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## **Increasing energy efficiency through investments in Combined Heat and Power (CHP)**

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## **Increasing energy efficiency through investments in Combined Heat and Power (CHP)**

### **Executive Summary**

Modern Combined Heat and Power plants (CHP or co-generation), which simultaneously produce electricity and heat, can achieve very high energy efficiency. Consequently increasing the share of such high efficiency CHP installations could contribute significantly to increasing overall energy efficiency of Moldova's energy sector. Indeed, CHPs in the shape of large thermo-electric plant have been a dominant pillar of Moldova's energy sector for decades. However, although well-maintained, existing CHP capacity was mostly built during soviet times and is therefore in need of upgrading. Additionally, there are hardly any new small and medium sized high efficiency CHPs built which in other countries contribute significantly to energy efficient generation.

**An improved framework for investors is the key to more investments in both types of CHPs** and in turn higher energy efficiency. In particular we identified two policy tasks for the government to reduce barriers to improve conditions for investments.

The first area is to **ensure predictable tariffs and appropriate tariff levels**. In order to improve planning for investors especially in new, smaller, decentralised CHPs, the government may introduce a simple, transparent, regulated tariff for electricity produced by those installations. This would avoid the current barrier of having to negotiate bilateral contracts with the TSO. Importantly, the regulated tariff should not constitute a subsidy but set at average market level. To improve predictability of tariff further the independence of ANRE needs to be strengthened, so investors can be insured that tariff adjustments happens according to clear, predicable rules. Political influencing of tariff setting has done considerable damage to existing investors and may have well deterred potential investors which considered investing in Moldova's energy sector.

The second policy task is to **ensure predictable demand for heat and electricity**, the two outputs of CHPs. To achieve this task, the government could put into place a purchase guarantee for electricity from those CHPs which fulfil certain minimum efficiency requirements. In addition operators of small and medium sized CHPs would benefit from modern grid codes to ensure smooth grid integration. To ensure predictable demand for the existing large CHP plants the key is improved competitiveness in order to stop consumers from disconnecting from the district heating grid. Again this requires investments. Given the huge investment backlog, the government should cooperate with donors to finance the most urgent upgrades. This would help to break the vicious circle of poor service quality, declining consumer numbers, increasing unit cost which in turn reduces the attractiveness of district heating provided by large CHPs. In addition, reconnecting public sector buildings back to the grid where economically feasible could help to lower the average unit cost and stop the decline in demand. Finally, formulating a specific capacity target for CHP built up could provide an important signal to investors.

Following this strategy would boost investments into the upgrade of existing plants as well as new high efficiency CHPs. This will lead to an overall improvement of energy efficiency while providing a much needed boost to domestic employment and ensure a secure and stable energy supply.

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## **1 Background and introduction**

### **1.1 Objectives of this policy paper**

The objective of this policy paper is to provide a strategy and policy measures in order to improve energy efficiency in the context of Combined Heat and Power (co-generation or CHP) installations in Moldova. It answers the question, what policy framework is needed so that

- (i) Investors have an incentive to install CHP installations which meet high energy efficiency standards and
- (ii) To improve the efficiency of existing installations.

Combined Heat and Power could be a promising option contributing to improved energy efficiency while also helping to further the overall energy policy objectives. Indeed in addition to high energy efficiency CHP offers a wide range of advantages for the energy system. As a cost competitive technology it can help to provide affordable energy. Being locally produced and able to use different fuels it can also contribute to energy security. In addition all CHP technologies are characterised by a high system quality. That means that electricity and heat produced through CHP are predictable and reliable. The produced electricity is suitable for balancing power in the power system and thus can contribute to grid stability. Another advantage is the varying size of CHP installation which means they can offer a flexible integration depending on local heat and electricity demand.

This suggests that CHP technologies are a viable option for meeting the overall energy policy objectives. However, a prerequisite is that CHP installations are well integrated in the energy system and that both markets – electricity and heat – offer a consistent framework and future outlook.

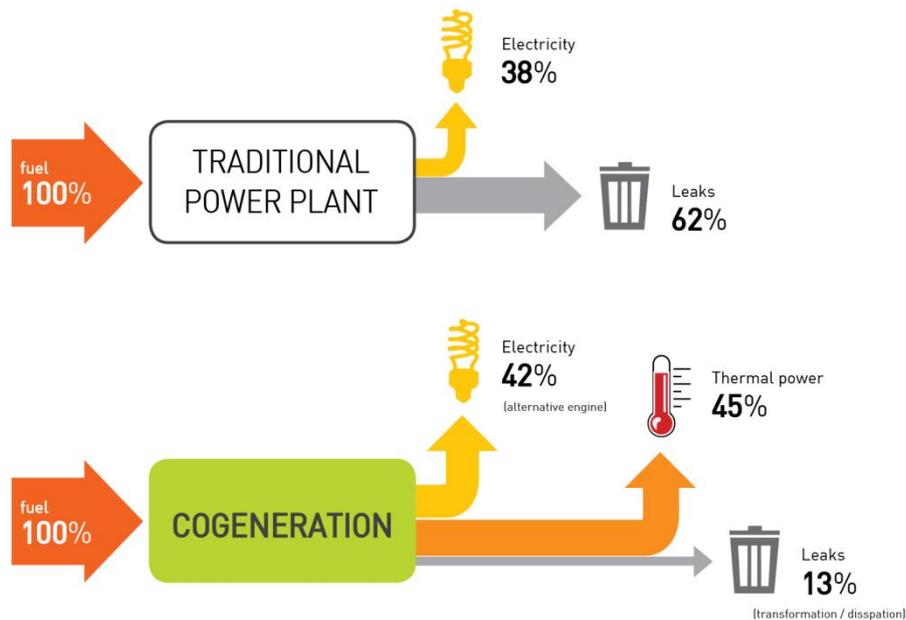
The Moldovan Government is right in wanting to increase the role of CHPs in Moldova. This paper will support this process by outlining the current status of CHPs (chapter 2), identify existing barriers (chapter 3) and make recommendations (chapter 3 and 4) towards a larger role of CHPs in Moldova's energy system.

### **1.2 What is Combined Heat and Power (CHP)**

The term Combined Heat and Power (co-generation or CHP) refers to the technical concept of simultaneous production of heat and power (electricity) in stationary power facilities. Due to the combined production CHP has an overall energy efficiency based on primary energy of more than 90%, which greatly exceeds the energy efficiency in the separate production of heat and electricity (see Figure 1).

**Figure 1**

Example for the overall energy efficiency of CHP in comparison to traditional power plants



Source: *costell.it*

CHP facilities can be run under three different modes:

- a) **Electricity optimized operation:** This mode of operation is mainly dedicated to a high share of electricity. Heat is a by-product.
- b) **Heat optimized operation:** This mode of operation is mainly dedicated to a high share of heat. Electricity is a by-product.
- c) **Alternate operations:** Selected CHP plants are able to switch flexible between the main and the by-product depending on market conditions.

The mode of operation determines both, the technical and economic concept of a CHP facility. The main features of the *technical concept*, namely electricity power and heat output (volume and temperature), connection to the grids, type of fuel (prices and availability) and projected running mode, are usually determined in the early stages of the CHP planning phase depending on the local specifics. The *economic concept* reflects the future earning potential from selling electricity and heat and the cost structure for the preferred concept. Both concepts determine each other.

The table below shows the different types of CHP and their possible fuel options. Heat quality refers to the fact that process heat usually requires warmer temperature levels than heat for heating and warm water. The last column headed “scale in the energy system” gives a perception of the possible impact of a single CHP unit of the type in question on the entire power system.

**Table 1**

Characteristics of common CHP types

Technology	Usual electricity power [MW]	Heat quality	Overall energy efficiency <sup>1</sup> [%]	Standard fuel	Scale in the energy system
gas and steam – heating plant	10 to 400	process heat	till 90	natural gas	large
steam turbine	0.075 to 250	process heat	till 90	coal, oil, waste	large
gas turbine	0.03 to 250	process heat	till 85	natural gas, diesel	large
block heat and power plant (combustion engine)	0.001 to 20	thermal heat, process heat	till 90	natural gas, biogas, diesel, vegetable oil	medium
organic rankine cycle plants	0.02 to 5	process heat	till 80	wood, waste heat	medium
fuel cell	0.001 to 0.25	process heat	till 90	natural gas, biogas, hydrogen	small

Source: dena

Heat output, due to the high volume and temperature level, is always consumed locally. The electricity produced, on the other hand, is usually fed into the grid and can easily be transported over high distances. This has historically led to construction of CHPs near the heat consumers. That is, urban areas with high heat demand. Indeed, heat transport over distances of more than 50 km is not being practiced.

CHP plants are in direct competition with separate production of heat (e.g. boilers, condensing boilers or heat pumps) and electricity (e.g. conventional gas or coal power plants). The described advantages – especially the high energy efficiency – of CHP technologies can only be realised, when both products, heat and electricity, are used. A decline in either one market will reduce the profitability of a CHP installation significantly. Therefore both markets have to offer suitable conditions and price signals which imply a need for adequate regulation and predictable demand scenarios.

As shown in this chapter, CHP technologies offer a wide range of possible applications. Due to the wide scope of possible installations, a coherent CHP policy should follow a holistic approach.

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<sup>1</sup> based on primary energy

### 1.3 Energy efficiency in the context of CHP

CHP technologies can contribute to an energy policy which aims at improving energy efficiency. Specifically there are two main policy areas which can be used to improve energy efficiency in the context of CHPs.

- Policies aimed at improving the **energy efficiency of existing CHP installations**.
- Energy policy to ensure that **newly built CHP plants** meet high energy efficiency standards and thus contribute to overall energy efficiency improvements.

In this paper we explore the potential, barriers and measures to higher energy efficiency in both areas: existing CHPs and newly added capacity.

Indeed, in the future it is likely that more and more decentralised CHP capacity will be added to the Moldovan energy system. The reasons for this development are obvious: small and medium size CHP are less costly, faster planned and built, and the technical layout can easily adapt to the existing heat demand.

Due to the differences between the two types of CHP plants – existing (large) and new (medium/small) – it is likely that different policy approaches are needed to improve energy efficiency in either area.

## 2 Status quo of Moldova's CHP capacity

### 2.1 Capacity of existing and recently newly installed CHP plants

Co-generation and district heating have a long tradition in Moldova. The first plants were commissioned in the late 1950s. In the past construction of CHP plants was combined with the construction of district heat networks which were either served by the CHPs or boiler houses. Table 2 below shows current CHP capacities in Moldova.

**Table 2**

Overview of the existing CHP capacities in Moldova

Name	Installed capacity (MW electricity)	Type	Fuel	District heating	Share of maximal national power load <sup>2</sup> in %	Share of national district heating demand <sup>3</sup> in %
<b>Centralised CHP</b>	<b>330</b>				<b>33</b>	<b>62.6 – 73.5</b>
<i>CHP1</i>	<i>66</i>	<i>centralised CHP</i>	<i>gas</i>	<i>yes</i>	<i>6.6</i>	<i>8.7 -13.1</i>
<i>CHP2</i>	<i>240</i>	<i>centralised CHP</i>	<i>gas</i>	<i>yes</i>	<i>24</i>	<i>45.9– 50.7</i>
<i>CHP Nord</i>	<i>24</i>	<i>centralised CHP</i>	<i>gas</i>	<i>yes</i>	<i>2.4</i>	<i>8 – 9.7</i>
<b>Decentralised CHP</b>	<b>3.46</b>				<b>0.35</b>	<b>(&lt; 1)</b>
<i>CHP Drochia</i>	<i>2.4</i>	<i>decentralised CHP</i>	<i>bio gas</i>	<i>no</i>	<i>0.24</i>	<i>(0.42)</i>
<i>CHP Firladani</i>	<i>1.06</i>	<i>decentralised CHP</i>	<i>bio gas</i>	<i>no</i>	<i>0.11</i>	<i>(0.42)</i>
<b>Sum all</b>	<b>333.46</b>				<b>33.35%</b>	<b>63.4 – 74.3</b>

Source: Own research

The table shows clearly the overwhelming share of CHP capacity resulting from existing centralised CHPs. Moldova is highly dependent on those CHP installations due to the electricity power and heat capacity they provide. Over 60% of the national heat demand is provided by district heating from the three large centralised CHPs. Currently all significant electricity power capacity in Moldova is provided by the three large CHPs (excluding Kuchurgan Power Plant which is located in Transnistria). Nevertheless these CHP can cover only a third of the maximum power load of about 1.000 MW.

In comparison, at the moment small, decentralized CHP do not play a significant role in the Moldovan energy sector. Indeed, their overall number is low and their operating status is partly unknown. To our knowledge there are only two decentralised CHPs in operation of which one is located in a sugar and one in a milling company providing process heat (and electricity) for the two companies.

Conclusion: CHPs have a significant role in heat and power production in Moldova. However, currently the overwhelming share of CHP capacity is made up by large centralised CHPs from Soviet

<sup>2</sup> Maximum national electrical power load about 1.000 MW in winter.

<sup>3</sup> Values based on own calculation. Share of national heat demand covered by district heating only.

times. Small decentralised high efficiency CHPs play only a minor role. This raises the question why no new CHP capacity is constructed.

## 2.2 Energy efficiency of current CHP capacity

The World Bank states that all centralised CHPs in Moldova operate beyond their economic lifetime. As these facilities were constructed in the 1950s and in the mid-1970s and in the absence of substantial rehabilitation or retrofitting since their construction, the efficiency and reliability of the CHPs have been steadily declining.<sup>4</sup>

Table 3 shows the development of energy efficiency of the three largest CHPs in Moldova based on our own calculations.

**Table 3**

Overall energy efficiency for centralised CHP in Moldova in %

Name/Year	2005	2006	2007	2008	2009	2010	2011	2012	2013
CHP1	73.38	75.02	70.1	69.6	67.3	79.3	81	85.5	83
CHP2	73.2	75	74.7	76.1	74.45	76	76.4	75.9	75.8
CHP Nord					75-72				

Source: Own calculations based on ANRE data

It has to be mentioned that the World Bank calculates a lower overall energy efficiency of 62% for CHP-1 and 71% for CHP-2.<sup>5</sup> The difference might be explained by different approaches and input data.<sup>6</sup> Regardless which estimates are used, the numbers suggest that efficiency of Moldova's existing CHPs is well below the overall energy efficiency of up to 90% that can be achieved by state of the art installations.<sup>7</sup>

While energy efficiency is low, it is noticeable from our discussions with stakeholders that Moldovan operators have several ideas and technical measures to maintain or to improve energy efficiency. However, putting them into practice seems to be not possible within the current framework.

For the few modern, decentralised CHP installations operating in Moldova no figures on energy efficiency are available due to the fact that they are in private property. It can be assumed that these facilities are modern ones and therefore have (theoretically) high energy efficiency if they are operated well.

Conclusion: The data show that energy efficiency of existing plants is below the potential of modern CHP system due to outdated equipment. Additionally, hardly any new energy efficient CHP installations have been installed in the recent years. Therefore it is necessary to understand what the main barriers are today and what has to be done to overcome these barriers to improve the energy efficiency of CHPs in Moldova.

<sup>4</sup> "District heating efficiency improvement project", World Bank, 2014 p.21

<sup>5</sup> "District heating efficiency improvement project", World Bank, 2014 p.21

<sup>6</sup> The setting of the system boundaries by evaluating the overall energy efficiency of power plants/CHPs varies often in the different approaches.

<sup>7</sup> For details see table 1.

### 2.3 Existing legislation and regulatory framework

Our review of Moldova's legislation and regulatory framework related to energy policy suggests that the government has already started promoting energy efficient CHP installations. The main legal documents in this context are:

The **Energy Strategy of Moldova** foresees the construction of a new CHP plant with a total of 650 MW electricity power operated as Combined Cycle Gas Turbine by 2030. Once the new plant is completed the old CHP 1 and CHP 2 will be decommissioned. If realised, this project will double today's centralised CHP electrical power and will significantly contribute to the amount of national electrical power capacities.

**National Renewable Energy Action Plan 2013-2020:** The Action plan aims for an increase of Renewable Energy Sources till 2020. In the electricity sector renewable energy should account for 10% and in the heat sector for 27% of consumption. The Action Plan also requires the modernisation of municipal district heating systems and of large CHPs.<sup>8</sup> However, in the current vision the Action Plan sees no significant contribution of CHP installations powered by renewable energy sources to the electricity generation capacity till the year 2020. Although the described biogas development path might include CHP technologies.<sup>9</sup> However, the Action Plan foresees implementation of two CHP related projects by 2016. First, to develop a feasibility study for conversion of coal CHP to biomass CHP and the second one is to ensure transparency for investors in biomass CHPs.<sup>10</sup> What is more, the National Renewable Energy Action Plan demands the implementation of a central electricity supplier which purchases renewable energy and offsets intermittent generation.<sup>11</sup>

**Law on electricity:** According to the law on electricity, electricity generation capacity (regardless of the fuel used) larger than 5 MW for public consumption and larger than 20 MW for internal consumption only has to apply for a generation licence by ANRE and shall collaborate with other power market participants.<sup>12</sup>

**Law on heat:** The purpose of the law is efficient functioning and regulation of thermal energy supplied by centralised systems and the promotion of cogeneration (CHP) based on useful thermal energy demand. The main objectives in context of CHP are: Promotion of thermal energy production in cogeneration mode and promotion of centralised systems for thermal energy supply. The regulator's tasks according to the law are to develop and approve the calculation methodologies and application of regulated tariff for thermal energy production and distribution and to apply the principle of priority purchase of the heat of the CHPs.

Importantly, the Law states a mandatory connection of heat consumers to the central heating grid unless the user proves with a feasibility study that this would cause unreasonable cost. Furthermore it demands a priority purchase of heat produced in high-efficiency co-generation.

**Conclusion:** While there is no single dedicated CHP strategy, there are a number of measures which already affect the way CHPs can operate.

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<sup>8</sup> National Renewable Energy Action Plan of the Republic of Moldova for 2013-2020, p.3

<sup>9</sup> National Renewable Energy Action Plan of the Republic of Moldova for 2013-2020, p.72

<sup>10</sup> National Renewable Energy Action Plan of the Republic of Moldova for 2013-2020, p.22

<sup>11</sup> National Renewable Energy Action Plan of the Republic of Moldova for 2013-2020, p.19

<sup>12</sup> National Renewable Energy Action Plan of the Republic of Moldova for 2013-2020, p.26

### **3 Barriers to improved Energy Efficiency in the context of CHP**

Combined Heat and Power production competes with production of electricity and heat in separated facilities. To have a competitive advantage in terms of price and quality, the energy efficiency of CHP operations is essential. Given the dual nature of CHP this requires stable and predictable conditions on both the heat and electricity market. Only if such a stable framework is provided, investments in energy efficient new capacities or into the improvements of existing CHPs can be attracted. Stable conditions are particularly important given the capital intensive and therefore long-term nature of these investments.

In order to provide such a stable framework for investments into CHP, Moldova's CHP policy needs to address the following areas:

- 1. A predictable regulatory framework and tariff policy**
- 2. Predictable heat and electricity demand**
- 3. Access to finance**

While this applies to CHP installations in general, the three areas differ depending if large centralised plants (i.e. most of Moldova's existing capacity) or new smaller, de-centralised plants are considered.

*Pre-condition: Make use of donor support where offered*

In order to improve energy efficiency of existing large centralised CHP plants, donor support offered by World Bank and others should be a key element of Moldova's strategy to increase efficiency in the context of CHPs. Working together with the World Bank, SIDA, EBRD and other donors will go a long way in addressing the causes of low energy efficiency of large and centralised CHP facilities.

Indeed, the World Bank has provided a viable rehabilitation strategy for the CHP plants in Chişinău and the urban district heating network in the capital. The bank offers loans for investments in the district heating system as well as technical support for modernising the corporate structure and management.<sup>13</sup>

However, while cooperation with donors should be an essential part of Moldova's CHP policies, a comprehensive CHP strategy should go further. Given that energy efficiency in CHP requires investments, the main task of the government is to improve the framework for such investments. Below we review existing barriers and provide recommendations in order to provide a suitable framework for increasing energy efficient CHP capacity.

#### **3.1 Regulatory framework and tariff policy**

The means to higher energy efficiency in CHP are investments which will only happen if investors can expect a reasonable return on investment or profitability. Tariff policy, in particular, the tariff setting approach and the tariff levels, determine the profitability of CHP plants and hence if investments take place.

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<sup>13</sup> District Heating Efficiency Improvement Project, World Bank, 2014

## *Tariff setting approach*

### Heat tariffs

The heat tariffs are set by a cost-plus methodology described in the Law on Heat.<sup>14</sup> This applies to all operators who provide heat for public consumption. So an investor who wishes to install a new CHPs and provide heat to public consumers would have to apply for a license and have its costs approved by the regulator ANRE.

### Electricity tariffs

The tariff setting approach for electricity produced through co-generation is not yet clearly regulated.<sup>15</sup> At the moment only electricity produced by the three large CHP in Moldova is subject to regulated tariffs. Tariffs for electricity produced by those large CHP are set using a cost plus approach.

In contrast, for operators of small and medium sized CHP installations no binding procedure for electricity tariffs exists. For them the only option to sell excess electricity is a bilateral contract with the grid operator. Given that there is only a sole buyer, the prices that can be achieved may not be favourable.

In sum, while the tariffs setting approach for heat is workable, the price for selling electricity produced in small and medium scale CHP installations is subject to considerable uncertainty. This poses a risk to the earning potential of CHP installations and may constitute a significant barrier for investments in new CHP capacities.

Thus there is a need to introduce a clear and transparent tariff methodology for small and medium sized CHPs below a certain threshold. Due to the potentially large number of co-generation plants and the various types of co-generations technologies, the regulatory approach “cost plus” is not practical. Cost plus would add a huge administrative burden to small scale CHPs wishing to feed relatively small amounts of electricity into the grid. Similarly, having to review individual costs of a potentially large number of small and medium sized CHPs may overwhelm the regulator.

A possible alternative would be an electricity tariff that is a moving average of the market price or the average of the cost-plus regulated operators. This would represent a simple transparent approach for investors considering installing CHP plants. At the same time the tariff for small CHPs would be similar to the tariffs for electricity produced by larger CHPs with traditionally regulated cost. Importantly, the feed-in tariff for CHPs should not provide financial incentives but be in line with the average electricity tariff.

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<sup>14</sup> Law on Heat Nr. 92, Article 45, 2014

<sup>15</sup> see tariff data published by ANRE

## Box 1

### Tariff policies in Germany

The CHP Act in 2002 declared the objective to increase the share of CHP in electricity production to 25% in 2020. To achieve this objective, the government planned to attract investments in new operations or refurbishment measures.

#### *Market integration*

One instrument was an improved market integration of fuel cells, districting heating and cooling and the installation of heat and cooling storage. Regulation obliges grid operators to buy and to distribute CHP power with priority.

#### *Tariff setting*

Under the law grid operators have to buy the CHP electricity at a “normal price”, unless agreed otherwise in a bilateral contract with the CHP-plant operator. The normal price is defined as the average base-load electricity price of the EEX (European Energy Exchange) in Leipzig over the previous quarter. For example, the normal price for the first quarter of 2015 was 32.1 EUR/MWh.

#### *Financial incentives*

Small and medium sized CHP plants also receive an extra bonus on the electricity they supply to public electricity networks. Additionally, the bonus is limited to a certain amount of runtime hours or years. For example CHP under < 50 kW could gain an extra bonus of 54.1 €/MWh for 10 years or 30.000 runtime hours. CHP larger than 50 kW and smaller than < 2MW claim an additional bonus between 18.0 €/MWh and 54.1 €/MWh for a maximum of 30.000 runtime hours. The overall costs for the support scheme are limited by law to EUR 750 m per annum and have to be borne by all power costumers in the shape of surcharge to their electricity cost (which ranges between 0.254 EUR/kWh for households and small companies and 0.025 EUR/kWh for energy intensive companies).

CHP powered with renewable energy (e.g. biogas) are mainly remunerated by the Renewable Energy Sources Act. The operator might switch the scheme if profitable.

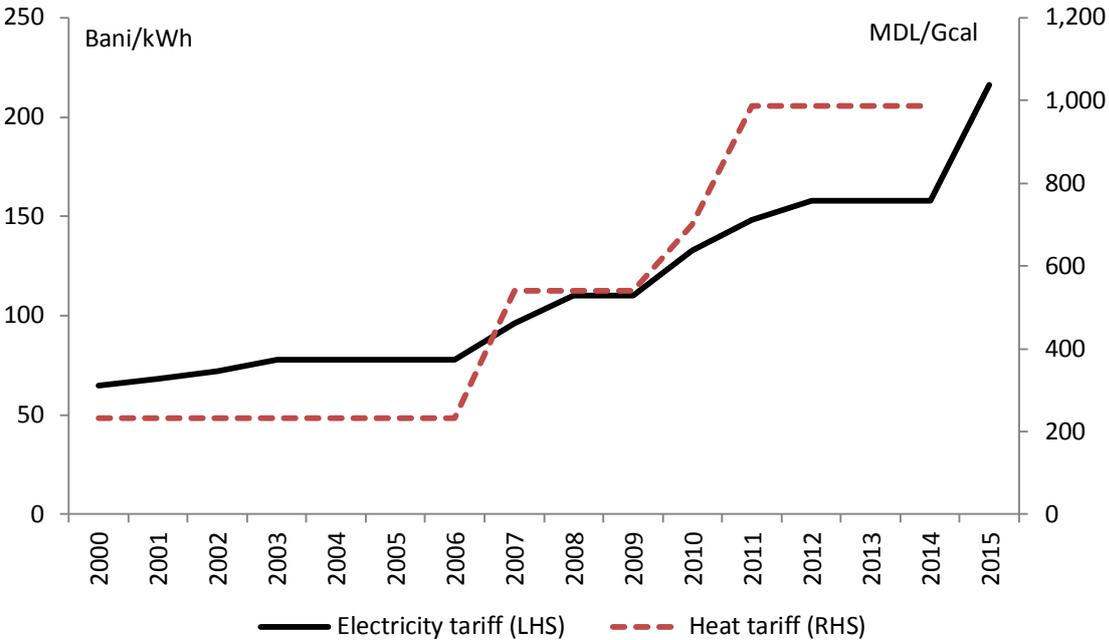
**Recommendation 1:** *The government should consider providing a simple, transparent, regulated feed-in tariff for electricity produced by small and medium size CHP plants. Such a tariff should be set at a level which reflects the average of cost-plus regulated tariffs.*

*Question 2: Is the current level of tariffs appropriate?*

The question if the tariff level is appropriate is a decisive factor for investments in the upgrade or new CHP installations. The chart below shows tariff levels for electricity in Moldova for the three large CHPs. Starting in 2006 Moldova increased heat and electricity tariffs so they could cover full cost recovery (see figure below). However, tariff adjustments paused between 2012 and 2015. As this period coincided with a depreciation of the Moldovan LEI, which gradually increased the cost of imported gas and electricity, this resulted in tariffs falling below the level needed to cover cost.

Although the gap between the cost recovery level and tariffs reduced following a large tariff increase in July 2015, the failure to adhere to the tariff setting policy as stipulated in the law has caused considerable damage to existing operators. What is more, it is likely to deter future investors from investing in Moldova’s CHP capacity.

**Figure 2**  
Regulated electricity and heat tariffs over time



Source: ANRE, own estimate

In addition to the mentioned problems with regular tariff reviews, the tariff methodology and setting has been subject to some ad-hoc changes in the past. For example, the weighted capital cost was changed on a short notice for Union Fenosa, the only private operator, which represents a huge barrier for investments and thus higher energy efficiency in the CHP sector.

**Recommendation 2:** *As a pre-requisite for any investment in the CHP sector, it is highly recommended that the government follows World Bank suggestions to strengthen the regulator’s role and to implement a truly independent tariff setting policy.*<sup>16</sup>

*Decentralised CHP plants*

In addition, there is the question if current tariff levels in general are sufficient to cover the generation cost of new small and medium size CHP installations. Clearly, generation cost will differ depending on the specific CHP plant. Nevertheless there is some merit in comparing generation cost of a prototypical CHP plant operated in Western Europe with tariff levels in Moldova in order to get a sense if investments in this field are feasible at all.

<sup>16</sup> “District heating efficiency improvement project”, World Bank, 2014 p.23

The table below shows an estimation of electricity generation costs for two types of decentralised natural gas powered CHPs. The first CHP is assumed to serve a commercial building while the second one provides energy for an industrial company. The examples suggest that production cost would lie somewhere in the range of 0.08 EUR/kWh and 0.10 EUR/kWh.

**Table 4**

Examples for the electricity generation costs of decentralised CHP installations<sup>17</sup>

Cost category	CHP serving a commercial building	CHP serving an industrial company
Electrical power size [kW]	100	1,000
Investment costs [EUR/kW]	1,700	1,200
Discount rate	8%	8%
Calculation period [year]	10	10
Full load hours [h]	6,000	6,000
Running costs [EUR/kWh]	0.02	0.02
Fuel costs [natural gas; EUR/kWh]	0.05	0.05
Electrical efficiency	35%	35%
Thermal efficiency	55%	55%
<b>electricity generation costs [EUR/kWh]</b>	<b>0.10</b>	<b>0.08</b>

Source: Own research based on Costell.it

In comparison current tariff levels lie somewhere between 0.09 and 0.11 EUR/kWh (see table below).

**Table 5**

Consumer tariffs by voltage level in 2015 in EUR/kWh<sup>18</sup>

0.4 kV	6 and 10 kV
0.103 -0.110	0.093 – 0.099

Source: ANRE

This indicates that generation costs and customer tariffs are comparable. Thus at current tariff levels there could be an economic case for electricity production with CHPs. The comparison also suggests that there is no immediate need for financial incentives for CHP operators.

<sup>17</sup> The calculation gives only an indicative view on the subject. Assumptions reflect West-European price levels.

<sup>18</sup> Based on own calculations with data from ANRE.

### 3.2 Predictable heat and electricity demand

As long term investments, CHP investors require predictable heat and electricity demand, the two outputs of CHP plants.

#### *Electricity demand*

For its electricity demand Moldova is highly dependent on electricity produced in Transnistria and in Ukraine. Indeed, current national power capacities add up to only half of national maximum consumption load.<sup>19</sup> Worryingly, the supply of electricity from abroad is by no means assured as the recent stop of electricity imported from Ukraine vividly illustrates. Due to the reliance on electricity imports, it is fair to say that there is a reasonable demand for new power capacity in Moldova. However, even if a new medium sized CHP plant is built, at the moment CHP operators rely on bilateral contracts with Moldelectrica in order to sell their electricity. As Moldelectrica is the sole buyer for producers wishing to sell electricity to the grid. As there is now purchase obligation new operators have to negotiate bilateral contracts with Moldelectrica which adds considerable uncertainty to any investment in CHP.

**Recommendation 3:** *To provide predictable demand especially for investors considering setting up small and medium sized CHPs, the government should consider a feed-in obligation which guarantees the purchase of electricity produced by high energy efficiency co-generation. Additionally, such an obligation for electricity produced by CHP is necessary if the government decides to regulate tariffs for small and medium sized CHPs.*

#### *Heat demand*

While there may be sufficient demand for new electricity generation, local heat demand may prove to be the bottle neck for investments in CHP installations. Here the situation differs between demand for heat produced by large (centralised) plants as exist already and demand for heat potentially produced by additional small and medium sized CHPs.

#### *Heat demand situation for large centralised CHP plants*

In the past demand for heat provided by large CHPs for district heating has dropped significantly. This is partly due to the economic transition as industrial consumers sharply reduced their heat consumption. In addition, demand for centrally produced heat and hot water from households has reduced as a significant share of households has chosen to disconnect from the district heating grid. The reason for disconnection is usually low service quality and cheaper alternatives suggesting that district heating provided by large CHP is not competitive. The decline in heat demand from district heating was aggravated as public sector consumers followed suit and disconnected a large number of public sector buildings from the district heating network.

This leads to a vicious circle: Due to the high fixed cost of district heating networks and large CHP installations as many customers (commercial, households and public sector) as possible within the reach of the grid have to be persuaded to connect to the centralised grid in order to achieve low cost per unit. This requires high service quality at low cost which in turn requires investment as well as changes to the corporate structure of the large district heating providers.

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<sup>19</sup> Excluding the Kuchurgan Thermal Power Plant which is based in the Transnistrian region.

**Recommendation 4:** *The World Bank District Heating project and other donor funded projects offer a viable route to increase service quality and reduce cost and thus break the vicious circle of falling user number which result in even higher cost.*

**Recommendation 5:** *Additionally, the government should review if the rights of district heating customers are sufficient. Consumers need to be able to appeal to a neutral watchdog in case the quality of heat and warm water provided does not fulfil certain minimum standards.*

**Recommendation 6:** *If based within the district heating grid, public sector buildings should be reconnected to the district heating network in order to increase heat demand.*

**Recommendation 7:** *Once service quality and customer rights are assured, and only then, administrative measures which make connection within the district heating grid obligatory may be warranted. The existing obligation to connect to the central heating grid seems to be not binding enough.*

#### *Demand situation for small and medium sized CHP*

For small and medium sized CHP the Law on Heat already provides a purchase obligation for heat produced by those facilities. If this provision is enforced in practice, it should provide predictable demand and thus good incentives for potential investors. Investors can be further assisted by developing and providing heat demand maps – a measure that is already being discussed. Furthermore, specifying and making public a specific target for CHP market share in gross consumption would be a good signal for investors that there is sufficient demand for increased CHP capacities.

**Recommendation 8:** *In addition, the state can assist with maps of heat demand and heat sources as are currently developed by the Energy Efficiency Agency and stipulated in the Law on Heat. Defining a future CHP goal (e.g. in % share of gross consumption) would also be an important signal for investors.*

### 3.3 Ensuring grid access and integration

In addition to predictable and stable demand (see chapter 3.2 above), the government also needs to ensure that additional CHP capacity can be properly integrated into the existing grid. The instruments needed to achieve this objective are grid codes. Grid codes stipulate basic requirement so grid network operators are able to cope with plenty of new, mainly decentralised, installations connected to the grid while at the time ensuring safe grid operations. Indeed, it is likely that grid operations will fundamentally change in the future if the government is successful in attracting new decentralised CHP capacities.

The following details should be clarified in contracts in order to ensure safe grid access for both parties (CHP and grid operator).

**Table 6**

Content of grid codes and grid standards

<b>CHP operator has to provide</b>	<b>Grid operator (TSO and DSO) has to provide</b>
Technical concept of CHP – (e.g. electrical power, fuel, share of own use power, wiring diagram)	Voltage, reactive power and frequency quality standards
Planned point of connection to the grid	Measurement, network handover and billing
Disclosure obligations <ul style="list-style-type: none"> <li>• Scheduled changes in power and operations</li> <li>• Damages and disorders</li> <li>• Changes in ownership)</li> </ul>	Emergency procedures and unplanned shutdown operations

*Source: Own research*

These grid codes promote stable running conditions for CHP operators and predictable power and heat feed-in for transmission and distribution grid operators. In case of a strained grid situation the grid codes emergency procedures help to steer production and to maintain stability in order to avoid unplanned shutdowns. These rules guarantee full runtime, which is a prerequisite of high energy efficiency CHP operations and planning safety for grid operators.

Basic grid codes and standards are appointed between grid operator and the CHP operator which follow standard contracts reviewed by the regulator or the TSO. In case of disagreement between the parties, the regulator should act as a mediator. The regulator should have the rights and capacity to evaluate grid standards in certain time steps and to push revisions in cooperation with the TSO. With regard to a future renewable energy dominated energy system, grid codes are the first step towards a smart grid approach with high shares of decentralised capacities.

In addition, in the future the impact of a large increase in decentralised power generation should be assessed to see if there is a need for interventions such as grid extensions, backup capacities and fine adjustment of the grid codes and standards.

**Recommendation 9:** *Introduce grid codes and standards for small and medium sized CHP operators in order to ensure smooth grid integration.*

### 3.4 Financing

Access to finance for investors is another crucial factor that determines if investments in existing or new CHP installations in Moldova take place. In this context providing appropriate tariffs (chapter 3.1) and predictable demand (chapter 3.2) will go a long way in order to provide sufficient cash flows for internal financing. However, additional external financing can provide a boost to investments in upgrades of existing CHP as well as new efficient CHP installations. Again the financing issues differ depending on the two types of CHP (large existing vs. new small and medium-sized installations).

### *Financing issues of existing large CHP plants*

It is clear that reducing the massive investment back-log of the **large existing CHP installations**, exceeds the means of the owners (i.e. local or central government) and what can be provided through internal financing from tariff income even after tariffs were adjusted. Hence here cooperation with international donors (in particular the World Bank, EBRD and SIDA) is advised to cover the costs of urgent basic investments that are needed to keep the system running and make operations economically viable. Only this assures that, in the long term, large existing CHPs are in a sound economic condition and the operators can get access to external financing at competitive interest rates. However, a pre-requisite for donor support is a sound financial and cooperate basis of existing providers.

**Recommendation 10:** *Financing energy efficiency improvements of large existing CHPs should follow a two staged-approach. Firstly, use donor technical and financial assistance to make CHPs economically viable operations. Secondly, once this has been successful, CHPs may access external finance or even invite external investors.*

### *Financing issues of new small and medium sized CHP plants*

As outlined in the first section of the report, modern CHP plants offer a range of benefits: High energy efficiency, stable base load energy supply and independence from external energy sources. With those benefits in mind, there is a good case for additional support. While a stable and predictable policy framework will go a long way, the government should also consider providing preferential financing conditions. Existing funds like MOSEFF and MOREFF already offer options to promote investments into new CHPs if these facilities meet minimum energy efficiency standards.

In addition, Moldova's Energy Efficiency Fund could provide an additional financing source. Given that Moldova's Energy Efficiency Fund already focusses on support of energy efficiency measures in the public sector, it could extend its activities to support investments into CHPs which serve public sector consumers. Indeed, examples from other countries show that small and medium sized CHPs lend themselves for the heat and electricity demand of public sector building such as schools, administrations and swimming pools. The potential for CHPs serving the public sector may be particularly large as many old boilers are in urgent need for upgrades and replacements.

**Recommendation 11:** *Moldova's Energy Efficiency Fund should be extended in order to include CHP installations for public buildings – such as schools, administration offices, etc.*

## 4 Summary of recommendations

The experience of other countries shows that CHPs can offer a cost-effective way to increase overall energy efficiency of the energy system. What is more, it can help to achieve the overall energy policy objective of affordable, secure and environmental energy supply.

To increase energy efficiency in and through CHPs requires substantial investments. As such, attracting investments into combined heat and power should be the main goal of the government's strategy to increase energy efficiency in the context of CHP.

### How can this be achieved?

To achieve this objective, the main task for the government is to make sure conditions are right for investments in CHP. Specifically, this includes the following three tasks:

- a) Appropriate and predictable tariffs
- b) Predictable electricity and heat demand
- c) Improved access to finance

Below we outline our recommendations for the three areas of government intervention in more detail:

#### *Task: Appropriate and predictable tariffs*

**Recommendation 1:** The government should consider providing a simple, transparent, regulated tariff for electricity produced by small and medium size CHP plants. For example, such a tariff could be set at a level which reflects the average of cost-plus regulated tariffs.

**Recommendation 2:** As a pre-requisite for any investment in the CHP sector, it is highly recommended that the government follows World Bank suggestion to strengthen the regulator's role and to implement a truly independent tariff setting policy.

#### *Task: Predictable electricity and heat demand*

**Recommendation 3:** To provide predictable demand especially for investors considering setting up small and medium sized CHPs, the government should consider a feed-in obligation which guarantees the purchase of electricity produced by high energy efficiency co-generation. Additionally, such an obligation for electricity produced by CHP is necessary if the government decides to regulate tariffs for small and medium sized CHPs.

**Recommendation 4:** The World Bank District Heating project and other donor funded projects offer a viable route to increase service quality and reduce cost and thus break the vicious circle of falling user number which result in even higher cost.

**Recommendation 5:** Additionally, the government should review if the rights of district heating customers are sufficient. Consumers need to be able to appeal to a neutral watchdog in case the quality of heat and warm water provided does not fulfil certain minimum standards.

**Recommendation 6:** If based within the district heating grid, public sector buildings should be reconnected to the district heating network in order to increase heat demand.

**Recommendation 7:** Once service quality and customer rights are assured, and only then, administrative measures which make connection within the district heating grid obligatory may be warranted. The existing obligation to connect to the central heating grid seems to be not binding enough.

**Recommendation 8:** In addition, the state can assist with maps of heat demand and heat sources as are currently developed by the Energy Efficiency Agency and stipulated in the Law on Heat. Defining a future CHP goal (e.g. in % share of gross consumption) would also be an important signal for investors.

**Recommendation 9:** Introduce grid codes and standards for small and medium sized CHP operators in order to ensure smooth grid integration.

*Task: Improved access to finance*

**Recommendation 10:** Financing energy efficiency improvements of large existing CHPs should follow a two staged-approach. Firstly, use donor technical and financial assistance to make CHPs economically viable operations. Secondly, once this has been successful, CHPs may access external finance or even invite external investors.

**Recommendation 11:** Moldova's Energy Efficiency Fund should be extended in order to include CHP installations for public buildings – such as schools, administration offices, etc.

Implementing the recommendations made in this study (in addition to measures already planned in other policy documents) would significantly improve the framework for investments in CHP installations. Those investments would lead to a gradual improvement of energy-efficiency of existing CHP facilities and see an increase of the capacity of new high efficiency CHP plants. As such, CHPs could be an important and cost-effective instrument for increasing the overall energy efficiency of Moldova's energy sector. What is more, an improved framework for CHPs could provide a welcome boost to (foreign direct) investments and employment in Moldova.

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