The Federative Republic of Brazil
The Government of State of Para

Study on Effects of GHG Emission Reduction Expected from Belem Metropolitan Trunk Bus System Project

Final Report

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TABLE OF CONTENTS

List of Tables

List of Figures

List of Abbreviations

The Study	Study on effects of GHG emission reduction expected from Belem Metropolitan Trunk Bus System Project
The 2010 Preparatory Survey	The Preparatory Survey for Belem Metropolitan Bus Transport System Project In The Federative Republic of Brazil
The 2003 F/S	Feasibility Study on the Improvement of Transport System in the Metropolitan Area of Belem in the Federative Republic of Brazil
AM	Approved Methodology
BRT	Bus Rapid Transit
CDM	Mecanismo de Desenvolvimento Limpo
CER	Certified Emission Reduction
C/P	Counterpart
CTBel	Transport Company of Belem Municipality
DCP	Documento de Concepcao de Projeto
D/D	Detail Design
DNA	Designated National Authority
DOE	Designated Operational Entity
E/N	Exchange Notes
GHG	Green House Gus
ICGCC	Interministerial Commission on Global Climate Change
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency
L/A	Loan Agreement
MRV	Measuring, Reporting and Verification
NGTM	Nucleus of Administration of Metropolitan Transport
OD	Origin and Destination
ODA	Official Development Assistance
SEPE	State Secretariat of Strategic Projects
SETRAN	Executive Secretariat of Transports

Executive Summary

Executive Summary

1. BACKGROUND OF THE PROJECT

JICA agreed and undertook in 2003 the Feasibility Study on Improvement of Transport System in the Metropolitan Area of Belem (hereafter referred to as the 2003 F/S). Subsequently in 2010, JICA again agreed to undertook the Preparatory Survey for Belem Metropolitan Bus Transport System Project (hereafter referred to as the 2010 Preparatory Survey). The 2010 Study reviewed and updated the findings and proposals of the 2003 Study to help formulate a project suitable for applying to the Japan's ODA Loan.

The 2010 Preparatory Survey proposed the trunk bus project that would service on Av. Almirante Barroso, BR-316, Av. Augusto Montenegro, the Centro and Icoaraci area. The proposal came to be known as the Y-net development because of the shape of the proposed trunk bus network. In view of the huge capital outlay needed for the entire project, however, the State of Para Counterpart (hereafter referred to as the Counterpart) concluded that the project should be divided into two phases in terms of the level of demand. Phase I implements the trunk bus system on Av. Almirante Barroso, BR-316 and the Centro area, or the I-net development. The remainder of the Y network will be implemented in Phase II sometime after 2014. Accordingly, the expected application to the Japan's ODA Loan concerns the I-net development of the trunk bus system.

The Study is a supplementary study on the I-net development which involves the review over the demand forecast and the estimation of Greenhouse Gas (GHG) emission reductions.

2. PURPOSE AND SCOPE OF THE STUDY

The Study reviews the demand forecast in accordance with the reduced scope of the trunk bus project to I-net development. Similarly, the GHG emission reduction is estimated to see if the scale of reductions is sufficient to warrant the CDM application. In addition, the Study suggests a scenario of institutional development for the Counterpart to undertake in readiness to the successful CDM application of the trunk bus project.

3. STUDY PROJECT

The Outline of the Project is shown below.

(1) Study Area

The study area is the same as the 2010 Preparatory Survey, namely, three cities of Belem, Ananindeua and Marituba in the metropolitan area of Belem.

(2) Target Year

The Study schedules that the proposed trunk bus project will come into operation at the end of 2015.

(3) Study Project

As already mentioned, the trunk bus project to be submitted for the Japan's ODA Loan is the I-net development with project components as listed below. See Figure 1.2-1 for the locations of the project components.

- Trunk bus exclusive lane on Av. Almirante Barroso, trunk busway on BR-316 and trunk bus priority lanes in the Centro: total extension of 27.1km
- One bus terminal : Marituba
- One bus station: Aguas Lindas
- Bus stops: 28 locations

(4) Basic Policy of Study

The most important output of the Study is the analysis of GHG emission reductions regarding the I-net development for the Japan's ODA Loan. Accordingly, the details of the project proposal in the 2010 Preparatory Survey are utilized to scale down and review the demand forecast and other procedural steps necessary for estimating emission reductions.

4. STUDY DURATION

The Study commenced in February 2011 and ended in September 2011.

5. THE CONTENTS OF THE STUDY

(1) TRAVEL DEMAND FORECAST

Basic Policy

- The demand forecast of the present Study uses the travel demand models developed by the 2010 JICA Preparatory Survey, with no basic revisions attempted on the model structure.
- The forecast uses the OD tables compiled by the 2010 JICA Preparatory Survey: namely, the 2009 OD tables derived from the traffic surveys and the forecast OD tables for the target years 2013, 2018 and 2025.
- The OD tables for the years mentioned above are interpolated to update the travel demand forecasts for the years in between.

Conditions of Forecast

- Target years of the demand forecast: 2016 (the first year of the trunk bus operation) and 2025 (the last year of the crediting period of GHG emission reductions).
- Trunk bus routes: the I-net portion of the initially proposed Y-net development.
- The present and the future road network and the existing bus routes: latest data obtained from the Counterpart, CTBel and other related agencies.
- OD tables used for demand forecast: interpolated from the tables prepared by the 2010 JICA Preparatory Survey.

Results of Forecast

- Daily trunk bus passengers
  2016: approximately 249,900 persons
  2025: approximately 303,600 persons
- Total turnk bus operation
  2016: approximately 17,400 vehicle kilometers
  2025: approximately 19,400 vehicle kilometers

(2) REDUCTION OF GHG EMISSIONS

- The CDM application of the trunk bus project uses AM0031 "Baseline Methodology for Bus Rapid Transit Projects."
- Estimated emissions of greenhouse gases are converted to CO_2.
- The mode after the project comes into operation is trunk bus.
- The modes for the baseline scenario are large bus and small bus.

- The total emission reductions by the trunk bus operation are estimated to be 499,011 tCO_{2eq} during the credited period of 10 years, or 49,901 tCO_{2eq} per annum.

(3) MRV SYSTEM DEVELOPMENT FOR THE TRUNK BUS PROJECT

- The establishment of the system and procedure of measuring, reporting and verification (MRV) is essential to ensure the effectiveness, the transparency and the equity of emission reduction/mitigation efforts among the parties concerned. Especially regarding the developing countries, the crucial issue is how to enhance the transparency of their mitigation efforts through MRV activities.
- At present, there are yet no internationally accepted rules about how to establish and operate the MRV system. However, the MRV procedure will be set in motion after 2013 when it is highly likely that the international MRV rules and standards will be agreed upon and take effect. All interested countries and parties are now individually taking preparatory steps towards the eventual MRV standardization.
- The possibility of GHG emission reductions by the trunk bus project has already been quantitatively assessed and in consultation and agreement with the Brazilian side, the quantified assessment results have been set up as indicators with which to evaluate the subsequent project performance in emission reduction. Because of the scaling-down of the project, the assessment of emission reductions is now being updated more strictly on the basis of more precise data.
- The updated assessment data will be duly agreed upon by JICA and the State Government of Para before the project implementation. Then, the assessment data will be publicly released pending the consent of the State Government of Para.

(4) CDM APPLICATION AND REGISTRATION

- The estimated CER sales over 10 years amount to US$0.6～3.8 million.
- The additionality of the proposed trunk bus project is arguably sufficient.
- The conditions in Belem justify the use of AM0031 “Baseline Methodology for Bus Rapid Transit Projects” for the CDM application.
- It is possible to justify Japan’s ODA financing of the proposed trunk bus project.
- It is concluded therefore that the proposed trunk bus project is likely to get CDM approval and registration.
- The remaining issues concern (i) the selection of project participants and the flow design of CER transfers, (ii) increasingly lengthening process of crediting approval and (iv) financial burden of performing MRV activities.

(5) MRV SYSTEM AFTER CDM REGISTRATION

- The public consortium will manage the MRV system.
- The role of the public consortium consists of (i) collection and compilation of monitored data and other relevant information, (ii) examination of the monitoring reports submitted by the commissioned consultants and (iii) submission of the reports to a DOE for verification.
- The role of consultants consists of (i) collection of monitored data and other relevant information, (ii) monitoring surveys, (iii) calculation of the emission reductions, (iv) quality control of measurement and analysis and (v) drafting monitoring reports and answering questions/demands from the DOE over the reports.
- The CO_2 emission reduction is calculated as a difference between the baseline scenario

and the actual emissions. Accordingly, monitoring is required to collect the measured data concerning the parameters and other indicators employed by the CDM-approved methodology (i.e., AM0031).

CHAPTER 1
Introduction

1. INTRODUCTION

1.1. BACKGROUND OF THE PROJECT

The State of Para is located in the northern part of the Federal Republic of Brazil and its metropolitan area of Belem has the aggregate population of about 2.1 million. Belem is the commercial center and the urban sprawl has been spreading from the city outward to nearby suburbs. Along with urbanization and population growth, the traffic congestion has been intensifying in the metropolitan area. Public transport is provided by bus services which are concentrated on a few arterial roads connecting to the Centro. Excessive bus operation is one of the causes of traffic congestion on these roads. For example, nearly 90% of the peak hour passenger traffic on Av. Almirante Barroso used bus services in 2009. With intensifying traffic congestion, the problem of air pollution has become serious. The metropolitan situation calls for a more efficient public transport system.

The State Government of Para realized the urgent need of a public transport project which would improve the problem in the metropolitan area of Belem and requested JICA to work on such a project. JICA subsequently agreed and undertook in 2003 the Feasibility Study on Improvement of Transport System in the Metropolitan Area of Belem (hereafter referred to as the 2003 F/S). Subsequently in 2010, JICA again agreed to undertook the Preparatory Survey for Belem Metropolitan Bus Transport System Project (hereafter referred to as the 2010 Preparatory Survey). The 2010 Study reviewed and updated the findings and proposals of the 2003 Study to help formulate a project suitable for applying to the Japan's ODA Loan.

The 2010 Preparatory Survey proposed the trunk bus project that would service on Av. Almirante Barroso, BR-316, Av. Augusto Montenegro, the Centro and Icoaraci area. The proposal came to be known as the Y-net development because of the shape of the proposed trunk bus network. In view of the huge capital outlay needed for the entire project, however, the State of Para Counterpart (hereafter referred to as the Counterpart) concluded that the project should be divided into two phases in terms of the level of demand. Phase I implements the trunk bus system on Av. Almirante Barroso, BR-316 and the Centro area, or the I-net development. The remainder of the Y network will be implemented in Phase II sometime after 2014. Accordingly, the expected application to the Japan's ODA Loan concerns the I-net development of the trunk bus system.

The Study is a supplementary study on the I-net development which involves the review over the demand forecast and the estimation of Greenhouse Gas (GHG) emission reductions.

1.2. PURPOSE AND SCOPE OF THE STUDY

(1) Purpose of Study

The purpose of the Study is the followings.

- The Study reviews the demand forecast in accordance with the reduced scope of the trunk bus project to I-net development. Similarly, the GHG emission reduction is estimated to see if the scale of reductions is sufficient to warrant the CDM application. In addition, the Study suggests a scenario of institutional development for the Counterpart to undertake in readiness to the successful CDM application of the trunk bus project.

In March 2010, the JICA on the Japan's ODA Loan applications reviewed the trunk bus project, noting the change from the Y-net to the I-net development. At the time, the down-scaling of emission reductions could be done only roughly from the original estimates of the 2010 Preparatory Survey on the Y-net development. It was thought necessary to review the demand forecast based on the I-net development and then estimate the GHG emission reductions with more accuracy. In addition, UNFCCC COP15 held at Copenhagen agreed on the importance of measuring, reporting and verification (MRV) in CDM project activities. The Counterpart needs technical capacity building to manage the trunk bus project as a CDM project activity.

(2) Study Area

The study area is the same as the 2010 Preparatory Survey, namely, three cities of Belem, Ananindeua and Marituba in the metropolitan area of Belem.

(3) Target Year

The Study schedules that the proposed trunk bus project will come into operation at the end of 2015.

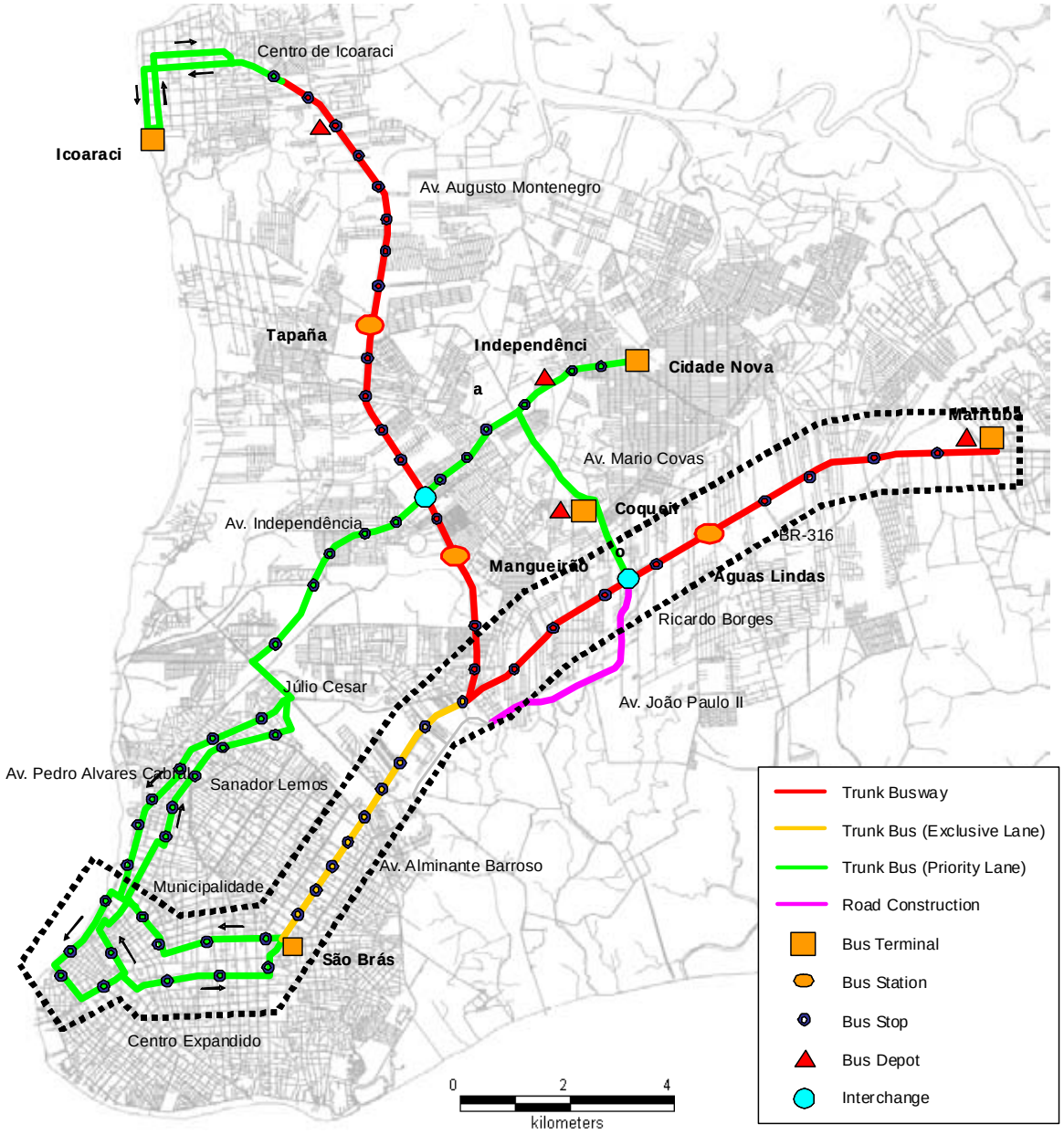
(4) Study Project

As already mentioned, the trunk bus project to be submitted for the Japan's ODA Loan is the I-net development with project components as listed below. See Figure 1.2-1 for the locations of the project components.

- Trunk bus exclusive lane on Av. Almirante Barroso, trunk busway on BR-316 and trunk bus priority lanes in the Centro: total extension of 27.1km
- One bus terminal : Marituba
- One bus station: Aguas Lindas
- Bus stops: 28 locations

(5) Basic Policy of Study

The most important output of the Study is the analysis of GHG emission reductions regarding the I-net development for the Japan's ODA Loan. Accordingly, the details of the project proposal in the 2010 Preparatory Survey are utilized to scale down and review the demand forecast and other procedural steps necessary for estimating emission reductions.

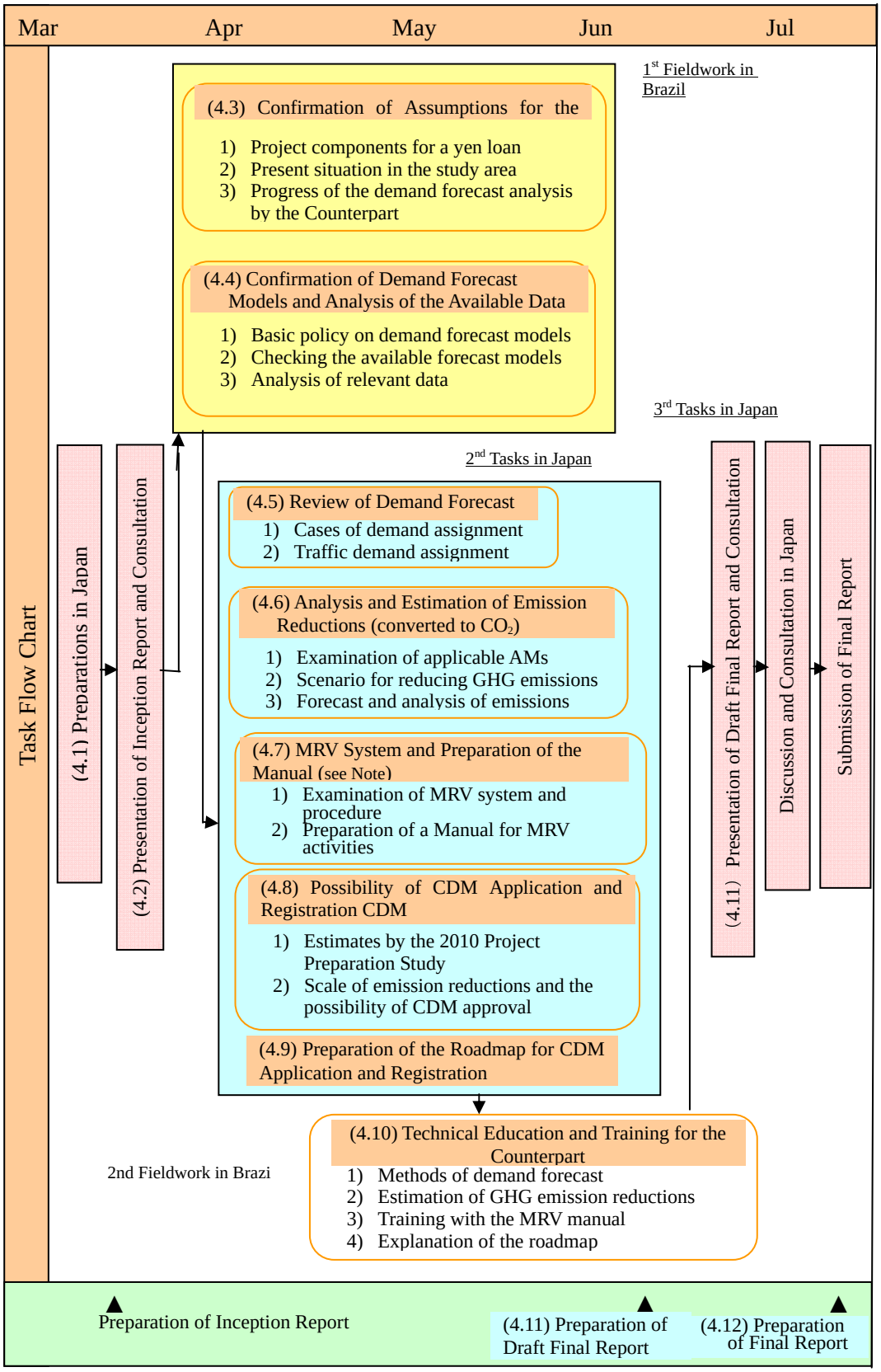


Note: the I-net development is shown by the dotted line.

Figure 1.2-1 The Trunk Bus System for I-net Development

1.3. OUTLINE OF THE STUDY

The schedule of the Study per task is shown by the flow chart in Figure 1.3-1.



Note: The Study item No. 4.7 is divided into the following two Chapters in the course of the Study.
1) Chapter 4: MRV System Development for the Trunk Bus Project
2) Chapter 6: Monitoring System on CDM Project
'Preparation of a Manual for MRV activities' in Item No. 4.7, 2) changes the title as 'Monitoring System on CDM Project'.

Figure 1.3-1 Flow Chart of the Study

1.4. OUTLINE OF THE PROPOSED TRUNK BUS SYSTEM

The trunk bus system proposed in the 2010 Preparatory Survey is a mass rapid transit system, literally with large transport capacity, rapid operation speed and low fare. More specifically, the system is provided with a number of operational characteristics. 1) The exclusive busways and/or lanes are provided for 2) the operation of articulated buses with large passenger capacity. In order to guarantee rapid services, 3) boarding and alighting passengers are spatially segregated from the flows of passers-by at terminals and bus stops, 4) longer spaces are kept between bus stops along the routes and 5) the boarding and alighting time at bus stops are shortened by the strictly pre-paid ticket system. In addition, 6) the transfers do not require new tickets. The trunk bus system will be operated by a newly created public consortium.

The benefits accruing from the project implementation are 1) mitigation and reduction of traffic congestion, 2) more efficient operation of bus services, 3) mitigation of air pollution and improvement of natural and social environment and 4) stimulation of social and economic activities. The major characteristics of the trunk bus project formulated by the 2010 Preparatory Survey are described below. The Study focuses on the I-net development shown in Figure 1.2-1.

(1) Trunk Bus System Plan

The trunk bus system is composed of trunk bus, feeder bus and existing conventional bus. Their respective roles in the system are that trunk buses in integration with feeder buses transport the dwellers in the outlying suburbs to the metropolitan CBD and that the conventional buses service passengers without direct access to the trunk bus routes. The trunk buses are operated on the exclusive busways or lanes, while conventional buses and other motorized vehicles are not allowed to use these busways or lanes. Suburbs are serviced by the fleet of feeder buses. Articulated double-body buses with 160 passenger capacity (up to 200 passengers during peak hours) are introduced to increase the transport capacity and raise the speed of service. The feeder services are provided by smaller buses with 50 to 70 passenger capacity suited to suburban roads with narrow width. In order to shorten boarding and alighting time, passengers have to buy tickets before entering bus stop facilities just like the passengers on the railways.

(2) Trunk Bus Road Plan

The trunk buses run on (i) trunk bus exclusive road, (ii) exclusive lanes and (iii) priority lanes. The trunk bus exclusive roads are completely segregated by concrete structure from the through traffic roadway and shut out other vehicles including conventional buses. Exclusive lanes are partially segregated by chatter bars from the roadway. Priority lanes are provided on the same roadway and give priority to the trunk bus during peak hours.

(3) Trunk Bus Terminals and Bus Stops

Four terminals are proposed to accommodate the passenger transfers between trunk and feeder bus and to provide the parking facility for the fleet. Three bus stations are proposed for the locations where large plots are not available. In order to increase the transport capacity of trunk bus services, bus stops are provided with a bus passing lane in order not to obstruct the through traffic.

1.5. IMPLEMENTATION SCHEDULE OF THE PROPOSED TRUNK BUS SYSTEM

The Study initially scheduled the start of trunk bus operation at the end of 2014. However, the delayed Exchange of Notes and other procedures for the Japan's ODA Loan suggest the need to adjust the scheduling. In consultation with the Counterpart, the start of operation has been rescheduled with the following consideration.

1) The Exchanged of Notes with its associated procedure is now nearly a year overdue.
2) The schedule has been adjusted by resetting the time for E/N to the middle of 2011, when the selection of consultants is to begin.

- Since the E/N signed on June 30 in 2011, the initial schedule is moved forward accordingly. If the preparation for selecting consultants begins sometime during June and July, the delay from the initial schedule will be 6 to 9 months, 12 months at the worst. The start of trunk bus operation would be mid-2015 if everything goes smoothly or the end of 2015 at the most.
- In consultation with the Counterpart, it has been agreed that the construction works will be completed near the end of 2015 and that the trunk bus operation will start before the end of the year.

CHAPTER 2
Travel Demand Forecast

2. TRAVEL DEMAND FORECAST

2.1. BASIC POLICY FOR DEMAND FORECAST

The basic policy for the Study is as follows.

1) The demand forecast uses the models developed in the 2010 Preparatory Survey and adds no basic change to the models themselves. In other words, the Study utilizes the OD tables for the years 2009, 2013 and 2025 for the demand forecast.

2) Three OD tables mentioned above are interpolated to obtain tables for the target years revised for the Study.

The justifications of the policy are as follows.

1) The 2010 Preparatory Survey conducted traffic volume count surveys to obtain the current data to build the demand forecast models. The surveys were conducted in April 2009 at 13 spots distributed on two screen lines, one cordon line and major arterial roads. It was found that the urban build-up sprawled from Belem City outward to outlying suburbs over the period of 2002 and 2009. The traffic flows in the suburbs increased 150%, while those in the Centro area remained relatively unchanged. The significant change in the pattern of traffic flows was reflected in the demand forecast models subsequently built by the 2010 Preparatory Survey.

2) The target year for the demand forecast was set in 2018, with 2013 for the short term and 2025 for the perspective long term, and the future socio-economic frame prepared by the State Government staff was used as parameters of demand forecast.

3) The demand forecast done by the 2010 Preparatory Survey is judged realistic because of its model building derived from the then newest traffic data and socio-economic parameters.

4) Demand forecast models are usually updated (i) when the traffic flow patterns in a given area have changed radically, and (ii) when the socio-economic conditions have begun to show clear signs of the changing trend. Normally, therefore, the demand forecast models are reviewed and updated after the elapse of time about 10 years or so.

2.2. DEMAND FORECAST MODELS

The Study relies on the demand forecast models developed by the 2010 Preparatory Survey. The details of the models are noted as follows

1) Based on the traffic data collected by the traffic volume surveys of 2009, the OD tables previously prepared by the 2003 F/S were updated to 2009.

2) The survey of stated preferences (SP) was conducted to get the data on passenger behaviors in modal choice. The findings were then used to build the model of modal split.

3) The socio-economic indices of 2009 were used to build models of trip generation, attraction and distribution.

4) Regarding traffic assignment, (i) trips by private means of transport were assigned by shortest path search to the road network and (ii) trips by public transport were assigned to the bus lines. Trunk bus trips were assigned to the exclusive trunk busways, while trips by existing conventional buses were assigned to other roadways together with other motorized vehicles. For this reason, the conventional buses dropped the speed of operation by the

traffic congestion. In the traffic assignment, the public transport demand was first forecast and then preloaded to the model and then the private motorized traffic were assigned to the road network.

2.3. REVIEW OF DEMAND FORECAST

2.3.1. TARGET YEARS AND CASES OF DEMAND ASSIGNMENT

By taking into consideration the then effective implementation schedule of the trunk bus project, the 2010 Preparatory Survey set the primary target year at 2018, with 2013 for the short term and 2025 for the perspective long term. As mentioned earlier in Section 1.5. of Chapter 1, however, the completion of the project will be later than the initially scheduled. In consultation with the Counterpart, it has been agreed that the project completion will be toward the end of 2015 and that the start of trunk bus operation would better be rescheduled to 2016. Moreover, the Study takes up the year 2025 as the primary target year for demand forecast, because the crediting period chosen for the possible CDM application of the trunk bus project is 10 years, over which the emission reductions must be estimated.

The demand forecast of the Study is for the years 2016 and 2025 and consists of two assignment cases, namely, “with” and “without” the trunk bus project, as shown in Table 2.3-1.

Table 2.3-1 Assignment Cases in the Demand Forecast

Year	Assignment Cases		Significance in the Study
	"without" Case	"with" Case	
2011	●	–	・Study conducted (the present situation / base year)
2016	●	●	・First year of trunk bus operation (scheduled to start at the end of 2015) ・First CDM credited year
2025	●	●	・Last CDM credited year (tenth year of trunk bus operation)

2.3.2. ASSUMPTIONS OF DEMAND FORECAST

Basic assumptions of the demand forecast in the Study are explained below. The road and traffic database compiled by the 2010 Preparatory Survey are updated after ascertaining the current situation in the study area.

(1) Routing of Trunk Bus Services

The trunk bus routes used for the demand forecast constitute the I-net portion extracted from the Y-net development proposed by the 2010 Preparatory Survey. The details of the I-net trunk bus development are given in Table 2.3-2. R attached to the route number stands for normal service and E for express service.

The Study employs the same trunk bus operation plan as that in the 2010 Preparatory Survey such as the normal and express service of the trunk bus operation including boarding and alighting at bus stops and fare system.

The location of each trunk bus route is shown in Figures 2.3-1 and 2.3-2.

Table 2.3-2 I-net Trunk Bus Routes

Trunk Bus Network	Origin	Route No.	By way of	Destination	Route Length (km)	Start of Operation (year)
I-net	Águas Lindas	R2502	Almirante Barroso BR-316	Centro	33.0	2016
		R2512	Almirante Barroso BR-316	São Brás	23.1	2016
		E2512	Almirante Barroso BR-316	São Brás	23.1	2016
	Marituba	R2602	Almirante Barroso BR-316	Centro	44.7	2016
		R2612	Almirante Barroso BR-316	São Brás	34.8	2016
		E2612	Almirante Barroso BR-316	São Brás	34.8	2016

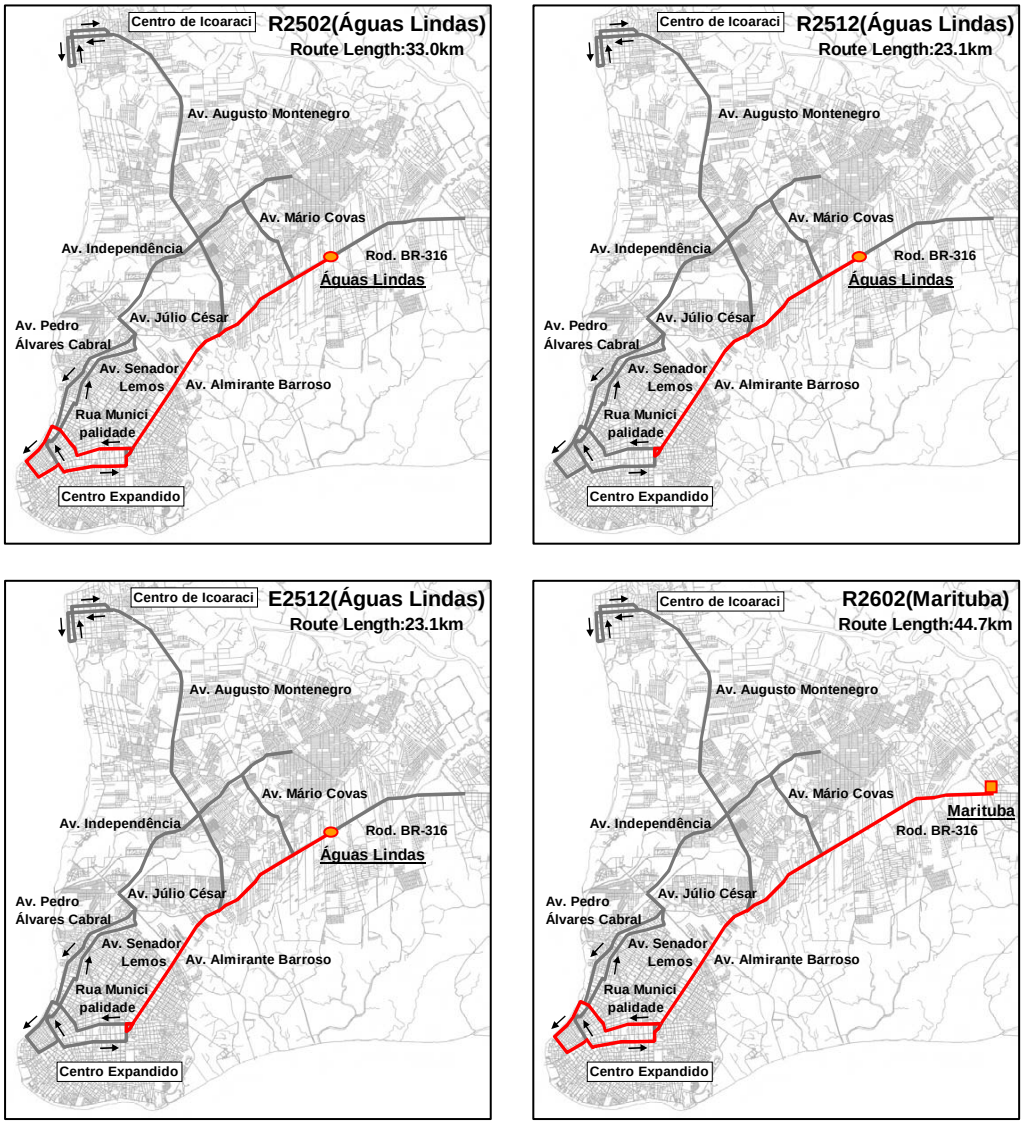


Figure 2.3-1 I-net Trunk Bus Routes (R2502, R2512, E2512 and R2602)

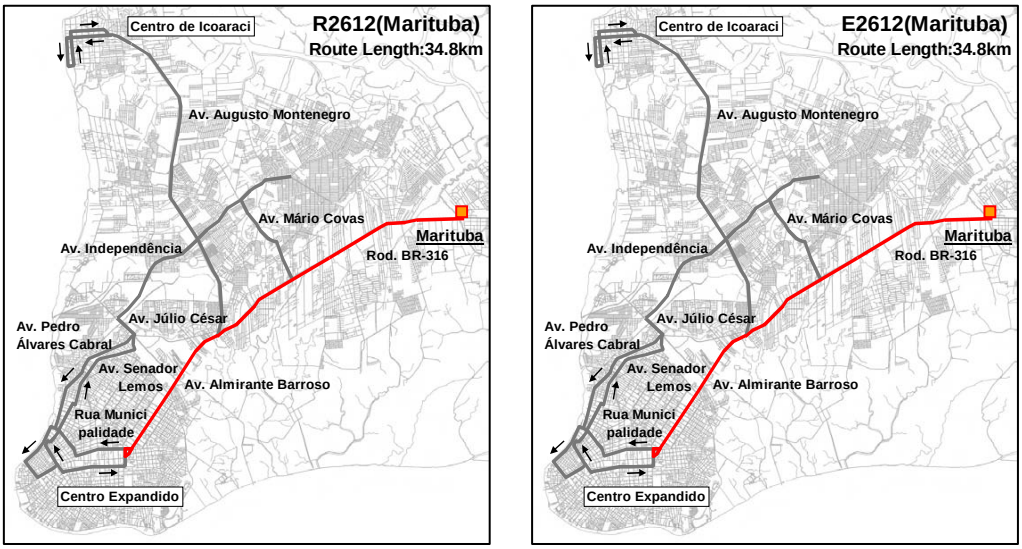


Figure 2.3-2 I-net Trunk Bus Routes (R2612 and E2612)

(2) Review of Road- and Traffic-related Data

1) Review of Road Network

In consultation with the Counterpart, the current statuses of those road segments opened after the 2010 Preparatory Survey and the future plans of those road projects scheduled to be completed by the respective target years of 2016 and 2025 are input to the road network database. The road data of the opened Av. Dalcidio Jurandir (a segment of Av. Independencia) is included in the data base of travel demand analysis. The demand forecast in Sections 2.3.3 to 2.3.5 is conducted on the same road network data.

2) Review of Existing Bus Lines

The newest information is obtained from CTBel regarding the existing bus lines and added to the bus line database. Following the reasoning presented in the 2010 Preparatory Survey, those bus lines that compete with the proposed trunk bus routes by 70% or more of their respective line length are to be discontinued. The cut ratio of 70% or more would discontinue 16 existing bus routes and retain 161 routes as shown in Table 2.3-3. This is input to the database for the demand forecast.

Table 2.3-3 Existing Bus Lines to be Discontinued by 2016 by Different Cut Ratio

Cut Ratio of Competition	Number of Lines				Total Line Length			
	Disucontinued		Retained		Disucontinued		Retained	
		Share		Share	(km)	Share	(km)	Share
Total Existing Bus Lines(2011)	—	—	177	100.0%	—	—	7,035.81	
0% or more and less than 10%	177	100.0%	0	0.0%	7,035.81	100.0%	0.00	0.0%
10% or more and less than 20%	130	73.4%	47	26.6%	5,262.97	74.8%	1,772.84	25.2%
20% or more and less than 30%	109	61.6%	68	38.4%	4,558.73	64.8%	2,477.08	35.2%
30% or more and less than 40%	87	49.2%	90	50.8%	3,668.51	52.1%	3,367.30	47.9%
40% or more and less than 50%	67	37.9%	110	62.1%	2,891.43	41.1%	4,144.38	58.9%
50% or more and less than 60%	46	26.0%	131	74.0%	1,910.45	27.2%	5,125.36	72.8%
60% or more and less than 70%	27	15.3%	150	84.7%	1,048.02	14.9%	5,987.79	85.1%
70% or more and less than 80%	**16**	**9.0%**	**161**	**91.0%**	**567.97**	**8.1%**	**6,467.84**	**91.9%**
80% or more and less than 90%	6	3.4%	171	96.6%	209.02	3.0%	6,826.79	97.0%
90% or more and less than 100%	1	0.6%	176	99.4%	28.31	0.4%	7,007.50	99.6%
100%	0	0.0%	177	100.0%	0.00	0.0%	7,035.81	100.0%

(3) Making of OD Tables

The OD tables for 2011 (base year), 2016 and 2025 are interpolated from the OD tables of 2009, 2013 and 2018 compiled by the 2010 Preparatory Survey.

Table 2.3-4 lists up the OD tables made by the Study. Figure 2.3-3 compares the forecasts of annual generated and attracted person trips by the 2010 Preparatory Survey and the Study.

Table 2.3-4 OD Tables Prepared by the Study

Year	The 2010 Preparatory Survey	The Study		Remarks
			Forecast Method	
2009	○	–		・The base year of the 2010 preparatory survey
2011	–	●	Interpolated from OD tables of 2009 and 2013	・The base year of the Study ・Used to estimate the present GHG emmisions
2013	○	–		・Start of the Y-net trunk bus operation in the 2010 preparatory survey
2016	–	●	Interpolated from OD tables of 2013 and 2018	・Start of I-net trunk bus operation in the Study (end of 2015) ・First CDM credited year in the present Study
2018	○	–		・Start of Y-net trunk bus operation in the 2010 preparatory survey
2025	○	●	OD tables of the 2010 preparatory survey	・Last CDM credited year in the Study

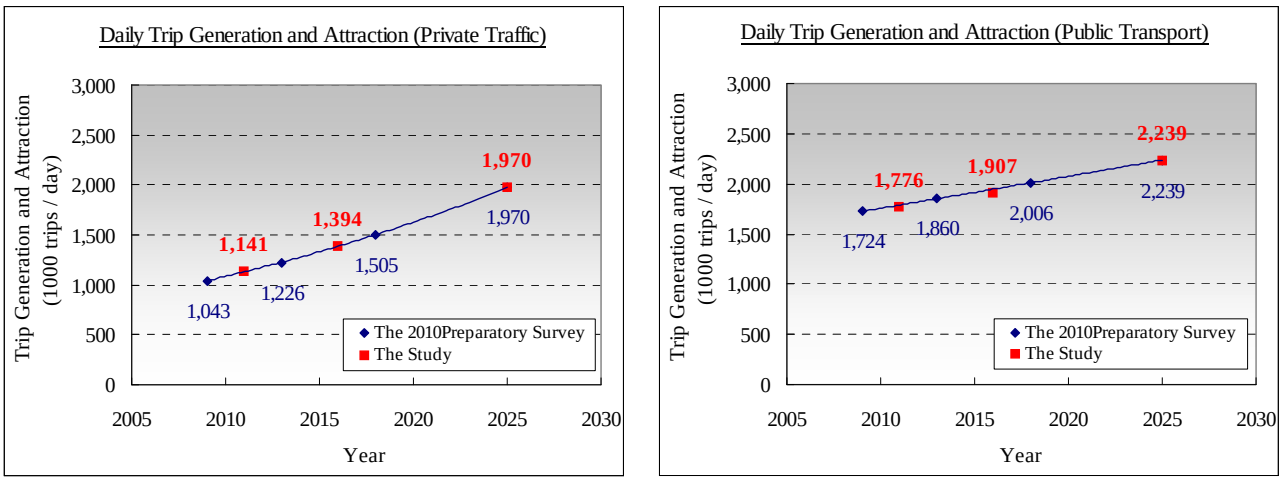


Figure 2.3-3 Forecasts of Annual Generated and Attracted Person Trips (Daily)

2.3.3. RESULTS OF DEMAND FORECAST

The demand forecast pertains to the trunk bus project of I-net development, which will be financed by the Japan's ODA Loan. In addition to the forecasts of daily trips which would be necessary to estimate GHGs emissions and the reductions thereof for the possible CDM application, the Study has made the forecasts of peak hour trips, which are the basic input to the stage of detailed design.

(1) Daily Passenger Trips

Daily passenger trips by trunk bus are required for the estimation of GHGs emission reductions which might justify or not justify the CDM application. Tables 2.3-5 and 2.3-6 show the details of the forecasts of daily passenger trips by the proposed trunk bus system. Daily trunk bus passengers are estimated to be 249,900 passengers in 2016, increasing to 303,600 by 2025. Vehicle kilometers of the trunk bus fleet would be 17,400 in 2016, reaching 19,400 by 2025. Trunk bus passengers, all together, would travel 2,482,500 passenger kilometers daily in 2016 and the figure would rise to 3,003,500 passenger kilometers in 2025.

Table 2.3-5 Daily Passenger Trips by the Trunk Bus System

Year	Service	Passengers		Vehicle Kilometers		Passenger Kilometers		Average Trip Length (km)
		(passengers)	Share	(vehicle km)	Share	(passenger km)	Share	
2016	Local	88,884	35.6%	7,637	43.8%	845,763	34.1%	9.5
	Express	160,980	64.4%	9,781	56.2%	1,636,785	65.9%	10.2
	Total	249,864	100.0%	17,418	100.0%	2,482,548	100.0%	9.9
2025	Local	109,039	35.9%	8,960	46.2%	1,039,368	34.6%	9.5
	Express	194,517	64.1%	10,428	53.8%	1,964,082	65.4%	10.1
	Total	303,556	100.0%	19,388	100.0%	3,003,450	100.0%	9.9

Table 2.3-6 Breakdowns of Daily Passenger Trips by Trunk Bus Route

＜year 2016＞

Origin	Destination	Route No.	Service	Main Throughfare	Route Length (km)	Frequency (service/day)	Passengers (passengers)	Vehicle Kilometers (vehicle km)	Passenger Kilometers (passenger km)
Águas Lindas	Centro	R2502	Normal	Almirante Barroso BR-316	33.0	46	21,000	1,516	178,929
	São Brás	R2512	Normal	Almirante Barroso BR-316	23.1	32	12,051	739	69,584
	São Brás	E2512	Express	Almirante Barroso BR-316	23.1	122	58,767	2,816	524,865
Marituba	Centro	R2602	Normal	Almirante Barroso BR-316	44.7	83	34,505	3,710	407,426
	São Brás	R2612	Normal	Almirante Barroso BR-316	34.8	48	21,328	1,672	189,824
	São Brás	E2612	Express	Almirante Barroso BR-316	34.8	200	102,213	6,966	1,111,920
Total					—	531	249,864	17,418	2,482,548

＜year 2025＞

Origin	Destination	Route No.	Service	Main Throughfare	Route Length (km)	Frequency (service/day)	Passengers (passengers)	Vehicle Kilometers (vehicle km)	Passenger Kilometers (passenger km)
Águas Lindas	Centro	R2502	Normal	Almirante Barroso BR-316	33.0	56	26,394	1,846	226,614
	São Brás	R2512	Normal	Almirante Barroso BR-316	23.1	35	14,705	808	85,647
	São Brás	E2512	Express	Almirante Barroso BR-316	23.1	150	73,368	3,462	657,194
Marituba	Centro	R2602	Normal	Almirante Barroso BR-316	44.7	99	42,650	4,426	502,137
	São Brás	R2612	Normal	Almirante Barroso BR-316	34.8	54	25,290	1,881	224,970
	São Brás	E2612	Express	Almirante Barroso BR-316	34.8	200	121,149	6,966	1,306,888
Total					—	594	303,556	19,387	3,003,450

(2) Peak Hour Trips

1) Peak Hour Trunk Bus Passengers

Table 2.3-7 and Figure 2.3-4 show the passenger volumes of trunk bus in the morning peak hour. In 2016 when the I-net trunk bus system is scheduled to start its operation, peak hour passengers are estimated to be about 18,600, which would grow by 20% to 22,800 after ten years of operation, reflecting the growth of the transport demand in the entire study area by 2025. Breakdowns by service show that the express services would cater to 70 to 80% of the trunk bus passengers, the remainder being on normal services.

Table 2.3-7 Peak Hour Trunk Bus Passengers in 2016 and 2025

[passengers / hour]

Service	2016 (I-net)		2025 (I-net)	
	Passengers	Share	Passengers	Share
Normal	4,252	22.8%	5,403	23.7%
Express	14,365	77.2%	17,371	76.3%
Total	18,617	100.0%	22,774	100.0%

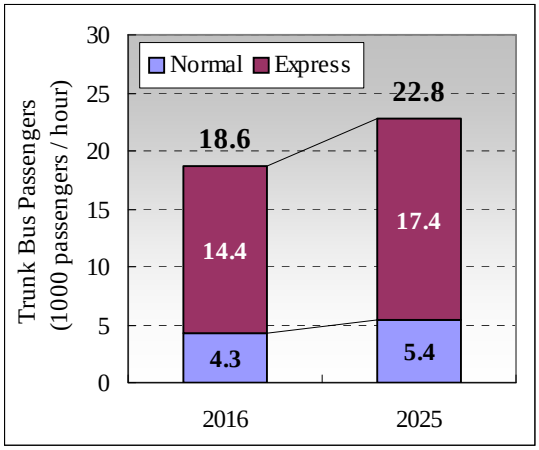


Figure 2.3-4 Peak Hour Trunk Bus Passengers in 2016 2025

2) Peak Hour Passenger Kilometers

Table 2.3-8 and Figure 2.3-5 show the projection in terms of passenger kilometers. The forecast is 180,300 passenger kilometers for 2016 when the I-net trunk bus system would come into operation and increases by 20% to 219,600 after ten years of operation. The express services would account for 80 to 90% of the total passenger kilometers, with the rest for normal services. The higher share of express services in passenger kilometers indicates that express services are preferred by trunk bus users who have to travel longer distance.

Table 2.3-8 Peak Hour Trunk Bus Passenger Kilometers in 2016 and 2025

[passenger km / hour]

Service	2016 (I-net)		2025 (I-net)	
	Passenger Kilometers	Share	Passenger Kilometers	Share
Normal	25,762	14.3%	32,369	14.7%
Express	154,578	85.7%	187,244	85.3%
Total	180,340	100.0%	219,613	100.0%

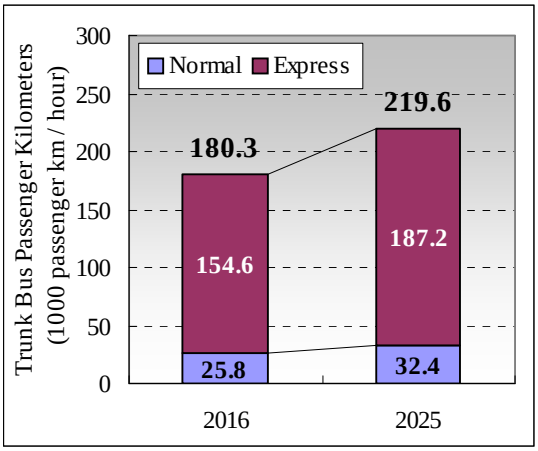


Figure 2.3-5 Peak Hour Trunk Bus Passenger Kilometers in 2016 and 2025

3) Trunk Bus Passengers by Terminal and Station

Table 2.3-9 shows the peak hour boarding and alighting trunk bus passengers. At the terminal of Marituba, peak hour boarding and alighting passengers would be about 6,100 in 2016 and increase to 7,100 in 2025 after ten years of trunk bus operation. At the station of Águas Lindas which is located between Marituba and the Centro of Belém City, the boarding and alighting passengers would be as many as 8,800 and 11,500 respectively in 2016 and 2025, because the station accommodates passengers with origin and destination in Marituba.

Table 2.3-9 Peak Hour Boarding and Alighting Passengers by Terminal and Station

[passengers / hour]

Terminal /Station	2016	2025
Águas Lindas	8,768	11,522
Marituba	6,108	7,079
Total	14,876	18,601

4) Trunk Bus Passengers at Major Route Cross-sections

Table 2.3-10 shows trunk bus passengers (one way) at six major locations. The location No. 3 (cf. Figure 2.3-6 for location) between Rod. Mário Covas and Entroncamento on Rod. BR-316 has the largest number of trunk bus passengers, reaching 10,000 in 2016 and 13,200 in 2025 in the morning peak hour. Nearly 30% of bus passengers on this road section would use the trunk bus. The location No. 4 between Entroncamento and the Centro on Av. Almirante Barosso has the next largest trunk bus passengers, numbering 8,600 in 2016 and 11,600 in 2025 in the peak hour.

Table 2.3-10 Trunk Bus Passengers by Major Route Cross-sections (per peak hour, one way)

[passengers / hour / one way]

No.	Raod	2016			2025		
		Conventional Bus	Trunk Bus	Total	Conventional Bus	Trunk Bus	Total
1	Rod. BR-316	7,879	4,437	12,316	10,495	4,846	15,341
		64.0%	36.0%	100.0%	68.4%	31.6%	100.0%
2	Rod. BR-316	9,510	9,442	18,952	12,433	12,560	24,993
		50.2%	49.8%	100.0%	49.7%	50.3%	100.0%
3	Rod. BR-316	27,601	9,964	37,565	34,080	13,239	47,319
		73.5%	26.5%	100.0%	72.0%	28.0%	100.0%
4	Av. Almirante Barroso	39,100	8,624	47,724	48,468	11,589	60,057
		81.9%	18.1%	100.0%	80.7%	19.3%	100.0%
5	Av. Governador José Malcher	34,948	301	35,249	39,125	427	39,552
		99.1%	0.9%	100.0%	98.9%	1.1%	100.0%
6	Av.Gentil Bittencourt	7,471	111	7,582	7,969	109	8,078
		98.5%	1.5%	100.0%	98.7%	1.3%	100.0%

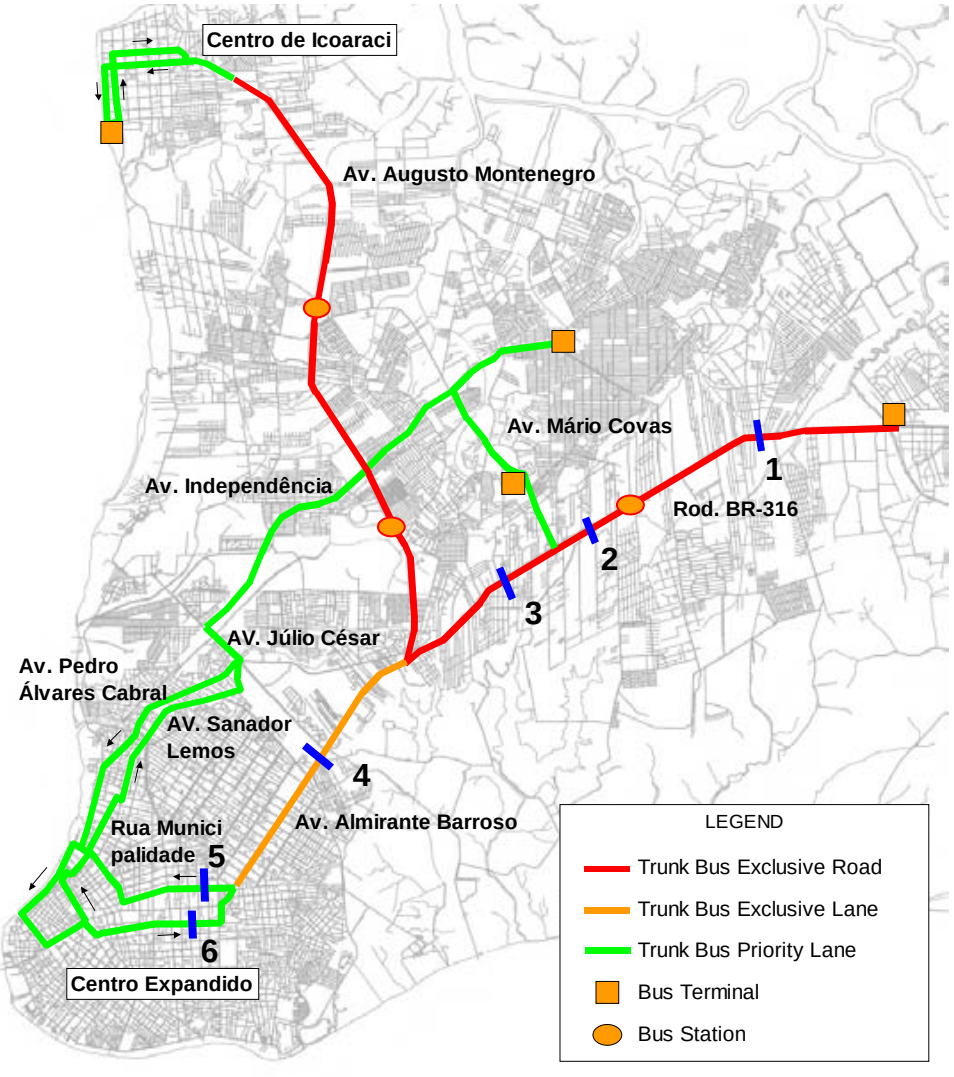


Figure 2.3-6 Location of Major Route Cross-sections of the Trunk Bus System

5) Required Service Frequency

The peak hour passengers at major locations are used to calculate the necessary frequency of service per trunk bus route. The results of calculation are assigned to each route section and the terminal and the station. Following the 2010 Preparatory Survey, it is assumed that the trunk bus capacity during the peak hour would be 200 passengers per bus fleet, which is 120% of the normal capacity of 160 passengers during non-peak hours.

a) Service Frequency per Route Section

Figure 2.3-7 shows the service frequency on two route segments. In 2016 when the trunk bus system would come into operation, the frequency is 34 services per hour along the segment from Marituba to Águas Lindas (service head of 106 seconds) and 56 services from Águas Lindas to São Brás (service head of 64 seconds). After ten years of trunk bus operation, the frequency would rise to 43 services (service head of 84 seconds) in the former segment and 73 services (service head of 49 seconds) in the latter segment.

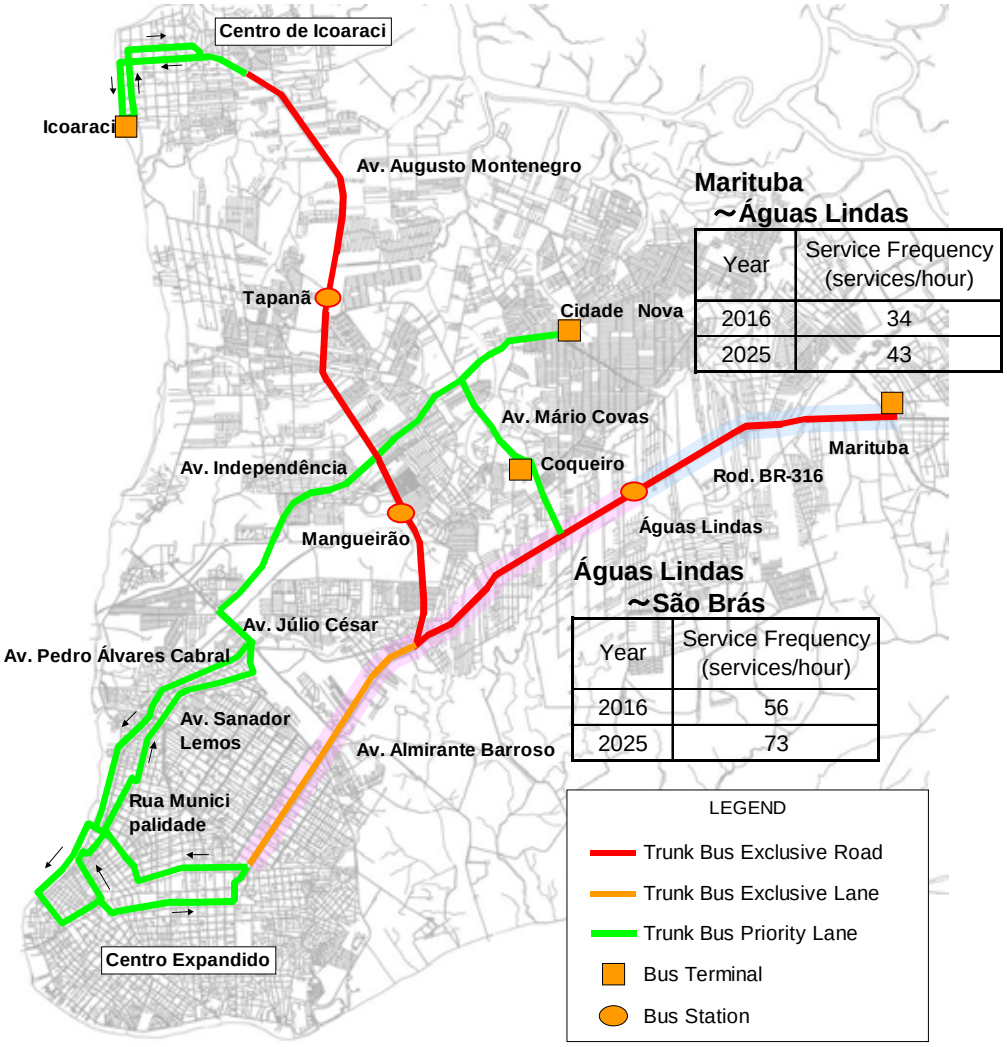


Figure 2.3-7 Peak Hour Service Frequency per Route Section (One Way)

b) Service Frequency at Terminal and Station

Table 2.3-11 shows the service frequency necessary at the terminal of Marituba and the station of Águas Lindas. The terminal would provide 43 services in the peak hour in 2016 and 43 services in 2025. The frequency at Águas Lindas would be higher due to the addition of passengers to and from Marituba, reaching 56 and 73 services respectively in 2016 and 2025.

Table 2.3-11 Peak Hour Service Frequency at Terminal and Station

[services / hour]

Terminal /Station	2016	2025
Marituba	34	43
Águas Lindas	56	73

6) Required Operated Number of Fleets

Table 2.3-12 shows the necessary operated number of trunk buses as calculated from the service frequency at the terminal and the station. The policy and the assumptions used in the 2010 Preparatory Survey are applied to the calculation. As shown in the table, the required number of operated trunk bus fleets including the reserve of 10% would be 92 units in 2016 and 122 units in 2025.

Table 2.3-12 Required Trunk Bus Fleet Size at Terminal and Station

Route No.	Terminal /Station	Route Length (km)	Operation Speed (km/h)	Trunk Bus Capacity (passengers /unit)	Operation Adjustment Time (minute)	Peak Hour Maximum Passengers at Cross-sections (passengers/hour/one way)		Required Fleet (units)	
						2016	2025	2016	2025
R2502	Águas Lindas	33.0	25.0	200	30	544	700	6	8
R2512	Águas Lindas	23.1	25.0	200	30	359	411	3	4
E2512	Águas Lindas	23.1	30.0	200	30	3,373	4,498	24	32
R2602	Marituba	44.7	25.0	200	10	606	766	7	9
R2612	Marituba	34.8	25.0	200	10	566	727	5	7
E2612	Marituba	34.8	30.0	200	10	5,206	6,953	39	51
						Águas Lindas		33	44
						Marituba		51	67
						Total		84	111
						Total (with 10% reserve)		92	122
						Break down by Service	Normal	23	31
							Express	69	91

The necessary number of berths at the terminal and the station is calculated from the peak hour service frequency required at the respective facilities and shown in Table 2.3-13. It must be noted, however, that the figures in the table are not meant for actual operation. The directional provision of berths, the frequency of feeder bus services and other details must be known to determine the actual number of berths at each facility (such details are examined during the D/D process).

Table 2.3-13 Necessary Berths at Terminal and Station

Terminal /Station	Peak Hour Service Frequency (services/hour)	Bus Handling Capacity per Berth (services/hour)	Necessary Berths
Águas Lindas	73	40	1.8 → 2
Marituba	43	20	2.2 → 3
Total	116		

2.3.4. INFLUENCE OF THE REDUCED PROJECT SCALE ON BUS SERVICES ON AV. AUGUSTO MONTENEGRO

(1) Outline of Study

As mentioned earlier, the Study deals with the I-net development for the introduction of trunk bus operation. The I-net trunk bus system does not include the development of the busway on Av. Augusto Montenegro and the trunk bus priority lanes in the Icoaraci area as initially envisioned in the Y-net development by the 2010 Preparatory Survey. Accordingly, it is necessary to examine the possible impact of the reduced project scope on bus passengers travelling on Av. Augusto Montenegro.

The absence of trunk bus service possibly influences the results of the forecast regarding bus passengers and the traffic conditions in general on Av. Augusto Montenegro. The possible influence can be clarified as follows.

1) The absence will cause a decline of the service level for bus passengers.

2) The existing right of way with three lanes one way would have been retained for general vehicle traffic other than trunk bus in the initially proposed project scope. Therefore, the presence or absence of trunk bus operation would not make any difference for general vehicle traffic conditions. In other word, the level of congestion on Av. Augusto Montenegro would be no more than the case with the trunk bus operation.

Accordingly, the Study analyzes the influence of the reduced project scope on bus passengers by ascertaining the following issues for comparison.

1) Effect on the entire Study Area

- Comparison of the total daily passenger hours between the I-net and the Y-net trunk bus system

2) Effect on bus passengers on Av. Augusto Montenegro

- I-net system: Total passengers on conventional buses in the peak hour
- Y-net system: Total passengers on trunk and conventional buses in the peak hour

3) Effect on the travel time of bus passengers on Av. Augusto Montenegro

- I-net system: Total passenger hours on conventional buses in the peak hour and the average speed thereof (km/hour)
- Y-net system: Total passenger hours on trunk and conventional buses in the peak hour and the average speed thereof (km/hour)

4) Effect on the total fleet size of buses operated on Av. Augusto Montenegro

- I-net system: Total conventional buses operated in the peak hour
- Y-net system: Total trunk and conventional buses operated in the peak hour

(2) Comparison of the Project Scale

In the beginning, the project scale is compared between the I-net and the Y-net trunk bus system, using the total route length as one of the indicators of project scale. The Y-net development as envisioned in the 2010 Preparatory Survey involves the total route extension of 46.876 km. The total route length of the I-net system is 27.139 km, which is 57.9% of the Y-net development.

(3) Effect on the Entire Study Area

The impact of the scale-down on the Study Area as a whole is measurable by comparing the total daily passenger hours by public transport (bus) between the "without" case, the "with I-net" case and the "with Y-net" case. Table 2.3-14 summarizes the results of the "with" and "without" demand forecasts for 2016 and 2025.

Table 2.3-14 Comparison of Total Daily Passenger Hours on Public Transport in the Entire Study Area

[passenger hours / day]

Year	Mode	(A) without Trunk Bus System	(B) with I-net System		(C) with Y-net System	
				Difference from without (B-A)		Difference from without (C-A)
2016	Conventional Bus	1,379,829	1,151,346	-228,483	1,052,611	-327,218
	Trunk Bus		80,905	80,905	140,197	140,197
	Total	1,379,829	1,232,251	-147,578	1,192,808	-187,021
2025	Conventional Bus	1,752,012	1,452,709	-299,303	1,326,687	-425,325
	Trunk Bus		98,064	98,064	166,910	166,910
	Total	1,752,012	1,550,773	-201,239	1,493,596	-258,416

In 2016, the total daily passenger hours of the I-net system are 147,600 less than the "without" case. The reduction by the Y-net system is 187,000 passenger hours in the same year. After ten years in 2025, the project effect would rise to the reduction of 201,200 passenger hours in the I-net system and 258,400 in the Y-net system. As indicated by the differences between the two "with" cases in Table 2.3-15, the reduction in daily passenger hours by the I-net system accounts for nearly 80% of the reduction by the Y-net system in both 2016 and 2025. Given the aforementioned fact that the I-net route length is a little less than 60% of the Y-net development, the project effect of the I-net system is larger per route kilometer than that of the Y-net development. In terms of investment efficiency, it is well justified that the introduction of the trunk bus system starts with the I-net development.

Table 2.3-15 Comparison of Reduction in Total Daily Passenger Hours Between I-net and Y-net Development

[passenger hours / day]

Year	I-net System (a)	Y-net System (b)	Comparison	
			Difference (a-b)	Ratio (a/b)
2016	147,578	187,021	-39,443	0.79
2025	201,239	258,416	-57,177	0.78

(4) Effect on Bus passengers on Av. Augusto Montenegro

On the basis of the peak hour forecasts for 2016 and 2025, total bus passengers at four locations on Av. Augusto Montenegro are compared between the I-net and the Y-net development. The results are presented in Table 2.3-16. It is obvious that the I-net system would have no trunk bus passengers on Av. Augusto Montenegro. At the location No. 1 (cf. Figure 2.3-8 for location) between Icoaraci and Tapanã, total passengers in the Y-net development would be somewhat larger than those in the I-net system. However, the differences between the I-net and the Y-net system are slight at other three locations. The location No. 1 of the Y-net system would have more passengers than the I-net system, primarily because bus users travelling from Icoaraci to the Centro would switch to the trunk bus service instead of using usual conventional bus services via Rod. Artur Bernades to the Centro.

Table 2.3-16 Total Bus Passengers during Peak Hour at Major Cross-sections on Av. Augusto Montenegro

＜year 2016＞ [passengers / hour /one way]

No.	Mode	I-net System (A)	Y-net System (B)	Comparison	
				Difference (A-B)	Ratio (A/B)
1	Conventional Bus	6,983	5,174	1,809	1.35
	Trunk Bus		3,351	-3,351	-
	Total	6,983	8,525	-1,542	0.82
2	Conventional Bus	17,133	7,641	9,492	2.24
	Trunk Bus		8,800	-8,800	-
	Total	17,133	16,441	692	1.04
3	Conventional Bus	22,713	13,385	9,328	1.70
	Trunk Bus		8,717	-8,717	-
	Total	22,713	22,102	611	1.03
4	Conventional Bus	36,807	25,119	11,688	1.47
	Trunk Bus		11,906	-11,906	-
	Total	36,807	37,025	-218	0.99

＜year 2025＞ [passengers / hour /one way]

No.	Mode	I-net System (A)	Y-net System (B)	Comparison	
				Difference (A-B)	Ratio (A/B)
1	Conventional Bus	9,044	6,661	2,383	1.36
	Trunk Bus		4,148	-4,148	-
	Total	9,044	10,809	-1,765	0.84
2	Conventional Bus	21,705	9,955	11,750	2.18
	Trunk Bus		10,698	-10,698	-
	Total	21,705	20,653	1,052	1.05
3	Conventional Bus	28,214	16,531	11,683	1.71
	Trunk Bus		10,620	-10,620	-
	Total	28,214	27,151	1,063	1.04
4	Conventional Bus	43,614	28,994	14,620	1.50
	Trunk Bus		14,511	-14,511	-
	Total	43,614	43,505	109	1.00

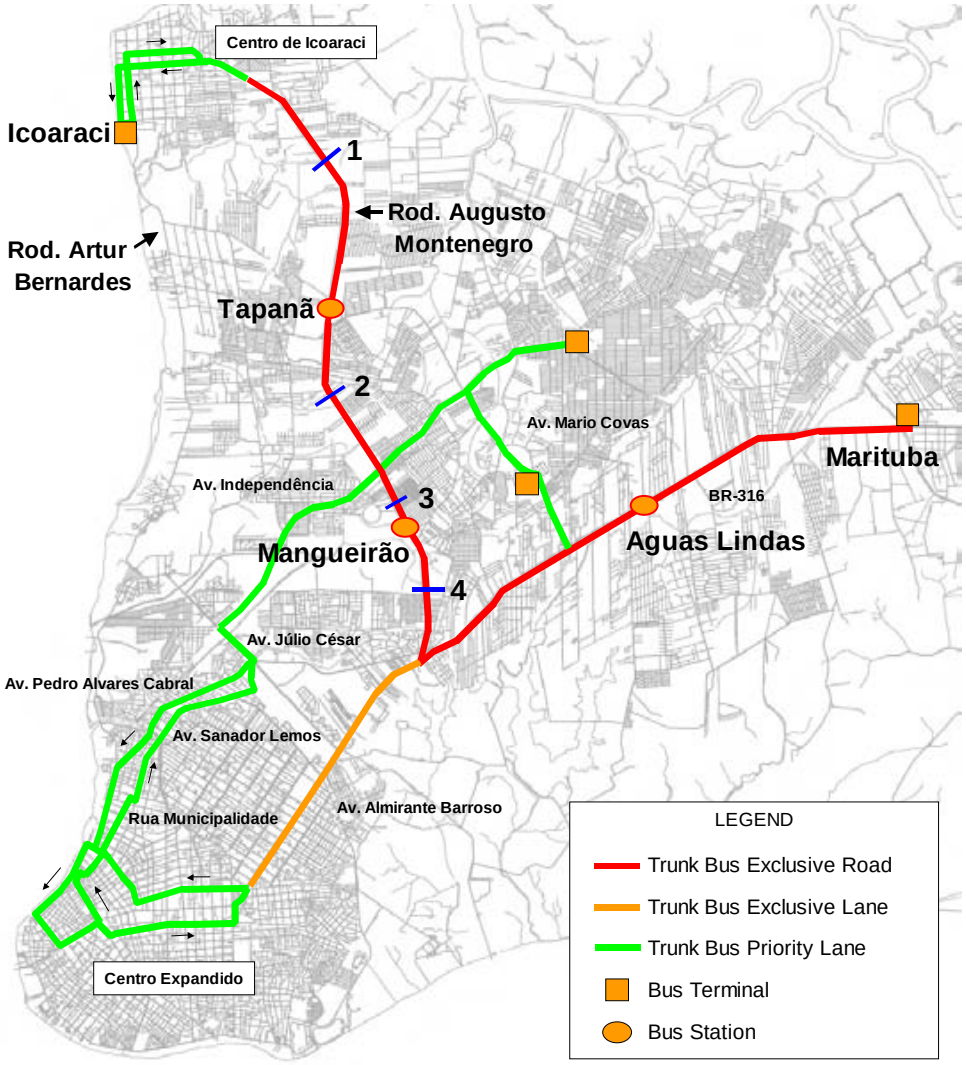


Figure 2.3-8 Location of Major Cross-sections on Av. Augusto Montenegro

(5) Effect on Travel Time by Bus Passengers on Av. August Montenegro

On the basis of the peak hour forecasts for 2016 and 2025, total travel time of bus passengers are compared between the I-net and the Y-net development. The results are shown in Table 2.3-17. In 2016, total travel time in the peak hour would be 16,100 passenger hours in the I-net system and 13,000 in the Y-net system. The figure would rise to 20,200 and 15,900, respectively, in 2025. In both 2016 and 2025, total travel time in the Y-net system is nearly 80% of the I-net development. To put this differently, the total travel time of bus passengers on Av. Augusto Montenegro would be longer by 25% in 2016 and by 27% in 2025 in the "without" case than in the "with" case.

Table 2.3-17 also compares the average speed of travel between the I-net and the Y-net system. There is no significant difference between the I-net system and the conventional bus service of the Y-net system both in 2016 and 2025. Because the I-net bus passengers on Av. Augusto Montenegro have no recourse to the trunk bus service which would have used the exclusive trunk busway, their average speed of travel would be slower by nearly 5 km per hour than the average of trunk and conventional bus passengers in the Y-net system. To put this differently, the I-net bus passengers on the said avenue would have to spend 25% longer time on average to reach their destinations.

Table 2.3-17 Total Bus Passenger Hours and Average Speed of Travel (per peak hour, one way)

＜year 2016＞

Mode		I-net System (A)		Y-net System (B)		Comparison (A-B)	
		Passenger Hours (passenger hours)	Average Speed (km/h)	Passenger Hours (passenger hours)	Average Speed (km/h)	Passenger Hours (passenger hours)	Average Speed (km/h)
Conventional Bus		16,081	17.3	9,470	17.7	6,611	-0.4
Trunk Bus		-	-	3,484	33.5	-3,484	-33.5
	Local	-	-	536	25.0	-536	-25.0
	Express	-	-	2,948	35.0	-2,948	-35.0
Total		16,081	17.3	12,954	22.0	3,127	-4.6

＜year 2025＞

Mode		I-net System (A)		Y-net System (B)		Comparison (A-B)	
		Passenger Hours (passenger hours)	Average Speed (km/h)	Passenger Hours (passenger hours)	Average Speed (km/h)	Passenger Hours (passenger hours)	Average Speed (km/h)
Conventional Bus		20,212	16.3	11,844	16.6	8,368	-0.4
Trunk Bus		-	-	4,067	33.4	-4,067	-33.4
	Local	-	-	637	25.0	-637	-25.0
	Express	-	-	3,430	35.0	-3,430	-35.0
Total		20,212	16.3	15,911	20.9	4,301	-4.7

(6) Effect on the total number of buses operated on Av. Augusto Montenegro

Again on the basis of the peak hour forecasts, the total number of buses operated at four major locations is compared between the I-net and the Y-net system. The results are shown in Table 2.3-18.

Because the trunk bus system is to introduce new articulated bus fleets of large passenger capacity, the total number of buses at four locations on Av. Augusto Montenegro is consistently smaller, by 10 to 20%, in the Y-net development than that of the I-net system with no trunk bus service.

Table 2.3-18 Total Buses Operated at Major Cross-Sections of Av. Augusto Montenegro (per peak hour, one way)

＜year 2016＞ [vehicles/hour/one way]

No.	Mode	I-net System (A)	Y-net System (B)	Comparison	
				Difference (A-B)	Ratio (A/B)
1	Conventional Bus	112	75	37	1.49
	Trunk Bus		24	-24	-
	Total	112	99	13	1.13
2	Conventional Bus	252	146	106	1.73
	Trunk Bus		45	-45	-
	Total	252	191	61	1.32
3	Conventional Bus	362	263	99	1.38
	Trunk Bus		45	-45	-
	Total	362	308	54	1.18
4	Conventional Bus	382	278	104	1.37
	Trunk Bus		60	-60	-
	Total	382	338	44	1.13

＜year 2025＞ [vehicles/hour/one way]

No.	Mode	I-net System (A)	Y-net System (B)	Comparison	
				Difference (A-B)	Ratio (A/B)
1	Conventional Bus	135	89	46	1.52
	Trunk Bus		27	-27	-
	Total	135	116	19	1.16
2	Conventional Bus	297	171	126	1.74
	Trunk Bus		53	-53	-
	Total	297	224	73	1.33
3	Conventional Bus	421	305	116	1.38
	Trunk Bus		53	-53	-
	Total	421	358	63	1.18
4	Conventional Bus	444	322	122	1.38
	Trunk Bus		72	-72	-
	Total	444	394	50	1.13

2.3.5. ANALYSIS OF TRAFFIC FLOWS CHANGED BY THE OPENING OF AV. DALCIDIO JURANDIR

The construction works of Av. Dalcidio Jurandir, which had been underway at the time of the 2010 Preparatory Survey, have been completed after the said Survey. The avenue constitutes a segment of Av. Independência, extending from the crossing with Av. Augusto Montenegro to the crossing with Av. Júlio César. It is likely that the traffic from Icoaraci toward the Centro is now diverted from Av. Augusto Montenegro to this avenue. The Counterpart conducted in 2010 two traffic surveys in the vicinity, one in August before and the other in November after the opening of Av. Dalcidio Jurandir.

The Study ran the traffic assignment on the changed network to compare the findings of the traffic surveys with the results of the traffic assignment for verification.

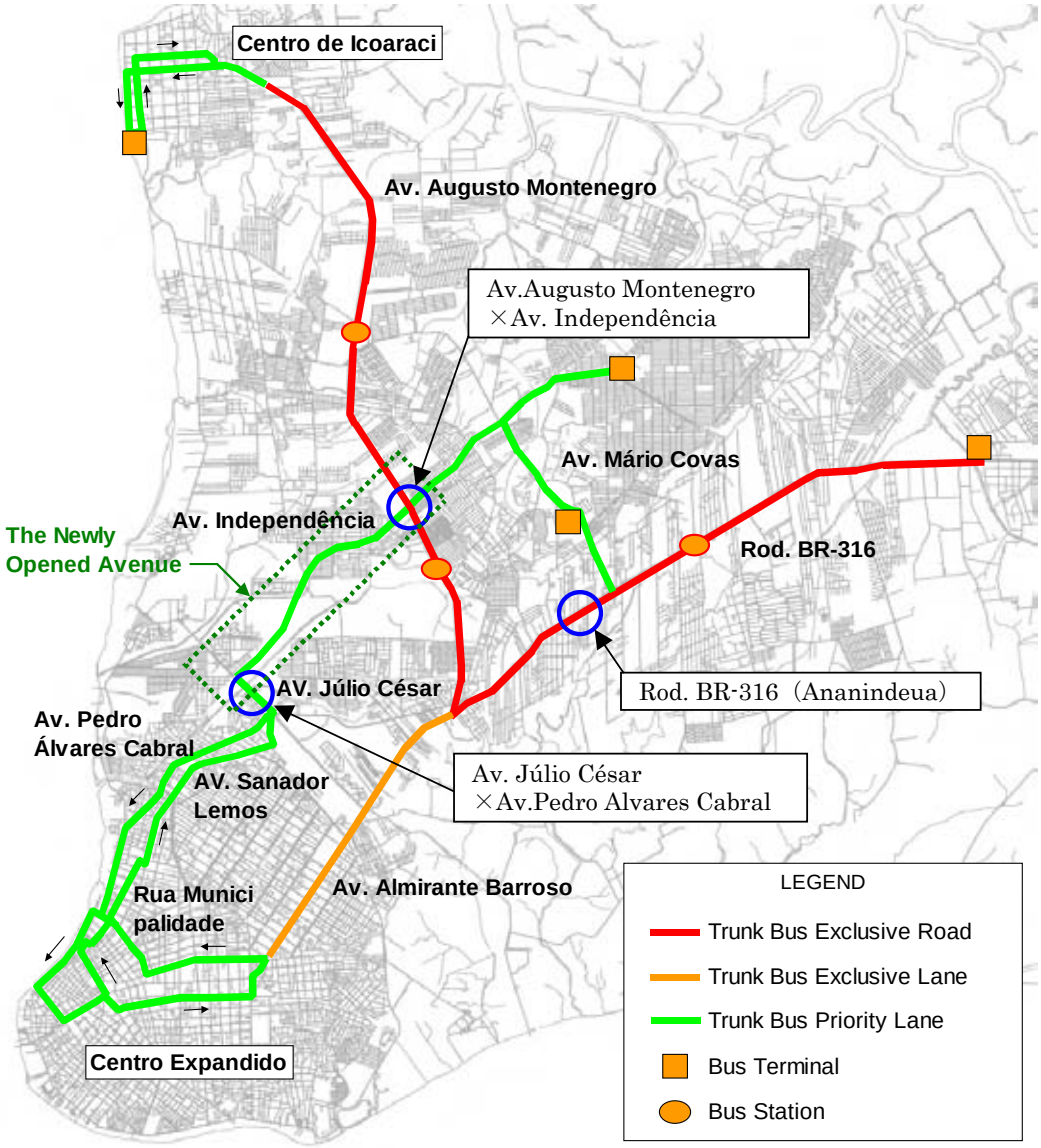


Figure 2.3-9 Location of the Spots for Traffic Surveys

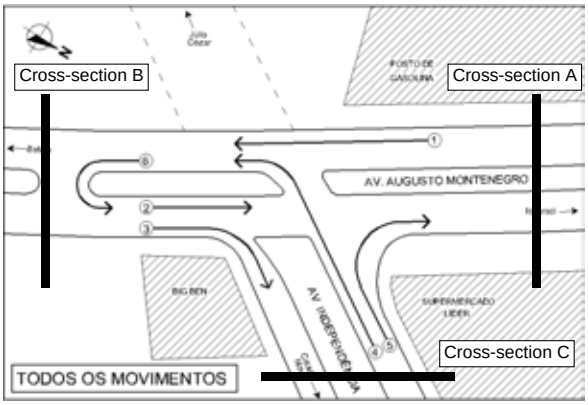
(1) Changes in Traffic Flows Found by Traffic Surveys

This section summarizes the salient features of the findings of the two traffic surveys conducted by the Counterpart. These surveys were conducted at three spots as indicated in Figure 2.3-9.

1) Crossing of Av. Augusto Montenegro and Av. Independencia

Figure 2.3-10 shows the traffic volume count surveyed at the crossing of Av. Augusto Montenegro and Av. Independência before and after the opening of Av. Dalcidio Jurandir. The cross-section D for observation is located on the newly opened avenue. Because the said avenue is a new extension of Av. Independência, the traffic flows changed at all the cross-sections set up for observation. The flows on Av. Dalcidio Jurandir at the cross-section D (on the side of Av. Júlio César) was 5,000 vehicles during the two peak hours after it was newly opened. The traffic flows increased by 10 to 20% at the cross-section A (on the side of Icoaraci) on Av. Augusto Montenegro, while those at the cross-section C (on the side of Cidade Nova) on Av. Independência grew by 40 to 50%. In contrast, the traffic flows dropped by 10 to 20% at the cross-section B (on the side of Av. Almirante Barosso) on Av. Augusto Montenegro. These changes indicate that the vehicular flows to the Centro from the directions of Icoaraci and Cidade Nova are now being diverted to Av. Dalcidio Jurandir from Av. Augusto Montenegro.

＜Before＞ Date: August 24th, 2010(Tuesday)



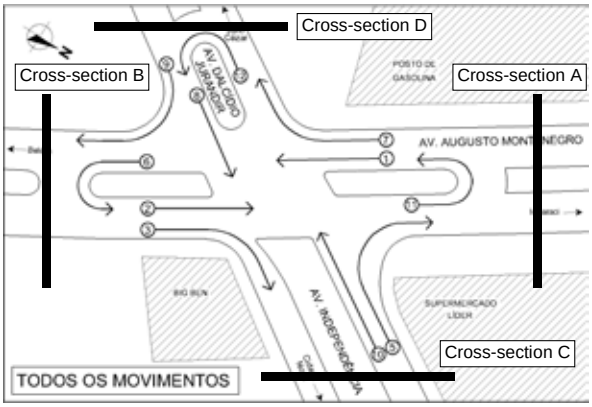
＜Morning: 6:00-8:00＞

Cross-section	Road	Direction of Observation	Traffic (vehicles /2h)
A	Av.August Montenegro	(①)+(②+⑤)	6,850
B	Av.August Montenegro	(①+④-⑥)+(②+③-⑥)	9,016
C	Av.Independência	(④+⑤)+③	2,832

＜Afternoon: 17:30-19:30＞

Cross-section	Road	Direction of Observation	Traffic (vehicles /2h)
A	Av.August Montenegro	(①)+(②+⑤)	7,644
B	Av.August Montenegro	(①+④-⑥)+(②+③-⑥)	9,459
C	Av.Independência	(④+⑤)+③	3,655

＜After＞ Date: November 11st, 2010 (Thursday)



＜Morning: 6:00-8:00＞

Cross-section	Road	Direction of Observation	Traffic (vehicles /2h)	Comparison with Before		
				Traffic (Before)	Difference (After-Before)	Ratio (After/Before)
A	Av.August Montenegro	(①+⑦-⑪)+(②+⑤-⑪)	7,398	6,850	548	1.08
B	Av.August Montenegro	(①+⑨-⑥)+(②+③-⑥)	7,061	9,016	-1,955	0.78
C	Av.Independência	(⑤+⑩)+(③+⑧)	4,203	2,832	1,371	1.48
D	Av.Dalcidio Jurandir	(⑦+⑩-⑫)+(⑧+⑨-⑫)	4,642	-	-	-

＜Afternoon: 17:30-19:30＞

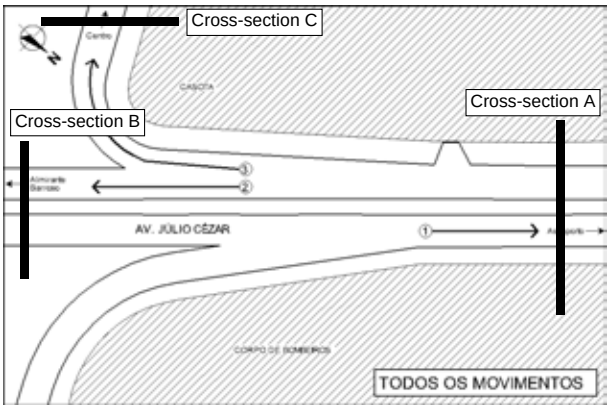
Cross-section	Road	Direction of Observation	Traffic (vehicles /2h)	Comparison with Before		
				Traffic (Before)	Difference (After-Before)	Ratio (After/Before)
A	Av.August Montenegro	(①+⑦-⑪)+(②+⑤-⑪)	9,031	7,644	1,387	1.18
B	Av.August Montenegro	(①+⑨-⑥)+(②+③-⑥)	7,904	9,459	-1,555	0.84
C	Av.Independência	(⑤+⑩)+(③+⑧)	5,275	3,655	1,620	1.44
D	Av.Dalcidio Jurandir	(⑦+⑩-⑫)+(⑧+⑨-⑫)	5,426	-	-	-

Figure 2.3-10 Results of Two Traffic Surveys (Crossing of Av. Augusto Montenegro and Av. Independência)

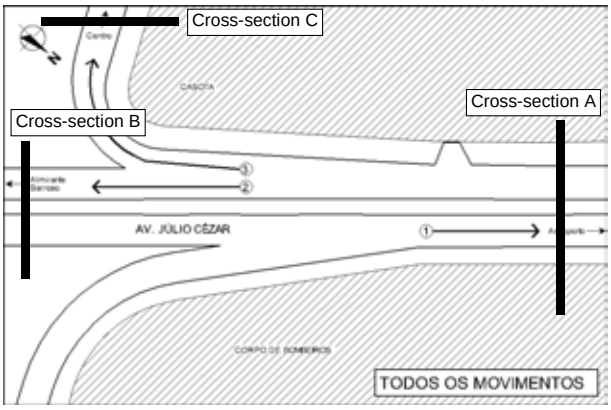
2) Crossing of Av. Júlio César and Av. Pedro Alvares Cabral

Figure 2.3-11 shows changes in the traffic flows at the crossing of Av. Júlio César and Av. Pedro Alvares Cabral. Because the crossing is located near the southwestern end of the newly opened avenue, the traffic flows increased by 50% to 100% at all three cross-sections of observation.

＜Before＞ Date: August 19th, 2010 (Thursday)



＜After＞ Date: November 11st, 2010 (Thursday)



＜Morning: 6:00-8:00＞

Cross-section	Road	Direction of Observation	Traffic (vehicles /2h)
A	Av.Júlio César	①+②+③	4,811
B	Av.Júlio César	②	2,122
C	Av.Júlio César	③	820

＜Afternoon: 17:30-19:30＞

Cross-section	Road	Direction of Observation	Traffic (vehicles /2h)
A	Av.Júlio César	①+②+③	6,426
B	Av.Júlio César	②	1,832
C	Av.Júlio César	③	1,021

＜Morning: 6:00-8:00＞

Cross-section	Road	Direction of Observation	Traffic (vehicles /2h)	Comparison with Before		
				Traffic (Before)	Difference (After-Before)	Ratio (After/Before)
A	Av.Júlio César	①+②+③	7,020	4,811	2,209	1.46
B	Av.Júlio César	②	3,145	2,122	1,023	1.48
C	Av.Júlio César	③	1,694	820	874	2.07

＜Afternoon: 17:30-19:30＞

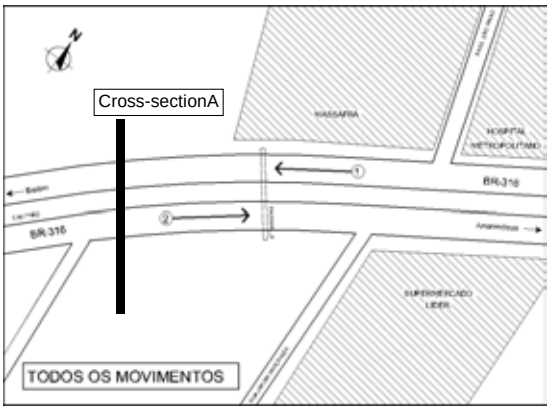
Cross-section	Road	Direction of Observation	Traffic (vehicles /2h)	Comparison with Before		
				Traffic (Before)	Difference (After-Before)	Ratio (After/Before)
A	Av.Júlio César	①+②+③	9,683	6,426	3,257	1.51
B	Av.Júlio César	②	2,950	1,832	1,118	1.61
C	Av.Júlio César	③	1,866	1,021	845	1.83

Figure 2.3-11 Results of Two Traffic Surveys (Crossing of Av. Júlio César and Av. Pedro Alvares Cabral)

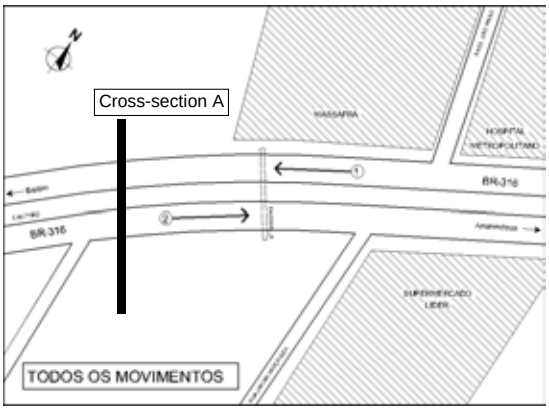
3) Rod. BR-316 (Ananindeua)

Figure 2.3-12 shows the traffic flows at Ananindeua on Rod. BR-316. There is no significant change in traffic flows at this cross-section. The opening of Av. Dalcidio Jurandir did not affect the traffic on Rod. BR-316.

＜Before＞ Date: August 19th, 2010 (Thursday)



＜After＞ Date: November 11st, 2010 (Thursday)



＜Morning: 6:00-8:00＞

Cross-section	Road	Direction of Observation	Traffic (vehicles /2h)
A	Rod.BR-316	①+②	11,909

＜Afternoon: 17:30-19:30＞

Cross-section	Road	Direction of Observation	Traffic (vehicles /2h)
A	Rod.BR-316	①+②	14,707

＜Morning: 6:00-8:00＞

Cross-section	Road	Direction of Observation	Traffic (vehicles /2h)	Comparison with Before		
				Traffic (Before)	Difference (After-Before)	Ratio (After/Before)
A	Rod.BR-316	①+②	11,919	11,909	10	1.00

＜Afternoon: 17:30-19:30＞

Cross-section	Road	Direction of Observation	Traffic (vehicles /2h)	Comparison with Before		
				Traffic (Before)	Difference (After-Before)	Ratio (After/Before)
A	Rod.BR-316	①+②	14,118	14,707	-589	0.96

Figure 2.3-12 Results of Two Traffic Surveys (Rod. BR-316 at Ananindeua)

(2) Changes in Traffic Flows by Traffic Assignment

The preceding section summarizes the salient changes in the traffic flows at three observation spots as surveyed by the Counterpart. The findings of the surveys indicate only localized changes influenced by the opening of Av. Dalcidio Jurandir. It is necessary to understand how the new extension of Av. Independência has influenced the traffic patterns in the entire network. The Study accordingly ran the assignment (peak hour) for the base year 2011 to the network that includes the new road extension. Figure 2.3-13 shows the changes in the traffic assignment at seven cross-sections.

The traffic assignment shows an increase of 2,800 vehicles per peak hour on Av. Dalcidio Jurandir. On Av. Independência that connects to the new avenue, the traffic increases by 700 vehicles per peak hour.

In contrast, the traffic that passes Av. Augusto Montenegro toward the Centro shows decreases. On Av. August Montenegro, the decrease is about 1,700 vehicles per hour. On Av. Almirante Barroso, the decrease is 500 vehicles per hour. Similarly, the traffic drops by 600 vehicles on Av. João Paulo II and by 800 vehicles on Av. Pedro Alvares Cabral.

It is clear that the vehicular traffic flows from the directions of Icoaraci and Cidade Nova are being diverted to Av. Dalcidio Jurandir from Av. Augusto Montenegro to reach the Centro.

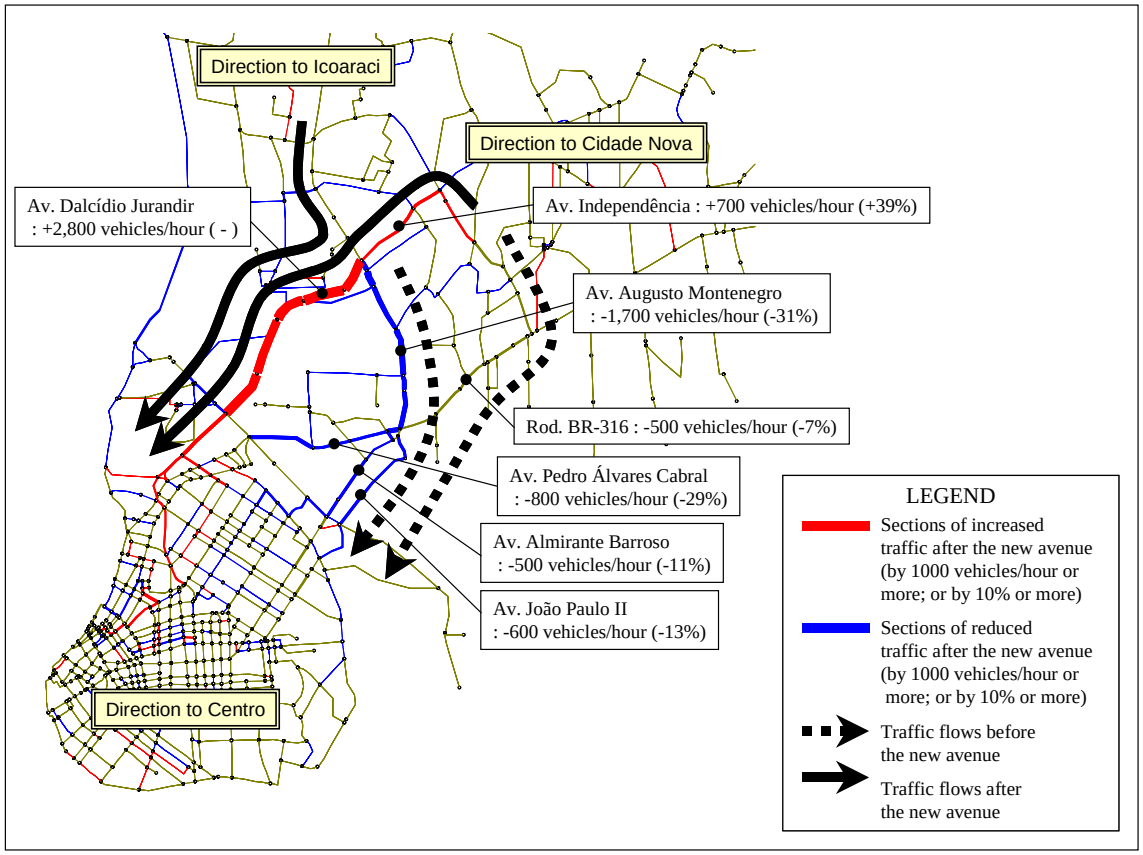


Figure 2.3-13 Changes in Traffic Flows by Assignment (2011)

CHAPTER 3
Reduction of GHGs Emissions

3. REDUCTION OF GHGS EMISSIONS

3.1. APPROVED METHODOLOGY (AM)

(1) Sectoral Scope of the Proposed Project

CDM projects are classified into 15 sectoral scopes according to the scale and the type of project activity. A CDM project must be formulated by applying a certain approved procedure and methodology specific to the sectoral scope of its activity. The first step is to identify the sectoral scope for the proposed project.

15 CDM sectoral scopes are listed in Table 3.1-1. The proposed project is Scope No. 7: Transport.

Table 3.1-1 Sectoral Scopes for CDM Projects

Scope No.	Sectoral Scopes
1	Energy industry (recyclable / non-recyclable energies)
2	Energy supply
3	Energy demand
4	Manufacturing
5	Chemical industry
6	Construction industry
7	Transport
8	Mining and mineral resource processing
9	Metal industry
10	Leakage of fuels (solid, petroleum, gas)
11	Leakage of halocarbon and sulfur hexafluoride during production and consumption
12	Use of solvents
13	Processing and disposal of wastes
14	Afforestation and reforestation
15	Agriculture

(2) Approved Methodologies Available for the Trunk Bus Project

A CDM project requires the application of a suitable approved methodology (AM) for its identification and formulation. When no approved methodology exists, it is required to develop and propose a new methodology for approval.

As of August 2011, there are three AMs for the CDM transport sector: namely, AM0031, “Baseline Methodology for Bus Rapid Transit Projects” AM0090, “Modal shift in transportation from road transportation to water or rail transportation” and ACM0016 “Baseline Methodology for Mass Rapid Transit Projects”. AM0090 deals with the modal shift from road to water or rail transport and therefore does not suit the proposed project. ACM0016 is a methodology for Mass Rapid Transit Projects. In order to secure applicability of ACM0016, the bus must be operated on the segregated bus lane exclusive of private vehicles. Therefore, ACM0016 is not applied to the project.

On the other hand, AM0031 was originally developed to get the CDM approval on BRT Bogota Colombia: TransMilenio Phases II to IV. It is judged appropriate to use AM0031 in the preparation of the proposed BRT project in Belem for CDM application.

(3) Conditions of AM0031 Applicability

For the preparation of a CDM project, it is necessary to ascertain the applicability of the chosen AM in more detail. On the basis of the foregoing analysis of the project situation in Belem, the details of applicability are summed up in Table 3.1-2. The conditions of Belem for a BRT project clearly satisfy the requirements of AM0031. The said AM has so far been successfully applied to obtain EB registration on two projects, namely, BRT Bogota Colombia: TransMilenio Phases II to IV and BRT Chongquing Lines 1-4, China.

Table 3.1-2 Applicability of AM0031 to Belem BRT Project

Condition for Application	Situation of Trunk Bus Project in Belem
The project has a clear plan to reduce existing public transport capacities either through scrapping, permit restrictions, economic instruments or other means and replace them by a BRT system.	The project replaces the present public transport system with a BRT system of trunk bus service.
Local regulations do not constrain the establishment or expansion of a BRT system.	The proposed project strictly conforms to the regulations on the national, state and municipal levels.
All types of fuels such as (liquified) gaseous fuels or biofuel blends, as well as electricity, can be used in the baseline or project case under the following conditions: Project buses must use a similar ratio of biofuel blend (similar percentage of biofuel) as the blend used by conventional buses in the country, i.e. the methodology can not be applied, if project buses use a higher or lower ratio of biofuel blends than those used by conventional buses. In addition, the project buses shall not use a remarkably higher ratio of biofuel blend than those of cars and taxis.	The proposed BRT system uses diesel and does not use bio fuels. When the possibility of hybrid buses is examined, the analysis utilizes emission factors publicly announced by bus manufacturers. The project is a trunk bus system and excludes from monitoring and analysis passenger cars, taxis, buses unrelated to the project and other vehicles. Those vehicles other than trunk buses are taken into account only when the baseline emissions are estimated.
The BRT system project is a road-based activity. The baseline public transport system and other public transport options must be the road- or rail-based system (air and water-based systems are excluded from the applicability). However the methodology is not applied if the project of BRT system replaces with an urban rail-based Mass Rapid Transit System (MRTS).	The baseline public transport system, the proposed BRT system and other possible public transport options all concern road transport only.
The BRT system partially or fully replaces a traditional public transport system in a given city. The methodology cannot be used for BRT systems in the areas where no public transport is currently available.	The trunk bus system will gradually replace the present public transport system. The present system is operating in the metropolitan area of Belem where the proposed project will directly influence.
The methodology is applicable if the analysis of possible baseline scenario alternatives concludes that the continuation of the current public transport system is the scenario that most reasonably represents the anthropogenic emissions by sources of greenhouse gases (GHG) that would occur in the absence of the proposed project activity.	The baseline scenario assumes that the present system will continue to operate in the future, as mentioned in 3.2.2 of Chapter 3.

(4) Time Limit on AM0031 Application

AM0031 has been effective since July 28, 2006 and as of August 2011, there is no stipulation to end its future application. It is justified to apply it to the trunk bus system proposed in Belem.

3.2. ANALYSIS OF GHGS EMISSION REDUCTION

The GHGs emission reduction is estimated by applying AM0031 to the baseline scenario and the proposed BRT project.

- The emission estimation concerns the I-net development of the BRT system.

3.2.1. SCENARIO FOR EMISSION REDUCTION

The project proposes the construction of trunk busways on the existing roadways and the introduction of articulated buses. This will establish the mass transit system with improved operation speed and ensure the substantial upgrading of public transport service in Belem. The GHGs emission reduction is expected mainly from three sources, namely, 1) downsizing of the present conventional bus fleet, 2) decrease of traffic congestion levels in the entire metropolitan area and 3) replacement of antiquated conventional buses by new articulated buses.

By applying AM0031 to the proposed scenario of trunk bus development, the GHGs emissions are estimated both for the project and the baseline situation (without the project), and the difference between the two estimates signifies the emission reduction realizable by the project implementation. Figure 3.2-1 shows the illustration of estimation of GHG's emission reduction.

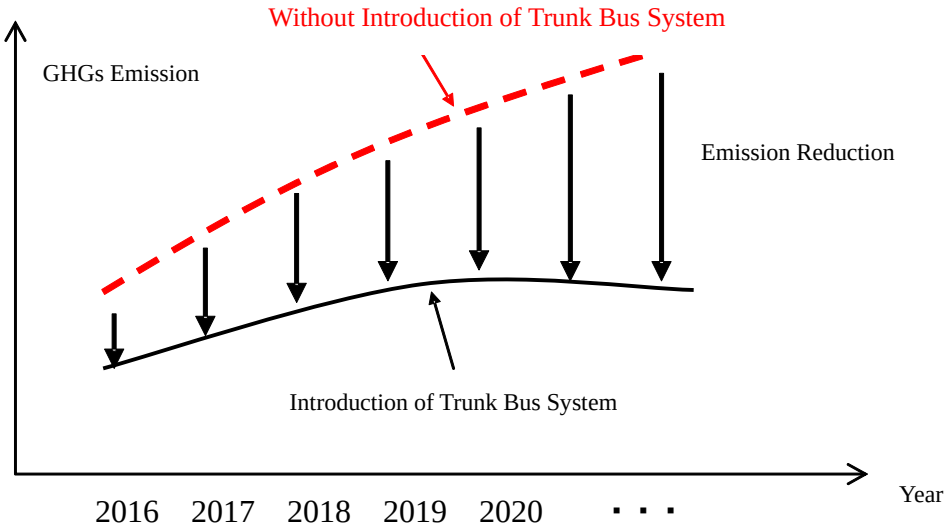


Figure 3.2-1 Estimation of GHGs Emission Reduction

3.2.2. GHGs Emission of the Baseline Scenario

The following flowchart (Figure 3.2-2) shows the steps for estimating the GHGs emissions of the baseline scenario.

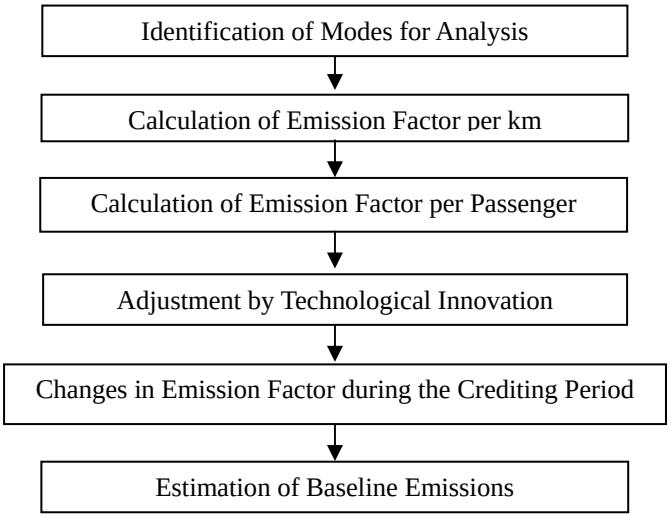


Figure 3.2-2 Steps for Estimating Baseline Emission

3.2.3. Crediting Period

It is necessary to establish the start and the duration of the crediting period during which the emission reduction is certified for a CDM project activity. The start of the CDM status is the starting date of implementation, construction or any action taken for the project in question. The crediting period for a given project starts when the estimated emission reduction is validated by a

DOE and lasts for the duration chosen by the project proponent. There are two options for choosing the duration of the crediting period, as shown below.

(1) Fixed Crediting Period

The start and the duration of the crediting period are unchangeable after a given CDM project activity is formally registered as such. The maximum period is 10 years.

(2) Renewable Crediting Period

The first crediting period is 7 years at maximum and renewable twice at maximum. The longest possible period is thus 21 years. At the time of renewal, it is necessary to have the validity of the original baseline scenario or the updated version derived from new data base verified by the DOE and then to notify EB accordingly.

The following points need be noted for the interest of the prospective project proponents.

- The crediting period should not exceed the period of project operation.
- The start of the CDM status does not need to coincide with that of the crediting period.
- It is necessary to decide the start and the duration of the crediting period before EB registration is finalized. The project proponents can decide the starting date after the registration, unless they choose the retroactive crediting option[1].

After close consideration of the available options mentioned above, the emission reduction by the trunk bus system is estimated by assuming the CDM starting date of Jan. 1, 2016 and the crediting period of 10 years.

3.3. ESTIMATION OF GHGS EMISSION

(1) Basic Parameters

Major basic parameters of estimation pertaining to AM0031 are summarized with their sources and comments in Table 3.3-1.

Table 3.3-1 Basic Parameters of Emission Estimation

Parameter	Source	Comment
$SEC_{x,i}$ x=gasoline, alcohol and diesel Energy consumption of the fuel type x by the vehicle category i	Arpel, 2005, *Measurement of In-Service Vehicle Emissions in Sao Paulo, Santiago and Buenos Aires*	Vintage 2005: See arguments in Chapter E.4, 2.1 about the reasons why this value is considered conservative. Original data was taken from this report, including gasoline fuelled vehicles in the three cities. The value taken is the mean of the respective averages of three cities. Emissions expressed in gr. CO2 were converted to liters gasoline based on EFCO2
$EF_{km,i}$ x=gasoline, alcohol and diesel Emission factor per km of the fuel type x	IPCC	Default value is used. See Baseline Methodology, Appendix A, Table A.1.
$N_{x,i}$ x=gasoline, alcohol and/or diesel No. of the vehicle type i that uses the fuel type x	SISTRÂNSITO, MARÇO/2009	GOVERNO DO ESTADO DO PARÁ DEPARTAMENTO DE TRÂNSITO DO ESTADO DO PARÁ DIRETORIA DE TECNOLOGIA DA INFORMAÇÃO REFERÊNCIA: MARÇO/2009 ASSUNTO : IDADE FROTA, TIPO, COMBUSTIVEL POR MUNICIPIO.
N_i i=passenger cars		

[1] It is possible to claim the retroactive CER dating back to the year 2000, which was before the first commitment period (2008 – 2012) stipulated in the Kyoto Protocol.

No. of passenger cars		
N_i i=buses No. of buses	SETRAN/BEL, Mai/2009	Diesel 100%
TD_i i=passenger cars Average travel distance of passenger cars	*The 2011 Preparatory Survey*	Average trip length ("without") is used. See Section 2 of "Demand Forecast"
OC_i i=passenger cars Average occupancy rate of passenger cars	*The 2011 Preparatory Survey*	Summary of Screen line and Cordon line used in the 2011 Preparatory Survey
$DD_{Z,S}$ Total operation distance of minibuses (vehicle km)	CTBel 2011	
$DD_{Z,L}$ Total operation distance of large buses (vehicle km)		
P_Z No. of bus passengers		Relative differences between weekdays, Saturdays and Sundays are taken into consideration.
$TD_{i,y}$ i=passenger cars Change in the year y of the average travel distance of passenger cars (km)	*The 2011 Preparatory Survey*	Average trip length ("without") is used. Annual changes are adjusted by single regression. See Section 2 "Demand Forecast"
$P_{i,y}$ i=buses Total volume of bus passengers (=no. of trunk bus users) in the year y without the project (person km)	*The 2011 Preparatory Survey*	Assigned person kilometers are used. Annual changes are adjusted by single regression. Daily figures are converted to the yearly figures by taking into account the relative differences between weekdays, Saturdays and Sundays. See Section 2 "Demand Forecast"
$IR_{i,t}$ i= passenger cars and buses Technological innovation factor after the elapse of t years	IPCC	Default value of 1% is used. See Baseline Methodology, Appendix A, Table A.2.
$SEC_{j,D,y}$ j=trunk buses Emission factor per km of trunk bus operation in the year y	*TransMilenio* 2006	Data of fuel consumption reported by all trunk route operators 1 through 5 are used. *The emission factor for the hybrid bus is 10%.
$DD_{TB,y}$ Total operation distance of trunk buses in the year y (vehicle km)	*The 2011 Preparatory Survey*	Assigned vehicle kilometers are used. Annual changes are adjusted by single regression. Daily figures are converted to yearly figures by taking into account the relative differences between weekdays, Saturdays and Sundays. The unit is million kilometer. See Section 2 "Demand Forecast" *Feeder buses are excluded from calculation.
$OC_{Z,y}$ Average passenger occupancy rate of trunk bus in the year y	*The 2011 Preparatory Survey*	The rate of 67% (i.e., the average of 120 passengers per 180-passenger capacity trunk bus) is used. No annual change is assumed. See Section 2 "Demand Forecast"
$CV_{Z,y}$ Average bus passengers in the year y	*The 2011 Preparatory Survey*	Taken from the Basic Project Plan. No annual change is assumed.
$BSCR_w$ Bus units scrapped by the project	CTBel 2011	Estimated from the registered number of buses.
$N_{Z,y}$ Total no. of buses in the year y	SETRANSBEL (May/2009)	Estimated from the registered number of buses.
D_y No. of days buses are operated in the year y		Total weekdays in the year in question
DW_y Days of operation in the		Total weekdays in the year in question The value is the same as D_y.

year y.		
V Travel speed	*The 2011 Preparatory Survey*	45km/h for the baseline scenario. 46km/h when the project is implemented.

(2) Points of Note in Reduction Estimation

The following three points must be noted for the calculation of emission reductions.

- The estimated emissions of the baseline scenario are converted to CO_2.
- The modes used for estimation consist of small and large bus in the baseline scenario and trunk bus in the project implementing scenario.
- Two modes used in the baseline scenario are those to which trunk bus passengers would divert when the proposed project is not implemented. The calculation assumes that the trunk bus passengers would not divert to passenger cars, i.e., all the trunk bus passenger diverts to the conventional bus. Following the example in the Monitoring Report covering 2006 through 2009 for the BRT project in Bogota (i.e., TransMilenio Phases II to IV), the sensitivity analysis examines the case in which 3% of trunk bus passengers divert to passenger cars.

(3) Steps for Estimating Emission Reduction

Key steps of estimation are as follows.

Step 1: Baseline Emission

$$BE_y = \sum_i \left(EF_{P,i,y} \times P_{i,y} \right)$$

Where,

BE_y Baseline emissions in the year y (gCO_{2eq})
$EF_{P,i,y}$ Transport emission factor per passenger in the vehicle category i in the year y (grams per passenger)
$P_{i,y}$ Passengers transported by the BRT project who would have used the vehicle category i in the year y in the "without project" case. The vehicle category i is Z (buses, public transport), T (taxis), C (passenger cars) or M (motorcycles)* (millions of passengers).

* NMT (non-motorized transport) and IT (induced transport) are not included in the vehicle categories because their emissions are zero.

Step 2: "With Project" Emission

Alternative B: Consumption of Specific Fuels and Transport Distance

$$PF_y = \left[\left(EF_{KM,TB,y} \times DD_{TB,y} \right) + \left(EF_{KM,FB,y} \times DD_{FB,y} \right) \right]$$

Where,

PE_y "With project" emissions in the year y (tCO_{2eq})
$EF_{KM,TB,y}$ Transport emission factor for trunk bus per unit of distance in the year y (tCO_{2eq} per km)
$DD_{TB,y}$ Total distance run by trunk bus in the year y (million km)
$EF_{KM,FB,y}$ Transport emission factor for feeder bus per unit of distance in the year y (tCO_{2eq} per km)
$DD_{FB,y}$ Total distance run by feeder bus in the year y (million km)

Step 3: Total leakage

$$LE_y = LE_{UP,y} + LE_{LF,Z,y} + LE_{LF,T,y} + LE_{CONG,y}$$

Where,

LE_y Emission leakage in the year y (tCO_{2eq})
$LE_{UP,y}$ Emission leakage in the upstream processes in the year y (tCO_{2eq})*
$LE_{LF,Z,y}$ Emission leakage caused by the change of load factor in bus transport in the year y

(tCO_{2eq})**

$LE_{LF,T,y}$ Emission leakage caused by the change of load factor in taxi transport in the year y (tCO_{2eq})***

$LE_{CONG,y}$ Emission leakage from the decrease of congestion in the year y (tCO_{2eq})
If LE_y is less than 0, this leakage is not included. If LE_y is more than 0, the leakage is included in the calculation.

* This term is not included in the calculation because the project does not use the evaporative fuel.
** and *** These terms are included in the calculation when the change is 10% or more.

Emission Reduction:

$$ER_y = BE_y - PE_y - LE_y$$

Where,

ER_y Emission reduction in the year y (tCO_{2eq})
BE_y Baseline emission in the year y (tCO_{2eq})
PE_y Project emission in the year y (tCO_{2eq})
LE_y Emission leakage in the year y(tCO_{2eq})

(4) Results of Estimation

The baseline emission during 10 years is estimated to add up to 598,931 tCO2eq (Table 3.3-2). The project emission for the same duration is estimated to be 99,888 tCO2eq (Table 3.3-3). Emission leakage will be 32 tCO2eq (Table 3.3-4). Thus, the CDM emission reduction during the crediting period totals 499,011 tCO2eq, or 49,901 tCO2eq per year (Table 3.3-5).

Table 3.3-2 Baseline Emission (zero switch to passenger cars)

Unit : tCO_{2eq}

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
$EF_{P,C,y}$	1,396	1,393	1,389	1,385	1,381	1,377	1,373	1,369	1,365	1,371
$EF_{P,Z,y}$	750	742	735	728	720	713	706	699	692	685
$P_{C,y}$	0	0	0	0	0	0	0	0	0	0
$P_{Z,y}$	81	83	85	87	89	90	92	93	96	99
BE_y	57,208	57,640	58,339	58,946	59,714	60,105	60,622	61,117	61,901	63,339

Table 3.3-3 Emission of Project Implementation

Unit : tCO_{2eq}

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
$EF_{KM,TB,y}$	1,640	1,640	1,640	1,640	1,640	1,640	1,640	1,640	1,640	1,640
$DD_{TB,y}$	6	6	6	6	6	6	6	6	6	6
$EF_{KM,FB,y}$	1,015	1,015	1,015	1,015	1,015	1,015	1,015	1,015	1,015	1,015
$DD_{FB,y}$	0	0	0	0	0	0	0	0	0	0
PE_y	9,513	9,585	9,705	9,812	9,949	10,026	10,128	10,228	10,380	10,563

Table 3.3-4 Emission Leakage of Project Implementation

Unit : tCO_{2eq}

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
$LE_{UP,y}$	0	0	0	0	0	0	0	0	0	0
$LE_{LF,Z,y}$	0	0	0	0	0	0	0	0	0	0
$LE_{LF,T,y}$	0	0	0	0	0	0	0	0	0	0
$LE_{CONG,y}$	3	4	3	4	2	3	3	3	3	4
LE_y	3	4	3	4	2	3	3	3	3	4

Table 3.3-5 Emission Reduction during Crediting Period

Unit : tCO_{2eq}

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	total
ER_y	47,692	48,051	48,632	49,130	49,763	50,076	50,491	50,885	51,518	52,772	499,011
BE_y	57,208	57,640	58,339	58,946	59,714	60,105	60,622	61,117	61,901	63,339	598,931
PE_y	9,513	9,585	9,705	9,812	9,949	10,026	10,128	10,228	10,380	10,563	99,888
LE_y	3	4	3	4	2	3	3	3	3	4	32

If the diversion to passenger cars is 3% instead of the assumed zero, the emission reduction would be 518,019 tCO_{2eq}, or 19,008 tCO_{2eq} (3.8%) more than the case of zero diversion. It is judged that the 3% diversion would have no significant influence.

Furthermore, the emission reduction is estimated regarding the future introduction of the hybrid bus. However, the transport emission factor for the hybrid bus is yet unavailable from IPCC. Therefore, the emission reduction is estimated by the ratio of green house gas reduction (90%) of the hybrid bus relative to the diesel engine bus, as announced by the bus manufacturer (Electra Inc.). Then, the reduction would be 588,139 tCO_{2eq} over the same period, or 89,129 tCO_{2eq} (17.9%) more than the diesel engine bus.

CHAPTER 4
MRV System Development for the Trunk Bus Project

4. MRV SYSTEM DEVELOPMENT FOR THE TRUNK BUS PROJECT

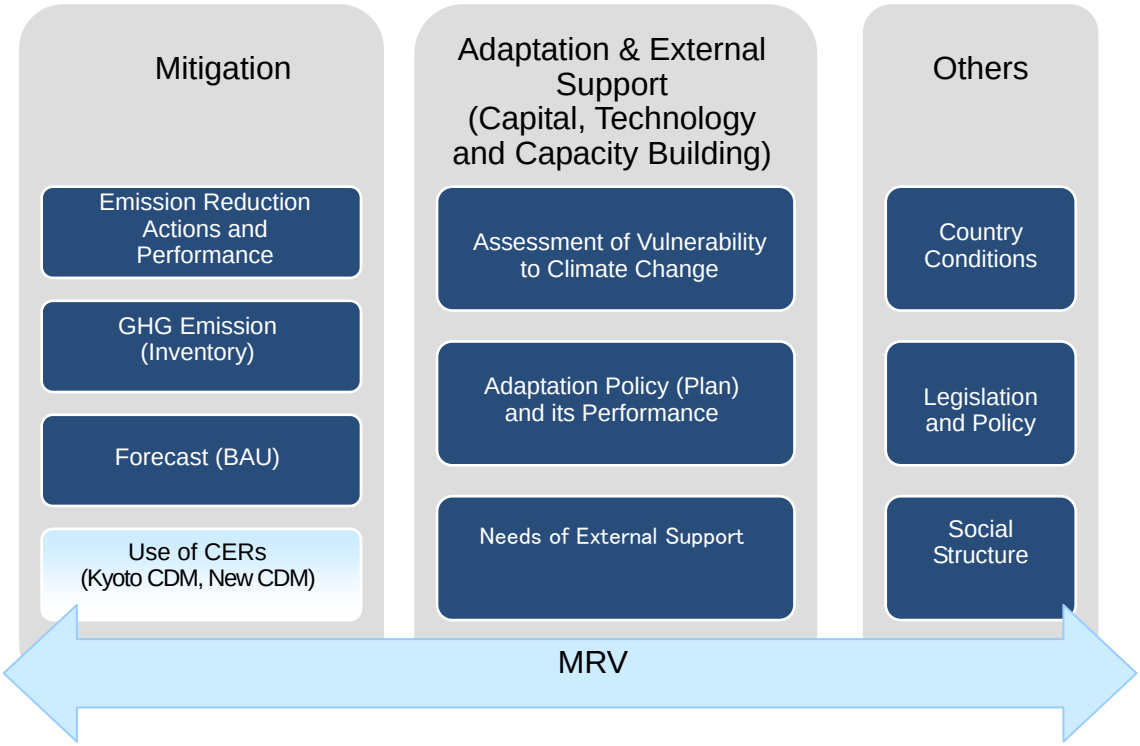
4.1. OUTLINE OF MRV SYSTEM

Regarding the GHG emission reduction targets and the "nationally appropriate mitigation actions (NAMA)" of the developing countries, one of the important steps is the establishment of the system and procedure of measuring, reporting and verification (MRV). The MRV process will ensure the effectiveness, the transparency and the equity of emission reduction/ mitigation efforts among the parties. Especially among the developing countries, the crucial issue is how to enhance the transparency of their mitigation actions.

The Copenhagen Accords of the 15th UNFCC Conference of Parties (COP15) contain the description specifying the biennial country reports by the developing countries on their mitigation actions including the emission inventory. It is supposed that the internationally acceptable MRV procedure be applied to those mitigation actions that are supported by external assistance. Independent actions without external support are subject to the nationally accepted MRV procedure and the resulting findings are presented for international consultation and analysis

MRV activities will become increasingly important because they are essential to grasp with accuracy emission reductions in each country and the impacts of external financial and technical supports on mitigation actions. Indeed, MRV activities are integral to wide-ranging interactions and negotiations related to the Framework of Global Climate Change as shown in Figure 4.1-1.

At the present moment, there are yet no internationally accepted rules about the establishment and the operation of the MRV system. However, the MRV procedure will be set in motion after 2013 when it is highly likely that the international MRV rules and standards will be agreed upon and take effect. All interested countries and parties are now individually taking preparatory steps towards the eventual MRV standardization.



Source: Institute of Global Environmental Strategy (IGES), *Measuring, Reporting and Verification: The Recent Trend and the Future Prospect of Discussions over the Next Framework of Global Climate Change*, Tokyo, December 2010.

Figure 4.1-1 Extensive Role of MRV in Clean Development Activities

4.2. PRESENT STANCE OF JICA REGARDING MRV PROCEDURE

Assuming, as judged from the on-going discussions over MRV rules, that the application of the MRV procedure to global warming mitigation projects become the international standard after 2013, JICA currently adopts the following steps regarding its lending to mitigation projects, with the proviso that the procedure would be appropriately revised along the progress of international MRV standardization.

1) The evaluation of a proposed mitigation project includes the quantitative assessment of its GHG emission reductions. CDM methodologies are consulted, among others, to perform such assessment.

2) In consultation and agreement with the host country or the host party, the quantified assessment results are set up as indicators with which to evaluate the subsequent project performance in emission reduction.

3) In consultation and agreement with the host country or the host party, the data of project assessment before lending decisions are officially announced. In the JICA procedure, the projects financed by Japan's ODA Loan are subjected to quantitative evaluation after two years since completion. This post-evaluation requires the statistical data prepared at the time of project appraisal.

The proposed trunk bus project in Belem has already passed the steps 1) and 2) above. Because of the scaling-down of the project, the assessment of emission reductions was updated on the basis of more precise data in the Study. The results of the updated assessment will be included in the agenda of loan negotiation between JICA and the State Government of Para (the updated data will be presented in the Project Memorandum at the signing of the Loan Agreement). Then follows the step 3) mentioned above. Namely, the assessment data will be made public pending the consent of the State Government of Para.

A Japan's ODA Loan project could be applied to the Clear Development Mechanism, when the project is judged highly likely to get the CDM approval, when the project host party has the clear intention of applying to the CDM procedure, and when the conditions for CDM application are satisfactorily met (e.g., strictly executed estimation of GHG emission reductions, favorable business environment for CER transactions, regular monitoring of emission reductions, validation and verification by DOEs, etc.). As for the proposed trunk bus project, the intention of the Brazilian side has been made clear at the time of loan negotiation between JICA and the State Government of Para, and recorded explicitly in the Memorandum of Understanding that were undersigned on March 10, 2011 by two parties.

The possibility of CDM application and registration for the trunk bus project and the monitoring system on CDM project are discussed respectively in Chapters 5 and 6.

CHAPTER 5
CDM Application and Registration

5. CDM APPLICATION AND REGISTRATION

5.1. POSSIBILITY OF CDM REGISTRATION

5.1.1. SIZE OF EMISSION REDUCTION

(1) Emission Reduction and Expected CER Acquisition

As mentioned in Chapter 3, the project activity emission of 99,888 tCO_{2eq} and the emission leakage of 32 tCO_{2eq} over 10 years means a reduction of 499,011 tCO_{2eq} in relation to the baseline emission of 598,931 tCO_{2eq}. In other words, the annual average emission reduction by the trunk bus project would be 49,901 tCO_{2eq}.

The sales of certified emission reductions (CERs) are estimated for three alternative cases of low, medium and high, following the practice of BRT Bogota Colombia: TransMilenio Phases II to IV. The expected sales of CERs would amount to US\$3/tCO_{2eq}, US\$10/tCO_{2eq} and US\$18/tCO_{2eq}, respectively, for the low, medium and high cases. According to the recent JBIC/Nikkei reporting on CER transactions[1], the sales price ranges between US\$15.0/ tCO_{2eq} and US\$20.2/ tCO_{2eq} in 2010.

The gross emission reduction by the proposed project is estimated to be 548,412 tCO_{2eq} over the crediting period of 10 years. The monitoring of BRT Bogota during 2006 – 2009 indicates the annual average credited ratio of 42.7% over four years. The Study uses the same ratio of 42.7% for CER acquisition.

The CER transactions require the payment of the following two commissions.

- Contribution to the overhead cost (SOP-Admin): US\$0.10/CER for the sale of up to 15,000 tons of CO_{2eq} and US\$0.20/CER for the sale of over 15,000 tons.
- Contribution supporting the adaptation in developing countries (SOP-Adaptation): 2% of the issued CERs

As shown in Table 5.1-1, the expected sales of CERs after deducting two commissions would amount to US\$0.6 – 4.2 million.

Unless the CER price plummets down considerably, the expected sales of CERs could cover the cost of monitoring and the verification fees paid to the DOE.

(2) Transfers (sales) of CERs

The issued CERs are distributed to the project participants according to their pre-agreed shares. Project participants in most CDM projects in Brazil are project executing or operating entities of the country and funds, banks and private companies of Annex I countries. The project executing parties acquire the entire CERs, or part thereof, and then transfer (or sell) them to the participating funds and banks. The transfers of this kind are now quite common. In recent years, unilateral CDM projects in which only the national parties participate have been increasing steadily in Brazil. The CER business is widely accepted in Brazil and CDM consultants and specialists act as brokers. The business environment for CER transactions is adequately developed in Brazil.

[1] Japan Bank of International Cooperation (JBIC) and Nihonkeizai Shimbun Digital Media

Table 5.1-1 Expected Sales of CERs (after deducting commission payments)

Year	Emission reduction	US$3/tCO$_{2eq}$ (US$)	US$10/tCO$_{2eq}$ (US$)	US$18/tCO$_{2eq}$ (US$)
2016	52,413	157,239	524,131	943,436
2017	52,860	158,581	528,604	951,488
2018	53,430	160,286	534,297	961,735
2019	53,982	161,945	539,815	971,667
2020	54,657	163,971	546,569	983,825
2021	55,017	165,051	550,171	990,307
2022	55,507	166,522	555,075	999,134
2023	55,979	167,937	559,791	1,007,624
204	56,587	169,761	565,869	1,018,564
2025	57,980	173,941	579,802	1,043,643
total	548,412	1,645,237	5,484,124	9,871,423
Crediting years	10			
Annual Reduction	54,841			
Credited Ratio in Bogota BRT	42.7%			
Expected CERs	234,002			
SOP-Admin		45,300		
SOP-Adaptation		10,968		
Expected Return		702,007	2,340,024	4,212,044
After Deducting Commission Payments		645,739	2,283,756	4,155,775
Estimated Sales		600,000	2,300,000	4,200,000
Sales in yen (¥)		48,690,000	186,645,000	340,830,000

5.1.2. ADDITIONALITY

To get the CDM approval, it is necessary to demonstrate in the Project Design Document (PDD) that a proposed project activity is additional to the situation where the said activity should be absent. The additionality is defined (cf. CDM Modalities and Procedures, Paragraph 43) as the reduction of anthropogenic emissions of greenhouse gases below those that would have occurred in the absence of the registered CDM project activity (i.e., baseline emissions). To prove the additionality, the project proponent must comply with the specifications of a CDM-approved baseline methodology. Many CDM-approved methodologies, including AM0031 selected for the trunk bus project, stipulate that the additionality be demonstrated by following the procedure specified in the "Tool for the Demonstration and Assessment of Additionality."

Regarding the proposed trunk bus project, the 2010 JICA Preparatory Survey prepared a draft PDD, in which the additionality of the project was examined in accordance with the specifications of the said Tool. For the initial step of demonstration, the draft PDD identified and examined four alternative scenarios; namely, A-1: a continuation of the current public transport system; A-2: the project proposal not implemented as a CDM project activity; A-3: rail- or water-based system and A-4: comprehensive re-organization of the existing transport system.

The demonstration of additionality requires that all alternatives be examined by following the procedure from Step 1 through Step 4 as explained below.

Step 1 is the identification of alternatives. Of the four alternatives mentioned above, A-3 was judged infeasible because of its technical and financial obstacles to the introduction of such a system in the metropolitan area of Belem. A-4 was also judged infeasible considering the difficulties of fostering a general consensus among the existing bus companies.

Accordingly, the investment analysis of Step 2 was made on the other two alternatives, i.e. A-1 and A-2. As was the case with BRT Bogotá Colombia: TransMilenio Phase II to IV, the proposed trunk bus project is to be constructed by the public investment of the State of Para and operated by the

private sector. Because the State of Para expects no direct returns from the investment of the proposed project, the investment analysis was not realized on A-2.

In the barrier analysis of Step 3, A-2 was judged infeasible after examining the inadequate availability of own capital necessary for land acquisition excluded from the application of Japan's ODA Loan and trunk bus operation and the resistance from the existing bus companies.

The common practice analysis of Step 4 showed that A-1, or the continuation of the current transport system, would have no additionality. In contrast to A-1, in the overall assessment, it was demonstrated that the proposed project has no similar activity (no common practice). Consequently, it was concluded that A-1 would serve as the baseline and that the proposed project would have the additionality.

The present Study focuses on the I-net trunk bus project which is a scale-down from the initial Y-net project proposed in the 2010 JICA Preparatory Survey. The I-net development excludes the trunk busway on Av. Augusto Montenegro and the trunk bus priority lanes in the Icoaraci area, but the trunk bus system itself remains unchanged. Because the scale-down concerns only the road network, it is arguable that the additionality of the proposed trunk bus system as demonstrated by the above-mentioned procedure should remain valid.

5.1.3. AM0031 AND ITS APPLICATION

For the CDM project preparation, it is necessary to ascertain the availability of approved methodologies (AM). The proposed trunk bus project in Belem satisfies the necessary conditions for applying AM0031 which was developed and approved for BRT projects. The details of applicable conditions are summed up in Table 3.1.2 in Chapter 3.

When no AM is available, the project proponent must develop a new methodology and get the formal approval of the CDM Executive Board. The process calls for time-consuming and intensive efforts. The profile of the trunk bus project satisfies the conditions of AM003 application, as mentioned above, and therefore the CDM application can go ahead without the protracted process of methodology development and approval.

5.1.4. CDM AND ODA

The Marrakech Accords of 2001 stipulated that CDM project activities should not be financed by ODA budgets. The project executing party needs to demonstrate in the national process of CDM application that the proposed CDM project activity would not be in contravention of the Accords, by attaching the official memorandum from the Brazilian side (project executing party) testifying to that effect.

It is difficult to prove the additionality when the project executing party has not the clear intention of applying to the CDM procedure for the project financed by ODA budgets before the project is executed. As for the proposed trunk bus project, the intention of the Brazilian side has been made clear at the time of loan negotiation between JICA and the State Government of Para, and recorded explicitly in the Memorandum of Understanding. JICA has confirmed the intention of the Brazilian side before execution of the project.

5.1.5. POSSIBILITY OF CDM APPROVAL ON THE PROPOSED PROJECT

The possibility for the trunk bus project to get CDM registration is favorable. Firstly, as mentioned earlier, the project is estimated to realize the annual emission reduction of 49,901 tCO_{2eq}. Secondly, the project has the demonstrable additionality and the justifiable compliance with the ODA-related injunction. Thirdly, Japan has already financed a few CDM projects from its ODA budget. Lastly, the project preparation can use the suitably available AM.

5.2. ROADMAP FOR CDM APPLICATION AND REGISTRATION

Chapter 6 describes the monitoring system on CDM project, which is required over the period from CDM project preparation to project monitoring after CDM registration. The description covers the details regarding PDD documentation, submission of project documents to the relevant national authority, approval and registration by the CDM Executive Board, establishment of the MRV system and actual monitoring activities and reporting thereof.

The process of CDM application and registration concurs with the regular process of project preparation, execution and operation, starting from PQ posting, bidding and selection of consultants, preparation of detailed design (D/D), selection of contractors, construction and test operation, ending in regular trunk bus operation. A public consortium will be established to handle the MRV process for CDM application and registration regarding the proposed project in Belem. The Study Team prepared a road map to facilitate the activities required of the public consortium, covering the examination of D/D details to ascertain the possibility of CDM application, the preparation and submission of necessary documents to get the CDM approval and registration and the monitoring over the project operation.

The road map for the MRV process was drawn up in consultation with the counterpart agency of the Study by taking into account the schedule of project preparation and implementation, on the one hand, and the normal practices in Brazil of CDM application and registration, on the other. The prepared road map is shown in Table 5.2-1.

- Formation of the CDM project management system: The first preparatory step is to establish a central institutional locus for developing the CDM-related procedure of monitoring. A new department or section need be created inside the public consortium to handle the necessary institutional development and initiate the MRV procedure.

- Facilitation of the CDM application procedure: The CDM procedure requires the participation of various parties other than the project operating entity. The consultants hired to prepare the project D/D need be asked to prepare the draft PDD in the CDM-required format. The draft PDD must be submitted to an independent third party, or a designated operational entity (DOE) in CDM parlance, and approved by the validation report from the DOE. The validation report must be attached to the CDM application documents. DOEs must be formally registered as corporate entities in Brazil and designated as such by the CDM Executive Board. The available DOEs need be short-listed for evaluation and selection concurrently with the preparation of the project D/D and the draft PDD.

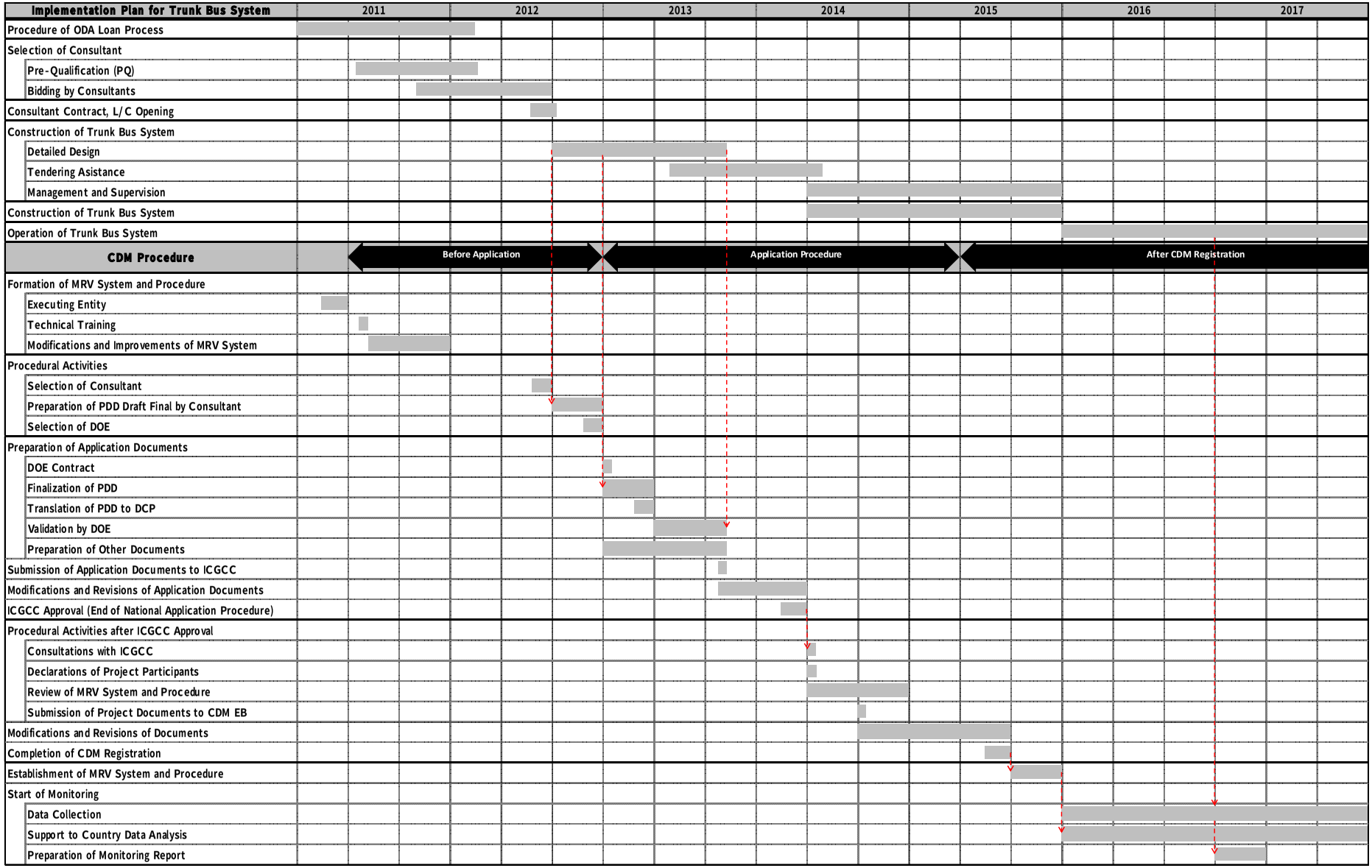
- Preparation and submission of application documents: After the formal DOE approval by the validation report, the PDD documents must be finalized and translated into Portuguese as DCP documents. The DCP, or the PDD written in Portuguese, is requisite in CDM application because only the documents written in Portuguese are legally binding in Brazil. The DCP documents are then submitted to ICGCC (Interministerial Commission on Global Climate Change) for examination and approval. This is the first step of CDM application. ICGCC examines the application and notifies its approval or disapproval within 60 days after the submission. ICGCC sometimes asks for modification or revision and the application documents must be modified or revised accordingly within a certain period of time. Appropriate time allowance is thus necessary for such an eventuality later on. The ICGCC approval is the final domestic step of the CDM procedure.

- Modification and revision: If the ICGCC approval is conditional, the Executive Secretary of ICGCC (Ministry of Science and Technology) sends a letter specifying what needs to be modified or revised. In such a case, the project documents must be properly modified or revised to obtain the ICGCC approval.

- Submission of application documents to the CDM Executive Board: After the submission of project documents to ICGCC, it is advisable to reexamine the instituted monitoring procedure, and if found necessary, to modify, revise or adapt accordingly. After the ICGCC approval, the project documents will be submitted to the CDM Executive Board for examination and registration.

- Completion of CDM registration: After the approval by ICGCC, the project application is forwarded to the CDM Executive Board for examination, and when found satisfactory, the project is formally registered as a CDM project activity.
- Establishment of monitoring system: The project monitoring starts after CDM registration. At this stage, therefore, it is necessary to establish the system of monitoring for project operation.
- Start of project monitoring: The MRV system handles the collection and analysis of data relevant for project monitoring and the reporting thereof.

Table 5.2-1 Roadmap for CDM Application and Registration



5.3. ISSUES IN CDM APPLICATION AND REGISTRATION

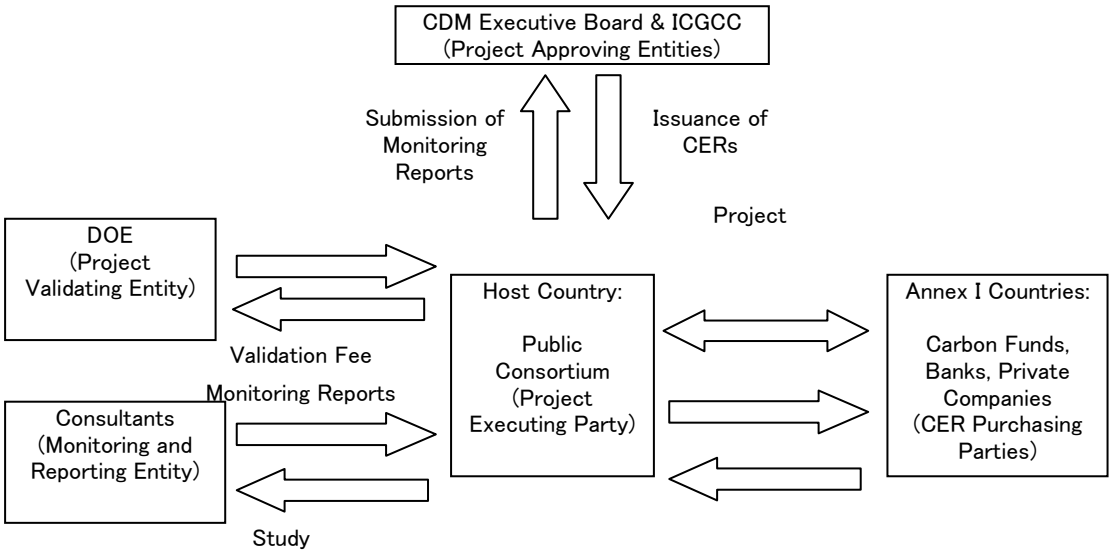
5.3.1. DECLARATIONS OF CDM PROJECT PARTICIPANTS AND CER TRANSACTIONS

The required documentation for CDM application includes the declarations of project participants and the transactional scheme of acquired CERs.

Generally, entities of the host country and of Annex I countries participate in CDM projects. Regarding the BRT project in Belem, a public consortium is likely to be formed in Brazil as the project executing party of the host country. From the Annex I countries, certain funds, banks and/or private companies are expected to participate as buyers of CERs.

The declared participants in a CDM project have to establish the ratios of sharing CERs. The purchasers of CERs must exchange emission reduction purchase agreements (ERPAs), with the public consortium. The transfers (or sales) of CERs must be transacted in accordance with ERPA stipulations. The terms of purchase agreements must be carefully thought out and worded in order to avoid unnecessary risks to the participants.

Probable participants in the Belem BRT project and the image of CER transactions among them are shown in Figure 5.3-1.



Note: ERPA (Emission Reduction Purchase Agreement)

Figure 5.3-1 Project Participants and the Flow of CER Transactions in the Proposed Project

It is possible to register the Belem BRT as a unilateral CDM project in which only the host country party participates. In this case, the host country party sells the acquired CDRs to some entities in Annex I countries through the brokering by CDM consultants.

5.3.2. PROLONGED PROCESS FROM CDM REGISTRATION TO CER ACQUISITION

According to a recent IGES publication,[2] CDM projects which acquired CERs were 748 as of August 1, 2010. They accounted for 32.4% of the total registered CDM projects. The average elapse of time between CDM registration and CER acquisition based on monitoring procedure were 472 days regarding these projects. It seems to take increasingly longer time for the registered CDM projects to receive the issuance of CERs. The average elapse of time for those projects which

[2] Institute of Global Environmental Strategy (IGES), *Measuring, Reporting and Verification: The Recent Trend and the Future Prospect of Discussions over the Next Framework of Global Climate Change*, Tokyo, December 2010.

acquired CERs in 2010 was more than 700 days. This suggests that the MRV procedural activities have grown to take more and more time due to the increasingly rigorous enforcement of CDM stipulations. It had been initially expected that monitoring process would become more efficient and less time-consuming by learning and experience.

Apparently, monitoring and reporting activities of the quality level readily verifiable by DOEs impose an increasingly heavy burden on the project executing parties. Furthermore, the increase, and the growing complexity, of CDM project designs put a severe pressure on the verification process of DOEs. These factors combine to lengthen the period of time needed for CER acquisition, with concomitant rise in the costs of monitoring and verification.

Regarding the transport sector, only two CDM projects have so far acquired CERs: namely, BRT Bogota: TransMilenio Phases II to IV (Columbia) and the Installation of Low Green House Gases Emitting Rolling Stock Cars in the Metro System (India). These projects required on average 267 days (about 9 months) to complete the verification process by the respective DOEs. The duration is about 50% longer than the CDM projects of other sectors. This is partly because CDM projects in the transport sector are yet very few. It might be said that the experience and expertise in monitoring and verification activities are yet inadequately developed.

Brazil has no registered CDM project in the transport sector. Accordingly, it is better to allow adequate time span in scheduling for the procedural activities of measuring, reporting and verification.

Table 5.3-1 Details of CER Acquisitions by CDM Projects

Project Category	Projects with CER Acquisitions/ Registered Projects	Projects with CER Acquisitions	Average Pages of Monitoring Reports	Average Pages of Verification Reports	Average Days Spent for Reporting	Average Days Spent for DOE Verification	Average Days of Examination at UNFCCC Secretariat and CDM Executive Board
Transport	66.7%	2	18	44	33	267	33
Fuel Change	52.7%	29	19	30	80	139	82
Biomass	43.2%	118	14	27	65	182	61
Wind Power	40.9%	159	10	29	43	137	76

Source: Institute of Global Environmental Strategy (IGES), *Annual Report*, 2010.

5.3.3. COSTS OF MONITORING AND REPORTING

Supposing that the proposed trunk bus project in Belem successfully seeks CDM registration, it would be necessary, as mentioned earlier, to establish the system and procedure of monitoring. The project executing party, the public consortium, would have to bear the responsibility of monitoring and reporting. It would be a heavy burden for the consortium to prepare the monitoring reports to the quality level required by the DOE verification. For example, the interview survey has to be conducted six times a year, incurring considerable expenditure on the part of the consortium.

The Study expects that the estimated CER sales in the range of US$0.6 and 3.8 million would meet the costs of monitoring, reporting and verification. However, the growing period of time between CDM registration and CER acquisition suggests that the public consortium must secure an adequate amount of budget for monitoring during the waiting period.

5.4. IMPORTANCE OF CDM REGISTRATION FOR THE PROPOSED PROJECT

The Government of Para State was the first in Brazil to launch community greening projects (Municípios Verdes) and has been actively supporting various environmental conservation efforts. The community greening projects aim to instill the awareness of social environmental responsibility in communities and encourage sustainable productive activities to reduce the CO_2 emission. In the forested areas along Amazon River, economic activities which do not require extensive clearing of vegetation cover are being promoted, by utilizing non-timber forest projects or introducing various

forms of agro-forestry and forest plantations. In already deforested areas, strict steps are being taken to ease the adverse environmental impacts of on-going and planned economic activities. Communities are being persuaded to observe laws and decrees that have been enacted to strengthen socio-environmental conservation efforts.

The proposed trunk bus project in Belem is consistent with the environmental policy stance of the State Government of Para. The implementation of the project according to the CDM protocol will effectively appeal the conservation efforts in the State of Para. The project not only brings monetary benefits in the form of CER acquisition but makes an effective public relations statement about the public administration.

CHAPTER 6
Monitoring System on CDM Project

6. MONITORING SYSTEM ON CDM PROJECT

6.1. OUTLINE OF MONITORING SYSTEM AND PROCEDURE

6.1.1. MONITORING SYSTEM ON CDM REGISTRATION OF PROPOSED PROJECT

The 2010 Preparatory Survey estimated the GHG emission reduction realizable by the implementation of the trunk bus project. The said Study examined furthermore the possibility of registration in the Clean Development Mechanism (CDM) and acquisition of the Certified Emission Reduction (CER). The Clean Development Mechanism was proposed in the Kyoto Protocol of 1997 and subsequently launched.

The CDM definition of emission reduction is stated in Clause 5 (c), Article 12 of the Kyoto Protocol as "reductions in emissions that are additional to any that would occur in the absence of the certified project activity." The estimation of emission reduction made by the project host party must be subjected to the rigorous verification and certification by the DOE. For CDM application, the project proponent prepares the project design document (PDD) in which "emissions in the absence of the certified project activity", or the baseline emissions, and "the reduced emissions by the certified project activity" are estimated by applying one of the methodologies approved by the CDM Executive Board. In addition, PDD must include the description of the monitoring plan which actually measures the emissions after the project construction is completed. The monitoring after the project implementation collects and records the pertinent data, from which both the actual GHG emissions with the project activity and the baseline emissions must be measured, calculated and/or estimated.[1]

The Counterpart Team of the Study intends to seek CDM registration of the proposed trunk bus project. Accordingly, the project host party must establish the system and procedure of monitoring and actually undertake monitoring activities.

6.1.2. PROJECT HOST PARTY RESPONSIBLE FOR MONITORING SYSTEM AND PROCEDURE

(1) Public Consortium

The project host party establishes the baseline scenario, calculates the GHG emissions and uses the figures to estimate the reduction expected by the project activity. The baseline scenario and the calculation of emissions require high level expertise. The CDM application might be easily rejected because of a certain improper practice found in the emission estimation. The process of CDM application has been growing more and more rigorous in its stipulated requirements. Therefore, it is essential to undertake institutional development appropriate to handle the CDM procedure.

According to the on-going project preparation, it is understood that the proposed trunk bus project in Belem will be constructed by the State Government of Para and that the maintenance and operation of the trunk bus system will be done by a newly formed public consortium. At present, NGTM (Metropolitan Transport Management Division) of the State Secretariat of Strategic Projects (SEPE) is chiefly handling the institutional issues and basic policies regarding the construction and operation of the proposed trunk bus system. No definitive decision has been reached so far about the institutional development for CDM application and registration, including the monitoring system development. Through the discussions with the Counterpart Team, the Study Team understands that the public consortium would shoulder the responsibility of CDM application and the accompanying monitoring activities. The Counterpart Team will soon begin to examine the possible organizational set up appropriate for the consortium to establish and manage monitoring activities.

[1] Source: Institute of Global Environmental Strategy (IGES), *Measuring, Reporting and Verification: The Recent Trend and the Future Prospect of Discussions over the Next Framework of Global Climate Change*, Tokyo, December 2010.

(2) Role of the Public Consortium in CDM Application

The expected role of the project host party in the process of CDM application and registration need be explained in some detail. The trunk bus project is now about to enter the stage of detailed design (D/D). The State Government needs to initiate the formation of the public consortium simultaneously with the progress of D/D. The consortium, in other words, must take part in the preparatory stage of CDM application for the trunk bus project. As will be described in later sections, the consortium has to follow through the process of PDD preparation, CDM application and registration, establishment of the monitoring system and monitoring according to the monitoring procedure. The monitoring system needs to produce substantive results after the CDM registration, namely, writing and submitting monitoring reports and presenting CDM-related data to ICGCC. These results actually require adequate lead time to produce. Accordingly, the description below will include a number of preliminary actions for the consortium to take during the period from the PDD preparation to the approval by CDM Executive Board. Regarding this preparatory stage, Section 6.2 below paraphrases the presentation made in the Report of the 2010 Preparatory Survey. Section 6.3 discusses details of the monitoring system and procedure. The description of required actions before, during and after the CDM application process is structured as follows.

1) Before CDM Application

- Formation of the CDM project management system
- Various adjustments associated with PDD preparations

2) During Application Procedure

- Submission of the application documents with the forward letter to ICGCC
- Various adjustments before submitting the nationally approved project documents to the CDM Executive Board

3) After CDM Approval and Registration

- Writing and submission of monitoring reports
- Submission of CDM-related data to ICGCC

6.2. PREPARATION FOR CDM APPLICATION AND APPROVAL

The following describes the national procedure of CDM application.

6.2.1. PROCEDURE OF CDM APPLICATION IN BRAZIL

The national procedure of CDM application is well established in Brazil. The ICGCC (Interministerial Commission on Global Climate Change) is acting as the designated national authority (DNA) as required by the Clean Development Mechanism. ICGCC meets every two months, or six times a year, to examine applied project documents. Figure 6.2-1 shows the national procedure of CDM application and approval.

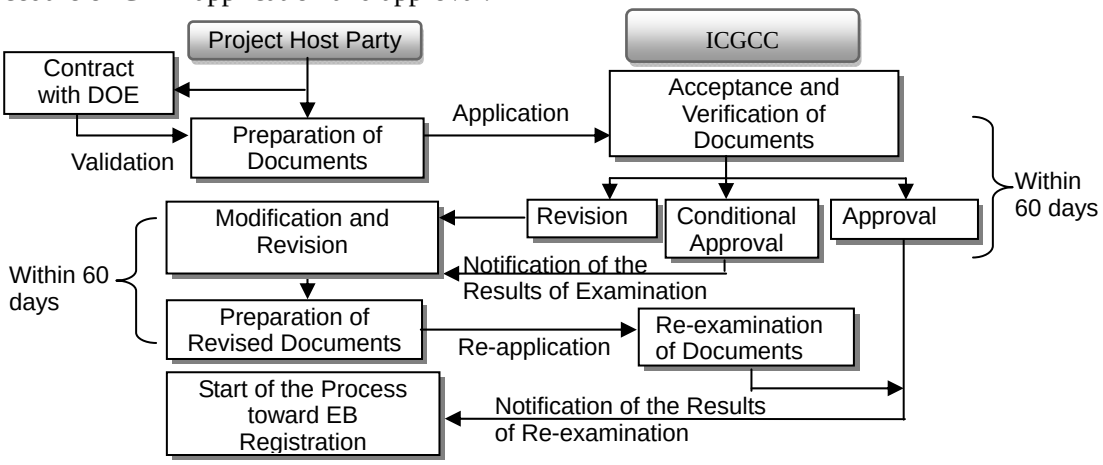


Figure 6.2-1 National Procedure of CDM Application and Approval

(1) Necessary Application Documents

The first step is to submit necessary application documents to the Executive Secretary of the Interministerial Commission on Global Climate Change. ICGCC examines the applications and notifies the applicants of its decisions within 60 days. All applications are open to the public including project design documents. The application to ICGCC consists of the following documents.

Forward Letter

(1) The project design document (PDD) written in English as stipulated in the EB regulations
(2) The DCP written in Portuguese as stipulated in the ICGCC regulations
(3) The document as stipulated in Annex III of Resolution No. 1
(4) Stakeholders' comments
(5) The validation report by the designated operational entity (in English and Portuguese)
(6) The declaration of participation
(7) Situation of the designated operational entity (DOE)

1) PDD

The process begins with the preparation of the CDM project design document (CDM-PDD), which describes the intended project activity and the manner in which the baseline methodology is selected and applied to formulate the project. The PDD is to be submitted to the CDM Executive Board (EB) to undergo the procedure of validation, periodic verification and certification. The PDD must be prepared according to the latest form prescribed by CDM EB. The latest form in force is the third version released on July 28, 2006.[2]

The detailed guideline, "the Guideline for Preparing CDM-PDDs and CDM-NMs," is published together with the PDD form. The prospective host party needs to refer to the latest guideline when they draft CDM-PDDs. More details about PDD are given in 5.2.3.

2) DCP

A DCP is a PDD written in Portuguese. Only the documents written in Portuguese are legally binding in Brazil and subject to the ICGCC examination and approval. Therefore, the content of the DCP must conform to the description of PDD. If the two documents do not correspond exactly, ICGCC is authorized to request a review during the process of EB examination (Resolution No. 3, Clause 9).

The DCP must be prepared in the latest form as required by ICGCC. The application form was first stipulated in Annex II of Resolution No. 1 of Dec. 2, 2003. The latest form in force is the third version as revised in July 28, 2006 (Resolution No. 6, Annex I).

3) Annex III

Resolution No. 1 of 2003 states in its Annex III the contribution to be made by CDM projects to sustainable development. The annex describes the following five points of interest regarding the contribution of CDM projects.

(1) Contribution to the environmental sustainability of local communities
(2) Contribution to the improvement of labor relations and the creation of job opportunities
(3) Contribution to the fairer income distribution
(4) Contribution to the development of technologies and human skills
(5) Contribution to the integrated regional development through project implementation

[2] A revision of the PDD form becomes effective when it is formally adopted by the Executive Board (EB). The following allowances must be noted regarding the EB's revision. A new version of the form does not apply to (a) those CDM PDDs which pass the DOE validation or are already submitted to an DOE for validation before the date when the new version is issued and (b) those PDDs which are submitted to DOEs within one month after the issue of the new version. After six months from the issue of the new version, those PDDs prepared according to the old form are not accepted any more.

The statement in Annex III must conform to the information and data contained in the DCP/PDD and the validation report by DOE.

4) Stakeholders' Comments

The opinions over a proposed CDM project activity must be collected from stakeholders and submitted to ICGCC. Relevant stakeholders would be as follows.

(1) Municipal offices and councils
(2) State government departments or bureaus for environmental administration
(3) Municipal departments or bureaus for environmental administration
(4) NGO forum (Forum Brasileiro de Organizacoes nao-Governamentais)
(5) Local communities directly and indirectly influenced by the proposed CDM project
(6) Representatives and heads of local municipal governments
(7) Ministerio Publico Federal

5) Validation Report (in English and Portuguese)

The application documents must be evaluated and validated by the third independent party (Designated Operational Entity: DOE) whether the project activity in question satisfies the CDM requirements.

6) Declaration of Participation

A declaration of participation must be attached with the following documents.

(1) Testimony to the observance of the communication and information disclosure requirement
(2) Testimony to the environmental conservation efforts in project activities
(3) Testimony to the adherence to the requirements of the labor law.

7) Situation of DOE

The PDD must be submitted to the third party DOE (Designated Operational Entity) for validation. The DOE validation report must be attached to the application documents, because DOEs examine and validate PDDs on behalf of the CDM Executive Board. This process of validation is called "Situation of the Designated Operational Entity." DOEs must be formally registered as corporate entities in Brazil. At present, there are four DOEs registered as corporate entities in Brazil which possess the qualifications in the transport sector. They are all foreign enterprises.

(2) Procedure after Approval

When a proposed CDM project activity is approved by ICGCC, the Letter of Approval, signed by the Minister of Science and Technology, is forwarded to the project applicant immediately after the ICGCC meeting that decided the approval.

(3) Procedure after Conditional Approval

If the proposed project activity is approved conditionally, the ICGCC Executive Secretary will forward to the project applicant a letter indicating the restrictions that need to be solved before approval. The applicant must correct the problems indicated in the restrictions and submit the corrected version within the period not exceeding 60 days after the receipt of the "restrictions" letter. If the deadline is not met, the project application will not get the approval.

(4) Procedure for Revision

When the project application is judged inadequate and denied the approval, the applicant receives a letter from the ICGCC Executive Secretary specifying what is required for revision. The applicant must revise the project documentation to the ICGCC specifications and submit the revised version within the period not exceeding 60 days after the receipt of the letter. If the deadline is not met, the project application will not get the approval. If the revision satisfies ICGCC, the Letter of Approval is immediately sent to the project applicant. ICGCC is to spend at least 10 days (excluding

holidays) to make sure that the re-applied project documentation is in fact revised to the ICGCC specifications.

(5) Revocation of Approval

The ICGCC approval once issued would be revoked or cancelled any time during the process of application or of project implementation, if the evidence proves some legal infraction or damage to the public interests.

6.2.2. PROCEDURE FOR EB REGISTRATION AFTER ICGCC APPROVAL

After ICGCC approval in Brazil, the application procedure is brought up to the CDM Executive Board. When the proposed project activity is approved and registered at this level, it becomes a CDM project. The procedural steps after ICGCC approval are as follows.

- The letter of approval sent from the ICGCC Executive Secretary to the applicant
- Submission by the DOE of PDD and other documents to the UNFCCC Secretariat
- Close examination by CDM Executive Board members of the application documents, and when judged satisfactory, CDM registration

6.2.3. OUTLINE OF PDD

(1) PDD Contents

According to the latest form in force (Version 3), the PDD contents are structured as follows. Section A describes the general outline of the proposed CDM project activity. Section B explains how a given methodology is chosen and applicable to the proposed activity. Section C describes the duration of the proposed project activity and the crediting period. The crediting period means the duration, as verified by the DOE, over which the certified emission reduction (CER) is issued by the Clean Development Mechanism. Section D describes the analysis of environmental impacts from the project activity. The PDD must be attached with the document concerning the analysis of the environmental impacts, including cross-border impacts. The document must contain the subjects legally required by the host country and the descriptions of the environmental risks that might materialize. Section E describes the legal requirements in the host country regarding the project activity implementation and the procedure to be followed to collect stakeholders' comments.

Contents
A. General description of project activity
B. Application of a baseline and monitoring methodology
C. Duration of project Activity / crediting period
D. Environmental impacts
E. Stakeholders' comments
Annexes
Annex 1: Contact information on participants in the project activity
Annex 2: Information regarding public funding
Annex 3: Baseline information
Annex 4: Monitoring plan

6.2.4. STEPS UP TO CDM APPROVAL

The public consortium starts the preparation of CDM application while the D/D work is underway. The D/D stage would begin with the posting of consultants' pre-qualifications, followed by bidding by consultants and the selection of a consultant for D/D. After the completion of D/Ds, contractors are selected for construction works. When the construction is over, the trunk bus system begins its operation after the test run.

As mentioned earlier in the roadmap for CDM registration in Section 5.2 of Chapter 5, the CDM-related preparation is initiated concurrently with this process in consideration of study results of a Detailed Design Stage

6.3. ORGANIZATIONAL SETUP FOR MONITORING

6.3.1. ORGANIZATION FOR MONITORING SYSTEM

The public consortium newly organized for the trunk bus operation will act as the project host party in the CDM-related monitoring process. The actual monitoring tasks and the reporting of the findings will be undertaken by the consultants in contract with the consortium. Figure 6.3-1 shows the outline of the monitoring system and procedure for the trunk bus project.

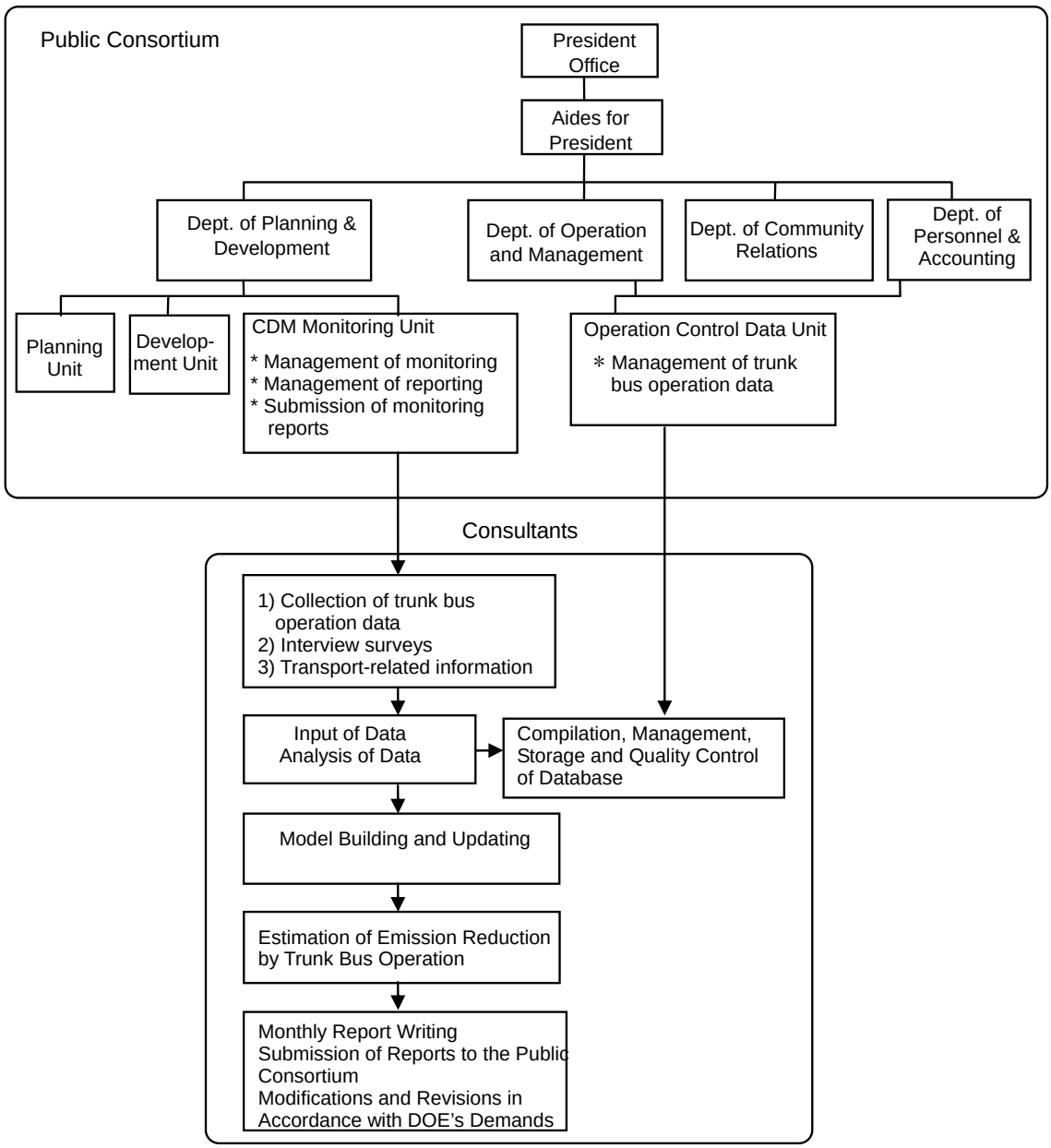


Figure 6.3-1 Outline of Monitoring System on CDM project

6.3.2. ROLE OF THE PUBLIC CONSORTIUM

The tentative organizational structure of the public consortium has been under consideration. There would be four operational departments: namely, Planning and Development, Operation and Management, Community Relations and Personnel and Accounting. The CDM monitoring unit might be set up in the Dept. of Planning and Development. This unit will be in charge of four monitoring activities listed below. The actual undertaking of these tasks is to be contracted out to consultants. The public consortium checks the contents of the monitoring reports from the consultants and forwards them to the DOE for verification.

The main responsibilities of the public consortium are as follows.

1. Collection and compilation of all the monitored data about the trunk bus system
2. Quality control of the database and information as stipulated in the manual
3. Keeping the documents in custody in the manner and at the timing as stipulated in the manual
4. Inspection and evaluation of the monitoring reports submitted by the consultants

6.3.3. ROLE OF CONSULTANTS

The private sector consultants that win the contracts conduct various tasks of monitoring and write up the reports. Their tasks must be carried out strictly according to the monitoring plan included in the PDD and the procedure stipulated in the approved methodology used in the PDD.

(1) Data Collection

- Collect trunk bus operation data
  The database should be available from the department of operation and management of the public consortium.
- Conduct Interview surveys
  The consultants conduct the stated preference survey by interviewing trunk bus users. The survey findings are used to measure (and forecast) the baseline modal split in the absence of the trunk bus project.
- Conduct other traffic surveys and collect relevant data

(2) Estimation of CO_2 Emission Reductions

- Analyze the collected data
- Build and update the model for estimating CO_2 emission reductions
- Input the data to the model
- Estimate the CO_2 reduction by comparing the emissions of the baseline scenario with the emissions of the trunk bus operation

(3) Quality Control of Database

- A series of tasks mentioned above must follow strictly the monitoring procedure of the approved methodology (AM) used in the PDD. Utmost care must be taken to eliminate errors in the collected data.

(4) Interactions with DOE (Designated Operational Entity)

- All descriptions in the monitoring reports are subject to the scrutiny of the DOE. They have to be based on the detailed but realistic monitoring plan. Consultants need to answer every technical enquiry from the DOE (e.g. parameters used for estimation or details of monitoring methods)

6.4. MONITORING PLAN

6.4.1. OUTLINE OF MONITORING PLAN

The basic requirement of the monitoring plan is to estimate the baseline emissions and the actual reduced CO_2 emissions by the project activity. The procedure consists of collecting measurable data

and other relevant information and estimating the emission reductions by using the collected data and the parameters stipulated in the approved methodology (AM).

1) The data of the actual trunk bus operation are collected and used to estimate the actual GHG emissions in adherence to the parameters and formulas stipulated in the approved methodology.
2) Trunk bus users are interviewed to state their modal preferences in the supposed absence of the trunk bus service. Their modal choices are then used to estimate the baseline emissions with the parameters and formulas of the approved methodology.
3) Emission reductions are calculated from the estimates of 1) and 2) above.

6.4.2. APPLICATION OF AM0031

(1) Outline of AM0031

The CDM approved methodology chosen for the trunk bus project is AM0031: namely, "Baseline Methodology for Bus Rapid Transit Projects." The applicability of this AM was examined in some detail in the 2010 Preparatory Survey. AM0031 is applicable to those bus projects that aim to reduce GHG emissions by the construction and operation of trunk bus systems. It is suited to the projects which try to expand the existing bus system by adding bus routes and other facilities.

- AM0031 specifies the parameters and the kinds of data to be used for the estimation of GHG emissions. The project design document (PDD) contains the procedure and the results of emission estimation that are carried out in adherence to the specifications and stipulations of this AM.
- The monitoring plan describes the methods of retrieving parameters and pertinent data after the trunk bus project is implemented and put to operation. The retrieved data and the parameters are then input to the models built to estimate CO emission reductions.

(2) Scenario for GHG Emission Reductions

The trunk bus project in Belem proposes to construct trunk bus exclusive road on the right of way of some existing roads and operate a fleet of articulated buses with large passenger capacity. The project provides Belem with a mass rapid transit system which would transport passengers more efficiently at rapid operational speed. The number of the operated bus fleets will be substantially reduced, thus easing the chronic problem of traffic congestion during peak hours.

AM0031 is used to estimate the emissions with the project and the emissions without the project (baseline emissions). The difference between the two is the emission reduction resulted from the trunk bus project.

6.4.3. METHODS OF DATA COLLECTION

(1) Data Monitoring of Trunk Bus Operation

The actual GHG emissions are calculated from the measurable performance of the trunk bus system in operation.

(2) Data Monitoring for the Baseline Scenario

The estimation of the baseline emissions requires the modal shares in the supposed absence of the trunk bus system. As mentioned earlier, it is necessary to understand the modal choices of the trunk bus passengers if the trunk bus system should not be in service. Interview surveys need be conducted to measure the stated preferences of modal shift among the trunk bus passengers.

The modal split obtained from SP surveys is then input to the demand forecast model. The resulting modal traffic share provides the database for AM0031 to estimate the baseline emissions.

6.4.4. CONTENTS OF MONITORING REPORTS

The monitored measurable data, the modal traffic forecast based on such data and the emission estimates are written up as monitoring reports. The reports must be submitted to the third party DOE for verification.

The format used in the 2008 monitoring report on the TransMilenio BRT in Bogota serves as an example of the contents of monitoring reports. The said report was 22 pages in length.

1) Outline of the Project Activity
2) Progress of the Project Activity
3) Monitoring Methods
4) Period of Monitoring
5) Monitored Data
   (i) With Trunk Bus System (Certified Project Activity)
      ・Collected data on trunk bus operation
      ・Estimated CO_2 Emissions
   (ii) Without Trunk Bus System (Baseline)
      ・Modal Choices Found by Interview Surveys
      ・Estimated CO_2 Emissions
   (iii) Total Leakage
   (iv) Estimated CO_2 Emission Reductions
6) Comparison with PDD
      ・Comparison of the emission reduction with the estimate in PDD and calculation of the ratio of achievement
7) Environmental Impacts

Annex1: Fuel Consumption and Total Vehicle Kilometers
Annex II: Total Passengers
Annex III Survey Results
Annex IV Total Leakage