CLEAN DEVELOPMENT MECHANISM

CDM-MP90-A01

Draft Large-scale Methodology

AM00XX: Hydrogen production from electrolysis of water

Version 01.0

Sectoral scope(s): 01

DRAFT

United Nations
Framework Convention on
Climate Change

COVER NOTE

1. Procedural background

1. A request for new methodology “NM0381: Emission reduction by hydrogen production from renewable energy sources”, was submitted by China United Hydrogen Technology ResearchInstitute Co., Ltd., Long yuan (Beijing) Carbon Asset Management Technology Co., Ltd. and Shanghai Environment and Energy ExchangeCo., Ltd. on 25 May 2022.

2. Purpose

2. The document presents a draft new large-scale methodology applicable to project activities that produce hydrogen from water electrolysis.

3. Key issues and proposed solutions

3. This methodology is applicable to project activities that involve the construction of a new solar or wind captive renewable power plant and a new electrolyser hydrogen production plant. Retrofitting, rehabilitation (or refurbishment), replacement or capacity addition of an existing electrolyser hydrogen production plant or of an existing captive renewable power plant are not covered by this methodology.

4. The electricity consumed by the electrolyser hydrogen production plant shall be sourced from a captive renewable power plant only or from a captive renewable power plant and the electric grid; however, the ratio between the electricity consumed from the grid and the electricity consumed from the captive renewable power plant shall be between 0 and 0.1 on an annual basis.

5. The project design document shall describe the measures undertaken to avoid double-counting of emission reductions and to ensure that the project uses no more than 5 per cent of the water available locally on an annual basis.

6. The methodology is applicable only if the most plausible baseline scenarios identified after applying “TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality” are: “P4： Production of hydrogen from the steam reforming of syngas produced from the gasification of coal” or “P5: Production of hydrogen from the steam reforming of natural gas”.

7. Additionality is demonstrated by applying “TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality”.

8. Baseline emissions are determined by multiplying the quantity of pure hydrogen produced by a baseline emission factor. This baseline emission factor shall be determined using the most recent official national data (or official data relevant to the region if national data are not published). When these are not available, the emission factors for different hydrogen production technologies published by the International Energy Agency or by the International Renewable Energy Agency can be used.

9. Project emissions are determined based on the electricity consumed from the electric grid.

10. The key monitored parameters are the flow, pressure and temperature of the pure hydrogen produced, the electricity consumed from the captive power plant, the electricity consumed from sources other than the captive renewable power plant, and official national data or official regional data related to hydrogen production (types and quantity of production plants, type of energy consumed, and year of construction and start of operation).

4. Impacts

11. The draft methodology, if approved, will become the first methodology to allow development of Clean Development Mechanism projects producing hydrogen from water electrolysis.

5. Subsequent work and timelines

12. The draft version of the methodology is recommended by the Methodologies Panel (MP) for consideration by the Board at its 117th meeting. No further work is envisaged.

6. Recommendations to the Board

13. The MP recommends that the Board adopt this new methodology, to be made effective at the time of the Board's approval.

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1. Introduction

1. The following table describes the key elements of the methodology:

Table 1. Methodology key elements

Typical projects	Production of hydrogen through electrolysis of water using electricity from a captive renewable power plant only, or a mix of electricity from a captive renewable plant and from the electric grid, replacing the production of hydrogen through steam reforming of synthesis gas (syngas) produced from the gasification of coal or steam reforming of natural gas.
Type of GHG emissions mitigation action	• Fuel or feedstock switch • Renewable energy

2. Scope, applicability, and entry into force

2.1. Scope

2. The methodology is applicable to project activities where hydrogen is produced by electrolysis of water, and where in the absence of the project activity the hydrogen would be produced through steam reforming of syngas produced by the gasification of coal, or through steam reforming of natural gas. The electricity consumed by the electrolyser hydrogen production plant shall be sourced from a captive renewable power plant only or from a captive renewable power plant and the electric grid.

2.2. Applicability

3. This methodology is applicable to project activities that include the construction of a new captive renewable power plant and a new electrolyser hydrogen production plant. Retrofitting, rehabilitation (or refurbishment), replacement or capacity addition of an existing electrolyser hydrogen production plant or of an existing captive renewable power plant are not covered by this methodology.

4. The captive renewable power plant shall be wind or solar. Purchase of renewable electricity via renewable electricity certificates are not covered by this methodology.

5. The project activity shall ensure that the ratio between the electricity consumed from the grid ($EC_{PJ,grid,y}$) and the electricity consumed from the captive renewable power plant ($EC_{PJ,captive,y}$) by the electrolyser hydrogen production plant is between 0 and 0.1 on an annual basis. The designated operation entity (DOE) shall confirm that this ratio requirement is met by comparing annually the data on the electricity consumed from the two sources.

6. The project participant shall demonstrate that double counting of emission reductions will not occur, e.g. via a contractual agreement with the consumer of the hydrogen produced. The steps to be taken to avoid double counting shall be documented in the project design document.

7. The methodology is applicable only if the most plausible baseline scenarios identified after applying “TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality” are:

(a) "P4：Production of hydrogen from the steam reforming of syngas produced from the gasification of coal"; or

(b) "P5: Production of hydrogen from the steam reforming of natural gas".

8. The project shall use no more than 5 per cent of the water available locally, to ensure that the water used in the electrolysis will not compete with other uses.

9. The applicability conditions included in the tools referred to below also apply.

2.3. Entry into force

10. The date of entry into force is the date of the publication of the EB ### meeting report on ## Month 2023.

2.4. Applicability of sectoral scopes

11. Designated operational entities validating and verifying clean development mechanism (CDM) project activities and programmes that use this methodology shall apply sectoral scope 01.

3. Normative references

12. This baseline and monitoring methodology is based on the proposed new methodology NM0381 "Emission reduction by hydrogen production from renewable energy sources" by China United Hydrogen Technology ResearchInstitute Co., Ltd., Long yuan (Beijing) Carbon Asset Management Technology Co., Ltd. and Shanghai Environment and Energy ExchangeCo., Ltd.

13. This methodology also refers to the latest approved versions of the following tools:

(a) "TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality" (hereinafter referred to as TOOL02);

(b) "TOOL03: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (hereinafter referred to as TOOL03);

(c) "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (hereinafter referred to as TOOL05);

(d) "TOOL08: Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (hereinafter referred to as TOOL08).

14. For more information regarding the proposed new methodology and the tools, as well as their consideration by the CDM Executive Board, please refer to <https://cdm.unfccc.int/methodologies/PAmethodologies/pnm/pending> and <https://cdm.unfccc.int/Reference/tools/index.html>, respectively.

3.1. Selected approach from paragraph 48 of the CDM modalities and procedures

15. "Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment"; or

16. "Existing actual or historical emissions, as applicable"

4. Definitions

17. The definitions contained in the Glossary of CDM terms shall apply.

18. For the purpose of this methodology, the following definitions apply:

    (a) **Electrolyser hydrogen production plant:** a facility that produces hydrogen from the electrolysis of water. Under this methodology, the hydrogen production plant includes the desalted water station, electrolytic cell, hydrogen compressor, gas-liquid processor, hydrogen purification unit and other ancillary equipment;

    (b) **Gasification of coal:** an industrial process where coal is converted into syngas through a process of gasification;

    (c) **Steam reforming of syngas:** an industrial process where the syngas produced from the gasification of coal reacts with steam in the presence of a catalyst to produce hydrogen, carbon monoxide and releases carbon dioxide as a by-product;

    (d) **Steam reforming of natural gas:** an industrial process where natural gas reacts with steam in the presence of a catalyst to produce hydrogen, carbon monoxide and releases carbon dioxide as a by-product.

5. Baseline methodology

5.1. Project boundary

19. The spatial extent of the project boundary encompasses:

    (a) The electrolyser hydrogen production plant;

    (b) The captive renewable power plant; and

    (c) All power plants/units connected physically to the electric grid to which the hydrogen production plant is connected.

20. The greenhouse gases included in or excluded from the project boundary are shown in Table 2.

Table 2. Emission sources included in or excluded from the project boundary

Source		Gas	Included	Justification/Explanation
Baseline	Emissions from hydrogen production through gasification of coal or steam reforming of natural gas	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
Project activity	Emissions from the electricity consumption	CO_2	Yes	Might be an important emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Emissions from the consumption of fossil	CO_2	Yes	Might be an important emission source
		CH_4	No	Excluded for simplification

	fuels (e.g. by the desalination plant)	N_2O	No	Excluded for simplification

5.2. Identification of the baseline scenario

21. Project participants shall apply the latest approved version of TOOL02 to identify the baseline scenario among all reasonable potential alternative scenarios that could provide similar output/services as the proposed project activity.

22. In applying Step 1 of TOOL02, baseline alternatives for the production of hydrogen, the project participant shall take into consideration, inter alia, the following alternatives:

    (a) P1: The proposed project activity undertaken without being registered as a CDM project activity;

    (b) P2: Production of hydrogen through electrolysis of water using electricity from the grid only;

    (c) P3: Production of hydrogen through electrolysis of water using electricity from a captive power plant that is neither solar nor wind;

    (d) P4: Production of hydrogen from the steam reforming of syngas produced from the gasification of coal;

    (e) P5: Production of hydrogen from the steam reforming of natural gas;

    (f) P6: Production of hydrogen as a by-product of industrial processes (e.g. as chlor alkali, coking, steel);

    (g) P7: Production of hydrogen from chemical raw materials (e.g. methanol, ethanol, liquid ammonia cracking);

    (h) P8: Production of hydrogen from the gasification of biomass;

    (i) P9: Production of hydrogen from photochemical process.

5.3. Baseline emissions

23. The baseline emissions are calculated based on the hydrogen produced from plants built over the most recent five years in the host country, as per the equation below.

$$BE_y = M_{H2,PJ,y} \times \frac{\sum_i M_{H2,i,5-years,y} \times EF_{BL,i,5-years,y}}{\sum_i M_{H2,i,5-years,y}} \quad \text{Equation (1)}$$

Where:

BE_y = Baseline emissions in year *y* (tCO_2)

$M_{H2,PJ,y}$ = Mass of pure hydrogen produced by project activity in year *y* (t_{H2})

$M_{H2,i,5-years,y}$ = Quantity of pure hydrogen produced in the host country by the hydrogen production plants *i* in year *y* built over the most recent five years (t_{H2}), excluding registered CDM project activities

$EF_{BL,i,5-years,y}$	=	Baseline emission factor for the production of hydrogen in the host country by hydrogen production plants *i* in year *y* built over the most recent five years (tCO_2/t_{H2}), excluding registered CDM project activities
i	=	Group of most recent hydrogen production plants built over the most recent five years

24. In order to address possible change in the mode of hydrogen production over time, the emission intensity of the baseline $EF_{BL,i,5-years,y}$ shall be determined ex-post (annually) using one of the options below:

    (a) Option A: Using the most recent official national data or official data relevant to the region if national data are not published. Data shall include but are not limited to annual hydrogen production by different plants, as well as their processes, quantity and type of energy consumed, as well as year of construction and start date of operation. This is the preferred option;

    (b) Option B: Using the emission factors from different hydrogen production technologies published by the International Energy Agency (IEA) or by the International Renewable Energy Agency (IRENA).[1] This option should only be applied if the data to determine Option A are not available. The project participant shall demonstrate that emission factors for respective hydrogen production technologies are conservative in the context of the host country, in particular where hydrogen production plants include water hydrolysis with electricity consumed from the grid.

25. If the project activity measures hydrogen production in volume units in standard temperature and pressure (STP), $M_{H2,y}$ is calculated according to the equation below:

$$M_{H2,PJ,y} = \sum_{t=1}^{y} V_{0,t} \times v_{H2,t} \times \frac{2}{22.4} \times 10^{-3} \quad \text{Equation (2)}$$

Where:

$V_{0,t}$	=	The volumetric flow of gas in STP in time interval *t* (Sm^3)
$v_{H2,t}$	=	Volumetric fraction of hydrogen in time interval *t* (m^3_{H2}/m^3_{gas})
t	=	The time-period of data reading (e.g. minute, hour, month)
22.4	=	Volume of gas in standard conditions (Sm^3/kmol)
2	=	Mass of one mole of hydrogen (kg/kmol)

26. If the project cannot directly monitor the volume of hydrogen under standard conditions, it can be converted through the following formula:

[1] This may include, for eample, the IEA Hydrogen Projects Database and other sources providing estimates of the emissions from hydrogen production technologies. Project participants may propose emission factors published by other international institutions or technology suppliers by submitting a request for revision of this methodology following the latest version of the procedure "Development, revision and clarification of baseline and monitoring methodologies and methodological tools".

$$V_{0,t} = \frac{V_{H2,t} \times P_{H2,t} \times 273.15}{101{,}325 \times \left(273.15 + T_{H2,t}\right)}$$ Equation (3)

Where:

$V_{H2,t}$	=	Volumetric flow of hydrogen at operational conditions in the time interval *t* (m^3)
$P_{H2,t}$	=	Pressure of compressed hydrogen in the time interval *t* (Pa)
$T_{H2,t}$	=	Temperature of compressed hydrogen in the time interval *t* (K)

5.4. Project emissions

27. Project emissions include the emissions from electricity consumption other than that from the captive renewable power plant and from any fossil fuel consumed (e.g. by the desalination plant), and are calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y}$$ Equation (4)

Where:

PE_y	=	Project emissions in year *y* (tCO_2e)
$PE_{EC,y}$	=	Project emissions from the consumption of electricity from sources other than the captive renewable power plant in year *y* (tCO_2e). Determined as per TOOL05.
$PE_{FC,y}$	=	Project emissions from the consumption of fossil fuels in year *y* (tCO_2e). Determined as per TOOL03.

5.5. Leakage

28. No Leakage is considered under this methodology.

5.6. Emission reductions

29. Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y$$ Equation (5)

Where:

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

6. Monitoring methodology

6.1. Data and parameters not monitored

30. The provisions on data and parameters not monitored that are contained in the tools referred to in this methodology, and which are needed to calculate emission reductions, apply.

31. All data collected as part of monitoring should be archived electronically and kept for at least two years after the end of the last crediting period. All of the data in the tables below should be monitored unless otherwise indicated. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

32. In addition, the provisions on monitoring contained in the tools referred to in this methodology apply.

6.2. Data and parameters monitored

Data / Parameter table 1.

Data / Parameter:	$M_{H2,i,5-years,y}$
Data unit:	t_{H2}
Description:	Quantity of pure hydrogen produced in the host country by the hydrogen production plants *i* in year *y* built over the most recent five years, excluding registered CDM project activities
Source of data:	Official national data, or official data relevant to the region if national data are not published
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	The data should be disaggregated in different production processes *i*.
Any comment:	Data shall include but are not limited to: annual hydrogen production by different plants, as well as their processes, quantity and type of energy consumed, as well as year of construction and start of operation.

Data / Parameter table 2.

Data / Parameter:	$EF_{BL,i,5-years,y}$
Data unit:	tCO_2/t_{H2}
Description:	Baseline emission factor for the production of hydrogen in the host country by hydrogen production plants *i* in year *y* built over the most recent five years, excluding registered CDM project activities

Source of data:	(a) Option A: the most recent official national data or official data relevant to the region if national data are not published. Data shall include but are not limited to: annual hydrogen production by different plants, as well as their processes, quantity and type of energy consumed, as well as year of construction and start date of operation. This is the preferred option; (b) Option B: using the emission factors from different hydrogen production technologies published by IEA or by IRENA.[1] This option should only be applied if the data to determine Option A are not available. The project participant shall demonstrate that emission factors for respective hydrogen production technologies are conservative in the context of the host country, in particular where hydrogen production plants include hydrolysis with electricity consumed from the grid.
Measurement procedures (if any):	-
Monitoring frequency:	Yearly
QA/QC procedures:	-
Any comment:	Data shall include but are not limited to: annual hydrogen production by different plants, as well as their processes, quantity and type of energy consumed, as well as year of construction and start of operation.

Data / Parameter table 3.

Data / Parameter:	$V_{0,t}$
Data unit:	Sm^3
Description:	The volumetric flow of gas in STP in time interval *t*
Source of data:	As per the TOOL08
Measurement procedures (if any):	As per the TOOL08.
Monitoring frequency:	As per the TOOL08.
QA/QC procedures:	As per the TOOL08.
Any comment:	Project participants shall specify whether the flow is measured on wet or dry basis and follow the monitoring provisions of the parameters $V_{t,wb}$ or $V_{t,db}$ from TOOL08 accordingly.

Data / Parameter table 4.

Data / Parameter:	$v_{H2,t}$
Data unit:	m^3_{H2}/m^3_{gas}
Description:	Volumetric fraction of hydrogen in time interval *t*
Source of data:	As per TOOL08
Measurement procedures (if any):	As per TOOL08.
Monitoring frequency:	As per TOOL08.
QA/QC procedures:	As per TOOL08.
Any comment:	Project participants shall specify whether the flow is measured on wet or dry basis and follow the monitoring provisions of the parameters $v_{t,i,wb}$ or $v_{t,i,db}$ from the TOOL08 accordingly.

Data / Parameter table 5.

Data / Parameter:	$V_{H2,t}$
Data unit:	Volumetric flow of hydrogen at operational conditions in the time interval *t*
Description:	m^3
Source of data:	As per TOOL08
Measurement procedures (if any):	As per TOOL08.
Monitoring frequency:	As per TOOL08.
QA/QC procedures:	As per TOOL08.
Any comment:	Project participants shall specify whether the flow is measured on wet or dry basis and follow the monitoring provisions of the parameters $V_{t,wb}$ or $V_{t,db}$ from the TOOL08 accordingly.

Data / Parameter table 6.

Data / Parameter:	$P_{H2,t}$
Data unit:	Pa
Description:	Pressure of the compressed hydrogen in time the interval *t*
Source of data:	As per TOOL08
Measurement procedures (if any):	As per TOOL08.
Monitoring frequency:	As per TOOL08.
QA/QC procedures:	As per TOOL08.
Any comment:	As per TOOL08

Data / Parameter table 7.

Data / Parameter:	$T_{H2,t}$
Data unit:	K
Description:	Temperature of the compressed hydrogen in the time interval *t*
Source of data:	As per TOOL08
Measurement procedures (if any):	As per TOOL08.
Monitoring frequency:	As per TOOL08.
QA/QC procedures:	As per TOOL08.
Any comment:	As per TOOL08

Data / Parameter table 8.

Data / Parameter:	$PE_{EC,y}$
Data unit:	tCO_2e/year
Description:	Project emissions from the consumption of electricity from sources other than the captive renewable power plant in year y
Source of data:	As per TOOL05.
Measurement procedures (if any):	As per TOOL05.

Monitoring frequency:	As per TOOL05.
QA/QC procedures:	As per TOOL05.
Any comment:	As per TOOL05.

Data / Parameter table 9.

Data / Parameter:	$PE_{FC,y}$
Data unit:	tCO_2e/year
Description:	Project emissions from the consumption of fossil fuels in year y
Source of data:	As per TOOL03.
Measurement procedures (if any):	As per TOOL03.
Monitoring frequency:	As per TOOL03.
QA/QC procedures:	As per TOOL03.
Any comment:	As per TOOL03.

Data / Parameter table 10.

Data / Parameter:	$EC_{PJ,grid,y}$; $EC_{PJ,captive,y}$
Data unit:	MWh
Description:	$EC_{PJ,grid,y}$: Electricity consumed by the hydrogen production plant from the grid in year *y* $EC_{PJ,captive,y}$: Electricity consumed by the hydrogen production plant from the captive renewable power plant in year *y*
Source of data:	The monitoring of these parameters shall follow the monitoring of $EC_{PJ,j,y}$ from TOOL05.
Measurement procedures (if any):	The monitoring of these parameters shall follow the monitoring of $EC_{PJ,j,y}$ from TOOL05.
Monitoring frequency:	The monitoring of these parameters shall follow the monitoring of $EC_{PJ,j,y}$ from TOOL05.
QA/QC procedures:	The monitoring of these parameters shall follow the monitoring of $EC_{PJ,j,y}$ from TOOL05.
Any comment:	These parameters are used to check the compliance of the project with paragraph 5 of the methodology.

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Document information

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