

# CODE2

Cogeneration Observatory  
and Dissemination Europe



## *D5.1 - Final Cogeneration Roadmap* Member State: **Romania**

**October 2014**

Leading CODE 2 Partner: Hellenic Association for Cogeneration of Heat and Power, HACHP

*Romania is part of the non-pilot Member States of the SE Europe CODE2 Region.*

*The CODE2 Region 'South-East Europe' comprises the following Member States: Bulgaria, Cyprus, Greece, Romania*



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This is a combined effort by policy makers and experts from Government, NGOs, Energy Agencies operating in Romania, SMEs and local industrial/energy associations, ESCOs to raise a new awareness campaign on the benefits of CHP and micro-cogeneration, through specialized seminars, published best cases studies that could provide more practical information to local engineers and planners, in Decision to get the needed knowhow and, then, promote this technology.....	20
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## Introduction and Summary

### The CODE2 project<sup>1</sup>

This roadmap has been developed in the frame of the CODE2 project, which is co-funded by the European Commission (Intelligent Energy Europe – IEE) and will launch and structure an important market consultation for developing 27 National Cogeneration Roadmaps and one European Cogeneration Roadmap. These roadmaps are built on the experience of the previous CODE project ([www.code-project.eu](http://www.code-project.eu)) and in close interaction with the policy-makers, industry and civil society through research and workshops.

The project aims to provide a better understanding of key markets, policy interactions around cogeneration and acceleration of cogeneration penetration into industry. By adding a bio-energy CHP and micro-CHP analysis to the Member State projections for cogeneration to 2020, the project consortium is proposing a concrete route to realise Europe's cogeneration potential.

### Draft roadmap methodology

This roadmap for CHP for Romania is written by CODE2 partner HACHP, based on a range of studies and consultations, with local experts and energy players, through a process of discussion and exchange of ideas and opinions on the promotion of CHP in the country.

### Acknowledgement

HACHP and the CODE2 team would like to thank all experts involved for their contributions to develop this roadmap, which has been valuable regardless of whether critical or affirmative. It has to be stressed that the statements and proposals in this paper do not necessarily reflect those of the consulted experts.

### Summary

Cogeneration has a long-tradition in Romania. Due to structural changes in the economy following the 1989 Revolution and more recent economic problems, CHP share on the total electricity production sharply declined between 2005-2008, but has made a slight comeback since indicating the start of an upturn.

The further development and modernization of the CHP sector is considered as a key measure to improve energy efficiency in Romania. Public support for CHP in Romania has been generally favourable, as the Government launched in 2011 a bonus scheme (feed-in premium) offering operational support for electricity produced in high efficiency CHPs.

Aged district heating and electricity networks, bureaucracy and the limited scope of support schemes constitute the main barriers for the further development of the CHP sector in Romania, resulting low investor confidence and limited deployment of new CHP installations.

Attaining the Roadmap Path would deliver 9.3 TWh/annum in primary energy saving (PES) under the Energy Efficiency Directive (EED) methodology. Considering the likely implementation path up to 20 TWh/annum in PES and 12 million tonnes of CO<sub>2</sub> reductions are achievable in practice.

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<sup>1</sup> For more details and other outcomes of the CODE2 project see: <http://www.code2-project.eu/>.

## 1. Where are we now? Background and situation of cogeneration in Romania

### 1.1 Current status: Summary of currently installed cogeneration

Cogeneration has a long-tradition in Romania. Due to structural problems of the economy CHP share in total electricity production declined sharply between 2005-2008. There has been a slight recovery since 2009, indicating the start of an upturn in the CHP sector.

Cogeneration was largely promoted in Romania during the centralized economy period, with the available technology and equipment of those times. Part of this CHP promotion was through extensive district heating infrastructure, many of them were using cogeneration units. The processes during open market economy period, in late 80s-early 90s, resulted to the closing of many heavy, energy-intensive industrial enterprises and this has deepened the cogeneration crisis in Romania, as these industrial units were consumers of the heat produced in still state-owned CHP plants and their closing generated a reduction in demand. Other industrial units had, as auto-producers, CHP plants, which supplied with heat their processes and the near-by apartment buildings. The closing of these units has also triggered in the end of the decommissioning of the entire local district heating system<sup>2</sup>. For more than a decade, the old model - CHP units providing steam to heavy-industry(ies), found near the city(ies) and the rest of heat distributed through DHS for heating purposes - was kept in operation through massive incentives, provided by local authorities and the state. So, until 2005, the cogenerated electricity share to the total electricity production reached 26%, more than double of the EU average of 11%. But, from 2006 and onwards, due to extensive operational costs and to the elimination of the incentives, many CHP units were closed down and, therefore, as a result, the CHP share on the total gross electricity generation shows a sharp declining trend from 2005 until 2008. The values registered in 2009 and afterwards show the beginning of an upturn for the CHP sector (Figure 1).

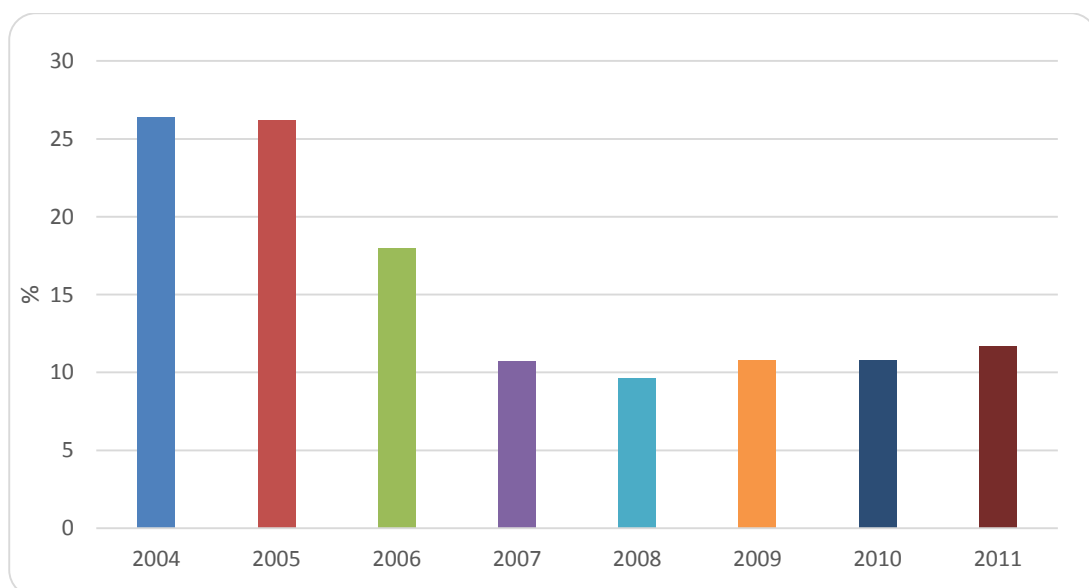
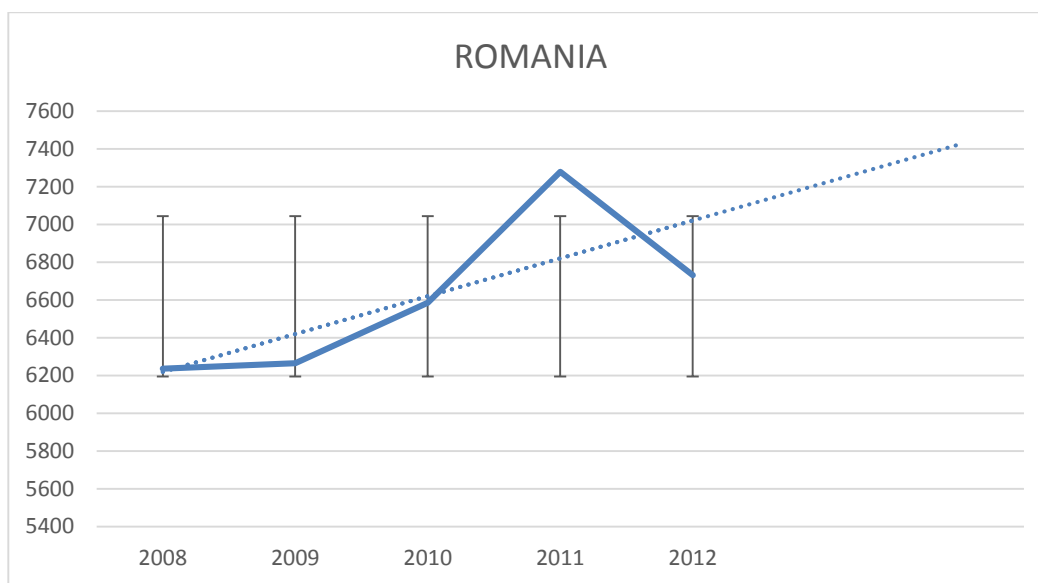


Figure 1: CHP share of gross electricity generation

<sup>2</sup> 2<sup>nd</sup> Energy Efficiency Action Plan, NAPEE

From Eurostat<sup>3</sup> the data for CHP in Romania, for 2012, is given as:

CHP Electrical capacity	2,18 GW
CHP electricity generation	6.72 TWh
CHP heat generation	66.1 PJ
CHP share in total electricity production	11.4 %
CHP share in total heat production	10.5 %



Cogenerated Electricity, in GWh, for 2008-2012

For comparison, the cogeneration share of total heat generation in Romania for 2011 was at 12.9%.<sup>4</sup>

The fuel input for CHP plants, feeding electricity into the Grid, shows great dependence in natural gas and solid fuels, which consist the 92.1% of the total fuel input (data for 2012). The cogenerators in Romania operating as main producers are the 83.9% and as auto-producers the 16.1% (Eurostat, 2014).

ANRE announced, with its Decision 2362/22.10.14<sup>5</sup>, 59 CHP installations operating in Romania that feed electricity into the network, with a total installed capacity of 17,772.94 MW<sub>e</sub> and their fuel type, which explained earlier. Analytically, there are

- 45 installations, using natural gas, of total capacity of 1067.35 MW<sub>e</sub>
- 12 installations using coal of 677.65 MW<sub>e</sub> and
- 2 other using different fuels, as LCO and petroleum residuals, of total capacity of 27.94 MW<sub>e</sub>.

From this data, it can be seen that there are 12 CHP units, with capacity up to 1 MW<sub>e</sub>; 17 units between 1 to 10 MW<sub>e</sub>; 23 units between 10 to 100 MW<sub>e</sub> and 7 above 100 MW<sub>e</sub>. In addition to these installations, which represent the capacities based on fossil fuels and which export electricity into the grid, there are

<sup>3</sup> Eurostat, 2014: <http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsdcc350>

<sup>4</sup> EEA, <http://www.eea.europa.eu/data-and-maps/indicators/combined-heat-and-power-chp-1/combined-heat-&-power-chp-2>

<sup>5</sup> "(CHP - ENER 020) - Assessment published Apr 2012", European Environment Agency & ANRE Decision 1279/28.05.14

several industrial cogeneration installations operated as auto-producers especially in the oil refining (OMV PETROM s.a.) and in chemical sector and some CHPs using renewable fuels.

Romania has a long tradition in district heating systems (DHS). In 90s, there were about 250 district heating companies in cities across Romania, most of which were operating in CHP mode. These district heating systems were built mainly to supply heat to a large uninsulated buildings stock (apartment buildings, tertiary, industrial sector, etc.). Due to a lack of maintenance and technology modernisation, most of them were found in an advanced state of wear and closed down. So, today, there are fewer than 80 DHS in operation, serving 19% of the population, and almost all of them are facing critical financial difficulties<sup>6</sup>. This is due both to a decrease in the quality of the services provided to consumers by DHS operators and a continuous increase of the heat cost, leading to a drop in the population's confidence in DHS and consequently a massive disconnection phenomenon by domestic consumers. In 2008 the DHS fuel mix consisted of 54 % natural gas, 26% oil fuel and 20 % coal, relying entirely on fossil fuels. The system-wide energy losses in DHS (generation, transport, distribution and final consumption) are quite high, ranging between 35% to 75%<sup>7</sup>.

## 1.2. Energy and Climate Strategy of Romania

High efficiency CHP is considered as an important technology to deliver Romania's energy and climate objectives. CHP is mentioned as a key technology in Romania's Energy Strategy and Climate Change Strategy Documents published in 2007 and 2011 respectively.

Romania has significant domestic energy production and supply, as it has the largest oil and gas reserves in the region, substantial coal deposits and produces large amounts of electricity from hydroelectric and nuclear power plants<sup>8</sup>. The Romanian Energy Strategy, published in 2007 (GD 1069/2007) and updated in 2011, outlines the potential avenues for developing the local energy sector, ranging from the attraction of financing of new generating capacities to the enforcement of measures aiming to improve energy efficiency and promote RES projects up to 2020. The 2011 Energy Strategy presents the promotion of high efficiency cogeneration as a key measure to reduce primary energy consumption in Romania. Another important measure for energy efficiency mentioned in the energy strategy is the mandatory energy audits for big industrial consumers.

The overall objective of the Energy Strategy is meeting energy needs in the short- medium- and long-term, at a low cost, suitable for a modern market economy and a civilized standard of living, in terms of quality, safety and compliance with the principles of sustainable development. The strategic objectives set are energy security, sustainable development, competitiveness, increasing energy efficiency, promoting energy production based on RES, and finally promotion of combined heat and power systems, for the production of electricity and heat from high efficiency CHP plants. The heating and urban district heating systems are analyzed separately in the strategy, identifying the following short-term objectives:

- establishing the cogeneration (and trigeneration) potential for industrial applications and heating

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<sup>6</sup> <http://www.euroheat.org/Romania-90.aspx>

<sup>7</sup> Source: Implementation of the EPBD in Romania, Status by November 2010.

<sup>8</sup> "South east Europe Energy Outlook", IENE, 2011

- increasing the efficiency of district heating systems and maintaining the heating urban consumption on this base
- drafting the local strategies for the implementation (development) of cogeneration in the areas identified as having cogeneration potential and based on the available fossil and renewable energy resources at the local level
- drafting feasibility studies for the promotion of the most efficient solutions for the production of cogeneration electricity and heating and to realize the full potential of renewable resources.

Of historical significance is that Romania was the first Annex I Party to ratify the Kyoto Protocol in 1999. The entity responsible for Energy Strategy in Romania is the Ministry of Economy, Trade and Business Environment, represented by the Minister Delegate for Energy.

The Romania's National Climate Change Strategy came in 2012, referring to mitigation as well as adaptation strategies and measures, and reforestation and afforestation policies. Climate mitigation is mainly supported through the promotion of RES and energy efficiency. The focus seems to be on energy efficiency and new energy generation capacities, as energy generation and distribution systems have already exceeded their lifespans and need to be updated. There are two sets of targets to evaluate, namely: the Kyoto Protocol targets for the period 2008-12 (which has just ended) and the 2020 targets for emissions not covered by the EU ETS. An evaluation of the latest greenhouse gas data (for the year 2011) shows that Romania's emissions have decreased on average by 55.7% compared to the Kyoto base year. Hence, Romania is expected to definitely meet its Kyoto target through domestic emissions reductions directly. The latest data suggest that Romania is currently on track to meeting this target<sup>9</sup>. In 2010, the National Renewable Energy Action Plan (NREAP) was published in Decision to set specific targets concerning the RES implementation in the national energy map. The target for 2020 is set to 38% of gross electricity consumption to derive from RES.

Romania's National Energy Efficiency Action Plan (NEEAP) establishes the following average- and long-term objectives:

- reducing heating costs for household consumers, up to maximum 10% of the gross average income per capita
- performing electricity and heating cogeneration production units with efficiencies over 80%
- replacing the pipeline networks for the transmission of the primary heat fluid and the worn and oversized heating distribution networks, as well as reducing technological losses in the network to values under 15%
- refurbishing the thermal stations and substations, by equipping them with high efficiency heat exchangers, variable revolutions, full automation and remote monitoring pumps,

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<sup>9</sup> Assessment of climate change policies in the context of the European Semester Country Report: Romania, Ecologic Institute - eclareon, 2013

- implementing the measurement and control systems throughout the energy chain source — grid — consumer, for the most accurate emphasis possible of losses afferent to various energy sub-assemblies and the correct replacement of energy balances,
- reducing or fully removing secondary distribution networks by installing substations or thermal modules at a real estate property level,
- fully replacing the heating distribution networks with real estate properties and adapting the configuration thereof to the needs for the individual metering of the heating consumption at an apartment level,
- metering all individual heating consumers both in condominiums, and in individual homes, simultaneous with the mounting of thermostatic valves on each piece of heating equipment and on the consumer hot water meters,
- informing and educating the population on the need to save energy resources, on environmental protection and expanding the use of renewable energy resources,
- expanding and implementing programs on the use of renewable resources and the production in cogeneration of electricity and heating, including in the rural environment.<sup>10</sup>

Especially for Cogeneration of Heat and Power, the Energy Efficient Action Plan aims in:

- promoting high efficiency cogeneration
- identifying and capitalizing the national cogeneration potential
- performing the energy audit of cogeneration units
- retrofitting and upgrade of the current subsystems, in Decision to increase efficiency and to reduce environmental impact
- erecting new high efficiency cogeneration subsystems.

The Romanian Energy Regulatory Authority-ANRE-has the obligation to compose an annual national report that contains information on the development of the electricity and natural gas markets.

### 1.3. Policy development

The Romanian government has supported the development of CHP in Romania, by creating a favourable legal environment. In 2011 the government introduced the cogeneration bonus rewarding electricity produced in high efficiency CHP mode. Bio CHP is promoted as part of the Romanian green certificates scheme.

The Romanian Energy Regulatory Authority, ANRE's Decision 25/2004 for the Commercial Code of Electricity Wholesale Market was approved and it establishes distinct commercialization rules for electricity qualified for priority production, for E-RES and electricity produced by CHP. Directive

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<sup>10</sup> Romania's Second National Energy Efficiency Action Plan (NEEAP)



2004/8/EC was transposed by GD 219, in 2007<sup>11</sup>. In ANRE's Decision 13/2007, the harmonized reference values of the efficiency for separate production of heat and electricity and the adjustment factors applicable at national level were adopted (according to Art.4 of the GD 219/2007). The ANRE Decision transposes into national legislation the Decision 2007/74/EC on the harmonized reference values of efficiency for separate production of electricity and heat. Electricity Law 13/2007, sets out the general framework for the promotion of electricity produced in high-efficiency cogeneration (art. 69-73). As it is stipulated in the Electricity Law, L.123/2012, specific measures establish the support scheme for the promotion of cogeneration. The act lays down the regulatory framework for the carrying out of the activities in the sector of electricity and thermal energy produced by cogeneration, by ensuring non-discriminatory and regulated access of all participants to the electricity market and energy grids of public interest, by ensuring the interconnected operation of the National Electrical Energy System with the electrical energy systems of the neighboring countries and with the electrical energy systems of the Union for the Coordination of Transmission of Electricity (UTCE), by promoting the use of new and RES and by ensuring operation safety of the National Electrical Energy System<sup>12</sup>. Also, Article 7 will be implemented through actions and measures, like training programmes, financing and fiscal incentives to promote high efficiency CHP and modernisation of existing CHP for the heating and cooling purposes at residential and commercial level. In GD 1461/2008 the procedure for issuing guarantees of origin for electricity produced in high efficiency cogeneration was approved (according to Art. 5 par. (3) GD 219/2007 and Art.5 par. 3 of the Directive 2004/8/EC). GD 1215/2009 establishes the criteria and required conditions to implement the support scheme for the promotion of high efficiency cogeneration based on useful heat demand; establish a state aid scheme for cogeneration plants in Decision to maintain them on the electricity and heat market, when they meet the requirements of high efficiency, realize fuel savings and significant emissions reduction, but have large costs of production. Additional laws and decisions on the framework of CHP in Romania are mentioned in the reference list in section 8.

Romania effectively applies support schemes that grants bonuses for the electricity produced in these plants. In parallel, Romania promotes the production of electricity from RES, including biomass, by applying the mechanism of mandatory quotas combined with the transaction of green certificates. In the case of high efficiency cogeneration installations, the producers have the right to choose either the cogeneration promotion scheme or the green certificates promotion scheme but no accumulation between the two support schemes is allowed. This option is available only for producers of biomass-based electricity in high efficiency cogeneration plants. Aid scheme N 437/2009 for the promotion of cogeneration, approved by the Commission on 17.9.2009, covers the following renewable energy sources: hydropower <10 MW, wind, solar, biomass from bio-waste (electricity only or high efficiency cogeneration), biomass from energy crops (electricity only), landfill gas and sewage treatment plant gas. According to the promotion mechanism through Green certificates<sup>13</sup> for HECHP systems using biomass, biogas or biofuels 1 Green Certificate is sponsored per MWh, for a duration of the support of 15 years. Since April 2011, for cogenerated electricity, with NG and coal, it has been introduced the bonus-type support. The scheme was notified to the Commission in accordance with European regulations on state aid. The government decision allows CHP plants to benefit from operating aid that covers the difference between production costs and market prices, as defined below. The Romanian authorities have calculated a "bonus", which is a sum per MWh of electricity produced, calculated as the difference

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<sup>11</sup> Romania's Second National Energy Efficiency Action Plan (NEEAP)

<sup>12</sup> National Renewable Energy Action Plan (NREAP), Bucharest 2010

<sup>13</sup> GD 443/2004

between the market price for electricity expected over the period of application of the scheme and the total production costs of a typical CHP plant. The amount of aid granted to each CHP plant benefiting from the scheme will be the applicable bonus multiplied by the electricity produced by the plant and sold on the market. In Decision to take account of the differences between the costs of different types of fuels and different conditions of fuel supply, the bonus is calculated for three types of CHP: solid fuel-based CHP, CHP fuelled by gas supplied directly through the transmission network and CHP fuelled by gas supplied through the distribution network.

For each of the three types of fuels, the bonus is calculated according to the following formula:

$$\text{BONUS} = (\text{TOTAL COSTS} - \text{REVENUE ELECTRICITY} - \text{REVENUE HEAT}) / \text{ELECTRICITY (MWh)}$$

where:

- *TOTAL COSTS = variable costs + fixed costs + return on capital*
- *REVENUE EL = income from the sale of the electricity delivered by CHP plant at electricity market price*
- *REVENUE H = income from the sale of the heat produced in the typical CHP plant at the price for heat*
- *ELECTRICITY = electricity delivered annually in the CHP plant*
- *Variable costs mainly include fuel costs whereas fixed costs are operating and maintenance costs (including personnel expenses) and depreciation costs. The evaluation of the productions costs also takes into account a (maximum) 9% return on capital.*

The estimated future electricity market price, on the basis of which the bonus is calculated, is the average price on the competitive day-ahead market prevailing in the previous year indexed by 3%. The estimated future price for heat is the price that a typical alternative heat generation source with the same generation capacity and using the same type of fuel as the CHP plant is expected to obtain. The Romanian authorities indicated that the price for heat used for district heating is regulated. The estimated heat price used to calculate the bonus will be the one actually applied by the regulatory authorities to the heat produced and sold by the beneficiaries of the scheme. For cogeneration plants using fuel mixes, the value of the bonus is established on the basis of the main fuel consumed. ANRE will analyze on an annual basis the values of the cost and revenues associated with the electricity and heat produced by each of the high-efficiency CHP plants benefiting from the notified scheme. ANRE sets the heat prices if the district-heating operator uses cogeneration; in addition, ANRE also sets the regulated prices for gas and electricity. For the support scheme are eligible both the producers active in cogeneration, except those using RES and the consumers which own low power and micro cogeneration plants, which use the electricity and heat produced mainly for own consumption. The support scheme is granted only for the amount of electricity produced in high efficiency cogeneration plant that is delivered to the power grid. It shall not be granted support scheme for the amount of electricity produced in high efficiency cogeneration plants that is not delivered to the power grid. For both support schemes monitoring methodologies have been developed to assess the functioning and their efficiency.<sup>14</sup>

CHP projects are also supported through EU-funds or favorable loans from financial institutions, as EBRD. For example, on July 2011, EBRD granted EnergoBit ESCO Company, a member of EnergoBit Cluj Group, a 10 million Euro loan, for financing many small energy efficiency projects, in public sector, including cogeneration systems for industrial clients and for the public sector. This new investment is a

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<sup>14</sup> NATIONAL REPORT 2011, September 2012, ROMANIAN ENERGY REGULATORY AUTHORITY-ANRE

part of the EBRD's strategy to support Romania in conforming to the EU standards regarding the energy efficiency.<sup>15</sup>

#### 1.4 Exchange of information and awareness

In Romania, cogeneration technologies were introduced during the 60s and 70s. In recent years awareness regarding CHP technologies has been soaring, especially among industry/auto-producers, which are becoming more interested in energy savings alternatives. High level political support for CHP has contributed to this phenomenon.

In Romania, the cogeneration technology was developed during the 1960s and 1970s. An extensive district heating network was developed and most of it still working, although most of the DH networks are in maintenance and replacement. In addition during the centralized economy period cogeneration technology was largely promoted in the industrial sector. Due to all these facts, the awareness level is satisfactory, beside the big drop in cogenerated electricity (compared to the gross produced electricity) that took place after 2005. The last years an increasing trend in awareness is provoked by political decisions towards energy efficiency and pollutant gas reductions. Sales of cogeneration to customers rely on a commercial proposition and a functioning market for the application of cogeneration. The policy intervention of the European Union to support cogeneration and assist the removal of market barriers is an important element of creating a good commercial proposition however in itself it will not be sufficient to grow sales of cogeneration if the customers are unaware or misinformed and lacking support within influencing groups or, and if the supply chain of skills and suppliers does not exist. A mature market for a product is characterized by a high degree of awareness among all the relevant players in the market and on-going buying and selling activity.

An assessment of awareness of cogeneration among key market actors has been developed. Using qualitative interview techniques with experts and market participants, four groups of the socio-economic actors for cogeneration were assessed. The four groups and their subsectors are below showed in Figure 3. The list is not exhaustive but contains all the most relevant players. More detailed analysis of the socio-economic actors in Annex 1 (Stakeholder group awareness assessment).

The different colors indicate the level of awareness in each actor and explained in Table 1.

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<sup>15</sup> Energy Efficiency Policies and Measures in ROMANIA, ODYSSEE- MURE 2010, Monitoring of EU and national energy efficiency targets, Energy Research and Modernizing Institute - ICEMENERG and Romanian Energy Regulatory Authority - ANRE

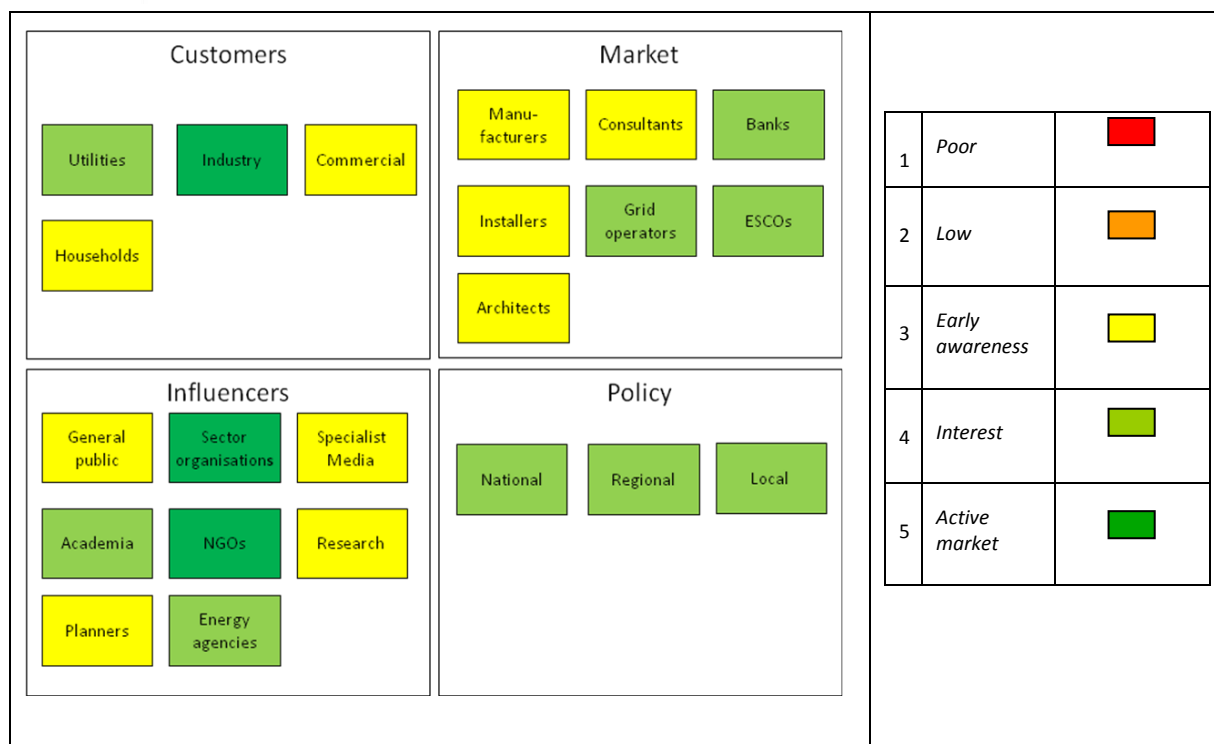


Table 1: Awareness level of different market actors for CHP, in Romania

The interaction between groups is still loose, and although the efforts performed by the policy makers, the market is showing signs of stagnation, due to the current economic recession. The most intense interaction is between policy makers and users, where the latter are always asking for a clearer and supporting path towards CHP development. On the other hand, the market group holds low level of awareness making the interaction bonds weak. Utilities and industries show a good level of awareness, while commercial customers and especially households are almost unaware of the benefits of CHP technologies. Policy makers are well aware of making suggestions and implementing measures that could benefit the development of CHP. There is not any actual presence of manufacturers based in Romania and this absence is a clear hindrance to wider CHP development. Local consultants and architects are not familiar, in depth, with the technology and banks are in early stages of awareness. General public and research show the lowest level of awareness. NGO's and sector organisations seem to have adequate level of awareness. The awareness of key groups in a quite specific and new market is important, not only for the understanding of the technology through the appropriate channels, but also for a productive relationship between policy makers and investors. Finally, regarding ESCOs, there is a strong awareness for CHP, as more than 5 ESCOs are operating in installing CHP units, either in BOO or in BOOT option, in the last years in Romania.<sup>16</sup>

### 1.5. The economics of CHP

According to CHP users, the return on investment period ranges between 4 to 5.5 years, depending on the size, type and fuel used by the cogeneration system. Two types of operational support schemes are available for high efficiency CHP: feed-in premium (cogeneration bonus) for fossil fuelled CHP and green certificates for those CHPs operating with renewable fuels.

<sup>16</sup> Interview with SE-GES, Romanian Energy investment Co, installer and operator of more than 50 MW CHP; [www.se-ges.ro](http://www.se-ges.ro)

As mentioned earlier, the two types of support mechanisms for cogeneration in Romania. The first one is based on a **Feed-in premium (F-i-P)** scheme, which is calculated to cover the difference between costs and revenues. It is calculated in an annual base and for every CHP installation separately. Eligible for the support are only HECHP installations over 1 MW<sub>e</sub> and up to 200 MW<sub>e</sub>. For installations over 200 MW<sub>e</sub> a detailed assessment is necessary in Decision to provide the grant.

The second support mechanism is based on **Green Certificate scheme and Quota Obligation Scheme**. The scheme is eligible for HECHP systems, below 2 MW, using biomass, biogas or biofuels and geothermal energy. One Green Certificate is sponsored per MWh, while the duration of the support is 15 years. The price of Green Certificate dropped from 55.47 €/GC in January-June 2012 to 40.09 €/GC in October 2013, decrease of almost 28%, and, in 2014, the price is around 29 €/GC. According to CHP users the return on investment period is between 4 to 5.5 years depending on the size type and fuel used by the cogeneration system.

Tables 2 and 3 present the retail electricity and natural gas prices<sup>17</sup> and the evolution of spark spreads .

Price/Year	Natural Gas €/MWh		Electricity €/MWh	
	Industry	Household	Industry	Household
2005	13.24	14.50	76.90	65.50
2006	22.44	23.17	77.30	79.20
2007	26.35	27.38	84.20	85.50
2008	22.44	21.42	88.60	88.50
2009	16.92	17.43	81.10	81.40
2010	14.81	15.05	85.00	85.60
2011	15.23	14.91	80.30	84.80
2012	19.03	14.19	83.30	79.50
2013	20.70	15.20	90.40	89.00
2014 Q1	21.30	16.00	75.30	91.00

Table 2: Natural Gas & electricity prices, excluding taxes and levies in Romania<sup>18</sup>

The differences between energy prices that apply on the ground, mainly in industry – for both gas and electricity – and those provided by Eurostat were found to be in the range of 2-6%. These differences are due to the capacity of each end-user (i.e. higher gas quantities used, lower the selling price), the regional gas/electricity supplier and distributor price policy, the origin of the gas (local or imported), etc. So, during this analysis the energy prices data provided by Eurostat is considered.

Year	Industry	Household
2005	5.81	4.52
2006	3.44	3.42
2007	3.0	3.12

<sup>17</sup> <http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/database>

<sup>18</sup> Energy prices excluding “all taxes and levies” and the electricity prices for households are for typical annual consumption between 1000 to 2500 kWh.

2008	3.95	4.13
2009	4.79	4.67
2010	5.74	5.69
2011	5.27	5.69
2012	4.38	5.60
2013	4.37	5.86
2014 Q1	3.54	5.69

Table 3: Spark spread ratios

For a spark power ratio over 2.5 the investment perspectives are positive.

Figure 2 shows the variation of spark ratio industries and for households, from 2005 to the Q1 of 2014.



Figure 2: Variation of spark ratio for households and industries, for introducing CHP

It is clear from Figure 4 that, for both household/tertiary and industrial sectors, the spark ratio far above the threshold of 2.5 and therefore, is favorable for implementation of CHP projects, at least from financial point of view.

In mid-2013, the Government of Romania considered a sharp cut-down of the cogeneration incentives, which adds a burden of more than 2% to the invoices of the Romanian consumers. But, the Romanian Energy Regulatory Authority, ANRE, turned it down; affirming that probably not all the issues related to the cogeneration tax are known and proposed a re-evaluation, possibly a cut-down in some special cases. In late 2013, ANRE proposed that from 1.1.2014 and on, the price of electricity produced in highly efficient cogeneration facilities and receiving supporting bonuses, will be cut down by 19.57%, according to a Decision, published in the Official Gazette of Romania. In practice, ANRE's move targeted to eliminate from the energy market most of the cogeneration producers falsely qualified as 'highly efficient ones', as they cannot operate with the proposed prices. The bonus cuts would have reduced the end-user invoices by 0.5% initially and by 2-3% more from 1.7.2014. Until now (end 2014) these cuts were not implemented for CHP sector, while they were imposed in all RES sector, as scheduled<sup>19</sup>.





<sup>19</sup> <http://energy-center.ro/en/actualitate-news/anre-face-putina-ordine-in-cogenerare-cine-primeste-bonusuri-are-preturi->

Table 4 is presenting a CHP economic matrix and the penetration of different CHP categories in different sectors.

**Table 4: CHP economics matrix**

Romania	Micro		Small & Medium		Large		
	up to 50kW		up to 10 MW		more than 10 MW		
	NG	RES	NG	RES	NG	Coal	RES
SME/Industry							
District heating/cooling							
Services							
Households							

**Legend:**

-  "normal" CHP Investment has **good economic benefits**, return on investment acceptable (8-10%) for the investors, **interest for new investment exists**; there are no significant economic barriers for the implementation.
-  "modest" CHP Investment has **modest/limited economic benefits** and return on investment (5-7%), **limited interest for new investments**.
-  "poor" CHP Investment has **poor or negative return on investment or is not possible due to other limitations, no interest/possibilities for new investments**.
-  **Not applicable** for the sector

**1.6. Barriers to CHP**

Aged district heating and electricity networks, bureaucracy and limited support schemes constitute the main barriers for CHP, resulting in low investor confidence and limited development of new CHP installations.

Based on all mentioned in previous sections, the barriers withholding the further improvement of CHP environment in Romania are presented below:

**Barrier 1: Complex and intransparent support scheme**

The support scheme in place for fossil fueled high efficiency CHP is very complex and intransparent, with many experts indicating that inconsistent implementation has led to a lack of trust in the scheme. There is some evidence that the methodology in place for designating high efficiency CHP plants is poorly implemented. So, it necessary to create the environment that all CHP units, injected electricity to the network, to be equipped with the appropriate measuring devices that will show on real time their

obtained efficiency. Those found in lower efficiency required to be financed by EU-CSF for Romania in Decision to reach the threshold and be characterized as HECHP.

**Barrier 2: Lack of specific national targets regarding the development of CHP-Complicated support schemes - No support mechanisms to encourage small-scale and micro-CHP.**

Without any specific national targets, it is almost impossible for policy makers to establish a concrete route towards development. In addition it is difficult to realize any possible paths for growth of CHP. The support schemes, through FiP for CHP, with NG and coal, and Green Certificates for CHP, with biomass, are quite complicated, while the fact of the annual recalculation of the support price does not give a clear economic picture of the investment. Potential investors have a harsh time calculating their future incomes thus preventing business activity. Apart from that, there is a limited financial support regarding CHP. Many CHP users and investors are complaining of the way the EU funds are managed and disbursed, setting CHP in the background. There are indications that this will be improved in the following structural support scheme for Romania, clearly favoring the development of CHP units. There are no support mechanisms, at all, to encourage the installation of micro-CHP or small-scale CHP units, up to 1 MW, in apartment buildings and on tertiary sector (hospitals, wet-sports centers, etc.).

**Barrier 3: Bureaucracy for obtaining permits**

Bureaucracy, along with the lack of experience and reluctance of the local authorities, is another important barrier towards the development of CHP. Long, complicated and non-transparent permitting process, especially with the local electricity distribution companies, which are seen CHP as competitors. The procedures for obtaining the permit, for any type of CHP units, are considered as complicated and time consuming, by both cogenerators and consultants.

**Barrier 4: Aged district heat networks, many of them connected with CHP units**

Aged district heating network are most of the operating DH systems. In addition, poor and insufficient maintenance results to an aged and insufficient district-heating network. The heating subsector is the most neglected of the energy subsectors and the RES-based heating received the least attention at legislative level. The centralized district thermal energy and cogeneration supply systems represent in Romania the most deficient energy sub-sector due to:

- the wear and obsolescence of the installations and equipment
- the high total energy loss upon transmission and distribution between the source and buildings as well as due to the inappropriate thermal insulation of the existing housing stock
- the insufficient financial resources for the operation, maintenance, rehabilitation and modernization<sup>20</sup>.

The need for major works in the sector sets very high levels of investments, which cannot be covered by private or governmental investments in a short term.

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<sup>20</sup> National Renewable Energy Action Plan (NREAP), Bucharest 2010



## 2. What is possible? Cogeneration potential and market opportunities

A rise in the share of CHP on thermal power is expected, while the share of cogenerated electricity for 2030 is estimated to reach over 20%.

As mentioned in previous sections (section 1.1), there was substantial drop of cogenerated electricity, compared to gross generated electricity, until 2008 and then, after 2009, there were signs of stability and rise was shown.

Figure 3 shows the share of cogeneration units on thermal power until 2030 and Figure 4 shows the percentage of cogenerated electricity, as projections until 2030, providing a long-term assessment for the economic market potential for CHP in Romania.

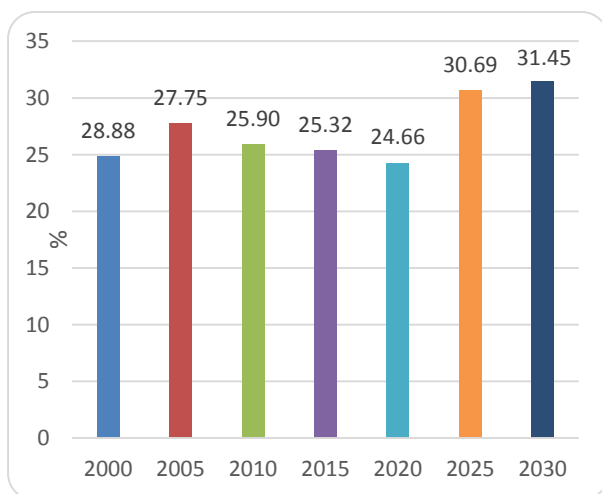


Figure 3: Share of CHP units on thermal power

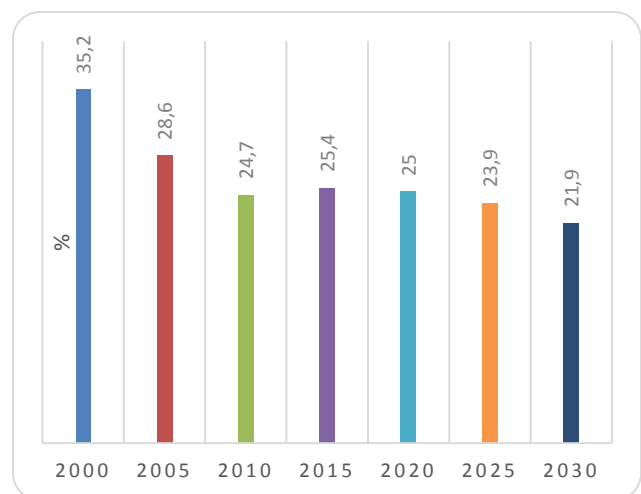


Figure 4: Percentage of cogenerated electricity

These are projections derived from calculative PRIMES model showing a significant deviation from the present situation. Nevertheless we can see the trends in the CHP sector. There is a long term decreasing trend in the share of electricity from CHP, although stabilized over 20%, due to the governments scheme to use nuclear power. On the other hand, a big rise in the cogenerated heat is expected through the development of the district-heating network.

The sectors that will probably show a higher degree of CHP development are industry and district heating. National policy is moving towards the development of CHP through the clarification of legal framework and the extension of support mechanisms. A more clear and stable path will give incentives to potential investors.

### **Bio energy**

Energy generated using biomass and its derivatives, such as biogas, has a great potential considering the available agricultural land and the existing landfills, source of raw materials in Romania. Currently, the development of this niche in the green energy market has been left behind, but remains of high importance in terms of balancing power capacities. The main factor for the slow development is the cost involved in a biomass or biogas project, especially in cogeneration mode, which is considerably higher than conventional one. Also, in the legislative sphere, the obtaining of all necessary permits can be a rather slow process, even up to twenty months are required for completion. At the same time,

there are some uncertainties about the support scheme, as there are many inconsistencies. For instance, for biogas to generate electricity and thermal power there are three green certificates, for a 15-yr period– two for electric power, one for thermal power - but when using landfill gas, there is only one green certificate. Also, peculiarities of producing biomass energy derive from an additional cost with fuel, which is hindering the investors' business plan, as besides the fact that funders and banks require for each project contracts or agreements on energy acquisition, to ensure that the power will be bought, long-term contracts for selling green certificates, for biomass projects banks usually request long-term contracts for supplying power plants with biomass.

The National Rural Development Plan (PNDR 2014-2020) includes measures meant to support investments in renewable energy with funds amounting to about 760 million Euro, concerning the entire period, *“for investment at farm level which can produce and use renewable energy for own consumption or for economic operators, other than farmers who want to process biomass to obtain renewable energy”*. Cogeneration technology has been a key-point, as combined with biomass and biogas as fuels it becomes a solution not only for ensuring electric and thermal power for internal consumption (as it is the case for wood product manufacturers, for instance) or for trading it, but also in terms of energy efficiency strategy of the country. The future development of the industry depends on a greater legislative predictability that causes uncertainties for the moment as the Government decided to annul the initial renewable energy quotas and to establish these quotas yearly, as well as on less strict financing proceedings<sup>21</sup>.

According to the Assessment of the national potential for Cogeneration for Romania (April 2009) the economic potential for HECHP, excluding industry and tertiary sector, is estimated to 20 MW<sub>e</sub>, where 10 MW<sub>e</sub> with solid biomass as fuel and 10 MW<sub>e</sub> with biofuel.

A bio CHP potential analysis carried out in CODE2 project, which is based on a “score card analysis” shows that under current conditions, as oil as fuel is expensive for agriculture purposes, the share of biofuels for micro- and small-CHP units is estimated to grow slowly up to 2030.

### **Micro CHP**

In Romania, micro-CHP systems suitable for the household/tertiary sector do appear to be financially viable, because of the existing favorable energy prices (see section 1.5) and the negligence from the state.

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<sup>21</sup> <http://actmedia.eu/energy-and-environment/biomass-biogas-cogeneration-romania-2014-national-conference/52140>

## 3. How do we arrive there? : The Roadmap

### 3.1. Overcoming existing barriers and creating a framework for action

The Romanian government should take the opportunity to review the current CHP policies in line with the obligations resulting from the EED , removing the existing barriers and revising the potential and opportunities for the further development of CHP.

*3.1.1. The obligations resulting from the EU-Energy Efficiency Directive should be taken as an impulse for reviewing the CHP policy.*

The EED requires that in the obligatory “comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling” according to Art. 14 a cost-benefit analysis shall be carried out based on socio-economic and ecologic criteria. Regarding the high capital intensity of CHP, it is also important that the discount rate used in the economic analysis for the calculation of net present values shall be chosen at a low value according to Annex IX of the EED and be nearby the discount rate as defined by the European Central Bank<sup>22</sup>. Generally the cost-benefit analysis should be based on a socio-economic consideration and not on common business level criteria (e.g. discount rate 2 to 3 % instead of > 10 %).

*3.1.2. There is a need for ANRE and the Government to look up the implementation of the methodology for high efficiency CHP plants and apply it in line with the EED guidelines*

The cogeneration sector will become sustainable, in Romania, only if the existing out-dated and poorly operated CHP units are replaced, with new ones, following an integrated support scheme to the operating CHP companies, possibly by the new Community Structural Fund Programme (2014-2020); as in Romania, almost all the existing CHP plants have been qualified for the cogeneration bonus, which is resulting a draining of more than 1 bn RON (240 mil E) paid by the consumers of electrical energy, just to support doubled costs for the heat, without any investment. The collapse of district heating and the expansion of inefficient and polluting individual household heating can be avoided only if the companies get support for actual high-efficiency CHP plants.

*3.1.3. The Government should consider revision of the existing permit policy, eliminating bureaucracy with the aim to incentivise new CHP investments.*

Bureaucracy holds the highest level in policy barriers in Romania. Procedures should become shorter and simpler, which is already mentioned in EED 2012/27/EU. In addition the reduction of authorization time plays among others an economic motive towards investors since they will be gaining profits from selling power sooner. Also simpler support schemes shall provide a clear CBA for any investment. In article 15 of the EED the simplification and shortening of authorization procedures is suggested. Making authorization procedures simpler could increase the interest in CHP and provide a great incentive to candidate investors to complete the investment.

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<sup>22</sup> Foot note 1 at part 1 of Annex IX EED: “The national discount rate chosen for the purpose of economic analysis should take into account data provided by the European Central Bank.”

### *3.1.4. Implementation of a targeted action plan for improving the operation of existing ageing DHS, strengthened the possibilities for new CHP, following the requirements of EED*

Improving the aged district heating and electricity network. According to the EED2012/27/EU article 15 the development of network tariffs and regulations shall provide incentives to transmission and distribution system operators to improve the network infrastructure. Energy audits are another important measure that could promote the use of energy efficient systems such as CHP. The important issue is not the audit itself but the implementation of the recommendations derived from that audit. CHP and HECHP are the most effective energy efficient systems and commonly recommended in cases of energy saving.

### *3.1.5. Government should boost development of a new support mechanism for cogenerators of up to 1 MWe, using different types of fuel (i.e. RES, oil, etc).*

Expanding the support schemes for the cogenerated electricity fed into the grid, from wider range of CHP systems, including now small-scale CHP units that now are excluded. The capability of connection to the grid system of electricity produced from high-efficiency micro-cogeneration units, referred in the EED is moving towards this concept. So, a redesigning the subsidy systems is required and their expansion will give a significant economic incentive for investors to turn to CHP.

### *3.1.6. Government and energy market players (ANRE, ESCOs, Energy Agencies, etc.) should launch a comprehensive awareness campaign among energy sector experts and in different industries for an enhanced understanding of high efficiency CHP in Romania- The important role of training, campaigns,*

This is a combined effort by policy makers and experts from Government, NGOs, Energy Agencies operating in Romania, SMEs and local industrial/energy associations, ESCOs to raise a new awareness campaign on the benefits of CHP and micro-cogeneration, through specialized seminars, published best cases studies that could provide more practical information to local engineers and planners, in Decision to get the needed knowhow and, then, promote this technology.

Limited technical knowledge and know-how could be improved by a close cooperation between Romanian government, ESCOs and educational institutes by bringing closer CHP experts and professionals who influence prospective investors. This could also reduce any additional cost of bringing experts from different countries. Article 7 of the EED mentions training and education, including energy advisory programs, which lead to the application of energy- efficient technology or techniques and have the effect of reducing end-use energy consumption. An information campaign about all-types of HECHP and its advantages could raise public awareness and expand the options of enterprises and consultants.

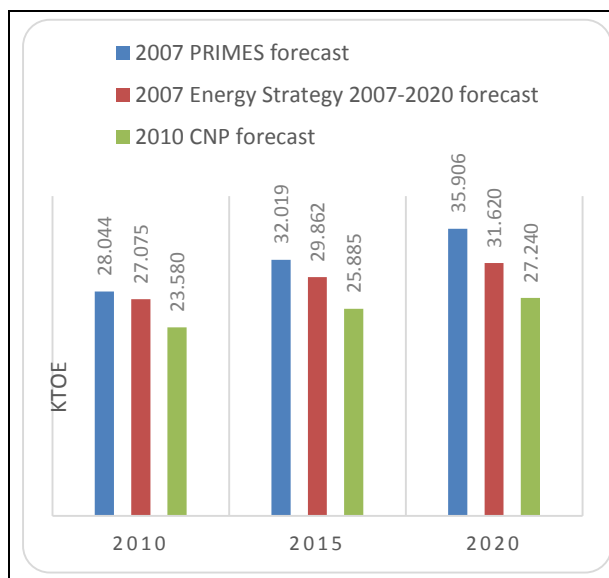
### 3.2. Possible paths to growth

The Romanian cogeneration roadmap analyses three forecasts to 2020: Energy Strategy of Romania forecast for the period 2007-2020, the PRIMES model forecast for the same period and the forecast performed by National Forecasting Commission (CNP) at the beginning of 2010. Two energy efficiency scenarios resulted from this analysis: the reference scenario and the high-energy efficiency scenario.

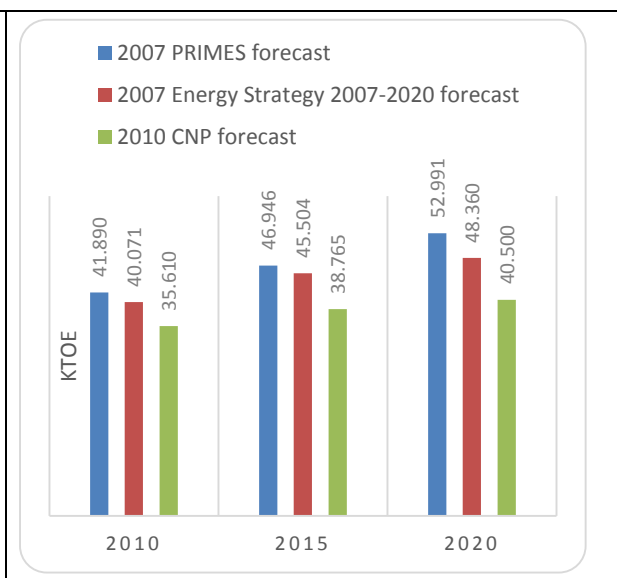
The main body responsible for the forecasts of macroeconomic and energy on medium and long term is held by the National Forecasting Commission (CNP). CNP updates annually the “Forecast of energy balance on a long term (10 years)”. The global economic crisis that started in 2008 is strongly affecting Romania in terms of energy consumption while medium and long-term influences are difficult to evaluate. There are 3 forecasts to 2020<sup>23</sup>. A forecast in the Energy Strategy of Romania for the period 2007-2020, a forecast performed using the PRIMES model, from the Technical University of Athens, for the same period and the forecast performed by CNP at the beginning of 2010. The reduction of the economic development level caused by the economic crisis directly and substantially influences current energy forecast values for 2020 in comparison with values forecasted in 2007.

Energy forecasts performed in 2007 (both the forecast performed using the PRIMES model and the forecast of the Energy Strategy in Romania for the period 2007-2020) took place within the same scenario of macroeconomic development. The CNP forecast of 2010 was performed considering a macroeconomic development scenario that considers the influences of current economic crisis as well as measures to increase energy efficiency.

The final energy consumption and primary energy consumptions forecasts are shown in Figures 5 and 6.



Figures 5: Final energy consumption forecasts



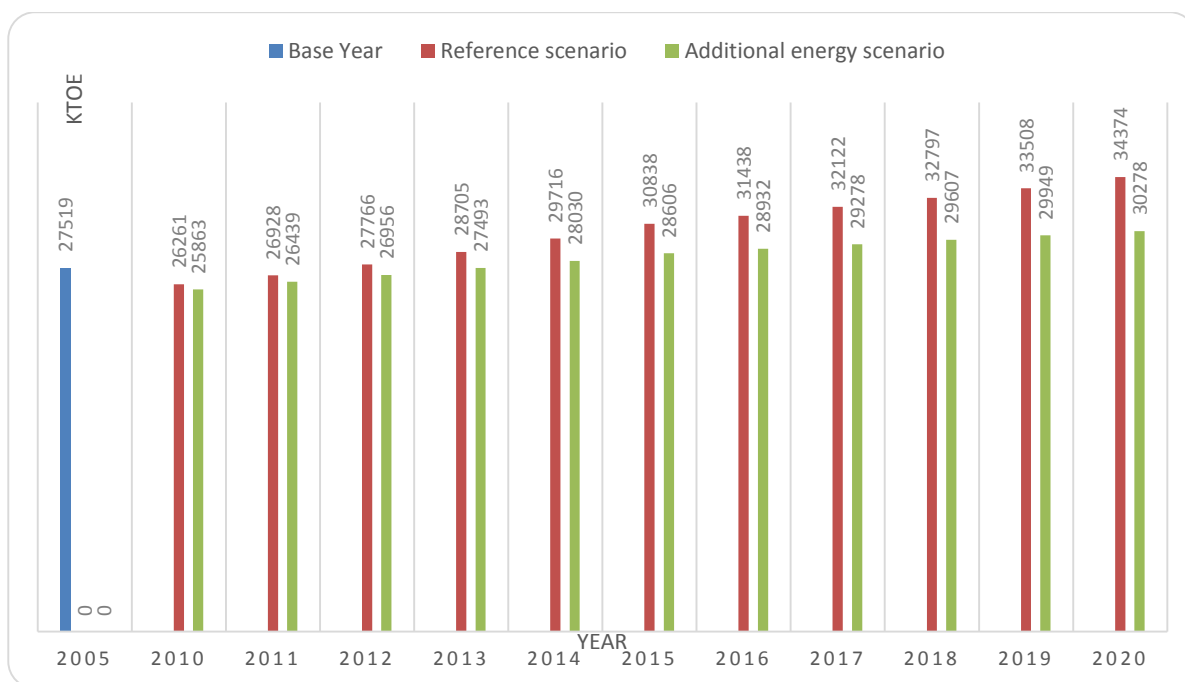
Figures 6: Primary energy consumption forecasts

<sup>23</sup> Romania’s Second National Energy Efficiency Action Plan (NEEAP)

Two scenarios were drafted and separated by measures taken for energy efficiency and saving adopted during the period following 2009<sup>24</sup>:

- **The “reference scenario”** considers the impacts of the energy efficiency and saving measures adopted by 2009 for the period 2010-2020
- **The “high energy efficiency scenario”** considers the impact of all energy efficiency and saving measures adopted starting in 2010

The expected gross final energy consumption, according to scenario, is shown in Figure 7.



Figures 7: Expected gross final energy consumption

The two scenarios on the energy consumption consider the economic evolution scenario presented in the forecast performed by CNP at the beginning of 2010. The main measures considered to increase energy efficiency are:

- Applying the state aid scheme afferent to high efficiency cogeneration. This measure will have a direct impact on the development of HECHP. The current support scheme seems in some case inadequate, therefore a state aid scheme will provide strong incentives to HECHP potential investors.
- The compulsory acquirement of the energy efficiency certificate, starting with 2010, for single parent homes and apartments in current blocks of flats that are sold or leased out. The certificate is aiming to connect the energy status with the price of the dwelling, providing incentives to the owners to increase the energy efficiency. Installing a micro CHP system is among the proposed interventions.

<sup>24</sup> National Renewable Energy Action Plan (NREAP), Bucharest 2010

- Continuing the certification of energy auditors both for buildings and for industrial activities. An energy audit could propose the installation of a CHP system, which could benefit both economically and environmentally.
- The enforcement by the central and local public authorities of GO no. 22/2008 on energy efficiency and the promotion of the final consumer use of energy from renewable sources. CHP using renewable sources are already promoted through support scheme and according to estimations (Figure 10) an important growth is expected.
- Expanding the National program for energy efficiency (retrofitting the heating system, retrofitting public buildings and increasing the efficiency of public lighting) for 2011 – 2015<sup>25</sup>. This could not only result the installation of new CHP systems from scratch, but also the replacement of aged and dysfunctional CHP units by new high efficient.

In the National Renewable Energy Action Plan (NREAP), published in 2010, estimations of expected CHP electricity capacity from renewable energy technology in Romania to 2020 are presented. According to these estimations there will be a considerable growth of CHP using renewable energy (Figure 8).

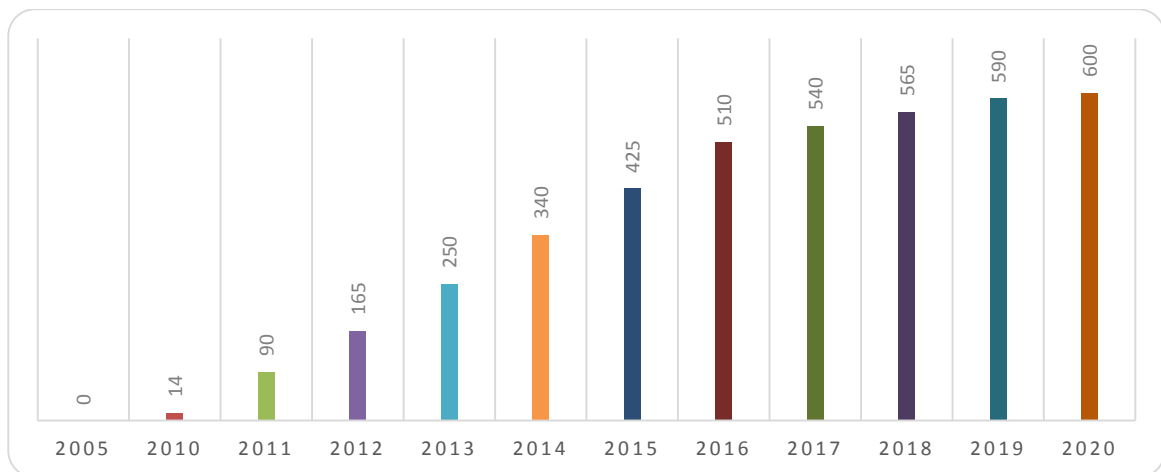


Figure 8: Expected annual electricity production from RES CHP in Romania 2005-2020 (MWh)

### 3.3. Saving of primary energy and CO<sub>2</sub> emissions by following the CHP roadmap pathway

Primary energy saving (PES) and CO<sub>2</sub> emissions saving projections resulting from increased use of CHP require assumptions about not just what types of fuel and technology are displaced, but also their operation on the market. Within CODE2 two approaches are developed. These represent two different analytic considerations, which are summarised here and more fully explored in Annex 5.

1) **Methodology according to Annexes I and II of the EED.** This method is used at a member state level today for national reporting to the European Commission and at project level for determining if a specific CHP plant is highly efficient. In the methodology, the efficiency of each cogeneration unit is derived by comparing its actual operating performance data with the best available technology for separate production of heat and electricity on the same fuel in the market in the year of construction of

<sup>25</sup> Romania's National Energy Efficiency Action Plan (NEEAP)

the cogeneration unit using harmonized reference values which are determined by fuel type and year of construction.

2) **Substitution method.** This method has been developed within the project and estimates the amounts of electricity, heat and fuel which are actually replaced by additional new CHP based on a projection of the supply base changes in the member state supply over the period are calculated. The situation in 2030 is compared to the current status. With this method PES for Romania through implementing the roadmap for CHP is estimated at a 20 TWh per year and CO<sub>2</sub> savings are estimated to be 12 million tons per year until to 2030. The actual saving is particularly dependent on the efficiency increase through upgrading both current power plant and CHP technology efficiencies. The final share of bio energy in additional CHP has a major impact on the CO<sub>2</sub> savings, which can be anticipated. The CO<sub>2</sub> reduction achieved is due to both higher energy efficiency and fuel switching towards low carbon (natural gas) or non-carbon (bio energy) fuel, but CHP development and fuel switching are anticipated to be an integrated process driven by policy objectives.

	Substitution method				EED method			
	Low case		High case		Low case		High case	
PE saving	20	TWh/a	23	TWh/a	9.3	TWh/a	9.3	TWh/a
CO <sub>2</sub> saving	12	Mio t/a	15	Mio t/a				
- per kWh el*	1.29	kg/kWh el	1.64	kg/kWh el				

Table 6: Saving of primary energy and CO<sub>2</sub> by the Romanian CHP roadmap

\* This value represents the CO<sub>2</sub> reduction of the power generation. It includes the avoided CO<sub>2</sub> emissions from fuel savings for separate heat generation in boilers; it must not be confused with the considerably lower CO<sub>2</sub> emissions of the substituted condensation electricity or with even lower emissions of compared power production according to the BAT approach in accordance with the EU CHP directive reference values.



## ANNEXES

### 1. Stakeholder group awareness assessment

A questionnaire on awareness of CHP and its benefits in the main groups was distributed to Romanian experts in meetings at Energy Conferences where CODE2 programme was presented. They were asked to fill a table with the main user groups and to give back their personal opinion on the grade of awareness. The results can be seen in Table A.1.

Table A.1: Ratings of CHP awareness of different influential groupings

Group	Romania
<b>Customers</b>	
Utilities	CHP is commonly known in the utilities sector.
SMEs/Commercial	CHP is quite known in some of these groups.
Households	For the ordinary citizen, CHP is known technology in general and mainly because of the extensive district heating network.
Industry	CHP is well known in principle. There are several decades that this sector has been familiarized with the technology although there are many old and with low maintenance establishments.
<b>Policy</b>	
Policy development at different levels:	There have been some major steps towards CHP development and legislation improvement. Nevertheless there are still things that need to be done and the support mechanisms in some case are partially confusing.

<b>Market and supply chain</b>	
Manufacturers	There is not a strong presence of CHP manufacturers in Romania. Although manufactures hold a high level of awareness, most of CHP systems are promoted and distributed by local resellers.
Installers	CHP is known in principle and detailed know-how is at a good level.
Grid operators	CHP is known in principle and detailed know-how is at a good level.
Consultants	CHP is known in principle, but often the detailed know-how design is missing.
Architects	CHP is known in principle, but often the detailed know-how design is missing.
Banks, leasing	Although the support mechanisms for CHP are quite insecure, there are still financing movements towards the sector.
ESCO's	CHP is known and detailed know-how is at a good level.

<b>Influencers</b>	
Information of the broader public	For the ordinary citizen, CHP is known technology in general and mainly because of the extensive district heating network.
Specialist Media	CHP technology is quite known among the specialized on energy media. Media generally hold a good image about CHP, which is considered, decentralized, environmentally friendly and close to the citizen
Universities/ Colleges	Some of the universities and technical colleges deal with CHP either in research or including CHP in their syllabus.
Research	There is a good knowledge in some institutes.
NGOs	Good image: decentralized, environmentally friendly, citizen close.
Planners	CHP is known in principle, but often-detailed know-how is missing.
Energy agencies	CHP is well known.

**Legend:**



Active CHP market



Low CHP awareness



Interest in CHP

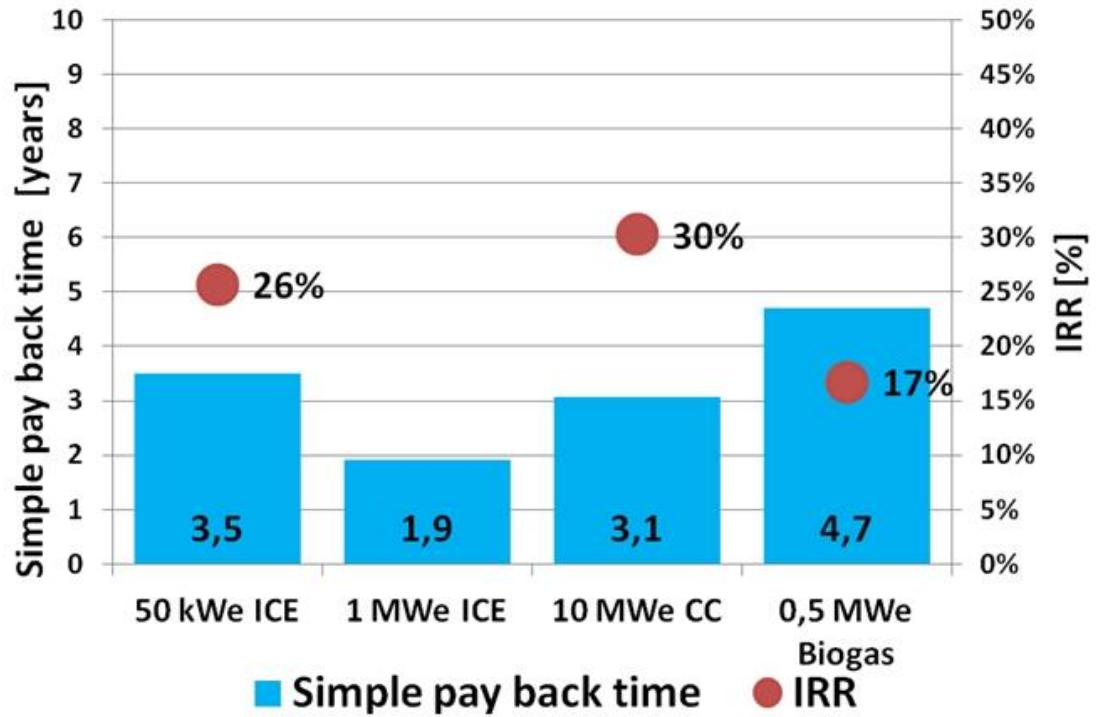


Poor CHP awareness



Early CHP awareness

## 2. Economic assessment of different types of CHP in Romania in terms of pay back time



### 3. Micro CHP potential assessment

#### Country statistics

Population: 21 300 000 (2010)  
 Number of households: 7 900 000 (2010)  
 GDP per capita: € 11 400 (2010)  
 Primary energy use: 22 500 ktoe/year (2010)  
 GHG-emissions: 122 Mton CO<sub>2,eq</sub>/year (2010)

#### Household systems (±1 kWe)

Boiler replacement technology

##### Present market (2013)

Boiler stock: 1 900 000 units  
 Boiler sales: 144 000 units/year

##### Potential estimation

Indicator	Score
Market alternatives	1
Global CBA	2
Legislation/support	1
Awareness	1
Purchasing power	0
<b>Total</b>	<b>4 out of 12</b>

#### SME & Collective systems (±40 kWe)

Boiler add-on technology

##### Present market (2013)

Boiler stock: 141 000 units  
 Boiler sales: 10 800 units/year

##### Potential estimation

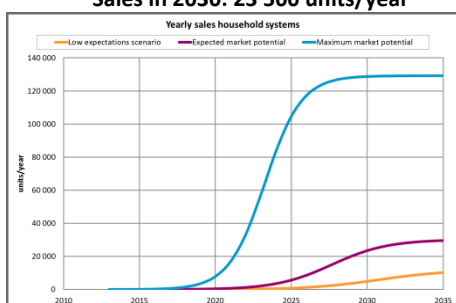
Indicator	Score
Market alternatives	1
Global CBA	1
Legislation/support	1
Awareness	1
<b>Total</b>	<b>3 out of 9</b>

Expected final market share: 21% of boiler sales in Household sector

Expected final market share: 12% of boiler sales in SME & Coll. sector

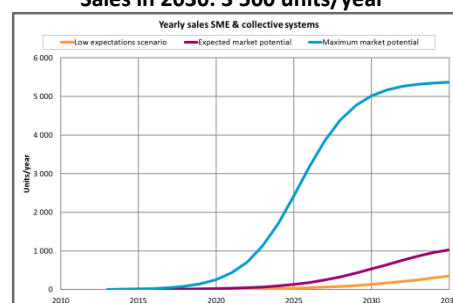
#### Yearly sales

Sales in 2020: 450 units/year\*  
 Sales in 2030: 23 500 units/year\*



#### Yearly sales

Sales in 2020: 20 units/year\*  
 Sales in 2030: 3 500 units/year\*



#### Stock

Stock in 2020: 1 000 units\*  
**Stock in 2030: 95 000 units\***  
 Stock in 2040: 291 000 units\*

#### Stock

Stock in 2020: 150 units\*  
**Stock in 2030: 2 000 units\***  
 Stock in 2040: 10 000 units\*

#### Potential savings in 2030

Primary energy savings:  
 2 PJ/year\*  
 47 ktoe/year\*

#### Potential savings in 2030

Primary energy savings:  
 2 PJ/year\*  
 41 ktoe/year\*



## micro-CHP potential summary Romania



## micro-CHP score card Argumentation



**GHG-emissions reduction:**  
0.2 Mton CO<sub>2,eq</sub>/year\*

**GHG-emissions reduction:**  
0.2 Mton CO<sub>2,eq</sub>/year\*

\*Corresponding to the expected potential scenario.

The score card is used to assess the relative position of an EU country based on current regulations, markets and economics. The score itself functions as input to the implementation model to 2030.

<b>±1 kWe systems (Households)</b> <i>Boiler replacement technology</i>		<b>±40 kWe systems (SME &amp; Collective systems)</b> <i>Boiler add-on technology</i>	
<i>Scorecard</i>		<i>Scorecard</i>	
<i>Indicator</i>	<i>Score</i>	<i>Indicator</i>	<i>Score</i>
Market alternatives	1	Market alternatives	1
Global CBA	2	Global CBA	1
Legislation/support	1	Legislation/support	1
Awareness	1	Awareness	1
Purchasing power	0	<b>Total</b>	<b>3 out of 9</b>
<b>Total</b>	<b>4 out of 12</b>		
<b>Market alternatives</b>		<b>Market alternatives</b>	
<b>Global CBA</b>		<b>Global CBA</b>	
SPOT: 10 years		SPOT: 13 years	
<b>Legislation/support</b>		<b>Legislation/support</b>	
Current legislation in favour <b>Electricity Law (2007) - Government Decision on the promotion of co-generation based on the effective thermal energy demand (2007) - Government Decision on the approval procedure for issuing guarantees of origin for electricity produced by high efficiency cogeneration (2008)</b>		Current legislation in favour <b>Electricity Law (2007) - Government Decision on the promotion of co-generation based on the effective thermal energy demand (2007) - Government Decision on the approval procedure for issuing guarantees of origin for electricity produced by high efficiency cogeneration (2008)</b>	
<b>Awareness</b>		<b>Awareness</b>	

Homeowners? **For the ordinary citizen, CHP is an almost unknown technology**

Consultants? **CHP is known in principle.**

Installers? **CHP is known in principle and detailed know-how is at a good level.**

Planners? **CHP is known in principle**

Government? **CHP is known in principle.**

Are manufacturers active in the market? **Yes**

Are stakeholders aware of the micro-CHP technologies

Consultants? **CHP is known in principle.**

Installers? **CHP is known in principle and detailed know-how is at a good level.**

Planners? **CHP is known in principle**

**Purchasing power**

**GDP: € 11 400 per year**

## 4. Bio CHP potential assessment

### Approach for bio-CHP potential analysis

#### ***EU Potential for bio-energy CHP***

The goal of this analysis is to estimate the uptake and thus the implementation potential, not the theoretical maximum potential, for bio-energy CHP in the 27 EU-member states (MS) until 2030.

To this end, the following main sources have been used to arrive at country specific potentials:

1. Data on "Heat demand from CHP and DH" from the EU energy trends to 2030<sup>26</sup> (based on PRIMES database)<sup>27</sup>
2. Data of targets for "biomass for heating" from the National Renewable Energy Action Plans of the MS<sup>28</sup>
3. Current levels of biofuel inputs to CHP from EEA/Eurostat<sup>29</sup>
4. Biomass potentials from the "Atlas of EU biomass potentials" (Project Biomass Futures)<sup>30</sup>

The approach chosen to perform this bio-energy CHP potential analysis and the basic assumptions are as follows:

#### ***Scope and assumptions, analysis steps***

The theoretical potential for bio-energy CHP is seen as the 100% fuel switch to bio-fuels in the CHP systems of a given country – in district heating (DH) as well as in industry. The aim of this study is to project on MS level the heat demand from bio-energy CHP systems – also in relation to the heat demand from all CHP systems – in 2030 with a milestone 2020.

##### **Step 1: Heat demand from CHP and DH**

The main data source for the development of CHP in the MS are the figures for *heat demand from CHP and DH* (Source: PRIMES) as published in the EU Energy Trends to 2030, Reference Scenario<sup>31</sup> (blue curve in country reports). In countries, for which specific energy trend data for CHP were available (e.g. Germany), these were chosen instead of the PRIMES data.

##### **Step 2: Current and future bio-energy penetration rate**

Coming from the current level of bio-energy CHP utilisation (EEA/Eurostat; 2010 value of green curve in country reports), the assumption is that the markets for bio-energy CHP will develop in close relation with the targets of the Renewable Energy Directive and the projections for renewable energy utilization as stipulated in the EU Energy Roadmap (30% in 2030). These figures are then further adapted on country level using specific national sources and in contact with national experts to arrive at a development path for the heat demand from bio-CHP for each MS (2030 value of green curve in country reports).

##### **Step 3: Determination of growth curve**

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<sup>26</sup> European Commission, DG Energy: "EU energy trends to 2030"; 2009.

<sup>27</sup> In some MS additional data or projections have been identified for "Heat demand from CHP and DH" or "bio-fuel input in CHP" and have been used instead of the sources mentioned here. Wherever this was done, the respective sources are mentioned in the respective country report.

<sup>28</sup> Energy Research Centre of the Netherlands, European Environment Agency: "Renewable Energy Projections as Published in the National Renewable Energy Action Plans of the European Member States"; 2011.; no figures available for Romania

<sup>29</sup> European Environmental Bureau, Eurostat: "Fuel input to CHP plants in EU-27 and EEA countries in 2009", <http://www.eea.europa.eu/data-and-maps/figures/fuel-input-to-chp-plants-4>

<sup>30</sup> Alterra, IIASA: „Atlas of EU biomass potentials: Spatially detailed and quantified overview of EU biomass potential taking into account the main criteria determining biomass availability from different sources“, 2012.

<sup>31</sup> Reduced by the share of non-CHP heat according to IEA and EUROSTAT statistics.



To determine the curve shape for the development of bio-CHP (green curve in country reports), two sets of data are used as reference (normally weighed 50:50): Firstly, the national target figures *Biomass for heating* (2015 and 2020, own extrapolation for 2025 and 2030) as laid down in the member states' National Renewable Energy Action Plans (yellow curve in country reports). Secondly, the development of the *final heat demand from CHP & DH* as projected by PRIMES (blue curve in country reports). Using IEA figures<sup>32</sup>, the non-CHP parts of DH in the PRIMES figures has been eliminated.

The intermediate result is a *projected heat demand from bio-energy CHP* under favourable framework conditions (green curve in country reports).

#### **Step 4: Assessment of framework conditions through scorecard**

In a further step, the bio-energy CHP penetration curve is modified by assessing the national frameworks for biomass fuelled cogeneration with a score card<sup>13</sup>. In this scorecard, the following aspects have been assessed and weighed:

- Legislative environment
- Suitability of heat market for switch to bio-energy CHP
- Share of Citizens served by DH
- National supply chain for biomass for energy
- Awareness for DH and CHP

Applying the scorecard results then results in the projection of the bio-energy heat demand from CHP and DH (in ktoe) for 2020 and 2030 (red curve in country reports).

#### **Step 5: Assessing biomass availability**

To cross-check, whether the projected demand can be satisfied with cost-efficient biomass available within the MS, the demand figures are compared with national biomass availability figures as published by the project "Biomass Futures" in the Atlas of EU biomass potentials (2012)<sup>33</sup> (pink curve in country reports). Due to the ongoing discussion in the EU about sustainability criteria for bio-energy, the figures from the Atlas' sustainability scenario were chosen, which take into account not only existing legislation but assume stricter sustainability rules to be applied in the future also for solid and gaseous biomass. As the Biomass Futures project also investigated price-levels, the figures used here describe a rather conservative assumption of biomass availability per country. It is assumed, that the technology to use the different sorts of cost-efficient biomass resources (largest groups: straw, manure, perennial cropping, forestry residues, waste) for CHP purposes will be available.

### ***Areas not covered***

Although being important factors for the future development of bio-energy CHP markets, due to limited availability of data the following aspects have not been incorporated in the potential this analysis:

- Small-scale CHP
- Trigeneration
- Regional or local biomass availability
- Biomass imports

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<sup>32</sup>: Website International Energy Agency, Statistics section:

<http://www.iea.org/stats/prodresult.asp?PRODUCT=Electricity/Heat> Score ratings by member state CHP experts.

<sup>33</sup> Assumptions for arriving at the available biomass for bioenergy CHP: 65% of available biomass used for heating; CHP factor 0.8.

## Bio-energy CHP potential in EU-27

25 member states<sup>34</sup> have been assessed with the approach described and are summarised each in a 2 page country report. These reports will be subject to further discussions on MS level in the context of the CHP road maps which are presently under development.

For the European Union, an overall assessment was established by aggregating the individual country figures. As country specific frameworks and policies are important aspects, which were assessed through the scorecards, this section is not depicted in the EU summary.

Analysing the overall picture from the member state level bio-energy CHP potential analyses, the following trends and conclusions can be made:

- There will be a steady increase in CHP heat demand in the EU until 2030
- *The strong increase in biomass for heating as stipulated in the MS's NREAPs will also support the development of bio-energy CHP*
- The expected penetration rate of bio-energy CHP in CHP markets is expected to reach 27,1% in 2030 (up from 19,5% in 2009)<sup>35</sup>
- The framework conditions – politically, economically, regarding awareness – for (bioenergy) CHP vary greatly throughout EU
- Under optimum framework conditions on national level, the penetration rate could reach 33% in 2030
- For the projected development, sufficient cost-efficient and sustainably produced biomass resources are available on a national level for further growth of bio-energy CHP. Again, the situation varies greatly between member states. In densely populated countries the nationally available biomass resources may fall short of the demand.
- To maximise the potential, technological progress towards the use of the whole range of biomass fuels should be promoted

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<sup>34</sup> France: still in discussion with experts; Malta: insufficient data, no (foreseeable) relevance for CHP

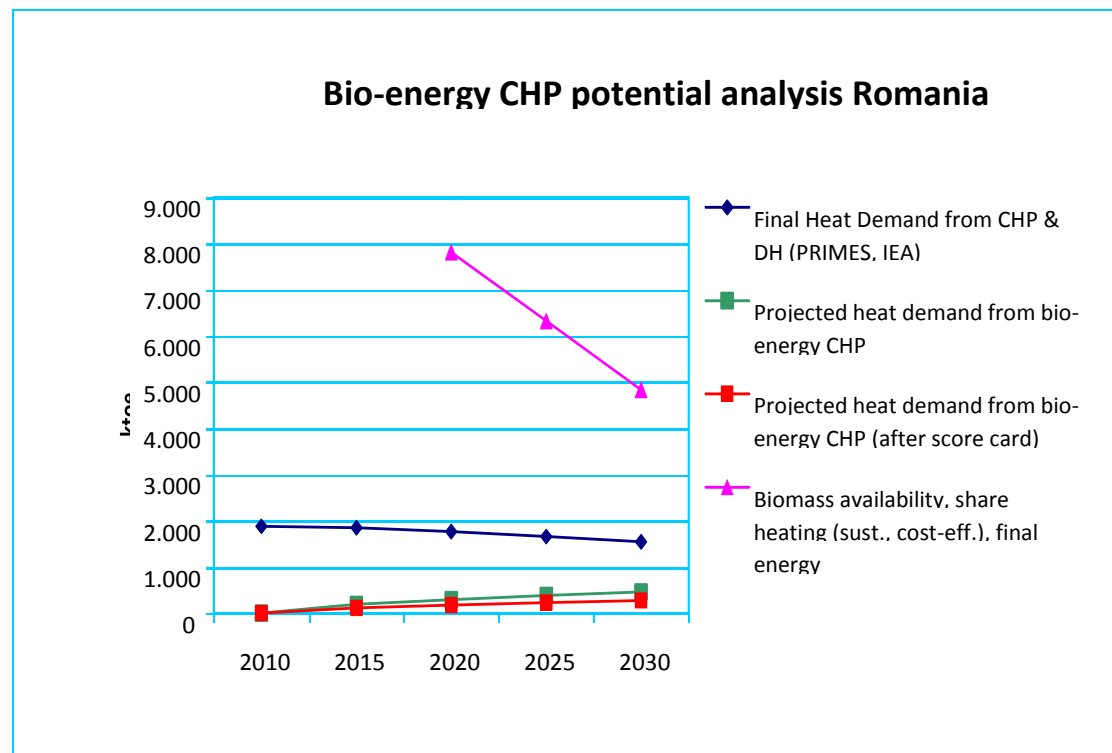
<sup>35</sup> The three countries Germany (large CHP market by volume), Sweden and Finland (both good CHP markets with high biofuel share) account for 76% of the bio-CHP heat demand in EU-27 (2009).



## Bio-energy CHP potential analysis Romania



Figures (projections)	2010	2020	2030
Final heat demand from CHP and DH (PRIMES, IEA), ktoe	1.894	1.774	1.558
(Projected) heat demand from bio-energy CHP and DH (after score card), ktoe	10	186	284
Bio-energy penetration rate in CHP markets (2009: EEA, Eurostat)	0,5% (2009)	10,5%	18,3%
Biomass availability, share heating (sust., cost-eff.), final energy (Biom. Futures), ktoe		7.812	4.838



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	Score	Short analysis
Legislative environment	+ 2 (of 3)	DH is promoted and there is an adequate DH grid access.
Suitability of heat market for switch to bioenergy CHP	+ 2 (of 3)	Adequate number of Industries with rather continuous heat demand.
Share of Citizens served by DH	+ 2 (of 3)	There is an important level of DH penetration.
National supply chain for biomass for energy	o 1 (of 3)	New area with good potential
Awareness for DH and CHP	+ 2 (of 3)	There is an awareness for HECHP and DH, as well as for bio-energy

### Comments on country analysis

#### General comments

- The national framework assessment through the scorecard results in a good medium score (9 of 15 possible points).
- Thus, it is projected that the growth potential for bio-CHP until 2030 will be exploited to 60%.
- The possible bio-CHP penetration rate in 2030 (2030 dot of green curve) under ideal framework conditions is seen at 30% (the country's RE target according to RED (28/2009) is at 24% in 2020)
- The share of bio-fuels in CHP (bio-energy penetration rate in CHP markets) is expected to grow from 0,5% (2009) to 18,3% (2030)
- The national biomass availability (cost-efficient, sustainable; pink curve) is sufficient to enable the projected growth; however, these biomass resources include types of biomass which are currently not usually used in CHP, but are expected to be utilisable by 2030

#### Specific issues

- The projected development of CHP heat demand (PRIMES, blue curve) foresees a slight but constant decrease after 2015
- From the Romanian NREAP, no figures for biomass for heating are reported, therefore the sole reference for the growth of the bio-CHP sector is the general expected development of CHP in Romania.

#### To be checked

- Are there maybe new data projections on biomass for heating until 2020? Has maybe Romania supplemented the NREAP?

## ***5. Assumptions used in the market extrapolation***

Detailed economic analysis of four CHP cases was implemented in all pilot roadmaps and optionally in non-pilot ones.

As requested detailed economic data analysis of the four CHP cases were not available or are not sufficiently reliable for making objective conclusions about CHP profitability and comparison of economics with other member states, detailed calculations is not included in this report.

## 6. Methodologies used to calculate the saving of primary energy and CO<sub>2</sub> emissions under the roadmap.

### Substitution method

This method has been developed in the CODE2 project. In doing this, two other approaches have been considered: 1) the “replacement mix method<sup>36</sup>” from the Munich FfE institute, which however cannot be used directly for a long term comparison as needed in CODE2; 2) a method used to calculate the CO<sub>2</sub> saving resulting from a voluntary commitment of the German industry for CO<sub>2</sub> reduction<sup>37</sup>, however this method has been considered as too simple. Therefore the following more differentiated approach has been developed:

Based on an estimate of the increase in cogeneration electricity the thereby caused decrease of CO<sub>2</sub> emissions and primary energy consumption is estimated. In this approach, an attempt is made to determine the actual quantities saved compared to the base year (e.g. 2010). Hence it refers to the actual saving of fuels for the production of the amounts substituted by modern CHP plants

- a) of electricity and heat in the replaced or retrofitted old CHP plants
- b) of electricity in power plants
- c) of heat in boilers.

The savings result from a combination of three effects:

- CHP effect
- Technology effect (improved CHP technologies)
- Fuel switching (e.g. lower carbon content of natural gas compared to coal, CO<sub>2</sub> neutrality of bioenergy)

The results show the savings actually induced by the expansion of CHP compared to the situation in the base year.

This approach differs fundamentally from the methods for checking the high-efficiency according to the CHP Directive or in accordance with ANNEX II of the EED (Directive 2012/27/EU on energy efficiency), in which a comparison between CHP and the best available Technology (BAT) of separate production of electricity and heat produced is carried out strictly on a same-fuel basis.

This procedure is considered to be inappropriate to deliver an estimate of the actual fuel saving quantities by CHP over a longer period, which is considered relevant value, representing meaningful the contribution of CHP to the long-term objectives of the EU to reduce CO<sub>2</sub> emissions and primary energy consumption. The BAT approach of the CHP Directive has been developed to verify the high efficiency of individual plants, but not to determine actual saved CO<sub>2</sub> emissions and primary energy quantities by CHP expansion.

In fact, the CHP expansion is closely associated with a replacement of old by new cogeneration technologies and a change in the structure of fuel away from coal to natural gas and bio-energy. These three developments,

- replacement of separate generation by cogeneration
- replacement of old by new cogeneration technologies
- replacement of carbon-rich by low-carbon fuels, can be usefully seen only as an integrated process.

To account for the uncertainties in particular with regard to fuel shares and technology development, a window of possible developments with an upper value and a lower value of emission reduction and savings has been determined. The different levels of results are due to assumptions about key parameters such as current share of electricity from cogeneration, which is replaced by electricity from new or retrofitted units, fuel shares in the replaced CHP plants, power plants and boilers as well as in the new CHP plants.

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<sup>36</sup> FfE Forschungsstelle für Energiewirtschaft e.V., Energiezukunft 2050; <http://www.fffe.de/die-themen/erzeugung-und-markt/257>

<sup>37</sup> The calculation has been made by the VIK Verband der Industriellen Energie- und Kraftwirtschaft e.V., 2010, Unpublished.

The results have been calculated based on the following input values: growth of CHP power production, share of current old CHP to be replaced by new installations and retrofitting, fuel efficiency and electric efficiency of new CHP and replaced CHP for different fuels, electric efficiency of replaced power from conventional power plants for different fuels, heat efficiency of replaced heat from boilers, corresponding fuel shares.

### **EED method**

The Primary Energy Savings methodology of the EED is used at a country level for national reporting to the Commission, and at project level for determining if CHP is highly efficient. In the methodology, each cogeneration unit is compared with the best technology for separate production of heat and electricity on the same fuel on the market in the year of construction of the cogeneration unit and the harmonized reference values are determined by fuel type and year of construction.

The underlying principle is that, knowing that regularly new investments have to be made in new energy production units, it is necessary to compare CHP with the centralized production installation which could be built using the same fuel rather than assuming a displacement of a different fuel or introduction of a new fuel. It is a logical approach when looking at the decision making process of investors or a member state government. By investing in or supporting CHP, a certain electricity generating capacity will be produced by CHP and NOT by centralized production based on the same fuel (= principle of 'avoided production').

For the timeframe of the roadmap (between 2010 and 2030), and especially in countries where there is no overcapacity, it is relevant to compare installing a certain capacity (at national level) of CHP compared to installing new capacity with another technology (power plant + gas boiler). Older installations being replaced with state-of-the-art technology is a typical reinvestment decision. New CHP-plant (or combination of smaller installations) would not necessarily lead to less production in older production installations, but would rather preempt investments in e.g. new CCGT investments.

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27. "Energy Service Companies Market in Europe - Status Report 2010", Angelica Marino, Paolo Bertoldi, Silvia Rezessy, JRC-IE



## 8. Reference list:

Additional laws and decisions setting the framework of CHP in Romania are:

- Law 372/2005 on energy performance of buildings
- GEO 152/2005 regarding the integrated pollution prevention and control (amended by GEO 40/2010 and Law 205/2010)
- G.D. 1069/2007 approved the Energy Strategy of Romania in the period 2007- 2020
- Law 220/2008 (amended by Law 139/2010 and GEO 88/2011) establishing promotion system to produce energy from renewable energy sources
- GEO 22/2008 regarding the energy efficiency and promotion of the use of renewable energy sources a the end-users
- GD 60/2008 regarding the approval of the National Plan for Allocation NAP) of allowances in greenhouse gas emissions for 2007 and 2008-2012 periods
- GEO 18/2009 on the increase of energy performance of residential buildings
- GD 780 establishing the trading scheme for greenhouse gas emission allowances (amended by GD 133/2010. GD 399/2010 and GD 1300/2010)
- GD 432/2010 regarding the establishment and development of the green investment scheme
- GD 935/2011 concerning the promotion of the use of biofuels and bio-liquids