasiun Tebet - Karet | Stasiun Tebet | Karet | 7 | Kampung Melayu | 2023 |
| 1E | Pondok Labu - Blok M | Pondok Labu | Blok M | 10 | Blok M | 2023 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5N | Kampung Melayu - Ragunan | Kampung Melayu | Ragunan | 9 | Kampung Melayu | 2023 |
| 6N | Ragunan - Blok M | Ragunan | Blok M | 10 | Blok M | 2023 |
| 1C | Pesanggarahan - Blok M | Pesanggarahan | Blok M | 8 | Blok M | 2023 |
| 8D | Joglo - Blok M | Joglo | Blok M | 8 | Blok M | 2023 |
| 3E | Puri Kembangan - Sentraland Cengkareng | Puri Kembangan | Sentraland Cengkareng | 17 | Kalideres | 2023 |
| 8E | Bintaro - Blok M | Bintaro | Blok M | 7 | Blok M | 2023 |
| 1Q | Rempoa - Blok M | Rempoa | Blok M | 7 | Blok M | 2023 |
| 11D | Pulogebang - Pulogadung 2 | Pulogebang | Pulogadung | 14 | Both Terminus | 2023 |
| 7P | Pondok Kelapa - BKN | Pondok Kelapa | BKN | 9 | Kampung Melayu | 2023 |
| 11Q | Kampung Melayu - Pulo Gebang | Kampung Melayu | Pulo Gebang | 7 | Both Terminus | 2025 |
| 9H | Cipedak - Blok M | Cipedak | Blok M | 15 | Blok M | 2025 |
| 8K | Batusari - Tanah Abang | Batusari | Tanah Abang | 13 | Grogol | 2025 |
| 1M | Meruya - Blok M | Meruya | Blok M | 13 | Blok M | 2025 |

For microbus routes, routes ranking from 1 to 15 are chosen. Routes with at least one terminal end are given priority. The selected routes will undergo full electrification.

*Table 20. Routes Selected for Mikrotrans Routes*

| Route Code | No. of Buses | Terminal | Start year of Electrification |
|---|---|---|---|
| JAK.53 | 43 | Grogol | 2024 |
| JAK.56 | 30 | Grogol | 2024 |
| JAK.30 | 30 | Grogol | 2024 |
| JAK.31 | 30 | Blok M | 2025 |
| JAK.46 | 41 | Pasar Minggu | 2025 |
| JAK.54 | 27 | Grogol | 2025 |
| JAK.15 | 48 | Tanjung Priok | 2025 |
| JAK.19 | 42 | Pinang Ranti | 2025 |
| JAK.84 | 31 | Kampung Melayu | 2025 |

## 8.2. Terminals Selected

Based on route ranking result, routes which ranks higher will be assigned to nearest terminals to carry out opportunity charging. The selection of the terminals has principles to minimise the dead kilometres hence to increase cost-effectiveness of the electrification. Routes that can be covered with overnight charging are assumed to be charged at the depots or other locations. Given that Transjakarta already has 122 layover areas across Greater Jakarta, installing charging equipment at each one may not be necessary in the initial phase of electrification. Instead, route grouping can help ensure mileage efficiency by avoiding the need for buses to travel to the farthest depot for charging.

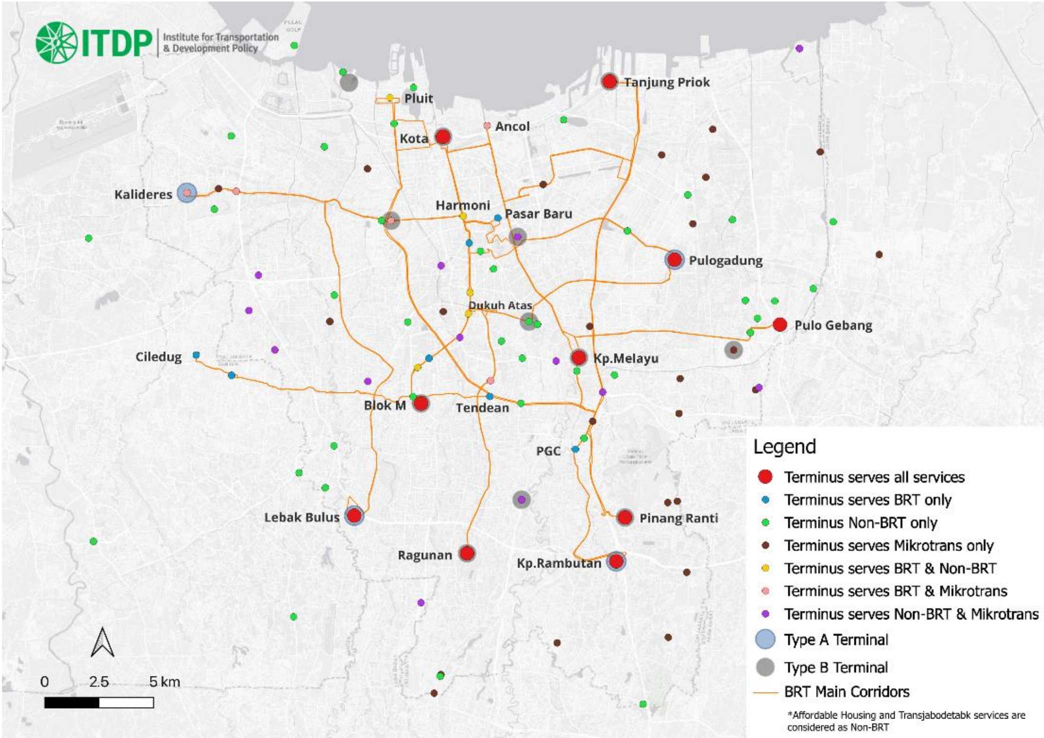



*Figure 7. Transjakarta layover points, divided into several archetypes*

Based on BRT and non-BRT route selected, terminal charging locations are selected as follows:

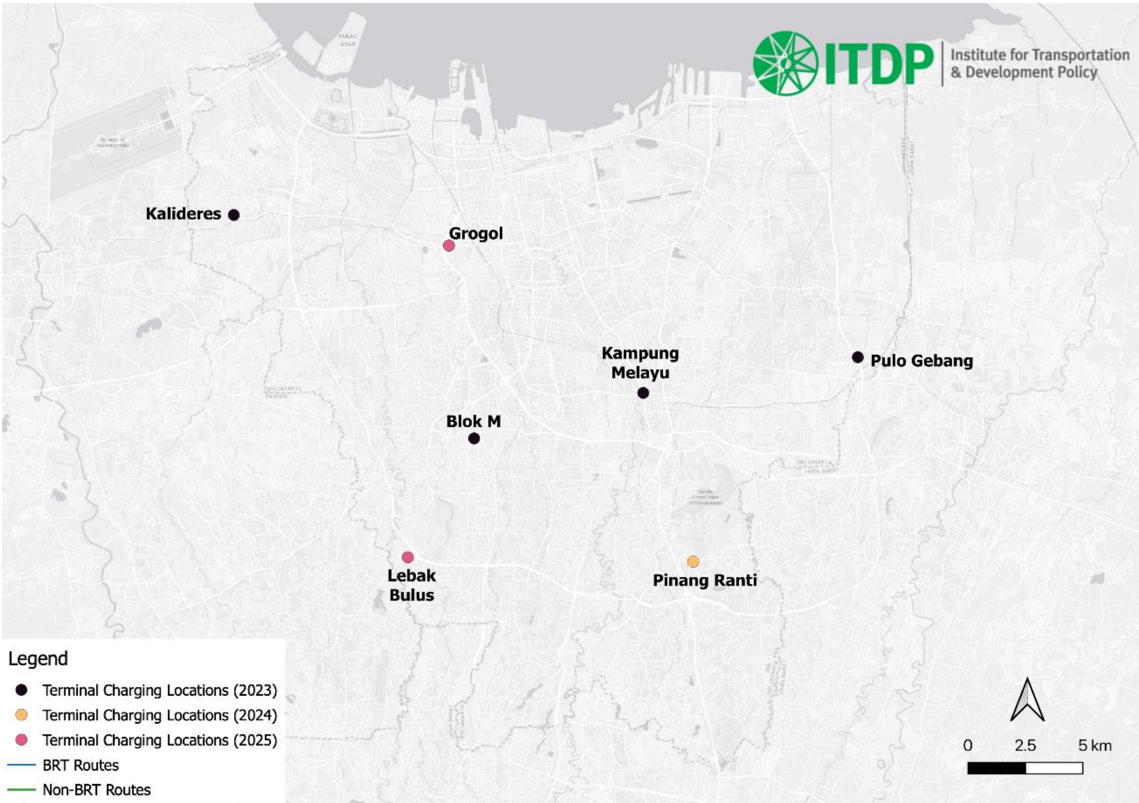



*Figure 8. Terminal charging location points*

## 8.3. The Type of Technology Proposed

### 1. Fleets' Technology Readiness and Fleets Typology

Given that Transjakarta has several types of services with different bus types, typologies of electric buses need to be identified that are suitable to replace the counterpart of diesel bus types considering the bus specifications, passenger capacity and gross vehicle weight limits.

Based on the market research for the available bus models and findings from the previous UNEP study, the service bus typologies presented in Table 21 are considered in this study. The battery capacity is heavily influenced by the governments' regulation on maximum Gross-Vehicle Weight allowed for each type of bus. The battery sizes are selected based on standard models available to avoid customisation which may cause longer procurement lead times. The bus typologies are selected for the bus type categories that Transjakarta is considering for the electrification program. These include 12-m single buses that operate on BRT and non-BRT routes, 12-m low entry buses that operate on non-BRT routes, 7-m medium bus, 18-m articulated buses, and 4-m microbuses. Transjakarta does not have a clear plan yet to electrify double decker buses and the Royaltrans buses. Hence these are not considered in the bus typologies for electric buses. In addition, 13.5-m maxi buses are also not considered as a separate typology as these will be either retrofitted or replaced by electric single buses.

Table 21 below presents the bus typologies that will be used in this study. It also serves as a baseline and assumptions regarding the e-bus technology based on the market availability when this study is developed.

*Table 21. Transjakarta's fleets typology*

| Bus typology | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Bus Type | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* |
| Type of Bus | **Single Bus (12-m)** | | **Medium Bus (7-m)** | | **Articulated (18-m)** | **Low Entry (12-m)** | | **Microbus (4-m)** |
| Max GVW (kg) | 16,000 | | 8,000 | | 26,000 | 16,000 | | 5,000 |
| Service Type | BRT, non-BRT | | Non-BRT, affordable housing routes | | BRT | Non-BRT | | Mikrotrans, Transcare |
| Battery (kWh) | 324 | 180* | 135 | 150** | 450 | 324 | 180* | 42 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Energy consumption, including factors such as AC usage (kWh/km) | 1.2 | 1 | 1 | 1 | 1.8 | 1.2 | 1 | 0.15 |
| Full battery range (km) | 270 | 180 | 135 | 150 | 250 | 270 | 180 | 280 |
| SoC reserve | 20% | 20% | 20% | 20% | 20% | 20% | 20% | 20% |
| Estimated range with 20 %SoC reserve (km) | 216 | 144 | 108 | 120 | 200 | 216 | 144 | 225 |
| Battery degradation by year 8 | 20% | 20% | 20% | 20% | 20% | 20% | 20% | 20% |
| Range at year 8 after degradation (km) | 173 | 115 | 86 | 96 | 160 | 173 | 115 | 180 |

** For Single Bus and Low Entry, a 324-kWh battery will be selected*

*** The 150-kWh battery has not yet met the Gross-Vehicle Weight requirement; therefore, the medium bus will use a 135 kWh battery for further analysis*

## 2. Charger Technology Readiness & Charging Facilities

There are other factors taken into account when developing the e-bus implementation phase, such as the battery technology, types of charging infrastructure, types of charger power, and fleets provision options (either the fleets will be provided by procuring the new ones or retrofitting the existing ones). This section will discuss the underlying rationale for recommending a specific technology for a specific period.

The battery technology in the initial phases is LFP since this is the predominant battery technology for buses available in the market, specifically in the Asian market. Though LFP will continue to be dominant, advanced chemistries such as NMC will also hold a major market share of around 40% by 2027/2028[1] [2]. In the future, e-buses with these advanced battery technologies will be available and these can be considered while also evaluating their economic viability. This can enable higher operational performance of e-buses with batteries of higher energy density, faster charging times, higher charger powers and lower energy consumption. The charging technology depends on the bus typology, the battery technology, and the techno-economic feasibility. The number of charging stations are estimated based on the charger to bus ratio for each bus type and type of charging, i.e., overnight or opportunity charging.

[1] https://www.idtechex.com/zh/research-report/li-ion-batteries-for-electric-buses-2018-2028/595

[2] https://www.interactanalysis.com/chinas-electric-bus-market-dominance-driving-demand-for-lithium-iron-phosphate-batteries/

The following part will showcase the charging technology, charger capacity, and the number of charging stations to be implemented for each type of electric bus. The analysis is categorised based on the number of electric bus fleets, as each type of electric bus has varying battery capacities, which leads to different charger power and charger-to-bus ratios. It is important to note that the charger-to-bus ratio serves as an initial evaluation of the required number of chargers, taking various factors into account. Further analysis must be conducted to determine the most efficient number of chargers to support the electric buses.

**12-m single electric bus (high-deck or low entry)**

The 12-m single buses both high-deck and low entry with 324 kWh LFP battery can have slow plug-in chargers up to 100 kW with a charging time of about 3.5 hours for 0% to 100% SoC and fast chargers up to 200 kW with a charging time of 1.25 hours for 10% to 80% SoC. For these bus types, double gun chargers with 200 kW power are recommended for both depot overnight charging and terminal opportunity charging. A single bus can be charged at 200 kW with one gun, or two buses can be charged at 100 kW with two guns. With evolving battery technology, faster charging power can be explored in the future phases. For overnight charging, the time available for charging is assumed to be 7 hours, each charger can charge two buses in succession. With double gun chargers, the overnight depot charger to bus ratio is therefore 1:4. For opportunity charging, the terminal charger to bus ratio is estimated considering the opportunity charging requirement and the charger power as 1:10.

**18-m articulated bus**

The articulated buses with battery size of 450 kWh fast charging with charger power of up to 400 kW with a charging duration of about 1.5 hours from 10% to 80% SoC and for overnight charging, 200 kW plug-in chargers with a charging duration of about 3 hours from 0% to 100 % SoC are recommended. Considering the available time of 7 hours for overnight charging, the overnight charger to bus ratio is 1:2 and for terminal charging it is estimated as 1:10 considering the opportunity charge requirement and the fast charger power. Fast charging these buses at the terminals both plug-in and pantographs are viable options. Pantographs provide innovative solutions for setting up the charging infrastructure to provide a seamless circulation of buses while optimising space. The choice of pantograph vs plug-in for terminal charging needs to be further assessed on a case-by-case basis from a technical and economic perspective.

**7-m medium buses**

Currently, the bus type and model for the medium buses is largely influenced by the gross weight limitations in Indonesia. The current suitable model is the BYD C6 with a battery size of 135 kWh. In the later phases, buses with higher battery capacities of 150 kWh but lighter weight may be developed. The charger power recommended for both overnight and terminal charging is 100 kW. The charging duration for overnight charging is around 1.3 hours and 1.5 hours for the 135kWh and 150kWh respectively. Therefore, the charger to bus ratio is calculated as 1:5 and 1:4 for

135kWh and 150kWh battery sizes respectively. For terminal charging, the charger to bus ratio is estimated around 1:3 based on the opportunity charging requirement and the charger power.

**4-m microbuses**

Similarly, the current market is dominated by LFP batteries for electric microbus models. The initial phases are recommended based on the local model of Gelora EV from DFSK with a battery size of 42 kWh and charger power of 22 kW. It is assumed that the cost of each microbus includes one charger. Additional charger requirement is estimated with a charger to bus ratio of 1:10 with a charging time of 1.3hours for 10% to 80% SoC to account for opportunity charging or any contingencies. As the market evolves there will be scope for models with higher battery capacities and charger powers.

## 3. Number of Chargers Needed

The number of chargers needed are justified by charging scheduling on each terminal. It results in higher or lower number of chargers needed compared to what have been originally assigned from charger per bus ratio. which presented as follow:

*Table 22. Number of chargers needed on each terminal*

| Terminal | 2023 | | 2024 | | 2025 | | | Total |
|---|---|---|---|---|---|---|---|---|
| | *MB* | *SB* | *MB* | *SB* | *MB* | *SB* | *AB* | |
| | 100 kW | 200 kW | 100 kW | 200 kW | 100 kW | 200 kW | 400 kW | |
| Blok M | 12 | 6 | - | 5 | 6 | - | 2 | **31** |
| Grogol | - | - | - | - | 4 | - | - | **4** |
| Kalideres | 6 | - | - | - | - | 3 | 2 | **11** |
| Kampung Melayu | 11 | - | - | - | 3 | - | - | **14** |
| Pulogebang | 5 | - | - | - | - | - | - | **5** |
| Pinang Ranti | - | - | - | 2 | - | - | 3 | **5** |
| Lebak Bulus | - | - | - | - | - | 2 | - | **2** |

## 4. Availability of Terminal Charging

The preferred charging strategy for the electric buses is overnight charging at depots with opportunity charging at terminals that are owned by the Government of Jakarta. Opportunity charging at existing terminals eliminates the need for land acquisition for setting up charging infrastructure and also provides an opportunity for developing the terminals as multi modal hubs. However, with Transjakarta's increasing fleet size and electrification, it is estimated that the current terminals will not be able to meet the charging infrastructure space requirement. Prior to 2027, the overall number of electric buses is less than the current fleet size. Also, an assessment of the available land at existing depots and terminals and the required land for the total number of buses each year also indicates additional land requirement from around 2027 onwards. Hence, the current space that is available in terminals and depots are still sufficient until 2027. In other words, additional charging locations need to be set up to accommodate the charging requirements that are proposed from 2027 onwards.

# 9. Business Models and Structured Financing Options

## 9.1. Business Models and Asset Separation Options

Considering the best practices and findings from the market consultation, a proposed business model was proposed that is believed to work in the Transjakarta electrification context. The bigger picture of the proposed solution is shown in the figure below where it accommodates the flexibility for new players mentioned in previous sections to also participate in the electrification efforts. It would also help operators to reduce the burden of providing high upfront costs as well as spread the risks since the ownership and financing are distributed among the actors. Additionally, the approach also considers GEDSI aspects where the alternative models would open opportunity to all stakeholders to participate while not neglecting the existing stakeholders, i.e., operators, who will still be able to participate in the e-bus deployment in this model.

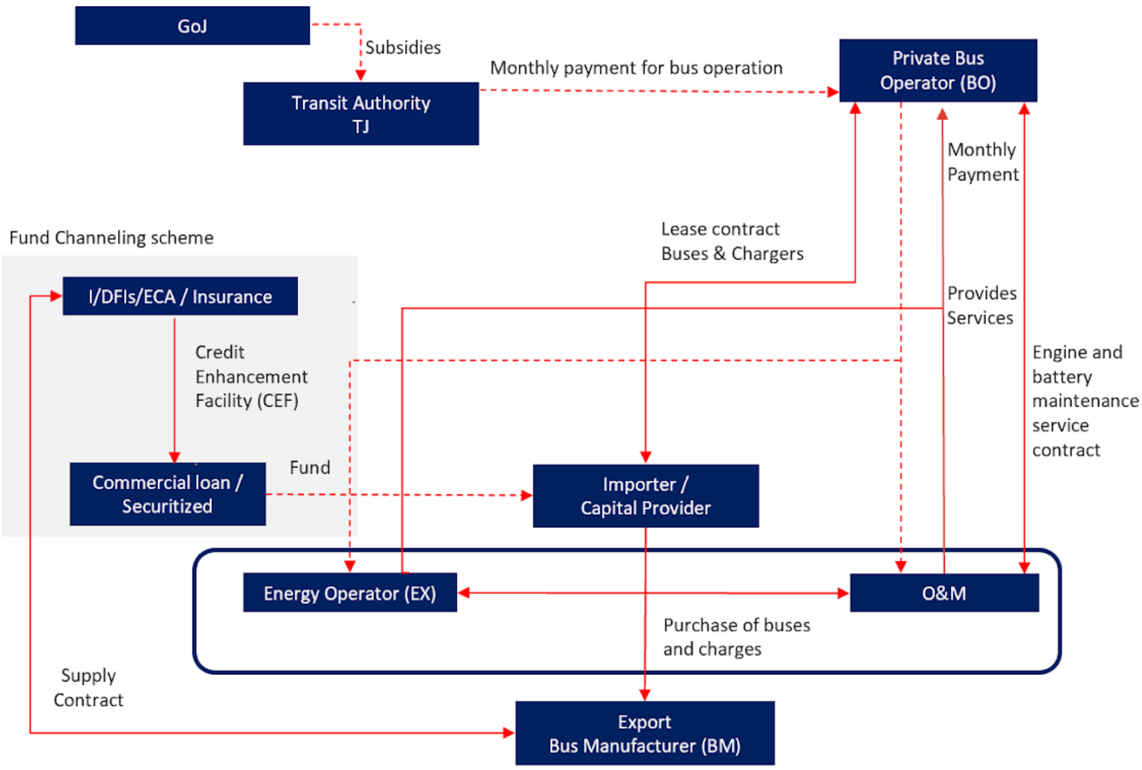



*Figure 9. E-Bus business models and structured financing*

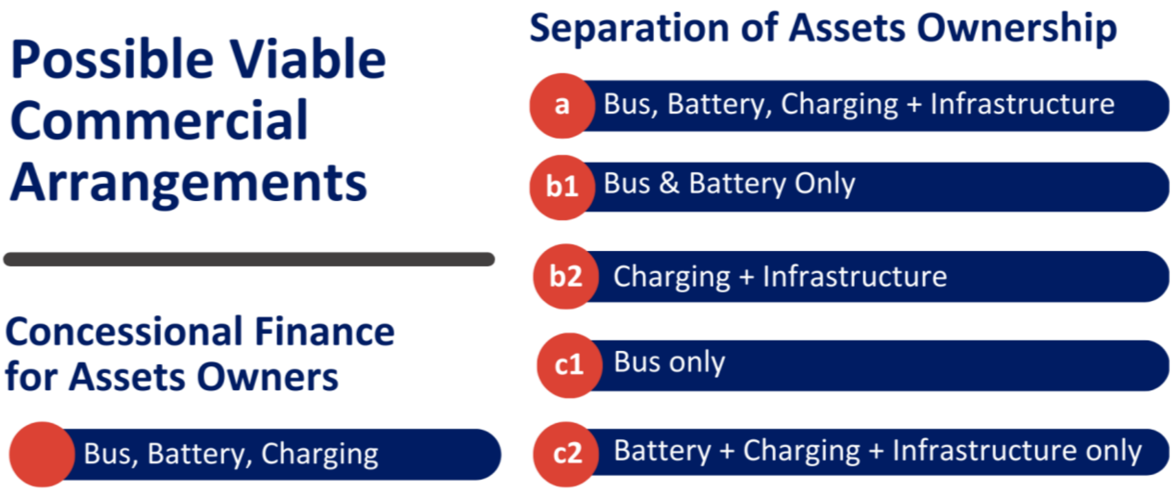



*Figure 10. Proposed possible viable commercial arrangements*

As shown in the scheme above and also have been discussed in previous sections that there are 2 business models that might potentially be explored. The first one is concessional finance where there is one asset owner and the second is separation of asset ownership.

Separation of asset ownership can help reduce the upfront costs and add flexibility to the model. This option suggests the assets do not have to be owned by one party hence one does not have to have strong capital to access those assets in the first place. This also offers flexibility for a new player to come and participate in the electrification.

For cities with privately-owned fleets operated by smaller operators, separated ownership of the asset and the bus system operation can mitigate the financing barriers associated with the transition. It also spreads risk between stakeholders. In this case, a third-party asset owner with good borrowing capabilities and expertise in asset management leases the vehicles and infrastructure to the operators.

Third party asset owners purchase all e-bus components or partially (chassis/body, battery, and charging station) to reduce upfront cost and risks for operators.

The key actors of this scheme are:

a. Third party asset owner(s)

The asset owner(s) could be any third party who has the borrowing capabilities and good asset management. Additionally, the asset owner will then lease it to the operators hence reducing the risk of the operators. Thus, the main role is to own and lease e-buses components for operation.

b. Financiers

Financiers are one who can provide financing to asset owners for the purchase of e-bus components.

c. Operators

Bus operators are ones who are in charge of operating the buses. They will have a lease agreement with the asset owner(s)

d. Public Transport Authority (PTA) / Transjakarta

The regulator of public bus services is the Transport Authority, Dishub, and Transjakarta is overseeing the bus operators on behalf of Dishub to ensure interoperability and quality. Their main role is to support leasing contracts and also can provide revenue guarantees.

In terms of the composition, the Capex requirements for the electrification of the fleet can be divided as under:

i. Bus including battery: Depending on the type and size of the battery, it can contribute up to 40% of the cost of the bus[3]. Further, there are uncertainties in terms of the life of the battery and when it needs to be replaced. Hence, in some cases, the ownership of the bus and the battery is separated. Given that the bus performance depends critically on the battery performance, the separation of ownership may introduce additional risks. Hence for the early stage of Transjakarta fleet electrification, it is recommended that the bus and the battery are owned by the same entity.

ii. Charging infrastructure (CI): Depending on charging strategy, the cost of charging infrastructure varies. Charging may include both overnight charging at the depot as well as opportunity charging at the bus terminals. In addition to the bus owner, additional players may be roped in to share this investment cost and provide charging services since this is not a core activity of the bus operators at present. However, it should be noted that the life of the charging infrastructure can be much longer than the life of the e-buses. Further, in case the e-bus contract is terminated, depending on the contractual and ownership situation, it may or may not be possible to use the charging infrastructure by the new e-bus service provider. Hence the ownership of the land, depot, buses and charging infrastructure are intricately linked. In order to minimise the risks, the following approach towards ownership of charging infrastructure is proposed:

   a. At the depots owned/leased by Operators – the CI will be arranged by the operator
   b. At terminals built on Government land – Either Transjakarta or an agency appointed by it shall invest in and manage the CI

iii. Depot Infrastructure: E-bus typically require more depot area than the diesel buses due to charging requirements. Whereas the current depots may be able to accommodate most of the diesel buses being replaced, for augmentation of the bus fleet, new depots would need to be

[3] Electric Bus Market (reportlinker.com)

created. Further, the petrol microbuses presently do not have dedicated parking space and in case of electrification, there is a need to provide a dedicated space for night time parking/charging of the microbuses.

iv. Electricity Provision: Although this an integral part of operation of e-buses, typically the onus of arranging and providing electricity for e-bus charging lies with the utility companies. In the case of Jakarta, it is PLN which is the state-owned monopoly. However, the cost of obtaining or upgrading the connection needs to be borne by the e-bus ecosystem.

### 9.1.1. Business Models for Terminal Charging Infrastructure

The bus terminals are owned by the regional government of Jakarta. Transjakarta (or other Government entity) may either invest in creating the charging infrastructure. However, since financial support to Transjakarta from the Government of Jakarta for e-bus deployment is in the form of Rp/km, to invest in charging infrastructure, TJ will have to borrow. Due to up-front funding requirements, it is likely that the deployment of infrastructure will get delayed.

Alternatively, Transjakarta can appoint a Charging Service Provider (CSP) for setting up, operating and maintaining the charging infrastructure for 20 years. Compensation to CSP can be either by way of single-part tariff or two-part tariff

1. Single part tariff
   - TJ or Operator pays to the CSP based on energy consumed as per agreed rate
   - Risk to CSP – Inadequate use of the charging facilities
   - Change in electricity prices
2. Two-part tariff
   - Fixed Charge – fixed amount per month for making infrastructure available
   - Energy Charge – Energy cost plus a markup to be paid by the Operator or TJ (and recovered from operator)

### 9.1.2. Business Models for Large and Medium E-Buses

Based on the same as well as discussions with various actors (such as Transjakarta, Financing entities, manufacturers, operators, Jakarta Transport Agency), the following relevant business models for Transjakarta are evaluated.

### 1. “Business As Usual” or “Buy the Service” Model

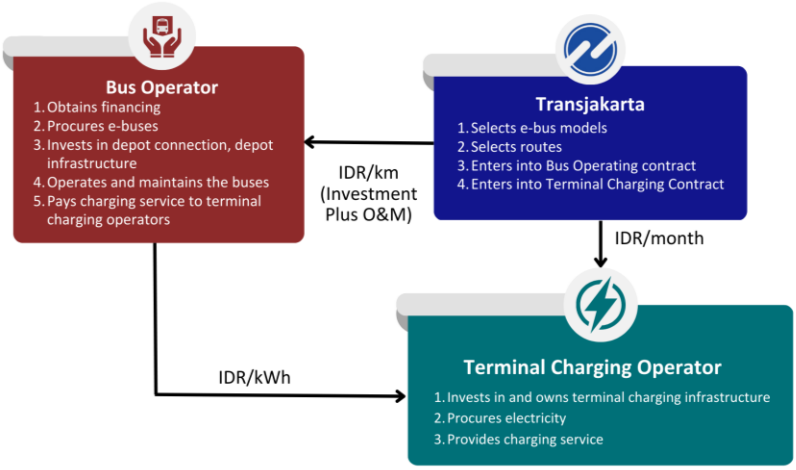



*Figure 11. Large or Medium Electric Buses Owned by Operator and Charged at Terminals or Staging Facilities*

In this business model:

a. The Operators acquires the e-buses and invests in depot charging infrastructure
b. Transjakarta arranges for terminal charging infrastructures needed, through a public private partnership model where its investment requirements are minimum.
c. The Charging Service Provider (CSP) invests in the terminal charging infrastructure and operates and maintains it. It receives compensation from:
    - Transjakarta for making the infrastructure available – agreed amount per month
    - the operator to the extent of energy used
d. Transjakarta pays to bus operators on the basis of the Rupiah/km rate agreed.

The advantages and disadvantages of this model are summarised in the table below:

*Table 23. Advantages and Disadvantages of Buy the Service Model*

| Pros | Cons |
|---|---|
| Regulatory and institutional mechanism already exist | Operators also need to invest in charging infrastructure |
| Simple Model | Banks are hesitant to extend finance towards new technology |
| All parties are already familiar with the process | Not all bus operators have financial capability to arrange down payment |

2. **Buses Acquired by Transjakarta using Concessional Finance**

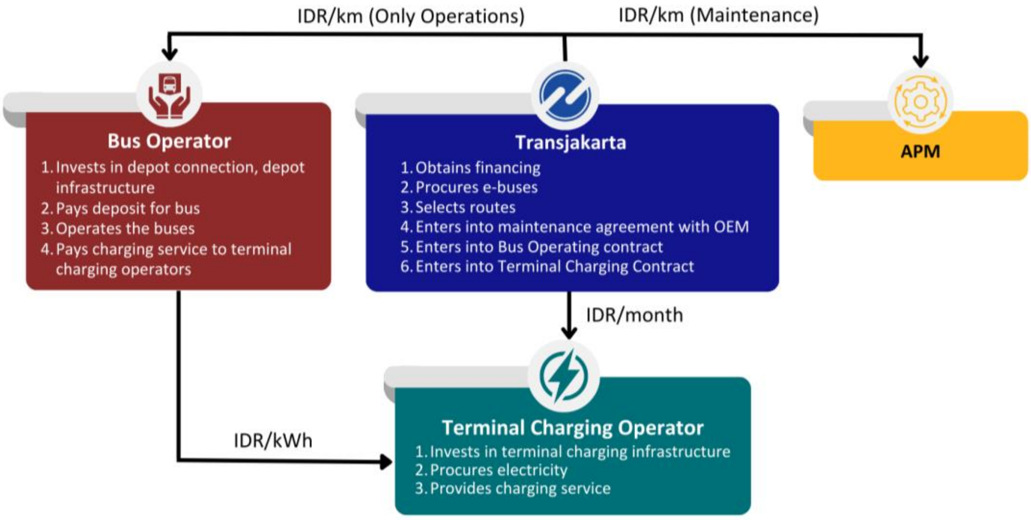



*Figure 12. Large or Medium Electric Buses Owned by Transjakarta and Charged on Terminals or Staging Facilities*

Typically, the cost of funds for private operators is more than that of Government entities. This advantage of government funding is exploited in this proposed business model which works as follows:

a. Transjakarta acquires the e-buses and allots them to the Operators
b. Transjakarta ensures maintenance of buses through a long-term contract with APM/OEM
c. The operator invests in depot charging infrastructure
d. Transjakarta arranges for terminal charging infrastructures needed, through a public private partnership model where its investment requirements are minimum.
e. The Charging Service Provider (CSP) invests in the terminal charging infrastructure and operates and maintains it. It receives compensation from:
   - Transjakarta for making the infrastructure available – agreed amount per month
   - the operator to the extent of energy used
f. Transjakarta pays to bus operators on the basis of the Rupiah/km rate agreed for operating the buses.
g. Transjakarta also arranges for funds for interest and repayment of principal

The advantages and disadvantages of this model are summarised in the table below:

*Table 24. Advantages and Disadvantages of Concessional Finance Model*

| Pros | Cons |
|---|---|
| Lower effective cost of financing | Transjakarta prefers asset-lite model |

| | |
|---|---|
| Easier for operators to adopt new technology | Government of Jakarta have indicated reluctance to arrange/guarantee debt financing for Transjakarta |
| Transjakarta have full control over the assets | Operators do not take care of the assets when these are not owned by them |

### 3. E-buses acquired through leasing mechanism

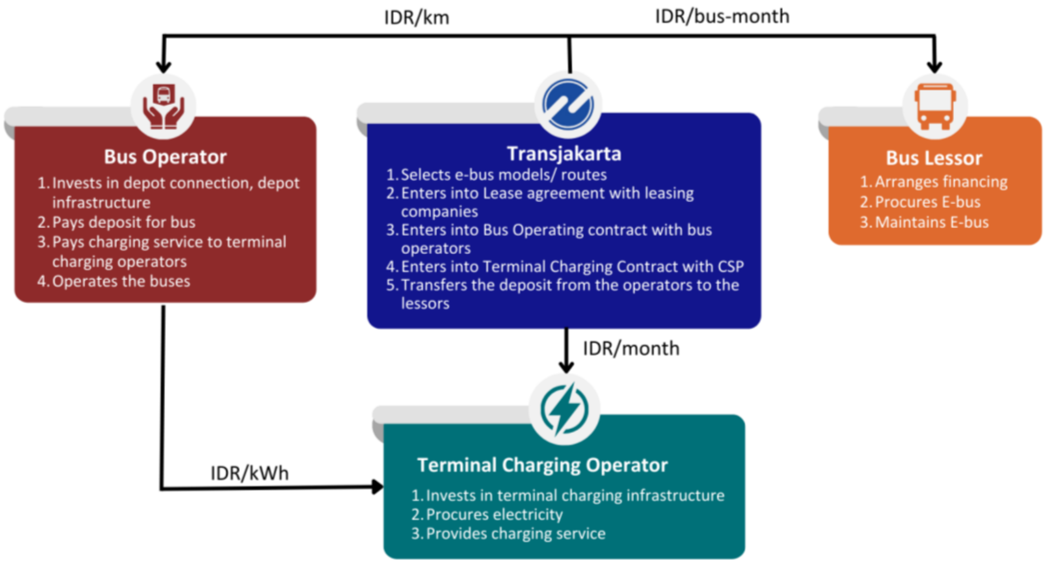



*Figure 13. Large or Medium Electric Buses Owned by a Leasing Company and Charged on Terminals*

Large institutional investors and green funds are interested to invest in environment friendly technologies like electric buses. Such entities also have the advantage of lower cost of funds. This model proposes to use their funding by way of a leasing model as follows:

a. Transjakarta acquires the e-buses from Lessor and allots them to the Operators
b. The operators (through Transjakarta) make a small security deposit for leasing of the buses
c. The Lessor ensures maintenance of buses through a long-term contract with APM/OEM
d. The operator invests in depot charging infrastructure
e. Transjakarta arranges for terminal charging infrastructures through a Charging Service Provider (CSP) which invests in the terminal charging infrastructure and operates and maintains it. It receives compensation from:
   - Transjakarta for making the infrastructure available – agreed amount per month
   - the operator to the extent of energy used
f. Transjakarta pays monthly lease charges to Lessor
g. Transjakarta pays to bus operators on the basis of Rupiah/km rate agreed for operating the buses

The advantages and disadvantages of this model are summarised in the table below:

*Table 25. Advantages and Disadvantages of Leasing Model*

| Pros | Cons |
|---|---|
| Neither Transjakarta nor the operators need to invest in procuring the e-buses | Transjakarta prefers asset-lite model |
| Lower cost of funds as compared to the operators owning the e-buses | Government of Jakarta have indicated reluctance to arrange/guarantee debt financing for Transjakarta |
| Such models have been used for intermediate public transit | Operators do not take care of the assets when these are not owned by them |

### 9.1.3. Business Models for Micro E-Buses

The following unique situation of the Microbuses require a separate business model for these as compared to the larger buses which are owned by corporate bus operators:

a. Individual Ownership - limited ability to raise higher upfront investment and loan
b. Contractual relationship – Transjakarta's contractual relationship is with the cooperative and not directly with bus owners/operators
c. Bus owners have no experience of electric bus maintenance
d. Unavailability of depot for night time charging
e. Being similar to passenger vehicles, Micro-electric buses can be charged at public charging stations as well

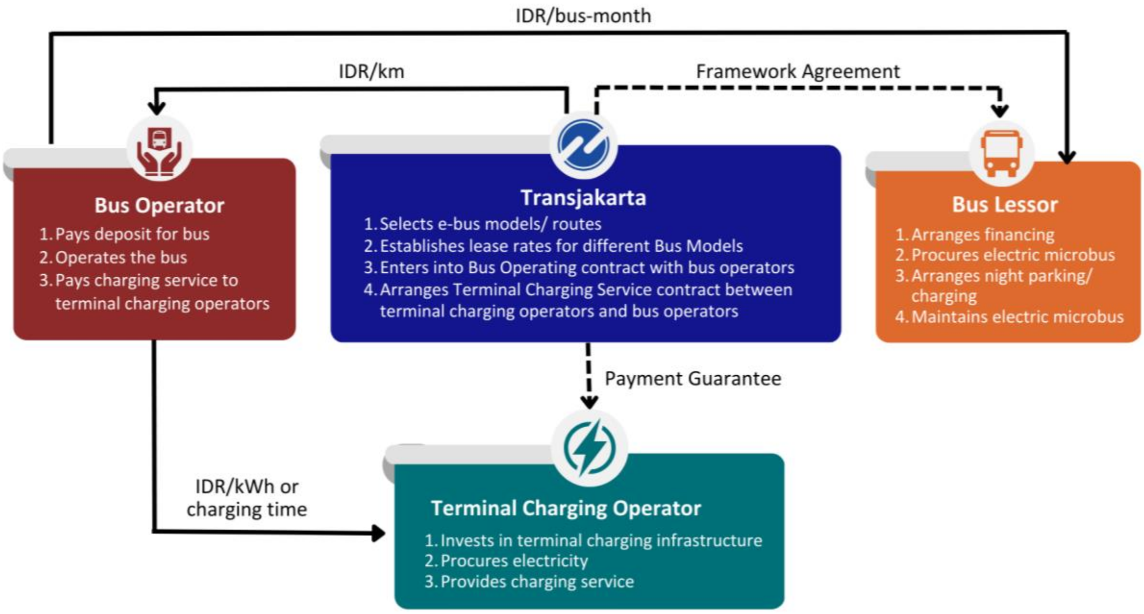



*Figure 14. Business Model for Electric Microbus*

Considering the large number of microbus operators and not so successful results from the cooperative mode of operation, the role of cooperatives is proposed to be shifted to leasing companies who in addition to procuring, financing the e-bus, will also ensure charging and maintenance of the buses. The operators will only operate the buses.

The model works as follows:

1. Transjakarta shortlists the suitable mikro-bus models based on operational suitability and cost competitiveness.
2. TJ enters into a framework agreement with lessors selected through a competitive process. The framework agreement, inter alia provides for:
    - Targeted fleet deployment
    - Escrow arrangement guarantee to make payment of lease charges from the operators' fees
    - Bus quality requirements
    - Operational aspects including daily running and charging
    - Provision for substitution of operators in case of poor performance
3. Transjakarta appoints operators who have to obtain the e-buses on lease from the leasing companies pre-selected by Transjakarta
4. The operators make a small security deposit for leasing of the buses
5. The Lessor ensures maintenance of buses
6. Transjakarta pays to bus operators on the basis of the Rupiah/km rate agreed.

## 9.2. Fund Channelling & Contractual Framework Options

E-bus implementation fund channelling involves the use of financial resources to support the implementation of electric bus systems. This includes the purchase of electric buses, installation of charging infrastructure, training of personnel, and other related activities. The funds may come from government or private sources, and can be used to cover the entire cost of implementation or just a portion thereof.

The cost of financing for E-bus Implementation can vary depending on the type of funding source used. For example, grants from government agencies, private financing, or public-private partnerships may all have different costs associated with them. Additionally, the length of the financing agreement and any interest rates associated with it will also affect the total cost. E-bus implementation fund channelling possibilities will explore various financing schemes and structured finance using financing instruments like Grants, Loan, Equity, etc. Fund channelling possibilities for the implementation of electric buses could include government subsidies or direct investment, public-private partnerships, crowdfunding, and private investment.

The fund channelling schemes that are developed in this study are divided into 2 types, public sector and private sector loan as described below:

A. Public Sector Loan
   1. PT. SMI Provides Regional Loan to the Government of Jakarta.
   2. The combination Regional Loans and financing products issued by PT. SMI.
   3. Development Financial Institution (DFIs) Loan to Government (2 step Loan).
B. Private Sector Loan
   1. Loan from Commercial Bank Loan to Private Sector.
   2. Private Sector issues financing products to finance the project.

The alternative of fund channelling schemes archetype is detailed on the Table 26 below.

*Table 26. Initial fund channelling scheme - summary and archetype*

| Scheme | Source of loan or fund | | Need GGL? | | Need to establish SPV? | | Need to issue other financing instruments? | |
|---|---|---|---|---|---|---|---|---|
| | Public sector | Private sector | Yes | No | Yes | No | Yes | No |
| **A-1** | | | | | | | | |
| **A-2** | | | | | | | | |
| **A-3** | | | | | | | | |
| **B-1** | | | | | | | | |

| B-2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|

In particular, SPV (Special Purpose Vehicle) is a legal entity that is created to isolate the financial risks in relation to the electrification program. It could be a newly established company or a subsidiary of Transjakarta. The reason for introducing SPV in this context is due to the aspiration from Transjakarta, in which owning or managing assets is not favourable. Hence, this role is then transferred to the SPV.

All the fund channelling alternatives are therefore being detailed in following sections.

### 9.2.1. Scheme A-1: PT. SMI Provides Regional Loan to The Government of Jakarta

Through the scheme A-1, PT. Sarana Multi Infrastruktur (PT. SMI)—a Special Mission Vehicle under the Ministry of Finance—will issue regional loans (*Pinjaman Daerah,* "Pinda") to the Government of Jakarta. The Government of Jakarta will use the loan as a capital injection to Transjakarta, as they will become the project implementer of the e-bus programme.

Further, Transjakarta needs to own or form a Special Purpose Vehicle (SPV) company to utilise assets for running the Transjakarta e-bus programme. The SPV could be Transjakarta's subsidiary or a joint venture between Transjakarta and other companies. The capital injection gained from The Government of Jakarta could be utilised as equity injection to the SPV. Further, the SPV will provide the maintenance service for the assets.

Since the status quo of the business model still applies, Transjakarta will have a contract with private bus operators to operate the bus and pay monthly payment for bus operation. As the asset provided by the SPV, Transjakarta will also pay monthly payments for leasing the assets from the SPV. Transjakarta will still receive the subsidy from the Government of Jakarta for providing the transportation service. A detailed scheme—including the steps taken to make this scheme works—provided on Figure 1Figure 15 below.

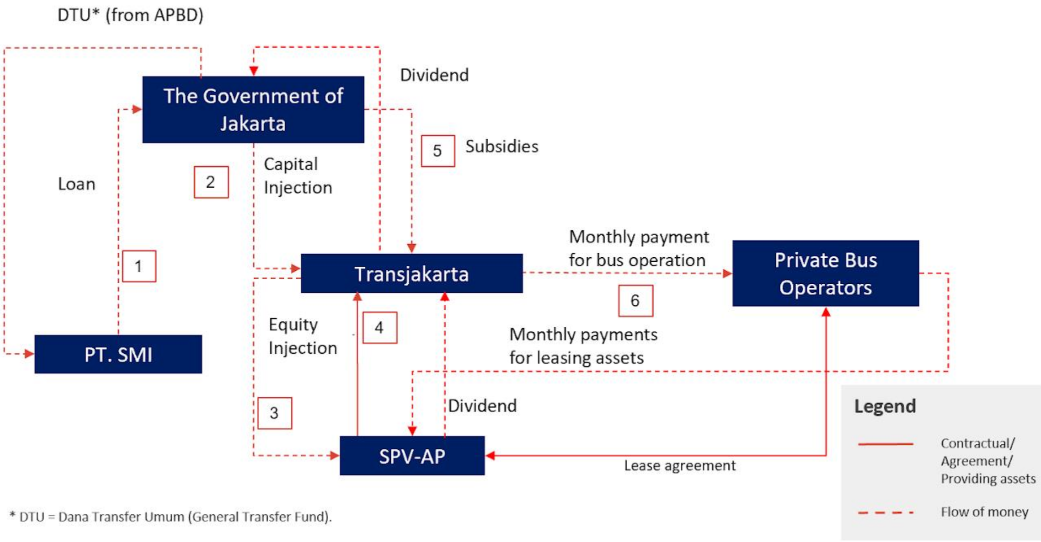



*Figure 15. Fund Channelling Scheme A-1: Regional Loan from PT. SMI to The Government of Jakarta*

The advantages and challenges of this scheme are documented on Table 27Table 22.

*Table 27. Advantages and challenges of Fund Channelling Scheme A-1*

| | |
|---|---|
| **Advantages** | |
| 1 | PT. SMI has managed the Government of Jakarta loan portfolio, so that the Provincial Government has gone through the Know-Your-Customer (KYC) process by PT. SMI. |
| 2 | The Government of Jakarta is familiar with the mechanism for issuing, distributing, and paying regional loan from PT. SMI. |
| 3 | The roles of main actors are optimised without changing the roles that have been carried out so far. |
| 4 | The bus operators will only operate the bus whereas the bus maintenance will be carried out by another party. |
| 5 | The risk to the public sector is distributed. |
| 6 | Cost of funds for municipality loans is relatively lower compared to market loans for the private sector. |
| 7 | The tenure of municipality loans can be longer (up to 20 years) compared to market loans from the private sector. |
| 8 | In case the Government of Jakarta is not able to pay the loan, PT. SMI will use DTU from APBD |
| **Challenges** | |

| | |
|---|---|
| 1 | Transjakarta must request the Government of Jakarta to issue the Regional Loan. Government of Jakarta must also have commitment for this scheme to work. |
| 2 | A regional regulation (*Peraturan Daerah* or *Perda*) needs to be issued and approval from the Regional People's Representative Council needs to be obtained for the regional loan issuance. The process is medium time consuming. |
| 3 | With the current scheme, Transjakarta already obtained PSO (public service obligation or subsidy) from the Government of Jakarta. Getting a regional loan dedicated for e-bus programmes under the Transjakarta service may potentially create issues or conflict because Transjakarta will get support from two kinds of funds (regional loan and PSO). |
| 4 | The operators may not take care of the buses properly as they are not the owner. This might need further mitigation in the form of a contract. |

### 9.2.2. Scheme A-2: The combination of Regional Loans and financing products issued by PT. SMI

This scheme is similar to scheme A-1. The Government of Jakarta will get a regional loan from PT. SMI. The difference is that PT. SMI will also use green funds for the stock market. The green fund will be used as a source of funds for the loan to The Government of Jakarta. The capital market investors will invest in the green fund issued by PT. SMI.

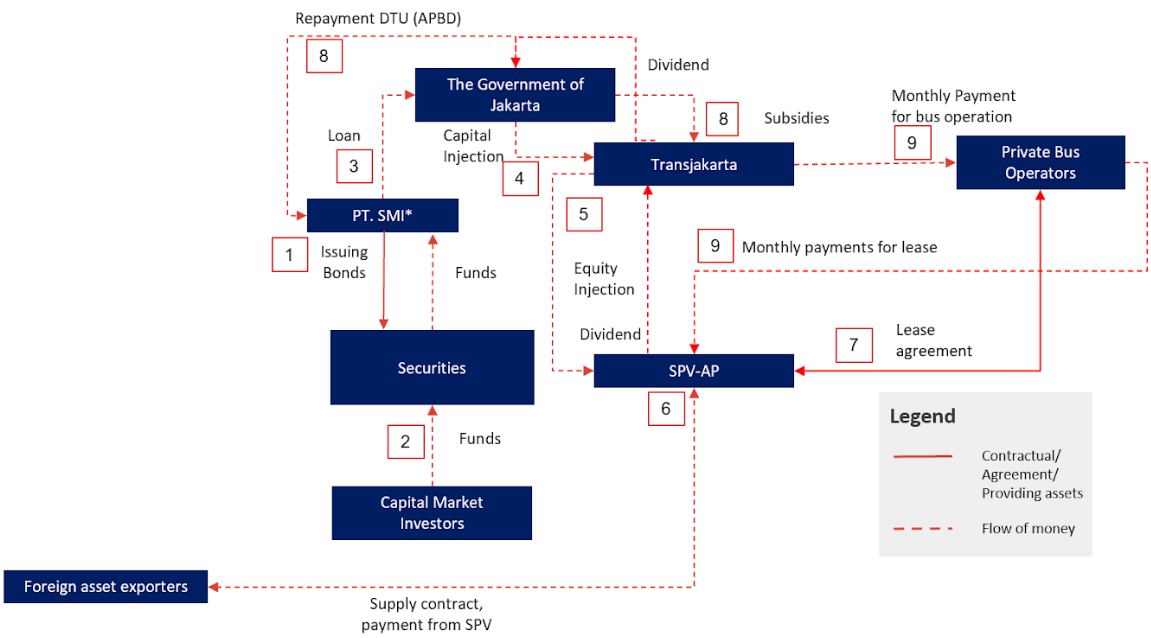



*Figure 16. Fund Channelling Scheme A-2: The combination of Regional Loans and financing products issued by PT. SMI*

DFIs or ECA could provide equity participation to the green fund issued by PT. SMI, even though this is an optional option and will involve the offshore institutions a lot. The ECA or DFI could also provide Credit Enhancement Facility (CEF) to the commercial foreign bank. The asset could be provided by the foreign manufacturers and having a supply contract with SPV. Similar to the scheme A-2, the SPV will provide assets to Transjakarta. However, the involvement of DFIs or ECA is optional.

Since the issuance of regional loan's advantages and challenges are quite similar to scheme A-1, Table 28 only highlights the additional advantages and challenges of PT. SMI also issues green funds.

*Table 28. Advantages and challenges of Fund Channelling Scheme A-2*

| | |
|---|---|
| **Advantages** | |
| 1 | PT. SMI has collaborated with several Development Financial Institutions (DFIs), such as Asian Development Bank (ADB) and World Bank (WB). |
| 2 | The role of DFIs is maximised because they can participate as lenders, provide equity supports to PT. SMI for issuing the green funds, or fund guarantors. |
| **Challenges** | |
| 1 | Compared to scheme A-2, the structured financing is more complex because the issuance of green fund is taken into account. |

### 9.2.3. Scheme A-3: Development Financial Institutions (DFIs) Loan to Government (2 Step Loan)

This is the only scheme discussed in this report where the **Government Guarantee Letter (GGL)** from the National Government (Ministry of Finance or The Indonesia Infrastructure Guarantee Fund (IIGF) is required. To utilise loans from Export Credit Agencies or Development Financial Institutions, the Ministry of Finance/ IIGF and The Government of Jakarta will have a regress agreement. After that, the GGL is obtained to guarantee the ECA or DFI about the Transjakarta electrification program. Similar to the previous fund channelling schemes, Transjakarta needs to own or establish an SPV as an asset owner or asset aggregator, as well as the e-bus programme implementer. Transjakarta could provide equity support to the appointed SPV.

ECA or DFI is not providing the loan directly to beneficiaries. They need to partner with commercial banks they are working with and provide them with a guarantee. After that, the commercial banks will provide loans to an asset aggregator or an SPV. The asset aggregator or SPV needs the loan to purchase the assets and pay a regular payment for assets maintenance.

If ECAs participate in the program, there needs to be an agreement regarding the local contents that will be incorporated under the program. For example, UK Export Finance (UKEF) requires 20% of UK content if they invest in Transjakarta's e-bus program. In this case, UKEF will do a supply contract with asset exporters from its origin countries. The asset exporters will export the asset to an APM.

Moreover, the APM will provide the assets and develop an assets maintenance service agreement with the SPV. As usual, the Government of Jakarta will provide subsidies to Transjakarta for running the mobility services. Transjakarta will provide monthly payments to SPV for leasing the assets and to private bus operators for bus operation on Rp/km basis (Gross-Cost Contract scheme), discounting SPV lease payment.

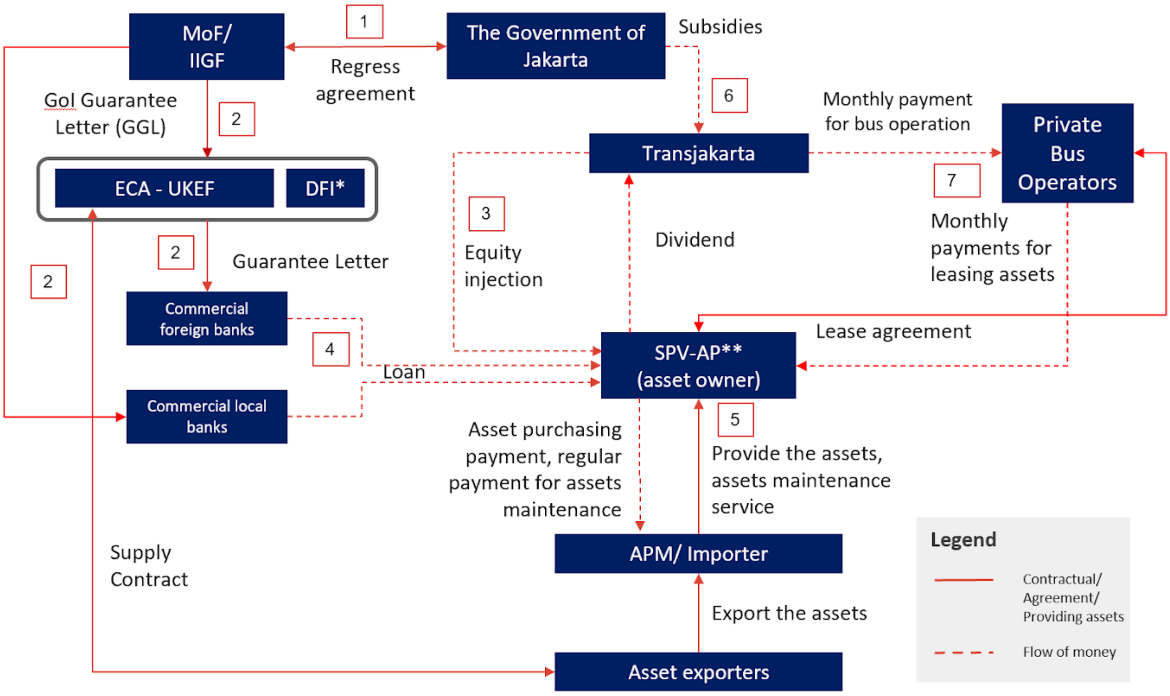



*Figure 17. Fund Channelling Scheme A-3: Development Financial Institutions (DFIs) Loan to Government (2 Step Loan)*

The advantages and challenges of this scheme are presented in Table 29.

*Table 29. Advantages and challenges of Fund Channelling Scheme A-3*

| | |
|---|---|
| **Advantages** | |
| 1 | Cost of funds for sovereign loans is relatively lower compared to market loans for the private sector. |
| 2 | Tenure of sovereign loan can be longer than 10 years. |
| **Challenges** | |
| 1 | ECA-UKEF requires a GGL from the Ministry of Finance. The UKEF Committee has never issued guarantees to replace the GGL from the Ministry of Finance (MoF-GGL) to guarantee letters issued by IIGF. |

| | |
|---|---|
| 2 | It is difficult to obtain MoF-GGL unless the Transjakarta e-bus programme is included in National Strategic Projects (*Proyek Strategis Nasional,* PSN). |
| 3 | There is no precedent that IIGF provides Guarantee Letter to BUMDs for non-PPP schemes. |
| 4 | The provincial government and BUMD are not allowed to get loans directly from abroad. |
| 5 | Based on OJK Regulations, Local banks only allow loans for companies with at least 2 years operation. Therefore, newly established SPV, as default, will most likely be not qualified as a borrower. |
| 6 | In the case of UKEF, no local bank has yet qualified to be an ECA. |
| 7 | Full financial risk to the public sector. |
| 8 | **Under this scheme**, SPV-AP should be formed as a State-owned Enterprise (SoE) **to enable access to the loan** . Transjakarta has to join with BUMN, and BUMN in total has to have a majority of shares. |

### 9.2.4. Scheme B-1: Loan from Commercial Foreign Banks to Private Sectors

This scheme points-out a heavy involvement of private sectors. Private sectors as importers, buyers, capital providers, or asset aggregators—to simplify, terminology “the private sector” will be used in this section of the report. The private sector will obtain commercial loans from **foreign** banks. Additionally, the involvement of ECAs and DFIs are optional where they could provide Credit Enhancement Facility to the foreign bank. Moreover, the foreign bank could have a supply contract with foreign assets exporters.

The foreign assets exporters will provide the assets to the private sector. Unlike the previous schemes where the establishment of SPV is needed, in this scheme, the private sector could sell or lease assets directly to bus operators, as well as providing maintenance services.

The Government of Jakarta will provide subsidies to Transjakarta, and Transjakarta will provide monthly payment for bus operation to bus operators on a Rp/km basis.

Private bus operators will provide regular leasing & O&M payments to the private sector. The private sector will pay loans to the foreign banks as they provide commercial loans to help procuring the assets.

The scheme B-1 is illustrated on Figure 18, while the advantages and challenges of this scheme is presented on Table 30. Advantages and challenges of Fund Channelling Scheme B-1.

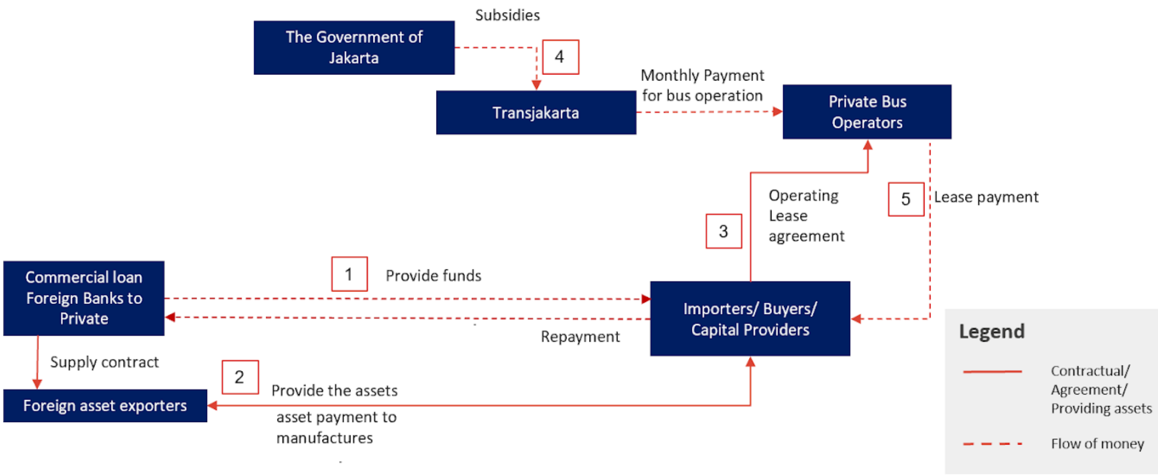



*Figure 18. Fund Channelling Scheme B-1: Loan from Commercial Foreign Banks to Private Sectors*

*Table 30. Advantages and challenges of Fund Channelling Scheme B-1*

| | |
|---|---|
| **Advantages** | |
| 1 | The risk will be fully borne by private sectors. |
| 2 | The bus operator will operate the bus, while the maintenance will be carried out by another party[4]. |
| 3 | The role of the main actors will be optimised without changing the roles that have been carried out so far. |
| **Challenges** | |
| 1 | Candidates of the private sector should have experience in the public transportation field with a strong balance sheet. |
| 2 | Potential resistance from existing operators that are afraid of private sectors will replace their current business or become competitors. |
| 3 | This might need higher Government financial support or subsidies to increase the level of confidence of the private sector |

[4] This point, in fact, could become either an advantage or a challenge. While the bus operators are not required to own the asset, there is no ownership transfer. This could potentially make the bus operator not have a willingness to operate/maintain the asset properly compared to when they are owning the asset or if there is ownership transfer at the end.

| | |
|---|---|
| 4 | The process is medium time consuming since it might require tender process for to select asset owner |

### 9.2.5. Scheme B-1A: Loan from Commercial Foreign Banks to Private Sectors - Business as usual (BAU)

Similar to Scheme B-1, in this scheme, the private sector also gets commercial loans from foreign banks to buy and own the assets. However, in this scheme the private sector will then sell the assets and maintenance services directly to bus operators. Hence, bus operators, who do not have the financial capacity, will take capital loans from local banks in order to own the assets. Furthermore, operators will also need to pay regular maintenance fees to the asset owner.

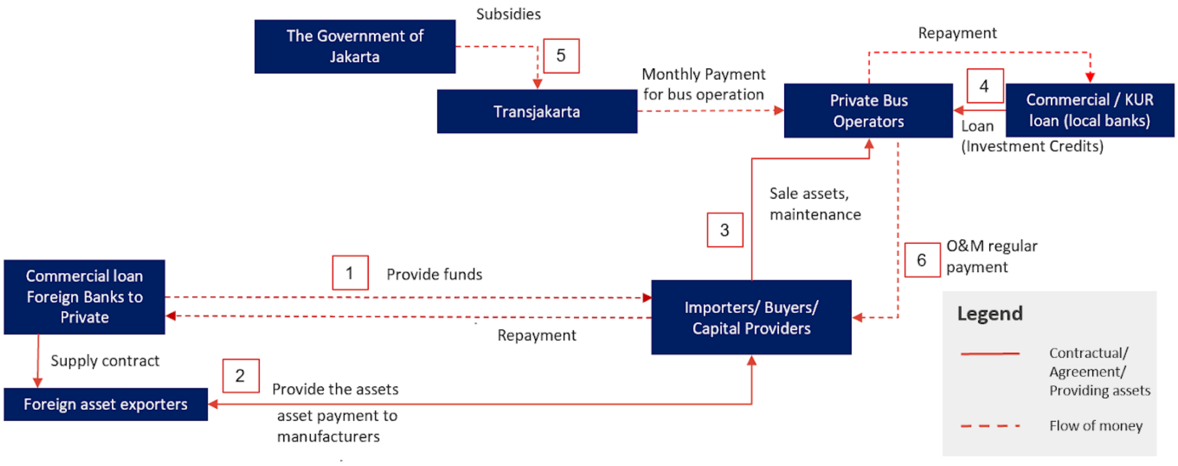



*Figure 19. Fund Channelling Scheme B-1A: Loan from Commercial Foreign Banks to Private Sectors – Business as Usual (BAU)*

*Table 31 Advantages and challenges of Fund Channelling Scheme B-1A*

| | |
|---|---|
| **Advantages** | |
| 1 | The risk will be fully borne by private sectors. |
| 2 | The bus operator will operate the bus, while the maintenance will be carried out by another party. There is a sense of ownership by bus operators. |
| 3 | The role of the main actors will be optimised without changing the roles that have been carried out so far (BAU) |
| **Challenges** | |
| 1 | Zero mitigation on current financial barrier, high upfront cost |

| | |
|---|---|
| 2 | May have higher cost of fund due to limited credit history |
| 3 | Less flexibility. Operators will be required to prepare down payment since they will be the asset owner |
| 4 | Financial capacity and bankability of operators are relatively low |

### 9.2.6. Scheme B-2: Private Sectors Issue Financing Products to Finance the Project

Through this scheme, the private sectors will issue the financing products (green fund or other financing products) to capital markets. The private sectors will raise the fund from the capital market investors and utilise the projects.

Scheme B-2 is quite similar to the Scheme B-1, the difference is that the source of funds for the Scheme B-1 is the loan from foreign bank whereas the Scheme B-2 gains the fund from the capital market.

The participation of offshore ECAs and DFIs, investment credits loan from local commercial banks to bus operators, and liquidity support from PT. SMI will only be optional in this scheme. The scheme is demonstrated on Figure 20 below, while the detailed structured financing and financing instrument used of this scheme will be analysed further.

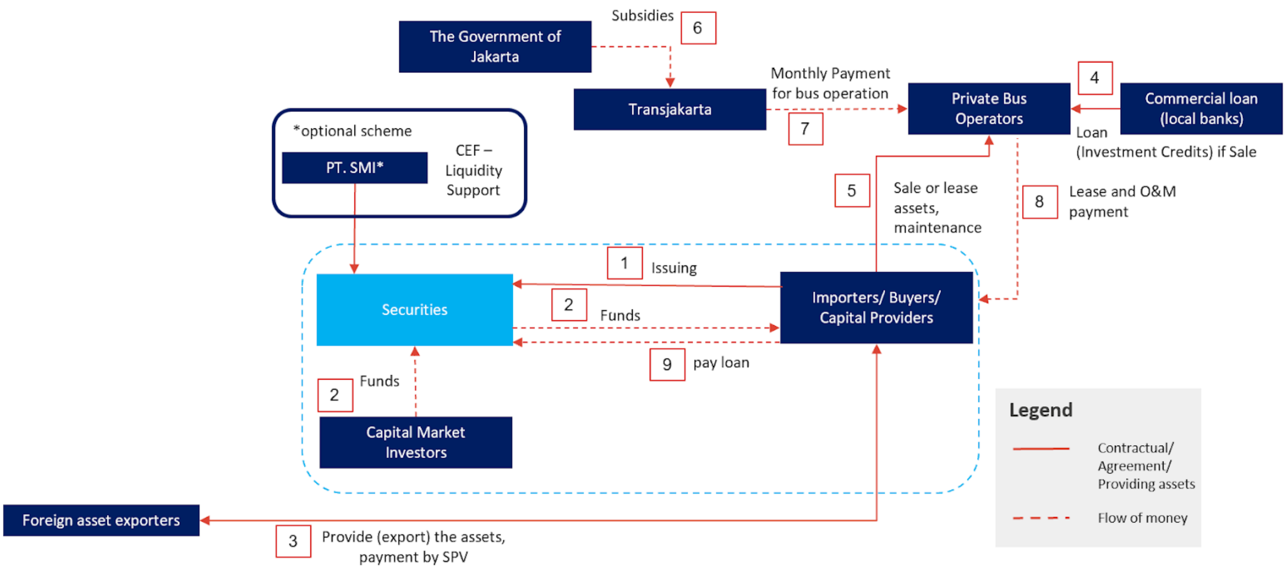
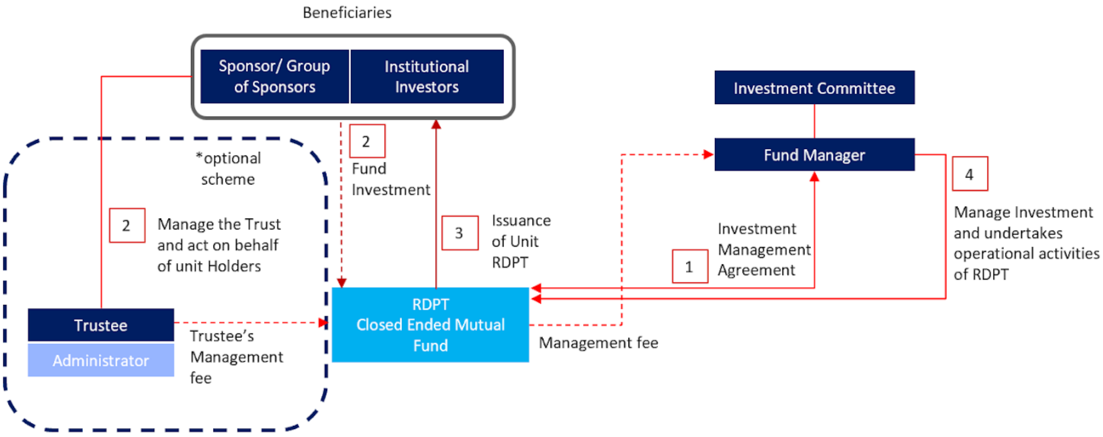



*Figure 20. Fund Channelling Scheme B-2: Private Sectors Issue Financing Products to Finance the Project*

As seen in the figure above in blue box, the main source of funds for this scheme is "Securities", which is one of financing products that is issued by the capital provider or any other private sector who would participate in the project. Amongst securities (shares, bonds and mutual funds) that are available in the market, it is thought that mutual fund is the most viable one to be utilised in the context of Transjakarta electrification. In particular, the mutual fund that will be looked at further is **Limited Participation Mutual Fund** (*Reksa Dana Penyertaan Terbatas,* "**RDPT**").




Legal basis:

1. Undang-Undang Nomor 8 Tahun 1995 tentang Pasar Modal;
2. Peraturan IV.A.3 - Keputusan Ketua Badan Pengawas Pasar Modal Nomor Kep-13/PM/2002 tentang Pedoman Pengelolaan Reksa Dana Berbentuk Perseroan;
3. Peraturan No. IV.C.5 - Keputusan Ketua Badan Pengawas Pasar Modal-Lembaga Keuangan Nomor KEP-43/BL/2008 Tahun 2008 tentang Reksa Dana Berbentuk Kontrak Investasi Kolektif Penyertaan Terbatas;
4. Peraturan Nomor IV.B.1 - Keputusan Badan Pengawas Pasar Modal-Lembaga Keuangan Nomor KEP-552/BL/2010 Tahun 2010 tentang Pedoman Kontrak Reksa Dana Berbentuk Kontrak investasi kolektif.

Source : Reksadana Kontrak Investasi Kolektif Penyertaan Terbatas - Klinik Hukumonline

*Figure 21. Typical structure of RDPT*

Limited Participation Mutual Funds (RDPT) are investment instruments specifically offered to professional investors with a high minimum purchase value. The Limited Participation Mutual Funds are then placed by investment managers into securities portfolios as well as capital for various sectors. Professional investors are owners of capital with the capacity to buy Participation Units as well as make risk analysis of Mutual Funds in the form of Limited Participation Collective Investment Contracts.

The regulations for Limited Participation Mutual Funds have been regulated by OJK. The provisions are specifically offered in limited quantities to professional investors and may not be sold through a public offering. In addition, it may not be controlled by 50 or more Parties. RDPT provides open information to the public regarding the composition of assets and investment portfolio instruments, the risks that accompany them, and various costs that arise. In addition, the bookkeeping procedure must also be carried out by an independent party outside the Investment Manager, namely the Custodian Bank and is required to be audited by a Public Accountant registered with the OJK.

In general, there are several parties that are involved in RDPT structure, which are:

1. **Fund manager and investment committee**
   The fund manager is an entity who will manage the fund pooled from the RDPT. Before managing the fund, the fund manager will develop an investment management agreement with trustees & investors/ sponsors. Investment committee, on behalf of the fund manager, will ensure the fund managed by the fund manager is in accordance with the RDPT issuance agreement—in this case is for financing the Transjakarta e-bus programme. The investment committee is at the same institution with the fund manager itself. There

will be a management fee for the fund manager to compensate their services of managing the fund pooled on the RDPT.

2. **Investors and sponsors (or group of sponsors)**
   Investors and sponsors are the ones who will invest their funds in the RDPT. There is no limitation regarding the kind of parties that are able to participate as sponsors, group of sponsors, or institutional investors. The investors could be foreign or local financial services institutions, both public and private companies.
   The investors and sponsors will issue the RDPT unit, after they conduct the investment.
3. **Trustee**
   Trustee is a party who represents the interests of the RDPT holder. The trustee has an important role for creditors because it will provide up-to-date information on the conditions and developments in the use of RDPT funds for the specific project. The government (OJK) has stipulated entities that could carry out the trustee's activities. There will be a trustee's management fee for the trustee on behalf of providing the trustee's services.
4. **Administrator**
   The administrator of the issuance of RDPT will manage the trustee and act on behalf of the unit holders.

***Infrastructure and Market Context***

RDPT is quite an attractive product for investors with the basic asset is infrastructure which is being massively worked on by the government. Investor interest in infrastructure project-based RDPT is still high because it is currently a priority for the government.

The yield on RDPT also varies depending on the type and location of the project which is the underlying asset. However, it is not uncommon for yields to match or even slightly outperform conventional stock-based mutual funds. Up to now, the generally attractive infrastructure assets are toll roads and airports. In terms of risk, RDPT investors are not exposed to market risk, but to liquidity risk and business risk. Investors are threatened with loss if the infrastructure projects that are assets of the mutual funds are not realised along the way.

At the end of March 2018, two BUMN subsidiaries, namely Bahana Investa Kapital and Danareksa Capital, together with 27 other BUMNs engaged in the financial intermediary sector, signed the formation of a Private Investment Fund. To complement infrastructure project development support, the presence of this investment fund will be one of the infrastructure funding solutions, as well as optimising the management and utilisation of BUMN funds, including their pension funds to invest in projects or securities portfolios.

Based on the disclosure of the Indonesian Central Securities Depository (KSEI), an official investment manager has recorded the issuance of the infrastructure RDPT instrument. One example, the Transjawa Equity Infrastructure Mandiri RDPT. This RDPT product from Mandiri Investment Management (MMI) has received an effective licence from the Financial Services

Authority. As the name implies, this RDPT has the basic assets of three Transjawa toll roads, namely the Solo-Ngawi toll road, the Ngawi-Kertosono toll road, and the Semarang-Batang toll road, issued on July 15, 2018. The three toll roads are projects worked on by PT Jasa Marga Tbk (JSMR). Through this IDR 3 trillion RDPT, they acquired part of Jasa Marga's share ownership through these toll roads. PT Jasa Marga Tbk stated that the option to issue Limited Participation Mutual Funds (RDPT) as an instrument for funding is one of the right options to be implemented at this time5. In addition to the easy process, the company has the option to buy back shares when it has better liquidity, so that the share ownership of the toll roads remains the property of the company.

*Table 32. Historical Return of RDPT Mandiri Infrastruktur Ekuitas Transjawa*

| **RETURN** | | | | | | |
|---|---|---|---|---|---|---|
| 1 month | YTD | 1 year | 3 years | 5 years | 10 years | Inception |
| -0,11% | 9,94% | 9,94% | 39,04% | - | - | 43,81% |

Source: Investasi RPDT Mandiri Infrastruktur Ekuitas Transjawa - Reksadana Online | Bareksa

Several limited investment mutual funds (RDPT) have also been issued to finance infrastructure managed by Investment Management companies. One of them is the construction of Kertajati Airport which has been tested recently. Another example is the infrastructure-based RDPT for toll roads built by Waskita and other state-owned construction companies, the Trans-Java toll road, and so on.

In the development of RDPT as one of the viable alternatives for Transjakarta electrification, there are further 3 possible variations thereof. The main difference lies within the role of SPV in the structure that will be discussed further below.

### 9.2.7. Scheme B-2, Alternative 1 Structured Financing

Within alternative 1, the **SPV** will act as an **asset aggregator** who owns the assets associated with the programme, such as the e-bus fleets, charging infrastructure, etc. They will enter into an operating lease agreement and O&M contracts directly with bus operators, and enter into a purchasing agreement with associated OEMs, APMs, or charging infrastructure providers.

[5] Ini Alasan Jasa Marga Pilih RDPT Ketimbang Opsi Pendanaan Lain (indopremier.com)

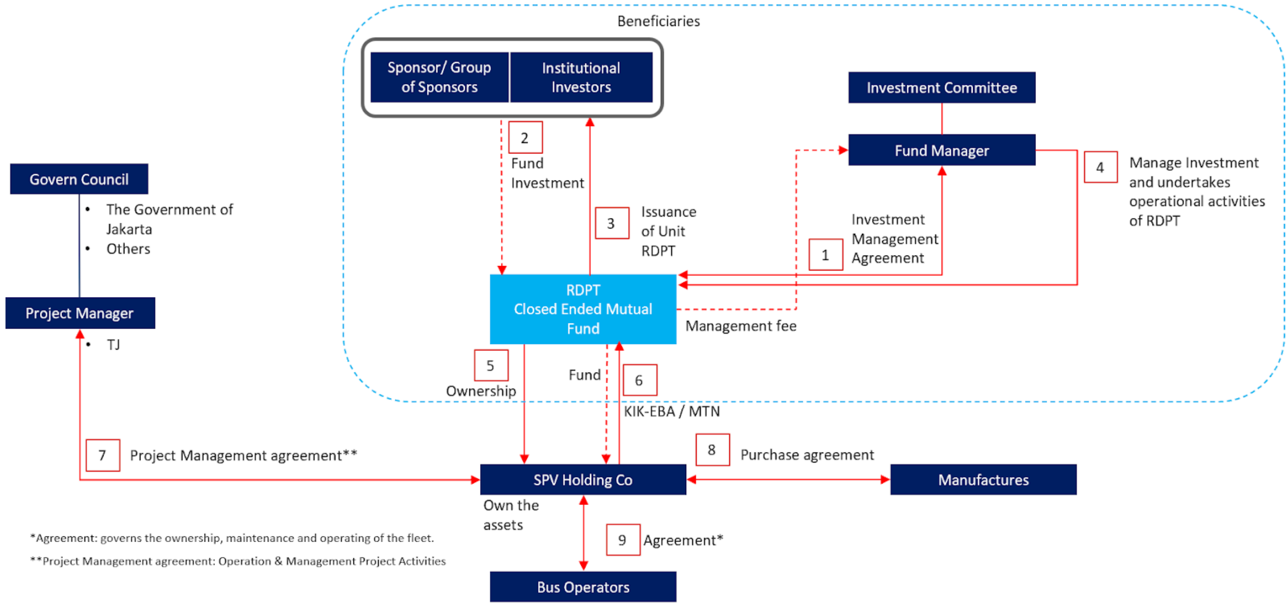



*Figure 22. Scheme B-2, Alternative 1 Structured Financing*

The implementation of such scheme could be realised in 4 main stages:

1. Stage I
    a. Fund Manager have corporation collaboration agreement with Transjakarta for E-bus deployment projects
    b. Transjakarta rank and select eligible routes and operators (Financial and Commercial Perspectives)
    c. Fund Manager and Transjakarta conduct feasibility E-bus deployment eligible project
2. Stage II (RDPT Issuance)
    a. Fund Manager (Manager Investasi / MI) issues RDPT
    b. Beneficiaries purchase RDPT units of Issuer
        i. Institutional Investors purchase RDPT units of Issuer: Promissory notes,
        ii. Sponsors purchase RDPT units of Issuer: Quasi Equity, Equity
3. Stage III
    a. Sponsors establish SPV Holding Co (assets ownership)
4. Stage IV
    a. Transjakarta contract agreement with operators
    b. Sale agreement between SPV Holding Co and Bus manufacturers
    c. Rental (Operation Lease) between SPV Holding Co and Operators
    d. O&M agreement between SPV Holding and O&M Co.
    e. Government of DKI Jakarta provide operation subsidies for buy the service from Operators

The advantages and challenges of this scheme are shown in the table below.

*Table 33 Advantages and challenges of Fund Channelling Scheme B-2, Alternative 1*

*Table 34. Advantages and challenges of Fund Channelling Scheme B-2, Alternative 1*

| | |
|---|---|
| **Advantages** | |
| 1 | Opportunity of collaboration between Fund Managers and Transjakarta (SOE – ROE synergy) that may increase the level of confidence as well as simplicity of the process |
| 2 | The role of the main actors will be optimised without changing the roles that have been carried out so far |
| 3 | SPV as asset owner with operating lease to operator |
| 4 | The risk is fully borne by private investor |
| 5 | The cost of fund may be cheaper than bank loan – would depend on the financial product rating |
| **Challenges** | |
| 1 | Resistant may come from existing operators that are afraid of capital provider take their business or become competitor |
| 2 | The scheme is quite complex and involve a lot of players hence may create a long and time-consuming process |
| 3 | The cost of fund is not necessarily cheap |
| 4 | The assets may not be used/maintained properly by operators since they are not the owner |

Furthermore, this scheme is also quite flexible to open the opportunity for foreign funds to participate in raising the funds to support the electrification as shown in the figure below. In this scheme, the SPV may have a sale agreement with foreign asset exporters as well as currency swap with foreign CEFs.

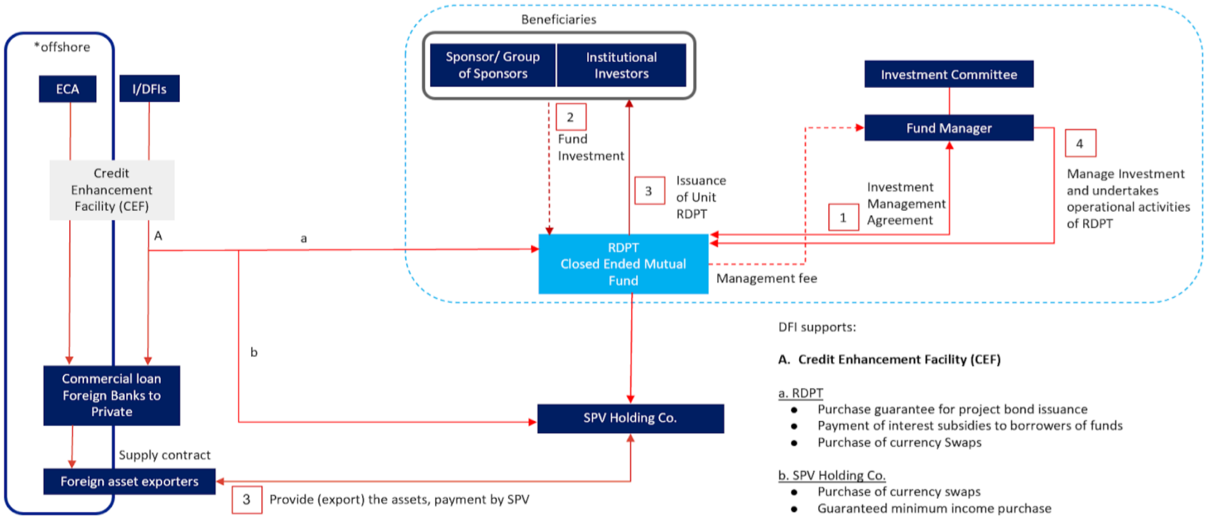



*Figure 23. Scheme B-2, Alternative 1 Structured Blended Financing*

In addition to advantages and challenges shown in **Error! Reference source not found.** above, this particular blended scheme also creates bigger opportunities in a way that the role of DFIs is maximised because they can participate as lenders, equity in fund channelling and fund guarantors. Furthermore, ECAs and DFIs are expected to provide low cost of funds and loan tenors to asset suppliers through back-to-back GL for foreign banks so that the final price of assets (electric buses, batteries and charging infrastructure) becomes cheaper.

### 9.2.8. Scheme B-2, Alternative 2 Structured Financing

The main difference with alternative 1 is the existence of Leasing Company who will provide finance lease to the operators. The SPV will have an agreement with the Leasing company and the Leasing company will be acting as a brokerage where they will enter into a purchase agreement with the OEM to buy the assets on behalf of the SPV since the ownership of the assets still lies with SPV. The assets are then leased to the operators through finance lease agreement. In turn, bus operators will pay for the lease to the SPV through the Leasing company.

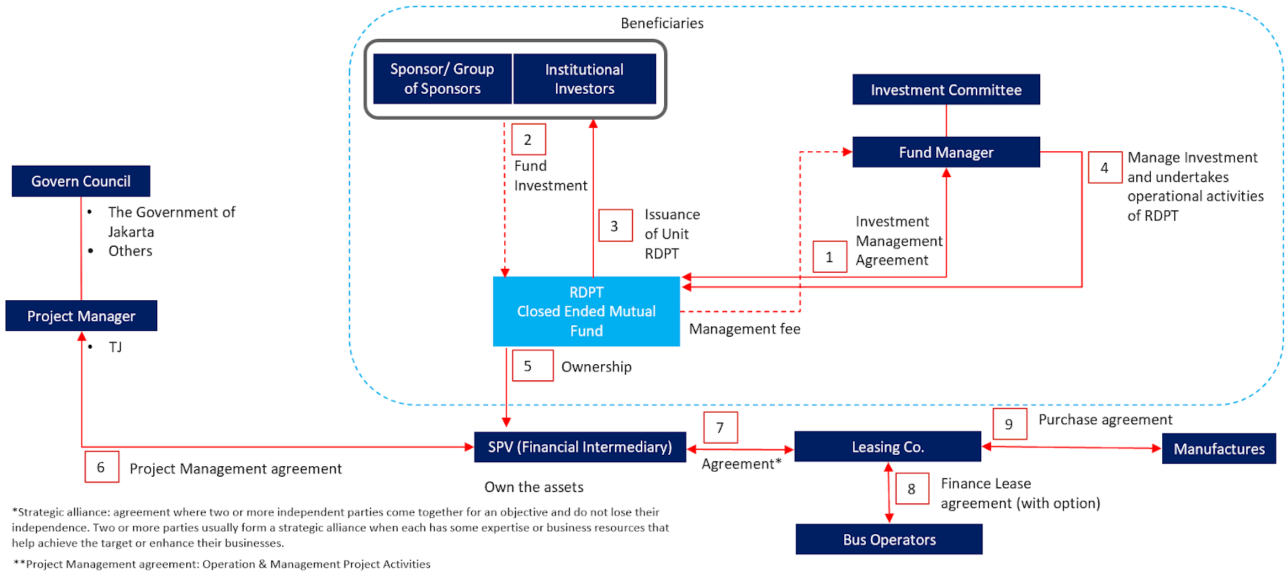



*Figure 24. Scheme B-2, Alternative 2 Structured Financing*

The stages of implementation of this scheme are as follows:

1. Stage I
   a. Fund Manager have corporation agreement with Transjakarta for E-bus deployment projects
   b. Transjakarta rank and select eligible routes and operators (Financial and Commercial Perspectives)
   c. Fund Manager and Transjakarta conduct feasibility E-bus deployment eligible project
2. Stage II (RDPT Issuance)
   a. Fund Manager (Manager Investasi / MI) issues RDPT
   b. Beneficiaries purchase RDPT units of Issuer
      i. Institutional Investors purchase RDPT units of Issuer: Promissory notes,
      ii. Sponsors purchase RDPT units of Issuer: Quasi Equity, Equity
3. Stage III
   a. Sponsors establish SPV (Financial Intermediary)
   b. SPV issued debt instrument such as: KIK-EBA or Medium-Term Notes (MTN)
   c. SPV have strategic alliance agreement: fund channelling lease agreement with Leasing Co to Operators

   Strategic alliance: agreement where two or more independent parties come together for an objective and do not lose their independence. Two or more parties usually form a strategic alliance when each has some expertise or business resources that help achieve the target or enhance their businesses.[6]

4. Stage IV

[6] [Source: Joint Venture vs Strategic Alliance | Top 6 Differences (with Infographics) (wallstreetmojo.com)]

a. Transjakarta contract agreement with operators
b. Finance lease agreement between Leasing Co and Operators
c. O&M agreement between Operators and O&M Co.
d. Government of DKI Jakarta provide operation subsidies for buy the service from Operators

The advantages and challenges of this scheme are shown in the table below.

*Table 35 Advantages and challenges of Fund Channelling Scheme B-2, Alternative 2*

*Table 36. Advantages and challenges of Fund Channelling Scheme B-2, Alternative 2*

| | |
|---|---|
| **Advantages** | |
| 1 | Opportunity of collaboration between Fund Manager, Leasing Company and Transjakarta (SOE – ROE synergy) that may increase the level of confidence as well as simplicity of the process |
| 2 | The role of the main actors will be optimised without changing the roles that have been carried out so far |
| 3 | SPV as asset owner have strategic alliance agreement (fund channelling) with Leasing Company (2 step) who have financial lease agreement with bus operators |
| 4 | The risk is fully borne by private investor |
| 5 | The cost of fund may be cheaper than bank loan – would depend on the financial product rating |
| **Challenges** | |
| 1 | The scheme is quite complex and involve a lot of players hence may create a long and time-consuming process |
| 2 | The 2-step process that must comply with strict OJK Regulation adds to additional process and time to implement |
| 3 | The cost of fund is not necessarily cheap |
| 4 | The assets may not be used/maintained properly by operators since they are not the owner |

Similar to Alternative 1 above, this scheme can also be flexible by opening an opportunity to allow foreign funds to come in the structure. The main difference is that since the role of SPV is financial intermediary, not holding company, currency swaps facility from DFIs/ECAs could not be purchased. The role of DFIs is maximised because they can participate as lenders, equity in fund channelling and fund guarantors. Furthermore, ECAs and DFIs are expected to provide low cost of funds and loan tenors to asset suppliers through back-to-back GL for foreign banks so that the final price of assets (electric buses, batteries and charging infrastructure) becomes cheaper.

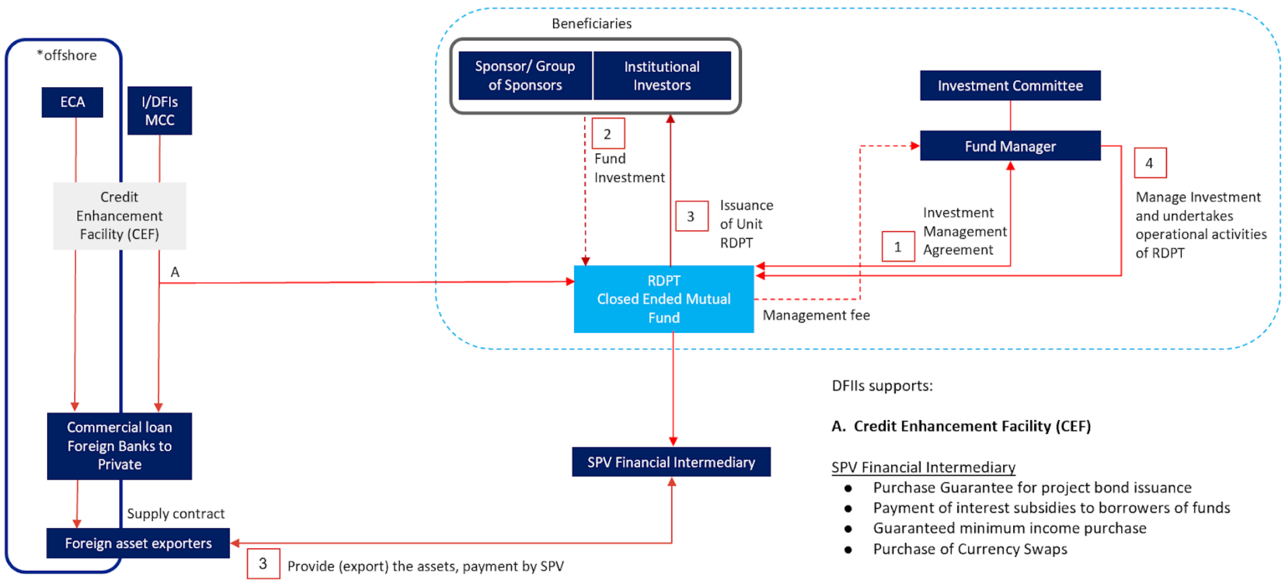



*Figure 25. Scheme B-2, Alternative 2 Structured Blended Financing*

### 9.2.9. Scheme B-2, Alternative 3 Structured Financing

This scheme is very similar to Alternative 2 Structured Financing above. However, in this scheme SPV is not the asset owner rather it is the bus operator. The SPV will have a leverage lease agreement with the Leasing Company who will purchase the assets from the manufacturers. The main point of this scheme is that the bus operators do not have to prepare the down payment to own the assets. Bus operators only need to have a finance lease agreement (lease to own) with the Leasing Company for the monthly payment to the Leasing Company. Hence, the role of SPV is only for fund channelling to the Leasing Company.

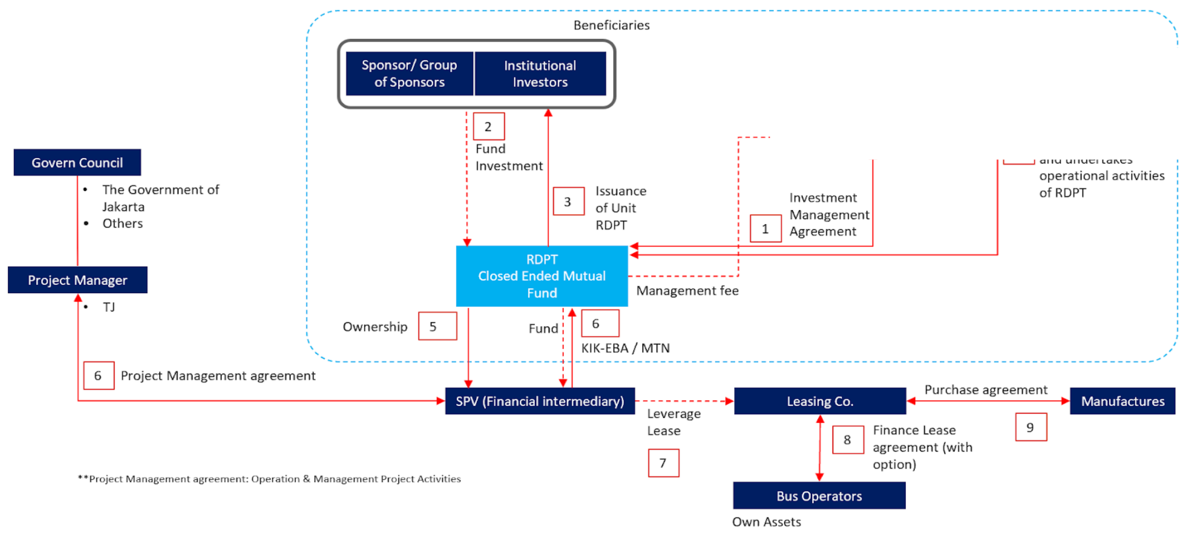



*Figure 26. Scheme B-2, Alternative 3 Structured Financing*

The implementation stages of this scheme is as follows:

1. Stage I
   a. Fund Management have corporation agreement with Transjakarta for E-bus deployment projects
   b. Transjakarta rank and select eligible routes and operators (Financial and Commercial Perspectives)
   c. Fund Management and Transjakarta conduct feasibility E-bus deployment eligible project
2. Stage II (RDPT Issuance)
   a. Fund Management (Manager Investasi/MI) issuing RDPT
   b. Beneficiaries purchase RDPT units of Issuer
   c. Institutional Investors purchase RDPT units of Issuer: Promissory notes,
   d. Sponsors purchase RDPT units of Issuer: Quasi Equity, Equity
3. Stage III
   a. Sponsors establish SPV (Financial Intermediary)
   b. SPV issued debt instrument such as: KIK-EBA or Medium-Term Notes (MTN)
   c. SPV have leverage agreement with Leasing Co
4. Stage IV
   a. Transjakarta contract agreement with operators
   b. Finance lease agreement between Leasing Co and Operators
   c. O&M agreement between Operators and O&M Co.
   d. Government of DKI Jakarta provide operation subsidies for buy the service from Operators

The main advantages and challenges of this scheme are as follows:

*Table 37. Advantages and challenges of Fund Channelling Scheme B-2, Alternative 3*

| **Advantages** | |
|---|---|
| 1 | Opportunity of collaboration between Fund Manager, Leasing Company and Transjakarta (SOE – ROE synergy) that may increase the level of confidence as well as simplicity of the process |
| 2 | The role of the main actors will be optimised without changing the roles that have been carried out so far |
| 3 | SPV have strategic alliance agreement (fund channelling) with Leasing Company (2 step) |
| 4 | The risk is fully borne by private investor and Leasing Company |
| 5 | Bus operators have financial lease agreement (lease to own) to own the assets, which will be maintained/utilised properly. |
| 6 | The cost of fund may be cheaper than bank loan – would depend on the financial product rating |

| Challenges | |
|---|---|
| 1 | The scheme is quite complex and involve a lot of players hence may create a long and time-consuming process |
| 2 | The 2-step process that must comply with strict OJK Regulation adds to additional process and time to implement |
| 3 | The cost of fund is not necessarily cheap |
| 4 | The assets may not be used/maintained properly by operators since they are not the owner |

The blended version of this scheme is also the same as Alternative 2 above. The currency swaps facility from DFIs/ECAs could not be purchased and the role of DFIs is maximised because they can participate as lenders, equity in fund channelling and fund guarantors. Furthermore, ECAs and DFIs are expected to provide low cost of funds and loan tenors to asset suppliers through back-to-back GL for foreign banks so that the final price of assets (electric buses, batteries and charging infrastructure) becomes cheaper.

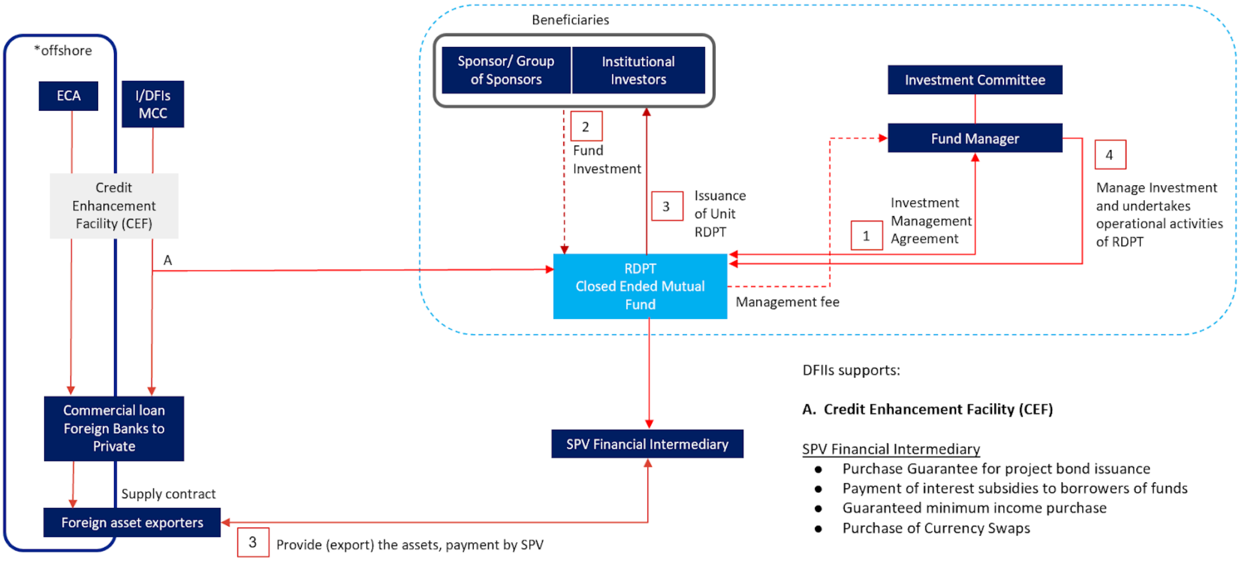



*Figure 27. Scheme B-2, Alternative 3 Structured Blended Financing*

### 9.2.10. Collaboration in Fund Channelling (SOE – ROE Synergy)

SOE – ROE synergy is being encouraged as a step to improve the economy. BUMN Minister revealed that this could create economic growth both nationally and regionally. He encouraged the local government to be more active in this endeavour. "Efforts and initiatives from the centre are not enough. Local government involvement is needed, which of course understands the characteristics of the area better. And in that case, the role of BUMD is important to become a partner and increase business activity in the region," said the Minister.

In DKI Jakarta, this cooperation has taken place in several sectors. For example, PT Tjipinang Food Station, which is a BUMD owned by the Government of DKI Jakarta and PT Sang Hyang Sri (Persero), a BUMN engaged in agriculture. In addition, BUMN and BUMD in DKI Jakarta are building joint ventures and integrated transportation systems in Jabodetabek.[7]

Through Government Regulation (PP) Number 113 of 2021 concerning Amendments to PP Number 25 of 1976 concerning the Republic of Indonesia State Equity Participation for the Establishment of a Limited Liability Company (Persero) **"Mutual Funds"** on November 10, 2021, PT Danareksa (Persero) was appointed as the holding company which oversees several sub-clusters, namely **financial services**, industrial estates, water resources, construction services and construction consulting, manufacturing, media and technology, as well as **transportation** and logistics. The formation of this holding is part of the transformation of BUMN management through consolidation and simplification of the number of BUMNs.[8]

In addition, there is also an opportunity for Transjakarta to collaborate with other SOEs who are in the utilities sector such as PLN, the electricity company. Collaboration allows for the development of interconnected E-bus systems that operate more efficiently than if either entity were to attempt to create a system on their own. PLN can provide expertise in the field of power technical aspects of the system.

The development of an electric bus system involves the installation of charging infrastructure along designated terminals and depots. PLN could also provide technical advice and expertise to Transjakarta regarding the best practices for the installation of charging that are powered by the PLN's power grid.

[7] Sinergi BUMN-BUMD Harapan Baru Ekonomi RI : Okezone Economy

[8] Tentang PT Danareksa (Persero) - PT. Danareksa (Persero)

## 10. Economic and Financial Analysis

### 10.1. Total Investment Cost Analysis

#### 10.1.1. TCO/km Calculation

It is evident that owning and operating a vehicle will incur costs that occur at different points in time, especially in the context of switching over to Battery Electric Vehicles (BEVs) where the initial costs are much higher and operating costs are much lower than ICE vehicles. To compare these costs across time, the total cost of ownership (TCO) methodology uses the financial formula of the present discounted value. This way, every cost can be included in one cost indicator to present the full cost of each alternative which includes the total discounted cost of owning, operating, and maintaining an asset over the lifetime of the asset.

The assumptions for computing the TCO/km for electric or diesel buses can be categorised into:

- CAPEX assumptions
- Operating parameters and OPEX assumptions
- Other assumptions

**CAPEX Assumptions**

The following assumptions have been made for various types of e-buses proposed to be deployed within Transjakarta service. The cost included on the table below only assumes depot charging only.

*Table 38. CAPEX assumptions for various types of E-buses*

| Bus Types* | Articulated Bus | Single Bus** | Medium Bus | Microbus |
|---|---|---|---|---|
| **Battery Size (kWh)** | 450 | 324 | 135 | 42 |
| **Landed Cost of bus (USD)** | 550,000 | 330,000 | 210,000 | 33,600 |
| **Cost per charger (USD)** | 58,000 | 58,000 | 29,000 | 17,000 |
| **Charger rating for overnight depot charging (kW)** | 200 | 200 | 80 | 20 |
| **Bus to Charger Ratio** | 2:1 | 4:1 | 5:1 | 1:1.1*** |
| **Replacement Ratio (ICE : E-Bus)** | 1:1 | 1:1 | 1:1.87 | 1:1 |

| | | | | |
|---|---|---|---|---|
| **Life of e-Bus (years)** | 15 | 15 | 15 | 8 |
| **Cost of comparable Diesel bus (USD)** | 350,000 | 164,000 | 63,000 | 19,600 |
| **Life of ICE bus (years)** | 10 | 10 | 7 | 7 |

** All bus types analysed on this chapter is air-conditioned, including microbus*

*** Both high-deck or low entry electric bus*

**** In addition to one slow charger supplied with the vehicles, one additional fast charger for 10 microbuses.*

Additionally, the following assumptions were also used:

a. The capital cost of a retrofitted single bus is assumed to be 65% of the cost of a new e-bus i.e., USD 215,000 plus residual value for the old diesel bus @ 20% of diesel bus cost.
b. Grid connection cost: IDR 10B for 10.4MVA connection[9].
c. Cost of the depot for 100 single buses is estimated at USD 3M (20% less for diesel buses). For medium and articulated buses, the depot costs are assumed to be 75% and 150% respectively of the single buses due their relative sizes.
d. Based on discussions with operators, other CAPEX costs will include legal, admin and financing costs and is considered at 3.5% of the cost of the bus.
e. Charger installation cost: 10% of cost of chargers (C40 CFF, 2021)

**<u>Operating Parameters and OPEX Assumptions</u>**

The per kilometre operating cost of a bus are estimated based on following assumptions:

a. <u>Distance travelled for variable operating costs such as tyres/tubes, and brake pads</u>.

The average distance travelled by various categories of buses is as follows:

*Table 39. Average distance travelled of each bus categories*

| Bus Types | Articulated Bus | Single Bus | Medium Bus | Microbus |
|---|---|---|---|---|
| kms/day | 205 | 192 | 188 | 196 |

[9] World Bank Study

These are average running by operating buses excluding the spare buses. 20 km of empty running is assumed to be included in this, based on the contracts between Transjakarta and bus operators.

b. Number of shifts operated

It is assumed that 2 shifts of 7 hours steering duty is assumed for each operating bus (excluding spares/ replacement).

c. Relieving ratio including weekly/ annual holidays, redundancies: 1.2

d. Cost of energy (electricity or diesel)

Based on the special tariff negotiated by Transjakarta with PLN, the cost of electricity is assumed @ IDR 825/ kWh. The current cost of diesel for public transportation fleets in Jakarta is IDR 6800/ litre.

e. Fuel Efficiency

The fuel efficiency of different categories of buses is considered as follows:

*Table 40. Fuel efficiency of each bus categories*

| Bus Types | Articulated Bus | Single Bus | Medium Bus | Microbus |
|---|---|---|---|---|
| **Electricity (kWh/km)** | 2.3 | 1.2 | 1 | 0.18 |
| **Diesel (km/litre)** | 1.45 | 2.03 | 3.2 | 8.5 |

The above assumptions are based on discussions with OEMs, operators, trials run done by Transjakarta, a 2020 report by Sustainable Bus[10].

f. Maintenance Cost

The maintenance cost of different categories of buses is considered as follows:

[10] Electric bus energy consumption in ViriCiti's spotlight. A report (sustainable-bus.com)

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*Table 41. Maintenance cost of each bus categories*

| Bus Types | Articulated Bus | Single Bus | Medium Bus | Microbus |
|---|---|---|---|---|
| **Electric (USD/ km)[11]** | 0.30 | 0.20 | 0.15 | 0.033 |
| **Diesel (USD/ km)[12]** | 0.63 | 0.36 | 0.19 | 0.061 |

The above parameters are considered based on discussions with OEMs, operators, and e-bus pilot projects by Transjakarta.

g. The cost of fare collection is excluded as the same is in the scope of Transjakarta and is common for diesel as well as electric buses and hence are excluded from the calculation of TCO.

h. Manpower Costs

- Drivers per bus (net): 2.4 (2 shifts x 1.2).
- Driver Wage: USD 8,714 per year (IDR 117 million p.a. considering UMP of IDR 4,573,845, 2 x UMP) for large/medium buses and USD 9,212 p.a. (IDR 140 million, 1 x UMP for microbus plus insurance) per driver per month including perquisites, retirement benefits etc).
- Other administrative costs: 30% of driver costs (0 for microbus since the buses are mostly operated by individual owners or drivers appointed by them).

**Other Assumptions**

a. Battery is assumed to be replaced after 8 years.
b. Battery replacement cost: $100/kWh
c. Reserve fleet is assumed @ 10% for diesel and 5% for electric buses since e-buses require less maintenance due to much lesser number of moving parts.
d. Inflation: The TCO is computed for 2022 prices without considering any change in input prices such as energy cost, manpower costs, general inflation etc.
e. IDR/USD: 15,200, based on exchange rate on October 4, 2022.
f. Insurance Cost: 1.5% of CAPEX (HPS)
g. Maintenance Cost of Infrastructure: 2.5% (CFF C40, 2021)
h. The Social Cost of Carbon (SCC) is based on Interagency Working Group on Social Cost of Carbon, 2016 estimates as shown below:

[11] IDR 3100/km for single bus (Source: Bakrie Auto Parts), 150% for articulated and 75% for medium bus

[12] Source: Transjakarta

*Table 42. The social cost of carbon*

| Year | USD @ 2007 Prices | Value of 1 USD in current price | Value of 1 ton $CO_2$ in current price |
|---|---|---|---|
| 2020 | 42 | 1.26 | 52.92 |
| 2025 | 46 | 1.46 | 67.16 |
| 2030 | 50 | 1.69 | 84.5 |

Accordingly, the cost of 1 kg of $CO_2$ in 2023 is estimated at IDR 963.

i. Discounting Rate:

*Table 43. The discounting rates*

| | |
|---|---|
| **10-year Government Bond Yield** | 7.38% |
| **Long term Inflation Expectation** | 3.29% |
| **Real Discounting Rate** | **4.09%** |

The following tables show the relative comparison of Total Cost of Operation during the life of the buses/contracts in IDR/km.

*Table 44. Total cost of ownership comparison for petrol and electric*

| Microbus | Unit | Petrol | Electric |
|---|---|---|---|
| Replacement Ratio | Units | -- | **1.0** |
| Investment/bus | IDR Mn. | 357 | 503 |
| Contract Period | Years | 7 | 10 |
| CAPEX Cost | IDR/km | 735 | 882 |
| OPEX Cost | IDR/km | 4,942 | 3,373 |
| Total TCO | IDR/km | **5,677** | **4,255** |
| % of Petrol TCO | | -- | 75% |
| Social Cost of Carbon | IDR/km | 387 | 115 |

| Microbus | Unit | Petrol | Electric |
|---|---|---|---|
| TCO with Environment Cost | IDR/km | **6,065** | **4,370** |

*Table 45. Total cost of ownership comparison for diesel and electric*

| Medium Buses | Unit | Diesel | Electric | | |
|---|---|---|---|---|---|
| | | | Depots overnight charging only | Overnight + opp. charging at depots | Depot overnight + terminal opp. charging |
| Replacement Ratio | Units | -- | 1.87 | 1.30 | 1.10 |
| Investment/bus | IDR Mn. | **1,402** | **7,412** | **5,153** | **4,360** |
| Contract Period | Years | 7 | 10 | 10 | 10 |
| CAPEX Cost | IDR/km | 3,149 | 13,558 | 9,425 | 7,975 |
| OPEX Cost | IDR/km | 9,061 | 9,511 | 9,259 | 8,208 |
| Total TCO | IDR/km | **12,210** | **23,068** | **18,685** | **16,184** |
| % of Diesel TCO | | | 189% | 153% | 133% |
| Social Cost of Carbon | IDR/km | 1,028 | 798 | 820 | 665 |
| TCO with Environment Cost | IDR/km | **13,238** | **23,866** | **19,505** | **16,848** |

Considering the higher TCO for medium electric buses with the present assumptions/specs, the following alternative scenarios are evaluated to understand the improvements required in the medium electric bus to match the diesel bus TCO.

1. Lighter chassis with larger battery of 150 kWh capacity (135 kWh now).
2. Higher range of 150 km per charge as compared to 108 km now, due to higher battery capacity and lower vehicle weight.

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3. Lower bus cost USD 130,000 as compared to USD 210,000 now[13].

Accordingly, the following TCO results is obtained:

*Table 46. Total cost of ownership result for medium bus*

| Medium Bus – Alternative Scenario | Unit | Diesel | Electric | | |
|---|---|---|---|---|---|
| | | | Depots overnight charging only | Overnight + opp. charging at depots | Depot overnight + terminal opp. charging |
| Replacement Ratio | Units | -- | 1.54 | 1.20 | 1.02 |
| Investment/bus | IDR Mn. | **1,402** | **4,187** | **3,273** | **2,789** |
| Contract Period | Years | 7 years | 10 years | 10 years | 10 years |
| CAPEX Cost | IDR/km | 3,149 | 7,658 | 5,987 | 5,102 |
| OPEX Cost | IDR/km | 9,061 | 8,705 | 8,968 | 7,912 |
| Total TCO | IDR/km | **12,210** | 16,363 | 14,955 | 13,013 |
| % of Diesel TCO | | | 134% | 122% | 107% |
| Social Cost of Carbon | IDR/km | 1,028 | 741 | 820 | 651 |
| TCO with Environment Cost | IDR/km | **13,238** | 17,104 | 15,775 | 13,665 |

*Table 47. Total cost of ownership result for single bus*

| Single Buses (High-deck and Low entry) | Unit | Diesel | Electric |
|---|---|---|---|

[13] A scenario for electric bus cost based on assumptions to show where the medium e-bus cost needs to be to achieve TCO parity.

| | | | New | Retrofit |
|---|---|---|---|---|
| Replacement Ratio | Units | | **1** | **1** |
| Investment/bus | IDR Mn. | **3,253** | **5,699** | **4,878** |
| Contract Period | Years | 7 years | 10 years | 7 years |
| CAPEX Cost | IDR/km | 7,157 | 10,207 | 12,162 |
| OPEX Cost | IDR/km | 16,627 | 12,991 | 11,977 |
| Total TCO | IDR/km | **23,784** | **23,198** | **24,139** |
| % of Diesel TCO | | **--** | 98% | **101%** |
| Social Cost of Carbon | IDR/km | 1,621 | 777 | 777 |
| TCO with Environment Cost | IDR/km | **25,405** | **23,975** | **24,917** |

*Table 48. Total cost of ownership result for articulated bus*

| Articulated Buses | Unit | Diesel | Electric |
|---|---|---|---|
| Replacement Ratio | Units | -- | 1 |
| Investment/bus | IDR Mn. | 6,680 | 10,423 |
| Contract Period | Years | 10 years | 10 years |
| CAPEX Cost | IDR/km | 11,206 | 17,485 |
| OPEX Cost | IDR/km | 20,935 | 16,122 |
| Total TCO | IDR/km | 32,140 | 33,607 |
| % of Diesel TCO | | -- | 105% |

| | | | |
|---|---|---|---|
| Social Cost of Carbon | IDR/km | 1,495 | 1,244 |
| TCO with Environment Cost | IDR/km | 33,636 | 34,851 |

Finally, the graph below represents the TCO/km of electric buses compared to single buses.

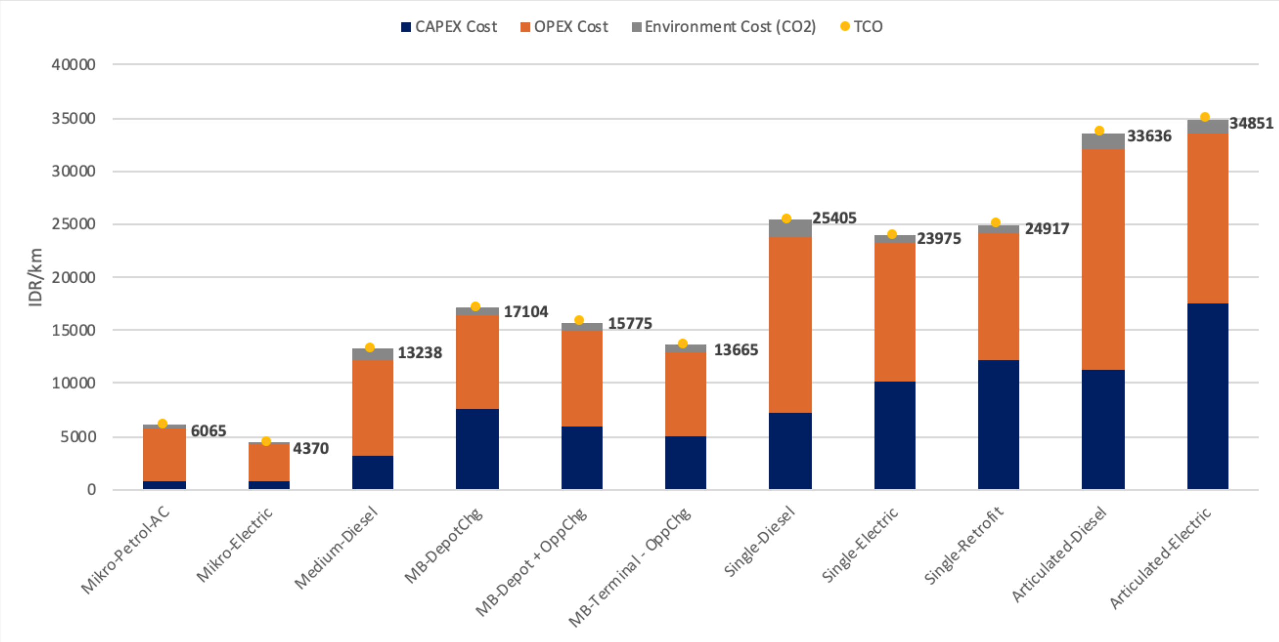


*Figure 28. TCO comparison between diesel/CNG and electric buses*

It is seen that the **Total Cost of Ownership of electric microbuses is already 25% lower than the comparable petrol buses** but with or without the environmental costs and are ready for large scale deployment. In the case of medium buses, the lowest electric bus TCO is still 15-58% higher than the comparable diesel counterpart. However, with an alternate scenario of improved bus range and lower cost, it is possible to bring down the TCO of medium electric buses to even lower than the present diesel bus TCO.

The cost of deployment of single electric buses (low entry and high deck) is 6% lower than the comparable diesel buses. **The retrofitted single buses however were not found to be as effective as the new (procured) single buses in terms of TCO**, although some further analysis on the effectiveness of retrofitted single buses needs to be conducted due to lack of reliable data sources. Similarly, the electric articulated buses TCO is slightly higher than their diesel counterparts.

The above analysis is carried out for average daily running of the buses. Further analysis and route level optimisation is possible to reduce the electric bus TCOs further.

### 10.1.2. Estimated Total Investment Cost

The total investment needed between 2023 and 2030 to completely electrify the Transjakarta fleet and also to augment the fleets from current 3,934 buses to targeted 10,047 buses is estimated on this section. For this purpose, in addition to the CAPEX assumptions made in the previous section, the following additional assumptions are made:

1. Bus Purchase Cost: Due to increase in volumes, indigenisation, technological advancement as well as decrease in battery prices, it is assumed that the cost of the e-buses will reduce by 5% per year.

2. Exchange Rates: Based on last 10 years trends, the USD is expected to appreciate by 5% p.a. against the IDR.
3. Charger Costs: The charge costs are expected to remain more or less the same, an increase @ 3.5% p.a. in line with manufacturing inflation is considered.
4. Depot Costs: The cost of depot for each additional bus is assumed at IDR 395 M for diesel buses and IDR 445 M for electric buses. The cost is expected to increase with inflation @ 3.5% p.a.
5. Land Costs: All land for depots as well as terminal infrastructure is assumed to be leased and hence no investment is estimated for the same.

Accordingly, the investment plan is prepared as follows:

*Table 49. Total cost of electric buses*

| Year | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| Articulated Bus | 0 | 0 | 823 | 1673 | 171 | 198 | 206 | 215 |
| Low Entry | 128 | 0 | 0 | 0 | 750 | 563 | 92 | 96 |
| Single Bus | 491 | 0 | 885 | 1,094 | 1,270 | 622 | 450 | 1,832 |
| Medium Bus | 242 | 181 | 234 | 488 | 426 | 484 | 617 | 952 |
| Microbus | 0 | 50 | 99 | 199 | 302 | 548 | 878 | 1,056 |
| Total | 861 | 232 | 2,041 | 3,455 | 2,919 | 2,416 | 2,243 | 4,151 |

*Price in IDR Billion*

The investment required in charging infrastructure is estimated as follows:

*Table 50. Total cost of charging infrastructure*

| Year | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| Chargers | 93.3 | 31.6 | 221.9 | 415.6 | 367.7 | 328.8 | 331.9 | 674.4 |
| Installation Cost | 9.3 | 3.2 | 22.2 | 41.6 | 36.8 | 32.9 | 33.2 | 67.4 |
| Grid Connection Cost | 9.8 | 2.8 | 30.7 | 55.4 | 34.2 | 28.1 | 25.1 | 48.4 |
| **Total** | **112.4** | **37.5** | **274.8** | **512.6** | **438.6** | **389.8** | **390.2** | **790.3** |

*Price in IDR Billion*

Due to expansion of the fleet, there will also be a requirement for depots. The cost of depot is estimated as follows:

*Table 51. Total cost of depot for fleet augmentation*

| Year | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|
| Equivalent No of Single Buses | -- | 120 | 140 | 192 | 222 | 263 | 311 | 373 |
| Cost of Diesel Bus Depot | -- | 49 | 59 | 84 | 101 | 123 | 151 | 187 |
| Cost of Electric Bus Depot | -- | 55 | 67 | 95 | 113 | 139 | 170 | 211 |

*Price in IDR Billion*

Thus, the total investment required for electric buses and comparative investment needed in business-as-usual scenario with diesel buses is presented below:

*Table 52. Total of investment needed for electric buses and comparative needed in Business as Usual (BAU)*

| Year | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | Total |
|---|---|---|---|---|---|---|---|---|---|
| **Investment in Electric Buses Programme, In Billion IDR** | | | | | | | | | |
| E-buses | 861 | 232 | 2,041 | 3,455 | 2,919 | 2,416 | 2,243 | 4,151 | **18,317** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Chargers | 93 | 32 | 222 | 416 | 368 | 329 | 332 | 674 | **2,465** |
| Charger Installation | 9 | 3 | 22 | 42 | 37 | 33 | 33 | 67 | **247** |
| Cost of grid connection | 10 | 3 | 31 | 55 | 34 | 28 | 25 | 48 | **234** |
| Depot Cost | 0 | 55 | 67 | 95 | 113 | 139 | 170 | 211 | **850** |
| Total Investment (A) | 973 | 324 | 2,382 | 4,062 | 3,471 | 2,945 | 2,803 | 5,153 | **22,113** |
| **Investment in Diesel Buses (BAU), In Billion IDR** | | | | | | | | | |
| Cost of diesel buses | 550 | 146 | 1,504 | 2,653 | 2,227 | 1,934 | 1,875 | 3,556 | **14,445** |
| Cost of Depot | | 49 | 59 | 84 | 101 | 123 | 151 | 187 | **755** |
| Total Investment (B) | 550 | 195 | 1,563 | 2,738 | 2,328 | 2,057 | 2,026 | 3,743 | **15,200** |
| Incremental Investment (A-B) | 423 | 129 | 819 | 1,324 | 1,143 | 887 | 777 | 1,409 | **6,913** |
| | 77% | 66% | 52% | 48% | 49% | 43% | 38% | 38% | **45%** |

It is seen that **adoption of 100% electric buses by Transjakarta is expected to require a total investment of IDR 22 T** as compared to a business-as-usual scenario investment of **IDR 15 T** i.e., **45% higher**. However, it is to be noted that this is only the total investment needed to deploy the e-bus, it has not considered the operating costs as described in section 7.2. It was described that when considering the operating costs, it will result in lower TCO as compared to diesel buses.

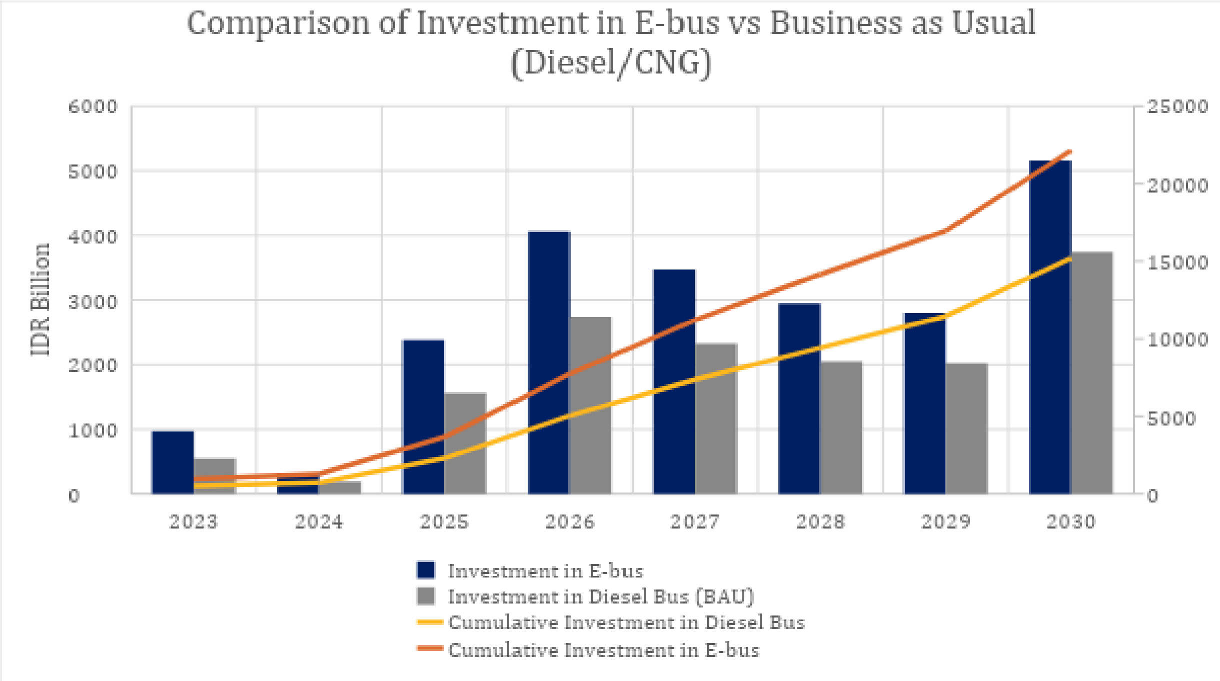


*Figure 29. Comparison of investment in E-buses vs BAU*

## 6.1. Financial Analysis

the financial feasibility is evaluated using Net Present Value of the difference of total pay-outs by Transjakarta between the Business-as-Usual (BAU) scenario and the following scenarios for deployment of electric buses:

- Option 1: E-buses are procured by operators directly and deployed through BTS contract.
- Option 2: E-buses are financed by Transjakarta/SPV and leased to operators.
- Option 3: E-buses are procured by Transjakarta or the operators through lease financing.
- Option 4: This option uses a combination of the above options for different bus types, i.e., option 1 for single/low entry and medium buses, option 2 for articulated buses and option 3 for microbus. Such an option divides the financing responsibility amongst the government, operators and asset aggregators/leasing companies and thus making the roadmap more implementable.

The total cashflow considered include the fees payable to operators, loan instalment/interest, insurance premium, lease rentals, asset management costs as applicable under each option but excludes the fare collection costs, cost of operation of the Transjakarta's owned fleets under options 1 and 3, and administrative and general overheads of Transjakarta as those expenses are likely to be same for diesel or electric buses. It should also be noted that the MAXI buses are assumed to be replaced by the single buses and Royaltrans and tourism services are also excluded from the scope of this analysis. The annual total pay-outs under the electrification options also include the payment of BTS fee with respect to the diesel fleet that are yet to be replaced with electric buses.

Accordingly, the summary of the financial feasibility analysis is presented below:

*Table 53. Difference in NPV from BAU (Figures in Rp Billion)*

| Type of Bus/Option | Option 1 | Option 2 | Option 3 | Option 4 |
|---|---|---|---|---|
| Articulated Buses | -126 | 376 | -188 | 376 |
| Low Entry Buses | 115 | 299 | 0 | 115 |
| Single Buses | 399 | 943 | -358 | 399 |
| Medium Buses | 723 | 990 | 391 | 723 |
| Mikro Buses | 3115 | 5583 | 5134 | 5134 |
| **Total** | **4225** | **8191** | **4978** | **6747** |
| %age of BAU NPV | 10.6% | 20.6% | 12.5% | 16.9% |

The estimated year-wise increase (negative) or decrease (positive) in PSO requirements as compared to BAU scenario for various options for electrification is shown in Table 54:

*Table 54. Reduction in Operating Subsidy (Figures in Rp Billion)*

| | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Option 1 | -11 | -15 | -23 | -13 | 63 | 212 | 457 | 823 | 948 | 1073 | 1235 |
| Option 2 | -13 | -11 | 6 | 58 | 172 | 391 | 754 | 1309 | 1602 | 1902 | 2112 |
| Option 3 | -32 | -49 | -63 | -87 | -31 | 112 | 394 | 811 | 1078 | 1352 | 1511 |
| Option 4 | -11 | -13 | -2 | 41 | 144 | 337 | 659 | 1143 | 1405 | 1674 | 1985 |

In case, The Government of Jakarta/ Transjakarta decides to pursue Option 2, the net funding required is shown below

*Table 55. Table 3. Net Funding Required from Transjakarta in Option 2*

| Yearly Funding Requirement | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | Total |
|---|---|---|---|---|---|---|---|---|---|
| Articulated Buses | | | 889 | 1321 | 152 | 175 | 182 | 190 | 2909 |
| Low Entry Buses | 113 | | | | | 817 | 419 | 90 | 1439 |
| Single Buses | 435 | 651 | 134 | 969 | 1138 | 486 | 471 | 1600 | 5883 |
| Medium Buses | 193 | | 96 | 391 | 476 | 482 | 495 | 760 | 2894 |
| Microbuses | | 45 | 87 | 176 | 267 | 485 | 777 | 935 | 2773 |
| **Total Investment Cost** | **741** | **695** | **1207** | **2857** | **2033** | **2446** | **2345** | **3575** | **15899** |

*(Figures in Rp Billion)*

Overall, all the four options considered are found to be financially feasible as compared to the Business-as-Usual scenario of using ICE buses. However, it should be noted that the absolute amount of PSO requirement will still increase as compared to current levels due to expansion of the fleet by 2.5 times by 2030 and increase in cost of manpower etc. This analysis only confirms that the overall cost will be lower with electric buses than with ICE buses.

Scenario analysis was carried out to ascertain the financial robustness of the various options considered. It is seen that, despite various adverse scenarios assumed, the NPV of electrification remains positive in all options except when electric buses imported from Europe are considered. Option 2 remains the most favourable of all options followed closely by option 4. It is seen that the financial feasibility is most sensitive to changes in CAPEX associated with the e-buses and is low to moderate sensitive towards changes in electricity prices, maintenance costs, or cost of funds. Also, it is seen that the alternate roadmap which accelerates the e-bus deployment has a higher NPV as compared to the base case scenario.

## 6.2. Sensitivity Analysis

The financial analysis presented in section 7.2 is dependent on the assumptions made. There may be variations in actual realisation of these assumptions. The objective of this section is to check the sensitivity of various assumptions on the financial feasibility and to identify the key parameters which must be watched carefully to ensure the continued financial feasibility of the electrification of the fleet.

The following scenarios are considered:

*Table 56. Parameters for Sensitivity Analysis*

| Parameter | Scenario Name | Assumptions |
|---|---|---|
| **Energy Price** | E1. Modest Fossil Fuel Price Increase | Diesel/Petrol/CNG prices and Electricity prices increase at the same rate of 3% p.a. |
| | E2. Higher Electricity price Rise | Diesel/Petrol/CNG prices and Electricity prices increase at the rate of 3% p.a. and 4.5% p.a. |
| **Capex** | C1. Over Supply in ICE Bus Market | Diesel Bus prices reduce by 5% p.a. |
| | C2. Rationalisation of E-bus prices in Indonesia | E-buses prices reduce by 15% p.a. for 3 years and then increase @ 3.5% p.a. |
| | C3. Considering E-buses imported from Europe | Cost of E-buses will be 67% more than in the base case.[14] |
| **Cost of Funds** | F1. Increase in cost of funds due to new technology | Cost of funds for each of the financing options increase by 1% p.a. |

[14] 12m E-buses in UK cost about USD 500,000 as compared to USD 300,000 assumed in base case.

| | | |
|---|---|---|
| **Maintenance Cost** | M1. Higher Maintenance Cost for E-buses | Increase in Maintenance cost of e-buses by 10% |
| **Accelerated Deployment** | D1. Faster deployment of Microbus | Using alternate deployment scenario B of implementation phase |

The impact of the above sensitivity scenarios on the NPV of each of the options is shown:

*Table 57. Sensitivity Analysis Results*

| Scenario/Option | A | B | C | D |
|---|---|---|---|---|
| Base Case | 4,225 | 8,191 | 5,245 | 6,786 |
| E1 | 3,170 | 7,127 | 4,181 | 5,713 |
| E2 | 2,944 | 6,941 | 3,995 | 5,496 |
| C1 | 766 | 4,491 | 1,661 | 3,274 |
| C2 | 8,298 | 11,286 | 9,453 | 10,492 |
| C3 | -4,141 | 1,152 | -3,771 | -1,130 |
| F1 | 3,343 | 6,860 | 4,040 | 5,650 |
| M1 | 3,546 | 7,527 | 4,581 | 6,124 |
| D1 | 4,319 | 8,603 | 5,602 | 7,143 |

*(Figures in Rp Billion)*

It is seen that, despite various adverse scenarios assumed, the NPV of electrification remains positive in all Options except C3 and Option 2 remains the most favourable of all Options followed closely by Option 4. It is seen that the financial feasibility is most sensitive to changes in Capex associated with the E-buses and is low to moderate sensitive towards changes in electricity prices, maintenance costs or cost of funds. Also it is seen that the alternate roadmap which accelerates the e-bus deployment has a higher NPV as compared to the base case scenario.

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# 7. Potential Economic Benefits of The Project

## 7.1. Quantifiable benefits

### 7.1.1. GHG Emissions and Social Cost of Carbon

The saving in average GHG emission for e-buses has been estimated after taking into account the transmission and distribution losses of 8.8% and 30% biodiesel content of the bio solar fuel and combined margin for grid of 0.817 kg of CO2/kWh. By 2028, grid GHG emission factor is expected to reduce to 0.67 resulting in further reduction in GHG emissions. This can be further supplemented with a generation of rooftop solar PV from bus depots, bus stations, terminals and halts.

In order to assess the economic value of the GHG emission reduction, the Social Cost of Carbon (SCC) is estimated based on Interagency Working Group on Social Cost of Carbon, 2016 central estimates based on 3% discount rate, which result in IDR 853,495/ $TCO_2$ in 2023 and IDR 1807,280/$TCO_2$ in 2030. The estimated social cost of carbon avoided by electrification is summarised below:

*Table 58. Estimated social cost of carbon avoided by electrification of Transjakarta fleet*

| | | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **GHG Emission from Motor Fuels Avoided** | | | | | | | | | | | | |
| Petrol consumption avoided | Million litres | | 0.70 | 2.10 | 4.91 | 9.12 | 17.04 | 29.66 | 44.82 | 44.82 | 44.82 | 44.82 |
| Diesel Consumption avoided | Miliion litres | 5.41 | 9.73 | 11.51 | 21.60 | 33.67 | 46.91 | 57.54 | 76.10 | 76.10 | 76.10 | 76.10 |
| CNG Consumption avoided (LSP) | Million LSP | | | 6.92 | 17.21 | 18.40 | 19.77 | 21.20 | 22.70 | 22.70 | 22.70 | 22.70 |
| **GHG Emissions avoided** | **000 tons** | **18.5** | **35.3** | **63.3** | **132.5** | **189.2** | **261.4** | **338.7** | **450.8** | **450.8** | **450.8** | **450.8** |
| **GHG Emission from Electricity consumed** | | | | | | | | | | | | |

| | | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| %age of RE Consumed | | 5% | 10% | 15% | 20% | 20% | 20% | 20% | 20% | 20% | 20% | 20% |
| %age Grid Electricity Consumed | | 95% | 90% | 85% | 80% | 80% | 80% | 80% | 80% | 80% | 80% | 80% |
| Grid Emission Factor | kg CO2e/kWh | 0.791 | 0.742 | 0.692 | 0.683 | 0.673 | 0.664 | 0.655 | 0.645 | 0.637 | 0.628 | 0.619 |
| **Electricity Consumed** | | **15.29** | **27.73** | **50.99** | **107.56** | **150.98** | **203.57** | **256.60** | **335.91** | **335.91** | **335.91** | **335.91** |
| **GHG Emission from Electricity consumed** | **000 tons** | **11.49** | **18.51** | **29.99** | **58.73** | **81.29** | **108.09** | **134.36** | **173.46** | **171.06** | **168.70** | **166.36** |
| GHG Emission Reduced | 000 Tons | 7.01 | 16.81 | 33.32 | 73.74 | 107.89 | 153.27 | 204.34 | 277.31 | 279.71 | 282.07 | 284.40 |
| Cost of GHG Emission | IDR/Tons | 1018985 | 1121099 | 1233446 | 1357052 | 1493045 | 1642665 | 1807280 | 1988391 | 2187651 | 2406879 | 2648077 |
| **GHG Emission reduction value** | **Bn IDR** | **7.14** | **18.85** | **41.10** | **100.07** | **161.08** | **251.77** | **369.31** | **551.40** | **611.90** | **678.91** | **753.12** |

#### 7.1.2. Air Pollution (SOx/NOx/PPM) and Their Social Cost

The social cost of the air pollution emitted as a result of transportation as well as electricity generation is estimated based on the cost per ton of respective emissions as estimated by the International Monetary Fund in "**Getting Energy Prices Right From Principle to Practice**", 2014 adjusted to current prices as follows.

*Table 59. Social Cost of Emissions*

| Emission Cost (Per Ton) | Sulphur Oxides | | | Nitrogen Oxides | | | Primary Fine Particulate Matters | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coal | Natural Gas | Ground Level | Coal | Natural Gas | Ground Level | Coal | Natural Gas | Ground Level |
| USD (2010) | 4,617 | 5,627 | 2,159 | 2,492 | 2,699 | 449 | 5,636 | 6,936 | 60,669 |
| USD (2023) | 6371 | 7765 | 2979 | 3439 | 3725 | 620 | 7778 | 9572 | 83723 |
| IDR (Million) | 97 | 118 | 45 | 52 | 57 | 9 | 118 | 145 | 1273 |

Considering that nearly 50% of electricity in Indonesia is produced from coal as compared to 35% from Natural gas and oil, weighted average values are considered.

The estimated value of emission reductions due to electrification of TJ fleet is shown below:

*Table 60. Estimated value of air pollution reductions due to electrification of Transjakarta fleet*

| | | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SOx Emissions avoided** | | | | | | | | | | | | |
| From motor fuels | Tons | 1 | 2 | 3 | 7 | 13 | 22 | 36 | 53 | 53 | 53 | 53 |
| From electricity | Tons | 15 | 22 | 38 | 73 | 99 | 128 | 155 | 194 | 184 | 175 | 166 |
| Savings/(Cost) | Bn IDR | **-0.7** | **-1.0** | **-1.8** | **-3.5** | **-4.8** | **-6.1** | **-7.2** | **-8.8** | **-8.5** | **-8.2** | **-7.9** |
| **NOx Emissions avoided** | | | | | | | | | | | | |
| From motor fuels | Tons | 207 | 373 | 453 | 857 | 1,324 | 1,838 | 2,256 | 2,980 | 2,980 | 2,980 | 2,980 |
| From electricity | Tons | 9 | 14 | 22 | 42 | 55 | 68 | 80 | 97 | 89 | 81 | 74 |
| **Total Savings/(Cost)** | **Bn IDR** | **1.9** | **3.7** | **4.6** | **9.0** | **14.6** | **21.2** | **27.2** | **37.5** | **39.1** | **40.8** | **42.6** |
| **PM2.5 Emissions avoided** | | | | | | | | | | | | |
| From motor fuels | Tons | (0.1) | (0.2) | (0.4) | (0.9) | (1.5) | (2.7) | (4.4) | (6.5) | (6.5) | (6.5) | (6.5) |
| From electricity | Tons | 0.8 | 1.1 | 1.9 | 3.4 | 4.4 | 5.4 | 6.3 | 7.4 | 6.8 | 6.1 | 5.5 |
| **Savings/(Cost)** | **Bn IDR** | **-1.1** | **-1.8** | **-3.2** | **-6.4** | **-9.2** | **-13.1** | **-18.0** | **-24.5** | **-24.2** | **-24.0** | **-23.8** |
| **Total Savings** | **Bn IDR** | **0.2** | **0.8** | **-0.4** | **-0.8** | **0.7** | **2.0** | **2.0** | **4.2** | **6.3** | **8.6** | **10.8** |

It is seen that the emissions from electricity produced exceeds those from motor fuels saved in case of SOx and $PM_{2.5}$. Efforts are needed in regard to reducing emissions from power generation plants as well reducing EV battery weights in order to make the EVs better than their ICE counterparts in this regard.

## 7.2. Reduction in Fuel Subsidy

Pertamina, the state-owned petroleum marketing company, supplies Pertalite (RON 90) at a price of IDR 10,000[15] as against a production cost of 14,450 i.e., with a subsidy of IDR 4,450. Similarly, diesel (Biosolar/ CN48) is sold at 6,800 rupiah per litre, compared with a production cost of 13,950 rupiah. As regards to the price of compressed natural gas used by articulated buses, the price was reduced in 2021 by Government of Indonesia by cutting the government profit's share from natural gas upstream[16]. Further, the price has been significantly increased in 2022 from IDR 3100 to IDR 4500 per litre premium equivalent (LSP). Hence it is assumed that there are no significant subsidies applicable to CNG.

On the other hand, electricity for e-bus charging is competitively priced. The government has decreed that the electricity for e vehicle charging will be determined by PLN between IDR 714 to 1625/kWh depending on the business prospects. This compares reasonably with the average electricity tariffs charged by PLN for various consumer groups which ranged between IDR 806 to 1447/kWh in 2021. Hence, it is reasonable to assume that the electricity for charging of e-buses is not subsidised. Thus, operating EVs would result in savings of to the government which it can deploy in other social benefit schemes as shown in Table 61.

*Table 61. Economic Impact of Reduction in Fuel Subsidy*

| Fuel Type | | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diesel | Rp Billion | 39 | 70 | 82 | 154 | 241 | 335 | 411 | 544 | 544 | 544 | 544 |
| Gasoline | | | 3 | 10 | 24 | 45 | 84 | 147 | 222 | 222 | 222 | 222 |
| **Total Reduction** | | **39** | **73** | **93** | **179** | **286** | **420** | **558** | **766** | **766** | **766** | **766** |

*(Figures in Rp Billion)*

## 7.3. Non-quantifiable benefits

### 7.3.1. Noise Pollution

Due to fewer moving components, electric buses are decidedly quieter in operation than comparable ICE buses considering noise from propulsion system only. Other sources of noise due to movement of the bus is not differentiate between technologies. However, a comparison and

[15] Indonesia bites the bullet on fuel prices as subsidies soar | Reuters| September 3, 2022

[16] Why Indonesia Should Abandon its Natural Gas Pricing Regulation – The Diplomat

calculation of the economic effect similar to that made in atmospheric emissions cannot be made without calculating the decibel levels within the bus and surrounding areas which are contributed by factors other than the bus itself. Hence, the quantitative benefit from lower noise levels is kept outside the scope of this report.

### 7.3.2. Reduction in Foreign Exchange Outgo

Indonesia is a net importer of petroleum. Due to gradual decline in domestic production and increase in consumption, the import of petroleum reached 233,000 barrels/day in Dec 2020 as compared to 215,583 barrels/day in Dec 2019. Assuming no change in domestic production, the reduction in demand for gasoline due to electrification of microbus fleet will reduce the import of crude oil/refined gasoline to that extent. The saving in foreign exchange outgo due to electrification of the microbus fleet is thus estimated in Table 62.

*Table 62. Reduction in Forex Outgo*

| Forex Outgo Reduced | | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **No of Barrels ('000s)** | | 34.0 | 66.1 | 87.1 | 170.2 | 275.5 | 414.1 | 569.2 | 791.8 | 791.8 | 791.8 | 791.8 |
| **Price per barrel (USD)** | | 77.3 | 79.6 | 82.0 | 84.4 | 86.9 | 89.6 | 92.2 | 95.0 | 97.9 | 100.8 | 103.8 |
| **Foreign outgo saved** | USD Mn | 2.6 | 5.3 | 7.1 | 14.4 | 24.0 | 37.1 | 52.5 | 75.2 | 77.5 | 79.8 | 82.2 |
| | Rp Billion | 44 | 93 | 132 | 279 | 488 | 793 | 1,179 | 1,774 | 1,918 | 2,075 | 2,244 |

Due to the import dependency, a large portion of the money spent on fuel goes out of the Indonesian economy and consequently produces very little economic activity. In the United States e.g., it is estimated that the amount spent in other sectors can generate 16 times as many jobs per dollar spent as compared to the petroleum sector[17]. The effect of foreign exchange outgo on domestic economy is a very complex subject and beyond the scope of this report. Besides, the burden of this outgo is mostly borne by the customers with about 11.3% borne by the government of Indonesia by way of subsidies in 2021[18] (10.5% in 2020) and the impact of the subsidies has already been discussed in the previous section and hence not quantified again to avoid double-counting.

[17] Indonesia bites the bullet on fuel prices as subsidies soar | Reuters| September 3, 2022

[18] Why Indonesia Should Abandon its Natural Gas Pricing Regulation – The Diplomat

## 7.4. Economic Analysis (NPV, BCR)

### 7.4.1. Key Assumptions

Fiscal Correction Factor: A correction factor of 0.8 is used in the economic analysis to correct financial transfers (taxes, subsidies etc).

Discount Rate: 7.15% (nominal discount rate corresponding to TJ/DKI Jakarta cost of funds)

For the purpose of Social Cost Benefit Analysis, the following has been considered:

*Table 63. Factors considered in calculating cost and benefits of deploying electric buses*

| Costs | Benefits |
|---|---|
| a) Incremental economic investment in acquiring the electric buses<br>b) Cost of charging infrastructure | a) Saving in Operating Costs<br>b) Saving in Social Cost of Carbon<br>c) Savings in health cost due to reduction in SOx/NOx/$PM_{2.5}$ emissions<br>d) Savings in subsidies on diesel/gasoline fuels |

Based on the above, analysis, the summary of economic indicators are as follows:

*Table 64. Social Cost Benefit Analysis Result*

| Parameter | Unit | 2031 | (2024-2034) |
|---|---|---|---|
| Reduction in GHG Emissions | '000 Tons | 288 | 1779 |
| Reduction in SOx Emissions | Tons | (154) | (1160) |
| Reduction in NOx Emissions | Tons | 2657 | 17,800 |
| Reduction in $PM_{2.5}$ Emissions | Tons | (9.7) | (69.3) |
| Reduction in Foreign Exchange Outgo | USD Mio | 75 | 457 |
| Reduction in Fuel Subsidy | IDR Bn | 1089 | 6760 |
| Economic IRR | | 34% | |
| PV of Benefits | IDR Bn | 10,070 | |
| PV of Costs | IDR Bn | 4,179 | |
| Cost Benefit Ratio | | 2.41 | |

# 8. Project Implementation Risk

Even though the concessional finance may offer attractive loan rates and tenure, it is thought to be more challenging to implement in the context of Transjakarta electrification as it requires strong financial power of the entity to be able to acquire all the assets related to electrification including buses, battery, charging infrastructures and its facilities. It also requires support from the government as the guarantor, which would be difficult since it would need political commitment. Furthermore, in this case, Transjakarta would be the asset owner, which through market consultation, is not preferred. Transjakarta would want the asset ownership to be either with the operators or a third party.

The asset separation model is believed to be more practical to adopt in the Transjakarta context as it offers more flexibility to allow new players to participate and is in line with Transjakarta preference of not owning the assets.

Each option offers different benefits and drawbacks and should be carefully evaluated to determine the best option for a particular project. Ultimately, the most financially sound BRT electric bus system is one that is tailored to the specific needs of the local community and the financial capabilities of the local authorities.

Depending on the specific needs and goals of the project, the best option should be chosen to ensure that the system is both cost effective and financially sustainable in the long run. For example, funding through grants, fare box revenue, and tax incentives can all be used to finance the project. Additionally, long-term financing options such as bonds and loans can be used to ensure that the project is able to continue providing service in the future. Ultimately, it is important to use the right mix of financing tools to ensure that the project is not only cost effective, but also financially sustainable in the long run.

Furthermore, the table below summarises how the 2 schemes, concessional finance and asset ownership separation, would address the main barriers that were identified.

*Table 65. Business Models Addressing Main Barriers*

| Main Barriers | Concessional Finance for Asset Owners | Separation of Asset Ownership |
|---|---|---|
| High up-front cost | Increases access to capital, helping access e-bus | Reduce up-front cost for operators because components (bus, battery, charging) are owned by third party owners |

| | | |
|---|---|---|
| Access and cost of financing | Reduces financial costs, by providing beneficial terms | Large players have access to better financing options, compared to bus operators |
| Limited access to financial guarantees to de-risk operations | Operators can be part of the solution, but are not given | Risk asset ownership is shifted to third party asset owner |
| Limited investment in infrastructure | Provide means to invest in infrastructure | Large players may attract more capital for infrastructures |

*Source: adopted from [www.c40knowledgehub.org](www.c40knowledgehub.org)*

As shown above that the barriers may be addressed by the new business models, it may not mitigate the risks yet. There are several risks that still exist. The figure below shows the type of risks and potential mitigations in order to reduce, if not eliminate, the risks.

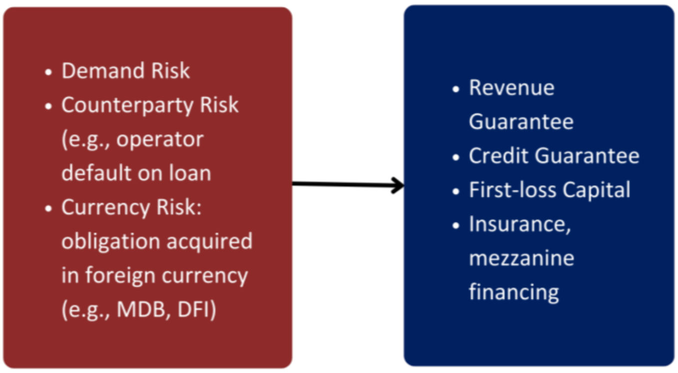


*Figure 30. Potential Risks and Its Mitigations*

Mitigation of financial risk can be accomplished by utilising a variety of methods, such as credit guarantee, revenue guarantee, also first loss capital. First loss capital is a type of financial instrument that is designed to absorb losses in the event of a default on a loan or other financial obligation. First loss capital is typically held by a lender as a form of collateral to protect against losses due to borrower default. Other methods include hedging, diversification, portfolio insurance and risk management. By utilising a combination of these methods, BRT electric bus systems can be made financially sustainable. The table below shows how this would work in the Transjakarta electrification context.

*Table 66. Risk Mitigation in E-Bus Deployment*

| Credit Guarantee and Revenue Guarantee Can Help Mitigate Counterpart and Demand Risk | | |
|---|---|---|
| **TYPES** | **OPTIONS** | **HOW WOULD THIS WORK?** |
| **Credit guarantees** | **Partial Credit Guarantee (PCG)**: cover part of debt if operators or asset purchases default on repayment | MDBs/I/DFIs or national development finance institution agree to pay certain portion of principal and/or interest in case of default; would be structured at portfolio level (e.g., across many operators) |
| **Revenue guarantee** | Creations on new-city level government trust | Dedicated government resources to set up city-level trust can guarantee certain types of payment, where they do not already exist |
| | Structuring of other guarantee | Structure e-bus guarantee pools with MDBs/I/DFIs |
| **First-loss capital can also mitigate financial risk for more senior investors** | | |
| **Revenue guarantee** | Direct minimum revenue guarantee: guarantee revenues to operators and/ or income to investors, mitigating counterparty risk for investors | • Analyze operators' path cash flows and demand<br>• Government grants to operator a minimum level revenue for contract period<br>• This can be structure as a put option, but and call option, or put and call option with limitation |
| **Others** | Insurance | Credit insurance company insures the savings promised to operators by guaranteeing a payment if promised saving are not meet |
| | Mezzanine finance: offer different repayment method for investors | Change repayment terms so that inventors receives a certain percent operator revenues for certain period of time – until the debt is repaid (revenue sharing models) |
| | First-loss capital: agrees to step in resulting from investment, decreasing risk for more senior investors | Donors or The Government of Jakarta/ Transjakarta step-in in case that investment is not profitable/ counterparty cannot repay obligations. |

*Source: www.c40knowledgehub.org*

Additionally, risk allocation could also help in mitigating the risks associated with the electrification of the fleets. Political risk can be allocated by having an agreement that defines the responsibilities of each actor in the event of political changes, such as changes in government, laws and regulations. This agreement can also define the specific rights and obligations of each party in the event of political changes.

Technology and operational risk can be allocated by setting up a detailed service level agreement that defines the quality and reliability of the services to be provided. This agreement can also include provisions for regular maintenance, monitoring and upgrades to the technology used.

Financial risk can be allocated by setting up a payment structure that includes a detailed payment schedule and penalty clauses for non-performance. This agreement can also define the scope of the financial risk, including the total amount of money that can be at risk, and the conditions under which the money can be returned or refunded.

Table 67. Risk Allocation in E-Bus Deployment

| Type of risk | Description | TJ PTA | Asset owners | Manufacturers | Financiers | Credit guarantees | Financial Intermediary | Operators |
|---|---|---|---|---|---|---|---|---|
| Political | Change in contracts (1) | | 2 | | | | | 1 2 |
| | Change in government (2) | | 2 | | | | | 1 2 |
| Tech & operational | Availability risk (3) | 1 2 | | 1 2 | | | | 1 2 |
| | Battery risk (4) | | | 1 2 | | | | |
| | Falling prices | | 2 | | | | | 1 |
| Financial | Demand risk (5) | 1 2 | | | | | | |
| | Counterparty risk | | | | 1 2 | 1 2 | 1 | |
| | Currency risk (6) | | 2 | | 2 | 1 2 | 1 | |

1 — Actor take on risk in concessional finance commercial arrangement (1)

2 — Actor take on risk in separation of assets commercial arrangement (1)

*Source: adopted from [www.c40knowledgehub.org](www.c40knowledgehub.org)*

## 9. Gender Impact Assessment

**Defining the "Vulnerable Groups" on E-Bus Electrification**

Vulnerable groups are seen as the most vulnerable stakeholders within a system and throughout the entire Transjakarta system this can include vulnerable passengers such as women, children, people with disabilities, older persons, people living in urban villages, low-income households, operators with less financial and knowledge capacity, drivers, technical workers, staff, as well as society as a whole, specifically those more vulnerable to negative impacts due to GHG and air pollution. Therefore, further GESI analysis should look at all stakeholders that may be impacted by the electrification process and ensure the no one left behind principle is always accommodated.

**Result from Market Consultations**

Market consultations show that there is high interest by market players to participate in the Transjakarta electrification, however high upfront costs may cause as a burden for operators who cannot benefit as much from economies of scale. Current procurement processes for the e-buses do not necessarily discriminate against any players from participating, however, extra attention should be given to market players with lower financial/knowledge capacity.

**Implementation Plan and Technical Aspects**

The implementation plan is divided into two scenarios in which scenario A is the default scenario to electrify all of Transjakarta's fleets by 2030, and scenario B aims to accelerate the process by also electrifying microbuses early on by 2023. The latter will also ensure more residential areas such as urban villages will have access to e-buses, and benefit from the lower GHG and pollution produced. However, it must be noted that microbuses are still less accessible for wheelchairs and strollers due to its smaller size and dimensions. As microbus has proven to be one of the buses that has a high number of vulnerable groups, it is important to do further participatory planning with vulnerable groups when electrifying this type of bus. Yearly GESI visions should be placed to monitor the electrification process of Transjakarta buses, after the UK PACT EUM 124 Project is finished, to ensure the sustainability of the GESI mainstreaming efforts.

Moreover, the current variables that are used to identify the route level analysis ensure the sustainability of the e-buses to meet Transjakarta's target to be fully electrified by 2023. The variables ensure effective electrification therefore people can benefit from the lower GHG and air pollution, specifically vulnerable groups that are more prone to negative impacts due to low air quality.

Charging infrastructure remains one of the most crucial aspects to be planned, as incidents in charging locations may cause a disturbance in Transjakarta's operations, highly affecting the mobility of vulnerable groups who make up a high percentage of Transjakarta's passengers.

**E-Bus Financing**

Alternative financing is necessary to support stakeholders that may have lower financial capacity to electrify their fleets. A distribution of risks through alternative financing will ensure that smaller operators will not be left behind during the electrification process.

**Social Benefit of The Electrification**

Electrifying Transjakarta's buses will lower social costs and benefit society as a whole. Increased air quality due to lower levels of GHG, pollutants and particulate matter will benefit society, especially vulnerable populations such as those more susceptible to respiratory diseases.

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