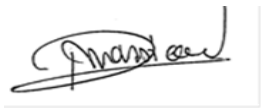
Validation opinion for post registration changes

Title of project activity:		
Moldova Energy conservation and greenhouse gases emissions reduction		
CDM reference number:	DNV project No.:	
0173	PRJC-106514-2008-CCS-NOR	
Date:	Validation of the changes were conducted:	
01/05/2014	☐ Prior to the commencement of a verification of the project activity ☒ When performing a verification of the project activity	
Work carried out by (name & signature):	Work verified by (name & signature):	Approved by (name & signature):
Patrice Massicard  Ole A. Flagstad	Michael Lehmann Michael Lehmann	Michael Lehmann Michael Lehmann

Overview of post registration changes

Type of post registration change		**Are the changes of a type specified in Appendix 1 of the CDM Project Standard?** Note: In case of "No", prior approval by the EB is required
A: Temporary deviations from the registered monitoring plan and/or monitoring methodology (refer to section A)		☐ Yes ☐ No ☒ No post registration change of this type
Applicable period for proposed deviations (inclusive):	From DD/MM/YYYY start date of the earliest included deviation to DD/MM/YYYY end date of the latest included deviation)	
B: Corrections (refer to section B)		☐ Yes ☐ No ☒ No post registration change of this type
C: Changes to the start date of the crediting period (refer to section C) *Prior approval by the CDM EB is not required in case of (a) bringing forward the start date up to one year earlier or (b) postponing the start date by up to one year (by up to two years for project activities in LDCs).*		☐ Yes ☐ No ☒ No post registration change of this type
Proposed start date of the crediting period:	DD/MM/YYYY (changed from DD/MM/YYYY)	
D: Permanent changes from the registered monitoring plan or		☐ Yes

applied methodology (refer to section D)	☒ No ☐ No post registration change of this type
E a): Changes to the project design of a registered project activity (refer to section E)	☐ Yes ☐ No ☒ No post registration change of this type
E b): Changes to the programme design of a registered PoA (refer to section E)	Note: All changes to the programme design of a registered PoA require prior approval by the EB. ☒ No post registration change of this type
F. Changes specific to afforestation or reforestation project activities	☐ Yes ☐ No ☒ No post registration change of this type

A. Temporary deviations from the registered monitoring plan and/or monitoring methodology

Not applicable

B. Corrections

Not applicable

C. Changes to the start date of the crediting period

Not applicable

D. Permanent changes from the registered monitoring plan or applied methodology

D.1 Description of the revision of the monitoring plan

The project participant has made revisions to the approved revised PDD, accepted 16/03/2011, and submitted the updated PDD (version 3) as request for post-registration change regarding a revision to the monitoring plan. Due to several clarification requests from the UNFCCC dated 06/11/2013, the project participant has further revised the PDD to version 7 (dated 7 April 2014) to clarify the issues raised. The proposed revision of the monitoring plan includes the following changes from the registered PDD:

1) Monitoring of heat produced by the project

   In the registered PDD, it is specified that the boiler heat output $Q_{boiler,PR}$ would be measured from heat meters where meters are already installed, and boiler efficiency would be a calculated as the ratio of the measured heat output and measured fuel consumption.

It was found during site visit that the heat output was measured only for a minority of sites and for a short period. For a majority of the sites, $Q_{boiler,PR}$ is calculated based on the fuel consumption and ex-ante estimates of the boiler efficiency value. Although this in accordance with the provisions of the registered PDD, the methodology AMS-III.B version 06, section 5 b) requires that both fuel use and output (heat output or electricity generated) shall be monitored.

Heat meters typically consist of a substation comprising several elements:

-flow meter at the outlet of the boiler,

-temperatures probes at inlet and outlet of the boiler to determine the temperature change through the boiler, and

-transmitter calculating the heat transfer based on the temperature and flow over time.

However, due to the high number of sites, the costs associated with the purchase, installation and maintenance of the meter, and the low CER revenues generated for each site, it is not possible for the project participants to install heat meters for each site at a reasonable cost. Hence, the project participants are seeking approval by the CDM EB for a permanent deviation from the applied methodology. In order to ensure the accuracy of the calculation of $Q_{boiler,PR}$ while not being able to monitor the heat output, it is proposed to monitor the boiler efficiency once ex-post based on a measurement campaign for a sample of project boilers. The sample size is defined in accordance with the "*Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities"* (Version 03.0). Simple random sampling is applied for the boilers, and an average value will be applied for each boiler. In accordance with par. 15 of the sampling standard, the project participant is seeking approval of the proposed sampling approach through this request for post registration change.

The revised monitoring plan further describe how the parameters Qcsm and $Q_{fuel,BSL}$ will be calculated based on the proposed approach:

$$Q_{fuel,BSL} = Q_{csm} / E_{BSL}$$

where

$$Q_{csm} = Q_{boiler,PR} * \eta_{net,PR} = V_{fuel,PR} * LHV_P * \eta_{boiler,PR} * \eta_{net,PR} / 1000$$

The parameter $\eta_{net,PR}$ represent the heat network losses in the project scenario. This calculation method was applied in the ER calculation sheet submitted at registration, however it was not specifically described in the registered PDD. .This parameter is now added in the list of ex-ante parameters in the revised PDD (ref. point 2 below)..

For the project activities where there is a fuel mix in the baseline scenario, $Q_{fuel,BSL,f}$ will be determined by the proportion of the energy coming from each fuel based on 3 years historical data prior to the project implementation (data from the period 2001-2003 are used since from 2004 onwards the consumption data are estimations). This ratio is noted p_f and has been calculated for each PA in the revised NPV calculation sheet submitted together with this post registration change request. The baseline emission of the source j would thus be calculated as follow:

$$Em_j = \sum_f Q_{fuel,BSL} \times EF_f \times p_f$$

2) List of ex-ante parameters

In the monitoring plan of the revised PDD approved on 16 March 2011, the monitored parameters were not clearly defined ex-ante or ex-post.

Some parameter, such as net calorific values and emission factors of the different fuels, were stated to be monitored (estimated) annually in the PDD. These values are neither measured by the project participants nor available from fuel suppliers, so that default national data or IPCC values are used. These parameters can thus be classified as ex-ante parameter. Some parameters (like baseline boiler efficiency, electrical and heat network efficiencies) were used for emission reduction calculations, but not specifically included in the monitoring plan of the PDD.

Thus, ex-ante and ex-post parameters have been clearly defined in the proposed revised monitoring plan of the PDD (version 04), with reference to the source of data.

The list of ex-ante parameters in the revised PDD comprises:

- Net calorific value of natural gas (33.5 MJ/Nm^3), sourced from national official data.
- Emission factor of natural gas (56.1 tCO_2/TJ), coal (94.6 tCO_2/TJ) and mazut (77.3 tCO_2/TJ), sourced from IPCC

Efficiency of existing coal boiler (60%) and mazut boiler (76%), and coal stove (40%) sourced from expert judgment. The efficiency of existing boilers was estimated based on typical values from technical literature (ref. Handbook of low capacity heating installations, K.F Roddatis, 1989), degradation factors over years, and the observed load factor of the boilers. The mandated expert is professor at technical university of Moldova and conducted the baseline study described in the PDD. The expert opinion is independent and qualified source and considered reasonable by DNV. By checking the expert statement, it was found the efficiency of Mazut boiler was estimated at 76% by expert, while 87% had been used in the estimation of ER for the PDD. Since there was no reference for the value of 87%, and the correct value of 76% was used for another similar project in Moldova registered at the same time (UNFCCC ref. 159), it is considered as a misstatement. This has been corrected in the revised PDD which result in a slight increase of emission reduction estimation by about 2%, as well as a decrease of the NPV of the project. This has however no impact on the additionality of the project since additionality was demonstrated through investment barrier in the registered PDD and the revised NPV is still negative.

- . The efficiency of baseline coal boilers and coal stove in the expert statement is consistent with the value used in initial emission reduction calculations (60% & 40%).
- Efficiency of existing external heat network (90%), sourced from expert judgment. The value was determined based on technical report ‘Moldova heating sector development projects’, by B. Kalkum and A. Rajkiewicz, 2002.
- Average efficiency of local power plants (33%), sourced from national electricity operator
- Efficiency of local electrical distribution network (80%), sourced from national agency for energy regulation.
- Efficiency of the project external heat network (98%), sourced from expert judgment.

- Ratio of energy coming from fuel f in the baseline scenario, calculated for each PA based on the historical consumption of fuels. It is used to correctly apportion $Q_{fuel,BSL}$ for each fuel.

The list of ex-post monitored parameters comprises:

- Amount of natural gas consumption, measured continuously and recorded monthly
- Boiler heat output, calculated from the fuel consumption and the boiler efficiency
- Efficiency of the boiler, measured once ex-post during the crediting period, on a sample of project boilers as explained in point 1) of this revision.

D.2 Assessment of the revision of the monitoring plan

The proposed revision of the monitoring plan ensures that the level of accuracy or completeness in the monitoring and verification process is not reduced as a result of the revisions

1) The monitoring plan and applied methodology require measuring the heat output of the project's boiler. In the proposed revision of the monitoring plan, the heat output is calculated based on measured boiler efficiency, which provide an accuracy level similar to the original monitoring plan (the total number of boiler in the project is 38 and the minimum sample size is 30 as required in the Standard for sampling and Surveys for CDM project activities, which provides an accuracy level less than 1%). Besides, the proposed revision improves the accuracy of emission calculation compared to using estimated values for the efficiency as initially proposed by the project participants. The completeness of the monitoring compared to the registered PDD is improved since the efficiency is now monitored ex-post while it was only estimated ex-ante initially.
2) Differentiating ex-ante and ex-post parameters explicitly does not affect the completeness / accuracy of the monitoring. The same source of data is used compare to the registered PDD;

The proposed revision of the monitoring plan is in accordance with the approved monitoring methodology applicable to the project activity whilst ensuring the conservativeness of the emission reductions calculation

1) It is not possible for the PP to continuously measure the heat output of each boiler at a reasonable cost due to the following reasons: .
   As shown in section B.5 of the PDD, the NPV of the project is negative, even when considering CER revenues. This means that each individual PA took on a loan to implement its new boiler, but they will not get financial return on this investment even with CER revenue. The PA are not project participants, but the project was established such that each individual PA is responsible for monitoring of the project activity. However, there is no national requirement for heat output from the boiler to be measured. Moldova's Parliament Law no. 1525 of 19.02.1998 on Energy requires that the natural gas purchased by the individual PAs be metered, and this monitoring has been done. However the heat user is the same entity as the heat producer; hence, the entities themselves do not require heat metering for e.g. billing purposes.

The cost for fuel meters has been obtained by quotations from Piroterm service. The cost for a typical 600kW meter (excluding installation cost) amount to 1043$. Applying this cost to each installed boiler (some boiler has higher or less capacity but this value covers most of the situation), it amounts to 39 634$ for all project activities, excluding installation and maintenance costs..

Hence, the project participant has not been capable of obliging the project owners to bear the additional cost for purchasing, installing and maintaining the heat meters because the project owners do not obtain sufficient financial incentives from CER revenues (the NPV is negative even with CER revenues).

As an alternative to direct measurements, the project participant proposes to calculate the heat generated based on fuel consumption and the efficiency of the boiler. The boiler efficiency was estimated ex-ante in the PDD. However, it is proposed in this request for deviation to monitor the boiler efficiency once ex-post during the crediting period on a sample of project boilers in order to provide accuracy and confidence level equivalent to the methodology requirement.

According to the international standard for measurement of boiler performances (ASME PTC-4-2008), there are 2 possible methods for measuring boiler efficiency: the direct method (also called input-output), based on the ratio of heat output by heat input; and the indirect method (heat losses method), based on flue gas analysis in chimney. As stated previously, heat meters are not in place at the project sites or, if in place, have not been maintained. Hence data are not available to use the input-output method for boiler efficiency measurements, meaning the indirect method is the only method that can be applied. By nature this method is based on discrete measurements, and therefore involves travelling to each site with the required calibrated equipments. The project entails 38 natural gas boilers, that were installed new under the project, located throughout the nation of Moldova. The boilers are of only three different manufacturers and all serve similar purposes in public institutions. Therefore their performance was expected to be relatively uniform; this was supported by the results of the sampling campaign as the range of measured efficiency varies from 83% to 96%, and most values are in the range 90 to 94%. Furthermore the project participant had to conduct additional boiler testing in Moldova for the project Ref. 159, which faces similar monitoring issue. Considering the number of locations and the nature of the measurements to be done, it is not cost effective to measure all boilers at regular frequency. Consequently sampling can be the only practical and cost-effective way to determine the efficiency of the boilers and is justified considering the results are expected relatively uniform.

Since the crediting period is running from January 2006 to January 2016, and measurements have been conducted in 2012 and 2013, there is no need to consider a possible decrease of efficiency overtime. Boilers are typically running for 30 years and the efficiency is not expected to vary during the remaining time of the crediting period.

In this project the number of boiler is 38 and sample size calculations to meet 90/10 confidence/precision level return a value of only 3 boilers. Initially, 11 boilers were selected by the project participant and the measurements started in April 2012. However, a new requirement was introduced in version 03.0 of the "*Standard for*

*Sampling and Surveys for CDM Project Activities and Programme of Activities"*issued in September 2012, whereas minimum of 30 samples shall be chosen if sample size calculations return a value less than 30. Hence the sample size has been increased to 30, which provides an accuracy level less than 1%.

At the time of submitting this post registration change, all measurements have been conducted by the project participants. The measurement were done by Piroterm Service SRL, a private company in Moldova specialized in heating and water systems.

Piroterm-Service SRL is authorized by the government for performing technical services for boilers (appendix 1). However, there are no directly applicable national standards related to efficiency testing that govern these tests in Moldova. The regulations governing the closest comparable situation were therefore considered. Government Decision No. 428 from 15.07.2009, Chapter IV on evaluation of compliance, Art.12 states that the means and measurement equipment used to determine efficiency and type examinations and final tests of new boilers must be adequate, certified, and verified as established by National Institute for Measurement and Calibration.
Piroterm Services AS used a calibrated flue gas analyser type "Afriso Multilyzer NG" from Germany for the carrying out the analysis (appendix 2). The analyser has been certified by the national metrological institute (appendix 3). Furthermore the engineer in charge of testing is certified as having been trained for use of the testing equipment (Appendix 4).

In terms of method, the testing method is as prescribed by AFRISO Euro-Index for application of its Multilyzer NG Flue Gas Analysis Computer (see attached "Operating Instructions Flue gas analysis computer Type: MULTILYZER NG", Appendix 5). The measurements are in accordance with the general regulations set forth by the German Bundes-Immissionsschutzverordnungen (BIMSchV) (same document, p. 6), and the Piroterm operators were trained in correct application of the Multilyzer (evidence already provided). Thus, we observe that the method is also in line with a German standard, in the absence of any applicable Moldovan requirement. Piroterm also confirmed this in its report.

It is DNV's opinion that the measurements were done in accordance with applicable national regulation, carried out by trained personnel using calibrated instruments.

Therefore, DNV is of the opinion that the measurements results are reliable and of better accuracy than the ex-ante value included in the registered PDD.

Measurement reports were provided and reviewed by DNV. Boiler efficiencies were tested at the maximum capacity, and at low capacity (50% or less) when the boiler's burner can be modulated. The measured efficiency at lower load is found always higher than that at high load. At lower load the flame is smaller, flue gas temperature and CO_2 content is lower which result in higher efficiency. Therefore, the efficiencies at full load were used for the calculations which is a conservative approach compare to the load factor during actual operation.

The results showed good consistency of the boiler performance, except for PA9 with 68.1% measured efficiency. However this value was excluded because it is believed to be the result of a faulty measurement. The oxygen level measured during this test was exceptionally high. The measurement at lower load for this boiler was normal (97%), and the measurements at both low and high load for the identical sister boiler at the

same site were also normal. DNV consider the exclusion of this measurement justified.

The measured values are between 83% to 96%, the average is 92.5% with a standard deviation of 2.8. This is in line with the initially estimated value of 92%, so that 92% efficiency is conservative and can be applied for the emission reduction calculations. Arithmetic means is used because the results are expected to be uniform and not dependant on the capacity of the boiler. Furthermore, in this case the range and representation of boiler capacity included in the sample is almost the same as that of the total population (30 out of 38). Thus applying either arithmetic or weighted mean leads to the same result (application of 92% efficiency). Details of the results are provided in attachment.

In order to be conservative, the lower limit of the 90% confidence interval using the student's t-distribution is selected. Moreover, boiler jacket losses (i.e. heat losses through the boiler envelop) have been considered. This has resulted in an efficiency of 90%.

It has been noted in the measurement results that there are 5 boilers where the capacity of the burner is higher than the nominal capacity of the boiler. It has been clarified by Piroterm that these boilers where initially designed and installed without burner. The burners were installed separately, using imported equipment from different suppliers. The capacity of the burners installed at the boilers are always around 10% above the capacity of the boiler because, at boiler start-up, it is necessary to minimize the time to increase the temperature of the heating agent (water) temperature, to the established threshold. However the accuracy of the boiler efficiency obtained via the flue gas analysis are not affected by this oversizing.

This observation has no impact on the project scale nor applicability of the methodology. The annual expected emission reductions included in section B.2 of the PDD were determined based on expected heat demand during the crediting period and thus not dependant of the boiler capacity. The boiler capacity was selected to meet or exceed the expected heat demand, and an increase of the boiler capacity has no impact on the project scale.

The results will also be included in the monitoring report for the first monitoring period since it is considered as ex-post parameter.

The heat output will be calculated based on the fuel consumption, (monitored continuously) and the boiler efficiency, measured once ex-post. DNV is of the opinion that this represents good monitoring practice and ensures emissions reduction calculations of a similar accuracy as what was foreseen in the monitoring plan. DNV is therefore seeking approval to the UNFCCC EB of this permanent deviation to the applied methodology.

2) The project applies small scale methodologies where ex-ante parameters are not specifically defined. The methodology AMS-III.B section 5) and section 6) specify:
   - Monitoring of the fuel use and output for an appropriate period (e.g., a few years, but records of fuel use may be used) prior to the fuel switch being implemented". It has been assessed during validation that historic fuel consumption can not serve as basis for future energy use because trends in energy uses have significantly changed. The forecasted heat demand have been determined on the basis of a

given reference year 2003 and expected annual growth rate in energy consumption of 5%. For the purpose of baseline emissions calculations, efficiency of the exiting boilers was determined by an expert who conducted the baseline study of the project. The efficiency of existing boilers were estimated based on typical values from technical literature, taking into account the degradation factors over years, and the observed load factor of the boilers. These estimates are considered reasonable by DNV.

- In the case of coal, the emission coefficient shall be based on test results for periodic sample of coal purchased if such tests are part of the normal practice for coal purchases. This is not the case for this project so that the emission factor for coal is based on default IPCC values.

DNV can confirm that the list of ex-ante and ex-post parameters is in accordance with the applied methodology

The findings of previous verification reports, if any, have been taken into account

Not applicable, this is the first verification of the project.

E. Changes to the project or programme design of a registered project activity or POA

Not applicable

F. Changes specific to afforestation or reforestation project activities

Not Applicable

Validation opinion

As per the requirements of the CDM validation and verification standard (version 05), DNV can confirm that:

(a) The proposed revision of the monitoring plan ensures that the level of accuracy and completeness in the monitoring and verification process is not reduced as a result of the revision;

(b) DNV has assessed that the project participants are unable to implement a monitoring plan that would comply with the approved methodology AMS-III.B (version 06)

(c) The consideration of the previous verification reports is not applicable, since no verification has yet been conducted prior to the revision.

In addition, the latest PDD template has been used and the information provided in the registered PDD has been correctly transferred to the revised PDD.

Hence, DNV recommends the approval of the revised monitoring plan submitted by the project participants.

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