Initiative for Climate Action Transparency - ICAT

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

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Deliverable 3-1

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H.M. Buddika Hemashantha, W. Indike Dassanayake,

D.M.Anuradha Lakmini Dissanayake, Wasundara Samarawickrama, Shyamika Shiwanthi, Nilni Malsha, Himesh Hansamal

Climate Smart Initiatives (Pvt) Ltd

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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 also has to present the status of achieving the NDC goals by 2020. In this context, Sri Lanka has been looking for assistance from various parties in order to establish 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 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.

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Climate Smart Initiatives (Pvt) Ltd.

Sri Lanka.

List of Acronyms

AD	Activity Data
AFOLU	Agriculture, Forestry and Other land Use
BAU	Business As Usual
BRT	Bus Rapid Transport
BUR	Biennial Update Reports
CAA	Civil Aviation Authority
CAGR	Compound Average Growth Rate
CCS	Climate Change Secretariat
CDM	Clean Development Mechanism
CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
COP	Conference of the Parties
CPF	Carbon Partnership Facility
CTF	Common Tabular Format
DMT	Department of Motor Traffic
EDGAR	Emission Database for Global Atmospheric Research
EF	Emission Factor
GEF	Global Environment Facility
GFEI	Global Fuel Efficiency Initiative
GHG	Greenhouse Gas
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
JICA	Japan International Cooperation Agency (Prepared by Japan Weather Association)
LULUCF	Land Use, Land Use Change and Forestry
MMDE	Ministry of Mahaweli Development & Environment
MMWD	Ministry of MegaPolis& Western Development
MoF	Ministry of Finance

MoH	Ministry of Highways
MoPRE	Ministry of Power & Renewable Energy
MoPS	Ministry of Petroleum Resource Development
MRV	Monitoring, Reporting, and Verification
MTCA	Ministry of Transport & Civil Aviation
NAMA	Nationally Appropriate Mitigation Action
NDC	Nationally Determined Contribution
NTC	National Transport Commission
NTMI	National Transport Medical Institute
RPTA	Road Passenger Transport Authority
SLR	Sri Lanka Railway
SLTB	Sri Lanka Transport Board
SNC	Second National Communication
UDA	Urban Development Authority
UNFCCC	United Nations Framework Convention on Climate Change

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Executive Summary

Transport sector is one of the major GHG emitting sector in Sri Lanka as its GHG emissions (6.76 MtCO2e) accounts nearly 20% of national GHG emissions in Sri Lanka (WRI, 2015). Further it is estimated that total transport sector emissions from 2020 to 2030 will reach to 162 MtCO2 (The Celestial Earth, 2018). In order to manage transport sector emissions, Sri Lanka's Nationally Determined Contributions is expected to reduce 10% of its GHG emissions from transport and other three sectors (waste, industry and forestry) within the period of 2020 -2030. This will be 3% unconditional and 7% conditional against BAU scenario.

In order to: a) meet the international reporting requirements; b) build mutual trust & confidence; c) promote effective implementation; and d) enhance the transparency, progress of achieving the emission reductions from each NDCs is required to be measured, reported and verified. Measurement, Reporting and Verification (MRV) of GHG effects of policy & actions in Sri Lanka is limited mostly to energy sector. However, there was not national MRV system in any sector to measure the GHG effects of policy and actions. Therefore, CCS of MMDE, MTCA and UNEP DTU Partnership decided to develop a national MRV system for the transport sector of Sri Lanka.

This assignment focuses on: reviewing existing MRV and institutional arrangement in transport sector; identifying appropriate methodologies to measure GHG impacts of prioritized NDCs; designing national MRV system including institutional arrangement, data management system, and reporting templates for a robust national MRV system.

There are 11 main NDCs and 31 sub NDCs for the transport sector. However, it is not possible to cover all NDCs and sub NDCs in this report due to the limited time and budget. As such NDCs were prioritized based on their financial feasibility, political preferences, effect on GHG reduction and availability of internationally accepted methodologies to measure the GHG effects. As outcomes of the prioritization, 6 sub NDCs were selected representing 4 main NDCs.

- Introduce park & ride system (4.1)
- Electrification of the railway system from Veyangoda to Panadura (5.1)
- Purchase new rolling stock for Sri Lanka Railway (5.2)
- Introduce electric buses (8.3)
- Introduce other electrified vehicles such as cars (8.4)
- Transport of heavy loads by railway (9.4)

Measurement (M)

Methodologies were selected to measure the GHG effect of respective sub NDCs. While selecting the methodologies, priority was given to UNFCCC CDM methodologies to quantify the GHG effects of actions (projects) and ICAT methodologies to quantify the GHG effects of policies. When UNFCCC CDM or ICAT methodologies were not available to quantify GHG effects of policies and actions, other methodologies such as JICA methodologies were used.

Data required to measure the GHG effects of each NDC are stipulated in the respective methodology. Based on this, responsible institutions were identified and data collection templates were also developed. Data collection templates were verified and approved by the relevant institutions indicating that they will be able to measure and provide these data in order to measure the GHG effects of the respective NDC. Developed data collection templates and other required information to measure the GHG effects are given in 11 procedures.

Ex-post emission reductions for each policy and action (NDC) will be measured against the reference scenario, which was developed based on 2010 base year in accordance with Sri Lankan NDCs. However, when the data are not available to develop the reference scenario using 2010 base year, the year which has latest data for the concerned mitigation action has taken as the base year. Ex-ante emission reduction for each policy and action was also done applying the same principle.

Reporting

Data management systems were developed to indicate how the data measured shold be reported to the relevant users. These systems were mostly built upon the existing data collection and reporting practices, and guidelines. In a situation, there is not existing practices for data management, new systems were introduced in consultation with the relevant stakeholders. Data management system provides the process of data reporting which addresses the criteria of; who will measure, record and report the data and how often. Collected data from each and every responsible agency will be reported to the "transport sector NDC unit", which will be established under MTCA. Processed information will be reported to the MRV coordination unit which will be established under the MMDE.

Verification

Data reported by each institution will be verified by MTCA. After the data verification, all the data will be processed by the NDC unit. Once the GHG effects of NDCs were communicated to MMDE, MRV expert committee will verify the emission reduction from each NDC. Finally, MMDE will submit the progress of achieving the emission reduction from each NDC to UNFCCC.

Summary of the chapters

There are five chapters in this report. First chapter gives an introduction to the report. Second to fourth chapters describe the proposed MRV framework for the selected NDCs while fifth chapter provides the overall institutional arrangement.

Chapter two includes discussions on the NDCs that are related to *improvement of the efficiency of railway system*; electrification of railway (NDC 5.1) and purchasing new rolling stocks (NDC 5.2).

Emission reductions attributed to the railway electrification is measured using JICA methodology, *Transport / Railway (Passenger) / Electrification –FIT Version 2*. SLR, SLSEA and CPSTL are required to provide the activity data and emission factors in order to measure the GHG effects of the proposed mitigation action. The procedures (P), P2, P3 and P9, provide: a) the information on the parameters required to be monitored ex-post; and b) also relevant data collection templates. The proposed mitigation action, "electrification of railway line from Veyangoda to Panadura", was used to calculate the ex-ante GHG impacts. According to the calculation, GHG impact of the proposed mitigation action will be 21,596 tCO_2e by 2030 while GHG emissions under BAU and project scenarios will be 32,265 tCO_2e and 10,669 tCO_2e respectively. In addition, the reporting and the verification processes are also described under this chapter.

NDC 5.2, "purchasing new rolling stocks for railway", is also discussed under this chapter. Power sets, Locomotives, Carriages, etc. are expected to be purchased in order to improve the efficiency of the railway system. In the absence of the new rolling stocks, the passengers would have used road transport such as buses, taxies and private vehicles, etc. Effect on the GHG emission reduction will be measured using a JICA methodology; *Transport / Railway (Passenger) / Modal Shift -FIT Version 2.0*. Data required to measure the GHG effect and responsible entities to provide the data are given in this chapter. Data will be required from SLR, NTC and CPSTL. Templates that can be used by each institute for the data collection are given in P5, P4 and P9 respectively. Sample calculation was done for purchasing six power sets for the SLR. According to the calculation, emission

reductions in the year 2030 will be around 1,049 tCO_2e. Data management procedure provides the detail on who will record the data, to whom and how often.

In the chapter three, under the introduction of new electric buses, three mitigation actions are discussed. Introduction of electric and hybrid vehicles (NDC 8.3), Introduction of carbon tax to promote electric cars (8.4), Introduction of tax rebates to promote the electric vehicles (8.4).

NDC 8.3 proposed to introduce electric buses in place of conventional diesel buses. GHG emission reduction can be measured by using CDM methodology; *AMS III.C; emission reductions by electric and hybrid vehicles*. Bus fleet of the country is managed by SLTB, NTC and RPTA. Data required to calculate the GHG effect and the institutions responsible for providing data are given in the chapter. Procedures for responsible institutions are P8; SLTB, P3; SLSEA and P9; CPSTL. Sample calculation was done for the project proposed by the SLTB to import 9 electric buses. According the calculation, emission reduction in the year 2030 will be around 76 tCO_2e. Reporting procedure was developed based on the existing data management systems of the respective institutions.

Under the promotion of low emission vehicles such as electric and hybrids, NDC 8.4 proposed to introduce 'other electric vehicles such as cars'. This chapter discusses two policy initiatives implemented by the government of Sri Lanka to promote the electric vehicles. Government has introduced a carbon tax for conventional petrol, diesel and hybrid vehicles based on engine capacity. Effect of this initiative on the GHG emission reduction can be measured by using ICAT transport pricing guidance. According to the calculations this initiative will reduce the emission by 969 tCO_2e in year 2030. Further, government has reduced the import tax of the electric vehicles and has increased the same for conventional vehicles with the purpose of increasing the electric vehicle penetration. Effect of this initiative can also be measured by using the ICAT transport pricing guidance. According to the calculations this will reduce the emission by 343,154 tCO_2e. Data will be required from DMT, SLC, VET, SLSEA and CPSTL for the calculation. Required data collection templates are given in P6, P7, P11, P3 and P9. Data reporting process of these institutions are described under the data management system.

Fourth chapter of the report discusses two more sub NDCs which aim to reduce traffic congestion. The two NDCs are passenger shift from private to public and introduction of park and ride system (NDC 4.1). Emission reduction associated with this mitigation action can be measured by using a CDM methodology; *ACM0016: Baseline Methodology for Mass Rapid Transit Projects; Version 4.0*. As an example for the proposed mitigation action, this chapter discuss shifting passengers from private vehicles to LRT system. Out of four proposed LRT systems, chapter will only discuss JICA funded LRT line as it is the most progressed project so far. If the project is implemented according to the plan, emission reduction in year 2030 will be around 59,266 tCO_2e. O&M company (yet to be established), SLSEA and CPSTL are the institutions which are responsible for providing data. Data collection templates and the data required from each institute are given in P1, P3 and P10.

Transport heavy loads by railway (NDC 9.4) is also discussed under the chapter four as this mitigation action intend to reduce the traffic congestion by shifting freight transport from diesel based road transportation modes to rail transportation. Effects of the proposed mitigation action on GHG reduction can be measured by using CDM methodology; *Modal shift in transportation of cargo from road transportation to water or rail transportation, AM0090 version 01.1.0.* Chapter discusses a project that transport aviation fuel from Kolonnawa main terminal to Katunayaka bulk depot via train. According to the calculation shifting total aviation fuel transportation from road to rail will reduce emission by 916 tCO_2e. As per the selected mitigation project, data will be provided by CPSTL and SLR. Required data and data collection templates are given in P9 and P10. Reporting process is explained based on the data requirement and the existing institutional arrangement.

Chapter 5 of this final report presents the existing institutions in the sectors of transport and climate change and builds the new institutional arrangement for the transport sector MRV system upon the existing institutional arrangement with few modifications. This chapter presents a clear picture of the potential roles and responsibilities and the details of the composition of each institution. Following the discussion on proposed institutional arrangement, chapter sets out the procedure for data quality management to ensure that

data are properly collected, handled, processed, used, and maintained at all stages of the MRV system. Finally chapter 5 makes few recommendations which should be carried out for the successful transport sector MRV system of Sri Lanka.

Stakeholder involvement

As MRV is an active process, it is important to maintain the practicality of the proposed framework which can be only achieve through the active participation of the stakeholders to the process of developing the MRV framework. Therefore, proposed framework was developed based on the series of stakeholder consolations meetings, bilateral meetings and interviews. Stakeholders represented the national and local government level entities and also the key private sector entities as well. Stakeholders were identified based on the responsible agencies to the selected NDCs. This group represented the officers who are responsible to Measure the data, officers involve in the process of Reporting and also the representatives of the Verification bodies. Further, combination of the stakeholders were varied depending on the objective of the consultation. List of the key institution that took part all along the process is given in Annex 3. As a result of maintaining an active stakeholder engagement throughout the project, proposed MRV system has already been approved by the stakeholders. Obligation of all the ministries, departments to provide information to the MMDE was an added advantage to develop the MRV system and maintain the stakeholder engagement. Further, consultation process was enriched and productive as we have followed the ICAT stakeholder guide.

Summary of the MRV system

NDC	Mitigation action	Measuring		Reporting	Verification
		Methodology	**Emission reduction tCO_2 (2030)**		
Introduce park & ride system (4.1)	Introduce LRT system from Pettah to Malambe	ACM0016: Baseline Methodology for Mass Rapid Transit Projects; Version 4.0	59,266	1.O&M company 2.SLSEA 3.CPSTL	1. Data verification - NDC unit of MTCA 2. Calculation -MRV expert committee
Electrification of the railway system from Veyangoda to Panadura (5.1)	Electrification of Veyangoda to Panadura railway line	JICA Transport / Railway (Passenger) / Electrification- Version 2 guideline	21,596	1.SLR 2.SLSEA 3.CPSTL	
Purchase new rolling stock for Sri Lanka Railway (5.2)	Purchase six power sets for Sri Lanka Railway	JICA Transport / Railway (Passenger) / Modal Shift - FIT Version 2.0	1,049	1.NTC 2.SLR	

				3.CPSTL 4.SLSEA	
Introduce electric buses (8.3)	Introduce 09 electric buses for the Colombo region	AMS III.C; emission reductions by electric and hybrid vehicles	76	1.SLTB 2.NTC 3.RPTA 4.CPSTL 5.SLSEA	
Introduce other electrified vehicles such as cars (8.4)	Imposing carbon taxes on motor cars	ICAT transport pricing guidance	969	1.DMT 2.SLC 3.VET 4.SLSEA 5. CPSTL	
	Reduction of excise duty of electric cars		343,154		
Transport of heavy loads by railway (9.4)	Transport aviation fuel from Kolonnawa main terminals to Katunayaka Airport	AM0090, "Modal shift in transportation of cargo from road transportation to water or rail transportation	916	1.CPSTL 2. SLR	

1 Introduction

1.1 Background

Sri Lanka's transport sector GHG emissions is growing rapidly and it reached to 5 $MtCO_2e$ in 2000 representing 35% of Sri Lanka's net total CO_2e emissions, and almost half of the emissions from the energy sector in the same year (MERE, 2011). Further same report (MERE, 2011) predicted that the transport sector emissions will be 11.4 $MtCO_2e$ by 2020, and will continue to increase. Road transport is the main source of GHG emission s in the transport sector as it represents nearly 90% of total transport sector GHG emissions (MERE, 2011).

MRV of GHG emissions in Sri Lanka

Since Sri Lanka is a party to UNFCCC, it is mandatory to report the GHG inventory periodically as part of the national communications(every four years) and biennial update reports (every two years). Sri Lanka has the expertise and experience of MRV of emissions in developing national GHG inventories as part of national communications to UNFCCC, so far, the island nation has developed two national communications (Initial National Communication - INC and Second National Communication - SNC) under the leadership of Climate Change Secretariat. Further CCS is leading the preparation of the third National Communication (TNC), which is expected to be completed by early 2019. All three national GHG inventories are developed based on IPCC Tier 1 approach.

MRV of NAMAs (policy and actions) in Sri Lanka

In relation to MRV of policies, Island nation has not yet established any national level MRV system. For MRV of actions, Sri Lanka has expertise in applying CDM methodologies for:

- Over 22 energy and waste sector projects under UNFCCC CDM;
- Energy generation and end use sector NAMA for three technologies (rooftop solar PV, high efficient motors, and bio gas) under GEF funded project managed by UNDP;
- Modern biomass energy technology project under GEF funded project managed by UNDP;
- 4 energy projects under Sri Lanka Carbon Crediting Scheme (SLCCS); and

Developing BRT NAMA project in the transport sector.

The experience in the application of the CDM methodologies can be used while developing MRV framework, in particular, establishment of the baseline, monitoring framework, data management system, etc. Further Sri Lanka also has an approved institutional arrangement for NAMA, which includes MRV component as well. Though Sri Lanka has MRV experience in the energy sector, it has limited experience in other sectors. MRV experience in the transport sector is limited only to the development of a proposal for BRT NAMA project as the only framework for MRV. MRV experience in the waste sector is limited to a small number of CDM projects, whilst negligible experience exists in the industry sector.

Sri Lanka has implemented few CDM projects, SLCCS and Global Environment Facility (GEF) funded projects, and has gained first-hand experience of MRV. Apart from these projects, the majority of relevant programs described in the previous paragraphs, such as the CPF, energy & end use NAMA, and the transport NAMA programs, are still in the design or pilot stages, and have not yet had a significant impact on capacity building of local experts.

1.2 Objective

- Objectives of ICAT and the assignment

This report on designing MRV system and establishment of roles and responsibilities for transport sector in Sri Lanka is the third report in a series of reports prepared to achieve the objectives of the ICAT and its assistance in developing national MRV system for the transport sector in Sri Lanka.

Objective of the Initiative for Climate Action Transparency (ICAT)

Monitoring Reporting and Verification of the progress on NDC implementation is needed to meet country's international reporting requirements, and "to build mutual trust and confidence and to promote effective implementation, an enhanced transparency framework for action and support, with built-in flexibility which takes into account Parties' different capacities and builds upon collective experience." (Article 13.1 of the Paris agreement). MRV of NDC progress is also important to meet domestic requirements. These could include reports: (a) to the parliament and the public in order to improve transparency; and (b) to policy-makers informing decisions on changes to the existing mitigation or adaptation actions. ICAT project was founded to respond to these critical needs to support improved transparency and capacity building under the Paris Agreement. The primary objectives of ICAT are to;

a) Strengthen institutional and human capacities in countries to develop and implement domestic system to MRV mitigation policies and actions (MPAs); and

b) Develop tools and guidance that can be used for an effective system for MRV MPAs implementation.

In order to achieve these objectives in the implementing countries, ICAT has three implementing partners: UNEP DTU Partnership; Voluntary Carbon Standard (VERRA); and World Resource Institute (WRI). Roles of the implementing partners are to coordinate with the implementing country, and the selected consultants to achieve the objectives of ICAT project in the implementing country.

Objective of ICAT project in Sri Lanka

With the view of achieving above mentioned objectives, the ICAT agreed to facilitate building a national MRV system for Sri Lankan transport sector based on a request from Sri Lanka. During a stakeholder consultation held in Sri Lanka; it was identified that Sri Lanka does not have a transport sector MRV system. Most of the experience in the MRV area is limited to energy sector. In addition, there are some ongoing MRV activities in energy sector under energy NAMA coordinated by UNDP Sri Lanka. However, there were not many MRV related activities in transport sector, which represents 50% of energy sector emissions. Further the transport sector is becoming the largest GHG contributor in Sri Lanka due to the rapid growth in the sector. In order to address this rapid growth of transport sector emissions and to meet the international obligation on reporting the status of achieving transport sector NDCs, it is vital to develop an affective national MRV system. As such, it was agreed between Climate Change Secretariat (CCS) under the Ministry of Mahaweli Development & Environment (MMDE), Ministry of Transport & Civil Aviation (MTCA), and UNEP DTU Partnership to prioritize the development of MRV system for the transport sector.

Objective of the ICAT project in Sri Lanka is to fill the gaps of MRV and institutional needs for reporting of NDCs by developing an affective national MRV system through enhancing existing institutional set up for the transport sector NDCs.

The assignment will focus on reviewing existing MRV and institutional arrangement within transport sector, identification of appropriate methodologies to measure GHG impacts of prioritized NDCs, design of MRV system, which includes: establishing institutional arrangement (roles and responsibilities, reporting channel), designing data management system, developing reporting templates; and identifying necessary legal arrangements. This will facilitate a robust and continuous national MRV system. The consultant will work in close cooperation with National Focal Point, UDP representative and national experts to deliver the expected output.

i. A report on the assessment of MRV & Institutional arrangement of transport sector

ii. A report on selected methodologies for assessing the impacts of GHG emissions on transport sector policies and actions

iii. A report on designing MRV system and establishment of roles & responsibilities for transport sector

1.3 Scope

Scope of this report which is the third of three reports on building national MRV system for transport sector of Sri Lanka, is to design MRV system and establish roles and responsibilities for MRV of the transport sector in line with Nationally Determined Contributions.

1.4 Limitations

There are 11 NDCs and 31 sub NDCs for the transport sector. However, it is not possible to cover all NDCs and sub NDCs due to the limited time and budget. As such, CCS & MTCA together with UNEP DTU Partnership agreed to prioritize the NDCs and Sub NDCs based on a quantitative method, which has been explained in the first and second of three reports on building national MRV system for transport sector of Sri Lanka (Chapter 1, sub section 1.6).

While selecting the methodologies to measure the GHG effects of policy and actions, the priority was given to UNFCCC CDM methodologies for project related methodologies and ICAT methodologies for policy related methodologies. When there are difficulties to apply

such methodologies, other methodologies such as JICA and IPCC quantification approaches were used.

1.5 Methodology

As part of the first and second deliverables, priority mitigation actions and relevant methodologies to assess the GHG effects of those mitigation actions were identified. Then, this report developed the MRV framework in four steps: i.) introduction to the mitigation actions, rationale, status of mitigation actions; ii.) detailed explanation on how to quantify the GHG effects of each prioritized mitigation actions; (iii)institutional arrangement for data management; and iv) application of the MRV framework for a real mitigation action. These steps were carried out separately for each prioritized NDC. In addition, MRV protocol (second report of third deliverable) and data management procedures (third report of third deliverable) were also developed for each prioritized NDCs in order to facilitate the measurement, reporting and verification of GHG effects of NDCs.

Methodology to identify prioritized mitigation actions

In order to identify the prioritized mitigation actions (policies and projects for each prioritized NDCs), two criteria (likelihood of the implementation, data availability) will be applied. Then, each criterion will be given a weight between 1 (least possibility) and 5 (highest possibility) with a discussion between MTCA, CCS of MMDE and ClimateSI (the consultant). In addition, selection of the prioritized mitigation actions will be further validated during workshop held for all institutions under MTCA and CCS of MMDE.

2 Improving efficiency of railway system

2.1 Electrification of railway

2.1.1 Description of the mitigation action

Mitigation Action - The proposed mitigation action involves the electrification of an existing railway lines and new lines to be added to the railway network. In the absence of the proposed mitigation action, the diesel engines would have continued to use in the railway line.

The proposed mitigation action is an action under sub NDC 5.1 (Electrification of the railway system from Veyangoda to Panadura) of NDC 5 (Enhance the efficiency and quality of public transport modes). This mitigation action is also in line with the ASI (Avoid-Shift-Improve) approach and it is a part of the improving strategy, which aims to achieve significant GHG reduction, reduce energy consumption, less congestion, with the final objective of creating more livable cities.

Application of the mitigation action

For example, The project activity involves 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.

Rationale for introducing the mitigation action

According to the National transport policy 2009[1], public transport accounts for nearly 68% of the total motorized passenger transport. Sri Lanka Railway (SLR) has around 5% share of public motorized passenger transport (120 million passengers per year). However, low speed (25 km per hour), and delay in arrival and departure of the trains make it less comfortable for passengers. Electric trains (power sets) are more energy efficient and have lower operation & maintenance costs compared to diesel trains (power sets). Indeed, fuel savings due to introduction of electric trains will be around 40 LKR per km, which will lead to save around 1 billion LKR for the country every year. In addition, operation and maintenance cost of electric train is 55% lower than that of diesel train. Moreover, electric trains can travel as fast as 100 km per hour. Considering all these factors, introduction of electric trains can lead to significant reduction of fuel (as well as greenhouse gas emissions), save the travel time for passengers, make the travel more comfortable, and save money for the country. Further electric trains can also attract new passengers to the railway reducing the traffic on the road and increasing its passengers share.

Based on these facts, the government proposed electrification of railway network as one of its NDCs. The main focus of NDC 5.1 is electrification of Veyangoda to Panadura railway line with 64 km which covers both main and coastal lines. According to National Transport Statistics 2014 and 2016 reports, following graph shows the passenger volume of main and coast lines from year 2011 to 2015.

[1] http://www.transport.gov.lk/web/images/pdf/tp.pdf

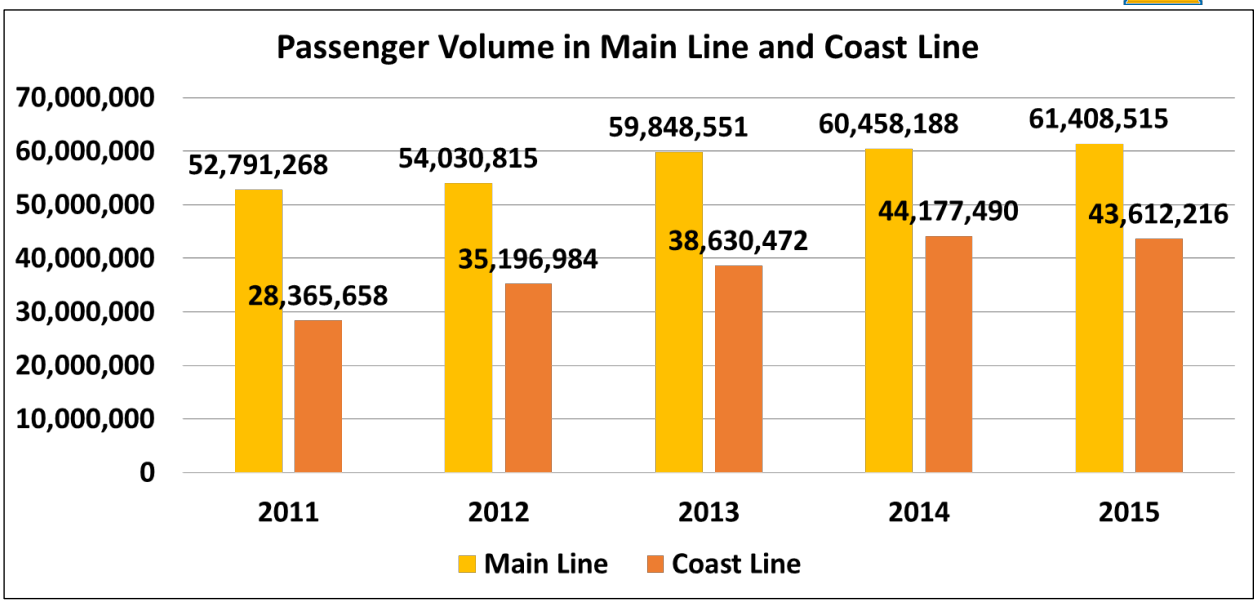


Figure 2.1Passenger Volume in main line and coast line (SLR, 2016)

According to the studies[2], around forty two percent (42%) of the passengers who use present rail network, get-in and get-off in Panadura – Veyangoda route. This is a manageable length which provide the optimum benefit to commuters for the given investment.

Current situation, which includes the policy & actions, institutional arrangement to implement those policy & actions

National Transport policy of Sri Lanka (2009) expects to: (a) increase the modal share of passenger of Railway from 6% to 10% by 2016; (b) increase frequency, reliability and capacity of the suburban railway services (electrification, station modernization and integrated ticketing); (c) improve comfort of travel and reduce travel time of long distance by introducing value added services; and (d) modernize the railway transportation by replacing the outdated obsolete, procedures, process and system with modern management technique and systems. As such, the development of railway sector seems to be highest priority in relation to transport sector development. Further

[2]https://www.parliament.lk/uploads/documents/paperspresented/performance-report-department-of-srilanka-railway-

Presidential manifesto 2015 and vision 2025 policy also indicate the electrification of railway.

Status of the implementation of the NDC, which includes the policy and actions taken to implement the NDC, and any proposed institutional arrangement specific to the NDC

In order to achieve the target of electrifying the railway system, SLR and Ministry of Mega Polis and Western Development have taken several initiatives, among others:

a) Railway electrification and modernization of Panadura- Veyangoda line (RL-M1) - Feasibility study has been carried out. It was proposed to be extended the scope of the feasibility to extend the study up to Polgahawela. The existing signaling and communication system along the existing line from Panadura to Polgahawela is up to 40 years old. Therefore, the feasibility to determine the possibility of phasing out the signal, communication and track upgrades as an initial measure and electrification to follow subsequently.

b) Kelani Valley (KV) line (RL-M3) – It connects major town centres such as Nugegoda, Kottawa, Homagama, Dompe and Avissawella on High level corridor. The current single line with slow speeds has already reached its capacity at peak time. Therefore, the KV line was proposed to be double tracked. Implementation of the railway electrification of KV line (60 km) is planned to be completed in two phases: a. first phase up to Kottawa to be completed on or before 2020; b. the second phase from Kottawa to Awissawella to be completed on or before 2025.

c) Ragama – Negombo line with new airport access (RL- M2) – Electrification of RL-M2 line with an airport access (26 km connecting the Bandaranayake International airport) is to be carried out as a medium-term intervention providing the connectivity to the Negombo corridor. The rail line is phased out to be operational on or before 2025.

d) Kottawa- Horana line (RL – NR1) – EIA has already been completed for new railway line from Kottawa to Horana (22 km). It will have to consider the electrification of the line as well.

e) Kelaniya to Kosgama via Biyagama and Dompe (RL – NR2) – The proposed RL-NR2 line is expected to carry both passenger and freight. It is expected to give access to the proposed plantation city at Avissawella and the proposed logistics zone. This can be either electrified.

Even though five projects have been proposed to electrify the railway lines of Sri Lanka, NDC (5.1) is only refereeing to Panadura – Veyangoda line (RL-M1). Therefore, analysis will be based on the selected RL-M1 line.

2.1.2 Scope and boundaries of monitoring approach

- *Causal chains*

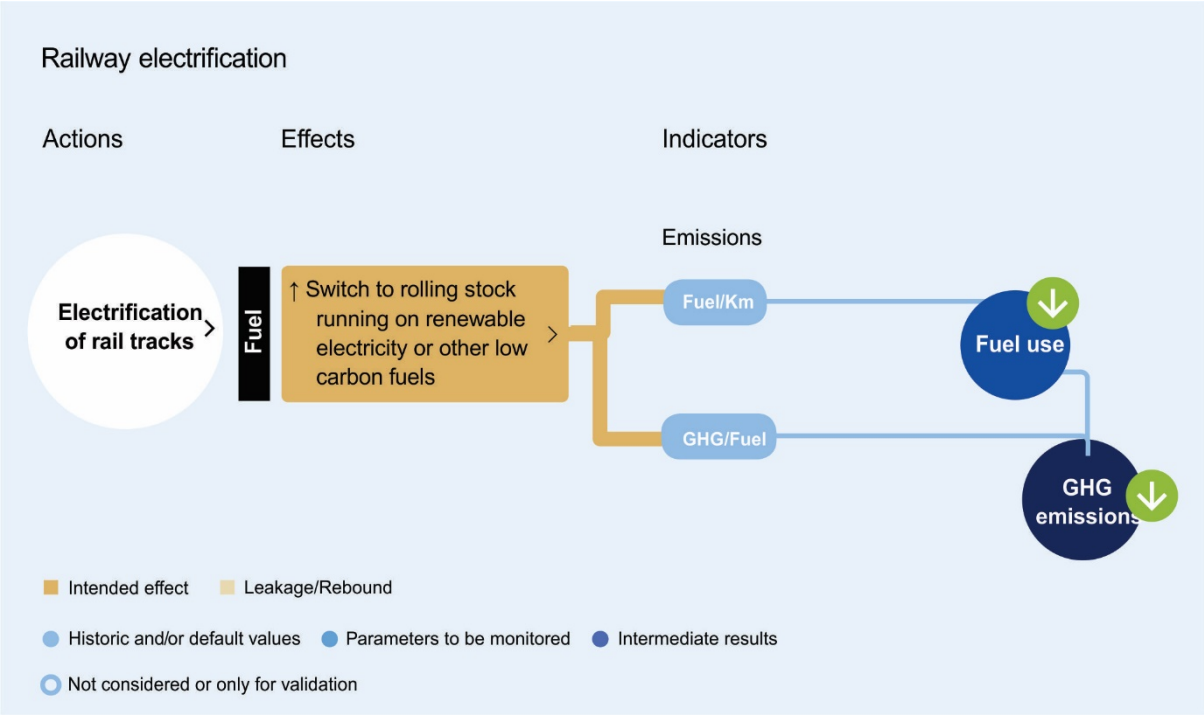


Figure 2.2 Causal chain of railway electrification

Source: Compendium on Greenhouse Gas baseline and monitoring, 2018

Relevance of effects

Table 2.1 Relevance of effects

Effect	**Likelihood**	**Magnitude**
Reducing of GHG emission	Very Likely	Major
Saving of fuel consumption	Very Likely	Major
Saving travel time	Very Likely	Major
Reducing air pollution	Very Likely	Major
Reducing noise pollution	Very Likely	Major
Making the travel more comfortable	Likely	Moderate
Reducing traffic on road	Likely	Moderate

- *Assessment Boundary*

The physical assessment boundary for estimating GHG emissions includes the operation of the railway, which is from Veyangoda to Panadura.

- *System Boundaries*

Table 2.2System boundaries

Boundary Elements	**Description**
Temporal Boundary	2021-2030
Sectoral Boundary	The MRV approach covers passenger transport from Veyangoda to Panadura
Geographic Boundary	Electrification and modification of the existing railway system from Veyangoda to Panadura
GHGs Included	CO_2, CH_4 and N_2O gases are covered by the Emission factor of fuel

2.1.3 Methodology

Japan International Cooperation Agency's Transport / Railway (Passenger) / Electrification –FIT Version 2 guideline was used to quantify the GHG effects of the mitigation action, railway electrification.

This methodology is applicable to electrification of railway passenger transportation and Model shift effects. Model shift effects are considered with the enhancement of transportation capacity. However, model shift effects are not applicable while calculating GHG effects of Veyangoda – Panadura Railway electrification project given the fact that the enhancement of transport capacity along with the electrification was not indicated as part of the project description.

Characteristics of the methodology is given in Annex 1

Key indicators

The emission reduction from the project activity is determined as the difference between the GHG emission of baseline scenario (existing scenario: the non-electrified railway) and project scenario (the electrified railway). Following are the key indicators that used for the calculation.

Table 2.3 Key indicators of NDC 5.1

$FC_{BL,i,y}$	Consumption of fuel i associated with the operation of the existing railway in year y
NCV_i	Net calorific value of fuel i
$EF_{fuel,i}$	CO_2 emission factor of fuel i
$EC_{PJ,y}$	Electricity consumption associated with the operation of the project activity in year y
EF_{elec}	CO_2 emission factor of the grid electricity

1. Calculation of Baseline Emissions

Baseline GHG emissions are calculated multiplying annual fossil fuel consumption of the existing railway byCO_2 emission factor of the fuel.

Equation 01

Baseline emissions

$$BE_y = FC_{BL,i,y} \times NCV_i \times EF_{fuel,i}$$

Table 2.4Key indicators of the baseline emission

$FC_{BL,i,y}$	Consumption of fuel i associated with the operation of the existing railway in year y
NCV_i	Net calorific value of fuel i
$EF_{fuel,i}$	CO_2 emission factor of fuel i

2. Calculation of Project Emissions

Project GHG emissions are calculated multiplying annual electricity consumption of the project activity by CO_2 emission factor of the grid electricity.

Equation 02

Project emissions

$$PE_y = EC_{pJ,y} \times EF_{elec}$$

Table 2.5key indicators of the baseline emission

$EC_{PJ,y}$	Electricity consumption associated with the operation of the project activity in year y
EF_{elec}	CO_2 emission factor of the grid electricity

2.1.3.1 Baseline Scenario

Identification of baseline scenario[3]

Five baseline alternatives have been identified for the mitigation action: railway electrification project,

Baseline alternative 1: Continue to use fossil fuel powered omnibuses[4] operated by state and private sectors. Currently, most of passengers are transported by state and private buses. As such, this baseline alternative is likely to continue.

Baseline alternative 2: Develop a LRT system– Most of the LRT systems are planned: a) in areas where there is no railway connection; and b) to connect with the existing railway line. As such, this baseline alternative is unlikely to replace the electrified railway line.

Baseline alternative 3: Develop mono-rails with tracks/underground railway network– There are no mono rail network or underground railway network established or planned in the country. Further construction of such infrastructure can be very expensive. As such, this option is unlikely to be a baseline alternative.

Baseline alternative 4: Continue to use fossil fuel powered trains (power sets) to carry the passengers. This is more logical option to make maximum use of the available tracks. Adding new carriages and rehabilitating existing carriages can also support to increase the number of passengers. Sri Lanka Railway commenced for procurement of 160 Nos. of passenger carriages and rehabilitation of 200 Nos. of abandoned carriages since 2016. It will be appropriate baseline alternatives.

Baseline alternative 5: Increase the railway tracks –Currently, single railway lines have already reached its maximum capacity at peak time. Passenger transportation volume

[3] Methodology requires to establish a credible baseline scenario after identifying several feasible baseline alternatives. As such, few baseline alternatives were identified and then most likely baseline alternative was selected as the baseline scenario.

[4] A term given by the SLTB and NTC to the general purpose buses

can be increased by increasing railway tracks. This option will not be appropriate due to limited land availability.

Baseline scenario: Passenger transport by existing fossil fuel-based trains (power sets)

- ***Data needs***

Data needs for calculating the GHG emission reduction are described in table 2.3: Data availability. Extra parameters are also collected and used for calculation due to unavailability of the parameters. Table 2.6 lists the collected extra parameters.

Table 2.6Collected extra Parameters

Unavailable parameter	Description	Extra parameter	Unit	Source
$FC_{BL,i,y}$	Consumption of fuel i associated with the operation of the existing railway in year y	Annual total trip distance associated with the operation of the existing railway in year y (**B_{km}**)	km	Sri Lanka Railway
		Specific fuel consumption associated with the operation of the existing railway in year y (**$SFC_{BL,i,y}$**)	Liter per km	Sri Lanka Railway
		Density of fuel i**(D_i)**	Kg/m^3	Ceylon Petroleum Corporation
$EC_{PJ,y}$	Electricity consumption associated with the operation of the	Annual total trip distance associated with the operation of the	km	Sri Lanka Railway

	project activity in year y	project activity in year y ($\mathbf{P_{km}}$)		
		Specific electricity consumption associated with the operation of the project activity in year y ($\mathbf{SEC_{PJ,y}}$)	kWh per km	Sri Lanka Railway

- ***Base year emission calculation***

Base year: 2018 (year y), Data is available only for 2018

Assessment route: Veyangoda to Panadura

Identified passengers: Main and coastal lines

Fuel consumed by baseline trains (i) : Diesel

Equation 01

Baseline emission

$$\boldsymbol{BEy = FC_{BL,i,y} \text{ x } NCV_i \text{ x } EF_{fuel,i}}$$

Baseline emission for the year 2018 is 16,976.5 tCO_2e. For the calculations please refer to Annex 2.

Uncertainties

- Baseline emission calculation was done based on the average value of fuel consumption per km while the guideline requires to use fuel consumption in tonne. The applied approach may lead to certain level of uncertainty.
- In the absence of historical data for several years (2010 - 2018), one month (December 2018) data was used to establish baseline emissions in 2018. This can also lead to certain level of uncertainty.

2.1.3.2 Ex Ante GHG Impact assessment

Methodological changes

Consumption of fuel i associated with the operation of the existing railway in year y *was calculated by multiplying* annual total trip distance with the operation of the existing railway in year y, Specific fuel consumption and Density of fuel i.

- ***Project emission calculation and Results***

Equation 02

Project emission

$$PE_y = EC_{pJ,y} \times EF_{elec}$$

Project emissions for the year 2018 is 5,613.7 tCO_2e. For the calculations please refer to the Annex 2.

Emission Reduction (for the year 2018)

Equation 03

$$ER_Y = BE_Y - PE_y$$

Table 2.7Emission Reduction Calculation for year 2018

Indicator		Value (tCO_2e/year)
Baseline Emission	BE_Y	16,976.5
Project Emission	PE_y	5,613.7
Emission Reduction	ER_Y	**11,362.8**

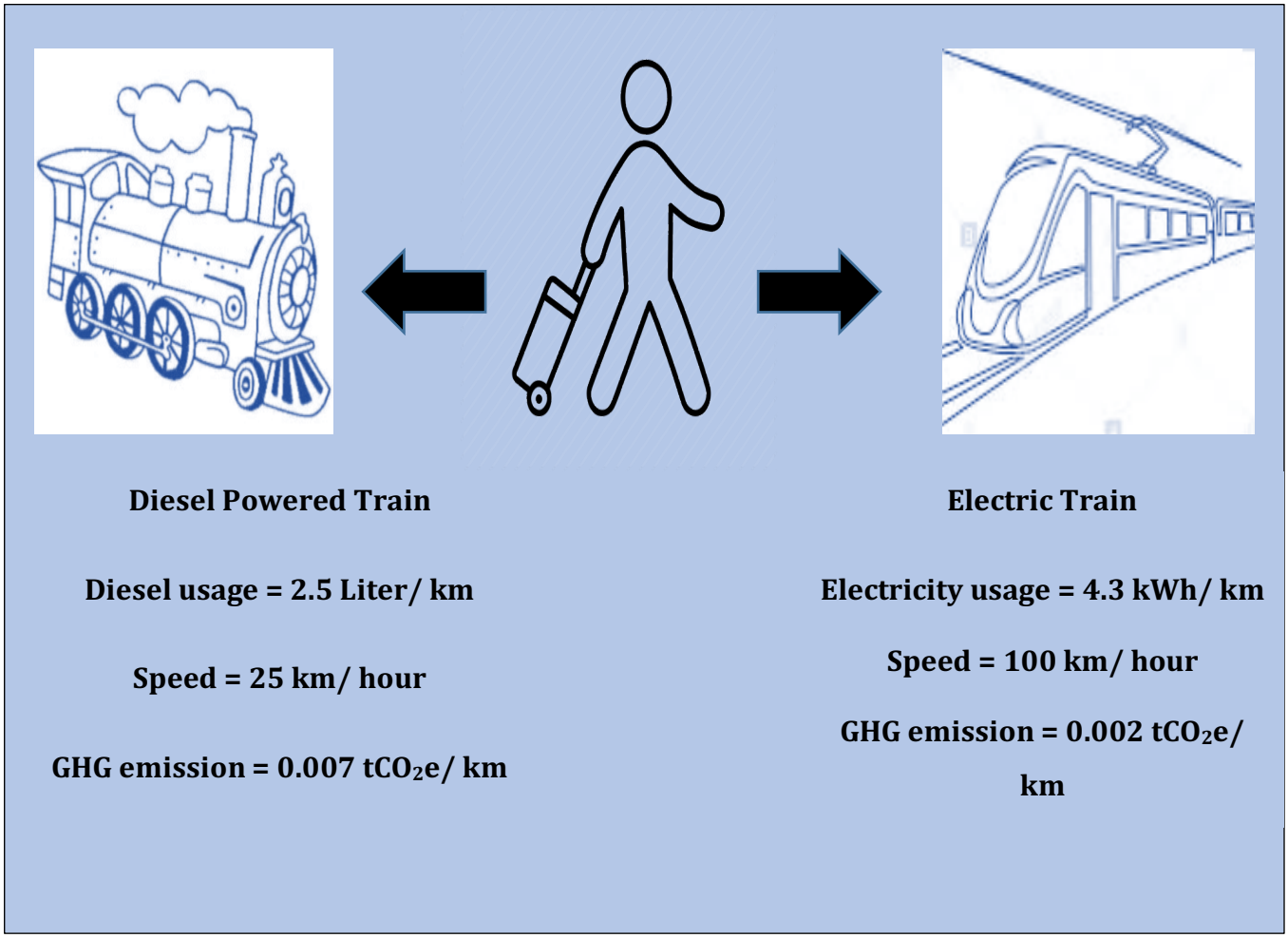


Figure 2.3Baseline & project emission

Source: ClimateSI, 2019

BAU and Project scenarios

Emission of the sector is highly correlated with the GDP of the country. Therefore, baseline scenario was established based on the projected GDP of the country. Figure 2.4.

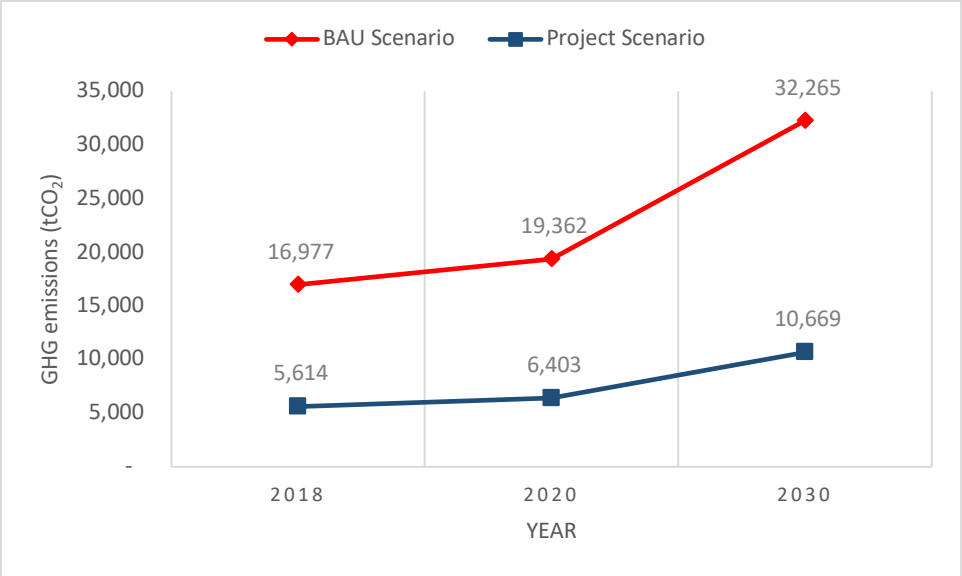


Figure 2.4 BAU and Project Scenarios – GHG emissions per year (tCO_2e)

Source: ClimateSI, 2019

As illustrated in Figure 2.3, emission of the year 2030 under BAU scenario will be around 32,265 tCO_2e while project scenario expects to be around 10,669 tCO_2e. This implies that if the proposed project successfully take place it will reduce the GHG emission by 21,596 tCO_2e. Emissions were extrapolated based on the predicted GDP of the country. (Annex 2)

2.1.3.3 Ex Post Assessment

Following data will be provided by SLR

Table 2.8Data requirement from SLR

Data requirement	In the absence of principal data, following data can be provided	Indicator	Unit
Electricity consumption associated with the operation of the project activity in year y	Annual total trip distance associated with the operation of the project activity in year y Specific electricity consumption associated with the operation of the project activity in year y	$EC_{PJ,y}$	kWh/year

Following data will be provided by SLSEA

Table 2.9Data requirement from SLSEAs

Data requirement	Indicator	Unit
CO_2 emission factor of grid electricity	EF_{elec}	$kgCO_2/kWh$

For more detail please refer to procedures. P2 and P3 and for SLR and SLSEA respectively.

2.1.4 Institutional arrangement

Institutional set up for implementation of mitigation action

- *Key internal institution under MTCA responsible for the implementation of the actions*

There are 9 agencies under the supervision of MTCA as illustrated in Figure 2.4. However, out of those agencies SLR is the key internal institute responsible for implementing this NDC.

Sri Lanka Railways (SLR)

Sri Lanka Railways is a government department functioning under Ministry of Transport and Civil Aviation. It is the only rail transport provider of the country. It has established through railway Ordinance which is commenced in 1902. Sri Lanka Railways Authority Act (No.60 of 1993) was enacted since 15th of December 1993. Act was repealed in February 2005 as Sri Lanka Railways Authority (Repeal) Act, No.3 of 2005. Below figure illustrates the governance structure of the SLR and vision, mission and objectives of the Sri Lanka Railways.

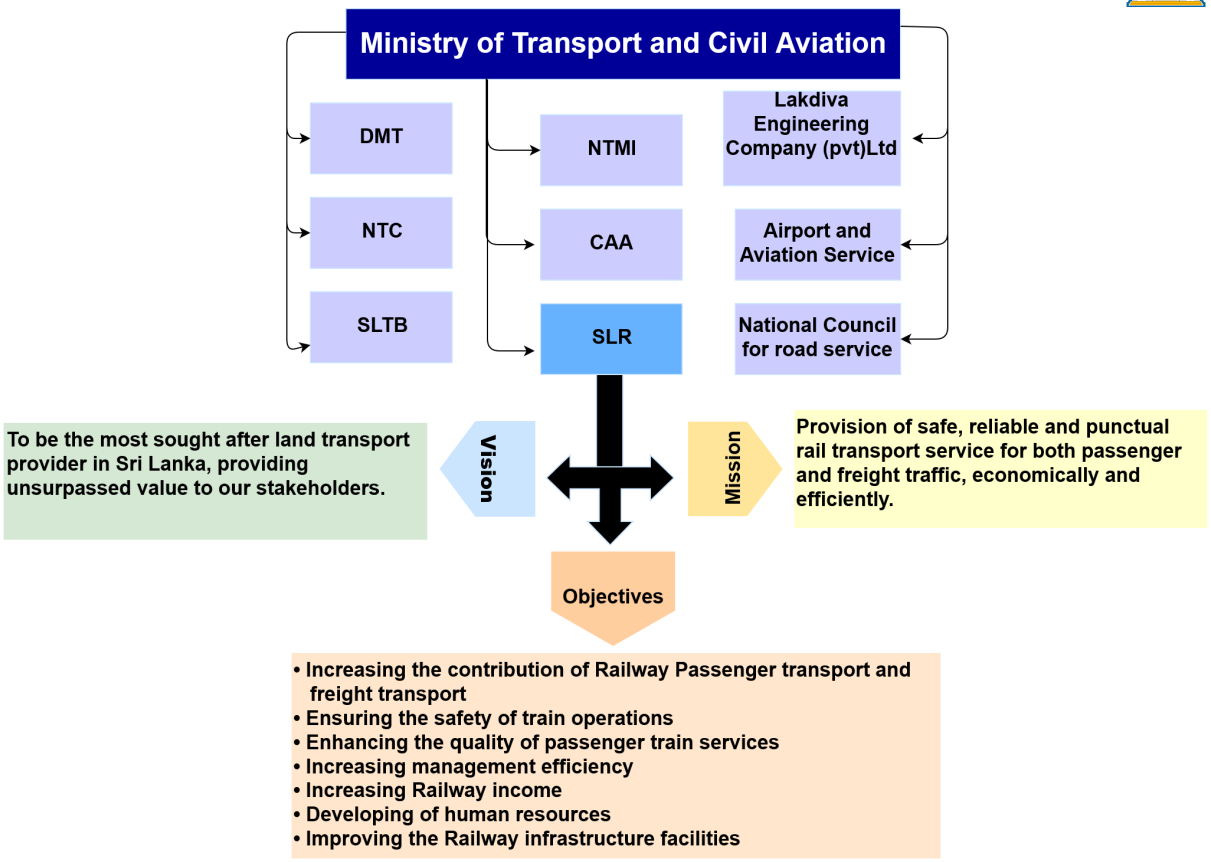


Figure 2.5 governance structure of the SLR

Source: ClimateSI, 2019 based on data from performance report of Sri Lanka railways, 2017

DMT: Department of Motor Traffic, NTC: National Transport Commission, SLTB: Sri Lanka Transport Board, NTMI: National Transport Medical Institute, CAA: Civil Aviation Authority, SLR: Sri Lanka Railways.

- ***Other related institutions***

According to "Project Idea Report- Technology Needs Assessment and Technology Action plans for Climate Change Mitigation", the overall project will be coordinated by a team consisting of the officers from Ministry of Transport and CIVIL Aviation, Sri Lanka Railways, The Institute of Engineers, Sri Lanka (IESL) and Ceylon Electricity Board.

- ***Roles and responsibilities of each institution engaged in the implementation of the Action***

Table 2.10 Roles & responsibilities of each institutions engaged in the implementation of theaction

Institution	Roles and Responsibilities
The Institute of Engineers	Prepare the proposals of Railway Electrification Project
Ceylon Electricity Board	Provision of electricity through overhead lines (25 kv) drawn above the railway lines
Sri Lanka Railways	Periodic maintenance of the system for smooth functioning
Ministry of Transport and Civil Aviation	Measure and evaluate of project progress

- ***Data management process for the indicators***

Data management process for each indicator is given in Figure 2.5: Proposed Data Management System for NDC 5.1. The all indicators which measure, collect, maintain the entry and calculate are included there.

As illustrated in figure 2.5, fuel consumption of the passenger trains will be recorded by running sheds. Electricity consumption of passenger trains will be directly recorded by motive power department. Collected data will be calculated by motive power department and will be monthly reported to the commercial department. All calculated data will be monthly transferred to the planning department from commercial department. Consolidated data will be annually reported to NDC unit by the planning department.

Net calorific value and density of the fuel will be measured and entered in to the SAP ERP system by the laboratory. All data will be monitored and recorded by the distribution unit. Data will be processed by the system and annually reported to the NDC unit.

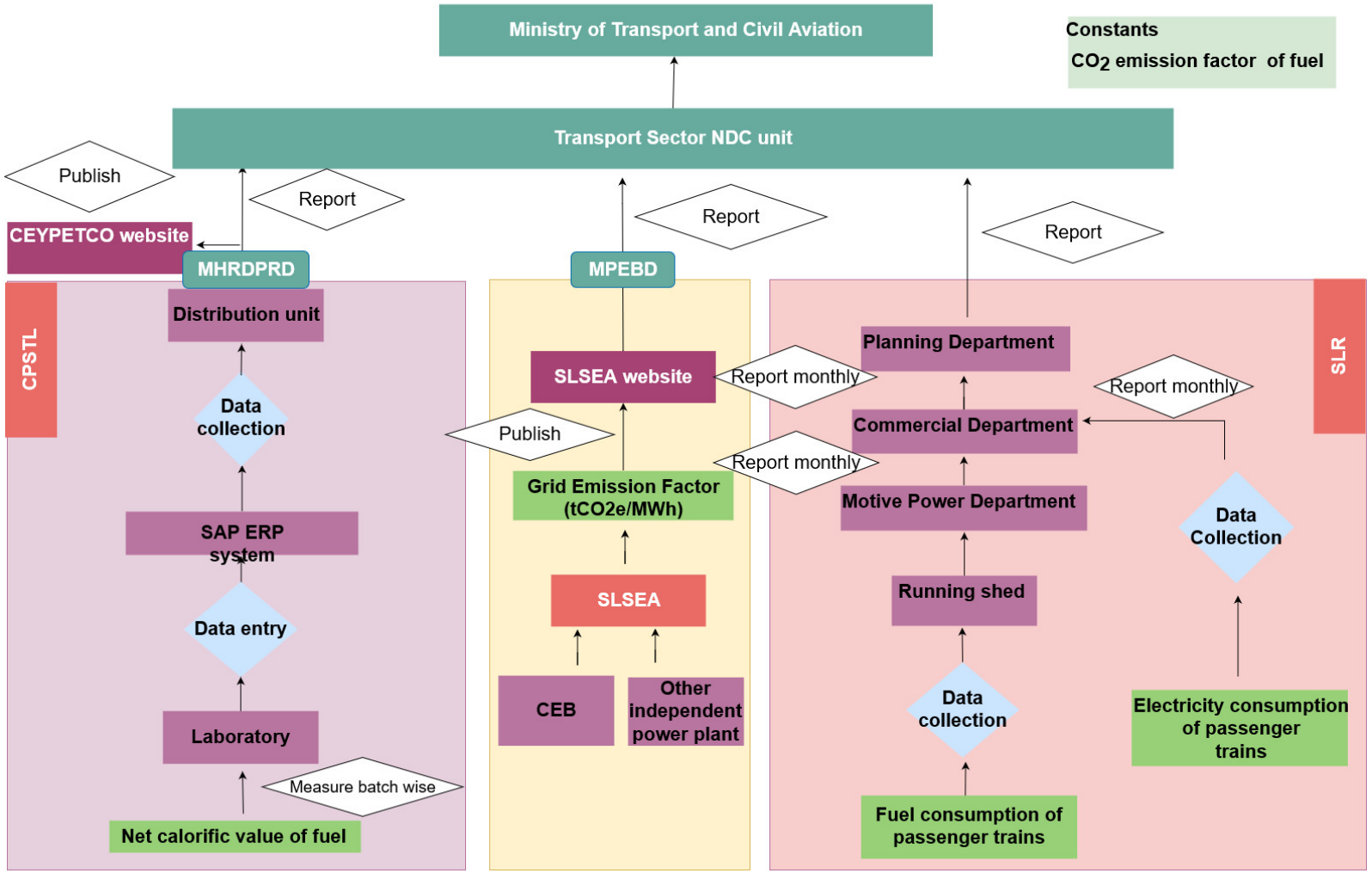
Grid emission factor that calculated by data collected from CEB and other independent power plants will be submitted to the NDC unit by SLSEA annually.

- ***Institutions responsible for measurement the indicators and reporting the GHG effects***

Table 2.11 Roles and responsibilities of each institution engaged in measuring and reporting the GHG effects

Institution/Department	Roles and responsibilities
Ceylon Petroleum Storage Terminal Limited (CPSTL)	Measuring and annually reporting following data 1. Net Calorific Value of fuel 2. Fuel Density Publish the data in CEYPETCO website.
Sri Lanka Railway	Collecting and annually reporting the data related to, 1. Fuel consumption 2. Passenger km 3. Electricity consumption, in specific routes
Sri Lanka Sustainable Energy Authority (SLSEA)	Measuring and annually reporting to "transport sector NDC unit" 1. Grid emission factor

- ***Institutions responsible for measurement the indicators and reporting the GHG effects***



MHRDPRD: Ministry of Highways, Road Development and Petroleum Resource Development

MPEBO; Ministry of Power, Energy and business development

CEYPETCO: Ceylon Petroleum Corporation

CPSTL: Ceylon Petroleum Storage Terminal Limited

SLSEA: Sri Lanka Sustainable Energy Authority

SLR: Sri Lanka Railways

Figure 2.6Proposed Data Management System for NDC 5.1

2.1.5 Verification

Respective institutions will report the required data annually to the MTCA. Quality and the accuracy of the data provided will be verified by the NDC unit of MTCA. GHG impact of concerned mitigation action will be calculated by the NDC unit. Accuracy of the calculations will be verified by an independent third party, the MRV expert committee to be appointed by the MMDE. Approved results will be submitted to the CCS of MMDE, who will ultimately submit the results to the UNFCCC. More information on the institutional arrangement is given in Chapter 05.

As illustrated in data management system, data will be required from institutions that are not regulated by the MTCA. Therefore strengthening the legal provisions of the NDC unit will be essential for the proper verification process.

2.1.6 Recommendations

It is difficult to gather relevant data from Sri Lanka Railways due to manual recording. Digitizing the data management system will support to monitor and report the data efficiently. Also responsible officer should be assigned for each department under MTCA to facilitate the MRV. In addition, a data sharing agreement should be established between the MTCA and other relevant ministries (MPEBD & MHRDPRD) to facilitate the data collection and reporting.

2.2 Purchasing new rolling stocks

2.2.1 Description of the mitigation action

Mitigation Action– The proposed mitigation action is to purchase **new rolling stocks (eg. Power sets, Locomotives, carriages)** for Sri Lanka Railway to improve the public transportation. In the absence of the new rolling stocks, the passengers would have used road transport such as buses, taxi and passenger owned vehicles, etc.

Application of the 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.

The proposed mitigation action is an action under sub NDC 5.2 (Purchase new rolling stock for Sri Railway) of NDC 5 (Enhance the efficiency and quality of public transport modes). This mitigation action is also in line with the ASI (Avoid-Shift-Improve) approach and it is a part of the improving strategy, which aims to achieve significant GHG reduction, maximize passenger transportation capacity, less congestion, with the final objective of creating more livable cities.

- ***Rationale for introducing the mitigation action***

Rail transport accepted as, economically viable, efficient, comfortable and environmentally friendly transport mode in national transport system in Sri Lanka. Sri Lanka Railways (SLR) is given fullest contribution for more passenger transport to

minimize the disadvantages in road traffic. During the year 2017, 120,311 Nos. of passenger trains were operated and 136.66 million passengers were transported. It was a 0.5% increase when compared with 2016. No. of passenger km was increased by 1.1% from 7,413.12 in 2016 to 7,495.06 in 2017.Renovation of railway stations, improvement of sanitary facilities, extension and raising of platforms were carried out to enhance the quantity of the passengers by railway. The project "Purchasing new rolling stocks" will be a one of the best options for passenger increment.

Current situation, which includes the policy & actions, institutional arrangement to implement those policy & actions

The National Transport Policy, 2009 for implementing railway electrification were applied for introducing new rolling stocks as well. (National Transport policy of Sri Lanka (2009) expects to: (a) increase the model share of passenger of Railway from 6% to 10% by 2016; (b) increase frequency, reliability and capacity of the suburban railway services (electrification, station modernization and integrated ticketing); (c) improve comfort of travel and reduce travel time of long distance by introducing value added services; and (d) modernize the railway transportation by replacing the outdated obsolete, procedures, process and system with modern management technique and systems. As such, the development of railway sector seems to be highest priority in relation to transport sector development.

- ***Status of the implementation of the NDC, which includes the policy and actions taken to implement the NDC, and any proposed institutional arrangement specific to the NDC***

Sri Lanka Railway commenced the procurement of new train fleet under the India Line of Credit. Following main items are included under this credit line.

- Six Power Sets
- Ten Locomotives
- One hundred sixty passenger carriages
- Thirty Oil Tank Wagon
- Twenty container Flat Wagons
- Nine Power sets and twelve Locomotives for upgrade the Up-Country Train Service

1. Procurement of 06 Power Sets and 10 locomotives

"Daily News" newspaper published the article "Enhanced rail passenger and freight services" on December 4, 2018. According to that a diesel electric locomotive engine and a power-set with nine compartments (five third class, two second class and two first class compartments) and two engines have arrived under the first consignment. The Ministry of transport and Civil Aviation will spend Rs.18 billion to import 10 power-sets and the six engines.

2.2.2 Scope and boundaries of monitoring approach

Determine relevance of effects

Table 2.12 Determine relevance of effects

Effect	Likelihood	Magnitude
Reducing of GHG emission	Likely	Major
Reducing air pollution	Likely	Moderate
Reducing traffic congestion	Likely	Moderate
Increasing share of passenger and heavy load transportation	Likely	Major

Causal Chain

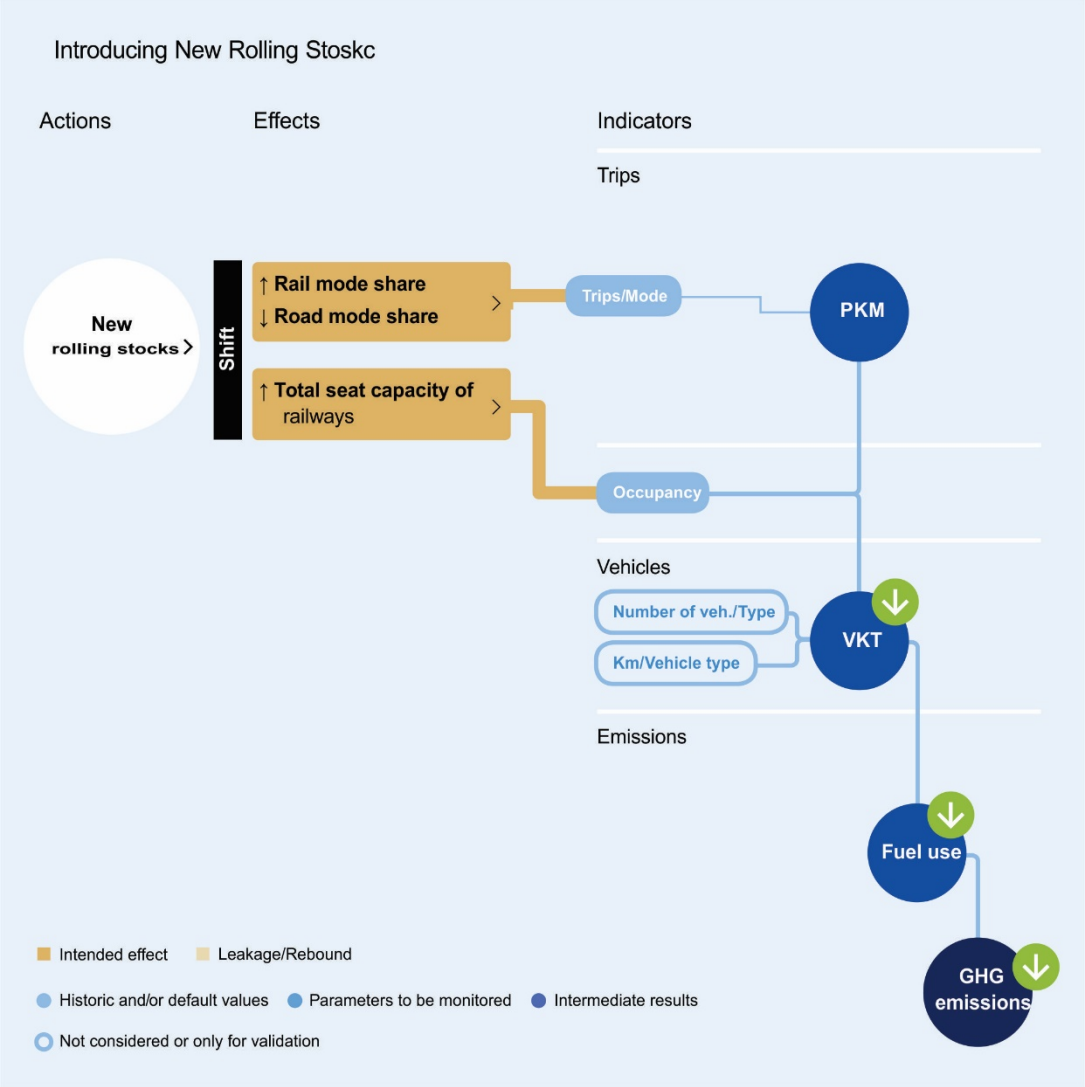


Figure 2.7 Causal Chain of purchasing new rolling stocks

Source: Compendium on Greenhouse Gas baselines and monitoring, 2018

Assessment Boundary

Sri Lanka Railway commenced the procurement of new train fleet under the India Line of Credit. Power sets, locomotives, oil tank wagons and container flat wagons are included in this project. Among them, purchasing of six power sets were considered as the assessment boundary.

System Boundaries

The physical boundary for estimating GHG emissions includes the operation of the new power sets.

Table 2.13 System Boundaries

Boundary Elements	Description
Temporal Boundary	2021-2030
Sectoral Boundary	The MRV approach covers passenger transport from existing transport modes (Baseline) to railway (Project)
Territorial Boundary	Purchasing six power sets to Sri Lanka Railway system for encouraging the public transportation
GHGs Included	CO_2, CH_4 and N_2O gases are covered by the Emission factor of fuel

2.2.3 Methodology

Short explanation of the methodology

Japan International Cooperation Agency's Transport / Railway (Passenger) / Modal Shift -FIT Version 2.0, March 2014 Japan International (Prepared by Japan Weather Association) was used to quantify the GHG effects of the mitigation action, purchasing six power sets.

This methodology is applicable for the development of transport system that can realize an efficient inner-city passenger transport (MRT, Railway, Monorail, BRT and Trunk bus). Also the baseline transport modes should be buses, private car, taxi and existing railway etc.

Characteristics of the methodology is given in Annex 1

Key indicators

The emission reduction from the project activity is determined as the difference between the GHG emissions of baseline scenario (existing mode of transportation) and project scenario (New rolling stocks). Following are the key indicators which were used for the calculation.

Table 2.14 Key indicators of NDC 5.2

$BPKM_y$	Passenger transportation volume/activity by the project in year y
P_y	Number of passengers transported by the project in year y
BTDPy	Average trip distance of the passenger of the project activity in year y
$MS_{i,y}$	Share of passengers by transport mode i in the baseline scenario in year y
$EF_{PKM,i}$	CO_2 emission factor per passenger kilometer for transport mode i
$EF_{KM,i}$	CO_2 emission factor of transport mode i
OR_i	Average occupation rate of transport mode i
$FC_{PJ,y}$	Consumption of fuel i associated with the operation of the project activity in year y
NCV_i	Net calorific value of fuel i
$EF_{fuel,i}$	CO_2 emission factor of fuel i
$EC_{PJ,y}$	Electricity consumption associated with the operation of the project activity in year y
EF_{elec}	CO_2 emission factor of the grid electricity

Calculation of Baseline Emission

Baseline GHG emissions are calculated based on the transportation activity (in passenger-km) completed by the project, share of passengers by baseline transport modes and CO_2 emission factor per passenger-km.

Equation 01

$$BE_y = P_y x\, BTDP_y \, x \, MS_{i,y}\, EF_{PKM,i}$$

$$EF_{PKM,i} = (EF_{KM,i}/OR_i)$$

Calculation of project Emission

Table 2.15 Definition of Baseline Parameters

$BPKM_y$	Passenger transportation volume/activity by the project in year y
P_y	Number of passengers transported by the project in year y
BTDPy	Average trip distance of the passenger of the project activity in year y
$MS_{i,y}$	Share of passengers by transport mode i in the baseline scenario in year y
$EF_{PKM,i}$	CO_2 emission factor per passenger kilometer for transport mode i
$EF_{KM,i}$	CO_2 emission factor of transport mode i
OR_i	Average occupation rate of transport mode i

1. The project activity using electricity
2. The project activity using fossil fuels

Project Emission

In the case of the project activity using electricity

$$PE_y = EC_{PJ,y} \times EF_{elec}$$

In the case of the project activity using fossil fuels

$$PE_y = FC_{PJ,y} \times NCV_i \times EF_{fuel,i}$$

Table 2.16 Definition of Project Parameters

$FC_{PJ,y}$	Consumption of fuel i associated with the operation of the project activity in year y
NCV_i	Net calorific value of fuel i
$EF_{fuel,i}$	CO_2 emission factor of fuel i
$EC_{PJ,y}$	Electricity consumption associated with the operation of the project activity in year y
EF_{elec}	CO_2 emission factor of the grid electricity

2.2.3.1 Baseline Scenario

Identification of baseline scenario[3]

These are the four alternative options that meet the same requirement of passenger transportation by purchasing new rolling stocks.

- Develop a MRT (Mass Rapid Transit)
- Develop mono-rails
- Develop a LRT (Light Rail Transit)
- Develop a BRT (Bus Rapid Transit)
- Use of personnel vehicles

Baseline alternative 1: Develop a MRT – There are no discussion to develop MRT. Construction of such infrastructure can be very expensive. As such, this option will not be an appropriate baseline alternative.

Baseline alternative 2: Develop Mono-rails: As per Megapolis Transport Master Plan, Monorail is identified as suitable system. However, it was not approved because it is limited to elevated areas only. Therefore, this mitigation option will not be an appropriate baseline alternative.

Baseline alternative 3: Develop a LRT – There are four LRTs planned under Megapolis and Western Development Transport Master Plan. Among them, LRT line planned for

Malambe Corridor (JICA LRT line) is the only line with a considerable progress compared to others as it has already completed the feasibility study and secured the finance.

Baseline alternative 4: Develop a BRT - Bus rapid transport (BRT) system project that lead by Ministry of Transport and Civil Aviation, submitted their NAMA project document to UNDP and waiting to start implementation process.

Baseline alternative 5: Use personnel vehicles and buses for travelling in the absence of the new rolling stocks. This is the existing scenario and also the likely baseline scenario.

Baseline scenario: Use of personnel vehicles and buses for travelling

Data needs

Data needs for calculating the GHG emission reduction are described in Table 2.14. Data availability. Extra parameters are also collected and used for calculation due to unavailability of the parameters. Table 2.17 lists the collected extra parameters.

Table 2.17Collected extra Parameters

Unavailable parameter	Description	Extra parameter	Unit	Source
$FC_{PJ,y}$	Consumption of fuel i associated with the operation of the project activity in year y	Total distance travelled per year by project activity (**P_{km}**)	km	Sri Lanka Railway
		Specific fuel consumption associated with the operation of the project activity in year y (**SFC $_{PJ,y}$**)	Liter per km	Sri Lanka Railway

		Density of fuel i(D_i)	Kg/m^3	Ceylon Petroleum Corporation

Baseline emission calculation

Base year: 2016 (year y), Data is available only for 2016

Assessment boundary: Six power sets for Sri Lanka Railways

Identified passengers: Passengers of Personnel vehicles and buses

Equation 01

Baseline Emission

$$BE_y = \sum(P_y * BTDP_y * MS_{i,y} * EF_{PKM,i})$$

According to the calculations (Annex 2), baseline emissions for the year 2016 is 3,317 tCO_2e.

Uncertainties

- There is no plan for allocation of new power sets yet. Therefore, the calculation was done for whole country covering all railway network.
- Calculation of the project emissions was done based on the average value of fuel consumption per km while the guideline requires to use fuel consumption in tonne. As such the applied approach may lead to certain level of uncertainty.

2.2.3.2 Ex ante GHG Impact assessment

Methodological changes

Consumption of fuel i associated with the operation of the project activity in year y was calculated by multiplying total distance travelled per year by project activity, Specific fuel consumption and Density of fuel i.

Project emission calculation

Equation 02

$$PE_y = FCP_{J,y} \times NCV \times EF_{fuel,i}$$

Project emission for the year 2016 is 2764 tCO_2e. For the calculation please refer to Annex 2.

Results

Emission reduction per year

Equation 3

$$ER_Y = BE_Y - PE_y$$

Table 2.18Emission Reduction Calculation for year 2016

Indicator		Value (tCO_2e/year)
Baseline Emission	BE_Y	3,317.38
Project Emission	PE_y	2,764.68
Emission Reduction	ER_Y	**553.7**

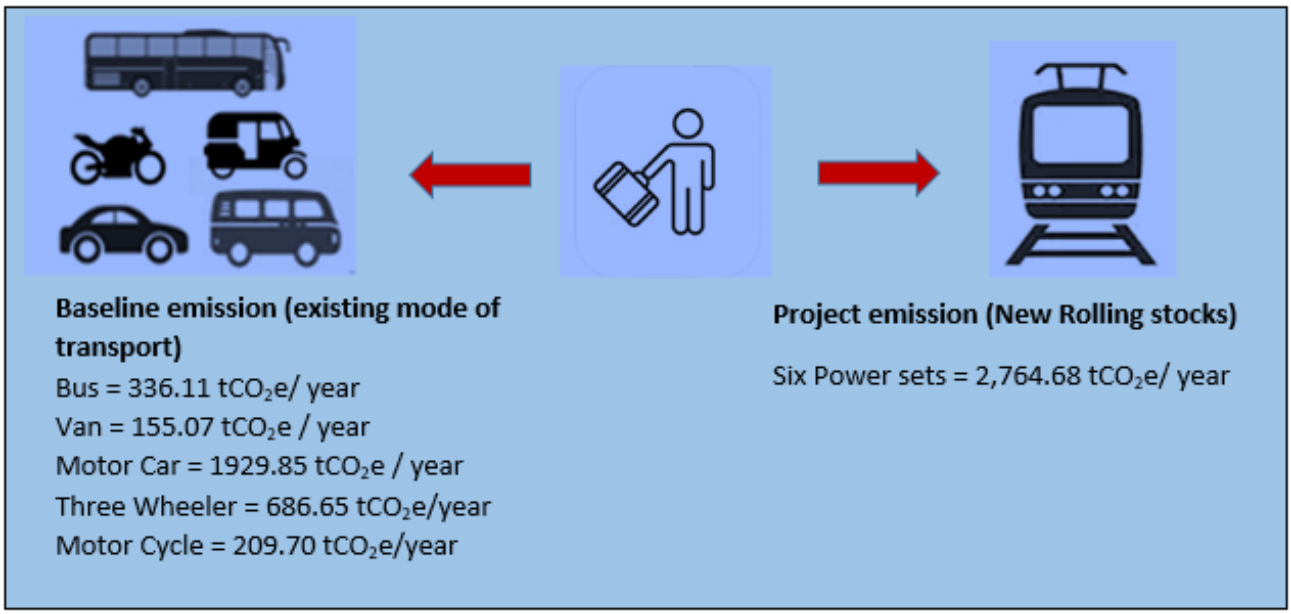


Figure 2.8Baseline and Project Emissions for Base year 2016

Direct effect of mitigation action

Values have been calculated for identified real project of purchasing six power sets for Sri Lanka Railways,

- Reduction of GHG emissions is 552.71 tCO_2e per year

BAU and Project scenario

Emission of the sector is highly correlated with the GDP of the country. Therefore, baseline scenario was established based on the projected GDP growth rate of the country. Figure 2.7.

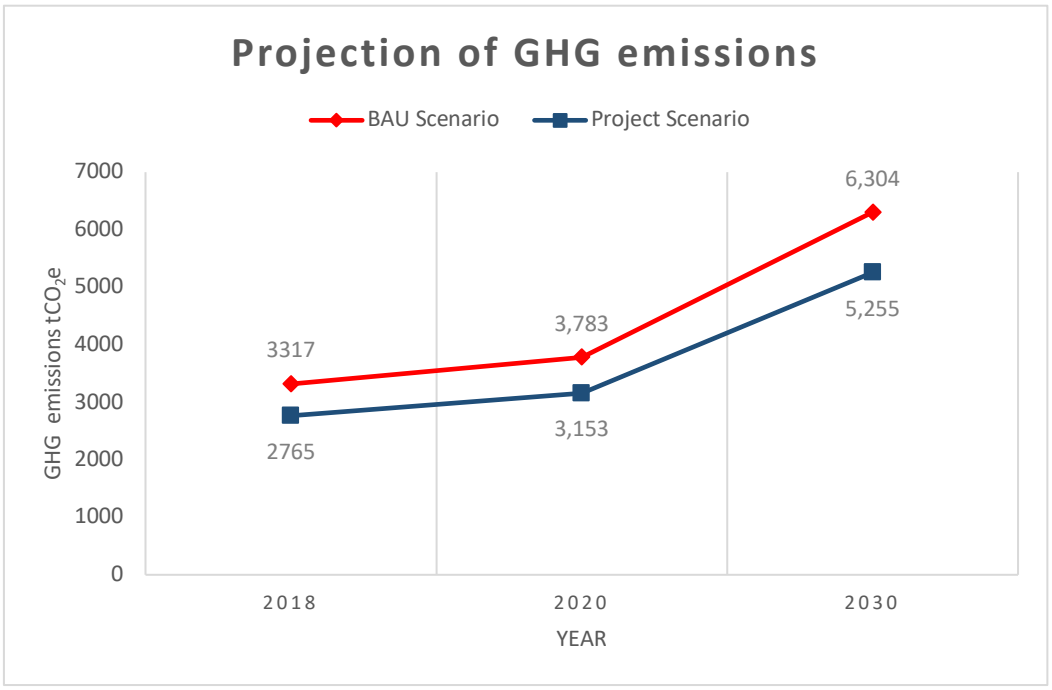


Figure 2.9 Projection of the GHG emission

If SLR introduce six power sets to the railway fleet, emission reduction in year 2030 will be around 1,049 tCO_2e. Emission was projected based on the GDP change of the country (Annex 2) However, SLR plans to purchase more locomotives except the considered 6 power sets. Therefore, emission reduction due to the purchasing of rolling stocks will be higher than the calculated value.

2.2.3.3 Ex Post Assessment

Following data will be provided by SLR

Table 2.19 Data requirement from SLR

Data requirement	In the absence of principal data, following data can be provided	Indicator	Unit
Average trip distance of the passenger of the project activity in year y		$BTDP_y$	km
Number of passengers transported by the project in year y		P_y	
Consumption of fuel i associated with the operation of the project activity in year y	Total distance travelled per year by project activity Specific fuel consumption associated with the operation of the project activity in year y	$FC_{PJ,y}$	tonne/year

Following data will be provided by NTC

Table 2.20Data requirement from NTCs

Data requirement	Indicator	Unit
Share of passengers by transport mode i in the baseline scenario in year y	$MS_{i,y}$	%

For more detail please refer to procedures. P4 and P5 for NTC and SLR respectively.

2.2.4 Institutional arrangement

Institutional set up for implementation of mitigation action

There are 9 agencies under the supervision of MTCA as illustrated in Figure 2.8. However, out of those agencies Sri Lanka Railways (SLR) is the key internal institute responsible for implementing this NDC.

Sri Lanka Railways (SLR)

Sri Lanka Railways is a government department functioning under Ministry of Transport and Civil Aviation. It is the only rail transport provider of the country. It has established through railway Ordinance which is commenced in 1902. Sri Lanka Railways Authority Act (No.60 of 1993) was enacted since 15th of December 1993. Act was repealed in February 2005 as Sri Lanka Railways Authority (Repeal) Act, No.3 of 2005. Below figure illustrates the governance structure of the SLR and vision, mission and objectives of the Sri Lanka Railways.

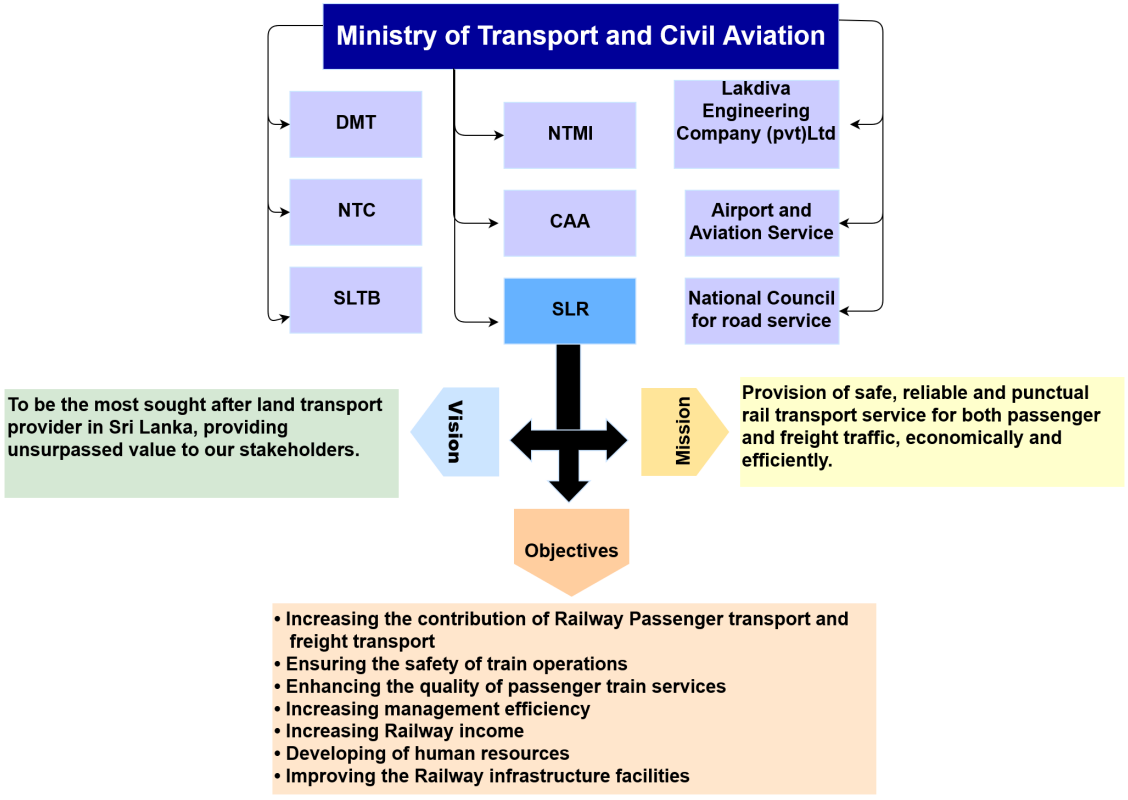


Figure 2.10 Governance structure of the SLR

Source: ClimateSI,2019

***DMT**: Department of Motor Traffic, **NTC**: National Transport Commission, **SLTB**: Sri Lanka Transport Board, **NTMI**: National Transport Medical Institute, **CAA**: Civil Aviation Authority, **SLR**: Sri Lanka Railways.*

Other related institutions

Ministry of Transport and Civil Aviation is responsible to allocate the fund, measure and evaluate the project progress.

Roles and responsibilities of each institution engaged in the implementation of the Action

Table 2.21 Roles & responsibilities of each institutions engaged in the implementation of the actions

Institution	Roles and Responsibilities
Sri Lanka Railways	Arrange the procurement of new rolling stocks under Indian Line of credit and conduct the study to allocation of new rolling stocks based on passenger demand
Ministry of Transport and Civil Aviation	Measure and evaluate of project progress

- **Data management process for the indicators**

Data management process for each indicator is given in Figure 2.9: Proposed Data Management System for NDC 5.2. The all indicators which measure, collect, maintain the entry and calculate are included in there.

As illustrates in Figure 2.9, fuel consumption of the passenger trains will be recorded by running sheds. Electricity consumption of passenger trains will be directly recorded by motive power department. Collected data will be calculated by motive power department

and will be monthly reported to the commercial department. Passenger km related data will be collected by station wise and will submitted to commercial department. All calculated data will be monthly transferred to the planning department from commercial department. Consolidated data will be annually reported to NDC unit by the planning department.

Net calorific value and density of the fuel will be measured and entered in to the SAP ERP system by the laboratory. All data will be monitored and recorded by the distribution unit. Data will be processed by the system and annually reported to the NDC unit.

Grid emission factor that calculated by data collected from CEB and other independent power plants will be submitted to the NDC unit by SLSEA annually.

Share of passenger by each transport mode (modal share) will be calculated by NTC and recorded in their performance report. The data will be submitted to the NDC unit by NTC annually.

- **Institutions responsible for measurement the indicators and reporting the GHG effects**

Table 2.22 Roles & responsibilities of each institutions engaged in measuring and reporting the GHG effect

Institution/Department	Roles and responsibilities
Ceylon Petroleum Storage Terminal Limited (CPSTL)	Measuring and annually reporting following data 1. Net Calorific Value of fuel 2. Fuel Density Publish the data in CEYPETCO website.
Sri Lanka Railway (SLR)	Collecting and annually reporting the data related to, 1. Fuel consumption Passenger km
National Transport Commission (NTC)	Measuring and Reporting to “transport sector NDC unit” Passenger share by each transport mode

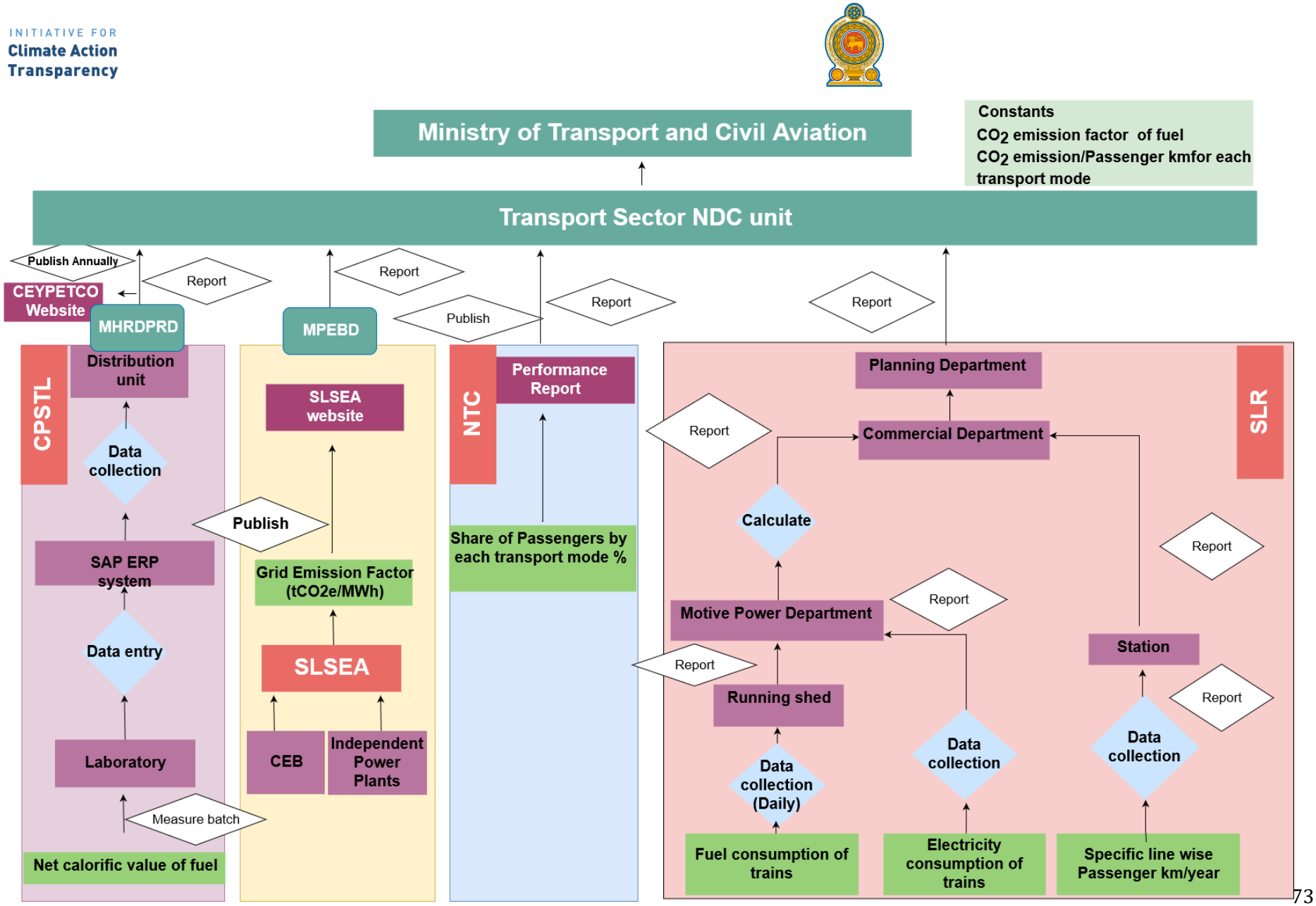


Figure 2.11Proposed Data Management System for NDC 5.2

2.2.5 Verification

Respective institutions will report the required data annually to the MTCA. Quality and the accuracy of the data provided will be verified by the NDC unit of MTCA. GHG impacts of concerned mitigation action will be calculated by the NDC unit. Accuracy of the calculations will be verified by an independent third party, MRV expert committee to be appointed by the MMDE. Approved results will be submitted to the CCS of MMDE who will submit the results to the UNFCCC. More information on the institutional arrangement is given in Chapter 05.

As illustrated in data management system, data will be required from institutions that are not regulated by the MTCA. Therefore, strengthening the legal provisions of the NDC unit will be essential for the proper verification process.

2.2.6 Recommendations

Sri Lanka Railways record their data manually on logbooks. Therefore, it is difficult to gather relevant data and the process of data collection is time consuming. Digitizing the data management system will facilitate monitoring and reporting the data more efficiently. Also responsible officer should be assigned for each department under MTCA to facilitate the MRV. Further data sharing agreements should be signed between MTCA and other relevant ministries (MPEBD & MHRDPRD).

3 Introduction of electric and hybrid vehicles

3.1 Introduction of new electric buses

3.1.1 Description of the mitigation action

Mitigation action:

The proposed mitigation action is to shift public passenger transport from conventional diesel buses to environmentally friendly electric buses.

The proposed mitigation action is an action under sub NDC 8.3 (Introduce electric buses) of NDC 8 (Encourage and introduce low emission vehicles such as electric and hybrid). This mitigation action is also in line with the ASI (Avoid-Shift-Improve) approach. The mitigation action is a part of the improve strategy, which aims to achieve significant GHG reduction, reduce energy consumption, less congestion, with the final objective of creating more livable cities.

Application of the mitigation action

The project activity will involve the introduction of 9 electric buses for the public passenger transportation in Colombo region by Sri Lanka Transport Board (SLTB). In the absence of the project activity, SLTB would have added another 9 conventional diesel buses into its fleet of 828 buses within Colombo region.

Rationale for introducing the mitigation action

Introducing buses into the road transport network can produce multiple benefits to the country, among others: (i) reducing traffic congestion given the fact that buses has only 1.5% share of vehicle population while it has 38% modal share of passengers; and (ii) reducing fuel consumption and GHG emissions as fuel consumption and GHG emissions

per passenger km by bus is significantly lower than that of other transport mode such as cars vans, three wheeler, etc.

The electric buses will lead to: a) further reduction of GHG emissions; b) enhance the comfort of public transport system; c) reduce the air pollution; and d) reduce the noise pollution in addition to the benefits of conventional buses (reduce the traffic congestion, fuel consumption and GHG emissions of road transport).

Considering multiple environment, economic and social benefits that can be expected from the electric buses compared to conventional diesel buses, the government has decided to include this as a mitigation action under Sri Lankan NDC.

Current situation, which includes the policy & actions, institutional arrangement to implement those policy & actions

Bus fleet of Sri Lanka is regulated by three main institutions namely Sri Lanka Transport Board (SLTB), Road Passenger Transport authority (RPTAs) and National Transport Commission (NTC). SLTB is the only state-owned transport provider of the country. SLTB owned an average bus fleet of 6,524 in 2017 which was recorded as 6,354 in 2016. According to National Transport Statistics 2017, private bus fleet consists 19,614 buses. This includes both intra and inter provincial buses. Out of these 16,322 buses are short distance buses (intra provincial) regulated by RPTAs. Rest of 3,292 are long distance buses regulated by NTC.

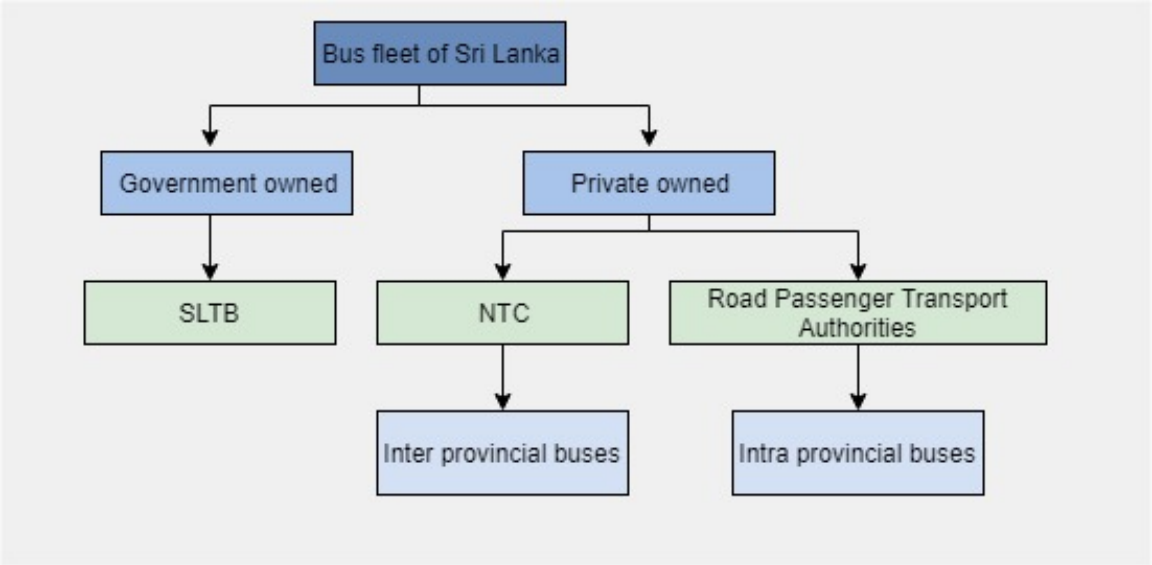


Figure 3.1 Regulation system of the bus fleet of Sri Lanka, Source: ClimateSI,2019

Except RPTAs, other two institutions are regulated by the MTCA. Therefore, National Transport Policy of Sri Lanka (2009) is applicable for both institutions.

According to the policy; increment of fossil fuel burning, vehicle population and traffic congestion, air pollution in urban areas are the major issues in this sector.

Therefore, to reduce the emission and pollution level of the country, government will study the possibilities of introducing less polluting or zero polluting vehicles for public transportation.

Further, in the budget speech, government proposed to convert all the vehicles owned by the government to hybrid or electric by 2025. And to reduce the import taxes on electric vehicles to rationalize the import taxes on vehicles powered by fossil fuel. Moreover, purchasing electric buses will be encouraged by revising the loan to value ratio as 90/10.

Pioneering these actions, government will introduce 09 electric buses to the SLTB bus fleet. These buses will be operated in Colombo region.

Status of the implementation of the NDC, which includes the policy and actions taken to implement the NDC, and any proposed institutional arrangement specific to the NDC

Two electric bus projects as shown in Table 3.1are under different stages of the implementation.

Table 3.1Main projects which are in progress to purchase electric buses

	Project Program	Responsible Organization
1	Purchasing 50 Electric buses[5]	MTCA, SLTB
2	Introduce 250 Electric buses[6]	MTCA

Purchasing 50 electric buses

In the budget of year 2018, 500 million Sri Lankan rupees has been allocated to purchase 50 new electric buses. However, as provision was not adequate to purchase 50 buses SLTB has decided to purchase 15 buses. Proceeding with the project, SLTB has published the 'invitation for the bids for 15 new low floor battery electric buses'[7]. Bid was valid up to 20th December 2018. However, according to the bidders and SLTB officers, allocated money will be only sufficient for 09 buses.

Introduce 250 electric buses

In the cabinet meeting held on 31st July 2018, ministers have been agreed to purchase 250 electric buses and 750 hybrid buses. However due to the political complications of the country project hasn't proceed.

[5]Budget speech -2018, delivered on 09th November,2017, Parliament of Sri Lanka

[6]https://news.lk/cabinet-decusions/item/21760-decisions-taken-by-the-cabinet-of-ministers-at-its-meeting-held-on-31-07-2018 (28th decision)

[7] https://www.mfa.gov.lk/wp-content/uploads/2017/09/Bid-Notice-Electric-Buses.pdf

3.1.2 Scope and boundaries of monitoring approach

Causal chains

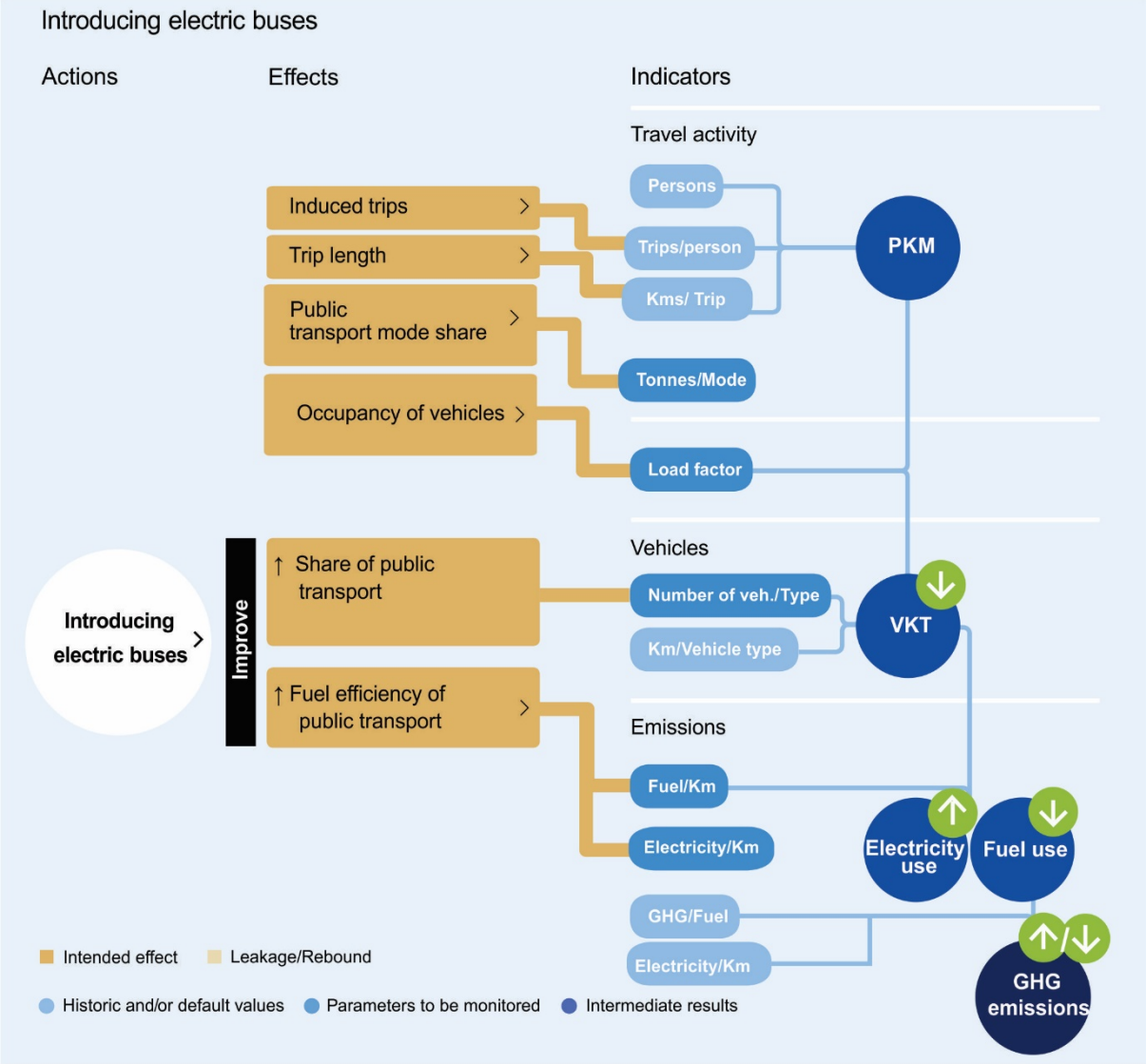


Figure 3.2 Causal chain for the introduction of electric buses

Source: Compendium on Greenhouse Gas baselines and monitoring, 2018

Relevance of effects

Table 3.2Effects of the mitigation action

Effect	Likelihood	Magnitude
GHG emission reduction	Likely	Minor
Reduce the fossil fuel usage	Likely	Minor
Reduce local air pollution	Likely	Moderate
Reduce noise pollution	Likely	Moderate
Energy security	Likely	Major

Assessment boundary

Nine electric buses will introduce to the 'Colombo region' which includes 11 SLTB depots. Therefore, Colombo region has taken as the assessment boundary.

System boundaries

Table 3.3 System boundaries of the project

Boundaries	Description
Temporal boundary	When calculating the effect of this mitigation action, 2010 considered as the base year. 2021-2030 will consider as the target period.
Sectoral boundary	Passenger transportation by conventional diesel buses in BAU scenario and by electric buses in project scenario
Geographic boundary	Transportation of passengers within the Colombo region
GHG included	Fuel consumption of conventional vehicles will generate CO_2, CH_4 and N_2O gases. But calculation will be only based on the CO_2 emission. Methodology has excluded the CH_4 and N_2O for simplification.

3.1.3 Methodology

Short explanation of the methodology

Effect of the mitigation action will be analyze using a small scale CDM methodology which is *AMS III.C; emission reductions by electric and hybrid vehicles*. This methodology applies to project activities including new electric and/or hybrid vehicles that displace the use of fossil fuel vehicles in passenger and freight transportation.

Characteristics of the methodology is given in Annex 1

Key indicators

Baseline emission

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

Project emission

$$\boldsymbol{PE_y = \sum_i EF_{PJ,km,i,y} \times DD_{i,y} \times N_{i,y}}$$

Table 3.4Key indicators of the methodology

BE_y	Total baseline emissions in year *y* (t CO_2)
$EF_{BL,km,i}$	Emission factor for baseline vehicle category *i* (g CO_2/km)
PE_y	Total project emissions in year *y* (t CO_2)
$EF_{PJ,km,i,y}$	Emission factor per kilometre travelled by the project vehicle type *i* (t CO_2/km)
$N_{i,y}$	Number of operational project vehicles in category *i* in year *y*
$DD_{i,y}$	Annual average distance travelled by the project vehicle category *i* in the year *y* (km)

3.1.3.1 Baseline Scenario

Identification of baseline scenario[3]

The baseline scenario for the introduction of electric buses is the operation of conventional diesel buses that would have been used to provide the same transportation service.

Baseline emissions *(BEy)*

$$BE_y = \sum_i EF_{BL,km,i} \times DD_{i,y} \times N_{i,y} \times 10^{-6} \qquad \text{Equation 01}$$

Methodology has given two approaches to calculate the baseline emissions

1. Using distance travelled by project vehicles
2. Using the electricity used to charge the vehicles

Considering the data availability, the baseline emissions calculated based on the unit of service provided by the project vehicles (travelled distance) times the emission factor for the baseline vehicle to provide the same unit of service. As per the methodology, Table 3.5 gives the data requirement to calculate baseline emission.

Table 3.5Availability of required data to calculate the baseline emission

Parameter	Description	Data Availability
$EF_{BL,i}$	Emission factor of fossil fuel consumed by baseline vehicle category *i* (g CO_2/J)	Calculate
$DD_{i,y}$	Annual average distance travelled by project vehicle category *i* in the year *y* (km)	No
$N_{i,y}$	Number of operational project vehicles in category *i* in year *y*	Yes

Baseline emission factor ($EF_{BL,km,i}$)

$$EF_{BL,km,i} = SFC_i \times NCV_{BL,i} \times EF_{BL,i} \times IR^t \qquad \text{Equation 02}$$

Table 3.6 Data need to calculate the emission factor for baseline vehicle category

Parameter	Description	Data Availability
$EF_{BL,i}$	Emission factor of fossil fuel consumed by baseline vehicle category *i* (g CO_2/J)	Yes
SFC_i	Specific fuel consumption of baseline vehicle category *i* (g/km)	No
$NCV_{BL,i}$	Net calorific value of fossil fuel consumed by baseline vehicle category *I* (J/g)	Yes
IR^t	Technology improvement factor for baseline vehicle in year *t*. The improvement rate is applied to each calendar year. The default value of the technology improvement factor for all baseline vehicle categories is 0.99	Yes
T	Year counter for the annual improvement (dependent on age of data per vehicle category)	Yes

Baseline emission calculation

Baseline emission was calculated considering the base year as 2016[8] (year y). Conventional diesel buses considered as baseline vehicle category. As per the calculations (Annex 2), emission factor for diesel buses are 836 gCO_2/km. And the baseline emissions for the NDC is 398 tCO_2e.

Uncertainties

Specific fuel consumption of conventional diesel buses was calculated based on the fuel cost per unit distance as given in the Annex 2 (Table 2.3).

Annual average distance travelled by project vehicle was calculated based on the total distance travelled by the SLTB buses within Colombo region. Annex 2 (Table 2.5)

Specific electricity consumption was calculated based on range and the battery capacity Annex 2 (Table 2.7)

The value of density of the fuels reported by the CPC on their website is in the form of a range. So, when the calculations are done, most possible value has to be assumed to do

[8] As grid emission factor is not available for year 2010, calculation was done for the year 2016 as it provide the latest grid emission factor of the country0

the calculations. As the density is a function of the atmospheric temperature, the value for the density of the fuel varies in a range with time. The tolerance for the density range will be affecting the accuracy of the calculations.

Above mentioned factors may cause some uncertainties to the calculation.

3.1.3.2 Ex ante GHG Impact assessment

Methodological changes

No methodological changes have done

Project Emissions

Project emissions include the electricity and fossil fuel consumption associated with the operation of project vehicles. Project emission also can be calculated by using two approaches.

1. Using the distance travelled by project vehicles
2. Using the electricity used to charge the vehicles

Approach one has selected to calculate the emissions associated to the project.

$$PE_y = \sum_i EF_{PJ,km,i,y} \times DD_{i,y} \times N_{i,y}$$ Equation 03

Table 3.7Availability of required data for project emission calculation

Parameter	Description	Data Availability
PE_y	Total project emissions in year *y* (t CO_2)	Calculate
$EF_{PJ,km,i,y}$	Emission factor per kilometre travelled by the project vehicle type *i* (t CO_2/km)	Calculate
$N_{i,y}$	Number of operational project vehicles in category *i* in year *y*	Yes
$DD_{i,y}$	Annual average distance travelled by the project vehicle category *i* in the year *y* (km)	Yes

Emission factor of the project vehicles ($EF_{PJ,km,i,y}$)

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

Equation 04

*$SFC_{PJ,km,I,y}/NCV_{PJ,i}/EF_{PJ,I}$ (These values are required to hybrid vehicles)

Table 3.8Availability of required data for emission factor calculation

Parameter	Description	Data availability
$SEC_{PJ,km,i,y}$	Specific electricity consumption by project vehicle category *i* per km in year *y* in urban conditions(kWh/km)	No
$EF_{elect,y}$	CO_2 emission factor of electricity consumed by project vehicle category *i* in year *y* (kg CO_2/kWh)	Yes
TDL_y	Average technical transmission and distribution losses for providing electricity in the year *y*	Yes

Emission reduction

$$ER_y = BE_y - PE_y - LE_y$$

Equation 05

Table 3.9 Data need for emission reduction calculation

ER_y	Emission reductions in year *y* (t CO_2e)
BE_y	Baseline emissions in year *y* (t CO_2e)
PE_y	Project emissions in year *y* (t CO_2e)
LE_y	Leakage emissions in year *y* (t CO_2e)

Table 3.10 Emission reduction due to introducing 09 electric buses

Indicators	Unit	Value
Baseline emissions	tCO_2e	398.39
Project emission	tCO_2e	365.45
Leakage emissions[9]	tCO_2e	-
Emission reductions	**tCO_2e**	**32.94**

As per the results introduction of the 09 electric buses, the GHG emissions associated with the Colombo region bus fleet will reduce by 33 tCO_2 for the year 2016.

Business as usual scenario and project scenario

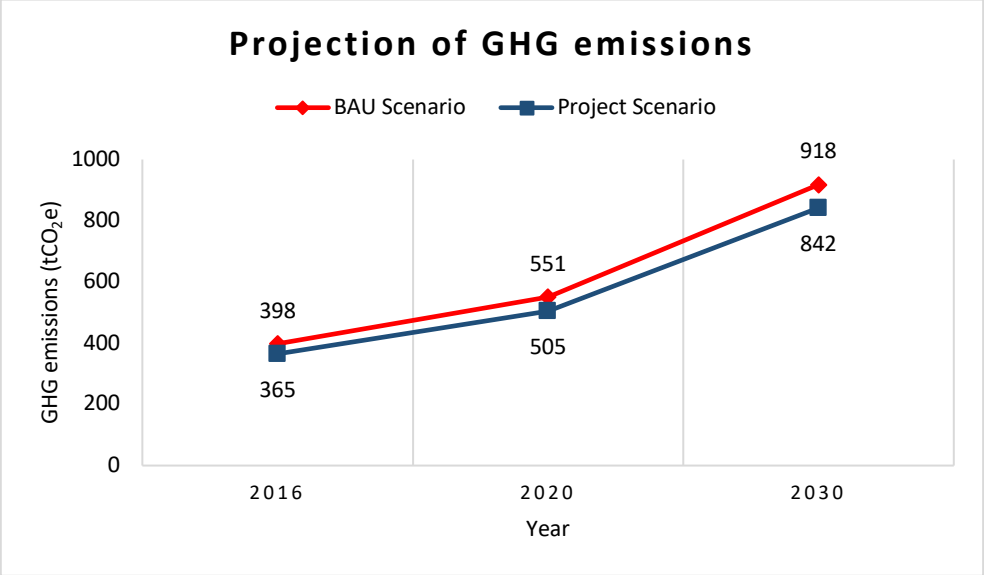


Figure 3.3 Forecasted emissions due to introduction of electric vehicles

As illustrated in Figure 3.2, if SLTB integrate 09 electric buses to their fleet, emission from the bus fleet will be reduced by 76 tCO_2e in 2030. Emissions were projected based on GDP of the country (Annex 2)

[9]Methodology states that leakage calculation is not required

	
Conventional diesel buses Specific fuel consumption: 0.32 L/km Emission factor: 836.18 gCO_2/km	**Electric buses** Specific electricity consumption: 1.22 kWh/km Emission factor: 767.03 gCO_2/km

Figure 3.4Comparison of electric and conventional buses

Source: ClimateSI, 2019

Direct effects of mitigation actions

Emission factors of conventional diesel and electric buses are 836.18 and 767.03 gCO_2/km respectively for the year 2016. Emission reduction has recorded as 69.15 gCO_2/km for the respective year (Annex 2).

3.1.3.3 Ex Post Assessment

Once the project is completed, respective institutions will monitor and report the data given below.

Following data will be provided by SLTB[10]

Table 3.11 Data requirement from SLTB

Data requirement	In the absence of principal data, following data can be provided	Indicator	Unit

[10] If private sector involves, these data will be provided by RPTA and NTC

Annual average distance travelled by project vehicle category *i* in the year *y*	Total distance travelled by e-buses Total number of e-buses operated	$DD_{i,y}$	km
Number of operational project vehicles in category *i* in year *y*	NA	$N_{i,y}$	
Specific fossil fuel consumption per km per project vehicle category I in year y	Fuel cost per km	$SFC_{PJ,km,i,y}$	g/km
Electricity consumed by the project vehicles of type i in year y		$ECP_{J,i,y}$	kWh

Following data will be provided by SLSEA

Table 3.12Data requirement from SLSEAs

Data requirement	Indicator	Unit
CO_2 emission factor of electricity consumed by project vehicle	$EF_{elect,y}$	kg CO_2/kWh
Average technical transmission and distribution losses for providing electricity in the year *y*	TDL_y	%

Following data will be provided by CPSTL

Table 3.13Data requirement from CPSTLs

Data requirement	Indicator	Unit
Net calorific value of fuel *i*	$NCV_{BL,i}$, $NCV_{PJ,i}$	J/g
Density of fossil fuel consumed by baseline vehicle category *I*		kg/m^3

For more detail, please refer to procedures: P8, P3 and P9 for SLTB, SLSEA and CPSTL respectively.

3.1.4 Institutional arrangement

Institutional set up for implementation of mitigation action

- ***Key internal institution under MTCA responsible for the implementation of the action***

Ministry of Transport and Civil Aviation regulate nine different institutions. Out of those, two are directly involve in introducing electric buses. Those are SLTB and NTC.

Central Transport Board (CTB) was established in 1958. Around 2,500 buses were operated under CTB. Two decades after introducing CTB, nine regional boards were introduced. Political influences, poor management and heavy losses failed the regional companies. Therefore, in 1979 private sector was invited to invest in transport sector. Just one year after introducing private buses, around 5,000 buses were operated without proper mechanism. Therefore, Peoplized bus companies[11] were established. Due to various reasons, Peoplized companies were integrated in to regional transport companies. After that SLTB was reconstituted by Sri Lanka Transport Board Act No 25 in 2005. In 1991, NTC was introduced to regulate inter provincial bus services and regional transport authorities (Road Transport Authorities) were established to regulate intra provincial bus services under 13 constitution. At present each province has their own RPTA.

Vision, mission and objectives of these institutions are illustrated in Figure 3.5Vision, mission and objectives of the Sri Lanka Transport Board and Figure 3.6 Vision and mission of National Transport Commission (NTC)

[11] This is the name of the institution

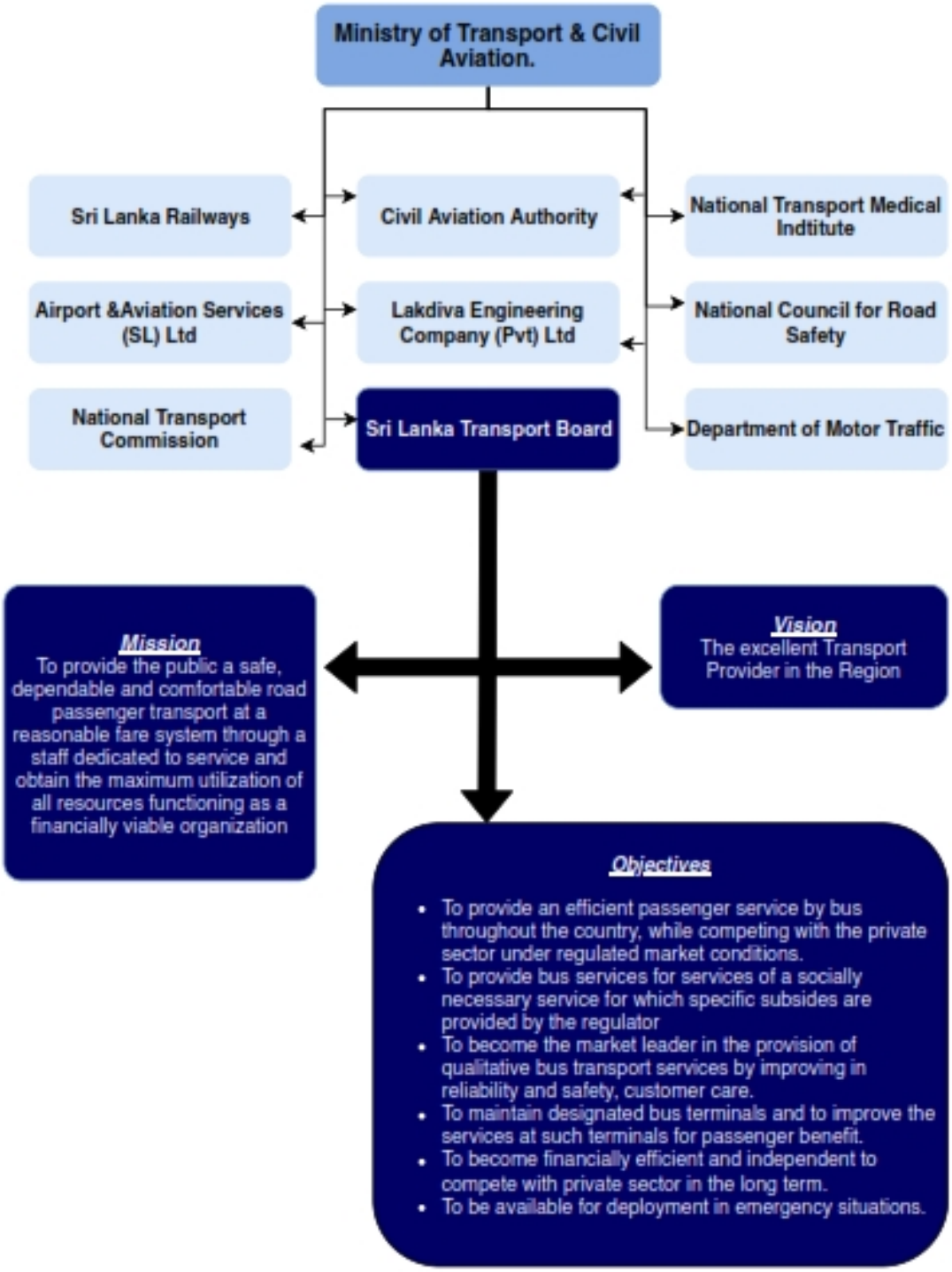


Figure 3.5Vision, mission and objectives of the Sri Lanka Transport Board

Source: ClimateSI, 2019 based on data from SLTB

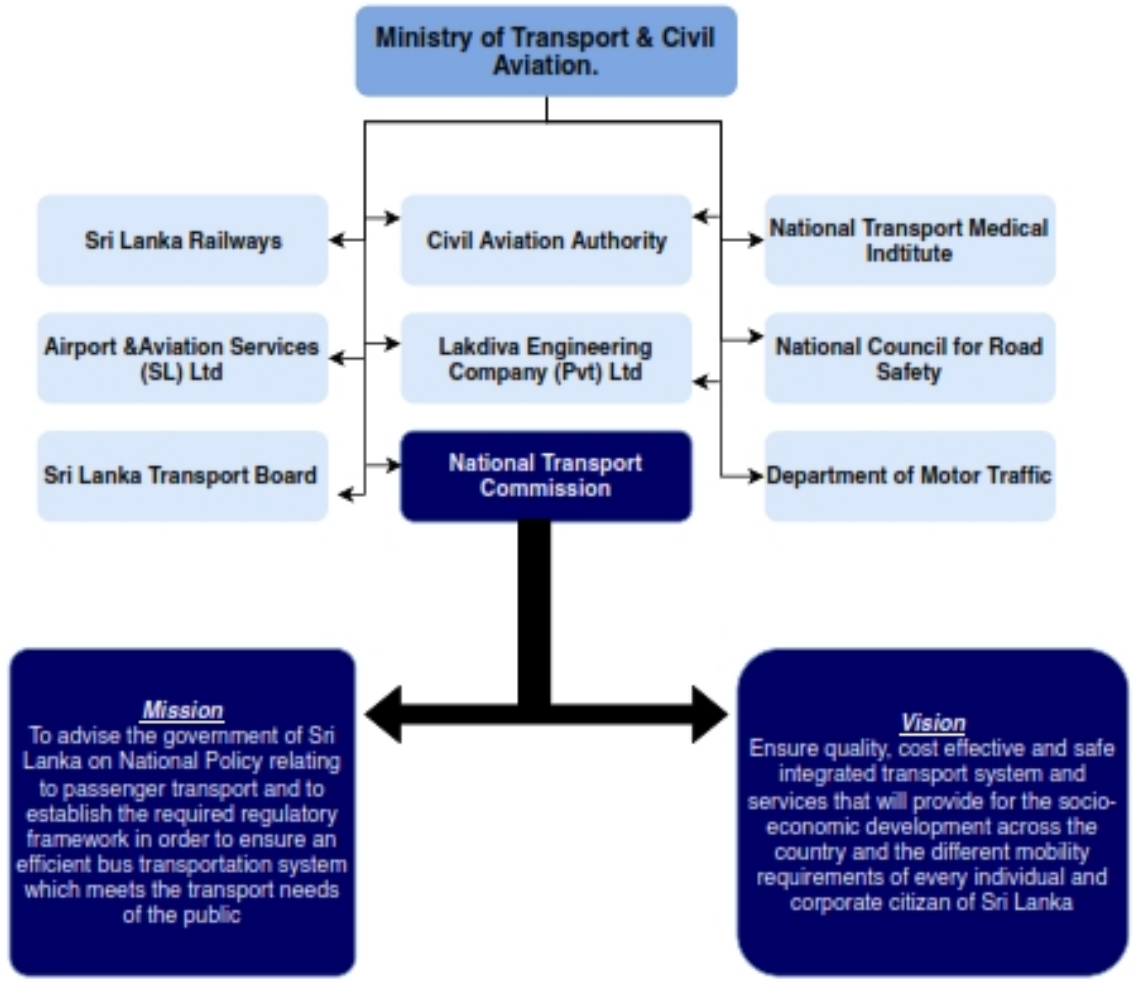


Figure 3.6 Vision and mission of National Transport Commission (NTC)

Source: ClimateSI, 2019 based on the data from National transport statistics, 2017

Roles and responsibilities of each institution engaged in the implementation of the action

Table 3.14 describes the roles and responsibilities of each institution in implementing the mitigation action while Table 3.15 gives the distribution of responsibilities in terms of data collecting, reporting and monitoring.

Table 3.14 Roles and responsibilities of the respective institutions in implementing mitigation action

Institution	Roles and responsibility
Ministry of Finance	Providing necessary financial support
Ministry of Transport and Civil Aviation	Supervisory activities (Policy)
Sri Lanka Transport Board	Operation Management
National Transport Board	Policy preparation

Table 3.15 Roles and responsibilities of the respective institutions in monitoring and reporting mitigation action

Institution	Roles and Responsibility
SLTB RPTA[12] NTC[12]	Measuring, recording and annually reporting following data 1. Annual average distance travelled by electric buses In the absence of 1, following data will be provided 1.1 Total distance travelled by e- buses 1.2 Total number of e-bus operated 2. Number of operated electric buses 3. Specific electricity consumption of electric buses In the absence of 3, following data will be provided 3.1 Ranges of the buses 3.2 Battery capacity 4. Specific fuel consumption of conventional buses In the absence of the 4, following data will be provided 4.1 Fuel cost per km
SLSEA	1. CO_2 emission factor of grid electricity 2. Average technical transmission and distribution losses
CPSTL	1. Net calorific value of fossil fuel consumed by conventional vehicle 2. Density of fossil fuel consumed by conventional vehicle

[12] If private buses operate

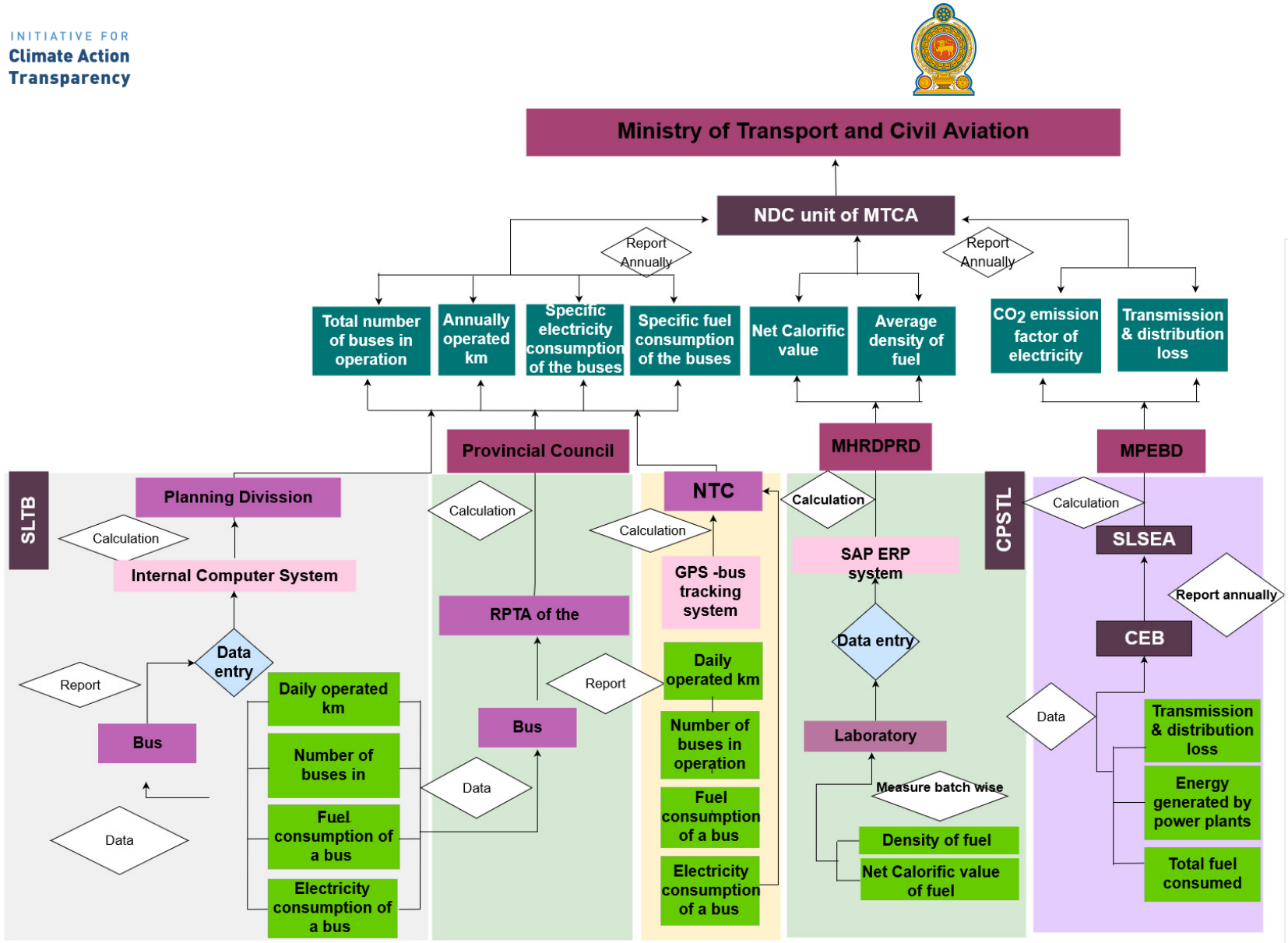


Figure 3.7Proposed data management system for NDC 8.3

MTCA: Ministry of Transport & Civil Aviation

MHRDPRD: Ministry of Highways, Road Development and Petroleum Resource Development

MPEBO; Ministry of Power, Energy and business development

SLTB: Sri Lanka Transport Board

RPTA: Road Passenger Transport Authority

NTC: National Transport Commission

CPSTL: Ceylon Petroleum Storage Terminal Limited

SLSEA: Sri Lanka Sustainable Energy Authority

CEB: Ceylon Electricity Board

Institutional set up for measurement and reporting GHG effects

If SLTB implement the project as it intended, Daily operated km of e-buses, Number of e-bus operated, electricity consumption of operated buses will be daily recorded by the bus depots. Fuel consumption of conventional buses, daily operated km of conventional buses will also be recorded by bus depots. These data will be updated monthly into internal computer system. Based on these data annual average distance travelled by e-buses, Number of operational e-buses, specific electricity consumption of e-buses and specific fuel consumption of conventional buses will be calculated by the planning division and report to the NDC unit annually (Figure 3.6).

However, if private sector joins to the project, all the above mentioned data will be provided by RPTA and the NTC for inter transport buses and intra transport buses respectively (Figure 3.6).

Sri Lanka Sustainable Energy Authority publishes the energy balance of the country. This report includes the CO_2 emission factor of the grid electricity and the average technical transmission and distribution loss as well. If e-buses charge using the grid electricity these values can be used for the assessment. SLSEA may calculate these values and report to NDC unit (Figure 3.6).

As illustrated in Figure 3.6density and net calorific values may calculate and report by CPSTL to the NDC unit annually. Currently density of the petroleum products are available in CYEPETCO website.

3.1.5 Verification

Respective institutions will report the required data annually to the MTCA. Quality and the accuracy of the data provided will be verified by the NDC unit of MTCA. In addition, GHG impact of concerned mitigation action will also be calculated by the NDC unit. Accuracy of the calculations will be verified by an independent third party, the MRV expert committee to be appointed by the MMDE. Approved results will be submitted to

the CCS of MMDE who will submit the results to the UNFCCC. More information on the institutional arrangement is given in Chapter 05.

As illustrated in data management system, data will be required from institutions that are not regulated by the MTCA. Therefore strengthening the legal provisions of the NDC unit will be essential for the proper verification process.

3.1.6 Recommendations

Both SLTB and NTC maintain an advanced computerized data management system, and also both institutions are regulated by the MTCA. Therefore measuring and reporting of the data will not meet any specific barriers. However, RPTAs are regulated by the respective provincial councils. As MTCA does not have authority over these institutions, maintaining the MRV system will be a challenge. Therefore, it is recommended to strengthen the legal framework of the proposed NDC unit, so that data collection from different entities will not be a challenge. Alternatively, a data sharing agreement can be signed between the MTCA and the relevant ministries. Reporting process will be delayed if the data to be collect through several ministries. Therefore, it is recommended to introduce a digitalized MRV system, which will provide direct access to the data upon signing a data sharing agreement between the relevant ministries.

3.2 Introduction of carbon tax to promote electric Cars

3.2.1 Description of the mitigation action

Mitigation action: The mitigation action is to introduce a carbon tax for conventional petrol and diesel vehicles to promote electric vehicle. In the absence of the proposed mitigation action, the conventional petrol and diesel-powered motor vehicles would have dominated the vehicle market. The mitigation action aims to increase the share of electric vehicles in the vehicle market.

Note: However application of mitigation action was limited only for passenger cars. Carbon tax effect on petrol, diesel, hybrid (petrol/electric hybrid and diesel/electric hybrid) and electric cars were covered in this study of MRV application.

The proposed mitigation action is an action under sub NDC 8.4 (Introduce other electrified vehicles such as cars) of NDC 8 (Encourage and introduce low emission vehicles such as electric and hybrid). This mitigation action is also in line with the ASI (Avoid-Shift-Improve) approach. The mitigation action is a part of the improve strategy, which aims to achieve significant GHG reduction, reduce energy consumption, less congestion, with the final objective of creating more livable cities.

Application of the mitigation action

The carbon tax has been introduced by the government for conventional diesel and petrol vehicles since 2019 based on the engine capacity, age and fuel type. The carbon tax is not applicable to electric vehicles while all other vehicles have to pay. As such, the carbon tax can lead to increase the market share of electric vehicles and reduce the GHG emissions.

Rationale for introducing the mitigation action

Sri Lanka vehicle fleet is dominated by the fossil fuel-based vehicles of various age categories. Due to the higher traffic conditions that pertain in the urban parts of Sri Lanka, the air quality becomes low and harmful to breathe in those areas. In certain parts of the country the average speed of the traffic goes down as low as 8 km/h during rush hours.

This state of speed makes the public to be exposed to the low-quality air for a long period of time. This may result in respiratory problems when this condition pertains regularly for a long period of time.

Further, Sri Lanka imports 100% of the fossil fuel requirement from various oil exporting countries. So, the increased demand for the fossil-fuel imposes logistical as well as the economic impact on the country.

To mitigate the possible oncoming health and other problems, a different energy source-based vehicle category becomes unavoidable. Thus, the government opted to support the use of electric vehicles by imposing more taxes on the higher capacity fossil fuel vehicles and announcing tax rebates on electric and hybrid vehicles.

Current situation, which includes the policy & actions, institutional arrangement to implement those policy & actions

According to the National Transport Policy 2009, Sri Lanka presently incurs a heavy expenditure on the importation and distribution of petroleum fuels for its transport activities. The government has been formulating strategies to overcome this problem without affecting the public.

Some of the actions formulated were,

- Reducing the unproductive transport
- Shifting of passengers from private to public modes of transport which are more fuel efficient
- Higher taxation for private use vehicles with higher engine capacities
- Taxation rebates for vehicles having newer fuel-efficient technology such as Hybrid and Electric technology which promotes greater fuel efficiency and also for use of non-fossil fuels.

As one of the initiatives that are mentioned in the Transport Policy of Sri Lanka 2009, Sri Lanka included electrification of vehicles in the NDCs for transport sector submitted following the Paris agreement.

Moreover, the transport sector worldwide consumes over 60% of the fuel imported, making the fuel supply chain much harder to manage, thus a need for an alternate energy source for the transport becomes inevitable.

Although the large amounts of fuel import and supply are difficult for the country to manage, the main concern is the air quality in the urban area. Due to the higher traffic conditions of the urban cities, the atmosphere in those areas become unhealthier to breathe. By introducing electric vehicles to the current fleet, the air quality can be managed well to a tolerant level.

3.2.2 Scope and boundaries of monitoring approach

Causal Chains

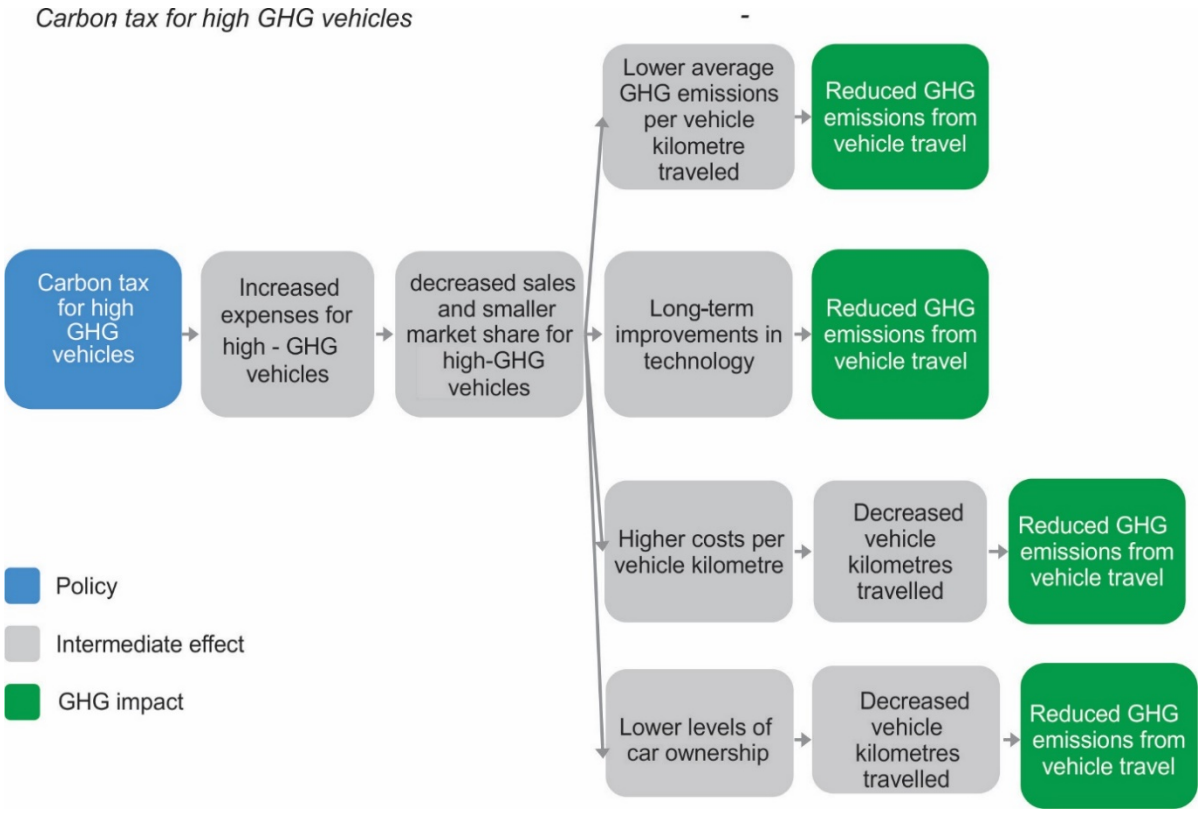


Figure 3.8 Causal chain of introducing Carbon tax for high GHG vehicles

Source: ClimateSI, 2019. Based on ICAT pricing guidance

Relevance of effects

Table 3.16 Effects of the mitigation action

Effect	Likelihood	Magnitude
Less fuel use	likely	Moderate
Reduce air pollution	likely	Minor

Assessment Boundary

Assessment boundary covers the entire vehicle fleet in Sri Lanka. Department of Motor traffics responsible for implementing carbon tax within the country.

System boundaries

Table 3.17Boundary elements of introducing a carbon tax

<table>
<tr><th>Boundary elements</th><th>Description</th></tr>
<tr><td>Temporal boundary</td><td>2021 - 2031</td></tr>
<tr><td>Sectoral boundary</td><td>For pricing policies, the relevant GHG impacts are reduced GHG emissions from vehicle travel, caused by reduced a shift to less GHG-intensive transport modes, and a shift to more fuel-efficient vehicles. [13]</td></tr>
<tr><td>Territorial boundary</td><td>For this project geographical territory consider as the entire country. (Sri Lanka)</td></tr>
<tr><td>GHGs included[14]</td><td>
<table>
<tr><td>Reduced GHG emissions from the use of less GHG-intensive modes</td><td>CO_2</td><td>Likely</td><td>Major</td><td>Included</td><td>Depends on the policy implementation and the quality and availability of substitutes, as well as consumer behaviour; considered significant for most fuel pricing policies</td></tr>
</table>
</td></tr>
</table>

[13]The report focused only on the passenger car fleet in Sri Lanka. The passenger car fleet consist of passenger cars, SUVs, station wagons and racing cars

[14]Methodology only focuses on CO2 emissions during the baseline emission calculation. However, IPCC, 2006 emission factors , which have the units of tCO_2e/TJ were used for the calculations. Since the final result of the calculation had the unit of tCO2e

Methodology only focuses on CO_2 emissions during the baseline emission calculation. However, IPCC 2006 emission factors, which have the units of tCO_2e/TJ were used for the calculations. Since the final result of the calculation had the unit of tCO_2e.

3.2.3 Methodology

Short explanation of the methodology

ICAT transport pricing guidance is a part of the Initiative for Climate Action Transparency series of guidance, which provides the methodological guidance to estimate the GHG impacts of the transport sector pricing policies. The guidance provides a stepwise approach for estimating the GHG impacts of higher fuel prices using price elasticities of demand and less depth approach for estimating the GHG impact of vehicle purchase intensives and road pricing policies.

Key indicators

Key indicators for calculation of baseline emissions

$$\boldsymbol{BE}_{i,,2}\ emissions\ (t\ CO_2) = [\boldsymbol{FC}_{i,j,y}\ in\ energy\ units\ (TJ)]\ x\ \ [\boldsymbol{EF}_i\ (t\ CO_2\ per\ TJ)] \quad \text{.....Equation 1}$$

Table 3.18Key indicators for calculation of baseline emissions

$\mathbf{FC}_{i,j,y}$	Total fuel energy i (from gasoline / diesel / electricity) used per mode j of passenger transport (road / rail) in year y
$\boldsymbol{EF}_i$	Emission factor for gasoline fuel (tCO_2/TJ)

Key indicators for calculation of GHG impact

GHG impact = (market share) x (annual new vehicle sale) x (per km emissions reduction) x (average lifetime km per vehicle).....Equation 2

3.2.3.1 Baseline Scenario

Identification of baseline scenario[3]

In the absence of the proposed mitigation action, the conventional petrol and diesel-powered motor vehicles would have dominated the vehicle market.

Identification of alternative scenarios

Three baseline alternatives were identified for the mitigation action of, "Introduction of tax to promote electric vehicles", as follows:

1. Introducing carbon tax for petrol, diesel and hybrid vehicles
2. Changing excise duty tax for petrol, diesel, hybrid and electric vehicles
3. Continue using conventional petrol and diesel vehicles without the carbon tax

Baseline alternative 1[15]: Introducing carbon tax for petrol, diesel and hybrid vehicles

The Department of Motor Traffic focuses on regularization of the carbon tax. The carbon tax was planned to implement in August 2018. However, the assessment was postponed until 2019 due to opposition from the public. The carbon tax will be imposed on the newly registered vehicles from 2019 onward. Currently department of Motor Traffic focus on regularization of carbon tax.

Baseline alternative 2: Changing excise duty tax for petrol, diesel, hybrid and electric vehicles

Recently Sri Lankan government changed the existing excise duty tax for vehicles (Sri Lanka Budget, 2018). The government increased the tax for petrol, diesel and hybrid vehicles while the tax for electric vehicles wads reduced. However, it is unlikely that the

[15] This is just to check if the proposed mitigation option would have happened in the business as usual scenario. If so, the proposed mitigation option will not lead to reduce the GHG emissions as it will anyway happen.

government can further increase the tax on vehicle due to mounting pressure from the public. As such, this may not be a viable solution.

Baseline alternative 3: Continue using petrol and diesel vehicles without a carbon tax. This was the existing scenario before the project activity and is likely to continue in the absence of the project.

Assessment of Options

Sri Lanka government need to contained low cost when implementing assessment relevant to taxes where they need to spend more money on introducing the process of electric buses.

Baseline scenario: Increasing number of petrol and diesel vehicles within Sri Lankan vehicle fleet due to less electric vehicle favorable taxes

Baseline emission calculation for the carbon tax done based on the "ICAT Transport Pricing Guidance". ICAT guidance presents three approaches to calculate baseline emission according to available activity data and geographical system boundary.

Overview of the approaches can be explained using the following table.

Table 3.19 Overview of three approaches under ICAT pricing guidance baseline calculation

Approach	**Data requirements**	**Boundaries / Coverage**		
		Geographical system boundaries	**Passenger / Freight**	**Fuel types**

Approach A	Only general fuel consumption data (Basis for calculation: top-down energy use data)	National	National transport (passenger and freight)	Fuel mix (gasoline/diesel)
Approach B	Specific gasoline and diesel consumption data (Basis for calculation: top-down energy use data)	National	National transport (passenger and freight)	Gasoline and diesel
Approach C	Comprehensive bottom-up travel activity data (e.g., distance travelled by mode j) (Basis for calculation: top-down energy use and bottom-up travel activity data)	Regional, urban	Only passenger transport in an urban context However, the assessment can be conducted for several (large) cities to enable a more extensive geographical coverage	Gasoline, diesel and electricity

Source: ICAT Transport Pricing Guidance, 2018

In Sri Lanka proposed carbon tax depend on engine capacity, fuel type and age of the vehicles. It does not directly depend on vehicle fuel consumption. Furthermore, it is hard to extract only the vehicle fleet fuel consumption from the total annual fuel consumption in the country. Since the approach C suitable for Sri Lankan carbon tax instead of approach A and B.

Approach C

Approach C base year calculation procedure can be explained using the following diagrams.

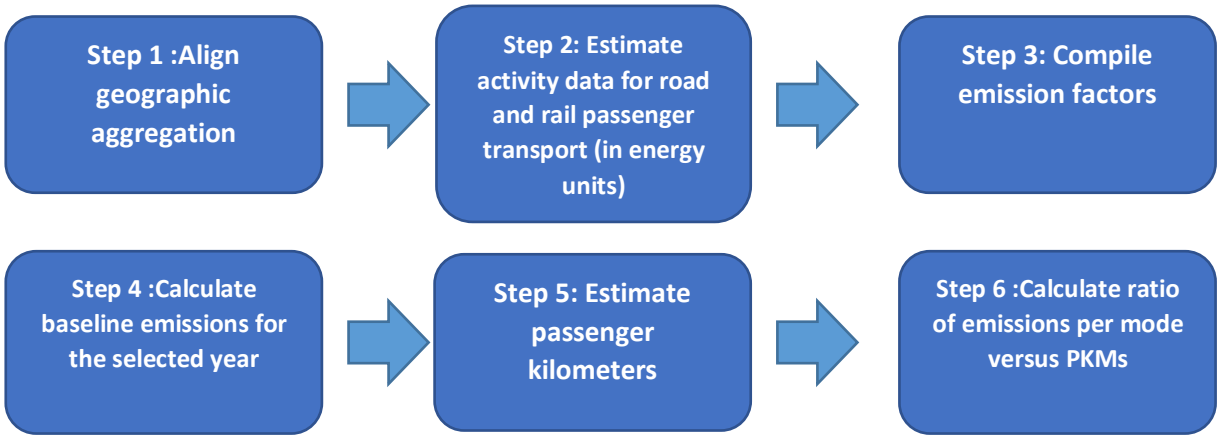


Figure 3.9 Overview of steps for Approach C

Source: ICAT Transport Pricing Guidance, 2018

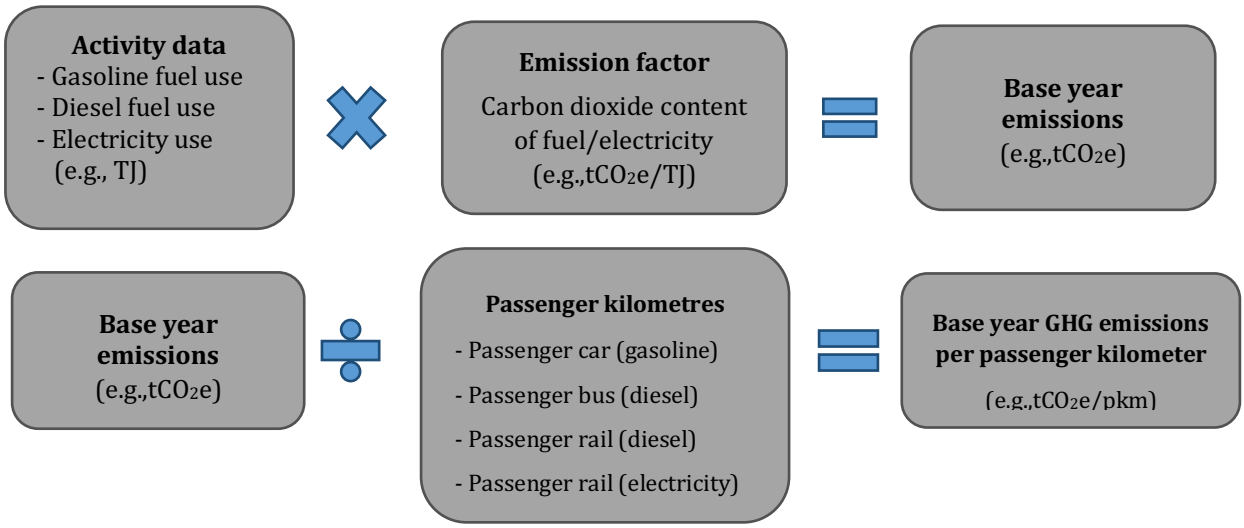


Figure 3.10Calculation of base year GHG emissions per PKM

Source: ICAT Transport Pricing Guidance, 2018

Data Needs

Table 3.20Necessary data for baseline calculation

Parameter	Description	Unit	Availability		Necessity
			Yes	No	
$d_{i,j,y}$	Vehicle kilometers traveled (with fuel type i, mode j, in year y).	VKT	Yes		Need
$sfc_{i,j,y}$	Specific fuel consumption. Average consumption per VKT in municipal, regional or national fleet	Liter per VKT	Yes		Need
p_i,	Density of fuel type i	kg/m3	Yes		Need
NCV_i	Net Calorific value of fuel type i	TJ/Gg	Yes		Need
$EF_{gasoline}$	Emission factor for gasoline fuel	tCO_2e/TJ	Yes		Need
EF_{diesel}	Emission factor for diesel fuel	tCO_2e/TJ	Yes		Need
$EF_{electricity}$	Emission factor for electricity	$kgCO_2e/TJ$		No	Need
	Car population in Sri Lanka under each fuel type		Yes		Need

Sri Lankan grid emission factor provides as $kgCO_2e/kWh$ instead of the requested unit by ICAT methodology, $kgCO_2e/TJ$. Since the calculation was done directly for the electricity consumption in kWh without converting it to energy (TJ).

All other data for the baseline calculation were found through national data bases and reports, CDM methodological tools and IPCC (2006).

Uncertainties

- Specific fuel consumption for hybrid cars in the calculation was taken from the document "Fuel Economy of Light Duty Vehicles in Sri Lanka _the Baseline (2015)" , which was considered suitable for both petrol hybrid as well as diesel hybrid when doing the calculations.

Grid emission factor after the year 2016, 0.57 kgCO_2e/kWh was used in the calculation assuming that the grid emission factor does not change during the entire period of 2011 to 2031. However, in real scenario grid emission factor was 0.47 kgCO2e/kWh before 2016. This misusage of emission factors does not have a major impact on the final result due to the low electric vehicle share during the period of 2011 to 2015.

3.2.3.2 Ex ante GHG Impact assessment

Methodological changes

The methodology covers the entire vehicle fleet in Sri Lanka. However, this report only focused on the car fleet in Sri Lanka to avoid the complexity and difficulty of the calculations.

Sri Lankan grid emission factor provides as kgCO_2e/kWh instead of kgCO_2e/TJ as the request by ICAT methodology. Since the calculation is done directly for the electricity consumption in kWh without converting it to energy (TJ).

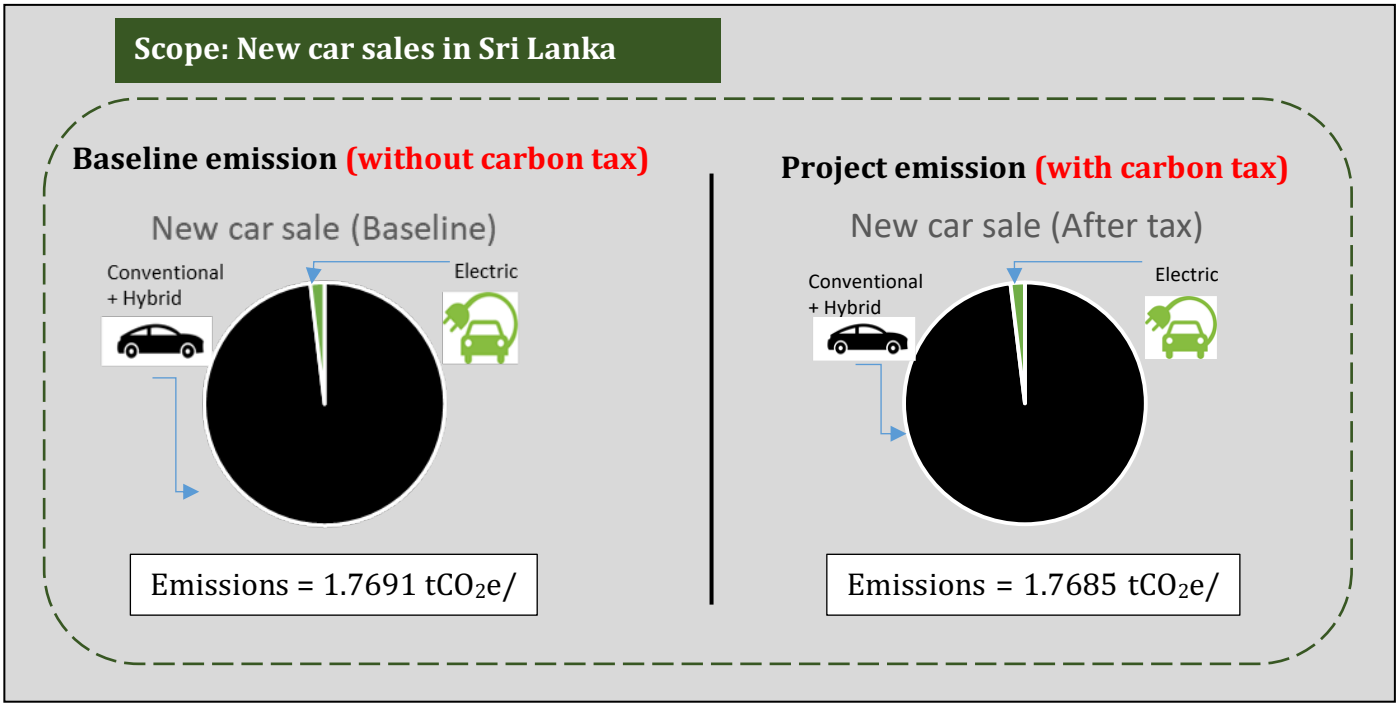


Figure 3.11Summary of project activity

Results

Direct effects of mitigation actions

- Emission reduction due to carbon tax for petrol and diesel cars is 969 tCO_2e
- Carbon tax on petrol cars causes fuel saving of 0.27 liters per car for the year 2030.
- Carbon tax on diesel cars causes fuel saving of 0.19 liters per car for the year 2030.

BAU and Project Scenario

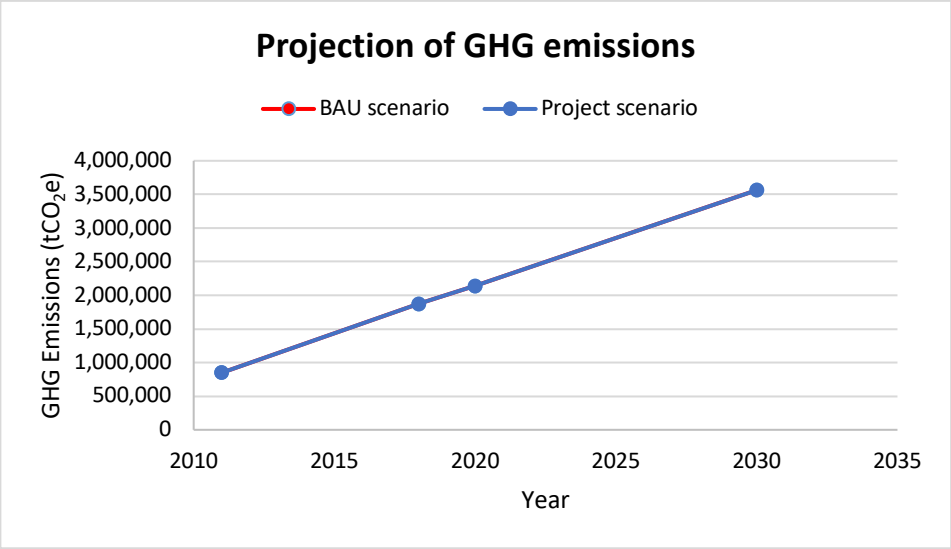


Figure 3.12 GHG effects due to Carbon tax on diesel car fleet (tCO_2e)

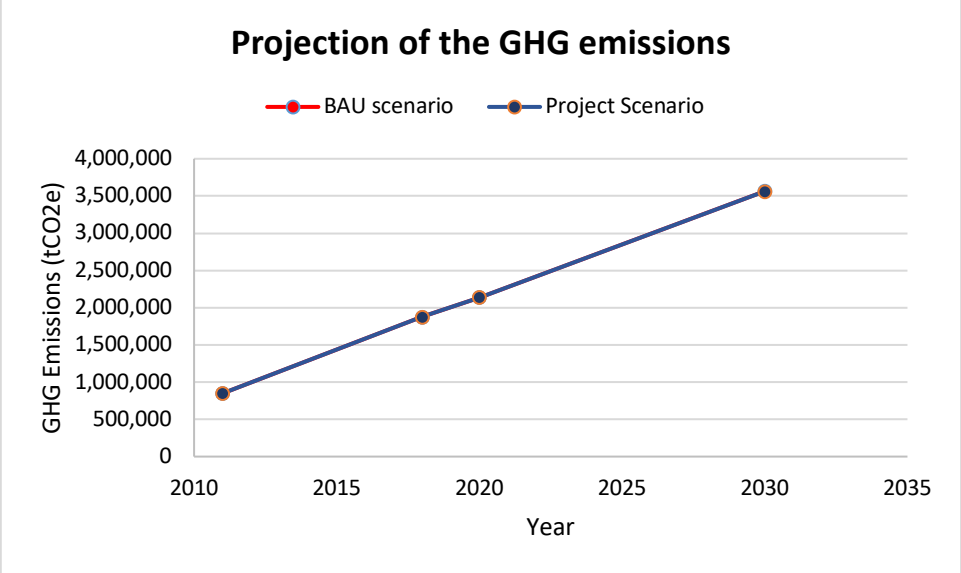


Figure 3.13 GHG effects due to Carbon tax on petrol car fleet (tCO_2e)

3.2.3.3 Ex post assessment

The following data will be provided by the DMT. Data should be collected annually.

Data requirement from DMT (Ex-post)

Data requirement	Indicator	Unit
Annual new vehicle sale of fuel type i mode j engine capacity c vehicles (year y)		No. of Vehicles
Total vehicle population		No. of Vehicles
New updates about the carbon tax		

The following data will be provided by SLC. Data will be collected annually.

Data requirement from SLCs

Data requirement	Indicator	Unit
Cost, Insurance and Freight (CIF) value		Rs.

The following data will be provided by VIASL. Data will be collected annually.

Data requirement	Indicator	Unit
The retail price of vehicle with engine capacity c fuel type i		Rs

3.2.4 Institutional arrangement

Institutional set up for implementation of mitigation action

Department of Motor Traffic

The Department of Motor Traffic (DMT) is responsible for enacting the Motor Traffic Act No. of 14 of 1951 which was an amendment in 2009. Registration of new motor vehicles, registration of ownership transfer, issuing a new driving license, an extension of old driving license and conversion of old driving licenses to new ones are the activities manage by DMT. There are two taxation processes drives by DMT that directly affixes to motor vehicles, which are luxury or semi - luxury taxes and carbon tax.

The carbon tax was supposed to implement on 10th August, 2018. However, the implementation process postponed to 1st January, 2019. Carbon tax collection process yet to be properly coordinate nevertheless the application stage of the process had been completed. Figure 3.14 illustrates the governance structure to implement the Carbon Tax.

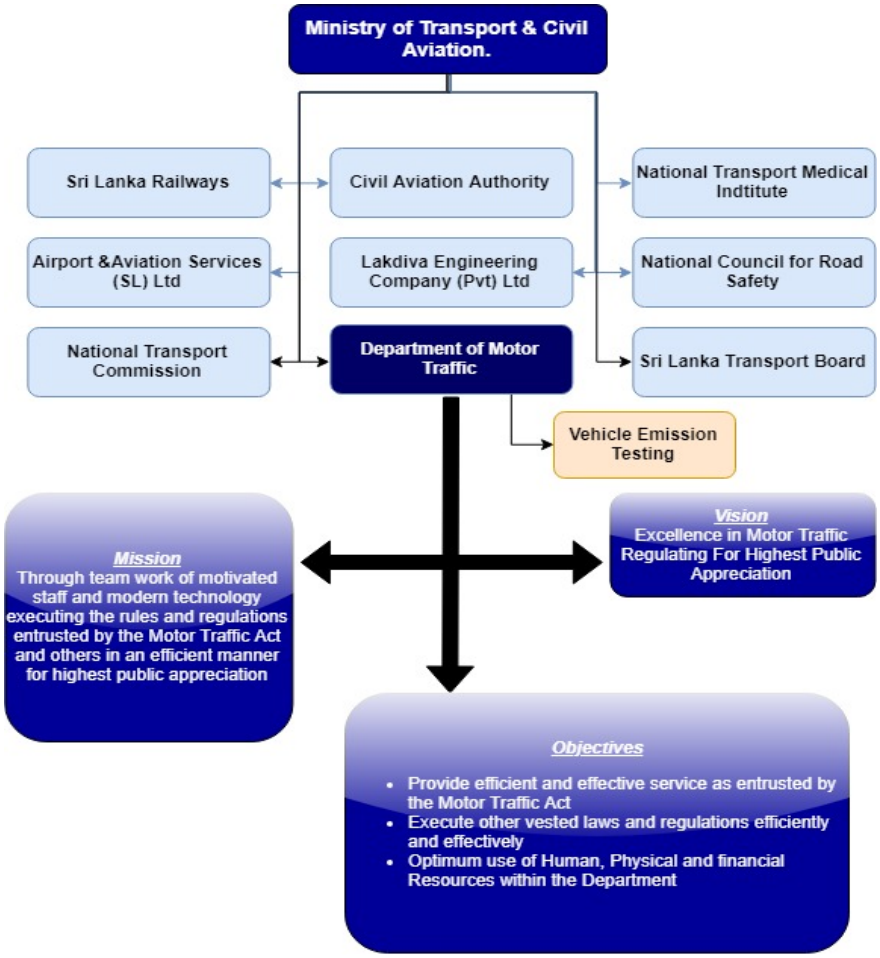


Figure 3.14 Illustrates the governance structure to implement the Carbon Tax

Source: ClimateSI, 2019 based on DMT

Institutional set up for measurement and reporting GHG effects

Department of Motor Traffic

Department of Motor Traffic under the Ministry of Transport and Civil Aviation is responsible for measure and collect data as well as reporting the collected data to NDC Unit which will be established under the same ministry.

Vehicle Emission Testing Programme carried out by Department of Motor Traffic, Central Environmental Authority, Gaseous Resources Management Centre and the Department of Measuring Units and Standards, is also responsible for collecting some of the data necessary for the calculation.

Sri Lanka Customs

In the year 1806 Sri Lanka Customs established with enacting the Custom Ordinance. Current Sri Lanka Custom is under the Ministry of Finance and Mass Media which responsible for the collection of revenue, prevention of revenue leakages and other frauds, facilitation of legitimate trade, collection of import and export data to provide statistics and finally cooperation and coordination with other government departments and stakeholders in respect of imports and exports.

The cost, insurance and freight (CIF) value data which collected from Sri Lanka Custom is very important to calculate the retail price of the vehicle. Vehicle retail price can be calculated using the CIF data as well as taking the value for taxes from custom and profit kept by the vehicle importer from vehicle importer association.

Sri Lanka Sustainable Energy Authority

The Sri Lanka Sustainable Energy Authority (SLSEA) was established on 1st October 2007 for the necessity of having a liable institution to drive Sri Lanka toward a new level of sustainability in energy generation and usage. The SLSEA is responsible for enacting the Sri Lanka Sustainable Energy Authority Act No. 35 of 2007.

As an illustration in Figure 3.15 Proposed Data Management System for the carbon tax, age, fuel type, category and engine capacity of vehicles will be recorded at new registration branches. Furthermore, the number of registered vehicles and the total vehicle population will be counted at new registration branches. Then new registration branches will be fed collected data into the database. The collected data will be recorded under DMT after consolidated by statisticians. Finally, all consolidated data will be reported annually to NDC unit under the Ministry of Transport and Civil Aviation. Apart from above procedures, specific electricity/ fuel consumption will be collected by DMT after every five years and reported the collected data to the NDC unit. (Default specific fuel consumption values in the CDM methodology tool 18 can be used in the absence of data). Furthermore, updates about the carbon tax will be informed to NDC unit by DMT.

The annual average distance traveled in vehicle km will be extracted by VET from the existing database. The primary data of the database will be collected by island-wide emissions testing centers and will be fed into the centralized database at the centers. Then the data will be transferred to the ICTA database. Through ICTA database VET will be received the collected primary data. Finally, extracted vehicle km data will be reported by VET to the NDC unit under MTCA.

Further, CIF values for vehicles will be collected by Sri Lanka Customs and will be reported to NDC unit. Retailed price of the vehicle will be annually collected at vehicle importers association. Net calorific value and density of the fuel will be measured and entered into the SAP ERP system by the laboratory. All data will be monitored and recorded by the distribution unit. Data will be processed by the system and annually reported to the NDC unit. Grid emission factor calculated by data collected from CEB and other independent power plants will be submitted to the NDC unit by SLSEA annually.

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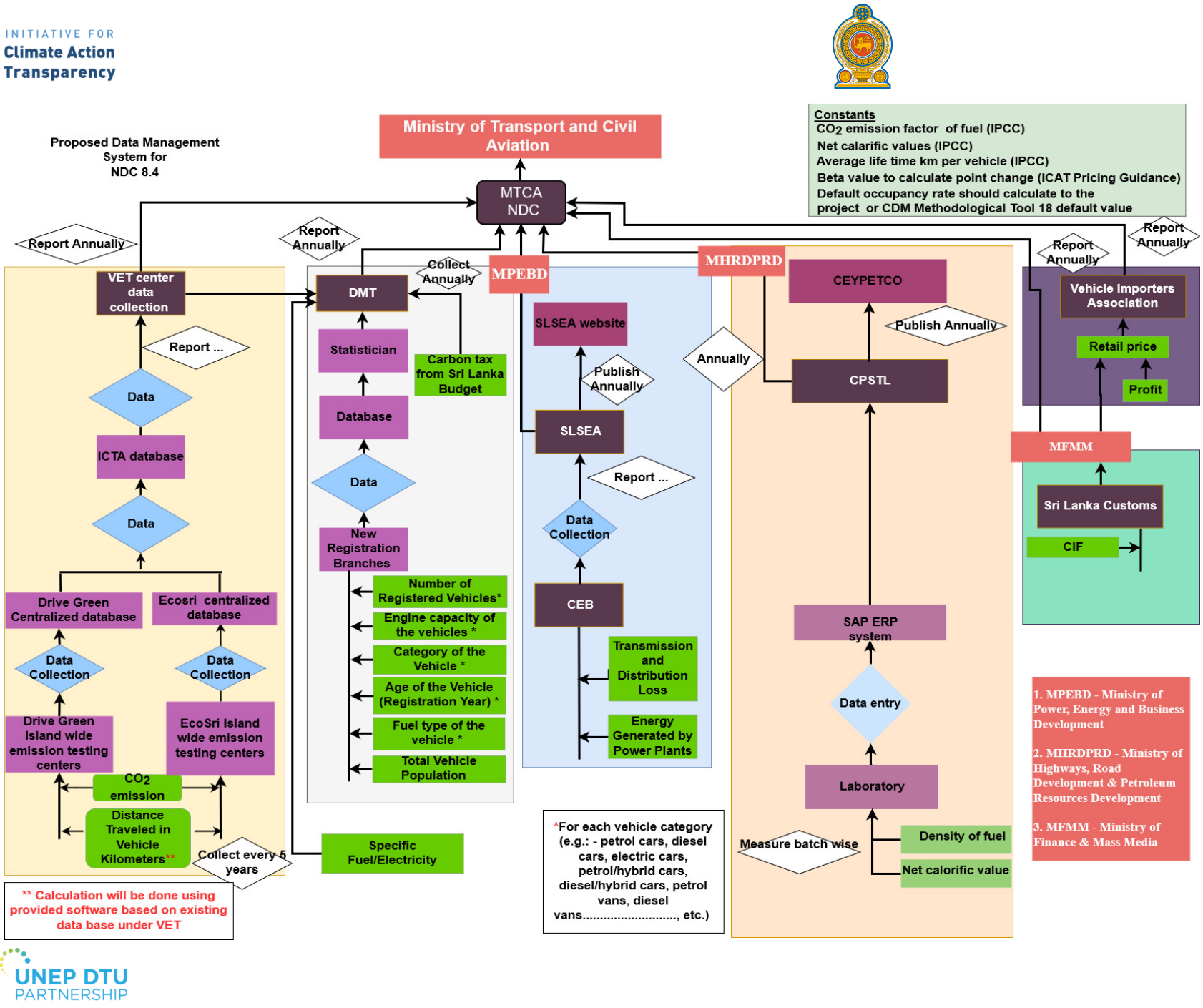


UNEP DTU
PARTNERSHIP

Figure 3.15 Proposed Data Management System for the carbon tax

***MOTCA**: Ministry of Transport and Civil Aviation, **VET**: Vehicle Emission Testing Programme, **DMT**: Department of Motor Traffic, **SLSEA**: Sri Lanka Sustainable Energy Authority, **CEB**: Ceylon Electricity Board, **CEPETCO**: Ceylon Petroleum Corporation, **CPSTL**: Ceylon Petroleum Terminal Limited*

Table 3.21 Proposed responsibilities of each institute (Carbon tax)

Institution	Responsibility related to the project
Department of Motor Traffic (DMT)	• DMT collect the most of the data that are necessary for the calculation. • Vehicle type, age, fuel type, engine capacity and specific fuel/electricity consumption are some of the data should be collected through DMT. Other than that total number of vehicles registering per year should also collect. • DMT should always be cautious about updates of carbon taxes
Vehicle Emission Testing	• Collect values for vehicle kilometers and CO_2 emissions
CEYPETCO	• Publishing values for specific weight of fuels in their official website
Sri Lanka Sustainable Energy Authority	• Publishing emission factor for grid electricity and average transmission and distribution loss in the Sri Lanka Energy Balance.
Sri Lanka Custom	• Collecting and reporting cost, Insurance and Freight (CIF) price

3.2.5 Verification

Respective institutions will report the required data annually to the MTCA. Quality and the accuracy of the data provided will be verified by the NDC unit of MTCA. In addition, GHG impact of concerned mitigation action will also be calculated by the NDC unit. Accuracy of the calculations will be verified by an independent third party, the MRV expert committee to be appointed by the MMDE. Approved results will be submitted to the CCS of MMDE who will submit the results to the UNFCCC. More information on the institutional arrangement is given in Chapter 05.

As illustrated in data management system, data will be required from institutions that are not regulated by the MTCA. Therefore strengthening the legal provisions of the NDC unit will be essential for the proper verification process.

3.2.6 Recommendations

Vehicle Importers Association of Sri Lanka (VIASL) is a private body which is not obliged to provide data to the Ministry of Transport and Civil Aviation (MTCA) as a government body. Since signing an agreement between MTCA and VIASL to obtaining data from VIASL will be convenient.

DMT and VET existing databases can be converted into web-based data management systems to enhance the accessibility for available data. Furthermore, it will be substantial to develop an equation or software to extract the necessary data from the database under VET.

Finally, It will be appropriate to assign an officer under each institution (DMT, VET, CPSTL and SLC) who will be responsible for collecting and managing the data relevant to GHG emission. Training for the responsible officers needs to carry out before appointing them into the relevant institute.

3.3 Introduction of tax rebate to promote electric vehicles

3.3.1 Description of the mitigation action

Mitigation action: The mitigation action is to introduce a tax rebate for electric vehicles in order to promote electric vehicles against conventional diesel and petrol cars, In the absence of the proposed mitigation action, the conventional petrol and diesel-powered motor vehicles would have dominated the vehicle market. The mitigation action aims to increase the share of electric vehicles in the vehicle market.

Note: However application of mitigation action was limited only for passenger cars. Excise duty tax effect on petrol, diesel, hybrid (petrol/electric hybrid and diesel/electric hybrid) and electric cars, that were covered in this study of MRV application.

Application of the mitigation action:

The government of Sri Lanka introduced tax rebated for electric vehicles in 2018 by reducing existing tax on the vehicles.

Rationale for introducing the mitigation action

Sri Lankan vehicle fleet is dominated by the fossil fuel-based vehicles of various age categories. Due to the higher traffic conditions that pertain in the urban parts of Sri Lanka, the air quality is deteriorating. In certain parts of the country, the average speed of the traffic has been reduced to 8 km/h (during rush hours), which can lead to make the public exposed to the low-quality air for a long period of time. As such, it can result respiratory problems when this condition pertains regularly for a long period of time.

Further, Sri Lanka imports 100% of the fossil fuel requirement from few oil exporting countries. So, the increased demand for the fossil-fuel imposes logistical as well as the economic impact on the country.

To mitigate the possible oncoming health and other problems, a different energy source-based vehicle category becomes unavoidable. Thus, the government opted to support the use of electric vehicles by imposing more taxes on the higher capacity fossil fuel vehicles and announcing tax rebates on electric and hybrid vehicles.

Current situation, which includes the policy & actions, institutional arrangement to implement those policy & actions

According to the National Transport Policy 2009, Sri Lanka presently incurs a heavy expenditure on the importation and distribution of petroleum fuels for its transport activities. The government has been formulating strategies to overcome this problem without affecting the public.

Some of the actions formulated were,

- Reducing the unproductive transport
- Shifting of passengers from private to public modes of transport which are more fuel efficient
- Higher taxation for private use vehicles with higher engine capacities
- Taxation rebates for vehicles having newer fuel-efficient technology such as Hybrid and Electric technology which promotes greater fuel efficiency and also for use of non-fossil fuels.

As one of the initiatives that are mentioned in the Transport Policy of Sri Lanka 2009, Sri Lanka included electrification of vehicles in the NDCs for transport sector submitted following the Paris agreement.

Moreover, the transport sector worldwide consumes over 60% of the fuel imported, making the fuel supply chain much harder to manage, thus a need for an alternate energy source for the transport becomes inevitable.

Although the large amounts of fuel import and supply are difficult for the country to manage, the main concern is the air quality in the urban area. Due to the higher traffic conditions of the urban cities, the atmosphere in those areas become unhealthier to breathe. By introducing electric vehicles to the current fleet, the air quality can be managed well to a tolerant level.

3.3.2 Scope and boundaries of monitoring approach

Causal Chains

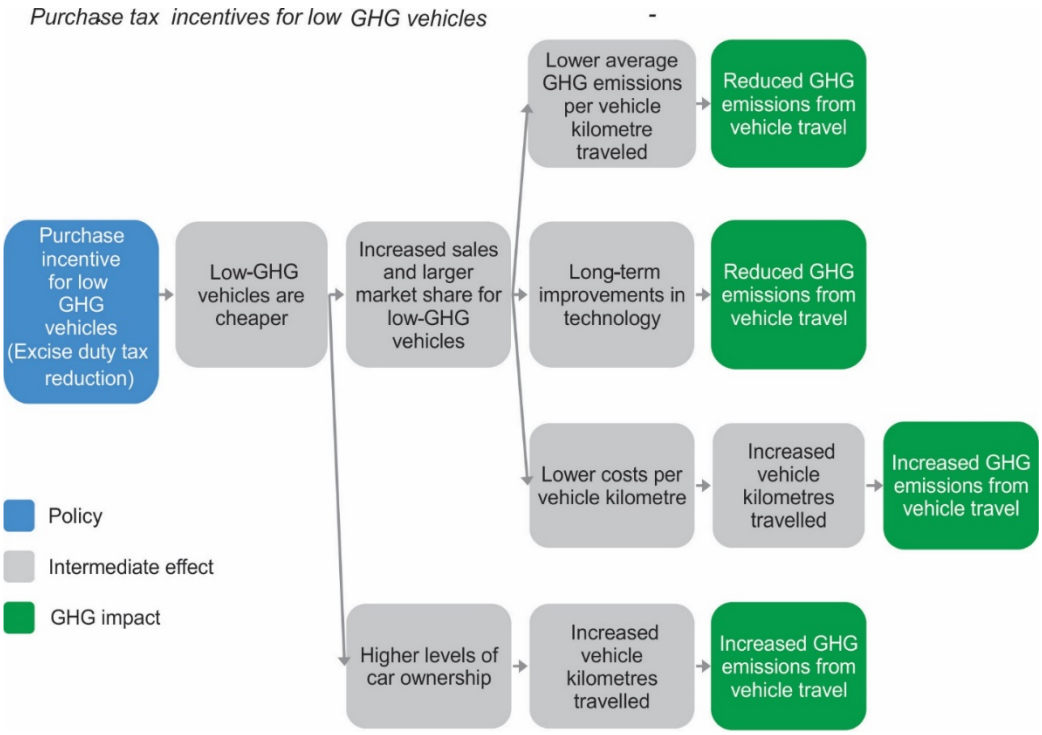


Figure 3.16 Causal chain of 'purchase incentives for low GHG vehicles'

Source: ClimateSI, 2019. Based on ICAT pricing guidance

Relevance of effect of mitigation action

Table 3.22 Effects of the mitigation action

Effect	Likelihood	Magnitude
Less fuel use	likely	Moderate
Reduce air pollution	likely	Minor

The available data sources are not specific for the MRV application. Another source that is necessary for common data availability template apart from the above sources is,

Sources for specific fuel consumption of other vehicles: Currently Sri Lanka do not calculate the specific fuel consumption for vehicles.

Assessment Boundary

Assessment boundary covers the entire vehicle fleet in Sri Lanka. Sri Lanka Customs is responsible for implementing excise duty tax for import vehicles.

System boundaries

Table 3.23Boundary elements of introducing excise duty tax

Boundary elements	Description
f) Temporal boundary	2010 is considered as the base year. 2021-2030 will be considered as the target period.
g) Sectoral boundary	For pricing policies, the relevant GHG emissions are reduced from vehicle travel, caused by a shift to less GHG-intensive transport modes, and a shift to more fuel-efficient vehicles. [16]
h) Territorial boundary	For this, project geographical territory is considered as the entire country. (Sri Lanka)

[16]The report focused only on the passenger car fleet in Sri Lanka. The passenger car fleet consist of passenger cars, SUVs, station wagons and racing cars

i) GHGs included[17]	Reduced GHG emissions from use of less GHG-intensive modes	CO2	Likely	Major	Included	Depends on the policy implementation and the quality and availability of substitutes, as well as consumer behaviour; considered significant for most fuel pricing policies

Methodology only focuses on CO_2 emissions during the baseline emission calculation. However, IPCC 2006 emission factors, which have the units of tCO_2e/TJ, were used for the calculations. As such, the final result of the calculation had the unit of tCO_2e

3.3.3 Methodology

Short explanation of the methodology

ICAT transport pricing guidance is a part of the Initiative for Climate Action Transparency series of guidance, which provides the methodological guidance to estimate the GHG impacts of the transport sector pricing policies. The guidance provides a stepwise approach for estimating the GHG impacts of higher fuel prices using price elasticities of demand and less depth approach for estimating the GHG impact of vehicle purchase intensives and road pricing policies.

[17] Methodology only focuses on CO2 emissions during the baseline emission calculation. However, IPCC, 2006 emission factors , which have the units of tCO_2e/TJ were used for the calculations. Since the final result of the calculation had the unit of tCO2e.

Key indicators

Key indicators for calculation of baseline emissions

$$BE_{i,,2}\ emissions\ (t\ CO_2) = [FC_{i,j,y}\ in\ energy\ units\ (TJ)]\ x\ \ [EF_i\ (t\ CO_2\ per\ TJ)]$$

Table 3.24Key indicators for calculation of baseline emissions

$FC_{i,j,y}$	Total fuel energy i (from gasoline / diesel / electricity) used per mode j of passenger transport (road / rail) in year y
EF_i	Emission factor for fuel i (tCO_2/TJ)

Key indicators for calculation of GHG impact

GHG impact = (market share) x (annual new vehicle sale) x (per km emissions reduction) x (average lifetime km per vehicle)

3.3.3.1 Baseline Scenario

Identification of baseline scenario[3]

In the absence of the proposed mitigation action, the conventional petrol and diesel-powered motor vehicles would have dominated the vehicle market.

1. Identification of alternative scenarios

Three baseline aalternatives were identified for the mitigation action of, "Introduction of tax to promote electric vehicles", as follows:

1. Introducing carbon tax for petrol, diesel and hybrid vehicles
2. Introducing electric buses

3. Changing excise duty tax for petrol, diesel, hybrid and electric vehicles

Baseline alternative 1: Introducing carbon tax for petrol, diesel and hybrid vehicles[18]

The Department of Motor Traffic focuses on regularization of the carbon tax. The carbon tax was planned to implement in August 2018. However, the assessment was postponed until 2019 due to opposition from the public. The carbon tax will be imposed on the newly registered vehicles from 2019 onward.

Baseline alternative 2: Changing excise duty tax for petrol, diesel, hybrid and electric vehicles

Recently Sri Lankan government changed the existing excise duty tax for vehicles (Sri Lanka Budget, 2018). The government increased the tax for petrol, diesel and hybrid vehicles while the tax for electric vehicles wads reduced. This encourages usage of electric vehicles and reduce GHG emissions that are contributed by transport sector.

Baseline alternative 3: Continue using petrol and diesel vehicles without a change in excise duty tax.

This was the existing scenario before the project activity and is likely to continue in the absence of the project.

Assessment of Options

Sri Lanka government need to contained low cost when implementing assessment relevant to taxes where they need to spend more money on introducing the process of electric buses.

[18] The proposed mitigation policy itself was also tested if it is likely to be the baseline scenario. If it happen to be the baseline scenario, this will happen in the business as usual scenario without additional effort as it is the most likely scenario. However, this assessment demonstrated that the proposed mitigation policy is unlikely to happen in the business as usual scenario.

Baseline scenario: Increasing number of petrol and diesel vehicles within Sri Lankan vehicle fleet due to less electric vehicle favorable taxes

Baseline emission calculation for the excise duty tax done based on the "ICAT Transport Pricing Guidance". ICAT guidance presents three approaches to calculate baseline emission according to available activity data and geographical system boundary.

Overview of the approaches can be explained using the following table.

Table 3.25Overview of three approaches under ICAT pricing guidance baseline calculation

Approach	Data requirements	Boundaries / Coverage		
		Geographical system boundaries	Passenger / Freight	Fuel types
Approach A	Only general fuel consumption data (Basis for calculation: top-down energy use data)	National	National transport (passenger and freight)	Fuel mix (gasoline /diesel)
Approach B	Specific gasoline and diesel consumption data (Basis for calculation: top-down energy use data)	National	National transport (passenger and freight)	Gasoline and diesel

Approach C	Comprehensive bottom-up travel activity data (e.g., distance travelled by mode j) (Basis for calculation: top-down energy use and bottom-up travel activity data)	Regional, urban	Only passenger transport is in an urban context However, the assessment can be conducted for several (large) cities to enable a more extensive geographical coverage	Gasoline, diesel and electricity

Source: ICAT Transport Pricing Guidance, 2018

In Sri Lanka, the proposed excise duty tax depends on engine capacity, fuel type and age of the vehicles. It does not directly depend on vehicle fuel consumption. Furthermore, it is hard to extract only the vehicle fleet fuel consumption from the total annual fuel consumption in the country. Since the approach C is suitable for Sri Lankan carbon tax instead of approaches A and B.

Approach C

Approach C - base year calculation procedure can be explained using the following diagrams.

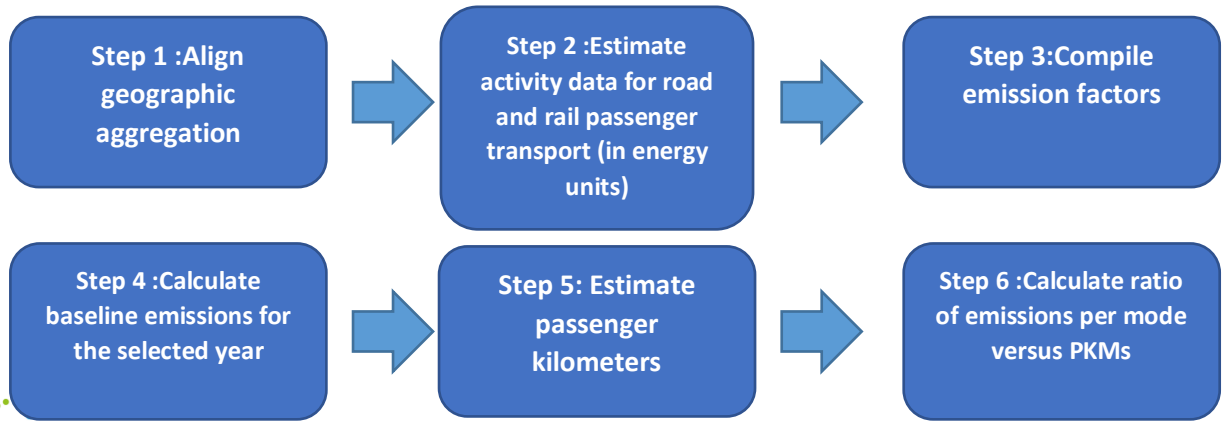


Figure 3.17 Overview of steps for Approach C

Source: ICAT Transport Pricing Guidance, 2018

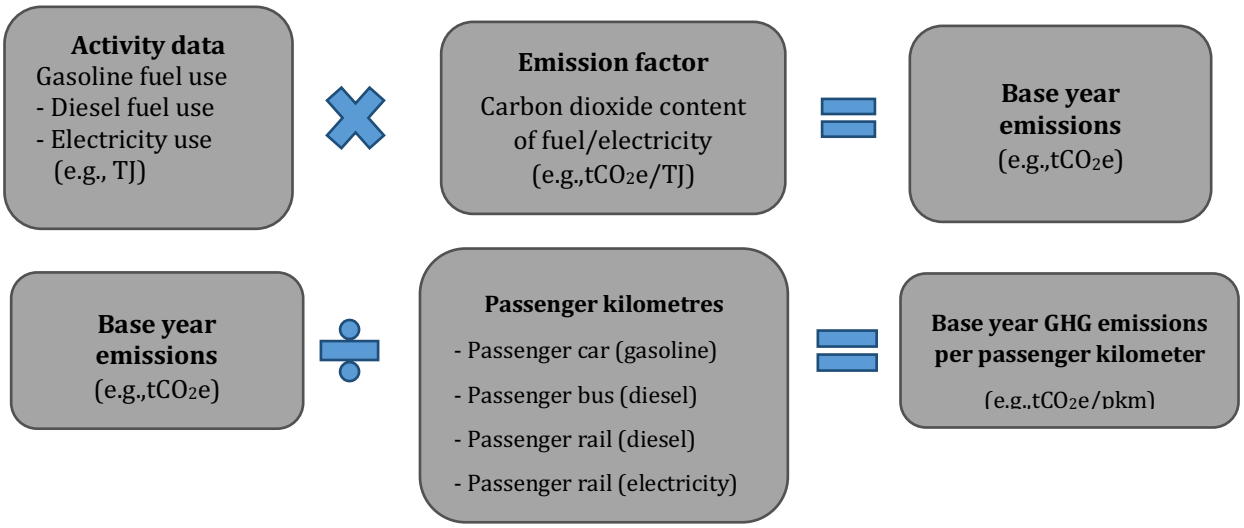


Figure 3.18Calculation of base year GHG emissions per PKM *Source: ICAT Transport Pricing Guidance, 2018*

Data Needs

Table 3.26 Necessary data for baseline calculation

Parameter	Description	Unit	Availability		Necessity
			Yes	No	
$d_{i,j,y}$	Vehicle kilometers travelled (with fuel type i, mode j, in year y).	VKT	Yes		Need
$sfc_{i,j,y}$	Specific fuel consumption. Average consumption per VKT in municipal, regional or national fleet	Liter per VKT	Yes		Need
p_i,	Density of fuel type i	kg/m3	Yes		Need

NCV_i	Net Calorific value of fuel type i	TJ/Gg	Yes		Need
$EF_{gasoline}$	Emission factor for gasoline fuel	tCO_2e/TJ	Yes		Need
EF_{diesel}	Emission factor for diesel fuel	tCO_2e/TJ	Yes		Need
$EF_{electricity}$	Emission factor for electricity	$kgCO_2e/TJ$		No	Need
	Car population in Sri Lanka under each fuel type		Yes		Need

Sri Lankan grid emission factor provides as $kgCO_2e/kWh$ instead of the requested unit by ICAT methodology, $kgCO_2e/TJ$. Since the calculation was done directly for the electricity consumption in kWh without converting it to energy (TJ).

All other data for the baseline calculation were found through national data bases and reports, CDM methodological tools and IPCC (2006).

Table 3.27 Calculation of projection of total base year emissions

	2011	2018	2021	2031
Population	20,315,017	21,679,884	22,162,000	22,888,000
tCO_2e	849,103	906,150	926,301	956,645

Segregated vehicle data according to the fuel type are available from 2011 onward. As such, the calculation is done considering 2011 as the base year instead of 2010.

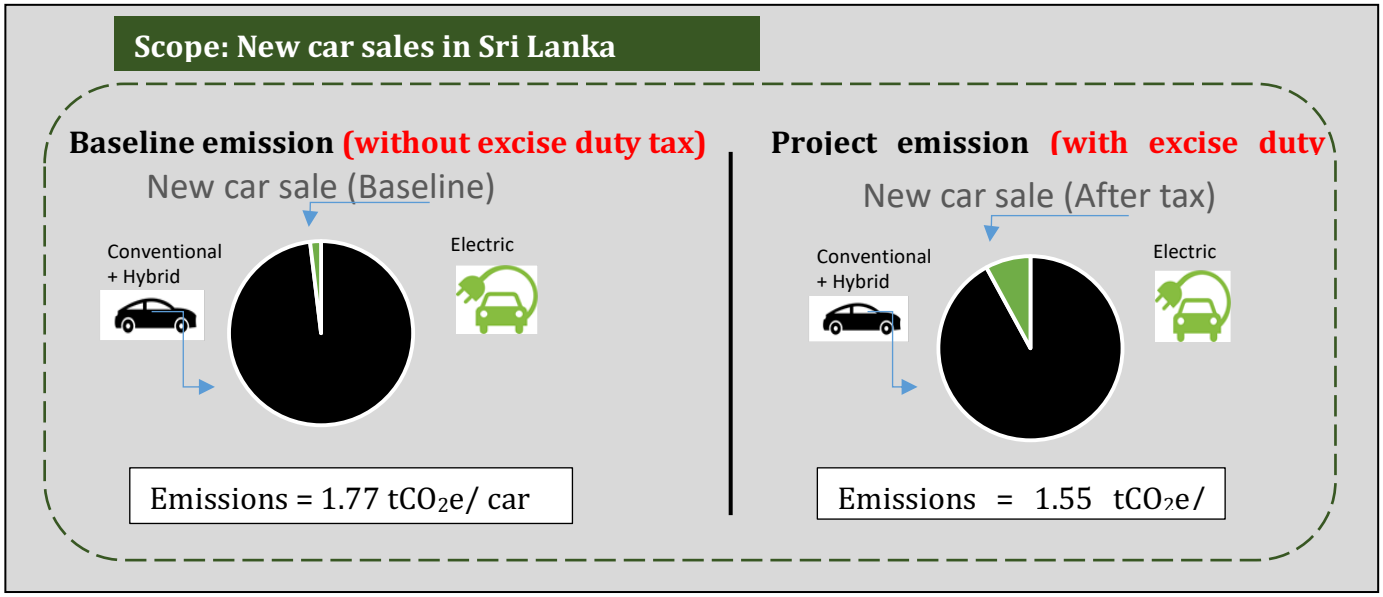
Uncertainties

- Specific fuel consumption for hybrid cars in the calculation was taken from the document "Fuel Economy of Light Duty Vehicles in Sri Lanka _the Baseline (2015)", which was considered suitable for both petrol hybrid as well as diesel hybrid when doing the calculations.
- Grid emission factor after the year 2016, 0.57 $kgCO_2e/kWh$ was used in the calculation assuming that the grid emission factor does not change during the entire period of 2011

to 2031. However, in real scenario grid emission factor was 0.47 $kgCO_2e/kWh$ before 2016. This misusage of emission factors does not have a major impact on the final result due to the low electric vehicle share during the period of 2011 to 2015.

3.3.3.2 Ex ante GHG Impact assessment

Methodological changes



The methodology covers the entire vehicle fleet in Sri Lanka. However, this report only focused on the car fleet in Sri Lanka to avoid the complexity and difficulty of the calculations. Sri Lankan grid emission factor provides as $kgCO_2e/kWh$ instead of $kgCO_2e/TJ$ as the request by ICAT methodology. Since the calculation is done directly for the electricity consumption in kWh without converting it to energy (TJ).

BAU and project scenario

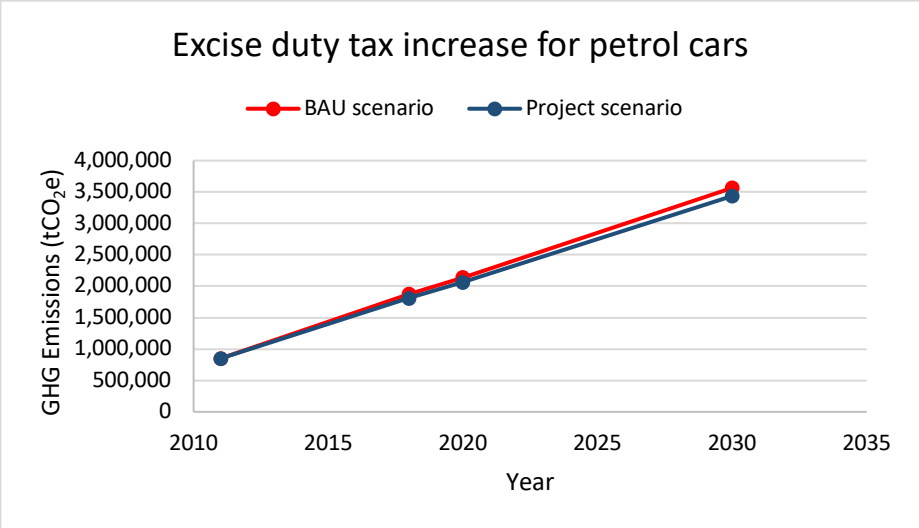


Figure 3.20 Excise duty tax increase for petrol cars

As illustrated in the Figure 3.20 Excise duty tax increase for petrol cars, increment of the excise duty taxes for the petrol vehicles will cause reduce GHG emissions by 128,791 tCO_2e in the year 2030. Projection is based on the historical GDP values (Annex 2).

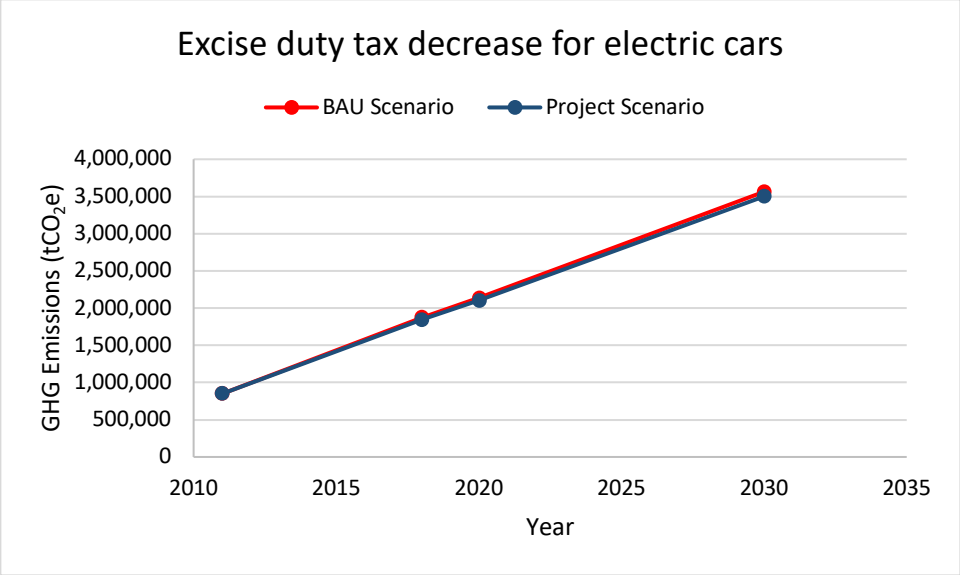


Figure 3.21 Excise duty tax decrease for electric cars

Decrease of the excise duty tax will reduce the GHG emission by 62,790 tCO_2e (

Figure 3.21 Excise duty tax decrease for electric cars). GHG emissions were forecasted based on the historical GDP. Annex 2 provides the more detail on the calculation.

GHG impact of increasing vehicle excise duty tax to reduce expenditure on diesel cars

GHG emissions for the years 2021 and 2031 were calculated based on past GDP values of Sri Lanka (Annex 2).

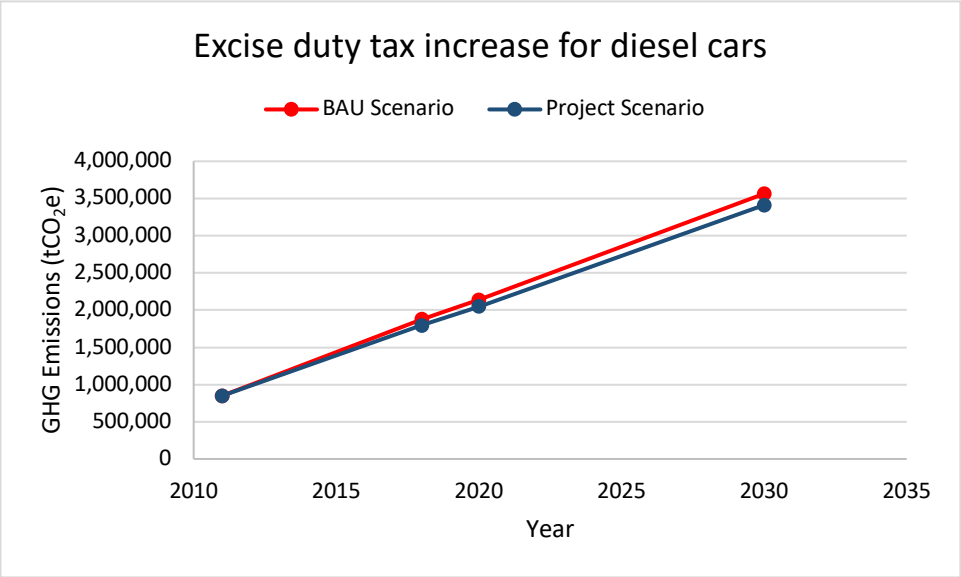


Figure 3.22 Excise duty tax increase for diesel cars

Excise duty tax increment for the diesel vehicles will reduce the associated emission by 151,573 tCO_2in the year 2030. Emissions were forecasted based on the historical GDP values (Annex 2).

The direct effect of mitigation action

- Emission reduction due to excise duty tax fluctuations for petrol, diesel and electric cars is 343,154 tCO_2e
- Fluctuation of excise duty tax on petrol cars causes fuel saving of 64.9 liters per car for the year 2030.
- Fluctuation of excise duty tax on diesel cars causes fuel saving of 67.5 liters per car for the year 2030.

3.3.3.3 EX-post Assessment

The following data will be provided by the DMT. Data should be collected annually.

Table 3.28 Data requirement from DMT (Ex-post)

Data requirement	Indicator	Unit
Annual new vehicle sale of fuel type i mode j engine capacity c vehicles (year y)		No. of Vehicles
Total vehicle population		No. of Vehicles

The following data will be provided by SLC. Data will be collected annually.

Table 3.29 Data requirement from SLCs

Data requirement	Indicator	Unit
Cost, Insurance and Freight (CIF) value		Rs.
New updates about tax		

The following data will be provided by VIASL. Data will be collected annually.

Table 3.30 Data requirement from SLCs

Data requirement	Indicator	Unit
The retail price of vehicle with engine capacity c fuel type i		Rs

3.3.4 Institutional arrangement

Institutional set up for implementation of mitigation action

The Sri Lanka Customs (SLC) established in the year 1806 and developed in to full pledge state organization with the introduction of the custom ordinance. SLC is responsible for the collection of revenue and the enforcement of the law.

According to the July 31st Gazette notification issued under the Excise (Special Provisions) Act, no. 13 of 1989, previous excise duty tax for motor vehicles was changed to new tax rates which will be influential for the GHG emissions of the country. Modified tax rates were enforced on 01st August, 2018 onward.

Sri Lanka Customs[19]

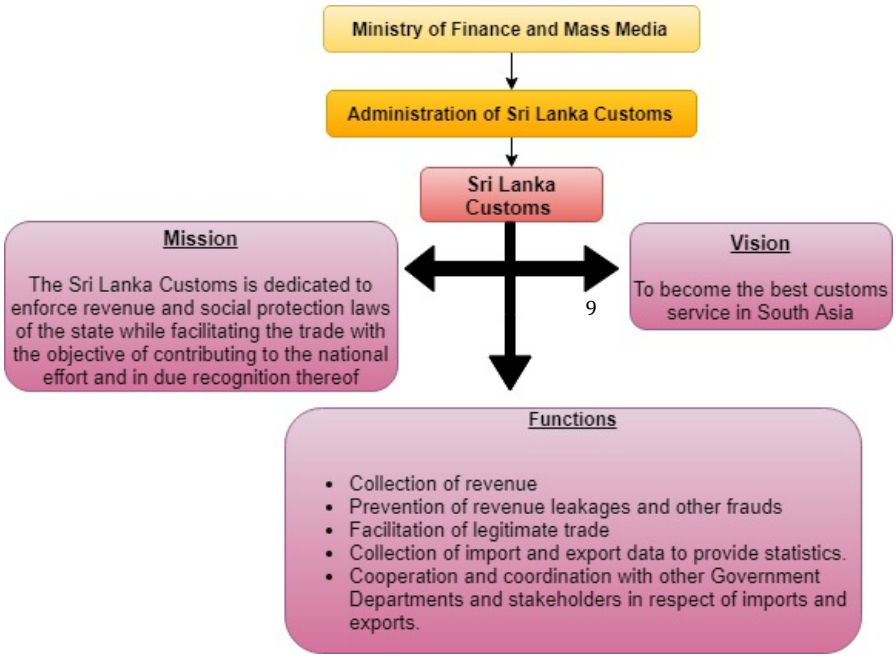


Figure 3.23 Illustrates the governance structure to implement the excise duty tax

[19]Annex 2: Organizational structure of Sri Lanka Customs

Source: ClimateSI,2019 based on Sri Lanka Customs

Institutional set up for measurement and reporting GHG effects

Department of Motor Traffic

Department of Motor Traffic under the Ministry of Transport and Civil Aviation is responsible for measure and collect data as well as reporting the collected data to NDC Unit which will be established under the same ministry.

Vehicle Emission Testing Programme carried out by Department of Motor Traffic, Central Environmental Authority, Gaseous Resources Management Centre and the Department of Measuring Units and Standards, is also responsible for collecting some of the data necessary for the calculation.

Sri Lanka Customs

To calculate the retail price of the vehicle, the cost, insurance and freight (CIF) value data which collected from Sri Lanka Custom is very important. Vehicle retail price can be calculated using the CIF data as well as taxes from custom and profit kept by the vehicle importer from vehicle importer association.

Sri Lanka Sustainable Energy Authority

The Sri Lanka Sustainable Energy Authority (SLSEA) was established on 1st October 2007 for the necessity of having a liable institution to drive Sri Lanka toward a new level of sustainability in energy generation and usage. The SLSEA is responsible for enacting the Sri Lanka Sustainable Energy Authority Act No. 35 of 2007.

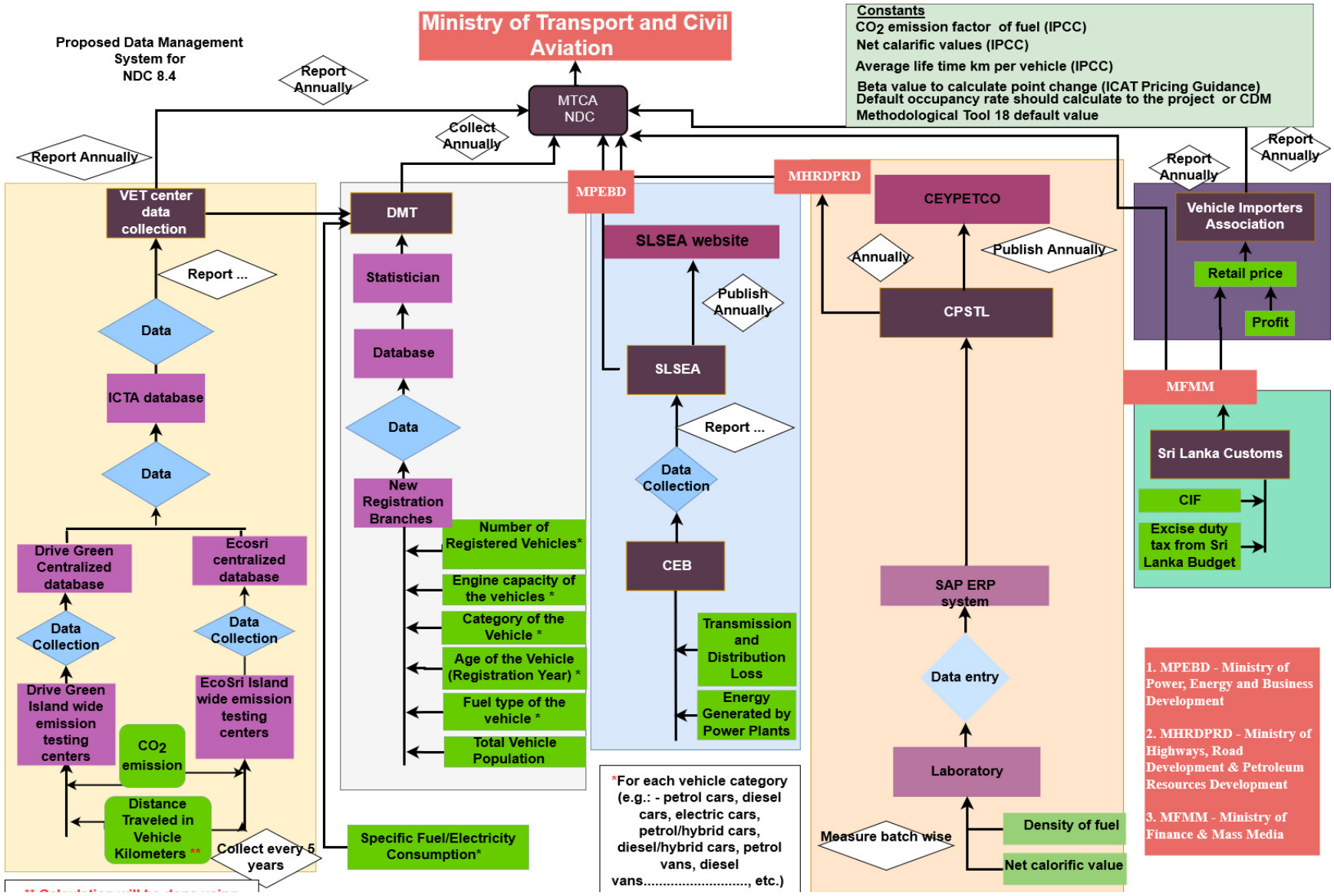


Figure 3.24Proposed Data Management System for excise duty tax

***MOTCA**: Ministry of Transport and Civil Aviation, **VET**: Vehicle Emission Testing Programme, **DMT**: Department of Motor Traffic, **SLSEA**: Sri Lanka Sustainable Energy Authority, **CEB**: Ceylon Electricity Board, **CEPETCO**: Ceylon Petroleum Corporation, **CPSTL**: Ceylon Petroleum Terminal Limited*

Table 3.31 Proposed responsibilities of each institute (Excise duty tax)

Institution	Responsibility related to the project
Department of Motor Traffic (DMT)	• DMT collect the most of the data that are necessary for the calculation. • Vehicle type, age, fuel type, engine capacity and specific fuel/electricity consumption are some of the data should be collected through DMT. • Other than that total number of vehicle registering per year should be collected.
Vehicle Emission Testing	• Collect vehicle kilometers and CO2 emissions
CEYPETCO	• Publishing values for specific weight of fuels in their official website
Sri Lanka Sustainable Energy ClimateSI,2019	• Publishing emission factor for grid electricity and average transmission and distribution loss in Sri Lanka Energy Balance.
Sri Lanka Custom	• Collecting and reporting cost, Insurance and Freight (CIF) price, Amount of excise duty tax • SLC should always be cautious about updates of excise duty taxes

3.3.5 Verification

Respective institutions will report the required data annually to the MTCA. Quality and the accuracy of the data provided will be verified by the NDC unit of MTCA. In addition, GHG impact of concerned mitigation action will also be calculated by the NDC unit. Accuracy of the calculations will be verified by an independent third party, the MRV expert committee to be appointed by the MMDE. Approved results will be submitted to the CCS of MMDE who will submit the results to the UNFCCC. More information on the institutional arrangement is given in Chapter 05.

As illustrated in data management system, data will be required from institutions that are not regulated by the MTCA. Therefore strengthening the legal provisions of the NDC unit will be essential for the proper verification process.

3.3.6 Recommendations

Vehicle Importers Association of Sri Lanka (VIASL) is a private body which is not obliged to provide data to the Ministry of Transport and Civil Aviation (MTCA) as a government body. Since signing an agreement between MTCA and VIASL to obtaining data from VIASL will be convenient.

DMT and VET existing databases can be converted into web-based data management systems to enhance the accessibility for available data. Furthermore, it will be substantial to develop an equation or software to extract the necessary data from the database under VET.

Finally, It will be appropriate to assign an officer under each institution (DMT, VET, CPSTL and SLC) who will be responsible for collecting and managing the data relevant to GHG emission. Training for the responsible officers needs to carry out before appointing them into the relevant institute.

4 Reduce traffic congestion

4.1 Passenger shift from private to public

4.1.1 Description of the mitigation action

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.

Application of the mitigation action:

The project activity aims to shift passengers from private vehicles to LRT system 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.

In the absence of the proposed mitigation action, the conventional petrol and diesel-powered personal motor vehicles would have dominated the Malabe corridor.

The proposed mitigation action is an action under sub NDC 4.1 (introduce park and ride system) of NDC 4 (Shift passengers from private to public transport modes). This mitigation action is also in line with the ASI (Avoid-Shift-Improve) approach. It is part of

the shifting strategy, which aims to achieve significant GHG reduction, reduce energy consumption, less congestion, with the final objective of creating more liveable cities.

Park and ride system include three major components: 1) the selected person drives own vehicle to park; 2) the selected person parks own vehicle at parking facility; and 3) the selected person rides public transport system to their destination.

The proposed LRT line in Malabe corridor will be facilitated by: 2 Park and Ride (P&R) facilities; 2 Multi-modal Transport Hubs (MmTH) with P&R facilities; and 3 Multi-modal Centers (MMC) with P&R facilities.

Rationale for introducing the mitigation action

Colombo Metropolitan area contributes around 42% of the gross domestic product in Sri Lanka while it also accommodates around 29% of Sri Lankan population. With the rapid economic and population growth, the number of personnel vehicles entered into the city has also been increased. Malabe corridor in the Colombo Metropolitan area has the highest traffic volume with 121,400 passenger car unit (pcu)/day/direction (Report on Preparatory Survey on the Project for Establishment of New Light Rail Transit System in Colombo, 2018). Due to high traffic volume, travel speed in Malabe corridor has reduced to 13.8 km per hour during peak period. If this situation continues, travel speed will reduce to 5.3 km per hour by 2020.

To mitigate the current saturated traffic condition at Malabe corridor, the government started to introduce an efficient public transport system.

Current situation, which includes the policy & actions, institutional arrangement to implement those policy & actions

National Transport Policy (2009) indicated that the introduction of high occupancy vehicle, which will facilitate the movement of the larger amount of people, will reduce the number of vehicles in an urban area and improve the traffic speed. In addition, the policy also provided some suggestions as follow:

- Introducing light transit system
- Introducing bus rapid transit (BRT) system
- Introducing high priority bus lane
- 1/3rd of existing road space on major highways within a dense urban area be reserved for high occupancy vehicles.
- 1/10th of road space within urban areas reserved for non-motorized transport

Status of the implementation of the NDC, which includes the policy and actions taken to implement the NDC, and any proposed institutional arrangement specific to the NDC

LRT line planned for Malabe corridor (JICA LRT line) is one of the four LRTs planned under Megapolis and Western Development Transport Master Plan. The JICA LRT line is the only line with considerable progress compared to others as it has already completed the feasibility study and secured the finance.

Bus rapid transport (BRT) system project that lead by the Ministry of Transport and Civil Aviation, submitted their NAMA project document to UNDP and waiting to start the implementation process.

Contrarily to previous projects, high priority bus lanes were implemented in Rajagiriya area to study the effect of the project under sensible condition. However, there are debates going on for the application of the project based on the outcome of the study.[20]

[20] http://www.sundaytimes.lk/180304/business-times/bus-priority-lanes-cause-chaos-in-colombo-283982.html

4.1.2 Scope and boundaries of monitoring approach

Causal Chains

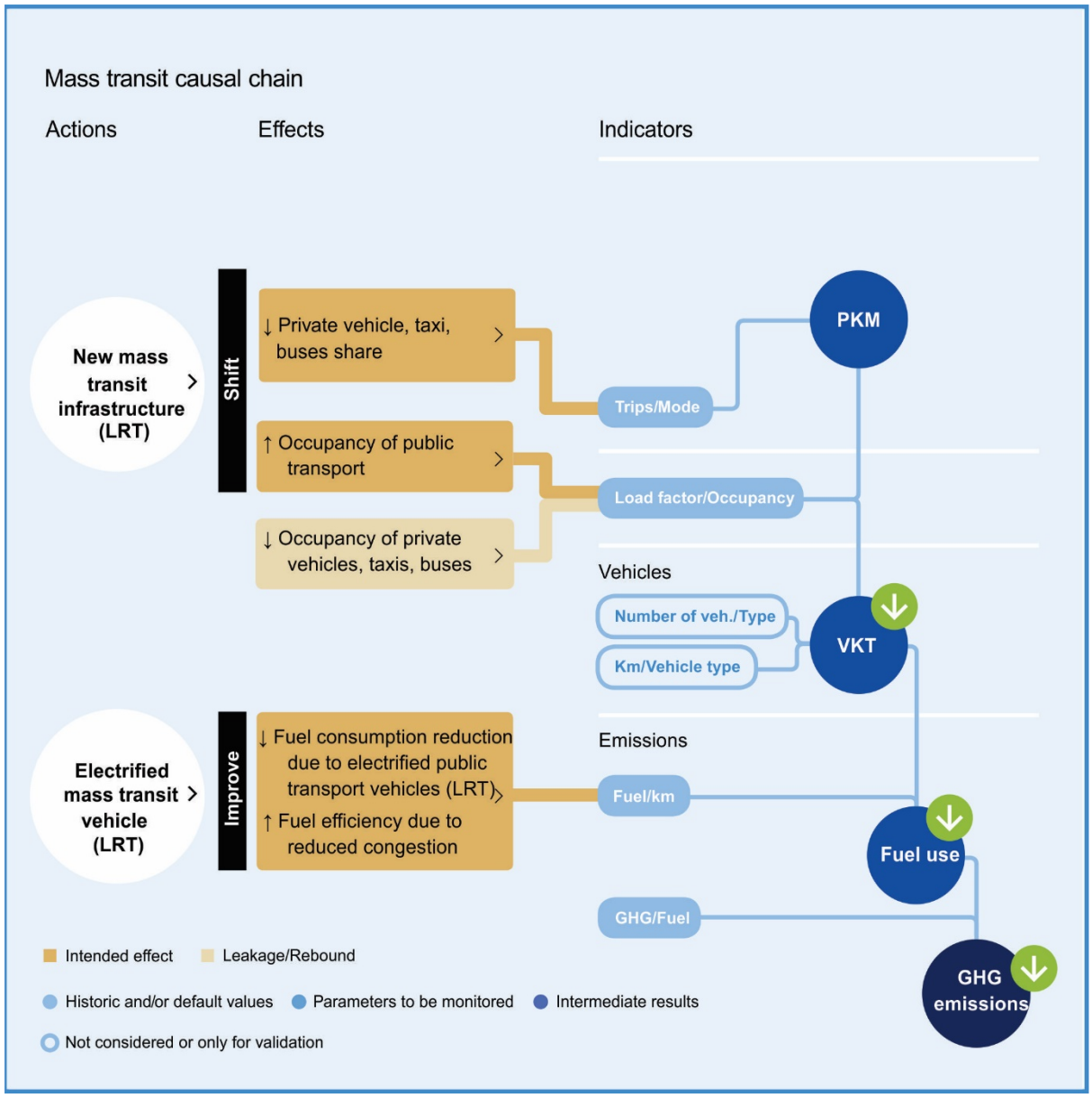


Figure 4.1 Causal Chain for introducing mass transit

Source: Compendium on Greenhouse gas baseline and monitoring

Relevance of effects

Table 4.1 Effects of the mitigation action

Effect	Likelihood	Magnitude
Less fuel use	Very likely	Major
Reduce traffic congestion	Very likely	Major
Reduce air pollution	Very likely	Major
Noise pollution	Very likely	Major

Data availability

Data availability for the projects of shifting passengers from private vehicles to light rail systems

Table 4.2Data availability of baseline scenario

Parameter	Baseline Emission[21] / Indirect Project Emission[2] Description	Unit	Availability Yes	Availability No	Source
$EF_{KM,i,x}$	**Emission factor per kilometer of vehicle category *i* in the year *y* (g CO2/km)** $EF_{KM,i,x} = \left[\sum_n [SFC_{i,n,x} \times NCV_{i,n} \times EF_{CO2,n} + SEC_{i,x} \times EF_{CO2,x}] \times \frac{N_{i,n,x}}{N_{i,x}}\right]$				
$SFC_{i,n,x}$	Specific fuel consumption of vehicle category *i* using fuel type *n* in year *x*	g/km	Yes		In the absence of local and national level specific fuel consumption, 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.

[21]Currently data not available to calculate indirect GHG emissions. Since for the calculation done only for GHG emissions that are directly attached to the distance that going to be replace by JICA LRT line (For the further clarification read section 5.1.5.1. methodological changes)

NCV $_{i,n}$	The net calorific value of fuel *n* used in vehicle category *i*	MJ/g	Yes		IPCC 2006 default values can be used in the absence of national default value
$EF_{CO2,n}$	Emission factor for fuel type n	gCO2/MJ	Yes		IPCC 2006 default values can be used in the absence of national value
Specific weight for fuel type *x* in the year *y*		kg/l	Yes		CEYPETCO website (National default value)
IR_i	Technology improvement factor	no unit	Yes		TOOL18 Methodological tool: Baseline emissions for modal shift measures in urban passenger transport Version 01.0
N $_{i,n,x}$	Number of vehicle-kilometers vehicle category *i* using fuel type *n* driven in year *x* or number of vehicles in vehicle category *i* using fuel type *n* in year *x*	Unit (Number of vehicles)	Yes (National value)		Value will depend on selected LRT project. According to CDM methodological tool 18 , as a last option national data can be used
N $_{i,x}$	Number of vehicle-kilometers of category *i* driven in year *x* or number of vehicles of category *i* in year x	Unit (Number of vehicles)	Yes (National value)		Value will depend on selected LRT project. According to CDM methodological tool 18, as a last option national data can be used
$OC_{i,x}$ or $OC_{B,x}$/$OC_{T,x}$/$OC_{C,x}$/$OC_{MR,x}$	Average occupancy rate of vehicle category *i* in year *x* (e.g.,buses (B), taxis (T), passenger cars (C), motorized rickshaw/bicycle (MR)	Unit (Number of passengers)	Yes		Default values are available in the CDM methodological tool 18. (National values are not available)
EFPKM,i : Emission factor per passenger-kilometre of vehicle category *i* in the year *y* (g CO2/PKM) **Calculated = $EF_{KM,i,y}$ /OC_i**					**Calculate**
BTD,p,i,y	Baseline trip distance *p* per surveyed passenger using mode *i* in the year *y*		km		No	The value will depend on the selected LRT project
IPTD $_{p,y,i}$		Indirect project trip distance of the surveyed passenger using mode "i"	km		No	The value will depend on the selected LRT project

BEp,y Baseline emissions per surveyed passenger *p* in the year *y* (t CO2) $BE_{p,y} = \sum_i BTD_{p,i,y} \cdot EF_{PKM,i,y} \times 10^{-6}$					**Calculate**
IPEp,y Indirect project emissions per surveyed passenger *p* in the year *y* (g CO2) $IPE_{p,y} = \sum_i IPTD_{p,i,y} \times EF_{PKM,i,y}$					**Calculate**
FEXp,y : Expansion factor for each surveyed passenger *p* surveyed in the year *y*					
n_{Ihps}	Number of stations *sp* selected in the stratum *h* (3 stratus are created i.e. high, medium and low passenger flow);	Unit (Number of station)		No	The value will depend on the selected LRT project
N_{Ihps}	Total number of *stations sp* in the stratum *h*	Unit (Number of station)		No	The value will depend on the selected LRT project
n_{ihps}	Number of passengers selected in the station *sp*, in stratum *h*	Passengers		No	The value will depend on the selected LRT project
N_{ihps}	Total number of passengers in the station *sp*, in stratum *h*	Passengers		No	The value will depend on the selected LRT project
P_y	Total number of passengers in the year *y*	Passenger		No	The value will depend on the selected LRT project
P_{SPER}	Number of passengers in the time period of the survey (1 week)	Passenger		No	The value will depend on the selected LRT project

BEy Baseline emissions in the year *y* (g CO2) $BE_y = \frac{P_y}{P_{SPER}} \sum_p \left(BE_{p,y} \cdot FEX_{p,y}\right)$					**Calculate**
IPEy Indirect project emissions in the year *y* (t CO2) $IPE_y = \frac{P_y}{P_{SPER}} \sum_p \left(IPE_{p,y} \cdot FEX_{p,y}\right) \times 10^{-6}$					**Calculate**
MS	Share of passengers using mode *i* for the baseline trip	%	yes		The value will depend on the selected LRT project
	Share of passengers using mode *i* for the project trip				

Table 4.3Data availability of project scenario

Direct Project Emission					
Parameter	**Description**	**Unit**	**Data Availability**		**Source**
			Yes	**No**	
$EF_{grid,CM}$	Emission factor for electricity generation in the grid based on combined margin (gCO_2/kWh)	tCO_2/MWh	Yes		National grid emission factor (Sri Lanka Energy Balance)
TDL	Average technical transmission and distribution losses for providing electricity	percentage	Yes		National grid emission factor (Sri Lanka Energy Balance)
EC_{PJ}	Quantity of electricity consumed by the metro (trains only)	MWh		No	The value will depend on the selected LRT project
DPEy Direct project emissions in the year *y* (t CO2) $DPE_y = EC_{PJ,y} \times EF_{grid,CM} \times (1 + TDL) \times 10^{-6}$					

Table 4.4Data availability of baseline scenario

Parameter	Baseline Emission[22] / Indirect Project Emission[3] Description	Unit	Availability Yes	Availability No	Source
$EF_{KM,i,y}$	**Emission factor per kilometer of vehicle category *i* in the year *y* (g CO2/km)**				
$SFC_{i,n,x}$	Specific fuel consumption of vehicle category *i* using fuel type *n* in year *x*	g/km	Yes		In the absence of local and national level specific fuel consumption, 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.
$NCV_{i,n}$	The net calorific value of fuel *n* used in vehicle category *i*	MJ/g	Yes		IPCC 2006 default values can be used in the absence of national default value
$EF_{CO2,n}$	Emission factor for fuel type n	gCO2/MJ	Yes		IPCC 2006 default values can be used in the absence of national value
Specific weight for fuel type *x* in the year *y*		kg/l	Yes		CEYPETCO website
IR_i	Technology improvement factor	no unit	Yes		TOOL18 Methodological tool: Baseline emissions for modal shift measures in urban passenger transport Version 01.0
$N_{i,n,x}$	Number of vehicle-kilometers vehicle category *i* using fuel type *n* driven in year *x* or number of vehicles in vehicle category *i* using fuel type *n* in year *x*	Unit (Number of vehicles)	Yes (National value)		According to CDM methodological tool 18 , as a the last option national data can be used (Specific project values are not available)
$N_{i,x}$	Number of vehicle-kilometers of category *i* driven in year *x* or number of vehicles of category *i* in year x	Unit (Number of vehicles)	Yes (National value)		According to CDM methodological tool 18, as a the last option national data can be used(Specific project values are not available)
$OC_{i,x}$ or $OC_{B,x}$/$OC_{T,x}$/OC	Average occupancy rate of vehicle category *i* in year *x* (e.g., buses (B), taxis (T),	Unit (Number of	Yes		Preparatory Survey on the Project for Establishment of

[22]Currently data not available to calculate indirect GHG emissions. Since for the calculation done only for GHG emissions that are directly attached to the distance that going to be replace by JICA LRT line (For the further clarification read section 5.1.5.1. methodological changes)

$OC_{C,x}/OC_{MR,x}$	passenger cars (C), motorized rickshaw/bicycle (MR)		passengers)			New Light Rail Transit System in Colombo 2018
EFPKM,i : Emission factor per passenger-kilometer of vehicle category *i* in the year *y* (g CO2/PKM) **Calculated = $EF_{KM,i,y}/OC_i$**						**Calculate**
$BTD_{,p,i,y}$	Baseline trip distance *p* per surveyed passenger using mode *i* in the year *y*		km	Yes		Preparatory Survey on the Project for Establishment of New Light Rail Transit System in Colombo 2018
$IPTD_{PS,i}$		Indirect project trip distance of the surveyed passenger using mode "i"	km		No	Preparatory Survey on the Project didn't considered the data relevant to project indirect emissions
BEp,y Baseline emissions per surveyed passenger *p* in the year *y* (t CO2) $BE_{p,y} = \sum_i BTD_{p,i,y} \cdot EF_{PKM,i,y} \times 10^{-6}$						**Calculate**
IPEp,y Indirect project emissions per surveyed passenger *p* in the year *y* (g CO2) $IPE_{p,y} = \sum_i IPTD_{p,i,y} \times EF_{PKM,i,y}$						**Calculate** (Not enough data to do the calculation)
FEXp,y : Expansion factor for each surveyed passenger *p* surveyed in the year *y*						
n_{Ihps}	Number of stations *sp* selected in the stratum *h* (3 stratus are created i.e. high, medium and low passenger flow);		Unit (Number of station)	Yes		Preparatory Survey on the Project for Establishment of New Light Rail Transit System in Colombo 2018
N_{Ihps}	Total number of *stations* sp in the stratum *h*		Unit (Number	Yes		Preparatory Survey on the Project for Establishment of

		of station)			New Light Rail Transit System in Colombo 2018
n_{ihps}	Number of passengers selected in the station *sp*, in stratum *h*	Passengers	Yes		Preparatory Survey on the Project for Establishment of New Light Rail Transit System in Colombo 2018
N_{ihps}	Total number of passengers in the station *sp*, in stratum *h*	Passenger	Yes		Preparatory Survey on the Project for Establishment of New Light Rail Transit System in Colombo 2018
P_y	Total number of passengers in the year *y*	Passenger	Yes		Preparatory Survey on the Project for Establishment of New Light Rail Transit System in Colombo 2018
P_{SPER}	Number of passengers in the time period of the survey (1 week)	Passenger	Yes		Preparatory Survey on the Project for Establishment of New Light Rail Transit System in Colombo 2018
BEy Baseline emissions in the year *y* (g CO2) $BE_y = \frac{P_y}{P_{SPER}} \sum_p (BE_{p,y} \cdot FEX_{p,y})$					**Calculate**
IPEy Indirect project emissions in the year *y* (t CO2) $IPE_y = \frac{P_y}{P_{SPER}} \sum_p (IPE_{p,y} \cdot FEX_{p,y}) \times 10^{-6}$					**Calculate**
MS	Share of passengers using mode *i* for the baseline trip Share of passengers using mode *i* for the project trip	%	Yes		Preparatory Survey on the Project for Establishment of New Light Rail Transit System in Colombo 2018

Table 4.5 Data availability of project scenario

Direct Project Emission					
Parameter	**Description**	**Unit**	**Data Availability**		**Source**
			Yes	**No**	
$EF_{grid,CM}$	Emission factor for electricity generation in the grid based on combined margin (gCO_2/kWh)	tCO_2/MWh	Yes		Since the Preparatory Survey on the Project not verified by responsible parties, calculation is done using the national default value from "National Energy Balance"

TDL	Average technical transmission and distribution losses for providing electricity[23]	percentage	Yes		Since the Preparatory Survey on the Project not verified by responsible parties, calculation is done using the national default value from "National Energy Balance"
$EC_{PJ,y}$	Quantity of electricity consumed by the metro (trains only)	MWh	Yes		Preparatory Survey on the Project for Establishment of New Light Rail Transit System in Colombo 2018

DPEy Direct project emissions in the year *y* (t CO2)

$$DPE_y = EC_{PJ,y} \times EF_{grid,CM} \times (1+TDL) \times 10^{-6}$$

Assessment boundary

The physical boundary of the project is from IT Park at Malabe to Pettah/Fort. The route contains 16 stations including IT Park and Pettah station.

Figure 4.2Stations recognized by JICA LRT line

In real project scenario as well as in the methodology ACM0016 were designed to cover both direct and indirect project emissions. However, the absence of sufficient data and information restricted the calculation only to direct emissions during this assessment. In consideration of that situation, this assessment only covered the part of the ride in LRT from Malabe to Petah.

[23]Current T and D loss used in the process of calculating project GHG emissions

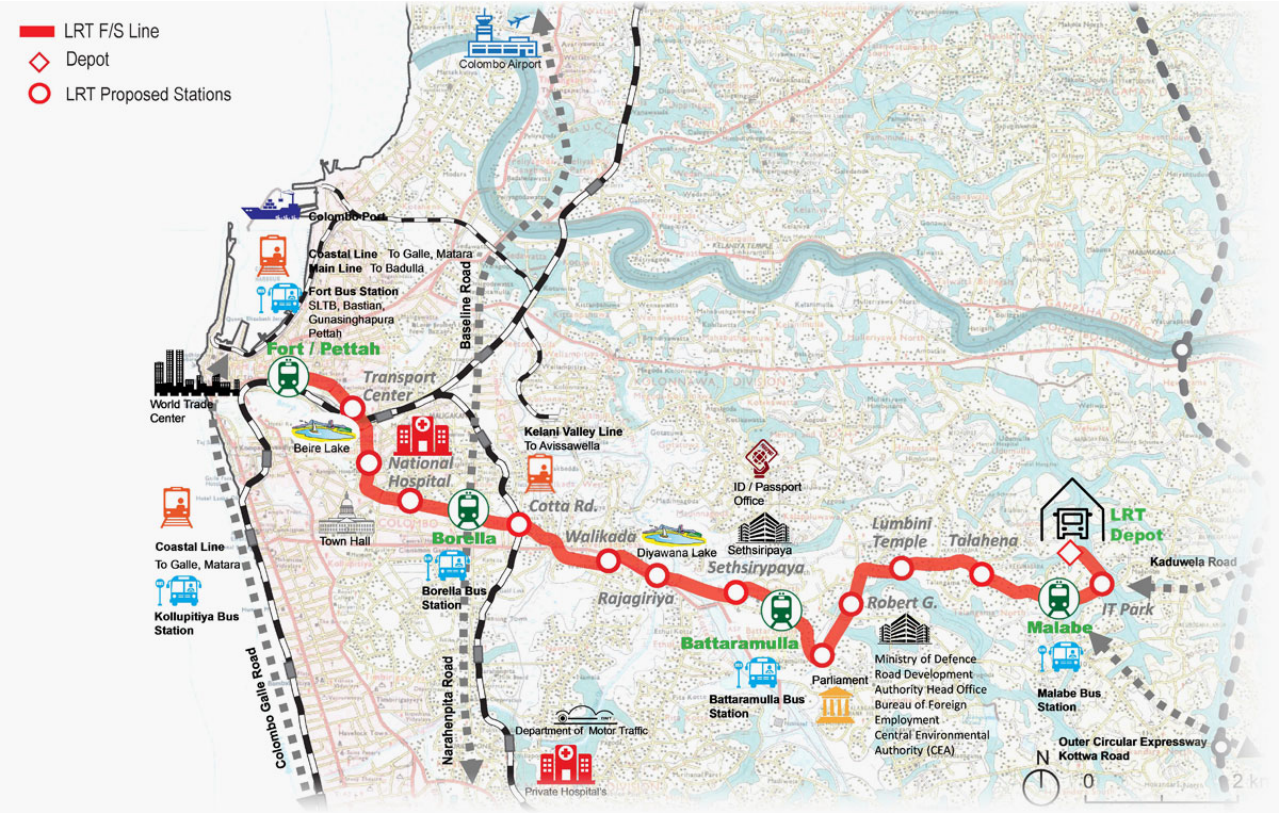


Figure 4.3Boundary of the JICA LRT line

System boundaries

Table 4.6System boundaries

Boundary elements	Description
Temporal boundary	2021 - 2030
Sectoral boundary	The MRV approach covers passengers transported by JICA LRT from Malabe to Petah.
Territorial boundary	The spatial extent of the project boundary encompasses the larger urban zone of the city in which the project takes place The project boundary also includes the power plants connected physically to the electricity system that supply power to the project, and/or the captive power plant.
GHGs included[24]	

[24]Methodology has calculation procedure described for all three GHGs, CO_2, CH_4 and N_2O. But in this document we limited to calculate only CO_2 emission due to absence of sufficient data.

	Source	Gas	Included	Justification/Explanation
Baseline	Mobile source emissions of different modes of transport due to the trips made by the passengers using the LRTs	CO_2	Yes	Major emission source
		CH_4	Yes	Included only if gaseous fuels are used and excluded for liquid fuels. CH_4 emissions are a minor emission source of the total CO_2e emissions in diesel/gasoline vehicles Neglecting these emissions in the baseline as well as project emissions is conservative as fuel consumption and thus also CH_4 emissions are reduced through the project
		N_2O	No	N_2O emissions are a minor source of the total CO_2e emissions. Neglecting these emissions in the baseline as well as project emissions is conservative as fuel consumption and thus also N_2O emissions are reduced through the project
Project activity	Mobile source emissions of the LRT due to the trips made by the passengers using it	CO_2	Yes	Major emission source
		CH_4	Yes	Included only if gaseous fuels are used. See argument above
		N_2O	No	See argument above
	Mobile source emissions of different modes of transport due to the trips made by the passengers using the MRTS, from their trip origin to the MRTS and from the MRTS to	CO_2	Yes	Major emission source
		CH_4	Yes	Included only if gaseous fuels are used. See argument above
		N_2O	No	See argument above

		their trip destination			

Source : ACM 0016: Large-scale Consolidated Methodology Mass rapid transit projects

4.1.3 Methodology

Short explanation of the methodology

ACM0016: Baseline Methodology for Mass Rapid Transit Projects; Version 4.0 is the methodology that assorted for the project. This methodology applies to the project activities that established and operate a rail-based and bus-based mass rapid systems in the urban or suburban region. The methodology can apply to the GHG mitigation actions that increase energy efficiency by displacement of high GHG intensive transport modes with low GHG intensive modes.

This methodology also cites to the following approved version of tools.

- "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

Characteristics of the methodology is given in Annex 1

Table 4.7Characteristics of Methodology

Applicability	
Scope	Ex-post focus; Leakage: bus and taxi occupancy change, congestion effect on fuel efficiency and induced trips, upstream emissions of gaseous fuels
Methodology documentation	Excellent
Data collection guidance	Excellent Includes survey template and guidance
Defaults provided	Technology improvement factor, Capacity restraint factor, IPCC upstream, fuel emission factors
Cost of tool	Free

Source: Compendium on Greenhouse Gas Baselines and Monitoring, 2018

Key indicator

$$BE_y = \frac{P_y}{P_{SPER}} \sum_p (BE_{p,y} \cdot FEX_{p,y}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Equation$$

Table 4.8Baseline key indicators

BE_y	Baseline emissions in year y (t CO_2)
$BE_{p,y}$	Baseline emissions per surveyed passenger p in year y (t CO_2)
$FEX_{p,y}$	Expansion factor for each surveyed passenger p surveyed in year y (each surveyed passenger has a different expansion factor)
P_y	Total number of passengers in year y
P_{SPER}	Number of passengers in the time period of the survey (1 week)
p	Surveyed passenger (each individual)
y	Year of the crediting period

$$PE_{EC,y} = \sum_i EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Equation$$

Table 4.9 Project key indicators

$PE_{EC,y}$	Direct project emissions from electricity consumption in year *y* (t CO_2)
$EC_{PJ,j,y}$	Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)
$EF_{EL,j,y}$	Emission factor for electricity generation for source j in year y (tCO_2/MWh)
$TDL_{j,y}$	Average technical transmission and distribution losses for providing electricity to source j in year y

4.1.3.1 Baseline Scenario

Identification of baseline scenario[3]

1. Identification of alternative scenarios that are consistent with current policy, laws and regulations

Five baseline aalternatives were identified for the mitigation action, "shift passengers from private to public transport by introducing LRT line with park and ride", as follow:

- BRT (Bus Rapid Transit)
- high priority bus lanes
- LRT
- Metro
- Use private vehicles

Baseline alternative 1: BRT with park and ride - There were some attempts to introduce BRT system with electric buses. However, there is no progress with this.

Baseline alternative 2: High priority bus lanes - Ministry of Megapolis and Western Development (MMWD) introduced a high priority bus lane from Battaramulla to Rajagiriya in 2018 during the peak hours. However, it was not supported by the park and ride facilities. As such, this cannot be considered as a similar alternative to the proposed mitigation action.

Baseline alternative 3: LRT with park & ride - The proposed mitigation action has completed the feasibility study and secured the finance with US$ 1,800 million concessionary loan from Japan. In the absence of the concessionary loan, the mitigation action would not have been implemented.

Baseline alternative 4: Metro system with park & ride - There were some discussions to develop a metro system. However, there is no progress yet.

Baseline alternative 5: Use private vehicles - The current practice is to use personal vehicles to travel from Malabe to Colombo Fort. In the absence of the proposed mitigation action, the most likely scenario is the continuation of the current practice.

2. **Assessment of Options**

Feasibility of each option can be compared by considering the following characteristics

Table 4.10 Comparison BRTs, MRTs and Metros[25]

Characteristic	BRT / Bus lane	LRT / Tram /Monorail	Metro
Segregation	Mostly at-grade	Mostly at-grade	Mostly elevated or underground
Passenger carrying capacity (phd[26])	15-35,000	11-20,000	up to 60,000
Initial cost (million USD/km)	13 -20	10-30	15 - 180 (depend on segregation)
Space requirement	2-4 lanes taken away from existing road space	2-3 lanes taken away from existing road space	Little impact on existing road

Based on the existing phd in the project area Metro and BRT system are not feasible as they can serve for an area with higher passenger density.

Table 4.11Demand forecast of Malabe to Fort (JICA LRT line)[27]

Indicator	2020	2025	2035
PHD	11,500	14,300	19,800
Max Section	Cotta Rd. - Walikada	Cotta Rd. - Walikada	Cotta Rd. - Walikada
Daily Passengers	295,000	363,000	498,000
Daily Passenger-km	1,736,000	2,087,000	2,787,000

Metro systems have a higher cost compared to other systems. BRT systems have comparable cost, but the space requirement of the system is higher than the other systems. JICA – LRT line proposed to be mostly elevated rail system. As such, LRT system has little impact on the existing road.

Other than that government of Sri Lanka decided LRT as the mode due to following reasons[28].

- There are only a limited number of monorail manufacturers worldwide, which constrains the competitiveness of the bidding process.

[25] CDM Project Cable Cars Metro Medellín, Colombia, Version 1.4, Table 3 & 4. page 15 and Mode-shift of passengers from private vehicles to MRTS for Gurgaon metro, Version 1.3, Table 5. page 15

[26] passengers per hour per direction

[27] **Final Report**: Preparatory Survey on The Project for Establishment of New Rail Transit System in Colombo, Table 2.2.1. page executive summary 6

[28] **Final Report**: Preparatory Survey on The Project for Establishment of New Rail Transit System in Colombo, page 2-11

- With the monorail, it is difficult to expand the lines in the future because other MMWD's proposed RTS lines are LRT, and it is also difficult to increase the number of cars for the monorail due to the difficulty of technical configuration.
- Certain sections of MMWD's other RTS lines in the suburban area will operate at-grade, which is impossible to introduce the monorail.
- The unfamiliarity of maintenance and inspection works of a monorail system in Sri Lanka.

Ultimately main purpose of the NDC 4.1 is to introduce park and ride system. Proposed JICA -LRT system clearly mentioned it will be associated with park and ride system. JICA – LRT line accommodates for 2 park and ride facilities as well as 2 MmTHs[29] and 3 MMCs[30] which are with park and ride facility.

Baseline scenario: *Use of private vehicles to transport passengers from Malabe to Colombo Fort.*

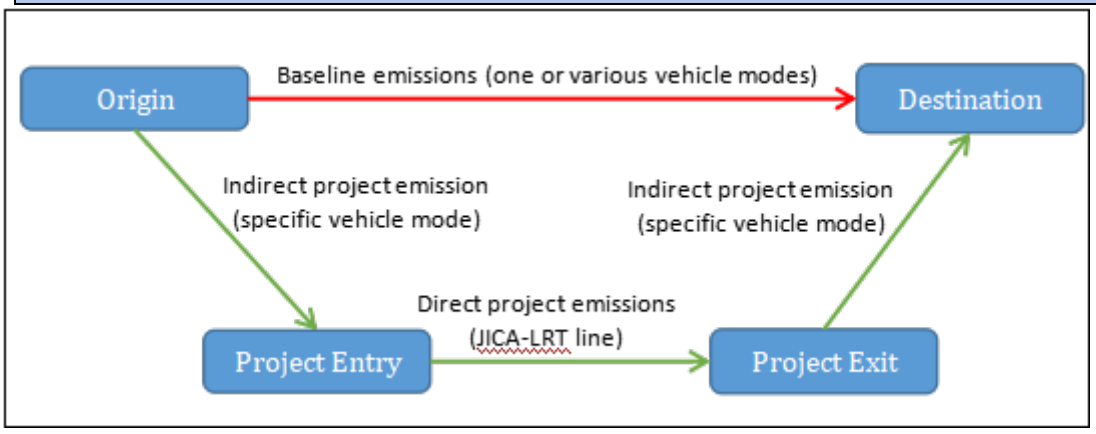


Figure 4.4Baseline and Project emissions

Data Needs

Table 4.12Necessary data for baseline calculation

Parameter	Baseline Emission[31]	Indirect Project Emission[3]	Unit	Availability		Necessity
	Description			Yes	No	
$EF_{KM,i,y}$	Emission factor per kilometer of vehicle category *i* in the year *y* (g CO2/km)					

[29] Multi-modal Transport Hub

[30] Multi-modal Center

[31] Currently data not available to calculate indirect GHG emissions. Since for the calculation done only for GHG emissions that are directly attached to the distance that going to be replace by JICA LRT line (For the further clarification read section 5.1.5.1. methodological changes)

$SFC_{i,n,x}$	Specific fuel consumption of vehicle category *i* using fuel type *n* in year *x*		g/km	Yes		Need
$NCV_{i,n}$	The net calorific value of fuel *n* used in vehicle category *i*		MJ/g	Yes		Need
$EF_{CO2,n}$	Emission factor for fuel type n		gCO2/MJ	Yes		Need
Specific weight for fuel type *x* in the year *y*			kg/l	Yes		Need
IR_i	Technology improvement factor		no unit	Yes		Need
$N_{i,n,x}$	Number of vehicle-kilometers vehicle category *i* using fuel type *n* driven in year *x* or number of vehicles in vehicle category *i* using fuel type *n* in year *x*		Unit (Number of vehicles)	Yes (National value)		Need
$N_{i,x}$	Number of vehicle-kilometers of category *i* driven in year *x* or number of vehicles of category *i* in year x		Unit (Number of vehicles)	Yes (National value)		Need
$OC_{i,x}$ or $OC_{B,x}$/$OC_{T,x}$/$OC_{C,x}$/$OC_{MR,x}$	Average occupancy rate of vehicle category *i* in year *x* (e.g.,buses (B), taxis (T), passenger cars (C), motorized rickshaw/bicycle (MR)		Unit (Number of passengers)	Yes		Need
EFPKM,i : Emission factor per passenger-kilometre of vehicle category *i* in the year *y* (g CO2/PKM) **Calculated = $EF_{KM,i,y}$ /OC_i**						**Calculate**
$BTD_{,p,i,y}$	Baseline trip distance *p* per surveyed passenger using mode *i* in the year *y*		km	Yes		Need
$IPTD_{PS,i}$		Indirect project trip distance of the surveyed passenger using mode "i"	km		No	Need. But data not available to calculate indirect GHG emissions

BEp,y Baseline emissions per surveyed passenger *p* in the year *y* (t CO2) $BE_{p,y} = \sum_i BTD_{p,i,y} \cdot EF_{PKM,i,y} \times 10^{-6}$					**Calculate**
IPEp,y Indirect project emissions per surveyed passenger *p* in the year *y* (g CO2) $IPE_{p,y} = \sum_i IPTD_{p,i,y} \times EF_{PKM,i,y}$					**Calculate** (Not enough data to do the calculation)
FEXp,y : Expansion factor for each surveyed passenger *p* surveyed in the year *y*					
n_{Ihps}	Number of stations *sp* selected in the stratum *h* (3 stratus are created i.e. high, medium and low passenger flow);	Unit (Number of station)	Yes		Need
N_{Ihps}	Total number of *stations sp* in the stratum *h*	Unit (Number of station)	Yes		Need
n_{ihps}	Number of passengers selected in the station *sp*, in stratum *h*	Passengers	Yes		Need
N_{ihps}	Total number of passengers in the station *sp*, in stratum *h*	Passenger	Yes		Need
Py	Total number of passengers in the year *y*	Passenger	Yes		Need
P_{SPER}	Number of passengers in the time period of the survey (1 week)	Passenger	Yes		Need
BEy Baseline emissions in the year *y* (g CO2) $BE_y = \frac{P_y}{P_{SPER}} \sum_p \left(BE_{p,y} \cdot FEX_{p,y}\right)$					**Calculate**
IPEy Indirect project emissions in the year *y* (t CO2) $IPE_y = \frac{P_y}{P_{SPER}} \sum_p \left(IPE_{p,y} \cdot FEX_{p,y}\right) \times 10^{-6}$					**Calculate**

All the necessary data for the baseline calculation is available on the project level or national level. Data obtained according to the methodology ACM0016.

Baseline emission calculation

The proposed base year for the calculation is 2010 (Sri Lankan NDC, 2016). But the JICA LRT project still far from operating. Since it is impossible to obtain actual activity data to calculate baseline and project emissions. For the calculation, we obtained estimated data for 2035 via the feasibility study of JICA LRT line.

According to the CDM methodology, the baseline emissions are calculated per passenger in the surveyed period and multiplied with the total number of passengers transported per year. The survey should be conducted to calculate individual baseline emissions. Then calculated individual baseline emissions are multiplied with individual expansion factor to getting the baseline emissions of all passengers of the specific period surveyed.

According to the calculations baseline emissions for the year 2010 is 15,847 tCO_2e.

Uncertainties

In the absence of sufficient information, it is assumed that the preparatory survey covered all the passengers from all sixteen stations in order to calculate the expansion factor.

4.1.3.2 Ex ante GHG impact assessment

Methodological changes

ACM0016 covers both direct and indirect emissions associated with the mitigation action. Due to the unavailability of the sufficient data, the indirect emissions associated with the transport of before or after using JICA LRT line was not included in the calculation. However, the direct emissions attributed to LRT line was considered.

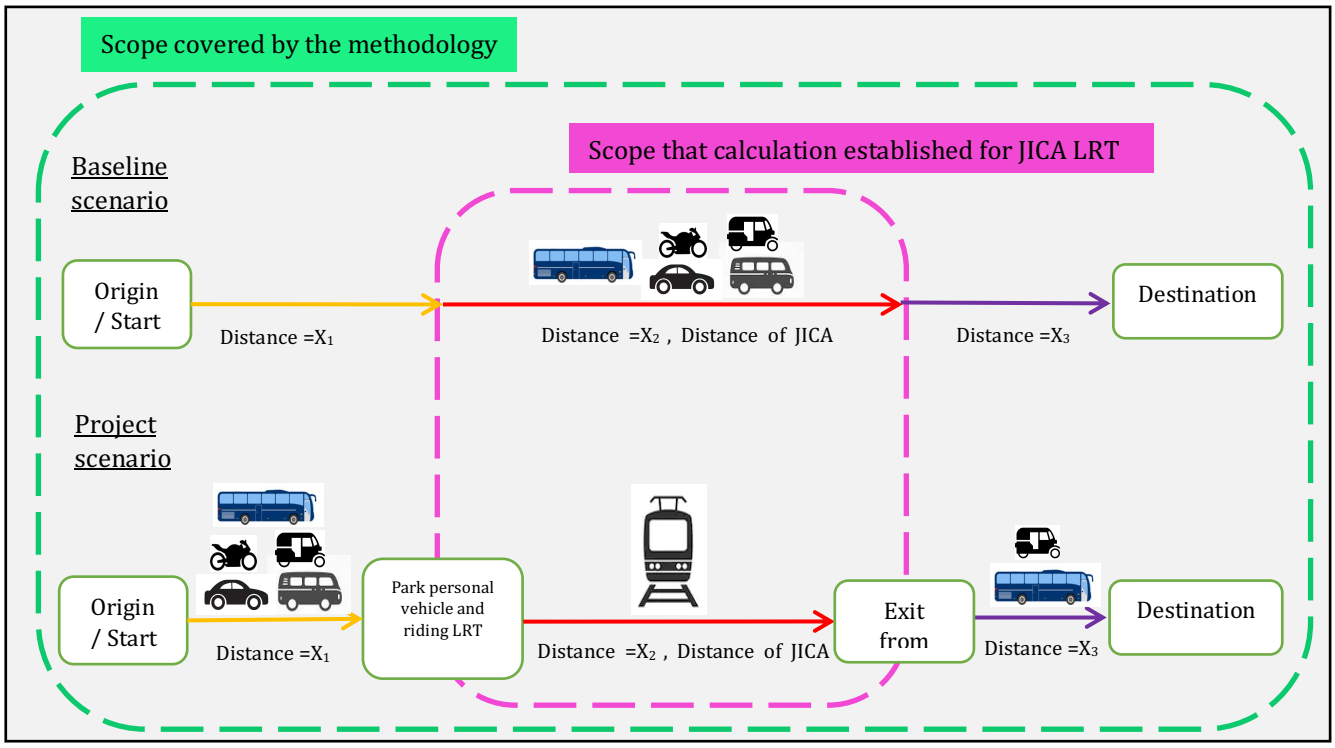


Figure 4.5Methodological changes

BAU and project Scenarios

According to the calculations project emissions for the year 2035 is 22,325 tCO_2. Back casting was done based on the available GDP (Annex 2).

Assumption: Data available only for the year 2035, which were included in the feasibility study prepared by project consultation agencies. In consideration of that reverse calculations were done to estimate GHG emissions of the years 2010, 2018 and 2025. However in real scenario baseline emission should calculate first to predict project emission.

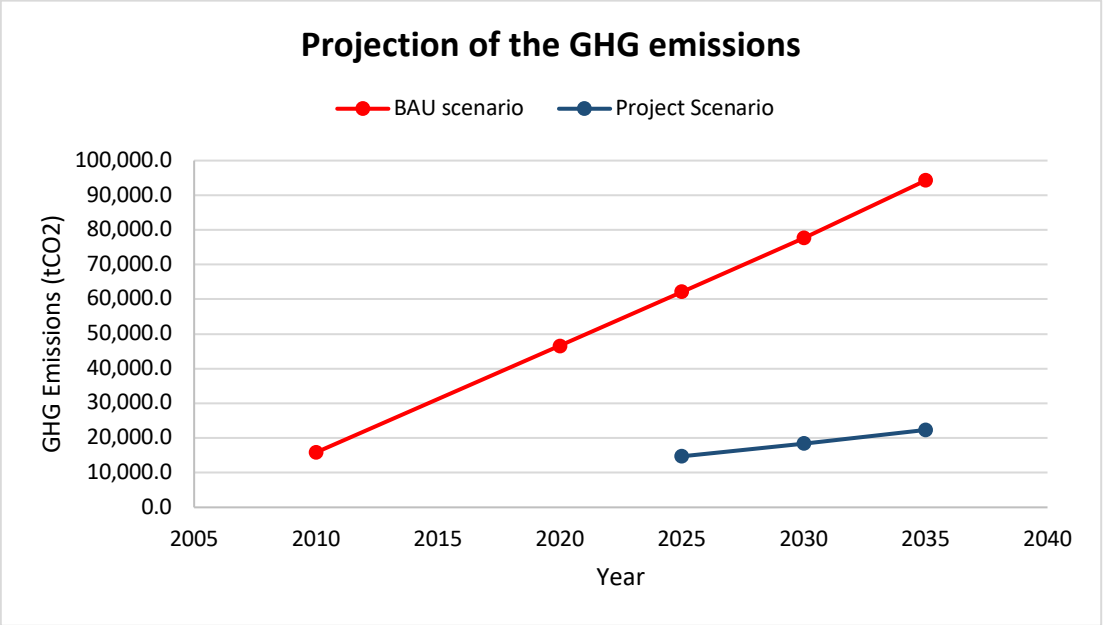


Figure 4.6GHG Impact form Implementing JICA LRT Line

As illustrated in Figure 4.5, proposed mitigation action will reduce emission by 59,266 tCO_2e in year 2030.

Direct effects of mitigation action

- Emission reduction per passenger km is 70.72 gCO_2 (emission factors for passenger transport from road and LRT are 92.67 and 21.95 gCO_2/passenger km respectively)

4.1.3.3 Ex post assessment

The following data will be provided by the O & M Company under Colombo LRT project. Some of the data will be collected for seven consecutive days for a year through a survey. The total number of passenger per year will be estimated using the number of ticket sales for the relevant year. The quantity of electricity consumption will be recorded using electricity bills or meter readings.

Table 4.13 Data requirement from O & M Company (Ex-post)

Data requirement	Indicator	Unit
Number of vehicle-kilometres vehicle category *i* using fuel type *n* driven in year *x* or number of vehicles in vehicle category *i* using fuel type *n* in year *x*	$\mathbf{N}_{i,n,x}$	Vehicles
Number of vehicle-kilometers of category *i* driven in year *x* or number of vehicles of category *i* in year x	$\mathbf{N}_{i,x}$	Vehicles
Number of passengers selected in the station *sp*, in stratum *h*	$\mathbf{n}_{ihps}$	Passengers
Total number of passengers in the station *sp*, in stratum *h*	$\mathbf{N}_{ihps}$	Passengers
Number of passengers in the time period of the survey (1 week)	$\mathbf{P}_{SPER}$	Passengers
Total number of passengers in the year *y*	$\mathbf{P}_{y}$	Passengers
Quantity of electricity consumed by the project LRT per year	$\mathbf{EC}_{PJ,y}$	MWh
Baseline trip distance *p* per surveyed passenger using mode *i* in the year *y*	$\mathbf{BTD}_{,p,i,y}$	km
Indirect project trip distance of the surveyed passenger using mode "i"	$\mathbf{IPTD}_{p,y,i}$	km

Following data will be provided by SLSEA

Table 4.14 Data requirement from SLSEAs

Data requirement	Indicator	Unit
CO_2 emission factor of grid electricity	EF_{elec}	$kgCO_2/kWh$
Average technical transmission and distribution losses for providing electricity to source *j* in year *y*	*TDL*	%

Following data will be provided by CPSTL

Table 4.15 Data requirement from CPSTLs

Data requirement	Indicator	Unit

Net calorific value of fuel i	NCV_i	TJ/t
The density of fuel i	D_i	kg/m^3

For more detail please refer to procedures. P1, P3 and P9 for O & M Company, SLSEA and CPSTL respectively.

4.1.4 Institutional arrangement

Institutional set up for implementation of mitigation action

Key internal institution responsible for the implementation of the action

Implementing agency: Project Management Unit (PMU) under Ministry of Megapolis and Western Development

Ministry of Megapolis and Western Development (Project Management Unit)

Ministry of Megapolis and Western Development (MMWD) established according to provisions published in the Extra Ordinary Gazette No.1933/13 dated 21st September 2015. The main focus of the MMWD is to plan and develop the Western Province of Sri Lanka.

Roles and responsibilities of institution engaged in the implementation of the action

It is significant to understand each institution mandatory functions to prepare full functional MRV system in the transport sector. The mandated functions of MMWD can be listed as below.

- Formulation of policies, programs and projects, monitoring and evaluation in regard to the subjects of megapolis and Western development, and those subjects that come under the purview of Departments, statutory Institutions and Public Corporations of the Ministry.

- Kottawa, Kaduwela and Kadawatha Township Development Project and related activities.
- Integrated and systematic promotion and regulation of economic, social and physical development of urban areas.
- Urban Solid Waste Management.
- Matters relating to reclamation and development of low-lying areas.
- Provide necessary guidance to develop urban areas low level of services and facilities and marshy land according to a common plan.
- Preparation of National Physical Plans and Regional Physical Plans.
- Direct and regulate all construction work on the basis of National Physical Plans in integrated urban development.
- Matters relating to all other subjects assigned to the institutions coming under the purview of the Ministry.
- Supervision of the institutions coming under the purview of the Ministry.

We can observe the absence of proper mandates to implement MRV system at the MMWD after scrutinizing the mandates.

MMWD is responsible for executes all the light rail projects. Responsible party to implements of JICA – LRT system is JICA-LRT Project Management Unit (JICA – LRT PMU) under MMWD. Nonetheless, JICA – LRT PMU responsible for implement the project, MMWD expects to assign an O & M Company to accomplish operational and management performance after implementing the project.

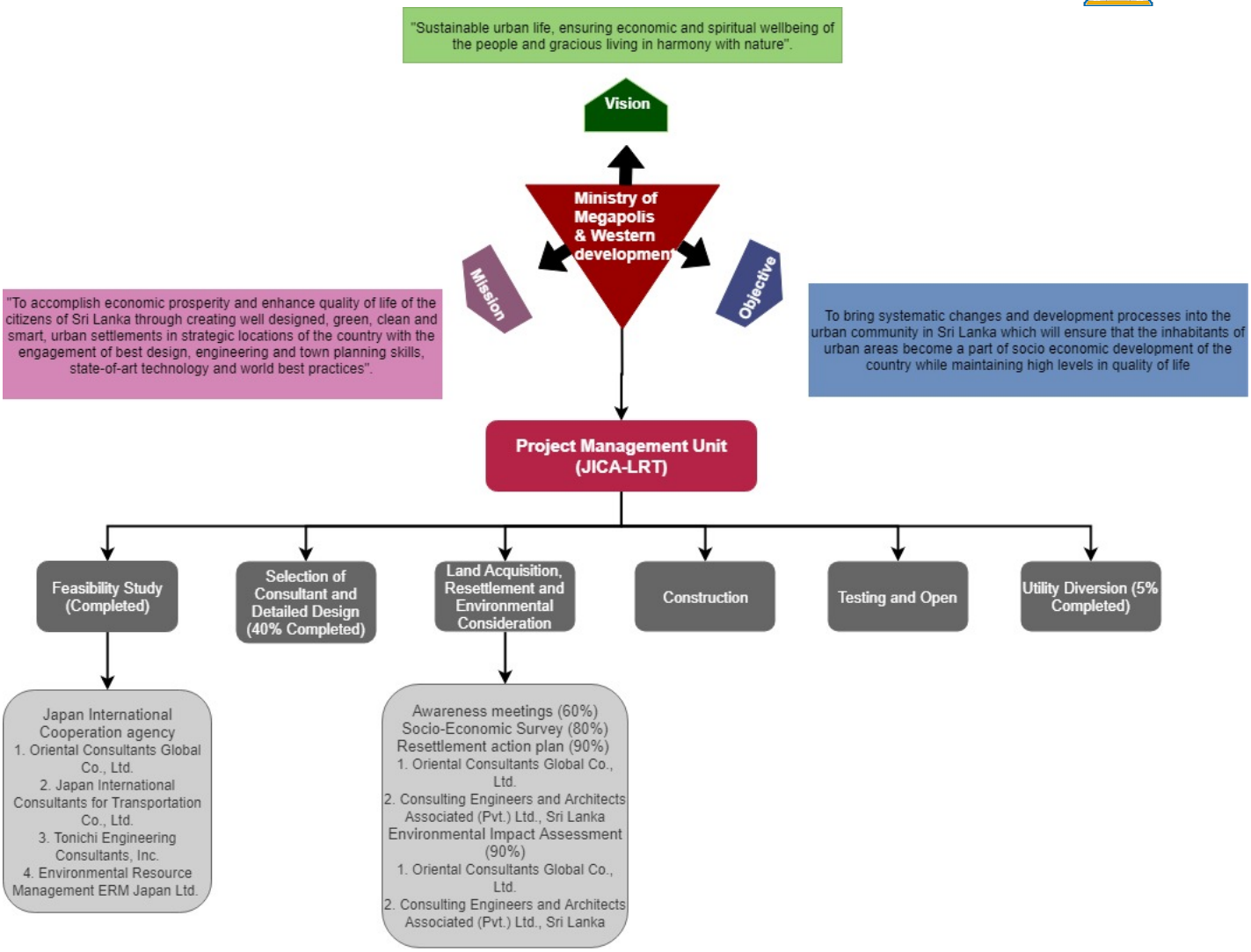


Figure 4.7Illustrates the governance structure to implement the JICA – LRT project and responsible parties to implementation of the project.

Institutions responsible for measurement the indicators and reporting the GHG effects

Ministry of Megapolis and Western Development (O & M Company)

O & M Company will be responsible for operational and management performance as indicated previously. In consideration of that, the MRV system should be established complementing the O & M Company of JICA – LRT system.

Since O & M Company is a proposed entity, it doesn't have attributed mandatory functions. However, it is recommended that the urban railway be managed by another legislative system from the national railway in Sri Lanka. A new act for JICA – LRT system in the process of establishing by PMU under MMWD.

Sri Lanka Sustainable Energy Authority

The Sri Lanka Sustainable Energy Authority (SLSEA) was established on 1st October 2007 for the necessity of having a liable institution to drive Sri Lanka toward a new level of sustainability in energy generation and usage. The SLSEA is responsible for enacting the Sri Lanka Sustainable Energy Authority Act No. 35 of 2007.

Institutional set up for measurement and reporting GHG effects

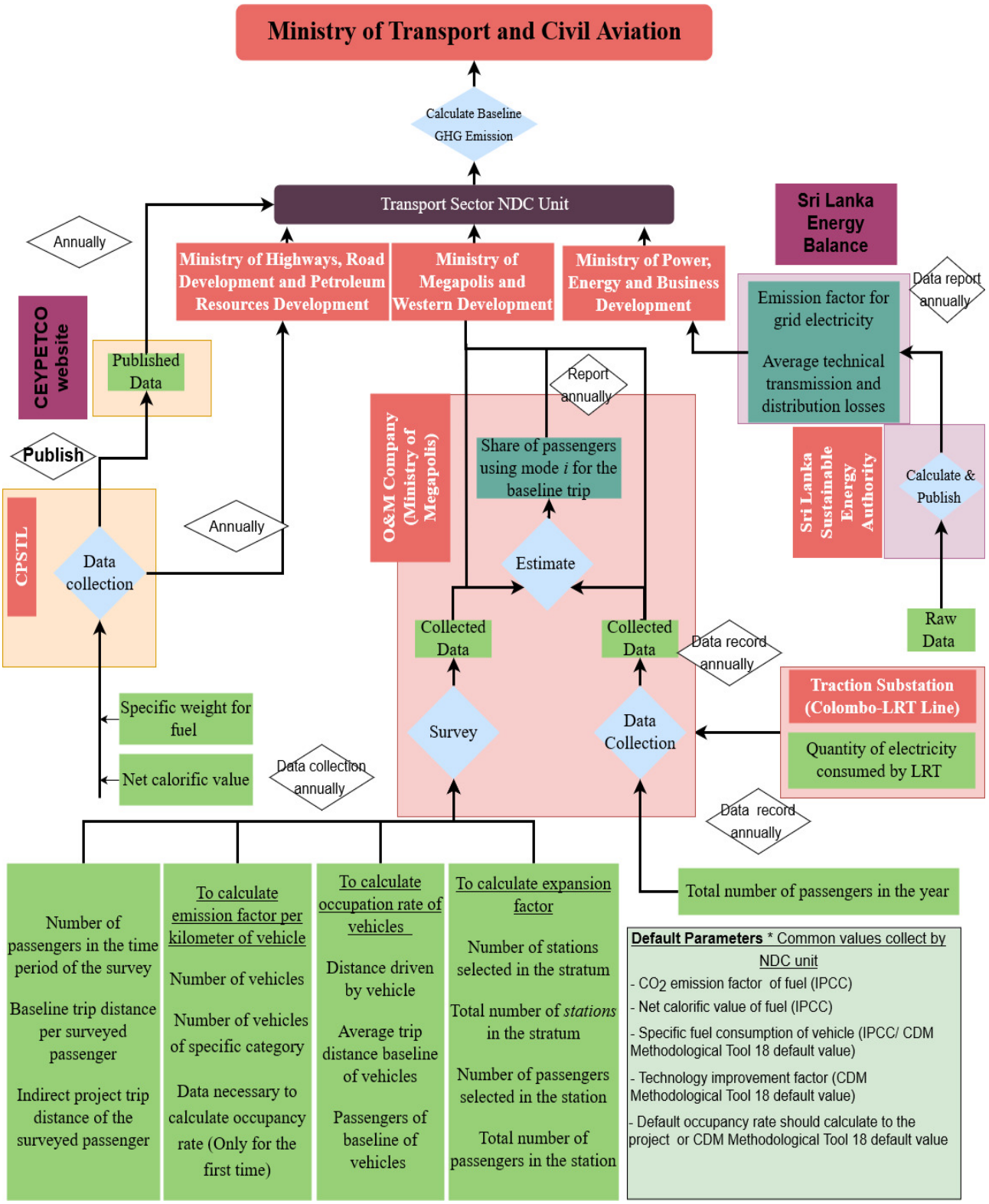


Figure 4.8Proposed data management system for JICA LRT project

As Figure 4.8 illustrates, an annual survey will be conducted by O & M company to collect number of passengers in the time period of the survey, baseline & indirect project distance per surveyed passenger, number of vehicles in different categories, necessary data to calculate occupancy rate, number of station selected from each stratum, number of passengers in the station at the time of the survey, total number of passengers in the station and number of vehicles. The total number of passengers will be counted using the annual ticket sales while the share of passengers per mode will be estimated using survey data and the total number of passengers. The quantity of electricity consumption will be recorded by O & M company using meter reading or electricity bills. Finally, the consolidated data will be transferred to the NDC unit through MMWD.

Further, net calorific value and density of the fuel will be measured and entered into the SAP ERP system of the CPSTL by the laboratory. All data will be monitored and recorded by the distribution unit. Data will be processed by the system and annually reported to the NDC unit. Grid emission factor calculated by data collected from CEB and other independent power plants will be submitted to the NDC unit by SLSEA annually.

Table 4.16Roles and responsibilities of each institute

Institution	Responsibility related to the project
O & M Company	Conducting a survey to collect • Direct and indirect trip distances for each passenger, • Specific fuel consumption and • Number of vehicles parked (according to each vehicle type) etc. • Reporting data to MMWD
Traction Sub-station (JICA LRT line)	• Collecting electricity consumption of the JICA LRT line.
Ministry of Megapolis and Western Development	• Reporting data of O & M Company to NDC unit under Ministry of Transport and Civil Aviation
CEYPETCO	• Publishing specific weight of fuels in their official website
Sri Lanka Sustainable Energy Authority	• Publishing emission factor for grid electricity and average transmission and distribution loss in Sri Lanka Energy Balance.

4.1.5 Verification

Respective institutions will report the required data annually to the MTCA. Quality and the accuracy of the data provided will be verified by the NDC unit of MTCA. In addition, GHG impact of concerned mitigation action will also be calculated by the NDC unit. Accuracy of the calculations will be verified by an independent third party, the MRV expert committee to be appointed by the MMDE. Approved results will be submitted to the CCS of MMDE who will submit the results to the UNFCCC. More information on the institutional arrangement is given in Chapter 05.

As illustrated in data management system, data will be required from institutions that are not regulated by the MTCA. Therefore strengthening the legal provisions of the NDC unit will be essential for the proper verification process.

4.1.6 Recommendations

O & M company under the Colombo light rail system (LRT) is yet to be established. Since there isn't any established data management system for the LRT project. Therefore, it will be suitable to establish a web-based data management system that will be providing easy access to data and data management. Furthermore, it will be better to establish a legal framework for the LRT system that encourages the GHG emission reduction. Finally, It will be appropriate to assign an officer under each section at O & M Company who will be responsible for collecting and managing the data relevant to GHG emission.

4.2 Freight shift from road to rail

4.2.1 Description of the mitigation action

Mitigation action: The proposed mitigation action involves shifting the freight transport from road to rail. In the absence of rail, same amount would have been transported by diesel powered road transport.

Application of the mitigation action: The proposed mitigation action involves transporting 243 million liter of aviation fuel annually from Kolonnawa main terminal to Katunayaka bulk depot by rail-based oil wagons (existing). In the absence of rail, this amount would have been transported by 7,381road based diesel bowsers. As such, the proposed mitigation action aims to shift transportation of aviation fuel from road-based diesel bowsers to rail based oil wagons. Distribution of aviation fuel from Kolonnawa main terminal to Katunayaka bulk depot has considered as the geographical boundary.

The proposed mitigation action is an action under sub NDC 9.4 (transport of heavy loads by railway) of NDC 9 (reduce traffic congestion in order to reduce GHG emission. This mitigation action is also in line with the ASI (Avoid-Shift-Improve) approach. The mitigation action is a part of the shift strategy, which aims to achieve significant GHG reduction, reduce energy consumption, less congestion, with the final objective of creating more livable cities.

- ***Rationale for introducing the mitigation action***

With regard to the transport of petroleum products from main terminals, majority of the products are transported by road (78% of the total product sales) to the depots while only 1% of the products are transported by rail to the depots, and around 21% of the products are transported by pipeline to the power plants (*Performance report of Ministry of Petroleum Resource Development, 2017*). As per Ceylon Petroleum Storage Terminals Limited (CPSTL), transportation of the petroleum products by rail is more cost effective compared to road transport given the fact that Sri Lanka Railways (SLR) charges the transport fee based on the tonnage of the wagon while road transport has a fixed tariff for all products. Further the transportation of the products by rail is more energy efficient and environmentally friendly as well. In addition, using rail for transporting petroleum products can lead to reduce the traffic congestion as heavy duty vehicles cause traffic on the road.

- **Current status**

In order to achieve the target of increasing the freight share in railway, SLR initiated four major projects with the participation of private entities and public authorities to shift freight from road to rail for following products:

1) Prima flour; 2) coal for cement factory; 3) lime stone; and 4) petroleum product

1. Status of transporting Prima flour by rail: SLR signed an agreement with Prima Ceylon in June 2017 to transport 15,000 tons of flour monthly from China harbor to Galle and Seeduwa.

2. Status of transporting coal for cement factory by rail: SLR has entered into an agreement with Holcim (Lanka) company to transport the imported coal from Trincomalee harbor to Maho station.

3. Status of transporting lime by rail: Through an agreement entered by SLR with a cement company, it has given the right to the company in order to use the rail track for the transport of lime stones using the company's own locomotives and wagons from Aruwakkalu. The rates, which are subjected to annual revision, are levied for the transportation of lime stones on the conditions entered. SLR may also provide locomotives on hire to the Company to transport lime stones on special charges.

4. Status of transporting petroleum products by rail: There are 263 oil tank wagons, which are currently used to transport the petroleum products to power plants and the airport as listed in Table 4.17 Details of the available railway wagons. SLR is also going to add another 30 oil tank wagons between 2018 and 2019 to enhance the transport capacity of the petroleum products by rail (SLR performance report, 2017).

Out of above-mentioned projects, transporting petroleum product by rail will have considerable impact of reducing GHG emission and traffic congestion. Therefore, this report will analyze the effect of aviation fuel transport by train from Kolonnawa to Katunayaka Airport. Current status is given in Table 4.18 Schedule of aviation fuel transportation.

Table 4.17 Details of the available railway wagons

Product	***Capacity (liters)***	***Quantity***
Jet-A1	45,400	31
Petrol/Diesel/Kerosene	26,370	135
	45,400	81
	50,000	16
	26,370	3

Furnace Oil	45,400	3
Total		**263**

Source: CPSSTL

At present only Kolonnawa main terminal transport aviation fuel to Katunayaka bulk depot. Below table provide the detail of aviation fuel transportation schedule (2018).

Table 4.18 Schedule of aviation fuel transportation

Number of trains per day	4
Number of wagons per train	8
Capacity of a wagon (L)	45,400
Frequency of train	7 days per week

Source: Ceylon Petroleum Storage Terminals Limited

4.2.2 Scope and boundaries of monitoring approach

- ***Causal chains***

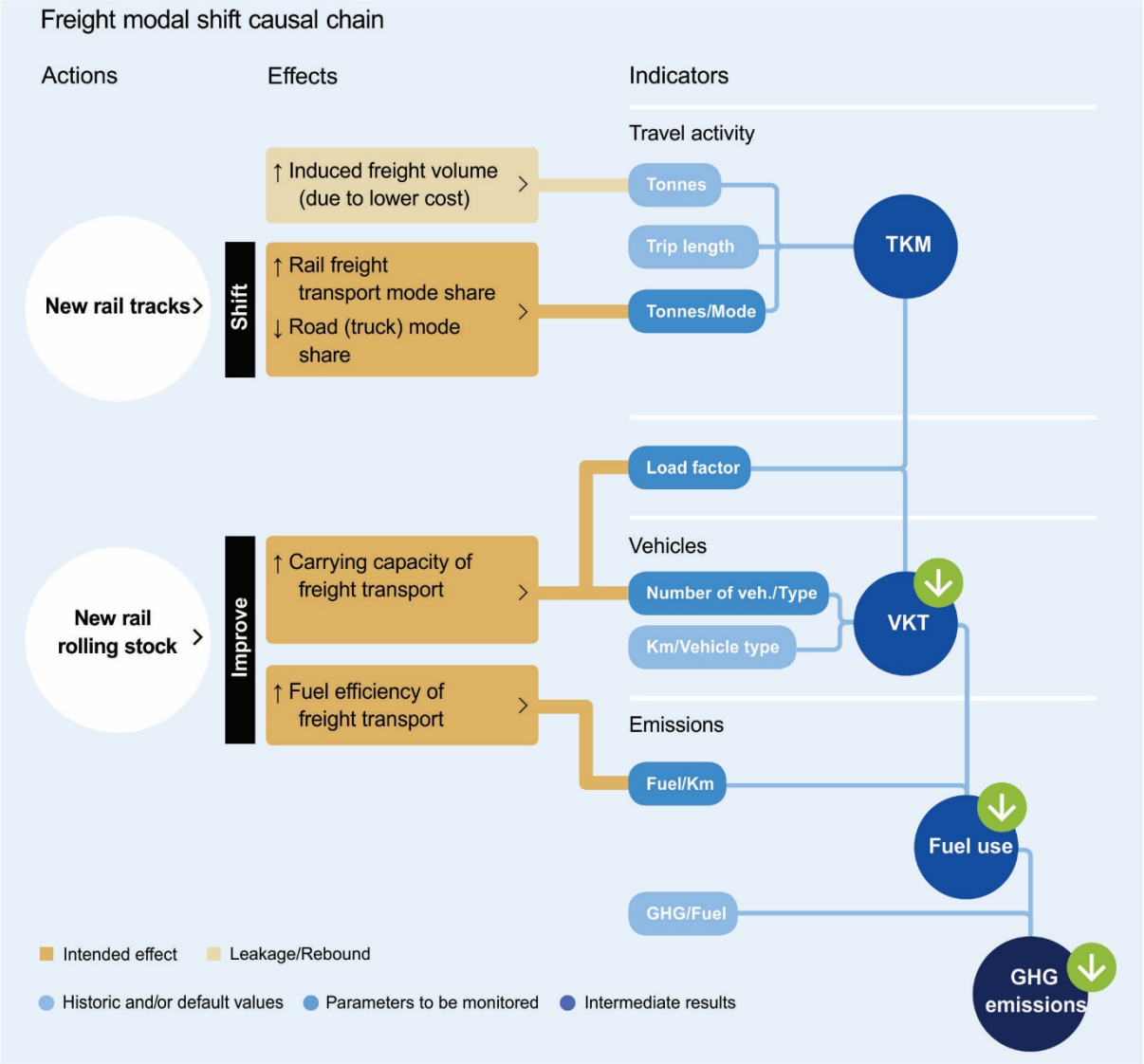


Figure 4.9 Causal Chain of freight shift from road to rail

Source: Compendium on Greenhouse Gas baselines and monitoring, 2018

Relevance of effects

Table 4.19Effects of the mitigation action

Effect	Likelihood	Magnitude
Less fuel use	Very likely	Major
Reduce traffic congestion	Very likely	Major

Reduce air pollution	Likely	Moderate
Cost effective	Very likely	Major
Noise pollution	Likely	Moderate

- ***Assessment boundary***

From Kolonnawa to Katunayaka bulk depot. Kolonnawa terminal supplies the petroleum products to 11 depots. However, only the supply of petroleum products (aviation fuel) from Kolonnawa to Katunayake was considered as assessment boundary due to limited data availability.

- ***System boundaries***

Table 4.20System boundaries of the mitigation action

Boundaries	Description
Temporal boundary	2021-2030
Sectoral boundary	The MRV approach covers petroleum product transport by rail to bulk depot.
Geographic boundary	Distribution of petroleum products from Kolonnawa main terminal to Katunayaka bulk depot.
GHG included	The focus is on direct, activity-based GHG emissions. The monitoring covers CO_2 emissions attributed to fuel consumed in order to transport petroleum products. Though CH_4 and N_2O can also be produced when consuming the fuel, the GHG emissions attributed to these two GHGs are excluded by the methodology for simplification.

4.2.3 Methodology

Short explanation on methodology

UNFCCC Clean Development Mechanism's aproved baseline and monitoring methodology AM0090 version 01.1.0, "Modal shift in transportation of cargo from road transportation to water or rail transportation", was used to quantify the GHG effects of the mitigation action, shift the petroleum product transport from road to rail.

This methodology is applicable to mitigation actions that result in modal shift in transportation of a specific cargo (excluding passengers) from road transportation using trucks to water transportation using barges or ships or rail transportation.

Characteristics of the methodology is given in Annex 1

Key indicators

Table 4.21Key indicators of the baseline emission(baseline) and Table 4.22Key indicators of the project emission(Project) provide the key indicators of the selected methodology

Baseline emission

$$BE_y = T_y \cdot AD \cdot EF_{BL} \cdot 10^{-6}$$

Table 4.21Key indicators of the baseline emission

T_y	Amount of cargo transported by the project transportation mode in year y (tonne)
AD	Distance of the baseline trip route (km)
EF_{BL}	Baseline emission factor for transportation of cargo (gCO_2 per tonne.km)

Project emission

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

Table 4.22Key indicators of the project emission

$PE_{FC,y}$	Project emissions from fossil fuel combustion in the project activity in year y (tCO_2)
$PE_{EC,y}$	Project emissions from electricity consumption in the project activity in year y (tCO_2)
$F_{RT,PJ,y}$	The factor to account for non-empty return trips in the project scenario in year y (fraction)
$PE_{CR,y}$	Project emissions from transportation of cargo in complementary routes in trucks in year y (tCO_2)

4.2.3.1 Baseline Scenario

Identification of baseline scenario[3]

Four baseline alternatives were identified for the mitigation action, "**shift** transportation of the **petroleum products** to the bulk depots from the **road-based** diesel trucks to **rail-based diesel wagons**", as follow:

Baseline alternative 1: Transport petroleum products via pipeline - There are no pipeline established to transport the petroleum products to the bulk depots. Construction of such infrastructure can be very expensive. Currently, the petroleum products are transported via pipeline only to the power plants. As such, this option is not likely baseline scenario.

Baseline alternative 2: Transport petroleum products via railway - The mitigation action itself indicate this as the project scenario. As such, this alternative cannot be considered as baseline scenario.

Baseline alternative 3: Transport petroleum products via water-based transport - Currently, there are no infrastructure in the country to transport the petroleum products via water. Construction of such infrastructure can be very expensive. As such, this option is not likely baseline scenario.

Baseline alternative 4: Transport petroleum products via road - The mitigation action itself indicate this as the baseline scenario. Currently, most of the petroleum products (78% of the total product sales) are transported by road from the main terminals to the bulk depots. As such, continuation of the current practice, use of roads to transport the petroleum products, can be considered as the likely baseline scenario.

Baseline scenario: *Transport petroleum products from main terminals to the bulk depots by road.*

Baseline emission calculation

Base year: 2010 (year y), which is in accordance with the NDC

Assessment route: Kolonnawa to Katunayake

Identified petroleum product: Aviation fuel

Fuel consumed by baseline trucks (i) : Diesel

Data needs

Table 4.23Data need for baseline emission calculation

Parameter	Description	Data availability
T_y	Amount of cargo transported by the project transportation mode in year *y* (tonne)	Yes
AD	Distance of the baseline trip route (km)	Yes
EF_{BL}	Baseline emission factor for transportation of cargo (g CO2 per tonne.km)	Calculate

Baseline Emission Factor (EF_{BL})

There are two options to calculate EF_{BL}: applying conservative default emission factors (option A); and based on historical records (option B).

A. Conservative default values

Methodology has provided emission factors depending upon the type of cargo transported in the baseline scenario. These default emissions factors are determined on the basis of trucks consuming petrodiesel. However, the emission factors shall be adjusted if trucks consume natural gas or if petrodiesel is blended with biofuels.

According to the methodology, emission factor for the solid mineral fuel and petroleum products transportation is **76 gCO_2/tonne.km**

B. Historical Data

The baseline emission factor (EFBL) is calculated based on historical data on the amount of fuels consumed for transportation of the cargo, the net calorific values and CO_2 emission factors of the fuel types used, the amount of cargo transported, the distance of the baseline trip route and a factor to account for non-empty return trips. This option can be applied only if:

- The cargo was transported in dedicated trucks which were not used for other purposes than transportation of cargo; and
- Data on the amount of cargo transported, the amount of fuel consumed and the fuel types used is available for the trucks dedicated to the transportation of the type of cargo

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

Table 4.24 Data need to calculate Baseline Emission Factor

$FC_{BL,i,x}$	Amount of fuel *i* consumed by the trucks in year *x* (liter or m^3)
$EF_{CO2,i,x}$	CO_2 emission factor of fuel *i* consumed by the trucks in year *x* (g CO_2/GJ)[32]
$NCV_{i,x}$	Average net calorific value of fuel *I* consumed by the trucks in year *x* (GJ per liter or m^3)
$F_{RT,BL}$	Factor to account for non-empty return trips in the baseline scenario (fraction)
T_x	Amount of cargo transported in trucks in year *x*(tonne)
$T_{RT,x}$	Amount of cargo transported in trucks in the return trips in year *x*(tonne)
RTD_x	Distance of the return trip route in year *x* (km)

[32] If the fuel is blended with biofuel, the emission factor of the blend shall be calculated assuming an emission factor of zero for the biofuel.

Baseline emission factor of the year 2010 has recorded as 43.67gCO_2 per tkm. Further, annual tonne kilometers transported by the bowser has recorded as 6 million tkm. This accounts for 279 tCO_2e emissions for the base year.

4.2.3.2 Ex ante GHG Impact assessment

Methodological changes

As per the methodology, unit of NCV was GJ per liter or m^3. However, IPCC does not provide the NCV in the unit indicated by the methodology while IPCC provides NCV in TJ/Gg. As such, NCV has to be multiplied by fuel density in order to convert NCV as required by the methodology.

According to the analysis, transporting petroleum products via train instead of road will reduce the emission by 70%

Bowsers

Capacity: 33,000 L

Fuel economy: 0.02 L/tkm

Wagons

Capacity of a wagon: 45,400 L

Number of wagons per train: 8

Total capacity of a train: 363 KL

Fuel economy: 0.005 L/tkm

Figure 4.10Emission reduction due to modal shift

Direct effects of mitigation action

- Reduction of GHG emissions is 30.53 gCO_2e/t.km (emission factors for freight transport from road and rail are 43.67 and 13.14 gCO_2e/t.km respectively.
- Fuel savings is 0.015 liters/t.km
- Number of vehicles replaced on the road is 20/day

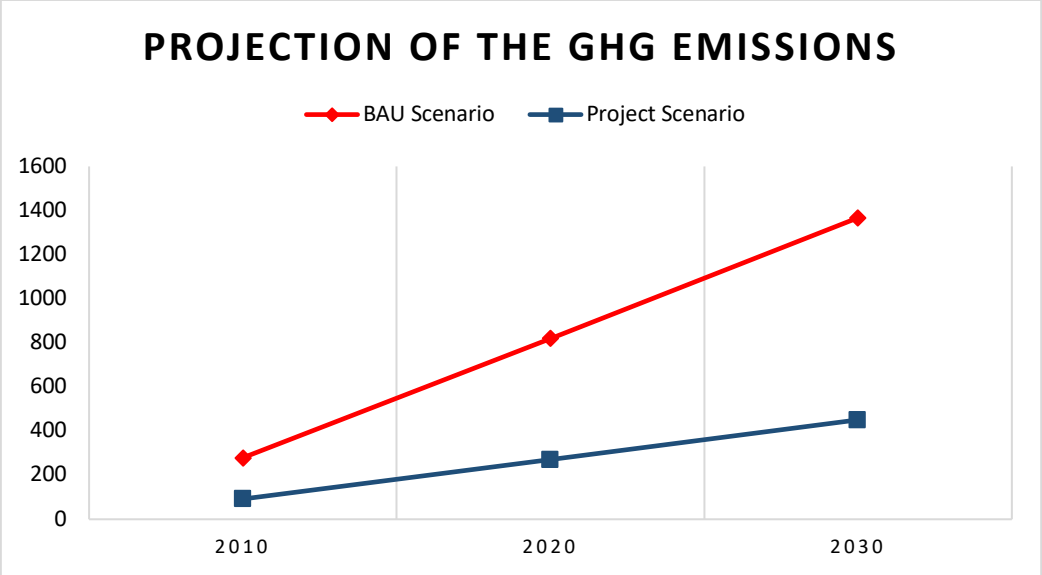


Figure 4.11Forecasted emission due to petroleum product transportation

As illustrated in the Figure 4.9, reduction of the GHG emissions due to the proposed mitigation action will be around 916 tCO_2e in the year 2030.

4.2.3.3 Ex post assessment

If the discussed mitigation action implement as intended following data need to be monitored. Following data will be monitored by SLR

Table 4.25Data requirement from SLR

Data requirement	Indicator	Unit
The origin and destination point and transportation route of the cargo transported by train in year *y*	OD_y	km
Type of cargo transported by the project transportation mode in year *y*	C_{ty}	

Amount of cargo transported by train in year *y*	T_y	tonne
Amount of cargo transported by train in the return trips in year *y*	$T_{RT,y}$	tonne

4.2.4 Institutional arrangement

Implementing agency: Sri Lanka Railways, Ceylon Petroleum Storage Terminals Ltd

Other related institutions: Civil Aviation Authority, Airport and Aviation Service.

Sri Lanka Railways (SLR)

Sri Lanka Railways, which is the only rail transport provider in Sri Lanka, is a department functioning under Ministry of Transport and Civil Aviation. SLR started its operation in 1902 after establishing it through railway Ordinance. Sri Lanka Railways Authority, Act (No.60 of 1993) was enacted since 15th of December 1993. Act was repealed in February 2005 as Sri Lanka Railways Authority (Repeal) Act, No.3 of 2005.

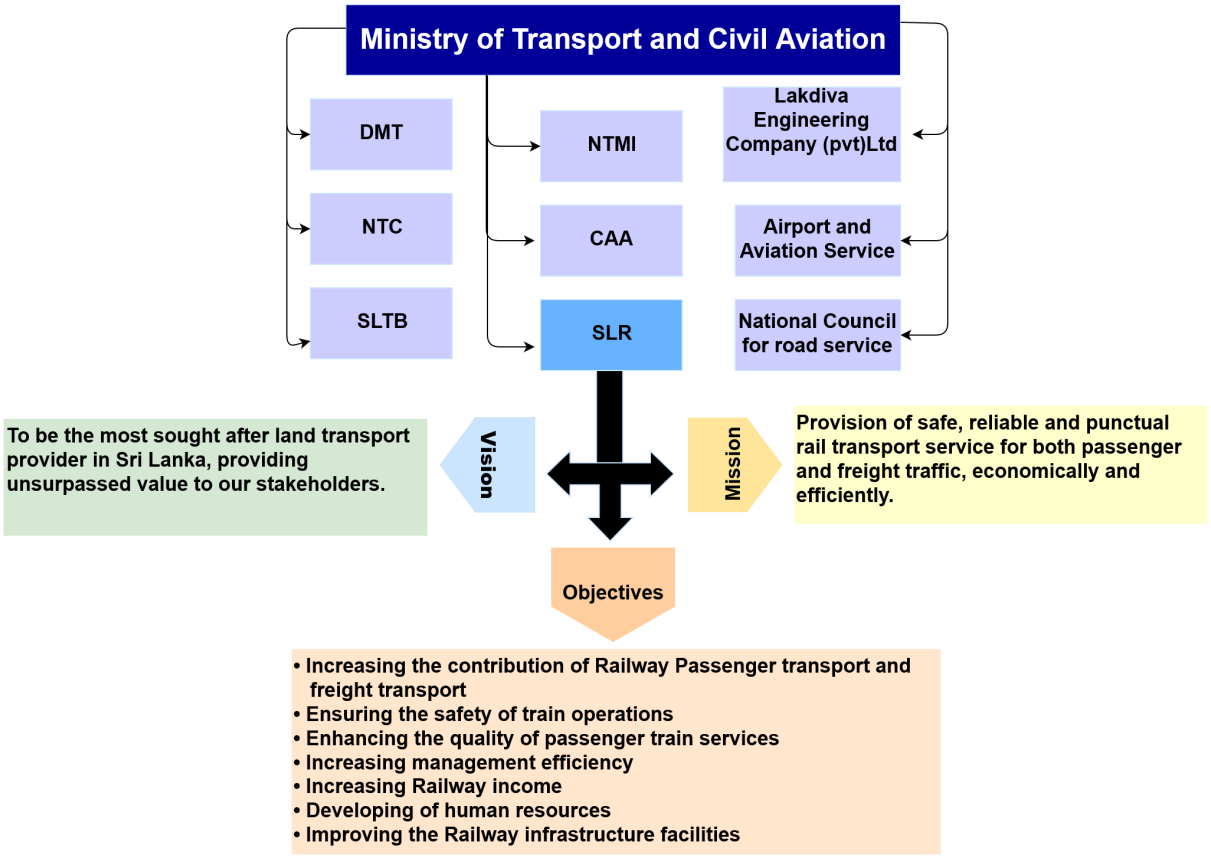


Figure 4.12Governance structure and Vision, Mission and Objectives of the SLR

Source: ClimateSI, 2019 based on data from performance report of Sri Lanka railways, 2017

Ceylon Petroleum Storage Terminal Limited (CPSTL)

CPSTL is an entity which govern by the Ministry of Highways, Road Development and Petroleum Resource Development. Further, CPSTL[33] is a Company duly incorporated under the companies Act No. 17 of 1982 in terms of Section 2 (1) of the conversion of Public Corporations or Government owned business undertakings into Public Companies Act No.23 of 1987, owns the Common User Facility (CUF) consisting of Oil Terminals, Storage Facilities, Pipelines and the Bowser Fleet, more fully described in the Government Gazette extraordinary bearing No. 1310-8 dated 13th October 2003.

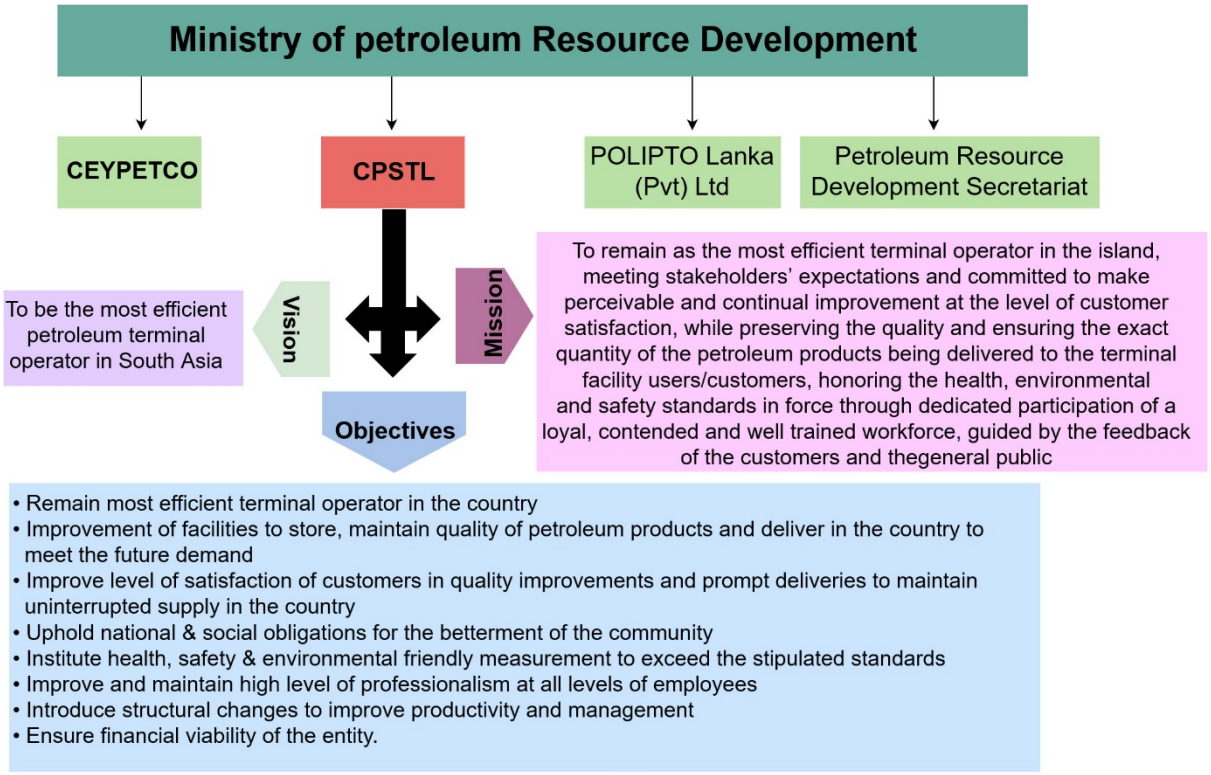


Figure 4.13Governance structure and Vision, Mission and Objectives of the CPSTL

Source: ClimateSI, 2019 based on the data from performance report of Ministry of Petroleum resource development, 2017

[33]Operated by 03 multi national companies (namely Caltex, Mobil and shell)

Roles and responsibilities of each institutions in GHG measurement and reporting

Table 4.26 Roles and responsibilities of the respective institutions in implementing mitigation action describes the roles and responsibility of each institution in implementing the mitigation action while Table 4.27Roles and responsibilities of the respective institutions in monitoring and reporting mitigation actionindicates the distribution of responsibilities in terms of data collecting, reporting and monitoring.

Table 4.26 Roles and responsibilities of the respective institutions in implementing mitigation action

Institution	Roles and Responsibility
Ministry of Finance	Providing necessary financial support
SLR	- Procurement of rolling stocks (Oil wagons, flat wagons, engines, etc.) - Developing infrastructure
CPSTL	Managing the fuel transportation

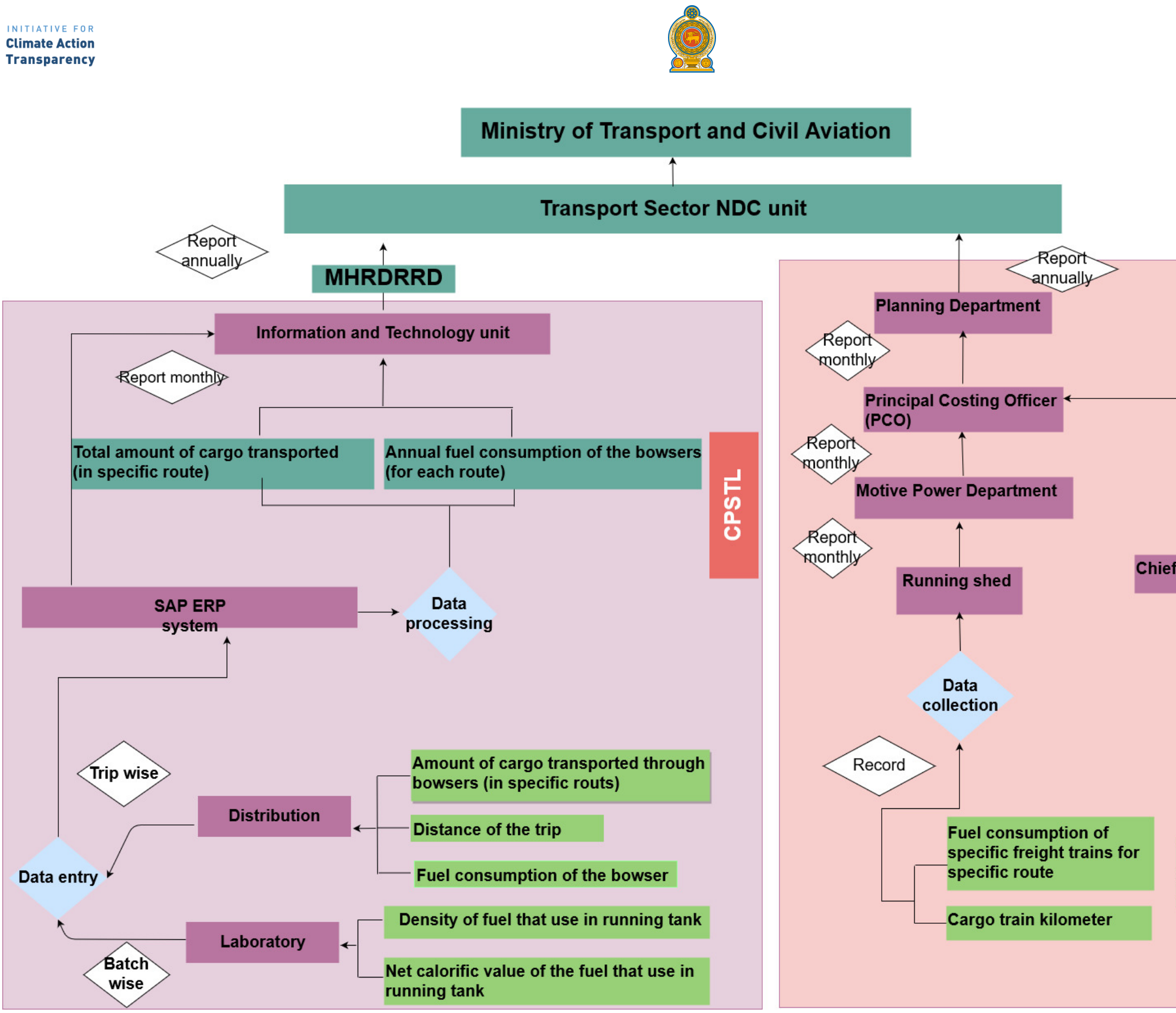


Figure 4.14Proposed Data Management System for NDC 9.4, *Source: ClimateSI, 2019*

MHRDPRD: *Ministry of Highways, Road Development and Petroleum Resource D*
Terminal Limited, ***SLR****: Sri Lanka Railways*

As illustrated in the Figure 4.14 required data from SLR will report as follows, type of the cargo and amount cargo of transported by the train in specific route will be recorded by chief wagon controller. Collected data will be reported to the principal costing officer. Running sheds will collect the fuel consumption of the specific train to transport the cargo in specific route. Cargo train kilometres will be also calculated by the running sheds and will report to the principal costing officer. All the collected data will be monthly transfer to the planning department. Consolidated data will annually report to NDC unit by the planning division.

Figure 4.14 also illustrates the data management system of CPSTL. According to the figure, net calorific value and the density of the fuel will be measured and entered in to the SAP ERP system by the laboratory. Amount of fuel consumed by the trucks, distance of the baseline trip route, and amount of cargo transported will be monitored and recorded by the distribution unit. Data will be processed by the system and annually report to the NDC unit.

Table 4.27Roles and responsibilities of the respective institutions in monitoring and reporting mitigation action

Institution	Roles and responsibility
CPSTL	Recording and annually reporting following data 1. Annual fuel consumption of the bowsers (for each route) In the absence of 1, following data will be provided 1.1 Total number of trips to a specific bulk depot 1.2 Fuel economy of each bowser (L/t.km) 2. Total amount of cargo transported (in specific route) 3. Density of the fuel in running tank 4. Net Calorific Value of the fuel in running tank
SLR	Recording and annually reporting following data 1. Amount of fuel combusted by freight trains to transport petroleum products In the absence of 1, following data will provide 1.1 Type of the engine used to transport the cargo 1.2 Fuel economy of each engine (L/t.km) 1.3 Number of trips travelled by each engine 2. Cargo train kilometers 3. Type and amount of cargo transported in specific route

4.2.5 Verification

Respective institutions will report the required data annually to the MTCA. Quality and the accuracy of the data provided will be verified by the NDC unit of MTCA. In addition, GHG impact of concerned mitigation action will also be calculated by the NDC unit. Accuracy of the calculations will be verified by an independent third party, the MRV expert committee to be appointed by the MMDE. Approved results will be submitted to the CCS of MMDE who will

submit the results to the UNFCCC. More information on the institutional arrangement is given in Chapter 05.

As illustrated in data management system, data will be required from institutions that are not regulated by the MTCA. Therefore strengthening the legal provisions of the NDC unit will be essential for the proper verification process.

4.2.6 Recommendations

As illustrated in Figure 4.12, data will be required from SLR and CPSTL to measure the GHG effect of the considered mitigation action. Both organizations have advanced data collection system in place. However, SLR only has a manual data management system while CPSTL has ERP SAP system for the monitoring process. Data collection through a manual system will be time consuming. Therefore, it is suggested to digitalize the data collection system of the SLR.

However, CPSTL regulated by the MHRDPRD. As MTCA does not have authority over this institution, maintaining the MRV system will be a challenge. Therefore, it is recommend to strengthen the legal framework of the proposed NDC unit, so that data collection from different entities will not be a challenge. Reporting process will be delayed if the data to be collect through several ministries. Therefore, it is recommend to introduce a digitalized MRV system which directly provide access to the respective data owners.

5 Proposed national institutional arrangement for transport sector MRV in Sri lanka

5.1 National institutional set up for implementation of mitigation actions

Development of a robust institutional structure which encompasses relevant institutions with clearly demarcated roles and responsibilities is essential for effective implementation of any MRV system. When developing institutional structure for transport sector MRV in Sri Lanka, it is important to understand the existing governance structure and the reporting lines in the sector. The proposed institutional arrangement is based on the existing system with necessary improvements.

5.1.1 Existing Institutional arrangements in transport sector

The institutional arrangements for Sri lankan transport sector is relatively fragmented and are spread over several ministries and agencies.(Kumarage, 2011). While MTCA has overall responsibility for developing policies, programs and projects in transport sector including the inter provincial road transport , rail, air and marine sub-sectors, there are nine institutions 0under the purview of MTCA in order to implement the transport sector policies, programmes and project, namely:

a. Department of Sri Lanka Railways;

b. Sri Lanka Transport Board;

c. National Transport Medical Institute;

d. Department of Motor Traffic;

e. National Transport Commission;

f. Civil Aviation ClimateSI,2019 ity;

g. Lakdiva Engineering company (Pvt) Ltd;

h. Airport and Aviation Services (Sri Lanka) Ltd;.

i. National Council for Road Safety.

In addition to these institutions, there are few ministries, which are directly involved in the transport related activities, such as Ministry of Megapolis and Western Development; Ministry of Provincial Council & Local Authorities; Ministry of Highways and Road Development. According to the thirteen amendment to the constitution transport is a devolved subject. Therefore, each province is empowered with legislative and executive powers in relation to the subjects specified in the provincial council list. Each province also has its ownministry for transport.

Figure 5.1depicts how each institution under MTCA reports to MTCA, and how the other relevant ministries interact with MTCA.

Roles and responsibilities of those institutions, who are working on the transport related activities, are listed in Annex 2.

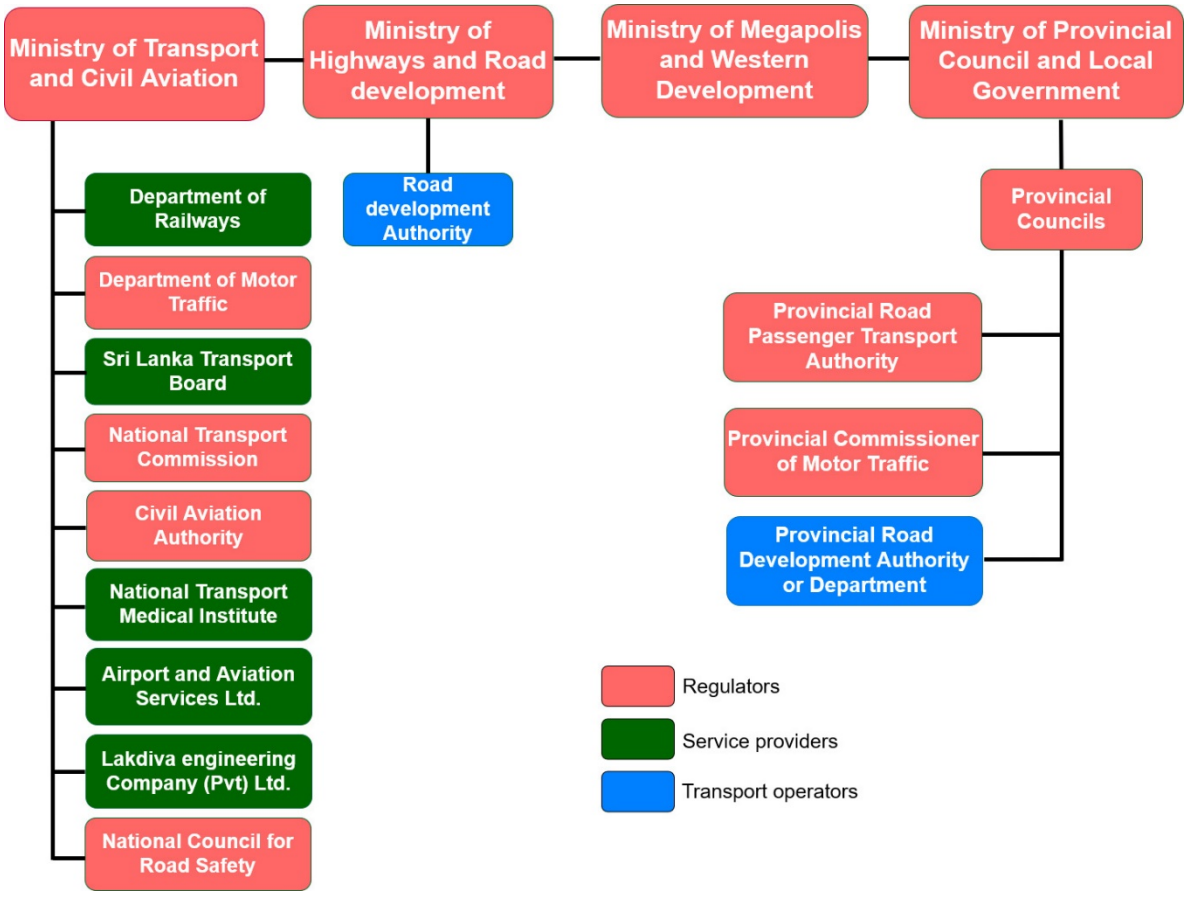


Figure 5.1Institutional arrangement in transport sector

5.1.2 Existing Institutional arrangements in transport sector

Several institutions which operate under the Ministry of Mahaweli Development and Environment forms the administrative structure for climate change related matters in the country.

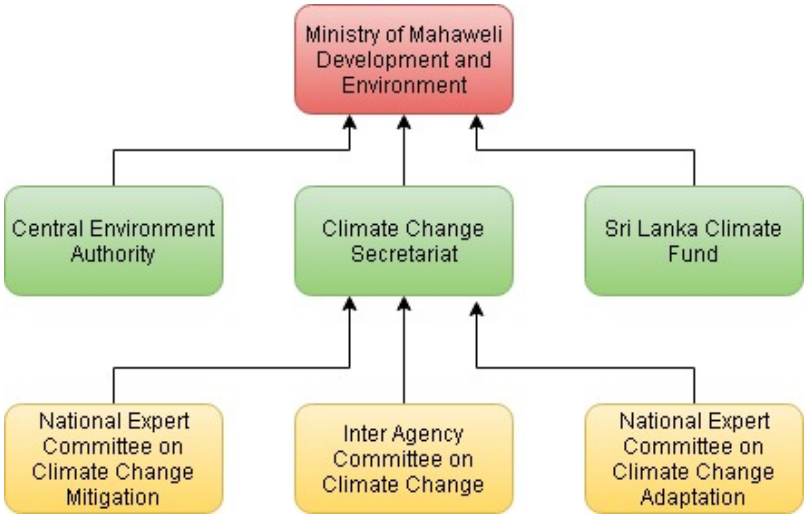


Figure 5.2Institutional arrangement for addressing climate change

Ministry of Mahaweli Development & Environment (MMDE) is the institutional head in the matters related to environment, natural resources and climate change. All the institutions related to climate change functions under the MMDE and it is the national focal point for UNFCCC.

Climate Change Secretariat, which comes under MMDE, is the operational focal point for climate change. Since the climate change is a cross cutting issue, CCS coordinates with multiple ministries, institutions and agencies to implement climate change related activities. CCS also creates platform for addressing climate change issues at the national level, and is responsible for developing relevant policies and programs; liaising with sectoral agencies to identify priorities and implementation mechanisms; and monitoring impacts of national climate responses. Moreover, CCS is also responsible for engaging other ministries and departments in addressing climate change.

As part of climate policy making process, three committees were established to enhance stakeholder engagement. These cross functional committees include the following:

The Inter-Agency Committee on Climate Change is a coordinating body made up of members of line ministries and line agencies, designed to ensure climate-related policies are aligned with the national development agenda, and also to guide policy makers on how to integrate international & national climate adaptation and mitigation into relevant policies and strategies. Along with this committee, two cross-sectoral, technical sub committees were also established.

The National Expert Committee on Climate Change Mitigation was set up in 2012 to provide guidance in the development of climate mitigation policies, legal instruments and action plans to address climate change as discussed under the international climate change negotiations. The committee was also tasked with supporting the preparation of the national greenhouse gas inventory, and guiding the implementation of NAMAs, CDM and other similar mechanisms.

The National Expert Committee on Climate Change Adaptation was set up in 2014 to raise Ministries' awareness of the country's vulnerability to climate change and to inform policies, strategies and action plans to avoid/minimize adverse impacts of climate change to people, livelihoods and ecosystems.

Sri Lanka Climate Fund (SLCF) is functioning under the Ministry of Mahaweli development and Environment. SLCF was established in 2009 as a government owned private company with the objectives

- To support Sri Lanka to achieve low carbon and climate resilient blue green development.
- To catalyse private investment for mitigating and adapting to climate change in commercially sustainable ways.
- To demonstrate commercially viable, public-private business models for addressing climate change and environmental problems

- To reduce the cost of clean energy generation by enhancing the effectiveness of financial instruments, promoting, monetizing and utilizing carbon credits and creating new financing instruments where possible.
- To be a conduit and point of contact for receiving and utilizing international climate finance, including those of the (Green Climate Fund, adaptation Fund) and private investment for the development of environmental and clean energy solutions for Sri Lanka.

Central Environmental Authority (CEA) is responsible for specifying environmental standards, as well as coordinating/carrying out reports related to the environmental management of natural resources, fisheries, wildlife, forestry and soil conservation. In accordance with the environmental protection standards and other criteria set out by CEA, sectoral agencies are required to submit an environmental impact assessment report to ensure that environmental considerations are integrated into policies (CEA, 2000).

5.1.3 Existing Institutional structure for NAMA

There's an approved (by cabinet on 19.07.2017) institutional setup for NAMAs, which covers energy, transport, waste, industry, agriculture and forestry sectors in Sri Lanka. Therefore when developing institutional set up for the implementation of NDCs in transport sector it is more practical to adopt and expand the existing institutional set up for NAMAs. As shown in Figure 5.3, the NAMA institutional arrangement covers both project approval and MRV process.

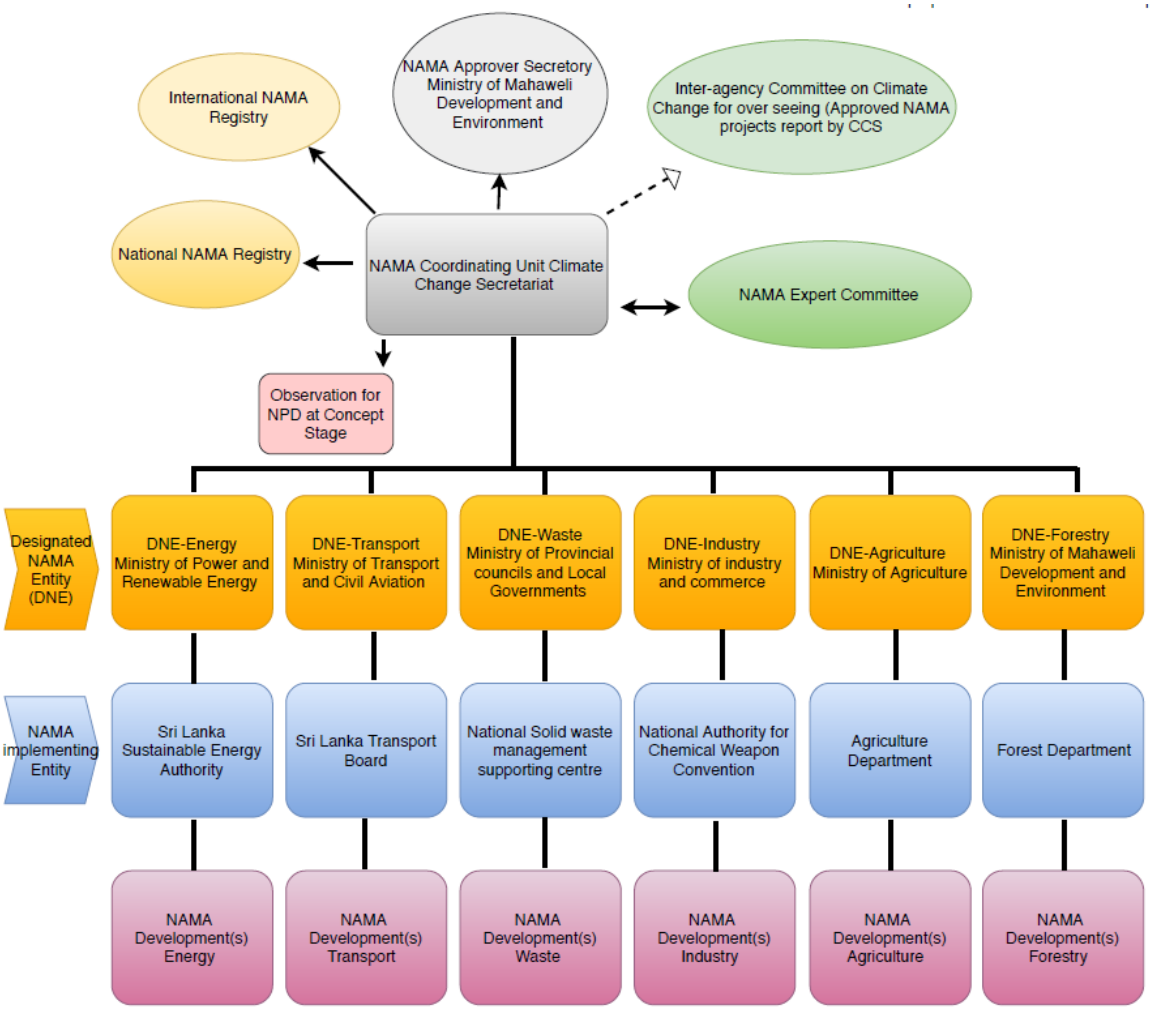


Figure 5.3Institutional arrangement for NAMAs in Sri Lanka

NAMA Approver/MMDE: The secretary to MMDE acts as the NAMA approving entity. All NAMAs to be implemented in Sri Lanka are required to get the approval from the NAMA approver.

NAMA Coordinating entity/CCS of MMDE: The Director of CCS acts as the head of NAMA coordinating unit In addition, MRV and NAMA registry will be maintained by NAMA coordinating entity.

Inter-Agency Committee on Climate Change: This existing committee at CCS includes the high level officials of ministries, departments and institutions who represent the Climate Change Mitigation and Adaptation sectors. CCS will report to this committee on the approved NAMA proposals.

NAMA Expert Committee: This committee will be approved by the secretary to MMDE, and it will be a sub committee of existing National Expert Committee on Climate Change Mitigation (NECCC - Mitigation). This sub-committee consists of chairman of NECCC - Mitigation,and one sector expert from the existing committee.In addition there will be representatives of five Implementing Entities (one from each implementing entity), one representative of implementing Entities(one representative fro each of five implementing entities)and one each from National Planning Department, External Resource Department, and NAMA coordinating unit. Also three representatives from resource pool at CCS will be part of this committee. The committee will play an advisory role for the process of formulating general guidelines to project developers and guidance to sectoral NAMA implementing entities.

Designated NAMA Entity: This is the Ministry of the relevant sector. This Designated NAMA entity is to submit project proposals to NAMA Coordinating unit with recommendations and should represent the inter-agency over-sight committee.

NAMA Implementing Entity: This entity can be appointed by the relevant designated NAMA entity of each sector, and it has the capacity to evaluate NAMA proposals.

NAMA Developer: NAMA Developer can be a private/public (PPP) entity interested in developing future NAMAs, and it can also submit voluntary or supported NAMAs to the relevant implementing entity.

5.2 Proposed national institutional set up for MRV of GHG effects of transport sector

With a sound knowledge of the existing institutional structure in both climate change area and the transport sector of the country, the institutional arrangement for the transport sector NDC implementation is developed based on the existing systems and making the best use of existing data collection mechanisms. The proposed structure is developed with extensive and effective stakeholder consultation including but not limited to MTCA, MMDE, CCS, all the related ministries and all the institutions under the MTCA. (The list of stakeholders is attached in annex 3). The overall institutional arrangement for the transport sector MRV is presented in Figure 4 bellow and the illustrated institutional arrangement including the institutions related to each selected NDC is presented in Annex 4. The institutional arrangement which is proposed in this document is capable of linking with a future national MRV system for implementation of all the NDCs in the sectors mentioned in Sri Lankan NDCs.

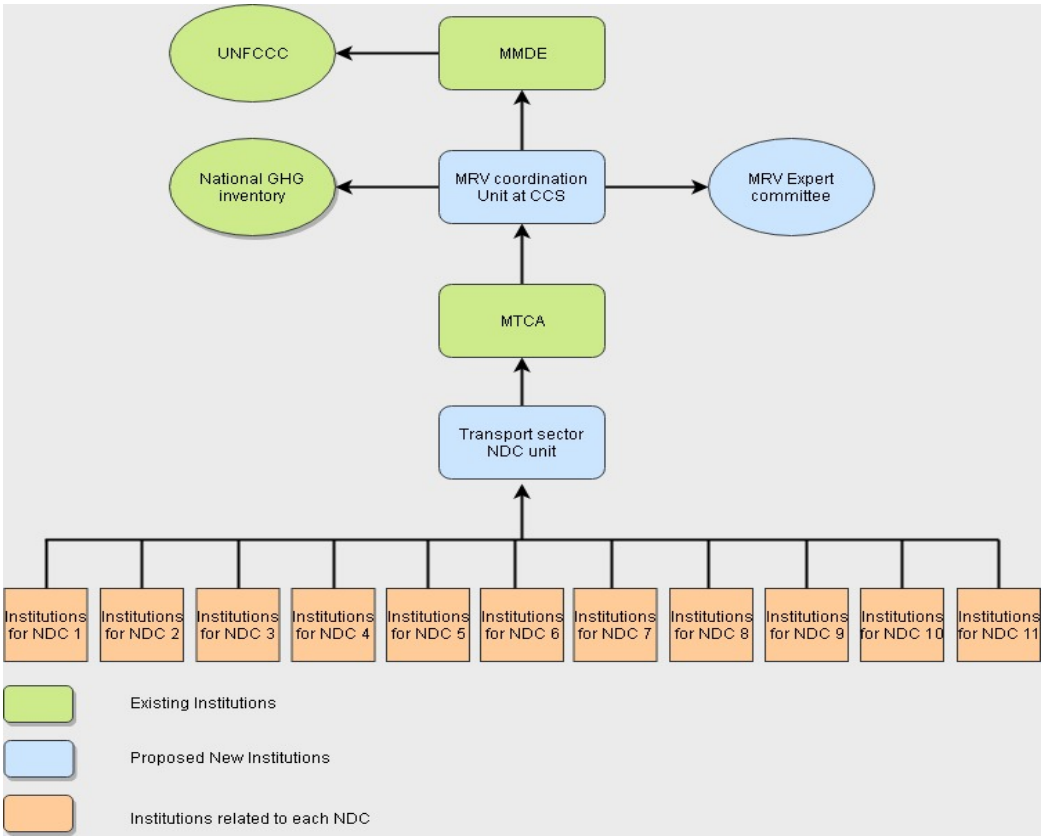


Figure 5.4Proposed MRV institutional arrangement for transport sector

5.3 Roles and responsibilities of the Institutions

Ministry of Mahaweli Development and Environment

As the national focal point to UNFCCC Ministry of Mahaweli Development and Environment is responsible for reporting the progress of NDC implementation to the UNFCCC through CCS.

MRV Coordination Unit at CCS

As the national operational focal point to UNFCCC, CCS is responsible to report the status of achieving the NDCs. For this purpose, it is proposed to establish a separate unit within CCS to monitor the progress of achieving NDCs in the country including transport sector NDCs.The unit will be headed by the director of CCS. All the emission reductions from the policies and actions which help to achieve NDCs will be reported to this MRV coordination unit through sectoral NDC units (eg. "transport sector NDC unit"). The MRV coordination unit will refer the emission reduction calculations to the MRV expert committee for verification.

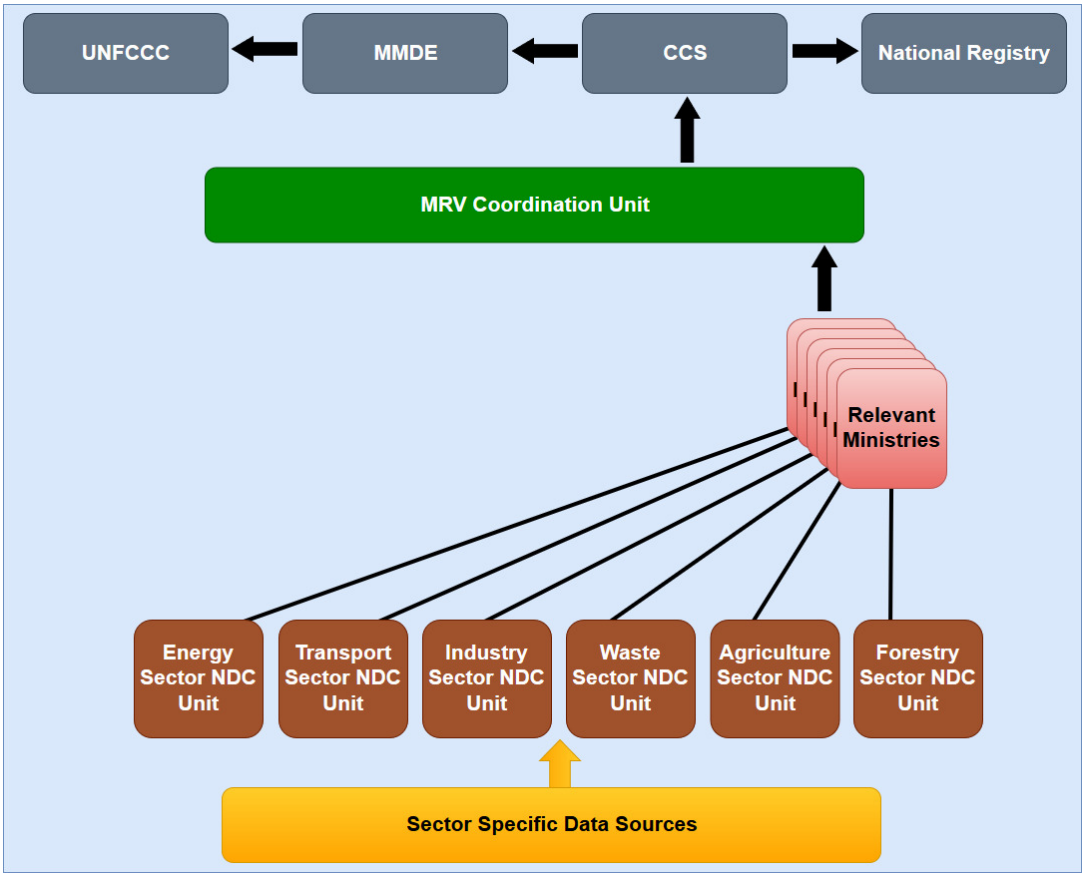


Figure 5.5MRV coordination unit-main institutional elements and interrelations

Responsibilities of the MRV coordination unit
1. Provide guidance and training to stakeholders for accurate data collection, data recording, data reporting, data analysis, and calculations of impact of policies or actions on GHG emission
2. Channelling technical and financial support for MRV of NDCs;
3. Establishment of extensive and effective communication with the stakeholders.
4. Plan and conduct all coordination and consultation activities with governmental and if appropriate non-governmental stakeholders in relation to MRV of policies, strategies and mitigation actions
5. Capacity building and keep track of capacity-building efforts, domestic (unilateral) as well as international
6. Conducting an evaluation exercise to identify key lessons learned and areas for improvement.
7. Compiling and integrating all the sectoral MRV reports and transform into a cohesive document to be submitted to UNFCCC
8. Incorporation of reporting from all line ministries and their regulatory bodies and keeping an updated registry of relevant actions (e.g. policies and projects);
9. Collection and aggregation of information on new mitigation actions and directing those to the MRV process
10. Maintaining and updating the registry of all the mitigation actions in the country
11. Reflection on progress of NDC implementation and adjustment to new circumstances;
12. Keeping the MRV expert committee informed of progress and emerging issues;
13. Establishing guidelines for quality control and the quality assurance of collected data and developing and overseeing the implementation of a quality assurance/quality control strategy for the entire MRV process
14. Mediate between parties when concerns surface, forexample, over a disagreement in terms of responsibilities or a potential conflict of interest

Table 5.1 Responsibilities of the MRV coordination unit

MRV Expert Committee

It is proposed to set up a new committee consisting of sectoral experts and MRV experts to verify the emission calculations done by sectoral NDC units including "transport sector NDC unit" and to provide necessary guidance to the sectoalr NDC units. The committee will be appointed by the secretary to the MMDE as a sub-committee to the existing National Expert Committee on Climate Change Mitigation (NECCM). This sub-committee will be chaired by the chairman of the NECCM. In addition, there will be expert selected from the resource pool at CCS for each sector mentioned in the NDCs and three MRV experts.

Table 5.2 Roles and responsibilities of MRV expert committee

Roles and responsibilities of MRV expert committee
1. Verification of the emission reduction calculations done by sectoral NDC units.
2. Provide necessary guidance and feedback to sectoral NDC units on calculations and selected methodologies.
3. Make recommendations for `improving the process for data collection
4. Provide recommendations on suitable methodologies to calculate the impact of the mitigation actions
5. Establishing systems and procedures for the verification of reported impacts of NDCs

Ministry of Transport and Civil Aviation

The ministry will be responsible for monitoring and reporting of GHG emissions related to transport sector NDCs. A new "transport sector NDC unit" is proposed to be established within the MTCA for this purpose.

Transport sector NDC unit

The multi-stakeholder nature of identification process and implementation of transport sector NDCs calls for an organizational arrangement that requires a designated focal point and the establishment of sectoral NDC unit addresses this need. This approach can "facilitate individual parties in ensuring that nationally appropriate procedures for collecting, processing, reporting and archiving required data and information are established and

operationalized in a sustainable manner on a continuous basis. These can facilitate effective coordination among all relevant stakeholders from the public and private sectors, in meeting the reporting requirements under the Convention, as well as addressing the broader issue of climate change at the national level"(UNFCCC, 2013).

The unit will be established by the secretary to the MTCA and will be headed by a director (Director MRV). The unit will consists of trained staff and necessary infrastructure. All the Institutions which are supposed to collect data for policies and actions which fall within the preview of transport sector NDCs will report the required data to this unit. Establishment of the NDC unit within the ministry makes institutional coordination easier as most of the data owners for transport sector NDC are the institutions under the ministry. Also there is a high tendency to submit data when it is requested at the ministerial level. Therefore this unit acts as a sectoral coordinating unit.

Mostly raw data will be sent, other than the data from the institutions which have required capacity to process the data. Quantification of mitigation actions in terms of emission reduction in transport sector NDCs will be done by the proposed "transport sector NDC unit". The unit will have the Authority to request any data related to monitoring of transport sector NDCs from relevant institutions through the MTCA. This unit will assure the QA and QC of data sent from the relevant institutions. (see section1.4 for data quality management process) The proposed "transport sector NDC unit" will have employees trained to calculate the emission reduction in the transport sector NDCs. This unit will consist of a team to ensure quality assurance and quality control, a team to collect data and a technical analysis team. Each group will be guided by a team leader appointed by the director of MRV. The NDC unit will annually report the calculated emissions to the CCS.

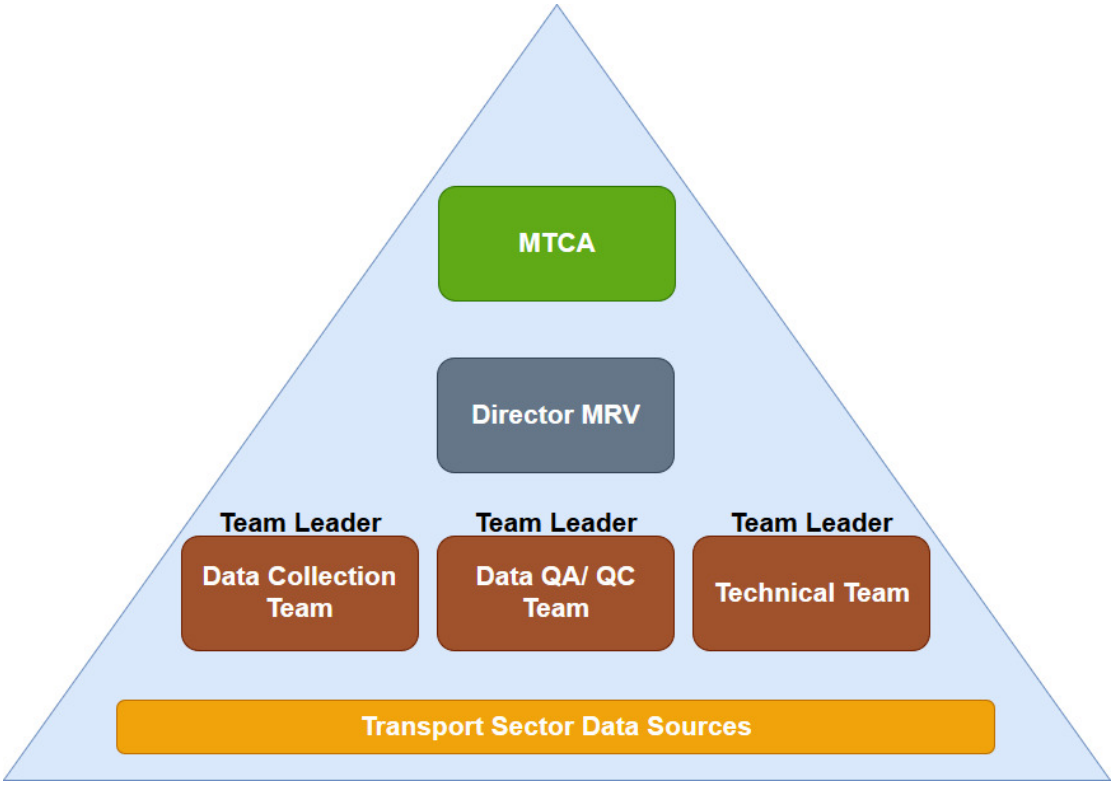


Figure 5.6structure of the "transport sector NDC unit"

Table 5.3 Responsibilities of transport sector unit

Responsibilities of "transport sector NDC unit".
1. Coordination of the flow of information from individual institution and ministries for a collective assessment of impacts and multiple benefits of policies, strategies and actions.
2. Calculation GHG impacts of transport sector policies strategies and actions
3. Quality assurance and quality control of data
4. Identify all institutions that will be involved in data collection
5. Allocate responsibilities for all institutions ensuring that there is a clear lead for each institution, and establish an institutional level formal approval process;
6. Develop and monitor a time frame and schedule for the preparation and submission of necessary data including specific dates for deliverable.
7. Documenting systematically, as appropriate, all the assumptions, data and methods used;
8. Store and safe keep of data and calculations.

Institutions related to each NDC

An institutional arrangement will be established for the collection of data to evaluate the performance of the policies and actions taken under each NDC. Those institutions will gather the required data and report to the "transport sector NDC unit".

5.4 Data quality management process

A process to ensure that data are properly collected, handled, processed, used, and maintained at all stages is a key to a reliable MRV system to improve transparency, consistency, comparability, completeness, and accuracy of the system. Therefore the transport sector MRV system encompasses the quality Assurance (QA) and quality control (QC) measures.

According to the IPCC Guidelines for National Greenhouse Gas Inventories (quality assurance quality control and verification) "*Quality Control (QC) is a system of routine technical activities to assess and maintain the quality of the inventory as it is being compiled. It is performed by personnel compiling the inventory. Quality Assurance (QA) is a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process. Reviews, preferably by independent third parties*"

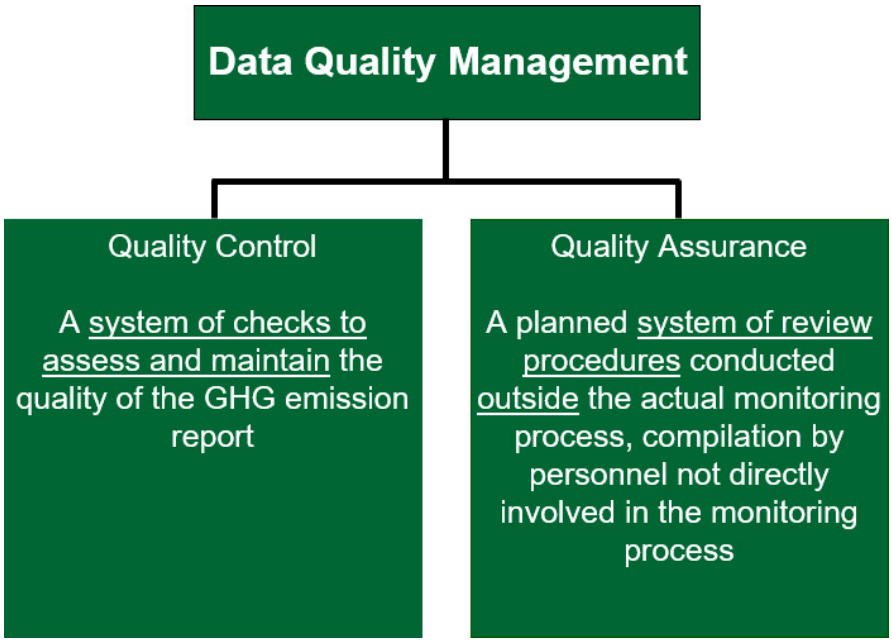


Figure 5.7 Data quality management

Data quality control will be done by the QA/QC team at the "transport sector NDC unit" and the working group will be responsible for the preparation of QA/QC plan. This will be done in one or more of the following methods.

1. **Assess and rely on the existing QA process of the data collection of the specific institution** -As most of the data are originally collected for the purposes other than GHG emission calculations many institutions already have a process to ensure the quality of data. If the QA/ QC team is satisfied with the existing QA process they can rely on that. However if the QA associated with activity data is inadequate then the team must go for other methods of QA listed below.
2. **Comparison with independently complied data sources -** Many of the transport sector data are compiled by various international organizations and local universities. Comparison can be done by similar statistics published by those entities.
3. **Comparison with samples -** Since transport is a devolved subject some of the required data are collected by provincial level by institutions like Provincial Road transport ClimateSI,2019 ities and bus deports at provincial level and other associations. These data sets when used as samples provide the opportunity to check the reasonableness of national data.
4. **Trend check** - Activity data can be compared with the data from the previous years. Activity data are normally shows consistent change from year to year. Therefore if there are major changes those data should be further investigated.

Calculation related QC will be done by the MRV Expert committee. The committee will check the duplication of inputs, unit conversion errors, or calculation errors. For further understanding on QA and QC process please refer IPCC Guidelines for National Greenhouse Gas Inventories (chapter 6, quality assurance quality control and verification).

5.5 Recommendations

Regulatory framework revision- Currently Sri Lanka does not have a mandatory GHG reporting system or regulations. This encounter difficulties in obtaining activity data due to the confidential nature of some data, lack of time to provide data and the lack of activity data. As part of the implementation of the transport sector MRV system required regulations and mandates for reporting should be developed in order to empower "transport sector NDC unit" to collect data. This ensures the regulated access to confidential data and data providers with additional assurances. Introduction of mandatory reporting regulations also ensure that the identified data gaps are addressed for effective reporting to the system and that the MRV system is periodically compiled in a sustainable manner. Also any changes in regulations has to be properly communicated to all the relevant parties. At the same time the existing regulatory framework should be revisited to if all the NDCs are translated to policies.

Human capacity -Human capacity is required to ensure that the necessary data are collected and reported periodically and systematically. Since there are new institutions such as "transport sector NDC unit" and MRV coordination unit at CCS, sufficient number of staff with relevant skills should be recruited.

Capacity and awareness building- Since MRV is a new concept to the country non-government and government stakeholders should be properly trained to enhance technical skills and should be educated about the roles and responsibilities of persons in each institution and MRV process and procedure. And also well-structured training programme should be carried out for the "transport sector NDC unit". After providing a training to the stakeholders, user-friendly manuals can be given for reference. Once-a-year MRV system performance review meeting should be held to reflect on the performance and challenges in implementing the transport sector MRV system.

High level support - Support from the high level officials is essential "Because the benefits of monitoring reporting systems do not necessarily secure directly to the entities that provide data to such systems. These entities may see few incentives in providing data. for this reason and specially in the context of centralized monitoring and reporting

systems clear mandate and high level support are often needed"[34] Therefore it is necessary to ensure the support from the officials of the MTCA as well as from other related ministries in order to effectively implement the MRV system. This can be achieved by raise awareness among all government agencies about the need and benefits of the MRV system.

Ensure good Institutional coordination - The 20th sub article, under the "Section F – General Statements" of the Sri Lanka Climate Change Policy, stresses the need to; "*develop and strengthen an inter-institutional coordinating, collaborating and monitoring mechanism for effective implementation of the activities related to climate change at national, provincial, district and divisional levels under the National Focal Point to the United Nations Climate Change Multilateral Agreements".* Lack of institutional coordination has always been a problem in the country especially in the area of climate change. Most of the time the relevant ministry is unaware of their roles and responsibilities in relation to climate change. Therefore good relationship should be maintained within the institutions related to the transport sector MRV system. MRV coordination unit at CCS as the lead agency for institutional coordination has a vital role to play in this regard.

[34]Bakhtiari, F., Hinostroza, M. L., & Puig, D. (2018). Institutional capacities for NDC implementation: a guidancedocument. UNEP DTU Partnership.

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