

# T/CAPID

## Association Standards of CAPID

T/CAPID 009—2024

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Voluntary certification scheme for  
zero carbon energy certificates —  
Specification for certification of  
bio-natural gas

零碳能源证书自愿核证体系 生物天然气  
核证规范

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## Foreword

*CAPID is in charge of this English translation. In case of any doubt about the contents of English translation, the Chinese original shall be considered authoritative.*

This standard is drafted in accordance with the rules given in the GB/T 1.1-2020 Directives for standardization-Part 1: Rules for the structure and drafting of standardizing Documents. This document is proposed by the China Association for the Promotion of Industrial Development (CAPID).

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## Introduction

The "14th Five-Year Plan" for Renewable Energy Development explicitly proposes the establishment of a sound mechanism for green energy consumption and the establishment of a system for the evaluation, certification, and labelling of green energy consumption. At present, China's verification and issuance of green power certificates and voluntary subscription system is basically established, but a proper mechanism for the non-electric utilization of renewable energy is not available, and the way of realizing environmental rights and interests is still absent. For example, a corresponding verification and certificate trading system has not yet been formed for green thermal energy, green gas and green liquid fuels, making it difficult to manifest the environmental rights and interests of the energy.

In order to implement the national carbon peaking and carbon neutrality strategy, promote the high-quality development of China's renewable energy, and create a diversified mechanism for realizing the environmental rights and interests of renewable energy, the Biomass Energy Industry Promotion Association, CAPID organized enterprises and experts to formulate the series standards for the "Voluntary Certification Scheme for Zero Carbon Energy Certificates" which is aimed at establishing a mechanism for the certification and consumption of non-electricity renewable energy, and further reflecting the environmental rights and interests of renewable energy.

As the guiding document, the Voluntary Certification Scheme for Zero Carbon Energy Certificates - General Rules establishes the structure of the certification system, clarifies the responsibilities of all relevant parties, and standardizes the whole life cycle from certification to cancellation of the certificates, so as to guarantee the environmental rights and interests of the Zero Carbon Energy Certificates.

A series of standards of Voluntary Certification Scheme for Zero Carbon Energy Certificates - Certification Code are formulated for specific renewable energy utilization, covering all areas of non-electricity utilization of renewable energy, providing normative guidance for the certification of different types of renewable energy projects, aiming to ensure compliance, voluntariness, uniqueness, transparency, accuracy, conservatism, etc.

This document provides the necessary references for the certification of zero-carbon energy certificates in the field of bio-natural gas in terms of the accounting scope and boundary, the accounting steps and methods, data quality management, the verification procedures, and the certification procedures, which covers the key links in the certification of zero-carbon energy certificates in the field of bio-natural gas, to regulate the certification work, to safeguard the quality of the certification, and to provide guidance and references for the participation of the relevant parties.

# Voluntary certification scheme for zero carbon energy certificates—Specification for certification of bio-natural gas

## 1 Scope

This document specifies the accounting scope and boundary, accounting steps and methods, data quality management, verification procedures, and certification procedures for certification of zero-carbon energy certificates for bio-natural gas.

This document is applicable to the accounting, verification and certification of Zero Carbon Energy Certificates for bio-natural gas. Other type of biogas project shall be implemented accordingly.

## 2 Normative references

The contents of the following documents constitute indispensable provisions of this document by means of normative references in the text. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 2589 *General rules for calculation of the comprehensive energy consumption*

GB/T 11062 *Natural gas—Calculation of calorific values, density, relative density and Wobbe indices from composition*

GB 17167 *General principle for equipping and managing of the measuring instrument of energy in organization of energy using*

GB/T 18603 *Technical requirements of measuring systems for natural gas*

GB/T 29488-2013 *Medium/high-power biogas generating set*

GB/T 30366-2013 *Terminology Related to Biomass*

GB/T 35211 *Measurement of nature gas calorific value—Continuous combustion*

GB/T 41328-2022 *Biogas-based natural gas*

JJF 1993-2022 *Metrological Specification for the Energy Measurement of Natural Gas*

NY/T 3239-2018 *Technical specification of remote monitoring for biogas engineering*

NB/T 10865-2021 *Specification for Preparation of Feasibility Study Report for Bio-natural Gas Projects*

T/CAPID 006 *Voluntary certification scheme for zero carbon energy certificates—general rules*

T/CAPID 007 *Voluntary certification scheme for zero carbon energy certificates—Specification for certification of biomass thermal energy*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in GB/T 30366-2013 and NB/T 10865-2021 the following apply.

### 3.1

Bio-natural gas;BNG

The bio-natural gas produced through anaerobic digestion and purification, using various urban and rural organic wastes as raw materials, such as crop straw, livestock and poultry manure, wastewater and residue from agricultural by-products processing, kitchen waste, and municipal sludge.

NOTE: NB/T 10865—2021, Definition 2.0.1

### 3.2

#### Biogas

Biomass, under specific temperature, humidity, pH, and anaerobic conditions, undergoes anaerobic digestion and decomposition by microorganisms to produce a mixed combustible gas with methane as its main component.

NOTE: NB/T 30366—2013, Definition 2.4.6

### 3.3

#### Subject of application for certification

The Subject that voluntarily registers an account, applies for certification, and performs other actions on the certification platform.

NOTE: T/CAPID 006—2023, Definition 3.5

## 4 Accounting content and boundaries

### 4.1 Accounting content

The subject applying for certification should, through the certification platform, calculate and report all types of energy used in all energy activities within its production system related to the production of bio-natural gas. This includes the types and quantities of renewable and fossil energies used, ultimately calculating the amount of net zero carbon energy corresponding to the produced bio-natural gas.

### 4.2 Accounting boundaries

4.2.1 The subject of application for certification shall identify the accounting boundaries and the timeframe involved in zero carbon energy certificates.

4.2.2 The subject of application for certification shall take as its boundary an enterprise legal person or a self-accounting unit treated as a legal person to account for and report the amount of zero-carbon energy generated or supplied by its production system. Production system includes the main production system, auxiliary system and accessorial system directly serving for the production; auxiliary system including dynamical system, power supply, water supply, laboratory, mechanic, warehouse, transportation, etc., and the accessorial system including the production commanding system (factory) as well as the departments and facilities serving for the production in the factory area (such as workers' cafeteria, workshop bathroom, health care station, etc.). When there are different product process lines within the production system, the production line for bio-natural gas should be separately calculated and reported. If the production lines cannot be distinguished, a conservative approach should be taken.

4.2.3 The determination of the accounting boundary should take reference to the facilities

and business scope of the subject of application for certification and their production process flow, which shall include various types of energy used during the raw material transportation and the bio-natural gas production, as shown in Figure 1. For instance, fossil energy used in the transportation of raw materials, fossil energy in the bio-natural gas production phase, purchased electricity, purchased heat, and the energy of bio-natural gas supplied externally.

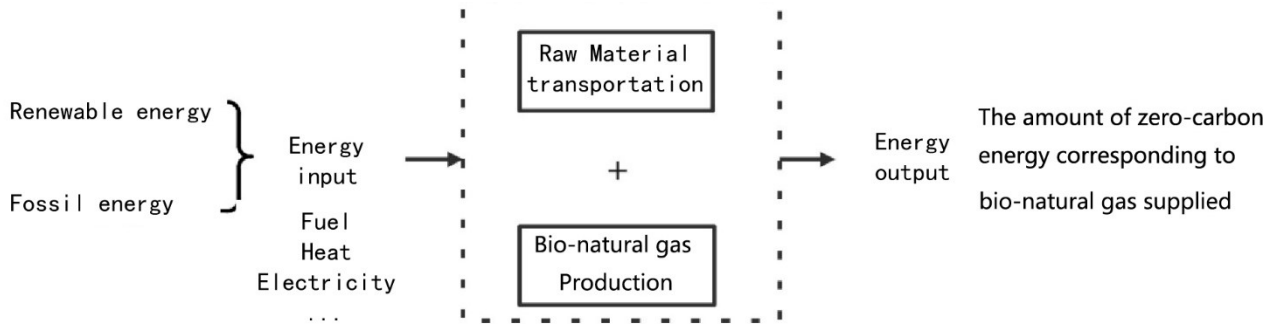


Figure 1 Schematic diagram of the accounting boundary

## 5 Accounting steps and methods

### 5.1 Accounting steps

The workflow of accounting and reporting for the subject of application for certification includes the following steps:

- a) Identify the accounting boundaries and collect data on activities on each phase;
- b) Calculate separately the fossil energy used within the accounting boundary during the raw material transportation phase, the fossil energy used during the production phase, the consumption of purchased electricity, the consumption of purchased heat, and the energy of bio-natural gas supplied externally, etc.
- c) Summarize and account for the zero-carbon energy produced and supplied by the subject of application for certification and other related information;
- d) Formulate the accounting report.

### 5.2 Accounting method

The amount of zero-carbon energy that the subject of application for certification is applying to certify  $Q_z$ , is calculated with equation (1):

$$Q_z = Q_{jc} - Q_{ys} - Q_{sc} \dots \dots \dots (1)$$

where:

$Q_z$ —Zero carbon energy amount, i.e. certified energy amount, the energy corresponding to the issued zero carbon energy certificate, in gigajoule (GJ);

$Q_{jc}$ —The total amount of bio-natural gas supplied outside by the subject of application for certification that is monitored online by the certification platform, in gigajoule (GJ);

$Q_{ys}$ —Energy from fossil energy sources used during the transportation of raw materials, in gigajoule (GJ);

$Q_{sc}$ —Energy from fossil energy sources used during the bio-natural gas production, in gigajoule (GJ).

### 5.3 Energy in the transportation of raw materials

The total fossil energy consumption in the raw material transportation is calculated according to equation (2), based on the fossil energy consumption and the corresponding calorific value:

$$Q_{ys} = \sum q_i \times m_i \dots\dots\dots (2)$$

where:

$q_i$ —Dry basis low level calorific value of the Type  $i$  fossil energy source, in gigajoule per tons or gigajoule per Normal Cubic Meter (GJ/t or GJ/Nm<sup>3</sup>);

$m_i$ —Mass of the Type  $i$  fossil energy source, in tons or Normal Cubic Meter (t or Nm<sup>3</sup>);

$i$ —Type  $i$  of fossil energy.

NOTE: The dry basis low level calorific value of fossil energy can be measured with reference to Annex A, GB/T 2589-2020 or through corresponding standards.

The fossil energy consumption of transportation vehicles can be calculated based on the transportation distance and the energy consumption per unit mileage, using formula (3):

$$m_i = \sum_n OC_{n,i} \times C_i \times D_{n,i} \dots\dots\dots (3)$$

where:

$OC_{n,i}$ —The fuel (gas) consumption per 100 kilometers for transportation vehicles, in liters per 100 kilometers (L/100km) or cubic meters per 100 kilometers (m<sup>3</sup>/100km);

$C_i$ —Density of the Type  $i$  fossil energy source, in tons per cubic meters or tons per liters;

The mileage of the transportation vehicle, in kilometers (km);

$i$ —Type  $i$  of fossil energy;

$n$ —Type  $n$  of transportation vehicle.

When transportation vehicles are powered by electricity, the consumption of electricity produced from fossil energy is calculated using formula (4):

$$Q_{ys} = \sum_n EC_n \times 3.6 \dots\dots\dots (4)$$

where:

$EC_n$ —The total electricity consumption of the transportation vehicles, in megawatt-hours (MW · h);

3.6—The conversion factor, in gigajoule per megawatt-hour (GJ/MW · h).

NOTE: Renewable electricity should be accounted for separately, and relevant supporting documentation must be provided and explained in the report. However, it should not be included in the energy calculation for the raw material transportation stage. If the relevant supporting documentation cannot be provided, all electricity will be considered as fossil energy electricity.

### 5.4 Energy in the bio-natural gas production phase

The total fossil energy consumption  $Q_{sc}$  in bio-natural gas production phase is calculated according to equation (5).

$$Q_{sc} = Q_{hs} + Q_{yd} + Q_{yr} \dots\dots\dots (5)$$

where:

$Q_{hs}$ —Total fossil energy used for bio-natural gas production in the gas production phase, in gigajoule (GJ);

$Q_{yd}$ —Total electricity used for bio-natural gas production in the gas production phase, in gigajoule (GJ);

$Q_{yr}$ —Total heat used for bio-natural gas production in the gas production phase, in gigajoule (GJ).

#### 5.4.1 Total fossil energy used for bio-natural gas production

The total fossil energy used for bio-natural gas production during the gas production phase should be calculated based on the amount of fossil energy used in the production system and its corresponding calorific value, using formula (2).

#### 5.4.2 Total electricity used for bio-natural gas production

The total electricity consumption used for bio-natural gas production in the gas production phase  $Q_{yd}$  shall be accounted for on the basis of meter access data for off-grid electricity within the accounting boundary.

$$Q_{yd} = EC_{yd} \times 3.6 \dots\dots\dots (6)$$

where:

$EC_{yd}$ —The total in grid electricity consumption used for bio-natural gas production in the production phase, in megawatt-hours (MW · h);

3.6—Conversion factor, in gigajoule per megawatt-hour (GJ/MW · h).

In case of electricity consumption within the factory, the source of electricity should be identified; Renewable electricity should be accounted for separately, and relevant supporting documentation must be provided and explained in the report. If the relevant supporting documentation cannot be provided, all electricity will be considered as fossil energy electricity.

Electricity generated from fossil fuels within the plant should be included in the total amount of fossil energy according to section 5.4.1.

#### 5.4.3 Total heat used for bio-natural gas production

The total heat used for producing bio-natural gas during the gas production stage,  $Q_{yr}$ , when sourced externally, should be recorded based on data from heat meters or steam flow meters within the accounting boundary. This should be done in accordance with T/CAPID 007 and calculated using formula (7):

$$Q_{yr} = m_{yr} \times (h - 83.74) \times 10^{-3} \dots\dots\dots (7)$$

where:

$m_{yr}$ —The mass of steam, in tons of steam (t);

$h$ —The enthalpy value of steam per kilogram at the corresponding temperature and pressure should be referenced from relevant industry standards, in kilojoule per kilogram (kJ/kg);

83.74—The enthalpy value of water at 20° C, in kilojoule per kilogram (kJ/kg);

$10^{-3}$ —Unit conversion factor, dimensionless.

The heat powered by renewable energy should be accounted for separately, and relevant supporting documentation must be provided and explained in the report. However, it should not be included in the total heat consumption for bio-natural gas production. If the relevant supporting documentation cannot be provided, all heat will be considered as fossil energy heat.

Heat generated from fossil fuels within the plant should be included in the total amount of fossil energy according to section 5.4.1.

### 5.5 The total energy of bio-natural gas supplied externally

The bio-natural gas measurement system should comply with the GB/T 18603. The standard reference conditions for measurement should be 101.325 kPa and 20° C, with the lower heating value of dry natural gas.

The certification platform should monitor the total energy of bio-natural gas supplied externally  $Q_{jc}$ , produced by the subject applying for certification. This should be done in accordance with JJF 1993—2022 and calculated using formula (8).

$$Q_{jc} = \sum V \times H_{jc} \times 10^{-3} \dots\dots\dots (8)$$

where:

$V$ —Monitoring the volume of bio-natural gas or biogas supplied externally, in cubic meters ( $m^3$ );

$H_{jc}$ —The lower heating value of bio-natural gas or biogas supplied externally at 20° C and 101.325 kPa, in megajoule per cubic meter ( $MJ/m^3$ ).

The subject applying for certification should select the appropriate standards based on on-site monitoring conditions to measure or calculate the lower heating value of the bio-natural gas.

The determination of the lower heating value of bio-natural gas  $H_{jc}$  includes the following three methods:

- a) When direct measurement conditions are available, the lower heating value of bio-natural gas should be calculated in accordance with GB/T 35211;
- b) When indirect measurement conditions are available, the lower heating value of bio-natural gas should be calculated in accordance with GB/T 11062;
- c) When neither condition is met on-site, the lower heating value of the bio-natural gas should be conservatively estimated based on the corresponding methane mole fraction. The values are provided in Table 1.

Table 1 Reference table for the heating value of biogas and bio-natural gas in relation to the methane mole fraction

Methane mole fraction mol/mol	Low heating value $MJ/m^3$	High heating value $MJ/m^3$	Note
100%	33.367	37.044	The heating value of methane as an ideal gas is determined according to Table 5 of GB/T 11062—2014
96%	30.323	34	The higher heating value of Category 1 bio-natural gas is determined according to Table 1 of GB/T 41328—2022

Methane mole fraction mol/mol	Low heating value MJ/m <sup>3</sup>	High heating value MJ/m <sup>3</sup>	Note
85%	27.723	31.4	The higher heating value of Category 2 bio-natural gas is determined according to Table 1 of GB/T 41328—2022
60%	20.934	24.611	The average lower heating value of biogas is determined according to Table A.1 of GB/T 2589—2020
30%	14	17.677	The average lower heating value of biogas is determined according to Table A.1 of GB/T 29488—2020
NOTE 1: According to the ideal gas law, at constant temperature and pressure, the mole fraction of a gas equals its volumetric content. When the methane mole fraction falls within a range, the corresponding lower/higher heating value of methane should be linearly calculated within that range. NOTE 2: The conversion between the higher heating value and the lower heating value of methane with different mole fractions should refer to the difference between the 100% methane higher heating value and lower heating value, which is $37.044-33.367=3.677$ MJ/m <sup>3</sup> .			

## 5.6 Sources of accounting data

### 5.6.1 Sequence of accounting data acquisition

The monitoring equipment shall meet the requirements of national standards, local standards and industry standards, and the instrumentation shall be properly calibrated on a regular basis to ensure the accuracy of the verification data. The data acquisition priorities for the accounting of Zero Carbon Energy Certificates are shown in Table 2:

Table 2 Data acquisition priority

Data types	Description	Priority
Raw data	Data obtained from monitoring and measurement by the certification platform	Highest
	Data obtained from direct instrumental measurement by the subject of application for certification	High
Secondary data	Data obtained by converting raw data	Medium
Alternative data	Data from similar processes or activities	Low

### 5.6.2 Frequency of accounting data acquisition

The accounting data, except those monitored in real time by the certification platform, shall be acquired at the frequency specified in the monitoring plan of the subject of application for certification. The monitoring plan shall conform to the national and local laws as well as regulations, policies, standards.

## 6 Data quality management

The subject of application for certification shall reinforce the management of data quality in the Zero Carbon Energy Certificates, including, but not limited to:

- a) Establish rules for the accounting and reporting of zero-carbon energy certificates for biomass thermal energy in enterprises, including the responsible organization and personnel, workflow and content, duty cycle and time nodes, etc.; a dedicated staff member is assigned to be responsible for the accounting and reporting of zero-carbon energy certificates in enterprises;

- b) Classify the accounting data of zero carbon energy certificates according to their priority, with a list of the accounting data of zero carbon energy certificates of enterprises, which provides corresponding requirements for the acquisition of accounting data of different classes;
- c) Evaluate the existing monitoring conditions in accordance with GB 17167 and NY/T 3239, to constantly improve their own monitoring capacities, and formulate corresponding monitoring plans to collect activity data; regularly maintain the measuring instruments, testing equipment and online monitoring instruments, with clear records;
- d) Establish a comprehensive zero-carbon energy certificate data recording management system, including the management of information on data sources, data acquisition times, and relevant responsible persons.
- e) Establish an internal review system for Zero Carbon Energy Certificate reports, regularly cross-check production activity data to identify potential risks of data errors and propose appropriate solutions.

## 7 Verification

### 7.1 Verification principles

#### 7.1.1 Objective and independent

The verification organization shall maintain its independence from the certified project activity, remain objective throughout the verification activity without bias or conflict of interest.

#### 7.1.2 Fair and just

The findings, conclusions and reports of the verification organization in its verification activities shall be true and accurate. The report shall include unresolved differences of opinion, in addition to significant obstacles during the certification.

#### 7.1.3 Honest and trustworthy

The verification organization shall exercise a high degree of responsibility to ensure the integrity and confidentiality of the verification.

#### 7.1.4 Professional

The verification organization shall possess the necessary professional skills for verification, able to exercise professional judgment in accordance with the importance of the task and the specific requirements of the client.

### 7.2 Verification Process

#### 7.2.1 Verification process

The process of verification of zero carbon energy certificates carried out by the verification organization consists of three phases, as shown in Figure 2.

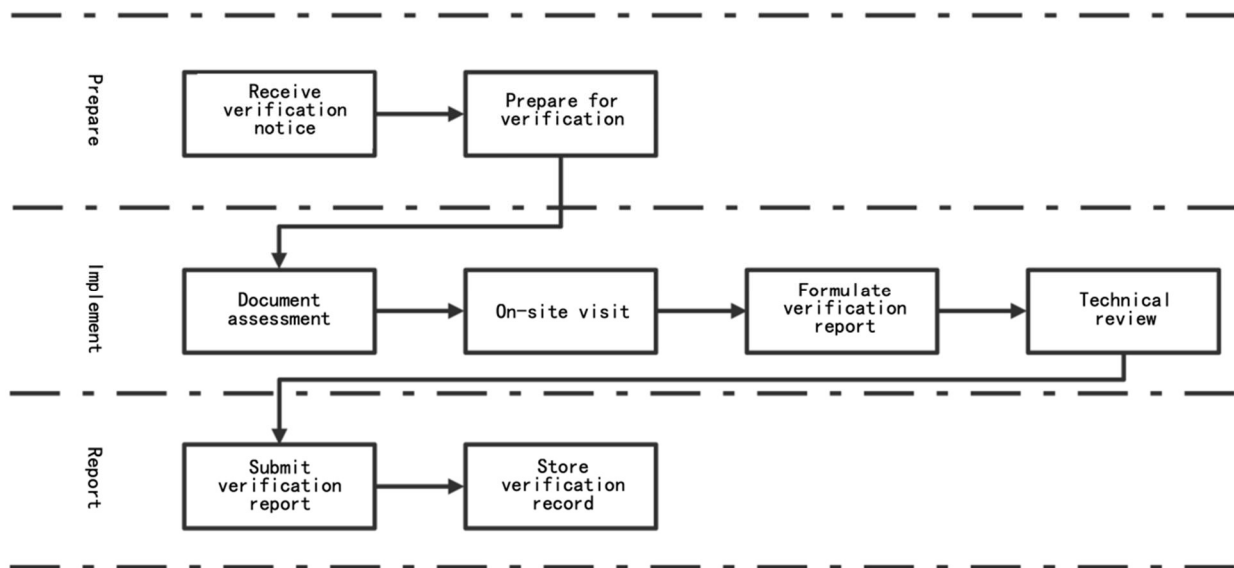


Figure 2 Verification process

### 7.2.2 Preparation

Upon receipt of the notification from the certification platform, the verification organization shall establish a verification team with professional skills in accordance with the project status, as well as the field of expertise and technical competence of the verifier, to prepare for the verification in advance.

### 7.2.3 Implementation of verification

The verification organization shall act in accordance with the corresponding certification standards and requirements and perform effective on-site visits after determination of the rationality of the materials to be verified, confirmation of the focus of the on-site visit and formulation of the on-site visit plan. The verification organization shall prepare a verification report based on the on-site findings and conduct a technical review to ensure that the verification report is truthful, objective and logically clear.

### 7.2.4 Reporting

After the technical review, the verification organization shall submit the verification report and other supporting relevant materials to the certification platform. The verification body shall keep all written and electronic documents in the verification process in a secure and confidential manner for at least 10 years.

## 7.3 Verification content

The verification organization shall conduct verification in accordance with the rules and relevant requirements of the certification platform. This includes confirming the uniqueness of the zero-carbon energy certificates for the project, assessing the reasonableness of the accounting results, verifying the configuration of production facilities and measurement equipment, verifying the operation of the monitoring system, and confirming the implementation of the monitoring plan, etc.

For the verification of bio-natural gas, the type and source of the raw materials should be clearly identified. The classification of raw materials can be referenced in Appendix B. If the materials are not listed in the appendix, it should be verified whether the raw materials are organic waste, and this should be explained in the report.

The total energy of bio-natural gas supplied externally should be cross-verified to ensure that the total energy of biogas before purification in the production system is greater than the total energy of the bio-natural gas supplied externally. Otherwise, the source of the issue should be investigated, and an explanation should be provided in the report. The total energy of biogas before purification should be considered as the total energy of the bio-natural gas supplied externally.

## 8 Certification

The certification of Zero Carbon Energy Certificates shall be conducted in accordance with T/CAPID 006 and related regulations.

## Annex A (Informative)

### Energy conversion and reference value

Due to the variety of non-electric renewable energy sources, the conversion between different energy sources should take reference to the relevant provisions of GB/T 2589-2020, with the energy unit unified as gigajoule (GJ). If the energy is not in joules, it is converted to gigajoule by means of a standard coal quantity.

NOTE 1: 1 kgce = 29307.6 kJ = 0.0293076 GJ = 7000 kcal

NOTE 2: 1 kW · h = 3600000 J = 0.0036 GJ

Table A.1 Standard coal conversion factors for energy sources (for reference)

Energy	Average low calorific value	Coefficient of conversion to standard coal
Raw coal	20934 kJ/kg (5000 kcal/kg)	0.7143 kgce/kg
Cleaned coal	26377 kJ/kg (6300 kcal/kg)	0.9000 kgce/kg
Middling	8374 kJ/kg (2000 kcal/kg)	0.2857 kgce/kg
Coal sludge	8374 kJ/kg~12560 kJ/kg (2000 kcal/kg~3000 kcal/kg)	0.2857 kgce/kg ~0.4286 kgce/kg
coal gangue (as energy)	8374 kJ/kg (2000 kcal/kg)	0.2857 kgce/kg
Coke (DryQuenching)	28470 kJ/kg (6800 kcal/kg)	0.9714 kgce/kg
Coal tar	33494 kJ/kg (8000 kcal/kg)	1.1429 kgce/kg
Crude oil	41868 kJ/kg (10000 kcal/kg)	1.4286 kgce/kg
Fuel oil	41868 kJ/kg (10000 kcal/kg)	1.4286 kgce/kg
Gasoline	43124 kJ/kg (10300 kcal/kg)	1.4714 kgce/kg
Kerosene	43124 kJ/kg (10300 kcal/kg)	1.4714 kgce/kg
Diesel oil	42705 kJ/kg (10200 kcal/kg)	1.4571 kgce/kg
Natural gas	32238 kJ/m <sup>3</sup> ~38979 kJ/m <sup>3</sup> (7700 kcal/m <sup>3</sup> ~9310 kcal/m <sup>3</sup> )	1.1000 kgce/m <sup>3</sup> ~1.3300 kgce/m <sup>3</sup>
Liquified natural gas	51498 kJ/kg (12300 kcal/kg)	1.7572 kgce/kg
Liquefied petroleum gas	50242 kJ/kg (12000 kcal/kg)	1.7143 kgce/kg
Refinery dry gas	46055 kJ/kg (11000 kcal/kg)	1.5714 kgce/kg
Coke oven gas	16747 kJ/m <sup>3</sup> ~18003 kJ/m <sup>3</sup> (4000 kcal/m <sup>3</sup> ~4300 kcal/m <sup>3</sup> )	0.5714 kgce/m <sup>3</sup> ~0.6143 kgce/m <sup>3</sup>
Blast furnace gas	3768 kJ/m <sup>3</sup> (900 kcal/m <sup>3</sup> )	0.1286 kgce/m <sup>3</sup>
Producer gas	5234 kJ/m <sup>3</sup> (1250 kcal/m <sup>3</sup> )	0.1786 kgce/m <sup>3</sup>
Residue fluid catalytic cracking gas	19259 kJ/m <sup>3</sup> (4600 kcal/m <sup>3</sup> )	0.6571 kgce/m <sup>3</sup>
Catalytic pyrolysis gas	35588 kJ/m <sup>3</sup> (8500 kcal/m <sup>3</sup> )	1.2143 kgce/m <sup>3</sup>
Coke gas	16329 kJ/m <sup>3</sup> (3900 kcal/m <sup>3</sup> )	0.5571 kgce/m <sup>3</sup>
Pressure gasified gas	15072 kJ/m <sup>3</sup> (3600 kcal/m <sup>3</sup> )	0.5143 kgce/m <sup>3</sup>
Water gas	10467 kJ/m <sup>3</sup> (2500 kcal/m <sup>3</sup> )	0.3571 kgce/m <sup>3</sup>
Crude benzene	41868 kJ/kg (10000 kcal/kg)	1.4286 kgce/kg
Methanol (as fuel)	19913 kJ/kg (4756 kcal/kg)	0.6704 kgce/kg
Ethanol (as fuel)	26800 kJ/kg (6401 kcal/kg)	0.9144 kgce/kg
Hydrogen (as fuel, density of 0.082kg/m <sup>3</sup> )	9756 kJ/m <sup>3</sup> (2330 kcal/m <sup>3</sup> )	0.3329 kgce/m <sup>3</sup>
Biogas	20934 kJ/m <sup>3</sup> ~24283 kJ/m <sup>3</sup> (5000kcal/m <sup>3</sup> ~5800kcal/m <sup>3</sup> )	0.7143 kgce/m <sup>3</sup> ~0.8286 kgce/m <sup>3</sup>

NOTE 1: 1 kgce = 29307.6 kJ = 0.0293076 GJ = 7000 kcal

NOTE 2: 1 kW · h = 3600000 J = 0.0036 GJ

**Annex B**  
**(Normative)**

**Main Types of Raw Materials for Biogas and Bio-Natural Gas**

The main types of raw materials for biogas and bio-natural gas are listed in Table B.1.

**Table B.1: Main Types of Raw Materials for Biogas and Bio-Natural Gas**

	Raw Material Type	Source Type
Crop Straw	Residues such as roots, stems, and leaves remaining after harvesting crops like wheat, corn, and rice	Agricultural
Livestock Manure	Solid waste including animal dung, bedding, and feathers produced during livestock farming	Agricultural
Agricultural By-Product Wastewater and Residues	Non-target materials from agricultural processing, such as corn cobs, sugarcane bagasse, rice husks, and peanut shells	Agricultural
Kitchen Waste	Perishable, organic household waste including food scraps, kitchen waste, and other similar waste	Domestic
Municipal Sludge	Residual activated sludge and primary settling tank sludge or their mixture from urban wastewater treatment, excluding screenings, scum, and grit	Domestic

## Annex C (Informative)

### Specification for certification of bio-natural gas

Table C.1 Energy in the transportation of raw materials  $Q_{ys}$

Fossil energy mass $m_i$	Average lower heating value of fossil energy $q_i$	Electricity powered by fossil energy $EC_n$	Energy in the raw material transportation stage $Q_{ys}$
t	GJ/t	MW · h	GJ
A1	A2	A3	$A=A1 \times A2 + 3.6 \times A3$
NOTE: If multiple vehicles or types of fossil energy are used, calculate the energy for each separately according to the formula, then sum the results.			

Table C.2 Total fossil energy used in the production of bio-natural gas  $Q_{hs}$

Mass of fossil energy used in bio-natural gas production $m_i$	Average lower heating value of used fossil energy $q_i$	Total fossil energy used in production of bio-natural gas $Q_{hs}$
GJ	GJ/t	GJ
B1	B2	$B=B1 \times B2$

Table C.3 Total electricity powered by fossil energy used in the production of bio-natural gas  $Q_{yd}$

Electricity powered by fossil energy used in production of bio-natural gas $EC_{yd}$	Total electricity used in production of bio-natural gas $Q_{yd}$
MW · h	GJ
C1	$C=3.6 \times C1$

Table C.4 Total heat powered by fossil energy used in the production of bio-natural gas  $Q_{yr}$

Mass of heat $m_{yr}$	Enthalpy of steam at given temperature and pressure $h$	Total heat powered by fossil energy used in production of bio-natural gas $Q_{yr}$
t	kJ/kg	GJ
D1	D2	$D=D1 \times (D2-83.74) \times 10^{-3}$

Table C.5 Total fossil-sourced energy used in the production of bio-natural gas  $Q_{sc}$

Total fossil energy used in the production of bio-Natural gas $Q_{hs}$	Total fossil-sourced electricity used in the production of bio-Natural gas $Q_{yd}$	Total fossil-sourced heat used in the production of bio-natural gas $Q_{yr}$	Total fossil-sourced energy used in the production of bio-natural gas $Q_{sc}$
GJ	MW · h	GJ	GJ
B	C	D	$E=B+C+D$

Table C.6 Total energy of bio-natural gas supplied externally  $Q_{jc}$

Volume of bio-natural gas or biogas supplied externally $V$	Lower heating value of bio-natural gas or biogas at 20° C and 101.325 kPa $H_{jc}$	Total energy of bio-natural gas supplied externally $Q_{jc}$
$m^3$	$MJ/m^3$	GJ
		$F=F1 \times F2 \times 10^{-3}$

Table C.7 Calculated zero-carbon energy amount  $Q_{zj}$

Energy in the transportation of raw materials $Q_{ys}$	Total fossil-sourced energy used in bio-natural gas production $Q_{sc}$	Total energy of bio-natural gas supplied externally $Q_{jc}$	Calculated zero-carbon energy amount $Q_{zj}$
GJ	GJ	GJ	GJ
A	E	F	$G=F-E-A$

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