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NAMA on Promotion small CHP in The R. of Moldova

Republic of Moldova

DAY MONTH YEAR
(VERSION)

Brief text on UNDP and LECB…..

Technical Oversight and Guidance

Xxx

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Acknowledgements

This product was developed under the UNDP Low Emission Capacity Building (LECB) Programme, a global initiative in 25 countries to build capacities to design and implement low emission development, with generous funding from the European Commission (EC), the German Federal Ministry for the Environment Nature Conservation (BMUB), Building and Nuclear Safety, and the Australian Government.

Contract Information

XXX

XXX

XXX

Editor

XXX

Design

XXX

Forward

To be completed after drafting and reviews

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Abbreviations and acronyms

ANRE	National Agency for Energy Regulation (Republic of Moldova)
BLS	Base Line Scenario
CDM	Clean Development Mechanism
CH4	Methane
CHP	Combined Heat and Power Plant, Cogeneration Power Plant
DH	District Heating
E5P	The Eastern Europe Energy Efficiency and Environment Partnership
EBRD	European Bank for Reconstruction and Development
EEA	Energy Efficiency Agency (Republic of Moldova)
EIA	Environmental Impact Assessment
ESCO	Energy Service Companies
EC	European Commission
EU	European Union
GAZPROM	Russian gas company
GD	Government Decree
Gg	10^9 gram
GJ	Gigajoule
GHG	Greenhouse Gases
IEA	International Energy Agency
ICE	Internal Combustion Engine
ICE CHP	Combined Heat and Power Plants based on internal combustion engines
IRR	Internal Rate of Return
IVA	Initial Value of Asset
kW	Kilowatt
kWe	Kilowatt electric
kWth	Kilowatt thermal
LEDS	Low Emission Development Strategy (Republic of Moldova)
LPA	Logical Problem Analysis
MCh	Municipality Chisinau
MCDA	Multi-Criteria Decision Analysis
MDL	Moldova currency, Lei
ME	Ministry of Economy
MEn	Ministry of Environment
MoSEFF	Moldova Sustainable Energy Financing Facility
MR	Monitoring Report
MRV	Measuring, Reporting and Verification
MTPP	Moldavian Thermal Power Plant (located in Transnistria region)
MW	Megawatt (10^6 Watt)
MWh	Megawatt Hour

NAMA	National Appropriate Mitigation Actions
NVA	Net Value of Asset
NGO	Non Government Organization
O&M	Operation and Maintenance
OECD	Organization for Economic Co-operation and Development
OM	Official Monitor
PFS	Policy Fact Sheet
PP	Power Plant
R&D	Research and Development
RES	Renewable Energy Sources
RM	Republic of Moldova
SC	Commercial Society
SNC	Second National Communication (Moldova)
tce	Tonne of coal equivalent
Thc	Heat capacity duration time
TNA	Technology Needs Assessment
toe	Tonne of oil equivalent
UNDP	United Nation Development Programme
UNEP	United Nation Environment Programme
UNFCCC	United Nation Framework Convention on Climate Change
USA	United States of America
USD	United States Dollar
USEPA	U.S. Environmental Protection Agency Combined Heat and Power Partnership
VAT	Value Added Tax
WACC	Weighted Average Cost of Capital
WB	World Bank

1. Introduction to small efficient CHP promotion in the Republic of Moldova

Given the fact that the Republic of Moldova is 85% dependent on electricity imported, the energy policies of the country are targeted at increasing energy security in two ways: in terms of energy production - by deployment of renewable energy sources and construction of efficient CHPs to meet the energy balance, and in terms of energy demand - by promoting energy efficiency. This policy coincides with one oriented to GHG emissions reduction which the Republic of Moldova expressed in its INDC. The Republic of Moldova is committed to an unconditional target of a 64-67 per cent reduction of its net greenhouse gas emissions by 2030 compared to 1990 levels, and 78 per cent reduction below 1990 level conditional to a global agreement addressing important topics, including access to low-cost financial resources, technology transfer and technical cooperation commensurate to the challenge of global climate change. In this respect the country has prepared Low Emission Development Strategy up to the year 2030, planned for approval by the mid of 2016. The target undertaken is seen to be achieved through the implementation of NAMAs. The list of such NAMAs, which is integral part of LEDS, comprises NAMA devoted to the implementation of efficient small CHPs as well. The potential for such CHPs is around 40 units with a capacity of 20MW to generate electricity and reduce CO2 emissions by 22 833 tCO2 per year. The sites for implementation are considered at hospitals, hotels, residential living blocks, campus, and industry. The Law on thermal energy and promotion of cogeneration approved in 2014 favors the implementation of such power plants.

This PDD NAMA is developed to justify the promotion of efficient small CHPs in the Republic of Moldova and subsequently to get Donor's support to implement them. At this stage no feasibility studies are available. In the frame of this document a cash flow and financial structure is carried out for a district heating company "Thermohouse" SRL, which provides heat and hot water services to around 20 multiapartment blocks.

Until now small CHPs have been implemented in the country, one at yeast plant "Franzeluta" and another at Moldova State University. But no information on their effective investments, O&M costs and incomes are available.

2. Background of the Energy Sector in the Republic of Moldova

The Energy Sector of the Republic of Moldova is distinguished by a very low security of energy supply due to the fact that about 87.1% of the primary energy sources are imported. The energy intensity is high and its value exceeds by three times the energy intensity of West European countries. To overcome these challenges and to ensure the necessary basis for economic development and social wellbeing, the authorities of the Republic of Moldova adopted a range of strategic documents in which there are provided for the main principles of the energy policy of the country namely electricity demand satisfaction from own power sources, energy efficiency, renewable energy sources development and reducing the impact of the Energy Sector on environment thus ensuring sustainable development.

- In this context in the Energy Strategy of the Republic of Moldova till 2030 and in other adopted documents regarding the Energy Sector's policies there are established concrete targets related to the development of the Energy Sector, including the decrease of the energy intensity. The adopted Energy Strategy provides for the construction in the Republic of Moldova by 2020 of 650 MW of electrical capacity in the combined heat and power plants and 400 MW of electric capacity in power plants operating on renewable sources of energy and the diminution of energy intensity by 20 %. The main requirement to achieve the target of the construction of combined heat and power plants is the presence of heat demand. For the conditions of the Republic of Moldova, where the climate is moderately continental, characterized with relatively mild winters with little snow, long warm summers and low humidity, feasible heat demand can be met mainly at industrial and service provider's level as well as by district heating system operators.
- Thus the promotion of the construction of combined heat and power plants of high efficiency is an important challenge for the Energy Sector of the country and since depending on the accomplishment of this desideratum depends to a great extent the successful solution of the problem of heat supply to meet the demand for space heating and hot water consumption at reasonable and affordable tariffs, at the same time ensuring the quality parameters and a lower impact on the environment.

2.1 Current situation and trends of the Energy Sector

The Republic of Moldova is a country of the South Eastern Europe that borders with Romania and the Ukraine. The total area of the Republic of Moldova is approximately 33.8 thousand square kilometers. The population of the Republic of Moldova on January 1, 2012 was approximately 3.56 million people (This figure does not include the population that lives in Transnistria region which according to the data provided in the Internet at the beginning of 2014 the number of population living in Transnistria region was 505.153 thousand people). About 2 million people live in rural areas, and a million and a half - in urban areas. The capital of the Republic of Moldova is the city of Chisinau with the population of about 794.8 thousand people. In Figures 2-1 and 2-2 there are shown the geographical location and boundaries of the Republic of Moldova, as well as of the Transnistria region.

The Republic of Moldova has a moderate continental climate that is characterized by short and mild winters, with little snow and warm summer, with a low amount of precipitation. The summers are warm and long, with temperatures averaging about 20 °C and the winters are relatively mild and dry, with January temperatures averaging −4 °C. The annual average air temperature is 8-10°C and 10-12°C on the surface of the soil. The frost-free period averages 170 days in the north and 190 in the south of the country, but in some years its duration can reach 200-230 days.

The proposed NAMA will be implemented in the city of Chisinau, the capital of the Republic of Moldova and later on it will be replicated in other cities and sites of the country especially in the cities where there exists the district heating systems or industrial and other sites that have an appropriate demand for heat during the whole year.

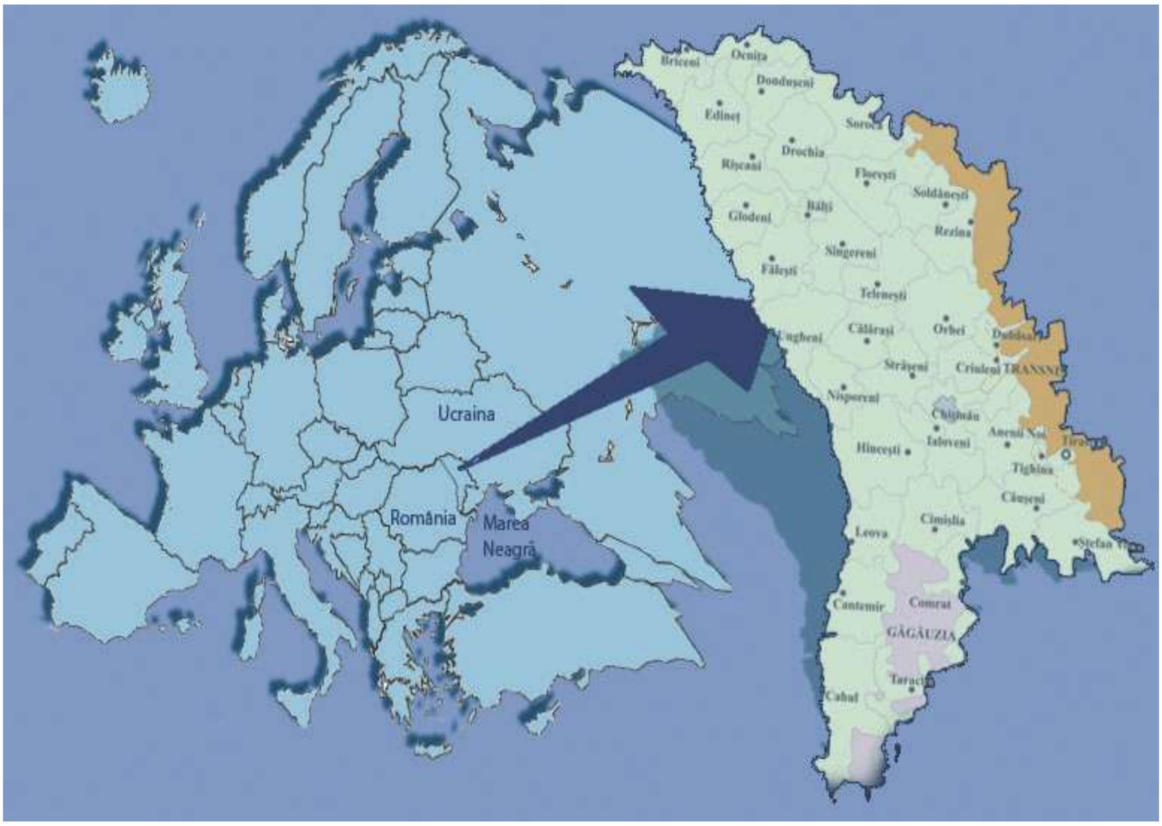


Figure 2-1. The map of the Republic of Moldova in continental aspect.
(Source: BUR report*)*

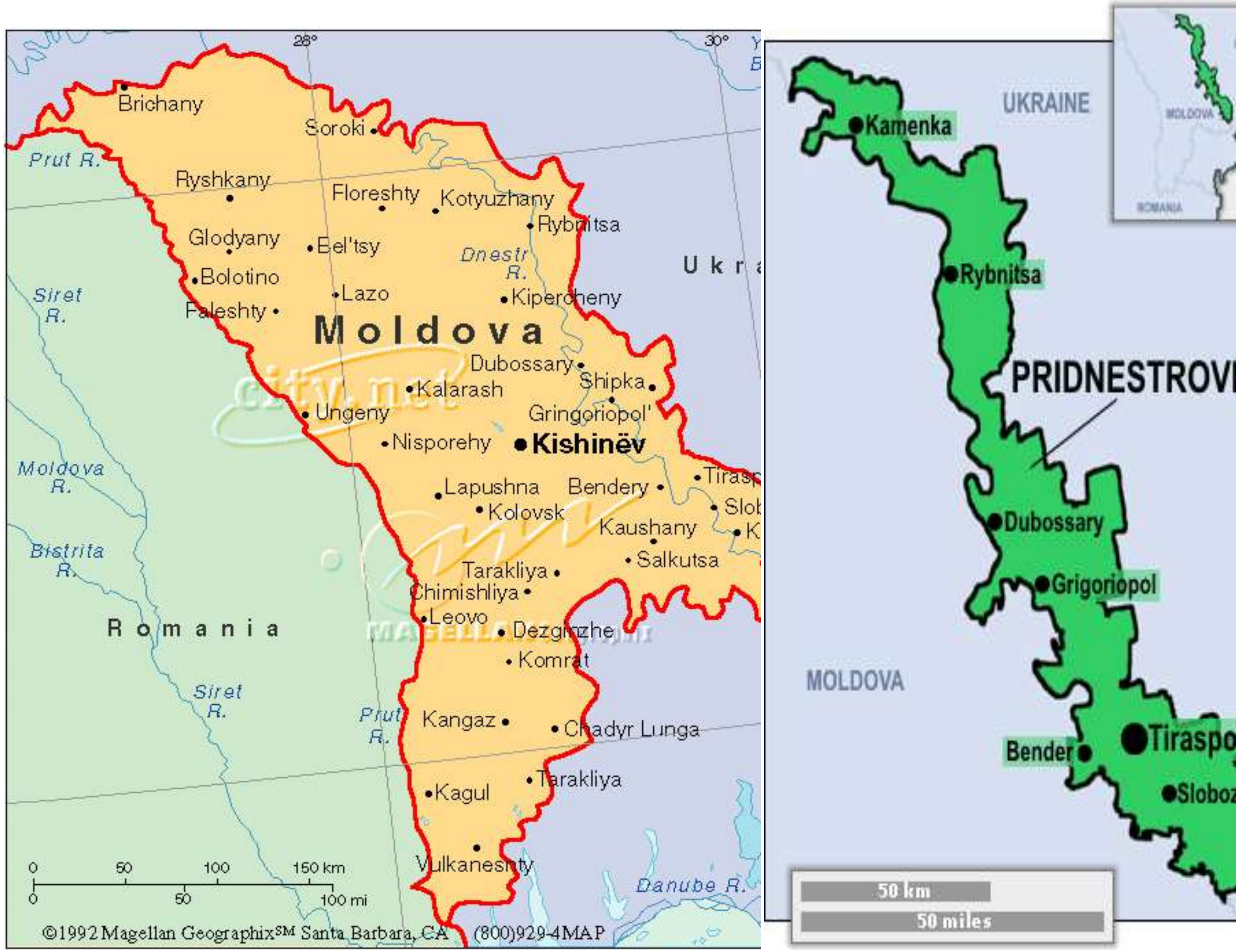


Figure 2-2. The map of the Republic of Moldova, including Transnistrian region.

(Source: Clean Development Mechanism Project Design Document Form (CDM-PDD) Construction of Combined Heat and Power Plant (CHPP) at SE "Tirotex", Tiraspol City, Republic of Moldova).

The Energy Sector of the Republic of Moldova comprises the following subsectors:

- electricity subsector;
- natural gas subsector;
- heating subsector,
- petroleum products market;
- solid fuel subsector.

As planned small CHPs will use natural gas as fuel to generate electricity and heat and the surplus electricity will be delivered into the electric network and the heat will be used to satisfy the need of space heating and hot water supply then this NAMA will in general relate to the Energy Sector as a whole and particularly to electricity, natural gas and heating subsectors.

The Energy Sector represents the most important source of greenhouse gas emissions and the share of the Energy Sector in the total amount of greenhouse gas emissions changed during the period 1990–2013 from 79.6% in 1990 to 65.5% in 2013 as shown in Figure 2-3.

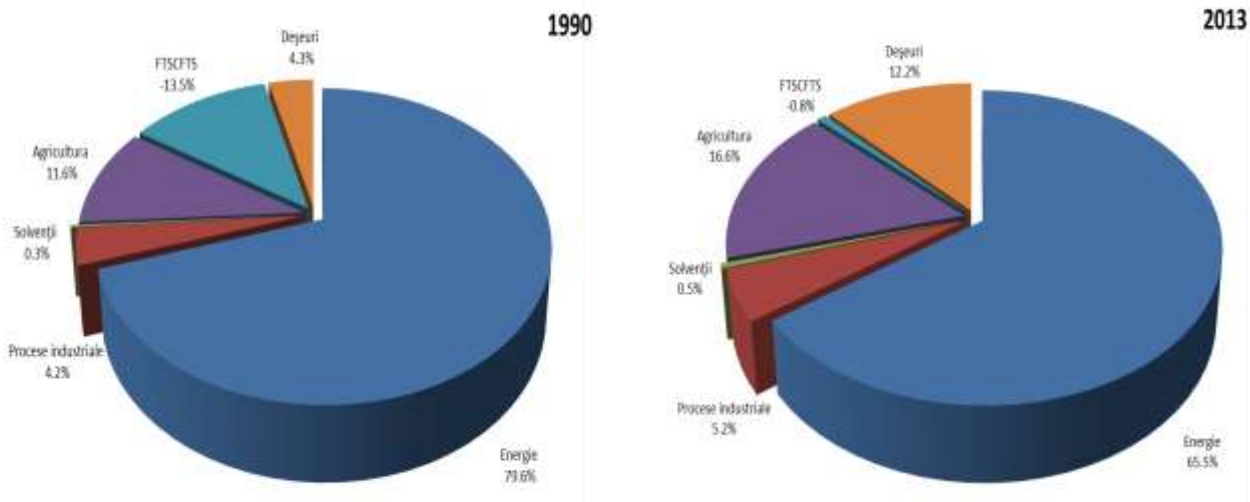


Figure 2-3. The share of greenhouse gas emissions of different sectors in 1990 and 2013.
(Source: BUR report)

The generation and consumption of electricity in the Republic of Moldova during the period 1990-2013 is presented in Table 2-1. The analysis of these data reveals that the electricity generation in the Republic of Moldova during the period 1990-2013 reduced by 71.4 % and the electricity consumption reduced by approximately 50 % during this time period.

Electricity generation sources consist of the following power plants:

Moldavian Thermal Power Plant located on the left bank of the Dniester river (in Transnistria region) with installed capacity of 2520 MW (12 units that operate on natural gas, heavy fuel oil and coal, that was built and commissioned during the period 1964-1982);

CHP 1 from Chisinau with installed capacity of 66 MW electricity and 254 Gcal/h of heat capacity, built during 1951-1961, which operates on natural gas and heavy fuel oil;

CHP 2 from Chisinau with installed capacity of 240 MW electricity and 1200 Gcal/h of heat, built and commissioned during 1976-1980, that operates on natural gas and heavy fuel oil;

CHP North from the city of Baltsi with installed capacity of 24 MW electricity and 200 Gcal/h of heat, built and commissioned during 1956-1970, which operates on natural gas and heavy fuel oil;

Hydro power plant Dubasari with installed capacity of 48 MW, located on the river Dniester and built and commissioned during 1954-1966 and belongs to Transnistria region;

Hydro power plant Costeshti with installed capacity of 16 MW, located on Prut river and commissioned in 1978;

9 CHPs of sugar refineries with installed capacity of 97.5 MW, operating on natural gas and heavy fuel oil, mainly during the period when the sugar beet is processed. At present some sugar refineries are closed, others do not operate on designed capacity. Electricity and heat produced by these CHPs is used mainly for own use and the surplus of electricity is delivered into the electricity network;

1 CHP of 31,328 MW, operating on natural gas and owned by textile company SE “Tirotex”, Tiraspol city, located in Transnistria region;

Some small power plants generating electricity from renewable energy sources. In the future it is expected to increase the generation of electricity from renewable energy sources due to the mechanism granting the procurement, by electricity suppliers and eligible customers, of the electricity produced by such power plants at tariffs approved by the National Agency for Energy Regulation for a period of 15 years from commissioning.

The list of power plants generating electricity is shown in Table 2-2.

Table 2-1. Generation and consumption of electricity in the Republic of Moldova during the period 1990-2013, billion kWh.

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Generation	15.690	13.154	11.248	10.376	8.308	6.168	6.240	5.375	4.841	4.110	3.624	4.912
Consumption	11.426	10.839	10.022	8.569	4.350	7.022	6.686	6.133	5.351	4.715	4.510	4.705
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Generation	4.408	4.062	4.179	4.225	2.867	3.869	4.026	6.195	6.115	5.785	5.801	4.491
Consumption	5.309	6.452	6.025	5.838	5.485	5.684	5.732	5.302	5.257	5.334	5.468	5.710

Source: Statistical yearbooks of the Republic of Moldova for 1994 (page 272), 1999 (page 311), 2003 (page 400), 2006 (page 319), 2009 (page 313), 2012 (page 317); 2014 (page 311); Statistical yearbooks of Transnistria for 2000 (page 99), 2006 (page 93), 2009 (page 92), 2010 (page 93), 2011 (page 94), 2012 (page 98), 2014 (page 91). (Source: BUR report.)

Table 2-2. Power plants existing in the Republic of Moldova.

No	**Power plant**	**Installed electrical capacity, MW**	**Type of fuel**	**Year of commissioning in**
1	Moldavian Thermal Power Plant	2520	Natural gas, coal, heavy fuel oil	1964-1982
2	CHP 1 Chisinau	66	Natural gas, heavy fuel oil	1951-1961
3	CHP 1 Chisinau	240	Natural gas, heavy fuel oil	1976-1980
4	CHP North	24	Natural gas,	1956-1970

			heavy fuel oil	
5	CHPs of sugar refineries	97,5	Natural gas, heavy fuel oil	1963-1985
6	Hydro Power Plant Dubasari 48 - 1954	48	-	1954
7	Hydro Power Plant Costesi 16 - 1978	16	-	1978
8	CHP of SE "Tirotex"	31,328	Natural gas	2010-2011
9	Other small renewable power plants	5,161	Biogas, wind, solar	Recent years

Combined generation of electricity and heat in the cogeneration mode

The amount of electricity generated by the power plants located on the right bank of river Nistru covers only about 15 % of the electricity demand of this territory. The electricity generation by these power plants is shown in Table 3. The amount of electricity generated by right bank power plants has been reduced by approximately 49 % during the period 1990 – 2014, due to decreasing the heat demand in the cities of Chisinau and Baltsi leading to electricity production diminishing as well.

Table 2-3. Electricity generation by the power plants located on the right bank of river Nistru during the period 1990-2014, billion kWh.

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Generated electricity	1.901	1.655	1.581	1.442	1.240	1.181	1.400	1.451	1.248	1.137	0.904	1.263	1.180
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**%**
Generated electricity	1.046	1.022	1.229	1.192	1.100	1.097	1.031	1.064	1.016	0.932	0.905	0.955	-49.8

Source: NBS, Statistical yearbooks for 1994 (page272), 1999 (page 311), 2003 (page 400), 2006 (page 319), 2009 (page 313), 2012 (page 317), 2014 (page 311). (Used from BUR report.)

Up to the year 2030 the development of power sector is seen through the construction of renewable sources and CHPs - from one side, from another - by increasing the capacity of electricity import from ENTSO-E, through the construction of at least two interconnection lines with Romania, both power systems working in asynchronous regime through back-to-back facilities installed at each of interconnection lines mentioned above. This scenario is coming to cover electricity demand shown in the Table 2-4, where along with demand forecast other country key parameters forecasted are presented.

Table 2-4. Electricity demand forecasts along with other parameters for the period 2010-2035 of the Republic of Moldova.

Parameters	UM	2000	2005	2010	2015	2020	2025	2030

Real GDP	mil. USA	1289	2988	5813	7948	10621	14130	18,939
Annual GDP growth	%	2.2.	18.3	14.2	6.5	6	5.9	6
Population	Th.	3640	3595	3562	3547	3504	3431	3331
Population growth	%	0.2.	0.0 - 0.2	0.0 - 0.2	0.1	0.0 - 0.2	0.4	<0.6
Electricity demand under BAU and WM	billion kWh	5.3	6.6	6	6.8	8.5	10.5	12.6
Annual growth of electricity demand under BAU and WM	%		4.8	2.1	2.6	4.8	4.3	3.7

Source: Moldova BUR1

Heat generation

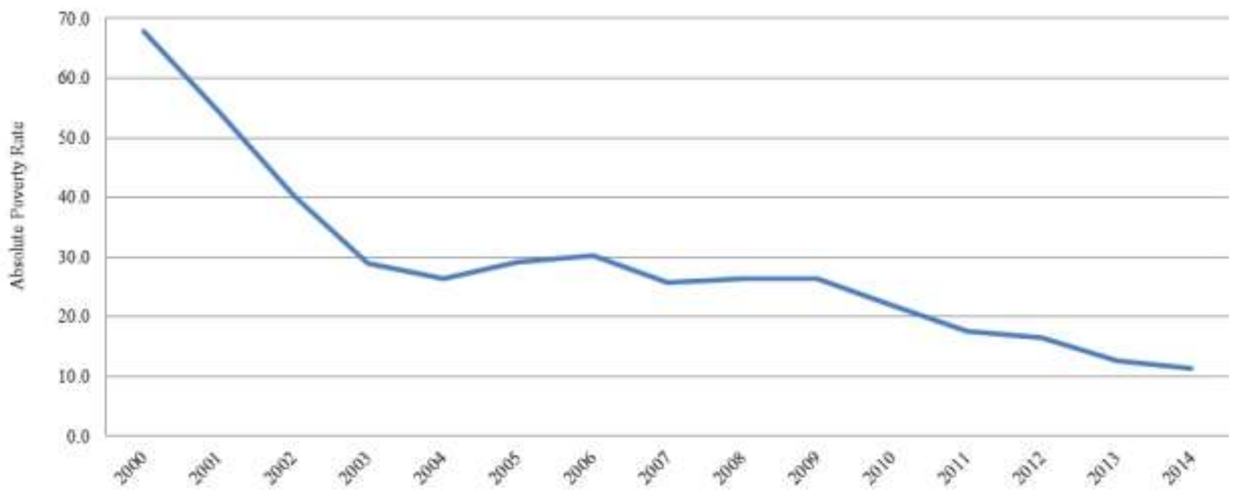
In the Republic of Moldova the heat is generated in the CHPs and a in large number of heat plants, the majority of which operate on natural gas, heavy fuel oil and some operate on coal and biomass. The amount of heat generated during the period 1990-2013 is shown in Table 5. These data reveal that the heat demand lately reduced significantly in comparison with the amount of heat demand during 1990s. The heat generation by sources is presented also in Table 2-5. The amount of heat generated by CHPs lately continues to decrease.

Table 2-5. Generation of heat in the Republic of Moldova during the period 1990-2013, million Gcal.
(starting with the year 1993 figures refer only to the right bank of river Nistru)

	1990	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Heat generation, inclusively:	22.212	10.208	7.507	7.097	7.077	6.590	6.120	4.647	3.057	3.298	3.217
by CHPs	7.220	4.657	3.641	3.528	3.659	3.294	3.127	2.534	1.847	2.113	2.128
by heat plants	14.802	5.542	3.862	3.568	3.417	3.296	2.991	2.113	1.207	1.183	1.087
by other generation sources	0.190	0.009	0.003	0.001	0.001	0.000	0.002	0.000	0.003	0.002	0.002
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Heat generation, inclusively:	3.347	3.347	3.591	3.552	3.094	3.074	2.638	2.874	2.721	2.596	2.681
by CHPs	1.922	1.922	2.140	2.165	1.855	1.939	1.647	1.874	1.780	1.701	1.655
by heat plants	1.423	1.423	1.451	1.358	1.386	1.133	0.990	1.000	0.940	0.895	1.022
by other generation sources	0.002	0.002	-	0.001	0.001	0.002	0.001	-	0.001	-	0.004

Source: Energy Balances of the Republic of Moldova for the period 1990-2013.(Used from BUR report.)

The main barrier which needs to be removed to implement energy sources development identified is poverty. The poverty rate is still high, reaching 11.4% in 2014 , but showing a steady decline (Figure 2-4).



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Source: statistica.md

Figure 2-4. Share of the population under the national absolute poverty threshold (absolute poverty rate).

2.2 Relevant stakeholders

The main stakeholders considered to be involved in the CHP NAMA development are as following:

The Ministry of Economy is the central public administration authority in the field of energy, energy security and energy efficiency that is responsible for:

- drafting, promoting and monitoring the implementation of the energy policy of the country: power system, natural gas, thermal energy, renewable sources of energy, energy efficiency, fossil energy sources;
- ensuring the energy security of the country through monitoring and coordination of the process of the development and proper operation of the energy systems;
- ensuring the security of energy supply and to monitor how the electricity and natural gas demands are met by supplies, under the conditions of the law;
- promoting the international relations in the energy field and to cooperate with international organizations in the energy field, inclusively for strategic purchasing of energy resources, investments attraction, extensions of energy interconnections as well as to promote the interests of the Energy Sector on the international level;
- monitoring the evolution of regional and global energy markets;
- harmonization of the national energy legislation with the respective legislation of the European Union;
- organization of the elaboration, together with energy companies and other interested parties, of the medium and long term development programs and investment projects for the development of the Energy Sector and its subsectors;
- for exercising of the function of the beneficiary/or general coordinator for the construction of the main transmission gas pipelines and other objects for gas supply;

- stimulation of competition and to limit the monopoly activities in the field of energy through the implementation of the Energy Sector policies.

The Ministry of Environment is the central public administration authority responsible for the protection of the environment and to fulfill this desideratum it:

- drafts the legal and normative acts in the field of environment protection harmonized with the requirements of European Union;
- implements the legislation in the field of environment protection;
- elaborates and improves the economic mechanisms in the field of environment protection and sustainable use of natural resources, promotes the integration of such mechanisms in the strategies for the development of the national economy’s sectors;
- ensures the performance of the environment expertise of projects, plans, programs, concepts, strategies for the development of national economy’s sectors and of drafted legal acts;
- coordinates the process of the strategic environment evaluation of policy documents with possible impact on the environment, according to provisions of international treaties and national legislation;
- coordinates the process of the evaluation of the impact on the environment of the planned objects and economic activity types with high impact on the environment;
- provides for guidance and coordinates the activities of the central and local public authorities and economic entities in order to ensure the implementation of policy documents, legal acts on local and sector level;
- ensures the promotion of the energy efficient and non-polluting technologies.

The Climate Change Office (CCO) of the Ministry of Environment provides logistical support to the Government of the Republic of Moldova, central and local public administration authorities, non-government and academic organizations, in activities implemented and promoted by the Republic of Moldova under the UNFCCC and the Kyoto Protocol. The CCO implements also climate change related projects and activities, including the elaboration of national GHG inventories, development and implementation of GHG mitigation projects and the implementation of activities that aim at raising awareness on climate change related issues.

The National Agency for Energy Regulation is a central public regulatory authority in the field of energy and water supply and sewerage. The Agency regulates the activities in the electricity, natural gas, heat supply sectors and petroleum products market as well as the water supply and sewerage systems.

The main responsibilities of the National Agency for Energy Regulation are:

- to issue licenses and to regulate the activities of licensees;
- to draft and approve the regulatory acts, including the methodologies for calculation of regulated tariffs in electricity, natural gas, heating sector, petroleum products market and water supply and sewerage;
- to approve regulated tariffs in the electricity, natural gas, heating sectors and for water supply and sewerage, according to the provisions of the laws;
- to monitor the competition in the electricity and natural gas markets as well as in the petroleum products one;

- to protect the interests of customers.

In relation to the NAMA project the National Agency for Energy Regulation will have the following role: to approve the tariffs for electricity and heat produced in cogeneration mode in case the CHP delivers heat into the district heating system and to require from the electricity suppliers or eligible customers to purchase the surplus of generated electricity that is to be delivered into the electric network.

Energy Efficiency Agency is an administrative authority subordinated to the Ministry of Economy which implements the state policy in the field of energy efficiency and renewable energy. The mission of the Energy Efficiency Agency is to ensure and support the accomplishment of objectives of the National program for improvement of the energy efficiency providing for the necessary assistance to develop the local energy efficiency programs and plans and to monitor their realization. The Energy Efficiency Agency has also the mission to supervise the evolution of the situation in the field of energy efficiency and renewable energy sources as well as to prepare and submit the synthesis of programs, evaluation of investments projects, to draft the normative acts, to create the information database and to disseminate the information on energy efficiency and renewable energy sources.

Energy Efficiency Fund is an independent legal autonomous entity, created to attract and manage financial resources to finance and implement energy efficiency projects and the exploitation of renewable energy sources in accordance with the strategies and programs developed by the Government of the Republic of Moldova.

Local public administration authorities have the exclusive responsibility for the creation, organization, coordination, monitoring and control of the municipal public services, as well as the creation, administration and operation of municipal public utility property of the local administrative units.

“Thermohouse” SRL will be the owner of the first small scale high efficiency CHP which at present is the supplier of heat to the multi apartments blocks of flats connected to its district heating system and it will be responsible to build, operate, maintain the high efficiency CHP and of course this company will be responsible for all costs related to investments and operation of the CHP at the highest possible efficiency.

2.3 Purpose and objectives of the NAMA

There are available many types of mature technologies for small scale CHPs. Based on the analysis and comparison of the characteristics of different CHP technologies provided by the institutions promoting cogeneration technologies[1] it is considered sound to use ICE CHP technology for implementation for around 40 replications identified.

[1] http://www.epa.gov/chp/catalog-chp-technologies; http://www.iea-etsap.org; http://www2.uned.es/experto-energia/EDUCOGEN_Tool.pdf; https://www.gov.uk/guidance/combined-heat-and-power; https://en.wikipedia.org/wiki/District_heating.

This assumption is considered sound based on the U.S. Environmental Protection Agency Combined Heat and Power Partnership (hereinafter referred to as USEPA) comparison of CHP technologies[2], that reveals perhaps the two most important practical characteristics of ICE CHP technology related to described NAMA:

- Can be overhauled on site with normal operators, which is an extremely important characteristic given that the Republic of Moldova does not have domestic CHP suppliers, and that until such time that there is a critical mass of installations, technology providers (producers or vendors) will not be willing to ensure that on-site support is readily and affordably available.

- Has high efficiency with part-load operational flexibility. It is observed from actual operational data, based on heat meter installed at boiler house, presented in Table 6, that high heat demand occurs only from November through to March, even though low temperatures continue longer. The heat demand in August, the month with the least demand, is just 7% that of December.

However, it is important to emphasise that this does not mean that NAMA will be limited only to ICE CHP technology. In case the analysis demonstrates that other small scale high efficiency CHP technology has better characteristics, for a particular site – for example, where the site has an existing source of steam for a steam turbine, then the respective technology will be implemented.

For the pilot NAMA foreseen for implementation at “Thermohouse” SRL (CHP_TH) premises main technical and economic indicators of the high efficiency CHP to be built are shown in Table 2-6.

Table 2-6. The main technical and economic indicators of CHP-TH.

Indicator	Measure unit	Value
Installed electric capacity	MWe	0,362
Power-to-heat ratio	-	0.724
Thermal capacity	MWth	0,5
Time of use of electric capacity during the year	hour	5059
Time of use of thermal capacity during the year	hour	5310
Annual electricity generation	MWh	1922.15
Annual heat generation	MWh	2529.61
Total annual energy generation	MWh	4451.8
Overall efficiency	%	85.84
Specific investments	USD/kWe	1173
Depreciation time	year	15

- The implementation of the small high efficiency CHP of “Thermohouse” SRL will result in the generation of:

[2] http://www.epa.gov/chp/catalog-chp-technologies

- 1.922 million kWh of electricity (the estimation is made taking into account the utilization of rated capacity of 5310 hours during the year);
- 2,529 million kWh of heat (the estimation is made taking into account the utilization of rated heat capacity of 5059 hours during the year);
- the efficiency of CHP is considered to be 85,84 %.

▪ The amounts of produced heat and electricity will be measured by the metering equipment installed for these purposes as well as this will be proved by less amounts of electricity consumed from the electric network.

Sustainable development co-benefits

The electricity produced by CHP-TH will displace the electricity produced by thermal power plant the efficiency of which is rather low, ≈37 %, that is very low in comparison with the modern technologies that can produce electricity at about 55 % efficiency and higher. The major part of electricity will be delivered into the electricity network and will be used locally, and this will also result in the reduction of electricity losses in the transmission grid, as well as in the electricity distribution network.

▪ In such case the annual fuel savings after the implementation of the small high efficiency CHP is equals to about 347 tce.

▪ In case by the year 2030 there are installed 40 small high efficiency CHPs of such capacity, then the total amount of annual fuel savings will reach 13880 t.c.e and CO2 emission reduction will equal to 22833 tCO2/year.

▪ The decrease of the amount of natural gas to be consumed will result in less imported natural gas and the decrease of the energy dependency of the country.

▪ Offer affordable heat for household and other customers;

▪ An opportunity to move towards more decentralized forms of electricity generation, where plant is designed to meet the needs of local customers, providing high efficiency, avoiding transmission losses and increasing flexibility in system use.

GHG mitigation potential

Increased efficiency of fuel conversion leading to annual fuel savings of about 347 tce, that constitutes the decrease of the natural gas use by about 35 %, will result in annual reduction of CO_2 emissions by 571 tones of CO_2 eq in case of the implementation of this small high efficiency CHP, or the reduction of greenhouse gas emissions may reach 22833 tones annually in case of the implementation of 40 small high efficiency CHPs by the year 2030. GHG emissions reduction will be calculated, not measured, based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and UNFCCC CDM Methodologies.

Financial ambition.

- It is estimated that the investments per kW of the installed electric capacity will be 1173 USD/kWe and in such a case the total amount of investment in CHP-TH will be 424.626 thousand USD.
- To built around 40 small high efficiency CHPs of this size, by the year 2030 there will be necessary 16,985 million USD.

3. Policy analysis

3.1 Relevant national and sector strategies and policies

The Republic of Moldova contributes about 0.03% of the global GHG emissions. In 2013, the country's total GHG emissions were 12.8 Mt CO_2e and the per capita GHG emissions were less than half of the world average. The Energy Sector represents the most important source of the total greenhouse gas emissions at national level and its share varied during the period 1990-2013 from 79.6 % to 65.5%, as shown in Figure 3. During the period 1990-2013 the total amount of greenhouse gases resulting from the activities of the Energy Sector reduced by about 75.5%: from 34.5204 Mt CO_2 equivalent in 1990 to 8.9465 Mt CO_2 equivalent in 2013.

The Republic of Moldova a Moldova joined the Copenhagen Accord in January 2010 and submited an objective for emission reduction that is specified in Annex II of this Accord "Nationally Appropriate Mitigation Actions for developing countries". The target of the mitigation actions of the Republic of Moldova in the framework of the Accord is "to reduce the total amount of greenhouse gases towards the year 2020 by not less than 25 % in comparison with the amount of the greenhouse gases in reference year (1990), by applying economic mechanism focused on mitigation of global climate changes, according to Conventions' principles and provisions". This target is submitted without specifying the identified and quantified Nationally Appropriate Mitigation Actions and without supplementary description of the necessary support to accomplish this target. At the same time it is recognised that in order to achieve this target there will be necessary a significant financial, tecnological and capacity building support that may be provided through UNFCCC mechanisms.

In September 2015, the Republic of Moldova submitted its Intended Nationally Determined Contribution (INDC) to the UNFCCC which states that the country "intends to achieve an economy-wide unconditional target of reducing its greenhouse gas emissions by 64-67 per cent by 2030 compared to 1990 levels and to make best efforts to reduce its emissions by 67 per cent" (Government of Moldova, 2015).

The 64 percent reduction corresponds to a self-sufficiency power system development scenario, while the 67 per cent reduction allows for a 30 percent import of electricity. The reduction commitment could increase up to 78 per cent reduction below 1990 level conditional to a global agreement addressing important topics, including access to low-cost financial resources, technology transfer and technical cooperation commensurate to the challenge of global climate change.

The Environmental Strategy for 2014-2023 and the action plan for its implementation were approved by the government of the Republic of Moldova in 2014. According to these policy documents, a 20% GHG emissions reduction compared to the baseline scenario has to be reached by 2020. Along with the overall national target, the Environmental Strategy defines GHG emissions reduction targets for seven economic sectors. For the Energy Sector, the greenhouse gas emissions has to be reduced by 25% by 2020 compared to the baseline scenario. This will be achieved through the improvement of the efficiency of energy generation, supply and consumption as well as the utilization of renewable energy.

By mid-2016, there will be prepared and approved a new draft of LEDS till 2030.. NAMAs are expected to be an important element of the LEDS.

The implementation of small scale high efficiency CHPs will contribute to the achievement of the above mentioned target of the Environmental Strategy and of the Energy Strategy of the Republic of Moldova till 2030.

The Ministry of Environment (MoEN) is the state authority responsible for the development and promotion of policies and strategies that address environmental protection, rational use of natural resources and biodiversity conservation. The MoEN is responsible for implementing international environmental treaties to which the Republic of Moldova is a Party (including the Rio Conventions). Under MoEN, Climate Change Office (CCO) is responsible for development of National Communications, Biennial Update Reports and the National Inventory Reports. The National Inventory Team of the CCO is responsible for estimating emissions by source and removals by categories of sinks, key sources analysis, quality assurance and quality control activities, uncertainty assessment, documentation and archiving of the information related to GHG inventory preparation process.

Following the Bali Action Plan (2007) on implementation of Nationally Appropriate Mitigation Actions (NAMA) in the context of sustainable development, supported and secured on the basis of technology, financing and capacity-building, in a Measurable, Reportable and Verifiable (MRV) manner, the Republic of Moldova has committed to establish an adequate National MRV System, in compliance with subsequent decisions adopted at COP 16 (Cancun, 2010), COP 17 (Durban, 2011) and COP 19 (Warsaw, 2013). The legal and institutional framework implementation will be finished by 2018.

3.2 Alignment with national and sector strategies and policies

The Energy Sector of the Republic of Moldova is regulated by a number of laws, government regulations and other normative acts issued by public authorities. The existing legal framework encourages the measures directed to the improvement of the energy efficiency, promotion and construction of high efficiency CHPs and distributed electricity generation.

In 2013, the Government of the Republic of Moldova approved the Energy Strategy of the Republic of Moldova till 2030 (No. 102 of February 5th 2013). The adopted Energy Strategy provides for the energy security and energy efficiency increasing.

To promote the construction of high efficiency CHPs the Parliament of the Republic of Moldova adopted the Law on thermal energy and promotion of cogeneration (No. 92 of May 29th 2014). The main objective of this Law is to improve the energy efficiency of the national economy and to diminish the negative impact of the heating subsector on environment, inclusively through the use of cogeneration technologies.

The Electricity Law adopted by the Parliament of the Republic of Moldova (No. 124 of December 23rd 2009) transposing the EU Directive 54/2003 EC provides for nondiscriminatory access to electric networks and promotion of distributed electricity generation, as the generation of electricity at the point of consumption eliminates the cost, complexity, interdependencies, and inefficiencies associated with electricity transmission and distribution. The construction of small scale high efficiency CHPs implemented as NAMAs is considered a path for the implementation of the concept of distributed electricity generation.

National Energy Efficiency Program for the period 2011-2020 approved by the Government of the Republic of Moldova (No. 833 of November 10th 2011) establishes that the Ministry of Economy shall promote high efficiency cogeneration based on useful heat demand that will save primary energy sources, avoid losses in the networks and to reduce emissions especially of greenhouse gases.

Thus the promotion of the construction of combined heat and power plants of high efficiency is an important challenge for the Energy Sector of the country and since depending on the accomplishment of this desideratum depends to a great extent the successful solution of the problem of heat supply to meet the demand for space heating and hot water consumption at reasonable and affordable tariffs, at the same time ensuring the quality parameters and a lower impact on the environment.

The NAMA proposed for the implementation corresponds to the existing policy framework in the country and the Energy Sector and the removal of barriers described below shall result in successful implementation of NAMA and to obtain the forecasted improvements.

3.3 Barrier analysis

In the process of the implementation of modern high efficiency cogeneration technologies there have been identified the following barriers, as shown in Table 3-1.

Table 3-1. The identified barriers

Category of barrier	Description of barrier
Policy, legal and	Uncertain incentives for private investors

	Unclear framework for negotiating the price for surplus non-regulated electricity
Economic and financial	High investments costs
	High operation and maintenance costs
	High transaction costs
	Reduced availability of financial resources
	High cost of financing
	Investment incentives not clearly defined
	Low affordability of consumers to pay for energy
Technical, market failure, imperfection	Economies of scale only at high level of investment
	Inadequate sharing of project experience
	Cost allocation for heat and power is not transparent
	Lack of supply market for equipment and spare parts
Institutional and organizational capacity	Slow development of institutional capacity in small efficient CHPs
	Limited availability of technical and business management skills
Social, Information and awareness	Environmental management not seen as a shared social responsibility
	Inadequate information on the implementation of small scale CHP projects

1. **Policy, legal and regulatory.** The adequate implementation of the provisions of the Electricity Law, Natural gas Law and the Law on thermal energy and promotion of cogeneration related to the approval of regulated tariffs and the elimination of existing cross subsidies will encourage the persons, entities interested in promotion of high efficiency CHPs to perform the respective calculation and to decide in favor of the implementation of such projects.
2. **Economic and financial**: The lack of finance is an important barrier to the implementation of small scale high efficiency CHPs in the country. High values of investment costs per kW of installed capacity in the construction of small high efficiency CHPs in comparison with the same indicator related to large CHPs, reduced availability of the financial resources for successful fulfillment of such investment projects and high costs for financing of such projects due to the high interest for bank loans makes difficult the successful implementation of such projects. Also, there are not clearly defined the incentives that may be granted in case of implementation of such projects. Regarding the incentives to promote the cogeneration technologies, they should be approved by the Government, according to the Law on thermal energy and promotion of cogeneration. Of similar importance is the low affordability of customers to pay for energy necessities and under such conditions the implementation of the NAMA project should obligatory result in lower prices for heat paid by customers in order to be able to justify the implementation of such projects on other sites.

To overcome these barriers it is very important to exempt from import duties small high efficiency CHPs technologies, to support the construction of small high efficiency CHPs from Energy Efficiency Fund or by foreign donors and to optimize the structure of heat sources by developing small high efficiency CHPs as heat and electricity sources close to customers.

3. **Technical, market failure and imperfection**: Though the cogeneration technologies are mature ones and the CHPs of different capacities, inclusively for distributed generation of electricity, exist worldwide, the lack of equipment for high efficiency CHPs on the market in the Republic of Moldova and the absence of the representatives of producers or vendors of such technologies on the local market do not encourage the implementation of such CHPs. It is also important to mention that the lack of spare parts of such technologies makes difficult the operation of such small high efficiency CHPs according to the planned schedule. To overcome this drawback it is important to have implemented some pilot projects in order to attract producers, vendors or their representatives in the country or to establish cooperation agreements with them to help in promotion of small scale high efficiency CHPs and provide spare parts timely and as necessary.

4. **Institutional and organizational capacity:**

- The Law on Energy Efficiency 2010 promotes the creation of energy service companies (ESCOs) – which could facilitate the implementation of small high efficiency CHPs through provision of audit and construction services, as well as through knowledge sharing – the number of ESCOs that have so far been established is rather small. The main reason continually cited for this – despite the Energy Strategy stating that incentives will be given for commercial banks to invest in energy efficiency projects – is the lack of start-up capital from financial institutions, which are unfamiliar with the business models of ESCOs.
- Limited availability of technical and business management skills. Given that small CHP projects have only recently been legally encouraged, technical experience required to prepare and start projects in this domain. Domain-specific business management expertise is inadequate and there is limited institutional framework available to provide business management consultancy. Certainly, these barriers can be overcome through targeted trainings of local personnel, and engagement of foreign consultants particularly in the initiation phases of the project, however this will clearly imply higher transaction costs for projects.
- The Energy Efficiency Agency should increase its involvement in promotion of small high efficiency CHPs projects, information campaign on small scale high efficiency CHPs development and on the operation of the existing small CHPs.

5. **Social, Information and Awareness:** The lack of adequate information related to the construction and operation of the small high efficiency CHPs makes the first project important both from the point of view of the obtained results, in comparison with the supply of heat produced by heat plant and the consumption of electricity from electric network, as well as the necessity and obligation to disseminate the correct and complete information regarding the operation of this CHP, including the economic indicators and the investment costs in order to provide adequate information on the functioning of such CHPs. Such data and information regarding the operation of this high efficiency CHP will demonstrate what are the obtained advantages and will be used lately for the construction of other CHPs of this type and will respectively encourage other entities, including private ones to build and operate such high efficiency CHPs.

In general the public supports the endeavors directed towards the improvement of the energy efficiency but at the same time it is skeptical that the actions related to the district heating systems will be beneficial for customers. This is based on the perception that the district heating systems are inefficient ones and the endeavors directed towards the improvement of the operation of the district heating systems cannot result in benefits to the customers, due to the criticism of the district heating system from the city of Chisinau, that is considered to be inefficient with big heat losses and high tariffs to be paid by customers. One of the most important factor is the price for heat generated by CHP that will be paid by customers and the customers really want a decrease in the price or at least to maintain it but not to rise it.

4. Baseline information and NAMA targets

4.1 Baseline boundary and scenario

According to this NAMA project, CHPs are planned to be built at any location in the Republic of Moldova where heat demand may ensure an annual load factor higher than 4500h. For these CHPs the boundaries are subject for separate consideration each time a new CHP is found eligible for implementation in frame of this PDD NAMA terms.

The pilot NAMA project, i.e. CHP "Thermohouse" SRL (CHP-TH), is planned be built in the district Melestiu of Municipality Chisinau, in the same building where existing 4x3 MWth boilers are located. The CHP will replace only 0,5MWth of the heat capacity generated by CHP-TH for supplying heat and hot water to 20 multiapartments blocks, or around 732 apartments, served by CHP-TH at present, or 0,36% of apartments under Chisinau which are supplied with heat through district heating systems in . In the Figure 4-1 the location of CHP-TH is shown.

Baseline selection

There are several baseline scenarios which may be considered for the determination of GHG emissions reduction as of the mitigation project implementation, as following:

a) Existing Melestiu heat supply system, i.e. status-quo: 0,5 MWth (project value maximum capacity) along with remaining thermal capacity (around 2,5 MW) of "Thermohouse" SRL boilerhouse is used to produce and supply heat to 20 multiapartments blocks. Load factor of 0,5 MWth used in the project is 5059h. Efficiency of "Thermohouse" SRL boilerhouse is 94%, heat losses in the heat supply system up to the multiapartments blocks – 2%; total electricity consumed for own "Thermohouse" SRL boilerhouse needs is 152 498 kWh, including 61 390 kWh electricity own needs for producing heat, calculated for the capacity of 0,5 MWth and 5059h load factor; Total heat produced by TH – 6283.7 MWh/year;

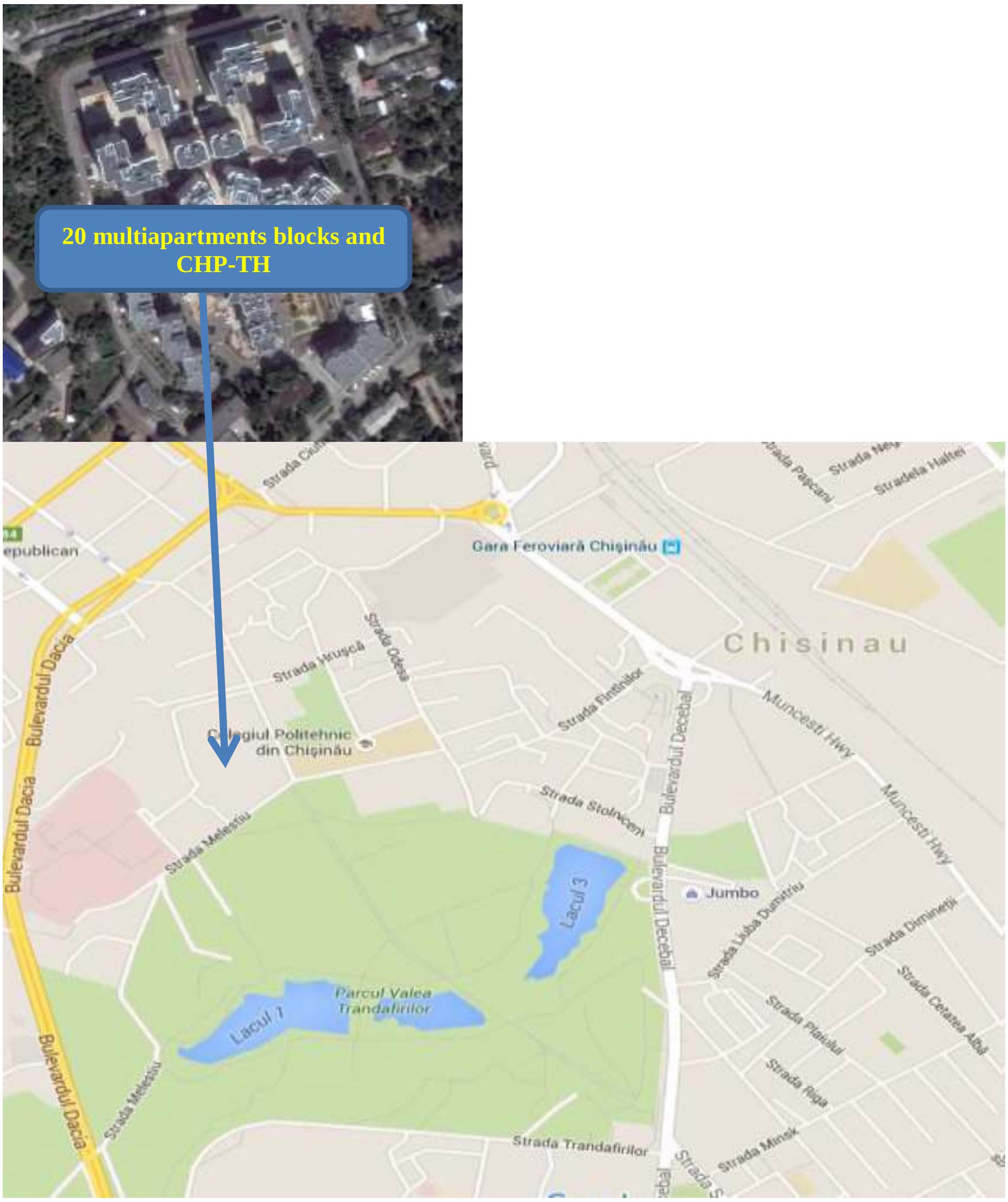


Figure 4-1. Location of CHP-TH and 20 multiapartments blocks to which the space heating and hot water services will be provided. *(all located in "Melestiu" district of Chisinau)*

b) The existing Melestiu heat supply system is connected to the district heating system of “Termoelectrica” S.A., which at present provides heat to more than 206 000 apartments in Municipality Chisinau and the boiler house of “Thermohouse” SRL is excluded from the scheme, i.e. all the heat supplied by “Termoelectrica” S.A. The Overall Efficiency of CHP-2, which belongs to “Termoelectrica” S.A. and generates heat and electricity is 71,39 %; heat losses in the grid – 20% plus 2% heat losses in the Melestiu heat supply system; Load factor of 0,5 MWth used in the project is 5059h.

c) All necessary heat is produced by individual natural gas fired boilers installed in each apartment, a phenomenon often met in Municipality Chisinau. The efficiency of individual natural gas fired boilers is 95%. The heat generation capacity of such individual boilers is usually 24 kWth. It means that the total installed capacity of such individual natural gas fired boilers will be 732*24 kWth = 17,568 MWth that is higher than the installed capacity of the boiler house of “Thermohouse” SRL. Total electricity consumed by individual natural gas fired boilers is at least 10% higher than the amount of electricity used for own needs in the boiler house of “Thermohouse” SRL, due to much higher capacity of water pumps of the individual natural gas fired boilers that is approximately 100 W and the total capacity will be 732*100 W = 7,32 kW.

As in all scenarios is used only natural gas, the comparison of natural gas amount burned in each scenario is applied to determine which scenario should be selected as baseline scenario for further examination. Because scenario c) cannot be implemented as the capacity of the natural gas network in the multiapartments blocks is limited to the capacity of natural gas demand to be used only for cooking by natural gas stoves, this scenario is excluded from the further analysis.

The methodology used for the determination of natural gas consumption according to scenarios a) and b) is the following:

Scenario a): The natural gas burned refers to the production of 6283.7 MWh/year of heat, at the efficiency of 94% + the production of 152 498 kWh of electricity for own use + 13% of electricity losses in process of transmission and distribution of this electricity through the electric networks. The efficiency of electricity production in the Republic of Moldova power system is considered equal to 37% and corresponds to the one recorded at Moldavian Thermal Power Plant located in Transnistria region (MTPP).

Scenario b): The actual overall efficiency of CHP-2 is 71,39 %. Because CHP-2 will increase the production of heat in cogeneration mode by an amount of 6283.7 MWh/year + the amount of heat necessary to cover 20% heat losses in the district heating system, thus the energy production of this combined heat and power plant will increase by approximately 0.43% which leads to efficiency increase from 71,39% to 71,45%. Thus the natural gas burned in this scenario will correspond to production of Ei + 7854.6 MWh (6283.7 MWh / (1-20%)) at the efficiency of 71,45%, where Ei = Q + W, where Q is the quantity of produced heat and W is the quantity of produced electricity in 2014 at the efficiency of 71,39%. In 2014 the quantity of produced heat, Q, was 1049748 Gcal or 1220,86 GWh and the quantity of produced electricity, W, was 601,331 GWh.

The calculation done revealed that in scenario a) the amount of natural gas burned is equal to 764,088 th m3, and in scenario b) – respectively – 945,859 th m3. That means the scenario a) is selected as baseline scenario for further examination as conservative one.

4.2 GHG baseline and mitigation targets

BLS CO2 emissions calculation

According to baseline scenario options investigated above the most plausible baseline scenario for this PDD NAMA corresponds to the existing Melestiu heat supply system status-quo. The boiler house of “Thermohouse” SRL (TH) was built in 2010 with the capacity of 12 MWth, 4 x 3 MWth heat boilers, designed to cover heat demand of multiapartments blocks planned to be built in the vicinity of the heat plant by Glorinal SRL Company. There was an option to connect the built buildings to district heating system of Municipality Chisinau (former “Termocom” S.A., now “Termoelectrica” S.A created in 2015 as a result of the merger of CHP-1 and CHP-2 and later on taking over of “Termocom” S.A. as a result of bankruptcy procedure), but very low quality of heat services provided by “Termocom” S.A. forced the company to build an independent source of heat. The heat demand was increasing from year to year reaching 6283,7 MWh in 2014, increasing by 6.7% in comparison to 2013 year. Because no more multiapartments blocks are foreseen to be built in the vicinity, the heat demand registered in 2014 is considered constant for the following years. The maximum heat capacity used since 2010 up to now is around 3MWth, i.e. the maximum Load Factor (LFth) in 2014 was 2095h which is very low and not feasible at all for the construction of a CHP of the same capacity. According to world experience LFth should be no less than 4500h in order a CHP to be feasible. Taking this into consideration and having data provided by “Thermohouse” SRL, the owner of TH, TH’s heat load duration curve of 2014 has been studded in order to determine the heat capacity at which LFth reach 4500h. It corresponds to 1 MWth. In the Fig. 4-2 CHP heat capacity determination for LFth = 4500 h is shown.

However, in this NAMA project document a capacity of 0.5 MWth for CHP-TH is considered for the reasons this capacity is more feasible in comparison with 1MWth, as analysis done in the next sections demonstrated. Based on data specified in p. a) in the Table 4-1 the calculation of CO2 emissions for baseline scenario is presented for CHP of 0.5MWth operating with Load Factor equal to 5059h. Other than CO2 GHG, i.e N2O and CH4, are not considered because they are negligibly small.

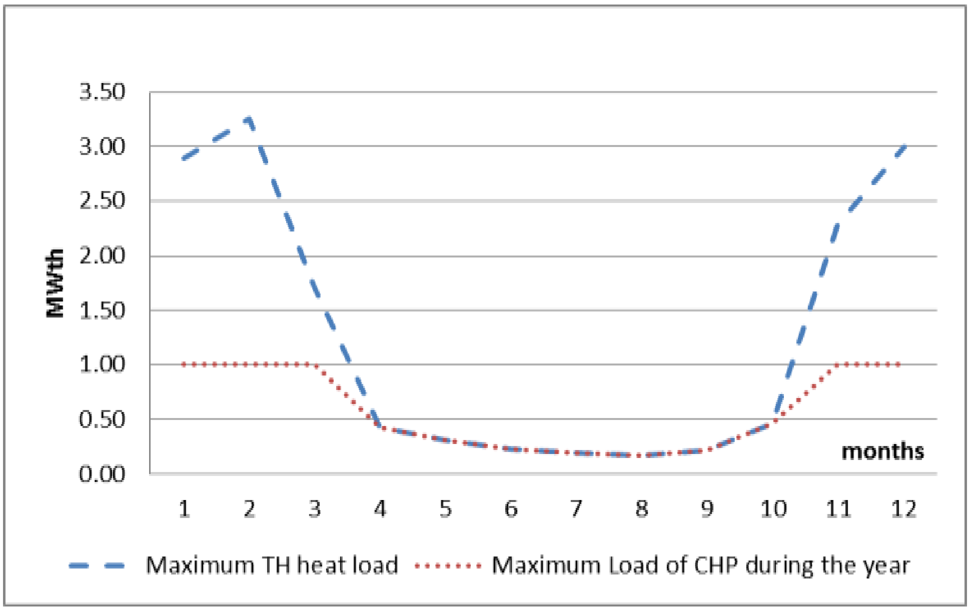


Figure 4-2. Determination of CHP heat capacity for LFth = 4500h.

Table 4-1. CO_2 emissions calculation for Base Line Scenario.

Items	Q/P, MWh	Efficiency of energy generation, %	Natural gas burned, TJ	CO2 emission factor, tonne/TJ	CO2 emissions, tonne	Comments and formula used
Calculation of CO2 emissions from heat generated by TH in BLS	2529.609	94	9.688	56.1	543.489	
Electricity used by TH	152.498	37	1.4838		82.239	Efficiency corresponds to TPP
Electricity losses (13%) from electricity delivered into the grid to cover TH needs	22.787	37	0.2217		12.438	
TOTAL	2704.894		11.393		639.166	

Mitigation scenario CO2 emissions calculations

NAMA mitigation scenario (MS) corresponds to the construction of a CHP which being installed in the same premises of TH will produce 2529,609 MWh of heat as byproduct of power plant electricity production. The analysis performed showed that from the economic point of view, the optimal electricity capacity of this CHP is 0.724 x Qth, MW, where Qth is the heat capacity of CHP equal in our case to 0.5 MWth, i.e. the electricity capacity of CHP is equal to 0.362 MWe. The specific CHP technology that has been selected as part of this NAMA is based on internal combustion engines

(ICE CHP). This technology is widely spread in the world. For example, in UK there are 1,438 CHP schemes in operation. Of these, 328 are in the industrial sectors and 1,110 are in commercial, public administration, residential, transport and agriculture sectors.
ICE CHP capacity is in range of 70kWe-1,500kWe with an electricity efficiency of 25-40%. The heat produced is usually hot water, rather than steam, and they generally produce 1-2 units of heat for each unit of electricity, with the ratio of heat to power generally decreasing with size (Carbontrast 2010).

For CHP-TH the electricity production efficiency of 38% is assumed. Electricity produced by this CHP will cover the electricity needs of TH and CHP-TH. Total electricity generated is equal to 1922153 kWh (362 kW x 5310h). It is assumed that approximately 5% of produced electricity is used for own needs of CHP (87000 kWh) and 91107 kWh (152 498 – 61 390 kWh, the last figure corresponding to share of BH electricity own needs calculated to CHP heat production) for TH. The remaining electricity in the amount of 1.74 mil kWh is delivered into the electricity distribution network. CO2 emissions in the mitigation scenario are created as a result of burning the natural gas at CHP-TH to produce 1922153 kWh at the efficiency of 37.06% and this electricity will be used for own use of CHP-TH and boiler house needs and will also displace the electricity produced by MTPP. As CHP-TH will also generate 2529,5 MWh of heat, then this heat will substitute for a part of the heat produced by boiler house of “Thermohouse” SRL. To determine the amount of electricity to be displaced at MTPP it is necessary to proceed as follows. The amount of electricity to be delivered into the electricity distribution network by the CHP-TH, $E_{CHP-TH,}$ equals to 1.74 mil kWh (1922153 kWh-182288 kWh). Under the conditions when no CHP-TH is built this amount of electricity would be delivered into the electricity distribution network from the transmission network, but this electricity would be produced at MTPP. The losses occurring during the process of transmission of this amount of electricity through the transmission network, TL, equal to 3%. Taking this fact into account, it is determined the amount of electricity to be supplementary produced by the MTPP in case no CHP-TH is built, i.e. $E_{MTPP} = E_{CHP-TH}/(1-TL)$.

This amount of electricity is used to determine the amount of CO2 emissions reduction as a result of electricity displaced by CHP-TH from the grid. In the Table 4-2 the calculation of CO2 emissions in the mitigation scenario is presented.

Table 4-2. CO2 emissions calculation for Mitigation Scenario.

Items	**Q/P, MWh**	**Symbol**	**Efficiency of energy production, %**	**Natural gas burned, GJ**	**CO2 emission factor, tCO2/TJ**	**CO2 emissions, tCO2/year**	**Comments and Formula used**
Total CHP-TH electricity generated	1922.153	E-CHP	37.06	18670	56.1	1047.387	
CHP-TH electricity own consumption, 8%	139						

Electricity used by TH for producing supplimented heat	43.3						
CHP-TH and TH electricity consumed	182.288	EO&M	37.06				
CHP-TH electricity delivered into the distribution network	1739.865	E CHP-TH					
CHP-TH electricity delivered at MTPP busbars (TL=3% transmisssion losses)	1793.675		37	17452		979.056	
Difference	128.478			1218		68.331	=(E-CHP)-E CHP-TH/(1-TL)

The calculations presented in Table 4-1 and Table 4-2 show that the GHG emissions as a result of CHP operation to generate electricity are by 68.331 tonnes of CO2 higher than to generate electricity at MTPP. However taking into account that the operation of CHP-TH will lead to reduction of GHG due to production of heat in the amount of 2529,5 MWh that will substitute for heat produced by boiler house and the electricity for own use, this will result in the decrease of GHG emissions equal to 639.166 tonnes of CO2. The total GHG emissions reduction is then (639.166 - 68.331) = 570.835 tonnes CO2 per year. CHP-TH has a lifetime of 25 years the total CO2 emission reduction during this time period will be 14270 tonnes of CO2.

Based on these assumptions, the direct GHG mitigation potential of the NAMA is estimated to be as follows:

- 2854 tonne CO_2 in 2020
- 13700 tonne CO_2 in 2025
- 42242 tonne CO_2 in 2030

4.3 SD baseline and co-benefit targets

The most applicable SD indicators identified within the NAMA baseline scenario are developed in tabular format and are presented in the Table 4-3 while the Intervention per indicators is shown in the Table 4-4.

Table 4-3. Identified Sustainable Development Indicators for ICE CHP NAMA.

Domain	Indicator	Identified impacts	Explanation of chosen indicator	Effect on Indicator	Monitoring done (Yes/No)
Environment	Climate change adaptation and mitigation	Mitigation	The NAMA will integrate climate change measures into national policies, strategies, and planning; improve education, awareness raising and human and institutional capacity on climate change mitigation	Positive	Yes
Social	Affordability of electricity	Reliability of electricity supplied	ICE CHP represents a second electricity source for customes located in the vicinity of CHP and may serve as reserve source of electricity (especially for hospitals) when an interruption of network supply happens	Positive	Yes
Growth and Development	Energy security	Increase of energy security	The expected total capacity of ICE CHP implemented correspond to around 3% of power deficit in 2030	Positive	Yes
	Capacity building	Number of persons tought to promote and implement ICE CHP	The implementation of ICE CHP cannot be done without knowledge transfer	Positive	Yes
Economic	Income generation/expenditure reduction/balance of payment	Income generation	Feasible ICE CHP implementation is a source of income for developers	Positive	Yes
	Asset accumulation and investments	Asset accumulation and investments	The promotion of ICE CHP will: a)enhance international cooperation to facilitate access to clean energy research and technology, including ICE CHP, and promote investment in energy infrastructure and clean energy technologies. b) expand infrastructure and upgrade technology for supplying modern and sustainable energy services in accordance with respective programmes of support	Positive	Yes

	Job creation (number of women and men employed)	Job creation	The implementation of ICE CHP will lead to: a) a higher levels of economic productivity through technological upgrading and innovation, including through a focus on high value added and labour-intensive sectors; b) promotion of development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage formalization and growth of micro-, small- and medium-size enterprises including through access to financial services; c) strengthening the capacity of domestic financial institutions to encourage and to expand access to banking, insurance and financial services	Positive	Yes

Table 4-4. Intervention by SD Indicators for ICE CHP NAMA.

Domain	**Indicator**	**Parameter Selection**			**Measurement value**	**Measurement type**	**Baseline Value**	**Target value estimated (ex-ante)**
		Number of parameters selected per indicator	**Parameter name**	**Effect**				
Environment	Climate change adaptation and mitigation	2	Mitigation - change in technology deployed	+	Number of policies where ICE CHP is integral part	Direct	2	at least 4
			Resilience - human	+	Number of people embraced in ICE CHP promotion	Indirect		
Social	Affordability of electricity	2	Cost per unit of electricity,	-	bani/kWh	Indirect	196	n/a
			cost per unit of heat	-	lei/Gcal	Indirect	1200	n/a
Growth and	Energy security	1	imported fuels	-	%	Direct	85%	82%

Development	Capacity building	2	Number and type of knowledge assets produced	+	Number of knowledge assets produced	Direct	0	n/a
			Private Sector Dialogue – or Dialogue across sectors and levels	-	Number of dialogues	Indirect	0	n/a
Economic	Income generation/expenditure reduction/Balance of payments	1	Fuel Savings per capita	-	tpe/capita	Indirect	0	n/a
	Asset accumulation and investments	2	Investment into new capacities	+	US$	Direct	0	more than US$20 million
			Setting an example for other industries	+	Number of examples	Direct	0	At least one
	Job Creation (number of men and women employed)	1	Number of jobs (men and women; permanent Vs temporary)	+	Number	Indirect	0	30

4.4 Transformational change

Innovation

Even at the sites where small efficient CHPs are feasible these technologies have been implemented in the Republic of Moldova in a very limited number (Moldova State University, “Franzeluta S.A.”- yeast factory for which no information is available). The main impediment for their dissemination has been very high up-front investments, exceeding by up to 20 and more times specific investments of heat plant, - from one side and, lack of both sufficient knowledge and experience on such projects – from another side. The opportunity to overcome this barrier by attracting donors’ investments through deploying energy efficient small CHP technologies make this NAMA one innovative for the country, as the best small CHP technology and practices will be implemented in the Republic of Moldova in a regime of transparency, when all information about amount of investments, donors’ participation in the financing the project, feasibility of NAMA CHP, etc. will be opened for public audience and thus they may have good chance for broad dissemination.

Private sector involvement.

In this respect private sector should have an important role. Their motivation is driven by reasonable profits the projects may give them and available successful experience from a private company on promoting, designing, implementation and operating of small CHP in the existing environment of the Republic of Moldova. This PDD NAMA shows the conditions when a small CHP becomes bankable and that may serve for any private company as a platform for determining the eligibility of their CHP projects, if load factor of heat consumed during the year is one appropriate at their site. The fact that small CHP of this PDD NAMA will be financed mostly by pure private company “Thermohouse” S.R.L. ensures the accumulation of experience described above making the project much valuable for private entities in obtaining the answers to crucial business questions.

Impact beyond the scope of the project. Under the conditions when country energy intensity is three times higher than average one of EU and, when 75% of electricity comes from import, energy security and energy saving are priority country target. This project comes to contribute in overcoming of these drawbacks. Apart from energy savings obtained and, production of own electricity at the site where small CHP is installed, the project has a positive system impact as well as it is part of distributed electricity generation concept implementation. Additional saving of energy is obtained in electricity distribution and transmission networks. Small CHP contributes to save investments in the increasing the capacity of transmission grid, as the last becomes less loaded and thus there is possibility to transmit an additional load, equal to the capacity of new ICE CHP put in operation. If CHP is built at hospital site there is no need to install second, independent source of electricity, as required by power supply security rules, in such manner increasing the reliability of electricity supply to hospitals and saving financial resources, as the CHP is in operation permanently. All these advantages will push national institutions to strengthen their capacities in order to realize all potential of feasible small CHP be realized.

Replicability.

Small scale high efficiency CHPs may be implemented not only to provide heat through district heating system, but it may also be used by industrial enterprises, hotels, resorts, university campuses, hospitals to cover heat and electricity necessities and the surplus of electricity to be delivered into the electric network.

According to the performed estimations at least at 40 sites efficient CHPs may be implemented by 2030, accumulating a total capacity of around 20 MW, which represents approximately 3% of load deficit by this year if no actions are undertaken to build new generation capacities on country territory located on right bank of river Nistru.

Scaling up

The potential for the project scaling up could be determined after the appropriate energy audits will be carried out at the sites established by Energy Efficiency Law (EEL 2010) and approved Energy Audit Regulation (EAR 2012). Energy Efficiency Agency will register all the audits and analyse them in order to elaborate respective recommendations on priority actions toward energy efficiency improvement, among which small CHP implementation is foreseen too.

Usually ICE CHP is designed as aggregate facility of a certain capacity. So that the project implementation will not require much time at the stage of its construction and commissioning.

By 2020 at least 1 MW of small CHP capacity is expected to be built on country territory. The experience learned and expected further available donor support will favor the acceleration of this technology implementation, by 2025 being implemented another 2-3 MW, accumulating by 2030 approximately 25 MW of small CHP.

5. Measures & interventions under the NAMA

Small and efficient CHP is well-known technology on worldwide level, while in the Republic of Moldova it is relatively new and this fact imposes the requirement to identify, develop and implement a comprehensive set of measures and activities that are needed to implement such kind of cogeneration power plant at the pre-established scale. The measures and activities are grouped together under the NAMA framework. They are selected based on the analyses of national energy efficiency plans and programmes and on barriers to the scale-up of cogeneration production of heat and electricity. The following sections provide information on financial, institutional, technological and capacity building support that is needed to build more than 20 MW of small CHPs.

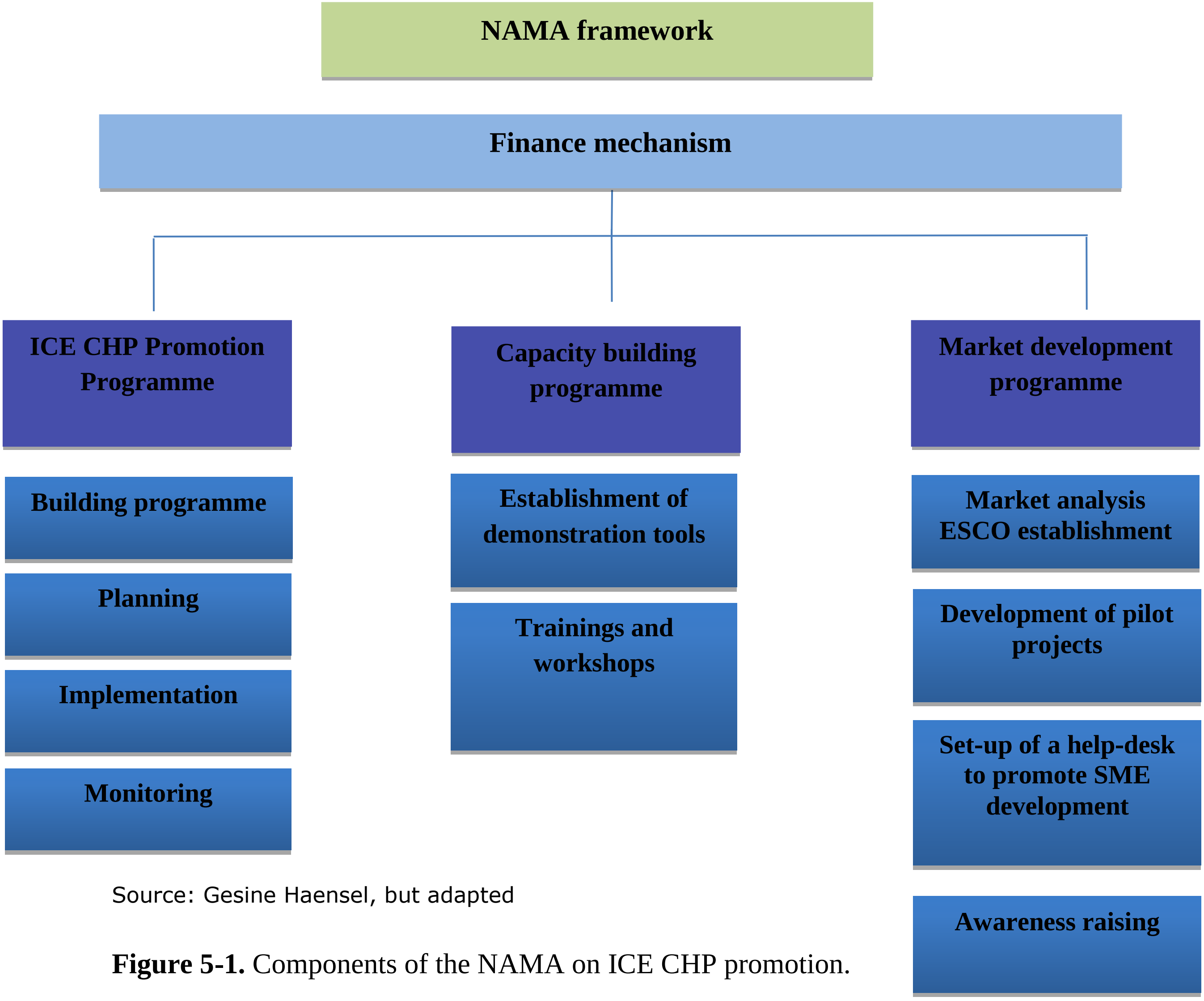
The NAMA framework has three components each of which consists of a set of measures to promote ICE CHP technologies. The components include:

(1) a **programme** to research, plan, implement and monitor ICE CHP;

(2) a **capacity building programme** to strengthen the skills and knowledge of interested parties; and

(3) a **market development programme** to promote the best ICE CHP and practices of implementation and operating.

A NAMA finance mechanism will be established to secure long-term finance for activities to be developed under the three NAMA components (Figure 5-1).



Source: Gesine Haensel, but adapted

Figure 5-1. Components of the NAMA on ICE CHP promotion.

The NAMA will be implemented in a phased approach consisting of three phases (Fig. 5-2):

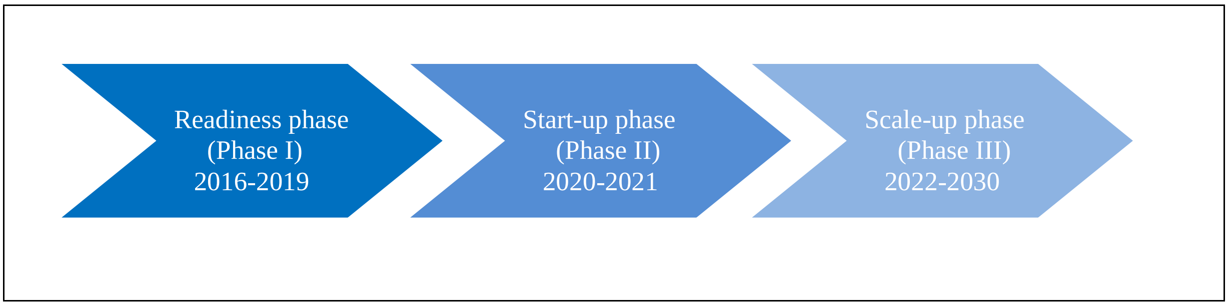


Figure 5-2. Three phases of NAMA CHP implementation.

- Focus of the “Readiness Phase” (2016-2018) is to develop and implement activities planned under a pilot scale, i.e. construction of 362 kWe CHP, which supplies heat to residential blocks "Melestiu" in Chisinau. The main goal for the ICE CHP promotion Programme is to identify the sites where eligibility of ICE CHP is proven and to prepare and initiate the planning and implementation of ICE CHP. Under the Capacity Building Programme, at least one demonstration site for ICE CHP and sustainable resource management will be established and training programmes will be initiated. The Market Development Programme will start with market research on ICE CHP components and O&M services. ESCO company with the capacity of ICE CHP identifying, designing, implementation and operating should be established. The scheme for a revolving loan fund to promote investments in ESCO will be designed and a testing phase of the loan scheme will be launched.

- Focus of the “Start-up Phase” (2019-2020) is the transition from pilot level ICE CHP to enterprises that operate under market conditions. The revolving loan fund will be launched and a help-desk will be established to support new developers of ICE CHP. Activities carried out under ICE CHP promotion Programme and Capacity Building Programme continue as in Phase I. Evaluation of results achieved under Phase I will be used to adjust or extend the scope of trainings offered to ICE CHP developers based on their feed-back, interest and request for support.
- Focus of the “Scale-up Phase” (2021-2030) is to promote ICE CHP development on a large scale based on experience gained from pilot ICE CHP and the testing phase of the revolving loan fund. Activities under the Capacity Building Programme will be slowly reduced.

5.1 ICE CHP Promotion Programme

The ICE CHP Promotion Programme is the component of the NAMA with the direct GHG impact. It comprises all activities and measures that are needed to implement and manage ICE CHP. The following sections give an overview of activities that will be implemented during the research/studies, planning, implementation and monitoring stages of the ICE CHP Promotion Programme.

5.1.1. Research/Studies stage

Research/studies will cover the activities on identifying the locations where ICE CHP are feasible, grouping them and establishing representative ICE CHP for each of the group. Specific aspects will be established and barrier analysis will be done for each representative ICE CHP, making conclusions on their feasibility in the environment of data uncertainty, especially the dependence on price of electricity sold. The feasible ICE CHPs are subject of implementation plan.

5.1.2 Planning stage

The information obtained from Research/Studies stage is used to complete Energy Efficiency National Action Plan, usually elaborated and published each three years by Energy Efficiency Agency. Moreover, projects are selected with the goal to create synergies with past and ongoing energy efficiency programs and plans as the "National Program for Energy Efficiency for the years 2011-2020", "Energy Efficiency National Action Plan for the period 2013-2015" and the draft for 2016-2-018. In the selection process MCDA will be used. Among the criteria social, economic, environment and security of energy supply will be considered.

5.1.3 Implementation stage

If implementation is done through ESCO the appropriate contracts will be prepared and signed with ICE CHP beneficiary.

If implementation is done by ICE CHP beneficiary the last will designate a responsible person to order ICE CHP design document, than follow all the procedure for project implementation.

At the first stage, in both stages, the International expert assistance will be needed in this respect.

5.1.4 Monitoring activities

The ICE CHP Promotion Programme will monitor the development of newly built ICE CHP, the quantity of fuel used, electricity and heat produced per each of small CHP. All these data are sufficient to calculate CO2 emissions per plant and CO2 emissions reduction in comparison to baseline scenario.

5.2 Capacity building programme

5.2.1 Trainings and workshops

Awareness raising and capacity building have shown to be some of the most effective measures to promote ICE CHP in the Republic of Moldova. The NAMA Capacity Building Programme will offer a series of trainings and workshops to beneficiaries identified at the research/studies and planning stages. Where relevant, trainings will have theoretical and practical elements. Trainings will target different stakeholder groups corresponded to residential boiler houses, hospitals, hotels, campuses, industry. Training will also be provided to staff of ESCO, EEA, EEF, research and design institutions with a special focus on climate change related topics.

5.2.2 Demonstration tools

Demonstration Spreadsheet tools will be elaborated and be freely accessible for stakeholders to demonstrate feasibility ICE CHP for concrete conditions where CHP may be built. Demonstration tool will take into consideration the specific characteristics of each group identified on research/studies stage. How to use the tool will be demonstrated at the appropriate trainings.

5.3 Market development programme

Within the NAMA framework, a market analysis will be done to evaluate the country capacity to cover the demand in all needed equipment and services to make ICE CHP projects implemented. Based on this the appropriate measures will be undertaken to reach a competitive environment on

ICE CHP input products and, remove the barriers identified. A crucial role in the development of ICE CHP should play ESCO enterprises. The key difference between an ESCO and an Energy Service Provider (ESP) is that Energy performance contracting (EPC) is a core business practice of the ESCO. In contrast, ESPs operates on a pay-for-service basis. The services offered by an ESCO are as following:

a) Identify and evaluate energy saving opportunities;
b) Arrange for financing;
c) Train beneficiary staff and provide ongoing maintenance services;
d) Develop engineering designs and specifications;
e) Manage the project from design to installation to monitoring;
f) Guarantee that savings will cover all project costs.

Development of pilot projects. Based on the market analysis and the short-list of products and services available, pilot projects for ICE CHP will be selected. Owners will be supported in the preparation of enterprise development plans and will receive training and assistance to start enterprise activities at the pilot level. The development of the pilot ICE CHP will be monitored and results of the evaluation will provide guidance on how to scale-up ICE CHP in the country.

Creation of a help-desk to support ICE CHP projects. A help desk will be established to support interested stakeholders with all issues relevant for the development, implementation and operation of ICE CHP. This includes support for the preparation of business plans, preparation of applications for the revolving loan fund and marketing of products.

6. Capacity development

The capacity development needs for implementing and actualizing the measures & interventions examined above are described in the chapters 5.2.1 and 5.2.2. Apart of this in the Table 6-1 is presented the description of common and specific barriers (to change) faced in the energy sector for preparing and implementing change, and how the proposed measures and interventions will alleviate this.

Table 6-1. Energy sector barriers for preparing and implementing change and the measures and interventions to overcome them.

Domain	Barriers	Measures and interventions to overcome the barriers	

Economic and Financial	High transaction costs; Reduced availability of financial resources; High cost of financing; Investment incentives not clearly defined.	To exempt from import duties ICE CHP installations To support ICE CHP construction from Energy Efficiency Fund For regulated ICE CHP to ensure shorter payback period of investments done through a Tariff methodology developed
Market Failure and Imperfection	ICE CHP are not produced in Moldova; There are cross subsidization on existing regulated CHPs, making heat cheaper; Inadequate sharing of project experience.	To reflect a transparent allocation of heat and power costs at CHPs; To get foreign assistance for ICE CHP knowledge and technology transfer To support creation of ESCOs with the ability to promote ICE CHP
Policy, Legal and Regulatory	Incomplete legal and regulatory framework Uncertain incentives for private investors	To develop and approve regulatory framework, including a tariff methodology for cogeneration PP, in order to make Law on thermal energy and promotion of cogeneration in effect applicable. Electricity produced in excess at enterprises and service providers should have a mandatory be purchased in the market at regulated price A study is needed to determine in a more accurate manner the potential of efficient ICE CHP replication
Institutional Capacity	Not sufficient capacity to promote efficient ICE CHP	To increase Energy Efficiency Agency capacity to promote successfully ICE CHP
Information and Awareness	Inadequate information on the implementation of small scale ICE CHP projects	To enlarge the forms of information on ICE CHP advantages. The key role on this belongs to Energy Efficiency Agency and ESCOs
Technical Issues	ICE CHP is relatively complicated technology and that make stakeholders be reserved in its implementation	The technology has a long period experience and demonstrated its high reliability and that should be brought to interested parties through awareness raising

7. NAMA financial requirements and mechanisms

As it was mentioned above, the main goal of this NAMA project is to build around 40 small CHPs based on ICE with a total capacity of approximately 20 MW by 2030. Specific average investments of ICE CHP is assumed at the level of 1173USD/kW. So that the total amount of investments needed is equal to USD23.4 million. Apart from these investments, financial and transfer of knowledge support is needed to overcome the existing barriers (see chapter 6) for successful ICE CHP implementation and to develop appropriate structures and mechanisms (see chapter 5) the implementation of this technology be foreseeable. There are three source of financing for this project to cover all the needs:

a) *National or local budgets*. Because of their scarceness, a very limited or zero contribution is expected be involved for ICE CHP construction from this source in the following 15 years. Public financial resources will be involved only for: 1) the development of ICE CHP Promotion Programme, appropriate research/sdudies (including market analysis), planning, monitoring; 2) Capacity building programme; 3) Regulatory framework development;

b) *Beneficiary financing* which can be private or public; Private investments may come from a concrete stakeholder, future owner of ICE CHP, or from an ESCO;

c) *Donors' investments*. Because this project is oriented mainly to CO2 emissions reduction, having in the same time a major impact on country sustainable development, it is considered a supported NAMA and thus, foreign investments are considered coming from funds oriented to mitigate climate change, having a form of grants, concessional loans, etc., stimulating the project promotion. However, it is not excluded the money may come from any other foreign sources. Of course, supported investments may be considered eligible if the project is not enough attractive for a full beneficiary financing. We assume that for the conditions of the Republic of Moldova, with quite high risks for investments, a payback period of maximum 7 years for the investments made by Beneficiary may be considered as criteria for a positive decision on climate change funds involvement.

The structure of the financial mechanism described above is shown in the Fig. 7-1.

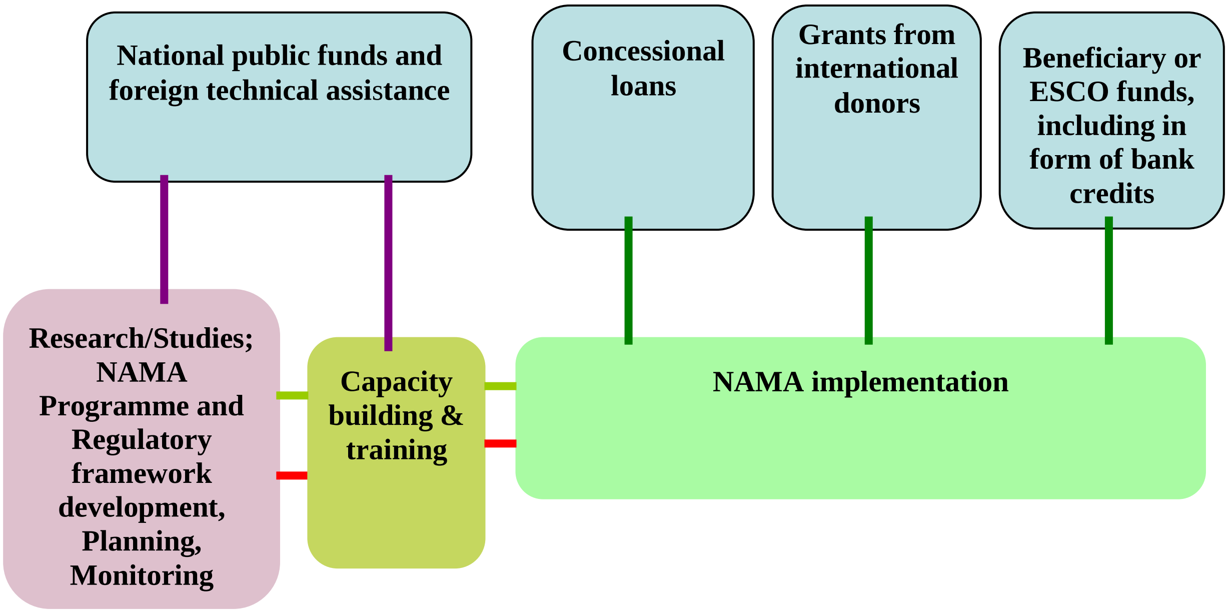


Figure 7-1. Structure of the NAMA finance mechanism.

Based on the three phases of NAMA CHP implementation described above (see Figure 5-2) the amount and the time of money involvement are determined below, based on the following methodology:

1. ICE CHP NAMA involves around 40 individual projects. In order to determine its budget:

Step 1: One representative individual project (abbreviated as "RP", in our case ICE CHP-TH) is selected and accurate budget as possible for it is prepared.

Step 2: Replicate representative project (with the same size or larger/smaller) rationally in accordance with the overall NAMA plans.

2. Interaction between budgeting and financial planning

Accurate and dependable budgeting is an indispensable prerequisite for financial planning. At the same time, outcomes of financial planning represent important elements of budgeting, affecting such core NAMA budgeting items as the number of individual projects to be included in the NAMA and public/private funds to be incorporated into a NAMA's budget. To deal with this interaction, two types of budgets will be prepared.

Budget 1: A Core Budget to focus on such factors as incomes and costs. This budget does not include financial factors and will serve as a key input for cash flow analysis and financial structuring.

Budget 2: An Augmented Budget that reflects both core factors and outcomes of financial structuring.

Budget for the representative project

The budget for the RP is analysed without financing factors (i.e. the combination of Step 1 of item 1 and Budget 1 of item 2).

ICE CHP is an established technology. In the absence of a feasibility study, this report relies heavily on performance and cost data available in /1/.

For the revenue side, data from "Thermohouse" SRL, as well as literature values for the Republic of Moldova market, have been used.

Size of CHP

In terms of the sizing of the CHP, the industry consensus is that the minimum load should be somewhere between 4,000 to 5,000 hours annually for the CHP to be economically feasible. In the section 4.2 it was shown that for CHP-TH a heat capacity of 1MWth the load factor is 4500h. In the same time, for a heat capacity of 500 kWth the load factor is equal to 5059h. The analysis demonstrated that CHP-TH is more feasible at the capacity of 500 kWth. In the same time this capacity is more close to average country heat capacity of foreseen 40 sites where ICE CHP may be implemented. For these reasons this capacity is considered below.

Initial investments

Initial investment costs are determined based on specific investments of ICE CHP, equal to US$1,173/kWe and include, largely: Engineering, permitting, and administration; Gas engine generator; Heat recovery system; Electrical systems; Labour; Contingency; Financing. All investments for a CHP project are expected in the first year of the project. To 1 unit heat capacity of CHP corresponds 0.724 units of electricity capacity. So that total investments needed are equal to USD424.626.

The lifetime of CHP system is largely dictated by the number of operating hours. The International Energy Agency's Energy Technology Systems Analysis Programme (IEA-ETSAP) suggests that the technical lifetime of a natural gas-fired ICE CHP system is 20 years whilst the economic lifetime is 15 years. For conservatism, 15 years is chosen.

Revenues

Potential revenues for the project include the revenues obtained from the sale of heat to residents, the sale of power to residents, and the sale of power to either the grid or an alternative offtaker. In a brownfield scenario with old inefficient boilers, there is a further possibility for avoided costs of fuel, however, for the RP, as the boilers are relatively new and efficient this is not the case.

1. *Sales of heat to residents*

The revenue from the sales of heat to residents is computed from the amount of heat supplied by the ICE CHP system, capped at the 2014 actual heat demand in the base case, and the sales price.

For an ICE CHP system with a small capacity, no steam can be recovered. This poses no problem for the residential heating needs, which only require hot water. Of the 6,279,487 kWhth of heat produced, 36% is currently sold as hot water and 64% as heat, all based on "Thermohouse" SRL data. As the hot water selling price is 120 Lei/m3 or 0.054 USD/kWhth and the heat selling price is 1,200 Lei/GCal or 0.052 USD/kWhth, the revenue under the baseline scenario is 331,055 USD/year and under the project - 133,361 USD/year for selling the heat produced by CHP 500 kWth only.

Sales of power to residents

It is assumed that the electricity will need to be sold to a supplier being delivered into the electric network at a price that is established by the National Agency for Energy Regulation (ANRE), the regulator. In doing so, it was deemed appropriate to expect ANRE to agree to a tariff that will give a payback period of 10 years – between USD0.04612/kWh and USD0.04916/kWh, depending on whether power is sold internally.

O&M costs

The major operational cost is fuel cost. Non-fuel operational and maintenance costs are mainly labour costs for the plant's daily operation and labour and equipment costs related to preventative maintenance and scheduled overhauls.

Budget without financing factors
Budgeting characteristics are summarized in **Error! Reference source not found.**.

Table 7-1. Key Budgeting Parameters for the RP (USD).

Parameter	Unit	Value	Comments
CHP Plant Capacity	kWe / kWth	362 / 500	
Thermal Output / Fuel Input	%	48.78	
Thermal Output	kWh_{th}/yr	2,529,609	
Electrical Output	kWh_e/yr	1,738,732	
Per Unit Revenue – Hot Water	USD/kWh_{th}	0.054	120 Lei/m^3, Thrmohouse SRL
Per Unit Revenue – Heating	USD/kWh_{th}	0.052	1,200 Lei/GCal, Thermohouse SRL
Per Unit Revenue – Electricity	USD/kWh_e	0.04612~0.04916	
Total Revenue	USD/yr	218,896	Heat, hot water and electricity sales
Initial investment costs	USD	424,626	
Annual O&M costs	USD/yr	176,433	Natural gas purchase cost and CHP operation and maintenance costs

The costs for the NAMA management including the management of incoming international funds, regulation development costs, research/studies needed, provision of capacity building training, etc. – will be borne by the Government of the Republic of Moldova as part of the country's "national ambition" and thus neutralized in terms of the NAMA's budget, they are not taken account of in the budgeting analysis.

Cash flow analysis for CHP-TH

The cash flow analyses are presented on the basis of a 15-year project lifetime. While it may be feasible to significantly extending the project lifetime with a major overhaul at the end of the assumed technical lifetime, this possibility is not dealt with in this report, as a project would be expected to graduate from under the NAMA umbrella by such time.

Baseline scenario cash flow

As the first step, the cash flow and IRR of the baseline scenario – on-site boiler and grid electricity for residents' energy requirements – is shown in Table 7-2.

The baseline financials are relevant in the sense that the profitability of that scenario will impact on the private sector uptake of the CHP technology. Project owners will expect the CHP option to provide at least a good a return as the baseline case, given that CHP technology is far more expensive. The baseline financials are thus a good indicator of market expectance to enable the shaping of a financial structure package.

Table 7-2. Baseline Cash Flow and IRR (USD).

Year	Total investment costs	O&M costs	Income	Net cash flow	Project IRR (before-tax)
	A	B	C	D=C-A-B	E
1	506,968[3]	243,864	331,055	-419,778	
2	0	243,864	331,055	87,190	
3	0	243,864	331,055	87,190	
4	0	243,864	331,055	87,190	
5	0	243,864	331,055	87,190	
6	0	243,864	331,055	87,190	
7	0	243,864	331,055	87,190	
8	0	243,864	331,055	87,190	
9	0	243,864	331,055	87,190	
10	0	243,864	331,055	87,190	
11	0	243,864	331,055	87,190	

[3] Assumed 60% of actual cost as installed capacity is 4 x 3MW boilers, with peak demand being less than 3MW. Taking into account the need for backup boilers, only 2 x 3MW is deemed necessary.

12	0	243,864	331,055	87,190	
13	0	243,864	331,055	87,190	
14	0	243,864	331,055	87,190	
15	0	243,864	331,055	87,190	19%

The baseline profitability (IRR before tax) is 19%. Income is derived from the sale of hot water and heat, as this scenario does not involve electricity generation. 19% is considered a reasonable benchmark for profitability expectations, taking into account Moldova's high interest rates.

In the Table 7-3 is presented cash flow and IRR for CHP-TH.

Table 7-3. Cash Flow and IRR for CHP-TH (USD).

Year	**Total investment costs**	**O&M costs**	**Income**	**Net cash flow**	**Project IRR (before-tax)**
	A	B	C	D=C-A-B	E
1	424,626	176,433	218,896	-382,163	
2	0	176,433	218,896	42,463	
3	0	176,433	218,896	42,463	
4	0	176,433	218,896	42,463	
5	0	176,433	218,896	42,463	
6	0	176,433	218,896	42,463	
7	0	176,433	218,896	42,463	
8	0	176,433	218,896	42,463	
9	0	176,433	218,896	42,463	
10	0	176,433	218,896	42,463	
11	0	176,433	218,896	42,463	
12	0	176,433	218,896	42,463	
13	0	176,433	218,896	42,463	
14	0	176,433	218,896	42,463	
15	0	176,433	218,896	42,463	7%

As it can be seen IRR of CH-TH project is quite low and equal to 7%.

Financial structure of ICE CHP-TH NAMA

To achieve a before-tax project IRR of 19% (BLS) from the 7% level for the RP, there are two basic options:

1. Reduce the total investment cost to USD246,838 from USD424,626 (42% reduction). The cost of the NAMA support will be USD177,788 at the start of the project.

2. Provide a supplementary income of USD30,593/year to increase revenue from USD218,896/year to USD249,489/year (14% increase, or if viewed as a percentage of electricity revenue, 36% increase in tariff). The cost of the NAMA support will be USD458,895 throughout the project lifetime.

Between these two extreme options the following structure may be well received as being reasonable by all stakeholders, for the first CHP NAMA project (i.e. RP). A different structure is likely necessary for the second project and beyond, when it has already been proven that the NAMA support measures in place function appropriately.

1. Interest free loan for 70% of the project investments cost. The proportion is set high taking into account both the fact that availability and affordability of debt financing is a real issue, and that no upfront grant is involved as would be expected of many NAMA financial structures due to the fact that, according to the country legal framework, grant are not considered into the tariff setting, i.e. the investments in the form of grant get zero value when the tariffs are calculated. The project owner will therefore only be required to fund 30% of the project in year 1. While this is to be repaid in six equal installments over six years, this almost completely removes the cash flow problem and the absolute amount needed as investment for private sector participants is very manageably small, at USD127,388.

Amount of funds:	USD297,238 at start of project.
Timing of funds:	At start of project
Benefit to the project owner:	Alleviation of financing and cash flow issues. As much as USD208,067 when 20% interest rate is assumed to be avoided
Final cost to the international supporter:	USD0 for the project as recovered funds will be used to support another project (i.e. counted as a cost for another project)

2. Revenue support in the form of a carbon transaction, at a price of $20/tCO2 for the first 500tCO2e delivered. Due to NAMA rules preventing any carbon sold and transferred to an Annex I country to be accounted for as the host country's emission reduction achievement for the purpose of its nationally determined contribution, it is suggested that any carbon achieved above 500tCO2 be kept domestically.

Amount of funds:	USD150,000 over 15-year project lifetime.
Timing of funds:	Annually upon delivery
Benefit to the project owner:	Increased profitability with injection of USD150,000 of income over 15 years
Final cost to the international supporter:	USD150,000

While a US$20/tCO2 figure for carbon appears high when viewed against the current prices for NAMA's market-based mechanism of CDM, it is thought that a simple comparison is unwarranted, first and foremost specifically because NAMA is not a market-based mechanism. NAMAs are by and large expected to have a grant component, and hence this value can be seen by the international sponsor as the value of "international support" together with an exchange of funds for a commodity, putting the true price of carbon much lower than it appears. Also, this type of results-based funding has the advantage of having no implementation risk, a risk that is inherently present for a grant that is disbursed at the beginning of the project.

3. Tax incentives in the form of waived import duties for major equipment and tax credit for the investment cost, as part of the Republic of Moldova’s domestic efforts.

The total value of international support, without taking into account the value of the interest-free loan that is to be reinjected in a different project, will be USD150,000 or USD20/tCO2. While at a glance a relatively high figure per unit reduction, this level pay be palatable to international supporters in view of:

- Improvement of energy efficiency is a high priority for the Republic of Moldova, a country with an energy intensity three times higher than that of the EU average .
- This is a measure that will have high replication potential within Moldova, with a potential for the per-tCO2 cost to decrease.
- The obvious potential for graduation from NAMA support.

Budget for Representative Project (RP) with financial factors

The budget for the RP with financing factors is shown in the below Table 7-4 as the Augmented Budget. Namely, this includes the carbon transaction (column E), and 70% interest free loans repaid over six years (columns G to I).

The equity IRR is calculated based on this budget, assuming a zero tax rate. The zero tax rate was assumed on the expectation of the state supporting fiscal exemptions.

Table 7-5 shows an equity IRR of 20% for the RP, which is deemed a reasonable level of profitability for the private sector.

Table 7-4. Augmented Budget for the RP with financing factors (USD).

Year	**Total investment costs**	**O&M costs**	**Income**	**Subtotal**	**Carbon Purchase**	**Funds contributed by equity investors**	**Loans borrowed**	**Loans repayment**	**Interest payments**	**Annual BNIP surplus / deficit**	**Aggregated annual BNIP surplus / deficit up to year**
	A	B	C	D=C-A-B	E	F	G	H	I	J=D+E+F+G-H-I	Ky=Ky-1+Jy
1	424,626	176,433	218,896	-382,163	10,000	0	297,238	0	0	-74,925	-74,925
2	0	176,433	218,896	42,463	10,000	0	0	49,540	0	2,923	-72,002
3	0	176,433	218,896	42,463	10,000	0	0	49,540	0	2,923	-69,079
4	0	176,433	218,896	42,463	10,000	0	0	49,540	0	2,923	-66,156
5	0	176,433	218,896	42,463	10,000	0	0	49,540	0	2,923	-63,234
6	0	176,433	218,896	42,463	10,000	0	0	49,540	0	2,923	-60,311
7	0	176,433	218,896	42,463	10,000	0	0	49,540	0	2,923	-57,388
8	0	176,433	218,896	42,463	10,000	0	0	0	0	52,463	-4,925
9	0	176,433	218,896	42,463	10,000	0	0	0	0	52,463	47,537
10	0	176,433	218,896	42,463	10,000	0	0	0	0	52,463	100,000
11	0	176,433	218,896	42,463	10,000	0	0	0	0	52,463	152,463
12	0	176,433	218,896	42,463	10,000	0	0	0	0	52,463	204,925
13	0	176,433	218,896	42,463	10,000	0	0	0	0	52,463	257,388
14	0	176,433	218,896	42,463	10,000	0	0	0	0	52,463	309,850
15	0	176,433	218,896	42,463	10,000	0	0	0	0	52,463	362,313
Total	424,626	2,646,501	3,283,440	212,313	150,000	0	297,238	297,238	0	362,313	362,313

Table 7-5. Equity IRR for the RP assuming zero tax (USD).

Year	**Investment and financing**				**P/L items**					**Non-P/L items**				**Net cash flow for equity holders**	**Equity IRR (after-tax)**
	Total investment costs	Grants	Funds contributed by equity investors	Loans borrowed	O&M costs	Income	Depreciation	Interest payments	Sub-total of P/L items	Tax	After-tax P/L	Depreciation added back	Loans repayment		
	A	B	C	D	E	F	G	H	I=F-E-G-H	J=I*tax rate	K=I-J	L	M	N=K+L-M-A+B+D	O
1	424,626	10,000	0	297,238	176,433	218,896	0	0	42,463	0	42,463	0	0	-74,925	
2	0	10,000	0	0	176,433	218,896	0	0	42,463	0	42,463	0	49,540	2,923	
3	0	10,000	0	0	176,433	218,896	0	0	42,463	0	42,463	0	49,540	2,923	
4	0	10,000	0	0	176,433	218,896	0	0	42,463	0	42,463	0	49,540	2,923	
5	0	10,000	0	0	176,433	218,896	0	0	42,463	0	42,463	0	49,540	2,923	
6	0	10,000	0	0	176,433	218,896	0	0	42,463	0	42,463	0	49,540	2,923	
7	0	10,000	0	0	176,433	218,896	0	0	42,463	0	42,463	0	49,540	2,923	
8	0	10,000	0	0	176,433	218,896	0	0	42,463	0	42,463	0	0	52,463	
9	0	10,000	0	0	176,433	218,896	0	0	42,463	0	42,463	0	0	52,463	
10	0	10,000	0	0	176,433	218,896	0	0	42,463	0	42,463	0	0	52,463	
11	0	10,000	0	0	176,433	218,896	0	0	42,463	0	42,463	0	0	52,463	
12	0	10,000	0	0	176,433	218,896	0	0	42,463	0	42,463	0	0	52,463	
13	0	10,000	0	0	176,433	218,896	0	0	42,463	0	42,463	0	0	52,463	
14	0	10,000	0	0	176,433	218,896	0	0	42,463	0	42,463	0	0	52,463	
15	0	10,000	0	0	176,433	218,896	0	0	42,463	0	42,463	0	0	52,463	20%

7.1 National and international finance: sources and distribution mechanisms

During the time period of 2016-2019 the development and implementation of activities planned under a pilot scale are foreseen, i.e. the construction of 362 kWe CHP, which supplies heat to multiapartments blocks in the district "Melestiu" in Chisinau.
In the Table 7-6 the breakdown of national and international finance is presented for this time period.

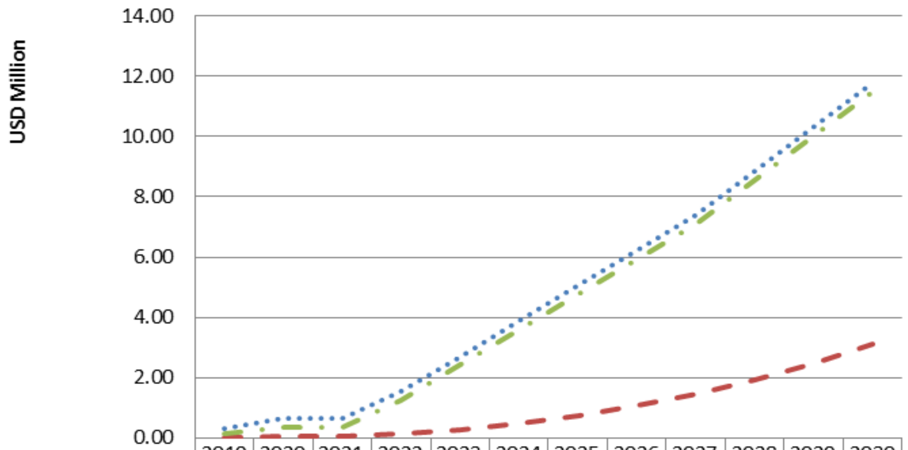
Table 7-6. Breakdown of national and international finance for the Readiness phase (Phase I), 2016-2018, of NAMA project implementation, US$ million.

Investments and costs	**Source of financing**	**Type of financing**				**TOTAL**
		Concession loan	**Grant**	**Beneficiary or ESCO**	**National budget**	
Investments	"Thermohouse" SRL	-	-	0.127	Partly through EEF	0.127
	Foreign (Donors, others)	0.297	0.15, through purchasing of CO_2	-	-	0.425
	National budget	-	-	-	-	-
O&M costs	Beneficiary or ESCO equity	-	-	0.035	-	0.035
Fuel		-	-	0.142	-	0.142
Management of the NAMA, capacity building, training, regulatory framework development, barrier removing, etc.					0.013 (3% of investments assumed)	0.013

Note: the amount of National budget involved constitutes 3% of total investments

For the Start-up phase (Phase II) comprising the period of 2019-2020, one more ICE CHP of the same capacity will be built, for which the Concession loan and grant will be reduced by approximately 10%, as experience will be accumulated and less risks the developer will endure.
During the Scale-up phase (Phase III), lasting from 2021 to 2030 year, the core part of ICE CHP will be built. At this stage Concession loan and grants will be reduced up to 20% for the same reasons: experience accumulated and less risks. The difference will be borne by Beneficiaries or ESCOs.

The evolution of amount of financing per type of sources of financing during all the time of ICE CHP NAMA implementation, i.e. 2016-2030, is shown in the Fig. 7.1-1.



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Accumulated Concessional loan	0.30	0.65	0.65	1.53	2.70	3.87	5.05	6.22	7.39	8.86	10.33	11.79
Accumulated Grant in form of CO2 purchasing	0.01	0.04	0.07	0.14	0.28	0.48	0.74	1.07	1.46	1.93	2.48	3.10
Accumulated Beneficiary or ESCO investments	0.13	0.36	0.36	1.24	2.41	3.59	4.76	5.93	7.11	8.57	10.04	11.51

Figure 7-2. The evolution of ICE CHP NAMA financing per type of sources.

7.2 National finance sources

To implement the project the following sources of financing are foreseen and types of financial mechanisms may be used:

National Central Budget. From this source EEF, EEA and Moldova Social Investment Fund are financed (MSIF). According to the roles, EEF may finance any efficiency projects, including CHP (not clear roles on CHP financing are established at the moment), but the amount is limited to … lei (US$). The contribution comes in different form of banking credits or grant. EEA is a budget organization and is financed from the Central Budget, having the mission to: manage the activity in the energy efficiency and renewable energy sectors; ensure the implementation and reach the objectives set out in the national energy efficiency and renewable energy programs and coordinate the actions in these fields; ensure the implementation of the legal framework in the field of energy efficiency and renewable energy. In other words, EEA may cover most part of works which refer to Management of the NAMA CHP, capacity building, training, regulatory framework development, barrier removing, etc.

Local budget may participate as co-financing party in an ICE CHP project if the case corresponds to hospitals in the area of local authority governing.

Beneficiary or ESCO: At least 50% of investments in ICE CHP will come from these entities in the form of equity or bank credits.

Local banks: Availability of local capital to finance technology costs is inadequate overall, which generally limits the interest of private agents to invest in energy efficiency projects. It is of no surprise therefore to observe that at the moment private investment in sustainable technologies is very limited in Moldova.

Table 7-7. Effectiveness of the NAMA.

No.	NAMA project indicators		Phase 1, 2016-2018	Phase 2, 2019-2020	Phase 3, 2021-2030	TOTAL
1	US$ foreign/tCO2, without Consecional loan		20	20	20	20
2	Total investment cost, mil US$		0.45	0.67	25.44	26.56
3	Co-financing ratio, mil US$	foreign	0.31	0.34	14.00	14.65
4		National budget	0.013	0.026	0.117	0.156
5		Beneficiary or ESCO	0.13	0.30	11.32	11.75
6	IRR	With the support	20%	19%	18%	19%
7		Without the support	7%	7%	7%	7%

7.4. Indicative NAMA financing needs

Indicative NAMA financing needs are presented in the Table 7-6.

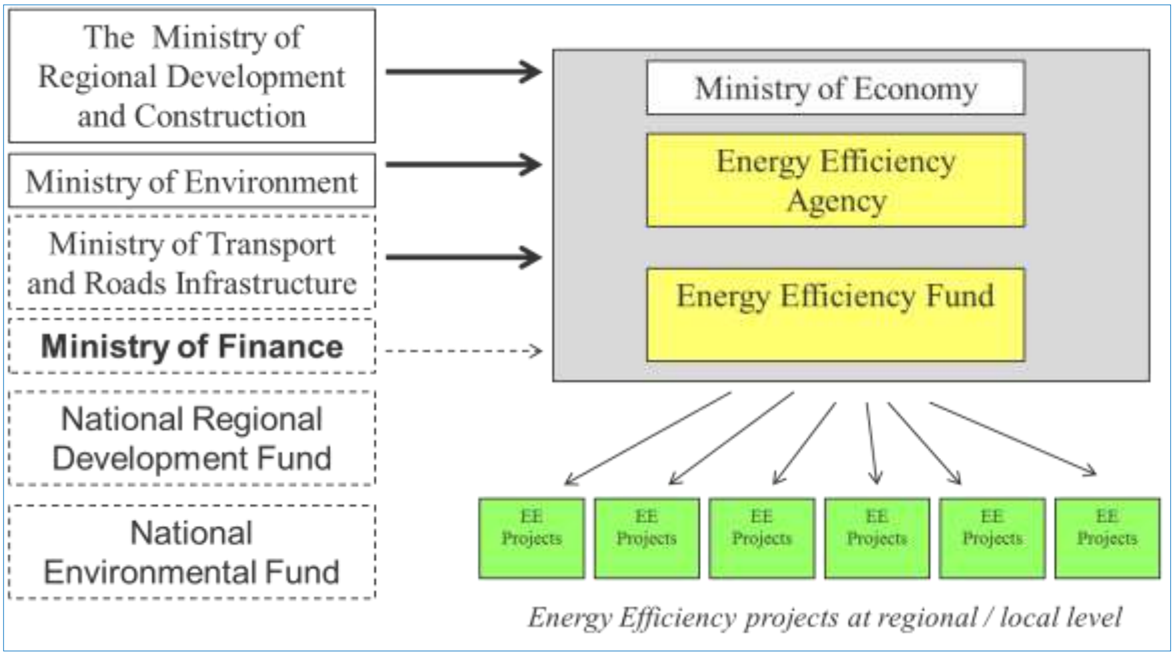
The preliminary cost estimate for international support to implement the NAMA is USD 20.42 million, including USD12.02 million in form of Loan with no banking interest (Concessional loan) and USD8.4 million in form of grant expressed in purchasing CO2 emissions at the price of 20USD/tCO2. This covers the full cost of construction of 40 small scale high efficiency CHPs with the installed capacity of 20 MWe.

8. NAMA implementation structure

8.1 Description of key operation bodies and implementing partners

ICE CHP NAMA promotion can be treated as one of energy efficiency activity and thus, it should be incorporated in the existing country organizational structure of energy efficiency measures implementation.

The main actors involved at present in the promotion and realisation of the country's EE & RES policies are shown in Fig. 8-1. These actors wiil be kept when ICE CHP NAMA Programme is launched.



Source: SIDA

Figure 8-1. Institutional framework for energy efficiency in the Republic of Moldova.

The responsibilities of stakeholders mentioned above are presented in the Table 8-2.

Table 8-2. Stakeholders responsibilities.

No	Public Institution	Responsibilities
1	Ministry of Economy	Central administrative authority which sets the priority directions of state policy on energy efficiency and the main activities of public authorities on energy efficiency, including: - Development, promotion and monitoring the implementation of state policy on EE and RES; - Harmonising of national legislation with EU one on energy; - Ensure the implementation of national programs in EE and RES; - Ensure enforcement of laws and regulations in the field of EE and RES.

2	Energy Efficiency Agency	Energy efficiency Administrative entity, which implements state energy efficiency and renewable energy sources policy, subordinated to Ministry of Economy, including: - Participates in drafting EE and RES plans and programs; - Develop EE and RES pilot projects; - Provides information to local and central public authorities on development the programs to increase EE and RES; - Creates EE and RES database; - Approves the draft of EE and RES projects financed by FEE; - Coordinate the programs and action plans developed by local public authorities; - Ensure the dissemination of information on EE&RES.
3	Energy Efficiency Fund	The EFF is an independent legal entity and autonomous, created to attract and manage financial resources to finance and implement energy efficiency projects and the exploitation of renewable energy sources in accordance with the strategies and programs developed by the Government
4	Ministry of Construction and Regional Development	State authority responsible for the energy performance in the construction sector
5	Ministry of Environment	State authority responsible for the development and promotion of policies and strategies in the field of environmental protection and sustainable use of resources
6	Ministry of Transport and Roads Infrastructure	State authority responsible for the rehabilitation and modernisation of transport networks, and for the monitoring and regulation of vehicle fleet
7	Ministry of Finance	State authority responsible for managing public funds

As it was described above the key responsible entities for ICE CHP NAMA Programme implementation are Energy Efficiency Agency and Energy Efficiency Fund. Their addresses are below:

Energy Efficiency Agency:
1, Alecu Russo str, block A1, Floor 10, Mun. Chisinau, MD-2068, Moldova
Director: Mihail Stratan
Phone: +(373 22) 31-10-01, +(373 22) 49-94-44
fax +(373 22) 31-10-01
e-mail: office@aee.md; info@aee.md

Energy Efficiency Fund:
180, Stefan cel Mare Bd. Floor 6, Office 607, MD-2004, Mun. Chisinau, Moldova
Phone : +(373 22) 000807
Fax.: +(373 22) 000809
GSM: +(373 60) 809709
E-mail: info@fee.md

"Thermohouse" SRL will be the beneficiary of the international support (grant) for the implementation of the small high efficiency CHP, pilot project, and will be responsible for construction, operation and maintenance of the built CHP.

18, Colina Puşkin str., ap. 4, Chisinau, Moldova
Director: Mihailova Lilia
Phone: +(373 22) 620222

8.2. NAMA operational & management system

As it was stated above, the key entities appointed to reach country energy efficiency goals, including through the promotion of ICE CHP NAMA Programme are Energy Efficiency Agency and Energy Efficiency Fund. The Energy Efficiency Fund was created to attract and manage financial resources to finance and implement energy efficiency projects and the exploitation of RES potential in accordance with the strategies and programs approved by the Government of the Republic of Moldova.

The structure of EEF is built on Administration Board and Investment Committee. The EEF Administration (Management) Board consists of nine members, representatives of public and private sectors and donor organisations (nominated for 4 years). The Administration Board and the Fund's Executive Directors are mandated with conducting the negotiations with donors and International Financial Institutions (IFIs) for possible co-financing of EE&RES projects.

The main stakeholders of the EEF are Ministries and government agencies (MoE, EEA), the international donor and financing communities, and private and public sector beneficiaries that are eligible for EEF Funding as well as NGOs concerned about EE issues.

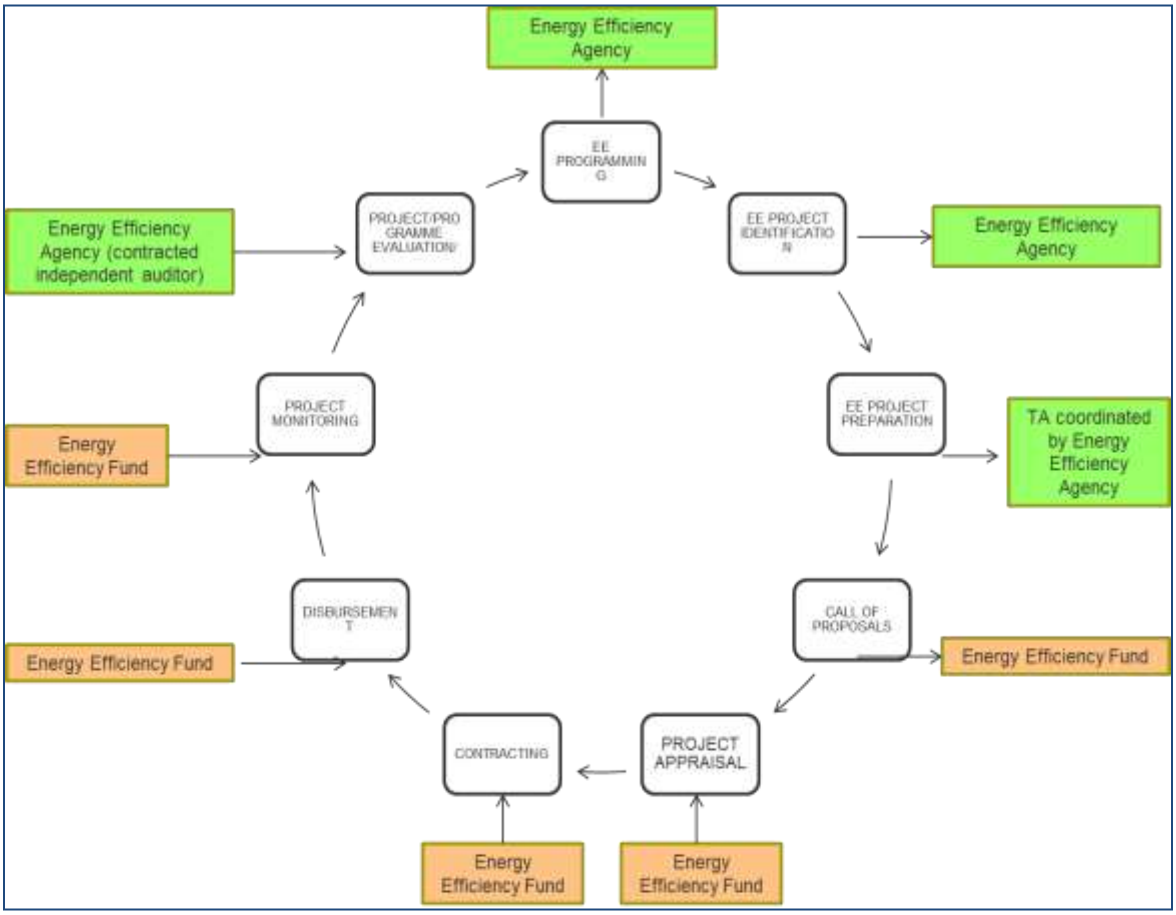
The Ministry of Economy (MoE) promotes its policy through the Energy Efficiency Agency, which participates in the EEF activities at the final stage of grant application approval. EEF's funding requests (from the state budget) are submitted by MoE to the Ministry of Finance (MoF).

The EEF has been positioned to be coordinator/negotiator of technical and financial assistance to the Republic of Moldova by international donors/IFIs. This role however is reserved for the MoE. The financing agreements that require state guarantees are negotiated with the MoF. The Fund Administrator cannot act independently but in coordination with/ or under the leadership of the MoE and MoF. In framework of the negotiations, the EEF's Executive Director signs a general framework agreement between the EEF and the respective donors. Signing of financial agreements with donors is usually done by GoM or MoE.

Specifically the EEF is responsible for promoting and financing projects that are economically feasible, technically and environmentally sustainable, and that reduce energy consumption and reduce emissions of greenhouse gases, among which ICE CHP NAMA is seen; providing direct financial contributions; acting as the agent or mediator for other sources of financing; providing collateral for loan financing by banks (i.e. loan guarantees); and providing assistance in identifying the optimal combination of project financing.

Translating the mandate of supporting the state energy EE and RES policies into a viable action plan is the responsibility of the EEF. The EEF, under the guidance of its Administration Board, decides which sectors and EE/RES technologies to support and develops financing and eligibility criteria, as well as operational procedures supporting the identification, evaluation, selection and financing of energy efficiency and renewable energy projects.

The allocation of function among the stakeholders when an EE&RES project is launched, including a concrete ICE CHP project, integral part of ICE CHP NAMA Programme, is presented in the Fig. 8-2.



Source: SIDA

Figure 8-2. The allocation of function among the stakeholders.

Once the ICE CHP NAMA Programme is approved by the Ministry of Economy at the request of EEA, Programme elaborator, and supported fund are predetermined, EEF will launch a bid for construction of ICE CHP. “Thermohouse” SRL, one of the participant of the bid, will follow the pre-established rules to win the bid and then follow all the steps to build CHP, operate it and be in compliance with MRV established at national level.

8.3. Phased implementation plan and schedule

Measures and Interventions plan for implementation this ICE CHP NAMA by time phases described in chapter 5 are presented in the Table 8-2, where the responsible entities are identified as well per each of action foreseen.

For the concrete ICE CHP-TH, which is considered a pilot project, Total time[4] needed for construction is equal to 12 months, ±2months, including:

- site assessment, 2-3 months;
- project design and fund obtaining, 3 months;
- equipment procurement, 3 months;
- equipment installation and commissioning, 3 months.

After synchronization with the power system in the commissioning phase, there will be a 2-3 weeks operational phase with technology provider's technician on site to handle training and operational details that may appear.

After commissioning the construction of this CHP is considered completed and "Thermohouse" SRL will request the National Agency for Energy Regulation to approve the tariffs for generated electricity and heat to be delivered into the district heating system and power network.

Once the tariffs are approved and published in the Official Monitor[5] of the Republic of Moldova "Thermohouse" SRL signs contract for selling of generated electricity with the electricity supplier and it begins the operation of the small high efficiency CHP and the delivery of generated electricity into the electric network and heat into the district heating system.

It is not excluded, ESCO may pass all the steps of financing and operating of ICE CHP. If so an appropriate contract will be signed between ESCO and "Thermohouse" SRL.

[4] based on: http://www.iea-etsap.org and CHP Project Development Handbook, U.S. Environmental Protection Agency Combined Heat and Power Partnership.

[5] Regulated tariffs and prices for electricity and heat shall be published in this official gazette before entering in force.

Table 8-1. Measures and Interventions plan for ICE CHP NAMA implementation.

No	Measures and Interventions	Phase 1				Phase 2		Phase 3									Responcible entity
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
1.	NAMA registration on UNFCCC register, seaking implementation support																MoE
2.	To make a study on ICE CHP replication potential and establish methodological principles on CHPs' heat and power prices calculation																ME: IPE ASM and TUM
3.	ICE CHP NAMA Programme development and approvale																EEA
4.	Secondary Regulatory framework development to implement the Law on thermal energy and promotion of cogeneration																ANRE
5.	Negotiation of Donors' support																ME, MoE
6.	Signing the Agreement with Climate Change Funds																ME
7.	Bid launching for ICE CHP construction																EEF
8.	Signing investment contracts with winners																EEF
9.	ICE CHP construction (Total 30 small CHP)				1	1		3	4	4	4	4	4	5	5	5	Beneficaries, ESCO
10.	ICE CHP tariffs for heat and electricity approval																ANRE
11.	Analysis of experience accumulated and ICE CHP NAMA Programme updating																
12.	Signing contracts of heat and electricity seling																Beneficaries, ESCO
13.	MRV implementation																CCO

Note: Starting with 2020 the average unit capacity of CHP is equal to 500kWe, it is assumed

8.4. NAMA current status

This NAMA is developed in the frame of Low-Emission Capacity Building Project – Republic of Moldova, financed by UNDP, EU, Germany and Australia, 2014-2016. According to the LECB plan, the NAMA should be registered into UNFCCC Register by September 2016 with the status of seeking financing for implementation. The input for development of this document served detailed information collected from "Thermohouse" SRL and broad estimation of ICE CHP replication in the country. From around of total 20 MW assumed small CHP replication, around 13 MW correspond to reserves owned by 35 hospitals, for which small CHP represents not only a measure of energy efficiency increasing, but as second source of power required, as mandatory, for this premises as well. However, an additional study is needed to clarify more precisely not only the small CHP replication, but the conditions in which these facilities are economically feasible in the frame of different applicable groups: district heating, hospitals, hotels and industry. As to ICE CHP "Thermohouse" SRL a feasible study is needed first before to launch the project as pilot.

9. Measuring, Reporting & Verification

9.1. Current MRV Legal and Institutional Framework

The Ministry of Environment (MoEN) is the state authority responsible for the development and promotion of policies and strategies that address environmental protection, rational use of natural resources and biodiversity conservation. The MoEN is responsible for implementing international environmental treaties to which the Republic of Moldova is a Party (including the Rio Conventions). Under MoEN, Climate Change Office (CCO) is responsible for the development of National Communications, Biennial Update Reports and the National Inventory Reports. The National Inventory Team of the CCO is responsible for estimating emissions by source and removals by categories of sinks, key sources analysis, quality assurance and quality control activities, uncertainty assessment, documentation and archiving of the information related to GHG inventory preparation process.

9.2. Establishing the Institutional Framework for NAMA's MRV System

Following the Bali Action Plan (2007) on implementation of Nationally Appropriate Mitigation Actions (NAMA) in the context of sustainable development, supported and secured on the basis of technology, financing and capacity-building, in a Measurable, Reportable and Verifiable (MRV) manner, the Republic of Moldova has committed to establish an adequate National MRV System, in compliance with subsequent decisions adopted at COP 16 (Cancun, 2010), COP 17 (Durban, 2011) and COP 19 (Warsaw, 2013).

The National MRV System will be focused on the three types of MRV:

1. MRV of GHG emissions;
2. MRV of NAMA projects and activities focused on reducing GHG emissions;
3. MRV of the support obtained from external donors for supported NAMA projects.

MRV for GHG emissions include identifying and/or defining institutional roles and responsibilities clearly spelled out to ensure smooth movement and standardization of information for all entities which develops; reports; and verifies GHG estimates. It is expected the current MRV system of GHG emissions will be further developed and improved by establishing an appropriate regulatory framework in terms up to 2018.

MRV for NAMA projects and activities focused on reducing GHG emissions will be developed for three types of measures:

a) Unilateral NAMA - reducing GHG emissions through nationally appropriate mitigation actions implemented with domestic financial support;
b) NAMA developed with donor support - reducing GHG emissions through nationally appropriate mitigation actions implemented with external financial support;
c) CDM Projects - reducing GHG emissions through carbon financing mechanisms.

To reduce costs and the time of the staff involved in the implementation of the MRV system, NAMA projects will be monitored using templates. In this respect, the regulatory framework will also require periodic filling in of said templates, with updated information about the proposed or on-going NAMAs, which shall be submitted to the Climate Change Office for processing. When the Environmental Protection Agency (EPA) is established, the MRV authorities for unilateral NAMAs will pertain to it. The templates will serve for monitoring of emission reductions for NAMA projects of all categories, including ICE CHP. However, the NAMA projects of type b) and c) will have their own MRV systems, while in the NAMA projects of type b) the MRV system will be set up by donors. In case of NAMA projects of type c), the MRV system will comply with UNFCCC requirements. The templates for NAMA projects of type a) and b) shall include: data on support obtained for the specific NAMA, such as: financial flows and their impact; transfer of technology and its impact; capacity building and associated impact, etc.

Regarding the process of NAMA approval, whether it has the support of donors, or it of CDM type, it shall be submitted to the National Commission in two stages. First, a concept note on the NAMA project will be sent and in the second stage – the NAMA as such. ICE CHP NAMA project passed both stages in National Commission.

The National Commission, upon evaluation of the NAMA Project Concept Note or of the NAMA project itself, issues a decision approving or rejecting the document submitted for approval. Schematically, the processing of a NAMA project proposal by the National Commission is shown in Figure 9-1.

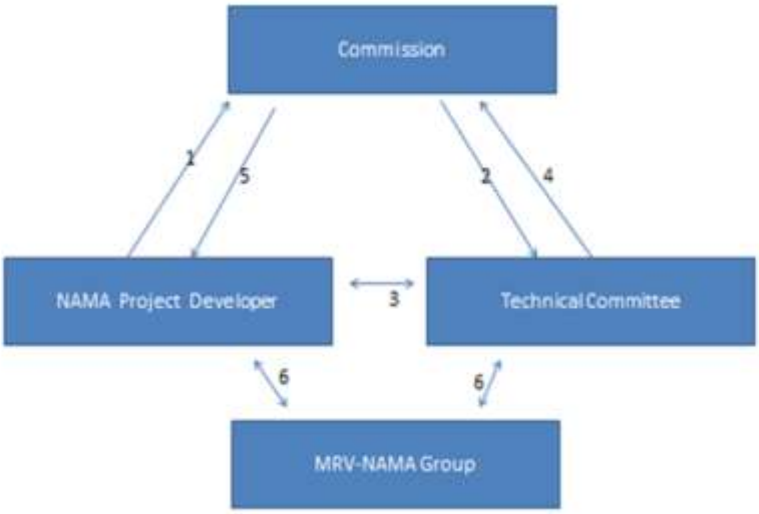


Figure 9-1. Processing of a NAMA Project Proposal by the National Commission.
(figures show sequence of actions)

At the time of the NAMA Project Concept Note approval, it will be decided who will maintain communication with the UNFCCC in order to record the NAMA project.

The regulatory framework for the implementation of the National Concept for NAMA MRV mentioned above is being developed under the UNDP Low Emission Capacity Building Project which will be over in December 2016.

9.2. Measurement

9.2.1. Emission reductions

Emissions reduction per this NAMA will be determined based on three measured parameters: a) Natural gas consumed, reflected into Natural Gas Supplier invoices, which is measured by homologated natural gas meters, recording the natural gas consumed per each hour. The natural gas measured and reflected in the invoice each month is sufficient to calculate CO2 emissions reduction in comparison with baseline scenario for which CO2 emission value for the whole year is predetermined. However, in order to have cross-checking of CO2 emissions calculated two additional parameters a subject for metering: heat and electricity supplied to consumers. Detailed information on measuring, frequency, data sources and monitoring criteria is presented in the Table 9-1.

Table 9-1. Measurement information for ICE CHP NAMA.

Data / Parameter:	Natural gas consumption
Data Unit:	**m^3**
Description:	The amount of consumed natural gas will be registered by natural gas meter that has also the electronic corrector of temperature and pressure to standard conditions. The

	electronic corrector has also a possibility to store the registered data. Registered data later on will be stored in an external data storage and will be available on request.
Measurement and QC procedures (if any):	The type of meter and of the corrector should be included in the State register of metering devices permitted for usage in the Republic of Moldova, by the National Institute of Metrology and correspond to legally established QC. They are sealed by the natural gas distribution system operator which reads metering indication on monthly basis. The electronic corrector has also a possibility to store the registered data. Registered data later on will be stored in an external data storage and used when necessary. Any interested stakeholder related to NAMA implementation may ask for access to the data in order to check the veracity of data.
Monitoring frequency:	The quantity of consumed natural gas will be monitored on monthly and annual basis.

Data / Parameter:	Electricity generated
Data Unit:	**kWh**
Description:	The amount of electricity generated will be registered by state-of-the-art electronic meter installed at the bus bars. The state-of-the-art electronic meter will have the capacity to register the amount of electricity kWh per each daily hour.
Measurement and QC procedures (if any):	The type of state-of-the-art electronic meters should be included in the State register of metering devices permitted for usage in the Republic of Moldova, by the National Institute of Metrology and correspond to legally established QC. They have the capacity to store the registered data. Any interested stakeholder related to NAMA implementation may ask for access to the data in order to check the veracity of data. The state-of-the-art electronic meter will be sealed by the electricity distribution system operator which will also read metering indication on monthly basis and reflect it in the appropriate invoices.

Monitoring frequency:	The quantity of generated electricity will be monitored on monthly and annual basis and reported accordingly as country MRV system prescribes.

Data / Parameter:	Heat generated
Data Unit:	**Gcal (kWh)**
Description:	The amount of generated heat will be registered by heat meters. The heat meters. have the capacity to register the amount of heat, temperature and the volume of hot water supplied.
Measurement and QC procedures (if any):	The type of meters installed should be included in the State register of metering devices permitted for usage in the Republic of Moldova, by the National Institute of Metrology and correspond to legally established QC.
Monitoring frequency:	The quantity of generated heat will be monitored on monthly and annual basis.

These data will be used to determine the fuel savings in comparison with BLS and will also be used to determine the amount of greenhouse gas emissions and then CO2 emission reduction per project.

9.2.2. Sustainable development

SD impact determination will be done by CCO or EPA based on information provided in the appropriate templates described above.

Table 9-2. SD monitoring criteria.

Data / Parameter:	a) Reliability of electricity supply; b) Increase of energy security; c) Income generation; d) Asset accumulation and investments; e) Job creation.
Data Unit:	Respectively: a) % increase; b) % increase; c) MDL; d) US$; e) number of empoyees.

Description:	The indicators are recorded (c, d, e) and calculated (a) by Beneficiaries and reported accordingly to CCO/EPA annually after which, based on electricity produced and country load covered by ICE CHP parameter a) is determined by CCO/EPA
Measurement and QC procedures (if any):	-
Monitoring frequency:	On annual bases

9.2.3. Support

As it was mentioned in section 9.2 NAMA projects will be monitored using templates. The regulatory framework will require periodic filling in of said templates by Beneficiaries, with updated information, including support obtained. The filled out templates shell be submitted to the Climate Change Office for processing. When the Environmental Protection Agency (EPA) is established, the MRV authorities for unilateral NAMAs will pertain to it. The templates for NAMA projects will include: data on support obtained for the specific NAMA, such as: financial flows and their impact; transfer of technology and its impact; capacity building and associated impact, etc. The details on support recorded are presented in the Table 9-3.

Table 9-3. Obtained support monitoring.

Data / Parameter:	a)Loan, grant, credit, equity; b)Type of technology and capacity; c) Capacity building received
Data Unit:	a)US$; b) MW; c) description
Description:	The template will have an instruction how to fill out it. The data on support will correspond to the information from contracts signed
Measurement and QC procedures (if any):	Information will be provided based on factual documents
Monitoring frequency:	Annually

9.2.4. Transformative change

The information provided in the Templates will be stored and kept for all ICE CHP NAMA Programme time scheduled, plus 5 years. The information accumulated, including CO2 emission reduction, sustainable development, and support will be used to track transformational changes over long time

9.3. Reporting

See Section 9.2

9.4. Verification & evaluation

The Template for filling out the monitoring information will be approved by Government Decree and thus it will have the status of statistical form. According to the country legal framework wrong data submission in these forms is punishable by law. However, depending on staff available, CCO/EPA will develop the appropriate plan of data checking, including visiting on sites, elaborating and using a mechanism for cross-checking of the information provided, applying as well the mechanism established by UNFCCC for preparation of country inventory report. The mechanism will take into consideration double counting be excluded. The appropriate instruments will be developed in the frame of LECB project for the Republic of Moldova and will be implemented up to the year 2018.

10. Risk management

The risks seen on the way of ICE CHP Programme implementation, how can they be mitigated, in what terms and who is responsible entities to overcome them are presented in the Table 10-1, below. The risks correspond to the case when external financial support is available to make the projects attractive for ICE CHP developers and, second regulatory framework is developed properly (mainly Tariff methodology for calculation the prices for heat and electricity produced by CHPs in cogeneration mode and the regulation describing the conditions of selling the surplus electricity and its delivery into the electric network, if CHP is not regulated) and published by ANRE to make the Law on thermal energy and promotion of cogeneration lucrative. If such do not exist no ICE CHP projects is expected be promoted in the Republic of Moldova.

Table 10-1. Risks and their mitigation.

No	Risks		Risk assessment (high, medium, low)	Measures to mitigate risks	Terms to overcome risks	Responsible entity
1.	Financial	The price for natural gas could be higher than one from DD (design document)	medium	To establish a regulated price for energy. Any deviation will be considered when the prices are updated. But at regulated prices the payback period may be higher	The decision should be taken at the stage of bidding to get Donors' financing	Beneficiary/ESCO
		Grants are not considered in the regulated energy prices	high	Instead of grant a contract of CO2 emission reduction should be signed between the Donor and Beneficiary	After the bidding stage	Beneficiary, Donors, EEF
2.	Technical and operation al	No important risks are foreseen				
3.	Social	No important risks are foreseen				
4.	Environm ental	No important risks are foreseen				

11. Conclusion

To be completed after stakeholders' comments considerations to the draft of CHP NAMA document

References

To be completed after stakeholders' comments considerations to the draft of CHP NAMA document

1. Landfill Gas Energy Technologies. Instytut Nafti y Gazu. Krakow, 2010, 90 pages

Annex 1: NAMA measures & interventions and their outputs,