



Monitoring report form for CDM project activity
(Version 07.0)

Complete this form in accordance with the instructions attached at the end of this form.

MONITORING REPORT

Title of the project activity	Associated Gas Recovery and Utilization at Khamilah oil field area at Block-27 in Wilayat Ibri of the Sultanate of Oman	
UNFCCC reference number of the project activity	10584	
Version number of the PDD applicable to this monitoring report	03.0	
Version number of this monitoring report	01	
Completion date of this monitoring report	16/10/2020	
Monitoring period number	1 st monitoring period	
Duration of this monitoring period	03/08/2020-15/10/2020	
Monitoring report number for this monitoring period	n/a	
Project participants	The Government of the Sultanate of Oman, represented by the Ministry of Oil & Gas	
Host Party	Oman	
Applied methodologies and standardized baselines	AM0009 "Recovery and utilization of gas from oil fields that would otherwise be flared or vented" Version 07.0	
Sectoral scopes	Sectoral scope 10: Fugitive emission from fuels (solid, oil, gas).	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0 tCO ₂ e	142,106 tCO ₂ e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	143,865 tCO ₂ e	

SECTION A. Description of project activity

A.1. General description of project activity

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The Associated Gas Recovery and Utilization at Khamilah oil field area at Block-27 in Wilayat Ibri of the Sultanate of Oman project (hereafter referred to as the Project) is Khamilah oil field at Block-27, Wilayat Ibri of Al- Dhahirah Governorate, the Sultanate of Oman. The project is operated by Occidental of Oman Inc. under a development and production sharing agreement with the Ministry of Oil and Gas.

The purpose of the project activity is to deliver recovered gas to the national gas pipeline to meet energy needs of end-users, and also to reduce local air pollution due to flaring.

The recovered associated gas by the project will be collected and processed at Khamilah station. The recovery process comprises three main stages including the separation stage where gas is separated from oil and water, the compression stage where gas is compressed for transportation to gas plant, and the processing stage where gas is processed to fit with conditions of gas pipeline for further transportation to end-users. Main equipment necessary for the proposed project activity comprises electric motor-driven reciprocating and screw compressors installed on site, and a network of pipelines for gas transportation.

The scenario existing prior to the start of the implementation of the proposed project activity is flaring of associated gas at the oil production site, the operation of the existing oil and gas infrastructure without processing of any recovered associated gas, and the use of gas-lift gas from the same source and quantity as under the project activity in the gas-lift system. The baseline scenario is the same as the scenario existing prior to the start of implementation of the proposed project activity. The project reduces greenhouse gases emissions as the utilization of recovered gas displaces the use of non-associated gas or other fossil sources at end-users.

The total estimated amount of associated gas to be recovered during crediting period is about 2.01 billion m³ while average methane content is estimated at about 78%. The project activity is expected to reduce emissions by approximately 432,416 tonnes of CO₂ equivalent annually over the crediting period.

The Project processes 66,566,558 Nm³ associated gas and the total emission reduction is 142,106 tCO₂e in the monitoring period (03/08/2020-15/10/2020).

A.2. Location of project activity

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The proposed project is located at Khamilah oil field at Block-27, Wilayat Ibri of Al- Dhahirah Governorate, the Sultanate of Oman. The recovered gas will be collected and processed at Khamilah station. Al-Dhahirah Region is in the Northern Oman.

Approximate coordinates of Khamilah station are east longitude of 56°14'38" and north latitude of 22°43'01". Figure1 shows the location of the project.

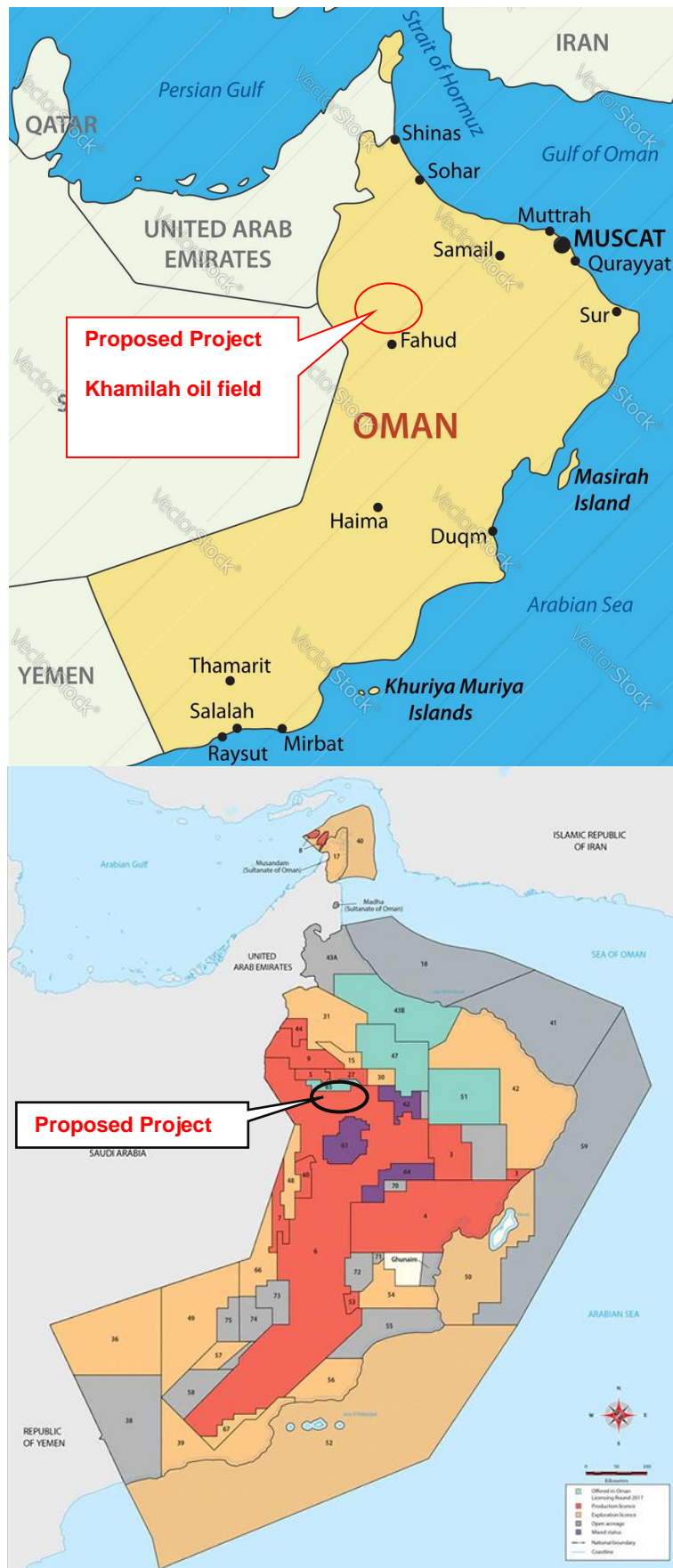


Figure 1 Location of the project

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Oman (Host)	The Government of the Sultanate of Oman, represented by the Ministry of Oil & Gas	No

A.4. References to applied methodologies and standardized baselines

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The project activity uses the baseline and monitoring methodology AM0009/Version 07.0: "Recovery and utilization of gas from oil fields that would otherwise be flared or vented".

Any other methodological tools to which the selected methodology AM0009/Version 07.0 refer:

- (a) "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 03.0)";
- (b) "Tool for the demonstration and assessment of additionality (Version 07.0.0)";
- (c) "Combined tool to identify the baseline scenario and demonstrate additionality" (Version 7.0);

For more information, please refer to:

<http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>.

A.5. Crediting period type and duration

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The project has been registered on 03/08/2020.

The fixed crediting period is chosen by the project which is from 03/08/2020 to 02/08/2030.

The first monitoring period is: 03/08/2020 – 15/10/2020.

SECTION B. Implementation of project activity**B.1. Description of implemented project activity**

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The proposed project activity aims to recover associated gas flow that is currently flared in Khamilah oil field and will be processed the recovered gas at Khamilah station. When oil is extracted from the wells, it comes to the surface together with sands, water and gas. The mixture is then stored into tanks to rest for a period so that through gravity, oil, water and sands are recovered from the bottom of the tank and gas is recovered from the top of the tank. This is called the phase separation. Only oil, gas, sands and water are recovered during phase separation. After that gas is compressed and transported to a processing plant on-site owned by onsite operator where it will be processed then further transported and sold by onsite operator to National Gas pipeline. Part of the recovered gas is consumed onsite to provide electricity to the project activity. Expected annual gross gas volumes to be recovered as part of the project activity are on average 8,106.8 mmscf over its lifetime. On average about 312.4 mmscf of the recovered gas will be used annually in captive power plant on-site to supply electricity to the project activity. The captive gas power plant is owned and operated by on-site operator and the gas is delivered free of charge to the power plant. Expected average net gas volumes delivered to National pipeline is 7,482.7 mmscf after deduction of onsite gas consumption due to project activity and deduction of a gas shrinkage factor due to gas treatment at gas plant for the purpose of meeting the specifications of the national pipeline.

The project activity mainly comprises the installation of compressor packages at Khamilah oil field, including compressor, motor, scrubbers, suction and discharge bottles, coolers, as well as

installation of a pipeline network. Technology employed by the proposed project activity mainly includes but is not limited to the following equipment:

- Reduction of the flare by a series of new pipelines and re-routes.
- Addition of electrical motor driven reciprocating compressor as well as electrical infrastructures including transformers and relays to support the high voltage and low voltage demands of the compressor. A new motor control center and switch gear room will be installed. The recovered gas will be sent to the gas plant for processing.

The below figure provides an overview of the pipeline network.

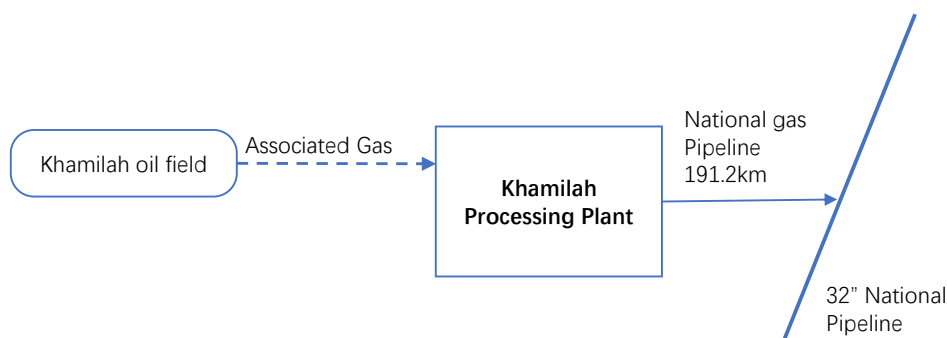


Figure 2 Pipeline network of the project

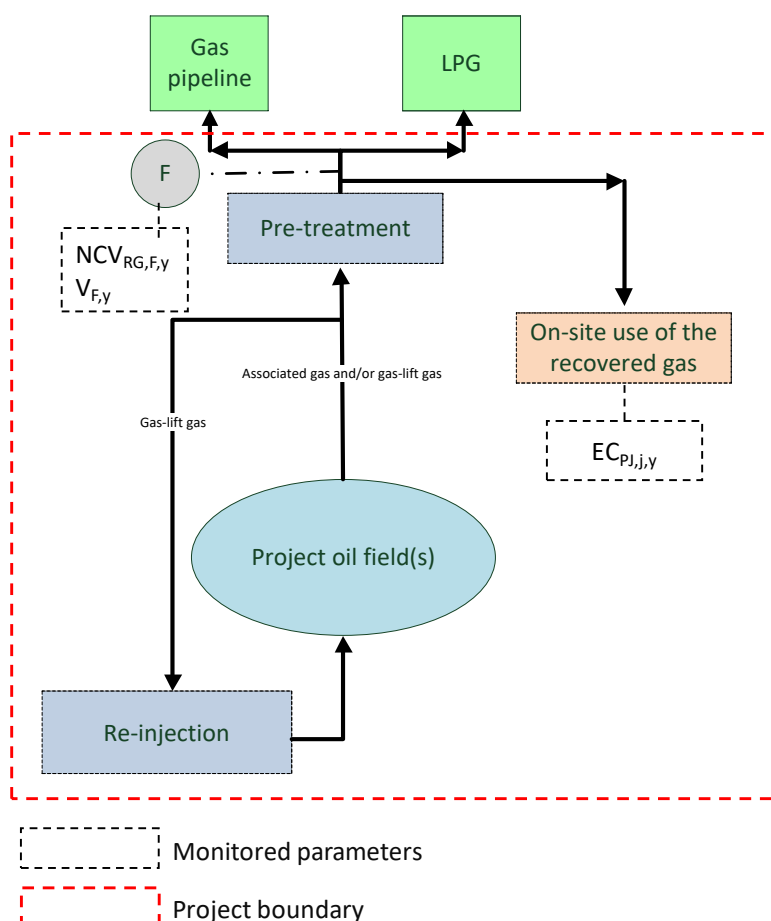


Figure 3 Flow diagram of the project boundary

Table 2 Main equipment and technical parameters in the project

Parameter	Value
Capacity	5 * 8 MMSCFD
Manufacturer	Ariel
Type	JGK-4
Technology	Reciprocating compressors
Rated Power	5*1680 HP(1HP = 735 W) 5*1234.8kW=6.174MW

B.2. Post-registration changes**B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies, standardized baselines or other methodological regulatory documents**

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Not applicable.

B.2.2. Corrections

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Not applicable.

B.2.3. Changes to the start date of the crediting period

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Not applicable.

B.2.4. Inclusion of monitoring plan

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Not applicable.

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents

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Not applicable.

B.2.6. Changes to project design

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Not applicable.

B.2.7. Changes specific to afforestation or reforestation project activity

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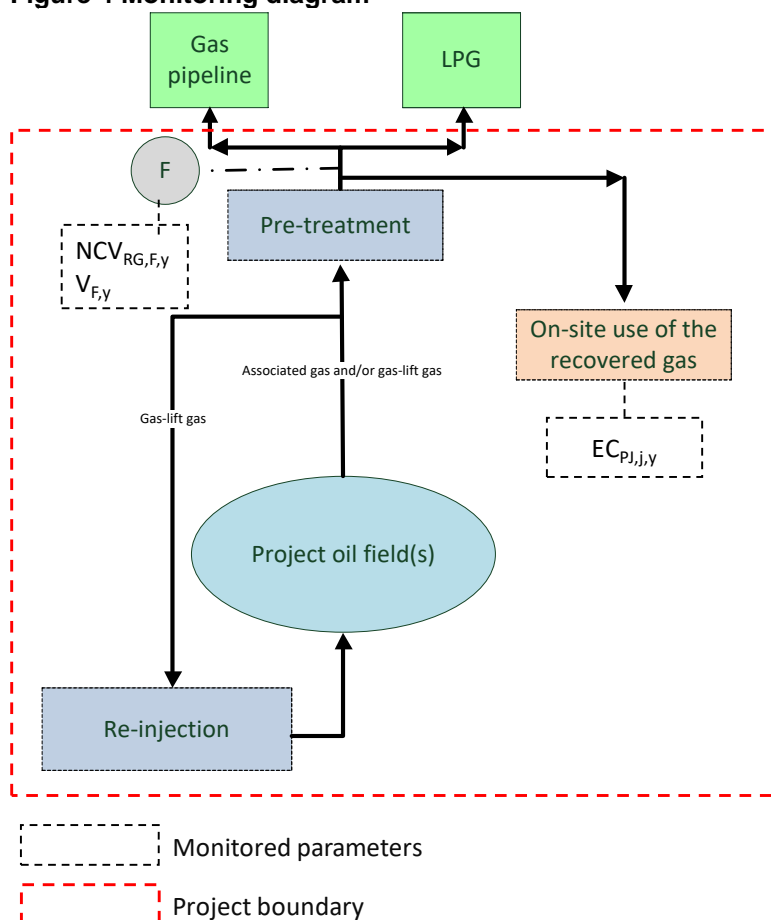
Not applicable.

SECTION C. Description of monitoring system

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The monitoring of the emission reductions will be carried out according to the scheme shown in Figure 4. The overall responsibility for the monitoring process will be held by the Monitoring Officer which will be selected among senior staff of the operating entity on-site. Some of the monitoring tasks will be delegated as indicated in Figure 5. Measurements of the associated gas volumes recovered and project electricity consumption will fall under the responsibility of the lead operator. Measurement of NCV of the recovered gas will be performed by on-site lab near the project.

Figure 4 Monitoring diagram



The monitoring officer will be responsible for collecting and performing plausibility check of the measurements. The monitoring reports and calculation of emission reductions will be prepared by experienced CDM consultant. The selection procedure, tasks and responsibilities of the monitoring officer are detailed as below:

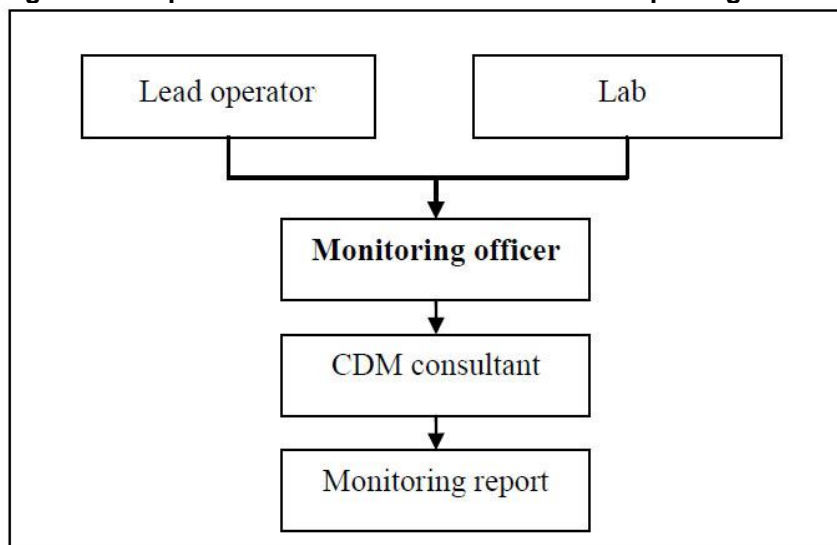
Selection procedure:

The monitoring officer will be appointed by the general manager of the entity operating the project. The monitoring officer will be selected from among the senior technical or managerial staff.

Tasks and responsibilities:

The monitoring officer will be responsible for carrying out the following tasks:

- **Supervise and verify metering and recording:** The monitoring officer will coordinate with the lead operators to ensure and verify adequate metering and recording of volumes of gas recovered. The monitoring officer will also coordinate with the designated Lab to ensure proper measurement of net calorific values of recovered gas.
- **Collect data:** The monitoring officer will collect volumes of recovered associated gas and net calorific values.
- **Monitoring report:** The monitoring officer will coordinate with CDM consultant to prepare periodic monitoring reports including calculation of emission reductions on the basis of measured results. The monitoring officer will be provided with a calculation template in electronic form by the project's CDM advisors.

Figure 5 Responsibilities for measurements and reporting emission reductions**Emergencies:**

In case of emergencies, the project entity will not claim emission reductions due to the project activity for the duration of the emergency. The project entity will follow the following procedure for declaring the emergency period to be over:

1. The project entity will ensure that all requirements for monitoring of emission reductions have been re-established.
2. The monitoring officer will sign a statement declaring the emergency situation has ended and normal operations have resumed.

Monitoring of volume of recovered gas ($V_{F,y}$)

Volume of gas will be metered through a flow meter installed. Measurements will be taken at the point where recovered gas exits the pre-treatment plant and after the point where the recovered gas is directed for on-site use.

The recorded gas volume is automatically converted to the volume at normal temperature and pressure using the temperature and pressure at the time to measurement.

The results from the gas flow meter are recorded by the lead operators for each month report to monitoring officer. The monitoring officer aggregated those data and reported them to Manager who would check and archive them, as well as manage the regular data back-up. All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period.

The calibration for the gas meter was conducted annually according to the national measurement standard and regulation by the qualified measurement technology verification institution authorized by the Oman government.

In summary, the meter has been working normally and calibrated according to the registered monitoring plan and relevant national standards.

Monitoring Net calorific value of recovered gas ($NCV_{RG,F,y}$)

The net calorific value (volume based) of the recovered gas in TJ/standard cubic meter will be calculated according to the following method:

$$NCV_{RG,F,y} = \frac{\sum(X_i \times NCV_i)}{\sum(X_i)}$$

X_i = molar fraction of the individual component i in the recovered gas sample at least monthly.

NCV_i = Net Calorific Value (volume based) of the individual component i as per ISO/DP 6976:1995 standard for a combustion reference temperature of 25°C and the same metering reference condition used for parameter $V_{F,y}$.

Gas composition measurements are undertaken in line with international fuel standards under the responsibility of the on-site lab near the project. Samples are taken monthly through gas analyzer. Calibration frequency of the gas analyzer is every 6 months under ISO 17025.

NCV will be calculated as the sum of molar fraction of each individual component in the natural gas sample multiplied by net calorific value of each individual component in the natural gas sample as referenced in ISO/DP 6976:1995 standard for a combustion reference temperature of 25°C . The average NCV during the period y is defined as the arithmetic average of NCV for the samples taken during the same period.

Based on the molar composition, NCV on a volumetric basis will be determined for each sample in line with ISO 6976 for a combustion reference temperature of 25°C and the same metering reference condition used for parameter $V_{F,y}$. The average NCV during the period y is defined as the arithmetic average of NCVs for the samples taken during the same period.

Monitoring of electricity consumption $EC_{PJ,i,y}$

Electricity meter will measure electricity consumed by the project.

$EC_{PJ,i,y}$ is continuous measured by the lead operators at the project location and report to monitoring officer. Calibration is performed annually.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

(Copy this table for each data or parameter.)

Data/Parameter	$EF_{\text{CO}_2, \text{Methane}}$		
Unit	tCO_2/TJ		
Description	CO_2 emission factor for methane		
Source of data	Calculated in line with procedures and data presented in ISO 6976:		
	Unit	Value	Source
	Carbon Content of Methane	12,011 kg/kmol	ISO 6976: Table 1
	CO_2 Emission Factor for Methane	44.01 kg/kmol	ISO 6976: Table 1
	NCV of Methane (at 25°C)	802.60 kJ/mol	ISO 6976: Table 3
Value(s) applied	54.834 tCO_2/TJ		
Choice of data or measurement methods and procedures	ISO 6976:		
Purpose of data/parameter	Calculation of baseline emissions		
Additional comments	---		

Data/Parameter	$\text{TDL}_{j,y}$		
Unit	-		

Description	Average technical transmission and distribution losses for providing electricity to source j year y
Source of data	Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 03.0)
Value(s) applied	0
Choice of data or measurement methods and procedures	Scenario B "Electricity consumption from an off-grid captive power plant" of the "Tool to calculate baseline, project and/or leakage emission from electricity consumption" applies. In case of scenario B, assume $TDL_{j,y} = 0$ as a simplification.
Purpose of data/parameter	Calculation of project emissions
Additional comments	---

Data/Parameter	$EF_{EL,j,y}$
Unit	tCO ₂ /yr
Description	Emission factor for electricity generation for source j in year y
Source of data	Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 03.0)
Value(s) applied	1.3
Choice of data or measurement methods and procedures	Scenario B, Option B2(a) is applied as per registered PDD.
Purpose of data/parameter	Calculation of project emissions
Additional comments	---

D.2. Data and parameters monitored

(Copy this table for each data or parameter.)

Data/Parameter	$V_{F,y}$
Unit	Nm ³
Description	Volume of the total recovered gas measured at point F in methodology Figure 2 in year y.
Measured/calculated/default	Measured by gas flow meter
Source of data	Flow meter installed by project entity
Value(s) of monitored parameter	66,566,558
Monitoring equipment	Data will be measured continuously using calibrated flow meter. Measurements will be taken at the point where recovered gas exits the pre-treatment plant and after the point where the recovered gas is directed for on-site use.
Measuring/reading/recording frequency	Data will be measured continuously and recorded monthly.
Calculation method (if applicable)	--
QA/QC procedures	Gas flow meter calibration frequency is annual. The calibration for the gas meter was conducted annually according to the national measurement standard and regulation by the qualified measurement technology verification institution authorized by the Oman government. The total recovered gas volume is crosschecked with commercial data.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	--

Data/Parameter	NCV _{RG,F,y}
Unit	TJ/Nm ³
Description	Average net calorific value of recovered gas at point F in methodology Figure 2 in year y
Measured/calculated/default	On site measurement and calculated
Source of data	<p>Gas composition measurements are undertaken in line with international fuel standards under the responsibility of the on-site lab near the project. Samples are taken monthly through gas analyzer. Calibration frequency of the gas analyzer is every 6 months under ISO 17025.</p> <p>NCV will be calculated as the sum of molar fraction of each individual component in the natural gas sample multiplied by net calorific value of each individual component in the natural gas sample as referenced in ISO/DP 6976:1995 standard for a combustion reference temperature of 25°C. The average NCV during the period y is defined as the arithmetic average of NCV for the samples taken during the same period.</p>
Value(s) of monitored parameter	Please refer to the ER sheet for more detail.
Monitoring equipment	Samples are taken monthly through gas analyser.
Measuring/reading/recording frequency	Sampling and compositional analysis and calculation of net calorific value monthly.
Calculation method (if applicable)	<p>Monthly NCV will be calculated as the sum of molar fraction of each individual component in the natural gas sample multiplied by net calorific value of each individual component in the natural gas sample as referenced in ISO/DP 6976:1995 standard for a combustion reference temperature of 25°C.</p> <p>The average NCV during this monitoring period is defined as the arithmetic average of NCV for the samples taken during the same period.</p>
QA/QC procedures	<p>Measurements are done as per ISO10715;</p> <p>Compositional analysis is in accordance with ISO 6974;</p> <p>Routine maintenance and calibration in accordance with ISO 10723;</p> <p>Calibration of the gas analyser is performed every 6 months, as per ISO 17025.</p>
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	---

Data/Parameter	EC _{PJ,j,y}
Unit	MWh/yr
Description	Quantity of electricity consumed by the project electricity consumption source j in year y
Measured/calculated/default	Measured by the electricity meter.
Source of data	Electricity meter installed at point F.
Value(s) of monitored parameter	9,139
Monitoring equipment	Electricity meter
Measuring/reading/recording frequency	Continuous measurement and monthly recorded
Calculation method (if applicable)	--

QA/QC procedures	Electricity meter will be calibrated annually in accordance with local requirements. The total consumed electricity is crosschecked with confirmation letter.
Purpose of data/parameter	Calculation of project emissions
Additional comments	--

D.3. Implementation of sampling plan

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Not applicable

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

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According to the methodology AM0009 Version 07.0, the emissions reduction by the project is calculated as follows:

$$BE_y = V_{F,y} \times NCV_{RG,F,y} \times EF_{CO_2,Methane}$$

Where:

BE_y = Baseline emissions in year y, (tCO₂e)

$V_{F,y}$ = Volume of total recovered gas measured at point F, in year y, (10⁴Nm³)

$NCV_{RG,F,y}$ = Average net calorific value of recovered gas at point F in year y, (TJ/Nm³)

$EF_{CO_2,Methane}$ = CO₂ emission factor for methane (tCO₂/TJ)

$EF_{CO_2,Methane}$ is ex-ante determined in the registered CDM-PDD which is 54.834 tCO₂/TJ. The average $NCV_{RG,F,y}$ during this monitoring period is defined as the arithmetic average of NCVs for the samples taken during the same period.

E.2. Calculation of project emissions or actual net removals

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Project emissions are calculated as follows:

$$PE_y = PE_{CO_2,fossilfuels,y} + PE_{CO_2,elec,y}$$

Where:

PE_y = Project emissions in year y, (tCO₂e)

$PE_{CO_2,fossilfuels,y}$ = CO₂ emissions due to consumption of fossil fuels for the recovery, pre-treatment, transportation, and if applicable, compression of the recovered gas up to the point F in year y (tCO₂e)

$PE_{CO_2,elec,y}$ = CO₂ emissions due to the use of electricity for recovery, pre-treatment, transportation and if applicable, compression of the recovered gas up to the point F in year y (tCO₂e)

According to PDD section B.6.1, there is no direct consumption of fossil fuels as part of the Project activity therefore above equation can be simplified as:

$$PE_y = PE_{CO_2,y} = PE_{EC,y}$$

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y})$$

Average technical transmission and distribution losses for providing electricity to source j in year y ($TDL_{j,y}$) is set at 0% as the project consumes electricity from an off-grid captive power plant, and $EF_{EL,j,y}$ is set at 1.3tCO₂/MWh as it is a project electricity consumption source, which is the conservative default value set in the tool.

E.3. Calculation of leakage emissions

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According to the registered PDD, there is no leakage emission considered, thus $LE_y = 0$.

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO ₂ e)	Project GHG emissions or actual net GHG removals (t CO ₂ e)	Leakage GHG emissions (t CO ₂ e)	GHG emission reductions or net anthropogenic GHG removals (t CO ₂ e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	153,987	11,881	0	0	142,106	142,106

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO ₂ e)	Amount estimated ex ante for this monitoring period in the PDD (t CO ₂ e)
142,106	143,865

E.5.1. Explanation of calculation of “amount estimated ex ante for this monitoring period in the PDD”

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The monitoring period (03/08/2020-15/10/2020) is 74 days. According to the registered PDD, the estimated ER in 2020 is 711,550 tones, therefore, the amount estimated ex ante for this monitoring period is calculated as: $711,550 \times 74 / 366 = 143,865$ tons.

E.6. Remarks on increase in achieved emission reductions

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The actual ERs is less than estimated in the PDD.

E.7. Remarks on scale of small-scale project activity

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Not applicable.

Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
07.0	31 May 2019	Revision to: <ul style="list-style-type: none"> • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Add a section on remarks on the observance of the scale limit of small-scale project activity during the crediting period; • Add "changes specific to afforestation or reforestation project activity" as a possible post-registration changes; • Clarify the reporting of net anthropogenic GHG removals for A/R project activities between two commitment periods; • Make editorial improvements.
06.0	7 June 2017	Revision to: <ul style="list-style-type: none"> • Ensure consistency with version 01.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: <ul style="list-style-type: none"> • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: <ul style="list-style-type: none"> • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from <i>F-CDM-MR</i> to <i>CDM-MR-FORM</i>; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.

<i>Version</i>	<i>Date</i>	<i>Description</i>
Decision Class: Regulatory Document Type: Form Business Function: Issuance Keywords: monitoring report		