C40 CITIES FINANCE FACILITY

HEAT

Business Case for Zero-Emission Buses

100 e-bus trial: experience with TransJakarta

November 19, 2020

Background

SITUATION IN JAKARTA

- Among global cities one with the worst air quality
- Commercial vehicles, representing <0.5% of the total vehicles, are responsible for 10-20% of emissions.
- 60% of the population suffers from various air pollution related diseases.

- 08/2019: Presidential Decree for Acceleration of Battery-Electric Vehicles
- 02/2020: DKI Jakarta and C40 Cities Finance Facility (CFF) collaboration “Zero Emission Buses in Jakarta”
- MEMR Regulation 13/2020: Development of private and public E-vehicle infrastructure

Problem Definition

An alternative public transport system that

- reduces/eliminates air pollution
- reduces GHG emissions
- is either economical or competitive to existing systems
- a pilot project that provides implementation experience and guidelines for broader implementation

Business Case Approach

To define a pilot project framework that

- is economically acceptable
- Is operationally feasible
- implementation model acceptable to stakeholders
- implementable in the expected timeframe
- mitigates social and environmental risks

- Key Inputs
  - Market Study
  - E Bus Phase 1 trials
  - Technical and financial feasibility study

TransJakarta: some key facts

NETWORK

Longest global BRT network 244 kms
950.000 riders per day

Corridors
13 main corridors - BRT
155 feeder routes - Greater Jakarta Area

FLEET

4077 buses
874 own buses
3,203 buses on contract

bus types: small, medium, single, maxi, and articulated buses

engine: diesel, gasoline, and CNG

TJ Management is very forward looking and is ably assisted by a capable technical team. Under the guidance of the Governor, DKI, TJ expects to operate a fleet of over 12,000 buses by 2030 with every 5 out of 6 buses running on clean fuel.

Technical Feasibility Study

Recommendations at a glance

Routes:	BRT	1, 3, 4, 6, 8 and 10.
	Non-BRT	1A, 7A, 7D, GR1, 6D, 1B, 6H, 9D, 5F and GR2.

Charging Strategy: (230 kms/day)	Big Battery (>300 kWh)	Depot charging
	Medium or small battery	Depot charging + Opportunity charging

Routes Selected

Routes	1st	2nd	3rd
Route Type	BRT	Non-BRT	Non-BRT
Bus Type	12m HE	12m LE	12m LE
Average Ridership (Pax/day)	35,392	5,148	4,582
Operating (kms/day)*	242	154	178
Prospective Depot Locations	Jati Asih, Cawang, Cakung, Cipulat		
Dead kms	40-50	~50	~40

The Depots are owned/rented by the operators. However, for Route 6 TJ is actively considering acquiring the land to develop a depot at Pejatan which is located along the route to both reduce dead kms and facilitate charging during off-peak hours.

**** It is assumed that the Op kms above includes 20 kms dead mileage***

Implementation Model

- Option 1: Owner-Operator Model –
  - *TJ procures and operates the buses*

- Option 2: Buy the Service Model
  - *Concessionaire procures the bus and operates for TJ*

The BTS Model is preferred due to:

1. E Bus requires substantial investment and technology is yet to be fully tested (one life cycle) in Indonesian conditions
2. Operators can enter into long terms relationships with manufacturers for maintenance, training, spares etc.
3. TJ already has systems in place and quotas are available under existing BTS contracts

Capital Expenditure

	US$ Million	%age
Bus Procurement Costs	**33.06**	**89%**
Charger Costs	**1.73**	**5%**
Electrical Connection	**0.78**	**2%**
Fees/Contingency	**1.78**	**5%**
Total Capex - Electric	**37.35**	**100%**
- Diesel (BAU)	**15.13**	

The total capex cost for the E Buses will be ~ US$ 37 m whereas for diesel buses it will be about ~ US$ 15 m

Investment Appraisal

- **NPV** Net present value of all cashflows
- **FIRR** Financial Internal Rate of return
- **EIRR** FIRR + Socio-economic benefits
- **Cost/km** Average cost per kilometre

Comparison of Options – 1st (BRT)

		Diesel	Electric		
		7 Years	7 Years	10 Years	12 years
Capex Charge/year	US$ m	1.45	3.66	3.04	2.79
Avg Opex per year	US$ m	4.67	3.79	3.97	3.94
Total cost/year	US$ m	6.12	7.45	7.01	6.73
Total Cost/km*	US$/km	1.22	1.48	1.39	1.34
Difference from BAU	US$/km	--	0.26	0.18	0.12
	%	--	22%	15%	11%

Above costs are estimated based on constant prices.

Comparison of Options – 2nd (non-BRT)

		Diesel	Electric		
		7 Years	7 Years	10 Years	12 years
Capex Charge/year	US$ m	0.40	1.04	0.86	0.79
Avg Opex per year	US$ m	0.89	0.77	0.86	0.85
Total cost/year	US$ m	1.29	1.81	1.73	1.64
Total Cost/km*	US$/km	1.43	2.02	1.92	1.82
Difference from BAU	US$/km	--	0.58	0.49	0.39
	%	--	41%	36%	29%

Above costs are estimated based on constant prices.

Comparison of Options – 3rd (non-BRT)

		Diesel	Electric		
		7 Years	7 Years	10 Years	12 years
Capex Charge/year	US$ m	0.35	0.93	0.77	0.71
Avg Opex per year	US$ m	0.88	0.74	0.82	0.81
Total cost/year	US$ m	1.23	1.67	1.59	1.52
Total Cost/km*	US$/km	1.35	1.84	1.75	1.67
Difference from BAU	US$/km	--	0.48	0.40	0.31
	%	--	36%	31%	25%

Above costs are estimated based on constant prices.

Environmental Impact – GHG Emissions

	GHG emission reduction	t CO_2 e
Annual	Year 2021	1,606
	Year 2050	3,337
	Years 2021-2030 (average)	3,135
Cumulative	Over the project horizon (for years 2021-2050)	94,054

Value of GHG emissions reduced/avoided : US$ 68/ton *
Annual Value : US$ 2.14 m p.a. or
Average /km : US$ 4.5 cents/km

** Based on estimation of social cost of carbon by Interagency Working Group on Social Cost of Carbon, 2016 (https://www.epa.gov)*

Reduction in Air Pollution

(kg / year)

Route	NOx	SOx	PM 2.5	Dust Content
1st	66,963	1,976	3,013	198
2nd	11,961	353	538	35
3rd	12,097	357	544	36
Total	**91,022**	**2,686**	**4,096**	**269**

The C40 Study estimates that due to E Bus trial Project:

- 0.02% PM2.5 reduction in the city's non-background concentration
- 1 Premature death averted per year
- 18 life years gained i.e. 0.07 day in life expectancy per citizen in the focus area
- 1 averted hospital admission per year
- US$ 733 healthcare costs avoided per year

Value for Money

US$ Dollar

	1st	2nd	3rd	Total
Diesel Bus				
Operating Cost /km	1.22	1.43	1.35	1.26
Effect of differential price increase	0.04	0.04	0.04	0.04
Total	1.26	1.48	1.40	1.30
Electric Bus				
Operating Cost /km	1.34	1.82	1.67	1.42
GHG Emission Reduction	-0.04	-0.04	-0.04	-0.04
Health benefits	-0.13	-0.13	-0.13	-0.13
Effect of additional taxes	-0.09	-0.13	-0.11	-0.10
Net cost/km	1.08	1.52	1.38	1.15
%age as compared to BAU	85%	103%	98%	88%

- *Effective rate of tax in procurement cost of buses considered @ 20%*
- *Diesel and Electricity prices assumed to grow @ 7% p.a. and 3% p.a.*

Risk Assessment - Some Key Aspects

- Unavailability of suitable rolling stock – The BRT corridors use high floor buses and the halts are designed for the same. The 12 m E Buses are typically low entry buses. Limited availability of HE buses may affect the competitiveness of the **bus prices and timely availability**
- Current Bus Concessions are for 7 years and E Bus due to high capital costs would be more competitive with a 10 year concession and even more with a possible 2 year conditional extension (12 years). **Requisite regulatory framework needs to be in place.**
- Current Diesel buses are indigenously produced and are satisfy prevailing regulations. The E Buses are designed and manufactured outside of Indonesia and may not meet the **National regulations/specifications**.
- The E buses require substantial capital investment and are untested in local conditions except for a 3 month phase 1 trial in Jakarta. The Operators/Investors/bankers may be **unwilling to take the risk** at the Trial stage.

Risk Assessment - Some Key Aspects

Cont´d

- Not many E Bus manufacturers may be keen to invest in **maintenance facility for a small number of buses** during the 100 E-Bus Trial phase.
- E Buses especially those dependent upon opportunity charging require **uninterrupted electric supply** all through the day. Even a few minutes outage may be sufficient to cause disruption in services.
- Indonesian grid predominantly depends on fossil fuel whereas the diesel is being mixed with increasingly higher amounts of biodiesel. Reduction in GHG emissions through the E Buses will therefore be contingent upon solarisation of the depots/stations/terminals **and substantial increase in renewable power generation in Indonesia**.
- A major component of the E Buses are likely to be imported into Indonesia and as such the Operators face the **risk of foreign exchange fluctuations**. Subsequently, spare parts and especially battery may also have to be imported if not manufactured in Indonesia.

Key takeaways

At pilot stage, project should be easy to implement even if a little expensive

- e.g. depot charging is easier to implement than opportunity charging

Facilitate operators to the maximum

- Provide depot facilities near the routes
- minimise empty kms & maximise utilisation: the e-bus OpEx cost is about 80% of the Diesel bus ➔ more utilisation results in greater savings

Product availability & Product suitability

- High entry e-buses not easily available, may need to be customized
- Imported E-buses may differ in specifications than nationally approved ones

Length of concession

- E Buses require longer concessions to reduce operating costs

Pricing of diesel / CNG

- The pricing of conventional fuel need to reflect economic and social costs to facilitate E bus adoption

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Thank you for your attention

Terimah Kasih Banyak!

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