



Initiative for Climate Action Transparency - ICAT



MEASUREMENT, REPORTING AND VERIFICATION PROTOCOL OF TRANSPORT SECTOR IN SRI LANKA





Initiative for Climate Action Transparency - ICAT -

MEASUREMENT, REPORTING AND VERIFICATION FRAMEWORK OF TRANSPORT SECTOR IN SRI LANKA

Deliverable 3-2

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June 2019

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This publication has been produced as part of a component of the Initiative for Climate Action Transparency project (ICAT) implemented by UNEP DTU Partnership (UDP). The views expressed in this publication are those of the authors and do not necessarily reflect the views of UDP.

PUBLISHED BY

Climate Change Secretariat, Ministry of Mahaweli Development and Environment

Ministry of Transport and Civil Aviation

PREPARED UNDER

Initiative for Climate Action Transparency (ICAT) project supported by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, the Children's Investment Fund Foundation (CIFF), the Italian Ministry of Ecological Transition (IMET) and ClimateWorks.









Federal Ministry for the Environment, Nature Conservation and Nuclear Safety





The ICAT project is managed by the United Nations Office for Project Services (UNOPS)







Acknowledgement

According to the Sri Lankan Nationally Determined Contributions (NDCs) submitted by the Government of Sri Lanka to the United Nations Framework Convention on Climate Change (UNFCCC) in 2016, and the Sri Lanka's Readiness Plan for Implementation of Intended Nationally Determined Contributions (INDCs) in 2016, the establishment of a national MRV(Measuring, Reporting & Verification) system is considered as a national priority. Sri Lanka has also to present the status of achieving the NDC goals in 2020. In this context, Sri Lanka has been looking for assistance from various parties to support the establishment of its national MRV system in the transport sector.

This report on monitoring reporting and verification (MRV) framework of mitigation actions for transport sector in Sri Lanka is the first part of the third deliverable of the assignment on developing a national MRV System for Transport Sector in Sri Lanka under the project Initiative for Climate Action Transparency (ICAT). This report was produced under the direct guidance and supervision of Climate Change Secretariat (CCS) of Ministry of Mahaweli Development and Environment (MMDE), Ministry of Transport and Civil Aviation (MTCA), and UNEP DTU Partnership.

To carry out this task, UNEP DTU Partnership awarded a short Term International Consultancy Contract to Climate Smart Initiatives (Pvt) Ltd (ClimateSI). In this regard, Climate Smart Initiatives (Pvt) Ltd wishes to express its gratitude to UNEP DTU partnership and ICAT for facilitating Sri Lanka to develop this national transport sector MRV system.

Our appreciation is also extended to Mr. L.P. Jayampathy (the secretary of MTCA), Mr.G.S. Withanage (former secretary to MTCA), Mr. Thilakarathne Banda (additional secretary of MTCA), the heads and the staff of all the institutions under MTCA, the head and staff of CCS, and the heads and the staff of other relevant ministries. We also express our profound thanks to Dr. Sunimal Jayathunga (Director of CCS) and Mr. S.S.A. Kularathne (Director of MTCA) for providing their invaluable guidance, comments and suggestions throughout this assignment.

We appreciate the regular guidance, feedback and supervision provided by Fatemeh Bakhtiari (Senior Researcher, UDP) and Subash Dhar (Senior Economist, UDP) in the design and preparation of this report.





Finally,ClimateSI wishes to thank all those who helped and contributed to make this assignment a success.

Authors: H.M. Buddika Hemashantha, W. IndikeDassanayake, D.M.Anuradha Lakmini Dissanayake, Wasundara Samarawickrama, Shyamika Shiwanthi, Nilni Malsha, Himesh Hansamal

Climate Smart Initiatives (Pvt) Ltd.

Sri Lanka.





List of Acronyms

AFOLUAgriculture, Forestry and Other land UseBURBianial Update ReportsBAUBusiness As UsualCAGRCompound Average Growth RateCIMClimate Change SceretariatCDMClean Development MechanismCTFComforence of the PartiesCMAConference of the Parties serving as the meeting of the Parties to theParis AgreemEEDGAREnsiston Database for Global Atmospheric ResearchEFGlobal Environment FacilityGFEGlobal Fuel Efficiency InitiativeGRGGlobal Fuel Efficiency InitiativeGHGGlobal Successes and Product UseIPPUIndustrial Processes and Product UseIPQLInternational Cooperation Agency (Prepared by Japan WeatherJRCAMinistry of Mahaweli Development & EnvironmentMMDEMinistry of Mahaweli Development & EnvironmentMMDEMinistry of Mahaweli Development & EnvironmentMATOMinistry of FinanceMATOMinistry of FinanceMARDEMinistry of Progence DevelopmentMARDEMinistry of Progence DevelopmentMARDEMinistry of Progence DevelopmentMARDEMinistry of Progence DevelopmentMARDEMinistry of Progence Active AverificationMARDEMinistry of Progence Active Averification	AD	Activity Data
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MTCA Ministry of Transport & Civil Aviation	MoPRE	Ministry of Power & Renewable Energy
	MoPS	Ministry of Petroleum Resource Development
MRV Monitoring Reporting and Verification	MTCA	Ministry of Transport & Civil Aviation
with womoning, reporting, and verification	MRV	Monitoring, Reporting, and Verification







NAMA	Nationally Appropriate Mitigation Action
NDC	Nationally Determined Contribution
NTC	National Transport Commission
SNC	Second National Communication
UDA	Urban Development Authority
UNFCCC	United Nations Framework Convention on Climate Change





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1 MONITORING, REPORTING & VERIFICATION PROTOCOL - PASSENGER SHIFT FROM PRIVATE TO PUBLIC

(NDC 4.1)

OVERVIEW

This protocol serves as an overview of the monitoring process, a qualitative assessment of the monitored parameters, the organizational structure, the primary responsibilities of the personnel involved in monitoring and QA/QC process.

1.1 Introduction

Mitigation Action - The proposed mitigation action is to shift passengers from private to public transport by introducing light railway transit (LRT) system with park and ride facilities from Malabe to Colombo Fort (Malabe corridor) in Sri Lanka. The LRT line has been designed to construct 17 km long elevated rail track including 16 stations to cover important and major intersections from Malabe to Colombo Fort. Under the proposed LRT system, 25 trains will be deployed for the service and each unit will comprise of four air-conditioned passenger compartments to accommodate 800 passengers. Based on the demand during the peak hours, trains will be operated with a minimum three-minute headway to ensure an efficient and comfortable ride for the passengers. The project is expected to be completed in 2026 and establishes the connectivity between many administrative complexes, commercial hubs and densely populated residential areas of the city.





1.2 Monitoring plan

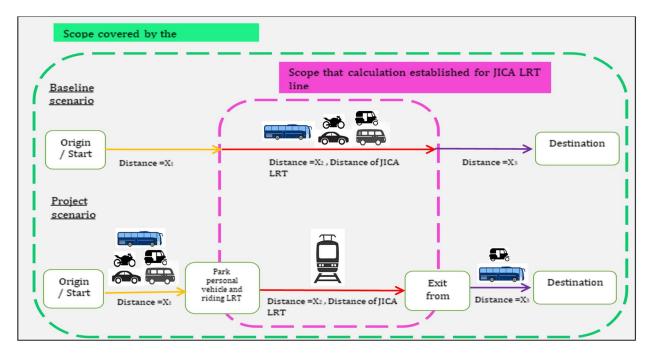


Figure 1.2-1 Monitoring plane

Data monitoring procedure of O & M Company (P1_PRS_OMC)

1.3 Monitoring methodology

Methodology /Tools

ACM0016: Baseline Methodology for Mass Rapid Transit Projects; Version 4.0

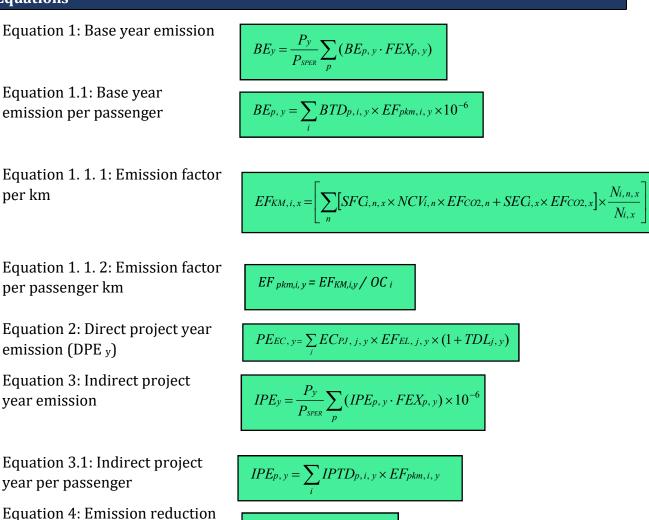
Tool,

- "Baseline emissions for modal shift measures in urban passenger transport", Version 01
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", Version 01
- > "Tool to calculate the emission factor for an electricity system", Version 05





Equations



 $ER_y = BE_y - PE_y + LE_y$

Parameters

1.3.1 Ex-ante parameters (fixed values)







- Specific fuel consumption of vehicle category *i* using fuel type *n* in year *x*
- Net calorific value of fuel *n* used in vehicle category *i*
- Technology improvement factor for vehicle category *i* per year
- Emission factor for fuel type n
- Average occupancy rate of vehicle category *i* in year *x*

1.3.2 Ex-post parameters (regularly monitored values)

- Number of vehicles of category i in year x
- Number of vehicles in vehicle category i using fuel type n in year x
- Total passengers transported by the project LRT per year
- Number of passengers in the time period of the survey (1 week)
- Number of passengers selected in the station sp, in stratum h
- Total number of passengers in the station sp, in stratum h
- Combined margin emission factor for the grid in year y
- Average technical transmission and distribution losses for providing electricity to source j in year y
- Quantity of electricity consumed by the project LRT per year

1.3.3 Parameters to verified/collected one time prior to the monitoring period

- Net calorific value of fuel *n* used in vehicle category *i*
- Technology improvement factor for vehicle category *i* per year
- Emission factor for fuel type n
- Average occupancy rate of vehicle category *i* in year *x*





1.4 Parameter and procedure

Parameter	Description	Instrument /method	Applied for (baseline, project, leakage)	Procedure
category <i>i</i> using fuel type <i>n</i> in year <i>x</i>		Default value / Calculate	Baseline & Project indirect	CDM tool 18/ P1_FSRR_CP
NCV i,n	Net calorific value of fuel <i>n</i> used in vehicle category <i>i</i>	Default value / Calculate	Baseline & Project indirect	IPCC/ P1_FSRR_CP
EFco2,n	Emission factor for fuel type n	Default value	Baseline & Project indirect	IPCC
Specific wei	ght for fuel type <i>x</i> in the year <i>y</i>	Calculate	Baseline & Project indirect	P1_FSRR_CP
IRi	Technology improvement factor	Default value	Baseline & Project indirect	CDM tool 18
N i,n,x	Number of vehicle-kilometers vehicle category <i>i</i> using fuel type <i>n</i> driven in year <i>x</i> or number of vehicles in vehicle category <i>i</i> using fuel type <i>n</i> in year <i>x</i>	Measure survey	Baseline & Project indirect	P1_PRS_OMC
N i,x	Number of vehicle-kilometers of category <i>i</i> driven in year <i>x</i> or number of vehicles of category <i>i</i> in year x	Measure survey	Baseline & Project indirect	P1_PRS_OMC
OC _{i,x} or OC _{B,x} /OC _{T,x}	Average occupancy rate of vehicle category <i>i</i> in year <i>x</i> (e.g. Buses (B),	Default value/ Measure	Baseline & Project indirect	CDM tool 18/P1_PRS_O MC

Table 1.4-1 Parameter and procedure table





100-100				
/OCc,x/OC MR, x	taxis (T), passenger cars (C), motorized rickshaw/bicycle (MR)			
MIC, X				
BTD,p,i,y	Baseline trip distance <i>p</i> per surveyed	Measure	Baseline	P1_PRS_OMC
D I D ,p,i,y	passenger using mode <i>i</i> in the year <i>y</i>	Measure	Dasenne	1 1_1 K5_0MC
IPTD _{p,y,i}	Indirect project trip distance of the	Measure	Project indirect	P1_PRS_OMC
F/3/-	surveyed passenger using mode "i"			
D -1	Number of stations on colociat in the	Measure	Baseline &	D1 DDS OMC
n Ihps	Number of stations <i>sp</i> selected in the stratum <i>h</i> (3 stratus are created i.e.	survey	Project indirect	P1_PRS_OMC
	high, medium and low passenger	Survey		
	flow);			
N Ihps	Total number of <i>stations</i> sp in the	Measure	Baseline &	P1_PRS_OMC
	stratum h	survey	Project indirect	
n ihps	Number of passengers selected in the	Measure	Baseline &	P1_PRS_OMC
	station <i>sp</i> , in stratum <i>h</i>	survey	Project indirect	
N		Manager	Deceline 9	
N ihps	Total number of passengers in the station <i>sp</i> , in stratum <i>h</i>	Measure	Baseline & Project indirect	P1_PRS_OMC
		survey		
Py	Total number of passengers in the	Measure	Baseline &	P1_PRS_OMC
L y	year y	incusure	Project indirect	11_110_0110
PSPER	Number of passengers in the time	Measure	Baseline &	P1_PRS_OMC
	period of the survey (1 week)	survey	Project indirect	
EF _{grid, CM}	Emission factor for electricity	Use	Project direct	P2_ER_SLSEA
	generation in the grid based on	calculated		
	combined margin (gCO ₂ /kWh)	national		
		value		





TDL	Average technical transmission and distribution losses for providing electricity	Use calculated national value	Project direct	P2_ER_SLSEA
EC _{PJ,y}	Quantity of electricity consumed by the LRT	Calculate	Project direct	P1_PRS_OMC

1.5 Organization structure and MRV specific responsibilities

Table 1.5-1 Organization structure and MRV specific responsibilities

Parameter	Tasks	Responsible staff	Procedure	Comment
description				
Specific fuel	Collect default	Project responsible	CDM tool 18/	
consumption	values and keeping	officer under NDC		
of vehicle	records	unit	P1_FSRR_CP	
category i				
using fuel type				
<i>n</i> in year <i>x</i>				
Net calorific	Collect default	Project responsible	IPCC/	
value of fuel <i>n</i>	values and keeping	officer under NDC	P1_FSRR_CP	
used in vehicle	records	unit		
category i				
Emission	Collect default	Project responsible	IPCC	
factor for fuel	values and keeping	officer under NDC		
type n	records	unit		
Specific weight	Calculate national	Responsible officer	P1_FSRR_CP	Value available
for fuel type <i>x</i>	value and publish on	under CEYPETCO		in the
in the year y	the website			CEYEPETCO
				website
Technology	Collect default	Project responsible	CDM tool 18	Value available
improvement	values and keeping	officer under NDC		under CDM
factor	records	unit		methodological
				tool 18
Number of	Conducting a	MRV Focal point at	P1_PRS_OMC	
vehicle-	survey, collecting	0 & M Company		
kilometres	the data and			
vehicle	reporting it to NDC			
category <i>i</i>	unit under			
using fuel type	Transport Ministry			





<i>n</i> driven in				
year x or				
number of				
vehicles in				
vehicle				
category i				
using fuel type				
<i>n</i> in year <i>x</i>				
Number of	Conducting a	MRV Focal point at	D1 DDC OMC	
vehicle-	survey, collecting	0 & M Company	P1_PRS_OMC	
kilometers of	the data and	1 5		
category <i>i</i>	reporting it to NDC			
driven in year	unit under			
<i>x</i> or number of	Transport Ministry			
vehicles of				
category <i>i</i> in				
year x	Estimate the	MDUEssel		Coloulate
Average	Estimate the	MRV Focal point at	CDM tool	Calculate
occupancy rate	average values and	0 & M Company	18/P1_PRS_0	default value to
of vehicle	reporting it to NDC		MC	specific project
category <i>i</i> in	unit under			only for one
year x	Transport Ministry			time
(e.g.,buses (B),	(Only onetime)			
taxis (T),				
passenger cars				
(C), motorized				
rickshaw/bicy				
cle (MR)				
Baseline trip	Measuring the	MRV Focal point at	D1 DDC OMC	
distance <i>p</i> per	values and reporting	0 & M Company	P1_PRS_OMC	
surveyed	it to NDC unit under			
passenger	Transport Ministry			
using mode <i>i</i> in				
the year y				
Indirect	Moscuring the	MRV Focal point at		
	Measuring the	-	P1_PRS_OMC	
project trip	values and reporting	0 & M Company		
distance of the	it to NDC unit under			
surveyed	Transport Ministry			
passenger				
using mode "i"				
Number of	Conducting a	MRV Focal point at	P1_PRS_OMC	
stations <i>sp</i>	survey, collecting	0 & M Company		
selected in the	the data and			
stratum <i>h</i> (3	reporting it to NDC			
stratus are				





created i.e. high, medium and low passenger flow);	unit under Transport Ministry			
Total number of <i>stations sp</i> in the stratum <i>h</i>	Conducting a survey, collecting the data and reporting it to NDC unit under Transport Ministry	MRV Focal point at O & M Company	P1_PRS_OMC	
Number of passengers selected in the station <i>sp</i> , in stratum <i>h</i>	Conducting a survey, collecting the data and reporting it to NDC unit under Transport Ministry	MRV Focal point at O & M Company	P1_PRS_OMC	
Total number of passengers in the station <i>sp</i> , in stratum <i>h</i>	Conducting a survey, collecting the data and reporting it to NDC unit under Transport Ministry	MRV Focal point at O & M Company	P1_PRS_OMC	
Total number of passengers in the year y	Conducting a survey, collecting the data and reporting it to NDC unit under Transport Ministry	MRV Focal point at O & M Company	P1_PRS_OMC	
Number of passengers in the time period of the survey (1 week)	Conducting a survey, collecting the data and reporting it to NDC unit under Transport Ministry	MRV Focal point at O & M Company	P1_PRS_OMC	
Emission factor for electricity generation in the grid based on combined margin (gCO ₂ /kWh)	Calculate national value and publish it through national energy balance	Responsible officer under Sustainable Energy Authority	P2_ER_SLSEA	Publicly available. NDC unit can collect it from the "Energy Balance"

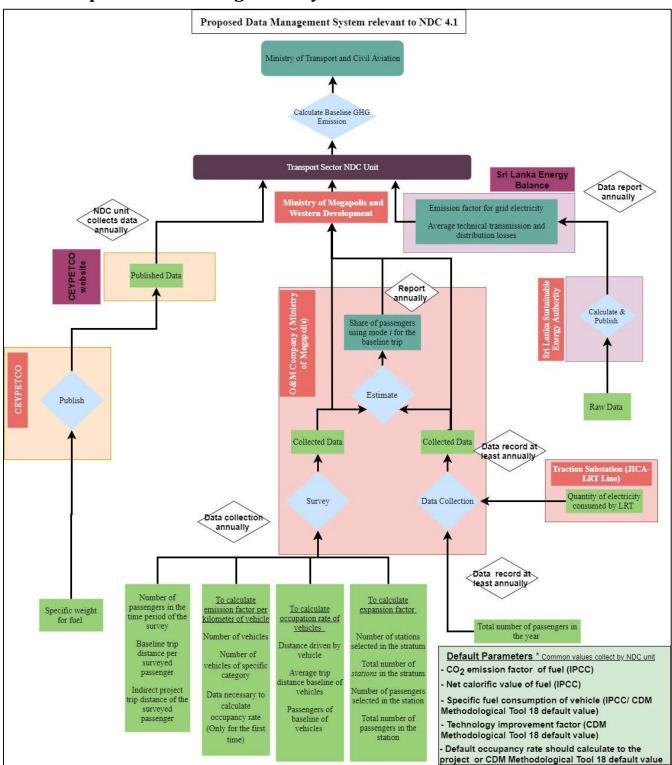




Average technical transmission and distribution losses for providing electricity	Calculate national value and publish it through national energy balance	Responsible officer under Sustainable Energy Authority	P2_ER_SLSEA	Publicly available. NDC unit can collect it from the "Energy Balance"
Quantity of electricity consumed by the LRT	Collect the values and reporting it to NDC unit under Transport Ministry	MRV Focal point at O & M Company	P1_PRS_OMC	







1.6 Proposed data management system

Figure 1.6-1 Proposed data management system





Data requirement

Parameters necessary for baseline and indirect project emissions

Data and parameters not monitored

<u>Data / Parameter table 1</u>

Data / Parameter:	SFC _{i,n,x}	SFC _{i,n,x}
Data unit:	Mass or volume units of fuel/km	Mass or volume units of fuel/km
Description:	Specific fuel consumption of vehicle category <i>i</i> using fuel type <i>n</i> in year <i>x</i>	Specific fuel consumption of vehicle category <i>i</i> using fuel type <i>n</i> in year <i>x</i>
Source of data:	 In decreasing order of preference: 1. Local measured data (studies, e.g. performed by universities, other institutions or ordered by project proponent); 2. National or international data from studies; 3. IPCC default values for the respective vehicle categories (latest IPCC report) 4. Design data for relevant vehicle categories 5. Globally applicable default values 	 IPCC default values or Globally applicable default values in CDM methodological tool 18 (Baseline emissions for modal shift measures in urban passenger transport)can be used.
Measureme nt procedures (if any):	The following alternatives are proposed to determine specific fuel consumption (in order of preference). In case one of the alternatives does not provide required values for all categories, the combination of these alternatives can be used and justification for the use of combination should be provided.	Alternative 3: latest IPCC default values reported matching the respective vehicle category, age, vehicle origin and technology. Alternative 5. Globally applicable default values (See table below).





Alternative 1: Measurement of fuel consumption data using total data (if available e.g. from bus or taxi companies) or a representative sample for the respective category and fuel type. Sampling per category and fuel should include, as core characteristics, vehicle age and motorization to ensure that the sample is as close as possible to the actual vehicle composition in the urban area(s) of the region for which the baseline is established. Vehicle age and technology (related often to emission standards such as Euro standards) are factors which influence, to a significant extent, the fuel consumption. To be conservative, specific fuel consumptions based on samples shall be based on the lower limit of the uncertainty band at a 95 per cent confidence level.

Alternative 2: Use of fixed values based on national or international literature. The literature data can either be based on measurements of similar vehicles in comparable surroundings (e.g. from comparable cities of other countries) or may include identifying the vehicle age and technology of average vehicles circulating in the urban area(s) of the region for which the baseline is established and then matching this with the most appropriate IPCC default values. The most important proxy to identify vehicle technologies is the average age of vehicles used in the urban area(s) of the region for which the baseline is established, to determine whether either US, Japanese or European default factors apply or local vehicle

Table 1 Specific fuel consumption forvehicle category

Specific fuel consumption	Value	Unit
Gasoline car (personal car and taxi)	6	l/100 km
Diesel car (personal car and taxi))	5	l/100 km
Motorcycle	2	l/100 km





manufacturer information can be used (in the case of having a substantial domestic vehicle motor industry or source of origin of vehicle imports).			
Alternative 3: latest IPCC default values reported matching the respective vehicle category, age, vehicle origin and technology.			
Alternative 4 . Design data for relevant vehicle categories.			
Alternative 5 . Globally applicable default values (See table below).			
Table 1 Specific fuel consumption forvehicle category			
Concerting for al	X7 - 1		
Specific fuel consumption	Value	Unit	
	6	Unit l/100 km	_
consumption Gasoline car (personal car		l/100	-
consumptionGasoline car(personal carand taxi)Diesel car(personal car	6	l/100 km l/100	-

Data / Parameter:	Ni,x	Ni,x
Data unit:	VKM or units	VKM or units





Description:	Number of vehicle-kilometers of category <i>i</i> driven in year <i>x</i> or number of vehicles of category <i>i</i> in year <i>x</i>	Number of vehicle-kilometers of category <i>i</i> driven in year <i>x</i> or number of vehicles of category <i>i</i> in year <i>x</i>
Source of data:	Municipal transit authorities based on vehicle registration statistics from the respective city or data from vehicle control stations (technical and emission control stations). If no city/municipal data is available, regional data (canton, state) or, as a last option, national data can be used	National Data Or Survey conducted by MRV officer(s) under LRT operation
Measureme nt procedures (if any):	-	For this option data should be monitored at least annually.
Any comment:	Used for all vehicle categories identified as relevant. In the cases of buses and taxis, informal or illegal units may operate. While estimates on the number of informal units may be available, these are by nature not trustworthy. For both categories it is thus recommended to only include formally registered units. For consistency, it is important that transported passengers are also based on the official records thus not including passenger trips on informal transport. For electrical vehicles fuel type <i>n</i> represents electricity	

Data / Parameter:	N _{i,n,x}	N _{i,n,x}
Data unit:	VKM or units	VKM or units





Description:	Number of vehicle-kilometres vehicle category <i>i</i> using fuel type <i>n</i> driven in year <i>x</i> or number of vehicles in vehicle category <i>i</i> using fuel type <i>n</i> in year <i>x</i>	Number of vehicle-kilometres vehicle category <i>i</i> using fuel type <i>n</i> driven in year <i>x</i> or number of vehicles in vehicle category <i>i</i> using fuel type <i>n</i> in year <i>x</i>
Source of data:	Municipal transit authorities based on vehicle registration statistics from the respective city or data from vehicle control stations (technical and emission control stations). If no city/municipal data is available, regional data (canton, state) or, as a last option, national data can be used	National Data Or Survey conducted by MRV officer(s) under LRT operation
Measureme nt procedures (if any):	-	this option data should be monitored at least annually.
Any comment:	Used for all vehicle categories identified as relevant vehicle categories. In the cases of buses and taxis, informal or illegal units may operate. While estimates on the number of informal units may be available, these are by their nature not trustworthy. For both categories it is thus recommended to only include formally registered units. For consistency, it is important that transported passengers are also based on the official records thus not including passenger trips of informal units. For electrical vehicles fuel type <i>n</i> represents electricity	

<u> Data / Parameter table 4</u>

Data /	NCV _{i,n}	NCV _{i,n}
Parameter:		





Data unit:			Energy/mass or volume units of fuel type n
Description:			Net calorific value of fuel <i>n</i> used in vehicle category <i>i</i>
Source of data:	if the relevant conditions apply: Table 3. Data sources and conditions for their usage		IPCC default values at the lower limit of the uncertainty at a 95 per cent confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
	Data source	Conditions for using the data source	
	(a) National default values	This source can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances)	
	(b) IPCC default values at the lower limit of the uncertainty at a 95 per cent confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories		





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Measureme nt procedures (if any):	-	
Monitoring frequency:	For (a): review the appropriateness of the values annually. For (b): any future revision of the IPCC Guidelines should be taken into account	(b): any future revision of the IPCC Guidelines should be taken into account
QA/QC procedures:	Verify whether the values under (a) and (b) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range, collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in (a) should have ISO17025 accreditation or demonstrate that they can comply with similar quality standards	
Any comment:	Vehicle owners or operators can buy fuel from a variety of sources (fuel stations). Therefore, in practice it is considered to be simpler to determine the parameter using options (a) or (b)	

Data / Parameter:	IRi	IRi
Data unit:	-	-
Description:	Technology improvement factor for vehicle category <i>i</i> per year	Technology improvement factor for vehicle category <i>i</i> per year





Source of data:	-	
Measureme nt procedures (if any):	When the tool is used for estimating baseline emissions for individual CDM project activities or Programmes of Activities, the default technology improvement factor is 0.99 for all vehicle categories;	The default technology improvement factor is 0.99 for all vehicle categories;
	When the tool is used for estimating emission for standardized baselines, the technology improvement factor is 1 for the first validity period of standardized baseline. However for subsequent years improvement factor shall be calculated based on historical trend of at least three years	
Any comment:	According to current requirements, standardized baselines need to be updated after its validity expires. The validity of standardized baseline is based on criteria established in the latest approved standard for coverage of data and validity of standardized baseline. For the application during the validity period of standardized baseline from the second version of the standardized baseline, technology improvement factor shall be calculated based on historical trend (minimum three years) of country specific data and used in calculations instead of the technology improvement factor of 1	

<u>Data / Parameter table 6</u>

Data / Parameter:	$OC_{i,x}$ or $OC_{B,x}/OC_{T,x}/OC_{C,x}/OC_{MR,x}$	$OC_{i,x}$ or $OC_{B,x}/OC_{T,x}/OC_{C,x}/OC_{MR,x}$
Data unit:	Passengers	Passengers





Description:	Average occupancy rate of vehicle category <i>i</i> in year <i>x</i> (e.g.,buses (B), taxis (T), passenger cars (C), motorized rickshaws (MR)		es (B), taxis	Average occupancy rate of vehicle category <i>i</i> in year <i>x</i> (e.g.,buses (B), taxis (T), passenger cars (C), motorized rickshaws (MR)	
Source of data:	-	tion 1. Municipal transit authorities specific studies. Vintage maximum ree years.			1. Measure by O & M Company through
	Option 2 . The following default values		ault values	2. Default values are available in the CDM methodological tool 18. (National values are not available)	
	Table 4. Ave vehicle type	-	ccupan	cy as per	
		Avera occup	-		
		Wor ld	South Asia	Unit	
	Car		2	Person (includin g the driver)	
	Taxi	1.1		Person (excludin g the driver)	
	Motorcyc le	40%80%Total		Person (includin g the driver)	
	Bus			Total capacity	
	Option 3.				
	motorized tr	Survey of occupancy of individual motorized transport (motorcycles, personal cars, taxis) in the urban area		cycles,	





	for which the baseline is established. The obtained occupancy rates can be used as default values for these vehicle categories at a country level, as variation in occupancy rates of individual motorized transport used in the urban context is relatively low. Survey of occupancy rates of public transport (bus, light rail, tram, metro, BRTs, etc.) in the urban area for which the standardized baseline is established. If standardized baselines for multiple cities in a country are established, these cities need to be grouped in categories of similar cities (based on population size, population density, etc.) and surveys on occupancy rates of public transport of sample cities need to be conducted. If there is no big variation in occupancy rates of the same mode in the cities of the same category, then surveyed occupancy rates of public transport can be used as defaults for the rest of the cities in the same category	
Measuremen t procedures (if any):	Based on visual occupation studies for all vehicle categories. For buses the occupation rate is based on boarding-alighting studies, electronic smart tickets or on visual occupation studies with expansion factors for routes served to determine the average occupation rate along the entire route. As an alternative for buses, the occupancy rate can be based on average trip distance of bus passengers, total passengers and total distance driven by buses.	For the JICA LRT project, data available in the "Preparatory Survey on the Project for Establishment of New Light Rail Transit System in Colombo 2018"





	For taxis (including motorized rickshaws), the driver should not be counted	
Any comment:	-	

<u>Data / Parameter table 7</u>

Data / Parameter:	EFc02,n		EFc02,n
Data unit:	g CO2/J		g CO2/J
Description:	Emission factor for fu	iel type n	Emission factor for fuel type n
Source of data:	The following data sources may be used, if the relevant conditions apply: Table 5. Data sources and conditions for their usage		IPCC default values at the lower limit of the uncertainty at a 95 per cent confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
	Data source	Conditions for using the data	
	(a) National default values	This source can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances)	
	(b) IPCC default values at the lower limit of the uncertainty at a 95		





	per cent confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories	
	Note: In case biofuels or biofuel blends are used, the CO2 emission factor for the share of biofuels used as pure or in blends is equal to zero	
Measuremen t procedures (if any):	-	
Monitoring frequency:	For (a): review the appropriateness of the values annually. For (b): Latest available IPCC Guidelines should be taken into account	Latest available IPCC Guidelines should be taken into account
QA/QC procedures:	-	
Any comment:	-	

Data and parameters monitored

Data / Parameter	Py
Unit	Passengers
Description	Total passengers transported by the project LRT per year





Source of data	MRV officer(s) under LRT operation
Measurement methods and procedures	The system for determining passenger numbers has not yet been defined.
Monitoring frequency	Continuously, aggregated at least annually
QA/QC procedures	Checked with ticket sales (average fare and income from ticket)
Purpose of data	Calculation of baseline and project emissions
Additional comment	

<u> Data / Parameter table 9</u>

Data / Parameter	PSPER
Unit	Passengers
Description	Number of passengers in the time period of the survey (1 week)
Source of data	Survey conducted by MRV officer(s) under LRT operation
Measurement methods and procedures	Survey
Monitoring frequency	at least annually
QA/QC procedures	See Annex xxx for the survey design
Purpose of data	Calculation of baseline emission
Additional comment	

Data / Parameter	n ihps , N ihps
Unit	Passengers
Description	Number of passengers selected in the station <i>sp</i> , in stratum <i>h</i>





	Total number of passengers in the station <i>sp</i> , in stratum <i>h</i>
Source of data	Survey conducted by MRV officer(s) under LRT operation
Measurement methods and procedures	Survey
Monitoring frequency	at least annually
QA/QC procedures	See Annex xxx for the survey design
Purpose of data	Calculation of baseline emission
Additional comment	

Parameters necessary for direct project emissions

Data and parameters monitored

Data /	EF _{grid,CM,y}	EF _{grid,CM,y}
parameter:		
Data unit:	tCO ₂ /MWh	tCO ₂ /MWh
Description:	Combined margin emission factor for	Combined margin emission factor for the
	the grid in year <i>y</i>	grid in year y
Source of	Calculate the combined margin	Sri Lanka Energy Balance by Sri Lanka
data:	emission factor, using the procedures	Sustainable Energy Authority
	in the latest approved version of the	
	.Tool to calculate the emission factor	
	for an electricity system.	
Measuremen	As per the .Tool to calculate the	Tool to calculate the emission factor for
t procedures	emission factor for an electricity	an electricity system.
(if any):	system.	
Monitoring	As per the .Tool to calculate the	Latest available grid emission factor
frequency:	emission factor for an electricity	should be taken into account (Annually
	system.	need to check for the value)
QA/QC	As per the .Tool to calculate the	
procedures:	emission factor for an electricity	
	system.	
Any	Only applicable to scenarios A and C	
comment:	(cases C.I and C.III)	





<u>Data / Parameter table 12</u>

Data / parameter:	$TDL_{j,y}$ and $TDL_{k,y}$ and $TDL_{l,y}$	TDL _{j,y}
Data unit:	-	
Description:	Average technical transmission and distribution losses for providing electricity to source <i>j</i> , <i>k</i> or <i>l</i> in year <i>y</i>	Average technical transmission and distribution losses for providing electricity to source <i>j</i> in year <i>y</i>





Source of data:	In case of scenario B and scenario C, case C.II, assume TDL _{j/k/l,y} = 0 as a simplification. In case of other scenarios (scenario A and scenario C, cases C.I and C.III), choose one of the following options: • Use recent, accurate and reliable data available within the host country; • Use as default values of 20% for (a) project or leakage electricity consumption sources; (b) baseline electricity consumption sources if the electricity consumption by all project and leakage electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies is <u>larger</u> than the electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies. • Use as default values of 3% for (a) baseline electricity consumption sources; (b) project and leakage electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies. • Use as default values of 3% for (a) baseline electricity consumption sources; (b) project and leakage electricity consumption sources if the electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies is smaller than the electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies is smaller than the electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies is smaller than the electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies.	Sri Lanka Energy Balance by Sri Lanka Sustainable Energy Authority
Measuremen t procedures (if any):	For a): $TDL_{j/k/l,y}$ should be estimated for the distribution and transmission networks of the electricity grid of the same voltage as the connection where the proposed CDM project activity is connected to. The technical	The distribution losses can either be calculated by the project participants or be based on references from utilities, network operators or other official documentation.





	distribution losses should not contain other types of grid losses (e.g. commercial losses/theft). The distribution losses can either be calculated by the project participants or be based on references from utilities, network operators or other official documentation.	
Monitoring	Annually. In the absence of data from	Annually. In the absence of data from the
frequency:	the relevant year, most recent figures	relevant year, most recent figures should
	should be used, but not older than 5	be used,
	years.	
QA/QC		
procedures:		
Any		
comment:		

<u>Data / Parameter table 13</u>

Data / Parameter:	EC _{PJ,y}
Data unit:	MWh
Description:	Quantity of electricity consumed by the project LRT per year
Source of data:	LRT operator(s) in transaction substation
Measurement procedures (if any):	Based on electronic meters and electric bills
Monitoring frequency:	Continuously, aggregated at least annually
QA/QC procedures:	Control with electricity invoices. Data is controlled with train-km and estimated energy consumption per train-km
Any comment:	Used to calculate together with the emission factor grid the DPE as per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".





2 MONITORING, REPORTING & VERIFICATION PROTOCOL -Railway Electrification

(NDC 5.1)

OVERVIEW

This protocol serves as an overview of the monitoring process, a qualitative assessment of the monitored parameters, the organizational structure, the primary responsibilities of the personnel involved in monitoring and QA/QC process.

2.1 Introduction

Mitigation Action - The proposed mitigation action involves the electrification of Veyangoda to Panadura railway line with 64 km which covers both main line and coastal line. Currently around 44 million passengers are carried by the existing diesel powered railway system annually. After improving the railway system, this number of passengers will use electric train.

2.2 Monitoring plan

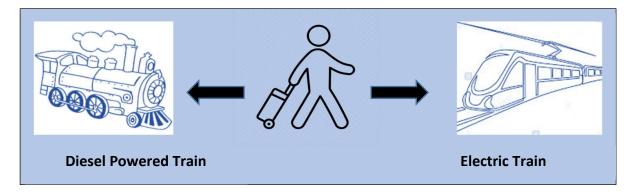


Figure 2.2-1 Monitoring plan

P2 and P3 Procedures will be applied to monitor and report the relevant parameters.





2.3 Monitoring methodology

Relevant methodology and equation

Baseline emission BE_y = FC_{BL,i,y} * NCV_i * EF_{fuel,i}

Project emission PE_y = EC_{pJ,y}* EF_{elec}

	1	
Parameter	Description	Unit
FC _{BL,i,y}	Consumption of fuel i associated with the operation of the existing railway in year y	t/year
EF _{fuel,i}	CO ₂ emission factor of fuel i	t-CO ₂ /TJ
NCVi	Net calorific value of fuel i	TJ/t
ЕСрј,у	Electricity consumption associated with the operation of the project activity in year y	MWh/year
EFelec	CO ₂ emission factor of the grid electricity	t-CO ₂ /MWh

Table 2.3-1 Parameter description table

2.3.1 Ex-ante parameters (fixed values)

- CO₂ emission factor of fuel i
- Net calorific value of fuel i
- CO₂ emission factor of the grid electricity

2.3.2 Ex-post parameters (regularly monitored values)

- Consumption of fuel i associated with the operation of the existing passenger railway
- Electricity consumption associated with the operation of the electrified train

2.3.3 Parameters to verified/collected one time prior to the monitoring period

The MRV focal point at the SLR and MRV officer at Transport NDC unit shall verify the above fixed values and regularly monitored values.





2.4 Parameter and procedure

Parameter	Description	Instrument /method	Applied for (baseline, project, leakage)	Procedure
FC _{BL,i,y}	Consumption of fuel i associated with the operation of the existing railway in year y	Annex 01	Baseline	P1_ER_SLR
EF _{fuel,i}	CO ₂ emission factor of fuel i	Annex 02	Baseline	P2_ER_SLSEA
NCVi	Net calorific value of fuel i	Annex 02	Baseline	P2_ER_SLSEA
EC _{PJ,y}	Electricity consumption associated with the operation of the project activity in year y	Annex 01	Project	P1_ER_SLR
EF _{elec}	CO ₂ emission factor of the grid electricity	Annex 02	Project	P2_ER_SLSEA

Table 2.4-1 Parameter and procedure description table

2.5 Organization structure and MRV specific responsibilities

Tasks	Responsible staff	Procedure	Comment
Recording and	MRV Focal point at	P1_ER_SLR	
reporting of Fuel	SLR		
consumption			
Recording and	MRV Focal point at	P1_ER_SLR	
reporting of	SLR		
electricity			
consumption			
Recording the fixed	MRV officer at	P2_ER_SLSEA	Go through relevant
value of parameter	Transport NDC unit		website

Table 2.5-1 Organization structure and MRV specific responsibilities





2.6 Proposed Data Management System

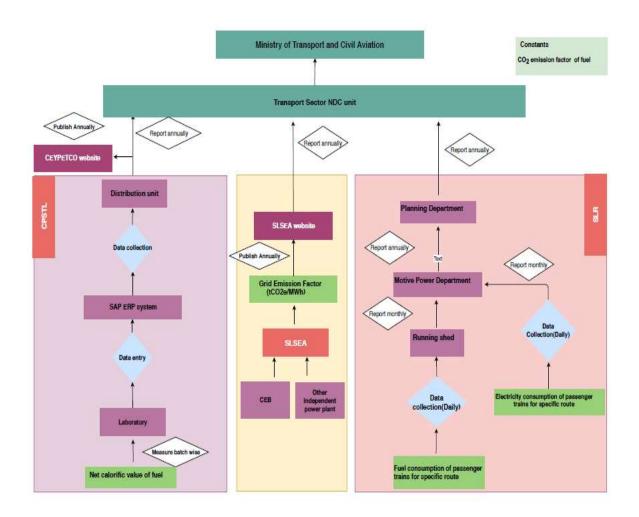


Figure 2.6-1 Proposed Data Management System for NDC 5.1





2.7 Annex

2.7.1 Annex 01: Sri Lanka Railway

Data /	FC _{BL,i,x}	FC _{BL,i,x}
Parameter:	1	1
Data unit:	liter or m ³	liter
Description:	Amount of fuel <i>i</i> consumed by	Amount of fuel i consumed by the
	the existing diesel powered	existing diesel powered railway in
	railway in year <i>y</i>	year y
Source of data:	Historical data from the project	Historical data from SLR
	participants	
Measurement	-	Purchase receipt of the fuel
procedures		
(if any):		
Monitoring	Daily, summed for a year	Annually
Frequency:		
QA/QC		
procedures:		
Any comment:	-	Currently this data is not available.
		Therefore value was calculated based
		on specific fuel consumption of diesel
		power power set, trip distance per
		annum.

Data /	ECpJ,y	EC _{PJ,y}
Parameter:		
Data unit:	MWh	MWh
Description:	Amount of electricity consumed by the electrified railway in year y	Amount of electricity consumed by the electrified railway in year y
Source of data:	Actual data from the project participants	A planned value
Monitoring Frequency: QA/QC	Daily, summed for a year	Annually
procedures:		
Measurement procedures (if any):	-	A monitored value of Electric meter
Any comment:	-	Currently this data is not available. Therefore value was calculated based on specific electricity consumption and annual total trip distance





2.7.2 Annex 02 – CPSTL, SLSEA and IPCC

Data /	EF _{fuel,i}	EF _{fuel,i}
Parameter:		
Data unit:	t CO ₂ / TJ	t CO ₂ / TJ
Description:	CO ₂ emission factor of fuel <i>i</i>	
Source of data:	The following data sources may be used :	IPCC default
	a) Values provided by the fuel supplier in invoices	value
	b) Measurements by the project participant	
	c) Regional or national default values	
	d) IPCC default value	
Measurement procedures (if any):	Measurements should be undertaken in line with national or international fuel standards	
Any comment:	If the fuel supplier provides the CO_2 emission factor on the invoice and the value is based on measurements for this	

Data / Parameter:	NCVi	NCVi
Data unit:	TJ/t	TJ/t
Description:	Average net calorific value of fuel <i>i</i>	
Source of data:	 The following data sources may be used : a. Values provided by the fuel supplier in invoices b. Measurements by the project participant c. Regional or national default values d. IPCC default value 	National default value provided by CPSTL
Measurement procedures (if any):	For a) and b): Measurements should be undertaken in line with national or international fuel standards	
Any comment:	QA/QC procedures: Verify that the values under a), b) and c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values out of this range, collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a), b) or c) should have ISO17025 accreditation or justify that they can comply with similar quality standards	



Data /	EF _{elec}	EF _{elec}
Parameter:		
Data unit:	t CO ₂ / MWh	t CO ₂ / MWh
Description:	CO ₂ emission factor for Grid connected electricity	
Source of data:	The following data sources may be used :	Country specific
	a) Values provided by the fuel supplier in invoices	grid emission factor published
	b) Measurements by the project participant	in SLSEA
	c) Regional or national default values	
	d) IPCC default value	
Measurement procedures (if any):	Measurements should be undertaken in line with national or international fuel standards	
Any comment:	If the fuel supplier provides the CO ₂ emission factor on the invoice and the value is based on measurements for this specific fuel, this CO ₂ factor should be used.	





3 MONITORING, REPORTING & VERIFICATION PROTOCOL – Purchasing new rolling stocks

(NDC-5.2)

OVERVIEW

This protocol serves as an overview of the monitoring process, a qualitative assessment of the monitored parameters, the organizational structure, the primary responsibilities of the personnel involved in monitoring and QA/QC process.

3.1 Introduction

Mitigation Action - The proposed mitigation action is to purchase **six power sets** for Sri Lanka Railway to improve the public transportation. Currently around seventy- seven power set are operated under Sri Lanka Railway.

3.2 Monitoring plan

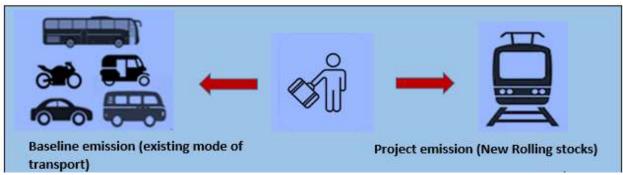


Figure 3.2-1 Monitoring plan

P5_PNRS_SLR and P4_PNRS_NTC Procedures are applied to monitor and report the relevant parameters.





3.3 Monitoring methodology

Relevant methodology and equation

Project Emission PE_y = FC_{PJ,y} * NCV_i *EF_{fuel,i} Baseline Emission BE_y = (P_y * BTDP_y * MS_{i,y} *EF_{PKM,i})

<i>Table 3.3-1 parameter description table</i>
--

Parameter	Description	Unit
Py	Number of passengers transported by the	Passenger/ year
	project in year y	
BTDPy	Average trip distance of the passenger of the	km
	project activity in year y	
MS _{i,y}	Share of passengers by transport mode i in	%
	the baseline scenario in year y	
ЕГРКМ, і	CO ₂ emission factor per passenger kilometer	t-CO ₂ / passenger-km
	for transport mode i	
FC _{PJ,i,y}	Consumption of fuel i associated with the	t / year
	operation of the project activity in year y	
NCVi	Net calorific value (NCV) of fuel i	
		TJ/t
EF _{fuel,i}	CO ₂ emission factor of fuel i	t-CO ₂ /TJ

3.3.1 Ex-ante parameters (fixed values)

- CO₂ emission factor of fuel i
- CO₂ emission factor per passenger kilometer for transport mode i

3.3.2 Ex-post parameters (regularly monitored values)

- Consumption of fuel i associated with the operation of the project activity in year y
- Share of passengers by transport mode i in the baseline scenario in year y
- Number of passengers transported by the project in year y
- Average trip distance of the passenger of the project activity in year y
- Net calorific value of fuel i





3.3.3 Parameters to verified/collected one time prior to the monitoring period

The MRV focal point at the SLR, NTC, CPSTL and MRV officer at Transport NDC unit shall verify the above fixed values and regularly monitored values.

3.4 Parameter and procedure

Parameter	Description	Instrument/ method	Applied for (baseline, project, leakage)	Procedure
Py	Number of passengers transported by the project in year y	Annex 01	Baseline	P1_PNRS_SLR
BTDPy	Average trip distance of the passenger of the project activity in year y	Annex 01	Baseline	P1_PNRS_SLR
MS _{i,y}	Share of passengers by transport mode i in the baseline scenario in year y	Annex 02	Baseline	P2_PNRS_NTC
ЕГркм,і	CO ₂ emission factor per passenger kilometer for transport mode i		Baseline	
FC _{PJ,i,y}	Consumption of fuel i associated with the operation of the project activity in year y	Annex 01	Project	P1_PNRS_SLR
NCVi	Net calorific value of fuel i		Project	P1_FSRR_CPSTL
EF _{fuel,i}	CO ₂ emission factor of fuel i		Project	

Table 3.4-1 Parameter and procedure table





3.5 Organization structure and MRV specific responsibilities

Tasks	Responsible staff	Procedure	Comment
Recording and	MRV Focal point at	P1_PNRS_SLR	
reporting of Fuel	SLR		
consumption,			
passenger volume			
and trip distance			
related data			
Recording and	MRV Focal point at	P2_PNRS_NTC	
reporting of share of	NTC		
passengers by each			
transport mode			
Recording and	MRV Focal point at	P1_FSRR_CPSTL	
reporting of NCV	CPSTL		
value			
Recording and	MRV officer at		Go through relevant
reporting fixed value	Transport NDC unit		website, guidelines
			and standard

Table 3.5-1 Organization structure and MRV specific responsibilities





3.6 Proposed Data Management System

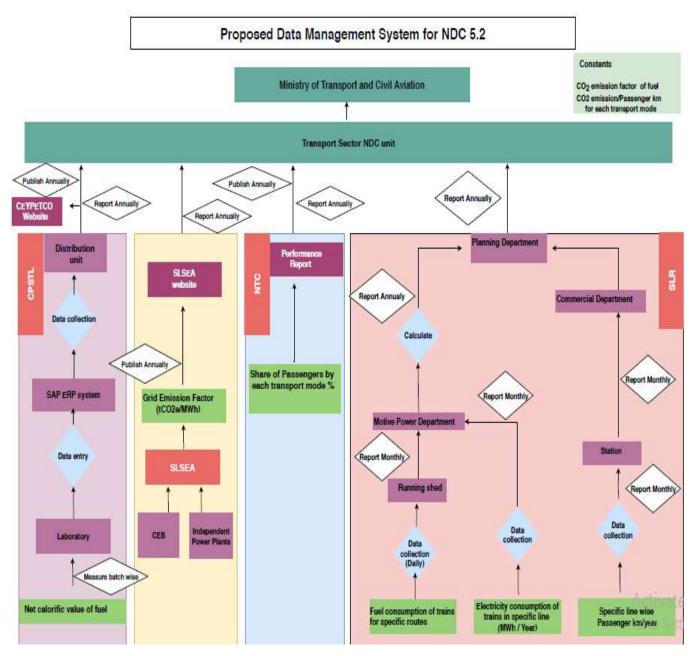


Figure 3.6-1 Proposed Data Management System





3.7 Annex

3.7.1 Annex 01: Sri Lanka Railway

Data / Parameter:	FC _{PJ,i,y}	FC _{PJ,i,y}
Data unit:	t / year	t / year
Description:	Consumption of fuel i associated with the operation of the project activity in year y	Amount of fuel i consumed by the existing diesel powered railway in year y
Source of data:	Data from the project participants	Historical data from SLR
Measurement procedures (if any):	-	Purchase receipt of the fuel
Monitoring Frequency:	Daily, summed for a year	Annually
QA/QC procedures:		
Any comment:	-	Currently this data is not available. Therefore value was calculated based on specific fuel consumption of diesel power power set, trip distance per annum.

Data /	Py	Py
Parameter:		
Data unit:	Passenger/ year	Passenger/ year
Description:	Number of passengers transported by the project in year y	Number of passengers transported by the project in year y
Source of data:	Actual data from the project participants	A planned value
Monitoring Frequency:	Daily, summed for a year	Annually
QA/QC procedures:		
Measurement procedures (if any):	-	
Any comment:	-	Currently this data is not available. Therefore value was calculated based on Average number of passengers transported by carriage





Data / Parameter:	BTDPy	BTDPy
Data unit:	Km/ year	t CO ₂ / TJ
Description:	Average trip distance of the passenger of the project activity in year y	
Source of data:	Actual data from the project participants	A planned value
Monitoring Frequency:	Daily, summed for a year	Annually
QA/QC procedures:		
Measurement procedures (if any):		
Any comment:		Currently this data is not available. Therefore calculation was carried out by considering total length covered by Sri Lanka Railway and total number of carriages

3.7.2 Annex 02: NTC

Data /	MS _{i,y}	MS _{i,y}
Parameter:		
Data unit:	Km/ year	Km/ year
Description:	Share of passengers by transport mode i in the baseline scenario in year y	
Source of data:	Actual data from the project participants	"Transport statistics" published by National Transport Commission.
Monitoring Frequency:	Daily, summed for a year	Annually
QA/QC procedures:		
Measurement procedures (if any):		
Any comment:		





4 MONITORING, REPORTING & VERIFICATION PROTOCOL-INTRODUCTION OF ELECTRIC BUSES (NDC 8.3)

OVERVIEW

This protocol serves as an overview of the monitoring process, a qualitative assessment of the monitored parameters, the organizational structure, the primary responsibilities of the personnel involved in monitoring and QA/QC process.

4.1 Introduction

Mitigation option: Introducing electric buses

4.2 Monitoring plan



Conventional diesel buses

Number of seats:

Specific fuel consumption: 0.29 L/km

Emission factor: 765.93 gCO₂/km

Fuel Cost per km: 21.13



Electric buses

Number of seats: Up to 41+1

Specific electricity consumption: 1.22 kWh/km

Emission factor: 767.03 gCO₂/km

Fuel Cost per km:

Figure 4.2-1 Monitoring plan





4.3 Monitoring methodology

Methodology /Tools

Small scale methodology, AMS III.C; emission reductions by electric and hybrid vehicles Tool to calculate project or leakage CO2 emissions from fossil fuel combustion

Equations

Equation 01 Baseline Emission

Equation 02 Baseline emission

Equation 03 Project emission $BE_y = \sum_i EF_{BL,km,i} \times DD_{i,y} \times N_{i,y} \times 10^{-6}$

$$EF_{BL,km,i} = SFC_i \times NCV_{BL,i} \times EF_{BL,i} \times IR^{t}$$

$$OR$$

$$BE_y = \sum_i EF_{BL,km,i} \times \frac{EC_{PJ,i,y}}{SEC_{PJ,km,i,y}} \times 10^{-6}$$

$$PE_{y} = \sum_{i} EF_{PJ,km,i,y} \times DD_{i,y} \times$$
OR
$$PE_{y} = \sum_{i} EF_{PJ,km,i,y} \times \frac{EC_{PJ,i,y}}{SEC_{PJ,km,i,y}}$$

Equation 04 Emission factor for project vehicle

$$EF_{PJ,km,i,y} = \sum_{i} SEC_{PJ,km,i,y} \times EF_{elect,y} / (1 - TDL_y) \times 10^{-3} + \sum_{i} SFC_{PJ,km,i,y} \times NCV_{PJ,i} \times EF_{PJ,i} \times 10^{-6}$$

Equation 05 Emission reduction

$$ER_{y} = BE_{y} - PE_{y} - LE_{y}$$





Parameters

_

Table 4.3-1 parameter table

Data requirement	
Annual average distance travelled by project vehicle category <i>i</i> in the year <i>y</i> (km)	$DD_{i,y}$
Number of operational project vehicles in category <i>i</i> in year <i>y</i>	$N_{i,y}$
Specific fuel consumption of baseline vehicle category <i>i</i> (g/km)	SFC _i
Specific electricity consumption by project vehicle category <i>i</i> per km in year <i>y</i> in urban conditions (kWh/km)	$SEC_{PJ,km,i,y}$
Technology improvement factor for baseline vehicle in year <i>t</i>	IR^{t}
Emission factor of fossil fuel consumed by baseline vehicle category i (g CO ₂ /J)	$EF_{BL,i}$
Net calorific value of fossil fuel consumed by baseline vehicle category I (J/g)	NCV _{BL,i}
CO ₂ emission factor of electricity consumed by project vehicle category <i>i</i> in year <i>y</i> (kg CO ₂ /kWh)	$EF_{elect,y}$
Average technical transmission and distribution losses for providing electricity in the year <i>y</i>	TDL_y
The electricity consumed for charging project vehicles category i at the charging stations/points in year y (kWh)	$EC_{PJ,i,y}$
Emission factor for baseline vehicle category i (g CO2/km)	$EF_{BL,km,i}$
Emission factor per kilometer travelled by the project vehicle type <i>i</i> (t CO ₂ /km)	$EF_{PJ,km,i,y}$

4.4 Parameter and procedure

Parameter	Description	Instrument	Applied for (Baseline/Project)	Procedure (P1,P2)
SFC _i	Specific fuel consumption of baseline vehicle category <i>i</i> (g/km)	Calculate	Baseline	P1
IR^{t}	Technology improvement factor for baseline vehicle in year <i>t</i>	Default	Baseline	Methodology
EF _{BL,i}	Emission factor of fossil fuel consumed by baseline vehicle category <i>i</i> (g CO ₂ /J)	Default	Baseline	IPCC

Table 4.4-1 Parameter and procedure





NCV _{BL,i}	Net calorific value of fossil fuel consumed by baseline vehicle category <i>I</i> (J/g)	Calculate	Baseline	P1_FSRR_CP STL
EF _{BL,km,i}	Emission factor for baseline vehicle category i (g CO2/km)	Calculate	Baseline	NDC unit
EF _{elect,y}	CO ₂ emission factor of electricity consumed by project vehicle category <i>i</i> in year <i>y</i> (kg CO ₂ /kWh)	Calculate	Project	P2_ER_SLSE A
TDL _y	Average technical transmission and distribution losses for providing electricity in the year y	Calculate	Project	P2_ER_SLSE A
EF _{PJ,km,i,y}	Emission factor per kilometer travelled by the project vehicle type <i>i</i> (t CO ₂ /km)	Calculate	Project	NDC unit
$DD_{i,y}$	Annual average distance travelled by project vehicle category <i>i</i> in the year <i>y</i> (km)	Calculate	Baseline & Project	P1_IEV_SLTB
N _{i,y}	Number of operational project vehicles in category <i>i</i> in year <i>y</i>	Measure	Baseline & Project	P1_IEV_SLTB
EC _{PJ,i,y}	The electricity consumed for charging project vehicles category i at the charging stations/points in year y (kWh)	Measure	Baseline & Project	P1_IEV_SLTB
SEC _{PJ,km,i,y}	Specific electricity consumption by project vehicle category <i>i</i> per km in year <i>y</i> in urban conditions (kWh/km)	Calculate	Baseline & Project	P1_IEV_SLTB





4.5 Organization structure and MRV specific responsibilities

MeasureReportVeritySri Lanka Transport Board (SLTB)Number of e-busesHead ofPlanningMRVP1_IEV_SLTBdepotdivisionmanagerP1_IEV_SLTBby e-busesdepotdivisionmanagerNumber of diesel busesHead ofPlanningMRVP1_IEV_SLTBdepotdivisionmanagermanagerTotal distance travelledHead ofPlanningMRVP1_IEV_SLTBby diesel busesdepotdivisionmanagerTotal distance travelledHead ofPlanningMRVP1_IEV_SLTBby diesel busesdepotdivisionmanagerTotal electricityHead ofPlanningMRVP1_IEV_SLTBconsumption of e-busesdepotdivisionmanagerTotal fuel consumptionHead ofPlanningMRVP1_IEV_SLTBdepotdivisionmanagermanagermanagerCeylon Petroeur Storage Terminals Limited (CPSTL)Net calorific value ofHeadHead of the information & technologyP1_FSRR_CPSTLby baseline vehicle category 1 (NCV _{BL})Head of the information & technologyMRVP1_FSRR_CPSTLColspan="2">Ceylon Terminals Eusitemet (USEA)Colspan="2">Ceylon Consumption of e-busesby baseline vehicle category 1 (NCV _{BL})Head of the information & technologyMRVP1_FSRR_CPSTLColspan="2">Colspan="2">MRVP1_FSR_CPS		ponsible s				Procedure	Comment
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Density of fuel consumed by baseline vehicle category IHead Laboratory unitHead of the information & technology unitMRV managerP1_FSRR_CPSTL P1_FSRR_CPSTLCO2 emission factor of electricity consumed by project vehicle category i in year y (EF_{elect,y})MRV managerMRV managerAverage technical transmission and distribution losses for providing electricity inMRV managerMRV manager							
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category I& technology unit& technology unitSri Lanka Sustainable Energy Authority (SLSEA)CO2 emission factor of electricity consumed by project vehicle category i in year y (EF_{elect,y})MRV managerAverage technical transmission and distribution losses for providing electricity inMRV managerMRV manager	Density of fuel consumed	Head		Head of the	MRV	P1_FSRR_CPSTL	
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Sri Lanka Sustainable Energy Authority (SLSEA)CO2 emission factor of electricity consumed by project vehicle category i in year y (EF_{elect,y})MRV managerAverage technical transmission and distribution losses for providing electricity inMRV manager	category I			& technology			
CO_2 emission factor of electricity consumed by project vehicle category <i>i</i> in year <i>y</i> ($EF_{elect,y}$)MRV managerAverage technical transmission and distribution losses for providing electricity inMRV manager							
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project vehicle category i MRV in year y (EF _{elect,y}) MRV Average technical MRV transmission and manager distribution losses for Image: Composition of the second sec					MRV		
in year y (EF _{elect,y}) Average technical transmission and distribution losses for providing electricity in					manager		
Average technicalMRVtransmission andmanagerdistribution losses forImageproviding electricity inImage							
transmission and manager distribution losses for providing electricity in manager	in year y ($EF_{elect,y}$)						
distribution losses for providing electricity in	Average technical				MRV		
providing electricity in	transmission and				manager		
	distribution losses for				_		
the year $y(TDL)$	providing electricity in						
ule year y (<i>IDL</i> _y)	the year y (TDL_y)						

Table 4.5-1 Organization structure and MRV specific responsibilities





4.6 Proposed data management



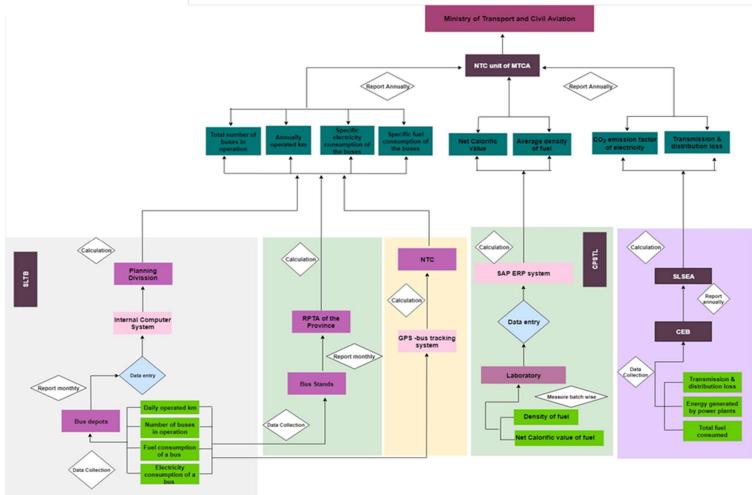


Figure 4.6-1 Proposed data management









Data required from SLTB

Data / Parameter:	$DD_{i,y}$		
Data unit:	km		
Description:	Annual average distance driven by project vehicle i in year y (km/yr)		
Source of data:	Measurement		
Measurement procedures (if any):	Measure the annual average distance driven by the project vehicles through: Option (A): monitoring of all vehicles or		
	Option (B): representative sample survey of vehicles for each vehicle category. Sample vehicles shall be chosen in accordance with the latest version of the "Guidelines for sampling and surveys for CDM project activities and programme of activities" using a 90 per cent confidence interval and +/- 10 per cent precision to determine the sample size. The lower bound of 95 per cent confidence interval shall be used as the annual distance travelled		
Any comment:	-		

Data / Parameter:	$SFC_{PJ,km,i,y}$
Data unit:	g/km
Description:	<i>Specific fossil fuel consumption per km per project vehicle category</i> i <i>in year</i> y
Source of data:	Measurement







NERSHIP	
Measurement procedures (if any):	<i>Measure the specific fossil fuel consumption through:</i> <i>Option (A): monitor consumption of all project vehicles</i>
	or
	Option (B): measure the amount of fossil fuels consumed per km travelled for a representative sample of each vehicle category. Sample vehicles shall be chosen in accordance with the latest version of the "Guidelines for sampling and surveys for CDM project activities and programme of activities" using a 90 per cent confidence interval and +/- 10 per cent precision to determine the sample size. The upper bound of 95 per cent confidence interval shall be used for the specific fuel/electricity consumed.
	Cross-checked against vehicle specifications (g/km) for urban conditions provided by the manufacturers and use the highest of the two values
Any comment:	-

Data / Parameter:	N _{i,y}			
Data unit:	-			
Description:	Number of project vehicle in operation in year y			
Source of data:				
Measurement procedures (if any):	Establish the number of the project vehicles in operation through: Option (A): based on annual sales records or official data on registered project vehicles cross-checked against the results from a representative sample survey vehicles to determine the percentage of vehicles in use or			
	Option (B): based on annual sales records or official data for registered project vehicles, multiplied by the default factor 0.9 ^t , where t is year counter for the number of years since the vehicle was introduced (for example: if n vehicles are sold in year 1, in year 2 the number of vehicles still in operation are assumed to be equal to n*0.9, and in year 3, n*0.9 ² , etc.)			
Any comment:	-			







Data / parameter:	<i>EC</i> _{PJ,iy}
Data unit:	kWh
Description:	Electricity consumed by the project vehicles of type <i>i</i> in year
	у
Source of data:	Electric charging records at the electricity charging station
Measurement	
procedures (if any):	
Any comment:	The electric charging records will be crosschecked by driver
	logs or invoices from electricity filling station

Data / Parameter:	$SEC_{PJ,km,i,y}$			
Data unit:	kWh/km			
Description:	Specific electricity consumption per km per project vehicle category i in year y			
Source of data:	Measurement			
Measurement procedures (if any):	Measure the specific electricity consumption through: Option (A): monitor electricity consumption of all project vehicles or			
	Option (B): measure the amount of electricity consumed per km travelled for a representative sample of each vehicle category. Sample vehicles shall be chosen in accordance with the latest version of the "Guidelines for sampling and surveys for CDM project activities and programme of activities" using a 90 per cent confidence interval and +/- 10 per cent precision to determine the sample size. The upper bound of 95 per cent confidence interval shall be used for the specific fuel/electricity consumed.			
	Cross-checked against vehicle specifications (kWh/km) for urban conditions provided by the manufacturers and use the highest of the two values			
Any comment:	-			







Data required from SLSEA

Data / Parameter:	EFelect
Data unit:	kg CO ₂ /kWh
Description:	<i>CO</i> ² emission factor of electricity used by project vehicle
Source of data:	Measurement
Measurement procedures (if any):	As per procedures of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"
Any comment:	-

Data / Parameter:	TDL_{y}
Data unit:	percentage
Description:	Average technical transmission and distribution losses for providing electricity in the year y
Source of data:	
Measurement procedures (if any):	As per the procedures of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"
Any comment:	-

Data required from CPSTL

Data / Parameter:	$NCV_{BL,i}$, $NCV_{PJ,i}$
Data unit:	J/g
Description:	Net calorific value of fuel i
Source of data:	
Measurement procedures (if any):	Country specific data or IPCC default value
Any comment:	-







5 MONITORING, REPORTING & VERIFICATION PROTOCOL -INTRODUCTION OF NEW ELECTRIC AND HYBRID VEHICLES _ TAX

(NDC 8.4)

OVERVIEW

This protocol serves as an overview of the monitoring process, a qualitative assessment of the monitored parameters, the organizational structure, the primary responsibilities of the personnel involved in monitoring and QA/QC process.

5.1 Introduction

Mitigation action: The mitigation action is to improve the road transport by introducing new electric and hybrid vehicles to vehicle fleet by implementing carbon tax/ excise duty tax, which is applicable only for hybrids vehicles, petrol and diesel-powered motor vehicles. The proposed carbon tax is calculated based on the fuel type, engine capacity and age of the vehicles. And the proposed excise duty tax is calculated based on the fuel type, engine capacity engine capacity of the vehicles.

In the absence of the proposed mitigation action, the conventional petrol and dieselpowered motor vehicles would have dominated the vehicle market. The mitigation action aims to increase the share of electric vehicles in the vehicle market.







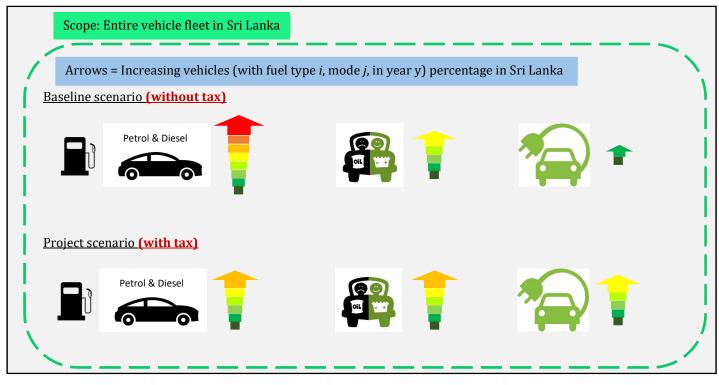


Figure 5.2-1 Summary of project activity

- P6_INEHV_DMT Data collection and management procedure for Department of Motor Traffic
- P11_INEHV_VET Data collection and management procedure for Vehicle Emission Testing
- P7_INEHV_SLC Data collection and management procedure for Sri Lanka Customs
- P3_ER_SLSEA Data collection and management procedure for Sri Lanka Sustainable Energy Authority
- P9_FSRR_CPSTL Data collection and management procedure for Ceylon Petroleum Storage Terminal Limited







5.3 Data monitoring procedure

Methodology /Tools

ICAT Transport Pricing Guidance (2018)

Tools,

"Baseline emissions for modal shift measures in urban passenger transport",

Version 01

Equations

-				
Equation 1: Base year emission	$BE_{i,j,y} in CO_2 emissions (t CO_2) = [FC_{i,j,y} in energy units (TJ)] x \\ [EF_i (t CO_2 per TJ)]$			
Equation 1.1: Total fuel consumption	Total fuel consumption $FC_{i,j,y}$ in volume units(litres) = $d_{i,j,y}(in VKT) \times SFC_{i,j,y}(in litre per VKT)$			
Equation 1. 2: Fuel energy use	$F_{i,j,y} in \ energy \ units(TJ)$ $= FC_{i,j,y} in \ volume \ units(litre) \times \rho_i$ $\times NCV_i \div 10^9$			
Equation 2.1: Discount rate (Only for carbon tax calculation)	$\frac{NPV}{F} = \frac{F}{F}$			
Equation 2.2: Tax rebate	Average value of tax rebates = (Previous carbon tax - New carbon tax)/ Retail price			
Equation 2.3: Market share	Market Share (percentage - point change) = (beta) x (average rebate value)			
Equation 2.4 Emission reduction	Per km emissions reduction = GHG emissions of fuel car per PKM -GHG emissions of electric car per PKM			







FANTNENSTIF	
Equation 2.4.1 Passenger kilometers	$PKM_{i,car,y} = \sum_{i} d_{i,car,y} (in VKT) \times I_{car,y} (in persons per vehicle)$
Equation 2.4.2 Base year emission per passenger kilometers	$BEpkm_{i,j,y} \text{ in } CO_2 \text{ emissions}(kg CO_2) \text{ per passenger kilometre} = BE_{i,j,y}(kg CO_2) \div PKM_{i,j,y}$
Equation 2 GHG impact	GHG impact = (market share) x (annual new vehicle sale) x (per km emissions reduction) x (average lifetime km per vehicle)

5.3.1 Ex-ante parameters (fixed values)

- Average (per VKT) number of persons travelling in same vehicle (with mode *j* in year *y*) Net calorific value of fuel *n* used in vehicle category *i*
- Specific fuel consumption. Average consumption per VKT in municipal, regional or national fleet (with fuel type *i*, mode *j*, in year *y*)
- Density of fuel type *i*
- Net calorific value of fuel type *i*
- Emission factor for gasoline fuel
- Emission factor for diesel fuel
- Beta value
- Taxes for the fuel type i engine capacity c age x vehicles
- Average vehicle lifespan (with fuel type *i*, mode *j*, in year *y*).

5.3.2 Ex-post parameters (regularly monitored values)

- Combined margin emission factor for the grid in year *y* Number of vehicles in vehicle category *i* using fuel type *n* in year *x*
- Retail price of vehicle with engine capacity c fuel type i
- Annual new vehicle sales (with fuel type *i*, mode *j*, in year *y*)

5.3.3 Parameters to verified/collected one time prior to the monitoring period

- Density of fuel type *i*
- Net calorific value of fuel type *i*
- Emission factor for gasoline fuel
- Emission factor for diesel fuel
- Beta value







5.4 Parameter and procedure

Table 5.4-1 Parameter and procedure

Danamatan	Decerintion	Instrument	Applied for	Procedure
Parameter	Description	Instrument	Applied for	Procedure
		/method	(baseline,	
			project,	
			leakage)	
l _{j,y}	Average (per VKT) number of	Default	Baseline &	CDM tool 18/
	persons travelling in same vehicle	value/	Project	P6_INEHV_DMT
	(with mode <i>j</i> in year <i>y</i>)	Measure		
SfCi,j,y	Specific fuel consumption. Average	Default	Baseline &	CDM tool 18/
	consumption per VKT in municipal,	value /	Project	
	regional or national fleet (with fuel	Calculate		P9_FSRR_CP
	type <i>i</i> , mode <i>j</i> , in year <i>y</i>).			
ρi	Density of fuel type <i>i</i>	Use	Baseline &	P9_FSRR_CP
		calculated	Project	
		national		
		value		
NCVi	Net calorific value of fuel type <i>i</i>	Default	Baseline &	IPCC/
		value/Use	Project	P9_FSRR_CP
		calculated		
		national		
		value		
EF gasoline	Emission factor for gasoline fuel	Default	Baseline &	IPCC
		value	Project	
EF diesel	Emission factor for diesel fuel	Default	Baseline &	IPCC
		value	Project	
Beta value	Beta value of Market Share	Default	Project	ICAT Transport
		value		Pricing Guidance
EF _{grid,CM,y}	Combined margin emission factor	Use	Baseline &	P3_ER_SLSEA
gilu,civi,y	for the grid in year y	calculated	Project	
		national	,	
		value		
Retail	Retail price of vehicle with engine	Estimated	Project	Vehicle retailers
price	capacity c fuel type i	value		
Carbon	Taxes for the fuel type i engine	Default	Project	P6_INEHV_DMT
Tax	capacity c age x vehicles	value		
Excise	Taxes for the fuel type i engine	Default	Project	P7_INEHV_SLC
duty	capacity c vehicles	value		
Tax				
Tax				







FARINERS				
Annual	Annual new vehicle sales (with fuel	National	Project	P6_INEHV_DMT
new	type <i>i</i> , mode <i>j</i> , in year <i>y</i>)	value		
vehicle				
sales				
d i,j,y	Vehicle kilometres travelled (with	Measure	Baseline &	P11_INEHV_VET
	fuel type <i>i</i> , mode <i>j</i> , in year <i>y</i>)		Project	
Vehicle	Average vehicle lifespan (for fuel	Default	Baseline &	IPCC
lifespan	type <i>i</i> , mode <i>j</i> , in year <i>y</i>)	value	Project	

5.5 Organization structure and MRV specific responsibilities

Parameter description	Tasks	Responsible staff	Procedure	Comment
Average (per VKT) number of persons travelling in same vehicle (with mode <i>j</i> in year <i>y</i>)	Collect default values and keeping records	MRV Focal point at DMT	CDM tool 18/ P6_INEHV_D MT	
Specific fuel consumption. Average consumption per VKT in municipal, regional or national fleet (with fuel type <i>i</i> , mode <i>j</i> , in year <i>y</i>).	Collect default values and keeping records	NDC unit under Ministry from MRV Focal point at CPSTL	CDM tool 18/ P9_FSRR_CPS TL	
Density of fuel type <i>i</i>	Calculate national value and publish on the website	MRV Focal point at CPSTL	P9_FSRR_CPS TL	Value available in the CEYEPETCO website
Net calorific value of fuel type <i>i</i>	Calculate national value	MRV Focal point at CPSTL	IPCC/ 91_FSRR_CPS TL	
Emission factor for gasoline fuel	Collect default values and keeping records	Project responsible	IPCC	

Table 5.5-1 Organization structure and MRV specific responsibilities table







PARTNERSHIP	2	<u> </u>		
		officer under		
		NDC unit		
Emission factor	Collect default values and	Project	IPCC	
for diesel fuel	keeping records	responsible		
		officer under		
		NDC unit		
Beta value of	Collect default values and	Project	ICAT	
Market Share	keeping records	responsible	Transport	
		officer under	Pricing	
		NDC unit	Guidance	
Combined	Calculate national value	MRV Focal	P3_ER_SLSEA	
margin emission		point at SLSEA		
factor for the				
grid in year y				
Retail price of	Estimate the values or	Project	Vehicle	
vehicle with	collect values	responsible	retailers	
engine capacity		officer under		
c fuel type i		NDC unit		
Taxes for the	Collect default values and	MRV Focal	P6_INEHV_D	Carbon Tax
fuel type i	keeping records	point at DMT	MT	
engine capacity				
c age x vehicles				
Taxes for the	Collect default values and	MRV Focal	P7_INEHV_SL	Excise duty
fuel type i	keeping records	point at SLC	C	tax
engine capacity				
c vehicles				
Annual new	Calculate values and	MRV Focal	P6_INEHV_D	
vehicle sales	keeping records	point at DMT	MT	
(with fuel type <i>i</i> ,				
mode <i>j</i> , in year				
y) Nahiala	Coloulate value a sud	MDV Foral	D11 INFUU V	
Vehicle	Calculate values and	MRV Focal	P11_INEHV_V	
kilometres	keeping records	point at VET	ET	
travelled (with				
fuel type <i>i</i> , mode <i>j</i> , in year <i>y</i>)				
Average vehicle	Collect default values and	Project	IPCC	
lifespan (for	keeping records	responsible		
fuel type <i>i</i> , mode	Keeping records	officer under		
j, in year y)		NDC unit		
j, ili year yj		NDC unit		







5.6 Proposed data management

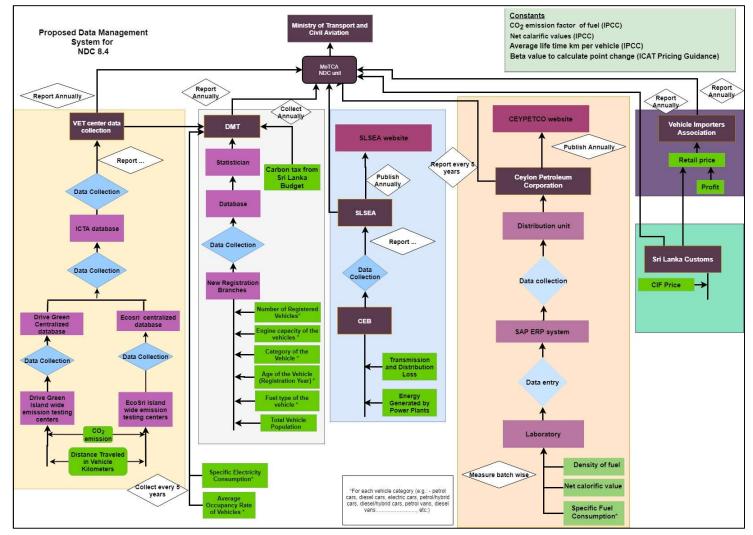


Figure 5.6-1 Proposed data management system for carbon tax







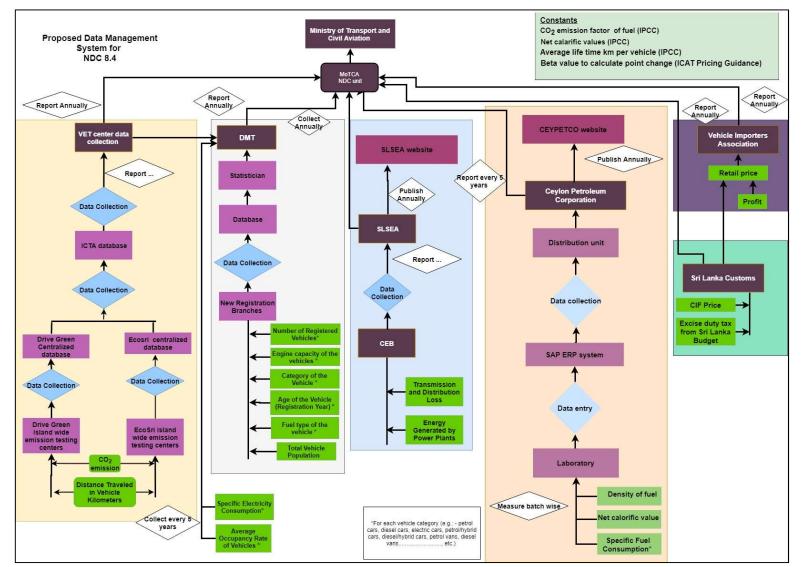


Figure 5.6-2 Proposed data management system for excise duty tax







Parameters necessary for baseline

Data and parameters not monitored

Data / Parameter table 1

Data / Parameter:	l _{j,y}	l _{j,y}
Data unit:	Persons per vehicle	Persons per vehicle
Description:	Average (per VKT) number of persons travelling in same vehicle (with mode <i>j</i> in year <i>y</i>). (only needed for estimation of PKM)	Average (per VKT) number of persons travelling in same vehicle (with mode <i>j</i> in year <i>y</i>). (only needed for estimation of PKM)
Source of data:	 Municipal, regional or national statistics or studies (from transit authorities) Municipal, regional or national data collection process or surveys Supra-regional default value (e.g., for continent). Else global default value: 2 persons, including the driver (UNFCCC 2014) 	 National data form DMT Default data (CDM TOOL18 Methodological tool: Baseline emissions for modal shift measures in urban passenger transport Version 01.0)
Measuremen t procedures (if any):	Measured/ estimated/ modelled	
Monitoring frequency	Every 5 years	Latest available updates should be taken into account
Any comment:		

<u>Data / Parameter table 2</u>

Data / Parameter:	<i>sfc</i> _{<i>i</i>,<i>j</i>,<i>y</i>}	<i>sfc</i> _{<i>i</i>,<i>j</i>,<i>y</i>}
Data unit:	Litre per VKT	Litre per VKT







PARTNERSHIF		
Description:	Specific fuel consumption. Average consumption per VKT in municipal, regional or national fleet (with fuel type <i>i</i> , mode <i>j</i> , in year <i>y</i>).	Specific fuel consumption. Average consumption per VKT in municipal, regional or national fleet (with fuel type <i>i</i> , mode <i>j</i> , in year <i>y</i>).
Source of data:	Municipal, regional or national statistics or studies (from transit authorities) Municipal, regional or national data collection process or surveys (e.g., from manufacturers) Supra-regional default values (e.g., for continent). Else, global default value for gasoline consumption of gasoline cars: 10 litres per 100 km (assumption by the authors	 National data from CPSTL Default values CDM TOOL18 Methodological tool: Baseline emissions for modal shift measures in urban passenger transport Version 01.0 for diesel and petrol cars electric vehicles Fuel Economy of Light Duty Vehicles in Sri Lanka _the Baseline (2015) prepared by Dr. Thusitha Sugathapala hybrid cars
Measuremen t procedures (if any):	Measured/ estimated/ modelled	
Monitoring frequency	Every 5 years	Latest available updates should be taken into account
Any comment:		

<u>Data / Parameter table 3</u>

Data / Parameter:	ρι	ρι
Data unit:	kg/m ³	kg/m ³







PARINERSHIP		
Description:	Density of fuel type <i>i</i>	Density of fuel type <i>i</i>
Source of	In order of priority:	1. National data from CPSTL
data:	2 National energy statistics	2. IPCC 2006 Default values
	Reliable international sources	
	Default values. Diesel: 835 kg/m3 at	
	15 deg C (Directive 1998/69/EC)26. Gasoline: 720 kg/m3 at 15 deg C	
	(NOAA).27	
Measuremen	Measured	
t procedures (if any):		
Monitoring	Every 5 years	Latest available updates should be taken
frequency		into account
Any		
comment:		

<u>Data / Parameter table 4</u>

Data / Parameter:	NCVi	NCVi
Data unit:	TJ/Gg	TJ/Gg
Description:	Net calorific value of fuel type <i>i</i>	Net calorific value of fuel type <i>i</i>
Source of data:	 In order of priority: National energy statistics Reliable international sources Default values. Diesel: 43.0 TJ/Gg, Gasoline: 44.3 TJ/Gg (both IPCC 2006, Vol. 2 Ch. 1 Table 1.2) 	3. National data from CPSTL4. IPCC 2006 Default values
Measurement procedures (if any):	Measured	







FARINERSHIP		
Monitoring frequency :	Every 5 years	Latest available updates should be taken into account
Any comment:		

<u>Data / Parameter table 5</u>

Data / Parameter:	EFgasoline	EFgasoline
Data unit:	tCO ₂ /TJ	tCO ₂ /TJ
Description:	Emission factor for gasoline fuel	Emission factor for gasoline fuel
Source of data:	 National energy or environmental statistics National fuel providers; for example refineries and/or fuel importers, based on their measurements Global default values. Gasoline: 69,300 kgC02/TJ, Diesel: 74,100 kgC02/TJ (both IPCC 2006, Vol. 2 Ch. 3 Table 3.2.1) 	1. Global default values 2. IPCC 2006 default values for CO ₂ , CH ₄ and N ₂ O
Measurement procedures (if any):	Measured	
Monitoring frequency :	Every 5 years	Latest available updates should be taken into account
Any comment:	-	







<u>Data / Parameter table 6</u>

Data /	EFdiesel	EFdiesel
Parameter:		
Data unit:	tCO ₂ /TJ	tCO ₂ /TJ
Description:	Emission factor for diesel fuel	Emission factor for diesel fuel
Source of data:	 National energy or environmental statistics National fuel providers; for example refineries and/or fuel importers, based on their measurements Global default values. Gasoline: 69,300 kgC02/TJ, Diesel: 74,100 kgC02/TJ (both IPCC 2006, Vol. 2 Ch. 3 Table 3.2.1) 	 Global default values IPCC 2006 default values for CO₂, CH₄ and N₂O
Measurement procedures (if any):	Measured	
Monitoring frequency :	Every 5 years	Latest available updates should be taken into account
Any comment:	-	

<u>Data / Parameter table 7</u>

Data / Parameter	Beta value
Unit	
Description	Beta value
Source of data	Default value from ICAT Transport Pricing Guidance
Measurement methods	
and procedures	
Monitoring frequency	Latest available updates should be taken into account
QA/QC procedures	







 Purpose of data
 Calculate GHG impact

 Additional comment
 Impact

Data and parameters monitored

Data / Parameter table 8

Data / parameter:	EF _{grid,CM,y}
Data unit:	tCO ₂ /MWh
Description:	Combined margin emission factor for the grid in year <i>y</i>
Source of data:	Sri Lanka Energy Balance by Sri Lanka Sustainable
	Energy Authority
Measurement	
procedures (if any):	
Monitoring frequency:	Latest available grid emission factor should be taken
	into account (Annually need to check for the value)
QA/QC procedures:	
Any comment:	

<u>Data / Parameter table 9</u>

Data / Parameter	Retail price of the eligible vehicle models
Unit	Sri Lankan Rupees (SLR)
Description	Retail price of vehicle with engine capacity c fuel type i
Source of data	Vehicle retailers
Measurement methods and procedures	
Monitoring frequency	At least annually
Additional comment	

<u>Data / Parameter table 10</u>

Data / Parameter	1. Carbon taxes
	2. Excise duty taxes
Unit	SLR







PARTNERSHIP	
Description	1. Taxes for the fuel type i engine capacity c age x vehicles
	2. Taxes for the fuel type i engine capacity c vehicles
Source of data	Sri Lanka budget, Gazettes, Ministry of Finance
Measurement methods	1. DMT collect updates about carbon tax
and procedures	2. SLC collect updates about excise duty tax
Monitoring frequency	At least annually
QA/QC procedures	
Purpose of data	
Additional comment	

Data / Parameter table 11

Data / parameter:	Annual new vehicle sales
Data unit:	Number of vehicles
Description:	Annual new vehicle sales (with fuel type <i>i</i> , mode <i>j</i> , in year <i>y</i>).
Source of data:	Department of Motor Traffics
Measurement procedures (if any):	
Monitoring frequency:	Annually
QA/QC procedures:	
Any comment:	

Data / Parameter table 12

Data / Parameter:	<i>d i,j,y</i>	d i,j,y
Data unit:	VKT	VKT
Description:	Vehicle kilometres travelled (with fuel type <i>i</i> , mode <i>j</i> , in year <i>y</i>).	Vehicle kilometres travelled (with fuel type <i>i</i> , mode <i>j</i> , in year <i>y</i>).

UNEP DTU PARTNERSHIP		"Path to Sustainability"
Source of data:	Municipal, regional or national statistics or studies (from transit authorities) Municipal, regional or national data collection process or surveys (traffic counting, odometer reading, appropriate vehicle stock data)	National statistics (VET) - VKT for diesel, petrol and hybrid vehicles IPCC_AR5 Annex III : Technology-specific Cost and Performance Parameters - Electric vehicles
Measurement procedures (if any):		Average W/T colculate using data base of
Monitoring frequency Any comment:		Average VKT calculate using data base of VET - Annually

<u> Data / Parameter table 13</u>

Data / Parameter:	Vehicle lifespan
Data unit:	years
Description:	Average vehicle lifespan (for fuel type <i>i</i> , mode <i>j</i> , in year <i>y</i>).
Source of data:	IPCC_AR5Annex III : Technology-specific Cost and Performance Parameters - default value
Measurement procedures (if any):	
Monitoring frequency:	Latest available updates should be taken into account
QA/QC procedures:	
Any comment:	







6 MONITORING, REPORTING & VERIFICATION PROTOCOL -Freight shift from road to rail

(NDC 9.4)

OVERVIEW

This protocol serves as an overview of the monitoring process, a qualitative assessment of the monitored parameters, the organizational structure, the primary responsibilities of the personnel involved in monitoring and QA/QC process.

6.1 Introduction

Mitigation option: Freight shift from road to rail

6.2 Monitoring plan

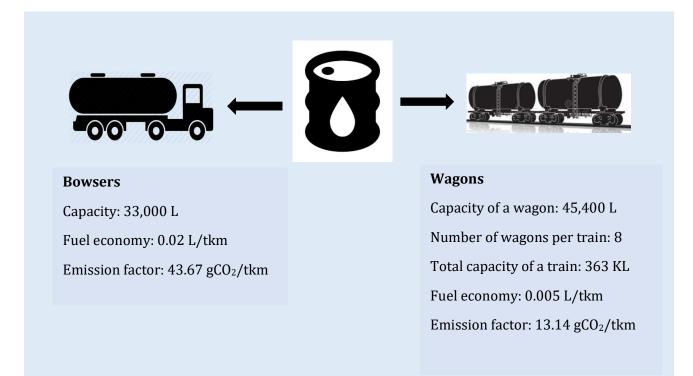


Figure 6.2-1 Monitoring plan







AM0090 version 01.1.0, "Modal shift in transportation of cargo from road transportation to water or rail transportation"

Tool to calculate project or leakage CO2 emissions from fossil fuel combustion

Equations

Equation 01 Baseline Emission

Equation 02 Baseline emission factor

Equation 03 Factor to account for non-empty return

Equation 04 Project emission

Equation 05 CO2 emission coefficient $BE_{y} = T_{y} \cdot AD \cdot EF_{BL} \cdot 10^{-6}$

$$EF_{BL} = \frac{\sum_{i} FC_{BL,i,x} \cdot NCV_{i,x} \cdot EF_{CO2,i,x} \cdot F_{RT,BL}}{T_{x} \cdot AD}$$

$$F_{\textit{RT},\textit{BL}} = \frac{T_{x} \cdot AD}{T_{x} \cdot AD + T_{\textit{RT},x} \cdot \textit{RTD}_{x}}$$

$$PE_{y} = \left(PE_{FC,y} + PE_{EC,y}\right) \cdot F_{RT,PJ,y} + PE_{CR,y}$$

or
$$COEF_{i,} = w_{C,y} \times 44/12$$
 or $COEF_{i,y} = NCV_{i,y} \times EF_{CO2i,y}$
or $COEF_{i,} = w_{C,y} \times \rho_{i,y} \times 44/12$







Parameters

Table 6.3-1 monitored and not monitored parameters table

Not monitored	
Distance of the baseline trip route (km)	AD
Amount of fuel <i>i</i> consumed by the trucks in year <i>x</i> (liter or m^3)	FC _{BL,i,x}
Average net calorific value of fuel <i>i</i> consumed by the trucks in year <i>x</i> (GJ per liter	NCV _{i,x}
or m ³)	
CO_2 emission factor of fuel <i>i</i> consumed by the trucks in year <i>x</i> (g CO ₂ /GJ)	EFco2,i, x
Amount of cargo transported in trucks in year <i>x</i> (tonne)	T _x
Amount of cargo transported in trucks in the return trips in year x (tonne)	T _{RT,x}
Distance of the return trip route in year <i>x</i> (km)	<i>RTD</i> _x
Monitored	
Amount of cargo transported by the project transportation mode in year y	Ty
(tonne)	
weighted average mass fraction of carbon in fuel type i in year y (tC/mass unit of	WC,i,y
the fuel)	
weighted average net calorific value of the fuel type <i>i</i> in year <i>y</i> (GJ/mass unit)	NCV _{i,y}







FARTNERSTIF	
weighted average CO_2 emission factor of fuel type <i>I</i> in year <i>y</i> (t CO_2/GJ)	EF _{CO2i} ,
	у
Quantity of fuel type i combusted in process j during the year y (mass or volume	FC _{i,j,y}
unit/yr)	
weighted average density of fuel type <i>i</i> in year <i>y</i> (mass unit/volume unit of the	? ?,?
fuel)	
	1

6.4 Parameter and procedure

Parameter	Description	Instrument	Applied for (Baseline/project)	Procedure (P1,P2)
T_y	Amount of cargo transported by the project transportation mode in year <i>y</i> (tonne)	Measured	Baseline	P2_FSRR_S LR
AD	Distance of the baseline trip route (km)	Measured	Baseline	P9_FSRR_C PSTL
$FC_{BL,i,x}$	Amount of fuel <i>i</i> consumed by the trucks in year <i>x</i> (liter or m^3)	Measured	Baseline	P9_FSRR_C PSTL
NCV _{i,x}	Average net calorific value of fuel <i>i</i> consumed by the trucks in year <i>x</i> (GJ per liter or m ³)	Measured	Baseline	P9_FSRR_C PSTL
EFco2,i,x	CO ₂ emission factor of fuel <i>i</i> consumed by the trucks in year <i>x</i> (g CO ₂ /GJ)	Default	Baseline	
T_x	Amount of cargo transported in trucks in year <i>x</i> (tonne)	Measured	Baseline	P9_FSRR_C PSTL
T _{RT,x}	Amount of cargo transported in trucks in the return trips in year <i>x</i> (tonne)	Measured	Baseline	P9_FSRR_C PSTL
<i>RTD</i> _x	Distance of the return trip route in year <i>x</i> (km)	Measured	Baseline	P9_FSRR_C PSTL







PARINER	5111 Z	1		1
WC,i,y	weighted average mass fraction of carbon in fuel type i in year y	Calculated	Project	
	(tC/mass unit of the fuel)			
NCV _{i,y}	weighted average net calorific value of the fuel type <i>i</i> in year <i>y</i> (GJ/mass unit)	Calculated	Project	
EF _{CO2i,y}	weighted average CO ₂ emission factor of fuel type <i>I</i> in year <i>y</i> (tCO ₂ /GJ)	Calculated	Project	
FC _{i,j,y}	Quantity of fuel type i combusted in process j during the year y (mass or volume unit/yr)	Measured	Project	P2_FSRR_S LR
ρ _{i,y}	weighted average density of fuel type <i>i</i> in year <i>y</i> (mass unit/volume unit of the fuel)	Measured	Project	P9

6.5 Organization structure and MRV specific responsibilities

Tahle 6 5-1	Organization structure a	ind MRV specific	responsibilities table
<i>Tuble</i> 0.5-1	organization structure a	mu mitv specific	responsibilities tuble

Tasks	Responsible staff			Procedure	Commont
Tasks	Measure	Report	Verify	Procedure	Comment
Ceylon P	etroleum Sto	orage Terminal	s Limited (CPSTL)	
Distance of the baseline	N/A	Head of the	MRV	P9_FSRR_CPS	
trip route (<i>AD</i>)		information	manager	TL	
		& technology			
		unit			
Amount of fuel <i>i</i> consumed	Manager	Head of the	MRV	P9_FSRR_CPS	
by the trucks in year <i>x</i>	Distributio	information	manager	TL	
$(FC_{BL,i,x})$	n	& technology			
		unit			
Average net calorific value	Head	Head of the	MRV	P9_FSRR_CPS	
of fuel <i>i</i> consumed by the	Laboratory	information	manager	TL	
trucks in year x (<i>NCV</i> _{<i>i</i>,x})		& technology			
		unit			
Amount of cargo	Manager	Head of the	MRV	P9_FSRR_CPS	
transported in trucks in	Distributio	information	manager	TL	
year $x(T_x)$	n	& technology			
		unit			
Amount of cargo	Manager	Head of the	MRV	P9_FSRR_CPS	
transported in trucks in	Distributio	information	manager	TL	







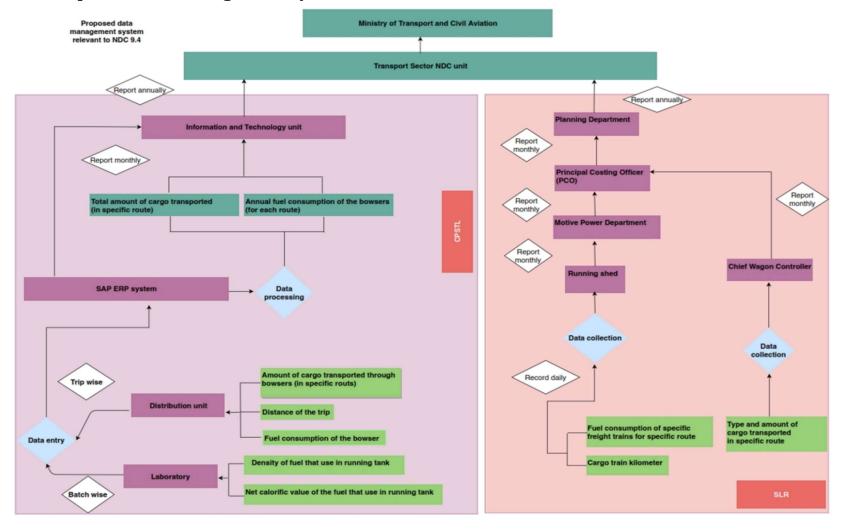
PARTNERSHIP				
the return trips in year	n	& technology		
$(T_{RT,x})$		unit		
Distance of the return trip		Head of the	MRV	P9_FSRR_CPS
route in year <i>x</i> (<i>RTD_x</i>)		information	manager	TL
		& technology		
		unit		
weighted average density	Head	Head of the		P9_FSRR_CPS
of fuel type <i>i</i> in year $y(\rho_{i,y})$	Laboratory	information		TL
		& technology		
		unit		
	Sri I	anka Railways.	(SLR)	
Quantity of fuel type i	Head	Director	MRV	P2_FSRR_SLR
combusted in process j	running	Planning	manager	
during the year y ($FC_{i,j,y}$)	shed			
Amount of cargo	Chief	Director	MRV	P2_FSRR_SLR
transported by train in	Wagon	Planning	manager	
year $y(T_y)$	Controller			
The origin and destination	Head	Director	MRV	P2_FSRR_SLR
point and transportation	running	Planning	manager	
route of the cargo	shed			
transported by train in				
year y(OD _y)				
Type of cargo transported	Chief	Director	MRV	P2_FSRR_SLR
by the project	Wagon	Planning	manager	
transportation mode in	Controller			
year y (C _{ty})				

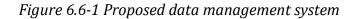






6.6 Proposed data management system











6.7 Annex

Data requirement from CPSTL

Data /	FC _{BL,i,x}	FC _{BL,i,x}
Parameter:		
Data unit:	liter or m ³	liter
Description:	Amount of fuel <i>i</i> consumed by the	Amount of diesel consumed by the
_	trucks in year <i>x</i>	bowsers in year 2010
Source of data:	Historical data from the project	Historical data from CPSTL
	participants	
Measurement	-	
procedures		
(if any):		
Any comment:	-	Currently this data is not available.
		Therefore value was calculated based
		on average fuel economy of most
		commonly used bowser, trip distance
		and the number of trips travelled per
		annum.

Data /	AD	AD
Parameter:		
Data unit:	Km	Km
Description:	Distance of the baseline trip route	Distance from Kolonnawa terminal to
	(km)	Katunayake bulk depot
Source of	Historical data or measurement	CPSTL data base
data:	from the project participants	
Measurement	-	
procedures (if		
any):		
Any comment:	-	

Data /	T _x	T _x
Parameter:		
Data unit:	tonne	tonne
Description:	Amount of cargo transported in	Amount of aviation fuel transported in
-	trucks in year <i>x</i>	bowsers in year 2010
Source of	Historical data from the project	CPSTL data base
data:	participants	
Measurement	-	
procedures (if		
any):		
Any comment:	-	







Data /	T _{RT,x}	T _{RT,x}
Parameter:		
Data unit:	tonne	tonne
Description:	Amount of cargo transported in trucks in	Amount of cargo transported in bowsers
	the return trips in year <i>x</i>	in the return trips in year 2010
Source of	Historical data from the project	
data:	participants	
Measureme	-	
nt		
procedures		
(if any):		
Any	-	All are empty return trips
comment:		

Data /	RTD _x	RTD _x
Parameter:		
Data unit:	km	km
Description:	Distance of the return trip route in year <i>x</i>	Distance from Katunayaka bulk depot to Kollonnawa main terminal
Source of	Historical data from the project	
data:	participants	
Measureme	-	
nt		
procedures		
(if any):		
Any	In many cases, RTDx will be the same as	
comment:	AD, where the trucks take the same	
	route in the return trip. However, in	
	cases where the trucks take different	
	route (diversion) in the return trip, the	
	RTDx is the actual length of the return	
	trip	

Monitoring parameters

Data /	PTMy	PTMy
Paramete		
r:		
Data unit:		







PARINERSH		
Descriptio	The project transportation mode in	The project transportation mode in
n:	year y	year 2010
Source of	Onsite records by project participants	
data:		
Measurem	The project participants will record the	CPSTL record the mode of
ent	mode of transportation in each trip. The	transportation in each trip
procedure	verifying DOE will check the records for	
s (if any):	confirmation.	
Monitoring	Each trip	Each trip
frequency:		
QA/QC	-	
procedure		
S:		
Any	The project transportation mode (either	
comment:	ships, barges or rail) in year y should be	
	the same project transportation as	
	defined in the CDM-PDD at the	
	validation of the project activity	
	This monitored parameter is required	
	in order to comply with the following	
	applicability condition:	
	• The project transportation mode is	
	defined in the CDM-PDD at the	
	validation of the project activity and no	
	change of transportation mode is	
	allowed thereafter	

Data /	NCVi,y	NCVi,y
Data unit:	GJ per mass or volume unit (e.g. GJ/m ³ , GJ/ton)	GJ per mass
Description:	Weighted average net calorific value of fuel type <i>i</i> in year <i>y</i>	Weighted average net calorific value of diesel in year







PARINERSHIP		3	
Data / parameter	The following data sources m conditions apply:	ay be used if the relevant	d) IPCC default values
Data unit:	conditions apply.		uerault values
Description: Source of data:	Data source	Conditions for using the data source	
	(a) Values provided by the fuel supplier in invoices	This is the preferred source if the carbon fraction of the fuel is not provided (Option A)	
	 (b) Measurements by the project participants 	If (a) is not available	
	(c) Regional or national default values	If (a) is not available. These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances)	
	(d) IPCC default values at the upper limit of the uncertainty at a 95%	If (a) is not available	
Measurement procedures (if any):	confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC		
Monitoring frequency:	Guidelines on National GHG Inventories		
QA/QC procedur			
Any comment:			
Measurement procedures (if any):	For (a) and (b): Measurements should be undertaken in line with national or international fuel standards		
Monitoring frequency:	For (a) and (b): The NCV should be obtained for each fuel delivery, from which weighted average annual values should be calculated.		
QA/QC procedures:	Verify if the values under (a), (b) and (c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in (a), (b) or (c) should have ISO17025 accreditation or justify that they can comply with similar quality standards		
Any comment:	Applicable where Option B is		







	Data requirement from Sri L	anka Railways
Data /	ODy	ODy
Parameter:		
Data unit:		
Description:	The origin and destination point and transportation route of the cargo transported by the project transportation mode in year y	Railway route from Kolonnawa main terminal to Katunayaka bulk depot
Source of data:	Onsite records by project participants	SLR
Measurement procedures (if any):	The project participants will record the origin and destination point and transportation route in each trip. The verifying DOE will check the records for confirmation	
Monitoring	Each trip	
frequency: QA/QC procedures:	-	
Any comment:	The origin and destination point and the transportation routes of the cargo transported by the project transportation mode in year y should be the same origin and destination points and transportation route as defined in the CDM-PDD at the validation of the project activity. This monitored parameter is required in order to comply with the following applicability condition: • The cargo is transported from the same origin (point A) to the same destination (point B) throughout the whole crediting period. These two points and transportation routes are defined in the CDM- PDD at the validation of the project activity and are fixed along the crediting period	







Data / Parameter:	CTy	CTy
Data unit:		
Description:	Type of cargo transported by the project transportation mode in year <i>y</i>	Petroleum product transportation via train
Source of data:	Onsite records by project participants	SLR
Measurement procedures (if any):	The project participants will record the type of cargo transported by the project transportation mode in each trip. The verifying DOE will check the records for confirmation.	
Monitoring frequency:	Each trip	Each trip
QA/QC procedures:	-	
Any comment:	 The cargo type transported in year <i>y</i> should be the same type as defined in the CDM-PDD at the validation of the project activity. This monitored parameter is required in order to comply with the following applicability condition: Both in the baseline and project activity, only one type of cargo, owned by the project participants, is transported and no mix of cargo is permitted (this condition does not apply to the return trip cargo). The cargo type of the project activity is defined in the CDM-PDD at the validation of the project activity and is fixed along the crediting period 	







Data / Parameter:	Ty	Ty
Data unit:	tonne	tonne
Description:	Amount of cargo transported by the project transportation mode in year y	Amount of petroleum product transported by rail in year 2010
Source of data:	Onsite measurements by project participants	SLR
Measurement procedures (if any):	The amount of cargo transported under the CDM project by the project transportation mode shall be measured at the point of origin using weight scales. The amount shall be crosschecked with the cargo received at destination	Amount of petroleum product transported via train is measured at the Kolonnawa main terminal by CPSTL and records are available in their data base. These amounts are also reported to Chief Wagon Controller of SLR
Monitoring frequency:	Daily, summed for a year	Record daily
QA/QC procedures:	-	







FARTNERSTIF		
Any	The project participants shall	
comment:	estimate the T _y to be used for <i>ex ante</i>	
	calculation in the CDM-PDD and for	
	the investment analysis and	
	document in the PDD. The sensitivity	
	analysis shall be performed as per	
	the procedure in the combined tool.	
	Changes to the value of T _y during the	
	crediting period as compared to the	
	<i>ex -ante</i> estimate (e.g. by more than	
	10%) represent a change to the	
	project design document and the	
	relevant procedures shall apply	
	•	

Data / Parameter :	Trt,y	T _{RT,y}
Data unit:	tonne	tonne
Description :	Amount of cargo transported by the project transportation mode in the return trips in year <i>y</i>	Amount of cargo transported by train in the return trips in year 2010
Source of data:	Onsite measurements by project participants	Onsite measurements by SLR
Measureme nt procedures (if any):	The amount of cargo transported by the project transportation mode in the return trips shall be measured at the point of origin using weight scales. The amount shall be crosschecked with the cargo received at destination	







PARTNERSH		"Path to Sustainability"
Monitoring frequency:	Daily, summed for a year	Daily
QA/QC procedures :	-	
Any comment:	The project participants shall estimate the T _{RT,y} to be used for <i>ex ante</i> calculation in the CDM-PDD and for the investment analysis and document in the PDD. The sensitivity analysis shall be performed as per the procedure in the combined tool. Changes to the value of T _{RT,y} during the crediting period as compared to the <i>ex- ante</i> estimate (e.g. by more than 10%) represent a change to the project design document and the relevant procedures shall apply.	Return oil wagons are empty







PARTNERSHIP		
Data / parameter:	FCi,j,y	FCi,j,y
Data unit:	Mass or volume unit per year (e.g. ton/yr or m ³ /yr)	m ³ /yr
Description:	Quantity of fuel type <i>i</i> combusted in process <i>j</i> during the year <i>y</i>	Quantity of diesel combusted for
Source of data:	Onsite measurements	SLR
Measurement procedures (if any):	 Use either mass or volume meters. In cases where fuel is supplied from small daily tanks, rulers can be used to determine mass or volume of the fuel consumed, with the following conditions: The ruler gauge must be part of the daily tank and calibrated at least once a year and have a book of control for recording the measurements (on a daily basis or per shift); Accessories such as transducers, sonar and piezo electronic devices are accepted if they are properly calibrated with the ruler gauge and receiving a reasonable maintenance; In case of daily tanks with pre-heaters for heavy oil, the calibration will be made with the system at typical operational conditions 	
Monitoring frequency:	Continuously	
QA/QC procedures:	The consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records	







PARTNERSHIP		"Path to Sustainability"
Any comments	Project activities or PoAs, where end users of the	Fuel consumption of
	subsystems or measures are	each engine is
	households/communities/small and medium	measured by 'running
	enterprises (SMEs), faced with data gaps due to meter	sheds'. But fuel
	failure or other reasons unforeseen, may estimate the	combustion for
	quantity of fuel, using one of the following options,	petroleum products
	provided the gap period does not exceed 30 consecutive	(cargo) transportation
	days within six consecutive months:	is not recorded
	Interpretation The purchased fuel/energy invoices/bills,	separately.
	where the purchased fuel can be identified	
	specifically for the CDM project;	In the absence of data,
	The energy produced by the equipment,	value was calculated
	adjusted by efficiency. Efficiency of the	based on the average
	equipment is determined using the	fuel consumption of
	'Methodological tool: Determining the baseline	mostly used engines to
	efficiency of thermal or electric energy	transport 500 tonnes.
	generation systems', and energy produced is	
	measured directly or calculated based on	
	operation hours;	
	The highest value of the parameter for the	
	same calendar period of the previous years;	
	The fuel consumption of a representative	
	sample of the first batch1 of project devices. It	
	may be assumed that the fuel consumption	
	measured in a representative sample of the first	
	batch of project devices apply to all subsequent	
	batches	