



MONITORING REPORT OF ASSOCIATED GAS RECOVERY AND UTILIZATION AT KHAMILAH OIL FIELD AREA AT BLOCK-27 IN WILAYAT LBRI OF THE SULTANATE OF OMAN

Document Prepared by Vitol SA

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CONTENTS

1	PROJECT DETAILS.....	3
1.1	Summary Description of the Implementation Status of the Project	3
1.2	Sectoral Scope and Project Type	4
1.3	Project Proponent	4
1.4	Other Entities Involved in the Project	4
1.5	Project Start Date	5
1.6	Project Crediting Period	5
1.7	Project Location	5
1.8	Title and Reference of Methodology	7
1.9	Participation under other GHG Programs	7
1.10	Other Forms of Credit and Supply Chain (Scope 3) Emissions	8
1.11	Sustainable Development Contributions	8
2	SAFEGUARDS	11
2.1	No Net Harm	11
2.2	Local Stakeholder Consultation	12
2.3	AFOLU-Specific Safeguards	12
3	IMPLEMENTATION STATUS	12
3.1	Implementation Status of the Project Activity	12
3.2	Deviations	15
3.3	Grouped Projects	15
4	DATA AND PARAMETERS.....	15
4.1	Data and Parameters Available at Validation	15
4.2	Data and Parameters Monitored.....	16
4.3	Monitoring Plan.....	19
5	QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS	23
5.1	Baseline Emissions	23
5.2	Project Emissions	25
5.3	Leakage.....	27
5.4	Net GHG Emission Reductions and Removals	27

1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

Associated Gas Recovery and Utilization at Khamilah oil field area at Block-27 in Wilayat Ibri of the Sultanate of Oman (hereafter referred as “the project”) consists of the recovery and utilization of natural gas found in association with oil at Khamilah oil field at Block-27, Wilayat Ibri of Al-Dhahirah Governorate, the Sultanate of Oman. 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 is being 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 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 proposed project installed 5 compressors (K01~K05), construction was started on 02/06/2019, and all the 5 compressors started commissioning on 05/01/2020. The project is implanted smoothly during this monitoring period.

The total estimated amount of associated gas to be recovered during the crediting period is about 2.20 billion m³ while average methane content is estimated at about 78%. The project is expected to have an annual average of 473,826 tCO₂e emission reduction over the crediting period. The estimated emission reductions are 4,738,260 tCO₂e over the fixed 10-year crediting period. The Project processes 179,658,380.561 Nm³ associated gas and the total emission reductions achieved is 384,590 tCO₂e in this monitoring period (05/01/2020-31/07/2020).

Audit Type	Period	Program	VVB Name	Number of years
Validation	03-August-2020	CDM	CTI	/

Validation	18-August-2022	VCS (Gap validation)	CTI	/
Verification	05-January-2020 to 31-July-2020 (this monitoring period)	VCS	CTI	0.57 (208/365=0.57)
Verification	03-August-2020 to 15-October-2020	CDM	China Certification Center, Inc. (CCCI)	0.20 (74d/365d=0.20)
	16-October-2020 to 15-November-2020	CDM	CCCI	0.08 (31d/365d=0.08)
	16-November-2020 to 15-December-2020	CDM	CCCI	0.08 (30d/365d=0.08)
Total	05-January-2020 to 31-July-2020	VCS	CTI	0.57 (208d/365d=0.57)
	03-August-2020 to 15-December-2020	CDM	CCCI	0.37 (135d/365d=0.37)

1.2 Sectoral Scope and Project Type

Scope 10: Fugitive emissions from fuels (solid, oil and gas)

The project is not a grouped project.

1.3 Project Proponent

Organization name	OQ Trading Limited
Contact person	Mr. Said Al Maawali
Title	Executive Director Middle East
Address	at Level 7, Gate Precinct Building 6 (Legatum Plaza), Dubai International Finance Centre, Dubai, United Arab Emirates
Telephone	+968 9137 0000
Email	said.almaawali@oq.com

1.4 Other Entities Involved in the Project

Organization name	Vitol SA
Role in the Project	VCS account manager

Contact person	Mr. Michael Ivanovitch
Title	Verra account manager
Address	Place des Bergues 3, 1201 Geneva, Switzerland
Telephone	+41 22 322 1111
Email	MXI@vitol.com

1.5 Project Start Date

The project started operation on 05/01/2020, thus the project start date is 05/01/2020.

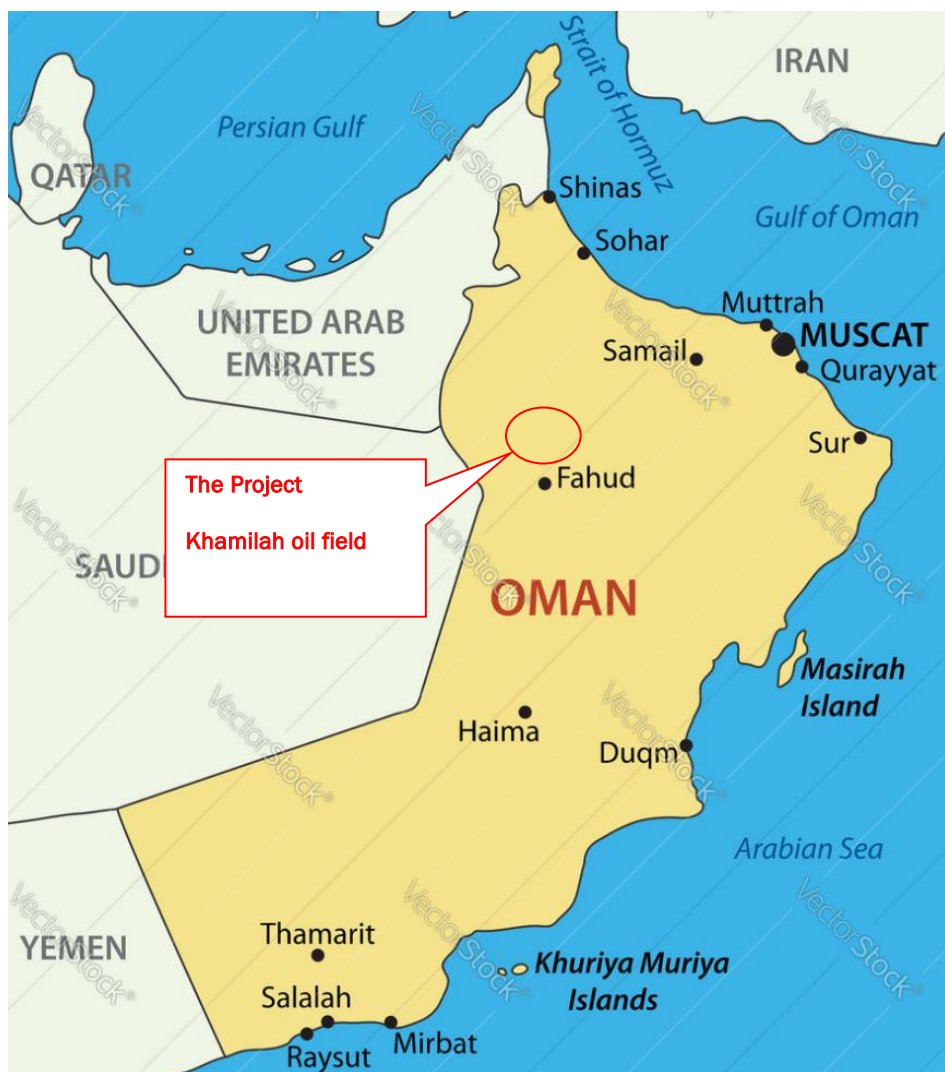
1.6 Project Crediting Period

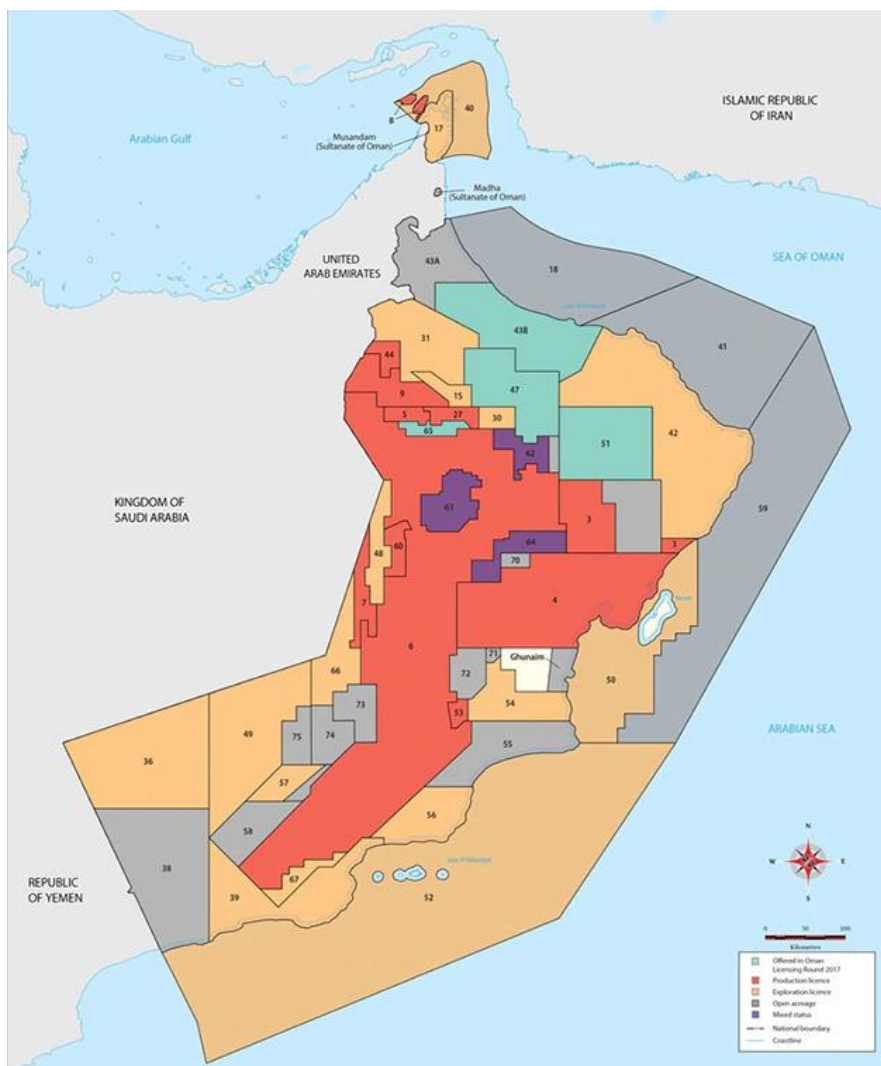
05/01/2020 – 04/01/2030, the crediting period is 10 years fixed from the project start date.

1.7 Project Location

The project collects associated gas from Khamilah oil field at Block-27, Wilayat Ibri of Al- Dhahirah Governorate, the Sultanate of Oman. The recovered gas is being 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". Figure A.1 shows the location of the project.





1.8 Title and Reference of Methodology

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);

<https://cdm.unfccc.int/methodologies/DB/ET4NXMVXFQ5C2EJ5L10F8YZIEVLVDA>

1.9 Participation under other GHG Programs

The project has been registered under CDM under AM0009, the CDM reference number is 10584. The crediting period under CDM is 03/08/2020 – 02/08/2030 (Fixed).

The project has not been, and will not seek registration under other GHG Programs, except for CDM and VCS. Below is the detail of the GHG credits under CDM:

Period	Program	Issued GHG Credits
03-August-2020 to 15-October-2020	CDM	142,106
16-October-2020 to 15-November-2020	CDM	58,875
16-November-2020 to 15-December-2020	CDM	57,094

1.10 Other Forms of Credit and Supply Chain (Scope 3) Emissions

Oman has not launched any mandatory carbon emission scheme, and GHG emission reduction scheme, thus GHG emission reductions and removals generated by the project has no way in legislation to be used for compliance in Oman.

The project has not been and will not apply for any other GHG emission reduction scheme, such as GCC, GS, etc, and is not in the project data base of these schemes.

The project proponent has signed declaration on not being used for the compliance and no double counting claiming of the credits. The project is not involved in an emission trading program or any other mechanism that includes GHG allowance trading.

The project has not sought or received another form of GHG-related environmental credit.

The project does not affect emissions associated with a good or service, thus Supply Chain (Scope 3) Emissions is not applicable.

1.11 Sustainable Development Contributions

The project contributed to the sustainable development through the following 3 SDGs:

- Created 27 job including 13 for engineering and 14 for operation and maintenance by the end of this monitoring period and achieved SDG 8 Decent Work and Economic. Oman

government has been encouraging creation of job opportunities, and promoting knowledge-based labour market¹.

- Prevented the release of 384,590 tonnes of CO₂e into the atmosphere and achieved SDG 13 Climate Action. In September 2020, Oman announced they will achieve carbon neutral in 2050².
- Recovered 179,658,380.561 Nm³ associated gas and delivered to the national pipeline for end-users, thus, reduced the consumption of the corresponding baseline gas and contributed to increasing the Oman's energy security and achieved SDG 7 Affordable and Clean Energy. As per Oman Vision 2040, Oman government is targeting to increase GDP per unit of energy use to 14.57 or top 40 countries by 2030 and to 74.69 or top 20 countries by 2040.³

Please refer to section 4 and section 5 of this monitoring report for the evidence of the project's contribution to SD 7 and SDG 13. And the evidence for SDG 8 will be submitted as a separate document to Verra due to confidentiality requirement of the project proponent.

¹ The Omani National Employment Programme (NEP) is all set to create a labour market filled with nationals who are qualified and skilled in their respective fields: <https://www.zawya.com/en/economy/omans-national-employment-programme-to-create-a-knowledge-based-labour-market-f1zwy8s6>

² Oman has signed a royal decree approving the country's pledge to reach net zero emissions by 2050: <https://www.argusmedia.com/en/news/2379719-oman-pledges-net-zero-emissions-by-2050>

³ https://climate-laws.org/geographies/oman/climate_targets/Economy-wide

Table 1: Sustainable Development Contributions

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime ⁴
1)	7	Volume of the total recovered gas that delivered to the national pipeline for the end-users	Implemented activities to increase	The project recovered 179,658,380.561 Nm ³ associated gas and delivered to the national pipeline for end-users during the monitoring period, thus reduced the consumption of the corresponding baseline gas and contributed to increasing Oman's energy security.	An accumulated 179,658,380.561 Nm ³ of recovered gas has been supplied to the national pipeline by end of the reporting period.
2)	8	Numbers of job opportunities provided by implementation of the project	Implemented activities to increase	The project has created 27 job opportunities including 13 for engineering and 14 for operation and maintenance by the end of this monitoring period.	27 people have been employed by the project as long-term employee by end of the reporting period.
3)	13	Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to increase	The Project has prevented the release of 384,590 tonnes of CO ₂ e into the atmosphere during the monitoring period	Prevented the release of 384,590 tonnes of CO ₂ e into the atmosphere by the end of the reporting period

⁴ This is the first time to report sustainable development contributions of the project. Therefore, the information for the project lifetime and the current monitoring period are the same as per VCS requirement.

2 SAFEGUARDS

2.1 No Net Harm

There is no binding national/regional regulation in Oman as to undertake an environmental impact assessment for the project. The environmental permit granted to the operator for the Exploration & Production of Oil & Gas was issued on September 3rd, 2018 by Ministry of Environment and Climate Affairs according to Law on Conservation of Environment and Prevention of Pollution promulgated by Royal Decree No.13287.

The project is located in landscape which has high sand dune area and gravel plains. The project is located in the middle of the Omani desert on an existing oil field, while the nearest town is far away. Only one small tribe lived nearby. All men from the tribe are employed on project site at the oil field and the tribe mainly consists of members of the same family. Thus, the project has limited impacts on local residents. Furthermore, the project has been built on an existing oil field for which an environmental impact assessment had already been approved by Omani Government. Still, the following has been identified as key possible environmental impacts:

1. Air quality:

Due to the general low industrial emission sources and low population density, air quality in Oman is good. Air pollution has been significantly reduced due to the project activity as a result of associated gas recovery.

2. Noise

The noise during the operation period is mainly from compressors. However, the project is located in remote area, where no surrounding resident. Therefore, noise from the project activity is not significant harmful to the environment. During construction phase, no significant impact on the environment is expected as the proposed project is implemented on existing clusters where oil extraction activities are taking place on daily basis.

3. Solid waste

The field itself already has a treatment system for solid waste, which is applied to the proposed project as well; the impact of solid waste on the environment is limited.

In light of the above analysis, it is concluded that the project activity has no significant negative impacts on the ambient environment during the construction and operation period. Some impacts are short-term, and others are mitigated through appropriate preventive and mitigation measures. Therefore, this project does not have significant negative environmental impact.

What's more, the project has recovered 179,658,380.561 Nm³ associated gas and delivered to the national pipeline for end-users that would otherwise be generated by the fossil fuels which increases the Oman's energy security and created 27 jobs including 13 for engineering and 14

for operation and maintenance. In conclusion, no net harm on local environment and social community has been detected for the project.

2.2 Local Stakeholder Consultation

LSC prior to the project implementation

In order to confirm the impact of the project on local stakeholders, the project entity carried out a separate consultation of local stakeholders near the project site on the 27th and 28th of April 2019. All comments received have been well addressed prior to the project implementation. Please refer to section E of the registered CDM-PDD of the project for detailed information. In conclusion, there was no significant negative comments received in the project preparation stage.

The mechanism for on-going communication with local stakeholders.

As described in sections A.4 of the registered CDM-PDD, the project is located in the middle of the Omani desert on an existing oil field, while the nearest town is far away. Only one small tribe leaves nearby. All men from the tribe are employed on project site at the oil field and the tribe mainly consists of members of the same family. Therefore, no formal written invitation for comments was considered necessary nor practical or most efficient, and the members of the tribe can raise their concerns and opinions directly in an open and transparent manner to the Health and Safety Department of the Operator on-site. No comments are received during this monitoring period. In addition, the local government authorities also conduct spot checks on the project implementation on a regular basis, and give suggestions on potential issues. There is no negative comment nor grievance received from the stakeholders of the project during this monitoring period.

2.3 AFOLU-Specific Safeguards

Not applicable as this is not an AFOLU project.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The project activity aims to recover associated gas flow that is currently flared in Khamilah oil field and is being 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

is 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. The project recovered 179,658,380.561 Nm³ associated gas during this monitoring period. The project is operated smoothly and there is no emergency happened during this monitoring period. The project includes a captive gas power plant on-site to supply electricity to the project activity, a small amount of recovered gas is used for captive power generation, which is used for the recovery, pre-treatment, transportation of pipeline network, compression involved in the project activity. Electricity is supplied to on-site electricity consuming facilities. The project consumed 25,173.080MWh electricity during this monitoring period.

The project installed 5 compressors (K01~K05), construction was started on 02/06/2019, and all the 5 compressors started commissioning on 05/01/2020.

Table 1 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

Detailed information regarding compressors is listed as follows:

Table 2 Milestone of the Project

No.	Date	Milestone
1	02/06/2019	The project construction started
2	05/01/2020	Fully commissioning
3	03/08/2020	Registered as a CDM project
4	03/08/2020-15/10/2020	CDM monitoring period 1
5	16/10/2020-15/11/2020	CDM monitoring period 2
6	16/11/2020-15/12/2020	CDM monitoring period 3
7	24/08/2022	Registered as a VCS project

8	05/01/2020-31/07/2020	This monitoring period
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The below figure provides an overview of the pipeline network.

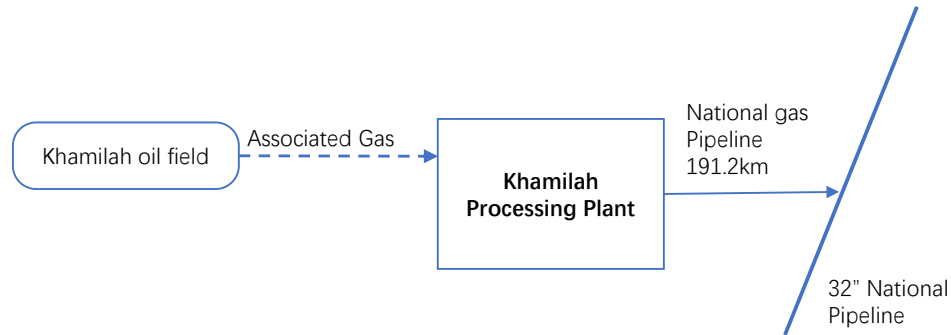


Figure 2 Pipeline network of the project

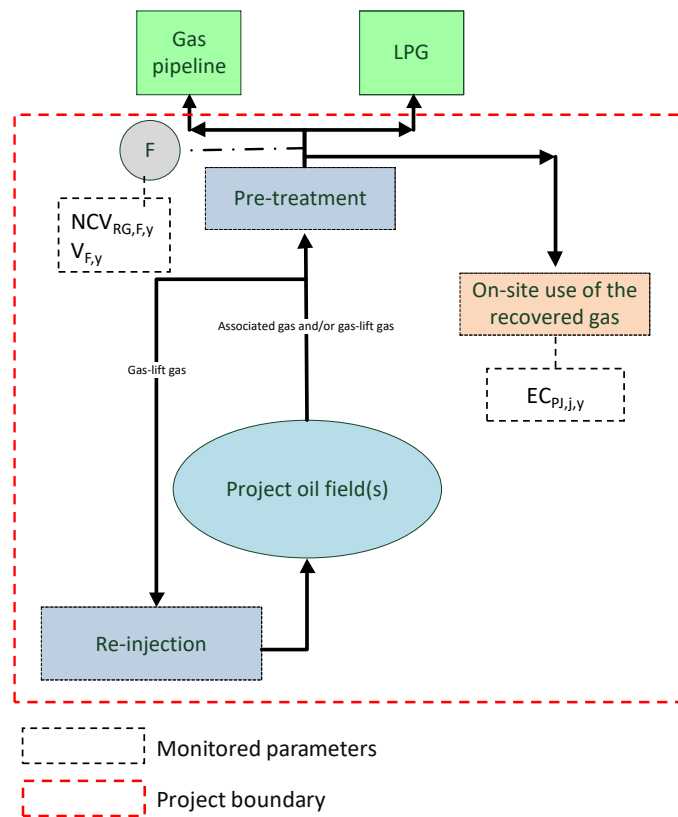


Figure 3 Flow diagram of the project boundary

3.2 Deviations

3.2.1 Methodology Deviations

No deviations from the methodology.

3.2.2 Project Description Deviations

No deviations from the Project Description.

3.3 Grouped Projects

The project is not grouped project, not applicable.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	EF _{CO₂,Methane}		
Data 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 applied	54.834		
Justification of choice of data or description of measurement methods and procedures applied	Calculated in line with procedures and data presented in ISO 6976		
Purpose of Data	Calculation of baseline emissions		
Comments	-		

Data / Parameter	TDL _{j,y}
Data 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 applied	0
Justification of choice of data or description of measurement methods and procedures applied	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	Calculation of project emissions
Comments	-

Data / Parameter	$EF_{EL,j,y}$
Data unit	t CO ₂ /MWh
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 applied	1.3
Justification of choice of data or description of measurement methods and procedures applied	Scenario B, Option B2 (a) of the methodology is applied.
Purpose of Data	Calculation of project emissions
Comments	-

4.2 Data and Parameters Monitored

Data / Parameter	$V_{F,y}$
Data unit	Nm ³
Description	Volume of the total recovered gas measured at point F in methodology AM0009 version 07.0 Figure 2 in year y.
Source of data	Flow meter installed by project entity
Description of measurement methods and procedures to be applied	Data is measured continuously using calibrated flow meter. Measurements is 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.
Frequency of monitoring/recording	Measured continuously and recorded monthly.

Value monitored	179,658,380.561			
Monitoring equipment	Measured by gas flow meter			
	Meter SN	Accuracy	Calibration date	Validity
	0500971	0.04%	02/01/2020	01/01/2021
QA/QC procedures to be applied	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.			
	Gas flow meter accuracy is 0.04%.			
	Lead operator of the project is responsible for monitoring. 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.			
	For this monitoring period, the gas flow meter was calibrated on 02/01/2020 with validity till 01/01/2021.			
	Please reference to Table 3 for the details of gas flow meters.			
	The total recovered gas volume is crosschecked with commercial data.			
Purpose of the data	Calculation of baseline emissions			
Calculation method	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.			
Comments	-			

Data / Parameter	$NCV_{RG,F,y}$
Data unit	TJ/Nm ³
Description	Average net calorific value of recovered gas at point F in AM0009 version 07.0 Figure 2 in year y
Source of data	Calculated based on the on-site gas sampling and compositional analysis.
Description of measurement methods and procedures to be applied	Sampling and gas compositional analysis are undertaken in line with ISO 10715 and ISO 6974 and under the responsibility of the on-site lab near the project. Samples are taken monthly through chromatography gas analyzer at point F in Figure 4. Based on the molar composition, Net Calorific Value on a volumetric basis is 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 $V_{F,y}$. NCV is 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 6976 standard for a combustion reference temperature of 25 °C. The average NCV during the period y is defined as the arithmetic average of NCVs for the samples taken during the same period
Frequency of monitoring/recording	Sampling and compositional analysis and calculation of net calorific value monthly.
Value monitored	Please refer to the ER sheet for more detail.
Monitoring equipment	Samples are taken and the gas composition is analyzed through chromatography gas analyser monthly.
QA/QC procedures to be applied	Sampling and gas compositional analysis are undertaken in line with ISO 10715 and ISO 6974 respectively; Routine maintenance and calibration are in accordance with ISO 10723; GC calibration gases are certified to ISO 6141; Calibration frequency of the gas analyzer is every 6 months under ISO 17025. For this monitoring period, the chromatography gas analyser was calibrated on 24/10/2019 and 24/04/2020 with validity till 23/04/2020 and 23/10/2020.
Purpose of the data	Calculation of baseline emissions.
Calculation method	The average NCV during the period y is defined as the arithmetic average of NCVs for the samples taken during the same period.
Comments	-

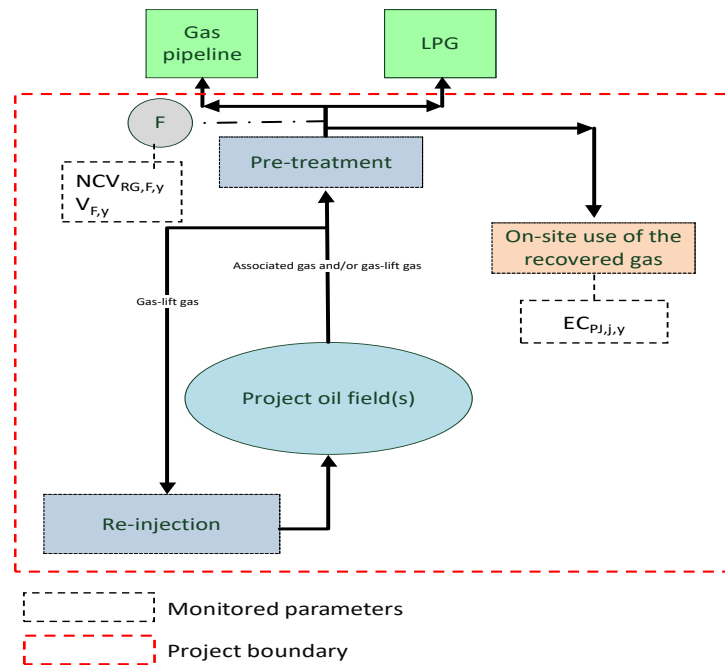
Data / Parameter	$EC_{PJ,y}$
Data unit	MWh
Description	Quantity of electricity consumed by the project electricity consumption source j in year y
Source of data	Electricity meter installed at point F.
Description of measurement methods and procedures to be applied	Lead operator of the project is responsible for monitoring. Electricity meter is subject to regular maintenance and testing in accordance with the stipulation of national requirements. Electricity meters is calibrated annually in accordance with national standards.
Frequency of monitoring/recording	Continuous measurement and monthly recorded

Value monitored	25,173.080			
Monitoring equipment	Electricity meter, please refer to Table 4 for more details.			
	Meter SN	Accuracy	Calibration date	Validity
	P13C8095	0.5s	02/01/2020	01/01/2021
QA/QC procedures to be applied	Accuracy is 0.5s. Lead operator of the project is responsible for monitoring. Electricity meter is subject to regular maintenance and testing in accordance with the stipulation of national requirements. Electricity meters is calibrated annually in accordance with national standards. Please reference to Table 4 for the details of electricity meters. The total consumed electricity is crosschecked with confirmation letter issued by Oman government.			
Purpose of the data	Calculation of project emissions			
Calculation method	-			
Comments	-			

4.3 Monitoring Plan

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

Figure 4 Monitoring diagram



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

Selection procedure:

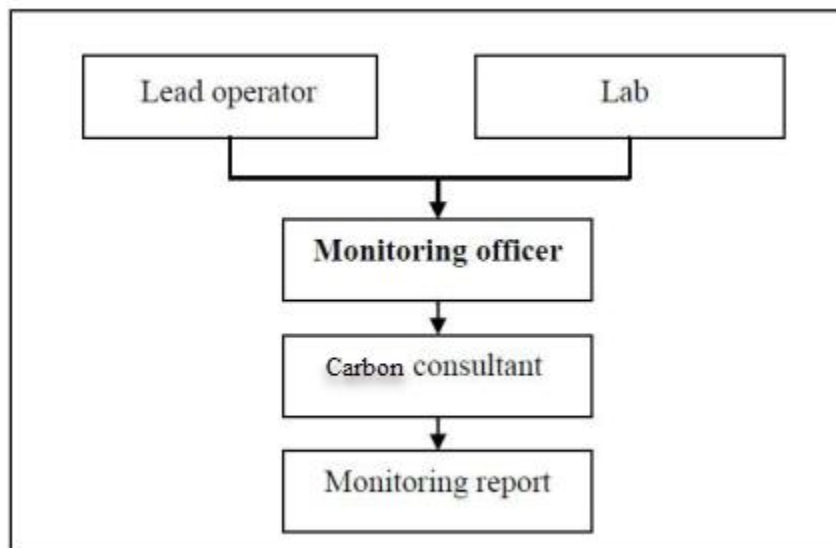
The monitoring officer is appointed by the general manager of the entity operating the project. The monitoring officer is selected from among the senior technical or managerial staff.

Tasks and responsibilities:

The monitoring officer is responsible for carrying out the following tasks:

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

There is no emergency incident happened during this monitoring period.

Data management:

All electronic and hard copy records of the metering devices, relevant documentation and the proof of calibration is collated by monitoring officer and electronic copy is provided to carbon consultant. All Data collected as part of monitoring will be archived electronically and kept at least 2 years after the end of the crediting period.

Operational procedures:

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

Volume of gas is metered through a flow meter installed. Measurements is 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, namely 101.325kpa, 25 °C follow ISO 6976.

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.

Table 3 Information of gas flow meter

Meter SN	Accuracy	Calibration date	Validity
0500971	0.04%	02/01/2020	01/01/2021

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

The net calorific value (volume based) of the recovered gas in TJ/Nm³ is 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 provided by the Lab using chromatography gas analyzer at least monthly.

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

Sampling are taken in accordance with ISO 10715, compositional analysis is in accordance with ISO 6974. under the responsibility of the on-site lab near the project. Samples are taken monthly through chromatography gas analyzer. Calibration frequency of the gas analyzer is every 6 months under ISO 17025. Routine maintenance and calibration are in accordance with ISO 10723. GC calibration gases are certified to ISO 6141.

For this monitoring period, the chromatography gas analyzer was calibrated on 24/10/2019 and 24/04/2020 with validity till 23/10/2020.

Based on the molar composition, Net Calorific Value on a volumetric basis is 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 $V_{F,y}$. NCV is 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 6976 standard for a combustion reference temperature of 25°C. 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 $EC_{PJ,y}$

Electricity meter installed at point F as displayed in Figure 4 measures electricity consumed by the project.

$EC_{PJ,y}$ is continuously measured and recorded at 24:00 of the last day of each month by the lead operators at the project location and report to monitoring officer. Calibration is performed annually. The total electricity consumption is crosschecked with commercial data, the higher value is adopted for in case any inconsistency between the monitored value and the commercial data.

Table 4 Description of electricity meter

Meter SN	Accuracy	Calibration date	Validity
P13C8095	0.5s	02/01/2020	01/01/2021

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

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

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

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)

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

Volume of total recovered gas measured at point F of the methodology figure 2 (after deduction of internal consumption) (Nm³)

The monitored values and the crosscheck process are shown in the table below:

Monitoring period	Confirmed Volume of total recovered gas (Nm ³)	Monitored volume of total recovered gas (Nm ³)	Commercial data of volume of total recovered gas (Nm ³)
05/01/2020-31/01/2020	23,485,792.630	23,485,792.630	23,485,792.630
01/02/2020-29/02/2020	25,263,245.532	25,263,245.532	25,263,245.532
01/03/2020-31/03/2020	26,092,899.076	26,092,899.076	26,092,899.076
01/04/2020-30/04/2020	25,838,679.304	25,838,679.304	25,838,679.304
01/05/2020-31/05/2020	26,528,603.811	26,528,603.811	26,528,603.811
01/06/2020-30/06/2020	25,963,029.333	25,963,029.333	25,963,029.333
01/07/2020-31/07/2020	26,486,130.875	26,486,130.875	26,486,130.875
Total	179,658,380.561	/	/

The average $NCV_{RG,F,y}$ during this monitoring period is defined as the arithmetic average of NCVs for the samples taken monthly during the same period. The NCVs for the monthly recovered gas samples and the average $NCV_{RG,F,y}$ are summarized in the table below:

	Jan-2020	Feb-2020	Mar-2020	Apr-2020	May-2020	Jun-2020	Jul-2020
$NCV_{RG,F,m}$	0.00004232	0.00004236	0.00004229	0.00004232	0.00004242	0.00004241	0.00004242
$NCV_{RG,F,y}$	0.00004236						

$EF_{CO_2,Methane}$ is ex-ante determined in the registered CDM PDD which is 54.834 tCO₂/TJ.

Therefore, the calculation of the baseline emissions is shown in the table below:

Monitoring period	$V_{F,y}$	$NCV_{RG,F,y}$	$EF_{CO_2,Methane}$	BE_y
	Volume of total recovered gas (Nm ³)	Net calorific value of recovered gas (TJ/Nm ³)	CO ₂ emission factor for methane (tCO _{2e} /TJ)	Baseline emissions (tCO _{2e})
05/01/2020-31/01/2020	23,485,792.630	0.00004236	54.834	54,554
01/02/2020-29/02/2020	25,263,245.532		54.834	58,682
01/03/2020-31/03/2020	26,092,899.076		54.834	60,610

01/04/2020-30/04/2020	25,838,679.304		54.834	60,019
01/05/2020-31/05/2020	26,528,603.811		54.834	61,622
01/06/2020-30/06/2020	25,963,029.333		54.834	60,308
01/07/2020-31/07/2020	26,486,130.875		54.834	61,523
Total	179,658,380.561			417,318

5.2 Project Emissions

Project emissions are calculated as follows:

$$PE_y = PE_{CO2, \text{fossilfuels}, y} + PE_{CO2, \text{elec}, y}$$

Where:

PE_y = Project emissions in year y, (tCO₂e)

$PE_{CO2, \text{fossilfuels}, y}$ = 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)

$PE_{CO2, \text{elec}, y}$ = 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:

$$PE_y = PE_{CO2, \text{elec}, y} = PE_{EC, y} = \sum_j EC_{PJ, j, y} \times EF_{EL, j, y} \times (1 + TDL_{j, y})$$

Where,

$EC_{PJ, j, y}$ = Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)

$EF_{EL, j, y}$ = Emission factor for electricity generation for source j in year y (t CO₂/MWh)

$TDL_{j, y}$ = Average technical transmission and distribution losses for providing electricity to source j in year y

j = Sources of electricity consumption in the project

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.

The monitored values and the crosscheck process of $EC_{PJ,j,y}$ are shown in the table below:

$EC_{PJ,j,y}$ Unit: MWh			
Monitoring period	Confirmed value	Monitored value	Commercial confirmed value
05/01/2020-31/01/2020	3,418.880	3,418.880	3,418.880
01/02/2020-29/02/2020	3,439.200	3,439.200	3,439.200
01/03/2020-31/03/2020	3,641.320	3,641.320	3,641.320
01/04/2020-30/04/2020	3,594.800	3,594.800	3,594.800
01/05/2020-31/05/2020	3,722.840	3,722.840	3,722.840
01/06/2020-30/06/2020	3,618.920	3,618.920	3,618.920
01/07/2020-31/07/2020	3,737.120	3,737.120	3,737.120
Total	25,173.080	/	/

The calculation of the project emissions is summarized in the table below:

Monitoring period	$EC_{PJ,j,y}$	$EF_{EL,j,y}$	$TDL_{j,y}$	$PE_{EC,y}$
	Quantity of electricity consumed by the project electricity consumption source j in year y (MWh)	Emission factor for electricity generation for source j in year y (tCO ₂ /MWh)	Average technical transmission and distribution losses for providing electricity	Project emissions from electricity consumption (tCO _{2e})
05/01/2020-31/01/2020	3,418.880	1.3	0%	4,445
01/02/2020-29/02/2020	3,439.200	1.3	0%	4,471
01/03/2020-31/03/2020	3,641.320	1.3	0%	4,734
01/04/2020-30/04/2020	3,594.800	1.3	0%	4,674
01/05/2020-31/05/2020	3,722.840	1.3	0%	4,840
01/06/2020-30/06/2020	3,618.920	1.3	0%	4,705

01/07/2020-31/07/2020	3,737.120	1.3	0%	4,859
Total	25,173.080	1.3	0%	32,728

5.3 Leakage

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

5.4 Net GHG Emission Reductions and Removals

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
05-January-2020 to 31-July-2020	417,318	32,728	0	384,590
Total	417,318	32,728	0	384,590

<u>Ex-ante emissions reductions/removals</u>	<u>Achieved emissions reductions/removals</u>	<u>Percent difference</u>	<u>Justification for the difference</u>
404,377 tCO ₂ e ⁵	384,590 tCO ₂ e	-4.89%	The actual ERs is only 4.89% less than the estimated amount in the PD, which is within the reasonable fluctuation range.

⁵ The monitoring period (05/01/2020-30/07/2020) is 208 days. According to the registered VCS PD, the estimated ER in 2020 is 703,773 tonnes for 05/01/2020-31/12/2020 which included 362 days, that's 1,944.12 tonnes per day (703,773/362=1,944.12). Therefore, the amount estimated ex ante for this monitoring period is calculated as (1,944.12*208=404,377) tons.