Research on Shenzhen Public Transportation Sector's Greenhouse Gas Emissions Quantification and Reporting Methodologies

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Introduction

In recent years, climate protection and low carbon economic transformation have become the core working objectives of the Chinese government. The Chinese government has targeted to reduce CO2 emissions from per unit GDP in 2020 by 40-45% compared with 2005, and has selected 7 pilots for carbon emissions trading. As one of the pilots, Shenzhen first officially launched its Carbon Emissions Trading Scheme in June 2013. Currently integrated sectors include energy, manufacturing and architecture. Given high energy consumption intensity of transportation, Shenzhen Municipal People's Government has determined to integrate public transportation into carbon emissions trading system first and will gradually cover other mobile emission sources once successful experiences are gained.

Quantification and reporting of Greenhouse Gas (GHG) Emissions is the foundation for carrying out carbon emissions. Standardized quantification and reporting procedures can enhance consistency, integrity, transparency, accuracy and applicability of public transportation sector's GHG Emissions data, and can lay a compliance foundation for cap control and reasonable allowances allocation in public transportation sector. Therefore, Shenzhen Low-carbon Development Foundation (SCDF) and GIZ jointly carry out the research on Shenzhen public transportation sector's GHG Emissions quantification and reporting methodologies.

Based on Specification with Guidance for Quantification and Reporting of the Organizations' Greenhouse Gas Emissions in Shenzhen, this research has fully drawn references from relevant existing technical standards, guidelines and literature data in China, and extensively learned about advice and suggestions from relevant departments, experts and transportation enterprises. Through site investigation, profound researches and case trial, the research report is formed. During the research, experts recommended by GIZ, Shenzhen Bus Group Co, Ltd., Shenzhen Eastern Public Transport Co., Ltd., Shenzhen Pengcheng Taxi Co., Ltd. and other relevant sectoral enterprises have provided great support.

1 Research Scope

The research on Shenzhen public transportation sector's GHG emissions quantification and reporting covers bus and taxi enterprises citywide. The GHG emissions in this research are only referred to carbon dioxide and no other GHG emissions are involved.

2 Quoted Documents

The following documents are an integral part for the application of this file. For those documents with a specific date, only the ones with a specific date shall be applicable. For those documents without a specific date, the most updated versions (all revised versions are included) shall be applicable.

- SZDB/Z 69-2012 Specification with Guidance for Quantification and Reporting of the Organizations' Greenhouse Gas Emissions
- Provincial Greenhouse Gas Emissions Inventory Compiling Guidelines (Climate Change Department, National Development and Reform Commission, 2011)
- ISO 14064-1: 2006 Greenhouse Gases – Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of the Greenhouse Gas Emissions and Removals
- GHG Protocol: A Corporate Accounting and Reporting Standard

3 Terms and Definitions

The following terms and definitions are applicable in this research:

3.1 Public Transportation

Public transportation in this guideline is only referred to buses and taxis while subways and other means of transportation are not included.

3.2 Operating System

GHG emissions from all the operating vehicles and the operating system in public transportation include direct emissions from fuel combustion and indirect emissions from electricity consumed by buses and taxis.

3.3 Supporting System

Supporting system of a public transportation organization is referred to other supporting part apart from the operating vehicles (e.g. office building, maintenance workshop, storehouse, staff canteen, staff apartment and enterprises' vehicles for internal use etc.). GHG emissions from the supporting system include direct emissions from fuel combustion and indirect emissions from consumption of purchased electricity and heat.

Note: If the staff canteen of a public transportation enterprise is sourced out and energy fees are paid to energy suppliers directly by the outsourcing party, emissions from this part of energy consumption will not be covered by quantification.

3.4 Greenhouse Gases (GHG)

Greenhouse gases are referred to gaseous elements that naturally present in the atmosphere or due to human activities, which can absorb and emits radiation produced by surface of the earth, atmosphere and cloud layer with lengths within thermal infrared range.

Note: Carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF6) are the major anthropogenic greenhouse gases.

3.5 GHG Emissions

GHG Emissions is referred to the whole amount of GHG released to the atmosphere within a certain period of time (calculated by mass unit).

3.6 Mobile GHG Sources

Mobile sources are referred to fuel combustion and electricity consumption by transport equipment such as vehicles, buses, and fork trucks etc.

3.7 Stationary GHG Sources

Stationary sources are referred to fuel combustion and electricity consumption by stationary equipment such as boilers, heating furnace, backup generator etc.

3.8 GHG Emission Factors

GHG emission factors are referred to factors that associate activity data with GHG emissions.

3.9 Direct GHG Emissions

Direct GHG emissions are referred to GHG emissions from sources that are owned or controlled by enterprises.

3.10 Indirect GHG Emissions from Energy Consumption

Indirect GHG emissions from energy consumption are referred to GHG emissions resulting from enterprises' production that consumes the purchased electricity, heat, cooling or steam.

3.11 GHG Activity Data

GHG activity data are referred to quantitative data that produce GHG emissions.

Note: GHG activity data include for example, consumption of energy, fuel or electricity, amount of material produced, number of services provided, or affected land area.

3.12 GHG Assertion

It is referred to announcement or actual objective statement by the responsible party.

Note 1: GHG announcement can be targeted against a certain time or cover a period.

Note 2: GHG announcement can be provided in the form of GHG report.

3.13 GHG Information Management System

It is referred to principles, processes and procedures that are used to establish, manage and maintain the GHG information.

3.14 GHG Report

It is referred to special documents that provide targeted users with relevant data of enterprises' GHG.

Note: GHG reports may contain GHG announcement.

3.15 Indeterminacy

It is referred to parameters that are relevant to quantitative results and indicate numerical errors.

Note: Indeterminacy generally refers to quantitative assessment of possible value deviation and qualitative description of reasons for possible difference.

3.16 Global warming potential (GWP)

GWP is an index that compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide.

3.17 Carbon dioxide equivalent (CO_2e)

Contribution of various GHGs on greenhouse effect can be measured by the emission rate of CO_2 and the conversion result is CO_2e.

Note: The CO_2e of a greenhouse gas is its mass multiplying its GWP.

3.18 Base year

Base year is a specific historical period for comparing GHG emissions from different periods or for comparing other relevant information of GHGs.

Note: The quantification of the base year can be based on a value in a specific period (e.g. a year), and can also be based on the average value of several periods (e.g. several years).

4 Investigation into Public Transportation Sector

The research is based on comprehensive and thorough understanding of Shenzhen's public transportation system. We has visited and interviewed Shenzhen Bus Group Co, Ltd. and Shenzhen Eastern Public Transport Co., Ltd. The purpose of the investigation is to discover possible problems during quantification and reporting of GHG emissions by public transportation companies, and to initially determine quantification procedures for GHG emissions from public transportation system. By discussing with relevant persons in charge in the companies, site surveys and other methods, we have learned about the companies' operating status, energy consumption, energy saving and emissions reduction and other aspects in recent years, and have collected vehicles operating data.

4.1 Investigation Content

The specific investigation content is as follows:

1) Basic Organizational Conditions of Public Transportation Companies

(1) Ownership structure and organizational structure of companies, to clarify the organizational boundary of bus and taxi companies;

(2) Companies' vehicles and operation data, to learn about its operation status in recent years, to acquire vehicle types, fuel types, actual fuel consumption, capacity, annually traveled mileage of currently existing buses and taxis as well as present energy saving and emissions reduction measures, to analyze its carbon emissions status and potential for energy saving and emissions reduction; to learn about vehicle types, performance parameters and numbers of buses and taxis that are planned to be upgraded.

2) Energy Consumption Status of Public Transportation Companies

(1) Types of consumed fuels;

(2) Energy consumption measurement devices and statistics methods: such as electric meter, refueling recording card etc.;

(3) Types of energy consumption evidence: invoice for diesel purchasing, electricity bill etc.

3) Carbon Emissions Status of Public Transportation Companies

(1) Determination of a company's GHG emissions operational boundary: namely, to identify the emission sources as direct or indirect emissions;

(2) Facility/activities of the emission source: e.g. cooking utensils consuming liquified petroleum gas in the canteen, fork trucks using diesel etc.;

(3) Companies' GHG emissions data management system, e.g. carbon emissions data input, quantification and output systems.

4) Companies' Status of Technical Reconstruction on Energy Saving

(1) Energy saving status in living zone, working zone, storehouses and other buildings;

(2) Energy conservation certification report that have gained by companies, such as energy auditing report, clean production report etc.

Data collected in the investigation are as follows:

a) Organizational chart, including structural chart of head office and structural chart of subsidiaries;

b) Organizational floor map, electricity calculation network map;

c) Relevant sheet for energy purchasing, consumption and storage;

d) Data of electricity consumption during 2011-2013 by subsidiaries;

e) Vehicle data and indicating data for vehicle operation.

4.2 Investigation Results

The objects of this research investigation include the Public Bus Branch Company of Shenzhen Bus Group and No. 1 Branch Company of Shenzhen Eastern Public Transport Co., Ltd.

Through investigation into the Public Bus Branch Company of Shenzhen Bus Group, we have learned about that it has 5 apartments, 5 canteens, 5 workshops, 19 fleets, 1 storehouse and 1 fuel department. Energy consumption and management in the Public Bus Branch are mainly categorized into three competent departments: the Office charges statistics of energy consumption within logistics system, which specifically includes energy consumed by material transport vehicles and other internal vehicles, canteens and apartments; the Maintenance Department charges energy consumption within maintenance system, which specifically includes fuels consumed by workshops, storehouses, vehicle washing rooms and fork trucks; the Operating Department charges energy consumption by the fleets. The management structure of the bus company is relatively simple. Since its canteens and apartments are both controlled by the company, its organizational boundary is easy to determine. However, it is found during the investigation that although the fuel storehouse is controlled by the Public Bus Branch Company, the operational range of the fuel storehouse and fuel trucks covers several subsidiaries of the whole group, thus it is needed to clarify the determination method for organizational boundary. Through research, it is decided to adopt mastery method for the Public Bus Branch Company. Since fuel storehouse is financially and operationally controlled by the Public Bus Branch Company, carbon emissions from the fuel storehouse belong to the Public Bus Branch Company.

During determination of quantification boundary of GHG emissions from the Public Bus Branch Company, it is found that staff from the bus company is not well informed about carbon inventory. Lest emission sources are omitted during carbon emissions liquidation, the research has interrogated and examined emission sources one by one in accordance with the organizational structure and departmental category of the bus company. According to different competent departments, the quantification boundary of the subsidiary bus company can be divided into two plates: operating system and supporting system, where the operating system is referred to the vehicle system operated by public transportation companies, and the supporting system is referred to departments and units serving production (e.g. working office, repair shops, storehouse, staff canteens, staff apartments and enterprises' internal transport vehicles etc).

It is found by the investigation that No. 1 Branch Company of the Eastern Public Transport Company has similar organizational structure with the Public Bus Branch Company of Shenzhen Bus Group and is much simpler

and clearer. It is composed of 13 independent fleets and each fleet includes working office, canteen, apartment, workshop, repair shop and storehouse etc. Each fleet is relatively independent and has independent statistics system. Therefore, the company's GHG quantification boundary can also be categorized into operating and supporting system.

Through investigation and research, we have raised a methodology for Shenzhen public transportation sector's GHG emissions quantification and reporting, and calculated GHG emissions from the Public Bus Company and the Eastern No. 1 Branch Company, which is specified in the following table.

GHG Emissions from the Public Bus Branch Company in 2012

Emission Category		Emission Amount (unit: tCO2)	Percentage
GHG Emissions from Operating System	Direct emissions from fuel combustion by buses/taxis	117,554.74	94.86%
	Indirect emissions from electricity consumption by buses/taxis of public transportation enterprises	1,635.63	1.32%
GHG Emissions from Supporting System	Direct emissions from fuel combustion by supporting system	1,002.59	0.81%
	Indirect emissions from consumption of purchased electricity and heat by supporting system	3,733.67	3.01%
Total Emission Amount		123,926.63	100%

GHG Emissions from the Eastern No. 1 Branch Company in 2012

Emission Category		Emission Amount (unit: tCO2)	Percentage
GHG Emissions from the Operating System	Direct emissions from fuel combustion by buses/taxis	68,669.43	87.82%
	Indirect emissions from electricity consumption by buses/taxis of public transportation enterprises	1,972.81	2.53%
GHG Emissions from the Supporting System	Direct emissions from fuel combustion by supporting system	261.83	0.33%
	Indirect emissions from consumption of purchased electricity and heat by supporting system	7,285.89	9.32%
Total Emission Amount		78,189.96	100%

5 Public Transportation Sector's GHG Emissions Quantification and Reporting Methods

5.1 Public Transportation Sector's GHG Emissions Quantification Boundary

Subjects of GHG emissions quantification and reporting of this research are companies or subsidiaries mainly operate public buses or taxis within Shenzhen.

Coverage of quantification and reporting of GHG emissions from public transport sector includes GHG emissions from the operating system and supporting system.

1) GHG emissions from the operating system

(1) Direct GHG emissions from buses/taxis fuel combustion

Emissions from buses/taxis fuel combustion are GHG emissions resulting from complete combustion of vehicle powered fuel such as diesel, gasoline or natural gas with oxygen.

(2) Indirect GHG emissions from electricity used by buses/taxis

Emissions from electricity used by buses/taxis are referred to electricity consumption whose actual emissions are from electricity enterprises.

Note: The emissions from hybrid buses can be direct emissions and indirect emissions.

2) GHG emissions from the supporting system

(1) Direct GHG emissions from fuel combustion

Direct emissions from fuel combustion in the supporting system involved in public transport enterprises are referred to direct emissions of GHG resulting from diesel, natural gas and coal and so on fully burnt with dioxide in various stationary or mobile combustion equipments (e.g. Canteen boilers, corporate internal vehicles).

(2) Indirect GHG emissions from net purchased electricity and heat in the supporting system

It is referred to GHG emissions corresponding net purchased electricity and heat (steam, hot, cold) by the supporting system of public transport enterprises.

If a public transport enterprise outsources its cafeteria operations and energy costs are independently paid to energy suppliers by the contracted party, emissions from consumption of this part of energy will not be included in quantification coverage.

Note: It is a necessity to clarify whether the outsourcing party is an independent legal person or a private business owner. In accordance with quantification and verification of an organization, if it is contracted to a private business owner with no independent legal person, it will be calculated as part of the verified party.

5.2 Public Transportation Sector's GHG Emissions Quantification Methods

The total amount of GHG emissions from a public transportation enterprise equals to GHG emissions from its operating system (which include direct emissions from fuel combustion by buses/taxis and indirect emissions from electricity used by buses/taxis) adding emissions from its supporting system (which include direct emissions from fuel combustion in the supporting system, indirect emissions from consumption of net purchased electricity and heat) within the enterprise's quantification boundary , which is calculated by formula (1):

E = Eoperating system + Esupporting system

= (Edirect emissions from vehicles + Eindirect emissions from vehicles)

+ (Edirect emissions from supporting system + Eindirect emissions from supporting system) **(1)**

In the formula:

E is the total amount of GHG emissions from a public transport enterprise and the unit is tCO_2e;

$E_{operating\ system}$ is the total amount of GHG emissions from the operating system of a public transport enterprise and the unit is tCO_2e;

$E_{supporting\ system}$ is the total amount of GHG emissions from the supporting system of a public transport enterprise and the unit is tCO_2e;

$E_{direct\ emissions\ from\ vehicles}$ is direct GHG emissions from fuel combustion by buses/taxis of a public transport enterprise and the unit is tCO_2e;

$E_{indirect\ emissions\ from\ vehicles}$ is indirect GHG emissions from electricity used by buses/taxis of a public transport enterprise and the unit is tCO_2e;

$E_{direct\ emissions\ from\ supporting\ system}$ is direct GHG emissions from fuel combustion by the supporting system of a public transport enterprise and the unit is tCO_2e;

$E_{indirect\ emissions\ from\ supporting\ system}$ is indirect GHG emissions from consumption of net purchased electricity and heat by the supporting system of a public transport enterprise and the unit is tCO_2e.

The above mentioned various greenhouse gases emissions will be quantified by the following methods:

1) Calculation of GHG Emissions from the Operating System

The qualification of GHG emissions from the operating system can adopt the calculation method based on Top to Bottom Method or on unit mileage energy consumption. Bottom to Top Method is referred to a method where GHG emissions are calculated from active level data and relevant parameters; Bottom to Top energy consumption per unit mileage method (i.e. Vehicle kilometers traveled VKT method) is referred to a method where GHG emissions during the whole driving process is calculated by measuring energy consumption per unit mileage by a certain type of vehicle.

Top to Bottom Method is recommended to adopt by buses, Bottom to Top Method is recommended to adopt by taxis.

(1) Top to Bottom Method of GHG emissions

a) Top to Bottom Method of direct emissions from fuel combustion by buses/taxis

Fuel combustion by buses/taxis belongs to mobile combustion sources. Its produced direct emissions is the footing of GHG emissions from combustion of all fuels by all operating vehicles in enterprise's quantification and reporting year, which is calculated by formula (2):

$$E_{\text{Direct Emissions from Vehicles}} = \sum_{i=1}^{n} (AD_i \times EF_i) \qquad (2)$$

In the formula:

$E_{\text{Direct Emissions from Vehicles}}$ is direct emissions from fuel combustion by buses/taxis of a public transport enterprise and the unit is tCO_2e;

AD_i is the active level data of the type i fuel used by buses/taxis and the unit is t;

EF_i is the emission factor of the type i fuel and the unit is tCO_2/t;

i is fuel type number.

① Acquisition of active data

Data of fossil fuel consumed by buses/taxis in the quantification and reporting year of the public transportation enterprises are collected according to energy consumption evidences provided by the enterprise, which should include all fuel consumption by all fueled vehicles in the enterprise.

Note: Receipts or account settling data provided by the suppliers are preferred (e.g. fuel refilling details in a year provided by oil supply companies) while internal records of verified enterprises only serve as a way for cross-examination.

② Acquisition of emission factor data

Emission factors of fossil fuels consumed by buses/taxis of the public transportation enterprises are calculated by carbon content per unit calorific value, carbon oxidation rate and other parameters, below is the calculation formula (3):

$$EF_i = CC_i \times OF_i \times CV_i \times 44/12 \qquad (3)$$

In the formula:

EF_i is the emission factor of the type i fossil fuel and the unit is tCO2/t;

CC_i is carbon content per unit calorific value of the type i fossil fuel and the unit is tC/TJ;

OF_i is carbon oxidation rate of the type i fossil fuel and the unit is %;

CV_i is calorific value of the type i fossil fuel and the unit is kJ/kg;

44/12 is the molecular weight ratio of CO_2 and C;

i is the fuel type number.

Please refer to Sheet 2 in Appendix for the common emission factors of mobile combustion sources of fossil fuel.

b) Indirect emissions from electricity used by buses/taxis in public transportation enterprises

Indirect emissions from buses/taxis powered by electricity is the footing of greenhouse gases emissions from electricity consumed by all vehicles using electricity in enterprise's quantification and reporting year, which is calculated by formula (4):

$$\mathbf{E_{indirect\ emissions\ from\ vehicles}=AD_{vehicle\ electricity}\times EF_{electricity}} \quad \mathbf{(4)}$$

In the formula:

$E_{indirect\ emissions\ from\ vehicles}$ is indirect emissions from electricity used by buses/taxis in public transportation enterprises and the unit is tCO_2;

$AD_{vehicle\ electricity}$ is active level data of electricity used by buses/taxis in enterprise's quantification and reporting year and the unit is MWh;

$EF_{electricity}$ is emission factor of electricity consumption and the unit is tCO_2/MWh.

① Acquisition of active level data

Data of electricity consumed in quantification and reporting year by buses/taxis in public transportation sector should be acquired by relevant settlement documents provided by electricity suppliers, or by adding monthly or batches of relevant settlement bills.

② Acquisition of emission factor

Please refer to Sheet 3 in Appendix for emission factors of purchased electricity and heat.

(2) Bottom to Top Method of GHG emissions (Method based on energy consumption per unit mileage, e.g. VKT (vehicle kilometers traveled) method)

GHG emission from the operating system of public transportation enterprises is referred to the footing of GHG emissions from all vehicles types in enterprises. Enterprises can quantify GHG emissions from a certain type if vehicle by VKT method, i.e., by multiplying measured GHG emissions per unit mileage and kilometers traveled (VKT) by the vehicle in quantification year. It is calculated by formula (5). GHG emissions acquired through method based on measurement, the emitters should be verified by method based on calculation.

$$\mathbf{E=\sum E_i}$$

$$\mathbf{=\sum(\ (number\ of\ vehicles)i\ \times\ (VKT)_i\ \times\ Energy\ consumption\ for\ per\ unit\ mileage\ _i\ \times\ (emission\ factor)_i\ )} \quad \mathbf{(5)}$$

In the formula:

E represents total annual GHG emissions and the unit is tCO_2;

E_i represents GHG emissions from all vehicles of type i and the unit is tCO_2;

Energy consumption for per unit mileage i is referred to energy consumption for per unit mileage by all vehicles of type i, such as electricity, diesel, gasoline etc., and the unit is t/km or MWh/km;

$(VKT)_i$ in the formula represents mileage traveled by all vehicles of type i in quantification and reporting year and the unit is km;

$(\text{emission factor})_i$ is referred to emission factors of consumed energy (fossil fuel or electricity) and the unit is tCO_2/t or tCO_2/MWh;

i represents different types of vehicles.

① Acquisition of active level data

Active level data include number of different types of vehicles, vehicle mileage in quantification and reporting year, energy consumption per unit mileage by different types of vehicles. Active level data can be acquired by public transportation enterprises by the following methods:

i. Number of different types of vehicles and vehicle's traveled mileage in a certain time period can be collected through enterprise's internal statistics system;

ii. Energy consumption per unit mileage for different types of vehicles should be based on investigated data or average fuel efficiency data during traveling of vehicle type i. If this kind of data cannot be acquired, then average fuel efficiency data for different vehicle types nationwide can be adopted.

② Acquisition of emission factor data

i. Emission factors of fossil fuel are calculated by carbon amount for per unit heat value, carbon oxidation rate and other parameters of the fuel. Please refer to Sheet 2 in Appendix for the common emission factors of mobile combustion sources of fossil fuel.

ii. Please refer to Sheet 3 in Appendix for emission factors of purchased electricity and heat.

2) Calculation of GHG Emissions from the Supporting System

(1) Direct emissions from fuel combustion in the supporting system

Fuel combustion is the supporting system of public transportation enterprises include stationary combustion sources and mobile combustion sources, direct emissions from which is the footing of CO_2 from combustion of diesel, natural gas, coal and other fuels in enterprise's quantification and reporting year by departments and units serving production, and it is calculated in accordance with formula (6):

$$E_{\text{direct emissions from supporting system}} = \sum_{i=1}^{n} (ADi \times EFi) \qquad (6)$$

In the formula:

$E_{\text{direct emissions from supporting system}}$ is direct emissions from fuel combustion by the supporting system of public transport enterprises and the unit is tCO_2;

AD_i is the active level data of the type i fuel using by departments and units serving production in enterprise's quantification and reporting year, and the unit is t;

EF_i is the emission factor of the type i fuel and the unit is tCO_2/t;

① Acquisition of active level data

Fuel consumption in the supporting system of public transportation enterprises should be acquired through enterprise's relevant measurement statistics, or by adding monthly or batches of bill settlements. If no relevant statistics are available and no monthly bill settlements are provided, then it can be acquired by the actual used amount at the beginning and end of quantification period, namely:

Consumed amount = purchased amount + (stock at the beginning - stock at the end)

② Acquisition of emission factor data

Emission factors of fossil fuel consumed by the supporting system of public transportation enterprises is calculated by carbon amount for per unit heat value, carbon oxidation rate and other parameters of the fuel. Please refer to Sheet 1, 2 in Appendix for the common emission factors.

(2) Indirect emissions from consumption of net purchased electricity and heat by the supporting system

Corresponding CO_2 emissions from production of electricity and heat for consumption of net purchased electricity and heat in the supporting system of public transport enterprises is calculated through formula (7):

$$\mathbf{E_{indirect\ emissions\ from\ supporting\ system} = AD_{electricity\ consumed\ by\ supporting\ system} \times EF_{electricity} + AD_{heat\ consumed\ by\ supporting\ system} \times EF_{heat}} \quad (7)$$

In the formula:

$E_{indirect\ emissions\ from\ supporting\ system}$ is indirect emissions from consumption of net purchased electricity by the supporting system of a public transport enterprise and the unit is tCO_2.

$AD_{electricity\ consumed\ by\ supporting\ system}$ is active data level of electricity used in the an enterprise's quantification and reporting year by the supporting system and the unit is MWh;

$EF_{electricity}$ is emission factor of electricity consumption and the unit is tCO_2/MWh;

$AD_{heat\ consumed\ by\ supporting\ system}$ is net purchased heat used in an enterprise's quantification and reporting year by the supporting system and the unit is GJ;

EF_{heat} is emission factor of heat consumption and the unit is tCO_2/GJ.

① Acquisition of active level data

Electricity consumed in quantification and reporting year by the supporting system of public transport enterprises should be acquired by relevant settlements invoices provided by electricity suppliers, or acquired by adding monthly or batches of relevant bill settlements.

② Acquisition of emission factor data

Please refer to Sheet 3 in Appendix for emission factors of electricity.

5.3 Quantification Data Management and Quality Guarantee

Public transportation enterprises should establish data information management system and quality guarantee system for their GHG emissions quantification and reporting, which mainly include the following aspects:

1) It is necessary to determine internal institution, positions and personnel for GHG emissions quantification and reporting as well as corresponding duties and accountability, and to train relevant personnel participating in GHG emissions quantification and reporting; to establish management program for GHG emissions information management program, the management process profiles should at least include the documents and records management programs, GHG emissions quantification and reporting programs as well as data quality management programs;

2) To guarantee efficiency and integrity, enterprises should adopt measures to guarantee the quality of data acquisition and processing.

Please refer to Diagram 1 for data management procedures:

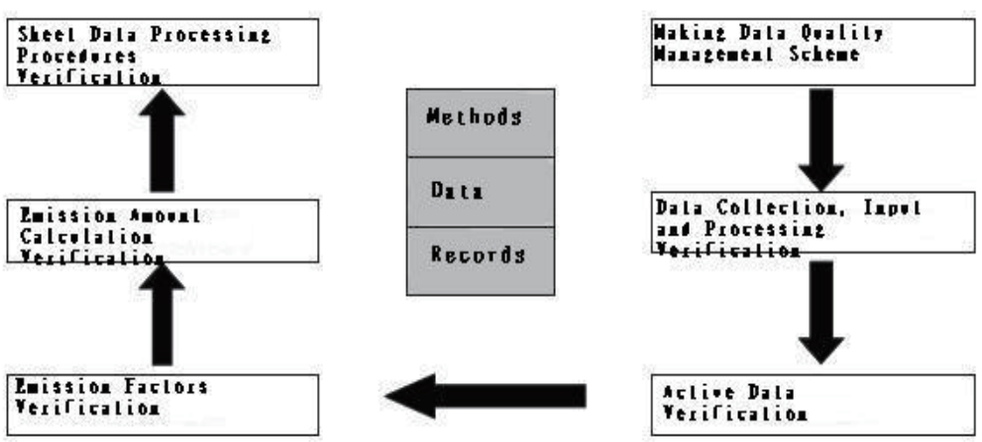

Diagram 1 Data Management Procedures

Please refer to Diagram 1 for data management procedures:

Sheet 1 Data Quality Management Scheme

Data collection, input and processing verification	Check errors of inputting data samples; Determine data integrity; Ensure proper edition control regulations for digital documents.
Active data verification	Ensure integrity of active data statistics; Check accuracy of active data calculation; Conduct cross examination on active data by different statistics methods.
Emissions factors verification	Check unit and conversion of emission factors; Determine rationality of emission factors; Check conversion coefficient; Determine accuracy of coefficient conversion process; Ensure timeliness of emission factors.
Emission amount calculation verification	Carbon emissions from buses/taxis can be verified by calculation method or VKT; Compare with historical data.
Sheet data processing procedures verification	Check data processing procedures in working sheet; Check whether clear differentiation has been made for input data and calculated data in working sheet; Check representative calculation samples by hand or digitally; Check data collection of all emission sources.

3) Enterprises should complete indeterminacy analysis of GHG emissions and form a document. Indeterminate information is not used for judge the correctness of the inventory, but for helping enterprises determine a prioritized direction to improve inventory accuracy and guide the methodology options.

5.4 Compiling Public Transportation Sector's GHG Emissions Quantification Report

The quantification report includes the following contents:

1) Leading official

2) Period covered by the report;

3) Enterprise's basic information sheet;

4) Determination of enterprise's quantification boundary;

5) Quantification sheet of GHG emissions;

6) Summary sheet of GHG emissions;

7) Data quality management;

8) Indeterminacy analysis of GHG emissions;

9) Other statements.

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