

# Chapter 7

## Emissions Monitoring, Reporting and Verification



### 7.1 Concept of MRV and Foreign and Domestic Studies

Carbon emissions transaction is made up of several links, e.g., emissions Monitoring, Reporting and Verification (MRV), allowances allocation, carbon pricing, transaction platform and transaction rules. MRV is an indispensable component, since data accuracy and truthfulness determines allowances computation, allocation efficiency and fulfillment of emissions reduction target. In aggregate, an appropriate MRV regime is an essential part for smooth operation of an emissions trading scheme [1].

#### 7.1.1 Definition of MRV

MRV regime, which is a process of monitoring, reporting and verifying the GHG emissions data of the ETS covered enterprises, is the backbone for normal operation and healthy development of a carbon market. The emitters (companies) are responsible for monitoring and reporting their GHG emissions, while a third-party verification institution accredited by government undertakes emissions verification.

“Monitoring” refers to measuring, acquiring, analyzing and recording the relevant emissions data (e.g., energy and supplies) of the covered enterprises with a slew of technologies and measures.

The validity, reliability and accuracy of monitoring are the basic principles of MRV regime. Data quality control—the foremost part of MRV—runs through the entire MRV process. The content of monitoring is made up of three parts:

- (1) Review and cross check all record sheets, including the invoices or receipts for purchasing energy and supplies, energy and supplies consumption records, product sales invoices, activity data summary sheets, and checklists.

- (2) Further examination of all elements of carbon verification, including the definition of organizational and operational boundaries, identification of emitting sources, collection of activity data, selection of emission factor, application of quantitative methodology, and calculation of emissions.
- (3) Conduct horizontal and vertical comparisons of the emissions data from the same industry and from the same-sized companies, and compare carbon intensity within the same industry.

“Reporting” deals with processing, integrating and computing the monitored data, and delivers the final version of monitored facts and data to the competent department in a standardized manner, e.g. spreadsheet or paper document in report template.

“Verification” is carried out by an accredited third-party verification institution. Through document review and on-site surveys to the covered enterprises, this institution validates the companies’ emissions data, produces a verification report, and endorses authenticity and reliability of the data. Verification is an independent process with an aim to validate the reported data and information are substantially accurate, and subject to monitoring as requested.

An integrate MRV regime helps build confidence of the stakeholders in the data, and in the entire emissions trading system.

### **7.1.2 Significance of MRV**

MRV usually manifests itself in the form of government document, which lists out the monitored GHG emissions data of the regulated emitters, reporting and verification rules (including fill-in requirements and technical norms), in an aim to ensure consistency, integrity, transparency and accuracy of the reported data.

“Integrity” indicates the monitoring and reporting shall cover all emitters within the companies’ organizational boundary; neither omission nor concealment is allowed. Besides, in addition to the emissions from normally-operating installations, the emissions from switching on or down the installations and from other emergencies are also monitored and reported.

“Transparency” means transparent acquisition of actual emissions and transparent computation of allowances. All the data stored and managed shall be transparent, clear-cut and traceable. All data sources and computation approaches are explainable. There are elaborate historical proofs, records and accessory evidence. Avoid to use of ambiguous data.

“Consistency” refers to consistent monitoring methodologies for different industries, regions and timescales; in other word, there are emissions from a specific installation at different times, and the emissions from the same-type installations owned by different companies within the same period, the monitoring methodologies shall be always uniform. Explicit explanations shall be made for possible inconsistency.

“Accuracy” requires accurate computation of the CO<sub>2</sub> emissions from the companies’ production and management activities, and minimization of deviations and uncertainties.

### ***7.1.3 Basic Flow of MRV***

Basic flow of MRV mainly consists of two parts: (1) The companies report their emissions, monitoring plan and annual emissions data to the competent department; (2) The competent department or an accredited third-party verifier validates the reported data.

The companies shall produce an emissions monitoring plan which covers all important information about their monitoring system, so as to prove the accuracy of the measurement and reporting about the emitting sources. Such plan is then delivered to the competent department for approval. The monitoring plan is subject to dynamic adjustment, i.e., whenever a significant change happens to the monitoring system, the monitoring plan is placed under continuous revision and re-applied to the competent department for approval and recording, and then the companies shall start monitoring of all regulated emitting installations, and report their annual emissions (in standardized report template) to the competent department.

The competent department reviews the monitoring plan submitted by the companies, and then conducts spot check of the emissions reports in reference to the monitoring plan.

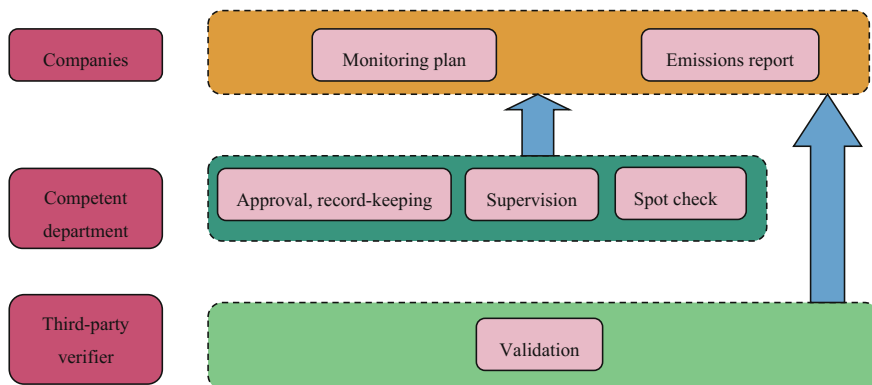
At the authorization of the competent department, an accredited third-party verification institution reviews and validates the monitoring plan and emissions reports submitted by the companies, then produces validation opinions and reports to the competent department.

MRV basic flow is shown in Fig. 7.1.

### ***7.1.4 Foreign and Domestic MRV Studies***

The core content of MRV regime comprises formulation of rules and criteria, definition of verification objects and data quality control. The MRV rules and criteria adopted by different countries usually involve companies’ monitoring, quantification and reporting guidelines, verification

The EU ETS regulation is split into three phases where the content of MRV regime changes accordingly [2]. With respect to the scope of monitoring, increasing categories of GHGs are involved by the ETS: Phase 1 and 2 only regulates CO<sub>2</sub> emissions, while Phase 3 regulates CO<sub>2</sub>, N<sub>2</sub>O and PFCs emissions. With respect to the monitoring procedures, more emphasis is given to the monitoring plan. With respect to the monitoring methodology, a uniform verification system and



**Fig. 7.1** MRV basic flow

accreditation criteria are established: an accredited third-party verifier takes charge of emissions verification, and the competent department validates the emissions reports.

The EU MRV regime is backed up by a series of rules and criteria: 280/2004/EC,<sup>1</sup> 2007/589/EC,<sup>2</sup> Verification of Greenhouse Gas Reporting and Accreditation of Third-Party Verification Institutions [3]. The scope of verification involves five industrial sectors, i.e., energy supply (electricity, heat and steam generation), oil refinery, iron and steel, building materials (cement, lime and glass), pulp and paper. In addition, the accreditation authority is subject to peer assessment in line with ISO/IEC17011:2004.<sup>3</sup> The verification institution is under administration in line with ISO 14065:2007.<sup>4</sup>

As for Tokyo ETS, the MRV regime is backed up by a series of rules and criteria: *Quantification Guidelines for GHG Emissions from Installations*, *Verification Guidelines for GHG Emissions*, *Guidelines for Registration and Application of Third-party Verification Institutions*. There are 1100 commercial installations and 300 factories falling into the scope of verification. In 2008, the Bureau of Environment of Tokyo founded Japan Verified Emissions Reduction (J-VER) which takes the following characteristics:

<sup>1</sup>280/2004/EC Decision of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol.

<sup>2</sup>2007/589/EC Guidelines for the monitoring and reporting of greenhouse gas emissions.

<sup>3</sup>ISO/IEC17011:2004 Conformity assessment—General requirements for accreditation bodies accrediting conformity assessment bodies.

<sup>4</sup>ISO 14065:2007 Greenhouse gases—Requirements for greenhouse gas validation and verification bodies for use in accreditation or other forms of recognition.

- (1) A top-down administration model is adopted for developing methodologies and defining benchmark values.
- (2) Relevant systems are established in reference to the international norms. For instance, ISO14064-2<sup>5</sup> is consulted for setting up the framework of MRV regime, monitoring and computation rules; ISO14064-3<sup>6</sup> is consulted for drawing up verification guidelines; and ISO14065<sup>7</sup> is consulted for defining the matters for accrediting verification institutions.

California began to ask the regulated emitters to report their annual GHG emissions since 2008. The covered enterprises are not allowed to access to the carbon market unless they have registered via Air Resources Board (ARB) and are ready to take mandatory verification by an accredited third-party verifier. In addition to the six GHGs that are regulated by all leading cap-and-trade mechanisms, California extends its coverage scope to NF<sub>3</sub> and other fluorides. About 350 companies and over 600 installations have joined in Cal ETS, i.e., extending from electricity sector and large industrial installations to fuel distributors in a stepwise manner. Cal ETS has developed emissions computation methodologies for 20 industrial sectors, insists on third-party verification, and organizes strict training and accreditation of such verification institutions. Currently, there are over 40 accredited third-party verification institutions with more than 200 verifiers [4].

Similar to the MRV rules in the EU and California, China's MRV regime also requires submission of annual emissions report, and third-party verification of emissions and companies' compliance. China is now developing a GHG emissions accounting and reporting system for key companies (institutions). It has already defined the reporting threshold, and published the GHG emissions accounting and reporting guidelines for 24 sectors (10 guidelines have become a national norm). It will build an administration system for verification institutions at both national and provincial/municipal levels. The current MRV regime in China's seven pilot carbon markets is briefed as follows:

Shenzhen has built an expert team for establishing GHG verification criteria, developed two universal guidelines, a set of methodologies for two special industrial sectors, and two universal technical specifications. There are also the *GHG Emissions Quantification and Reporting Methodologies for Electricity Sector*, *GHG Emissions Quantification and Reporting Methodologies for Water-supply Sector*, *Notice on Defining the Technical Requirements for Carbon Emissions Verification*, and *Specification on Uniform Adoption of Emissions Factors*. The objects of verification are those legal person-led organizations. In order to safeguard

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<sup>5</sup>ISO 14064-2: Greenhouse gases—Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements.

<sup>6</sup>ISO14064-3 Greenhouse gases—Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions.

<sup>7</sup>ISO14065 Greenhouse gases—Requirements for greenhouse gas validation and verification bodies for use in accreditation or other forms of recognition.

data quality, Development and Reform Commission of Shenzhen Municipality has developed a ‘statistics sheet for major energy-intensive equipment in organizations’ for cross-checking accuracy of data.

Beijing has published the emissions counting guidelines for six industrial sectors, i.e., heat production and supply, thermal power generation, cement production, petrochemical production, tertiary industry and enterprise industry. For the key emitters (the aggregate direct and indirect emissions from fixed installations are at or above 10,000 tCO<sub>2</sub>/year), conduct actual measurements of the activity level and emissions factors in the annual report, and calculate their GHG emissions during the reporting period. For the key installations (the direct emissions are above 10,000 tCO<sub>2</sub>/year), conduct separate measurement. The reporting entities shall deliver their previous year’ emissions report (in electronic form) to Beijing Municipal Development and Reform Commission (BJ DRC) before each March 31. The key emitters shall submit their previous year’ emissions report and verification report (in paper form and sealed) to BJ DRC before each April 30. Conduct dynamic administration of the third-party verification institution, set strict rules for accession and a strict penalty mechanism, and constantly improve professionalism of verifiers.

Tianjin asks the ETS covered enterprises to deliver their next year’s emissions monitoring plan to Tianjin Development and Reform Commission (TJ DRC) before each November 30, produce the previous year’s emissions report in the first quarter of each year, and deliver both emissions report and verification report produced by a third-party verification institution to TJ DRC before each April 30. Besides, Tianjin has established a mandatory reporting system for key CO<sub>2</sub> emitters, i.e., even if the reporting companies are not qualified to join in the ETS, they are obliged to deliver previous year’s emissions report before each April 30, but monitoring plan and verification report are exempted.

Shanghai asks the ETS covered enterprises to deliver their next year’s emissions monitoring plan to Shanghai Municipal Development and Reform Commission (SH DRC) before each December 31; both regulated and reporting companies shall deliver their previous year’s emissions report before each March 31. A third-party verification institution recording system and verification rules are established, the name list of such institutions are made to the public. The third-party verification institution shall submit the verification report to SH DRC before each April 30.

Chongqing asks the ETS covered enterprises to deliver previous year’s emissions report and project-based emissions reduction report to Chongqing Development and Reform Commission (CQ DRC) before each February 20; and upload the annual emissions and reductions to the online reporting system. CQ DRC shall, within 5 business days upon receipt of the written emissions reports, entrusts a third-party verification institution to conduct emissions verification of the concerned companies.

Hubei MRV regime focuses on resolving major issues, i.e., it only regulates the CO<sub>2</sub> emissions from key emitters. The scope of regulation involves direct emissions, emissions from production processes and indirect emissions, but disregards of fugitive emissions. Hubei has established the *Hubei ETS Monitoring, Quantification*

*and Reporting Guidelines, Hubei GHG Emissions Verification Guidelines, and Recording and Administration Measures for Third-party Verification Institutions.* The ETS covered enterprises are asked to deliver next year's emissions monitoring plan to Hubei Provincial Development and Reform Commission before the last workday of each September, and submit previous year's emissions report before the last workday of each February; the third-party verification institution shall submit the verification report before the last workday of each April.

Guangdong ETS is now regulating the CO<sub>2</sub> emissions from four sectors (electricity, petrochemical, cement and iron and steel). It started counting the emissions from paper, glass, textile, non-ferrous, aviation and ceramics sectors since 2015. Guangdong has come up with the *Carbon Dioxide Emissions Reporting Guidelines for Companies* (for trial), which lists out both general provisions and the specific rules for electricity, petrochemical, cement and iron and steel companies. The MRV rules of Guangdong will be elaborated in Sect. 7.3.

## 7.2 Current Emissions Metering and Monitoring in Guangdong

In light of the *JIF 1001-1998 General Terms in Metrology and Their definitions*, 'metering' is an activity for unifying measurement units and providing accurate magnitude; 'metrology' is part of measurement, but stricter than common measurement, since it covers the entire area of measurement, and plays a role of guidance, supervision and assurance in measurement.

Metering of energy and supplies involves inspection, measurement and computation of the quantity, quality, performance parameters and characteristic parameters of energy and supplies at each link. Metering is an instrument that provides accurate analysis of energy and material utilization, and forms scientific and unbiased basis for energy and supplies administration [5].

The metering and monitoring of energy and supplies in Guangdong is in line with the *Metrology Law of the People's Republic of China, Energy Conservation Law of the People's Republic of China, Energy Conservation Regulation of Guangdong Province, Measures for the Implementation of the Metrology Law of the People's Republic of China in Guangdong*, and the *General Principle for Equipping and Managing of the Measuring Instrument of Energy in Organization of Energy Using* (GB17167-2006). The major content of metering and monitoring is shown as follows:

- (1) In reference to GB17167-2006, all of the energy input-and-output organizations, secondary energy input-and-output organizations and major energy-using equipment shall be equipped with metering instrument. Regular detection and calibration are required to ensure accuracy of such instrument. Gross energy is made up of non-renewable energy (gas, coke, heat, crude oil, natural gas, gas, LPD, refined oil products and biomass energy), and other useful energy through

direct or indirect processing or conversion. The metering instrument consist of electricity meter, water meter, Natural gas flowmeter, loadometer and steam flowmeter [6].

- (2) The supplies not only include materials or raw materials, but all the goods that are related to product production, e.g., raw materials, accessories, semi-finished products and finished products. Without uniform criteria, supplies metering mainly relies on the companies' uniform criteria administration system which records supplies warehousing, circulation, utilization and depletion.
- (3) A specialized metering administration shall be set up. Experienced metrologists—with professional background and holding at least an intermediate technical title—are invited to take charge of metering administration. Occupational trainings for metrologists and statisticians are held from time to time. All energy and supplies data shall be collectable and traceable.

The companies' emissions verification of Guangdong reveals a fact that large companies are doing a better metering job, particularly electricity companies, they have a full variety of data that are available for cross-checking. Even the companies of different business scope, industrial property and production scale have common ground in energy metering, which is shown as follows:

- (1) Weak awareness of metering. Several companies have not yet realized the importance of metering for energy conservation. Owing to incomplete energy metering administration, and halfway implementation of accountability system, the front-line workers regard energy metering as the responsibility of leaders.
- (2) Unappropriate metering instrument. The energy metering instrument fails to satisfy the standard and trace the emission sources. The energy input-and-output organizations and secondary energy input-and-output organizations have complete metering equipment, but the major energy-using equipment do not, which is hard to meet MRV's requirements that all monitored data shall be traced back to equipment and units.
- (3) Disordered metering administration. Energy and supplies metering is a fairly complicated system that involves companies' supplies purchase, production, consumption and record-keeping. The on-site investigations show that the production department usually keep the metering instrument, the supplies department takes charge of purchasing, the workshops use the instrument, and the statistics department keep metering records, i.e., each department is doing its own way and sometimes passes the buck to the other.

### **7.3 Compilation of the Guidelines for Reporting of CO<sub>2</sub> Emissions**

After Guangdong was designated as one of the first seven areas to carry out the pilot ETS program, Guangdong Government, after making preparations, promulgated the *Interim Measures for Guangdong Carbon Emissions Administration* (No. 197 [2014])



GD Gov) [7] in January 2014, stating explicitly to establish a corporate-level emissions reporting and verification system. In light of the “Interim Measures” and the job requirements for carrying out the ETS program, Guangdong Provincial Development and Reform Commission (GD DRC) organized the compilation of the *Implementation Rules for Guangdong Corporate Emissions Reporting and Verification* (for trial) [8] and the *Carbon Dioxide Emissions Reporting Guidelines for Companies* (for trial) [9]; the latter is split into the separate guidelines for electricity, cement, petrochemical and iron and steel sectors, which take full account of the distinctive production processes of the four sectors as noted, and integrate with the actual levels of production, metering and detection, have become important basis for quantifying the corporate carbon emissions.

The construction experiences of the global carbon markets prove that normal operation and healthy development of a carbon market depends on reliable and accurate corporate-level emissions data, which are based on a standardized emission reporting system. The guidelines for corporate-level emissions reporting have laid a technical basis in this regard, and provided scientific methodologies for emissions quantification, thus vigorously propping up the normal operation of Guangdong carbon market. They play a positive guiding role in the ETS study, companies’ transition to low-carbon development path, assessment of energy conservation and low carbon emissions, and implementation of the work for regulating the emissions from key sectors. Besides, they are able to promote low-carbon development of Guangdong-based electricity, cement, petrochemical and iron and steel sectors, and build up their product competitiveness on global market.

The authors of this book joined in compiling the emissions reporting guidelines for electricity, cement, petrochemical and iron and steel sectors of Guangdong, and took charge of the guidelines for cement sector. Their train of thought, compiling principles and relevant policies are introduced in Subsects. 7.3.1 and 7.3.2, which will reveal the key points, difficulties and distinctive creation in the MRV regime for Guangdong ETS.

### 7.3.1 *Compiling Principles*

The compilation of the guidelines at the corporate level for reporting of CO<sub>2</sub> emissions is strictly in line with *GB/T 1.1-2009 Directives for Standardization*, and abiding by the basic principles as “correlation, consistency, accuracy, transparency and authenticity”.

- (1) Correlation: Choose appropriate methodologies for calculating companies’ CO<sub>2</sub> emissions. Decomposition calculation is able exhibit the emissions from each production process and their correlations. With feasible technologies and reasonable cost, the companies shall improve monitoring conditions and upgrade quality of the reported data.

- (2) Consistency: Use uniform methodologies to define the emissions reporting scope, data gathering, calculation and reporting, and to compare relevant CO<sub>2</sub> emissions information.
- (3) Accuracy: Calculate CO<sub>2</sub> emissions from the companies' production and administration activities in an accurate manner.
- (4) Transparency: The data gathering and calculation process shall be clear-cut and verifiable. There shall be explanations for the calculation methodologies and data sources.
- (5) Authenticity: The data provided by the companies shall be authentic; and the content of monitoring plan and emissions report shall truly reflect the actual emissions.

In addition to the above principles, Guangdong ETS research group proposed to add another two principles for compiling the guidelines at the corporate level for reporting of CO<sub>2</sub> emissions, for the purpose of maintaining practicability and creativity of these guidelines.

(6) Sustainability:

The compilation of the guidelines for companies' reporting of CO<sub>2</sub> emissions shall follow the principle of sustainability, which embraces the calculation methodologies at different levels (whether there are equipment-level metering or measured emissions factors). The information modules for emissions reporting covers the company's basic information, major product information, emitting installations and emitting sources, and production situation, so as to reflect the companies' emissions in an all-round manner, build a linkage with the potential methodologies and allowances allocation mechanism in the national uniform carbon market in the future. The principle of sustainability helps maintain continuity and stability of the calculation methodologies, sustain the emissions information for the national uniform carbon market, and mitigate any adverse impact from changing calculation methodologies or inadequate information modules.

Sustainability also represents that the guidelines shall be applicable to the reporting demands of the companies of varied size or during different period, and the guidelines are effective during both historical emissions reporting period and official reporting period. For large companies that are capable of measuring emissions, the reporting may adopt measured emissions factors and measured calorific value, the emissions data may be traced back to emitting equipment. For small companies incapable of measuring emissions, the reporting may adopt reference emissions factors and default value (calorific value) free from measurement. For the historical emissions reporting period, in case of data vacancy or incompleteness, relevant default value is used. For the official reporting period, a measurement method is recommended after the emissions data are standardized and refined.

(7) Operability:

The compilation of the guidelines for companies' reporting of CO<sub>2</sub> emissions shall follow the principle of operability: the data sources and statistics shall be

based on the companies' current monitoring level and metering system; the data sources at different levels shall be provided to enable the companies, at the prerequisite of operability, improve monitoring and metering. Moreover, the guidelines shall involve standardized filing method and template, detailed filling items, and explanations for the filling content, so as to reduce the reporting difficulties, raise the accuracy and standardability of the reports, and facilitate the third-party verification institution to verify and trace back the companies' emissions reports and monitoring plan.

### **7.3.2 Basic Framework of the Guideline [9]**

The *Carbon Dioxide Emissions Reporting Guidelines for Companies* (see No. 16 in References) consists of ten parts: scope, criteria for quotations and references, glossary and definition, principles, reporting scope, emissions computation methodologies, data monitoring and quality control, monitoring plan, emissions report and appendix. The essential components are explained as follows:

#### (1) Reporting scope

In light of the *Carbon Dioxide Emissions Reporting Guidelines for Companies*, the reporting scope refers to the year of reporting, identification of organizational boundary, identification of CO<sub>2</sub> emissions activities, identification of CO<sub>2</sub> emissions unit and equipment, and selection of data reporting hierarchy.

#### (a) Definition of organizational boundary:

Definition of organizational boundary, which aims to clarify the legal statistical scope of a company, consists of an accounting report with the legal person as basic unit, and the company's foundation date, production capacity, business scope, equity structure, asset situation, ownership condition, plan area layout plan and organization chart. Furthermore, detailed explanations shall be made in case there is a corporate group legal person, trans-provincial subsidiary, changes upon organizational boundary or business outsourcing,

#### (b) Definition of CO<sub>2</sub> emissions activities:

From the perspective of technologies and in light of the physical and chemical properties of CO<sub>2</sub> emissions, CO<sub>2</sub> emissions activities consist of direct and indirect emissions activities, as well as special emissions activities.

Direct emissions are generated from fossil fuel combustion, alternative fuel combustion (excluding biomass fuel), carbonate decomposition, organic carbon decomposition, carbon precipitation and flue gas desulfurization. Indirect emissions arise from consumption of purchased electricity and heat. There shall be detailed definitions and explanations of special emissions.

(c) Definition of CO<sub>2</sub> emissions units and facilities:

CO<sub>2</sub> emissions units and facilities refer to the specific physical location where the emissions activities are taking place. Based on organizational boundary and definition of CO<sub>2</sub> emissions activities, we are able to further identify the corresponding emissions equipment owned by the emissions unit, and the energy and carbonaceous supplies used in the installations. Emissions unit is made up of all fixed or mobile units that directly link with CO<sub>2</sub> emissions (Table 7.1).

Deciding on levels of emissions reporting:

Levels of emissions reporting indicate that, under certain conditions, for each type of emissions activity, the company may choose the emissions data at different levels for computation and summarization. The reported data are from the levels of company, emitting unit or equipment. As for the company's emissions reporting and verification system of Guangdong, the default emissions data are assigned to the corporate level; however, if the emitting unit or equipment is available for better metering, and the accuracy of metering instrument is not lower than the

**Table 7.1** Exemplary CO<sub>2</sub> emissions scope [9]

CO <sub>2</sub> emissions scope		Exemplary activities	Exemplary emissions unit	Exemplary emission facility
Direct	Stationary combustion	Combustion of solid, liquid and gas fuels occurring on fixed production equipment, or combustion of other alternative fuels or combustible substance fossil carbon, e.g., coal, petroleum, natural gas, gasoline, LNG, gas, solid waste, liquid waste	Cement: clinker calcination Electricity: generating unit Iron and steel: sintering, iron-making Petrochemical: constant pressure reducing device	Cement: decomposing furnace, rotary kiln Electricity: boiler Iron and steel: blast furnace hot-blast stove, blast furnace Petrochemical: heating furnace
	Mobile combustion	Fuel combustion (gasoline or diesel) from transport activities with the transport means (vehicle, ship) owned by the company/unit itself	Proprietary transport means	Vehicle, ship
	Industrial processes	Carbonaceous raw material processing and non-fossil fuel utilization, e.g., cement, ceramics and lime production (there are CO <sub>2</sub> emissions from decarbonation process),	Cement: clinker calcination Iron and steel: lime calcination	Cement: decomposing furnace, rotary kiln Iron and steel: lime kiln Petrochemical: hydrogen

(continued)

**Table 7.1** (continued)

CO <sub>2</sub> emissions scope		Exemplary activities	Exemplary emissions unit	Exemplary emission facility
		iron and steel manufacturing (there are CO <sub>2</sub> emissions from iron-making flux decomposition and steel-making carbon reduction)	Petrochemical: catalytic cracking	production plant
Indirect	Consumption of purchased electricity and heat	Consumption of purchased electricity and heat arising from operational process of company or unit.	Cement: raw meal preparation, cement grinding Iron and steel: catalytic cracking Petrochemical: catalytic cracking	All installations that use purchased electricity
Special	Biomass fuel-based emissions	(i) Biomass fuel combustion: impregnated wood chips, dried sludge, wood, non-impregnated wood chips, agricultural wastes, organic waste, textile waste (ii) Partial biomass fuel combustion: waste tire, waste leather	Cement: clinker calcination Electricity: generating unit	Cement: decomposing furnace, rotary kiln Electricity: boiler
	CO <sub>2</sub> transfer	CO <sub>2</sub> is one of the raw materials for producing carbonated drinks, dry ice, fire extinguishing agent, refrigerant, experimental gases, food solvent, chemical solvent, chemical raw material, paper-making	Entire company	–

corporate-level metering, the priority shall be given to the emissions data from the level of emitting unit or equipment.

## (2) Methodology of CO<sub>2</sub> emission calculation

The *Guidelines for the Corporate-level Emissions Reporting* introduce the methods and formulas for quantifying direct and indirect CO<sub>2</sub> emissions. Direct

emissions stem from fuel combustion and production, and indirect emissions are generated by consumption of purchased electricity and heat. Such calculation relies on Emission Factor Approach and Material Balance Approach. In addition, Calorific Value Approach and Carbon Content Detection Approach are available for calculating the emissions from fuel combustion.

In order to ensure sustainability and operability of emissions reporting, the *Guidelines for the Corporate-level Emissions Reporting* also provide several reference values for detection, e.g., net calorific value and emission factor of all fossil fuels, and carbon content of alternative fuels, in case the direction detection is infeasible. The reference values and detection technics about emission factor are quoted from the world, domestic and provincial levels and from multiple departments (e.g., the national norms, the NDRC-initiated accounting guidelines, international files, the list of regulated GHGs released by Guangdong), and subject to certain adjustment in light of the special situation of Guangdong.

### (3) Data monitoring and quality control

In order to standardize data monitoring and quality control, the *Guidelines for the Corporate-level Emissions Reporting* specify the relevant requirements for data monitoring, recording, filing and uncertainty evaluation; and also clarify the technical norms, detection methods, monitoring frequency and requirements for defining data sources, and for preserving necessary evidence like fuel purchase invoice and test reports produced by technical institution.

There may be uncertainties in obtaining activity data and emission factor. Currently, the cement, electricity, iron and steel and petrochemical sectors of Guangdong are not suitable for quantitative evaluation of uncertainties, so the activity data and emission factor are subject to qualitative explanation; and the companies are obliged to explain the measures that they have adopted to reduce such uncertainties.

### (4) CO<sub>2</sub> emissions monitoring plan

In order for the companies to obtain emissions data, standardize emissions data, and abide by the principles of operability, consistency and sustainability, the Guidelines include templates for emissions monitoring, refine the filing items, make detailed explanations for the content for filing, for the understanding of companies and third-party verification institution. The Guidelines ask the companies, when significant change occurs to emissions data, they shall amend their monitoring plan and not lower the monitoring requirements. Moreover, when any major change occurs to the emissions data, the companies shall retain intact internal record for verification by the third-party verification institution (the template for the CO<sub>2</sub> monitoring plan is attached in the appendix).

### (5) CO<sub>2</sub> emissions report:

In light of the principles of operability, consistency and sustainability, for the companies to finish their emissions report in an accurate and convenient manner,

the Guidelines include the template for the CO<sub>2</sub> emissions report, and detailed content for filing, and offers detailed explanations for the content for filing, so as to lower the difficulties in filing the report, and facilitate verification by the third-party verification institution (the template for the CO<sub>2</sub> emissions report is attached in the appendix).

#### (6) Appendix

For the purpose of enabling the companies to complete their CO<sub>2</sub> emissions report in an accurate and convenient manner, the Guidelines provide detailed and complete appendix which involves treatment of special situation of organizational boundary, direct emissions from fuel combustion, emission factor of indirect emissions, net calorific value and emission factor of certain alternative fuels, template for CO<sub>2</sub> emissions monitoring plan and report, for the sake of filing and verification by third-party verification institution.

### 7.4 Verification Rules and Quality

In the entire MRV design of Guangdong ETS, the covered enterprises are main bodies in report, they shall develop a monitoring plan in light of the *Implementation Rules for Guangdong Corporate Emission Reporting and Verification (For Trial)* [8] (no amendments to the monitoring plan in case of no significant change) and a report on previous year's emissions, and report to Guangdong Provincial Development and Reform Commission (GD DRC) via the Emissions Reporting and Verification System, and coordinate with the third-party verification institution to verify the monitoring plan and emissions report. Through the government-initiated bidding for third-party verification institutions, GD DRC will define one institution to conduct CO<sub>2</sub> emissions verification. Such institution carries out verification according to law and in an independent and impartial manner, take responsibility for standardization, authenticity and accuracy of their verification report, and perform the duty of confidentiality as required by law. The development and reform commissions at all levels administration of such institutions. GD DRC take charge for organization, implementation, comprehensive coordination and supervision of the entire province's emissions administration. The municipal people's governments at and above the prefecture level shall guide and support the emissions administration within their administrative area. The municipal development and reform commissions at and above the prefecture level are responsible for organizing verification of the companies' emissions report (Fig. 7.2).

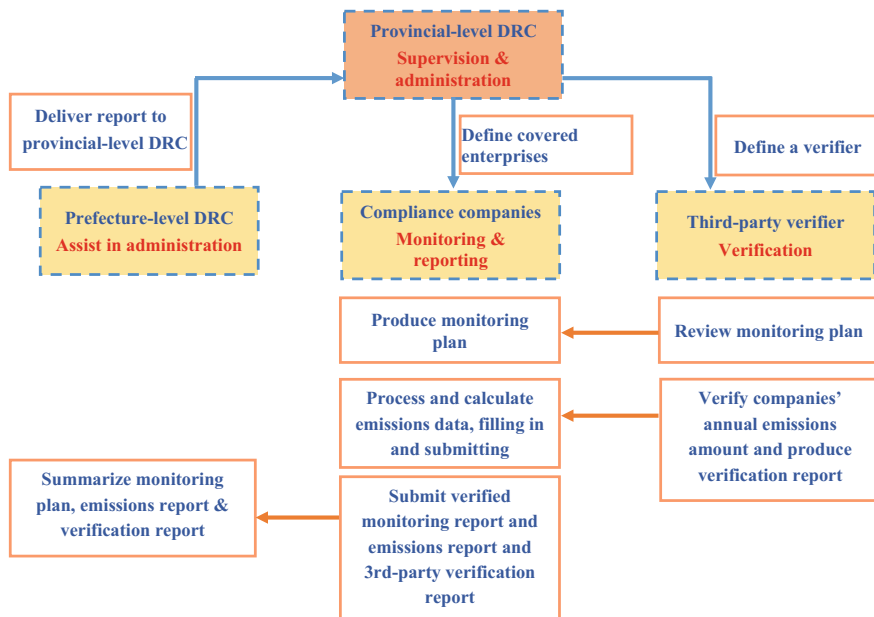


Fig. 7.2 MRV flow in Guangdong ETS

### 7.4.1 Verification Principles

The *Guidelines for the Corporate-level Emissions Reporting* is a scientific basis for quantifying companies’ CO<sub>2</sub> emissions in a standardized and normalized manner; they are also a technical cornerstone for the entire MRV regime by providing a consistent quantification criterion for the emissions from different sectors, different areas or in different time frame, thus enabling transparent calculation of actual emissions and projected emissions. The work of verification, in an aim to check and confirm the integrity and accuracy of emissions data, involves all emitters without exception. Relevant materials for tracing, certification and summarization are backed up during verification.

When carrying out the verification, the third-party verification institution shall follow the principles of independence and impartiality, and moral conduct that is credible, integrate, confidential and prudent. Meanwhile, the verification institution and the company to be verified shall have no conflict of interest for the sake of independent verification.



### **7.4.2 Requirements for Verification Competence**

#### (1) Verification institution

Being the principal party in undertaking the verification, the third-party verification institution shall make sure that all the participating verifiers are capable of fulfilling their assignment and professionally qualified. The verification institution shall establish competency criteria for verification chief, verifier and technical reviewer, particularly for verification chief and technical reviewer, devise the methods for evaluating competence and performance of verifiers regularly, and maintain occupational trainings for verifiers so that they are able to finish the verification successfully within the time limit.

#### (2) Verifiers

The verifiers shall have enough professionalism and occupational ethics, be skilled in utilizing the principles, procedures and technologies for verification, ensure consistency and systematization of verification, and confirm that the verified evidence is adequate and suitable to draw the verification conclusion. The verification chief, in addition to the abilities of common verifiers, shall be able to preside over an efficient and orderly verification, and lead the verification team to work out the conclusions and produce a verification report. The technical reviewer take charge of reviewing the verification report and internal verification documents, they shall be as competent as the verification chief, and have necessary professional background to judge the integrity and authenticity of the verified information, then accurately assess the verification result.

### **7.4.3 Verification Process**

The entire verification process is made up of five parts: contract review and acceptance, verification startup, on-site verification, compilation of verification report and closeout of verification. In order to make sure the verification quality, the third-party verification institution shall, in addition to a verification group, appoint an independent reviewer who conducts final examination of the on-site verification plan, data sampling process, verification findings and conclusions, so as to lower the risks in verification. The process of verification can be represented in the following framework diagram (Fig. 7.3).

The focus of on-site verification is placed on examination of data quality administration system, which is basis and instrument for tracing and confirming the emissions data. The examination of such system shall follow the three steps in the flow chart hereunder (Fig. 7.4):

Data collection focuses on gathering and maintaining the emissions data from major emitting installations, and calibration of detecting device and metering instrument.

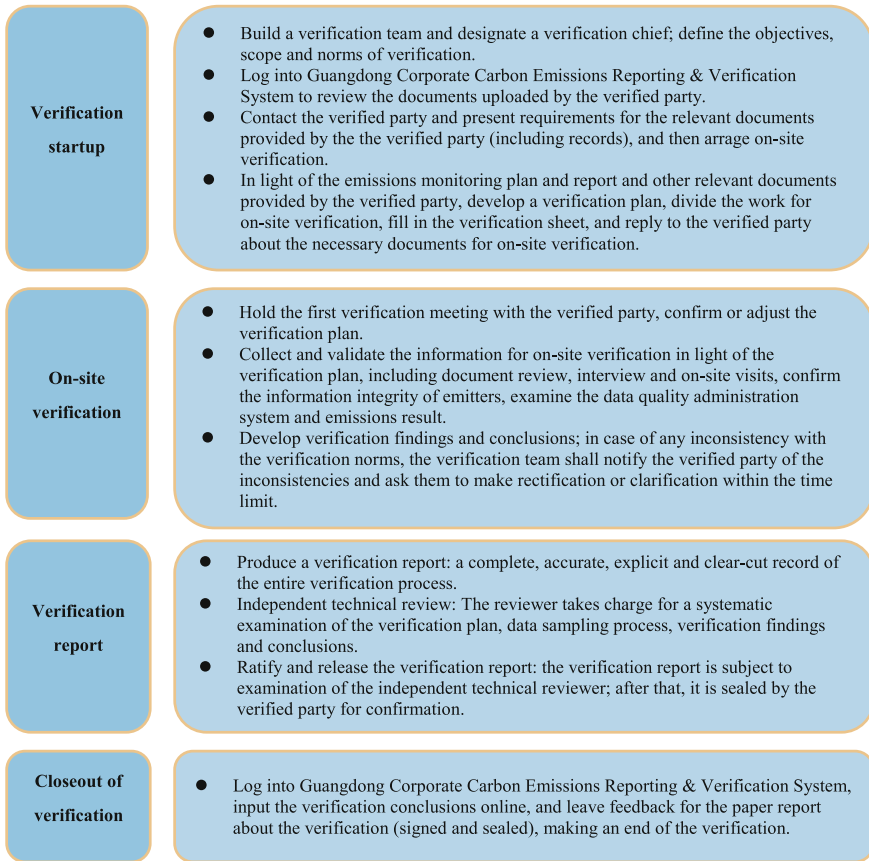


Fig. 7.3 Verification process [8]

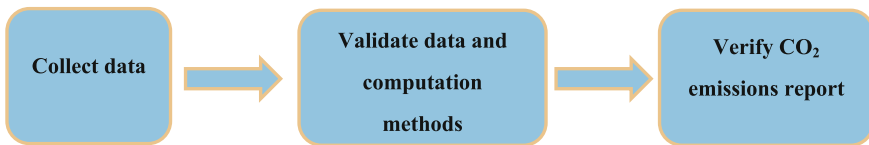


Fig. 7.4 Verification data chain

As for validation of data and computation methods, it is used for examining the relevant records and methods in reference to the activity data, computation methods, emissions factor and emissions amount that are covered in the emissions report, and based on the high-risk links (e.g., key emitters) that are clarified in the sampling plan. The aim of validation is to find out the abnormal value, fluctuations, trends and data deficiency in the emissions report, and confirm if there is any major deviation amid the data provided by the verified party.

- (1) Trace the emissions data back to their original records.
- (2) Predict the emissions trends through comparison of the historical emissions data.
- (3) Evaluate the consistency of the emissions data through comparison of the emissions from similar emitters.
- (4) Cross check the emissions data from diverse sources.

The third-party verification institution shall preserve their verification records and relevant papers (in both electronic and paper forms) for ten 10 years since the end of the entire verification work. The materials kept by the verification institution include the materials provided by the verified party, the internal verification papers (important work records and auxiliary materials) and the verification report. Without authorization of the development and reform commission, the verification institution may not disclose any information about the verified party.

#### ***7.4.4 Improvement of Verification Quality***

Verification quality is affected by the following factors: the competence of verification institution and its verifiers, the competence and coordination of the verified party (regulated companies), and supervision and administration of the competent authority. Therefore, the improvement of verification quality is determined by the competent authority, the verified party, verification institution and its verifiers.

##### **(1) Competent authority**

Under the MRV framework, the competent authority takes charge for coordination and supervision of companies' emissions reporting and verification. A properly-designed verification system, selection and supervision of the verification institution are part of the determinants for smooth execution of the verification work. The establishment of a third-party verification system, and fair, objective and transparent selection of a verification institution not only improves verification quality, but foster high-quality verification institutions, which will provide professional services to government and companies.

Guangdong ETS is under administration of Guangdong Provincial Development and Reform Commission (GD DRC) which takes charge for coordination, supervision and administration of the provincial MRV regime, and defines the third-party verification institution by means of bid invitation. GD DRC has announced the strict requirements for verification of in such bidding documents for the verification of the emissions from key companies/institutions and qualifications of verification institutions. Such documents state GD DRC has one-vote veto for qualifications and suitability of verification institution, and present strict requirements: technical and commercial review, understanding of the focal point of the verification work, implementation ideas and plan of verification, basis for work, qualifications, research experiences and requirements for personnel, setting a high threshold for

accession of verification institutions. As for administration of verification quality, the verification institution shall, in light of the Notice on the Provisions for Emission Reporting and Verification of Companies (For Trial) [9], The Guidelines for the Corporate-level Emissions Reporting, the Carbon Dioxide Emissions Reporting Guidelines for Companies (For Trial) [10], as well as the CO<sub>2</sub> emissions report, re-examination of verification report, and double check of verification quality.

### (2) The verified party

Being the main body that receives verification, the verified party itself (abilities in monitoring and metering emissions and making statistics, and coordination with the verifier) significantly affects verification quality. And their possession of some essential statistics, traceable documents and invoices that concern CO<sub>2</sub> emissions also affects verification quality. In sum, the emissions administration office and energy administration office and staffing of the verified party have significant impact on verification quality.

CO<sub>2</sub> emissions reporting and verification is a wholly new experience for companies, most of them have yet built an emissions reporting and administration system, and not clarified the emissions metering responsibility. At the initial phase of Guangdong ETS, four industrial sectors fall into the ETS regulation, some companies were not at the level playing field for emissions data monitoring, and some companies failed to carry out the work for energy metering and making statistics, and failed to properly record and make archive for monitored data, thus, they were somewhat resistant to CO<sub>2</sub> emissions reporting and verification. Therefore, it is a great stimulus to upgrading verification quality by holding trainings about carbon transaction, emissions reporting and verification, and cultivating talents in carbon and energy management. Along with continuous operation of the ETS, the companies have become highly aware of the importance of the emissions reporting and verification, from passive acceptance to active coordination, which has greatly improved verification quality.

### (3) Verification institution

Being the executor of the verification work, the verification institution plays a critical role in ensuring verification quality. The verification institution shall, in light of the verification specifications, carry out the verification work (including document review and on-site verification) according to law and in an independent and impartial manner, take charge for the standardability, authenticity and accuracy of the verification report, perform duty of confidentiality, and bear legal liability. The verification institution shall make sure that all participating verifiers are capable for fulfilling their tasks, particularly the verification chief and technical reviewer, and evaluate comprehensive quality of all participants. Moreover, all verifiers shall attend regular occupational trainings so as to improve verification quality.

#### (4) Verifiers

The verifiers—direct participants in verification work—play a decisive role in verification quality. Owing to particularity of verification work, and varied capability and understanding of verifiers, there may be disparity in verified emissions that are assigned to individual verifiers with varied common sense and verification scope. Therefore, there shall be standardized and normalized verification procedures, the verification institution shall strengthen occupational trainings and quality improvement of verifiers, so as to mitigate the disparity in verification result arising from individual verifiers.

The verifiers shall bear in mind of the verification principles and procedures and apply them into the practice to achieve a consistent and systematic verification result. They shall have a full understanding of the production processes of the verified party, so that they will be able to distinguish between true information and the fake one when dealing with massive information and data, and then cross check the relevant information. Moreover, they shall be able to examine and analyze the data systematically, giving priority to important issues, particularly the key emitting sources that are exposed to major deviations.

## 7.5 Dissection of Key Issues and Suggestions

Carbon trading is a newborn event in China, while a standardized and normalized MRV regime, which is foundation for normal operation and sound development of carbon trading, is also new to China. Among one of the first pilot carbon markets in China, Guangdong Province is fully aware of the importance of the MRV regime, so it has poured massive energy into MRV design. When developing the *Guidelines for the Corporate-level Emissions Reporting*, which is recognized as technological basis for the MRV regime, Guangdong had paid attention to lots of practical issues.

### 7.5.1 Key Issues in Developing the Guidelines

#### (1) Reasonable definition of companies' organizational boundary

Guangdong Province is home to a large number of companies, yet their organizational boundary is fairly complicated, e.g., different companies share the same energy sources, inexplicit property rights, non-independent corporate enterprise, conglomerate and cross-regional enterprises, which has caused great difficulties in defining their organizational boundary. As such, when developing the *Guidelines for the Corporate-level Emissions Reporting*, the authors consulted and surveyed lots of authorities and channels to improve their definition of companies' organizational boundary, and to fix a scientific statistical boundary for companies.

- (2) Taking account of the differences in emissions monitoring, metering and detecting among companies

Most companies have yet built a carbon emissions data monitoring system, nor clarified the duties of emissions metering. They are not on a level playing field of emissions data monitoring, e.g., some of them have failed in metering and keeping statistics for energy or failed in recording and archiving the monitoring data. Under such difficult situation, the authors have taken full account of the differences in emissions data monitoring, metering and detecting among companies when developing the *Guidelines*, and they designed varied data hierarchies, defined emissions factor, net calorific value of fuels and other relevant default values, so as to guide the companies to finish the emissions report. The default values are firstly based on the reference values announced by NDRC, NBS and other competent authorities.

- (3) Effect implementation of the *Guidelines*

The companies in Guangdong actually have tremendous differences. It is a core mission to develop applicable calculation methodologies during compilation of the *Guidelines*. As such, the authors organized extensive surveys of relevant companies, industry associations and research institutions, held discussions to draw opinions and suggestions from companies and industry experts on the framework of the *Guidelines* and calculation methodologies. Moreover, the authors invited some companies with different production scale and metering strength to produce trial report on emissions and try out the *Guidelines*, and then draw the feedbacks from companies to amend and improve the *Guidelines*. The text of the *Guidelines* is published via official websites, emails, symposiums, seminars and trial operation to solicit the opinions from the electricity, cement, iron and steel and petrochemical companies, research institutions and industry associations for further improvement. The *Guidelines* were finally applied by the electricity, cement, iron and steel, petrochemical companies in producing historical emissions reports in 2013.

### ***7.5.2 Key Issues in Emissions Verification***

The MRV regime of Guangdong has been constantly improved. Local companies have paid more attention to emissions reporting and verification, and most of them have shifted stance toward active collaboration with the verification institutions. Through deliberate cultivation and regulation, local verification institutions and verifiers have become more competent. Yet some problems remain in existence:

- (1) MRV policies and regulations and administration remain weak

Guangdong has so far accumulated some experiences in MRV construction and operation, but the relevant policies and regulations and administration remain somewhat defective, the technical supporting system needs to be further refined and

improved, and the capacity building and financial support in relevant fields shall be strengthened.

- (2) Lack of a perfect emissions data monitoring system, levels of data monitoring and metering vary greatly

Among Guangdong-based companies, the current emissions monitoring equipment are built in line with the existing energy conservation and emissions reduction system. Despite of online monitoring in some companies, their focus is placed on such conventional pollutants as dust, nitrous oxide and SO<sub>2</sub>, which is to satisfy the general environmental protection standards, instead of the specific parameters (fuel element, calorific value and carbon content) marking GHG emissions. The companies shall strengthen their awareness in energy metering and statistics keeping, and make up for the deficiency in inept recording and archiving of monitored data which may lead to missing of tracing materials and affect the verification result.

- (3) Lack of functional divisions and professionals

Without functional divisions or professionals, most companies are incompetent in organizing professionals in quality control and supervision of emissions monitoring, metering, statistics making, data processing, reporting and verification, and in division of responsibilities. It is a common practice for the companies to transfer personnel temporarily from other departments to take charge of emissions reporting and verification, yet they lack basic emissions knowledge, which worsens quality of emissions report and increases difficulties in verification. Therefore, Guangdong Provincial Development and Reform Commission have input massive manpower and material resource into building the carbon transaction skills of companies, organized trainings on emissions reporting and verification, seminars joined by companies' representatives, on-site surveys to companies, on-site guidance of producing emissions reports, invited industry experts to provide professional guidance, helped companies cultivate talents and enhance their carbon occupational skills.

- (4) Lack of carbon asset management division and professionals

In Guangdong carbon market, only a small number of companies have set up a specialized carbon asset management division to make statistics of the company's own emissions and evaluate the company's potential asset value. Such weak awareness of carbon asset directly impacts the activity of carbon market. Although the situation is constantly improved, it still needs to be further strengthened.

- (5) Administration and cultivation of verification institutions shall be further improved

Although Guangdong has established the admittance criteria for the verification institutions and exercised strict supervision and administration, more work shall be done to further improve their administration and cultivation. For the purpose of improving verification quality, monitoring and management and verification

institutions shall be strengthened, the spot check of verification institutions shall be strengthened to assess their verification level. There shall be a system for archiving credit of verification institutions, which will include their wrong doings (receiving bribes from the verified party or any major deviations in the verification result) into the archives. Any institution with a bad record for dishonest behavior shall be disqualified and exposed to the public.

(6) The qualifications and professional skills of verifiers shall be further improved

Guangdong has established strict admittance criteria for the verification institutions, but lack of specific requirements for qualifications of verifiers. The verifiers vary greatly in their competence, which may affect the qualification result. The verification institutions shall strengthen professional trainings and management of their verifiers to prevent from any deviated verification arising from verifiers' individual differences. Moreover, the verification institutions shall improve the professional skills and credit of verifiers, so that they will not muddle through their work; establish an accreditation system that not only benefits standardized management of the institutions, but raises work efficiency and sustains the work of emissions verification. The verification quality will be improved through sustainable supervision of verification institutions and improvement of verifiers' quality.

(7) Tight schedule for verification

The emissions verification of Guangdong concentrates before the deadline of companies' compliance, which exerts high pressure upon both arrangement of verifiers and schedule for on-site verification, which will leave major impact on the verification quality. It is better for the competent authority to shift the emissions reporting to an earlier date, so the third-party verification institution may start verification as early as possible. Besides, the competent authority may call up the verification institutions to report their working progress and the problems before the deadline of the verification, which helps enure smooth completion of the verification.

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