T-VER-P-METH-14-03

Production and Utilization of Biochar

Version 01

Scope: 05 - Chemical Industry

Scope: 13 - Waste Handling and Disposal

Scope: 15 - Agriculture

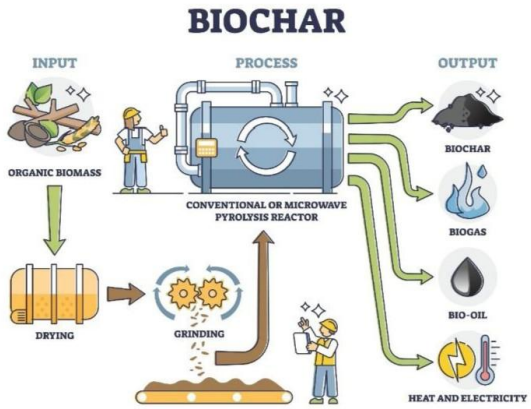
Entry into force on 24 September 2025

1. Methodology	Production and Utilization of Biochar
2. Project Type	Capture, storage, and/or utilization of greenhouse gas
3. Sector scope	Scope: 05 - Chemical Industry Scope: 13 - Waste Handling and Disposal Scope: 15 - Agriculture
4. Project Outline	A project involves the production of biochar from biomass and the application of biochar to soil and non-soil materials for the purpose of permanent greenhouse gas sequestration over a 100-year period
5. Applicability	The project activities shall include: 1. The removal of greenhouse gases through the conversion of biomass into biochar with high resistance to decomposition when applied in environmental settings. 2. The application of the produced biochar in areas where its long-term resistance to decomposition can be monitored over a 100-year period. The biochar shall be utilized in ways that preserve its greenhouse gas (carbon) sequestration properties. Eligible utilization formats include the following: 2.1 Soil application — the use of biochar through land burial to improve soil quality. 2.2 Non-soil application — the use of biochar as an additive in long-lasting products (e.g., concrete and asphalt) or landfilling in designated areas for the purpose of carbon sequestration.
6. Project Conditions	1. Biochar must be produced from sustainable biomass sources, such as agricultural residues, wood waste, food waste, and other materials (as specified in documents published by the Intergovernmental Panel on Climate Change, or IPCC; see document title in Section 10). The biochar must comply with the following conditions:

	1.1 In the case of sustainable agricultural residues, at least 30% of the residues shall be left on the cultivation area to avoid adverse impacts on soil health and agricultural productivity. 1.2. Damaged wood resulting from natural disasters shall not be considered a sustainable biomass source. 2. The primary biomass feedstock used for biochar production must originate exclusively from sources within Thailand. 3. The primary biomass feedstock for biochar production must be utilized within one year of collection and must not be stored under anaerobic conditions. 4. Pre-treatment of biomass prior to biochar production shall be limited to mechanical processes (such as compression, pelletizing, and cutting) and thermal processes (such as drying and roasting) only. 5. Project developers must demonstrate net outcomes across the life cycle of biomass fuel sourcing, biochar production, and biochar utilization. The assessment shall include data disaggregated by process stage and by type of greenhouse gas. 6. Fossil fuels (e.g., coal, fuel oil, and natural gas) may be used to supply initial heat for start-up in the biochar production process. However, co-combustion of fossil fuels and biomass is not permitted, as fossil carbon may contaminate the biochar product. 7. Syngas generated during the biochar production process must be combusted or recovered through engineered systems to prevent methane emissions to the atmosphere. Additionally, syngas and bio-oil (products derived from syngas) may be stored for future use as renewable energy or material inputs. 8. For each biochar production cycle, only one type of biomass is allowed and measurements of biochar products corresponding standard biochar composition must be completed for each production cycle.

	9. Project activities must include measures and conditions to ensure safety operations, including safty handling and transportation of biochar, provision of material safety data sheets, temperature reduction of biochar after production, and installation of appropriate exhaust gas treatment systems. 10. The produced biochar must meet the specifications set by relevant Thai authorities (if available) or other applicable standards, such as the International Biochar Initiative (IBI) Biochar Testing Guidelines, the European Biochar Certificate (EBC), the Japanese Industrial Standards (JIS), and the Japan Biochar Association Standard (JBAS). 11. The produced biochar may be utilized only within Thailand and must be applied within one year from the date of production. 12. Project developers must specify the geographic coordinates of areas where biochar is applied, the quantity of biochar utilized in each location, and establish a method for tracking the applied biochar throughout the 100 year period 13. The produced biochar must not be used in ways that result in the reversal of sequestered greenhouse gases (carbon), such as combustion for fuel, conversion into activated carbon, or use as fuel in steel production processes 14. The produced biochar must not be applied to soil located in areas prone to recurrent flooding. The project developer is required to provide official documentation of the area from relevant authorities, such as the Land Development Department. 15. Biochar must not be applied to soil in areas where greenhouse gas reduction, removal, or sequestration activities are being implemented in the forestry and agriculture sectors 16. Soil application of biochar through land burial must be conducted at a depth of no less than 10 centimeters and must be certified by relevant experts or authorities confirming that the burial depth does not fall within organic soil classification to minimize the risk of

	carbon reversal. The project developer must specify the maximum quantity of biochar to be applied, ensuring that it does not cause adverse impacts particularly regarding potential contaminants in the biochar and post-application soil quality in the Sustainable Development and Safeguards Assessment Report 17. The project developer must implement risk mitigation measures to prevent biochar applied in non-soil materials from being subject to burning, land-use change, or natural degradation. 18. In the event that any issue is later identified which affects the carbon sequestration of biochar that has been utilized, the project developer shall be responsible for compensating the certified carbon credits issued by TGO, in accordance with the measures stipulated by TGO
7. Project Starting Date	The date on which the project owner (employer) and the contractor jointly signed the construction or installation agreement for the greenhouse gas reduction project to be developed as a T-VER project
8. Definition	**Biomass residues** refer to Agricultural residues from harvesting or processing activities such as rice husks, sugarcane bagasse, rice straw, and corn cobs as well as wood and wood waste that can be used as fuel or naturally decomposed **Biochar** refers to a carbon-rich material produced by heating biomass under low-oxygen or oxygen-free conditions, resulting in the conversion of carbon in the biomass into a stable solid form. Other by-products may also be generated during the process, such as synthetic gas (syngas) and bio-oil (products derived from syngas), as illustrated. Biochar must meet relevant standards, such as the IBI Biochar Testing Guidelines, the European Biochar Certificate (EBC), Japanese Industrial Standards (JIS), the Japan Biochar Association Standard (JBAS), and applicable standards issued by relevant authorities in Thailand (if any)

	 **Gasification** refers to Thermal conversion of biomass under low-oxygen conditions, producing biochar, syngas, and other compounds, with heating temperatures exceeding 700°C and a complete combustion system for syngas **Pyrolysis** refers to A thermal decomposition process under low-oxygen conditions, with heating temperatures exceeding 350°C and a complete combustion system for syngas, resulting in the production of biochar, syngas, and other compounds **Soil applications** refer to the utilization of biochar in soil, such as land burial for the purpose of improving soil quality **Non-soil applications** refer to a utilization of biochar beyond soil applications, such as blending into long lasting products like concrete and asphalt, or burial in designated areas for underground carbon sequestration
9. Note	

Details of voluntary emission reductions program for

Production and Utilization of Biochar

1. Emission reductions activities used in the calculations

Table 1: Sources and Types of Greenhouse Gases

Greenhouse gas emission	Source	Greenhouse Gas	Details of activities that emit greenhouse gas emissions
Baseline Emission	Biochar	CO_2	Organic Carbon in Biomass released to the atmosphere owing to combustion
Project Emission	Energy consumption (electricity and fossil fuels)	CO_2	Use of grid electricity
			Use of fossil fuels, such as in Biochar production systems, backup generators, biomass loaders, etc.
	Biochar production system	CO_2, CH_4	Leakage of synthetic fuel gas from biochar production systems
	Synthetic fuel gas combustion system	CO_2	Incompletely combusted synthetic fuel gas
	Utilization of residual biomass	CO_2, CH_4	• Transportation of residual biomass • Transport of waste biomass
Leakage Emission	Transportation of biochar	CO_2	Combustion of fossil fuels during the transportation of biochar for utilization
	Sustainable biomass utilization	CO_2, CH_4	• Additional processing of residual biomass diverted from other uses due to project activities • Management of residual biomass from project activities • Transportation of biomass / residual biomass

2. Scope of Project

The characteristics and scope of a project for converting biomass into biochar with high resistance to decomposition in the environment must comprehensively consider three key aspects

- Biomass sources or biomass collection points, including any pre-treatment steps prior to biochar production (if applicable)
- Biomass conversion process into biochar
- Areas where biochar is applied for use in soil and non-soil materials

3. Additionality

The project must undergo further proof of operation from normal operations. (Additionality) by using the “Proof of Operations Guidelines in addition to normal operations (Additionality) under the Thailand Voluntary Emission Reduction Program (T-VER)" standard equivalent to the international standards prescribed by the TGO.

4. Baseline Scenario

In accordance with the approach for establishing baseline data below Business as Usual (Below BAU), the Business as Usual (BAU) scenario for biochar production through closed combustion systems for beneficial use is defined as the greenhouse gas (carbon dioxide) emissions from biomass combustion being sequestered in the biochar. Therefore, the project’s baseline data refers to the carbon dioxide sequestration resulting from biomass combustion in biochar produced via gasification or pyrolysis processes, in which a portion of the sequestered carbon dioxide may be released into the environment depending on the production temperature and over the duration of biochar application.

5. Baseline Emission

Baseline emissions are calculated based on the proportion of organic carbon content and the persistence factor related to the decomposition of biochar, depending on the combustion process and the temperature used. The details are as follows

$$BE_y = W_{biochar,y} \times FOC_y \times Fperm_y \times \frac{44}{12}$$ Equation (1)

Where

BE_y	=	Baseline emissions in year y (tCO_2/year)
$W_{biochar,y}$	=	The dry weight of biochar produced from project activities in year y (ton/year)
FOC_y	=	The organic carbon content of biochar for each production (%)
$Fperm_y$	=	Biochar degradation persistence value from project activities in year y (%)
44/12	=	Carbon to carbon dioxide mass conversion factor

6. Project Emission

Project emissions are considered only in terms of carbon dioxide (CO_2) emissions arising from fossil fuel combustion, electricity consumption from the power grid, greenhouse gases contained in synthetic gas (syngas) generated through chemical reactions, the incineration of syngas, and the use of residual biomass. These emissions can be calculated as follows:

$$PE_y = PE_{FF,y} + PE_{EC,y} + PE_{fugitive,y} + PE_{flaring,y} + PE_{Biomass,y}$$ Equation (2)

Where

PE_y	=	Project emissions in year y (tCO_2/year)
$PE_{FF,y}$	=	Project emissions from fossil fuel combustion in year y (tCO_2/year)
$PE_{EC,y}$	=	Project emissions from electricity consumption sourced from the grid in year y (tCO_2/year)
$PE_{fugitive,y}$	=	Project emissions contained in synthetic gas (syngas) generated through chemical reactions within the biochar production system in year y (tCO_2/year)
$PE_{flaring,y}$	=	Project emissions from the incineration of synthetic gas (syngas) within the biochar production system in year y (tCO_2/year)
$PE_{Biomass,y}$	=	Project emissions from biomass and biomass residues in year y (tCO_2/year)

6.1 Project emissions from fossil fuel combustion ($PE_{FF,y}$)

Project emissions from fossil fuel combustion due to project activities shall be calculated using the latest version of the calculation tool T-VER-P-TOOL-02-01: “T-VER-P-TOOL-02-01: Tool to Calculate Project or Leakage CO_2 Emissions from Fossil Fuel Combustion.” If fossil fuels are used to operate equipment related to biomass quality improvement, storage, and transportation of fossil

fuels and biomass such as biomass preparation, conveyor systems, dryers, pelletizing, briquetting, etc. These emissions shall be considered under the parameter $PE_{Biomass,y}$

6.2 Project emissions from electricity consumption sourced from the grid ($PE_{EC,y}$)

Project emissions from electricity consumption sourced from the grid can be calculated based on the amount of electricity consumed, the emission factor of electricity generation, and transmission and distribution losses in the power grid, as follows

$$PE_{EC,y} = EC_{PJ,y} \times EF_{Elec,y} \times (1 + TDL) \quad \text{Equation (3)}$$

Where

$PE_{EC,y}$ = Project emissions from electricity consumption sourced from the grid (tCO_2/year)

$EC_{PJ,y}$ = Quantity of grid electricity consumption resulting from project implementation in year y (MWh/year)

$EF_{Elec,y}$ = Emission factor for electricity generation/consumption in year y (tCO_2/MWh)

TDL = Average technical transmission and distribution losses for providing electricity in year y

Electricity consumed by equipment used for on-site or off-site preparation, storage, processing, and transportation of fossil fuels and biomass such as biomass preparation, conveyor systems, dryers, pelletizing, briquetting, etc. shall also be accounted for under the parameter $PE_{EC,y}$

6.3 Project emissions contained in synthetic gas (syngas) generated through chemical reactions within the biochar production system ($PE_{fugitive,y}$)

Project emissions contained in syngas generated through chemical reactions within the biochar production system can be calculated as follow

$$PE_{fugitive,y} = \sum_{i} Q_{biochar,i,y} \times SMG_y \times f \times GWP_{CH4} \quad \text{Equation (4)}$$

Where

$PE_{fugitive,y}$ = Project emissions contained in synthetic gas (syngas) generated through chemical reactions within the biochar production system in year y (tCO_2/year)

$Q_{biochar,i,y}$ = Quantity of charcoal type i produced and used in year y (ton/year)

SMG_y = Specific methane generation for biochar generation process in the year y

(tCH_4 /t biochar)

f = A fraction attributed to project biochar production technology

GWP_{CH4} = Global Warming Potential of Methane (t CO_2e/t CH_4)

6.4 Project emission from the incineration of synthetic gas (syngas) within the biochar production system ($PE_{flaring,y}$)

Project emissions from the combustion of syngas can be calculated using the latest version of the T-VER-P-TOOL-02-04 tool: "Calculation of greenhouse gas emissions from biogas destruction in project operations.

6.5 Project emissions from biomass and biomass residues ($PE_{Biomass,y}$)

In cases where the project activity involves the production of biochar from residual biomass, project emissions shall be calculated using the latest version of the T-VER-P-TOOL-02-02: "Calculation of greenhouse gas emissions from project operations and beyond project boundaries for biomass.

1) Transportation of residual biomass

2) Processing of residual biomass

7. Leakage Emission

Leakage emission is calculated based on the production of biochar from sustainable biomass or residual biomass, and the transportation of biochar for utilization, with details as follows

$$LE_y = LE_{Biomass,y} + LE_{Biochar,TR} \quad \text{Equation (5)}$$

Where

LE_y = Leakage emissions in year y (tCO_2/year)

$LE_{Biomass,y}$ = Leakage emissions from biomass and residual biomass in year y (tCO_2/year)

$LE_{Biochar,TR}$ = Leakage emissions from the transportation of biochar for utilization in year y (tCO_2/year)

7.1 Leakage emissions from biomass and residual biomass ($LE_{Biomass,y}$)

For the production of biochar from sustainable biomass beyond the leakage emissions, the project developer shall determine greenhouse gas emissions outside the project boundary using the

latest version of T-VER-P-TOOL-02-02: "Calculation of greenhouse gas emissions from project operations and beyond project boundaries for biomass.

1) Processing of residual biomass diverted from other uses due to increased demand resulting from project activities
2) Management of residual biomass from project activities for disposal or beneficial use
3) Transportation of sustainable biomass from the source to the project activity site

7.2 Leakage emissions from the transportation of biochar for utilization ($LE_{Biochar,TR}$)

Leakage emissions from the transportation of biochar for utilization can be calculated as follows:

$$LE_{Biochar,TR} = \sum D_y \times Q_y \times EF_{CO2,i} \times 10^{-6} \quad \text{Equation (6)}$$

Where

$LE_{Biochar,TR}$ = Leakage emissions from the transportation of biochar for utilization (tCO_2/year)
D_y = Round-trip distance between the origin and destination of biochar transportation activities for utilization in year y (km)
Q_y = Quantity of biochar transported in year y (t biochar)
$EF_{CO2,i}$ = Emission factor from the use of fossil fuel type i for transporting biochar for utilization (gCO_2/tkm)
i = Type of fossil fuel

8. Emission Reduction

Emission Reduction can be calculated as follow

$$ER_y = BE_y - PE_y - LE_y \quad \text{Equation (7)}$$

Where

ER_y = Emission reductions in year y (tCO_2e/year)
BE_y = Baseline emissions in year y (tCO_2e/year)
PE_y = Project emissions in year y (tCO_2e/year)
LE_y = Leakage emissions in year y (tCO_2e/year)

9. Monitoring Plan

9.1 Monitoring Guidelines

1) The project developer shall explain and specify the steps for monitoring the project activity data (Activity data) or verify all measurement results in the project proposal document. including the type of measuring instruments used Person responsible for monitoring results and verifying information Calibration of measuring instruments (if any) and procedures for warranty and quality control Where methods have different options, such as using default values or on-site measurements The project developer must specify which option to use. In addition, the installation, maintenance and calibration of measuring instruments should be carried out in accordance with the instructions of the equipment manufacturer and in accordance with national standards. or international standards such as IEC, ISO and JIS.

2) All data collected as part of the greenhouse gas reduction monitoring. The data should be stored in electronic file format and the retention period is in accordance with the guidelines set by the Administrative Organization or the organization's quality system, but the period is not less than that specified by TGO. Data collection must follow the methods specified in the follow-up parameters specified in section 9.2.

9.2 Data and parameters monitored

Parameter	$EC_{PJ,y}$
unit	MWh/year
Description	Quantity of grid electricity consumption resulting from project implementation in year y
Source of data	Monitoring Report
Measurement procedures	Measured by kWh Meter and continuously monitored throughout the tracking period (electricity quantity deducted from self-consumption before being supplied to the grid)
Monitoring frequency	Continuous monitoring is conducted, and data is recorded at least monthly

Parameter	TDL_y
unit	-
Description	Average technical transmission and distribution losses for providing electricity in year y
Source of data	**Option 1:** Report based on monitoring data in cases where information is available on the amount of electricity supplied by the producer and the amount of electricity received by the user

	Option 2: Use the most recent value announced by TGO (value = 0.0596), which is based on data from the Thailand Energy Balance Report for the year 2023, by the Department of Alternative Energy Development and Efficiency
Measurement procedures	1) If Option 1 is chosen, the project developer must monitor the specified value annually throughout the monitoring period of greenhouse gas emission reductions 2) If Option 2 is chosen, the project developer must use this value consistently throughout the monitoring period of greenhouse gas emission reduction
Monitoring frequency	To be determined once in the first year of the carbon crediting period

Parameter	$EF_{Elec,y}$
unit	tCO_2/MWh
Description	Emission factor for electricity generation/consumption in year y
Source of data	Report on greenhouse gas emissions (Emission Factor) from electricity generation/consumption for projects and activities of greenhouse gas reduction published by TGO.
Measurement procedures	**For the preparation of project proposal documents** Use the latest $EF_{Elec,y}$ announced by TGO **For monitoring the results of reducing greenhouse gas emissions** Use the $EF_{Elec,y}$ values announced by TGO according to the year of the carbon creditCertification period. However, in the case that the year of the Carbon CreditCertification period does not have $EF_{Elec,y}$ values announced by TGO, use the latest $EF_{Elec,y}$ values announced by TGO in that year instead.
Monitoring frequency	-

Parameter	$W_{biochar,y}$
unit	ton/year
Description	The mass of biochar incorporated into mineral soil during the inventory year for each biochar production in year y
Source of data	Record of the dry weight of biochar produced from the project
Measurement procedures	Measured using a weighing scale
Monitoring frequency	To be determined once in the first year of the carbon crediting period

Parameter	$Q_{biochar,i,y}$
unit	ton/year
Description	Quantity of charcoal type i produced and used in year y

Source of data	Record of biochar produced from the project
Measurement procedures	Measured using a weighing scale
Monitoring frequency	To be determined once in the first year of the carbon crediting period

Parameter	Temperature
unit	^0C
Description	Temperature in the biochar production system from project implementation
Source of data	Temperature records in the biochar production system from the project
Measurement procedures	Measured by temperature sensors
Monitoring frequency	To be determined once in the first year of the carbon crediting period

Parameter	GWP_{CH4}
unit	t CO_2e / t CH_4
Description	Global Warming Potential of Methane
Source of data	Use data from the IPCC Assessment Report prepared by the Intergovernmental Panel on Climate Change (IPCC), as announced by TGO
Measurement procedures	**For project proposal documentation** use the latest GWP_{CH4} value as announced by TGO. **For monitoring Emission reductions** use the GWP_{CH4} value specified by TGO for estimating emissions during the certified crediting period.
Monitoring frequency	-

Parameter	Q_y
unit	t biochar
Description	Quantity of biochar transported in year y
Source of data	Record of transported biochar
Measurement procedures	Measured by a weighing scale
Monitoring frequency	To be determined once in the first year of the carbon crediting period

Parameter	D_y
unit	km
Description	Round-trip distance between the origin and destination of biochar transportation activities for utilization in year y
Source of data	Records from the project
Measurement procedures	Report on the transportation distance of biochar
Monitoring frequency	To be determined once in the first year of the carbon crediting period

Parameter	FOC_y
unit	%
Description	The organic carbon content of biochar for each production
Source of data	Record the proportion of organic carbon in biochar from the project
Measurement procedures	Measurement of the proportion of organic carbon in biochar in a certified laboratory
Monitoring frequency	To be determined once in the first year of the carbon crediting period

9.3 Data and parameters not monitored

Parameter	$Fperm_y$
unit	%
Description	Biochar degradation persistence value from project activities in year y
Source of data	Appendix 4 in volume 4: Agriculture, Forestry and Other Land Use from 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Applicable value	

Number	Production Process	$Fperm_p$
1	High temperature pyrolysis and gasification (> 600 °C)	0.89
2	Medium temperature pyrolysis (450-600 °C)	0.80
3	Low (350-450 °C)	0.65

Parameter	SMG_y
unit	tCH_4/t biochar
Description	Specific methane generation for biochar generation process in the year y
Source of data	1) Clean Development Mechanism (CDM), AMS-III.BG : Small-scale Methodology Emission reduction through sustainable charcoal production and consumption version 04 2) Measure

Applicable value	0.030 (For Source of Information No. 1)

Parameter	f
unit	%
Description	A fraction attributed to project biochar production technology
Source of data	1) Clean Development Mechanism (CDM), AMS-III.BG : Small-scale Methodology Emission reduction through sustainable charcoal production and consumption version 04 2) Measure
Applicable value	0.1 (For Source of Information No. 1)

Parameter	$EF_{CO2,i}$
unit	gCO_2/tkm
Description	Emission factor from the use of fossil fuel type i for transporting biochar for utilization
Source of data	1) Measured from fossil fuel consumption 2) Use a constant value
Applicable value	In the case of selecting data source option 2, use the following values: 1) For transportation by small-sized vehicles, use a value of 245 gCO_2/tkm 2) For transportation by large-sized vehicles, use a value of 129 gCO_2/tkm

10. Reference

1) Clean Development Mechanism (CDM), AMS_III.L : Avoidance of methane production from biomass decay through controlled pyrolysis version 02

2) Clean Development Mechanism (CDM), AMS-III.BG : Small-scale Methodology Emission reduction through sustainable charcoal production and consumption version 04

3) VCS Methodology : Methodology for biochar utilization in soil and non non-soil applications

4) 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Appendix 4 Method for Estimating the Change in Mineral Soil Organic Carbon Stocks from Biochar Amendments: Basis for Future Methodological Development

5) Biochar Methodology for CO_2 Removal Edition 2025 V1

6) Japanese Industrial Standards
https://webdesk.jsa.or.jp/books/W11M0090/index/?bunsyo_id=JIS+M+8812%3A2004

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01	-	24 September 2025	Initial adoption