

CODE2

**Cogeneration Observatory
and Dissemination Europe**



D5.1 - Final Cogeneration Roadmap Member State: **Bulgaria**

November 2014

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

*Bulgaria is part of the non-pilot Member States of the South Eastern CODE2 Region.
The CODE2 Region ‘South Eastern Europe’ comprises the following Member States:
Bulgaria, Cyprus, Greece, Romania*



Co-funded by the Intelligent Energy Europe
Programme of the European Union

The CODE2 project¹

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) and in close interaction with the policy-makers, industry and civil society through research and workshops.

The input of all experts has informed these roadmaps. The content of the roadmaps, and opinions of the roadmaps presented reflect the conclusions of the CODE2 project only.

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 Bulgaria is written by, CODE2 partner HACHP, based on a range of studies and consultations. It has been developed through a process of discussion and exchanges with experts.

Executive Summary

Cogeneration has a long tradition in Bulgaria. Cogenerated electricity production passed through a decline period, mainly due to a shifting towards to the use of nuclear energy and of lack of new investments for this technology, and now is recovering.

A more intense use of cogeneration is met in DH, showing a good prospective and an interest for large investments, by foreign investors. The implementation of EED and of proposals presented in this roadmap can lead to the increase of the share of cogenerated electricity from 7% in 2011 to 14% in 2030.

Forecasts for heat production from CHP show that the share of cogeneration units on heating production will reach 30% to 2030. CHP development potentials are expected in the sectors of DH, agriculture & forestry sector, in tertiary and social infrastructure sector.

The roadmap path would deliver 7.8 to 10 TWh/yr of primary energy saving (PES) under the EED methodology. Considering the likely implementation path of such, the roadmap forecasts 17.5 TWh/yr in PES and more than 10 million tonnes of CO₂ reductions are achievable in practice.

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

Table of Contents

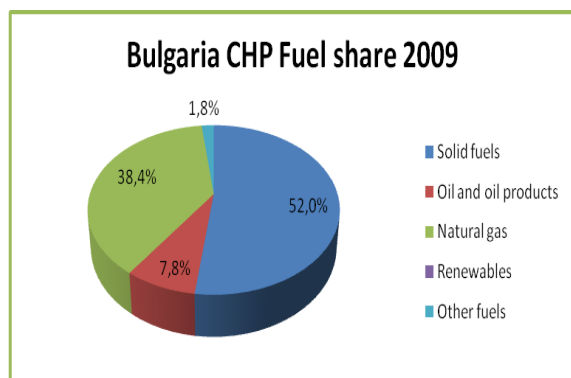
Executive Summary	2
1. Where are we now? Background and situation of cogeneration in Bulgaria	4
1.1 Current status: Summary of currently installed cogeneration in Bulgaria	4
1.2. Energy and Climate Strategy of Bulgaria	6
1.3. Policy development in Bulgaria.....	7
1.4 Exchange of information and awareness in Bulgaria.....	8
1.5. The economics of CHP in Bulgaria	9
1.6. Barriers to CHP in Bulgaria	11
2. What is possible? Cogeneration potential and market opportunities in Bulgaria	13
3. How do we arrive there? The Roadmap	15
3.1. Overcoming existing barriers and creating a framework for action in Bulgaria	15
3.2. Possible paths to growth in Bulgaria	17
3.3. Saving of primary energy and CO ₂ emissions by the CHP roadmap of Bulgaria	18
ANNEXES.....	20
1. Stakeholder group awareness assessment	20
2. Micro CHP potential assessment.....	22
3. Bio CHP potential assessment.....	24
Policy Background.....	24
Climate Change Mitigation Potential	25
Applications of bio-energy CHP	26
Fuel types for bio-energy CHP.....	26
Approach for bio-CHP potential analysis	28
EU Potential for bio-energy CHP	28
Areas not covered	30
4. Assumptions used in the market extrapolation	34
5. Methodologies used to calculate the saving of primary energy and CO ₂ emissions under the roadmap.	35
6. Sources	37

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

1.1 Current status: Summary of currently installed cogeneration in Bulgaria

The CHP share in the total electricity production of Bulgaria is 6.7% (2011), it shows a declining trend after its peak in 2008, while solid fuels and NG consist the main fuel input.

Bulgaria has a long tradition on cogeneration from the centrally planned economy era, as large scale CHP



units have been implemented, which with the extensive district-heating infrastructure providing SHW and space heating to citizens in many cities of the country. In late 90s, the share of cogeneration was 16% of the total installed capacity and 31% of the thermal power plant capacity². The fuel input for CHP plants, for 2009, shows great dependence in natural gas and solid fuels, which consist the 90.4% of the total fuel input, while the rest are oil and oil products (7.8%) and RES/biomass of 1.8% (Figure 1). In 2011, the CHP space heat production reached 44,453 TJ, with a share of 26.7%³ compared to

the total space heat production and the DHS are serving 17% of the population⁴.

From Eurostat⁵ the data for CHP in Bulgaria, for the period from 2005 to 2012, is given in Table 1:

Year	CHP electricity generation TWh	Main activity producers	Auto-producers	Share of CHP in total electricity generation	CHP Electrical capacity, GW	CHP Heat production, PJ	Main activity producers	Auto-producers	CHP Heat capacity, GW
2012	2,77	93,2%	6,8%	5,9%	1,17	41,6	97,9%	2,1%	4,1
2011	3,39	97,9%	2,1%	6,7%	1,13	38,5	99,2%	0,8%	4,1
2010	3,72	95,0%	5,0%	8,0%	1,02	40,4	98,2%	1,8%	3,9
2009	4,04	95,4%	4,6%	9,4%	1,28	44,5	96,4%	3,6%	5,8
2008	4,49	81,3%	18,7%	10,0%	1,37	58,9	83,9%	16,1%	:
2007	4,05	69,3%	30,7%	9,4%	1,30	57,3	71,5%	28,5%	:
2006	2,77	81,6%	18,4%	6,0%	1,14	48,0	69,2%	30,8%	:
2005	2,72	84,1%	15,9%	6,1%	1,19	50,4	67,3%	32,7%	:

Table1: CHP data from 2005 to 2012.

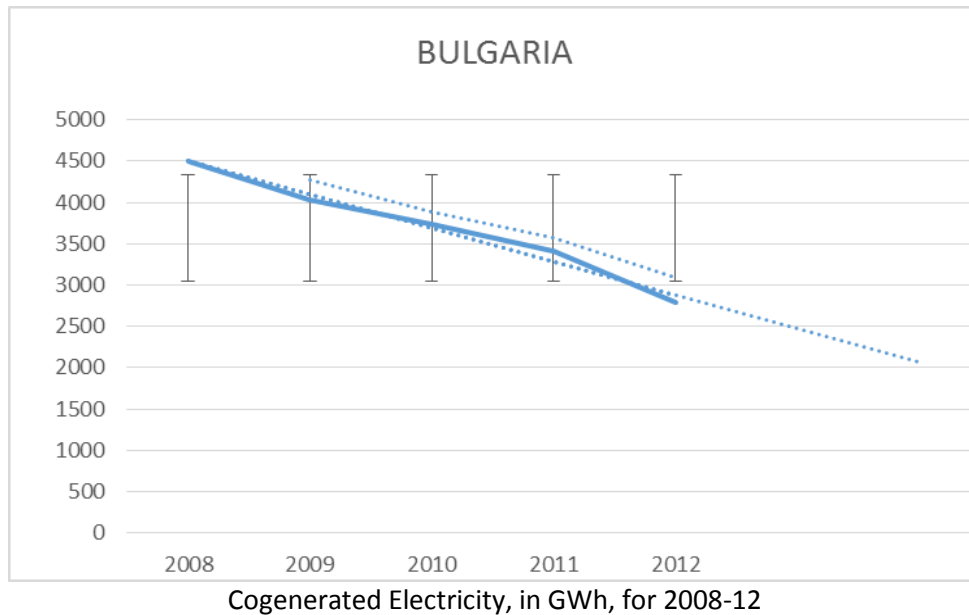
From the data of Table 1, it can be seen that the installed CHP electrical capacity ranges from 1.14 GW (min) to 1.37 GW (max) with average operating hours of 2900 per annum. Also the vast majority of the cogenerators, above 90%, are the so-called “main activity producers” who are injecting the cogenerated electricity to the Grid and the auto-producers are rapidly declining the last five years, as shown in next fig.

² http://www.sec.bg/userfiles/file/Municipal%20Bulletins/Municipal_bulletin6_ENG.pdf

³ “Combined heat and power (CHP) (ENER 020) - Assessment published Apr 2012”, European Environment Agency

⁴ <http://www.euroheat.org/Bulgaria-187.aspx>

⁵ Eurostat, <http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsdcc350>



The CHP share on the total electricity production shows a declining trend, after its peak of 10% in 2008, resulting, in 2011, a 6.7% of the electricity in Bulgaria being delivered in cogeneration mode (Figure 2).

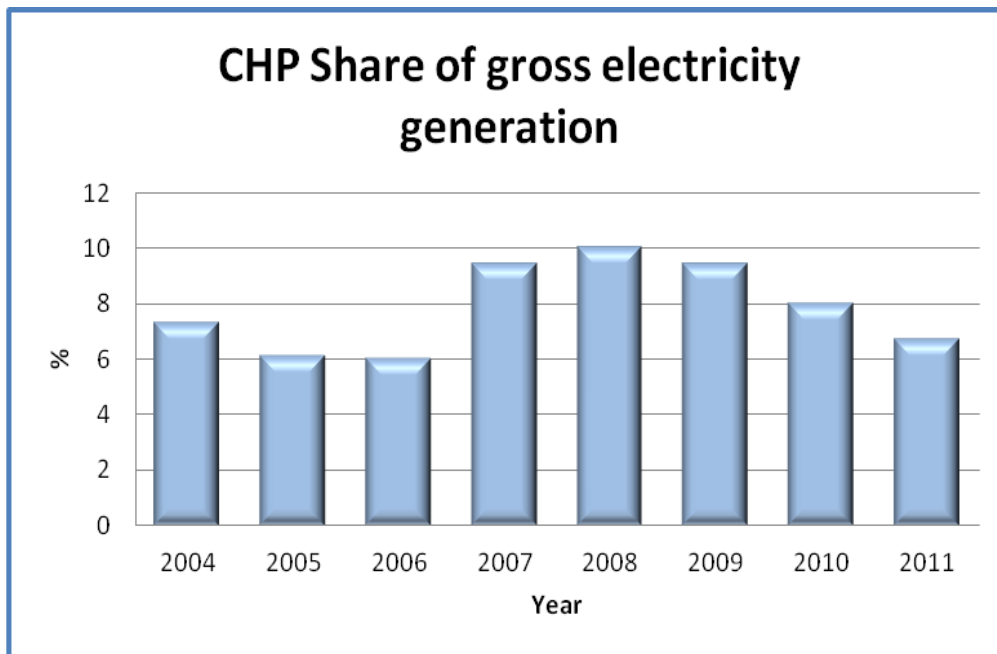


Figure 2: CHP Share of gross electricity generation⁶

⁶ Eurostat, <http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsdcc350>

1.2. Energy and Climate Strategy of Bulgaria

The energy strategy of Bulgaria focuses on the energy security, the increase of RES share and the competitiveness of the energy market, with attention to CHP, as EE technology.

Bulgaria has very small oil and gas reserves, but considerable reserves of lignite and sub-bituminous coal. However, lignite cannot be easily exploited, due to several geological constraints⁷. Bulgaria also uses nuclear power in order to cover energy needs. The energy strategy of Bulgaria suggests that nuclear power shall be promoted in order to reduce external energy dependency.

The Energy Strategy of Bulgaria is contained in three documents "*Energy Strategy of Republic of Bulgaria till 2020 for reliable, efficient and cleaner energy*", the "*Second National Energy Efficiency Action Plan 2011-2013*" both published in June 2011, and, in May 2012, the "*Third national action plan on climate change for the period 2013-2020*" document was published pointing out the importance of CHP development towards the achievement of strategic objectives.

The strategic objectives, set along with the expected results according to the energy strategy, are shown in Table 2.

Strategic objectives	Expected results
Energy security for the Bulgarian industry and population	Established power exchange
Reduction of greenhouse gas emissions	Increase of the RES share to 12% of the total final energy consumption
Increase of the share of renewable energy sources in the total final energy demand	
Energy Efficiency Enhancement	20% lower energy intensiveness of GDP ⁸
Better utilization of the indigenous energy resources	
Building of a competitive energy market as a way to achievement of high priority objectives - competitiveness, energy security & sustainable development	Higher-quality energy supply at affordable and predictable prices
Alternatives to the supply of natural gas	Increased share of freely negotiated quantities of electricity in the internal market

Table 2: Strategic objectives - expected results

The current legal climate framework concerning adaptation in Bulgaria has been defined by the following documents⁹:

- The Environmental Protection Act defines the Bulgarian national green investment scheme as an instrument intended to be used for the development of projects with adaptation activities.

⁷ "South east Europe Energy Outlook", IENE, 2011

⁸ Energy intensity is a measure of the energy efficiency of a nation's economy. It is calculated as units of energy per unit of GDP.

⁹ <http://climate-adapt.eea.europa.eu/countries/bulgaria>

- The Second and Third National Action Plan on Climate Change defines a small number of adaptation measures in the agriculture and forestry sectors, clearly suggesting the support and development of HECHP.
- The Fifth National Communication on Climate Change to the UNFCCC - was coordinated by the Ministry of Environment and Water and realized by the Energy Institute in cooperation with the Ministry of Agriculture and Food, Ministry of Industry, Energy and Tourism and National Institute of Meteorology and Hydrology.

1.3. Policy development in Bulgaria

The policy framework plays an important role in the development of CHP, by giving incentives to potential investors under the scope of a liberalized energy market.

The "Energy Strategy of Republic of Bulgaria till 2020 for reliable, efficient and cleaner energy", published in 2011, is a fundamental document of the national energy policy that is approved by the Council of Ministers and passed by the National Assembly, which reflects the political vision of the Government for a European development of Bulgaria pursuant to the up-to-date European energy policy framework and the global trends in the development of energy technologies. The legislative framework about CHP includes the promotion of CHP setting the surcharge price in cogenerated electricity¹⁰, the framework of energy efficiency national strategy¹¹ and the development of CHP in Bulgaria^{12,13,14,15}. Under the Energy Act, the State Energy and Water Regulation Commission, SEWRC, sets the mandatory purchase of all energy produced through high efficiency cogeneration, registered with a certificate of origin, with the exception of energy generated for internal use, or energy used on the free energy market. The preferential prices are based on individual production costs and supplements per producer group according to the following criteria: a) Predominant nature of the main thermal load, b) Type of fuel used, c) Cogeneration technology and d) Unit/station capacity. This preferential electricity price is set individually for each CHP producer from the SEWRC regulator. There are three main groups of producers: a) Heat producers, where the main heat load is for heating and for domestic hot water, b) Industrial producers, who are supplying industry with the required thermal energy, mainly steam and hot water and c) Agriculture, where thermal energy is required for greenhouses, mainly for growing vegetables¹⁶. Additionally, there are financing projects for the implementation of energy saving technologies and renewable energy sources under the operational program "Competitiveness", of EU-Structural Supporting Funds for the country. These projects include provision of grants for small-scale co-generation installations for own needs for large enterprises. According to Energy Act in case of a declared demand for heat, new plants with a capacity exceeding 5 MW_e and using natural gas as fuel shall be constructed in cogeneration mode. The transmission company and the distribution companies shall perform priority

¹⁰ Energy Act and Energy Efficiency Act of Bulgaria promulgated in 2003 and 2004

¹¹ Law on Energy Efficiency, which is in force from 14 November 2008

¹² Energy from Renewable Sources Act promulgated in 2011

¹³ Bulletin on the state and development of the energy sector prepared pursuant to Article 4, paragraph 2, point 17 of the Energy Act, describes the energy status

¹⁴ Second National Energy Efficiency Action Plan 2011-2013, published in 2011 describes the support mechanisms, the importance and provides suggestions for the development of CHP

¹⁵ 2nd and 3rd National Action Plan on Climate Change sets HECHP as an important factor towards the environmental goals

¹⁶ Progress Report on the application of Directive 2006/32/EC on energy end-use efficiency and energy services and on the application of Directive 2004/8/EC on the promotion of cogeneration based on a useful heat demand in the internal energy market Brussels, 8.1.2014

connection of all power plants generating electricity using high-efficiency combined generation, having installed capacity up to 10 MW_e, to the transmission, and the distribution network, respectively.

There are, also, two funds supporting cogeneration projects: one set up by the Bulgarian state and a second one is called “the Energy Efficiency Fund” and the main donor is the World Bank. In 2014, the European Bank for Reconstruction and Development, EBRD, is co-financing with the district heating company serving the City of Sofia, a project for the upgrading and modernization of DH production and distribution system for the city of Sofia. This project includes the construction of a 10 MW cogeneration plant. In addition to that, a new HECHP unit of 35 MW_e and 89 MW_{th} is going to be installed, in a chemical factory. Although small scale CHP is underdeveloped, CHP installations of that size (up to 1 MW) are encountered in SME in the tertiary sector.

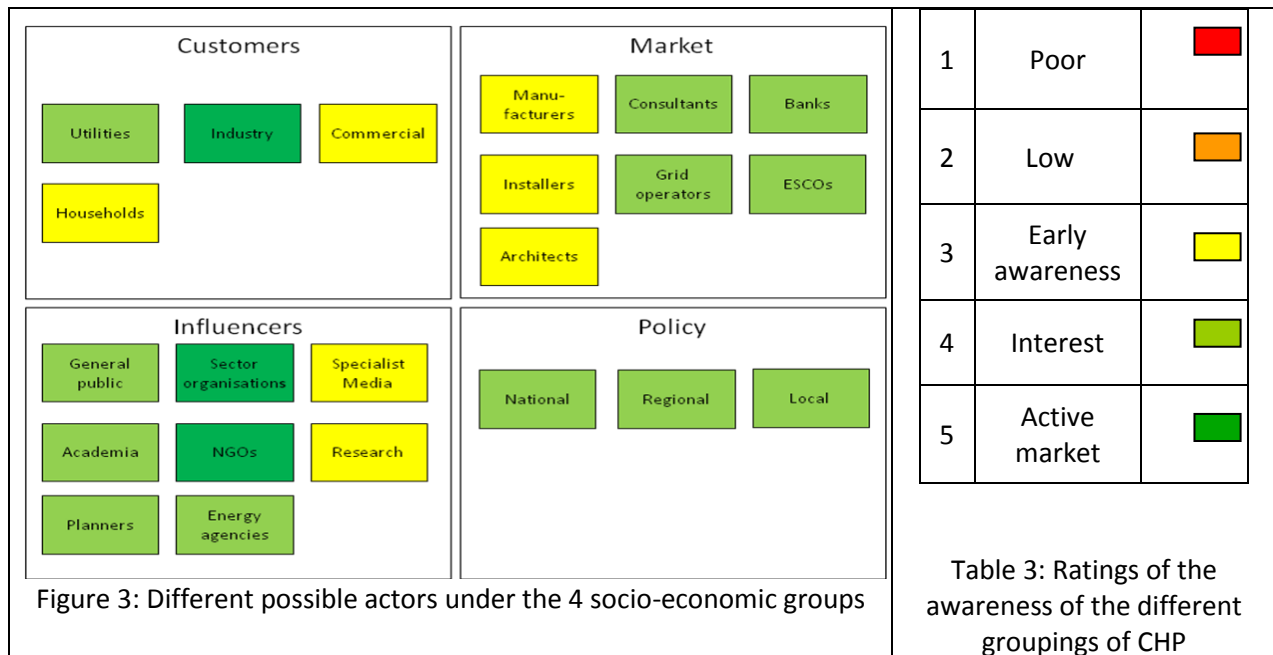
1.4 Exchange of information and awareness in Bulgaria

The extensive DHS, many of them operating using CHP, provide good background awareness within almost all socio-economic groups. Recently, an increasing political interest in energy efficiency and pollution reduction has increased awareness for CHP among policy makers.

During the past years, an increasing trend in awareness is provoked by political decisions towards energy efficiency and pollutant gas reductions, mainly due to environmental awareness and public pressure to politicians for these issues. CHP was arising as one EE technology and EED played an important role.¹⁷ 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 in 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. A CHP awareness assessment among key market actors has been developed using qualitative interview techniques with experts and market participants.

Four groups of socio-economic actors for cogeneration were assessed. The four groups and their subsectors are below shown 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 colours indicate the level of awareness in each sector (explained in Table 3).

¹⁷ Discussion with local expert on CHP situation in Bulgaria



Although in some of the interest groups the interaction is quite intense, there are some instable economic and political issues that draw investors away from the sector. Nevertheless a good interaction level could help the development of cogeneration in Bulgaria. Additionally a good awareness level is found in the majority of the groups, while ESCOs seem to hold a key role within policy makers and the market. Among the customers group, industry and utilities show the higher level of awareness. Banks, NGO's, academics and grid operator also show high awareness, while architects and installers do not hold deep knowledge of CHP. Commercial and household customers although users of DH from CHP, are unaware of the benefits of CHP. The average Bulgarian citizen does not know how exactly the heating from the network is produced. Research also holds early awareness due to low level of funding for CHP.

1.5. The economics of CHP in Bulgaria

According to CHP users the return on investment period is between 3.5 and 5 years depending on the capacity of CHP type and the fuel used by the cogeneration system.

The electricity and natural gas prices¹⁸ for Bulgaria and the calculated “*spark power ratio*” are presented in Tables 4 and 5. All energy prices are with “all taxes and levies included” and the electricity prices for household are for a typical annual consumption between 1000 to 2500 kWh.

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

¹⁸ <http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/database>

Year/Price	Natural Gas €/MWh		Electricity €/MWh	
	Industry	Household	Industry	Household
2009	25.7	34.8	86.4	81.3
2010	32.6	40.0	85.3	81.2
2011	36.4	45.1	89.5	84.4
2012	45.7	52.5	102.2	90.1
2013	42.9	51.3	111.2	93.4

Table 4: Natural Gas & electricity prices for industry and household sectors

Year	Spark ratio	
	Industry	Household
2009	3.36	2.34
2010	2.62	2.03
2011	2.46	1.87
2012	2.24	1.72
2013	2.59	1.82

Table 5: Spark ratio

Figure 4 shows the variation of spark ratio for households and industries, for a period from 2009 to 2013.

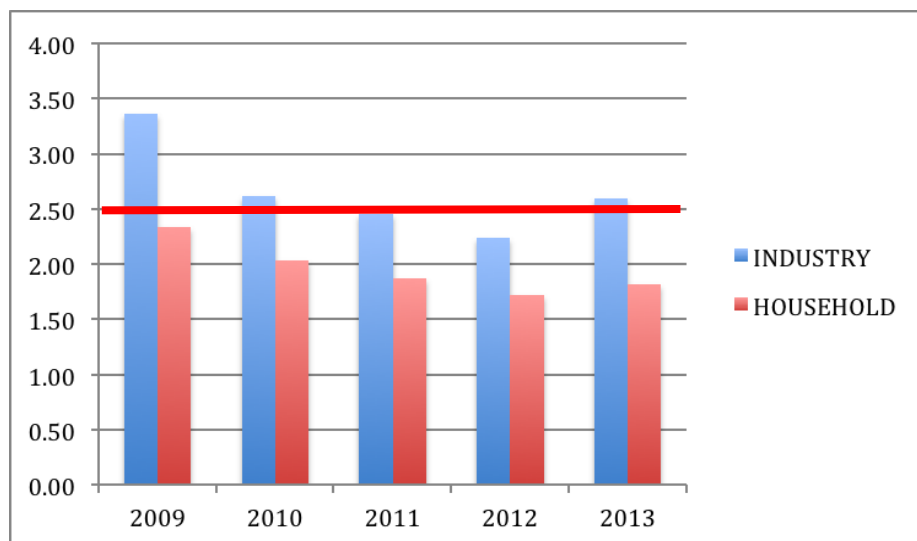


Figure 4: Variation of spark ratio for households and industries

From the data in Figure 4, it can be seen that for both household/tertiary and industrial sectors, the spark ratios are not favorable for implementation of CHP projects, at least from financial point of view. More analytically, for industry the spark ratio is just on the limit for considering the investment for further analysis, but for the households/tertiary is far below the 2.5 threshold and any investment in this sector requires incentives, in order to be financial viable.





The support mechanisms for CHP in Bulgaria are mainly based on a preferential electricity price for cogenerated electricity, priority connection to the grid and in some cases provision of grants and loans with favourable terms. According to CHP users and investors the return on investment period is between

3.5 to 5 years, depending on the size, type of the installation and the fuel used by the cogeneration system. Some major investments in the DH sector using CHP are already in progress and according to CHP experts new investments are expected. Industries, on the other hand, are quite reluctant to CHP investments, although the economics have a good return on investment period, mainly due to the unstable political and economic situation. Table 6 gives a screen shot on the current 2014 economic situation of CHP in the main use areas.

Table 6: Economic situation of CHP in major user groups

Bulgaria	Micro		Small & Medium		Large		
	<i>up to 50kW</i>		<i>up to 10 MW</i>		<i>more than 10 MW</i>		
	NG	RES	NG	RES	NG	Coal	RES
SME/Industry	Green	Green	Green	Green	Green	Yellow	Grey
District heating/cooling	Grey	Grey	Green	Green	Green	Yellow	Grey
Services	Red	Grey	Green	Green	Green	Red	Grey
Households	Red	Grey	Red	Grey	Grey	Grey	Grey

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 in Bulgaria

Unfavourable energy prices, unstable political situation, bureaucracy, limited funds and no fixed and firm feed-in tariff constitute the main barriers to CHP, all result low investor confidence and limited development of new CHP installations.

During the analysis of the energy sector of Bulgaria, with regard to CHP, barriers and obstacles are arising and are presented below.

Barrier 1: Unfavourable energy prices – existing heat price prevents competitive deployment of CHP, and is a particular difficulty for effective management of DH schemes.

The crucial measure for payback of a CHP investment is the difference between the cost of fuel used and the cost of electricity sold to the end-user by a provider, setting this as a major impact on the ROI.

In 2011, the average DH price was 10.7 €/GJ¹⁹ while for the same period the average electricity price was around 18 €/GJ²⁰, making new investment for CHP unprofitable.

Barrier 2: Inconsistency in the policy for the biomass sector and of the renewables sector in general.

Producers using RES, especially those using biomass, have no incentive to use cogeneration technologies, as the pricing of renewable energy provides an adequate financial guarantee of a return on their investment simply through the combustion of the biomass for heat. Investors do not see any advantage in taking on the extra investment and possible complexity of also generating electricity. Biomass CHP users state that the low levels of premium payment for energy crops, compared to the management of the crop for fuel, makes growing energy crops only marginally attractive for the farmers in comparison to food crops making it difficult to get enough biomass supply at a good price.

Barrier 3: The role of existing political environment and of bureaucracy in the promotion of CHP.

Unstable political situation in Bulgaria creates an insecure environment for investors. According to CHP investors and users, the fact of continuous energy law changes is affecting CHP investments. This environment is supporting bureaucracy, which along with the lack of experience and reluctance of the local authorities, is becoming another important barrier towards the development of CHP. Long, complicated and non-transparent permitting process, sets major barriers. The procedures and requirements for obtaining the permit and connecting to the electricity grid, for any type of CHP units, are considered as complicated and time consuming, by both cogenerators and consultants, who are setting these periods between 1 to 2.5 years. Moreover, as the feed-in-premium price of cogenerated electricity is connected to the gas price, every time it changes, CHP producers have to apply for new approved prices and to refill the papers and require approval by SEWRC (State Energy and Water Resources Commission), a long-standing bureaucratic procedure. This causes an, at least, yearly change in the preferential price and a low certainty of the support mechanisms perceived by investors.

Barrier 4: Heat trading in the district-heating sector.

Bulgaria is the only country in Europe where the heat supply company sells the heat not “to the entire building”, but to each individual apartment of the building. Some heat energy consumers fail to pay their bills on time, for various social and other grounds. As a result, almost all heat distribution and DH enterprises are in financial problems, spending time handling individual cases and only few have managed to perform well. Many companies operate at a loss, which makes it difficult to make additional investments. The unresolved problems relative to the heat trading in the district-heating sector have a negative impact on the development of cogeneration.

Barrier 5: Exclusion from F-i-T the electricity consumption of an independent cogenerator.

In the Bulgarian Energy Act it is stated that the electricity, produced from a high efficiency CHP is subject of a preferential feed-in tariff, but excluding the consumption of the independent producer-cogenerator. So, the customer occasionally has a limited or no benefit for installing a high capital investment, as a CHP system.

Barrier 6: Relatively limited funds for energy efficiency measures.

Part of the energy efficiency funds are relate to building's insulations and DH upgrade. The funds for RES are included in three different programs – Competitiveness, Agriculture and Regional Development - are relatively limited, making difficult the access to the investment grants. In these three programs, CHP systems are eligible, but the limited funds leave little space for intensive capital investment as a HECHP.

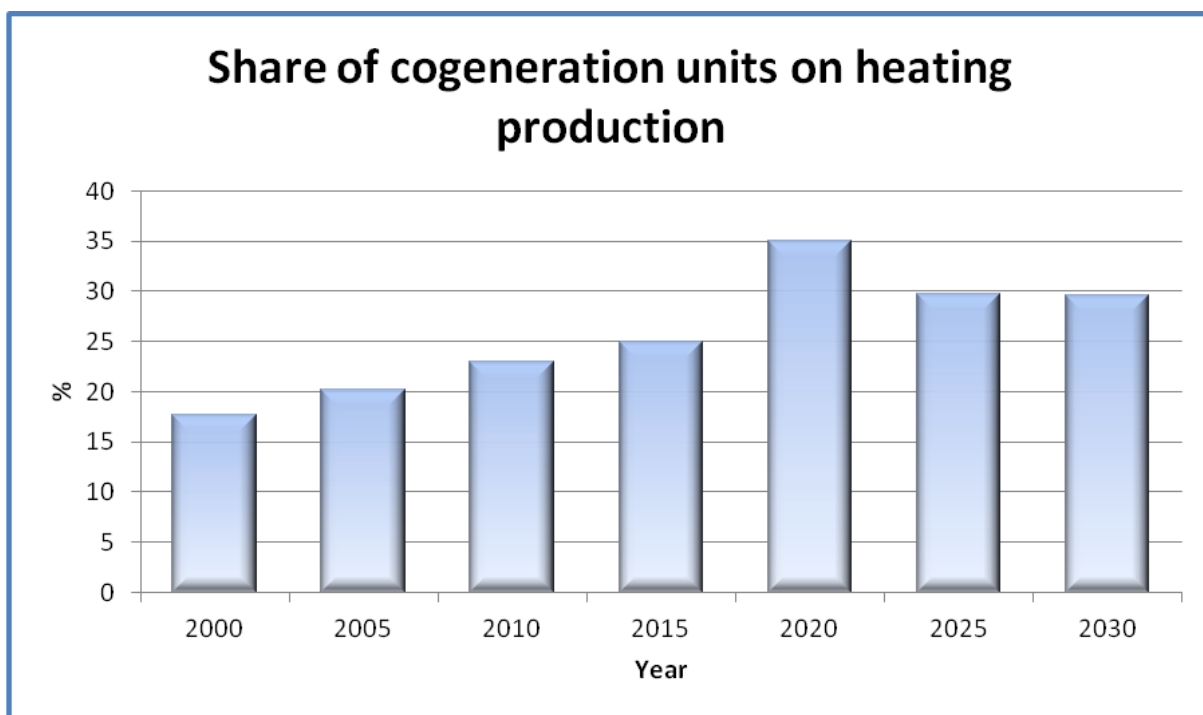
¹⁹ <http://www.euroheat.org/Bulgaria-187.aspx>

²⁰ Eurostat

2. What is possible? Cogeneration potential and market opportunities in Bulgaria

A rise in the share of CHP on heating production is expected till 2015, while the share of cogenerated electricity for 2030 is estimated near 14%. On the other hand the share of cogenerated thermal power for 2030 is estimated near 30%.

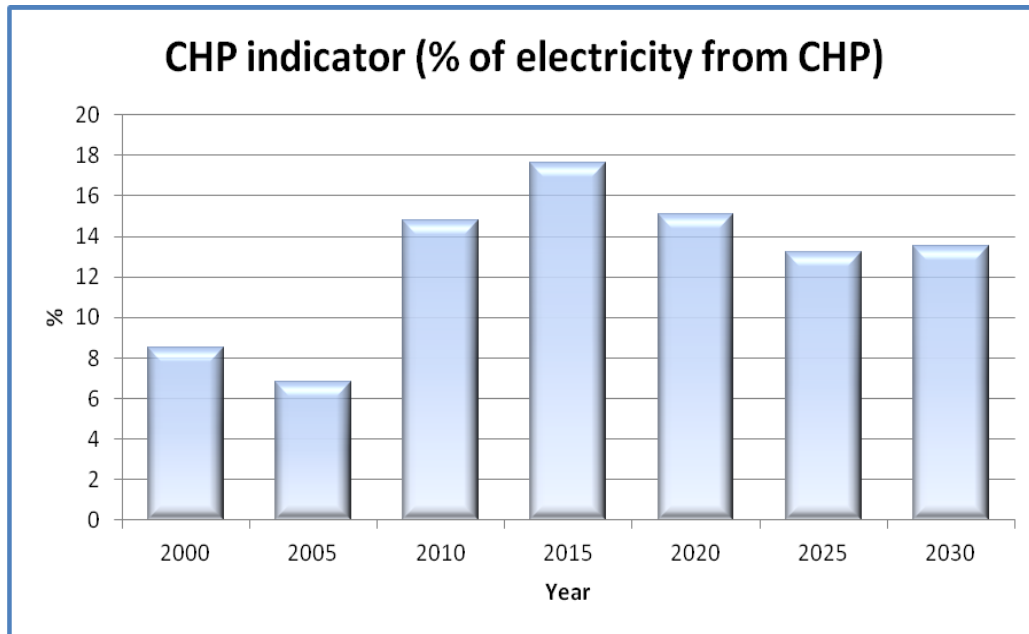
The published data sources used for the market (economic) potential of CHP in Bulgaria are the “*EU energy trends to 2030 — UPDATE 2009*”, by the EC Directorate-General for Energy in collaboration with Climate Action DG and Mobility and Transport DG and the “*Energy Strategy of Republic of Bulgaria till 2020 for reliable, efficient and cleaner energy*”, published in June 2011. The latter consist a fundamental document of the national energy policy that is approved by the Council of Ministers and passed by the National Assembly of the Republic of Bulgaria. Figures 5 and 6 show the economic market (economic) potential of CHP in Bulgaria. The share of cogeneration units for heating production is set to relatively high levels (Figure 5)



Figures 5: Share of CHP units for heating production²¹

Figure 6 shows the percentage of electricity from CHP from 2000 to 2030.

²¹ “EU energy trends to 2030 — UPDATE 2009”, EC Directorate-General for Energy in collaboration with Climate Action DG and Mobility and Transport DG



Figures 6: Percentage of electricity from CHP^{22,23}

These are projections derived from calculative PRIMES model showing a significant deviation from the present situation. Base year is set to 2005. Nevertheless we can see the trends in the CHP sector. There is an increasing trend in the share of electricity from CHP till 2015 and afterwards it is stabilized to lower levels. A long-term rise in the cogenerated heat is expected through the development of the district-heating network reaching in 2030 the capacity of 1,342 MW_{th}. This development is expected by the installation of CHP systems with high heating efficiency and low electricity efficiency. The latter in conjunction with the increasing use of nuclear energy for electricity production, justifies the different trends between electricity and heat production from cogeneration. Experts and users state that the sectors that will probably show a higher degree of CHP development are industry and district heating. Industries expected to invest in CHP are from the food, forestry and chemical sector. SME of the tertiary sector have already shown an interest towards cogeneration systems. Public swimming pools and hospitals are the main social infrastructures expected to install HECHP systems over the next years. 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.

The potential in micro CHP systems due to its high purchase cost, seems that, for the next few years, will not show any notable growth.

Bio CHP is already showing signs of development. Apart from the general rise of awareness towards bio CHP the economic benefits of such systems are satisfactory, according to investors.

²² "Energy Strategy of Republic of Bulgaria till 2020 for reliable, efficient and cleaner energy", June 2011

²³ "EU energy trends to 2030 — UPDATE 2009", EUROPEAN COMMISSION Directorate-General for Energy in collaboration with Climate Action DG and Mobility and Transport DG

3. How do we arrive there? : The Roadmap

3.1. Overcoming existing barriers and creating a framework for action in Bulgaria

Removing bureaucratic procedures and developing a secure investment environment are key factors that could lead the progressive course of CHP. The implementation of EED holds a dominant role in overcoming existing barriers and support for the development of CHP.

To move forward and exploit the additional potential for CHP in the Bulgarian economy it is required that the major barriers, identified in section 1.6, are addressed and solved accordingly. The main recommendations for overcoming the barriers regarding the development of CHP in Bulgaria are:

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

The full transposition of EED into the Bulgarian energy legal system was completed. The thorough implementation of EED, which through articles 14.15 and 16 would put a consistent structure in place for CHP development and will create a policy framework. Especially Article 16's requirement to make cogenerated electricity equal to the RES one in terms of network access will provide easier connection to the cogenerators to the grid, with better financial terms. The best way to obtain this is by providing a 50% reduction in the connection cost for HE-CHP systems. The EAD – the Bulgarian Transmission System Operator- should provide, within a short period of time, binding connection reports. HECHP systems developed in the tertiary (small-scale CHP, up to 1 MW_e) and residential (micro CHP, up to 50 kW_e) sectors must be provided with a simpler, non-discriminatory access to the electricity grid. Simple rules should be established for micro-cogenerators to connect to the Grid and the rules provided by Regulator should be clear and unambiguous. Additionally, EAD personnel should be trained on these issues by experienced agencies. All that will make easier current procedures that they are lengthy and time-consuming.

Additionally, 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 Bank²⁴. 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 %). This also will improve the penetration of tri-generation especially in hospitals, hotels, etc., lowering their current operation costs.

Finally, EED creates a policy framework encouraged in article 18, which allows the ESCO market to develop further in Bulgaria.

3.1.2. The Government should consider revision of the existing energy prices, especially for heat, eliminating bureaucracy, in order to make more appealing new CHP investments.

²⁴ 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.”

A revision of the energy pricing, applied in Bulgarian energy market, could be considered by centralized governmental organizations. This should be made through transparent procedures and under public consultations in order to bring producers and consumers closer, by overcoming any prejudices of the past. This way more investors-producers will be attracted creating a healthier competitive market. On the other hand, consumers will receive higher quality services in competitive prices.

Bureaucracy holds the highest level in policy barriers in Bulgaria. Procedures should become shorter and simpler, which is already mentioned in EED 2012/27/EU Articles 15 and 19. In addition the reduction of authorization time plays among others an economic role towards investors, since they will be gaining profits from selling power sooner. Making authorization procedures simpler and faster could increase the interest in CHP and provide a great incentive to candidate investors to proceed.

3.1.3. Government should boost development of an appealing support mechanism for cogenerators of HECHP and for DHS/trigeneration-New loans & grants for HECHP

Developing a secure investment environment. This could become possible with the help of EU and the implementation of several measures, by the central government that will dissolve any negative impressions about the national investment possibilities. Also measures and decisions could be "locked" in a way where they will not get affected by changes in the political status.

Active support for highly efficient co-generation of heat and electricity with emphasis on technologies using RES, including waste biomass, vegetable and animal waste. Additional incentives for CHP producers using RES should be given and higher level of premium payment for energy crops could give a significant boost to the sector.

Preservation of the centralized district heating also remains a priority, in which case the companies shall be technically modernized and financially stabilized. For that purpose, a program for stabilization and development of the heating sector should be developed and adopted.

Expanding the support schemes for the cogenerated electricity fed into the grid, from wider range of CHP systems, including now micro-scale CHP and for trigeneration units that now are not treated with attention. 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 micro-CHP and to trigeneration and/or district cooling systems, as EED requires.

Providing loans combined with grants for the development of HECHP systems, including micro co-generation and micro tri-generation. Article 20 proposes a financial structure around EE investments, which would be supportive of CHP, through the Energy Efficiency National Fund.

3.1.4. A new awareness campaign of the benefits of HECHP targeting towards Government and energy market players should be boost in Bulgaria-The important role of training, information campaigns, best cases, etc.

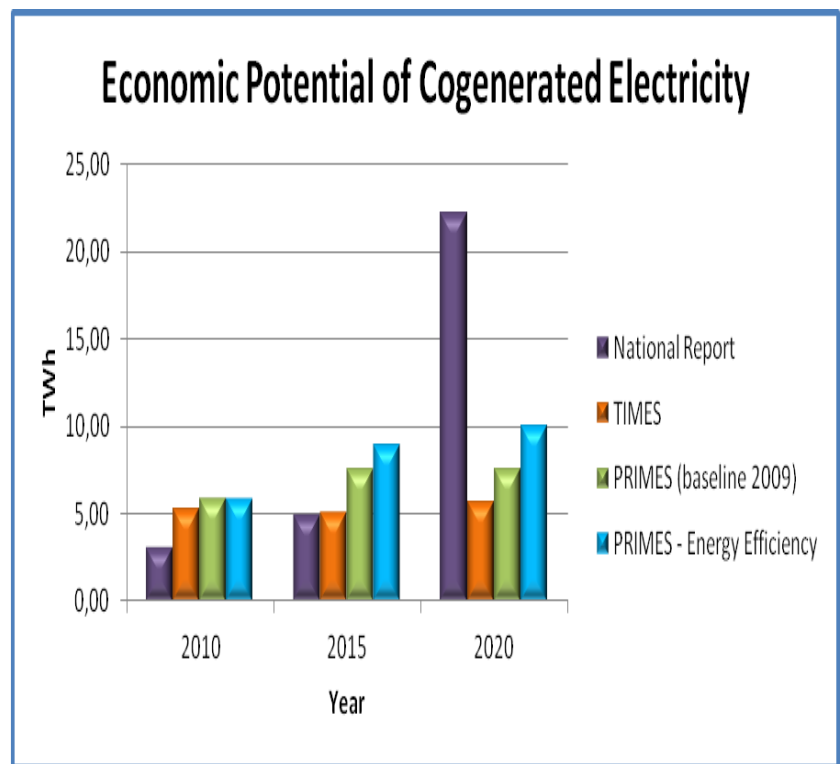
This is a combined effort to raise a new awareness campaign on the benefits of CHP, micro- and tri-cogeneration, through specialized seminars, published best cases studies that could provide more practical information to policy makers and experts from Government, to engineers and planners working for local and regional government, in order to promote this technology and to avoid setbacks as the last revision of the HECHP tariffs. Limited technical knowledge and know-how could be improved by a close cooperation between Greek government, ESCOs and educational institutes by bringing closer CHP experts and professionals who influence prospective investors.

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 in Bulgaria

Four forecasts to 2020, a forecast derived from national reports, a forecast using TIMES and two forecasts using PRIMES model. These forecasts show a large deviation of cogenerated electricity from 5.7 to 22.5 TWh per year for 2020. Another forecast from “EU energy trends to 2030 — Update 2009” document include a projection of produced cogenerated electricity for 2030 of 7.8 TWh/y.

There are four forecasts to 2020 showing an increase in the economic potential in the cogenerated



electricity. The studies for the forecasts are namely: a) the national report, developed on behalf of the Commission, b) the TIMES, which has been developed in the framework of the Energy Technology Systems Analysis Program (ETSAP) implementing agreement of the International Energy Agency (IEA)²⁵ and c) the PRIMES, the official energy analysis model of the EU. According to these forecasts the production of cogenerated electricity in 2020 will range from 5.7 to 22.5 TWh per year depending on the model for calculations. “EU energy trends to 2030 — UPDATE 2009” include projections to 2030 of 7.8 TWh per year for cogenerated electricity.

²⁵ <http://ipts.jrc.ec.europa.eu/activities/energy-and-transport/TIMES.cfm>

Figure 7: Final energy consumption forecasts²⁶

Experts state that the implementation of the EED will result the removal of a number of barriers a development of the CHP sector will take place. The sectors expected to lead the rise are the forestry and the food industry, promoting further CHP with biomass. Chemical industry is also expected to invest in CHP, while SMEs in the tertiary sector already show the most intense interest. Hotels, hospitals and sport facilities are among the prospective investors of CHP systems.

National economic potentials have been identified using the TIMES energy system model, developed by the Joint Research Centre, on behalf of the Commission. The Commission also assessed whether the progress realized by 2010 represented a sufficient trajectory towards the longer term potential in 2020. The potentials recorded in the national reports are typically based on national models or bottom-up estimation of the potential.

The potentials derived from the TIMES model are based on an EU-wide optimization model that simulates possible futures of the entire European energy system. The TIMES model might therefore overlook specific local circumstances that are taken into account in the national reports. This is the reason of the significant difference between the potentials from the national reports and the potentials from the TIMES model. Base year is set to 2007.

An alternative source of estimates of cogeneration potential is provided by PRIMES model, where two scenarios are considered: the PRIMES Reference (Baseline 2009), and PRIMES - Energy Efficiency. The same comment as for the TIMES model is applicable here: the PRIMES model is a complete simulation model of the entire European energy system, hence its results may be significantly different from the bottom-up analyses done by Bulgaria's national report. The PRIMES reference scenario considers for the period 2010-2020, only the energy efficiency and saving measures adopted by 2009. The Energy Efficiency scenario considers all energy efficiency and saving measures estimated to be adopted starting with 2010 and the effect of their application mentioned in the second EEAP, which are:

- The technical upgrading of the district heating companies, providing for measures to be implemented in heat generation, transmission, distribution and consumption. Technologies for high efficiency co-generation will be actively supported and a program to stabilize and develop the district heating sector is planned to be developed for the purpose.
- Incentive feed-in tariffs and mandatory off-take of electricity produced by modern high-efficiency co-generation plants (this measure has already been implemented);
- Providing loans combined with grants for the development of decentralized energy production, including micro co-generation and micro tri-generation.
- Support of small-scale co-generation installations, especially in tertiary sector (hospitals, hotels, athletic centres, etc).

3.3. Saving of primary energy and CO₂ emissions by the CHP roadmap of Bulgaria

Primary energy saving (PES) and of CO₂ 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 Annexe 6.

²⁶ Progress Report on the application of Directive 2006/32/EC on energy end-use efficiency and energy services and on the application of Directive 2004/8/EC on the promotion of cogeneration based on a useful heat demand in the internal energy market Brussels, 8.1.2014.

- 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 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 EED method is estimated 7.8 to 10 TWh/yr while with the method PES for Bulgaria through implementing the roadmap for CHP is estimated at 17.5 TWh per year and CO₂ savings are estimated to be between 10.2 and 12.3 Million tons per year in 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 CO₂ savings which can be anticipated. The CO₂ 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.

Table 7: Saving of primary energy and CO₂ by the Bulgarian CHP roadmap

	Substitution method		EED method	
	Low case	High case	Low case	High case
PE saving	17.3 TWh/a	17.6 TWh/a	7.8 TWh/a	10 TWh/a
CO ₂ saving	10.2 Mio t/a	12.3 Mio t/a		
-per kWh el*	1.31 kg	1.57 kg		

* This value represents the CO₂ reduction of the power generation. It includes the avoided CO₂ emissions from fuel savings for separate heat generation in boilers; it must not be confused with the considerably lower CO₂ 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

Group	Bulgaria
Customers	
Utilities	CHP is commonly known in the utilities sector.
SMEs	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.

Market and supply chain	
Manufacturers	There is not a strong presence of CHP manufacturers in Bulgaria. 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 and detailed know-how is at a good level.
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.

Policy	
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.

Influencers	
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 and detailed know-how is at a good level.
Energy agencies	CHP is well known.

	Poor	
2	Low	
3	Early awareness	
4	Interest	
5	Active market	

Ratings of the awareness of the different groupings of CHP

2. Micro CHP potential assessment



micro-CHP potential summary Bulgaria



Country statistics

Population: 7 360 000 (2010)
 Number of households: 2 800 000 (2010)
 GDP per capita: € 11 600 (2010)
 Primary energy use: 8 800 ktoe/year (2010)
 GHG-emissions: 61 Mton CO_{2,eq}/year (2010)

Household systems (±1 kWe) Boiler replacement technology

SME & Collective systems (±40 kWe) Boiler add-on technology

Present market (2013)

Boiler stock: 169 000 units
 Boiler sales: 13 000 units/year

Present market (2013)

Boiler stock: 13 000 units
 Boiler sales: 1 000 units/year

Potential estimation

Indicator	Score
Market alternatives	1
Global CBA	0
Legislation/support	2
Awareness	1
Purchasing power	0
Total	3 out of 12

Potential estimation

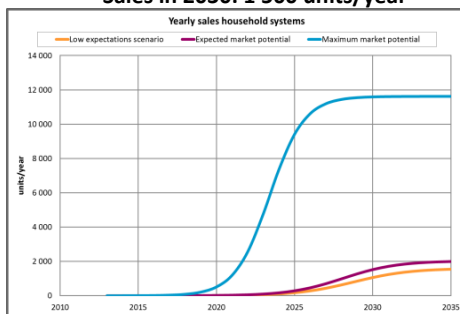
Indicator	Score
Market alternatives	1
Global CBA	3
Legislation/support	2
Awareness	1
Total	6 out of 9

Expected final market share: 16% of boiler sales in Household sector

Expected final market share: 23% of boiler sales in SME & Coll. sector

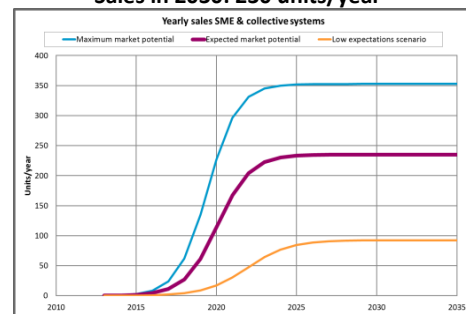
Yearly sales

Sales in 2020: 20 units/year*
 Sales in 2030: 1 500 units/year*



Yearly sales

Sales in 2020: 100 units/year*
 Sales in 2030: 230 units/year*



Stock

Stock in 2020: 40 units*
 Stock in 2030: 5 600 units*
 Stock in 2040: 20 000 units*

Stock

Stock in 2020: 600 units*
 Stock in 2030: 2 200 units*
 Stock in 2040: 2 400 units*

Potential savings in 2030

Potential savings in 2030



micro-CHP score card Argumentation



Primary energy savings:
0 PJ/year*
3 ktoe/year*

GHG-emissions reduction:
0.0 Mton CO_{2,eq}/year*

Primary energy savings:
2 PJ/year*
40 ktoe/year*

GHG-emissions reduction:
0.0 Mton CO_{2,eq}/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.

<i>±1 kW_e systems (Households)</i> <i>Boiler replacement technology</i>	<i>±40 kW_e systems (SME & Collective systems)</i> <i>Boiler add-on technology</i>																										
Scorecard	Scorecard																										
<table border="1"> <thead> <tr> <th>Indicator</th> <th>Score</th> </tr> </thead> <tbody> <tr> <td>Market alternatives</td> <td>1</td> </tr> <tr> <td>Global CBA</td> <td>0</td> </tr> <tr> <td>Legislation/support</td> <td>2</td> </tr> <tr> <td>Awareness</td> <td>1</td> </tr> <tr> <td>Purchasing power</td> <td>0</td> </tr> <tr> <td>Total</td> <td>3 out of 12</td> </tr> </tbody> </table>	Indicator	Score	Market alternatives	1	Global CBA	0	Legislation/support	2	Awareness	1	Purchasing power	0	Total	3 out of 12	<table border="1"> <thead> <tr> <th>Indicator</th> <th>Score</th> </tr> </thead> <tbody> <tr> <td>Market alternatives</td> <td>1</td> </tr> <tr> <td>Global CBA</td> <td>3</td> </tr> <tr> <td>Legislation/support</td> <td>2</td> </tr> <tr> <td>Awareness</td> <td>1</td> </tr> <tr> <td>Total</td> <td>6 out of 9</td> </tr> </tbody> </table>	Indicator	Score	Market alternatives	1	Global CBA	3	Legislation/support	2	Awareness	1	Total	6 out of 9
Indicator	Score																										
Market alternatives	1																										
Global CBA	0																										
Legislation/support	2																										
Awareness	1																										
Purchasing power	0																										
Total	3 out of 12																										
Indicator	Score																										
Market alternatives	1																										
Global CBA	3																										
Legislation/support	2																										
Awareness	1																										
Total	6 out of 9																										
Market alternatives	Market alternatives																										
Global CBA	Global CBA																										
<i>SPOT: not economical</i>	<i>SPOT: 6 years</i>																										
Legislation/support	Legislation/support																										
Awareness	Awareness																										
<p><i>Are stakeholders aware of the microCHP technologies</i> Homeowners? For the ordinary citizen, CHP is an almost unknown technology</p> <p><i>Consultants? CHP is known in principle.</i> Installers? CHP is known in principle and detailed know-how is at a good level.</p> <p><i>Planners? CHP is known in principle.</i> Government? CHP is known in principle. Are manufacturers active in the market? Yes</p>	<p><i>Are stakeholders aware of the microCHP technologies</i> Consultants? CHP is known in principle.</p> <p><i>Installers? CHP is known in principle and detailed know-how is at a good level.</i> Planners? CHP is known in principle. Government? CHP is known in principle.</p>																										
Purchasing power																											
GDP: € 11 600 per year																											

3. Bio CHP potential assessment

Policy Background

The European Union is well on the way to achieve the 2020 target of 20% energy from renewable sources in gross final consumption of energy²⁷. In the Energy Roadmap of 2011, the European Commission expects a rise of the renewables share to 30% in 2030 and up to 55% in 2050²⁸.

However, the EU is not on track to achieve the target to enhance the Union's energy efficiency by 20% until 2020. The combined production of heat and power (CHP) is a crucial technology to achieve the target. The relevance of CHP is underlined by the EU policies on cogeneration²⁹.

Why bio-energy CHP?

The preamble of the CHP directive (2004/8/EC) summarizes well the main advantages of combined heat and power (CHP) and why it is a priority issue for the European Union's energy policies:

Promotion of high-efficiency cogeneration based on a useful heat demand is a Community priority given the potential benefits of cogeneration with regard to saving primary energy, avoiding network losses and reducing emissions, in particular of greenhouse gases. In addition, efficient use of energy by cogeneration can also contribute positively to the security of energy supply and to the competitive situation of the European Union and its Member States. It is therefore necessary to take measures to ensure that the potential is better exploited within the framework of the internal energy market.

As CHP systems can be run with a variety of fuels, biomass – be it liquid, gaseous or solid – is the ideal choice to maximise the CO₂ reduction potential in CHP systems.

Current fuel input to CHP systems

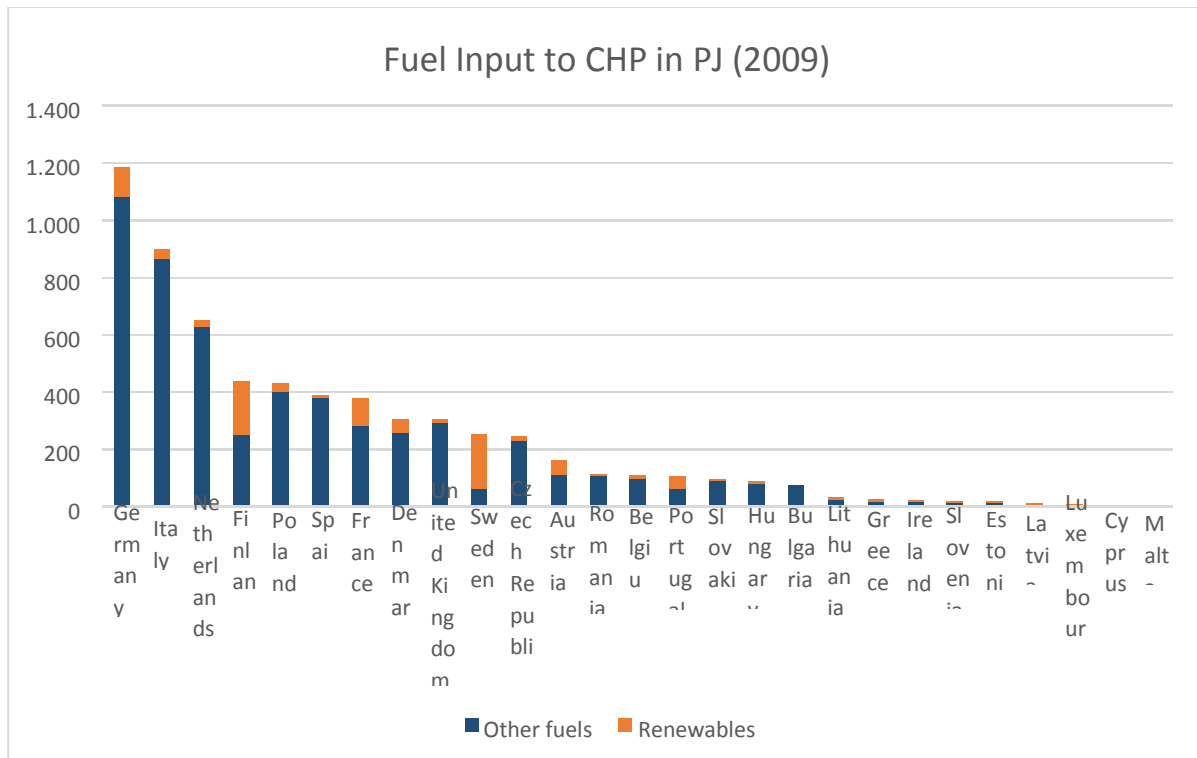
Currently, the penetration rates of bio-energy CHP in the CHP markets vary greatly in Europe. In Scandinavian countries with large forestry biomass resources and a traditionally strong CHP sector, the penetration rate is already very high (Finland: 42.6%, Sweden: 74.9%)³⁰.

²⁷ Directive 2009/28/EC.

²⁸ Communication 2011/885/2, p.7, p.10.

²⁹ Directive 2004/8/EC, Directive 2012/27/EU

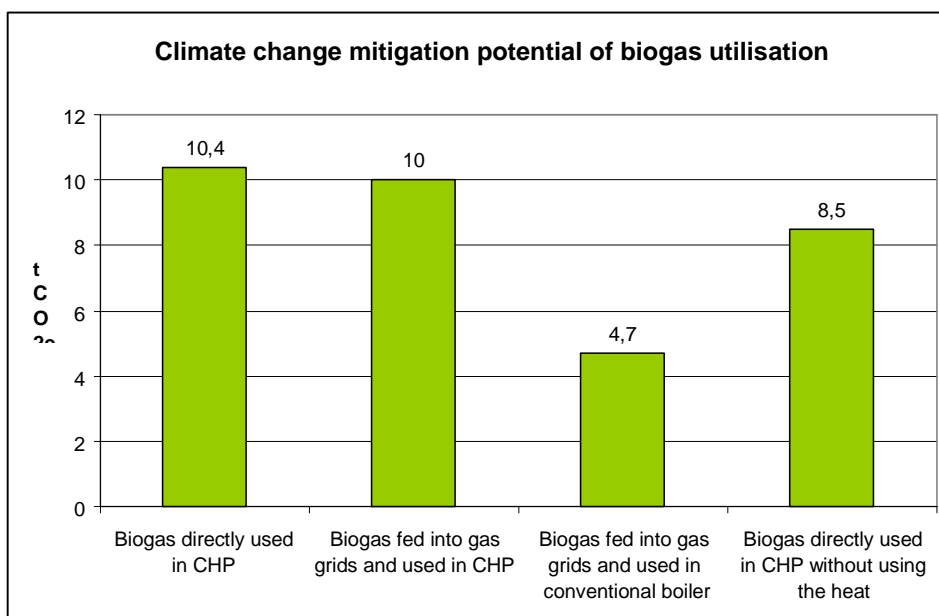
³⁰ European Environmental Bureau, Eurostat (2009)



Source: European Environmental Bureau, Eurostat (2009)

Climate Change Mitigation Potential

The climate change mitigation potential of biomass fuels can roughly be doubled by using them in CHP systems, which clearly underlines the priority which should be given to CHP solutions. For the example of Germany, the climate mitigation potential of biogas has been assessed as follows:



Source: www.unendlich-viel-energie.de, FNR, IFEU, UBA, 1/2011

Applications of bio-energy CHP

There are various kinds of bio-energy CHP systems in operation already today. The applications vary largely in size, usage types and fuel-type used.

Although national regulatory and economic frameworks on CHP and bioenergy have great differences between member states, there is a clear trend that presently bio-energy CHP has its biggest potential in medium to large size applications.

In the example of Germany, the marginal costs for heat produced in micro and mini biogas CHP plants can hardly compete with market heat prices of competing heat producers. So a good business case in the current regulatory regime can normally only be achieved for biogas CHP applications > 300kW_{el}, although there are examples of smaller systems.

Also concerning the primary energy factors (PEF) and the GHG emissions, the size of the bioCHP system plays an important role. In the example of biomethane CHP systems, the PEF can decrease down to zero for systems of 300kW_{el} or larger due to the much better coefficient of performance (COP) of larger CHP systems. Therefore, the application of choice for bio-energy CHP systems presently lies clearly on medium to large size systems.

Resulting from the economic frameworks mentioned, the majority of bio-CHP applications has so far been realised in district heating contexts or by auto-producers. However, successful realisations also exist in residential contexts.

Fuel types for bio-energy CHP

Generally speaking, a great variety of biomass can be used for bio-energy CHP applications. The most common ones used in Europe are bio-methane and wood (residues). However, examples exist also for applications with other biofuels, e.g. peat or colza oil. Technological progress will enhance the range of bio-fuels to be used in CHP systems in the future.

Since long supply routes increase the fuel costs and also the carbon footprint significantly, the choice of fuel will normally be strongly connected to the (regional) availability of a certain fuel, as local and regional resources have a price advantage through smaller costs for transport. At the same time, the constant availability of the respective resource in sufficient amounts has to be ensured.

In the future the competition between traditional and energy farming is likely to increase and bioenergy utilizations are challenged increasingly due to unresolved sustainability issues. Therefore, further biomass types, which are currently not in the general focus, will become increasingly

interesting. The project Biomass Futures³¹ identified in different scenarios amounts of cost-efficient, sustainably achievable biomass resources on member state level in Europe.

	2010	2020 (Sustainability Scenario)	2030 (Sustainability Scenario)	Cost efficiently available
	ktoe	ktoe	ktoe	
Agriculture				
Dedicated Perennial Cropping (woody)		21.742	9.043	yes
Dedicated Perennial Cropping (grassy)		29.879	27.774	yes
Manure	56.815	46.724	49.852	yes
Straw		49.287	47.495	yes
Woody residues of fruit trees etc.		10.106	8.836	yes
Forestry				
Round wood	56.735	56.115	56.115	no
Additionally harvestable round wood	41.046	34.973	35.595	no
Primary forestry residues	20.285	18.738	18.769	no
Landscape care wood	9.073	11.417	11.004	yes
Secondary forestry residues				
Saw Dust	4.496	4.984	5.597	yes
Other sawmill residues	9.072	10.093	11.316	yes
Tertiary forestry residues				no
Black Liquor	6.223	16.751	8.742	yes
Post-consumer Waste	7.593	8.793	9.839	yes
Industrial wood residues	4.637	5.461	6.488	yes
Paper Cardboard	13.874	14.295	13.068	no
Waste				
Grassland cuttings on road verges	1.098	1.142	1.160	yes
Animal waste	2.775	2.881	2.904	yes
Municipal Solid Waste (MSW)	6.371	8.871	7.247	yes
MSW landfill	22.140	13.320	11.160	yes
Common sludges	7.768	8.078	8.214	yes
Fats and Oils	2.099	2.135	2.159	no

Source: Biomass Futures, 2012

³¹ 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.

The analysis shows that in a time perspective until 2030, the availability of biomass, sustainably produced in Europe, will decrease. As the EU already recommends to the member states to apply sustainability criteria similar to those for biofuels also to solid and gaseous biomass, the availability of biomass for energy can only be extended, if additional biomass resources can be utilized.

As several biomass resources, e.g. round wood, are likely to be too expensive to be used as a fuel for energy production in the long-term, alternative and more cost-efficient biomass types, for which significant amounts are and will be available, have to be taken in focus. These options should be investigated with priority for bioenergy utilizations (also in CHP) for the post-2020 period.

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 2030³² (based on PRIMES database)³³
2. Data of targets for "biomass for heating" from the National Renewable Energy Action Plans of the MS³⁴
3. Current levels of biofuel inputs to CHP from EAA/Eurostat³⁵
4. Biomass potentials from the "Atlas of EU biomass potentials" (Project Biomass Futures)³⁶

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.

³² European Commission, DG Energy: "EU energy trends to 2030"; 2009.

³³ 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.

³⁴ 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.

³⁵ 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>

³⁶ 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.

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 Scenario³⁷ (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

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 figures³⁸, 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 card¹³. 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

³⁷ Reduced by the share of non-CHP heat according to IEA and EUROSTAT statistics.

³⁸ Website International Energy Agency, Statistics section:

<http://www.iea.org/stats/prodresult.asp?PRODUCT=Electricity/Heat> ¹³

Score ratings by member state CHP experts.

- 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)³⁹ (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

Bio-energy CHP potential in EU-27

25 member states⁴⁰ 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.

³⁹ Assumptions for arriving at the available biomass for bioenergy CHP: 65% of available biomass used for heating; CHP factor 0.8.

⁴⁰ France: still in discussion with experts; Malta: insufficient data, no (foreseeable) relevance for CHP

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)⁴¹
 - 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

⁴¹ 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).

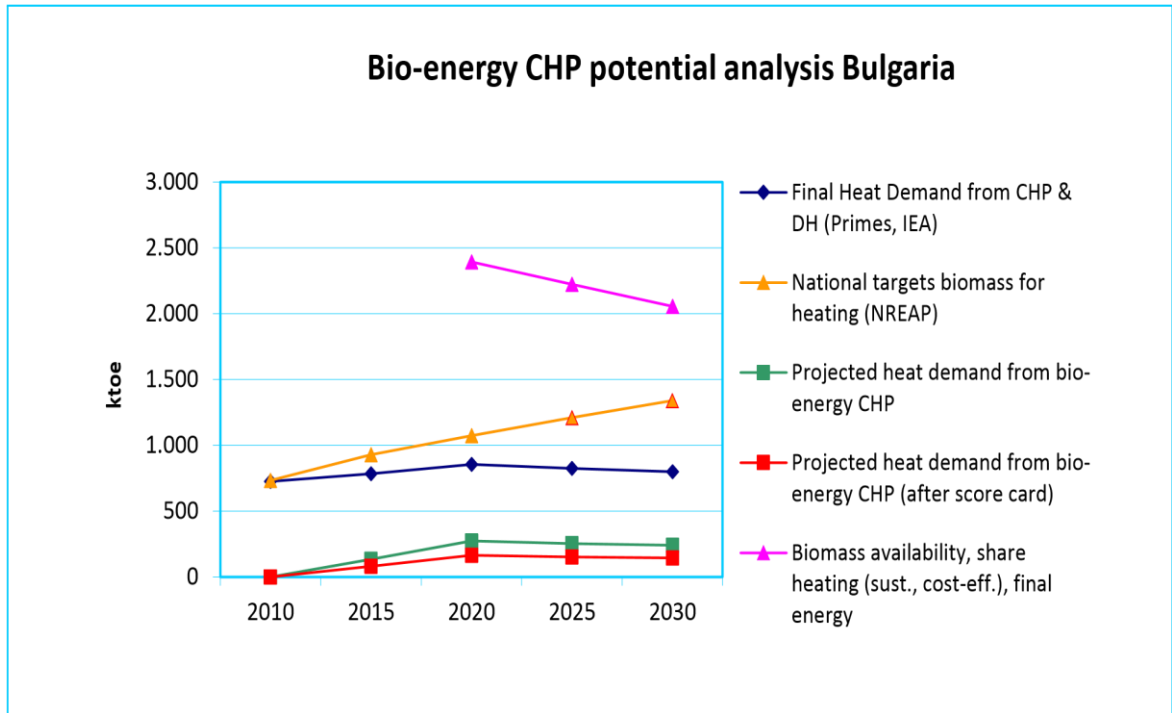


Bio-energy CHP potential analysis Bulgaria



Figures (projections)	2010	2020	2030
Final heat demand from CHP and DH (PRIMES, IEA), ktoe	725	854	800

Framework Assessment (Score card)	Score	Short analysis	
Legislative environment	+ 2 (of 3)	The Bulgarian legislation is favourable towards DH.	
Suitability of heat market for switch to bioenergy CHP	+ 2 (of 3)		
Share of Citizens served by DH	+ 2 (of 3)	An important presence of heat demanding industries.	
National supply chain for biomass for energy	o 1 (of 3)	16% of citizens are served by DH. (Bulgarian DH Association)	
Awareness for DH and CHP	+ 2 (of 3)	New area with good potential	
(Projected) heat demand from bio-energy CHP and DH (after score card), ktoe	0	164	144
Bio-energy penetration rate in CHP markets (2009: EEA, Eurostat)	0,0% (2009)	19,2%	18,0%
Biomass availability, share heating (sust., cost-eff.), final energy (Biom. Futures), ktoe		2.393	2.055



Comments on country analysis

General comments

- The national framework assessment through the scorecard results in a good 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 16% in 2020)
- The share of bio-fuels in CHP (bio-energy penetration rate in CHP markets) is expected to rise from 0% (2009) to 18% (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 growth until 2020, after that a slight decline
- National targets for biomass for heating (yellow curve) see a stronger and more constant growth
- The growth projections of the bio-energy CHP heat demand (green and red curves) apply the average growth rates of both the blue and the yellow curve (weighting 50:50)

To be re-confirmed

- No bio-CHP in BG at all today?
- If so, is 18% by 2030 realistic?

4. 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.

5. Methodologies used to calculate the saving of primary energy and CO₂ 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 method⁴²” 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 CO₂ saving resulting from a voluntary commitment of the German industry for CO₂ reduction⁴³, 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 CO₂ 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 (eg lower carbon content of natural gas compared to coal, CO₂ 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 CO₂ emissions and primary energy consumption. The BAT approach of the CHP Directive have been developed to verify the high efficiency of individual plants, but not to determine actual saved CO₂ 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 towards carbon intensive 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.

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.

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

⁴³ The calculation has been made by the VIK Verband der Industriellen Energie- und Kraftwirtschaft e.V., 2010, Unpublished.

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 pre-empt investments in e.g. new CCGT investments.

6. Sources

- DIRECTIVE 2004/8/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC.
- DIRECTIVE 2012/27/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC.
- "South east Europe Energy Outlook", IENE, 2011
- "Combined heat and power (CHP) (ENER 020) - Assessment published Apr 2012", European Environment Agency
- "National energy efficiency and energy saving targets", European Council for an Energy Efficient Economy, May 2011.
- "Energy Strategy of Republic of Bulgaria till 2020 for reliable, efficient and cleaner energy", June 2011
- "BULLETIN ON THE STATE AND DEVELOPMENT OF THE ENERGY SECTOR IN THE REPUBLIC OF BULGARIA", 2012
- "Annual Report to the European Commission", State Energy and Water Regulatory Commission (SEWRC) Bulgaria, July 2012.
- Energy Act of Bulgaria, 2003.
- Energy Efficiency Act of Bulgaria, 2008.
- Energy from Renewable Sources Act of Bulgaria, 2011.
- "Deliverable D13 Characteristics of RES-e in Central and Eastern Europe", futures-e December 2008.
- "Analysis of options to move beyond 20% greenhouse gas emission reductions and assessing the risk of carbon leakage", EUROPEAN COMMISSION, Brussels, 26.5.2010.
- "Second National Energy Efficiency Action Plan 2011-2013", June 2011, Sofia.
- "Second National Action Plan on Climate Change 2005 - 2008", Republic of Bulgaria.
- THIRD NATIONAL ACTION PLAN ON CLIMATE CHANGE FOR THE PERIOD 2013-2020 MINISTRY OF ENVIRONMENT AND WATER, REPUBLIC OF BULGARIA, SOFIA MAY 2012.
- Progress Report on the application of Directive 2006/32/EC on energy end-use efficiency and energy services and on the application of Directive 2004/8/EC on the promotion of cogeneration based on a useful heat demand in the internal energy market Brussels, 8.1.2014
- COMMISSION DECISION of 21 December 2006 establishing harmonized efficiency reference values for separate production of electricity and heat in application of Directive 2004/8/EC of the European Parliament and of the Council.
- COMMISSION DECISION of 19 November 2008 establishing detailed guidelines for the implementation and application of Annex II to Directive 2004/8/EC of the European Parliament and of the Council.
- DIRECTIVE 2006/32/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC.
- A new Energy Strategy for Europe 2011-2020 European Parliament resolution of 25 November 2010 on towards a new Energy Strategy for Europe 2011-2020.
- "EU energy trends to 2030 — UPDATE 2009", EC Directorate-General for Energy in collaboration with Climate Action DG and Mobility and Transport DG
- Eurostat
- "Energy Service Companies Market in Europe - Status Report 2010", Angelica Marino, Paolo Bertoldi, Silvia Rezessy, JRC-IE
- <http://www.euroheat.org/Bulgaria-187.aspx>
- <http://climate-adapt.eea.europa.eu/countries/bulgaria>
- <http://ipts.jrc.ec.europa.eu/activities/energy-and-transport/TIMES.cfm>
- http://www.kape.gov.pl/PL/Programy/Programy_UniiEuropejskiej/SAVE/aP_PROCHP/Potential/a_Bulgaria.html
- <http://climate-adapt.eea.europa.eu/countries/bulgaria>