Environmental Impact Assessment

Project No. 47279-002
May 2018

PAK: Karachi Bus Rapid Transit Project

Appendix A-H

Prepared by the Transport and Mass Transit Department, Government of Sindh, for the Asian Development Bank.

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Appendix-B Rapid Environmental Assessment (Screening) Checklist

Screening Questions	Yes	No	Remarks
A. Project Siting **Is the project area…?**			Note: This completed REA checklist was submitted to ADB as part of its routine categorization for the project.
▪ Densely populated?	√		The project is located in an urban setting with dense population all along the route. Roadway traffic demands and intersecting thoroughfares are typical along the project alignment.
▪ Heavy with development activities?	√		The areas close to city center are developed and the undeveloped areas along the route fall under, ongoing heavy development activities.
▪ Adjacent to or within any environmentally sensitive areas?		√	Schools, hospitals etc but these are typical of an urban setting. No known recognized environmentally sensitive area is directly in the alignment or façade to façade area, though parts of Karachi University campus are maintained as natural space.
▪ Cultural heritage site ▪		√	The project does not have any known cultural site close to the route. (Note the MA Jinnah Mausoleum is a heritage site but at a distance from alignment).
▪ Protected Area		√	There are no protected areas along the alignment.
▪ Wetland		√	There are no wetlands close to the alignment.
▪ Mangrove		√	There are no mangroves along the corridor
▪ Estuarine		√	There are no estuary along the alignment
▪ Buffer zone of protected area		√	There are no buffer zones of a protected area along the alignment
▪ Special area for protecting biodiversity		√	There are a few parks such as (Safari park/ Zoo and Askari park etc) along the route but at a considerable distance from the alignment. They do not fall under any special known area/ category for protecting biodiversity.
▪ Bay		√	Not near the alignment
B. Potential Environmental Impacts **Will the Project cause…**			
▪ Impacts on the sustainability of associated sanitation and solid waste disposal systems and their interactions with other urban services.	√		The setting up of worker camps and construction activities could lead to issues relating to sanitation and solid waste disposal. Strict implementation of necessary measures in the EMP/

Screening Questions	Yes	No	Remarks
			Site specific contractors EMP will ensure the impacts are short term and limited to construction phase.
▪ Deterioration of surrounding environmental conditions due to rapid urban population growth, commercial and industrial activity, and increased waste generation to the point that both manmade and natural systems are overloaded and the capacities to manage these systems are overwhelmed?		√	Improvement is envisaged with better maintenance of vehicles and efficient emission controls and faster turn over travel time
▪ Degradation of land and ecosystems (e.g. loss of wetlands and wild lands, coastal zones, watersheds and forests)?		√	There are none along the route. Some trees will need to be pulled down along the route. However, the overall area will be improved with better landscaping and additional indigenous tree plantation.
▪ Dislocation or involuntary resettlement of people?		√	Physical property related resettlement is not envisaged. Some disturbance in access to livelihood may occur, and traffic congestion could increase during construction.
▪ Disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable group?		√	Not envisioned
▪ Degradation of cultural property, and loss of cultural heritage and tourism revenues?		√	Not expected
▪ Occupation of low-lying lands, floodplains and steep hillsides by squatters and low-income groups, and their exposure to increased health hazards and risks due to polluting industries?		√	Not envisioned
▪ Water resource problems (e.g. depletion/degradation of available water supply, deterioration for surface and ground water quality, and pollution of receiving waters?		√	Not applicable
▪ Air pollution due to urban emissions?		√	BRT users and residents will benefit. New and well-maintained transport is expected to reduce emissions, particularly CO and SO_2, leading to improved air quality and eventually health.
▪ Risks and vulnerabilities related to occupational health and safety due to physical, chemical and biological hazards during project construction and operation?	√		Keeping in view the highly populated nature of the project corridor, the risks related to occupational health and safety during the construction phase do exist. However, any such impacts will be short term and limited to the construction phase with no long-lasting impacts expected and their mitigation will be covered in the site-specific contractors EMP
▪ Road blocking and temporary flooding due to land excavation during rainy	√		Potential for blockage of traffic during excavation of underpasses at

Screening Questions	Yes	No	Remarks
season?			intersections. Implementation of traffic management plan during construction phase can mitigate some of the impacts.
▪ Noise and dust from construction activities?	√		Potential for excessive dust generated along alignment. The strict implementation of mitigation measures in the EMP can minimize impacts. Other impacts on community use and values can occur during construction without strict enforcement of community safety and health guidelines by the contractor.
▪ Traffic disturbances due to construction material transport and wastes? ▪	√		Interference with longitudinal traffic along alignment and cross-traffic at underpass construction. Also, spoil or construction materials placed in the right of way can interfere with traffic. Implementation of the traffic management plan can reduce these impacts
▪ Temporary silt runoff due to construction? ▪		√	Not envisioned
▪ Hazards to public health due to ambient, household and occupational pollution, thermal inversion, and smog formation?		√	Dust generated by construction will be a problem if not properly mitigated.
▪ Water depletion and/or degradation? ▪		√	Not envisioned
▪ Overpaying of ground water, leading to land subsidence, lowered ground water table, and salinization?		√	Not envisioned
▪ Contamination of surface and ground waters due to improper waste disposal?		√	Not envisioned
▪ Pollution of receiving waters resulting in amenity losses, fisheries and marine resource depletion, and health problems?		√	Not envisioned
▪ Large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?		√	The project is in an urban setting with a healthy mix of population from all over the country. No new influx of people is envisioned due to the project.
▪ Social conflicts if workers from other regions or countries are hired?		√	No conflicts are expected since Karachi is an urban cosmopolitan city and the work force hired will most probably be domiciled in Karachi already.
▪ Risks to community health and safety due to the transport, storage, and use and/or disposal of materials such as explosives, fuel and other chemicals during operation and construction?	√		The strict implementation of mitigation measures in the EMP will reduce these impacts, however the risks exist.
▪ Community safety risks due to both accidental and natural hazards, especially where the structural elements	√		The installation of structures is part of the project which is located in a highly populated project corridor and it

Screening Questions	Yes	No	Remarks
or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning?			carries the risk of structural failure and accidents. However, implementation of mitigation measures in the EMP will minimize if not completely eliminate risks.

	Screening Questions	Score	Remarks
Location and Design of project	Is siting and/or routing of the project (or its components) likely to be affected by climate conditions including extreme weather-related events such as floods, droughts, storms, landslides?	0	No known recent history in the alignment area of any of the mentioned events
	Would the project design (e.g. the clearance for bridges) need to consider any hydro-meteorological parameters (e.g., sea-level, peak river flow, reliable water level, peak wind speed etc)?	0	EMP should disallow placement of hoardings on bridges to mitigate high wind problems (if any). No known recent history in the alignment area of any of the mentioned events
Materials and Maintenance	Would weather, current and likely future climate conditions (e.g. prevailing humidity level, temperature contrast between hot summer days and cold winter days, exposure to wind and humidity hydro-meteorological parameters likely affect the selection of project inputs over the life of project outputs (e.g. construction material)?	0	Winter is mild, Shade for waiting area and pedestrian bridges for hot summer. Railing of wood etc to ensure hand do not hold hot railings etc
	Would weather, current and likely future climate conditions, and related extreme events likely affect the maintenance (scheduling and cost) of project output(s)?	0	Not envisaged
Performance of project outputs	Would weather/climate conditions and related extreme events likely affect the performance (e.g. annual power production) of project output(s) (e.g. hydro-power generation facilities) throughout their design life time?	0	Not envisaged

Appendix-C GHG and Air Quality Impact of the BRT Karachi and Assessment of Technology Options for BRT Buses by Grutter Consulting Report

GHG and Air Quality Impact of the BRT Karachi and Assessment of Technology Options for BRT Buses

Client	ADB
Version nu.	1
Date	12.05.2018
Lead Author	Jürg M. Grütter, Grütter Consulting
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Contents

Acronyms

AC	Air Conditioning
ACM	Approved Consolidated Methodology
ADB	Asian Development Bank
BAU	Business as Usual
BRT	Bus Rapid Transit
BC	Black Carbon
BEB	Battery Electric Vehicle
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CDM	Clean Development Mechanism
CNG	Compressed Natural Gas
COPERT	Computer Programme to calculate Emissions from Road Transport
EEA	European Environment Agency
EF	Emission Factor
GHG	Greenhouse Gases
LNG	Liquefied Natural Gas
LPG	Liquefied Petrol Gas
GWP	Global Warming Potential
IEA	International Energy Agency
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
MAC	Marginal Abatement Cost
NCV	Net Calorific Value
OPEX	Operational Expenditure
pkm	passenger kilometre
PM	Particle Matter
PT	Public Transport
SFC	Specific Fuel Consumption
SOC	State of Charge
TCO	Total Cost of Ownership
TTW	Tank-to-Wheel
UNFCCC	United Nations Framework Convention for Climate Change
WTW	Well-to-Wheel

Summary

1. Bus technology options assessed for the BRT Karachi are diesel, CNG, hybrids (diesel and CNG) and electric buses. For diesel Euro standard III was assumed in accordance with the available diesel quality and for CNG units Euro V standard. The following table compares the annual emissions of the different bus technologies for the BRT Karachi i.e. based on the number of 9m, 12m and 18m buses and their respective annual mileage.

Table 1: Annual BRT Emissions for Different Bus Technologies (tons)

Parameter	Diesel	CNG	Diesel hybrid	CNG hybrid	BEB
GHG TTW	22,000	22,000	18,000	18,000	0
GHG WTW incl. BC	32,000	31,000	25,000	25,000	14,000
$PM_{2.5}$	6.4	0.0	5.1	0.0	0.0
NO_x	356	63	285	50	0
SO_2	7.0	0.0	5.6	0.0	0.0

2. Diesel and diesel hybrids have the lowest total financial costs. CNG and CNG hybrids have 3-6% higher total lifetime costs due to higher CAPEX costs which are not completely compensated with lower OPEX costs. Total costs of BEBs are around 30% higher than of diesel units due to having significantly higher CAPEX costs.

3. The BRT component of the project reduces Greenhouse Gas (GHG) emissions due to usage of larger buses (replacement of small buses including paratransit with larger units), a higher average operating speed due to bus-only lanes and mode switch. In the future avoided mode switch will be more important i.e. the BRT offers a convenient, attractive and safe public transport system which can avoid that inhabitants of Karachi procure and use private vehicles. The following table shows the impact of the BRT on average per annum on emissions with different bus technologies.

Table 2: Annual Emission Reductions of BRT Karachi Using Different Bus Technologies (tons)

Parameter	Diesel	CNG	Diesel hybrid	CNG hybrid	BEB
GHG TTW	57,000	57,000	62,000	62,000	83,000
GHG WTW incl. BC	71,000	72,000	78,000	79,000	91,000
$PM_{2.5}$	225	558	306	572	629
NO_x	-2.5	4.8	-1.0	4.8	4.8
SO_2	7	15	9	15	15

4. Independent of the technology used in the BRT GHG emission reductions would occur. In terms of air pollution however, using diesel powered BRT buses will result in increased particle emissions compared to the current transport system. Although the economic damage based on the data values of the IMF are of minor nature, the result is still that one of the most critical urban pollutants namely $PM_{2.5}$ would increase with the BRT compared to a situation without the BRT. This is not considered to be a desirable outcome. Therefore, it is strongly suggested to pursue the option of using CNG or CNG hybrid buses which allow to reduce not only significantly GHG emissions but would also have a strong impact on reducing air pollution including NO_x, $PM_{2.5}$ and SO_2.

5. Calculations realized are considered as conservative as they are based on UNFCCC approved methodologies, do not account for reduced road congestion and increased mode-switch from private vehicles and taxis in the future where a significant increase of private modes of transport can be expected under Business-as-Usual. Calculations are primarily based on local data combined with the performance and costing of large alternate technology fleets basically in the PR China.

1. Introduction

This report includes following components:

- Rapid assessment of bus technology options for the BRT Karachi;
- Rapid assessment of GHG and air quality impact of the BRT Karachi including different technology options.

2. Bus Technology Options for BRT Karachi

2.1. Introduction

A rapid assessment of the environmental, financial and economic impact of using different bus technologies for the BRT Karachi is made. Bus technologies assessed include:

- Diesel buses;
- Diesel hybrid buses;
- Compressed Natural Gas (CNG) buses;
- CNG hybrid buses;
- Battery-electric buses (BEBs);

The assessment was performed for 9m, 12m and 18m units.

2.2. Methodological Approach Environment

Emissions included in this report are:

- Greenhouse gas emissions (GHGs) including direct (tank-to-wheel or TTW) as well as indirect emissions (well-to-tank or WTW). Black Carbon (BC) emissions are included as indirect emissions.
- Local pollutants including Particle Matter ($PM_{2.5}$), NO_x and SO_2 resulting from engine combustion. These are critical pollutants which are affected directly by the BRT and the bus technology used. CO and HC emissions are primarily of concern with gasoline powered vehicles. BRT buses will however either be diesel, CNG or electric but not gasoline powered. Mode shift is basically expected to be from the current bus system and rickshaws which are also diesel or CNG powered. Therefore, the focus is on $PM_{2.5}$, NO_x and SO_2 which are also considered as of today to be the major urban air pollution problems.

GHG Emissions

The GHGs included under the United Nations Framework Convention on Climate Change (UNFCCC) are carbon dioxide (CO_2), methane (CH_4), nitrous oxides (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulfur hexafluoride (SF_6) and trifluoride nitrogen (NF_3). Relevant for the transport sector are only CO_2, CH_4 and N_20. However, according to methodologies for determining emissions from the transport sector of the UNFCCC, N_2O emissions are very marginal. Therefore,

only CO_2 emissions are included, and in addition for gas-based engines emissions of CH_4[1]. CO_2 emissions are determined based on the energy consumption according to the IPCC methodology (2006) also used in all approved UNFCCC methodologies:

$$E_{CO2,C} = FC_x \times NCV_x \times EF_{CO2,x}$$

where:

$E_{CO2,C}$	*CO_2 emissions due to combustion*
FC_x	*Consumption of fuel type x*
NCV_x	*Net Calorific Value of fuel type x*
$EF_{CO2,x}$	*CO_2 emission factor of fuel type x*

Direct GHG emissions also include for gaseous vehicles methane slip. This is a relevant emission source. Methane slip is determined based on average reported values of the ICCT which summarizes different sources. Leakage of unburnt methane is important due to the high Global Warming Potential (GWP) of CH_4. Methane slip is caused within the vehicle in the crankcase and the exhaust pipe and "upstream" due to leaks in the gas pumps and wells.

Increased particle emissions result not only in a worsening air quality but also in higher Black Carbon (BC) emissions. A scientific assessment of BC emissions and impacts found that these are second to CO_2 in terms of climate forcing. BC is on average 2,700 times more effective on a mass-equivalent basis than CO_2 in causing climate impacts within 20 years, and 900 times more effective within 100 years[2]. BC is part of particulate matter (PM) from diesel engines. The GHG impact of BC is determined based on the mass of $PM_{2.5}$ emissions (using the European emission model COPERT), the fraction of BC in $PM_{2.5}$ and the GWP_{100} of BC.

The most important indirect emission is due to electricity production including transmission and distribution losses. Electricity based emissions are based on the GHG emissions of electricity production in Pakistan and the net electricity production (gross electricity production minus transmission and distribution losses). Indirect emissions include also well-to-tank emissions of fossil fuels as not only electricity causes upstream emissions but also fossil fuels. A standard mark-up factor per fossil fuel type is used to estimate the GHG upstream impact of fossil fuels based on the UNFCCC to account for emissions caused upstream by fossil fuel extraction, refinery and transport.

Local Pollutants

Local pollutants considered, due to their impact on local air quality, are $PM_{2.5}$, SO_2 and NO_x. Only combustion related emissions are included. Particle emissions caused e.g. by tires, brake abrasion or particle resuspension are not considered. PM and NO_x pollutants are determined based on the emission category of the vehicle and emissions per unit of distance driven using the European emission model COPERT[3] whilst SO_2 is based on the sulfur contents of fuel and the specific fuel usage.

2.3. Approach Financial and Economic Calculations

Financial data calculated is:

[1] IPCC, 2006, chapter 3
[2] see Bond, 2013 or World Bank, 2014
[3] EEA, 2016

- Capital Expenditure (CAPEX); for BEBs also CAPEX infrastructure is included; this is not realized with fossil fuel options as the fuel station price is taken. For BEBs a 16 years lifetime is assumed compared to fossil buses of 12 years based on minor vibrations and stress on the bus (with battery replacement after 8 years); For charging infrastructure a lifetime of 20 years is assumed.
- OPEX including maintenance (bus plus charging infrastructure) and energy cost; For fossil fuel an annual real price increase is included in calculations;
- Total Cost of Ownership (TCO) is determined based on discounted values for a 12-year period;
- All values are expressed in constant USD of 2016.

A rapid assessment of the economic value of the reduced emissions is made by assigning a monetary value to emissions of $PM_{2.5}$, NO_x, and CO_2. The values are taken from an IMF (International Monetary Fund) publication. The values of pollutants calculated by the IMF are values for Pakistan based on local levels of pollution at the ground level and the impact on health and costs caused by this type of pollution. This is based on exposure to population contamination and how increased pollution increases mortality risks using the World Health Organization's response functions to concentration. The greater risk of mortality or, more precisely, the value of premature death is valued economically based on stated preference studies performed by the OECD.

2.4. Base Parameter Values

The following tables show the main general parameters used for calculations.

Table 3: Base Parameters

Parameter	Value	Unit	Source
NCV of diesel	43	MJ/kg	IPCC, 2006, table 1.2
CO_2 emission factor of diesel	74.1	gCO_2/MJ	IPCC, 2006, table 1.4
Density of diesel	0.844	kg/l	IEA, 2005
Well-to-tank mark-up factor diesel	23%		UNFCCC, 2014, Table 3
NCV of CNG/LNG	48	MJ/kg	IPCC, 2006, table 1.2
CO_2 emission factor of CNG/LNG	56.1	gCO_2/MJ	IPCC, 2006, table 1.4
Density of NG	0.714	kg/m^3	IGU, 2012
Well-to-tank mark-up factor CNG	18%		UNFCCC, 2014, Table 3
GWP_{100} of BC	900		Bond, 2013; see also IPCC, 2013, Table 8.A.6
GWP_{100} of CH_4	28		IPCC, 2013, Table 8.A.
Social Cost of Carbon	40	USD/tCO_2	IMF, 2014, Annex 4.2. USD of 2017
BC fraction Euro III HDVs	70%		EEA, 2016, tabla 3-117
CAGR projected price increase diesel	2.5%		World Bank 04/2017, real USD prices for 2030 66 USD/bbl; price June 2017 48 USD/bbl based on https://ycharts.com/indicators/average_crude_oil_spot_price
CAGR projected price change of battery price 2015-2022	-12%		US DOE projections, 2017; https://energy.gov/sites/prod/files/2017/02/f34/67089%20EERE%20LIB%20cost%20vs%20price%20metrics%20r9.pdf
CAGR projected price increase electricity	0%		assumption
Methane slip as % of NG consumption TTW	1.1%		Average low and high value of ICCT, 2015, table 4 for crankcase and tailpipe
Methane slip as % of NG consumption WTW	3.4%		Average low and high value of ICCT, 2015, table 4 for well-to-pump and fuelling
Conversion factor Sulfur ppm	0.843	gSO_2/l	based on molecular equivalency
Sulfur levels in diesel	500	ppm	https://www.dawn.com/news/1333239

Table 4: Country Parameters

Parameter	Value	Unit	Source
Economic cost $PM_{2.5}$	20,400	USD/t	IMF, 2014, Annex 4.2. USD of 2017
Economic cost NO_2	150	USD/t	IMF, 2014, Annex 4.2. USD of 2017
Economic cost SO_2	700	USD/t	IMF, 2014, Annex 4.2. USD of 2017
CO_2 grid factor of electricity	0.496	$kgCO_2/kWh$	losses; Value for 2015
Diesel price	0.83	USD/l	May 2018 based on HSD; http://pakbiz.com/finance/petroleumprices.html
CNG price	0.66	USD/kg	May 2018; 77 Rp wholesale price estimated by ADB
Electricity price	0.10	USD/kWh	https://www.dawn.com/news/1321771
Exchange rate USD to PKR	115	PKR per USD	Interbank rate May 2018
Discount rate	10%		Finance model
Technical lifespan buses	12	years	
Fleet 9m buses	42	buses	Fleet composition yr. 1; FC-3; ODBM Red Line, 04/2018
Fleet 12m buses	190	buses	
Fleet 18m buses	61	buses	
Annual distance driven 9m bus	48,000	km	Logit, 2018
Annual distance driven 12m bus	75,000	km	Logit, 2018
Annual distance driven 18m bus	105,000	km	Logit, 2018

2.5. Diesel Buses

Diesel buses modelled for this report are Euro III standard. This is the best possible standard due to the diesel fuel quality available in Pakistan (500ppm of sulfur). The following table shows the environmental, financial and economic impact per diesel bus for different sizes. The impact is related to the estimated average annual mileage per bus for the BRT and the bus lifespan of 12 years (see Table 2).

Table 5: Impact per Diesel Bus for BRT Karachi (Euro III standard)

Parameter	Unit	Value 9m bus	Value 12m bus	Value 18m bus	Source
Fuel consumption	l/100km	23	33	49	average multiple Chinese operators
CO_2 TTW	g/km	619	887	1,318	calculated with actual fuel consumption
CO_2 WTW incl. BC	g/km	891	1,265	1,827	calculated with actual fuel consumption
$PM_{2.5}$	g/km	0.207	0.275	0.327	COPERT, 2016, Tier 3 with 50% load factor, 0% gradient, speed 15km/h
NO_x	g/km	11.11	14.21	20.54	
SO_2	g/km	0.194	0.278	0.413	Calculated with fuel consumption
Economic costs of GHG emissions	USD/km	0.036	0.051	0.073	calculated with WTW CO_2 emissions
Economic costs of pollutants	USD/km	0.006	0.008	0.010	excludes CO_2
Total environmental costs	USD/km	0.042	0.059	0.083	GHG plus pollutants
CAPEX	USD	95,000	140,000	230,000	Excluding maintenance cost; data provided by ADB; 2 doors
Yr 1 energy cost	USD	9,216	20,661	42,950	calculated based on fuel usage; valid yr.1 without projected price increase
Maintenance cost	USD/km	0.14	0.20	0.30	estimation
Cumulative discounted energy cost lifespan	USD	70,159	157,285	326,963	Includes discount value and energy price increase
Cumulative discounted maintenance cost lifespan	USD	45,780	102,205	214,631	Includes discount value
Financial TCO discounted per km	USD/km	0.37	0.44	0.61	
Economic TCO discounted per km	USD/km	0.41	0.50	0.70	
Cumulative GHG emissions WTW incl. BC lifetime	tCO_2	513	1,130	2,302	

2.6. CNG Bus

CNG buses became popular in many cities basically due to having lower emissions than diesel buses (prior Euro VI). CNG is widely used in Pakistan. CNG buses have a slightly higher weight compared to diesel units due to gas tanks (0.5-1 ton relative to the bus size) which can lead to a slightly smaller passenger capacity - however, it is not significant and depends more on the manufacturer of the bus. Operating ranges are slightly lower than of diesel buses but can be adapted to the requirements of the operator and are therefore not considered a limitation of the bus. CNG buses modelled for this report are Euro V standard which is feasible based on the fuel specifications. Most manufacturers worldwide can comply without problems with this standard (standard e.g. also in force currently in PR China).

Table 6: Impact per CNG Bus BRT Karachi (Euro V standard)

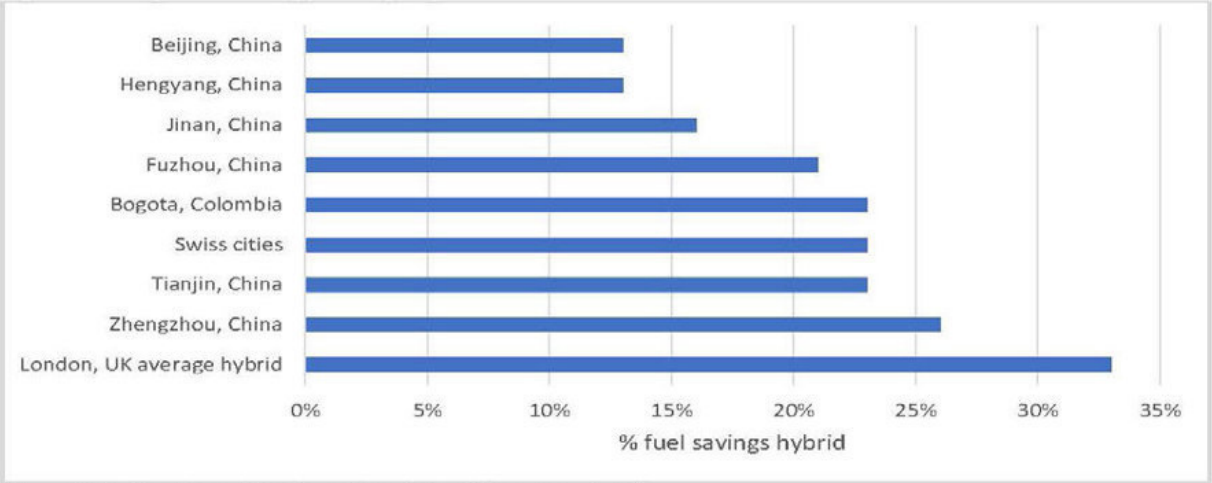
Parameter	Unit	Value 9m bus	Value 12m bus	Value 18m bus	Source
Fuel consumption	kg/100km	24	28	46	average multiple Chinese operators
CO_2 TTW	g/km	720	840	1,380	calculated with actual fuel consumption and methane slip TTW
CO_2 WTW incl. BC	g/km	991	1,156	1,900	calculated with actual fuel consumption and methane slip WTW
$PM_{2.5}$	g/km	0	0	0	COPERT, 2016, Tier 2 for standrad urban bus and same relation as diesel for
NO_x	g/km	1.95	2.50	3.61	smaller and larger units
SO_2	g/km	0	0	0	
Economic costs of GHG emissions	USD/km	0.040	0.046	0.076	calculated with WTW CO_2 emissions
Economic costs of pollutants	USD/km	0.000	0.000	0.001	excludes CO_2
Total environmental costs	USD/km	0.040	0.047	0.077	GHG plus pollutants
CAPEX	USD	138,000	192,000	300,000	Excluding maintenance cost; data provided by ADB; 2 doors
Yr 1 energy cost	USD	7,603	13,860	31,878	calculated based on fuel usage; valid yr.1 without projected price increase
Maintenance cost	USD/km	0.15	0.22	0.33	Calculated with 10% surcost compared to diesel
Cumulative discounted energy cost lifespan	USD	57,881	105,512	242,678	Includes discount value and energy price increase
Cumulative discounted maintenance cost lifespan	USD	50,367	112,426	236,094	Includes discount value
Financial TCO discounted per km	USD/km	0.43	0.46	0.62	
Economic TCO discounted per km	USD/km	0.47	0.50	0.69	
Cumulative GHG emissions WTW incl. BC lifetime	tCO_2	571	1,041	2,393	

2.7. Diesel Hybrids

Large hybrid bus fleets (each operator with >>100 units) are operating since multiple years in many Chinese cities, in London, in Bogota and in New York. Many other cities worldwide have smaller fleets of hybrid buses. Multiple cities in PR China are operating diesel, CNG, LNG as well as LPG hybrids since many years with most units being 10-12m buses. However also 8m, 14m and 18m hybrids are ploughing the streets. Hybrid buses are available in virtually all sizes (except 26m bus) and with all fuel combinations. Types of hybrids include basically series and parallel hybrids as well as "mild" hybrids using e.g. flywheels to recover braking energy. A differentiation is made between "conventional" and "plug-in" hybrids. Latter allow for electric charging by an external power source. Fuel efficiency gains in hybrids are basically due to being able to use a smaller than normal conventional internal combustion engine operating at constant periods of maximum efficiency, and usage of regenerative braking (energy lost due to braking is recovered and utilized to charge the battery). In terms of noise emissions, hybrid buses have approximately 3 decibels less noise compared to a diesel bus basically when leaving the bus stop[4].

The following graph shows average fuel savings of hybrids in different cities. All data is based on comparing same size and types of conventional and hybrid units operating on comparable routes. The average improvement rate of hybrids is thereby around 20% (average of 18 cities in PR China 17%) compared to conventional buses i.e. hybrids will result in 20% lower energy consumption, GHG as well as local pollutants emissions. Differences between cities are basically due to bus types and brands used and their different hybrid systems.

Figure 1: Comparison Energy Savings Hybrids



Source: Grutter Consulting based on data of bus operators[5]

[4] Clean Fleets, 2014, p.27; see also Faltenbacher, 2011, p. 71

[5] with exception of Swiss cities each bus operator has minimum 300 hybrids operating on the same routes as conventional buses with data collection of minimum 12 months per bus; London includes 12m and 14m double decker buses; Zhengzhou includes 12m, 14m and 18m hybrids; All other cities 10.5, 12m and 14m hybrids; Buses include Euro III, IV, V and VI units; Fuels used include diesel, CNG and LNG (comparison always between hybrid and conventional same fuel type); multiple brands included

Plug-in hybrids are largely used in PR China due to only subsidizing since various years plug-in hybrids and not anymore conventional hybrids. Plug-in hybrids are not considered in this report due to operational complexity in charging, significant additional investment costs whilst the efficiency gains can be limited due to plug-in hybrids having limited impacts under high AC usage or high operating speeds[6]. In practice in 18 cities in PR China using large plug-in hybrid fleets where monitoring of bus performance was realized through an ADB project[7] the result was that operators do not charge plug-ins except in very singular cases i.e. the buses where used just like conventional hybrids whilst having a much higher investment cost[8].

Table 7: Impact per Diesel Hybrid Bus (Euro III standard)

Parameter	Unit	Value 9m bus	Value 12m bus	Value 18m bus	Source
Fuel consumption	l/100km	18	26	39	calculated with savings rate
CO_2 TTW	g/km	495	710	1,054	calculated with actual fuel consumption
CO_2 WTW incl. BC	g/km	713	1,012	1,461	calculated with actual fuel consumption
$PM_{2.5}$	g/km	0.166	0.220	0.262	COPERT, 2016, Tier 3 with 50% load factor, 0% gradient, speed 15km/h;
NO_x	g/km	8.89	11.37	16.43	calculated with fuel savings rate hybrid
SO_2	g/km	0.155	0.223	0.330	Calculated with fuel consumption
Economic costs of GHG emissions	USD/km	0.029	0.040	0.058	calculated with WTW CO_2 emissions
Economic costs of pollutants	USD/km	0.005	0.006	0.008	excludes CO_2
Total environmental costs	USD/km	0.033	0.047	0.066	GHG plus pollutants
CAPEX	USD	118,750	175,000	287,500	Excluding maintenance cost; data provided by ADB; 2 doors; 25% surcost to diesel
Yr 1 energy cost	USD	7,373	16,529	34,360	calculated based on fuel usage; valid yr.1 without projected price increase
Maintenance cost	USD/km	0.14	0.2	0.3	same as conventional diesel
Cumulative discounted energy cost lifespan	USD	56,127	125,828	261,570	includes discount value and energy price increase
Cumulative discounted maintenance cost lifespan	USD	45,788	102,205	214,631	includes discount value
Financial TCO discounted per km	USD/km	0.38	0.45	0.61	
Economic TCO discounted per km	USD/km	0.42	0.49	0.67	
Cumulative GHG emissions WTW incl. BC lifetime	tCO_2	411	911	1,841	

2.8. CNG Hybrids

The same savings rate for CNG hybrids is applied as for diesel hybrids. Large CNG hybrid fleets plough the streets of Chinese cities since a decade.

Table 8: Impact per CNG Hybrid Bus (Euro V standard)

Parameter	Unit	Value 9m bus	Value 12m bus	Value 18m bus	Source
Fuel consumption	kg/100km	19	27	37	calculated with savings rate hybrids
CO_2 TTW	g/km	576	672	1,104	calculated with actual fuel consumption and methane slip TTW
CO_2 WTW incl. BC	g/km	793	925	1,520	calculated with actual fuel consumption and methane slip WTW
$PM_{2.5}$	g/km	0	0	0	Based on CNG bus and savings rate of hybrid
NO_x	g/km	1.56	2.00	2.89	
SO_2	g/km	0	0	0	
Economic costs of GHG emissions	USD/km	0.032	0.037	0.061	calculated with WTW CO_2 emissions
Economic costs of pollutants	USD/km	0.000	0.000	0.000	excludes CO_2
Total environmental costs	USD/km	0.032	0.037	0.061	GHG plus pollutants
CAPEX	USD	165,600	230,400	360,000	20% surcost of CNG bus
Yr 1 energy cost	USD	6,003	11,088	25,502	calculated based on fuel usage; valid yr.1 without projected price increase
Maintenance cost	USD/km	0.15	0.22	0.33	same as CNG
Cumulative discounted energy cost lifespan	USD	46,305	84,410	194,143	includes discount value and energy price increase
Cumulative discounted maintenance cost lifespan	USD	50,367	112,426	236,094	includes discount value
Financial TCO discounted per km	USD/km	0.46	0.47	0.63	
Economic TCO discounted per km	USD/km	0.49	0.51	0.69	
Cumulative GHG emissions WTW incl. BC lifetime	tCO_2	457	833	1,915	

[6] In these cases, plug-in hybrids stop operating on batteries and the fossil engine takes over

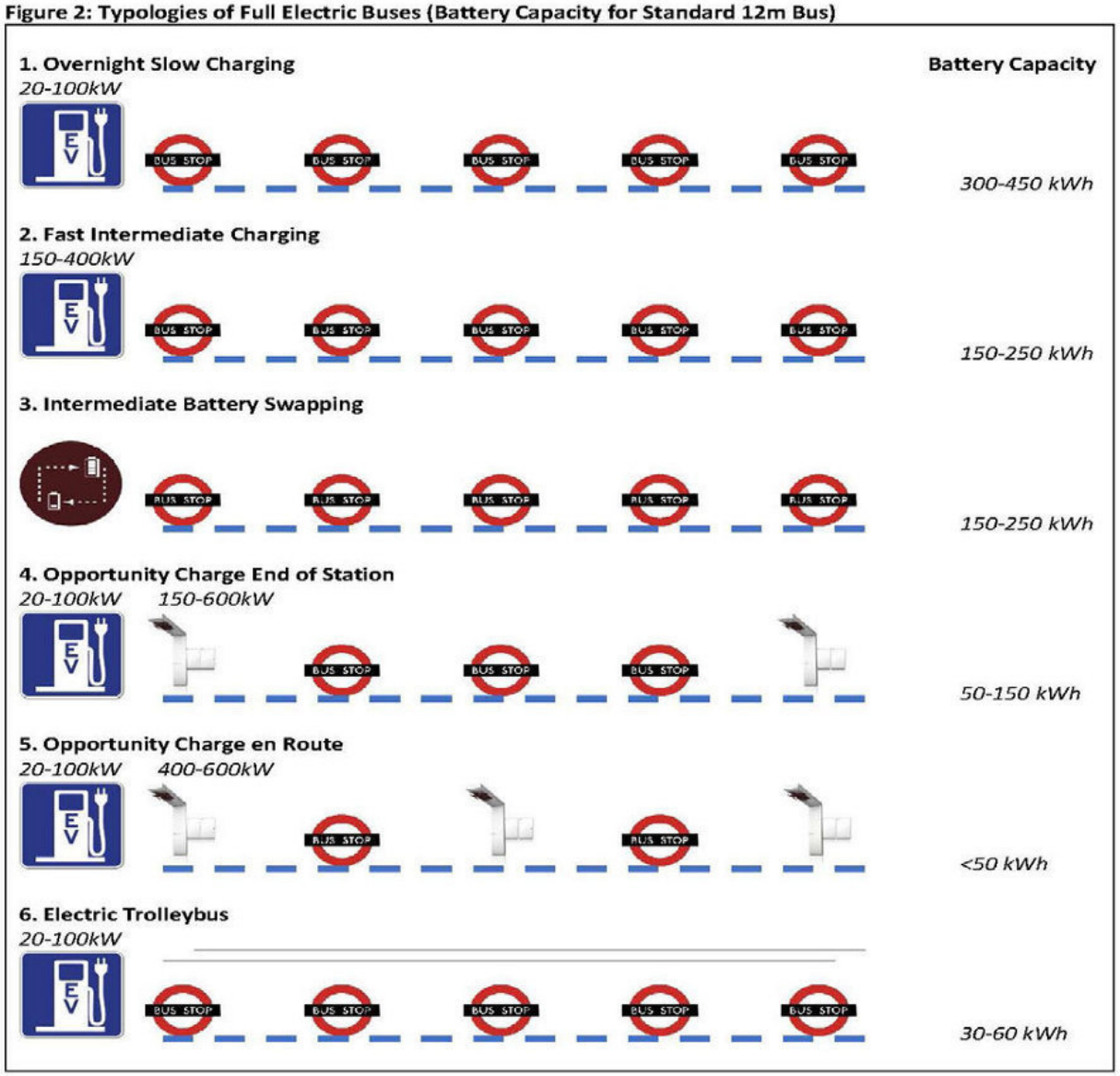
[7] Grutter Consulting, 2018, forthcoming

[8] The reason why operators purchased plug-in hybrids and not conventional hybrids is that former are heavily subsidized and latter do not receive (anymore) subsidies making them more expensive than plug-ins.

2.9. BEBs

Full electric buses include Battery Electric Buses (BEBs), opportunity charged BEBs and electric trolleybuses. All operate without an internal combustion engine and basically their differences are related with the electricity charging approach involved (see following figure).

Figure 2: Typologies of Full Electric Buses (Battery Capacity for Standard 12m Bus)



Trolleybuses and opportunity charge systems are not included in this report due to usage of an open BRT system with multiple routes i.ee. buses use the BRT route only partially. This would require a very large number of routes equipped with overhead wiring or opportunity charge systems. Also, the

electric system is very unstable and overloaded in Karachi making such systems non-feasible. The alternative assessed are thus usage of BEBs.

Table 9: Core Parameters for BEBs

SOC year 5	85%		8 years warranty with 80%; new units on longest routes
daily distance 9m bus	141	km	based on annual distance and 340 working days operation
daily distance 12m bus	221	km	
daily distance 18m bus	309	km	
reserve ratio	10%		for operational reasons
Additional energy usage summer	25%		based on monthly measurements in China; due to AC usage
Lifetime batteries	8	years	Normal warranty period batteries
Lifetime bus	16	years	2x battery life-span; less vibrations and moving parts
Cost per kWh battery	350	USD/kWh	Market price for bus batteries as of 04/2018
Slow chargers power 9m bus	60	kW	Based on 6 hours charging with 2 buses per charger (2 nozzles; each delivering 50% of nominal power); 90% charging efficiency
Slow chargers power 12m bus	90	kW	
Slow chargers power 18m bus	130	kW	
Day charging time space	6	hours	estimated off-peak from 9AM to 3pm for charging
Charging time max per bus	0.8	hours	
Number of buses per slow charger	1.6	bus/charger	night charging with 1 charger and 2 nozzles to reduce construction costs and space requirements; 20% reserve
Number of 12m buses per fast charger	6	bus/charger	Based on available time, charging time and 30% reserve; each charger with 2 nozzle delivering both to the same bus; 12m buses 1 charge per day
Number of 18m buses per fast charger	3	bus/charger	Based on available time, charging time and 30% reserve; each charger with 2 nozzle delivering both to the same bus; 18m buses 2 charges per day
Power fast charger 12m bus	250	kW	Based on available time day, 80% charging
Power fast charger 18m bus	370	kW	
Cost per kW charger	300	USD/kW	Includes charging post (150 USD/kW), electric installations, transformers; based on cost in China
Lifetime charger	20	years	US DOE
Maintenance service stations/chargers	10%		Percentage of CAPEX

Table 10: Impact per BEB Bus

Parameter	Unit	Value 9m bus	Value 12m bus	Value 18m bus	Source
Energy consumption	kWh/km	0.65	1.14	1.8	average multiple Chinese operators; for 18m bus European values
Battery size only night charging	kWh	148	407	899	Based on energy usage, 85% SOC, 10% reserve
Recommended battery size 9m bus	kWh	148			no intermediate charging required
Recommended battery size 12m bus	kWh		226		1 day charging with 80%
Recommended battery size 18m bus	kWh			346	2 day charging each 80%
CO_2 TTW	g/km	0	0	0	No direct emissions
CO_2 WTW	g/km	322	565	893	Includes electricity based emissions
$PM_{2.5}$	g/km	0	0	0	no exhaust emissions
NO_x	g/km	0	0	0	
SO_2	g/km	0	0	0	
Economic costs of GHG emissions	USD/km	0.013	0.023	0.036	calculated with WTW CO_2 emissions
Economic costs of pollutants	USD/km	0.000	0.000	0.000	excludes CO_2
Total environmental costs	USD/km	0.013	0.023	0.036	GHG plus pollutants
CAPEX bus	USD	209,000	308,000	506,000	Factor 2.2 diesel bus average Europe, USA, China
CAPEX chargers	USD	11,250	30,268	64,018	see above for chargers required
Maintenance chargers yr 1	USD	1,125	3,027	6,402	
Yr 1 energy cost	USD	3,275	8,974	19,837	calculated based on fuel usage; valid yr.1 without projected price increase
Maintenance cost	USD/km	0.11	0.16	0.24	80% of diesel bus based on experience in China
Cumulative discounted energy cost lifespan	USD	22,312	61,145	326,963	Includes discount value and energy price increase
Cumulative discounted maintenance cost lifespan	USD	36,630	81,764	171,705	Includes discount value
Financial TCO discounted per km	USD/km	0.43	0.50	0.84	
Economic TCO discounted per km	USD/km	0.44	0.52	0.88	
Cumulative GHG emissions WTW incl. BC lifetime	tCO_2	186	509	1,125	

Large numbers of BEBs of multiple brands are being introduced in Chinese cities. Many cities initially introduce smaller 6-8m BEBs and then move on to 10-12m units. Few cities also manage electric double-deckers and 14m units. Chinese e-bus manufactures dominate the global market in terms of units sold. The top 5 manufactures in terms of units sold in 2016[9] were Yutong with 19% of the Chinese market share followed by BYD with 13%, Zhontong (10%), Nanjing Jinlong and Zhuhai Yinlong[10]. Many other manufacturers also produce e-buses. Most cities in PR China use a combination of slow charging during the night combined with fast charging during the day. The battery capacity of BEBs and the charging infrastructure has been calculated for this project considering the average daily distance driven, the State of Charge (SOC) of batteries in year 5 (85%),

[9] Total production around 116,000 units
[10] Bloomberg NEF, 2018

a 10% SOC reserve rate of batteries and a 25% higher electricity usage in months with high temperatures.

2.10. Comparison

Comparisons are made per bus and for the average BRT bus. The average BRT bus is weighted based on the estimated number of buses per size category and the average estimated distance estimated per bus size.

Figure 3: GHG Emission Factor per Bus per km (TTW)

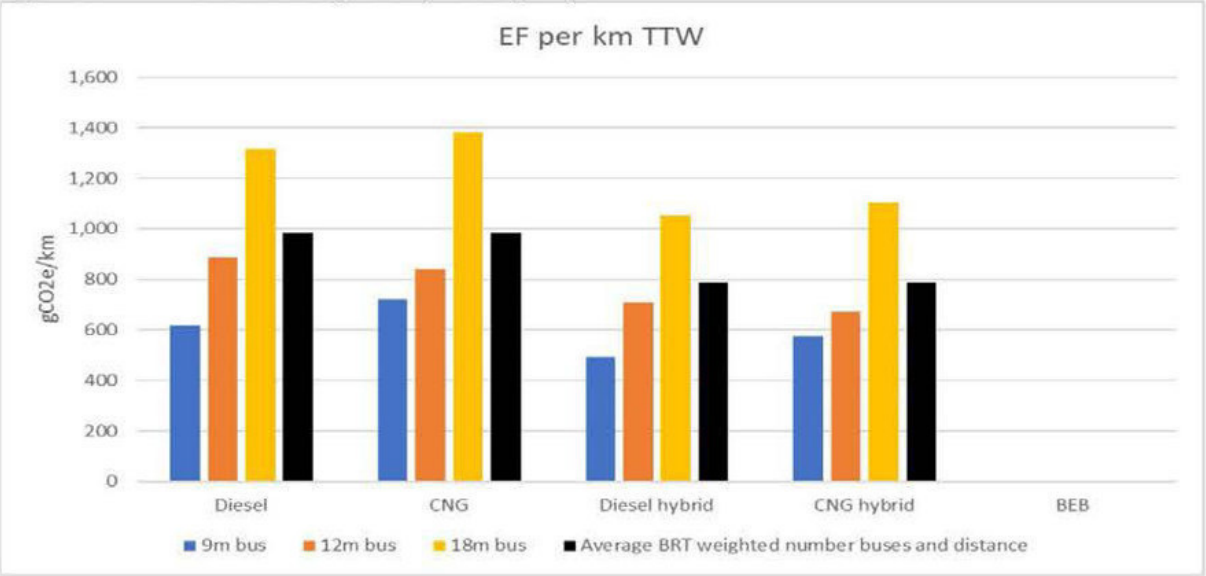


Figure 4: GHG Emission Factor per Bus per km (WTW)

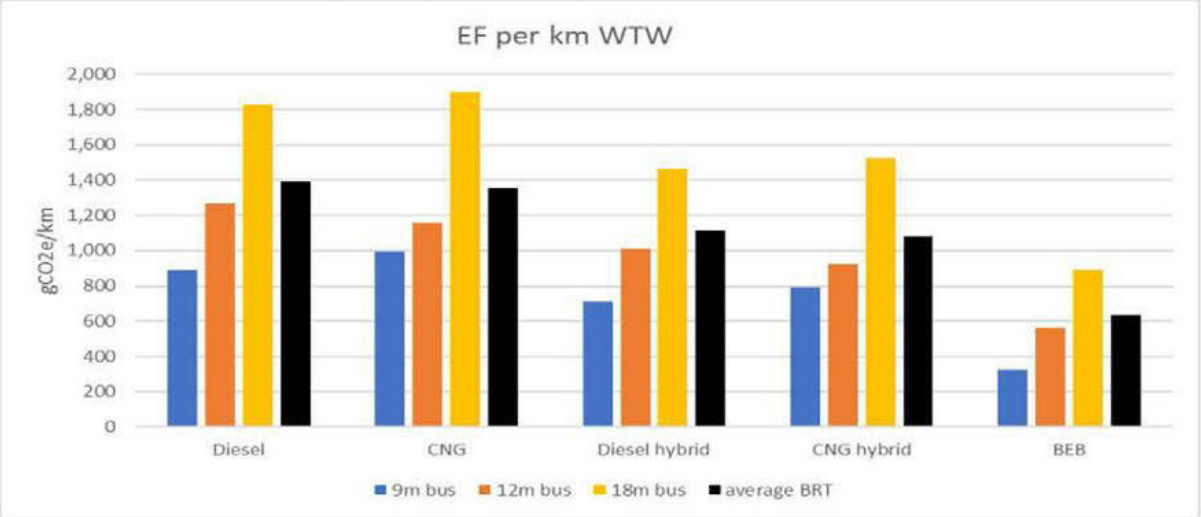


Figure 5: $PM_{2.5}$ Emission Factor per Bus per km

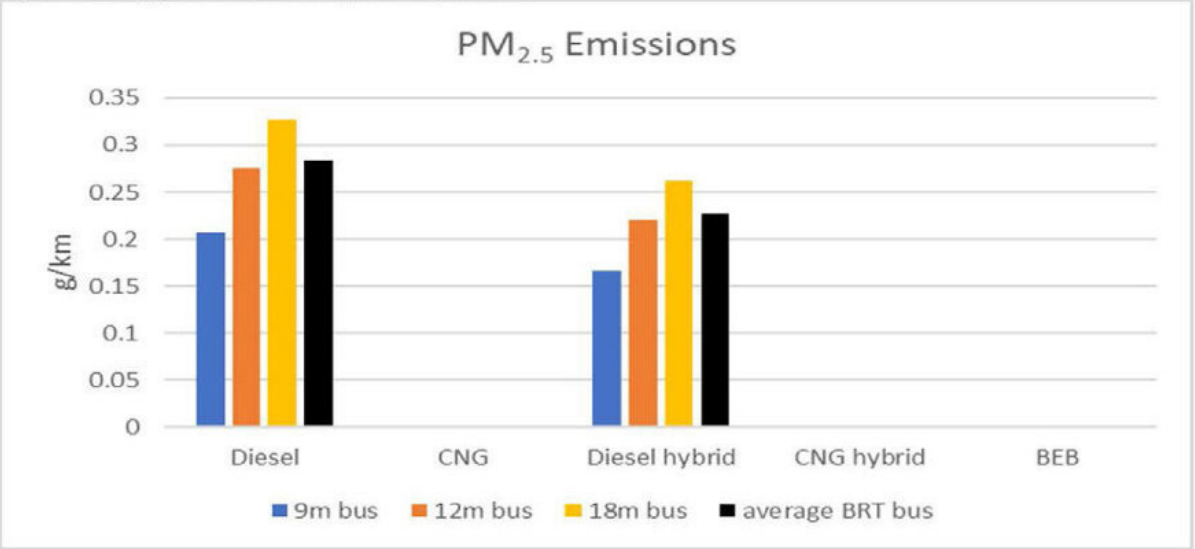
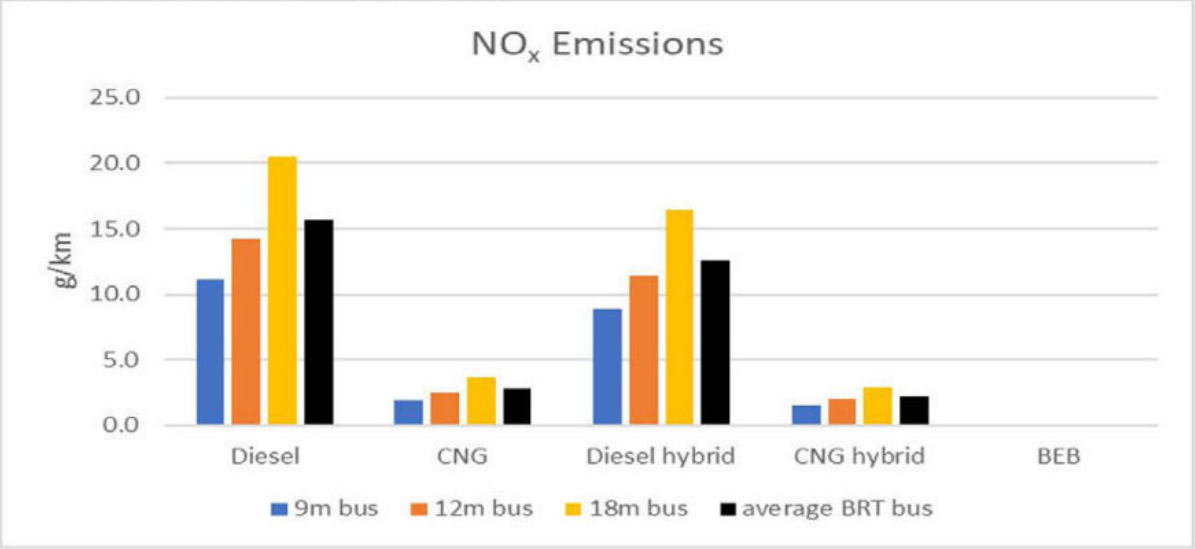


Figure 6: NO_x Emission Factor per Bus per km



The following table compares the annual emissions of the different bus technologies for the BRT Karachi i.e. based on the number of 9m, 12m and 18m buses and their respective annual mileage.

Table 11: Annual Emissions of BRT Karachi Buses with Different Bus Technologies

Parameter	Unit	Diesel	CNG	Diesel hybrid	CNG hybrid	BEB
GHG TTW	tons	22,333	22,266	17,866	17,813	0
GHG WTW ind. BC	tons	31,521	30,641	25,217	24,513	14,426
$PM_{2.5}$	tons	6.4	0.0	5.1	0.0	0.0
NO_x	tons	356	63	285	50	0
SO_2	tons	7.0	0.0	5.6	0.0	0.0

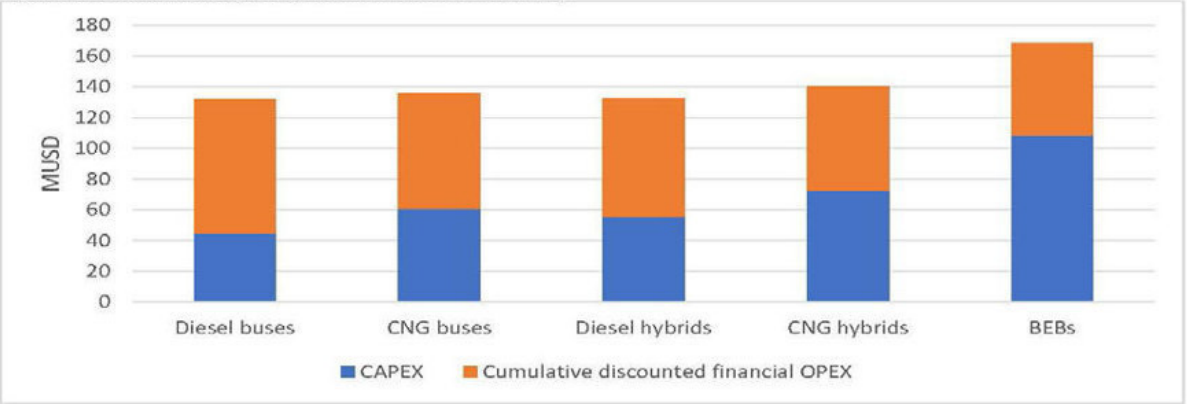
The following table shows the environmental reductions associated with using alternate technologies versus using the baseline technology of Euro III diesel buses. These numbers are based on constant mileage over a 12-year lifespan for the bus fleet of the BRT as designed for year 1.

Table 12: Environmental Impact of Usage of Alternate Bus Technologies

Parameter	Unit	CNG	Diesel hybrid	CNG hybrid	BEB
GHG TTW	tons	801	53,599	54,240	267,997
GHG WTW incl. BC	tons	10,553	75,650	84,093	205,141
$PM_{2.5}$	tons	77	15	77	77
NO_x	tons	3,525	855	3,675	4,277
SO_2	tons	84	17	84	84
Economic benefit of reduced pollution	MUSD	2.6	3.5	5.5	10.5

If CNG instead of diesel buses are used the GHG reductions are small concerning TTW and around 10,000 tCO_{2e} WTW over the 12 years. The difference WTW to TTW is basically due to lower upstream and Black Carbon emissions of CNG buses. CNG buses also have a significant impact on reduced NO_x and $PM_{2.5}$ emissions. Diesel hybrids have a significantly higher GHG impact than CNG buses. However, in terms of local pollutants they have a positive albeit much lower impact than CNG buses. CNG hybrids have slightly higher GHG emission reductions than diesel buses and significant local pollution reductions. BEBs have by far the highest GHG impact whilst on local pollutants their impact is comparable to CNG hybrids. The carbon grid factor of electricity result in some WTW GHG emissions of BEBs, however even under WTW the BEBs can still reduce more than 200,000 tCO_{2e} compared to diesel units.

Figure 7: Financial Impact (Constant MUSD of 2016)

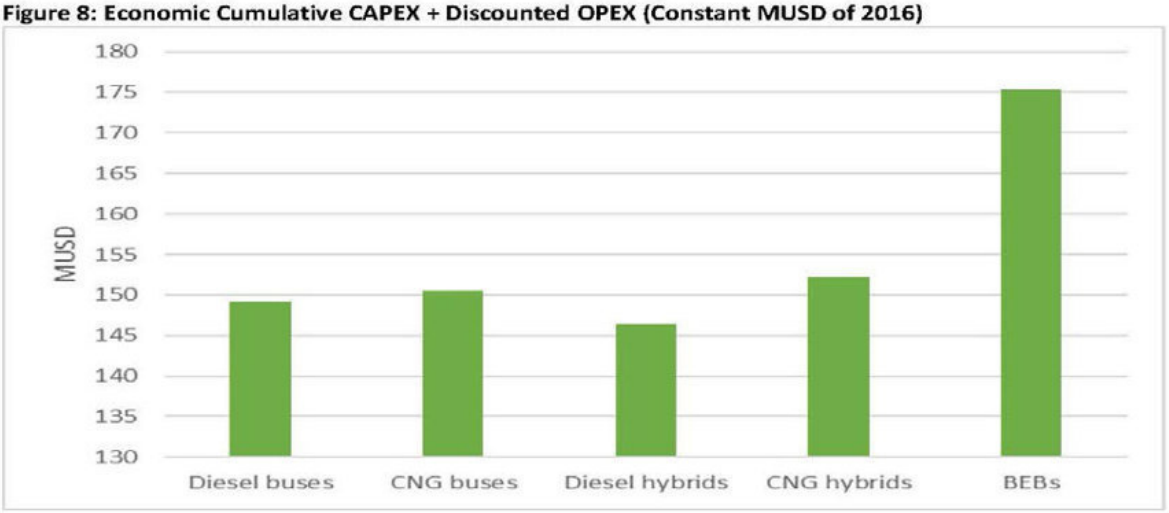


Diesel and diesel hybrids have the lowest total financial costs. CNG and CNG hybrids have 3-6% higher total lifetime costs due to higher CAPEX costs which are not completely compensated with lower OPEX costs. Total costs of BEBs are around 30% higher than of diesel units due to having significantly higher CAPEX costs.

Considering the economic benefits of reduced emissions, the diesel hybrid options comes with the lowest cost (see figure below). However, also CNG hybrids have only around 2% higher cumulative costs compared to conventional diesel units. If an increase in pollution costs is assumed, which is highly probable considering the low average assumed pollution costs for $PM_{2.5}$, NO_x and SO_2 for Pakistan, CNG hybrids would profit most and the relative position could easily change[11]. It is clear however, that BEBs are also in economic terms far costlier than diesel units with nearly 20% higher cost levels.

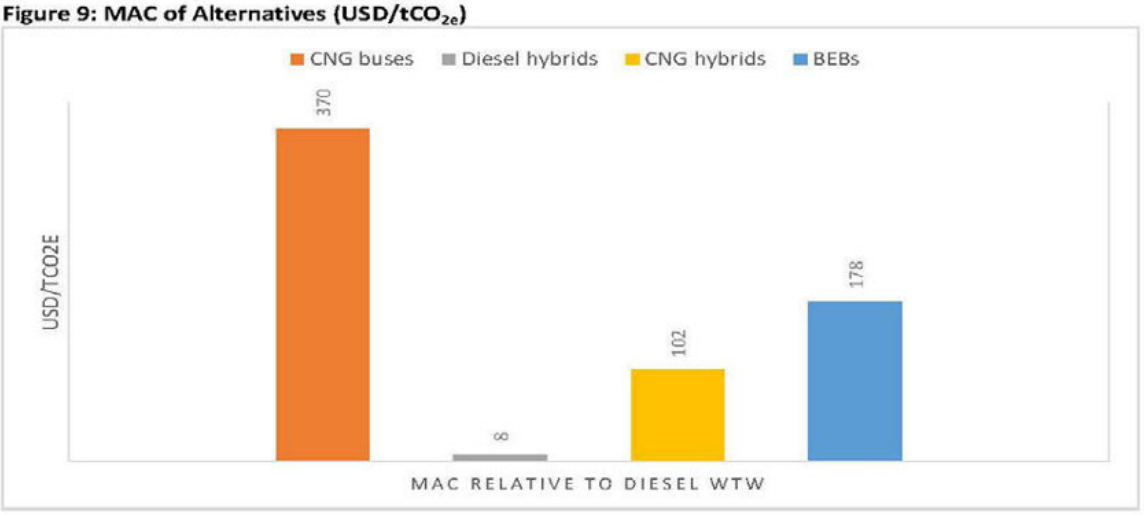
[11] IMF assumes e.g. for Pakistan a pollution damage value for $PM_{2.5}$ in USD of 2010 of 18,000 USD; other countries: Bangladesh 52,000 USD, Cambodia 15,000 USD, PR China 124,000 USD, India 32,000 USD, Indonesia 61,000 USD, Malaysia 108,000 USD, Mongolia 61, 000 USD, Philippines 39,000 USD, Sri Lanka 13,000 USD, Thailand 59,000 Vietnam 42,000 USD

Figure 8: Economic Cumulative CAPEX + Discounted OPEX (Constant MUSD of 2016)



The following figure gives the Marginal Abatement Cost of alternate technologies compared to diesel technology. The MAC is calculated based on the total financial discounted cost difference between the alternative and the diesel baseline option and the WTW GHG reduction of the alternative (cumulative for 12 years).

Figure 9: MAC of Alternatives (USD/tCO_{2e})



Diesel hybrids have very low marginal abatement costs. CNG hybrids and BEBs have relatively high MACs and pure CNG buses are obviously no cost-effective GHG mitigation option.

2.11. Conclusions Concerning Bus Technology

Overall the option of CNG hybrids is the most appropriate technology for the BRT bus system of Karachi based on following arguments:

- GHG as well as air pollution impacts are significant;
- The total economic costs of CNG hybrid buses are comparable to conventional diesel buses;

- CNG hybrid bus technology is proven and is operated in large fleets in numerous Chinese cities. Also, multiple manufacturers exist, and maintenance is straightforward.
- Conventional and diesel hybrid buses result in significant air pollution emissions especially concerning PM and NO_x. The available diesel quality does not offer the option of implementing higher Euro standards.
- Electric buses offer substantial environmental benefits. However, the financial and economic cost is significantly higher than using other bus technologies. Also, GHG abatement costs are significant. Additionally, BEB usage for 18m buses is very uncommon and requires intermediate fast charging or opportunity charging putting stress o the fragile electric grid in the city and making this option technically complex and risky in its implementation.

3. BRT Emission Impact

3.1. Approach

The methodological base for calculations relies on the UNFCCC approach for mode shift towards Mass Transit Systems which is based on the CDM methodology ACM0016. Following are the major elements used for calculating the GHG reduction:

a). Number of expected passengers for the BRT system and their average trip distance;

b). Expected share of passengers in the BRT system from baseline modes of transport.

c). Emission factors per passenger-km for different modes of transport based on specific fuel consumption per mode, the NCV, and EF_{CO2} per fuel type, methane slip with the GWP of CH_4 for CNG vehicles and average occupation rates per mode. A tank-to-wheel and a WTW approach is used.

Emission reductions are calculated based on the differential emission factor per passenger using baseline modes of transit and the project emission factor per passenger multiplied with the activity level (number of passengers).

The comparison case for public transport (i.e. the Business-as-Usual scenario or baseline) is a continuation of the current public transport system with normal vehicle renewal rates. The comparison case is made with the BRT system using diesel Euro III[12], CNG Euro V, diesel-hybrid Euro III, CNG -hybrid Euro V or BEB vehicles.

The project infrastructure life-time is 30 years. The cumulative impact is calculated however for the lifetime of vehicles (12 years) as well as an average annual emission reduction over the 12-year period which can be used to determine a cumulative 30-year impact.

[12] Current fuel specifications with 500ppm sulfur contents of diesel point to Euro II vehicles, however Euro III units (max. sulfur contents 350ppm) can run with this fuel.

Equations

1. Emission Factor per km per vehicle category	
$EF_{km} = \sum_{n} SFC_i \times NCV_i \times EF_{CO2,i} \times \frac{N_i}{N} + EF_{CH4}$	
EF_{km}	Emission factor per km
SFC_i	Specific fuel consumption of vehicle using fuel type i
NCV_i	Net Calorific Value of fuel type i
$EF_{CO2,i}$	CO2 emission factor of fuel type i
N_i/N	Share of vehicles using fuel type i
EF_{CH4}	CO2 equivalent emissions of CH4 emissions of gaseous powered vehicles

2. Emission Factor per passenger-km per vehicle category	
$EF_{pkm} = \frac{EF_{km}}{OC}$	
EF_{pkm}	Emission factor per pkm
EF_{km}	Emission factor per km per vehcile category
OC	Occupation rate of the vehicle category

3. Baseline (BAU) emissions	
$BE = \sum_{x} EF_{pkm,x} \times TD \times S_x \times P$	
BE	Baseline emissions
$EF_{pkm,x}$	Emission factor per passenger-km of transport mode (idem vehicle category) x
TD	Trip distance of passengers (if available per mode category)
S_x	Share of passengers which would have used mode (vehicle category) x in absence of the project
P	Passengers transported by the project

3.2. Input Data

Trip Parameters			
Parameter	**Value**	**Unit**	**Source**
Average trip distance on BRT	5.9	km	Logit, 2018
Passengers from rickshaws	25%		Logit, 2018, ODBM, Vol.2, p.53
Passengers from public transport	75%		
Project commercial lifespan	30	years	Infrastructure lifetime
Passenger numbers year 1 per day	429,019	passengers/day	Logit, 2018, slide 31
Conversion factor to year	340		ADB, 2018
Annual passengers yr	145,866,460		
CAGR passenger growth	2.26%		ADB, 2018
Lifespan buses	12	years	

Rickshaws			
Parameter	**Value**	**Unit**	**Source**
Specific fuel consumption CNG rickshaws	6.3	m^3/100km	Grutter Consulting, 2016 based on data of rickshaw operators in Dhaka, Bangladesh; 100% of rickshaws use CNG
Occupation rate rickshaws	0.96	passengers	Logit, 2018, ODBM, Vol.1, table 3.3 excludes driver
NO_x emissions rickshaw	0.5	g/km	Indian emission standard year 2010 onwards for 3-wheelers

Parameter	**Value**	**Unit**	**Source**
Specific fuel consumption standard 12m CNG bus	94	m^3/100km	Based on measurements of buses realized in Peshawar by SGS, 2017
Specific fuel consumption minibus and coach CNG	71	m^3/100km	Based on relative fuel consumption of mini-bus/coach versus standard bus Euro II diesel based on COPERT, 2016
Specific fuel consumption standard 12m diesel bus	66	l/100km	Based on measurements of buses realized in Peshawar by SGS, 2017
Specific fuel consumption minibus and coach diesel	50	l/100km	Based on relative fuel consumption of mini-bus/coach versus standard bus Euro II diesel based on COPERT, 2016
Share CNG buses	60%		ADB, 2018
Share Minibus	47%		Logit, 2018, ODBM, Vol.1, table 3.3
Share coach	32%		
Share large bus	20%		
Occupation rate Minibus	21	passengers	Logit, 2018, ODBM, Vol.1, table 3.3
Occupation rate coaches	21	passengers	
Occupation rate large bus	23	passengers	
BC fraction Euro II HDVs	65%		EEA, 2016, tabla 3-117
$PM_{2.5}$ emission diesel Euro II urban bus	0.27	g/km	COPERT, 2016, Tier 3 with 50% load factor, 0% gradient, speed 15km/h
NO_x emission diesel Euro II urban bus	14.6	g/km	
NO_x emission CNG Euro II urban bus	15	g/km	COPERT, 2016, table 3-23, Tier 2 appoach

3.3. Results BRT

The following figure shows WTW GHG emissions per passenger-kilometre of the baseline (current) transport system including buses and rickshaws. Other modes are not included as no passenger shift is expected from other modes. The average baseline emissions of a BRT passenger are based on a modal share of 25% of passengers coming from rickshaws and the rest from the current buses. The figure thereafter compares the baseline GHG emissions with the BRT system looking at different possible technology options for the BRT buses. The figure calculated is conservative as over a 30-year period it is expected that under Business as Usual (BAU) more mode shift from passenger cars and private vehicles (with a higher emission factor) would occur due to increased economic prosperity resulting in higher BAU mode shares of private transport. Taking a constant mode shift only from rickshaws is thus considered a conservative approach.

Figure 10: GHG WTW Emissions per pkm of Baseline Modes of Transport in Karachi

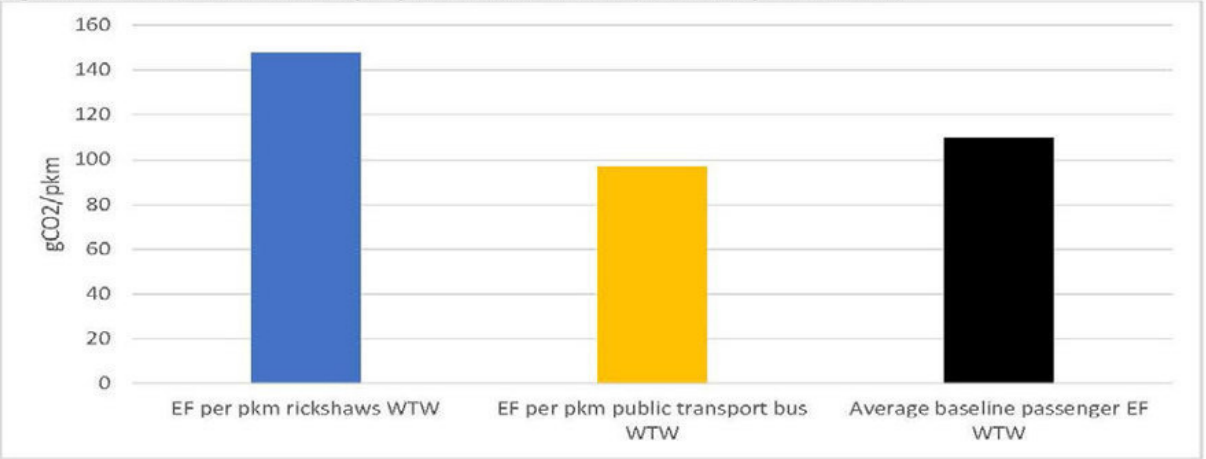
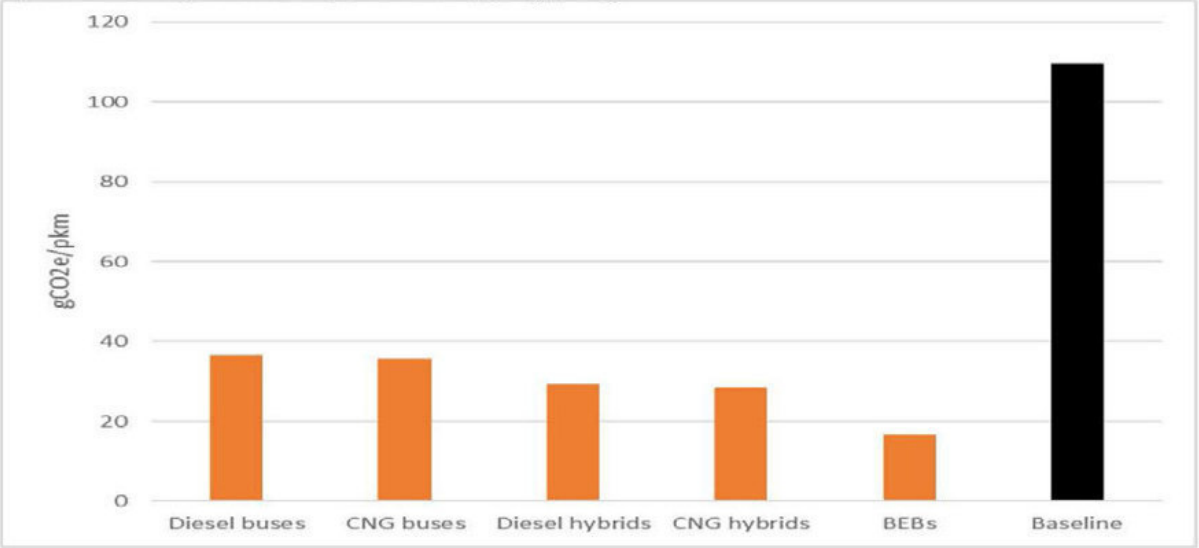


Figure 11: Average BRT Passenger EF WTW (gCO_{2e}/pkm)



The following table shows the impact of the BRT on GHGs and air pollutants and the economic value of these emission reductions comparing also different vehicle technologies.

Table 13: BRT Emission Reduction (annual average impact)

Parameter	Unit	Diesel buses	CNG buses	Diesel hybrids	CNG hybrids	BEBs
GHG reduction TTW	tCO_{2e}	57,177	57,253	62,243	62,304	82,507
GHG reduction WTW incl. BC	tCO_{2e}	71,126	72,124	78,276	79,074	90,515
NO_x reduction	tNO_x	225	558	306	572	629
$PM_{2.5}$ reduction	$tPM_{2.5}$	-2.5	4.8	-1.0	4.8	4.8
SO_2 reduction	tSO_2	7	15	9	15	15
Environmental savings monetized	MUSD	2.8	3.1	3.2	3.4	3.8

Over the BRT project lifetime of 30 years GHG reductions of 2.13 million tCO_{2e} for diesel, 2.16 million tCO_{2e} for CNG, 2.35 million tCO_{2e} for diesel hybrids, 2.37 million tCO_{2e} for CNG hybrids and 2.72 million tCO_{2e} if using BEBs can be expected i.e. the project has a considerable GHG impact. The above figures are conservative manner as they are based on the average emission reduction for the

year 1-12 (lifetime of buses) whilst passenger numbers will continue to grow, an increased mode shift from private vehicles can be expected and a shift can be expected towards larger and more efficient buses due to higher ridership levels. All these factors result in increased emission reductions. Baseline emission factors per pkm on the other hand are not expected to diminish significantly over time improved vehicle efficiency is counteracted with drops of the average occupation rate of vehicles over time.

Independent of the technology used in the BRT GHG emission reductions would occur. In terms of air pollution however, using diesel powered BRT buses will result in increased particle emissions compared to the current transport system. Although the economic damage based on the data values of the IMF are of minor nature, the result is still that one of the most critical urban pollutants namely $PM_{2.5}$ would increase with the BRT compared to a situation without the BRT. This is not considered to be a desirable outcome. Therefore, it is strongly suggested to pursue the option of using CNG or CNG hybrid buses which allow to reduce not only significantly GHG emissions but would also have a strong impact on reducing air pollution including NO_x, $PM_{2.5}$ and SO_2.

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Appendix-D Traffic Management Clauses for Tender Documents (indicative)

Traffic Management Provisions

No later than thirty (30) days from the receipt of the Commencement Date, the Contractor shall submit for the Engineer's approval a Traffic Management Plan to explain the means and methods to be taken for proper and adequate control of traffic during the course of the Works. This Plan shall include but not be limited to the following:

- The traffic control equipment the Contractor proposes to use for the Works;
- Traffic control signage including location and sign descriptions;
- How and when the Contractor proposes to use traffic control flagmen;
- Traffic control means during no-working periods; and
- Traffic control means and devices for night and off-hour periods.
- Lane availability and minimizing interference with traffic flows past the works site.
- Establishment of acceptable working hours, constraints and public safety issues.
- Agreement on time scale and establishment of traffic flow/delay requirements.
- Programming issues including the time of year and available resources.
- Discussion of the TMTD inspection/monitoring role.
- Establishment of complaints management system for duration of the works
- Agreement on publicity/public consultation requirements (advance signing etc.).

General Traffic Management Requirements

The Contractor shall present a Traffic Management Plan in the preconstruction phase as an integral requirement of the SSEMP which shall include but not be limited to the following conditions which shall apply in regard to traffic management:

a. The Contractor shall keep existing roads open for traffic during the performance of the Works, provided that when approved by the Engineer the Contractor may bypass traffic over a detour. The Contractor shall at all times keep roads and footpaths affected by his operations free from material spillage.

b. The Contractor shall keep the length of the construction areas in such condition that traffic will be accommodated safely. Stockpiles of working materials will be placed in an orderly fashion so as not to block the smooth flow of traffic or create traffic hazards. Stockpiles of working materials in traffic lanes will have markers that are clearly visible in daytime and at night. Traffic control devices and services shall be provided and maintained both inside and outside the Project limits as needed to facilitate traffic guidance should this be necessary.

c. Prior to the start of construction operations, the Contractor shall erect such signs, barricades, and other traffic control devices as may be required by the plans, specifications or directed by the Engineer.

d. Any devices provided under this Sub-Clause that are lost, stolen, destroyed, or deemed unacceptable while their use is required on the Project shall be replaced by the Contractor without compensation.

e. Nighttime construction operations shall be illuminated by a lighting system approved by the Engineer. The lighting system shall be positioned and operated to preclude glare.

f. The Contractor shall take necessary care at all times during the execution of the works to ensure the convenience and safety of residents along and adjacent to the road, and any public highway or port facility that may be affected by the Works is maintained.

g. The Contractor shall ensure that traffic safety is maintained and excessive delays to public traffic are avoided. The Contractor shall co-operate with the pertinent agencies regarding traffic control measures, the details of which will be subject to the Engineer's approval. (h) The Contractor's obligations shall include, but not be limited to provisions of traffic control devices and services and flagmen for the control and protection of traffic through areas of construction.

h. Any failure of the Contractor to meet these requirements will entitle the Engineer to carry out such works as he deems to be necessary and to charge the Contractor with the full cost thereof plus ten percent of such cost, which sum will be deducted from any money due or which may become due to the Contractor under the Contract.

Temporary Road Works

The following conditions shall apply in regard to temporary works:

a. The Contractor shall furnish, maintain, and remove on completion of the work for which they are required, all temporary road works such as sleeper tracks and staging over roads, access and service roads, temporary crossings over streams or unstable ground, and shall make them suitable in every respect for carrying materials for the work, for providing access for traffic for himself or others, or for any other purpose. Such temporary road works shall be constructed to the satisfaction of the Engineer, but the Contractor shall nevertheless be responsible for any damage done to or caused by such temporary road works.

b. Before constructing temporary road works, the Contractor at no cost to the Employer, shall make all necessary arrangements, including payment if required, with the public authorities or landowners concerned, for the use of the land and shall obtain the approval of the Engineer. Such approval will be dependent on the Engineer being satisfied with the Contractor's proposals for items such as signing, lighting and riding quality of the temporary road together with the proposed maintenance arrangements. Such approval will not, however, relieve the Contractor of his responsibilities under the Contract. Upon completion of the works the Contractor shall clean up and restore the land to the satisfaction of the Engineer.

c. The Contractor, when required by the Engineer, shall submit for the Engineer's approval drawings giving full details of temporary roads. Such details shall include alignment, profile, pavement construction, signing, lighting and the duration of the temporary road.

Traffic Control

The Contractor shall ensure that all works are adequately sign posted (see Table A) especially where restrictions on the width of the highway are imposed due to construction works. The Contractor shall provide details in writing to the Engineer for his approval at least seven (7) days in advance of the works. On receipt of the Engineer's approval, advance warning signs (reflectorized), coning and bunding, stop and give way signs, other appropriate signing and lighting shall be provided and

maintained by the Contractor in accordance with his proposals and the effectiveness of this signing and lighting shall be constantly monitored by the Contractor.

All full, partial and temporary road closures shall be manned by the Contractor, day and night. All operatives shall be trained and fully briefed by the Contractor on their responsibilities. These shall include achieving minimum disruption to traffic consistent with the safety of pedestrians, construction operatives and supervisory staff and vehicular traffic.

The Contractor shall utilize flagmen to safely direct the flow of traffic. Where appropriate the traffic controllers or flagmen shall be provided with communication equipment.

Traffic Signs and Safety

Diversions shall be signposted down the road in advance of the works and fully signed and lighted when implemented. Safety of all parties using and working on the road shall be paramount. The contractor will be required to provide and maintain effective protective fences, banding, etc. below slope works and to define the edges of steep excavations or existing down slopes, provide signing and lighting as necessary. This in any case shall be subject for approval of the Engineer.

Typical Traffic Control Signs, Delineators and Warning Lights

Item Specification

1. General The contractor shall provide one-way traffic control for the 200 metre or less long construction section through the project, except for the repair of small areas of damaged concrete slabs. In these areas the Contractor shall provide for one-way traffic control beginning and ending 50 metres from the work area. Signs, delineators, warning lights and flagmen shall be posted and maintained as described in Items 2, 3 and 4.
2. Signs 1.2m x 1.3m square plywood painted reflective white with 12cm reflective red letters shall be installed at 50m intervals commencing 150m from the worksite. The signs shall be 1.2m high and placed on the edge of pavement facing the traffic flow. Sign wording shall be SLOW-LANE or ROAD CLOSED AHEAD; CAUTION: ROAD CONSTRUCTION AHEAD; REDUCE SPEED, CONSTRUCTION PROGRESS; STOP, OBEY FLAGMEN; REDUCE SPEED, ONE LANE AHEAD.
3. Delineators Reflective red or orange plastic or rubber cones 45cm high shall be placed at 30m interval along the traffic side of the restricted area.

Item Specification

4. Warning Lights Amber flashing lights with a 15cm diameter lens head shall be provided at all sign locations. The intensity of the lights shall be at least 4 candle powers and have a flash rate between 50-75 flashes directing traffic movements.

All barricades, fences and such other aids that maybe required shall be reflectorized and shall be illuminated at night by lanterns. This in any case shall be subject for approval of the Engineer. The Contractor shall appoint, subject to the approval of the Engineer's Representative, a responsible member of his staff to inspect daily all traffic aids within the site and to arrange such cleaning and repair as the Engineer considers necessary to maintain the proper effectiveness of these traffic aids at all times.

Appendix-E Emergency Response Procedures

D-1. Purpose

The purpose of this Emergency Response Procedure is to provide initial guidance for development of an emergency preparedness plan for the Bus Rapid Transit Project. This appendix can serve as a template for identifying risks, and for clarifying roles and responsibilities. The Contractor is responsible for developing a complete Safety and Emergency Planning Manual derived from this starting point.

The aim of the Emergency Response Procedure is to:

i. Ensure all personnel and visitors to the office/job sites are given the maximum protection from unforeseen events.

ii. Ensure all personnel are aware of the importance of this procedure to protection of life and property.

D-2. Emergency Preparation And Response Measure Scope

The emergency management program is applied to all Project elements and intended for use throughout the Project life cycle. The following are some emergencies that may require coordinated response.

i. Construction Accident

ii. Road & Traffic Accident

iii. Hazardous material spills

iv. Structure collapse or failure

v. Trauma or serious illness

vi. Sabotage

vii. Fire

viii. Environmental Pollution

ix. Loss of person

x. Community Accident

D-3. Responsibilities

The detailed roles and responsibilities of certain key members of the Emergency Response team available to assist in emergency are provided in

Table D-1: Emergency Response Team

Action Group	Responsibility
Emergency Coordinator	▪ Overall control of personnel and resources. ▪ The Emergency Coordinator will support and advise the Site Safety Supervision as necessary. ▪ Serves as public relations spokes persons, or delegates to some staff member the responsibility for working with news media regarding any disaster or emergency. Also assure proper coordination of news release with appropriate corporate staff or other designated people.
Site Safety Supervision (Emergency Commander)	▪ Overall responsibility for activating emergency plan and for terminating emergency actions. ▪ Be alternative of emergency response chairpersons. ▪ Disseminates warnings and information as required to ensure all people in the immediate area have been warned and evacuated either by alarms or by word of mouth. ▪ Supervise the actions of the Emergency Response Team to ensure all persons are safe from the danger. ▪ Notify outside authorities if assistance is required. ▪ Carries the responsibility for coordinating actions including other organizations in accordance with the needs of the situation. ▪ Ensure maximum co-operation and assistance is provided to any outside groups called to respond to an emergency. ▪ Establish and appoint all emergency organization structure and team. ▪ Assures adequate delegation of responsibilities for all key positions of assistants on the Project to assist with any foreseeable emergency. ▪ Ensure resources available to purchase needed emergency response equipment and supplies. ▪ Assures that all persons on the Emergency Response Team aware and fully understand their individual responsibilities for implementing and supporting the emergency plan. ▪ Establish the emergency drill schedule of all identified emergency scenarios, track the status and evaluate the emergency. ▪ The Emergency Commander shall ensure that senior management personnel have been reported of the emergency as soon as practical after the event.
Security Team	▪ Ensure that the exit route is regularly tested and maintained in good working order. ▪ Maintain station at the security gate or most suitable location to secure the area during any emergency such that only authorized personnel and equipment may enter, prevent access to the site of unauthorized personnel. ▪ Assist with strong/activation of services during an emergency.

Action Group	Responsibility
	▪ Ensure vehicles and obstructions are moved to give incoming emergency vehicles access to the scene, if ambulance or emergency services are attending the site, ensure clear access and personnel are located to direct any incoming emergency service to the site of emergency.
Rescue & Medical Team	▪ Protect the injured from further danger and weather. ▪ Provide treatment to the victim(s) to the best of their ability by first aid and then transfer to hospital. ▪ Remain familiar with the rescue activities and rescue apparatus. ▪ Assist outside medical services personnel when they arrive
General Administration Team	Response to support any requested general facilities for assisting Emergency Response Team in their work.
Government Relation Team	▪ Coordinate with local government on a matter of concerned in the emergency response plan to liaise with local officers in their affair for support Emergency Response Team. ▪ Coordinate emergency plan with the government authorities, local community.
Environment Team	In case of emergency related to the environmental pollution such as the chemical spill, oil spill into the ambient, the environment team will support the technical advice to control and mitigate the pollution until return to the normal situation.
Department Heads	▪ Call up of personnel into the safe location for protective life and property. ▪ Take immediate and appropriate action while Emergency Response Team is being mobilized. ▪ Keep in touch with the Emergency Commander ▪ Control and supervise operators and contractors on the implementation of this procedure, with consultation with Safety Team as necessary. ▪ Provide and maintain emergency equipment of their responsible areas.
Other Staff and Employees	▪ All other staff and employees will remain at their workstations or assembly point unless directed otherwise from Emergency Response Team. ▪ Each supervisor will ensure that all members of his work group are accounted for and keep in touch with each of their Department Head.

D-4. Procedure

Emergency situation and injuries to person can occur at any time or place either on Project site or elsewhere. The most two common types of emergencies on site are fire and serious accident.

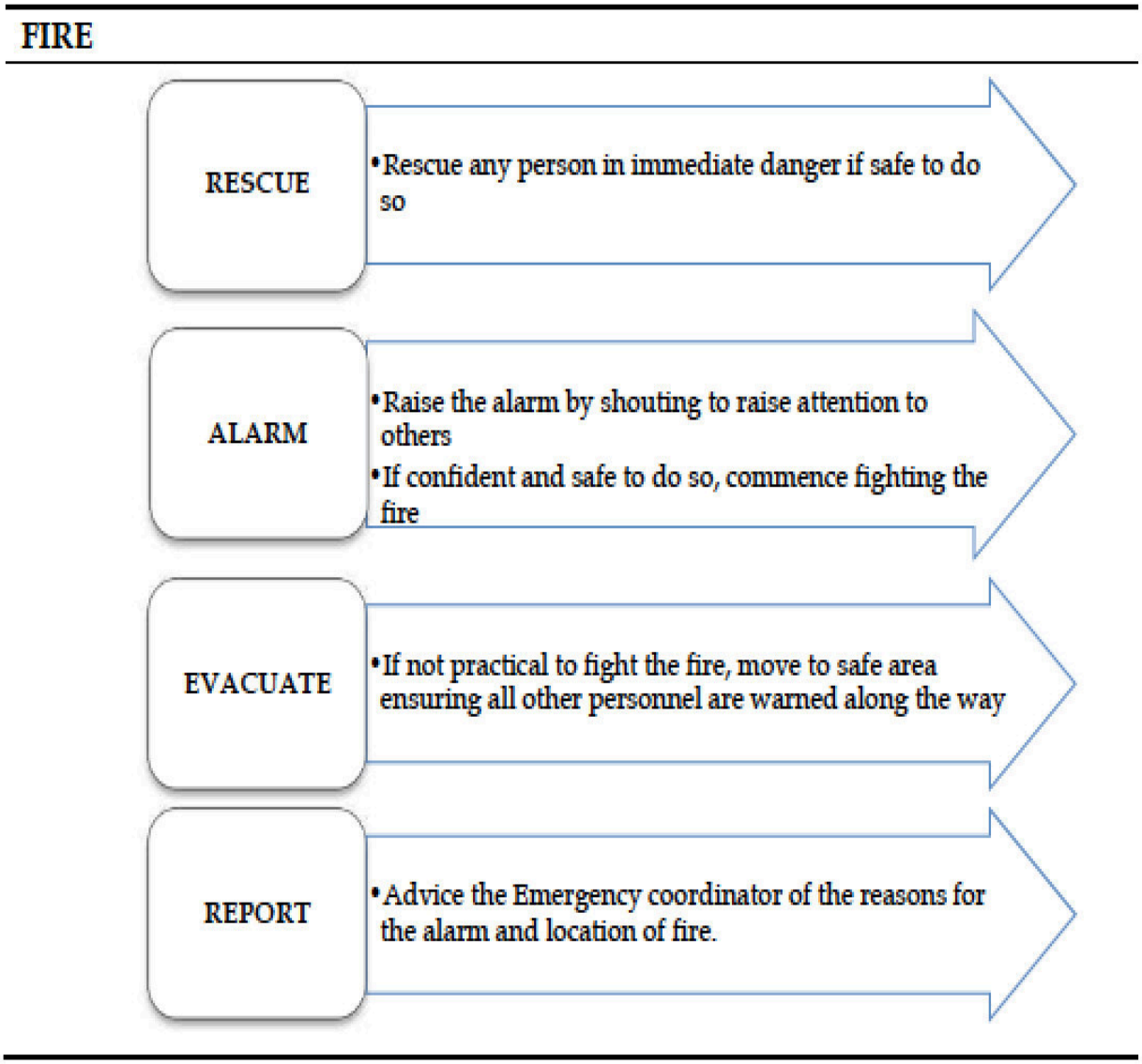


Figure D- 1: Emergency Procedure for Fire

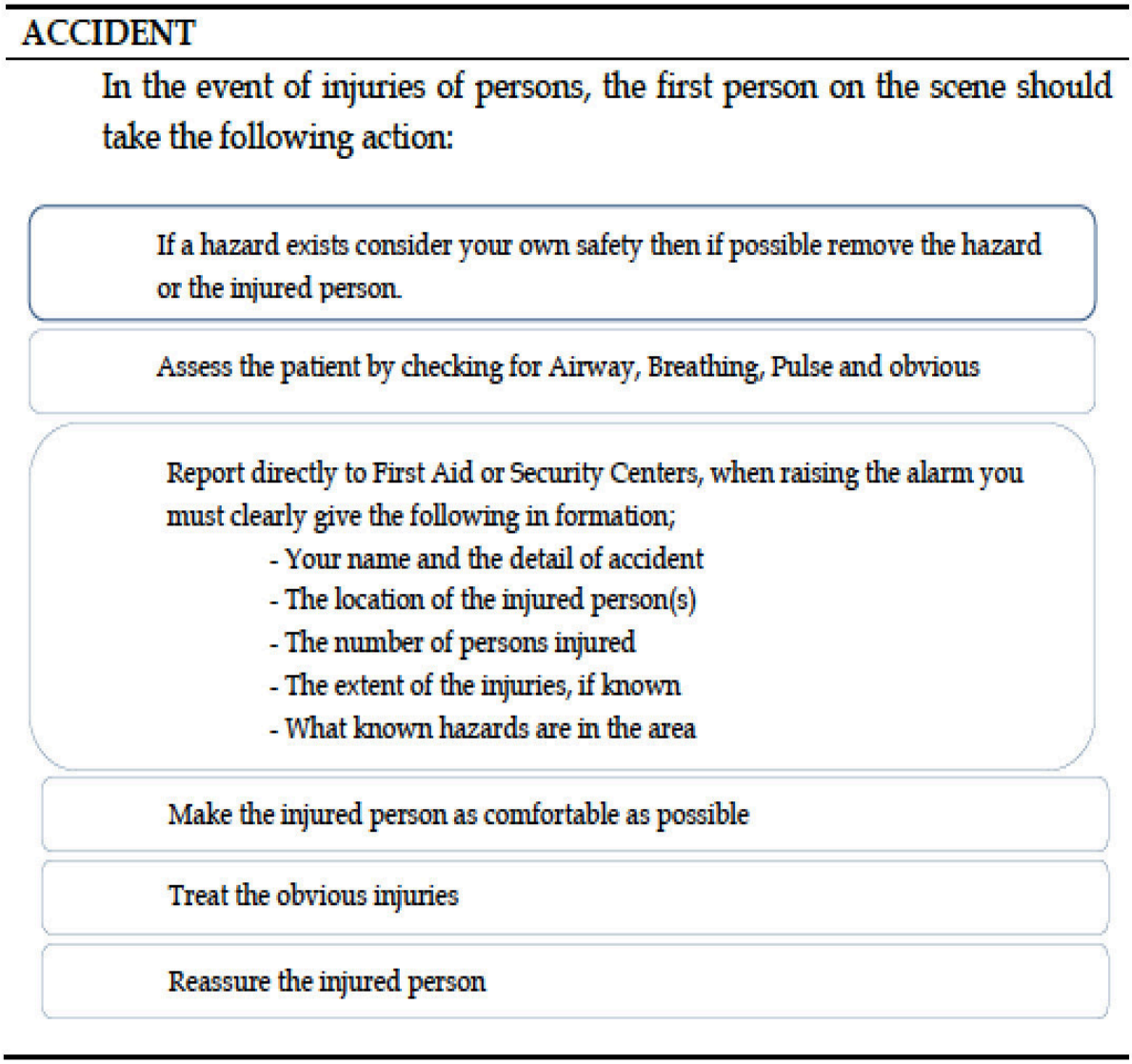


Figure D- 2: Emergency Procedure for Serious Accident

- Provide treatment to the victim(s) to the best of his/her ability.
- Ensure the safety of victims by ceasing any work activity in the area.
- Protect the injured from further danger and weather.
- Assist medical services personnel when they arrive.

General Administration Team

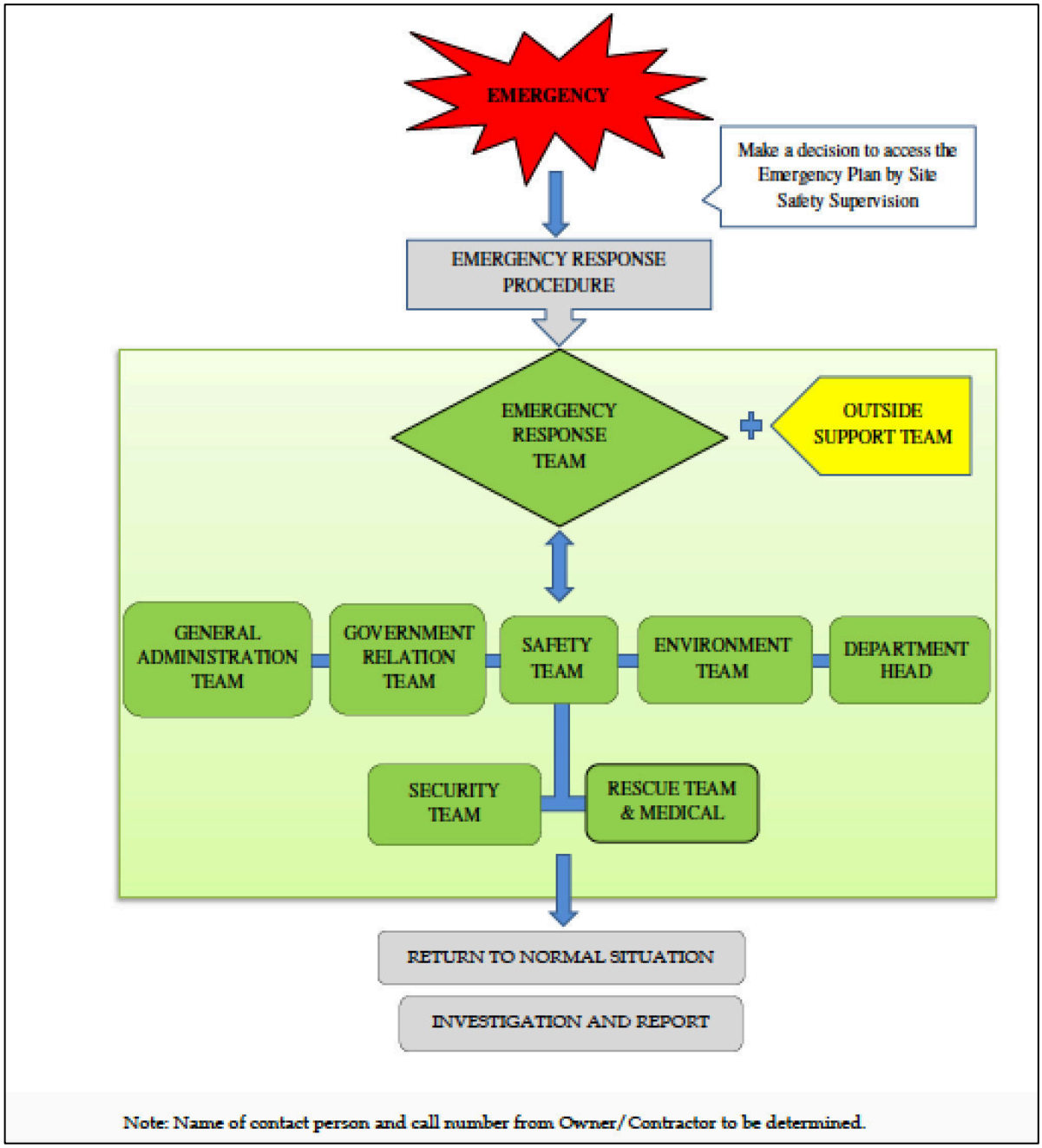
Upon advice of medical emergency, maintain contact with first aid personnel and summon ambulance if required.

Security Team

- If ambulance or emergency services are attending the site, ensure clear access and personnel are located to direct vehicle closest to the scene.
- Prevent access to the site of unauthorized personnel (press, etc.).

Emergency Coordinator

- The Emergency Coordinator shall assist emergency personnel at the scene as required through allocation of company resources.
- The Emergency Coordinator shall ensure next-of-kin are properly notified as soon as possible and give whatever company support and assistance is necessary to assist them bundle the situation
- The Emergency Coordinator shall ensure that senior management personnel are advised of the emergency as soon as practical after the event.



D-5. Incident And Accident Report

Section A: Identification Data

Report No:	Date of Reported:	Reporter:	Sign:
Job Title:		Company Name:	

Section B: Violence Rate

Accident Violence: ☐ 01-Death ☐ 02-Serious Injury ☐ 03-Lost Time Injury ☐ 04-First Aid ☐ 05- Not Injury ☐ 06-Near Miss

Property Damage Cost: ☐ 1-2,000 USD ☐ 2,001-10,000 USD ☐ 10,001-50,000 ☐ > 50,001

Section C: Environmental Impact

Affected area	☐ Construction area	☐ Public area	
Receptor	☐ None	☐ Workers	☐ Community
Type of pollution	☐ Physical	☐ Chemical	☐ Biological
Toxicity	☐ Non-toxic	☐ Low - toxic	☐ High - toxic
Return to Normal	☐ 1 day	☐ 1 day to 1 week	☐ ≥ 1 week
Cumulative impact	☐ Non-cumulative	☐ Cumulative	

Section D: Injured/Illness Employee

1.Name:	Sex: ☐ Male ☐ Female	Date of Birth: Month / Day / Year	Age:	Regular Job Title:	Experience: In this job title Years Weeks / In this Project Years Weeks

Site:	Company:	Reference:	Phone No:	Social Security Numbe

Part of Body Injured or Affected:

☐ Head	☐ Hands	☐ Face	☐ Nose
☐ Eyes	☐ Legs	☐ Teeth	☐ Neck
☐ Trunk	☐ Toes	☐ Elbow	☐ Shoulder
☐ Back	☐ Ankle	☐ Wrist	☐ Foot
☐ Arms	☐ Thump	☐ Fingers	☐ Internal

Remark: .....

Nature of Injury or Illness:

☐ Laceration	☐ Amputation	☐ Puncture	☐ Fracture
☐ Strain & Sprain	☐ Burns	☐ Contusion	☐ Dry Heat Friction
☐ Hernia	☐ Foreign Body	☐ Chemical	☐ Contamination
☐ Skin (Occupationnel)	☐ Rash	☐ Irritation	

Remark: .....

2.Name:	Sex: ☐ Male ☐ Female	Date of Birth: Month / Day / Year	Age:	Regular Job Title:	Experience: In this job title Years Weeks / In this Project Years Weeks

Site:	Company:	Reference:	Phone No:	Social Security Numbe

Part of Body Injured or Affected:

☐ Head	☐ Hands	☐ Face	☐ Nose
☐ Eyes	☐ Legs	☐ Teeth	☐ Neck
☐ Trunk	☐ Toes	☐ Elbow	☐ Shoulder
☐ Back	☐ Ankle	☐ Wrist	☐ Foot
☐ Arms	☐ Thump	☐ Fingers	☐ Internal

Remark: .....

Nature of Injury or Illness:

☐ Laceration	☐ Amputation	☐ Puncture	☐ Fracture
☐ Strain & Sprain	☐ Burns	☐ Contusion	☐ Dry Heat Friction
☐ Hernia	☐ Foreign Body	☐ Contamination	☐ Chemical
☐ Skin (Occupationnel)	☐ Rash	☐ Irritation	

Remark: .....

Section E: Accidents/incident Details

Date Accident/Incident Occurred:	Time Accident/Incident Occurred:	Exact Location of the Accident / Incident:

Details of the actual Job Being done at the time:

Details of Accident / Incident / What actually happened?

Section F: Accident Cause (Basic cause mark X / Contributing cause, if any mark O)

UNSAFE CONDITIONS		UNSAFE ACTS	
1	☐ Inadequately Guarded	1	☐ Operating Without Authority / Training
2	☐ Unguarded	2	☐ Operating at Unsafe Speed
3	☐ Defective Tools, Equipment, or Substance	3	☐ Marking SHE Device Inoperative
4	☐ Unsafe Design or Construction	4	☐ Using Unsafe Equipment or Equipment Unsafely
5	☐ Hazardous Arrangement	5	☐ Unsafe Loading, Placing, Mixing
6	☐ Unsafe Illumination	6	☐ Taking Unsafe Position
7	☐ Unsafe Ventilation	7	☐ Working on Moving or Dangerous Equipment
8	☐ Unsafe Clothing	8	☐ Distraction, Teasing, Horse Play
9	☐ Insufficient Instruction	9	☐ Failure to use Personal Protective Devices
10	☐ Lack of system of work	10	☐ Lack of effective instruction or supervision

Why was the unsafe act committed? _____ Why did the unsafe condition exist? _____

Section G: Guide to Corrective Action (Base on the cause checked above, I am taking the following corrective action)

UNSAFE ACT	UNSAFE CONDITION	If Supervisor can't handle, then recommend to
☐ Stop the Behaviour	☐ Remove	☐ Site Engineer, or
☐ Study the job	☐ Guard	☐ Site Manager, or
☐ Instruct (tell-show-try-check)	☐ Warn	☐ Project Manager, or
☐ Follow Up	☐ Supervisory Training	☐ Safety Committee
☐ Enforce		

Detail below any immediate remedial actions that have been taken:

Detail below any corrective and preventative actions that could be taken to prevent future re-occurrence:	Responsible	Completion Date

Section H: Witness Statement	
Witness Name	**Interviewer Name**

Section I: Reviewed & Recommend by			
Recommendation:			
Reviewed By:	Position:	Signature:	Date:

Remarks : If Accident or Incident happened with lost time injury and affected to the publicity must further report to Safety Department;
: First Aid Cases will not applicable to this form;
: The accident report shall submit to Safety Department within 3 days
: Attached the photograph or sketch the location of accident / incident;

Appendix-F Archaeological 'Chance Find' Procedures

Background

The purpose of this document is to address the possibility of archaeological deposits becoming exposed during ground altering activities within the project area and to provide protocols to follow in the case of a chance archaeological find to ensure that archaeological sites are documented and protected as required.

The Pakistan Antiquities act 1975, and the Sindh Cultural Heritage Preservation Act 1994, protect archaeological sites, whether on Provincial Government owned or private land. They are non-renewable, very susceptible to disturbance and are finite in number. Archaeological sites are an important resource that is protected for their historical, cultural, scientific and educational value to the general public and local communities. Impacts to archaeological sites must be avoided or managed by development proponents. The objectives of this 'Archaeological Chance Find Procedure' are to promote preservation of archaeological data while minimizing disruption of construction scheduling. It is recommended that due to the moderate to high archaeological potential of some locations within the project area, all on site personnel and contractors be informed of the Archaeological Chance Find Procedure and have access to a copy while on site.

Potential Impacts to Archaeological Sites

Developments that involve excavation, movement, or disturbance of soils have the potential to impact archaeological materials, if present. Activities such as road construction, land clearing, and excavation are all examples of activities that may adversely affect archaeological deposits.

Relevant Legislation

It ensures the protection, preservation, development and maintenance of antiquities in the province of Sindh. The Act defines "antiquities" as ancient products of human activity, historical sites, or sites of anthropological or cultural interest, national monuments, etc. The Act is designed to protect these antiquities from destruction, theft, negligence, unlawful excavation, trade, and export. The law prohibits new construction in the proximity of a protected antiquity and empowers the GOS to prohibit excavation in any area that may contain articles of archaeological significance. Under the Act, the subproject proponents are obligated to ensure that no activity is undertaken in the proximity of a protected antiquity, report to the Department of Antiquities, Government of Sindh, any archaeological discovery made during the course of the project.

Remedies and Penalties

The Sindh Antiquities Act provides for heritage inspection or investigation orders, temporary protection orders, civil remedies and penalties to limit contraventions. These powers provide:

''A contravention of any provision of this Act or the rules shall, where no punishment has been specifically provided be punishable with rigorous imprisonment for a term which may extend to two years, or with fine up to rupees ten hundred thousand, or with both. ''

Archaeological 'Chance Find' Procedure

If you believe that you may have encountered any archaeological materials, stop work in the area and follow the procedure below:

The following 'chance-find' principles will be implemented by the contractor throughout the construction works to account for any undiscovered items identified during construction works:

i. Workers will be trained in the location of heritage zones within the construction area and in the identification of potential items of heritage significance.

ii. Should any potential items be located, the site supervisor will be immediately contacted and work will be temporarily stopped in that area.

iii. If the site supervisor determines that the item is of potential significance, an officer from the department of Archaeology (DoA), GoSindh will be invited to inspect the site and work will be stopped until DoA has responded to this invitation.

iv. Work will not re-commence in this location until agreement has been reached between DoA and PDA as to any required mitigation measures, which may include excavation and recovery of the item.

v. A precautionary approach will be adopted in the application of these procedures.

Detailed Procedural Steps

- If the Director, department of Archaeology receives any information or otherwise has the knowledge of the discovery or existence of an antiquity of which there is no owner, he shall, after satisfying himself as to the correctness of the information or knowledge, take such steps with the approval of the Government, as he may consider necessary for the custody, preservation and protection of the antiquity.
- Whoever discovers, or finds accidentally, any movable antiquity shall inform forth with the Directorate within seven days of its being discovered or found.
- If, within seven days of his being informed, the Director decides to take over the antiquity for purposes of custody, preservation and protection, the person discovering or finding it shall hand it over to the Director or a person authorized by him in writing.
- Where the Director decides to take over an antiquity, he may pay to the person by whom it is handed over to him such cash reward as may be decided in consultation with the Advisory Committee.
- If any person, who discovers or finds any movable antiquity contravenes the provisions of the Act, he shall be punishable with imprisonment for a term which may extend to five (05) years, or with fine not less than fifteen hundred thousand rupees or with both and the Court convicting such person shall direct that the antiquity in respect of which such contravention has taken place shall stand forfeited to Government.
- The Director or any officer authorized by him with police assistance may, after giving reasonable notice, enter into, inspect and examine any premises, place or area which or the sub-soil of which he may have reason to believe to be, or to contain an antiquity and may cause any site, building, object or any antiquity or the remains of any antiquity in such premises, place or area to be photographed, copied or reproduced by any process suitable for the purpose.
- The owner or occupier of the premises, place or area shall afford all reasonable opportunity and assistance to the Director.

- No photograph, copy of reproduction taken or made shall be sold or offered for sale except by or with the consent of the owner of the object of which the photograph, copy or the reproduction has been taken or made.
- Where substantial damage is caused to any property as a result of the inspection, the Director shall pay to the owner thereof reasonable compensation for the damage in consultation with the Advisory Committee.
- If the Director after conducting an inquiry, has reasonable grounds to believe that any land contains any antiquity, he may approach the Government to direct the Revenue Department to acquire such land or any part thereof and the Revenue Department shall thereupon acquire such land or part under the Land Acquisition Act, 1894 (I of 1894), as for a public purpose.

Appendix-G Environmental Construction Specification

(Suggested Environmental Safeguard Provisions for Tender Documents)

F-1. Environmental Safeguards

The following Environmental Protection Safeguard Clauses are to be read in conjunction with the rest of the Contract Documents.

F-2. General Provisions

The Contractor shall take all necessary measures and precautions to ensure that the execution of the Works and all associated operations are carried out in conformity with statutory and regulatory environmental and social requirements of the Government of Sindh. The Contractor shall refer to the Environmental Impact Assessment (EIA) prepared for the Project, which is available at __[web address__] and is included by reference as an integral part of this specification.[33]

The EIA in its entirety is the primary authority regarding environmental performance for the implementation phase of the Project. The EIA is supported by other environmental requirements as found in the EMP (a part of the EIA), related parts of the contract bid documents, and conditions set forth by the ADB and the Sindh EPA related to approval of the EIA and their policies in general.

These Environmental Safeguard Provisions and the EMP (Chapter 7 of the EIA) make up a part of the Contract Specifications, and are legally enforceable under the laws of the State of Sindh. The Employer reserves the right to withhold payments and/or stop construction in the event of serious or repeated violations of the conditions stipulated in the EMP and Contract Specifications.

F-3. Environmental Management Plan (EMP)

The Environmental Management Plan (EMP) forms part of the contract. The EMP has been prepared based on current information as required under SEPA's review procedure, as specified in the Sindh Environmental Protection Act and EP Regulations (2014).

The Contractor is advised that in the event that mitigation measures in the EMP (a) are not applied thoroughly by the Contractor or (b) if there are unexpected impacts or (c) if there are changes to the alignment at the preconstruction stage; the EMP will be updated as necessary to respond to such circumstances, as required by the SEPA under its Regulations for Environmental Approval. In that case the updated EMP will take precedence and form part of the Contract.

The prescriptions detailed in the EMP are mandatory, but may be applied in a progressive fashion as needed to mitigate impacts targeted by the mitigation measure and at the discretion of the Construction Supervision Consultant (CSC). The EMP is equally applicable to sub-contractors including nominated sub-contractors, if any. The main contractor shall be responsible for the compliance with the requirements of the EMP by the sub-contractors including nominated sub-contractors. The CSC acting as "Engineer" on behalf of the Employer and the Project Implementation Unit (PIU) will monitor compliance with the EMP by the Contractor.

[33] The EIA was prepared by the EPCM Consultants in February 2018 in the detailed design stage. Chapter 7 of that document is the Environmental Management Plan (EMP), which contains both a management framework applicable to the Contractor as well as specific mitigation measures and additional requirements set out by SEPA.

The bidders are advised to carefully consider the EMP requirements when preparing the bid and pricing the items of work. The prescriptions and clauses in the EMP presented as an attachment to this specification are an integral part of the specification for relevant items of work, unless separate items are included in the Bill of Quantities.

F-4. Construction Environmental Management Plan

The Contractor will prepare a Construction Environmental Management Plan (SSEMP) at the start of the work that is site-specific, keyed to the timing and implementation schedule for the project, and geared to commitment of personnel and resources. The SSEMP will describe how and under what conditions the Contractor will implement the environmental mitigation measures prescribed in the EIA. The Contractor may recruit assistance in preparing the SSEMP, but shall assume full responsibility for its contents.

The SSEMP will describe a management framework for construction, including appointment of an Environmental Management Officer (EMO), Health and Safety Officer (HSO), and any additional management staff it deems necessary to execute the plan.

The SSEMP will also contain the Contractor's method statements or sub-plans in relation to the following:

1. Air Quality Control
2. Dust Management Plan
3. Noise Control
4. Traffic Management
5. Communication Plan
6. Occupational Safety and Health
7. Site Specific Drainage Management
8. Spoil and Solid Waste Disposal (including material handling)
9. Utilities and Telecommunications Relocation
10. Emergency Response Plan
11. Any other discrete packages of work related to environmental protection, and community/occupational health and safety requiring detailed explanation

The SSEMP will describe parameters, locations and frequencies for in-house and independent monitoring of air, noise and water quality, as well as any specialized monitoring for exhausts, equipment noise levels, vibration levels, sanitary flows, storm water and other types as necessary, to be undertaken during the course of construction.

The SSEMP shall include site specific information on construction methodology, permits and licenses for material suppliers, quarry and asphalt plant locations, gravel extraction sites, labor camp facilities, construction yards and office locations, spoil disposal sites, haul routes and any other site-specific information considered relevant to implementation of a sound environmental management system during project implementation.

The SSEMP shall be submitted to the TMTD for approval and endorsement as part of the Contractor's environmental obligations under the Contract. Implementing the requirements of the

SSEMP is the Contractor's obligation. The Contractor's environmental policy will also be presented in the SSEMP.

F-5. Monitoring of Performance

The Engineer will monitor performance of the Contractor against the SSEMP and the contents of the EIA. The Contractor shall assist the Engineer in monitoring the SSEMP implementation by (a) maintaining up to date records on actions taken by the contractor with regard to implementation of SSEMP requirements (b) timely submission of reports, information and data required by the Engineer or specified in the SSEMP, (c) performing in-house and independent monitoring of air, water and noise, (d) participating in the meetings convened by the Engineer and (e) any other assistance requested by the Engineer.

In case the contractor or his sub-contractor fails to implement the EMP recommendations after being informed in writing by the Engineer, the Engineer will take whatever actions it is deemed necessary to ensure that the EMP is properly implemented and/or to rectify the damages caused by such negligence. Any cost thus incurred will be recovered from the contractor's payments.

The Contractor will update the SSEMP from time-to-time as conditions change and understanding of methods improve. The SSEMP should be updated and amended as necessary with any new site-specific information such as locations of contractor yards, material sources, stockpiles, casting yards and spoil disposal areas.

The Contractor's attention is drawn to recognize that adherence to the SSEMP does not absolve the Contractor from other obligations under the Laws of Government of Sindh as may be updated and amended from time to time.

F-6. Special Provisions

Bidders are advised that if they choose to operate and supply materials from a dedicated quarry, a separate environmental approval may be required to cover quarry, stone-crushers, batching plant and asphalt mixing plant etc. owned or operated by the Contractor. Materials obtained from commercial sources must come from facilities holding an Environmental Approval. The Contractor is advised to carefully consider the requirements of all Laws of Government of Sindh and especially SEPA Regulations for Environmental Approval.

Material to be used for station construction, casting concrete, embankment, sub-base, base, drainage and pavement surface courses, shall be obtained from locations and facilities that have been disclosed to SEPA under SEPA Regulations and have an environmental approval where required by SEPA.

Where the Contractor elects to supply materials from the Contractor's own locations and facilities they shall have been disclosed in the pre-construction stage to the SEPA under SEPA Regulations and the authorities for mineral extraction and have environmental approval from SEPA and mineral license, where required.

Trees may be cut only after permission from the Director of Parks and Horticulture, following procedures set out in the EIA. The felling of trees by construction workers outside of these procedures is expressly prohibited, and the contractor is responsible for imposing sanctions on any workers who are caught felling trees, or being in possession of timber from trees cut from the project areas.

F-7. Damages

In the event that the Contractor or Subcontractors fail to implement the EMP recommendations, terms of the SSEMP, or other mandatory guidance, the Engineer shall take necessary action(s) to ensure that such guidance is properly implemented and/or to rectify by imposition of damage payments caused by such negligence. Any cost thus incurred will be recovered from the Contractor's payments.

F-8. Schedule and Payment for Performance

Within 30 days following the commencement date for the contract, the Contractor shall submit a site-specific Construction Environmental Management Plan (SSEMP) for review and approval by the Engineer.

Except as described in the following clause, separate payment will not be made in respect of the cost of compliance with the EMP and implementation of the SSEMP.

Provisional sums may be allowed for performance of some of the terms of the EMP, upon the discretion of the Engineer and the Contracts Officer, to be included as such in the bid schedule.

Appendix-H First Stage of Public Consultation under the EPCM

General

A public meeting of invited institutional stakeholders was held at the Marriott Hotel in Karachi on 16 Feb 2018, and attended by some 56 persons representing a variety of institutional interests. There was active interest in environmental aspects of the project. The meeting was billed as the Karachi BRT Red Line Stakeholder Workshop for the Environmental Impact Assessment. The purpose of the workshop was to assemble a range of institutional stakeholders, provide them with an overview of the EIA for the BRT Red Line Project, and give the stakeholders an opportunity to voice their concerns and suggestions.

Institutional stakeholders invited (many attending) included:

Utilities:

- Sui Southern Gas Company
- K Electric
- Karachi Water & Sewerage Board
- PTCL
- Others

Academia:

- Karachi University
- NED University
- Dawood Engineering University
- Bahria University
- Federal Urdu University

NGOS (Karachi)

- Sheri
- Country Representative, IUCN Pakistan
- WWF Pakistan
- Aman foundation
- Citizens for Environment

Plus, numerous organizations of provincial, city and local government:

- Commissioner Karachi
- Local Government
- President, Karachi Transport Itehad
- Transportation & Communication, Karachi Metropolitan Corporation
- Department of Antiquities
- Sind Environmental Protection Agency
- Parks & Horticulture Department
- Karachi Urban Transport Corporation (KUTC)
- President, Karachi Chamber of Commerce & Industry
- Chief Conservator, Sindh Wildlife Department
- Chief Conservator, Sindh Forest Department
- DIG, Traffic Police
- Women Development Department
- Others

Presentation

A presentation was made that reviewed the project components, contents of the EIA, expected environmental impacts, and management plan and framework. Project history and early planning were described; nearer term actions for development of the Red Line mentioned; the alignment was

shown; architectural rendering of stations; layout of carriageway and intersections; depot locations and equipment.

EIA context was reviewed (policies and laws); the content of the EIA was summarized in terms of major headings, impacts and mitigation measures (general); the management framework and use of construction EMP explained. Remaining steps to obtain approval were described along with ADB and Government commitment to environmental protection on the project.

Attendees

Those attending from ADB, the PIU, other affiliated consultant efforts and the EPCM are listed below:

S#No	Name	Designation	Company
Asian Development Bank			
1.	Nurlan Djenchuraev	Senior Environment Specialist	ADB
2.	Asim Sabzwari	Environment Consultant	ADB
Client (PIU)			
1.	Rasheed Ahmed Mughal	Project Director,	PIU Redline
2.	Fazal Karim Khatri	Coordinator,	PIU Redline
3.	Riaz Karim khan	Communication / media / PR Specialist	PIU Redline
4.	Syed Nadeem Arif	Environment Specialist	PIU Redline
5.	Saquaib Ejaz Hussain	Social Development Specialist	PIU Redline
6.	Fahad Mangi	Office Manager	PIU Redline
EPCM			
1.	Colin Ridding	Team Leader	EPCM
2.	Timothy Whitington	Senior Environmentalist	EPCM
3.	Alexandra Niesslein	Resettlement Specialist	EPCM
4.	Gaynor Dawson	Gender and Social Development	EPCM
5.	Ejaz Alam	Project Director	EPCM
6.	M A Shishmahal	Senior Environmentalist	EPCM
7.	Sajjad Anwar	Deputy Team leader	EPCM
8.	Ashfaq Memon	Senior Advisor	MMP
9.	Hammad Hayat Khan	Urban Planner & GIS	EPCM
10.	Amanullah Qureshi	Project Coordinator	MMP
11.	Aqeel Ahmed Magsi	Environmentalist	EPCM
12.	Syed Hassan Ali	Office Manager	MMP
13.	Ziad Chandio	Engineer	MMP
14.	Syeda Sadia Sharfat	Design Engineer	EPCM
15.	Sadiq Aftab	Planning Engineer	EPCM

Guest participants include the following individuals:

Guest Participant List			
S#No	**Name**	**Designation**	**Company**
1	Hamera Aisha	Manager	WWF- Pakistan
2	Tanveer		Karachi Municipal Committee
3	Yousuf		Karachi Municipal Committee
4	Dr. Muhammad Mansha	Director	SUPARCO
5	Mudasser Umer	Assistant Manager	SUPARCO
6	Javeed Ahmed Mahar	Conservator Forest	Sindh Forest Department
7	Muhammad Imran Sabir	Deputy Director	Sindh Environmental Protection Agency
8	Muhammad Iqbal Siddiqui	Director	Traffic Engineering Bureau
9	Engr. Parvez Sadiq	VC	Institute of Engineering Pakistan
10	Irshad Bukhari	President	Karachi Transport Itehad
11	Shiza Channa	HR / Admin	Consultancy Firm
12	Roshan Ali Kanasro	Director	Culture, Tourism & Antiquities Department
13	Imtiaz Ali Sangrani	Engineer	Culture, Tourism & Antiquities Department
14	Nazar Hussain Shahani	Secretary	RTA Karachi
15	Sardar Sarfarz	Director	MET Department
16	Dr. Atif Mustafa	Co-chairperson	NED University
17	Malik Zafar Iqbal	SSP/ DIG Traffic	Traffic Police
18	Shafqat Hussain Domki	Senior Manager	PTCl
19	Engr. Gulzar Memon	Principal Engineer	Techno / Institute of Engineering Pakistan
20	Abdul Jabbar Kazi	Conservator Forest	Forest Department
21	Peter Armitage		PMCCB ITP
22	Mohammad Rafiq	Managing Director	Sustainable Consultant
23	Dr Shahid Amjad	Professor	Institute of Business Management
24	Danish Rashdi	Program Manager	IUCN
25	Dur-e-Shahwar	Managing Director	Shah-war Security Consultant
26	Rizwan Khan	XEN Civil	Karachi Municipal Committee
27	Komal Naeem	Senior Officer	WWF- Pakistan
28	Nasreen Bukhari		Sheri Foundation
29	Ali Ahmed	DGM	Sui Southern Gas Company
30	Abiha Fatima	Design Engineer	Exponent Engineer

Commentary at the Meeting

The record of questions, comments and suggestions by attendees is shown in the following:

S. No.	Name designations and Department	Queries	PIU / EPCM / ADB Responses
1	Engr. Gulzar Ahmed Memon, Retd Chief Engineer KWSB & Institute of Engineers Pakistan.	The study should take into consideration mitigation measures as the following may be disrupted: 1. Main/ bulk drinking water supply line/ conduit are passing through the Safoora Chowrangi along the University road and ends at the reservoir how it will be handled. 2. Atleast 3 Electricity pylon 132KV passing through Safoora and University Road and these may have to be shifted. 3. Many Mature trees may have to be cut which are present along the alignment. 4. Link road to DOW University & hospital, SUPARCO etc. how they will be taken care. 5. Rush due to encroachment and transportation problem along DOW University and Safoora Chowrangi how to remove these. 6. Water pumping station at NIPA Chowrangi, also needs to be taken care off. Where will it be shifted?	Mr. Mughal advised to come and meet in the office & especially to discuss these lines, passing through this area and questioned regarding the life of these lines. Mr. Ejaz Alam stated briefly the main points in English for the benefit of Specialist present.
2	Engr. Parvez Sadiq, Sheri	1. How many acres of land will be required for the depots and if within city the environmental impact of these bus depot should be considered very carefully 2. We have been informed that buses are to be procured independently by various people contracted out. From Engineering point of view , with so many bus lines their interchangeability, maintenance sustainability & commonality should be considered 3. Integration with other lines is necessary otherwise a wonderful project may not remain viable. 4. Feeder services from the stations to the other areas should be incorporated. 5. Architect Perveen Rehman did a lot of good work on water flow in the rainy systems and one of the things she mentioned that the outflows have been blocked, so there is no point in reinventing the wheel her study should be taken into consideration.	Mr. Mughal advised that two depots are planned one near Malir Halt and one at Mausamiat. Feeder services are all under planning and will be incorporated along with restructuring. The design will be standardized diesel hybrid being used in Peshawar is being considered but decision is still under finalization.

		6. Provisions should be made in case of breakage in water line.	
3	Shafqat, PTCL	1. Estimate of PTCL relocation costs should be taken into consideration prior to starting of construction activities. 2. 2. Route is being used extensively by army circuit and PTCL lines may need to be relocated. This should be taken into consideration prior to construction activities.	Mughal Sb. said we will discuss with each utility company
4	Dr. Atif Mustafa, Co-Chair Environmental engineering NED University	Design of the system should integrate sustainability of: 1. Green City concept 2. Green bus stations 3. Trees cut down in the project, replantation of trees plus green walls concept should be incorporated in the design 4. Recycling and waste water treatment of water used in washing of buses incorporated in the design. 5. Size of the utility should be able to accommodate the large number of students using the corridor especially students using these facilities in large numbers at specific points especially near KU and NED and this should be incorporated in the design.	
5	Asim Sabzwari, ADB Consultant environment.	1. Air quality monitoring baseline has already been carried out but the study catered for only short term averages, conducted within a short time frame. Monitoring should be done through permanent stations for long term Air Quality monitoring on a regular basis for the key pollutants. SUPARCO may have cumulative long term data which may be included in EIA study. 2. Cumulative impact assessment should be under taken and should know which other projects are being conducted in parallel and there effects should also be taken into account.	
6	Imran Sabir, SEPA	This whole corridor has a lot of extremely sensitive sites. It should be noted that not only academia are located on it 1. Once due to exam at KU on a Sunday traffic problem were faced. 2. Another time due to a pipeline burst, massive traffic jams were witnessed for a whole week.	Nadeem Sb. response Construction should be packages wise less disturbance to be given the peoples M.A Shishmahal. All relocation activities are planned prior to start of construction activities and Mr. Rasheed Mughal has a

		The whole corridor is very sensitive for example: 1. Safari Park has visitors approximately five to six thousand per day. 2. Two Religious places are present in this corridor and on Thursday where 30,000- 40,000 people influx is noticed. 3. Masjid Baitul Mukarum is part of this corridor 4. Many Commercial zones 5. Central Jail with 10,000- 15,000 people daily visit 6. Car Showrooms 7. As per past experience at Green line where more than 200 feet wide corridor was available yet the green belt had to be cut to accommodate the system. Evan though this was a wide road yet a lot of problems was faced. On the other hand the Redline corridor does not have such alternates, so how will they deal with such problems. Recently road has been revamped, but in Ramzan, fasts had to be opened on the road. 8. In this corridor if a problem is at one ends the travelers all along the corridor get affected. 9. Alternative traffic management plan / diversion should be available so as to reduce congestions and problems prior to start of project. Using all media resources, ultimately delays effect the Air quality etc. also. 10. Time scheduled and especially design of the project, should not vary from the one approved by EIA 11. It should be ensured that Impact of air and dust quality is mitigated.	Gold standard bus system in mind and with these thoughts and your support you will be amazed what can be done for people of Karachi.
7	Muhammad Rafiq, Independent Consultant	1. Is the draft EIA ready for the public? 2. Draft EIA should be made available to public in whatever form it is available. 3. Conspicuous absence in the discussion regarding Cultural / historical impacts. This should be carefully assessed and incorporated in EIA we have the Lahore example in front of us, where it went up to the Supreme court and has resulted in delays. 4. It should be ensured that there are minimum disturbances to the utilities and services. Tired & sick of seeing digging up of roads every single day just because the project does not take into account what the other utilities are doing. It would be better to ensure restoration is an integral part of the	Mr. M.A Shishmahal, draft is not ready for the public as yet. Meantime scoping is being conducted ahead so the comments received may be incorporated in the EIA. Mr. M.A Shishmahal a very passionate speech please note a broad spectrum of representatives from key institutions including civil society representative are present and their opinions are being sought here. It is a requirement of ADB and SEPA to upload the EIA on web and a competent team

project rather than compensating another agencies for restoration, who end up digging the road again to restore their particular service and so on and so forth and this end up in an endless loop.

5. I am very pleased with the way this consultation is being dealt with however the effects of public consultations process are not actually visible in any of our projects as the decisions are already cast in stone. beforehand.
6. The design of the project should be finalized in all respects and only after its completion then the EIA should be prepared and then it should be followed with the project being undertaken by the government.
7. Zero faith in actual implementation of concepts mentioned in EIA as we have no history of this. I am sure very competent people are actually producing a brilliant EIA but as part of environmental managements an institutionalized arrangement taking the people like the civil societies inputs on a regular basis is required to provide some security.

from Mott MacDonald, GoS, MMP, PIU and all their advisors are there to support this process.

Mr Syed Nadeem Arif our office of GoS and PIU is their at three swords (teen Talwar) and any member of the civil society may walk in anytime and look at the drawings and plans make their comments..

Furthermore Antiquities department is on board to ensure heritage laws are followed. We have invited peoples from all the utilities so we believe their inputs are being incorporated. Regarding your comments on having zero faith in implementations. I don't blame anyone, as implementation comes with commitment and that is why we are here and doing this exercise. The commitment also requires resources and these are certainly not enough but SEPA is still doing their best.

Your comments will add value and we are trying to do our best and we will try to do better.

- Mr Nurlan a small comments actually about EIA disclosure, it's a very correct comment and under ABD we have a 120 day rule so the draft EIA will be placed on ADB website, so its four months, once the first acceptable EIA is available it will be published immediately on ABD website. Besides it will be disclosed locally. For local disclosure you advise where? At PIU or wherever in libraries etc, you tell the best location and we shall place it there, then you will have a chance to comment on the draft EIA. Now it is a bit too early so the

			scoping meeting just to include your initial thoughts in the EIA. Mr Imran Sabir from SEPA. The comments may be valid but being a SEPA representative, I can say that SEPA has always done more than their capacity. Whenever we do a public hearing we never publish in small newspaper but large ones and place it on our website even though it is not required by law. We issue more than 100 letters. We have to rely on people who actually respond, if we receive good arguments from learned people we shall benefit and make good decisions. We have many examples such as one of the people present here made good comments on famous LPG project having top notch people yet it was changed and redesigned not a single mangrove was cut. A standing committee has verified that we have planted mangroves on more than 2500 acres.
8	Javed Ahmad Mahar, Conservator Forest MFMC	1. We cannot ignore comments by Mr. Rafiq but have to point out that SEPA should have a cognizance & monitoring mechanism to ensure their effectiveness before problems are raised by civil society and SEPA is blamed.	
9	Dr Shahid Amjad, IoBM	1. The project tries to give images of a futuristic system, rightly coming now. 2. What fuel will be used, preference to hybrid should be given to control Air pollution in the area. 3. Safety of children, women, disabled and elderly should be part of the design consideration as they will be travelling on these buses.	
10	Saquib Ejaz Hussain , PIU Red line, Social , Gender and Public participation specialist	Plans should be made to handle the following issues: 1. Fruitful opportunities for women to participate in the project and these are being provided as part of gender action plan being prepared by Dr. Gaynor a gender specialist. 2. Cultural heritage sites are also a part of EIA and recent declaration by Sindh High court should be checked. 3. Drainage system need a relook	

		especially as during rainy season roads become water courses and especially on University road as seen during the last monsoon system. One has to keep in mind that Karachi is made from Creek. It is thus hard to conceive that Karachi not having a drainage problem once a project is being initiated. Our water supply and drainage system is old and has outlived its age and has completely collapsed as mentioned by Supreme Court in a report. KWSB needs to be included in discussions as mentioned by Mr. Rasheed Mughal as we cannot place such a big and expensive investment at risk. During rainy season our transport system breaks and shuts down completely. 4. Vegetation cover removal which stands at less than two percent and its replacement cost should be part of EIA based on how many trees and how many of these are mature trees etc. 5. Spoil disposal should be a part of a proper management plan in the EIA 6. Grievance redress mechanism should be included in the EIA. 7. Air quality monitoring should not be based on primary data alone, which has already been taken by SUPARCO but also based on data from secondary reports. SEPA is doing continuous monitoring and its web site shows exceedences particularly in particulate matter levels. PM 10 with 80 % exceedences and 170 % exceedences in PM 2.5 levels and this should be included in the EIA report. A mechanism should be mentioned in the EMP for control of dust pollution during construction phase.	
11	Dr. Mansha (Suparco)	1. Impact of Air quality and noise in the EIA report should highlight current situation and compare present to future through modeling and should highlights the positive effect of before and after implementation of the project.	Mr. Syed Nadeem Arif requested Dr. Mansha and Suparco to share available data. Offsetting by new system due to mode shift will take place by use of diesel hybrid reducing the air pollution level.
12	Mohammad Iqbal Siddique (Director TEB, KDA)	1. No space for parking 2. Suggest for extension up to Malir Halt 3. Interchange on Shahrae Faisal	

13	Irshad Buhkhari (Karachi Transport Ittehad)	1. My question was regarding availability of bus depot, which were not given to the transporters anyway now it has already been explained that the project will get two depots. Furthermore most of the problems related to transporter will start once the project is completed and we shall come in touch then.	
14	Ali Ahmad (SSGC)	1. Our planning and development department is already on board and SSGC will provide full cooperation	
15	Abdul Jabbar Kazi (Conservator of Social Forest Karachi) Forest Department	1. EMP is part of the EIA however its implementation and monitoring mechanism is weak, thus a steering committee with a permanent board should be formed to ensure implementation consisting of people from Forest, Horticulture, Wild life department and SEPA. 2. The results and progress of monitoring should be made public.	
16	Nasreen Bukhari (Sheri)	1. 1.Project lead to many problems such as traffic jams, messy roads without diversions 2. Project should be completed in time 3. Material is left on the road 4. Project monitoring and evaluations is non-existent and only projects pass through the approval process.	

Minutes recorded by ADB Project Special Consultant:

Karachi Bus Rapid Transit Project (BRT Red Line)

EIA Scoping Consultation Workshop

16 February 2018

Minutes of the Workshop

1. An EIA scoping consultation workshop was organized by the Engineering Design, Procurement and Construction Management (EPCM) Consultant on 16th February 2018 in Karachi. The purpose of the workshop was to identify the major environmental issues as perceived by the various stakeholders. These will then be incorporated during the preparation of the Environmental Impact Assessment (EIA) study for the Project. The workshop was attended by various stakeholder representing the government departments, Non-governmental Organizations (NGO's), academia and local communities. Staff / consultants from the Project Implementation Unit (PIU) and Asian Development Bank (ADB) also attended the workshop.
2. The workshop started with the recitation of Holy Quran. The Project Director, PIU, Mr. Abdul Rasheed Mughal and Senior Environmental Specialist ADB, Mr. Nurlan Djenchauraev gave the opening remarks and welcomed the participants. EPCM's International Environmental Consultant then gave a presentation on various project components as well as the major environmental issues to be covered in the EIA study.
3. One of the participants mentioned about the presence of utility lines within the project area Right of Way (RoW) including underground water supply and 132 KV overhead electricity cables and suggested for the timely re-location of these to ensure uninterrupted supply to the consumers. The participant also mentioned about presence of trees along the proposed project RoW and emphasized on the need to have a proper re-vegetation plan. He also urged for preparation and implementation of Traffic Management Plan (TMP) during construction phase to minimize disturbance to the locals living near the Project area.
4. Another participant mentioned about the need to address the adverse environmental impacts arising due to operation of the bus depot; He also enquired about inclusion of any feeder services in the project design. He was told by P.D, PIU that no feeder service is proposed as part of the Project;
5. Dr. Arif from NED University emphasized on the need to incorporate sustainability considerations in the project design including provision of green walls and an effective re-plantation strategy. He also suggested inclusion of wastewater treatment facility at the proposed bus depot as the same will also be used for washing of buses. This can result in surface and groundwater contamination in case the water is not treated prior to discharge;
6. Mr. Asim Sabzwari (ADB Environmental Consultant) suggested for inclusion of secondary air quality data in the EIA study to ascertain the ground level concentration values of different pollutants for annual averaging time periods. Secondary air quality data can be used for this purpose considering no permanent air quality station exists in Karachi. He also emphasized on the need to carry out a comprehensive cumulative impact assessment as part of the EIA study due to other ongoing projects near the project area and to provide adequate mitigation measures to minimize the adverse environmental impacts;
7. Another participant raised his concerns about various environmental / social issues. These include unavailability of alternate routes for the locals especially during the project's construction phase. Moreover, he also showed his concern that any design changes may not be adequately reflected in the EIA study at a later stage. He also emphasized on the need for easy availability of the draft EIA study for public review / comments. He also highlighted on the need to incorporate design changes in the project because of public consultations as this practice was not carried out in the past with the consultations usually carried out as a mere formality. Lastly, he suggested to incorporate project impacts on nearby archaeological and cultural sites in the EIA study. He also showed his concern on in-effective implementation of the Environmental Management Plan (EMP) especially during the project construction phase. He also questioned the role of Sindh

Environmental Protection Agency (SEPA) in giving No Objection Certificate (NOC) to various Projects. Mr. Nurlan Djenchauraev told him that the draft EIA study is disclosed on ADB website at least 120 days prior to board approval. Moreover, the EIA can also be disclosed at various public places (such as libraries, etc.) for easy public access and review;

8. Mr. Imran Sabir (SEPA representative) told the audience that SEPA is doing everything within its jurisdiction to ensure adverse environmental impacts from projects remain negligible. He mentioned about mangrove plantation on an area of about 2,500 Acres was also initiated by SEPA to offset adverse environmental impacts from one of the projects;
9. Another participant suggested on use of hybrid buses to ensure the air emissions remain low. He also suggested that design considerations related with use of bus service by disable people should also be incorporated in the design;
10. One of the participants mentioned about the drainage problems being faced by the residents of Karachi and emphasized on the need to replace the old system. He also suggested to prepare a re-vegetation plan. The same can be used during tree plantation activity to compensate for the trees cut during project construction phase. He also talked about the poor air quality of the city as the recorded pollutants levels (e.g. PM2.5 and PM10) are much higher than the SEQS and WHO guideline values;
11. Dr. Mansha from SUPARCO suggested on carrying out impact on air quality in a quantitative manner by comparing the air emissions due to the proposed project with the ones prior to the project. There is a consensus that the local air quality will improve as the vehicles exhaust emissions will be reduced due to replacement of old buses with the new ones as well as reduction in total traffic volumes (e.g. motor cycles) on the road as more people will prefer using the BRT rather than using their own transport;
12. One participant mentioned the need of forming a steering committee to over see effective implementation of the Environmental Management Plan (EMP) especially during project construction phase. The mentioned committee having representation from various government departments, and civil society will review the measures taken by EA / Consultant / Contractor for effective implementation of the EMP and will also provide suggestion to overcome any gaps;
13. One of the female participants mentioned that environmental management is not carried out at one of the BRT Projects (i.e. Green Line) undergoing construction as issues related with debris, waste management, and inadequate drainage can be observed at site. She also highlighted on taking appropriate measures so as not to repeat such types of issues for the proposed Red Line project;
14. Mr. Arif Nadeem, Environmental Specialist, PIU gave the concluding remarks. He thanked all the participants for their valuable feedback and gave assurance that all the project related environmental concerns as raised by the participants will be adequately addressed in the EIA study. Moreover, adequate measures will also be taken to ensure proper implementation of the EMP especially during the project construction phase.