REDUCING GAS LEAKAGES WITHIN THE HUDUDGAZ GAS DISTRIBUTION NETWORKS ACROSS UZBEKISTAN

GASGREEN Asia

Project title	Reducing Gas Leakages within the Hududgaz Gas Distribution Networks across Uzbekistan
Project ID	4531
Monitoring period	22-August-2023 to 15-September- 2024
Original date of issue	05-September-2024
Most recent date of issue	18-November-2024
Version	3
VCS Standard Version	4.5
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PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The proposed project aims to reduce gas leakages from components[1] in the natural gas distribution system operated by Hududgazta'minot JSC (Hududgaz)[2] in Uzbekistan in the Divisions/Areas of Hududgaz' service area.

Construction began on the gas system in the 1960s and 1970s and over the years it has not been adequately maintained. As a result, a significant percentage of the natural gas throughput which is 95% or more methane (CH_4) leaks from components in the system and is released into the atmosphere contributing to global warming. Leaks in the distribution system are caused by normal component wear, thermal and vibrational stresses and seasonal expansion/contraction cycling from ambient air temperature changes. Natural gas leaks occur through various sources including, thread connections of gas pipes, broken gaskets and other broken parts of ball/plug valves, broken membranes of pressure regulators and connectors, etc. These components are not routinely checked for leaks under the existing safety practices of Hududgaz.

The company's operators lack the operational advanced leak detection equipment, advanced repair materials and trained workers to identify chronically leaking components, accurately measure the leak rates and make reliable repairs of the leaks within the project boundary. Teams generally rely on odor and soap bubbles to identify leaks. This approach is ineffective as odor does not allow a repairman to pinpoint a leak or its size. In fact, in above ground outdoor equipment, odor is extremely ineffective in isolating leaks. Soap can be used to isolate leaks, but this method gives no information on the actual size of the leak which is critical to making cost effective repairs. Furthermore, even for those leaks that are identified through bubbles and odor, the company lacks the modern repair materials required to fix all but the simplest leaks that require only tightening of components.

The project beginning with the first repair on 22-August-2023, reduces methane emissions at valves, insulating joints, pressure regulators and other above ground gas distribution infrastructure. The project activity reduces natural gas leakage in the distribution network of Hududgaz in the project area through the implementation of advanced leak detection and repairs (LDAR) procedures using advanced leak detection and measurement technology such as HiFlow Samplers, Leak Measurement Devices and Gasurveyors. The project activities include inspection and leak measurements of above ground equipment, as well as repair works on components of specific equipment in the natural gas above ground distribution system using advanced repair materials such as (ePFTE) sealing material, advanced membrane replacement materials, advanced sealing paste for conical connections, Tangit string for thread connections, and nitrile-rubber O-rings.

[1] The selected methodology AM0023 (Version 04.0.0) defines a component as "above-ground process equipment in natural gas production, processing, transmission, storage, distribution systems", including valves, flanges and other connectors etc.

[2] Also written in English as Khududgazta'minot and Hududgazta'minot.

GHG emission reductions generated in 22-August-2023 – 15-September-2024 period	**3,849,288** tCO_2e

1.2 Audit History

Audit type	Period	Program	Validation/verification body name	Number of years
Validation	19-July-2024 (date of Registration)	VCS	Carbon Check (India) Private Ltd.	10 years
Verification	22-August-2023 – 15-September-2024 (Including both days)	VCS	Carbon Check (India) Private Ltd.	1.07 years

1.3 Sectoral Scope and Project Type

Sectoral scope[3]	10
Project activity type	Fugitive emissions from fuels (solid, oil, and gas)

Sectoral scope	Not applicable as the project is not a AFOLU project.
AFOLU project category[4]	
Project activity type	

1.4 Project Proponent

Organization name	GasGreen Asia LLC

[3] *Projects, activities, or methodologies may be developed under any of the 16 VCS sectoral scopes: https://verra.org/programs/verified-carbon-standard/vcs-program-details/#sectoral-scopes*

[4] *See Appendix 1 of the* VCS Standard

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1.5 Other Entities Involved in the Project

Organization name	Climate Compass LLC
Role in the project	Project Development and Implementation
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Organization name	Ecoeye Co., Ltd
Role in the project	Investor
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1.6 Project Start Date

Project start date	22-August-2023
Justification	This is the date of the commencement of the baseline study when the first project-scale activity of measuring and repairing leaks led to the first methane emission reduction.

1.7 Project Crediting Period

Crediting period	☐ Seven years, twice renewable ☒Ten years, fixed ☐ Other (state the selected crediting period and justify how it conforms with the VCS Program requirements)
Start and end date of first or fixed crediting period	22-August-2023 to 21-August-2033

1.8 Project Location

Equipment containing leaking components found across the entire above ground gas distribution system found in the service and franchise areas operated by Hududgaz gas distribution networks across Uzbekistan.

The project is hosted by Hududgazta'minot JSC (referred to as "Hududgaz" in this document). The company's headquarters are based in Tashkent, Uzbekistan with the coordinates of 41.2861429ºN, 69.2332984ºE.
The exact locations of all the equipment hosting components that are sources of physical leakage identified and repaired and additional components, that while not currently leaking could be sources of future leaks from the project boundary, are recorded in the monitoring system database using the unique GPS coordinates for each piece of equipment hosting a repaired component, and a street address when possible or a description of the location. A photo of the equipment and an engineering schematic identifying the equipment with the leak repair(s) and the specific component(s) with leakage has also been made for each leak included in the project. The project found leaks to include in the project boundary in the gas distribution systems of Hududgaz across Uzbekistan.

Map 1

The methodology defines the project boundary as follows: "The spatial extent of the project boundary includes the components where the project activity is being implemented. The spatial extent of the project boundary should be clearly illustrated in the CDM-PDD. Moreover, only methane (CH_4) emissions from physical leaks that were detected through the introduction of the advanced LDAR program should be included in the project boundary."

Therefore, the actual project boundary consists of all the equipment with physical leaks detected and added to the database as the methodology requires a database of all the equipment with leaks found to be used to define the project boundary. The list of the equipment with leaks included in the database that forms the entire project boundary has been provided with corresponding GPS locations and addresses (see section 5.3 of the PD). The key information captured in the database is outlined in Section 4.1 of the PD and includes the relevant information on the detection of the physical leak (e.g. the detection date and which specific component is involved).

It should be noted that projects with different counterparties sharing some general subareas of the Hududgaz service area were registered under CDM using AM0023 (project 3339, 3910, 4085, 4883, 5176, and 5166). The CDM projects 4085 and 5166 were never implemented and the other projects ended well before completion. The leaky components that made up those previous CDM project boundaries have been excluded from this project to avoid any overlap of the project boundaries.

1.9 Title and Reference of Methodology

Type (methodology, tool or module).	Reference ID, if applicable	Title	Version
Methodology	AM0023	"Leak detection and repair in gas production, processing, transmission, storage and distribution systems and in refinery facilities".	04.0.0
tool	Tool 02	"Combined tool to identify the baseline scenario and demonstrate additionality."	7.0.

1.10 Double Counting and Participation under Other GHG Programs

1.10.1 No Double Issuance

Is the project receiving or seeking credit for reductions and removals from a project activity under another GHG program?

☐ Yes ☒ No

1.10.2 Registration in Other GHG Programs

Is the project registered or seeking registration under any other GHG programs?

☐ Yes ☒ No

1.11 Double Claiming, Other Forms of Credit, and Scope 3 Emissions

1.11.1 No Double Claiming with Emissions Trading Programs or Binding Emission Limits

Are project reductions and removals or project activities also included in an emissions trading program or binding emission limit? See the *VCS Program Definitions* for definitions of emissions trading program and binding emission limit.

☐ Yes ☒ No

1.11.2 No Double Claiming with Other Forms of Environmental Credit

Has the project activity sought, received, or is planning to receive credit from another GHG-related environmental credit system*? S*ee the *VCS Program Definitions* for definition of GHG-related environmental credit system.

☐ Yes ☒ No

If yes, provide all required evidence of no double claiming as outlined by the VCS Standard.

1.11.3 Supply Chain (Scope 3) Emissions

Do the project activities affect the emissions footprint of any product(s) (goods or services) that are part of a supply chain?

☐ Yes ☒ No

1.12 Sustainable Development Contributions

In addition to reducing greenhouse gas emissions, this project which reduces the leakage of methane from the gas distribution system across the country of Uzbekistan, will also contribute to Uzbekistan's sustainable development goals by:

- Improving environmental quality and minimizing risks for employees and local communities due to the reduction of harmful pollutants (methane) from local communities;
- Preserving a finite resource (natural gas) by avoiding methane wasted through leakage.;
- Capacity building of the local staff through training and oversight in advanced LDAR techniques;
- Transferring advanced technology and knowhow that have heretofore not been utilized in Uzbekistan without carbon credit-based investment through the project investment in repair material and leak detection and measurement equipment and maintenance;
- Job creations through the hire of 164 staff to implement the project;
- Strengthening human capital in the country through employment of locals to support the project implementation.

All of the contributions described above correspond to the sustainability goals Uzbekistan outlined in its 2018 United Nations published report "On measures for Implementing the National Sustainable Development Goals and Targets of the Republic of Uzbekistan."5 The

[5] https://uzbekistan.un.org/en/157674-national-sustainable-development-goals-and-targets-republic-uzbekistan?afd_azwaf_tok=eyJhbGciOiJSUzI1NiJ9.eyJhdWQiOiJ1emJla2lzdGFuLnVuLm9yZyIsImV4cCI6MTcyNTI3NTAwMywiaWF0IjoxNzI1Mjc0NzAzLCJpc3MiOiJ0aWVyMS01Yzg4ZGI4YzY0LWJ4dHY1Iiwic3ViIjoiMTkzLjIwNy4yMDMuMjE1IiwiZGF0YSI6eyJ0eXBlIjoiaXNzdWVkIiwicmVmIjoiMjAyNDA5MDJUMTA1ODIzWi0xNWM4OGRiOGM2NGJ4dHY1eHpzMnJ6NXRobjAwMDAwMDBiNGcwMDAwMDAwMWJlMzAiLCJiIjoia2N1b1U4YTBKbHpwWmlqVUJSbDBUOHZMLWx2Q2MtMXVHY3pBSFR3RGM5OCIsImgiOiJGOHNQem45bGVNTjVvWDM4VnlTc0RUQ0FOR2xaYWNzQUVaYjFxdXZOV1RFIn19.Omz6GfIsNIzdITmEupFAuIWRFc8xVpADZaUzAMMMNkQ3fi6huEJsj4N82PI84q0wqL0mIFuCCRiDLXiYmLQP82bTXYxeLuesmfwQ7husHJuyPaF5m_i_Xd8bHYVPMNQ6nR2ZFmL2_oBR0a-WV4miyiENbp1P8KOJWJrhB6OvAM5M62mUPynCjv0Mtw8ExYsk_Lp_qoUSr5DoScBPLoIR6Hvd3ACRAG5UKKfFw3X3gNVaoZswH1c

results of the project are reported directly through Hududgaz to the Government which tracks the progress.

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Table 1: Sustainable Development Contributions

Row number	SDG target	SDG indicator	Net impact on SDG indicator	Current project contributions	Contributions over project lifetime
Sequential row number	*SDG Target number*	*Number and text of SDG indicator or, if no official SDG indicator is applicable, user-defined indicator*	*Indicate the project's contribution to the SDG Indicator (implemented activities to increase or decrease)*	*Brief description of the quantifiable impact of the project's activities related to the SDG indicator, during the monitoring period.*	*Brief description of the cumulative quantifiable impact of the project's activities related to the SDG indicator, over the project lifetime.*
1)	7.1	7.1.2 Proportion of population with primary reliance on clean fuels and technology	Implemented activities to decrease natural gas losses from distribution pipeline. Improved availability of economically important fuel.	755,097 l/min of new leaks were found and repaired.	Found and eliminated gas leakage totaling more than 755,097 liters per minute
2)	9.4	9.4.1 CO_2 emission per unit of value added	Implemented activities to decrease natural gas per units of GDP	755,097 l/min of new leaks were found and repaired meaning increased GDP output is achieved with the same natural gas input as less methane is lost into the atmosphere and more methane goes toward useful economic purposes	Over 755,097 liters per minute of new leaks were found and repaired meaning increased GDP output is achieved with the same natural gas input as less methane is lost into the atmosphere and more methane goes toward useful economic purposes

3)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to increase	Reducing methane emissions from pipeline from leaks by identifying and making repairs and undertaking regular monitoring. Prevented the release of **3,849,288** tonnes of carbon dioxide equivalent methane into the atmosphere	Prevented the release of over **3,849,288** tonnes of carbon dioxide equivalent methane into the atmosphere
4)	11.6	By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	Reduce potentially dangerous and harmful methane leakage	755,097 l/min of new leaks were found and repaired eliminating possible dangerous and harmful local emissions	Over 755,097 liters per minute of new leaks were found and repaired eliminating possible dangerous and harmful local emissions
5)	8.5	By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value	Creating well paid jobs with advanced technical training including entry level jobs for young people with chance of promotion	164 full time workers have been hired and employed through the end of the first monitoring period.	164 workers associated with this project for the baseline study and first monitoring period and the expectation is around 67 will continue to be employed throughout the project

1.13 Commercially Sensitive Information

No commercially sensitive information has been excluded.

2 SAFEGUARDS AND STAKEHOLDER ENGAGEMENT

2.1 Stakeholder Engagement and Consultation

2.1.1 Stakeholder Identification

Stakeholder Identification	Not Applicable as the stakeholders have not changed since validation.
Legal or customary tenure/access rights	Not Applicable- The gas equipment is wholly owned by the gas company.
Stakeholder diversity and changes over time	Not Applicable- A large portion of the population is connected to the gas grid involving customers of all social, economic and cultural groups.
Expected changes in well-being	Not Applicable- The stakeholder characteristics were not expected to change in the baseline case.
Location of stakeholders	Not Applicable- The location of stakeholders has not changed as gas system is static in relation to the customer base and no new sections of pipeline will be included in the project.
Location of resources	Not Applicable- The gas equipment is wholly owned by the gas company and access to the system has not changed.

2.1.2 Stakeholder Consultation and Ongoing Communication

Ongoing consultation	To undertake the baseline and monitoring activity, the teams attempt to visit every piece of above ground gas equipment included in the database return at least one time in each monitoring period. In the process of conducting the monitoring, they regularly meet the customers and neighbors near the gas equipment and explain that they are repairing and maintaining leaks. The local customers are the people most directly impacted by the work and also benefit directly from the improved service and eliminated odor and local air pollution elimination. The teams receive regular feedback from customers. In addition, the gas company maintains a customer service line and any issues that arise would be passed to the teams as needed. We also hold regular consultations with the gas distribution company management and key government officials. The feedback from all these sources can be summed up as "please find and repair more leaks and faster."
Date(s) of stakeholder consultation	22-August-2023 to 15-September-2024- Ongoing communication with customers in person and ongoing reporting of results to the Uzbek Government through Hududgaz.
Communication of monitored results	Hududgaz gets real time updates of activities and transmits the results through regular reporting to the Uzbek Cabinet of Ministers. Customers who are present during the monitoring are notified in real-time of the results and any questions are answered by the teams at the time.
Consultation records	The formal reports from Hududgaz relayed to the government.
Stakeholder input	The input we have received from all the stakeholder is that the gas leak reductions are welcome.

2.1.3 Free, Prior, and Informed Consent

Consent	Not Applicable- The gas equipment is wholly owned by the gas company. Fixing leaks in no way disrupts IP, LCs, and customary rights holders as the system already exists and repairs are made only to the existing system
Outcome of FPIC	Not Applicable- The Gas Distribution Company owns the gas distribution system. There is general agreement that repairing leaks is beneficial to the local population.

2.1.4 Grievance Redress Procedure

Grievances received	Resolution and outcome
No grievances were raised.	Not applicable as no grievances were raised. If any issue did arise, the customer could ask the workers in the field directly for clarification. If the response they receive was not satisfactory, they could communicate any issues with the local gas company directly or to government officials. At the stakeholders meeting, the attendees were provided with direct contact information of the project managers and invited to communicate any issues at any time.

2.1.5 Public Comments

Summary of comments received	Actions taken
At the stakeholder meeting on 2-December-2022 the PP received the following comments.	
Will there be training for equipment operators?	Training was provided from 04-June-2023 and finished 21-August 2023 for around 200 staff for the project.
Will the project cover all regions of the Republic of Uzbekistan?	The project has covered a large portion of the gas distribution system in all regions of Uzbekistan.
Are you going to implement the project on the same methodology as in the past (CDM project)?	The project is using AM0023 v4.
What is the duration of the project?	The project will last a total of ten years.
What materials and equipment will be used to repair leaks during the project?	We are using Gasurveyor-500s to detect the leaks and Hi-Flow samplers to measure the leaks. We have imported advanced repair materials from around the world to effectively repair leaks that we find in the project.
How many people are planned to be involved in the project to reduce gas leaks?	During the baseline study and first monitoring period 164 people were directly involved in the project.

What are the expected results of the project?	We have found ad repaired already leaks resulting in 755,097 liters per minute of gas savings. We will work during the remaining project period to find and repair additional leaks on the equipment within the project boundary.
What objects of the gas distribution network are planned to be surveyed?	We have surveyed Gas Regulation points, residential regulation points, stand-alone valves and other above ground gas distribution equipment.
What is the experience of the executor of this project?	Climate Compass and its partner MBS have about 20 years of experience implementing these types of projects
Based on the previous survey, what can you say about the potential of this project?	This project has found and repaired 755,097 liters per minute of gas leaks.
What assistance can you provide JSC "Hududgazta'minot"	The PP has worked closely with Hududgaz to help find leaks and repair them and build the capacity in Uzbekistan to find and repair leaks.

2.2 Risks to Stakeholders and the Environment

	Risk identified	Mitigation or preventative measure taken
Risks to stakeholder participation	No risk identified	There were no risks to stakeholder encouraging our teams to find and fix leaks.
Working conditions	Working with natural gas and natural gas systems has risks if workers are not properly trained and equipped with needed safety gear.	Only staff deemed qualified as confirmed by Hududgaz were invited to apply for a position in the project. Those workers chosen were given appropriate safety gear and training.
Safety of women and girls	No risk identified	No unique dangers were posed to woman and girls from fixing leaks
Safety of minority and marginalized groups, including children	No risk identified	No unique dangers were posed to marginalized groups from fixing leaks
Pollutants (air, noise, discharges to water, generation of waste, release of hazardous materials)	No risk identified	Fixing leaks does not lead to any pollutants and instead eliminates the emission of natural gas.

2.3 Respect for Human Rights and Equity

2.3.1 Labor and Work

Discrimination and sexual harassment	No complaints of sexual harassment were received during the monitoring period.
Management experience	Not applicable- The lead project implementor has nearly 20 years of experience implementing similar projects.
Gender equity in labor and work	Key senior managers in the project are women including the project manager. The pay scale is based on position and years of experience and has no relation to gender.
Human trafficking, forced labor, and child labor	Each worker is a certified and trained expert in gas systems that sought out the employment opportunity and can leave the project at any time. No children are employed in the project.

2.3.2 Human Rights

The project which finds and repairs leaks in an existing gas distribution system no direct impact on rights of IPs, LCs, or customary rights holders. The project has tried to fix leak in all areas of the country to everyone's benefit.

2.3.3 Indigenous Peoples and Cultural Heritage

The project is designed to ensure all workers are able to celebrate critical cultural and religious events in order to help maintain and preserve their connection to their cultural heritage.

2.3.4 Property Rights

Disputes over rights to territories and resources	N/A
Respect for property rights	Not Applicable- The project repairs leaks in equipment wholly owned by the gas distribution company.

2.3.5 Benefit Sharing

Summary of the benefit sharing plan	NA- There is no impact on property rights from this project.
Benefit sharing during the monitoring period	NA- There are no adversely affected local stakeholders. Everyone benefits from reduced gas leaks.

2.4 Ecosystem Health

	Risk identified	Mitigation or preventative measure taken during the monitoring period
Impacts on biodiversity and ecosystems	No risk was identified.	Reducing gas leaks on an existing gas distribution system has only a beneficial impact on ecosystems.
Soil degradation and soil erosion	No risk was identified.	Reducing gas leaks on an existing gas distribution system will not affect soil erosion.
Water consumption and stress	No risk was identified.	Reducing gas leaks on an existing gas distribution system does not impact water issues.
Usage of fertilizers	No risk was identified.	Reducing gas leaks on an existing gas distribution system is not connected with fertilizer usage.

2.4.1 Rare, Threatened, and Endangered species

Species or habitat	Not Applicable- The project does not intrude on the habitat of species.

2.4.2 Introduction of species

N/A as this is a project with no planting or species introduction.

Species introduced	Classification	Justification for use	Adverse effects and mitigation

Existing invasive species	Mitigation measures to prevent spread or continued existence of invasive species

2.4.3 Ecosystem conversion

Not applicable- The project does not affect existing ecosystems.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The initial survey was begun on 22-August-2023 with tens of thousands of leaks being identified, repaired using advanced repair materials, and monitored with the key information captured in the database. The first of regular subsequent surveys that are currently planned to take place annually was conducted through 15-September-2024. As part of the monitoring activity the monitoring team attempts to visit and check the integrity of each leak repair on the equipment included in the project boundary. Every single visit and the results are included in the Emission Reduction Database. Furthermore, hardcopies, electronic copies, photos, and downloaded measurement files are also maintained. During these monitoring visits, if the teams find additional leaks on the equipment within the project boundary, as per the methodology, they measure the leak rate, make repairs immediately and add the leaks to the project database. In addition, some equipment is removed during the monitoring period during the normal course of development as old buildings are removed and new construction takes its place. These are tracked as well and “cut-out” risers are removed from the database in the subsequent monitoring after they have been highlighted as cut-out. Not every leak repair can be visited during the monitoring period as construction or other impediments prevent the team from taking the required measurements. To be conservative, no Emission Reductions are claimed in the monitoring period for those leak repairs that could not be monitored.

3.2 Deviations

3.2.1 Methodology Deviations

There have been no methodology deviations.

3.2.2 Project Description Deviations

There have been no project deviations.

3.3 Grouped Projects

This is not a grouped project.

3.4 Baseline Reassessment

Did the project undergo baseline reassessment during the monitoring period?

☐ Yes ☒ No

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	**GWP_{CH4}**
Data unit	tCO_2e/tCH_4
Description	Global warming potential
Source of data	The Fifth Assessment Report of the Intergovernmental Panel on Climate Change
Value applied	GWP_{CH4} = 28 for the commitment period
Justification of choice of data or description of measurement methods and procedures applied	5th Assessment Report of the IPCC
Purpose of data	Calculation of baseline emissions Calculation of project emissions Convert tCH_4 to tCO_{2e}
Comments	This value applies for the calculation of the baseline and project emissions.

Data / Parameter	**ConvFactor**
Data unit	tCH_4/ Nm3 CH_4
Description	The factor to convert Nm3 CH_4 to tCH_4
Source of data	-
Value applied	0.0007168
Justification of choice of data or description of	The leak flow rate (FCH_4,j) and conversion factor (ConvFactor) should be reduced to the same reference conditions. As noted

measurement methods and procedures applied	from correspondence by Heath Consultants the Hi-Flow™ sampler automatically accounts for standard temperature and pressure (i.e., 0 degree Celsius and 101.3 kPa) in its leak flow rate (FCH_4,j) measurements. As such, a conversion factor (ConvFactor) of 0.0007168 reflects the methane density at 0 degree Celsius and 101.3 kPa, which is derived by dividing the methane density at standard conditions by Avogadro constant (22.414 l/mol). This value is taken from literature, and is applied to convert Nm3 CH_4 to tCH_4
Purpose of data	This value applies for the calculation of the baseline and project emissions
Comments	The Hi-Flow™ Sampler automatically adjusts readings to standard temperature and pressure (0°C and 101.3 kPa) so conversion rate for these conditions is applied.

4.2 Data and Parameters Monitored

Tz and URz parameters are not reported here as there were no Project Emissions.

Data / Parameter	$T_{j,y}$
Data unit	Hours
Description	The time the relevant component, in which physical leak j, occurred, would leak in the baseline scenario and would be eligible for crediting during the crediting year y (hours)
Source of data	Operational logs. The repairs will be cross referenced with customer ID numbers which will require the involvement of local offices and their revenue personnel. The time period of any shutdown is subtracted from the emission reduction calculation.
Description of measurement methods and procedures to be applied	The dates of the various measurements are recorded directly by the operators on handwritten files and are captured electronically in the Hi-Flow Samplers and cameras. These dates are cross-referenced with operational logs to determine how many hours of operation the leak repair functioned during the monitoring period. Any shut-offs of equipment are deducted from the time of operation.
Frequency of monitoring/recording	The measuring is ongoing throughout the monitoring period.
Value monitored	Multiple Values for each leak 'j' (see Emission Reduction Calculation sheets for each leak including shut-offs where applicable)

Monitoring equipment	The dates of the various measurements are recorded directly by the operators on handwritten files and are captured electronically in the Hi-Flow Samplers and cameras.
QA/QC procedures to be applied	Any outages resulting from system repairs will be documented and logged in the project database in the form of a reduction in the time of operation. To be clear, if an unrelated activity requires the shut-down of an already repaired piece of component, the hours of operation for every piece of affected component with be reduced in the database for the entire duration of the shut-down. Any other unscheduled shutdown will also be timed and accounted for through a reduction of operating hours.
Purpose of the data	This value applies for the calculation of the baseline emissions
Calculation method	Hours of system operation are tabulated with any system shut offs affecting a leaking repair subtracted from the total hours of operation
Comments	To be conservative, it is assumed that any reappeared leak found in a given monitoring period occurred immediately after the previous monitoring period ended.

Data / Parameter	**Temperature and pressure of natural gas**
Data unit	°C and bar
Description	The temperature and pressure at the point at the time of measurement.
Source of data	Included in the HFS measurement.
Description of measurement methods and procedures to be applied	The Hi-Flow™ Sampler automatically adjusts readings to standard temperature and pressure (0°C and 101.3 kPa) and this is reflected in the machine's margin of error. Therefore, there is no need to monitor these parameters separately. They are integrated in the measurement results
Frequency of monitoring/recording	Done with each leak measurement.
Value monitored	Included in the HFS reading of leak-rate. (See the Emission Reduction calculation sheets). Temperature and pressure measurements are taken into account by the hi-flow sampler at the time of measurement and are integrated into the results from the hi-Flow sampler device.
Monitoring equipment	Included in the HFS measurement.

QA/QC procedures to be applied	The high flow sampler is calibrated and double checked every 30 days while in use with the date and signature of the person in-charge of the calibration recorded in a calibration log.
Purpose of the data	This value applies for the calculation of baseline and project emissions.
Calculation method	Values accounted for in the HFS measurement.
Comments	-

Data / Parameter	UR_j
Data unit	Fraction
Description	The uncertainty range for the measurement method applied to leak j
Source of data	Calculated using the manufacturer's documented margin of error ±10% per measurement and the data of each measurement.
Description of measurement methods and procedures to be applied	Estimated using a 95% confidence interval per guidance provided in Chapter 6 of the 2000 IPCC Good Practice Guidance. The URj is calculated using leakage flow rates and the respective UR of the Hi-Flow sampler used for the leak. The uncertainty calculations are included in the ER calculations spreadsheet.
Frequency of monitoring/recording	Measurements are taken regularly with the Uncertainty calculated from all the measurements
Value monitored	0.00074814 (see Emissions Reductions calculation sheets for complete calculations)
Monitoring equipment	Leaks are identified and measured using the Hi-Flow sampler. The serial numbers, calibration dates are listed above. The calibrations as per manufacturer's recommendation are valid for one month. The readings as per the operator's manual are ±10% accurate.
QA/QC procedures to be applied	The high flow sampler is calibrated and double checked every 30 days while in use with the date and signature of the person in-charge of the calibration recorded in a calibration log.
Purpose of the data	This value applies for the calculation of the baseline emissions.

Calculation method	Leaks are identified and measured using the Hi-Flow sampler. The serial numbers, calibration dates are listed above. The calibrations as per manufacturer's recommendation are valid for one month. The readings as per the operator's manual are ±10% accurate.
Comments	Assures to a 95% level of confidence as per methodology that the measurement values used in the calculations are conservative.

Data / Parameter	$F_{CH4,j}$ / $F_{CH4,z}$
Data unit	m^3CH_4/h
Description	The leak flow rate of methane for leak (j, z) from the leaking component
Source of data	From Hi-Flow™ sampler readings during on-site measurements and Gasurveyors
Description of measurement methods and procedures to be applied	Gasurveyors are used to detect any gas leakage and HFS are used to measure any leakage detected.
Frequency of monitoring/recording	At least once per monitoring period
Value monitored	See ER calculation sheet for the values of each j and z.
Monitoring equipment	Manufacturer procedures applied. Measurements with Hi-Flow™ Sampler are automatically adjusted to the methane content, temperature and pressure and, thus, will directly yield methane leak flow rates. Gasurveyors are used to check for any reemerged leakage.
QA/QC procedures to be applied	The high flow sampler is calibrated and double checked every 30 days as per manufacturers specifications while in use with the date and signature of the person in-charge of the calibration recorded in a calibration log. The Gasurveyor is calibrated as per manufacturer specifications at least once per year.
Purpose of the data	This value applies for the calculation of baseline and project emissions
Calculation method	Measurement devices
Comments	Values taken from Hi-Flow sampler measurements. In some small number of cases, access to the repaired equipment was blocked (construction sites, street repairs, etc.) preventing the monitoring teams from accessing leak repairs to monitor them.

	In order to ensure the results are conservative, no Emission Reductions were claimed in this period for those leaks that were not able to be monitored.

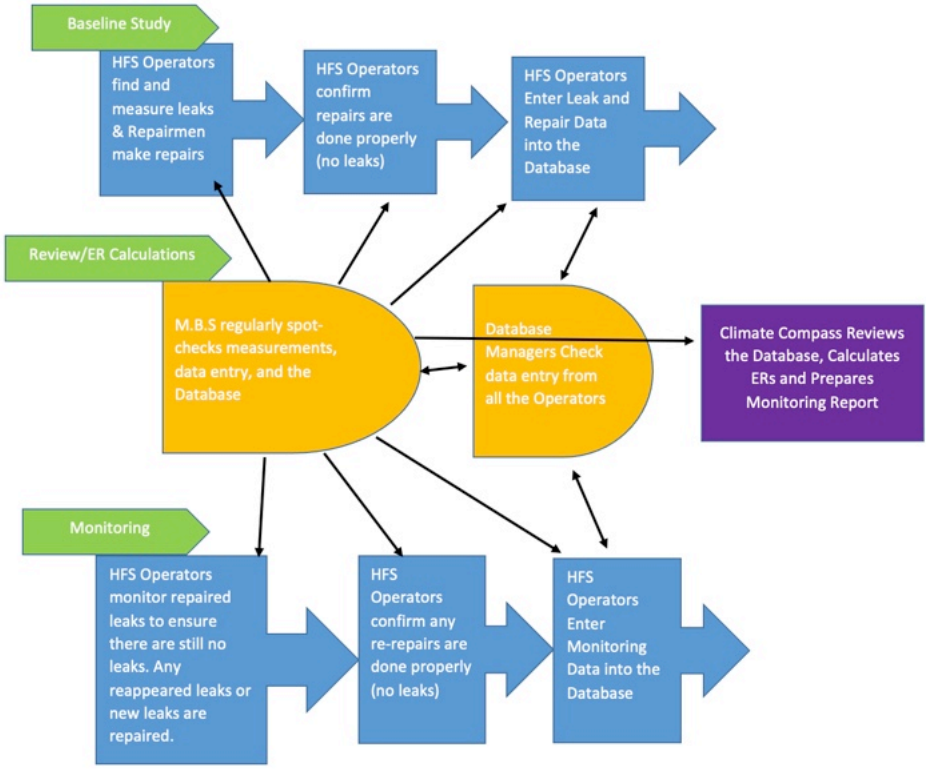
Data / Parameter	**BE_{CAP}**
Data unit	tCO_2e
Description	Capped quantity of the baseline emissions, defined as the expected baseline emissions for the first full year of the crediting period
Source of data	Measured and calculated based on baseline methane emission reductions reduced in first year
Description of measurement methods and procedures to be applied	Measured baseline emissions in l/m during the baseline period.
Frequency of monitoring/recording	Once during baseline and calculated. Calculated after the baseline leak detection and repair period is completed
Value monitored	7,957,362
Monitoring equipment	Measurements of leaks taken with Hi-Flow Samplers
QA/QC procedures to be applied	Calculated from verified baseline methane emissions using appropriate GWP for methane from 5th Assessment of IPCC.
Purpose of the data	Capped quantity of emissions that can be claimed Calculation of baseline emissions
Calculation method	The sum of each measured leak rates found during the baseline period multiplied by the time the relevant component, in which physical leak occurred, would leak in the baseline scenario and would be eligible for crediting during the crediting year y (hours) and converted to tCO_2e using GWP for methane from 5th Assessment of IPCC.
Comments	-

4.3 Monitoring Plan

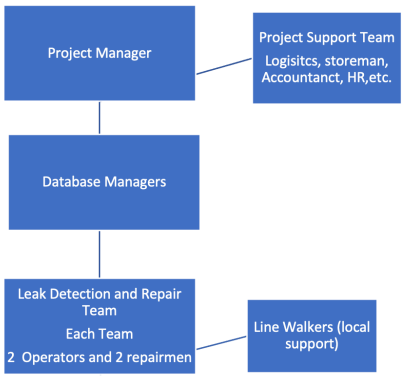
Summary of the Project Team and Roles.

The project takes place on the gas distribution system of Hududgaz. GasGreen Asia LLC provides all the funds required to implement the Project along with its South Korean investor Ecoeye Ltd. The Project is overseen by Climate Compass LLC. which manages the project implementation including organizing survey equipment, repair materials, transportation for the project, and compliance with the approved methodology. Climate Compass has hired MBS as a 3rd party technical consultant to help confirm through regular inspections that the project is compliant with the methodology. Climate Compass has also hired the Tashkent based company EkoCarbon Services (EKS) (also referred to in some documents as EcoCarbon Services ECS), to do much of the local project implementation work on a day-to-day basis. The EKS team, selected based on referrals from Hududgaz, includes project managers to direct the daily workflow, database managers to ensure the data gathered from the project is recorded correctly, operators in the field who take the appropriate measurements and log the data, and repairmen. The roles and responsibilities of each of these parties is described in more detail below.

The flow of data in the project occurs as follows:



Monitoring Team Structure



MONITORING TEAM

The Project team consists of by key staff from the Tashkent based company EkoCarbon Services (EKS).

The **Project Manager** responsible for EKS's Project team is Gulnora Arslanova.

Another important role within the Hududgaz Project team is that of the **Project Coordinator**. The **Project Coordinator** plays also important role of the **Senior Database Manager**. He is coordinating **Leak Detection and Measurement Team (LDMT)** activity with the Gas Company. He oversees the Project database, which includes all baseline, measurement, repair and monitoring data provided by the **LDMT** Hi-Flow Sampler Operators. The Project Coordinator/Senior Database Manager for the duration of this monitoring period was Ismatullayev Damir Rashitovich of EKS.

Climate Compass (CC) and MBS (third party consultants) have maintained their involvement and oversight during the entire monitoring period. In addition, both Climate Compass and MBS have undertaken a full review of the database.

The LDMT gather data for entry into the Project Database from their own field observations and input from the Repair Team. The LDMT are responsible for leak detection and measurement, subsequent measurement of repairs, and ongoing monitoring of repairs using sophisticated leak detection and measurement equipment – the Gas Surveyor and the Hi-Flow Sampler (HFS). Operators from the LDMT take written field notes, draw schematics and take pictures, which they then transcribe into excel format. The excel forms are delivered to the Database Managers, who review the data for errors before entering it into the Project Database.

The **Repair Team** was organized and trained for the purpose of executing the Project. Members of the Repair Team are comprised, for the most part, of experienced former Hududgaz employees now working for EKS employees who were trained in the use of modern repair materials and repair techniques. The typical LDMT Cell was linked with two repairmen tasked with completion of repairs. In addition, often local line walkers were temporarily included on the team to provide access in cases where cabinets were locked and at times these people served as repair assistants.

The inventory of modern repair materials supplied by GasGreen Asia, as well as secure storage of the expensive Hi-Flow Samplers, is the responsibility of the EKS Store Men.

RESPONSIBILITIES OF DIFFERENT PARTIES

The Leak Detection and Measurement Team

Responsibilities:

- **LDTM** units undertook an initial baseline study across the gas distribution system.
- Once a new leak was encountered and measured, thereby generating a baseline reading, the Repair Team repaired the leak.
- Throughout the duration of the monitoring period of the Project, the LDMT has checked existing repairs for the re-appearance of leaks and checked the equipment included in the project boundary for any additional leaks and made additional repairs.

Certification of members of the LDMT by MBS

The following members of the LDMT are certified as competent to perform leak measurement using the Hi-Flow Sampler, Gasurveyor 500, and related techniques by MBS. All certificates are available upon request.

Operator	Database Manager/Operator	Senor Database Manager/Operator
		Исматулаев Дамир
Файзуллаев Хусан	Примкулова Татьяна	
Биккулов Алим		
Анарбоев Алибек		
Хошимов Салохидин		
Амутов Фаррух		
Каримов Хикматжон		
Усмонов Моруф		
Мирсултонов Бахром		
Уринов Ойбек		
Жуманов Одил	Тухтамишев Сахобджон	
Журакулов Гайрат		
Бахронов Сирож		
Абдувоитов Элмурод		
Ширинов Миркомил		
Тухтаев Феруз		
Хаитов Икром		
Жиянмуродов Эргаш		
Сагдуллаев Шерзод		
Аминжонов Аваз		
Азаматов Ботир		
Газибаев Фуркат		
Каримов Карим		
Муртазин Дамир		
Хожиев Шермухаммад		
Ахмедов Элдор		
Дамлажонов Бахром	Кудайбергенов Азат	
Сайидалиев Сохибжон		
Нишонов Охунжон		
Ашуров Музаффар		
Мулажонов Бахтиёр		
Жураев Икром		
Усканбоев Ахлиддин		
Ахунов Хусниддин		
Курамбаев Эркин	Кудайбергенов Азат	
Кутлымуратов Саламат		
Пулатбоев Насим		
Ибадуллаев Отебай		
Ордошев Нурмухамед		
Бозорбоев Ислом		
Жаббарбергенов Ауез		
Таджимуратов Тенелбай		
Бакиев Алижон	Азимов Шухрат	
Султонов Фаррух		
Нарзиев Улугбек		
Азимов Наимжон		
Курбонов Хикмат		
Турдиев Алимардон		
Дусанов Эшкул	Курбонов Шерзод	
Мухаммедов Рамил		
Набиев Бахтиёр		
Фармонов Мухтор		
Турдиалиев Шавкат		

Responsibilities
The database management team entered the data into the Project Database. The database management team is led by Ismatullayev Damir Rashitovich

Members of the leak detection and management team provided the database team with the data. The database management team performed an important quality control function by checking the data was reasonable before entering and asking individual operators to carefully review reports for leaks.

Calibration of Hi Flow Samplers and GS
The Calibration task was performed by:

1. D. Ismatulayev
2. S. Azimov
3. A. Kudaybergenov
4. T. Primkulova
5. F. Usupov
6. S. Kurbonov
7. S. Tuhtamishev

Ongoing *Training by MBS and Experienced Operators*

Table showing time spent by MBS staff for in person for project preparation training and inspections during the monitoring period:

Date	MBS staff	Working Days
09-11/04/2023	V. Potapenko V. Rudenko	6
04-30/06/2023	V. Potapenko V. Rudenko O. Khotymchenko M. Manuilov V. Nesin L. Kalynychenko V. Dubytskyi Y. But	200
01-15/07/2023	V. Potapenko V. Rudenko M. Manuilov L. Kalynychenko Y. But	70
11/08-01/09/2023	V. Potapenko V. Rudenko O. Khotymchenko M. Manuilov L. Kalynychenko V. Dubytskyi Y. But	154
10-21/10/2023	V. Potapenko V. Rudenko O. Khotymchenko M. Manuilov L. Kalynychenko V. Dubytskyi	93
17/01-03/02/2024	V. Potapenko V. Rudenko O. Khotymchenko M. Manuilov L. Kalynychenko V. Dubytskyi	123
18/06-10/07/2024	V. Potapenko V. Rudenko	

	O. Khotymchenko M. Manuilov L. Kalynychenko	110
Total MBS' days spent for inspecting the Project		576

Baseline Selection:

In selecting leaks to be included in the baseline, the LDMT followed the Decision Tree when deciding whether or not a leak could be added to the baseline, the LDMT first had to determine whether or not it constituted an Emergency Repair. If the repair involved equipment that had ceased to function altogether, then the repair was deemed an Emergency Repair, and therefore, the repair did not qualify to be included in the Project Database. To be clear, an emergency repair will not ever be added to the ER Master file used to calculate ERs. This is the case because this work is done by completely separate staff that has no access to the ER database.

Additionally, the Hududgaz staff do not measure the leaks for an emergency repair and would have none of the accompanying paperwork that is required to upload the leak into the database and cross check the results (paper file, excel sheet with photos, etc). In fact, the emergency repair teams do not have Hi-Flow samplers or LMDs and so no record of a measurement could ever be taken. Finally, if a piece of leaking equipment that is in the database is replaced on account of an emergency leak at a later date, this would be noted during the subsequent monitoring visit (the equipment would be changed and not match the picture and technical drawings of the site) and any additional ER calculations would be terminated in the database as with any cut-off point. Therefore, the ER Master File database has no leaks that result from emergency repairs.

The next branch of the Decision Tree considers the schedule for equipment replacement. If the equipment has been scheduled for replacement, then the leak is only included up until the actual time of equipment replacement. The company maintains a record of all the equipment that has been replaced and the project's database of leak locations is checked against these records for the verification time period. During each monitoring visit the operator checks the current configuration of the equipment against the photographs and technical schematics completed during the baseline study. Database entries representing leaks that have been shut off are no longer used to calculate ERs. Hududgaz does not replace equipment based on age. In fact, as was confirmed during validation, there is no average lifetime of equipment as most of the equipment is still in use as during the last 20 years no major replacements have occurred. Therefore, the expected lifetime of non-replaced equipment will exceed the crediting period.

Lastly, if the leak can be identified and repaired with materials and know-how available prior to the Project-such as a simple tightening of a loose fitting or connection-then such a leak has not been included in the Project Database. The decision process described above was implemented through intensive training given to all operators before they collected baseline data. To be clear, the operator who has identified and measured the leak with the Gas Surveyors and Hi-Flow Samplers only includes the leak in the database if the leak could not be immediately repaired in the field by simply tightening the fittings. The repair team that is then sent out to fix the leak uses advanced repair materials provided though the Project to make the repairs. The material used to make each repair is tracked in the database.

Recording of Leaks

For each leak that satisfied the test for inclusion in the Project Database, the LDMT recorded the information as follows:

- The date of leak detection (dd-mm-yyyy)
- The date of leak repair (dd-mm-yyyy)
- The exact location of the leak including GPS coordinates
- The leak flow rate prior to repair (l/m)
- The measurement method- Once a leak was detected, all measurements for leak flow rate were taken using Hi-Flow Samplers, each Hi-Flow Sampler unit was assigned a number and the unit responsible for each measurement was thereby recorded. Furthermore, Hi-Flow Samplers recorded each measurement with a number between 1 and 999; the number corresponding to each measurement of leak flow rate is recorded in the Project Database.
- The nature of the repair made (whether or not it involved replacement of equipment, use of advance repair material or another method).

The LDMT followed additional quality control and assurance measures to better record and permit future rigorous monitoring of each leak. These measures were:

- A weatherproof tag was attached to each leak with the measurement date, the Hi-Flow Sampler number, the name of the measured point and the leak flow rate all recorded on the tag.
- It should be noted that many of these tags have been stolen or removed by a member of the curious public. There is an ongoing effort to replace tags that have been removed. As envisioned, however, the other back-up methods have proved sufficient for the purpose of recording and identifying leak locations.
- Digital photos were taken of the tag and immediate area of the leak to permit future identification of both the leak and its location. Digital photos have been numbered, time stamped and recorded. Smartphones with cameras were supplied to the LDMT.
- A schematic was drawn in the **Excel Form** (Described below), showing the location of the leak on a gas equipment and the method used to repair it, which serves to simplify the detail shown on the photographic record.

Field observations were recorded using common format written field reports. The field reports include details on the location and date, the readings from the Hi-Flow sampler, the Hi-Flow sampler serial number, a schematic drawing of where the leak was found on the equipment, notes on the repair required and other key details described above. These reports are kept on file and can be easily cross referenced by the operators at any time with electronic files.

Members of the LDMT are responsible for transcribing all details noted above from the hard copies into a common format Excel Form and inserting the aforementioned photographs, schematics. The Excel sheets include the information that is included on the hard copy reports and are saved in multiple places to ensure their continued safety.

These Hi-Flow Sampler readings transcribed onto the Excel sheets are cross referenced with the actual Excel data files that are generated by the Hi-Flow Samplers to ensure accuracy. The data files from the Hi-Flow Samplers retain up to 999 measurements and are downloaded before they exceed this number. The data is cross-referenced using the Hi-Flow Sampler serial number and date of measurement with the manually input spreadsheet.

Once all the information above is transcribed into an Excel Form and checked, this Excel Form is sent to a Database Manager, who is responsible for entering the data into the Project Database. A column in the Project Database is devoted to each of the data fields noted above.

This master database provides the ER calculations and the data can be transparently traced back through each of the other data records.

Monitoring of Repaired Leaks

The task of monitoring leaks requires the LDMT to perform the following steps:

- Finding the repaired leak: The HFS Operator returned to the address of a repaired leak using primarily the GPS coordinates and the leak tag to locate and identify the leak (The precise location of each repaired leak is indicated by a tag; and contained on the Excel Form containing a schematic diagram, and a digital photograph). In a number of instances, the leak tag was absent, presumably removed by children (Much of the gas infrastructure is within easy reach of children). In such instances, the schematic diagram and photograph served as a precise record for the location of the repaired leak and a new tag was attached to the site of the leak. Replacement tags have been supplied.
- Once the repaired leak was located, the following information was recorded:
  - Date of monitoring (dd-mm-yyyy)
  - Measurement method (Initially the LDMT used Gas Surveyors to establish whether a leak in the Project Database had begun leaking again, if it was shown to be leaking, then it employed a Hi-Flow Sampler to measure the leak flow rate and the responsible Hi-Flow Sampler's unit number was recorded)
  - Leak flow rate (if any) (l/m)
  - Measurement number in the Hi-Flow Sampler memory
- If the leak required re-repair, then a repair team was dispatched and the following was recorded:
  - Date of re-repair (dd-mm-yyyy)
  - The repair materials

The LDMT recorded the information above on common form Field Notes and transcribed the data into the same Excel spreadsheet that was used when the leak was entered into the Project Database.

In a small number of cases, the repaired leaks were inaccessible to the monitoring teams (construction sites, road repairs, etc.). In order to be conservative, these leak repairs were not counted towards the calculation of ERs. The teams will attempt to visit them in subsequent monitoring periods to include them in those ER calculations.

Equipment Provided to Leak Detection and Measurement Team

Each unit of two HFS operators was supplied, with the following equipment). The equipment provided proved sufficient for the LDMT to perform all of its aforementioned tasks.

- Hi-Flow Sampler
- Rental cars
- Smartphone with GPS
- Gas Surveyor
- Tags
- Personal computer

Quality Control and Quality Assurance

- **Hi-Flow Sampler Digital Records:** All leak flow rate measurements present in the Project Database were compared by members of the LDMT against the Hi-Flow Sampler record to double check them for accuracy. In all instances when a Leak Flow Rate measurement in the Excel Notes taken by the LDMT differed from the downloaded data taken from the

Hi-Flow Sampler, the measurement's record in both the Project Database and the Excel Forms was changed to reflect the download taken from the memory of the Hi-Flow Sampler. The step was taken because the data downloaded from the Hi-Flow Sampler is not subject to manual transcription error. As a final check we ran an electronic cross-reference search between the Hi-Flow Sampler records and the master datasheets to confirm consistency between the two separate data repositories. Any discrepancies were manually checked and errors corrected.

HFS memory files for some reason due to coding error are found in both the following date format mm/dd/yyyy or mm.dd.yyyy or mix of those two formats. Both types of dates convert into Excel improperly. Excel also does not recognize date as a date after the conversion. Edits were made, and these date formatting errors now conform to the format dd.mm.yyyy.

Database Managers

Responsibilities
The Database Managers are responsible for entering all baseline, measurement, repair and monitoring data into an excel spreadsheet, known as the Project Database. In addition, the Database Managers performs a Quality Assurance and Quality Control function. They check for reasonableness and accuracy of all data they enter into the Project Database using Excel Forms transcribed by members of the LDMT from their Field Notes.

Detailed Description of the Work Performed by Database Managers

Data entry
Most of the Database Managers' information was supplied by the LDMT. The information was contained within an Excel form transcribed from a Field Report. For the purpose of recording a leak and its ongoing monitoring, data for the following fields was entered into the Project Database:

- Number and location of the regulator system (street address and building number & GPS Coordinates)
- Region
- Name of operator in Leak Detection and Technical Measurement Team.
- Name of responsible person on the Repair Team
- Leak number (code)
- Type of facility surveyed (Residential, Gas Regulation point, stand-alone valve, etc)
- Component that was leaking
- The leak flow rate
- Hi-Flow Sampler instrument number
- Leak record number in the Hi-Flow Sampler memory (1-999)
- Date and time of measurement / repair (dd-mm-yyyy)
- Digital photo number(s)
- The date of leak detection (dd-mm-yyyy)
- The date of leak repair (dd-mm-yyyy)
- The date of each monitoring action (dd-mm-yyyy)
- The date of leak re-repair (If necessary) (dd-mm-yyyy)
- The measurement method (Leaks were first sought using a Gas Surveyor. When leaks were present, all measurements of actual leak flow rates were taken using Hi-Flow Samplers. The HFS number responsible for each measurement was recorded)
- The nature of the repair made (Whether or not it involved replacement of equipment, usage of PTFE tape or another method)
- Form of re-repair (If necessary)
- Note about any removal of equipment with leaks and any shut off occurrences.

As the average lifetime of the equipment was determined during validation to be beyond the duration of the crediting period, all non-replaced equipment is eligible for credits from repairs.

Quality Control and Quality Assurance

- **Reasonableness:** The Database Managers checked all data for reasonableness before it was entered into the Project Database. For example, if an operator entered a date incorrectly, such as an illogical time series, then the Database Manager spotted the error and asked the operator to check his field notes for manual transcription error. The minor error caused by inconsistent date conventions was quickly caught and addressed through the QA/QC steps.
- **Materiality:** For all baseline leak flow rate measurements that were recorded in excess of 20 liters CH_4 per minute the Database Managers requested that members from the LDMT check all data fields for any transcription error before adding such data to the Project Database.
- **Tracking by HFS and LDMT unit:** Each measurement of a leak flow rate entered into the Project Database can be associated with a given unit from the LDMT and a given Hi-Flow Sampler unit. Such granularity helps the Database Managers isolate problems in data entry to one team or associate faulty measurements with one Hi-Flow Sampler unit. The Database Management Team did not identify any systemic problems with any particular unit or Hi-Flow Sampler unit.

Data Protection and Storage

The protection of data is vital to the Project. Parties involved in the Project have followed the three guidelines described, namely:

- MBS maintains digital copies of Project Data. All the data was stored in EKS as well. Then the data was kept on individual computers at the in the EKS offices. Climate Compass has also stored backup files.

Repair Team

Responsibilities

The Repair Team, created to serve each of the three cells, was responsible for repairing leaks identified by the LDMT. All members of the Repair Team were trained in the use of modern repair materials and techniques. The Repair Team was in place during the initial repair period and continues to be available to redo repairs that have started to leak again during part of the measurement period.

Training

The project manager and his deputies trained each member of the Repair Team, with assistance from MBS. Members from the Repair Team were forbidden to use anything other than the modern repair materials provided.

Modern Repair Materials and other equipment supplied to the Repair Teams

- Rental car
- Tags (To replace missing tags and indicate repair information on tags)
- Modern Repair Materials such as:
    - **Tangit thread** – Thin synthetic thread absorbed by silicon for sealing pipe threads of 15-25 mm diameter.
    - **O-rings –** Made of high-quality nitrile rubber for replacement in leaky gaskets made of rubber
    - **Paste** – High quality made for sealing conical connections of low-pressure valves
    - **Valves** – For replacement broken high-and low-pressure valves
    - **Pressure regulators** - to replace broken bodies of such regulators

- **Membrane material sheets** – For making new membranes
- **Teflon tape –** High density Gas PTFE tape for sealing pipe threads (Pipe diameter – 15-50 mm).
- **Fittings and pieces of pipes with gas threads** – for replacement broken components
- **Insulating Joints** – to replace broken leaky IJ
- **Repair tools** – good quality gas wrenches to do repair

Description of Repair Process and Interaction with Leak Detection and Measurement Team

Once a qualifying leak was detected by the LDMT (Regardless of whether it was a leak that qualified to be added to the Project Database or a re-appearance of a leak already present in the Project Database), a LDMT unit interacted with a Repair Team unit by first recording the leak's location, exact description, and other relevant information in a Field Report and upon its return to the office, submitting a copy of its Field Report to the Repair Team unit. Each Cell from the LDMT were typically assigned to the same unit of the Repair Team to facilitate communication, familiarity with a given district of the gas system, as well as fulfil a QA/QC function (described below). The Repair Team unit subsequently visited the leak described in the Field Report and was responsible for implementing the repair and recording its work.

Rental Car Service

Hududgaz lacks appropriate transportation for the Project. Hence, for the duration of the Baseline Study and monitoring period, EKS hired vehicles, complete with drivers, of sufficient size and specification to allow members of the Repair Team and LDMT to fulfil its roles.

GasGreen Asia Team

GasGreen Asia has provided the capital necessary via Climate Compass to purchase equipment used to implement the Project, including purchasing modern repair materials, provided training in the use of modern repair materials and measurement equipment, rented vehicles, and purchased computers and software for the Project Database. The investment is provided by South Korean company Ecoeye.

Climate Compass with its partner MBS Services, provide project management, quality control and ongoing training of EKS Employees.

MBS

MBS Ltd., a Ukraine-based technical consultancy, has significant experience and expertise concerning the preparation and execution of gas leak reduction projects in transmission and distribution systems. MBS Ltd. has more than 9 fully trained and certified staff able to operate, calibrate, and manage the data outputs of Hi-Flow Samplers and other leak detection tools such as the Gas Surveyor. Certification was attested to by Heath Consultants the sole distributor of the Hi Flow Sampler.

MBS ltd. staff have logged thousands of hours taking leak measurements, assisting in database development and management and directing the day-to-day management of leak detection and repair programs. It has hands on experience working with many of the advanced repair materials required to eliminate leaks. Its team has surveyed gas systems and compressor stations for companies in Ukraine, Bangladesh, Tunisia, Colombia, Uzbekistan, Georgia, Egypt, and Pakistan.

MBS Ltd. was responsible during the monitoring period for quality control of the Project. MBS Ltd. was present in the field during parts of the monitoring period.
During its visits MBS:

- Verified that maintenance and monitoring of leaks was being conducted in accordance with the monitoring plan including equipment calibrations.
  - MBS found that maintenance and monitoring of leaks was in compliance with the monitoring plan.
- Observed the project database manager work to ensure that data was being recorded and handled as per the requirements of the monitoring plan.
  - MBS found that the database manager's work was in compliance with the monitoring plan.
- Conducted audits of the data to ensure that adequate records were being kept, and that leaks found and leaks repaired were accurately documented in the database.
  - MBS concluded that adequate records were being kept and that leaks found and repaired were documented in hard form and then after some delays were transferred to the electronic database.
- Observed technical teams to ensure that they operated equipment and conducted leak detection, monitoring and repair work in the correct manner, and advised on any training needs required.
  - MBS concluded that the LDMT operated equipment and conducted leak detection and monitoring in the correct manner.
- Conducted on-the-ground assessments to verify that project implementation was on schedule and highlighted any risks of delay.
  - MBS tracked progress on-the-ground as the Project developed. Its presence ensured that members of the LDMT understood that their work was being externally audited.
- Verified repair/replacement schedule of any regulators that are due to be replaced or repaired for the coming year.
  - MBS verified historical data about replacements that corresponded to leaks in the Database.

Calibration of Monitoring Instruments
Calibration of Hi-Flow Sampler Equipment

EKS was provided with made-for-purpose calibration kits. The kit was used in conjunction with two specially manufactured gas mixtures at highly accurate known concentrations of methane (high and low concentrations) according to the HFS manual purchased from the Calibration Gas supplier Ukrmetrteststandart. Using the calibration kits and known methane concentrations in air inside the gas mixture cylinders to control the variable parameters, the operators enter into the Hi-Flow Sampler all the controlled and known parameters. Then they separately allow the known CH_4/air mixture at both high and low concentrations to flow into each Hi-Flow Sampler device. The device then automatically calibrates both of the hydrocarbon detectors (main and background) based on the entered input parameters. The readings as per the operator's manual of a properly calibrated HFS are ±10% accurate.

1. The Hi-Flow Samplers were regularly calibrated while in use to ensure accurate measurements and to conform to the QA/QC procedure. All the measurements taken during the monitoring period were supported by the calibration efforts of D. Ismatulayev, S. Azimov, A. Kudaybergenov, T. Primkulova, F. Usupov, S. Kurbonov and S. Tuhtamishev. They have been fully trained in calibration techniques and logbook management by MBS. MBS confirmed their qualifications for this task as part of their training function and the performance of the calibration supervisor is regularly checked as part of MBS's ongoing project review. They performed this task every month during the monitoring period when the

units were in use, as is suggested by the Hi-Flow Sampler manual. In cases where use of the HFS was not needed for more than a month, they recalibrated the unit immediately prior to the equipment being used for the project. No measurements this monitoring period were taken by an HFS outside the manufacturers recommended calibration schedule. In the case where the Hi-Flow Sampler fell out of calibration, it remained unused during the impacted period. The date on which each Hi-Flow Sampler was calibrated is shown in the separate Calibration Log file that also demonstrates that every Hi-Flow Sampler measurement was taken with a unit that was calibrated within at least 30 days prior to that measurement.

Serial Numbers of the Hi-Flow Samplers used in this project and dates of calibration:

# HFS	PV1006	PV1008	PW1002	PW1003	PW1004	PW1005	PW1006	PW1007	QR1003	QR1004
Calibration date	6/21/23	7/10/23	6/21/23	6/21/23	6/21/23	6/21/23	6/22/23	6/21/23	8/19/23	8/19/23
Calibration date	7/10/23	7/29/23	7/10/23	7/10/23	7/10/23	7/10/23	7/10/23	7/10/23	8/26/23	9/16/23
Calibration date	7/29/23	8/19/23	7/29/23	7/29/23	7/29/23	7/29/23	7/29/23	7/29/23	9/16/23	10/12/23
Calibration date	8/19/23	9/16/23	8/19/23	8/19/23	8/19/23	8/19/23	8/19/23	8/19/23	10/12/23	11/8/23
Calibration date	9/16/23	10/14/23	8/26/23	9/16/23	9/16/23	9/16/23	9/16/23	8/26/23	10/14/23	12/6/23
Calibration date	10/14/23	10/8/23	9/16/23	10/14/23	10/14/23	10/14/23	10/14/23	9/16/23	11/10/23	1/3/24
Calibration date	11/11/23	11/3/23	10/12/23	11/11/23	11/11/23	11/11/23	11/11/23	10/14/23	12/7/23	1/28/24
Calibration date	12/9/23	11/14/23	10/14/23	12/9/23	12/9/23	12/9/23	12/9/23	10/12/23	1/5/24	2/23/24
Calibration date	1/6/24	12/13/23	11/10/23	1/6/24	1/6/24	1/6/24	1/6/24	11/10/23	1/26/24	3/19/24
Calibration date	2/3/24	1/10/24	12/7/23	2/3/24	2/3/24	2/3/24	2/3/24	12/7/23	2/2/24	4/16/24
Calibration date	3/2/24	2/7/24	1/5/24	3/2/24	3/2/24	3/2/24	3/2/24	1/5/24	3/1/24	5/13/24
Calibration date	3/29/24	3/6/24	1/26/24	3/30/24	3/30/24	3/30/24	3/30/24	1/26/24	3/30/24	6/29/24
Calibration date	4/27/24	4/3/24	2/2/24	4/27/24	4/27/24	4/27/24	4/27/24	2/2/24	4/27/24	7/27/24
Calibration date	6/19/24	5/1/24	3/1/24	6/22/24		6/22/24	6/22/24	3/1/24	5/20/24	8/2/24
Calibration date	7/13/24	7/5/24	3/30/24	7/20/24		7/20/24	7/20/24	3/30/24	6/26/24	8/24/24
Calibration date	8/10/24	8/2/24	4/27/24	8/16/24		8/16/24	8/16/24	4/27/24	7/25/24	
Calibration date			5/20/24					5/20/24		
Calibration date			6/26/24					6/26/24		
Calibration date			7/24/24					7/25/24		

# HFS	QR1006	QR1007	QR1008	QR1011	QR1012	QR1014	QR1015	QR1016	QR1017	QR1018
Calibration date	6/21/23	6/21/23	6/21/23	6/21/23	9/16/23	6/21/23	6/21/23	6/21/23	6/21/23	7/29/23
Calibration date	7/10/23	7/10/23	7/10/23	7/10/23	10/14/23	7/10/23	7/10/23	7/10/23	7/10/23	8/19/23
Calibration date	7/29/23	7/29/23	7/29/23	7/29/23	11/11/23	7/29/23	7/29/23	7/29/23	7/29/23	9/16/23
Calibration date	8/19/23	8/19/23	8/19/23	8/19/23	12/9/23	8/19/23	8/19/23	8/19/23	8/19/23	10/13/23
Calibration date	9/15/23	9/16/23	9/16/23	9/16/23	1/6/24	9/16/23	9/16/23	9/16/23	8/26/23	11/2/23
Calibration date	10/12/23	10/14/23	10/14/23	10/13/23	2/3/24	10/14/23	10/12/23	10/12/23	9/16/23	11/27/23
Calibration date	11/8/23	11/11/23	10/8/23	11/2/23	3/2/24	11/11/23	11/8/23	11/8/23	10/12/23	12/23/23
Calibration date	12/6/23	12/9/23	10/21/23	11/25/23	3/29/24	12/9/23	12/6/23	12/6/23	11/10/23	1/20/24
Calibration date	1/3/24	1/6/24	11/3/23	12/23/23	4/27/24	2/4/24	1/3/24	1/4/24	12/7/23	2/17/24
Calibration date	1/28/24	2/3/24	11/14/23	1/20/24	6/19/24	3/2/24	1/28/24	1/28/24	1/5/24	3/16/24
Calibration date	2/24/24	2/17/24	12/13/23	2/17/24	7/13/24	3/30/24	2/23/24	2/23/24	1/26/24	4/13/24
Calibration date	3/19/24	3/16/24	1/10/24	3/16/24	8/10/24	4/27/24	3/19/24	3/19/24	2/2/24	5/11/24
Calibration date	4/16/24	4/13/24	2/3/24	4/13/24		6/22/24	4/15/24	4/16/24	3/1/24	6/29/24
Calibration date	5/13/24	5/11/24	2/7/24	5/11/24		7/20/24	5/13/24	5/13/24	3/30/24	7/24/24
Calibration date	6/29/24	6/29/24	3/2/24	6/29/24		8/16/24	6/29/24	6/29/24	4/27/24	
Calibration date	7/27/24	7/24/24	3/29/24	7/24/24			7/27/24	7/27/24	5/20/24	
Calibration date			4/27/24						6/26/24	
Calibration date			6/19/24						7/25/24	
Calibration date			7/13/24							
			8/10/24							

# HFS	QR1019	QR1021	QR1022	QR1023	QR1024	QR1025	QR1026	QR1029	RR1006	RR1007
Calibration date	7/29/23	6/21/23	8/19/23	6/21/23	6/21/23	6/21/23	7/10/23	7/29/23	6/21/23	7/10/23
Calibration date	8/19/23	7/10/23	9/16/23	7/10/23	7/10/23	7/10/23	7/29/23	8/19/23	7/10/23	7/29/23
Calibration date	9/16/23	7/29/23	10/14/23	7/29/23	7/29/23	7/29/23	8/19/23	9/16/23	7/29/23	8/19/23
Calibration date	10/14/23	8/19/23	11/11/23	8/19/23	8/19/23	8/19/23	9/16/23	10/8/23	8/19/23	9/16/23
Calibration date	10/8/23	9/16/23	12/9/23	9/16/23	9/16/23	8/26/23	10/14/23	11/3/23	9/16/23	10/12/23
Calibration date	10/21/23	10/13/23	1/6/24	10/14/23	10/14/23	9/16/23	11/11/23	11/14/23	9/15/23	11/8/23
Calibration date	11/3/23	11/2/23	2/3/24	11/11/23	11/11/23	10/12/23	12/9/23	12/13/23	10/13/23	12/7/23
Calibration date	11/14/23	11/27/23	3/2/24	12/9/23	12/9/23	11/10/23	1/6/24	1/10/24	11/2/23	1/4/24
Calibration date	12/13/23	12/23/23	3/30/24	1/6/24	1/6/24	12/7/23	2/3/24	1/25/24	11/25/23	1/28/24
Calibration date	1/10/24	1/20/24	4/27/24	2/3/24	2/3/24	1/5/24	3/2/24	3/6/24	12/23/23	2/23/24
Calibration date	2/7/24	2/17/24	6/22/24	3/2/24	3/2/24	1/26/24	3/29/24	4/3/24	1/20/24	3/19/24
Calibration date	3/6/24	3/16/24	7/20/24	3/29/24	3/30/24	2/2/24	4/27/24	5/1/24	2/17/24	4/16/24
Calibration date	3/29/24	4/13/24	8/16/24	4/27/24	4/27/24	3/1/24		7/5/24	3/16/24	5/13/24
Calibration date	4/3/24	5/11/24		6/19/24	6/22/24	3/30/24		8/2/24	4/13/24	6/29/24
Calibration date	5/1/24			7/13/24	7/20/24	4/27/24			5/11/24	7/27/24
Calibration date	7/5/24			8/10/24	8/16/24	5/20/24			6/29/24	8/24/24
Calibration date	8/2/24					6/26/24			7/24/24	
Calibration date						7/25/24				
Calibration date										

# HFS	RR1009	RR1016	RR1017	RR1026	RR1031	RR1032	RR1033	QR1020	RR1010	RR1030	QR1000	RR1000
Calibration date	6/21/23	6/21/23	2/3/24	6/21/23	7/10/23	7/10/23	6/21/23	1/28/24	1/20/24	1/20/24	3/1/24	8/26/23
Calibration date	7/10/23	7/10/23	3/2/24	7/10/23	7/29/23	7/29/23	7/10/23	2/23/24	2/7/24	2/7/24	3/30/24	9/16/23
Calibration date	7/29/23	7/29/23	4/27/24	7/29/23	8/19/23	8/19/23	7/29/23	3/19/24	3/6/24	3/6/24	4/27/24	10/12/23
Calibration date	8/19/23	8/19/23	6/19/24	8/19/23	9/16/23	9/16/23	8/19/23	4/16/24	4/3/24	4/3/24	5/20/24	11/10/23
Calibration date	9/16/23	8/26/23		9/16/23	10/14/23	10/8/23	8/26/23	5/13/24	5/1/24	5/1/24		12/7/23
Calibration date	10/12/23	9/16/23			11/11/23	11/3/23	9/16/23	6/29/24	7/5/24	7/5/24		1/5/24
Calibration date	11/10/23	9/16/23			12/9/23	11/14/23	10/12/23	7/27/24	8/2/24	8/2/24		1/26/24
Calibration date	12/7/23	10/12/23			1/6/24	12/13/23	11/10/23					2/2/24
Calibration date	1/5/24	11/10/23			2/3/24	1/10/24	12/7/23					3/1/24
Calibration date	1/26/24	12/7/23			3/2/24	1/25/24	1/5/24					3/30/24
Calibration date	2/2/24	1/5/24			3/30/24	2/3/24	1/26/24					4/27/24
Calibration date	3/1/24	1/26/24			4/27/24	3/2/24	2/2/24					5/20/24
Calibration date	3/30/24	2/2/24			6/19/24	3/29/24	3/1/24					6/26/24
Calibration date	4/27/24	3/1/24			7/13/24	4/27/24	3/30/24					7/25/24
Calibration date	5/20/24	3/30/24			8/10/24	6/19/24	4/27/24					
Calibration date		4/27/24				7/13/24	5/20/24					
Calibration date		5/20/24				8/10/24	6/26/24					
Calibration date		6/26/24					7/25/24					
Calibration date		7/25/24										

Serial Numbers of the Gasurveyors, which require annual calibration according to the manufacturer's recommendation, used during this monitoring period and relevant dates of calibration:

521014: 30-May-2023; 20-May-2024
517422: 30-May-2023; 20-May-2024
517426: 30-May-2023; 20-May-2024
514414: 30-May-2023; 20-May-2024
517417: 30-May-2023; 20-May-2024
521015: 30-May-2023; 20-May-2024
517423: 30-May-2023; 20-May-2024
517425: 30-May-2023; 20-May-2024
517428: 30-May-2023; 20-May-2024
517412: 30-May-2023; 20-May-2024
517409: 30-May-2023; 20-May-2024
517397: 30-May-2023; 20-May-2024
517397: 30-May-2023; 20-May-2024
517424: 30-May-2023; 20-May-2024
517420: 30-May-2023; 20-May-2024
520981: 30-May-2023; 20-May-2024
521012: 30-May-2023; 20-May-2024
520982: 30-May-2023; 20-May-2024
517414: 30-May-2023; 20-May-2024
517403: 30-May-2023; 20-May-2024
517394: 30-May-2023; 20-May-2024
517405: 30-May-2023; 20-May-2024
557888: 30-May-2023; 20-May-2024
557893: 30-May-2023; 20-May-2024
557889: 30-May-2023; 20-May-2024
557894: 30-May-2023; 20-May-2024
557886: 30-May-2023; 20-May-2024
557897: 30-May-2023; 20-May-2024
557890: 30-May-2023; 20-May-2024
557891: 30-May-2023; 20-May-2024
557896: 30-May-2023; 20-May-2024
557887: 30-May-2023; 20-May-2024
557892: 30-May-2023; 20-May-2024
557895: 30-May-2023; 20-May-2024
520984: 30-May-2023; 20-May-2024
510441: 30-May-2023; 20-May-2024
517398: 30-May-2023; 20-May-2024

517404: 30-May-2023; 20-May-2024
520983: 30-May-2023; 20-May-2024
521008: 30-May-2023; 20-May-2024
517415: 30-May-2023; 20-May-2024
508355: 30-May-2023; 20-May-2024
520985: 30-May-2023; 20-May-2024
521002: 30-May-2023; 20-May-2024
517408: 30-May-2023; 20-May-2024
517395: 30-May-2023; 20-May-2024

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

The fundamental calculation of baseline ERs for every leak as per the methodology is as follows:

The baseline leak flow rate (F_{CH4}) is measured using a HiFlow Sampler or Leak Measurement Device (LMD) and converted from litres of CH_4 / minute to m^3 CH_4 / h (ConvFactor) for each leak included in the baseline (j). Any reappeared leakage found during the subsequent monitoring is measured using the HiFlow Sampler or LMD in the same way and subtracted from the initial measurement. The calculated uncertainty (UR) of the measurement using the guidelines in the methodology is deducted from this leak rate to ensure a conservative result. This conservative leak rate value for each leak during the monitoring period is then multiplied by the hours of operation (t) of the same leak between the baseline measurement and the monitoring measurement taking into account any temporary shut-offs of the equipment. Finally, the number of tonnes of CO2e emission reductions generated in the monitoring period by each leak is calculated using the GWP of methane. The values for all the leaks monitored are then added together to get the ER amount. The calculations are found in more detail in the ER calculation spreadsheet provided. The formulas that the baseline calculations are based on are as follows:

$$BE_y = \min\left\{ BE_1, ConvFactor \times \sum_j \left[F_{CH4,j} \times T_{j,y} \times \left(1 - UR_j\right) \right] \times GWP_{CH4} \right\}$$

With,

$$BE_1 = ConvFactor \times \sum_j \left[F_{CH4,j} \times T_{j,y=1} \times \left(1 - UR_j\right) \right] \times GWP_{CH4}$$

Where:

BE_1	=	Baseline emissions for the first crediting year of the crediting period (tCO_2e).
BE_y	=	Baseline emissions for crediting year *y* (tCO_2e)
ConvFactor	=	Conversion factor to convert Nm^3 CH_4 into tCH_4. The Hi-Flow sampler automatically accounts for standard temperature and pressure in data readings; as such this factor amounts to $0.0007168tCH_4/Nm^3$ CH_4 (i.e., 0 degree Celsius and 101.3 kPa).
j	=	All physical leaks that are included in the project activity for which physical leaks were detected and repaired and which would leak in the baseline scenario during the crediting year *y*.
$F_{CH4,j}$	=	Measured flow rate of methane for the physical leak *j* from the leaking component (Nm^3 CH_4/h)
UR_j	=	Uncertainty range for the flow rate measurement method applied to physical leak *j*. The uncertainty of the measurement is taken into account by using the flow rate at the lower end of the uncertainty range for the measurement at a 95% confidence interval for baseline emissions from leaks
$T_{j,y}$	=	The time the relevant component, in which physical leak *j* occurred, would leak in the baseline scenario and would be eligible for crediting during the crediting year *y* (hours)
GWP_{CH4}	=	The global warming potential for methane valid for the commitment period (tCO_2e/tCH_4). After the commitment period, this value may be revised based on any decision by the CMP.

Uncertainty is calculated using the following formula:

$$UR_j = \frac{\sqrt{(UR_1 * x_1)^2 + (UR_2 * x_2)^2 + \ldots + (UR_n * x_n)^2}}{x_1 + x_2 + \ldots + x_n}$$

Where

UR_j = the percentage uncertainty in the sum of the quantities (half the 95% confidence interval divided by the total (i.e. mean) and expressed as a percentage);

x_n and UR_n = the uncertain quantities and the percentage uncertainties associated with them, respectively.

(Note: "n" in this case refers to each recorded leak rate of each component surveyed)

Baseline Emission **3,849,288** tCO_2e (See the calculations in the ER calculation spreadsheet attached.)

5.2 Project Emissions

There are no project emissions as finding and repairing gas leaks does not create Project Emissions. Any new leaks or leaks that reappear are immediately repaired.

5.3 Leakage Emissions

Not Applicable. No leakage produced from repairing leaks.

5.4 GHG Emission Reductions and Carbon Dioxide Removals

All relevant calculations are included in an attached excel sheet.

Vintage period	Baseline emissions (tCO_2e)	Project emissions (tCO_2e)	Leakage emissions (tCO_2e)	Reduction VCUs (tCO_2e)	Removal VCUs (tCO_2e)	Total VCUs (tCO_2e)
22-Aug-2023 to 31-Dec-2023	275,254	0	0	275,254	0	275,254
01-Jan-2024 to 15-Sept-2024	3,574,034	0	0	3,574,034	0	3,574,034
Total	**3,849,288**	0	0	**3,849,288**		**3,849,288**

Vintage period	Ex-ante estimated reductions/ removals	Achieved reductions/ removals	Percent difference	Explanation for the difference
22-Aug-2023 to 31-Dec-2023	1,399,842	275,254	80%	The project baseline study and the teams took longer than expected to ramp up to working at the expected rates. As the teams gained experience, they eventually exceeded the expected leak reduction through repairs.
01-Jan-2024 to 15-Sept-2024	*(259/366 *5,270,617=)* 3,729,754	3,574,034	4%	The project baseline study and the teams took longer than expected to ramp up to working at the expected rates. As the teams gained experience, they eventually met and even exceeded the expected leak reduction through repairs.
Total	5,129,596	**3,849,288**	25%	The project baseline study and the teams took longer than expected to ramp up to working at the expected rates. As the teams gained

				experience, they eventually met and then exceeded the expected leak reduction through repairs.