The Carbon Finance Unit of the Republic of Moldova

World Bank

MOLDOVA

GRID EMISSION FACTOR ASSESSMENT

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Acronyms and Abbreviations

BM	Build Margin
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
CES	Connected Electricity System
CFU	Moldova Carbon Finance Unit
CHP	Combined Heat & Power (Cogeneration Power Plant)
CM	Combined Margin
CO_2	Carbon dioxide
EB	Executive Board
EBRD	European Bank for Reconstruction and Development
Energy Community	Energy Community of South East Europe (ECSEE) and European Energy Community (EEC)
ERPA	Emission Reduction Purchase Agreement
GHG	Greenhouse gas
HPP	Hydropower plant
kWh	Kilowatt hour
LCD	Load Duration Curve
MW	Megawatt
MWh	Megawatt hour
MGRES	Condensing Power Plant located in Transnistria
MPS	Moldova Power System
OM	Operation Margin
PDD	Project Design Document
PES	Project Electricity System
pmr	pridnestrovian moldavian republic
PP	Power Plant
PU	Power Unit
ANRE	National Energy Regulatory Agency
Moldelectrica	National System Operator and Transport of Electricity
t.c.e.	tone coal equivalent, 1 t.c.e. = 7000 Gcal
HSP	Hydro Storage power plant
Tool	"Tool to calculate the emission factor for an electricity system", Version 2, October 16 2009, EB 50
TSO	Transport and System Operator
MPS	Moldova Power System

Executive Summary

The analysis of the Moldova Power System for the purpose of calculating the of grid emission factor (GEF) showed that due to Transnistria secessionism, the Moldova electricity authority (Ministry of Economy) does not control the power system on the left bank of the river Nistru, and therefore does not have access to all data on electricity generation in the country. This suggests that there may be limits to the options which can be used to determine the GEF for the country as a whole, and it may only be determined for the right bank. An initial aim of this study is to determine which approach for calculation of the GEF is applicable to Moldova, and if the GEF can be calculated for the country as a whole.

A more detail analysis of the information available on the power units and power plants (PPs) located on the left bank of the river Nistru (MGRES and Dubasari HPP) indicated that with the exception of the type of fuel used, its net calorific value and electricity production efficiency by each of the power units, all other information needed for GEF calculation is known at Moldelectrica. This allows application of a conservative approach to determine the missing data for MGRES, by using the default figures from Annex 1 of the Tool to calculate the emission factor for an electricity system[1] (referred in the document as 'Tool'). As a consequence the whole electricity system of the Republic of Moldova (left and right banks of the river Nistru) is treated as a single project electricity system.

Low cost/must run resources of this system constitute less than 50% (being equal to 19.64%) of the total grid generation in average of the five most recent years. As a consequence, the Simple OM method was proposed to calculate the operating margin (OM) emission factor. The ex-ante option is chosen to calculate the OM for the Moldova grid as 3 years generation-weighted average data for the most recent years (2008-2010) is known.

In terms of vintage of data to calculate the build margin (BM), Option 1 is chosen as per the Tool. Default approach as per the Tool is used to determine the Combined Margin (CM).

Based on the concept mentioned above an appropriate Excel Spreadsheet was created, permitting to determine GEF depending on PP's data availability and what category each PP belongs to: low cost/must run or not low cost/must run.

Guidance for subsequent annual GEF updating is developed in Annex 2.

The following are the results of Moldova GEF calculation for the crediting period starting at the beginning of 2010:

Simple OM	**BM**	**CM**		
		Wind and solar	**All other, for the first crediting period**	**All other, for the second and third crediting period**
0,3806	0,4643	0,4015	0,4224	0,4434

1 http://cdm.unfccc.int/filestorage/2/9/L/29LIXUT6W4Z0AKD37RYQ1EVSMG8HBN/eb61_repan12.pdf?t=N3R8MTMwNzQyNDkxMC45OA==|eCBV6uCWxME2DFkb35NqRDHJM4M=

Definitions

Build Margin (BM) is the emission factor that refers to a cohort of power units that reflect the type of power units whose construction would be affected by the proposed CDM project activity. It is a reflection of the likely future power plants being built.

Combined margin (CM) is defined as weighted average of the build margin and the operational margin.

Connected Electricity System (CES) defined as an electricity system that is connected by transmission lines to the project electricity system. Power plants within the connected electricity system can be dispatched without significant transmission constraints but transmission to the project electricity system has significant transmission constraint.

Crediting period is the time from CDM project registration until the end of the specified time when emission reductions can be claimed on the project.

Electricity imports are defined as electricity transfers from connected electricity systems to the project electricity system

Electricity exports are defined as electricity transfers to connected electricity systems

Ex-ante is defined as a calculation based on historic data referring to the future applying the ceteris paribus clause. E.g. the host country's future emissions are calculated by the host country's historic fuel consumption – assuming that everything stays the same.

Low-cost/must-run resources are defined as power plants with low marginal generation costs or power plants that are dispatched independently of the daily or seasonal load of the grid. They typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. If coal is obviously used as must-run, it should also be included in this list.

Net electricity generation refers to the difference between the total quantity of electricity generated by the power plant / unit and the auxiliary electricity consumption of the power plant / unit (e.g. for pumps, vans, controlling, etc).

Operation Margin (OM) is the emission factor that refers to a cohort of power plants that reflects the existing power plants whose electricity generation would be affected by the proposed CDM project activity.

Project Electricity System (PES) defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity (e.g. the renewable power plant location or the consumers where electricity is being saved) and that can be dispatched without significant transmission constraints.

Power plant/unit: A power plant / unit is a facility for the generation of electric power. Several power units at one site comprise one power plant, whereby it is characteristic for a power unit that it can be operated independently of the other power units at the same site. If several identical power units (i.e. with the same capacity, age and efficiency) are installed at one site, they may be considered as one single power unit.

1. Introduction

The determination of emission reductions from energy efficiency and renewable energy CDM projects involving the electricity grid (supply of electricity and/or reduction of demand) is based on the calculation of the grid emission factor (GEF). The experience gained from the Clean Development Mechanism/Joint Implementation (CDM/JI) projects under the Kyoto Protocol indicates that most individual project developers have limited capacities to calculate the emission factors for national (and/or relevant sub-national) power grids, especially in countries like Moldova. This is due to limited access to relevant information and data to carry out the calculation. In order to facilitate, increase efficiency and reduce the costs of CDM PDD elaboration the developers of such projects should either know beforehand the values of GEF or have available a simple instrument or procedure to determine it.

The Moldova National Grid is distinguished by a very low security of supply due to a lack of own energy resources and high import of electricity & natural gas from abroad. By joining the Energy Community in 2010 Moldova has an opportunity to overcome this problem, including by developing renewable energy and energy efficiency projects. These have the potential to be registered as CDM projects for which a grid emission factor is needed to calculate the CO_2 emission reductions.

This report describes the importance of the GEF, how the GEF for Moldova has been calculated and how the Excel tool of GEF calculation can be used in the future under different circumstances. This will help CDM project developers to calculate the Emission Reductions, called Certified Emission Reductions (CERs) under the CDM, generated by their project activity.

2. Moldova Electricity System

The main characteristics of the Moldova Power System are outlined below:

- Because of Transnistria secessionism, the Moldova Power System (MPS) is divided into two parts: right bank and left bank (Transnistria) of river Nistru. Nevertheless, the Moldova Government considers both parts to belong to one system, i.e. to MPS, and thus to the same host country;
- Less than 25% of right bank annual electricity consumption is covered by the power plants located on this territory. The remaining proportion comes from Ukraine or Transnistria condensing PP (MGRES), which is located on the left bank;
- Most electricity on the right bank is generated by CHPs (92-96%), which are regulated. The remaining part is produced mainly by one hydropower plant;
- On the left bank two PPs are operating at the moment: MGRES and Dubasari HPP.

Although both left and right banks of the MPS are operated by the System Operator (TSO) located on right bank, the left bank is not controlled by the Moldova official authority. This means that much of the data needed from the left bank for the calculation of the GEF cannot be obtained or verified, except for meter readings which are available to the TSO.

2.1 The capacity and electricity generated on right and left banks

The maximum load consumed on the right bank is around 720 MW, with own PP installed capacity being 280 MW (30%)[2]. Unfortunately not all of the installed capacity on the right bank can be used to satisfy demand. Local CHP's, except Elteprod CHP which is very small, were designed before 1990 to operate at a heat capacity almost twice what is used at present. Since 1990 this capacity dropped significantly which has led to an operation regime for PPs far from one considered as efficient for cogeneration. As a result, local CHP load is below the nominal value, their specific fuel consumption being quite high, and not as it is expected for cogeneration energy production. However, it is mandatory for all electricity produced by CHP-1, CHP-2 and CHP-Nord to be bought on the power market, as established by the National Energy Regulatory Agency (ANRE). As to CHP Sugar Factories and CHP Elteprod, the electricity produced by these PPs is considered to be a by-product of the industrial process, and is sold at a price lower than the cheapest electricity available on the market.

As to the left bank, there is no available data about own electricity consumption, but the power delivered to the grid by PPs (MGRES and Dubasari HPP) located within this part of the country is known. Moldelectrica has access to the load curves for MGRES. For Dubasari HPP, electricity delivered to the grid is only known by month, being published on the web[3] by the pridnestrovian moldavian republic[4] (pmr).

[2] The information is provided by Ministry of Economy, ANRE and Moldelectrica

[3] http://mepmr.org/gosudarstvennaya-statistika/informacziya/92-ekspress-informacziya-za-2009-god

[4] The Pridnestrovian Moldavian Republic is an unrecognized state which claims the territory to the east of the river Dniester

Table 1 provides basic information on Moldova power units as of 1st January 2010. From the total electricity produced on the right bank, 6% is generated by hydro PPs and 94% by thermal PPs.

With respect to the left bank, because of the lack of data for MGRES, the fuel consumption is calculated applying a conservative approach (See Excel Spreadsheet), using: a) capacity of units; b) default values for efficiency as prescribed in Annex 1 of the “Tool to calculate the emission factor for an electricity system”; c) units merit order loading, i.e. for each concrete hour is dispatched first the unit with the lowest fuel specific consumption.

Table 1: Main data for Moldova power units (2010)

Power Plant	Unit no.	Commissioned	Installed Capacity, MW	Average fuel consumption 2008-2010, tonnes/ year	Average electricity generated 2008-2010, MWh/year
Right bank					
CHP-1	PU 1	1959	12	4,575	19,054
	PU 2	1961	25	9,532	39,696
	PU 3	1961	5	1,906	7,939
	PU 4	1995	12	4,575	19,054
	PU 5	2001	12	4,575	19,054
	TOTAL		**66**	**25,165**	**104,798**
CHP-2	PU 1	1976	80	43,104	215,940
	PU 2	1978	80	43,104	215,940
	PU 3	1980	80	43,104	215,940
	TOTAL			**129,312**	**647,820**
CHP-Nord	PU 1	1995	12	4,670	27,634
	PU 2	2005	12	4,670	27,634
	TOTAL		**24**	**9,340**	**55,268**
CHP Sugar Factories	Cupcini			Coal	
	Drochia			Coal	
	Glodeni			Coal	
	Falesti			Coal	
	TOTAL			Coal	**3,958**
CHP Elteprod	**TOTAL**	**2007**		Coal	**469**
HPP Costesti	PU1	1973	16	Hydro	
	TOTAL	**1973**	**16**	**Hydro**	**71,381**
Left bank					
MGRES	PU 1	1964	200		
	PU 2	1965	200		
	PU 3	1965	200		
	PU 4	1967	200		
	PU 5	1968	200		
	PU 6	1969	200		
	PU 7	1970	200		
	PU 8	1971	200		
	PU 9	1973	210		
	PU 10	1974	210		
	PU 11	1980	250		
	PU 12	1982	250		
	TOTAL		**2520**		**4,060,937**

HPP Dubasari	PU 1	1954	12		
	PU 2	1954	12		
	PU 3	1955	12		
	PU 4	1958	12		
	TOTAL		**48**	**Hydro**	**312,728**

Sources: ANRE, Moldelectrica for all PPs except HPP Dubasari; http://mepmr.org/gosudarstvennaya-statistika/informacziya - for HPP Dubasari

2.2. Demand satisfaction

Table 2 and Table 3 show the evolution of electricity sources participation for demand satisfaction throughout the MPS (right and left banks) during the years 2005-2009, in mil. kWh and % of total demand.

Table 2: Electricity delivered to Moldova Grid, mill.kWh

Source	Plant	2006	2007	2008	2009	2010	Average 3 years 2008-2010	Average 5 years
Right bank	CHP-1	124,800	130,600	120,700	116,700	76,993	104,798	113,959
	CHP-2	689,600	682,200	640,700	639,400	663,361	647,820	663,052
	CHP-Nord	61,800	55,400	55,200	53,500	57,104	55,268	56,601
	HPP Costesti	75,900	32,900	81,800	54,000	78,343	71,381	64,589
	CHP Elteprod	0	379	489	480	438	469	357
	CHP Sugar Factories	5,600	2,221	6,111	1,920	3,842	3,958	3,939
	Total right bank	**957,700**	**903,700**	**905,000**	**866,000**	**880,081**	**883,694**	**902,496**
Left bank	Total MGRES	1,226,400	2,619,701	2,668,427	4,848,076	4,666,308	4,060,937	3,205,782
	MGRES for right bank of river Nistru	*15,040*	*452*	*3,953*	*2,934,341*	*3,007,769*	*1,982,021*	*1,192,311*
	Dubasari HPP	296,000	275,000	307,354	302,867	327,962	312,728	301,837

	Total left bank	**1,522,400**	**2,894,701**	**2,975,781**	**5,150,943**	**4,994,270**	**4,373,665**	**3,507,619**
Ukraine	**Import**	**2,697,836**	**2,931,360**	**2,957,998**	**5,863**	**23,785**	**995,882**	**1,723,368**
	TOTAL	**5,177,936**	**6,729,761**	**6,838,779**	**6,022,806**	**5,898,136**	**6,253,240**	**6,133,484**

Source: ANRE, Moldelectrica for all PPs except HPP Dubasari; http://mepmr.org/gosudarstvennaya-statistika/informacziya - for HPP Dubasari

There is strong competition between Ukraine and MGRES for supplying the Moldova power market, which accounts for the annual fluctuations of supply from these two sources, which reflects which supplier offered the cheapest electricity for each year.

Table 3: Electricity delivered in Moldova Transport Grid, %

Source	Plant	2006	2007	2008	2009	2010
Right bank	CHP-1	2.4	1.9	1.8	1.9	1.3
	CHP-2	13.3	10.1	9.4	10.6	11.2
	CHP-Nord	1.2	0.8	0.8	0.9	1.0
	HPP Costesti	1.5	0.5	1.2	0.9	1.3
	CHP Elteprod	0.0	0.0	0.0	0.0	0.0
	CHP Sugar Factories	0.1	0.0	0.1	0.0	0.1
	Total right bank	**18.5**	**13.4**	**13.2**	**14.4**	**14.9**
Left bank	Total MGRES	23.7	38.9	39.0	80.5	79.1
	MGRES for right bank of river Nistru	0.3	0.0	0.1	48.7	51.0
	Dubasari HPP	5.7	4.1	4.5	5.0	5.6
	Total left bank	**29.4**	**43.0**	**43.5**	**85.5**	**84.7**
Ukraine	**Import**	**52.1**	**43.6**	**43.3**	**0.1**	**0.4**
	TOTAL	**100**	**100**	**100**	**100**	**100**

As it can be seen from table 4, during the last five years approximately 12% to 17% of electricity demand has been covered by local CHP’s located on the right bank, 4.6% to 7.2% by hydropower plants, 23.7% to 80.5% by MGRES and 0.1% to 52.1% by import from Ukraine.

Table 4: The share of main sources in electricity balance of MPS, %

	2006	2007	2008	2009	2010
Local CHP	17.0	12.9	12.0	13.5	13.6
HPP	7.2	4.6	5.7	5.9	6.9
MGRES	23.7	38.9	39.0	80.5	79.1
Import	52.1	43.6	43.3	0.1	0.4
Total	100	100	100	100	100

2.3. Electricity imports

From **Error! Reference source not found.** it is seen how the import of electricity from Ukraine has evolved during the last five years. In 2006 a maximum value was reached, equal to 52.1%, but dropping to 0.1% in 2009.

As to import from Romania, due to the difference in frequency standards the systems do not work in parallel, i.e. import or export of power can take place based on island principal only. Because the price for electricity in Romania is much higher than that produced in Ukraine or MGRES an import of power can be expected in extraordinary cases only, such as happened in 2000 when several high voltage (HV) lines were destroyed by ice-slick in the North part of the country and a unique solution for power supply in the short term was the connection to the Romania Power System. At the same time, the export of power to Romania has been on-going on a regular basis since 2007, the source being MGRES, the interconnections serving 3x110kV lines and 1x400kV line.

Table 5: shows the evolution of this export during the last years.

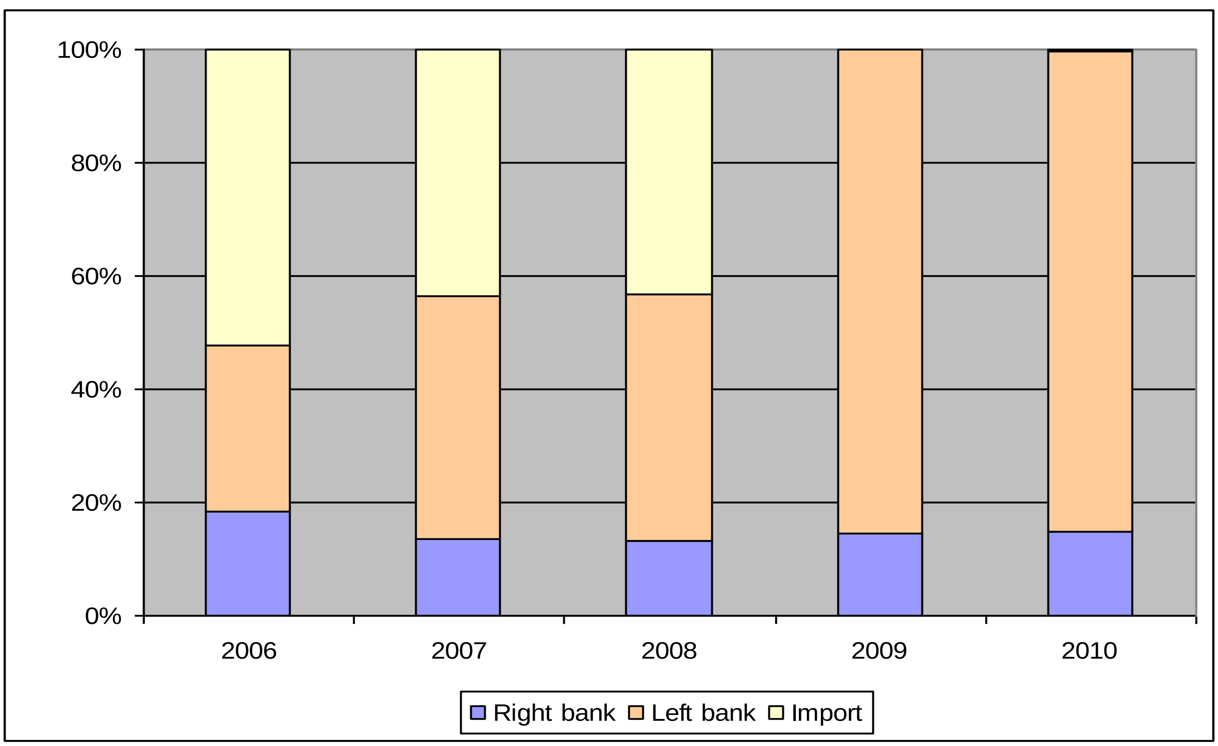

Figure 1: Share of electricity delivered to the grid by sources to cover the demand

Table 5: Export to Romania from MGRES, mill. kWh

Source	2006	2007	2008	2009	2010
MGRES for export	0	635,652	789,119	423,195	383,046

Source: Moldelectrica

2.4. Electricity Transmission System

The electricity transmission system of the Republic of Moldova operates synchronously with the Ukrainian electricity system with which it is connected by fourteen 110 kV lines and six high voltage interconnection lines of 330 kV, while a 400 kV overhead power line connects it to the electricity systems of Romania and Bulgaria (Fig. 2). Three other overhead power lines of 110 kV provide interconnections with the Romanian electricity system in an "insular regime". Interconnection lines with Ukraine permit import of up to 900 MW, while the maximum load recorded on right bank is around 720 MW[5], and the maximum load for the whole country (right and left banks) being around 1100MW.

In the event of a load deficit in Moldova the demand can be covered by importing electricity from Romania, but no more than 250MW, applying a so-called island principal of network operation (because of the Moldova and Romania power systems frequency discrepancies), using 3 x 110 kV lines (Stinca-Costesti, Tutoara-Ungheni, Cioara-Husi) and the Isaccea (Romania) - Vulcanesti (Moldova) 400kV interconnection. Because this scheme of load satisfaction leads to buying electricity at a price much higher than that supplied from Ukraine and as it cannot ensure a reliable power supply (the electricity for each island is provided through one line, without reserve lines), the above mentioned scheme is not a preferred option and has only been used once during the last 10 years, in 2000.

In order to strengthen the import capacity, new interconnection lines are planned to be built with neighboring countries, as specified in the National Energy Strategy[6]. The most powerful is the 400 kV Transport Network Dnestrovsc (Ukraine) – Balti (Moldova) – Suceava (Romania).

Ukraine is going to increase its power transport capacity in the region which neighbors Moldova. According to the Ukrainian Plan[7], in the next 3-5 years the Power System in the west part of the country will have an excess of power as the production at Hmelnitcaia and Rovenscaia Nuclear Power Plants will increase. Ukraine foresees completion of the Hydropower Storage Plant Dnestrovsc with a capacity of 2450MW. In order to have the possibility to transport electricity from HSP Dnestrovsc, 2 circuit 330kV lines HPP Dnestrovsc-HSP Dnestrovsc and one 330kV line Bar-HSP Dnestrovsc are planned to be built in the next 5-6 years. In the southern part of the country one more circuit 330kV line Adjalic-Usatovo will be built in the near future[8].

[5] Source: Moldelectrica
[6] Energy Strategy of the Republic of Moldova up to 2020. Official Monitor, no.141-145/1012 from 07.09.2007
[7] Ministry of Economy
[8] Source: INFOTAG. 09.08.07

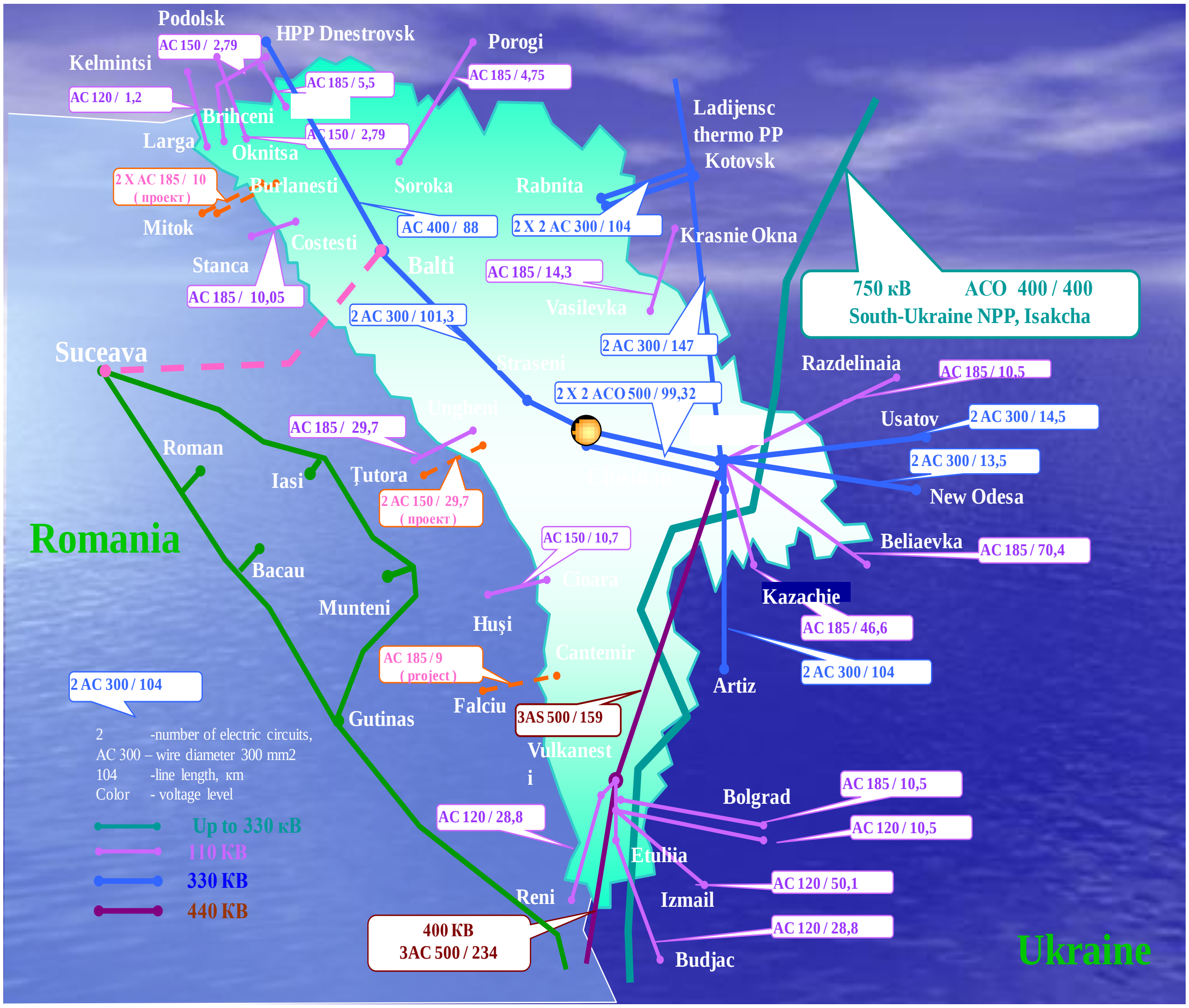

Figure 2. Moldova Power System interconnections

3. GEF calculation Methodology

In order to calculate the Moldova Grid Emission Factor (GEF) the “Tool to calculate the emission factor for an electricity system”, Version 02.2.0, EB 61, Annex 12[9] is applied. The steps applied to calculate the GEF will be further updated in accordance with any latest version of the Tool that might be issued in the future.

At the start of this study the option of calculating the GEF for the grid located on the right bank of the river Nistru only was considered due to difficulties in accessing data from power plants located on the left bank. However, for the power sources on the left bank, part of the information for GEF determination according to the Tool is known, namely total electricity delivered to the grid by each PP, as for MGRES the annual load curve and power capacity of each of its units is available. For

9 http://cdm.unfccc.int/filestorage/2/9/L/29LIXUT6W4Z0AKD37RYQ1EVSMG8HBN/eb61_repan12.pdf?t=N3R8MTMwNzQyNDkxMC45OA==|eCBV6uCWxME2DFkb35NqRDHJM4M=

determining other data needed a conservative approach can be applied as is recommended in Annex 1 of the Tool. In addition, as the fuel type used by MGRES is not known, the conservative assumption is made that the thermal units are fired with natural gas, which is the fossil fuel with the lowest emission factor. So that hereinafter the GEF is determined for the Moldova country grid taken as a whole, comprising both parts of the river Nistru.

3.1. General Guidance from the Tool

The Tool determines the CO_2 emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the “operating margin” (OM) and “build margin” (BM) as well as the “combined margin” (CM). The combined margin is determined as a weighted average of the build margin and the operational margin, as defined by the Tool. The weights of OM and BM are assigned as prescribed in Step 6 of the Tool.

3.2. Identification of the relevant electric power system

The Moldova Power System (MPS) can be considered as a project electricity system as per the Tool for the purpose of determining the grid emission factor. MPS is a relatively small system with boundaries with the national systems of Ukraine and Romania (figure 2). The national transmission and distribution networks were designed for the supply corresponding to the 1990 level. This supply has subsequently been more than halved since then due to decreasing demand provoked by the country’s transition to a market economy. Therefore at present the country transmission grid has enough capacity which allows the power system to be dispatched without transmission constraints.

3.3. Off-grid power plants

The Tool permits to include in the calculation off-grid power plants. According to the definition, an off-grid power plant is a power plant/unit that supplies electricity to specific consumers through a dedicated **distribution** network which is not used by any other power plants.

In the Republic of Moldova off-grid power plants are used by the consumers requiring first category of power supply reliability. Usually, such customers have two independent sources of electricity supply, the off-grid PP being operated when the grid fails. Because the Moldova System Average Interruption Duration Index (SAIDI) is quite high, being around 12[10], off-grid PPs are rarely used, and operating data on these PP is practically unavailable. That’s why for the purpose of GEF calculation the Option I, as per the Tool, is chosen for operating and build margin emission factor determination, i.e. only grid power plants are included in the GEF calculation.

3.4. Selection of the operating margin (OM) method

Hereinafter the operating margin (OM) is calculated under the concept that the project electricity system encompasses the totality of the Moldova Power System (both right and left banks of the river Nistru).

The operating margin refers to a cohort of power plants that reflect the existing power plants whose electricity generation would be affected by the proposed CDM project activity.

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[10] www.anre.md

The OM is calculated as the weighted average CO_2 emissions per unit of electricity generation. The OM is also calculated for the connected electricity grid (CES). The CES may be a national or international grid, but the Tool states that: "For imports from connected electricity systems located in Annex-I country(ies), the emission factor is 0 tons CO_2 per MWh". The import of electricity to Moldova during the last 10 years has come from Ukraine only, which is an Annex-I country. Thus the emission factor of this import is equal to 0 tons CO_2 per MWh.

The Tool proposes four methods to determine the operating margin:

a) **Simple OM** is calculated as the generation weighted average CO_2 emission per unit net electricity (tCO_2/MWh) of all generating power plants serving the system excluding low cost/must run plants/units;

b) **Simple adjusted OM** is a variation of the Simple OM where the power plants/units (including imports) are separated in low cost/must run power sources and other sources;

c) **Dispatch data analysis OM** determined based on the power units that are actually dispatched at the margin during each hour where the project is displacing electricity. This requires annual monitoring and is not applicable top historical data; this option is data intensive.

d) **Average OM is** calculated as an average emission rate of all power plants including must run sources.

Any of the four methods can be used, however, the simple OM method (option a) can only be used if low-cost/must-run resources constitute less than 50% of total grid generation in: 1) average of the five most recent years, or 2) based on long-term averages for hydroelectricity production, as stated in the Tool.

According to the definition of the Tool "Low-cost/must-run resources are defined as power plants with low marginal generation costs or power plants that are dispatched independently of the daily or seasonal load of the grid. They typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. If coal is obviously used as used as must-run, it should also be included in this list, i.e. excluded from the set of plants."

Strictly following the definition, only Costesti HPP and Dubasari HPP, hydropower PPs of 16 MW and 48MW respectively, could be treated as low-cost/must-run resources. However, there are three cogeneration PPs (CHP-1, CHP-2, CHP-Nord) that should be identified as must-run. Along with the electricity production they provide heating and hot water to Chisinau and Balti households. Even though the price for electricity produced by CHP-1, CHP-2 and CHP-Nord is much higher than that produced by MGRES or PPs in Ukraine, the National Agency for Energy Regulation (Regulator) makes it mandatory for customers to buy all the power produced by these CHPs[11], i.e. these power plants are dispatched independently. In other words, the mentioned CHPs cannot be displaced by a CDM project and thus these sources should be examined under the definition of must-run as per the Tool. Such approach is used in the study[12] for determining GEF for the Ukraine Power System.

The two other CHPs of MPS, CHP Sugar Factories and CHP Elteprod (milk factory), can be considered as low cost PPs, as they sell the (by-product) electricity at a price lower than any other on the power market.

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[11] ANRE decision on share of electricity bought from Moldova electricity sources

[12] EBRD. Development of the electricity carbon emission factor for Ukraine. 2010. http://www.lahmeyer.de/fileadmin/fm-lahmeyer/dokumente/li-aktuell/Draft_Baseline_Study_Ukraine.pdf

Based on the determined low cost/must run PPs for the case of Moldova, Table 6 presents their percent contribution to the total Moldova grid generation mix.

Table 6: The share of low cost/must-run resources in the total grid generation mix

Type of PP	Sources	Delivered to the grid	
		MWh average per 2006-2010	% from total
Low cost/must run PPs	CHP-1	113,958.6	1.9
	CHP-2	663,052.3	10.8
	CHP-Nord	56,600.8	0.9
	HPP Costesti	64,588.5	1.1
	Dubasari HPP	301,836.6	4.9
	CHP Elteprod	357.2	0.0
	CHP Sugar Factories	3,938.8	0.1
	Total low cost/must run PPs	**1,204,332.8**	**19.6**
Non low cost/must run Sources	Total MGRES	3,205,782.4	52.3
	Import	1,723,368	28.1
Total non low cost/must run PPs		**4,929,150.8**	**80.4**
TOTAL		**6,133,483.6**	**100.0**

Sources: ANRE, Moldelectrica for all PPs except HPP Dubasari; http://mepmr.org/gosudarstvennaya-statistika/informacziya for HPP Dubasari

As it is seen from table 6, low cost/must run resources constitute 19.6% of total grid generation, i.e. it is below 50% and thus Simple OM can be used for Moldova grid GEF calculation.

As to the other methods we can state with certainty that dispatch data analysis OM is not appropriate to the Moldova case as in the Republic of Moldova no merit order is used to involve PPs in the energy balance. Relatively long term power purchase contracts (usually one year contracts) between the customers and traders (PP, independent supplier) are dispatched by the system operator.

Simple adjusted OM is too data intensive in comparison with Simple OM and thus the preference should be given to the latter OM method.

Average OM can be used for Moldova case as well, but it will be considered as a reserve to the use of Simple OM and only for the situation when the data availability would require using it.

3.4.2. Simple OM method

According to the Tool, the simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units.

The simple OM may be calculated applying one of two Options:

Option A: Based on the net electricity generation and a CO_2 emission factor of each power unit; or
Option B: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.

In this Report Option A is used, as Option B can only be used if:

(a) The necessary data for Option A is not available; and
(b) Only nuclear and renewable power generation are considered as low-cost/must-run power sources and the quantity of electricity supplied to the grid by these sources is known, which is not the case for Moldova.

Under Option A, the simple OM emission factor is calculated based on the net electricity generation of each power unit and an emission factor for each power unit, as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,OMsimple,y}$	=	Simple operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh) (in the denominator of the formula import from Ukraine is considered as well)
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m	=	All power units serving the grid in year *y* except low-cost / must-run power units
y	=	The relevant year as per the data vintage chosen in Step 3

The emission factor of each power unit *m* is determined according to Option A1 of the Tool if for a power unit *m* data on fuel consumption and electricity generation is available:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{EG_{m,y}}$$

Where:

$EF_{EL,m,y}$	= CO_2 emission factor of power unit *m* in year y (tCO_2/MWh)
$FC_{i,m,y}$	= Amount of fossil fuel type *i* consumed by power unit *m* in year *y* (Mass or volume unit)

$NCVi,y$	=Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ/mass or volume unit)
EF_{CO2},i,y	= CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
EGm,y	= Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
m	= All power units serving the grid in year *y* except low-cost/must-run power units
i	= All fossil fuel types combusted in power unit *m* in year *y*
y	= The relevant year as per the data vintage chosen in Step 3 of the Tool

If for a power unit *m* only data on electricity generation and the fuel types used is available, the emission factor should be determined according to the Option A2 of the Tool, i.e. based on the CO2 emission factor of the fuel type used and the efficiency of the power unit, as follows:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \cdot 3.6}{\eta_{m,y}}$$

Where:

$EF_{EL,m,y}$	= CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
$EF_{CO2,m,i,y}$	= Average CO_2 emission factor of fuel type *i* used in power unit *m* in year *y* (tCO_2/GJ)
$\eta_{m,y}$	= Average net energy conversion efficiency of power unit *m* in year *y* (ratio)
m	= All power units serving the grid in year *y* except low-cost/must-run power units
y	= The relevant year as per the data vintage chosen in Step 3

3.4.3. Data Vintage

The Tool offers two options for collecting the data for OM calculation:

1. **Ex-ante option:** The ex-ante option is based on the 3 years generation-weighted average, based on the most recent data available at the time of validation. Once the project is registered this option does not require monitoring and recalculation of the emission factor during the crediting period.

2. Ex-post option: The ex-post option requires calculation of the GEF for each year in which the project activity displaces grid electricity. This option requires the emission factor to be updated annually during monitoring.

As 3 years generation-weighted average data is available the ex-ante option is chosen to calculate OM for Moldova Power System.

3.5. The Calculation of the Build Margin

The build margin refers to a cohort of power units that reflect the type of power units whose construction would be affected by the proposed CDM project activity. According to the Tool, the BM is calculated as the emission factor of a) the five power units that started to supply electricity to the grid most recently or b) the set of power capacity additions that have been built most recently and that compromise 20% of electricity generation. The BM is calculated based on the set that has the larger annual electricity generation.

The BM is determined for the project electricity system except where recent or likely future additions to transmission capacity enable significant increases in imported electricity. In such cases, the transmission capacity may be considered a BM source[13].

With respect to transmission capacity, the Ukraine-Moldova interconnection lines have been built before 2000, but the increase of supply into Moldova from these lines was implemented recently, during 2007-2009, as a result of power plant capacity increasing in the Odessa region power system (Ukraine) which borders with Moldova power system in the country's southern part. This capacity is determined from the Steady-State Stability Study, respecting the normative level of Stability. Up to 2005-2006 Ukraine-Moldova interconnection capacity, available for import to Moldova, could reach a maximum of 150MW as the majority of the interconnections' line capacity was used to transport electricity to the Odessa region from other parts of Ukraine (via Moldova), whereas this figure was increased to more than 900MW during 2007-2009. The carrying capacity of the lines, however, has not been physically changed. Because the Tool refers to "recent or likely future additions to transmission capacity enable significant increases in imported electricity", and that in the case of Moldova the increase in import capacity was not due to any "recent … addition to transmission capacity" but rather existing capacity being freed up, it is concluded that the increase in transmission cannot be integrated into the BM calculation. For the BM calculation, therefore, only the most recently build PPs will be taken into consideration.

In Table 7 the sets of power units reflecting abovementioned options a) and b) are shown. Because the set b) registers more electricity delivered to the grid it is chosen for BM calculation.

Table 7: The sets of power units built most recently according to BM calculation procedure

Set of Power Units	No	Power Plant	Power Unit	Year of commissioning	TOTAL electricity delivered to the grid in 2010	Electricity delivered to the grid in 2010 by power units, MWh
a)	1	CHP-1	PU 4	1995		13,999
	2	CHP-Nord	PU 1	1995		28,552
	3	CHP-1	PU 5	2001		13,999
	4	CHP-Nord	PU 2	2005		28,552
	5	Elteprod		2007		438
	TOTAL					**85,539**
	Share from TOTAL, %					**1.5%**
b)	1	Elteprod				438
	2	CHP-Nord	PU 2	2007		28,552
	3	CHP-1	PU 5	2005		13,999
	4	CHP-Nord	PU 1	2001		28,552

[13] Page 4 of the Tool: For the purpose of determining the build margin emission factor, the spatial extent is limited to the project electricity system, except where recent or likely future additions to transmission capacity enable significant increases in imported electricity. In such cases, the transmission capacity may be considered a build margin source.

	5	CHP-1	PU 4	1995		13,999
	6	MGRES	PU 12	1995		2,189,445
	TOTAL					**2,274,984**
	Share from TOTAL, %					**39%**
TOTAL electricity delivered to the grid in 2010					**5,898,136**	

The BM is therefore calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_{m} EG_{m,y} \times EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

Where:

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EF_{EL,m,y}$ = CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m = Power units included in the build margin
y = Most recent historical year for which power generation data is available

3.6. The calculation of combined margin emissions factor

According to the Tool the calculation of the combined margin (CM) emission factor ($EF_{grid,CM,y}$) is based on one of the following methods:

(a) Weighted average CM; or
(b) Simplified CM

For the Moldova case, the weighted average CM is chosen as Moldova is not a Least Developed Country (LDC), as the required by the Tool.

The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$

Where:

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EF_{grid,OM,y}$ = Operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
w_{OM} = Weighting of operating margin emissions factor (%)
w_{BM} = Weighting of build margin emissions factor (%)

The CM calculation will be done for the following default values of w_{OM} and w_{BM}, as specified in the Tool:

- Wind and solar power generation project activities: w_{OM} = 0.75 and w_{BM} = 0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods;
- All other projects: w_{OM} = 0.5 and w_{BM} = 0.5 for the first crediting period , and w_{OM} = 0.25 and w_{BM} = 0.75 for the second and third crediting period, unless otherwise specified in the approved methodology which refers to this tool.
- Alternative weights can be proposed, as long as $w_{OM} + w_{BM} = 1$, for consideration by the Executive Board, taking into account the guidance on selecting alternative weights under Step 6 on Calculating the combined emission factor of the latest Methodological Tool version 03.

4. The Tool for ex-ante GEF calculation

Based on the concepts agreed above an Excel tool to calculate the Moldova ex-ante GEF values was developed. The main features of this spreadsheet tool are as follow:

1. The Moldova GEF calculation Sheet is based on a modified IGES CDM ERs (cdm-info@iges.or.jp) Calculation Sheet to which five sheets are added, reflecting the automatic calculation of net electricity production by MGRES power units for the last 5 years: 2006-2010. The last 5 sheets are completed with data only when the total volume of electricity delivered to the grid by this PP is known. In order to reflect low-cost/must-run PP on conventional fuels appropriate changes are introduced in the IGES Sheet as well;
2. Due to the lack of data on type and fuel consumption per power unit for MGRES the conservative approach is used to determine these parameters, applying the information on type of units built at this PP, the year of their commissioning and the recommended efficiency of such units according to Annex 1 of the Tool;
3. Thus, in the Excel spreadsheet the fuel consumption is calculated applying: a) capacity of units; b) default values for efficiency as prescribed in Annex 1 of the "Tool to calculate the emission factor for an electricity system"; c) units merit order loading, i.e. for each hour of each three most recent years it is charged first the unit with the lowest fuel specific consumption; d) net electricity production of each power unit is calculated;
4. In addition, at MGRES three types of fuels are used - natural gas, heavy fuel oil and coal - but it is not known exactly which ones participate in the electricity production at each power unit. It is therefore necessary, as the Tool prescribes, to make a conservative assumption, i.e. that the thermal units are fired with natural gas, which is the fossil fuel with the lowest emission factor;
5. The OM, BM and CM are calculated in separate sheets;
6. OM is calculated based on the ex-ante approach; Option 1 for vintage of data is used for BM calculation and standard approach and default values for CM is applied.

The Guidance for subsequent annual updates of the GEF by the DNA or Carbon Office of Moldova is presented in Annex 2

5. The results of GEF calculation

Using the Excel tool attached the following are the results of Moldova GEF calculation for the crediting period starting with 2011:

Table 8: The results of Moldova GEF calculation, tCO_2/MWh

Simple OM	BM	CM		
		Wind and solar	All other, for the first crediting period	All other, for the second and third crediting period
0.3806	0.4643	0.4015	0.4224	0.4434

6. Guidance on the annual input data collection for the determination of *ex-ante* GEF values

The guidance on the annual input data collection for Moldova GEF calculation is reflected in the Guidance specified above and presented in Annex 2.

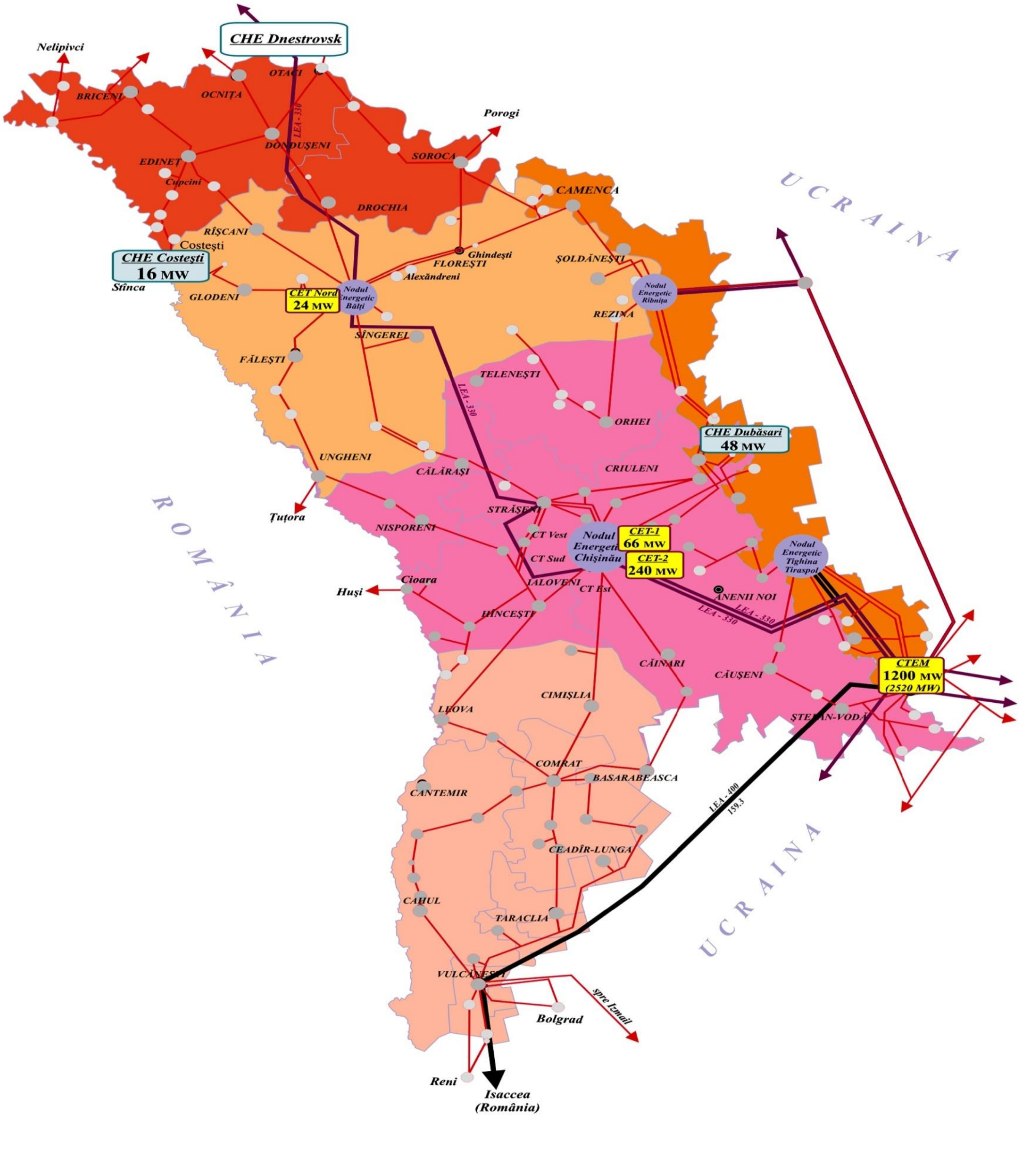
7. Training module

Training module is incorporated in the Guidance specified above and presented in the Annex 2.

Annex 1. Moldova Power System

The Moldova Power System is a relatively small system with boundaries which are limited by the national systems of Ukraine and Romania. (See map below).

Map of Moldova Power System



The main participants in the electricity market are:

- four state-owned generation companies: CHP1, CHP2, CHP Nord, and one thermal power producer MGRES (The Moldovan Regional State Power Station);
- five small private CHPs delivering by-product electricity to the grid
- one state–owned transmission and dispatch company, Moldelectrica, acting as a system operator. Moldelectrica owns and operates the transmission network;
- three distribution companies. One owned by Spanish company RED Union Fenosa (UF), operating the three regional distribution networks (Chisinau, Centru and Sud) which cover 70% of the population. Two are state-owned: RED Nord and RED Nord-West. All companies hold licenses for distribution and supply of electricity at regulated tariffs, and have exclusive rights to supply power to all non eligible customers within their authorized territory;
- 12 companies hold licenses for supply of electricity at non-regulated tariffs

The electricity market is regulated by an independent energy regulator, ANRE, which is responsible for licensing, establishing quality of service standards, and consumer protection. The regulator also develops the methodology and sets tariffs of electricity and heat produced by CHPs as well as tariffs for end-consumers supplied by distribution companies.

Power generation and supply

Electricity is produced by CHPs simultaneously with heat, which supplies the centralized district heating systems in the cities of Chisinau and Balti. The main fuel used for electricity production is natural gas. Heavy fuel oil is only used occasionally, as for example during gas supply disruptions.

The capacity use of existing CHP plants is very low due to their extremely worn-out condition. Two of the CHPs have been in operation for more than 55 years, and another CHP for more than 35 years; most notably, without any major upgrading.

The power demand on the right bank of the river Nistru is covered at 25% from the sources located on this territory, and another 75% is being imported from Ukraine or delivered from MGRES, located on the left bank of river Nistru, in Transnistria, a breakaway territory in eastern Moldova. For example, in 2008 the electricity came from Ukraine, in 2009 it was coming from MGRES. That is a result of the competition between these sources for the cheapest electricity. (See Table A1-1 further below).

Except for both sugar factory power plants (PP), which are operating seasonally, and CHP Elteprod (Milk Factory), all other cogeneration PPs on the right bank and HPP Costesti are regulated, their energy produced being a mandatory to be bought on the power market.

Typically, it is considered that power needs for left bank are covered from the sources located within this territory.

Table A1-1. Moldova PP Installed capacity and electricity production (2005)[14]

Parameters	MGRES	CET-1 (CHP-1)	CET-2 (CHP 2)	CET (CHP-Nord)	HPP Dubasari	HPP Costesti	PPs in sugar factories (SFPP)
Electric Capacity (MW)	2520 (12 units)	66	240 (3 units)	28.5	48	16	98
Availability (hours/year, 2005)	n/a	8542	8011	3990	n/a	6137	720
Electricity produced (GWh, 2005)	2485	154.9	854.4	67.8	295	83.7	5.8
Type of fuel used	Gas, coal, HFO	gas, HFO	gas, HFO	gas, HFO	n/a	n/a	Gas, HFO
Amount of fuel used:							
- gas (thousand m^3)	unknown	84.8	326.8	44.3	n/a	n/a	unknown
- HFO (tonnes)	unknown	0.9	3	0	n/a	n/a	unknown

Electricity network

Moldova operates a transmission system consisting of 4 411 km of 35 kV to 400kV lines. The electricity system in Moldova operates synchronously with the Ukrainian electricity system. Interconnections to adjoining countries can ensure electricity transit at a level of 4-5 TWh per year. They include six high voltage electric lines of 330 kV with Ukraine, one 400 kV overhead power line with Romania and Bulgaria and three overhead power lines of 110 kV with Romania. Transmission losses of 3.8% in 2006 are considered reasonable, since the system also includes 35kV lines.

The distribution network is extensive (a total of 58 763 km of low voltage lines) with more than 98% of the population having access to electricity. The distribution system is divided into five regions, namely the Capital, Central, South, North and West.

Overall, the efficiency of the electricity system has improved significantly. Total system losses dropped from over 40% in 2001 to about 19% in 2006. However, this is still high compared to western European standards (not higher that 10%)

[14] Ion Comendant and others. Investment concept for realization of power sources development scenarios. Energy of Moldova-2005, 2005, pages 389-397

Annex 2.

The Carbon Finance Unit of the Republic of Moldova

World Bank

Guidance for Moldova Grid Emission Factor updating

Chisinau 2011
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Table of Contents

Introduction

The determination of emission reductions from energy efficiency and renewable energy CDM projects involving the electricity grid (supply of electricity and/or reduction of demand) is based on the calculation of the grid emission factor (GEF). The experience gained from the Clean Development Mechanism/Joint Implementation (CDM/JI) projects under the Kyoto Protocol indicates that most individual project developers have limited capacities to calculate the emission factors for national (and/or relevant sub-national) power grids. This is due to limited access to relevant information and data to carry out the calculation. In order to facilitate, increase efficiency and reduce the costs of CDM PDD elaboration the developers of such projects should know beforehand the values of GEF or have available a simple instrument or procedure to determine it.

This Guidance describes the general knowledge the user should be familiar with; the method chosen to calculate Grid Emission Factor; the steps needed to pass in order to calculate GEF for concrete year, including data collection and appropriate Excel spreadsheet utilization; as well as the monitoring procedures regarding the data used for GEF determination.

This will help CDM project developers to calculate the Emission Reductions, called Certified Emission Reductions (CERs) under the CDM project mechanism, generated by their project activity.

Acronyms and Abbreviations

BM	Build Margin
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
CES	Connected Electricity System
CFU	Moldova Carbon Finance Unit
CHP	Combined Heat & Power (Cogeneration Power Plant)
CM	Combined Margin
CO_2	Carbon dioxide
EB	Executive Board
EBRD	European Bank for Reconstruction and Development
Energy Community	Energy Community of South East Europe (ECSEE) and European Energy Community (EEC)
ERPA	Emission Reduction Purchase Agreement
GHG	Greenhouse gas
HPP	Hydropower plant
kWh	Kilowatt hour
LCD	Load Duration Curve
MW	Megawatt
MWh	Megawatt hour
MGRES	Condensing Power Plant located in Transnistria
MPS	Moldova Power System
OM	Operation Margin
PDD	Project Design Document
PES	Project Electricity System
pmr	pridnestrovian moldavian republic
PP	Power Plant
PU	Power Unit
ANRE	National Energy Regulatory Agency
Moldelectrica	National System Operator and Transport of Electricity
t.c.e.	tone coal equivalent, 1 t.c.e. = 7000 Gcal
HSP	Hydro Storage power plant
Tool	"Tool to calculate the emission factor for an electricity system", Version 2, October 16 2009, EB 50
TSO	Transport and System Operator
MPS	Moldova Power System

Definitions

Build Margin (BM) is the emission factor that refers to a cohort of power units that reflect the type of power units whose construction would be affected by the proposed CDM project activity. It is a reflection of the likely future power plants being built.

Combined margin (CM) is defined as weighted average of the build margin and the operational margin.

Connected Electricity System (CES) defined as an electricity system that is connected by transmission lines to the project electricity system. Power plants within the connected electricity system can be dispatched without significant transmission constraints but transmission to the project electricity system has significant transmission constraint.

Crediting period is the time from CDM project registration until the end of the specified time when emission reductions can be claimed on the project.

Electricity imports are defined as electricity transfers from connected electricity systems to the project electricity system

Electricity exports are defined as electricity transfers to connected electricity systems

Ex-ante is defined as a calculation based on historic data referring to the future applying the ceteris paribus clause. E.g. the host country's future emissions are calculated by the host country's historic fuel consumption – assuming that everything stays the same.

Low-cost/must-run resources are defined as power plants with low marginal generation costs or power plants that are dispatched independently of the daily or seasonal load of the grid. They typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. If coal is obviously used as must-run, it should also be included in this list.

Net electricity generation refers to the difference between the total quantity of electricity generated by the power plant / unit and the auxiliary electricity consumption of the power plant / unit (e.g. for pumps, vans, controlling, etc).

Operation Margin (OM) is the emission factor that refers to a cohort of power plants that reflects the existing power plants whose electricity generation would be affected by the proposed CDM project activity.

Project Electricity System (PES) defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity (e.g. the renewable power plant location or the consumers where electricity is being saved) and that can be dispatched without significant transmission constraints.

Power plant/unit: A power plant / unit is a facility for the generation of electric power. Several power units at one site comprise one power plant, whereby it is characteristic for a power unit that it can be operated independently of the other power units at the same site. If several identical power units (i.e. with the same capacity, age and efficiency) are installed at one site, they may be considered as one single power unit.

1. The Goal of the Guidance

The goal of this Guidance is to:

a) describe the data needed for Moldova grid emission factor calculation; and the steps needed to collect it

b) provide explanations on how to use the developed Excel spreadsheet to calculate GEF

c) indicate monitoring procedures that should be respected under a CDM project that requires GEF application

This Guidance also serves as the basis for a training module.

2. General provisions

Before proceeding to use the Guidance the user should be familiar with the main features of the Moldova Power System and the assessments undertaken in choosing the method to calculate the Moldova GEF, both described in the Report “Moldova Grid Emission Factor Assessment” above, developed with World Bank support and assistance.

In order to calculate the Moldova Grid Emission Factor the “Tool to calculate the emission factor for an electricity system”, Version 02.2.0, EB 61, Annex 12[15] (the Tool) is applied. The steps applied to calculate GEF should be further updated in accordance with any new version of the CDM that might be issued in the future.

The Tool determines the CO_2 emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the “operating margin” (OM) and “build margin” (BM) as well as the “combined margin” (CM). The combined margin is the weighted average of the build margin and the operational margin. The weights of OM and BM are assigned as it is prescribed in the Step 6 of the Tool.

For the purpose of Moldova GEF calculation only grid connected power plants are included in the GEF determination, i.e. off-grid PPs are excluded from examination as their capacity and electricity delivered to the grid do not satisfy Tool requirements (See Page 2 and Annex 2 of the Tool).

Simple OM is used for the Moldova case, the electricity system for assessment and definition of GEF corresponding to the whole country, including Transnistria.

Ex-ante Option is chosen to calculate OM for Moldova case, i.e. the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required. For grid power plants, a 3-year generation-weighted average is used, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation.

The developed Excel tool to calculate GEF permits to determine Grid Emission Factor based on such approach.

In terms of vintage of data to calculate BM, Option 1 is chosen as per the Tool, i.e.

15 http://cdm.unfccc.int/filestorage/2/9/L/29LIXUT6W4Z0AKD37RYQ1EVSMG8HBN/eb61_repan12.pdf?t=N3R8MTMwNzQyNDkxMC45OA==|eCBV6uCWxME2DFkb35NqRDHJM4M=

- **Option 1:** For the first crediting period, calculate the build margin emission factor *ex ante* based on the most recent information available on units already built for sample group *m* at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

The default approach as per the Tool is used to determine Weighted average CM.

3. Simple OM, BM and CM calculation

3.1. Simple OM

According to the Tool, the simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units.

Simple OM emission factor is calculated based on the net electricity generation of each power unit and an emission factor for each power unit, as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,OMsimple,y}$	=	Simple operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh) (in the denominator of the formula import from Ukraine is considered as well)
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m	=	All power units serving the grid in year *y* except low-cost / must-run power units
y	=	The relevant year as per the data vintage chosen in Step 3

The emission factor of each power unit *m* is determined according to the Option A1 of the Tool, if for a power unit *m* data on fuel consumption and electricity generation is available::

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{EG_{m,y}}$$

Where:

$EF_{EL,m,y}$ = CO_2 emission factor of power unit *m* in year y (tCO_2/MWh)

FCi,m,y	= Amount of fossil fuel type *i* consumed by power unit *m* in year *y* (Mass or volume unit)
NCVi,y	=Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ/mass or volume unit)
EF_{CO2},i,y	= CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
EGm,y	= Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
m	= All power units serving the grid in year *y* except low-cost/must-run power units
i	= All fossil fuel types combusted in power unit *m* in year *y*
y	= The relevant year as per the data vintage chosen in Step 3 of the Tool

If for a power unit m only data on electricity generation and the fuel types used is available, the emission factor should be determined according to the Option A2 of the Tool, i.e. based on the CO2 emission factor of the fuel type used and the efficiency of the power unit, as follows:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \cdot 3.6}{\eta_{m,y}}$$

Where:

$EF_{EL,m,y}$	= CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
$EF_{CO2,m,i,y}$	= Average CO_2 emission factor of fuel type *i* used in power unit *m* in year *y* (tCO_2/GJ)
$\eta_{m,y}$	= Average net energy conversion efficiency of power unit *m* in year *y* (ratio)
m	= All power units serving the grid in year *y* except low-cost/must-run power units
y	= The relevant year as per the data vintage chosen in Step 3

3.2. Build Margin calculation

BM is calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,BM,y}$	= Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{m,y}$	= Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EF_{EL,m,y}$	= CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m	= Power units included in the build margin
y	= Most recent historical year for which power generation data is available

The sample group of power units *m* used to calculate the build margin should be determined as per the following procedure:

(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-units}}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-units}}$, in MWh);

(b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG_{total}, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEGtotal (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ($SET_{\geq 20\%}$) and determine their annual electricity generation ($AEGSET_{\text{-}\geq 20\%}$, in MWh);

(c) From $SET_{5\text{-units}}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample});

Identify the date when the power units in SET_{sample} started to supply electricity to the grid. If none of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the build margin. The same SET_{sample} is used for BM calculation if no power units are registered as CDM project activities.

Until now no power units as CDM project activities have been recorded in the Moldova Power System. That permits the user to consider for BM calculation the set of power units (abovementioned a) or b)) that comprises the larger annual generation. If in the future power units are registered as CDM project activities in Moldova then the user shall follow the steps (d), (e) and (f) from Step 5 of the Tool.

Project participants should use the set of power units that comprises the larger annual generation.

As a general guidance, a power unit is considered to have been built at the date when it started to supply electricity to the grid.

Capacity additions from retrofits of power plants should not be included in the calculation of the build margin emission factor.

3.3. The calculation of Combined Margin emissions factor

According to the Tool the calculation of the combined margin (CM) emission factor ($EF_{grid,CM,y}$) is based on one of the following methods:

(a) Weighted average CM; or
(b) Simplified CM

For Moldova case weighted average CM is chosen as Moldova is not defined as a Least Developed Country (LDC), as the Tool requires.

Combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$

Where:

$EF_{grid,BM,y}$	-	Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EF_{grid,OM,y}$	-	Operating margin CO_2 emission factor in year y (tCO_2/MWh)
w_{OM}	-	Weighting of operating margin emissions factor (%)
w_{BM}	-	Weighting of build margin emissions factor (%)

CM calculation will be done for the following default values of w_{OM} and w_{BM}, specified in the Tool:

- Wind and solar power generation project activities: $w_{OM} = 0.75$ and $w_{BM} = 0.25$ (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods.
- All other projects: $w_{OM} = 0.5$ and $w_{BM} = 0.5$ for the first crediting period , and $w_{OM} = 0.25$ and $w_{BM} = 0.75$ for the second and third crediting period, unless otherwise specified in the approved methodology which refers to this tool.
- Alternative weights can be proposed, as long as $w_{OM} + w_{BM} = 1$, for consideration by the Executive Board, taking into account the guidance on selecting alternative weights under Step 7 on Calculating the combined emission factor of the latest Methodological Tool version 02.

4. Data needed and its collection

The experience obtained during carrying out of GEF assessing Report showed that:

a) CHP-1, CHP-2, CHP-Nord, Costesti HPP, Elteprod CHP and Dubasari HPP do not dispose of the hourly load data for each year. Only the days' or months' quantities of electricity delivered to the grid are available;

b) For CHP-1, CHP-2 and CHP-Nord specific fuel consumption is known for electricity delivered to the grid. This information is available at ANRE;

c) For Elteprod CHP the fuel (gas) consumption was not known. Conservative approach was used (as per Annex 1 of the Tool)

As ex-ante method is chosen to calculate OM the data needed to determine GEF should be collected on time, before the start of crediting period. This mission is recommended to be carried out each year by Moldova Carbon Finance Unit[16] based on Governmental Decision, promoted by the Ministry of Ecology, that would mandate CFU to collect pre-established information from Moldova Power Market stakeholders.

The electricity delivered to the grid in the year y for CHP-1, CHP-2, CHP-Nord, Costesti HPP, Dubasari HPP and hourly Load data for MGRES should be requested from Moldelectrica[17] by, for example, January 15 of year y. For Sugar factories' CHP, Elteprod CHP and other PP, if any, connected to the distribution network (6 – 10kV), not the transmission grid, the electricity delivered to

[16] Moldova Carbon Finance Unit has the status of an independent legal entity and is empowered to provide technical assistance for institutional and human capacity building in the area of Kyoto Protocol and CDM activities, as well as the financial assistance to the potential project beneficiaries

[17] Moldelectrica has this data. At the time of data collection for this project, Moldelectrica informed the consultant that it would be best to get the data from the sources. The experience showed that the sources do not have the data in the required format.

the grid[18] should be requested from the Distribution Companies whom they are connected to, or from ANRE. According to the existing rules[19] all power plants connected to the distribution or transport network are obliged to install electronic meters having the capacity to record power delivered to the grid for at least 45 days, including hourly load values. So that the Government Decree that would regulate the mechanism of data collection for GEF determination should specify the duties of distribution, ANRE and TSO operator to archive the data of electricity entered into their grid from each PP during the year, and submit it to CFU by January 15 of the year following the one for which the data is collected. As to the specific fuel consumption (or the quantity of fuel used for electricity production) at PP connected to the distribution grid (6-10kV), this data should be requested from the owner of the appropriate PPs. If the data collection for Sugar factories' CHP, Elteprod CHP and other small PP if any, connected to the distribution network (6 – 10kV), not the transmission grid, is not successful, the yearly electricity delivered to the grid will be used from MPS electricity balance, provided to ANRE by Moldelectrica on a regular basis, and this data should be used further to get needed input data as it is required by GEF calculation Excel tool attached, with reference to the default values in Annex 1 of the Tool if needed. The terms and form of data presentation should be known by the providers beforehand, in order the information be organized properly in good time.

5. How to use Excel Spreadsheet for GEF calculation

Moldova GEF calculation Sheet is based on a modified IGES CDM ERs (cdm-info@iges.or.jp) Calculation Sheet to which five sheets are added, reflecting the automatic calculation of net electricity production by MGRES power units for the last 5 years: 2006-2010. The last sheets are filled in with the data only when the total volume of electricity delivered to the grid by this PP is known.

1. The user should follow the Guidance from the Excel sheet attached.

2. The sheet will automatically calculate the CO_2 emission from the grid system in the baseline for Clean Development Mechanism (CDM) project activity while entering only several key data. Detailed calculating formulas are also provided on this sheet so that the user will be able to modify any conditions or assumptions based on its own interests.

3. The sheet is applicable to "Simple OM", using "Option A" and "grid power plants". Those requirements are:

- The simple OM method can only be used if low-cost/must-run resources constitute less than 50% of total grid generation in: 1) average of the five most recent years, or 2) based on long-term averages for hydroelectricity production.
- The necessary data for Option A (the net electricity generation of each power unit) is available. In addition, data of fuel type and consumption data of each power plant is preferred.

4. The calculation sheet adopts ex-ante option as a data vintage. It is required to use a 3-year generation-weighted average for OM emission factor and a historical year for BM emission factor,

[18] According to the Normative acts such PPs are obliged to have electronic meters with the capacity to register hourly values of the electricity delivered to the grid.

[19] Regulation on commercial electricity metering. Official Monitor, no.214-220/765 from 05.11.2010

based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation.

5. The simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units, and including electricity imports to the grid.

6. Option A is based on the net electricity generation and a CO_2 emission factor of each power unit.

7. Only grid power plants (Power plant/unit that supplies electricity to the electricity grid and, if applicable, to specific consumers), including import are included in the calculation.

8. Some of the cells in the sheet are marked in color, making it easier for the user to complete the input data, select the data from the attached to the sheet list, reflect adequately low cost/must run PPs operating on conventional fuels and see the final results.

6. Monitoring procedures

All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data should be monitored if not indicated otherwise in the tables ”Data and parameters” from the pages 22-27 from the Tool. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

Some parameters listed below under ”Data and parameters” either need to be monitored continuously during the crediting period or need to be calculated only once for the crediting period, depending on the data vintage chosen, following the provisions in the baseline methodology procedure outlined above and the guidance on „monitoring frequency” for the parameter.

The calculation of the operating margin and build margin emission factors should be documented electronically in a spreadsheet that should be attached to the CDM-PDD. This should include all data used to calculate the emission factors, including:

• For each grid-connected power plant/unit the following information:

  - Information to clearly identify the plant;
  - The date of commissioning;
  - The capacity (MW);
  - The fuel type(s) used;
  - The quantity of net electricity generation in the relevant year(s);
  - If applicable: the fuel consumption of each fuel type in the relevant year(s);
  - In case where the simple OM or the simple adjusted operating margin is used: information whether the plant/unit is a low-cost/must-run plant/unit;

• Net calorific values used;

• CO_2 emission factors used;

• Plant efficiencies used;

• Identification of the plants included in the build margin and the operating margin during the relevant time year(s);

• In case the simple adjusted operating margin is used: load data (typically in MW) for each hour of the year *y*;

The data should be presented in a manner that enables reproducing of the calculation of the build margin and operating margin grid emission factor.

Prior to the start of the crediting period, the organization of the monitoring team will be established.

Project activity will be administrated by the Carbon Finance Unit (CFU), created by the Governmental Decision nr. 899 from August, 25, 2005 which proposes to develop and monitor CDM projects, as well as other environmental projects. At this moment the CFU monitors the Emissions Reduction of 3 CDM registered projects for the period 2006 – 2016.

Specific responsibility for CFU Technical Assistant as GEF monitor, regarding the ex-post GEF calculation, would be as follows,

- Contact power market stakeholders for data collecting and documentation as is required by the appropriate CDM methodology or Tool;
- Verify the quality of data collected and its integrity, fill out collected data in the handbook / workbook;
- Check if ex-post GEF calculation is done according to the appropriate Tool or CDM methodology requirements and assumptions;
- Assure that the data are stored and relevant measures are taken to avoid the losses of information;
- Create the database regarding GEF calculation;
- Keep the address of the stakeholders which the data were collected from;
- Elaborate the Annual Report on ex-post GEF calculation, if such is done by the CDM projects users.

Specific responsibility for the CFU Administrator:

- Initiate the GEF calculation in case of relevant CDM projects development;
- Verify the correctness of GEF calculation by the users;
- Submit to the DNA the PDDs with GEF calculation software.