MRV FRAMEWORK FOR TRANSPORT SECTOR IN CAMBODIA

Initiative for Climate Action Transparency - ICAT

Report on designing the national MRV system, establishment of roles and responsibilities and providing recommendations on how to address barriers/gaps/issues to improve data collection and reporting for transport sector emissions.

Deliverable #5

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May 2022

DISCLAIMER

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The Initiative for Climate Action Transparency (ICAT), supported by Germany, Italy, the Children's Investment Fund Foundation and the ClimateWorks Foundation.

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

Acknowledgement

The Royal Government of Cambodia (RGC) ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1995 and the Paris Agreement in 2017. The country submitted her Intended Nationally Determined Contribution (INDC) in 2015 and the updated NDC in 2020 to the UNFCCC.

The transport sector plays a significant role in GHG emissions reduction. As such, several mitigation actions related to the transport sector were submitted to the UNFCCC through the updated NDC. Tracking progress made in implementing and achieving NDCs is a requirement of the Enhanced Transparency Framework (ETF). Therefore, having a Measurement, Reporting and Verification (MRV) system in place is essential for Cambodia to achieve these targets in a standard and transparent manner.

The UNEP-DTU Partnership is providing technical assistance to the RGC under this ICAT project, which aims to design an MRV system for selected mitigation actions in the transport sector of Cambodia. A Team of National Experts, and International Experts of Climate Smart Initiatives (Pvt) Ltd (ClimateSI), were selected to support the Cambodian Team for this project.

Appreciating the invaluable contribution extended from all stakeholders related to the assignment, we would like to extend our sincere thanks and gratitude to (a) H.E. Dr. Tin Ponlok, Secretary of State of the Ministry of Environment;(b) H.E. Dr. Vann Monyneath, Secretary-General, the General Secretariat of the National Council for Sustainable Development; (c) Dr. Hak Mao, Director of the Department of Climate Change, the General Secretariat of the National Council for Sustainable Development; and the Ministry of Public Works and Transport, and other relevant key stakeholders for cooperating and assisting with this assignment by granting necessary approvals making relevant officers available for participation for the discussions, and providing necessary information. We appreciate the contributions and continued support extended by the participants and other key stakeholders. We would also like to appreciate senior researchers of the UNEP-DTU Partnership for their kind contribution in supervising, reviewing, editing, and providing valuable inputs to improve the quality of this report.

List of Acronyms

BAU	Business as Usual
BRT	Bus Rapid Transit
BURs	Biennial Update Reports
CCTWG	Climate Change Technical Working Group
CBA	City Bus Authority
CDM	Clean Development Mechanism
COP	Conference of the Parties
DCC	Department of Climate Change
DNA	Designated National Authority
ERIA	The Economic Research Institute for ASEAN and East Asia
FOLU	Forestry and Other Land Use
GACMO	The Greenhouse Gas Abatement Cost Model
GHG	Greenhouse gas
GSSD	General Secretariat of the National Council for Sustainable Development
GVW	Gross Vehicle Weight
ICA	International Consultation and Analysis
INDCs	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
LCV	Low Calorific Value
LRT	Light Rail Transit
M&E	Monitoring and Evaluation
MME	Ministry of Mines and Energy
MoE	Ministry of Environment
MPWT	Ministry of Public Works and Transport
MRT	Mass Rapid Transit
MRV	Measurement, Reporting and Verification
NAMAs	Nationally Appropriate Mitigation Actions
NCCC	National Climate Change Committee
NCs	National Communications
NCSD	National Council for Sustainable Development
NDCs	Nationally Determined Contributions
NIS	National Institute of Statistics

PKM	Passenger kilometers
PM	Particulate Matters
PPCA	Phnom Penh Capital Administration
QA	Quality Assurance
QC	Quality Control
REDD+	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
RGC	Royal Government of Cambodia
SD	Sustainable Development
UNFCCC	United Nations Framework Convention on Climate Change

Glossary of Terms

Adaptation	Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.
Capacity building	In the context of climate change, the process of developing the technical skills and institutional capability in developing countries and economies in transition to enable them to address effectively the causes and results of climate change.
CDM	Clean Development Mechanism. A mechanism under the Kyoto Protocol through which developed countries may finance greenhouse-gas emission reduction or removal projects in developing countries, and receive credits for doing so which they may apply towards meeting mandatory limits on their own emissions.
COP	Conference of the Parties. The supreme body of the Convention. It currently meets once a year to review the Convention's progress. The word "conference" is not used here in the sense of "meeting" but rather of "association". The "Conference" meets in sessional periods, for example, the "fourth session of the Conference of the Parties."
Designated National Authority (DNA)	An office, ministry, or other official entity appointed by a Party to the Kyoto Protocol to review and give national approval to projects proposed under the Clean Development Mechanism.
Greenhouse gases (GHGs)	The atmospheric gases responsible for causing global warming and climate change. The major GHGs are carbon dioxide (CO2), methane (CH4) and nitrous oxide (N20). Less prevalent --but very powerful -- greenhouse gases are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6).
ICA	International consultation and analysis, a form of review currently being negotiated and designed in the UNFCCC intergovernmental process.
Intergovernmental Panel on Climate Change (IPCC)	Established in 1988 by the World Meteorological Organization and the UN Environment Programme, the IPCC surveys world-wide scientific and technical literature and publishes assessment reports that are widely recognized as the most credible existing sources of

	information on climate change. The IPCC also works on methodologies and responds to specific requests from the Convention's subsidiary bodies.
Mitigation	In the context of climate change, a human intervention to reduce the sources or enhance the sinks of greenhouse gases. Examples include using fossil fuels more efficiently for industrial processes or electricity generation, switching to solar energy or wind power, improving the insulation of buildings, and expanding forests and other "sinks" to remove greater amounts of carbon dioxide from the atmosphere.
MRV	Measurable, reportable and verifiable. A process/concept that potentially supports greater transparency in the climate change regime.
National communication	A document submitted in accordance with the Convention (and the Protocol) by which a Party informs other Parties of activities undertaken to address climate change. Most developed countries have now submitted their fifth national communications; most developing countries have completed their first national communication and are in the process of preparing their second.
Nationally appropriate mitigation actions (NAMAs)	At COP 16 in Cancun in 2010, Governments decided to set up a registry to record nationally appropriate mitigation actions seeking international support, to facilitate the matching of finance, technology and capacity-building support with these actions, and to recognize other NAMAs.
NDC	According to Article 4 paragraph 2 of the Paris Agreement, each Party shall prepare, communicate and maintain successive nationally determined contributions (NDCs) that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions.
Non-Annex I Parties	Refers to countries that have ratified or acceded to the United Nations Framework Convention on Climate Change that are not included in Annex I of the Convention.
Party	A state (or regional economic integration organization such as the European Union) that agrees to be bound by a treaty and for which the treaty has entered into force.
Quality Assurance	A planned system of review procedures is conducted by personnel not directly involved in the inventory compilation/development process.
Quality Control	A system of routine technical activities to assess and maintain the quality of the inventory as it is being compiled.

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Executive summary

Cambodia submitted its updated NDC in 2020, indicating ambitious targets to reduce GHG emissions and strengthen adaptation capacity in line with the government's national development plans. According to this document, the estimated emissions reduction with the FOLU by 2030 under the NDC scenario will be approximately 64.6 $MtCO_2e$/year (41.7% reduction in the total country emissions of which 59.1% is from the FOLU). Proposed mitigation actions in the Energy sector[1] expect to reduce 40% emissions compared to the Business-as-Usual scenario (BAU) by 2030.

The National Transport sector MRV of Cambodia was developed to measure and report GHG impacts related to two transport sector mitigation actions in NDC, namely 1. Promote integrated public transport systems in main cities, 2. Enhance maintenance and inspections of vehicles. In line with the temporal boundary of the NDC, GHG impact assessment was conducted considering the 2016 -2030 period. As given in the table below, these two mitigation actions will reduce 0.16 $MtCO_2e$ of GHG emissions by 2030, contributing to the achievement of the NDCs.

NDC	**Mitigation Action**	**Measuring**		**Reporting**	**Verification**
		Methodology	Emission reduction $MtCO_2e$		
Promote integrated public transport systems in main cities	Shift passengers from private vehicles to 23 public buses in Phnom Penh	Traffic congestion mitigation/ Modal shift (passenger), Version 3.0 published by JICA	0.0022	General Department of Land Transport CBA, Phnom Penh Capital Administration MME NIS	NDC unit at MPWT MRV expert committee
Enhance maintenance and inspection of vehicles	Establishment of 20 new inspection centres	AMS-III.BC.: Emission reductions through improved efficiency of vehicle fleets- Version 2.0" published by CDM.	0.10	General Department of Land Transport Vehicle inspection centres MME NIS	

[1] This includes energy demand sectors, and therefore energy use in the Transport sector is included.

1 Introduction

1.1 Background

The Royal Government of Cambodia (RGC) has a strong commitment to addressing climate change and accelerating the transition to a climate-resilient, low-carbon, sustainable development mode. Therefore, the country supports global efforts against climate change through being a Party to the United Nations Framework Convention on Climate Change (UNFCCC) since 1996, the Kyoto protocol since 2002, and the Paris Climate Agreement since 2017. Accordingly, Cambodia submitted its Intended Nationally Determined Contribution (INDC) in 2015 and the updated NDC in 2020, indicating ambitious targets to reduce GHG emissions and strengthen adaptation capacity in line with the government's national development plans.

Cambodia's Updated Nationally Determined Contribution (NDC)

Cambodia's Updated NDC includes 33 priority mitigation actions and 58 priority adaptation actions, with details on technology needs. According to this document, the estimated emissions reduction with the FOLU by 2030 under the NDC scenario will be approximately 64.6 million tCO_2e/year (41.7% reduction in total country emissions, of which 59.1% is from the FOLU). Proposed mitigation actions in the Energy sector[2] are expected to reduce 40% emissions compared to the Business As Usual scenario (BAU) by 2030. Table 1.1 indicates the emissions reduction targets of each sector.

Table 1-1: Summary of BAU emission and emissions reduction targets of NDC

Sector	BAU 2016 emissions (MtCO2e)	BAU 2030 emissions (MtCO2e)	NDC 2030 Scenario (MtCO2e)	NDC 2030 reduction (MtCO2e)	NDC 2030 emission reduction (%)
FOLU	76.3	76.3	38.2	-38.1	-50
Energy	15.1	34.4	20.7	-13.7	-40
Agriculture	21.2	27.1	20.9	-6.2	-23
IPPU	9.9	13.9	8.0	-5.9	-42
Waste	2.7	3.3	2.7	-0.6	-18
Total	125.2	155.0	90.5	-64.5	-42

Source: GSSD 2020, Cambodia's Updated Nationally Determined Contribution

Mitigation actions proposed under the Transport sector such as promoting integrated public transport systems in main cities, enhancing maintenance and inspection of vehicles (Piloting maintenance and emission inspections of vehicles), and shifting long-distance freight movement from trucks to train will play a major role in reducing the emissions from the Energy use in the Transport sector. As such, The Second Phase of the ICAT was primarily

[2] This includes energy demand sectors, and therefore energy use in the Transport sector is included.

focused on developing the Measurement, Reporting and Verification (MRV) system for Cambodia's Transport sector. Table 1.2 presents the Transport sector mitigation actions and related SDGs as per the NDC of Cambodia.

Table 1-2: Mitigation actions/projects in Transport sector NDCs

Mitigation actions/projects	Benefits	Related SDGs
Enhance maintenance and inspection of vehicles (Piloting maintenance and emission inspections of vehicles)	1. Reduce maintenance costs 2. Reduce traffic accidents, injuries and fatalities 3. Reduce air pollution and GHG emissions 4. Innovate technology	3,5,8,9
Promote integrated public transport systems in main cities	1. Reduce traffic congestion 2. Reduce air pollution 3. Easy access to transport modes 4. GHG emissions reduction 5. Cost-saving 6. Save travel time 7. Increase the comfort and safety in transport	3,5,8,9
Shift long-distance freight movement from trucks to train	1. Reduce traffic congestion 2. Save travel time 3. Reduce air pollution and GHG emissions	3,5,8,9

Source: GSSD 2020, Cambodia's Updated Nationally Determined Contribution

Measurement, Reporting and Verification (MRV)

The regular collection, analysis, and use of reliable information on climate action and support to reduce GHG emissions and increase resilience, and data on GHG emission trends, both historical and projected, is essential for evidence-based decision-making and information-sharing, which in turn build trust and understanding and promote stakeholder engagement. This data collection and reporting activity forms a critical component of what is commonly known as' MRV' under the Convention and has recently been encapsulated by the term' transparency' under the Paris Agreement.

Key components of MRV include international MRV, Domestic MRV, and MRV for REDD+. Figure 1.1 details the key elements of the MRV framework. As Cambodia expects to develop MRV to assess emissions reductions attributed to mitigation actions, the proposed Transport sector MRV will fall under the Domestic/National MRV category.

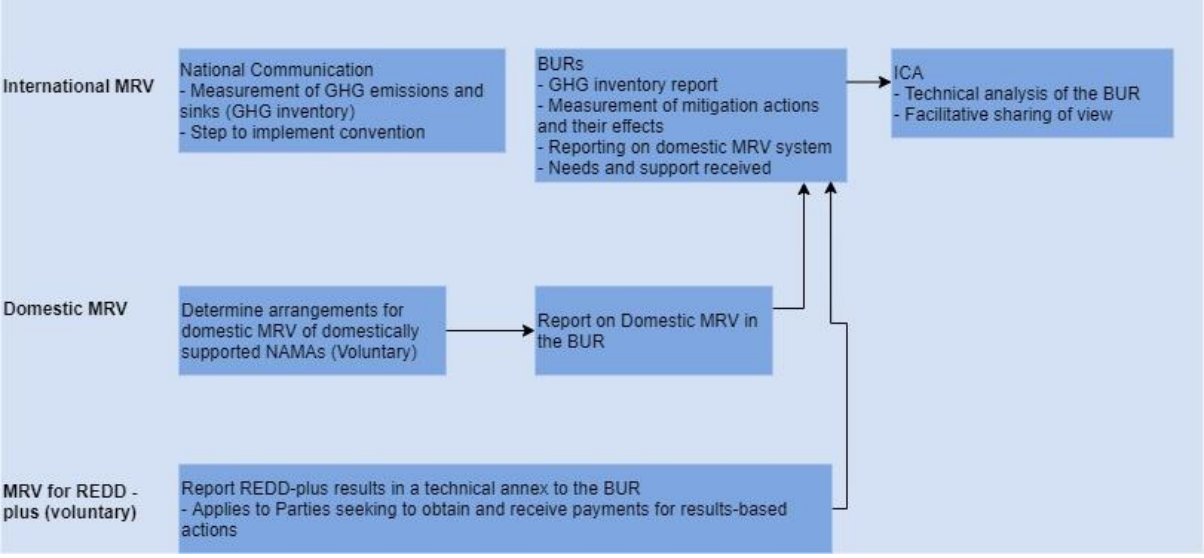


Figure 1-1: Key elements of the MRV framework

Source: UNFCCC 2014, *Handbook on Measurement, Reporting and Verification for developing country parties*

At the national level, Parties are expected to implement the international guidelines for domestic MRV frameworks and to prepare and report information according to the guidance on reporting through national communications and BURs. Domestic/national MRV systems include three elements: 1) MRV of emissions; 2) MRV of NAMAs/mitigation actions; 3) MRV of support.

MRV of mitigation actions involves assessing (ex-ante or ex-post) GHG emissions reductions and/or sustainable development (non-GHG) impacts of policies, projects, and actions. It also involves assessing progress toward mitigation goals.

1.2 Objectives of the project

1.2.1 Objectives of the project

The main objectives of the project are;

- Develop the MRV framework for the transport sector in Cambodia; and
- Build capacity on the use of transparency related tools; GACMO, ICAT SD assessment tool, and selected methodologies for MRV and GHG impacts.

1.2.2 Objectives of this deliverable

- Design MRV Systems for the two selected mitigation actions for the transport sector in Cambodia; and
- Develop institutional arrangements with well-defined roles and responsibilities to implement the MRV systems.

1.3 Scope

The scope of this report is to design MRV systems for two mitigation actions of the transport sector, taken from the NDC of Cambodia, and develop the required institutional arrangement with defined role and responsibilities to implement the MRV systems.

There are three transport sector mitigation actions in the NDC of Cambodia, of which, two were selected to develop the MRV systems. The selection process is described in Deliverable 1[3].

1.4 Limitations

Results from this report can not be generalized for other mitigation actions in the transport sector. For additional actions, the methodology to assess emissions reduction may be different, and institutional arrangement and data management systems may also need to be reviewed, though modification needed could be minor in some cases.

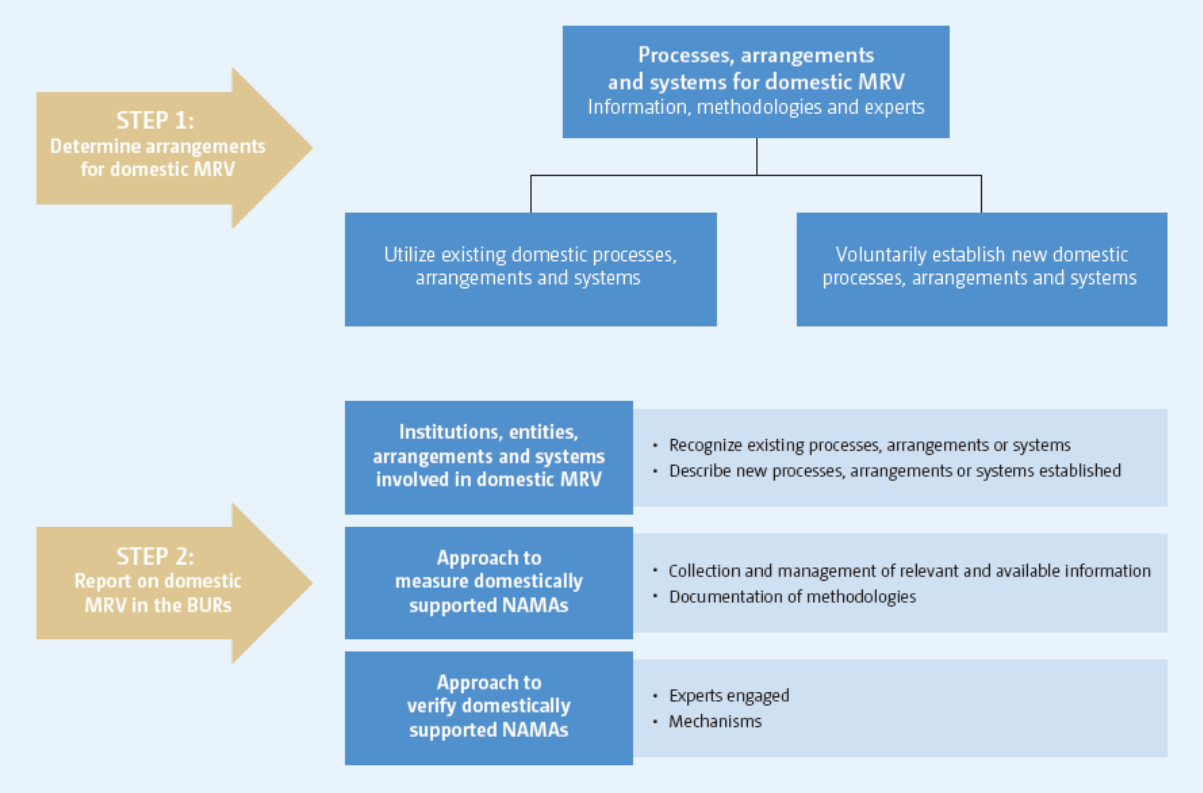
2 Methodology

The National MRV system for the Transport sector of Cambodia is an MRV of NAMA/mitigation actions. Guidelines available for the development of said MRV types are general, voluntary, pragmatic, non-prescriptive, non-intrusive and country driven. The main guideline related to the development of domestic measurement, reporting and verification of domestically supported NAMAs by developing country Parties (Decision 21/CP.19) were adopted at the 19th COP. As per the guidelines, MRVs may be developed considering national circumstances and national priorities, acknowledge the diversity of NAMAs, build on existing domestic systems and capacities, recognize existing domestic measurement, reporting and verification systems and promote a cost-effective approach.

[3] Deliverable 1: *Report on the selection of appropriate policy/action/target for the development of MRV for the transport sector of Cambodia.*

Handbook developed by the UNFCCC on MRV for developing country parties includes two major steps to follow in developing an MRV of mitigation actions, as indicated in Figure 2.1.

Figure 2-1: Guideline for domestic MRV of domestically supported NAMA



Source: UNFCCC 2014, *Handbook on Measurement, Reporting and Verification for developing country parties*

National MRV system for Transport sector was developed considering both of above steps and good practices of other countries.

For each (of the two) identified mitigation actions, the steps in developing the MRV framework were as follows.

Step 01

As given in decision 21/CP.19, the diversity of the mitigation actions given in the NDC of Cambodia needs to be acknowledged. However, considering time and budget limitations, Transport sector NDCs were prioritized based on expert judgement and stakeholder consultation considering political preference, effects on GHG emissions reduction, and sustainable development impacts. Mitigation actions and policies attributed to these NDCs were mapped and then prioritized based on expert judgement and stakeholders consultations considering the likelihood of implementation and data availability for analysis. For further details, please refer to Deliverable 1[4].

[4] Deliverable 1: *Report on the selection of appropriate policy/action/target for the development of MRV for the transport sector of Cambodia*.

Step 02

As given in both guidance steps, national circumstances and national priorities, existing domestic systems and capacities, and existing domestic measurement, reporting and verification systems need to be considered. As such, under Deliverable 3[5], of this assessment, these were studied along with identification of barriers and gaps in the transport sector.

Step 03

Appropriate methodologies to develop the MRV system as well as to assess GHG impacts of selected mitigation actions and policies were mapped in Deliverable 4[6]. It was decided to utilize existing domestic processes and systems with minimum changes to ensure the sustainability of the proposed MRV system.

Step 04

Systems containing procedures to measure GHG impacts of selected mitigation actions, data management system and data collection templates, were developed for each institution responsible for data collection. These were presented to respective stakeholders for their feedback and approval.

The systematic institutional arrangement was established based on stakeholders consultations with defined roles and responsibilities to meet the reporting requirements of the UNFCCC, inform policymakers and assist activities relating to reporting on climate change. The proposed system was integrated into existing institutional arrangements of the MRV systems, climate change management, and the transport sector to ensure sustainability. The institutional arrangement was presented to the respective stakeholders for their feedback and approval. A protocol was prepared to oversee the implementation process of the MRV.

A verification system was also established, including different verification layers such as in-house data verification, QC procedures in the NDC unit, third party review, and QA by an expert team.

Step 05

An implementation plan including instructions for capacity building and the next step was developed.

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[5] Deliverable 3: *Report on MRV assessment of the existing national MRV system and report on designing an institutional governance structure for the Transport sector as a part of a unified national MRV System in the country for NDCs and providing recommendations on how best to remove the most significant visible barriers documented*

[6] Deliverable 4: *Final report on the assessment of methodologies for the development of MRV system, including assessment of GHG emission impacts of policies and actions in the Transport sector.*

3 Promote integrated public transport systems in main cities

Shift passengers from private vehicles to 23 public buses in Phnom Penh

In this section MRV system has been designed, institutional arrangement developed with role and responsibilities to implement the MRV system for the mitigation action, "Promote integrated public transport systems in main cities".

3.1 Background

Phnom Penh capital city of Cambodia has a land area of 678 km^2 and a population of 2.3 million by 2019 (NIS/MoP, 2020). Although Phnom Penh is located in the Southern Economic corridor connecting ASEAN economic zones, public bus services in the city have only been started in 2014. By 2016, Phnom Penh Capital Administration (PPCA) was operating 57 buses in 3 routes, but this has been inadequate compared to the population of the city. Due to the limited availability of public buses, there has been a rapid increase in private vehicles in the city in recent years. Mainly, private cars, motorbikes and motodops (motorcycle taxis) are used in the city for passenger transport. There were 237,757 vehicle registrations in Phnom Penh, accounting for 41 per cent of the total vehicle registrations in Cambodia in 2018. Figure 3.1 shows the percentage share of private cars, motorbikes, and other vehicles in Phnom Penh in 2018(Chan S., 2019). According to that, the highest percentage contribution is from motorbikes, followed by private cars, which account for almost 99% of the vehicles in the city.

Source: Traffic Management project in Phnom Penh, 2018

The high number of vehicles on roads caused heavy traffic congestions and high GHG emissions in the city. Further, this has increased traffic accidents on the roads. By 2016, the road fatality rate was 12 deaths per

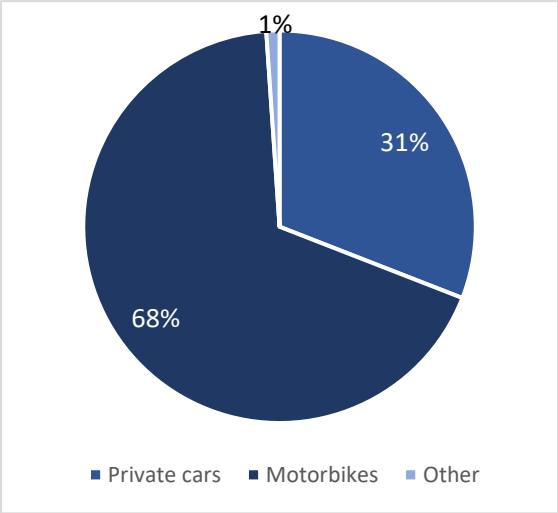


Figure 3-1: Percentage share of private cars, motorbikes and other vehicles in Phnom Penh in 2018

100,000 population in Cambodia and Phnom Penh has contributed highly to the road fatality rate of the country (Asian Development Bank- Southeast Asian Department, 2019).

Therefore, it is important to reduce the share of private vehicles on the road. Following are a few initiatives to promote an integrated public transport system in Phnom Penh city.

1. Increase the modal share of public transport to 30%, initiated by a 10% increase in 2020 through a scheme of 10 bus routes (JICA, 2014).
2. Replacing 57 old buses with brand new buses (JICA, 2016a).
3. Add 23 new buses to the public bus fleet (JICA, 2016a)

In order to achieve above, JICA has supported Cambodia to introduce 80 new buses to the fleet. As per the project, 57 of these new buses will be used to replace the old buses while rest will be improve the capacity of the public transportation. Introduction of 23 new buses as part of this project has considered for the development of the MRV system.

Overall Objectives of introducing public buses to the in Phnom Penh city are to 1) address traffic issues such as congestion, accidents and air pollution, 2) increase average speed of transport modes in the capital city and improve overall urban mobility, 3) reduce number of private automobiles, 4) create employment for people and 5) improve traffic flow in the capital as a pilot for BRT. Among others main objective of the selected mitigation action is to improve the modal share of the public buses.

3.2 Scope and boundaries of the project

3.2.1 Causal chain

Promoting integrated public transport systems in main cities is one of the transport sector's NDC of Cambodia. A mitigation project implemented in 2018 under the programme "Project for Improvement of Public Bus Operation in Phnom Penh" (PiBO) has been considered for the development of the MRV system.

Project has introduced 80 new buses in Phnom Penh, which replaced 57 old buses operated in the city, and added of 23 new buses to the public transport system. The addition of 23 new buses to the system increased the share of public transport in the city. This action is expected to reduce the share of private vehicles and increase the share and occupancy of public buses. Due to the operation of the low number of private vehicles on the road as a cause of the above action, a low level of fossil fuel consumption occurs, which in turn will reduce the GHG emissions from passenger transport in Phnom Penh. The causal chain of this mitigation action is shown in Figure 3.2.

The reduction of private vehicles may negatively affect the jobs of mechanics. However, new bus introduction will create new job opportunities as drivers, conductors, etc. Operation and maintenance (O&M) costs will be reduced in private vehicles due to reduction of usage, accidents, etc.

With the replacement of 57 old buses, the number of old vehicles on the road were reduced. Mobility of passengers and number of trips may increase due to the attraction of passengers to public transport. Passenger shift may positively affect emission reduction, while increased mobility will cause a negative impact on the environment.

Out of the above impacts, GHG emission reduction due to a low level of fossil fuel burning from public transportation compared to the public vehicles will be considered for MRV development.

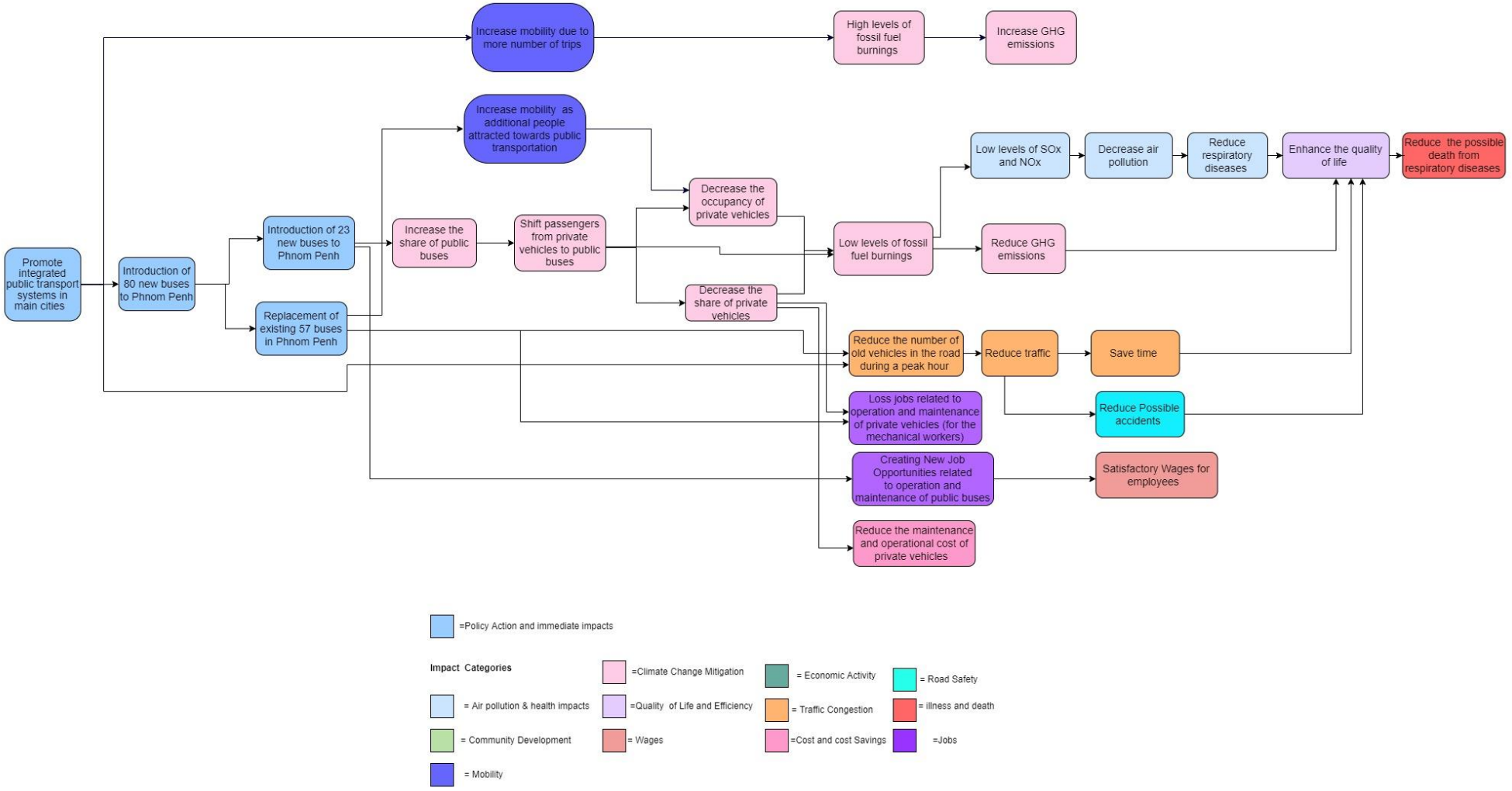


Figure 3-2: Causal chain for the shift passengers from private vehicles to 23 public buses

3.2.2 Impacts from mitigation action

A qualitative analysis of the impacts of this mitigation action is given in Table 3.1. The impacts are mainly categorized under three dimensions: environmental, social, and economic. The likelihood describes the probability of the impact taking place. The magnitude presents the size and type of impact. The likelihood and the magnitude of these impacts were decided based on expert judgement, literature reviews and stakeholder consultations.

Table 3-1: Environmental, social and economic impacts from the project "shifting passengers from private vehicles to 23 public buses"

Dimension	Special impacts	Likelihood	Direction and the Magnitude[7]
Environment	Reduction of GHG emissions from vehicle fleet due to the reduction of fossil fuel combustion	Very likely	positive impact
	Reduce the potential for respiratory diseases of the residence in Phnom Penh due to low pollutants (PM) emissions	Very likely	positive impact
	Decrease air pollution due to the low gaseous emissions from vehicles	Very likely	positive impact
	Increase mobility due to an increase in the number of trips[8]	Less likely	negative impact
Social	Decrease possible deaths from respiratory diseases	Very likely	positive impact
	Enhance the quality of life by creating a rich and comfortable urban environment and eco-friendly suburban environment	Likely	positive impact
	Loss of properties due to infrastructure development (E.g. road)	Likely	negative impact
	Traffic levels decreased due to decrease in the number of vehicles which will save time for passengers	Likely	positive impact

[7] Impacts depends on project size and impacts here are minor since project size is very small. Hence all impacts are minor or negligible.

[8] Preparatory Survey Report Project for Improvement of Transportation Capacity of Public Bus in Phnom Penh indicate operation rate of buses will increase from 67.5% to 100%. Increased reliability and affordability will increase the mobility.

	Increase mobility due to attraction of more passengers to public transportation	Likely	positive impact
	Reduce possible accidents due to the reduction of private vehicles such as motorbikes	Possible	positive impact
Economical	Satisfactory wages for employees due to increased job opportunities	Very likely	positive impact
	Operation and maintenance cost savings from private vehicles and cost-saving due to low fare for public transport	Very likely	positive impact
	Create new job opportunities related to the introduction of 23 new buses	Likely	positive impact
	Loss of jobs related to reduced operation and maintenance of private vehicles and old buses (E.g. mechanical workers)	Unlikely	negative impact

Other than the above-mentioned qualitative elements, the level of significance, whether the considered impact is in or out of the jurisdiction, was also used for the qualitative analysis. For detailed analysis, please refer to Annex 1. Out of the above impacts, MRV will be developed for GHG emissions reduction from public transport.

3.2.3 System boundary

This mitigation action was initially planned to be implemented from 2016 to 2020, but it was implemented in 2018. GHG impact of the project will be assessed from 2018-2030, considering the target period of the NDC. Private cars, motorbikes, and motodops are the most common passenger transport modes in Phnom Penh in the baseline scenario. Further, the selected methodology only facilitates emission estimations for baseline transport modes such as buses, private cars, taxis, motorbikes, and railways. Considering both these provisions and the fact that motordops are a taxi type, private cars and motorbikes were selected as vehicle modes for the baseline scenario.

Only CO_2 emissions were considered for the assessment as CH_4, and N_2O emissions from diesel powered transportation are insignificant compared to CO_2 emissions and also methodology only provide provision to assess the CO_2 emission. In order to avoid complexities, scope of the assessment has excluded the emissions attributed to upstream and downstream operations. Therefore, they are not included in the assessment. Table 3.2 shows the summary of the system boundary for the assessment.

Table 3-2: System boundary for the project "Shift passengers from private vehicles to 23 public buses"

Boundary elements	Description
Geographic Boundary	Phnom Penh
Temporal Boundary	2018 – 2030
Transport subsector	Passengers transport Passengers transported by public buses, private cars, and motorbikes
Upstream/downstream	Not considered
GHGs Included	CO_2

3.3 Measurement

GHG emissions reductions attributed to mitigation action were assessed using a JICA methodology; *Traffic congestion mitigation/ Modal shift (passenger), Version 3.0*. This methodology can be used to assess the GHG emission reductions due to shifting of passengers from the existing modes of transport to Mass Rapid Transit (MRT), railways, monorail, Light Rail Transit (LRT), Bus Rapid Transit (BRT) and trunk buses which are operating as inner-city passenger transport systems. The existing modes for which the methodology is valid includes buses, private cars, taxis, motorbikes or existing railways. Further, this methodology can be used for the assessment of projects which will reduce the GHG emissions by reducing congestion from existing transportation facilities through road maintenance, bridge construction, introduction of double-track, etc. These types of mitigation actions may have rebound effects such as increased number of trips due to availability of attractive public transport systems and decrease in speed of vehicles due to induced traffic. But this methodology is unable to assess the effect of these rebound effects and leakages.

3.3.1 Key Indicators

This methodology mainly assesses the emissions reduction due to increase in the modal share of high occupancy vehicles while reducing the modal share of private vehicles. Table 3.3 shows the key indicators used in this methodology to estimate GHG emissions reductions through this mitigation project.

Table 3-3: Key indicators for the estimation of the GHG emissions due to the project "shifting of passengers from private vehicles to 23 public buses"

Indicator	Symbol	Unit
Number of passengers transported by public buses under the project in year y	P_y	passengers/year
Average trip distance of a passenger by a public bus under the project activity in year y	$BTDP_{by}$	km
Average occupation rate of transport mode i (i=private car, motorbike, bus) in the base year	$OR_{b,i}$	passenger/vehicle
Share of passengers by transport mode i in the baseline scenario in year y (i=private car, motorbike)	$MS_{bi,y}$	%
Fuel consumption rate of mode i (i=private car, motorbike)	SFC_i	litres/km
Consumption of diesel associated with the operation of the public buses in year y	$FC_{PJ,y}$	tons/year
CO_2 emission factor of transport mode i (i=private car, motorbike)	$EF_{KM,i}$	tCO_2/km
CO_2 emission factor of fuel x (x=gasoline, diesel)	$EF_{fuel,x}$	tCO_2/TJ

Note: Table developed based on *Traffic congestion mitigation/ Modal shift (passenger), Version 3.0. (JICA, 2019) and Compendium on Greenhouse Gas baseline and monitoring- Passenger and freight transport (UNFCCC, 2018)*

3.3.2 Baseline Scenario

Identification of baseline scenarios

Several baseline scenarios can be identified based on the mode of transportation. Commuting within the city by foot, cars, motorbikes and motodops are some of them. Out of these, commuting by foot was excluded as induced demand and shift from non-motorized transport was not considered for the assessment. Shifting from the motodops were excluded as scope is the assessment limited to the shifting from private vehicles to public vehicles. The base year was selected as 2016 based on the NDC report.

Baseline scenarios: Passengers commuting within the city by private cars and motor bikes

Methodology

The baseline emissions were calculated considering the number of private cars and motorbikes that would have been used in the absence of newly introduced 23 public buses to meet the commuting demand within the city. Equation 3.1 is used as the principal equation to assess the baseline emission. CO_2 emission factor of private cars and motorbikes were calculated using Equation 3.2.

Equation 3.1: Baseline Emissions

$$BE_y = \sum_i \left(\frac{P_y \times MS_{bi,y}}{OR_{bi}} \times BTDP_{by} \times EF_{KM,i} \right)$$

Equation 3.2: Emission factor for mode of transport

$$EF_{km,i} = SFC_i \times NCV_{x,y} \times EF_{fuel,x}$$

Where:

BE_y	Baseline emissions (tCO_2/year)
P_y	Number of passengers transported by the project in year y (passenger/y)
$MS_{bi,y}$	Share of passengers by transport mode i in the baseline scenario in year y (%)
OR_{bi}	The average occupancy rate of transport mode i (passenger/vehicle)
$BTDP_{by}$	Average trip distance of the passenger of the project activity in year y (km)
$EF_{KM,i}$	CO_2 emission factor of transport mode i (tCO_2/km)
SFC_i	Fuel consumption rate of mode i (litres/km)
$NCV_{x,y}$	Net calorific value of fuel type x (TJ/litre)
$EF_{fuel,x}$	CO_2 emission factor of fuel type x (tCO_2/TJ)
i	Mode of transport (private cars, motorbikes)
y	The year that the emission is estimated (2016)
x	Type of fuel gasoline

Data requirement

Data required for the calculation of GHG emissions under the baseline scenario are presented in Table 3.4.

Table 3-4: Data required for the baseline emission calculation of the project "shift passengers from private vehicles to 23 public buses"

Parameter	Description	Unit	Data availability	Source
P_y	Number of passengers transported by the public buses in the base year	passenger/y	Available	Calculated based on Preparatory survey report (JICA, 2016) [9]
$MS_{bi,y}$	Share of passengers by private cars and motorbikes in the base year	%	Not available	Calculated
OR_{bi}	The average occupancy rate of private cars and motorbikes	passenger/vehicle	Available	The default value in the GACMO tool (UNEP DTU Partnership, 2015)
$BTDP_{by}$	Average trip distance of a passenger of the public bus in base year	km	Available	The preparatory survey report (JICA, 2016)
SFC_i	Fuel consumption rate of cars and motorbikes	litres/km	Available	Cambodia Transport sector assessment, 2019(ADB- 2019) Default in GACMO tool (UNEP DTU Partnership, 2015)
$NCV_{x,y}$	Net calorific value of gasoline	TJ/litre	Not available in the required unit	Converted from Low calorific content of gasoline LCV available from MME (NCSD, 2020)
$EF_{fuel,x}$	CO_2 emission factor of gasoline	tCO_2/TJ	Available	(IPCC, 2006)

[9] Value available in the report is for 76 vehicles, apportioned it for 23 buses

As indicated in Table 3.4, the share of passengers by private cars and motorbikes for the baseline scenario was not available directly from sources. Cambodia only has LCV of gasoline instead of NCV. As such, LCV was converted to NCV. Those were calculated using extra parameters as given in Table 3.5.

Table 3-5: Extra parameters used for baseline emission estimation due to the project "shift of passengers from private vehicles to public buses"

Unavailable parameter	Extra parameter	Unit	Source
$MS_{b,i,y}$	Number of private cars in Phnom Penh in 2016 (**$N_{2016,car}$**)	Cars	Traffic management project in Phnom Penh (Matsuoka, 2018)
	Number of motorbikes in Phnom Penh in 2016 (**$N_{2016,bike}$**)	Motorbikes	
	The occupancy rate of a private car (**OR_{car}**)	Passengers/ car	The default value in the GACMO tool (UNEP DTU Partnership, 2015)
	The occupancy rate of motorbike (**OR_{bike}**)	Passengers/ motorbike	
	Population in Phnom Penh in 2016		The project for comprehensive Urban Transport plan in Phnom Penh capital city (JICA, 2014)
$NCV_{x,y}$	The low calorific content of gasoline (**$LCV_{gasoline}$**)	TJ/kg	MME (NCSD, 2020)
	Density of gasoline (**$d_{gasoline}$**)	kg/litres	(Ministry of Energy Mines Lao PDR & ERIA, 2018)

Methodological challenges

- Share of passengers transported by cars and bikes ($MS_{bi,y}$) in 2016 were calculated using separate equations.
- The net calorific value of gasoline ($NCV_{gasoline}$) in the units of TJ/litre was calculated using the density of gasoline ($d_{gasoline}$) and the low calorific content of gasoline ($LCV_{gasoline}$) in the units of TJ/kg.

Results

Baseline emissions for 2016 were 8.5 x 10^{-4} $MtCO_2$, whereas for 2021, emissions were 0.003 $MtCO_2$. Emission factors for the cars and motorbikes were considered as 1.6 x 10^{-4} tCO_2/km and 5.6 x 10^{-5} tCO_2/km, respectively. For detailed calculations, please refer to Annex 2.

3.3.3 Project scenario

3.3.3.1 Ex-post assessment

Under the project scenario, a fraction of passengers who use private cars and motorbikes will be shifted to 23 diesel buses. Initially, the project was planned to be implemented during 2016-2020 period. However, the project was implemented in 2018. The *Preparatory Survey Report on the Project for Improvement of Transportation Capacity of Public Bus in Phnom Penh* by the Japan International Cooperation Agency (JICA, 2016a), has set targets of the project to 2021. Therefore, the project emissions were calculated for 2018 and 2021. Ex-ante assessment was conducted for the 2030, assuming that share of passengers shift for the buses will increase along with the growth of the population.

According to the *Preparatory Survey Report on the Project for Improvement of Transportation Capacity of Public Bus in Phnom Penh* by the Japan International Cooperation Agency (JICA, 2016a), two additional routes need to be added to the system to implement this project. This was also considered in the estimation of emissions under the project scenario.

Project scenario: Passengers commuting within the city by 23 public buses

Methodology

Project emissions were calculated considering the total fuel consumption of 23 buses. As indicated in Equation 3.3, the net calorific value and CO_2 emission factor of diesel were also considered.

Equation 3.3: Project Emissions

$$PE_y = FC_{PJ,y} \times NCV_{x,y} \times EF_{fuel,x}$$

Where:

PE_y Project emissions (tCO_2/year)

$FC_{PJ,y}$	Consumption of fuel x associated with the operation of the buses in year y (t/y)
$NCVx,y$	Net calorific value of fuel x (TJ/t)
$EF_{fuel,x}$	CO_2 emission factor of fuel x (tCO_2/TJ)
y	The year that the emission is estimated
x	Type of fuel (Diesel)

Data requirement

Data required for the calculation of GHG emissions under the project scenario are presented in table 3.6.

Table 3-6: Data required for the project emission calculation of "shift passengers from private vehicles to 23 public buses" project

Parameter	Description	Unit	Data availability	Source
$FC_{PJ,y}$	Consumption of diesel associated with the operation of the buses in year y	t/y	Not available	Calculated
$NCV_{x,y}$	Net calorific value of diesel	TJ/t	Available	MME (NCSD, 2020)
$EF_{fuel,x}$	CO_2 emission factor of diesel	tCO_2/TJ	Available	IPCC guideline, (IPCC, 2006)

As indicated in Table 3.6, diesel consumption of buses was not directly available from a source. Therefore, extra parameters given in table 3.7 were used for the calculation.

Table 3-7: Extra parameters used for project emission estimation due to the project "shift of passengers from private vehicles to public buses"

Unavailable parameter	Extra parameter	Unit	Source
$FC_{PJ,y}$	Specific fuel consumption of bus (**$SFC_{Pi,y}$**)	litres/km	Energy Consumption in the Road Transport sector (*Parking Lot Survey in Cambodia, Lao PDR, and Myanmar*, n.d.)
	The density of diesel (**d_{diesel}**)	kg/litre	(Ministry of Energy Mines Lao PDR & ERIA, 2018)

	Annual milage traveled by buses (VKM $_{bus,y}$)	km	preparatory survey report[9] (JICA, 2016)

Methodological changes

- Product of total fuel consumption from the 23 buses under the project scenario ($FC_{x,y}$) and the net calorific value of diesel (NCV_{diesel}) was calculated from specific fuel consumption of a bus, density of diesel, net calorific value of diesel, occupancy rate of bus, annual distance travelled by a bus, and the annual number of passengers.

Results

Project emissions for the year 2018 were calculated considering the ridership in buses in 2018 in Phnom Penh city, and it accounted for 7.6 x 10^{-4} $MtCO_2e$. Project emissions for the year 2021 work out 7.5 x 10^{-4} $MtCO_2e$ $MtCO_2e$. Vehicle kilometers travelled by buses has reduced in 2021 compared to the 2018. For detailed calculations, please refer to Annex 2.

3.3.3.2 Ex-ante assessment

Ex-ante assessment was conducted for the year 2030, assuming that passenger shift to the public buses will be highly corelated with the population growth of the city. Emission reduction for the year 2030 accounted for the 8.41 x 10-4 $MtCO_2e$

3.3.4 Emission reduction (Ex-post for 2018 and Ex-ante for 2030)

Emissions estimated for the years 2016, 2018, 2021 and 2030 are summarized in Table 3.8.

Table 3-8: Emission reduction in 2018, and 2030 due to the project " shifting of passengers from private vehicles to public buses"

Scenario	Emissions (x $10^{-4}$$MtCO_2e$)			
	2016	2018	2021	2030
Baseline emissions	8.51	8.93	27.68	30.83
Project emissions	-	7.61	7.55	8.41
Emission reductions	-	1.32	20.13	22.07

Emission estimation for the BAU and the project scenario till 2030 are shown in Figure 3.3. As indicated in the graph, contribution of the project to emission reduction increase over the years.

Figure 3-3: BAU and project emissions for the shift of passengers from private vehicles to 23 public buses

Emissions reduction from the project will be 2.21 x 10^{-5} $MtCO_2e$ by 2030.

3.3.5 Uncertainties

Following assumptions may cause some uncertainty to the assessment

- It was assumed that the passengers will be shifted from private cars and motorbikes to public buses at the same rate from 2018 to 2030
- The number of passengers using private cars and motorbikes in 2016 was calculated using the number of private cars and motorbikes in Phnom Penh in 2016 and the occupancy rates of the respective mode of transport.
- It was assumed that all the passengers of the buses were shifted from cars or motor bikes (The number of passengers that can be accommodated by 23 buses was divided among the private cars and motorbikes. This division was done based on the number of passengers who used private cars and passengers who used motorbikes in 2016.)

3.4 Reporting

Reporting takes place in different stages of the process. Activity data need to be measured by data collecting agencies and reported to the NDC unit, which is proposed to be established under the Ministry of Public Works and Transport (MPWT). Please see Chapter 5 for more details. Emissions reduction attributed to the mitigation action (project) needs to be reported to the MRV coordination unit and the National Council for Sustainable Development (NCSD). Details related to mitigation actions need to be reported in NC, while details related to domestic MRVs are reported in the BUR.

As a part of the MRV system development, data collection templates required to monitor the activity data by relevant institutions have been included in the procedures. These data collection templates include the types of data that should be collected, their units, frequency of collection. the entity including name and the designation of the officer responsible for data collection, and date. Please refer to data collection templates procedures (P1- P4) for this mitigation action.

3.5 Verification

Verification takes place at different levels to ensure Transparency, completeness, consistency, Comparability and accuracy (TCCCA) of data. The accuracy of the activity data will be checked at the organization level before submitting it to the NDC unit. TCCCA of the data provided will be assessed by the QC control team of the NDC unit. Quality assurance procedures, including third-party review, will be conducted by the Climate Change Working Group (CCWG) as the MRV experts. BURs will also be subjected to the International Consultation and Analysis (ICA).

3.6 Data Management System

Data that need to be collected from various institutions, reporting hierarchy, and frequency are illustrated in Figure 3.4. As shown in the figure, data need to be collected from the General Department of Land Transport, City Bus Authority Phnom Penh Capital Administration, Ministry of Mines and Energy (MME), and The Economic Research Institute for ASEAN and East Asia (ERIA) reports. Table 3.10 summarizes the roles and responsibilities of these institutions.

Table 3-9: Roles and responsibilities of institutions related to MRV activities of the project "shifting passengers from private vehicles to 23 public buses"

Institution	Roles and Responsibilities
General Department of Land Transport	Measuring and annually reporting following data 1. Share of passengers transported by cars and motorbikes in Phnom Penh

	2. The average occupancy rate of motorbikes and private cars 3. Specific gasoline/diesel consumption of motorbikes and private cars
City Bus Authority Phnom Penh Capital Administration	Collecting and annually reporting the data related to the following 1. Average annual trip distance of a passenger by a public bus 2. The average number of passengers transported by 23 buses 3. Fuel consumption by 23 buses
Ministry of Mines and Energy ERIA	Measuring and annually reporting following data 1. Net calorific value of gasoline 2. Net calorific value of Diesel

The data collected by these institutions should be reported to the transport sector NDC unit, which is under the Department of monitoring and evaluation of MPWT. This unit will calculate the intermediate parameters using the data collected and estimate the emissions related to this mitigation action. Then this department will report to the Ministry of Public Works and Transport, who will then report it to the MRV coordination unit at the General Secretariat of the National Council for Sustainable Development (GSSD). When these are submitted to the NCSD, they will direct these to the Climate Change Technical working group to verify the data and estimations of GHGs. Department of Climate change may get information from this unit as required to compile BURs, NCs, etc. Then this verified information will be submitted to the Ministry of Environment through the NCSD, who will ultimately submit it to the UNFCCC.

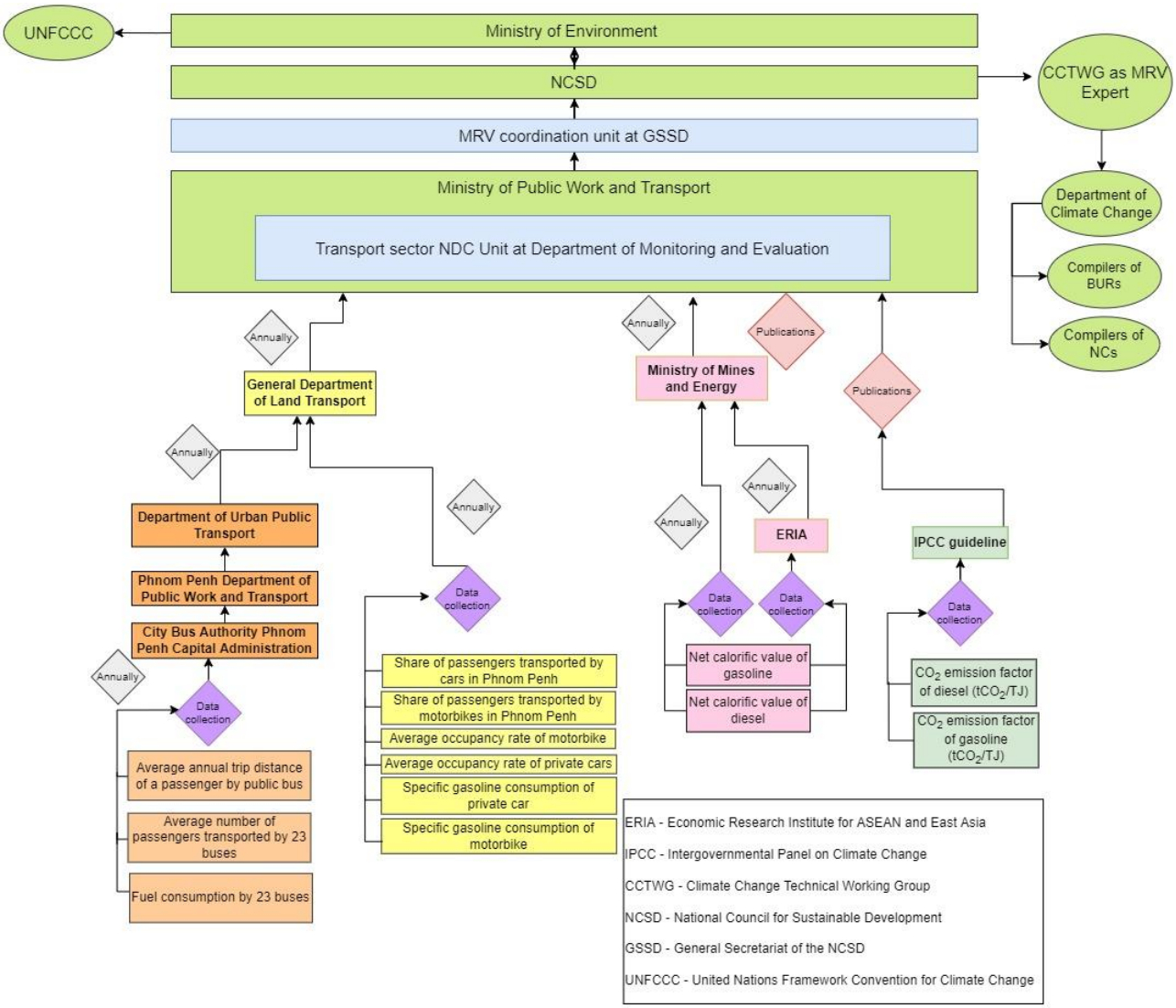


Figure 3-4: Data management system for the shift from private vehicles to 23 public buses

3.7 Recommendations

It is recommended to appoint an officer in each relevant institution to facilitate implementation of the MRV system. Establishing data-sharing agreements between relevant organizations and ministries is necessary to have a proper data flow for the MRV system. Further, the digitalization of the system can enhance efficiency and reduce human errors in assessment. Providing online access to collected data through the digitalization of the system is also recommended, which will be helpful to maintain the transparency of the MRV system.

4 Enhance maintenance and inspection of vehicles

Establishment of 20 new vehicle inspection centres

In this section MRV system has been designed, institutional arrangement developed with the role and responsibilities to implement the MRV system for the mitigation action, " Establishment of 20 new vehicle inspection centers ".

4.1 Background

Cambodia has established vehicle inspection centres to improve the conditions of the vehicle fleet. Currently, 15 inspection centres are operating around the country (Ministry of Public Works and Transport, 2019). Vehicle owners are liable to bring their vehicles for inspections; commercial vehicles once a year and private vehicles once every two years. Inspection includes nine different tests: appearance inspection, speedometer test, exhaust gas test, sound level test, headlight inspection, weight measurements, underbody inspection, slide slip test, and brake test. A certificate is issued to the vehicles that pass all these tests. Vehicles that fail the tests need to be rectify the defects and re-apply for the certificate. Vehicle owners with expired certificates or who fail to get their vehicles inspected within the required time period are subjected to fines. Figure 4.1 illustrates the process at inspection centres.

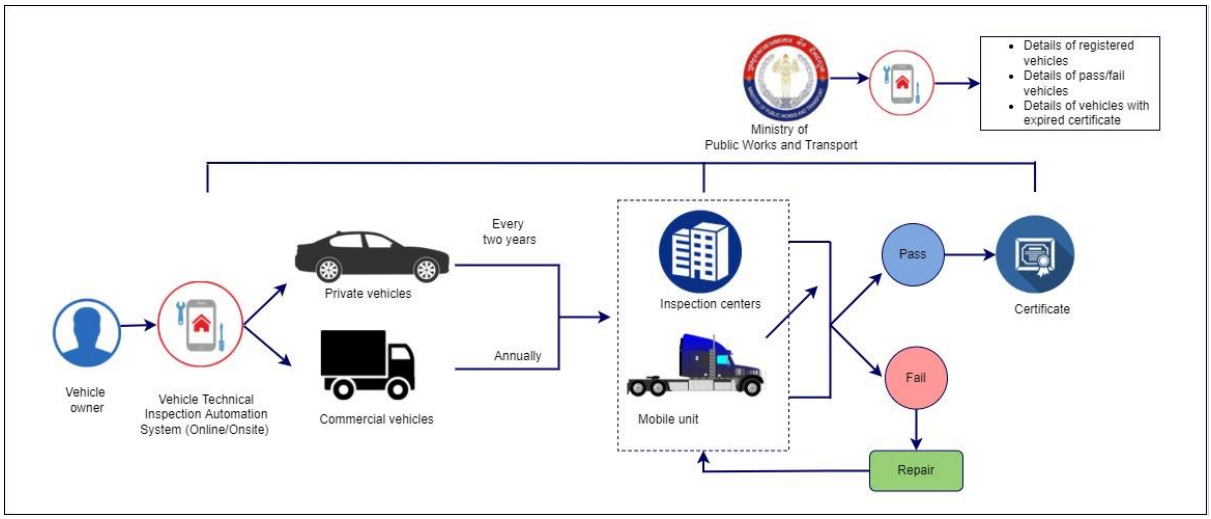


Figure 4-1: Process at vehicle inspection centres

Existing vehicle inspection centres have the capacity to inspect approximately 300,000 vehicles. According to the recent road safety assessments conducted by the existing inspection centres, nearly 28 % of vehicles have not passed or undertaken the inspection. As per the data over the past years (2010-2015), the number of vehicles inspected has increased at an annual average rate of 27%. Nearly 223,720 vehicles were inspected in 2016 (Ministry of Public Works and Transport, 2019).

The death rate in road accidents remain high in Cambodia (Ministry of Public Works and Transport, 2019). Poorly maintained vehicles and high traffic levels were considered as some of the underlying reasons for road accidents. The inspection process detects the poor maintenance at the early stages of the vehicle leading to action for necessary improvements. Therefore, vehicle inspections facilitate vehicles to be used longer by maintaining them in good conditions. It also ensures road safety, reduced traffic jams, and reduced air pollution.

To align with the base year of the updated NDC of Cambodia, 2016 was taken as the base year for emissions calculations. There were ten inspection centres throughout the country in 2016.

The mitigation action intended to have 30 inspection centres by 2030. Therefore, 20 more inspection centres are planned to be established to achieve the target of 1,000,000 vehicle inspections.

All vehicles are subjected to nine tests during inspection, including the exhaust gas test. This test determines the need to improve the engine efficiency of a vehicle. Improvement can be carried out by either tuning the engine or by installing retrofits. In general, average fuel savings with proper maintenance are expected to be 4% in cars and 5% in heavy-duty vehicles. Thus, successful implementation of this mitigation action is expected help existing vehicles to achieve better fuel economy.

4.2 Scope and boundaries of the project

4.2.1 Causal Chain

Enhanced maintenance and inspection of vehicles is one of the transport sector's NDC of Cambodia. As per this NDC, 30 vehicle inspection centres will be made available by 2030. Apart from 10 inspection centres already available in 2016, 20 new centres will be established by 2030 to achieve the NDC target.

These inspection centres will measure the combustion efficiency of engines by taking required measurements for exhaust gases. The vehicles either pass or fail to achieve the required standard. The vehicles that fail need to take action to improve the efficiency of the engines to pass the test and obtain the certificate. Therefore, overall fuel efficiency of the vehicle fleet will increase, and fuel consumption will decrease. This will lead to the reduction in GHG emissions from vehicles.

The establishment of inspection centres will create new job opportunities. Further, the mitigation action (vehicles inspection) will also reduce the operation and maintenance costs of vehicles. Low levels of emissions is expected to reduce the risk of respiratory diseases and thereby enhance the quality of life. The inspection process is also expected to reduce the number of old and malfunctioning vehicles on the roads and reduce traffic levels during peak hours. Other than these impacts, this mitigation action will contribute to reducing the formation of photochemical smog due to low gaseous emissions. The causal chain of this mitigation action is shown in Figure 4.2, illustrating all possible impacts of the mitigation action.

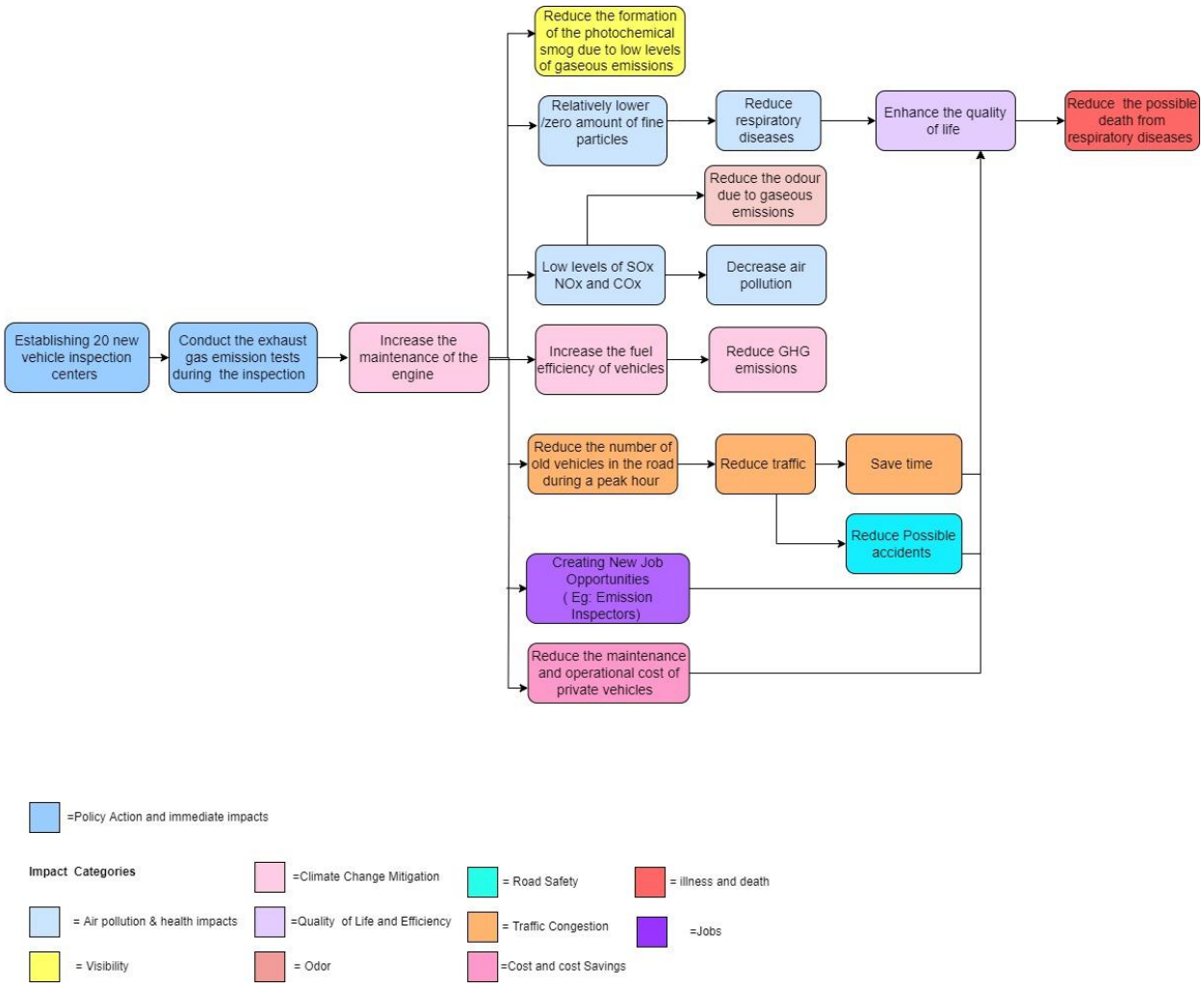


Figure 4-2: Causal Chain for the implementation of 20 new inspection centres

4.2.2 Impacts from the mitigation action

A qualitative analysis of the relevance of the impacts of this mitigation action is given in Table 4.1. The impacts are mainly categorized under three dimensions: environmental, social, and economic. The likelihood describes the probability of an impact occurring because of the implementation of mitigation action. The magnitude refers to the size and the type of the impact. The likelihood and the magnitude of the impacts were analysed through expert judgement, literature reviews and through stakeholder consultation.

Table 4-1: Impacts from the project "establishment of 20 new vehicle inspection centres"

Dimension	Specific Impact	Likelihood	Magnitude
Environment	Reduction in GHG emissions due to the higher fuel efficiency and well maintained vehicle engine	Very likely	Major positive impact
	Decreased air pollution due to the low level of gaseous emissions	Very likely	Major positive impact
	Low probability of photochemical smog due to low level of emissions of pollutants	Likely	Minor positive impact
	Reduced odours from gaseous emissions due to lower emissions	Possible	Minor positive impact
Social	Decreased deaths from respiratory diseases	Very Likely	Minor positive impact
	Enhanced quality of life for example through reduced respiratory diseases and traffic levels.	Likely	Major positive impact
	Reduced traffic levels due to removal of old and malfunctioning vehicles through inspections	Likely	Major positive impact
	Reduced accidents due to low traffic levels	Possible	Major positive impact
	Reduce respiratory diseases of the adjacent residence due to low pollution (PM) emissions	Very Likely	Major positive impact
Economical	Creation of new job opportunities in 20 new inspection centres	Likely	Major positive impact
	Reduced use of old and malfunctioning vehicles, thereby reduction in the fuel and maintenance costs	Likely	Major positive impact

Detailed impact analysis of the mitigation can be found in Annex 1.

Of the various indicated in the table, GHG emissions reduction from vehicle fleet due to the improvements in engine efficiency have been considered for the MRV system development.

4.2.3 System boundary

10 inspection centres already exist by 2016 contributing to GHG mitigation through better upkeep of vehicles. This mitigation action will enhance the maintenance and inspection of vehicles by introducing 20 new inspection centres at the national level. Only CO_2 emissions were considered in the assessment, as CH_4 and N_2O emissions are not considered significant. System boundary is indicated in Table 4-2.

Table 4-2: System boundary of the project "implementation of 20 inspection centres".

Boundary Elements	Description
Geographic Boundary	National
Temporal Boundary	2016– 2030
Sectoral Boundary	Commercial and private sector vehicles
Upstream/ downstream	Not considered
GHGs Included	CO_2

4.3 Measurement

GHG emission reductions attributed to the mitigation action were assessed using the methodology, "*AMS-III.BC.: Emission reductions through improved efficiency of vehicle fleets- Version 2.0"* published by CDM[10].

This methodology is for project activities that improve the efficiency of vehicle fleets (e.g., fleets of trucks, buses, cars, taxis, or motorized tricycles), resulting in reduced fuel usage and greenhouse gas emissions. Project activity may include Retrofits that improve engine efficiency, aerodynamic drag reduction measures, tire-rolling resistance improvements, etc. However, this methodology is not applicable to project activities such as technologies employed to improve combustion efficiency without improvements in engine efficiency. Further, it does not have provisions to assess leakages and rebound effects.

The considered project activity is focused on increasing vehicle fuel efficiency by enhancing maintenance and inspection of vehicles. The exhaust gas test of the inspection process determines the requirement for improving combustion efficiency by improving engine efficiency of the vehicle, and it can be achieved through engine retrofit and other measures to improve engine performance. Therefore, this methodology was considered in the assessment and a control group was defined including vehicles which has the same age, same average

[10] It is indicated that the methodology is applicable when "Vehicle fleets are centrally owned and managed by a single entity and driven by contractors or employees of the central entity". Even though this is not the exact scenario in the selected mitigation action, the methodology was applied to assess GHG emissions considering all inspection centers and guidelines are managed by the Ministry of Public Work and Transport.

passenger capacity, same area of usage or less age, less average passenger capacity and less area usage when compared with the selected vehicle category.

4.3.1 Key indicators

This mitigation action reduces the GHG emissions of the vehicle fleet by improving its fuel efficiency. Table 4.3 shows the key indicators used in this methodology for the estimation of GHG emission reductions.

Table 4-3: Key indicators for the GHG emission estimation from the project "implementation of vehicle inspection centres"

Indicator	Symbol	Unit
Activity level of the project in tkm of vehicle category i using fuel type x in the year y	$AL_{tkm,i,x,y}$	tkm
Activity level of the project in km of vehicle category i using fuel type x in the year y	$AL_{km,i,x,y}$	km
Specific baseline fuel consumption of control group[11] vehicle category i using fuel type x in year y	$SFC_{BL,i,x,y}$	g/km
CO_2 emission factor for fuel type x in year y	$EF_{CO2,x,y}$	gCO_2/MJ
Average Gross Vehicle Weight (GVW) per vehicle unit of control group vehicle category i using fuel type x in the year y	$AW_{BL,i,x,y}$	tonnes
Specific project fuel consumption of project group vehicle category i using fuel type x in year y	$SFC_{PJ,i,x,y}$	g/km
Average Gross Vehicle Weight (GVW) per vehicle unit of project group vehicle category i using fuel type x in the year y	$AW_{PJ,i,x,y}$	tonnes

Note: Based on *AMS-III.BC.: Emission reductions through improved efficiency of vehicle fleets, Version 2.0 (CDM,2013) and Compendium on Greenhouse Gas baseline and monitoring- Passenger and freight transport (UNFCCC, 2018)*

4.3.2 Baseline Scenario

Identification of baseline scenarios

Several baseline scenarios can be identified based on the types of vehicles. For example, scenarios for poorly maintained heavy-duty vehicles (trucks and buses) and light-duty vehicles (cars, motorbikes, and tuk-tuks). . However, though tuk-tuks were widely used, were not considered due to data availability limitations.

Baseline scenario: Poorly maintained Heavy-duty vehicles (Trucks and Buses) and Light-duty vehicles (Cars and Motorbikes)

Methodology

Two main categories were considered in the calculations: (a) Emissions (per tonne-km (tkm)) for heavy-duty vehicles (bus, truck), (b) Emissions (per km) for all other vehicles categories (cars and motorbikes). Emissions were calculated separately for the above categories, applying Equation 4.1 and Equation 4.3. Further, baseline emissions factors (BEF) required for emission calculation were calculated, by Equation 4.2 and Equation 4.4, as explained below.

(a) Baseline emissions calculation for trucks and buses

Equation 4.1: Baseline Emissions

$$BE_y = \sum_{i,x} BEF_{tkm,i,x,y} \times AL_{tkm.i.x.y} \times 10^{-6}$$

Equation 4.2: Baseline Emission Factor

$$BEF_{tkm,i,x,y} = \frac{SFC_{BL,i,x,y} \times NCV_{x,y} \times EF_{CO_2,x,y}}{AW_{BL,i,x,y}}$$

Where:

BE_y	Baseline emissions in the year y (tCO_2)
$BEF_{tkm,i,x,y}$	Baseline emission factor per tkm of vehicle category i using fuel type x in the year y (gCO_2/tkm)
$AL_{tkm,i,x,y}$	Activity level of the project in tkm of vehicle category i using fuel type x in the year y (tkm)
$SFC_{BL,i,x,y}$	Specific baseline fuel consumption of control group vehicle category i using fuel type x in year y (g/km)
$NCV_{x,y}$	Net calorific value of fuel type x in year y (MJ/g)
$EF_{CO2,x,y}$	CO_2 emission factor for fuel type x in year y (gCO_2/MJ)
$AW_{BL,i,x,y}$	Average Gross Vehicle Weight (GVW) per vehicle unit of control group vehicle category i using fuel type x in the year y (tonnes)

i	Vehicle category (trucks & buses)
y	The year that the emission is estimated (2016)
x	Type of fuel(diesel)

(b) Baseline emissions calculation for all other vehicles (cars and motorbikes)

.

Equation 4.3: Baseline Emissions

$$BE_y = \sum_{i,x} BEF_{km,i,x,y} \times AL_{km.i.x.y} \times 10^{-6}$$

Equation 4.4: Baseline emission factor

$$BEF_{km,i,x,y} = \left(SFC_{BL,i,x,y} \times NCV_{x,y} \times EF_{CO_2,x,y}\right)$$

Where:

BE_y	Baseline emissions in the year y (tCO_2)
$BEF_{km,i,x,y}$	Baseline emission factor per km of vehicle category i using fuel type x in the year y (gCO_2/km)
$AL_{km,i,x,y}$	Activity level of the project in km of vehicle category i using fuel type x in the year y (km)
$SFC_{BL,i,x,y}$	Specific baseline fuel consumption of control group vehicle category i using fuel type x in year y (g/km)
$NCV_{x,y}$	Net calorific value of fuel type x in year y (MJ/g)
$EF_{CO2,x,y}$	CO_2 emission factor for fuel type x in year y (gCO_2/MJ)
i	Vehicle category (cars and motorbikes)
y	The year that the emission is estimated (2016)
x	Type of fuel (diesel and gasoline)

Data requirement

Data required for the calculation of GHG emissions under the baseline scenario are presented in Table 4.4.

Table 4-4: Data requirement for the baseline emission calculation of the project "implementation of vehicle inspection centres"

Parameter	Description	Unit	Data availability	Source
$BEF_{tkm,i,x,y}$	Baseline emission factor per tkm of vehicle category i using fuel type x in the year y	gCO_2/tkm	Not available	Calculated
$BEF_{km,i,x,y}$	Baseline emission factor per km of vehicle category i using fuel type x in the year y	gCO_2/km	Not available	Calculated
$AL_{tkm,i,x,y}$	Activity level of the project in tkm of vehicle category i using fuel type x in the year y	tkm	Not available	Calculated
$AL_{km,i,x,y}$	Activity level of the project in km of vehicle category i using fuel type x in the year y km	km	Not available	Calculated
$SFC_{BL,i,x,y}$	Specific baseline fuel consumption of control group vehicle category i using fuel type x in year y	g/km	Not available	Calculated
$NCV_{x,y}$	Net calorific value of fuel type x in year y	MJ/g	Not available	Calculated
$EF_{CO2,x,y}$	CO_2 emission factor for fuel type x in year y (gCO_2/MJ)	gCO_2/MJ	Available	(IPCC ,2006)
$AW_{BL,i,x,y}$	Average Gross Vehicle Weight (GVW) per vehicle unit of control group vehicle category i using fuel type x in the year y	tonnes	Available	(Schoemaker,2007)

As indicated in Table 4.4, activity levels of vehicle categories, the specific baseline fuel consumption of vehicles were not available in sources directly. Therefore, extra parameters given in Table 4.5 were used for the calculation.

Table 4-5: Extra parameters used for baseline emission estimation of the project "implementation of vehicle inspection centres"

Unavailable parameter	Extra parameter	Unit	Source
$AL_{tkm,i,x,y}$	Number of vehicles inspected in 2016	vehicles	Backcasted based on (MPWT, 2019)
	GDP of Cambodia (1990-2016)	USD	(World Bank GDP, 2021)
	Vehicle shares(2020)	%	Assumed based on (ADB, 2019)
	Average annual distance travelled by vehicle category (Bus, Truck, 2016)	km/year/ vehicle	(Ministry of Energy Mines Lao PDR & Economic Research Institute for ASEAN and East Asia, 2018)
	No. of vehicle inspection centres in 2016	Inspection centres	(MPWT, 2019)
	No. of vehicles targeted to be inspected in 2030	vehicles	(GSSD, MoE, 2020)
	Number of inspection centres targeted to be implemented by 2030	Inspection centres	(MPWT, 2019)
$SFC_{BL,i,x,y}$	Fuel efficiency of poorly maintained trucks and buses(2016)	km/l	For trucks: GACMO default value, for buses and bikes: (Ministry of Energy Mines Lao PDR & Economic Research Institute for ASEAN and East Asia, 2018)
	Fuel efficiency of poorly maintained bikes (2016)	km/l	Parking Lot Survey in Cambodia, Lao PDR and Myanmar https://iea.blob.core.windows.net/assets/imports/events/605/11a.EnergyConsumptionintheRoadTransportSector.pdf

	Fuel efficiency of a poorly maintained gasoline cars (2016)	km/l	ASEAN Fuel Economy Roadmap for the Transport Sector 2018-2025: with Focus on Light-Duty Vehicles https://asean.org/wp-content/uploads/2021/08/ASEAN-Fuel-Economy-Roadmap-FINAL-2.pdf Assumption: Values given in 2015 are same as 2016
	Fuel efficiency of poorly maintained diesel cars (2016)	km/l	
	Densities of Diesel and Gasoline(2016)	kg/l	(Ministry of Energy Mines Lao PDR & Economic Research Institute for ASEAN and East Asia, 2018)
$NCV_{x,y}$	Net Calorific value(2016)	toe	
	Conversion factor	MJ/toe	(IPCC ,2006)

Methodological changes

Specific fuel consumptions for vehicle categories were calculated using the density of fuel type and the fuel efficiency of poorly maintained vehicles. Activity levels of the vehicles were calculated using the total distance travelled and the total weight carried by each vehicle category.

Results

There were ten vehicle inspection centres in operation by 2016. As per the calculations, these inspection centres inspected 8,949 heavy-duty vehicles in 2016. BAU scenario was projected for 2030, considering the GDP growth of Cambodia. As per the calculations for the BAU scenario 22,510 heavy duty vehicles will be inspected in 2030. For poorly maintained diesel buses and trucks, baseline emission factors were 43 and 25 gCO_2/tkm, respectively. Baseline emissions from poorly maintained diesel buses and trucks for the year 2016 are presented in Table 4.6

Table 4-6: Baseline emissions from poorly maintained diesel buses and trucks

Vehicle type	Number of Vehicles		GHG emissions (10^{-6} $MtCO_2e$)	
	2016	2030	2016	2030
Buses	4385	17,490	21,900	87,363
Trucks	4385	17,490	57,278	268,808

Inspection centres operated in 2016 have inspected 24,609 cars and 190,162 motorbikes that year. Based on the calculations of the BAU scenario, it is expected that the same number of inspection centres will be capable of inspecting 37,931 cars and 293,171 bikes in 2030. Baseline emission factors for poorly maintained gasoline cars, diesel cars, and gasoline bikes are 161, 204, and 109 gCO_2/km, respectively. Baseline emissions from poorly maintained gasoline cars, diesel cars & gasoline bikes for the year 2016 are presented in Table 4.7.

Table 4-7: Baseline emission from poorly maintained cars and motorbikes

Vehicle type	Number of Vehicles		GHG emissions (10^{-6} $MtCO_2e$)	
	2016	2030	2016	2030
Diesel Cars	9,646	9,620	8,012	17,724
Gasoline Cars	2,411	38,479	23,608	60,214
Motorbikes	93,171	371,670	84,008	171,747

Under these conditions, total baseline emissions for 2016 and 2030 are 0.19 and 0.6 $MtCO_2e$, respectively. For detailed calculations, please refer to Annex 2.

4.3.3 Project scenario

4.3.3.1 Ex-ante assessment

It is expected to introduce 20 more vehicle inspection centres by 2030 to reach 30 centres. As this target is yet to be achieved, analysis was conducted in an ex-ante approach. This includes emissions attributed to well-maintained heavy-duty vehicles (Trucks and Buses) and light-duty vehicles (Cars and Motorbikes).

Project scenario: Transportation by well-maintained heavy-duty vehicles (Trucks and Buses) and light-duty vehicles (Cars and Motorbikes)

Two main categories were considered in the calculations: (a) Emissions (per tonne-km (tkm)) for heavy-duty vehicles, (b) Emissions (per km) for all other vehicle categories (cars and motorbikes). Emissions were calculated separately for the above categories, applying Equation 4.5 and Equation 4.7. Further, project emissions factors (PEF) required for emissions calculation were calculated using Equation 4.6 and Equation 4.8, as explained below.

(a) Project emissions calculation for trucks and buses

Equation 4.5: Project Emissions

$$PE_y = \sum_{i,x} PEF_{tkm,i,x,y} \times AL_{tkm.i.x.y} \times 10^{-6}$$

Equation 4.6: Project emission factor

$$PEF_{tkm,i,x,y} = \frac{SFC_{PJ,i,x,y} \times NCV_{x,y} \times EF_{CO_2,x,y}}{AW_{PJ,i,x,y}}$$

Where:

PE_y	Project emissions in the year y (tCO_2)
$PEF_{tkm,i,x,y}$	Project emission factor per tkm of vehicle category i using fuel type x in the year y (gCO_2/tkm)
$AL_{tkm.i.x.y}$	Activity level of the project in tkm of vehicle category i using fuel type x in the year y
$SFC_{PJ,i,x,y}$	Specific project fuel consumption of project group vehicle category i using fuel type x in year y (g/km)
$AW_{PJ,i,x,y}$	Average GVW per vehicle unit of project group vehicle category i using fuel type x in the year y (tonnes)
$NCV_{x,y}$	Net calorific value of fuel type x in year y (MJ/g)
$EF_{CO2,x,y}$	CO_2 emission factor for fuel type x in year y (gCO_2/MJ)
i	Vehicle category(trucks & buses)
y	The year that the emission is estimated (2030)
x	Type of fuel (diesel)

(b) Project emissions calculation for all other vehicles (cars and motorbikes)

Equation 4.7: Project Emissions

$$PE_y = \sum_{i,x} PEF_{km,i,x,y} \times AL_{km.i.x.y} \times 10^{-6}$$

Equation 4.8 Project Emission Factor

$$PEF_{km,i,x,y} = \left(SFC_{PJ,i,x,y} \times NCV_{x,y} \times EF_{CO_2,x,y}\right)$$

Where:

$PEF_{km,i,x,y}$	Project emission factor per km of vehicle category i using fuel type x in the year y (gCO_2/tkm)
$AL_{km.i.x.y}$	Activity level of the project in km of vehicle category i using fuel type x in the year y (km)
$SFC_{PJ,i,x,y}$	Specific project fuel consumption of control group vehicle category i using fuel type x in year y (g/km)
$NCV_{x,y}$	Net calorific value of fuel type x in year y (MJ/g)
$EF_{CO_2,x,y}$	CO_2 emission factor for fuel type x in year y (gCO_2/MJ)

i	Vehicle category (cars and bikes)
y	The year that the emission is estimated (2030)
x	Type of fuel (diesel and gasoline)

Data requirement

Data required for the calculation of GHG emissions under the project scenario are presented in Table 4.8.

Table 4-8: Data requirement of the project emission calculation of the project implementing inspection centres

Parameter	Description	Unit	Data availability
$PEF_{tkm,i,x,y}$	Project emission factor per tkm of vehicle category i using fuel type x in the year y	gCO_2/tkm	Not available
$PEF_{km,i,x,y}$	Project emission factor per km of vehicle category i using fuel type x in the year y	gCO_2/km	Not available
$AL_{tkm,i,x,y}$	Activity level of the project in tkm of vehicle category i using fuel type x in the year y	tkm	Not available
$AL_{km,i,x,y}$	Activity level of the project in km of vehicle category i using fuel type x in the year y km	km	Not available
$SFC_{PL,i,x,y}$	Specific project fuel consumption of control group vehicle category i using fuel type x in year y	g/km	Not available
$NCV_{x,y}$	Net calorific value of fuel type x in year y	MJ/g	Not available
$EF_{CO2,x,y}$	CO_2 emission factor for fuel type x in year y (gCO_2/MJ)	litres/km	Available
$AW_{PL,i,x,y}$	Average Gross Vehicle Weight (GVW) per vehicle unit of project group vehicle category i using fuel type x in the year y	tonnes	Available

As indicated in Table 4.5, activity levels of vehicle categories, and the specific baseline fuel consumption of vehicles, were not available in sources directly. Due to the limitations of data, the methodology was simplified by collecting extra parameters for calculations. However, data related to actual parameters stated in the methodology to be collected as displayed in the data management system to claim actual emission reductions in the future.

Methodological changes

Specific fuel consumptions for vehicle categories were calculated using the density of fuel type and the fuel efficiency of poorly maintained vehicles. Activity levels of the vehicles were calculated using the total distance travelled and the total weight carried by each vehicle category.

Results

By the year of 2030, 30 vehicle inspection centers will be in operation. Based on the calculations, these inspection centres will inspect 40,000 heavy-duty vehicles in 2030, achieving the NDC target. As per the calculation of project emission factors for well-maintained diesel buses and trucks were accounted for 31.7 and 21.9 gCO_2/tkm, respectively. Project emissions from well-maintained diesel buses and trucks for the years 2016 and 2030 are presented in Table 4.9

Table 4-9: Project emissions from poorly maintained diesel buses and trucks

Vehicle type	Number of Vehicles		GHG emissions ($10^{-6}MtCO_2e$)	
	2016	2030	2016	2030
Buses	4,385	40,000	16,117	64,293
Trucks	4,385	40,000	49,591	197.824

Inspection centres in 2030 will be inspecting 110,000 cars and 850,000 motorbikes that year. As per the calculations, project emission factors for well-maintained gasoline cars, diesel cars and gasoline bikes are 99, 109, and 54 gCO_2/km, respectively. Project emissions from well-maintained gasoline cars, diesel cars & gasoline bikes for the years 2016 and 2030 are presented in Table 4.10.

Table 4-10: Project emissions from well-maintained cars and motorbikes

Vehicle type	Number of Vehicles		GHG emissions ($10^{-6}MtCO_2e$)	
	2016	2030	2016	2030
Diesel Cars	2,411	22,000	7,703	17,043
Gasoline Cars	9,646	88,000	22,700	57,898
Motorbikes	93,171	850,000	80,777	165,142

Under these conditions, total project emissions for 2016 and 2030 are 0.17 and 0.5 $MtCO_2e$, respectively. For detailed calculations, please refer to Annex 2.

4.3.3.2 Ex-post assessment

Ex-post assessment is conducted with the actual data related to the project once period (year for which it needs to be done) is over. Parameters presented in Table 4.11 need to be monitored by the respective institutions to conduct the ex-post assessment.

Table 4-11: Parameters to be monitored for ex-post assessment

Parameter	Unit	Responsible institution
Parameters according to the CDM methodology		
Specific Fuel Consumption of vehicle category i using fuel type x in year y	g/km	Inspection centres
Activity level (Annual total distance) travelled by vehicle category (cars and bikes)	Km	General Department of Land Transport, Inspection centres
Average Gross Vehicle Weight	Tonnes	General Department of Land Transport
Activity level of the vehicles (Bus & Trucks)	tkm	General Department of Land Transport
Alternative Parameters Required		
Number of vehicles inspected by each inspection centre by each category every year	Vehicles	Inspection centres
Fuel Savings due to the inspected vehicles, in each category	%	Inspection centres
The fuel efficiency of poorly maintained vehicles in each category	%	General Department of Land Transport, Inspection centres

4.3.4 Emission reduction (Ex-ante)

Emission reduction due to the mitigation action in the year 2030 is presented in Table 4.12.

Emission Reductions for the year 2030 by implementing inspection centres

Table 4-12: Emission reduction for the year 2030 by implementing inspection centres

Scenario	**$MtCO_2e$**
Baseline emissions	0.60
Project emissions	0.50
Emission reductions	0.10

Emission projections for the BAU scenario and the project scenario for 2030 are shown in Figure 4.3.

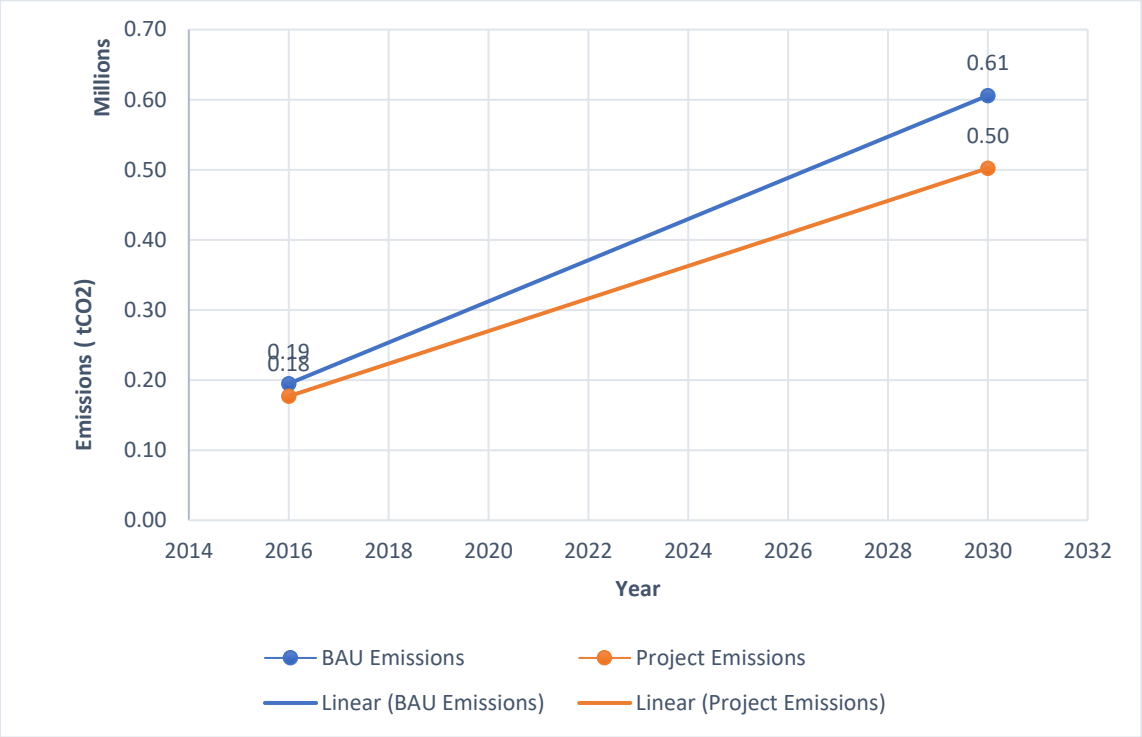


Figure 4-3: BAU and Project scenario emissions of the introduction of 20 vehicle inspection centres,

Emission reduction will be 0.10 $MtCO_2e$ by 2030.

4.3.5 Uncertainties

Following assumptions may cause some uncertainties

- When calculating the baseline emissions, it was assumed that the number of inspection centres in 2016 is the same as that of 2015.
- In project emissions, it was assumed that all inspected vehicles undergo engine efficiency improvements.
- Number of vehicles inspected due to the project was calculated considering the NDC target, which is to inspect 1,000,000 vehicles by 2030 with 30 inspection centers.
- It was assumed that, all the vehicles that could not go through the inspections, due to these additional inspection centers (20) are poorly maintained.

4.4 Reporting

Reporting takes place in different stages of the process. Activity data need to be measured by data collecting agencies and reported to the NDC unit, which is proposed to establish under the MPWT. Please see Chapter 5 for more details. Emissions reduction attributed to the mitigation action must be reported to the MRV coordination unit and the NCSD. Details related to mitigation actions need to be reported in NC, while details related to domestic MRVs are reported in the BUR.

As part of the MRV system, the data collection templates required to monitor the activity data by respective institutions are provided as procedures. These data collection templates include the types of data that should be collected, in which units they should be recorded, the frequency of data collection (one time, annually etc.), the name and the designation of the officer responsible for data collection, and the date that the data is recorded. Please refer to procedures (P2-P5) for data collection templates of this mitigation action.

4.5 Verification

Verification takes place at different levels to ensure transparency, Completeness, Consistency, Comparability and Accuracy (TCCCA). The accuracy of the activity data will be checked at the organization level before submitting it to the NDC unit. TCCCA of the data provided will be assessed by the QC control team of the NDC unit. Quality assurance procedures, including third-party review, will be conducted by the Climate Change Working Group (CCWG) as the MRV experts. BURs will be subjected to the ICA.

4.6 Data Management System

Data that need to be collected from each institution, reporting hierarchy, and frequency are illustrated in Figure 4.4. Due to the limitations of data, the methodology was simplified by collecting alternative parameters as indicated in the table 4.13. Alternative parameters were developed due to the unavailability of data with respect to original parameters given in the methodology. However, emission reduction attributed to the mitigation action will only be able to claim if data related to actual parameters are collected as displayed in the data management system. As shown in Figure 4.4, data should be collected by the General Department of Land Transport, Ministry of Mines and Energy, Vehicle Inspection Centres, and ERIA. Table 4.13 summarizes the roles and responsibilities of these institutions.

Table 4-13: Roles and responsibilities of institutions in data collection for GHG impact assessment of vehicle inspection

Institution	Roles and Responsibilities	
General Department of Land Transport	Measuring and annually reporting following data	
	Original parameters from the CDM methodology	Alternative parameters

	1. Average Gross Vehicles Weight (GVW) of Diesel buses and Diesel trucks.	1. Total number of passengers on a bus 2. Average weight of a passenger including a carried luggage
General Department of Land Transport	Collecting and annually reporting the data related to the original parameters of the CDM methodology	
Vehicle inspection centres	1. Activity level (annual total distance traveled) by i) diesel cars ii) Gasoline cars iii) Gasoline bikes 2. Activity level of the i) diesel buses, ii) diesel trucks	
Vehicle inspection centres	Measuring and annually reporting following data required for the parameters of the CDM methodology	
	Original parameters from the CDM methodology	alternative parameters
	1. Specific fuel consumption of (i) diesel buses, ii) diesel trucks iii) diesel cars iv) Gasoline cars v) Gasoline bikes which fail the inspection	1.No of vehicles inspected in each center, by vehicle category 2. Fuel efficiency of vehicles which pass and fail the inspection (i) diesel buses, ii) diesel trucks iii) diesel cars iv) Gasoline cars v) Gasoline bikes which fail the inspection
	Measuring and annually reporting following data required for the original parameters of the CDM methodology	
National Institute of Statistics	Gross Domestic Product	
Ministry of Mines and Energy	Measuring and annually reporting following data	
	Original parameters from the CDM methodology	alternative parameters
ERIA	1. NCV of gasoline 2. NCV of diesel	1.The density of motor gasoline 2. Density of diesel

The data collected by these institutions should be reported to the transport sector NDC unit, which is under the Department of monitoring and evaluation of the MPWT. This department will report to the Ministry of Public Works and Transport, then report it to the MRV coordination unit at the GSSD. Department of Climate change can get the information required from the coordination unit to compile BURs and NCs or from the NCSD. When these are submitted to the NCSD, they will direct these to the Climate Change Technical working group, who will verify the data and estimations of GHGs as MRV experts. Then this verified information will be submitted to the Ministry of Environment, who will ultimately submit it to the UNFCCC.

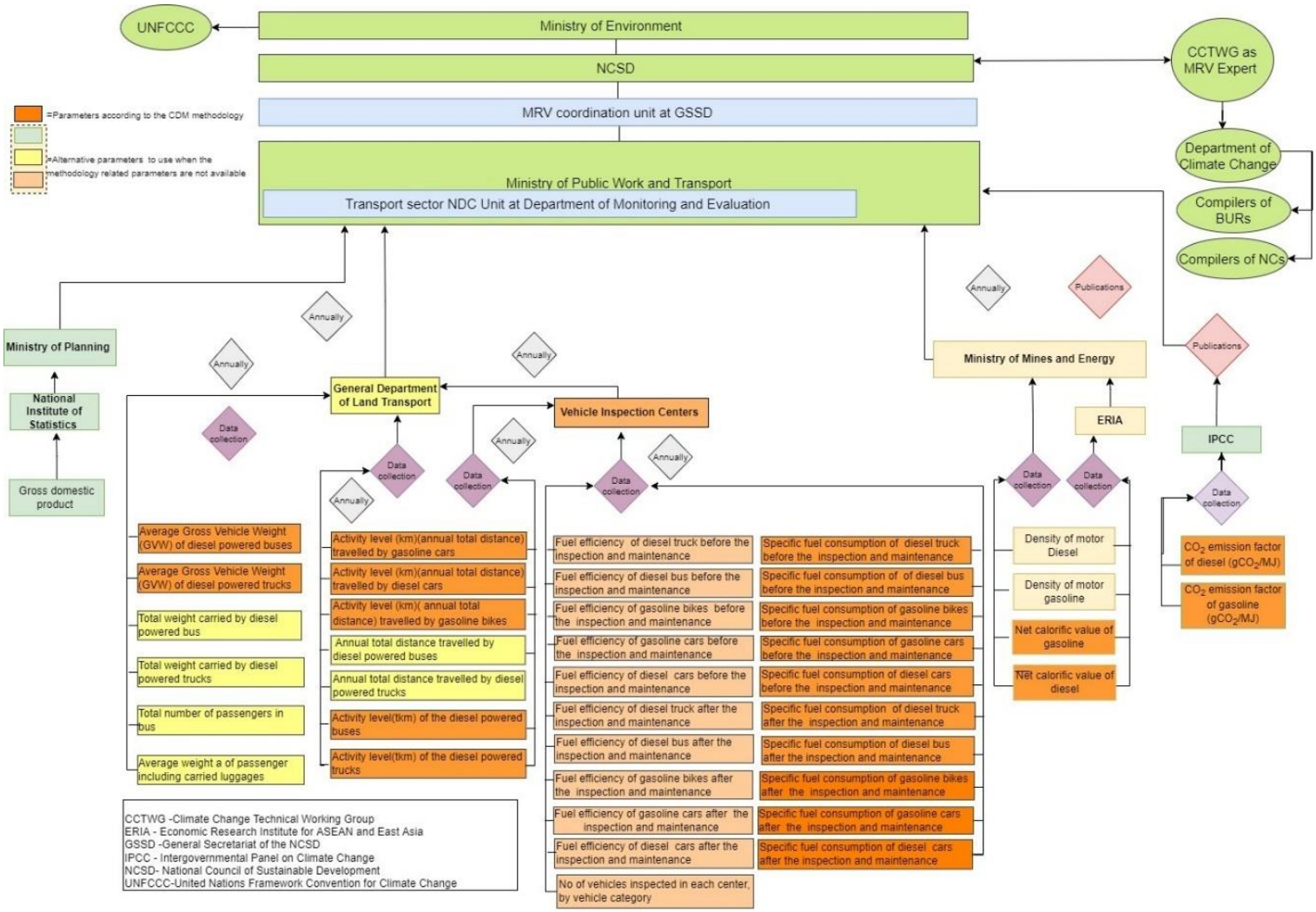


Figure 4.4: Data Management System for Implementation of Inspection Centres

4.7 Recommendations

In order to avoid the uncertainty and to collect data related to methodology, it is recommended to improve the available data collection systems of the inspection centers in accordance with the procedures. It can be recommended to appoint an officer under each authority to facilitate the MRV system. Based on data collection templates provided it is important to develop an internal data management system to establishing data-sharing agreements between the relevant organizations and the ministries is necessary to have a proper data flow for the MRV system. Further, the digitalization of the system can enhance efficiency and reduce human errors in assessment. Explore the possibility of interconnecting digitalized MRV systems and the existing digital system of the inspection centers. Providing online access to collected data through the digitalization of the system can also be recommended, which will be helpful to maintain the transparency of the MRV system.

5 Proposed national institutional arrangement for transport sector MRV in Cambodia

5.1 Overview

MRV requires the regular collection, analysis, and use of reliable information on climate action. Data and information need to be accurate to make correct decisions on time to reduce GHG emissions and increase resilience. Data on historical and predicted trends in GHG emissions are essential for evidence-based decision-making and information exchange, thus promoting stakeholder trust, understanding, and engagement. As such, countries need systematic institutional arrangements in place. A robust institutional arrangement helps to sustain the MRV system by defining coherent roles and responsibilities among the involved stakeholder organizations, providing expert support, developing data flows, stakeholder engagement, etc.

The advantages of robust institutional arrangements extend from supporting decision-making to enhanced and efficient reporting. Strong institutional arrangements enable countries to:

- Meet reporting requirements under the Convention
- Further, build national capacities and ensure the sustainability of reporting processes
- Inform national and international policymakers at different levels
- Assist in institutionalizing activities relating to reporting on climate change

5.2 Key components of an Institutional arrangement

It is important to note that there is no one-size-fits-all model for institutional arrangements. Institutional arrangements differ from country to country based on national conditions, priorities of actions, and information requirements for stakeholders. When developing an institutional arrangement, transparency objectives and outputs need to be defined. Then institutional structure should be drafted with the proposed legal framework. Securing human and financial resources is also important for the sustainability of the institutional arrangement, as well as introducing systems and tools for measuring, managing, and archiving information.

In some countries, all these objectives and outcomes may be the responsibility of a single institutional structure, while in others, these responsibilities may be shared among various independent organizations. However, some common elements for institutional arrangements that are essential to support continuous improvement in the quality of reporting of climate action and support are defined in Handbook on institutional arrangements to support MRV/transparency of climate action and support by the UNFCCC, based on the different country experiences and lessons learned(UNFCCC, 2020). Institutional arrangements can be organized around five separate components such as,

a) Organizational mandates;
b) Expertise;

c) Data flows;

d) Systems and tools;

e) Stakeholder engagement.

Institutional arrangements include organizations ranging from government ministries and agencies, academic and research institutions, private institutions, and consultants linked with these five components. Furthermore, the development of these components is a continuous gradual improvement process through a well-developed improvement plan. Figure 5.1 further describes the key components of an institutional arrangement for an MRV system.

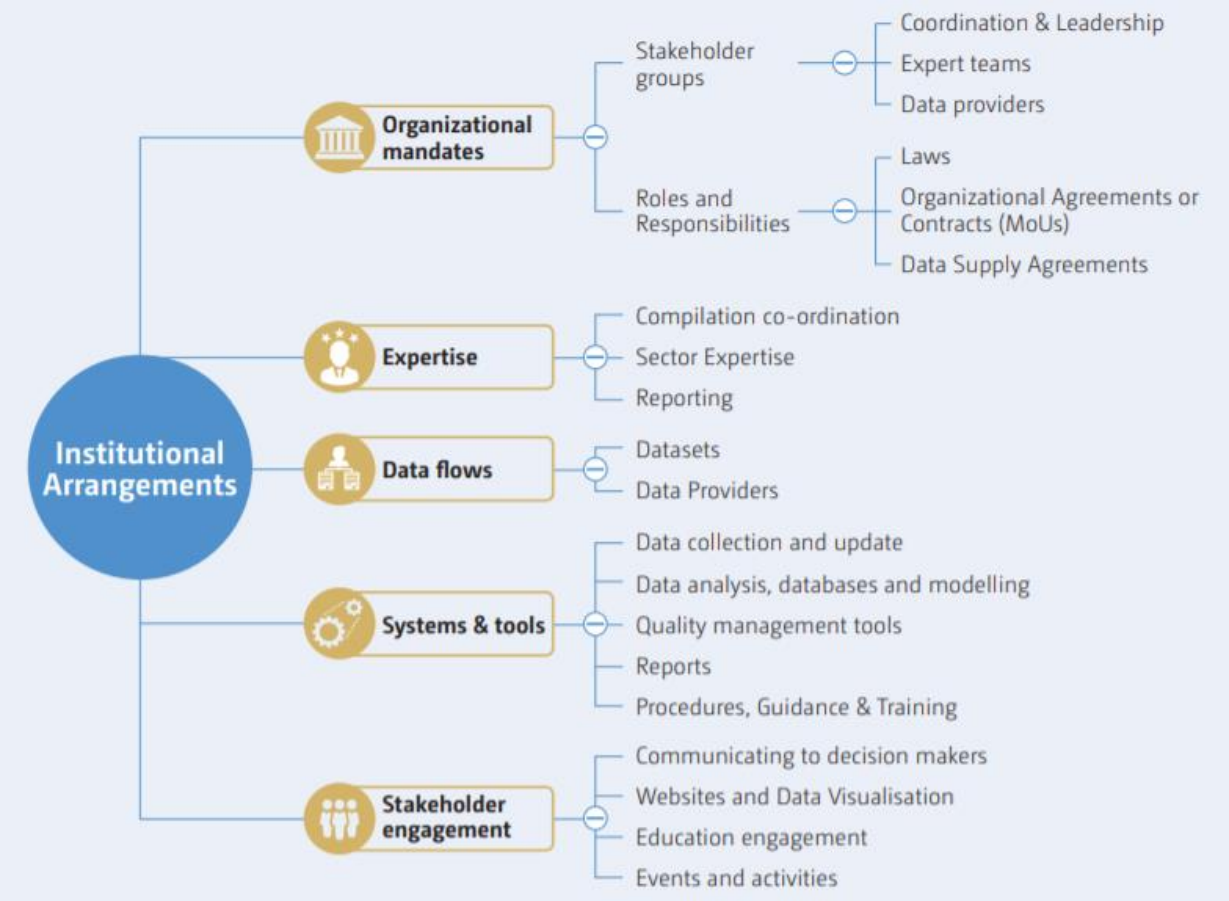
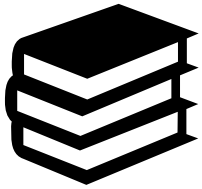


Figure 5-1: Key components of an institutional arrangement for MRV system

Source: UNFCCC 2020, *Handbook on institutional arrangements to support MRV/transparency of climate action and support*

5.2.1 Organizational mandates

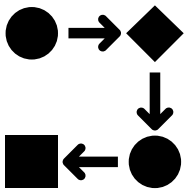


Organizational mandates ensure that organizations and individuals work together, including terms of references designed to guarantee that the human, financial, and data resources needed are made available and to clarify the decision-making process. It includes roles and responsibilities of organizations under the relevant institutional arrangement, laws, organizational agreements/ MoUs, data supply agreements, etc.

5.2.2 Expertise

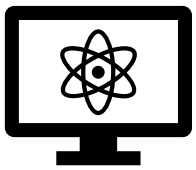
Experts capable of gathering and processing required data are a very important part of an institutional arrangement. Availability of strong expert resources ensures the regular generation of technical outputs which can be used to inform decision-making.

5.2.3 Data flow



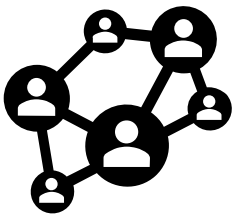
Well-functioning data flow ensures that data needed to understand the challenges and demonstrate progress and climate ambition is available and accessible. Managing required datasets and data providers and identifying and engaging with the correct stakeholders who supply data are important points to consider under data flows. The data sets include national statistics and government data, various forms of measurement data, company and trade association reports, and censuses and surveys that have already been undertaken and reported.

5.2.4 Coordination, systems, and tools



Institutional arrangements need to provide facilities for developing and maintaining work plans, engagement tools, databases, data analysis, indicators, and reports. Effective coordination, systems, and tools help to access the data and manage the data flow, perform QA/QC and produce good quality outputs on time.

5.2.5 Stakeholder engagement



Stakeholder engagement is essential for an evidence-based transparency system to develop better (and more effective) decision-making and report production. Strong stakeholder engagement ensures that the transparency system reaches a broad range of stakeholders, including those from the national government, local government, the private sector, academia, NGOs, the media, and the public. Through these stakeholder engagements, data can be gathered from the most reliable and relevant sources, and the outputs can be informed to relevant authorities and relevant stakeholders for their decision-making processes.

5.3 Process of developing the institutional arrangement

Institutional arrangements were built on existing national arrangements where possible as such existing institutional arrangement was thoroughly studied. Following are the main steps followed to establish the proposed system.

5.3.1 Defining transparency objectives and outputs

Initially, the thematic scope for the transparency system's institutional arrangements should be determined. It is important to define the broader climate goals and targets and the expected transparency outputs which will be needed to track the progress. This helps to identify and prioritize the relevant data needs, expertise and organizations.

The objective of establishing this institutional arrangement was to collect data required to measure the GHG impacts of transport sector NDC, measure the GHG impacts, establish a process to verify data and assessment, establish a process to provide information to respective stakeholders.

5.3.2 Understand the existing process, arrangement, and systems

Existing institutional arrangements in climate change management and the transport sector were studied to understand the possibility of integrating roles and responsibilities of MRV into the existing institutional arrangement.

5.3.3 Structuring institutional arrangements

Based on the above objectives and mandates of the institutions, roles and responsibilities were defined for the respective stakeholder. The structure of the institutional arrangement was built considering the existing hierarchy and newly defined roles and responsibilities.

5.3.4 Establishing legal frameworks

The institutional arrangements require legally binding frameworks and mandates to access adequate resources. These frameworks formalize the roles, responsibilities, resources, and relationships needed to deliver the transparency system outputs. The existing legal framework needs to be analyzed for gaps to identify new legal requirements to maintain the effectiveness of the MRV system. Gaps can be addressed by developing the laws, MOUs, and data sharing agreements that will secure the data flows and expertise needed for a sustainable transparency system.

However, the establishment of the legal framework is not within the scope of this assignment, but barriers and gaps in developing legal frameworks and data sharing agreements among line ministries, private sectors, and other relevant stakeholders were identified based on stakeholder consultation.

5.3.5 Human and financial resources

Sustainable institutional arrangements require sufficient dedicated human and financial resources. Establishing and maintaining new organizational relationships, establishing and adapting data flows, recruiting and retaining expertise, developing and implementing systems and tools, implementing communications and stakeholder engagement approaches, and delivering new outputs require resources. Ongoing provision of financial and human resources needs to be assessed for gaps, including capacity development needs, needs for supporting staff, and other technical or financial needs and opportunities that need to be suggested.

Human resources required to perform the defined roles and responsibilities related to the MRV system were identified.

5.3.6 Systems and tools

An efficient MRV mechanism requires proper systems and tools to improve the quality and timeliness of data and get useful outputs. A clear work plan with defined milestones and deliverables is an effective tool for compiling and updating information. Systems and tools for data collection/ database development and update, data analysis, modeling, quality management, report preparation, etc., are also very important tools for an effective MRV system. Procedures, guidance & training are also important to have an effective MRV system.

A procedure to implement the MRV system, data collection templates to collect data, templates for the QA process were developed as part of this assignment. Data management systems were developed, including what, who, when to report data. An implementation plan was developed, including capacity building requirements, milestones, next steps, etc., of the MRV system.

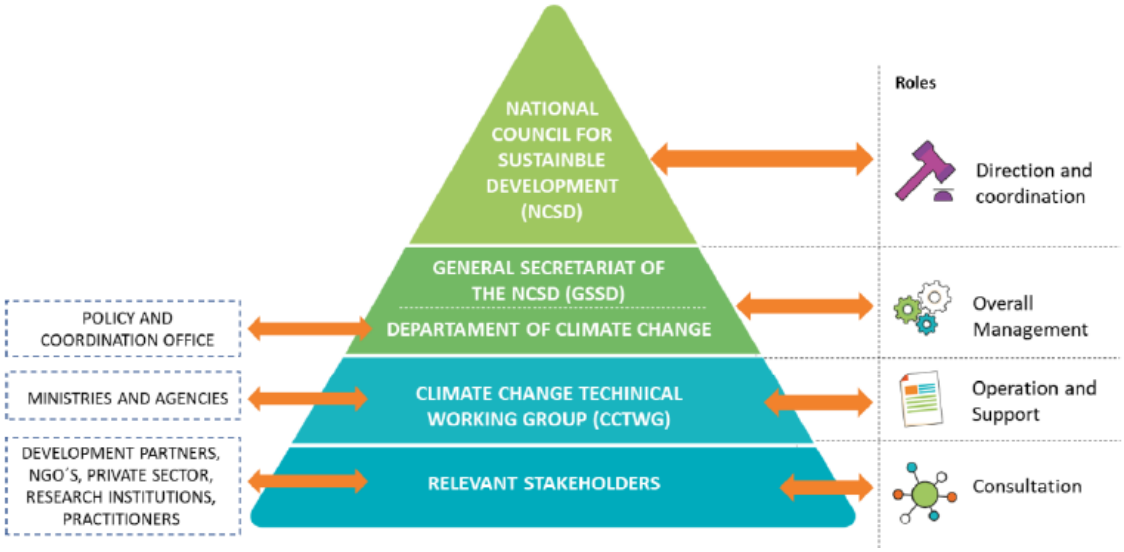
5.4 Existing institutional arrangements

The existing institutional arrangement of Cambodia is quite disaggregated. Those institutional arrangements can be divided into three main categories: institutional arrangements for climate change management, for executing climate change mitigation actions, and for transport sector activities of the country.

5.4.1 Institutional Arrangement – Climate Change Management

Overall institutional arrangement of Cambodia for climate change management and national responses are illustrated in Figure 5.2. As presented in the figure, NCSD, GSSD, Department of Climate Change, and Climate Change Technical Working Group (CCTWG) are the key players of the system.

Figure 5-2: Institutional arrangement for climate change management and national responses



Source: GSSD 2020, First *Biennial Update Report of Cambodia*

NCSD is a policy-making body established in May 2015 to promote sustainable development and to ensure economic, environmental, social, and cultural balance within the Kingdom of Cambodia. By its establishment, NCSD took over functions of the National Climate Change Committee (NCCC), which was initially formed with a mandate to prepare, coordinate, and monitor the implementation of policies, strategies, legal instruments, plans, and programs of Cambodia. It was created as an inter-ministerial mechanism, cross-sectoral and multi-disciplinary in nature, to coordinate climate change response.

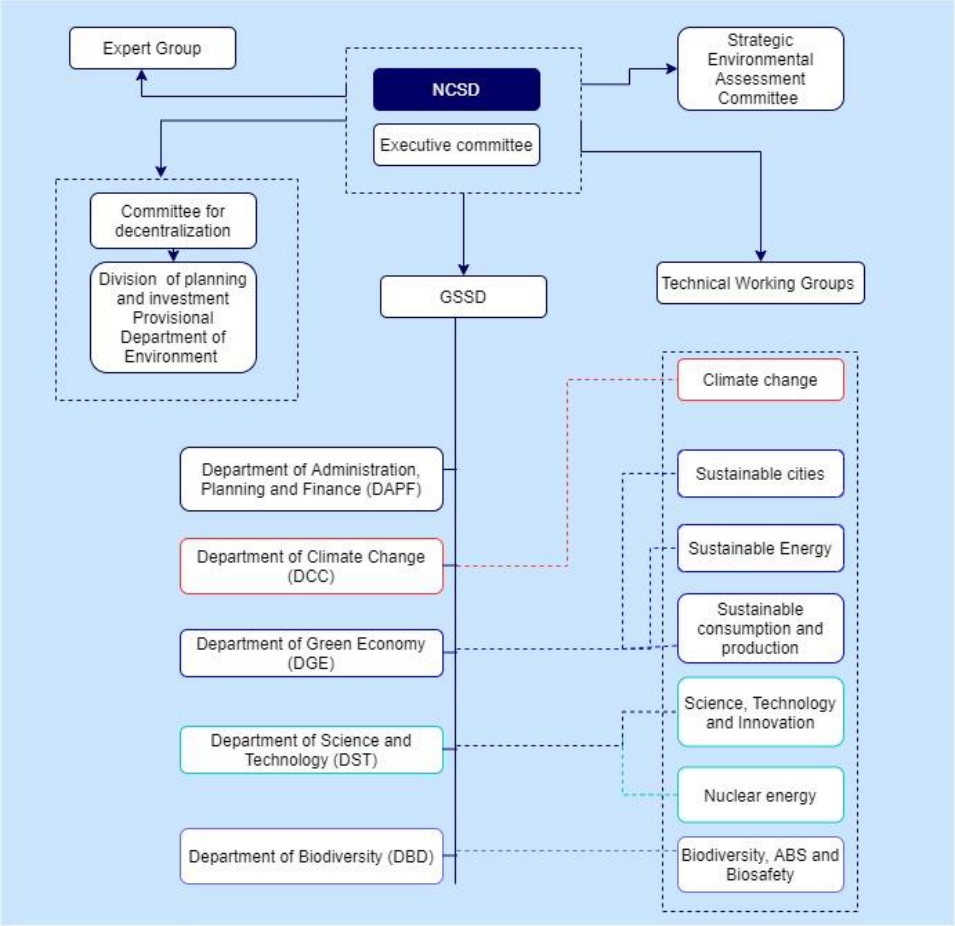


Figure 5-3: Institutional arrangement of NCSD

Source: NCSD, 2021

The Council is composed of high-level representatives (Secretaries and Under-Secretaries of State) of key government ministries and agencies, with the Prime Minister as its Honorary Chair and the Minister of Environment as its Chair. Council membership has increased compared to the NCCC, covering a greater number of ministries and agencies, including provincial governors. Institutional arrangement of NCSD as illustrated in Figure 5.3.

Currently, NCSD has made efforts to improve the coordination of climate change activities in Cambodia and to promote a stronger, comprehensive, and effective climate change response, including the preparation of the Cambodian Climate Change Strategic Plan 2014-2023, the Sectoral Climate Change Action Plans and the Climate Change Financing Framework.

General Secretariat of the National Council for Sustainable Development (GSSD)

GSSD, which is the general secretariat to the NCSD, acts as the functional focal point to the UNFCCC. It is responsible for preparing and implementing legal instruments, policies, strategic plans, action plans, programs, and projects related to sustainable development. GSSD also coordinates the stakeholders at national, regional, and international levels.

Department of Climate Change (DCC)

Department of Climate Change (DCC) serves as the secretariat of the Climate Change Technical Team (CCTT) and convenes and coordinates the CCTWG to discuss key priorities: the update and review of national institution indicators, which are part of the National Monitoring and Evaluation (M&E) Framework; the Review of the Implementation of Cambodia's Climate Change Strategic Plan 2014-2023 (CCCSP); and Cambodia's NDC.

Climate Change Technical Working Group (CCTWG)

The inter-ministerial CCTWG, established in 2017, is chaired by a Deputy Secretary-General of the NCSD, and its membership totals 25 members from 19 different ministries/agencies. CCTWG provides technical and advisory support on climate change to the members of the NCSD, with terms of reference covering legal policy and regulatory frameworks, knowledge management and quality assurance, monitoring, and evaluation, reporting on the sectoral responses, reporting to UNFCCC, technical appraisal, resource mobilization and partnerships, capacity development, and awareness and communication on climate change.

5.4.2 Institutional Arrangement – Mitigation actions

Institutional arrangement for Clean Development Mechanism (CDM)

Ministry of Environment (MoE) has acted as the Designated National Authority (DNA) for Clean Development Mechanism (CDM) since July 2003. To date, the MoE is the national implementing agency for numerous projects that aim to generate broad understanding and develop institutional and human capacity to fully participate as an equal partner with developed countries in the formulation and implementation of potential CDM projects in Cambodia. The Cambodian DNA is responsible for assessing proposed CDM projects against national sustainable development criteria and is authorized to provide written approval for proposed CDM projects in accordance with these criteria. To do so, Cambodia uses a sustainable development matrix as a tool for assessing the contribution of CDM projects in four aspects of sustainable development: economic, social, environmental, and technology transfer.

The GSSD acts as the Secretariat of Cambodia's DNA for the CDM, while selected members from CCTWG relevant to mitigation activities create the Board of the Cambodian DNA. Board activities include technical and institutional capacity strengthening, CDM awareness-raising, CDM project identification, and facilitation of host country approvals in accordance with the requirements of the Kyoto Protocol of the UNFCCC.

Figure 5.4 illustrates the existing institutional arrangement for mitigation actions management in Cambodia.

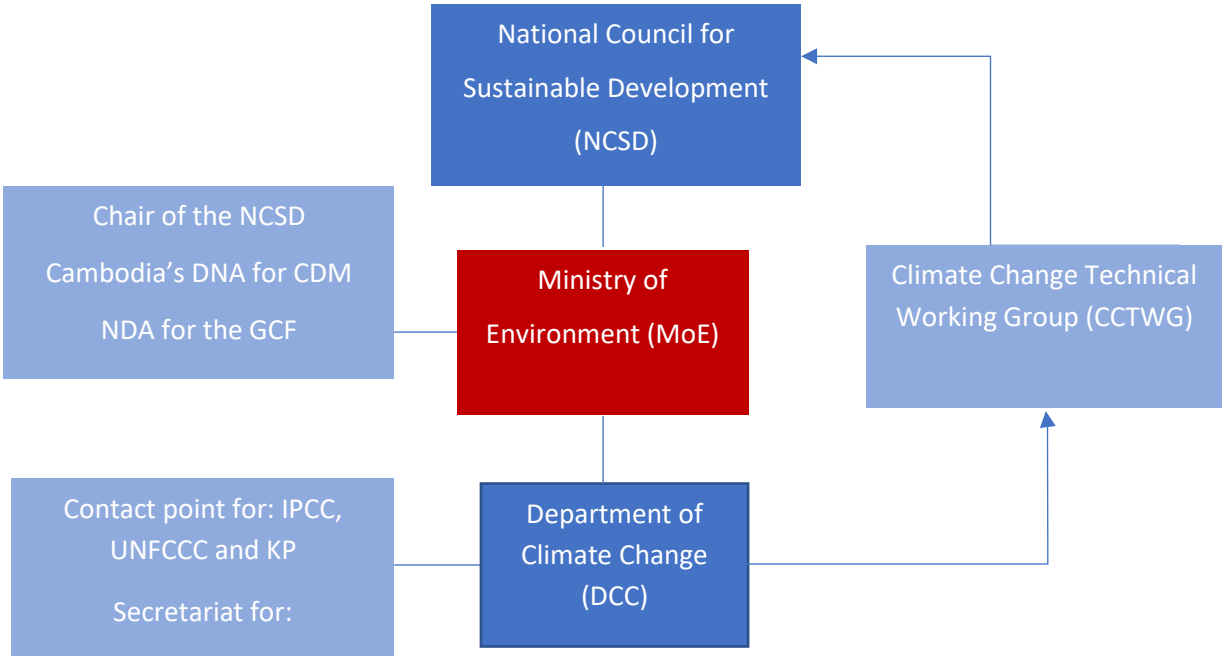


Figure 5-4: Institutional arrangement for mitigation actions

Source: GSSD 2020, *First Biennial Update Report of Cambodia*

Institutional arrangement for Nationally Appropriate Mitigation Actions (NAMAs)

The designated NAMA focal point at the GSSD is responsible for approving all individual NAMAs before being recorded in the NAMA Registry. MoE and Chair of the National Council for Sustainable Development are authorized to approve NAMA.

The responsibility for the MRV of NAMAs is defined in the specific NAMA measurement plan and generally lies on the NAMA implementer. Government entities responsible for collecting statistics could also be involved in collecting data by integrating data collection formats in their regular data collection activities.

Two entities are involved in the development of NAMA´s measurement plans:

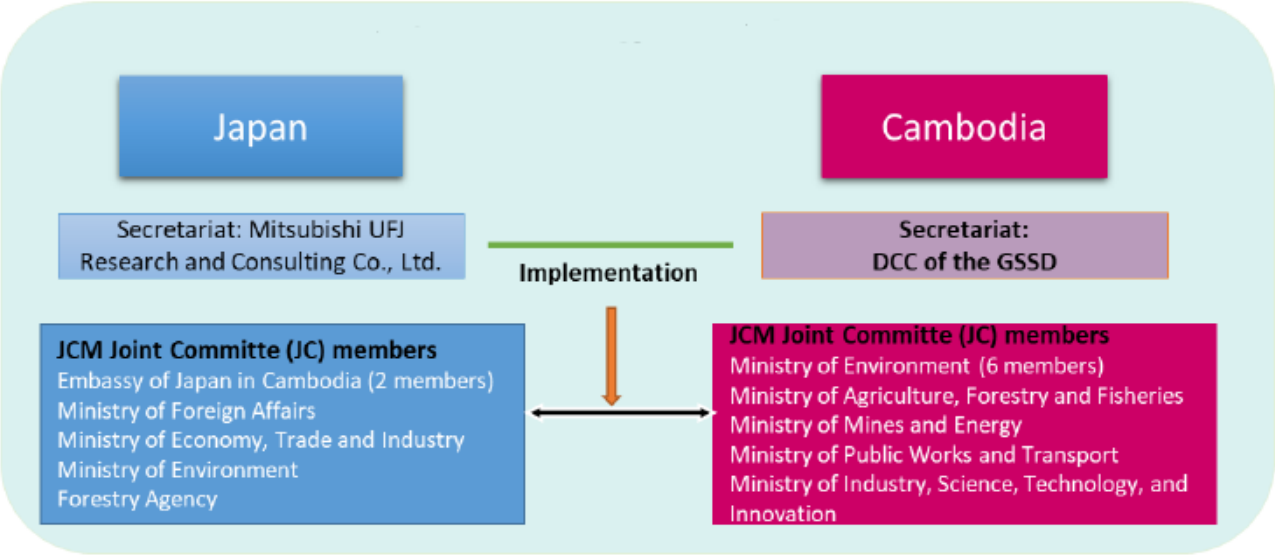
- The national socio-economic and environmental data collection entity; and
- The entity is responsible for preparing national GHG inventories, the NCSD.

These entities provide information on data already collected. As such, it is easy to identify the data that need to be collected under NAMA.

Institutional arrangement of Joint Crediting Mechanism (JCM)

The Joint Committee (JC), which includes representatives from Japan and Cambodia, is responsible for implementing and administering JCM projects. Figure 5-5 illustrates the institutional mechanism of JCM.

Figure 5-5: Institutional arrangement of JCM mechanism



Source: GSSD 2020, *First Biennial Update Report of Cambodia*

A Draft Sub-Decree on Rules and Procedures for Participation in GHG Emissions Reduction Mechanisms has been prepared to be approved in 2022. The main purpose of the sub-decree is to establish a permanent national authority and to provide the rules and procedures regarding the participation in all GHG emissions reduction mechanisms, including but not limited to CDM, REDD+, VCS, and JCM.

5.4.3 Institutional arrangement - The transport sector of Cambodia

The Ministry of Public Works and Transport (MPWT)

The Ministry of Public Works and Transport is the government ministry responsible for public works and transport in Cambodia. The Ministry is mandated to "build, maintain and manage all the transportation infrastructure such as roads, bridges, ports, railways, waterways and buildings" in the nation. Public services of the ministry include vehicle registration, technical inspection, driver's license, railway services, water taxi, and transport licensing. As such, it governs the Department of land transport, the Department of Railways, the Department of waterway transport, etc. Further, the General Department of Planning and Policy of the MPWT manage and facilitate planning, information system, policies, monitoring, and evaluation of the public works and transport. Public works and transport activities at the municipal and provincial levels are governed by separate departments established at municipal and provincial councils. Please see Figure 5.6 for more details.

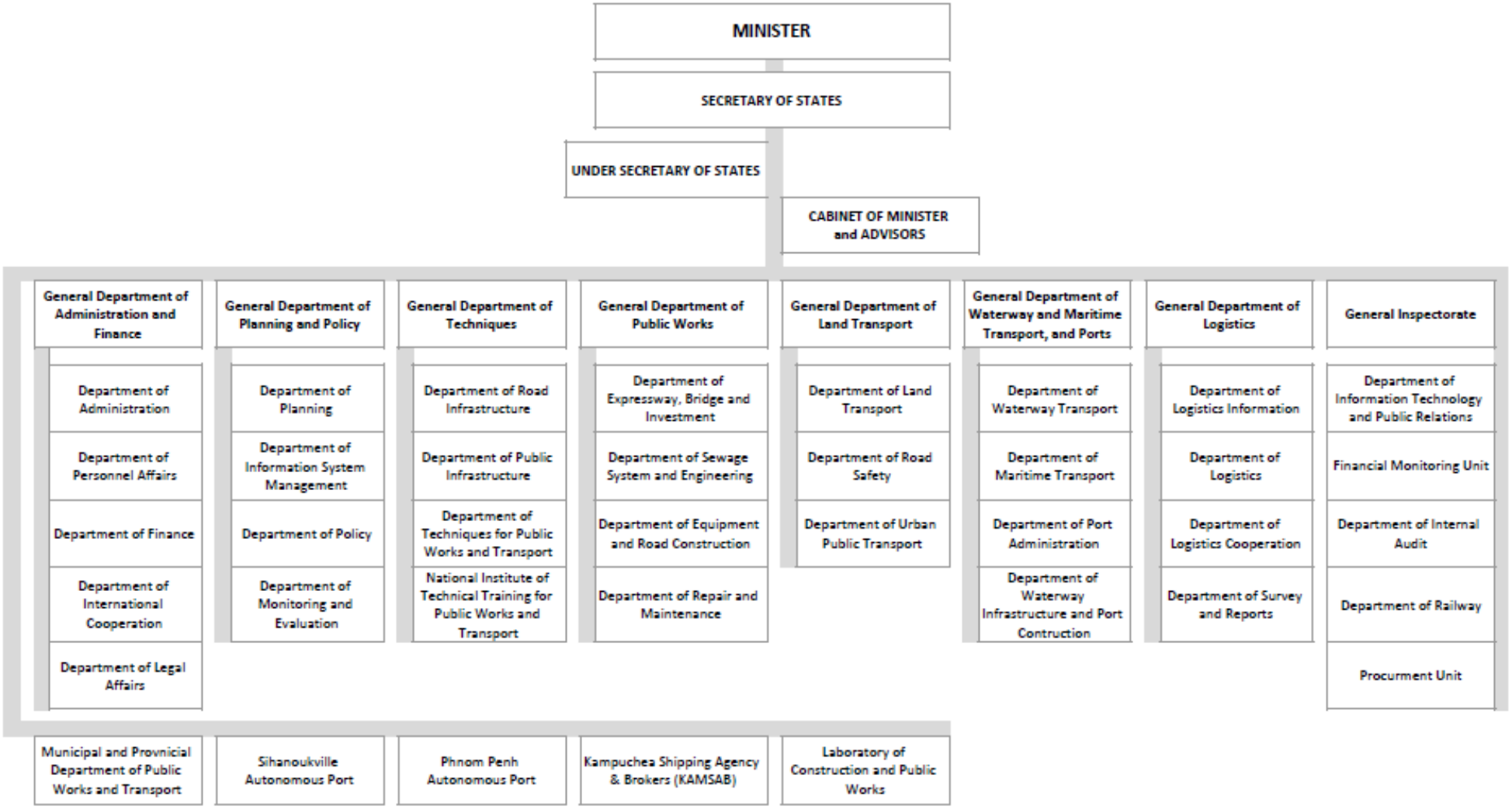


Figure 5-6: Organization chart of Ministry of Public Works and Transport, Source: MPWT, 2021

5.5 Proposed institutional arrangement

Institutional arrangement was proposed based on comprehensive analysis of existing institutional arrangements related to climate action and the transport sector in Cambodia. There are not any existing clear institutional arrangements linking climate action and the transport sector in Cambodia. This proposed institutional arrangement will interlink the transport sector and climate action of Cambodia in an effective way addressing all the identified gaps in existing institutional arrangements. The overall institutional arrangement for the transport sector MRV is presented in Figure 5.7 below.

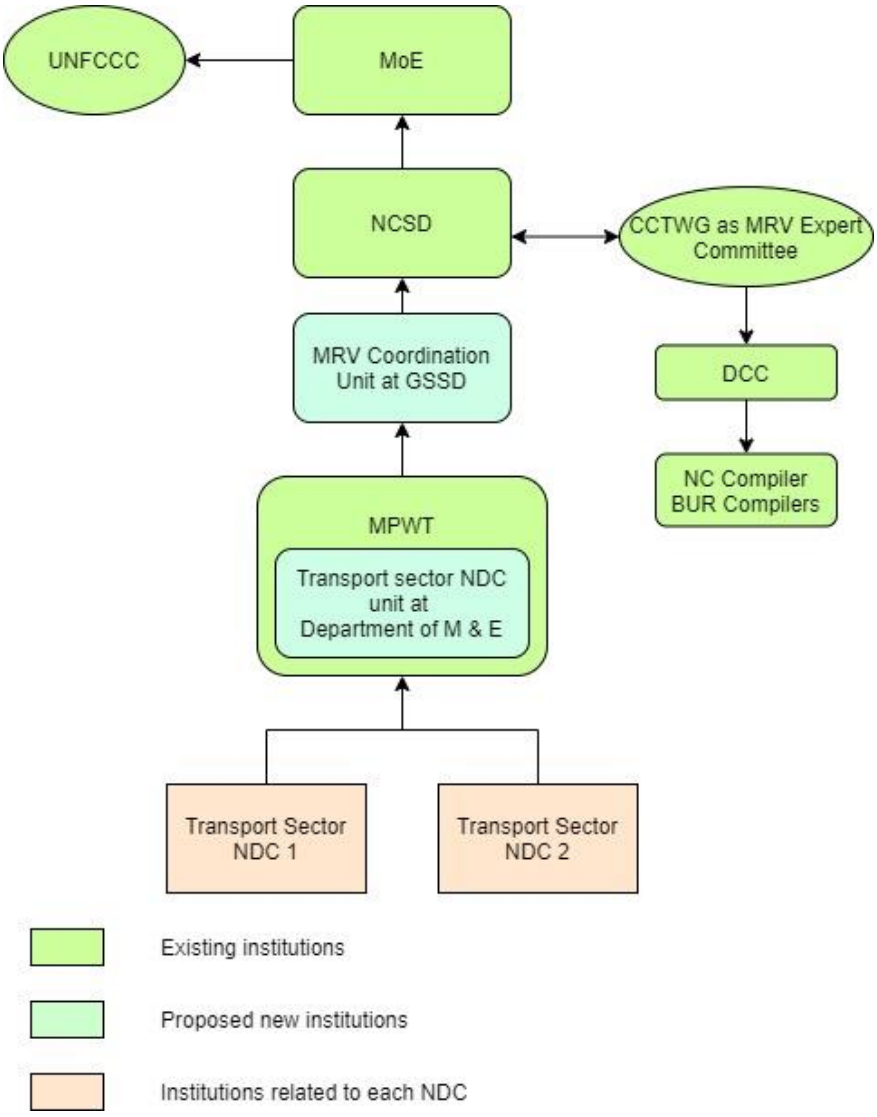


Figure 5-7: Proposed institutional arrangement for the transport sector MRV

5.5.1 Roles and responsibilities

Ministry of Environment and NCSD

Ministry of Environment and NCSD is responsible for the overall functioning of the MRV system. Ministry is also responsible for reporting the status of achieving NDC targets to the UNFCCC as the focal point to the Convention.

MRV Coordination Unit at GSSD

GSSD is the functional focal point to the UNFCCC. Further, its functions and duties already include coordination among institutions, regular monitoring, evaluation, and reporting related to sustainable development activities. Please see Annex 3 for the detailed list of functions and duties. Considering the above, the MRV coordination unit is proposed to establish at the GSSD.

The unit will be headed by the Director of the Department of Climate Change. As illustrated in Figure 5.8, emission reductions assessments conducted by different NDC units will be submitted to the MRV coordination unit.

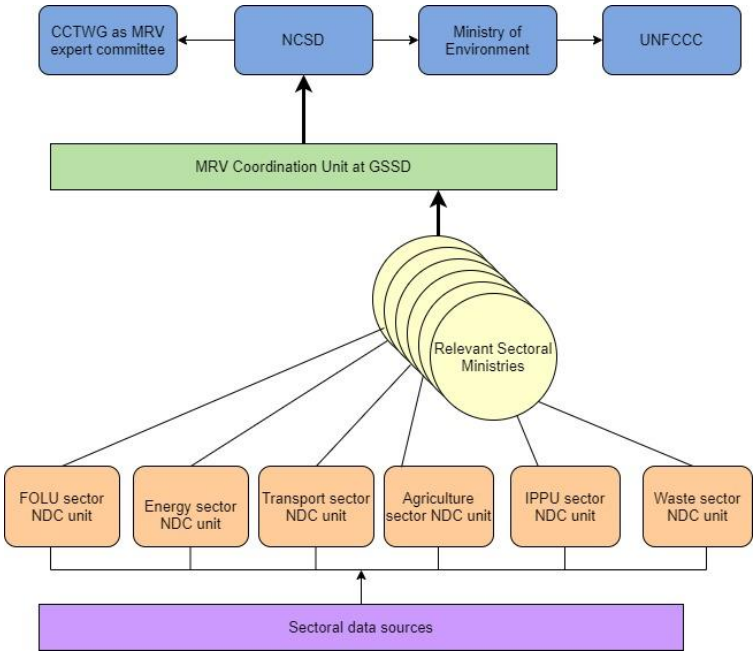


Figure 5-8: MRV coordination unit-main institutional elements and interrelations

The MRV coordination unit will refer the emission reduction calculations to the MRV expert committee for verification. More details on the roles and responsibilities of the unit are listed in Table 5.1.

Table 5-1: Responsibilities of the MRV coordination unit

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 the 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 keeping 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 transforming them into a cohesive document to be submitted to the 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 the 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 of collected data and developing and overseeing the implementation of a quality control strategy for the entire MRV process; and
14. Mediate between parties when concerns surface, for example, over a disagreement in terms of responsibilities or a potential conflict of interest.

Climate Change Technical Working Group as MRV Expert Committee

An MRV expert committee consisting of climate change experts and sectoral experts needs to verify the emission calculations done by sectoral NDC units, including the transport sector NDC unit, and provide necessary guidance to the sectoral NDC units. Further, the committee is also responsible for assuring the quality of the assessment. More details of the roles and responsibilities are listed in Table 5.2.

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;
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; and
6. Quality assurance of the GHG impact assessment.

Cambodia has already established Climate Change Technical Working Group (CCTWG) under the NCSD, including 25 members from 19 different ministries/agencies. CCTWG provides technical and advisory support on climate change to the NCSD, with terms of reference covering legal policy and regulatory frameworks, knowledge management and quality assurance, monitoring, and evaluation, reporting on the sectoral responses, reporting to the UNFCCC, technical appraisal, resource mobilization and partnerships, capacity development, and awareness and communication on climate change. As such, it is proposed to integrate the roles and responsibilities of the MRV expert committee into the CCTWG.

Ministry of Public Works and Transport

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

Transport sector NDC unit

The multi-stakeholder nature of the identification process and implementation of transport sector NDCs calls for an organizational arrangement that requires a designated focal point, and the establishment of a sectoral NDC unit addresses this need. This approach can facilitate collecting, processing, reporting, and archiving required data and information sustainably. These can facilitate effective coordination among all relevant stakeholders from the public and private sectors in meeting the reporting requirements.

Currently, MPWT has a separate department for monitoring and evaluation. As the unit already collects information for M&E purposes, it is proposed to establish the NDC unit under this department.

The unit will be established by the secretary to the MPWT and headed by the head of the General Department of Planning and Policies. The unit will consist of trained staff and the 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. Establishing the NDC unit within the ministry makes institutional coordination easier as most of the data owners for the 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 coordination unit.

As illustrated in Figure 5.9, the NDC unit will have three separate teams: the data collection team, Quality assurance team, and technical team. The respective team lead will lead each team. Director MRV will be the head of the unit.

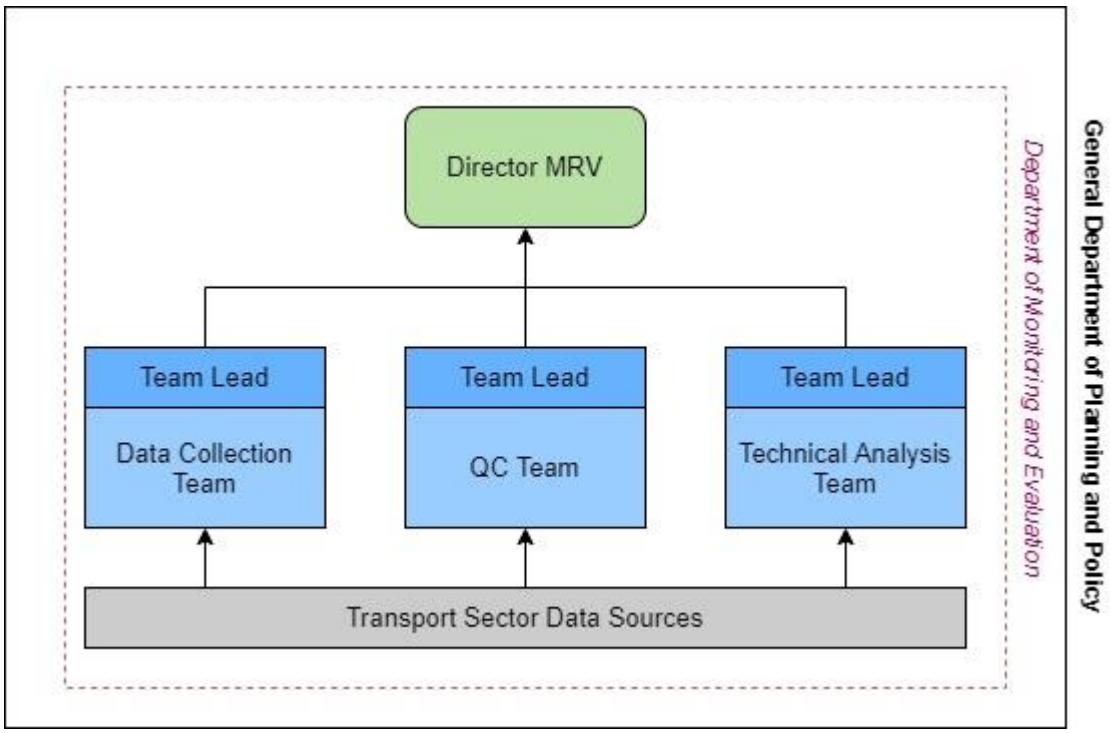


Figure 5-9: Structure of Transport sector NDC unit

NDC unit will be mainly responsible for collecting, analysing data, and quantifying GHG impacts of mitigation actions related to Transport sector NDCs. The unit will have the authority to request any data related to the above actions from relevant institutions through the MPWT. The proposed unit will have employees trained to calculate the emission reduction in the transport sector NDCs. Please see Table 5.3 for more details on roles and responsibilities.

Table 5-3: Responsibilities of transport sector NDC unit

Responsibilities of Transport sector NDC unit
Director MRV
1. Coordination of the flow of information from individual institutions and ministries for a collective assessment of impacts and multiple benefits of policies, strategies, and actions;
2. Allocate responsibilities for all institutions, ensuring that there is a clear lead for each institution, and establish an institutional level formal approval process;
3. Develop and monitor a time frame and schedule for preparing and submitting necessary data, including specific dates for the deliverable; and
4. Report GHG impacts of NDCs to MRV coordination unit annually.

Data collection team
5. Identify institutions responsible for measuring, collecting data related to transport sector NDCs;
6. Coordinate with the identified institutions and collect data annually; and
7. Archive data.
Quality assurance team
8. Ensure transparency, consistency, comparability, completeness, and accuracy of the activity data and analysis. Please refer to Chapter 6 for more details on the quality control procedures
Technical team
9. Identify appropriate methodologies to assess GHG impacts of transport sector mitigation actions related to NDC;
10. Calculate GHG impacts of transport sector mitigation actions;
11. Documenting all the assumptions, data, and methods used systematically; and
12. Assist data collection team to identify data sources.

Institutions related to each NDC

Institutions related to each NDC are responsible for collecting and reporting data requested by the NDC unit. Institutions related to selected two mitigation actions under this assessment were identified and included in the data management system. It is proposed to appoint an MRV focal point at each of these institutions to collect the required data. Data need to be collected; data collection templates are included in the procedures.

6 Quality Control and Quality Assurance

An effective quality assurance and quality control (QA/QC) system is an important element to enhance the confidence of decision-makers and the international climate action community. A process to ensure that data are properly collected, handled, processed, used, and maintained at all stages is key to a reliable MRV system to improve the transparency, consistency, comparability, completeness, and accuracy of the system. Therefore, the transport sector MRV system encompasses the quality Assurance (QA) quality control (QC) measures.

6.1 Quality Control

System of routine technical activities implemented by the compilers to measure and control the quality of the assessment as it is prepared. Provide routine and consistent checks and documentation points in the inventory development process to verify data integrity, correctness, and completeness to;

- Identify and reduce errors and omissions
- Maximize consistency within the preparation and documentation process
- Facilitate internal and external inventory review processes

6.2 Quality Assurance

Quality Assurance (QA) is a planned system of review procedures conducted by personnel not involved in assessing GHG impacts of NDCs. QA procedures are performed upon having a completed assessment following the implementation of QC procedures and preferably by independent third parties.

6.3 Roles and responsibilities

The QC team at the NDC unit will perform the QC procedure to ensure the transparency, accuracy, completeness, consistency, and comparability of activity data and the GHG impact assessment. The team may follow the QC procedure given in Annex 4.

Once the completed assessment is submitted to the MRV expert team, experts will review the assessment. Once comments are received from the expert team, the technical team in the NDC unit will update the assessment as appropriate.

6.4 Reporting, Documentation, archiving procedure

Reporting

It is recommended to report a summary of implemented QA/QC activities and key findings

- List out all the activities performed internally and what was subjected to external reviews;
- Present the key findings, describing major issues regarding the quality of input data, methods, processing, or estimates and show how they were addressed or planned to be addressed in the future;

Internal documentation and archiving

It is recommended to document and archive all information in every stage relating to the planning, preparation, and management of activities.

7 Barriers and gaps

7.1 General gaps and barriers

Gaps in capacity building

Cambodia has received numerous capacity-building support since 2000. However, experts and researchers in the fields of GHG inventory and mitigation, climate vulnerability assessment and adaptation measures, climate change, and energy, climate agronomists, climate economists, etc., are still limited. Lack of capacity and expertise remains the key challenge in successfully implementing climate change projects (GSSD, 2020).

Financial gaps

Cambodia has received grants and loans from development partners and donor countries to design and implement climate change projects. The proportion of climate change expenditure to GDP is 1.1% on average during 2009-2017. However, Cambodia still faces financial constraints to ensure the effective implementation of adaptation and mitigation actions (GSSD, 2020).

Barriers and gaps to the data management system

Insufficient data

Insufficient data for mitigation actions will be the major barrier in this project. Most of the data are not readily available with the respective institutions. Institutions may have to put extra effort, resources to collect data. This may reduce the interest of the organization to participate in the process actively.

The lengthy institutional process to obtain existing data.

In current practice, respective institutions take several months to respond to the data request letter of DCC. In many cases, the DCC needs to inquire about the status of its official request directly with the relevant Ministries to obtain a formal answer. The official response of the concerned Ministry or National Authority does not include the relevant data. Yet, it merely acknowledges the official request of the DCC through the MoE and affirms the consent of the relevant Ministry or national institution in participating in the data collection process.

Unavailability of common data source

The National Institute of Statistics used to periodically publish data compiled from all other line ministries in an annual compendium of statistics. This source of national statistics was available in print for 2003, 2005, 2006, and 2008. The NIS has ceased publication of the annual compendium of Cambodia's statistics for a decade. This has created a challenging situation to collect data from different institutions.

Unavailability of a dedicated budget for data collection

Without a dedicated budget, it is difficult to collect required data continuously. In current practice country only resume data collection at the beginning of transparency reporting. Once the respective reporting cycle is over, the collection of activity data from relevant government institutions essentially comes to an end due to budget limitations.

Barriers and gaps for developing institutional arrangement

Lack of capacity to assess GHG impacts of mitigation actions

The proposed institutional arrangement requires the establishment of a technical team at the NDC unit of the MPWT. However, employees attached to the department of M&E do not have the technical capacity to assess the GHG impact. As such, this will be negatively affected in implementing the institutional arrangement.

Lack of coordination among institutions

Since the cease of publishing Cambodia’s annual compendium of statistics, Ministries had to follow a lengthy process for inter-ministerial data exchange. The current process is not only time-consuming but also requires administrative resources. Personal connections between technical staff from different institutions may facilitate data exchange if the statistics have already been compiled and are readily available. As such, lack of coordination among institutions has also been identified as a barrier to establishing an institutional arrangement.

Inadequate human resources

Additional data collection at the respective institutions as well as proposed new units will require additional human resources. Unavailability of adequate staffing in the ministries and respective institutions can be identified as barriers to establishing the proposed institutional arrangement.

Discontinuity in staffing

Continuity in staffing is critical to creating institutional knowledge, memory, and experience that can be shared and passed on to new organization members. There needs to be an overlap between staff who have expertise in GHG assessment and newer members. However, discontinuity in staffing can also be identified as a barrier in the current practice of Cambodia to prepare transparency-related reports.

Barriers and gaps for developing legal arrangement

Unavailability of Environmental Code

The Cambodian law is based on the 1993 constitution, four fundamental codes, Criminal Code, Code of Criminal Procedures, Civil Code and Code of Civil Procedures, and various primary legislation adopted and reviewed by the Cambodian-bicameral legislative institutions and the secondary legislation that make up the regulatory system in Cambodia (Phallack et al., 2020).

Lack of capacity

Environmental law is a newly emerging area of law that has recently developed, and there are yet not enough experts and interest in environmental law education and practice. Ministry of Environment of Cambodia took the lead to prepare the first-ever Environmental Code aimed at building a sound environmental legal framework for the country. (Phallack et al., 2020)

Lack of policy basis for data collection and sharing

Cambodia lacks the policy for GHG data collection and data sharing. Existing policies mostly cover the importance of institutional coordination, and do not give enough attention to the data collection and data sharing needs, including the need for a legal foundation for data sharing.

7.2 Recommendations

Capacity and awareness building

Since MRV is in the area ov mitigation is relatively a new concept to the country, non-government and government stakeholders need to be properly trained to enhance technical skills and roles and responsibilities of persons in each institution well-defined in the MRV process. A well-structured training program should be designed and implemented for the "Transport sector NDC unit." User-friendly manuals should be prepared and given to stakeholders for reference purposes. Performance review meetings should be held once a year to reflect on the performance and challenges in implementing the transport sector MRV system.

Budget allocation

Required financial support needs to be provided to the relevant institutions to collect data, and maintain human and other required resources.

Institutionalize data management system

The quality of the analyses depends on the quality of the available data. Data management systems need to be institutionalized with clearly defined roles and responsibilities to improve data quality and ensure continuous data availability.

Digitalization of the MRV system

MRV systems can be digitalized in order to avoid lengthy data collection processes and administrative procedures. This will enable efficient data sharing among ministries. Further, this will reduce the human resource requirement in the NDC unit, the capacity building requirement of stakeholders, and the human errors in GHG assessment.

Ensure good Institutional coordination

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, a good coordination mechanism needs to be established between the institutions related to the transport sector MRV system. MRV coordination unit at NCSD, as the lead agency for institutional coordination, has a vital role to play in this regard. Entering into MoU with relevant institutions for data sharing agreements is recommended for a sustainable MRV system.

Human capacity

Human capacity is required to ensure that the necessary data are collected and reported periodically and systematically. Since new units proposed include the “Transport sector NDC unit” and "MRV coordination unit" at the GSSD, staff with relevant skills will need to recruited. Adequate human resources need to be dedicated to MRV activities. Continuity of these staff members also needs to be ensured for the sustainability of the MRV system.

Regulatory framework revision

It requires including appropriate clauses to the draft Environment Code to enhance data sharing efficiency and ensure the sustainability of MRV systems. Regulations to empower the transport sector NDC unit to collect data from related institutions, and MRV coordination unit to gather GHG impact assessment from relevant ministries may need to be established. The introduction of mandatory reporting regulations is also recommended to ensure continuous data flow. Changes in regulations have to be properly communicated to all the relevant stakeholders.

High-level support

Support from the high-level officials is essential because the entities that provide data may not benefit directly from MRV Therefore, they may not have any few incentive to provide data. It includes support from the officials of the MPWT, MoE, and other related ministries to effectively implement the MRV system. This can be achieved by raising awareness among all government agencies about the need and benefits of the MRV system.

Establishment of a detailed implementation plan

The implementation plan needs to contain the following information / meet the following requirements to ensure successful implementation of the MRV system.

- Definition of goals/objectives - define the goals to be accomplished, who will be impacted, and how the plan will improve operations and efficiency.
- Allocation of resources – Identify the resources needed. Ensure availability of adequate resources, including time, finances, and staffing needed for successful implementation.
- Planning tasks and milestones - Identify tasks, dependencies, and outcomes required and milestones.
- Designation of responsibilities - Assign roles and tasks to staff members
- Identification of contingencies - Prepare backup plans that would allow the team to act quickly when issues arise at any phase
- Define success - The first component is the definition of goals. Similarly, a successful outcome also need to be defined.
- The legislative framework will provide certainty and continuity to the implementation plan, which will ultimately ensure the successful implementation of the project.

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