Bulgaria’s promising market segments for heating with solid biomass (> 100 kW)

Horizon 2020 Coordination and Support Action number 646495: Bioenergy for Business „Uptake of Solid Bioenergy in European Commercial Sectors”

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Task 2.4 REPORT

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Executive Summary

National Biomass Association BGBIOM is Bulgarian partner in the Horizon 2020 project Bioenergy4Business which aims to increase the usage of bioenergy through a fuel-switch from coal, oil or natural gas, which are used in “in-house” boilers in commercial sectors for heat purposes or in district heating, to solid biomass sources.

The share of fossil fuels in gross inland energy consumption in Bulgaria is presented in chapter 2. Fossil fuels cover 138.7 TWh or 70 % of the total energy consumption. The coal used in Bulgaria includes nearly 2,3 TWh coal in industry and nearly 1.9 TWh in households. The oil usage includes 2.38 TWh oil used in industry and 1.4 TWh in households. 85% of total oil consumption in Bulgaria is attributed to the transport. Natural gas is used mainly in industry - 77% of total gas consumption for 2013, or nearly 8.8 TWh. The origin of fossil fuels is presented in 2.3, and in 2.4 - the history of prices of fossil fuels as well as woody fuels as a result of own calculations, based on European commission weekly oil bulletin (petrol, euro diesel, diesel for heating, heavy fuel oil and LPG, and own market research for wood chips and wood for heating.

Chapter 3 represents Bulgarian supply situation of solid biomass based on National Strategy for Forestry Sector Development. It is shown that Bulgaria has serious resources of solid biomass from domestic forests (Ch.3.1) as well as from by-products of wood based industry (Ch.3.2). Production of pellets, briquettes and charcoal on the territory of Bulgaria is illustrated with maps of Trichkov & Dinev, 2014. Prices of heating with different fuels are compared as well. The possible energy contribution of agriculture (Ch.3.4) is 12,500 GWh, of which 5 640 GWh is from straw. Chapter 3.5 presents the distribution of forest territories in Bulgaria according to their ownership (about 70% of total forest area is owned by the state; about 12.4 % are municipal forests, about 10% are owned by private persons; the distribution of wood logging (more than 75% of total wood logging is from state forests, about 14 % - from private ones); changes in forests territories in last 50 years.

Chapter 4 presents the state of Bulgaria’s solid biomass market. The number of installed biomass boilers in the period 2000-2013 as well as their capacity in kW is presented in Figures 17-20. The consumption of wood fuels as well as the input of RES in heat production in Bulgaria for the same period also is shown.

Chapter 5 presents the results of Stakeholder interviews. Six representatives of different business groups have been interviewed. Most of the interviewees share the opinion that pellets, briquettes and wood chips are the most promising sources of bioenergy in Bulgaria. Some of them underline that solar energy and geothermal energy are also available and give good opportunities. Currently hotels and wood-processing factories have the biggest perspective for development of bioenergy use. This is because this type of consumers benefit from EU financial aid. For private homes this possibility does not exist yet.

The most promising market segments presently have been developed in some municipalities that are located in areas near the forest and far away from gas pipelines and other heat sources. The fossil fuel used for heating (black oil) has been successfully substituted for with woody biomass in some of these municipalities. There are, however, still considerable numbers of small municipalities that could profit from this opportunity of fuel switch. In the future biofuels would be used in public buildings such as hospitals, schools centres of nursing homes, etc. Municipalities are obliged to develop programs promoting the use of energy from RES and biofuels in line with the NREAP. The Renewable Energy Act (ZEVI) which entered into force in 2011 provides mechanisms encouraging the use of renewable energy in administrative, industrial and residential buildings.
Chapter 6 presents characterisation of promising market segments in Bulgaria and a review of the Historical development of GHG-mitigation potential in Bulgaria.
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1 Introduction

The Horizon 2020 project Bioenergy4Business aims to increase the usage of bioenergy through an (at least partial) fuel-switch from coal, oil or natural gas, which are used in “in-house” boilers in commercial sectors for heat purposes or in district heating, to solid biomass sources. The erection of completely new biomass heat applications is considered as an option as well. Bioenergy4Business focuses on solid biomass sources and on medium and large heat-only boilers (> 100 kW heat load) providing low temperature and process heat for commercial usage.

Bioenergy4Business builds bridges between policies and markets to support the creation of an enabling environment, the use of sound business and financing models and the careful assessment and implementation of bioenergy heat in local and district heating and in “in-house” applications. These aspects are considered for the most promising market segments among industry and commerce, residential buildings, agriculture and commercial and public services.

Bioenergy4Business involves partners from 12 EU Member States and Ukraine. 11 of these project partners (AT, DE, BG, CR, FI, GR, NL, PL, RO, SK and UA, except BE and DK) are target countries, where tailor-made activities for the most promising market segments will take place from January 2015 until August 2017.

Figure 1: Countries where Bioenergy4Business will be implemented.

Bioenergy4Business helps exploiting the considerable economic and sustainable potential of European bioenergy sources for heating, which are locally available at reasonable prices. These can offer a viable alternative to vulnerable European businesses currently depending on fossil resources, which are often imported from politically unstable regions.

Bioenergy4Business makes new market segments for solid biomass usage accessible and enhances the use of both more solid biomass sources and so far not used ones (e.g. pellets, straw etc.) in European heat markets.

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2 Fossil fuel usage in Bulgaria

2.1 Share of fossil fuels in gross inland energy consumption

Figure 2 shows the gross inland energy consumption divided in fossil and non-fossil energy carriers. In 2013 the total gross inland energy consumption in Bulgaria was 197.2 TWh. The share of fossil fuels coal, oil, gas and combustible waste made up 138.7 TWh or 70 % of total gross energy consumption. 30% of gross inland energy consumption is supplied by renewable energy sources (mainly bioenergy and hydropower).

Figure 2: Gross inland energy consumption in Bulgaria.

2.2 Domestic usage of fossil fuels

This chapter shows pie charts for coal, oil, gas and nuclear, showing for every of these four energy carriers the share of energy used for different usage categories.

What is of interest for Bioenergy4Business regarding the coal usage in Bulgaria is that Figure 3 shows that nearly 2.3 TWh coal is used in industry and nearly the same quantity of about 1.9 TWh in households (the latter probably for heat only). Those are the main consumers of coal in Bulgaria, but their consumption is about 1 % of the Gross inland energy consumption.
What is of interest for Bioenergy4Business regarding the oil usage in Bulgaria is that Figure 4 shows that 2.38 TWh oil is used in industry and 1.4 TWh in households (the latter probably for heat only). The biomass stakeholder interviews (results see chapter 5) showed that heavy oil is the most interesting energy carrier to be substituted by solid biomass in Bulgaria. Main consumption of oil products - 87%, is in transport sector.

Figure 4: Division of total oil consumption in Bulgaria 2013 (without storage changes).
Source: National Statistical Institute, Energy Balance Sheets, 2013


What is of interest for Bioenergy4Business regarding the gas usage in Bulgaria is that Figure 5 shows that gas is used mainly in industry - 77% of total gas consumption for 2013, or nearly 8.8 TWh. The biomass stakeholder
interviews (results see chapter 5) showed however that it is rather difficult to substitute for gas by solid biomass competitively in general in Bulgaria.

Figure 5: Division of total gas consumption in Bulgaria 2013 (without storage changes).

2.3 Origin of fossil fuels

In 2013 1008 ktoe (11,723 GWh) coal were imported to Bulgaria. Gross inland consumption of coal was 5,923 ktoe (68,884.5 GWh). In 2013 less than 20% of used coal was imported.

The lignite coal are prevailing in the coal production structure – 93.0%, followed by brown coal - 7.0% and black coal - 0.02%.

The total production of lignite coal is 31.0 million tonnes and the main producer is Maritsa Iztok Mines EAD with a share of 96.2%. Other producers of lignite coal are the Beli Breg Mines (1.7%), Stanyantsi Mines (1.7%) and Chukurovo Mines (0.5%).

The total production of brown coal is 2.3 million tonnes, produced mainly in the Bobovdol (0.97 million tonnes) and Pernik (1.09 million tonnes) basins.

The total production of black coal is insignificant (7.2 thousand tonnes) and has been realized in Balkan 2000 Mines EAD.

In 2013 imported crude oil in Bulgaria was 5,505 ktoe (64,023 GWh), gross inland consumption was 8,179 ktoe (95,122 GWh). Domestic raw oil extraction in Bulgaria was 2,674 ktoe (31099 GWh), this contributed about 30% to total raw oil supply in Bulgaria.

Oil is produced in Bulgaria in insignificant amounts – 23.5 thousand tonnes in 2012. Production was realized by Oil and Gas Exploration and Production EAD in Dolni Dabnik, which was privatized in 2004.
The demand of **oil** in the country is met mainly by imports. The main oil importer and processor is Lukoil Neftohim Burgas AD. In 2012 the refinery imported about 5.7 million tonnes of crude oil, which is by 24.1% more than in 2011.

Overall gas demand in Bulgaria increased in 2013 by 7% compared to 2012. The traded volumes were 2,854.8 million m³ for non-households and 70.2 million m³ for households. (Source: ACER/CEER Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2012, November 2013.)

Imported gas in 2013 was 2,226 ktoe (25,888 GWh), gross inland gas consumption was 2,388 ktoe (27,772 GWh), so domestic natural gas production was 162 ktoe (1884 GWh) – less than 1%. Bulgaria largely depends on gas imports from Gazprom. Bulgargaz EAD, which is part of Bulgarian Energy Holding (BEH), is the largest natural gas importer. In 2013, a second trader, affiliated with Gazprom, entered the gas market, which imported gas from Russia and sold gas to its distribution companies as well as end users.

**Imports** of natural gas in Bulgaria for 2012 amounted to 2,527 million m³ /including 245 million m³ of fuel gas for the operation of the transit system/, which was by 10% less than the previous year (2011). The local production of natural gas is realized by Melrose Resources Sarl and Oil and Gas Exploration and Production EAD. In 2012 they have produced 389 million m³ or by 12% less compared to 2011.

Bulgaria operates the underground CHIREN Gas Storage with a capacity of active gas of about 450 million m³ per annum. In 2012, 222 million m³ of natural gas was compressed in this Gas Storage and the withdrawn quantity amounted to 346 million m³.

**Consumption** of natural gas in the country for 2012 was 2,749 million m³, which was by 8% less than in 2011.

In 2014 Bulgaria remains fully dependent on a single source of gas on a single route by a single supplier. It has only limited domestic underground storage capacities that could help in balancing disruptions in high demand periods. Interconnections with the neighbouring countries are very poor and still under development.


### 2.4 Prices of fossil fuels, wood-chips and pellets (industry, import and spot market prices)

In 2012, Bulgaria registered an annual price decrease for natural gas close to 4%, for both household and industrial customers. Taking purchasing power into account, retail gas prices for the average consumer in Bulgaria are the highest in Europe. Natural gas prices (including taxes and levies) increased by 42.2% for residential consumers and by 49.2% for industrial users from 2008 to 2012. The main drivers behind these price rises were energy and supply costs, although VAT rises and higher distribution costs (for industrial users) were also significant factors [The EC, Energy Prices and Costs report, 2014].

Figure 6 shows the following prices in Euro/MWh from 2008 to 2015 (where available):

- Petrol Super 95 (excl. VAT, duties and other taxes)
- Eurodiesel (excl. VAT, duties and other taxes)
- Diesel for heating (excl. VAT, duties and other taxes)
- Heavy oil – mazut (excl. VAT, duties and other taxes)
- LPG – propan–butan (excl. VAT, duties and other taxes)
- Wood chips (excl. VAT, duties and other taxes)
- Wood for heating (excl. VAT, duties and other taxes)
- Natural gas
- Natural gas, gross price for industry with annual consumption 100 GWh (excl. VAT)

Figure 6: Bulgarian fossil fuels prices for industry and wood-chips prices in Euro/MWh.
Sources: Own calculations, based on European commission weekly oil bulletin (petrol, euro diesel, diesel for heating, heavy fuel oil and LPG), and own market research (wood chips and wood for heating).
3 Bulgarian supply situation of solid biomass for energy purposes

Chapter 3 of this report gives an overview of the current situation of energy production from solid biomasses e.g. firewood, wood residues or straw the expected development of this sector.

3.1 Energy wood from domestic forests

Bulgaria has considerable resource for biomass production. The total area of Bulgaria counts 110,910 sq km, of which the land is 110,550 sq km and the water takes 360 sq km. Approximately 60% of the territory of Bulgaria (flat countries and hills) is occupied by arable lands and agricultural breeding: arable land - 44%; permanent crops - 2%; permanent pastures - 14%. The forestry takes the second place with about 30% of the territory. They occupy the medium- and high- mountain regions.

Forest wood is one of the main biomass resources in Bulgaria. Forest state and development can be assessed from the data in Table 3. It can be seen that the forest's stock in m³/ha is rising regularly last fifteen years.

![Biomass resources in Bulgaria](image)

Figure 7: Biomass production resources in Bulgaria
Source: Anna Aladjadjiyan, The potential of the Bulgarian Agriculture concerning the biomass supply for energy, Proceedings of the International Forum for Bioenergy in South-Eastern Europe, 25-26 April 2007, Sofia, Bulgaria,

Forest wood is one of the main biomass resources in Bulgaria. Forest state and development can be assessed from the data in Table 3. It can be seen that the forest's stock in m³/ha is rising regularly last fifteen years.

<table>
<thead>
<tr>
<th>Forest types</th>
<th>1995</th>
<th>2000</th>
<th>2005</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coniferous</td>
<td>164</td>
<td>221</td>
<td>239</td>
<td>260</td>
</tr>
<tr>
<td>Deciduous toll</td>
<td>181</td>
<td>193</td>
<td>203</td>
<td>220</td>
</tr>
<tr>
<td>Reconstruction</td>
<td>134</td>
<td>130</td>
<td>38</td>
<td>-</td>
</tr>
<tr>
<td>Copice conversion</td>
<td>45</td>
<td>44</td>
<td>127</td>
<td>114</td>
</tr>
<tr>
<td>Low-steam trees</td>
<td>59</td>
<td>55</td>
<td>53</td>
<td>43</td>
</tr>
</tbody>
</table>

Source: National Strategy for Forestry Sector Development 2013-2020

Table 4 presents an estimation of the quantities in m³ of different kind timber produced in Bulgaria.
Table 4: Estimates for quantity of timber produced in m$^3$ in Bulgaria

<table>
<thead>
<tr>
<th>Indicator</th>
<th>2005</th>
<th>2015</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity of coniferous timber harvested</td>
<td>2,116,474</td>
<td>2,800,000</td>
<td>3,400,000</td>
</tr>
<tr>
<td>Quantities of coniferous wood fuels produced (20%)</td>
<td>429,950</td>
<td>560,000</td>
<td>680,000</td>
</tr>
<tr>
<td>Increase in coniferous wood harvested for fuels (compared to 2005)</td>
<td>-</td>
<td>130,000</td>
<td>250,000</td>
</tr>
<tr>
<td>Quantity of broad-leaved timber harvested</td>
<td>3,545,998</td>
<td>4,200,000</td>
<td>5,100,000</td>
</tr>
<tr>
<td>Quantities of broad-leaved wood fuels produced (75%)</td>
<td>2,643,109</td>
<td>3,150,000</td>
<td>3,825,000</td>
</tr>
<tr>
<td>Increase in broad-leaved wood harvested for fuels (compared to 2005)</td>
<td>-</td>
<td>506,000</td>
<td>1,181,000</td>
</tr>
<tr>
<td><strong>Total quantity of timber harvested</strong></td>
<td><strong>5,662,472</strong></td>
<td><strong>7,000,000</strong></td>
<td><strong>8,500,000</strong></td>
</tr>
</tbody>
</table>


Based on the above data, Table 5 gives estimates for the amount of unused wood biomass and its energy equivalence. By 2020, timber harvested for wood fuels could increase by 1,431,000 m$^3$ per year, compared to 2005 figures.

Table 5: Available unused quantities of woody biomass

<table>
<thead>
<tr>
<th>Origin of wood biomass</th>
<th>Currently unused quantities</th>
<th>Energy equivalent, GWh/yr</th>
</tr>
</thead>
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<tr>
<td>Wood biomass from forestry, including: Branches and twigs</td>
<td>315,000 m$^3$/yr</td>
<td>757.1</td>
</tr>
<tr>
<td>Possible increase in timber harvested (forecast for 2020)</td>
<td>1,431,000 m$^3$/yr</td>
<td>3568.1</td>
</tr>
<tr>
<td>Industrial wood waste</td>
<td>50,000 metric tonnes (t) dry matter/yr</td>
<td>267.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4592.7</strong></td>
<td></td>
</tr>
</tbody>
</table>


Based on the data in Table 4, the energy equivalents of these additional quantities of wood fuels are respectively:

- in 2015: 284.9 GWh/yr for coniferous wood and 1,293.2 GWh/yr for broad-leaved;
- in 2020: 548.9 GWh/yr for coniferous wood and 3,019,2 GWh/yr for broad-leaved.

The population in Bulgaria uses predominantly firewood for heating; but wood is burnt in incineration facilities the energy efficiency of which is low (efficiency up to 50-60%). If such incineration facilities are replaced by high energy efficient ones, the quantity of the used combustibles, i.e. wood, can be reduced. The highest potential is in the public sector premises: schools, hospitals, kindergartens. Besides that, there are 5 thermal power stations in Bulgaria, where wood chips of moisture content up to 45% are utilized. (Source: www.formec.org/images/proceedings/2014/a39.pdf)
3.2 By-products of wood-based industries

The bioenergy potential of by-products from wood-based industries in Bulgaria can be assessed on basis of data in Table 6. The estimated potential is approximately 99 GWh.

Table 6: Biomass potential of wood processing residues in Bulgaria

<table>
<thead>
<tr>
<th>Type of industrial wood-waste</th>
<th>Processed wood, mil. m$^3$</th>
<th>Waste share, %</th>
<th>Energy use rate, %</th>
<th>Potential, GWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country total</td>
<td>2.102</td>
<td>32</td>
<td>50</td>
<td>989</td>
</tr>
<tr>
<td>Broad-leaved wooden materials</td>
<td>0.267</td>
<td>32</td>
<td>50</td>
<td>144</td>
</tr>
<tr>
<td>Oak parquet</td>
<td>0.104</td>
<td>36</td>
<td>50</td>
<td>55.6</td>
</tr>
<tr>
<td>Shaped details</td>
<td>0.803</td>
<td>36</td>
<td>50</td>
<td>430.5</td>
</tr>
<tr>
<td>Plywood</td>
<td>0.0065</td>
<td>36</td>
<td>60</td>
<td>5.6</td>
</tr>
<tr>
<td>Coniferous wooden materials</td>
<td>0.227</td>
<td>42</td>
<td>50</td>
<td>122.2</td>
</tr>
<tr>
<td>Plates of wooden fractions</td>
<td>0.138</td>
<td>36</td>
<td>50</td>
<td>36.1</td>
</tr>
<tr>
<td>Window frames</td>
<td>0.046</td>
<td>18</td>
<td>50</td>
<td>13.9</td>
</tr>
<tr>
<td>Doors and door frames</td>
<td>0.307</td>
<td>20</td>
<td>50</td>
<td>91.7</td>
</tr>
<tr>
<td>Pallets</td>
<td>0.195</td>
<td>20</td>
<td>50</td>
<td>86.1</td>
</tr>
<tr>
<td>Crates, cases, etc.</td>
<td>0.0086</td>
<td>30</td>
<td>50</td>
<td>2.8</td>
</tr>
</tbody>
</table>


3.3 Pellets and Briquettes

Along with the fast rising firewood and charcoal consumption, a rise is also noted in pellets and briquettes instead of firewood consumption. There are reasons to suggest that the same trend will also be kept in the future, taking into account the high potential of wood-based biofuels, compared to all the renewable energy sources.

Three maps of Bulgaria have been made (Trichkov, Dinev, 2014), which contain the main companies-producers, their location and the volume of production: pellets, briquettes and charcoal, respectively (see figures 9, 10 and 11). The maps have been elaborated on the basis of the data provided by Bulgarian National Statistical Institute and by a WS survey, after site visits to the firms-producers. The reasons for which we have resourced to different sources are that we have had some doubts about incomplete information given to us by the firms.
The average annual production volume of the companies vary from 250-10,000 tons of pellets, 400-1,100 tons of briquettes and 100-5,000 tons of charcoal, respectively. The low volumes produced by small-scale firms while the high ones by large-scale producers: i.e. factories. The factories have put in their business plans production which is about twice higher than its volume indicated in documents. There are 60%, approximately, of the pellet producers (where the pellet share amounts to 15-20% of the total production) who use smallsize presses. Such pressing machines use as row material for pellets saw-dust and other wood waste which leads to unfair competition because of a non declared production of pellets and their lower purchase prices. The reasons for that are: unregulated and vague market, unfair firms and companies dealing with pellet production; on the one hand, it is due to the low business opportunities in Bulgaria, and, on the other one, to a scarcely provided control not only on production but also on purchase. Missing implementation of quality standards is a serious hurdle for the dissemination of biomass technologies.

Figure 9: Map of manufacturers, location and the volume of production of pellets in Bulgaria
(Source: www.formec.org/images/proceedings/2014/a39.pdf)
Figure 10: Map of manufacturers, location and the volume of production of briquettes
(Source: www.formec.org/images/proceedings/2014/a39.pdf)
The total analysis of wood pellets and briquettes sales shows that about 2/3 of sales have been and are being realized at home market, under previously concluded contracts, especially after quality requirements adoption. The most frequent exports are for Greece, Turkey and Italy.

Figure 12 shows the distribution of woody biofuels in Bulgaria. Data on 60-70% of the production of pellets, eco briquettes and charcoal in Bulgaria have been indicated therein. The rest 30-40% are shares belonging to the shadow economy. There are, for example, too many enterprises (factories) for wood processing and furniture production, missing to declare their entire production of pellets and eco briquettes.
Observations have been conducted where the costs for raw materials are considered to take the main part in the prime cost of production of pellets production. Other basic components of the costs and expenses are payroll and manufacturing costs where costs for drying are included: of 25% and 20%, respectively. In Bulgaria small and medium pellets factories prevail. In principle, two workers only are necessary for the whole process of production in these factories. The best quality of the pellets is obtained when pellets are produced from deciduous wood: from logs and not from waste. If more bark is left in wood, pellets quality gets worse; so, the best pellets are mad from logs while the worst ones from cuttings, shavings, branches etc.

According to the assessments of Trichkov and Dinev, the most favorable climate for the development of biofuels production is the production of briquettes for home market and of pellets for foreign ones while charcoal production is good for both of the markets. Figure 13 shows the production of pellets in Bulgaria, in 2013, in dependence of wood used for the purpose.

Figure 13: Production of pellets in dependence of wood used for the purpose
(Source: www.formec.org/images/proceedings/2014/a39.pdf)

In that relation, it can be stated that there are serious problems in Bulgaria regarding the construction of the plants and the production of biofuels from wood biomass (pellets, briquettes and charcoal, as, for example, the following below:

- Incorrect suppliers of machines and equipment.
- It has been proved that during the tests of the plants either suppliers or buyers are often not too familiar with the process; hence, such an incomplete knowledge leads to a delay in the credit allotment and repayment; subsequently, the amounts of the interests rise creating pecuniary embarrassments for both of the parties.
- Missing services for maintenance.
- The large-scale companies are provided of raw material while the small-scale firms often miss it.
- The small-scale firms have no VAT registration; that is why their purchase prices are lower.
- It is very hard to find quality workers. Preliminary training should be provided but it is not regulated.
- When raw material is purchased, especially if it is a root purchase, that raw material or wood is not separated to wood designed for pellets, briquettes and charcoal: as a minimum, it is mixed, instead, with the technological wood designed for plates and cellulose production.
- There is also unfair competition in the field of charcoal production and sale both at home and foreign markets, especially, by countries which are not EU members, as the method applied to charcoal production is the open-ended one.
To start building a plant, one shall also rely on one’s own funds, and not on 100% crediting by banks.

Table 7: Costs for residential heating with pellets and other fuels in 2014/2015

<table>
<thead>
<tr>
<th>Fuels</th>
<th>Energy value</th>
<th>Fuel price</th>
<th>Specific price €/MWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecobriquettes</td>
<td>3.72 kWh/kg</td>
<td>150 BGN/tonne</td>
<td>29.6 €/MWh</td>
</tr>
<tr>
<td>Firewood</td>
<td>3.14 kWh/kg</td>
<td>145,28 BGN/tonne</td>
<td>33.7 €/MWh</td>
</tr>
<tr>
<td>Electricity</td>
<td>1.00 kWh</td>
<td>0.171 BGN/kWh</td>
<td>87.8 €/MWh</td>
</tr>
<tr>
<td>Propan -butan</td>
<td>12.80 kWh/kg</td>
<td>2 101.56 BGN/tonne</td>
<td>92.9 €/MWh</td>
</tr>
<tr>
<td>Diesel for heating</td>
<td>11.63 kWh/kg</td>
<td>2 057.41 BGN/tonne</td>
<td>102.5 €/MWh</td>
</tr>
<tr>
<td>Industrial heavy fuel</td>
<td>10.98 kWh/kg</td>
<td>1 900.29 BGN/tonne</td>
<td>100.5 €/MWh</td>
</tr>
<tr>
<td>Wood pellets</td>
<td>4.88 kWh/kg</td>
<td>380.00 BGN/tonne</td>
<td>44.9 €/MWh</td>
</tr>
</tbody>
</table>

Source: [http://kuoreterm.com/%D1%80%D0%B0%D0%B7%D1%85%D0%BE%D0%B4-%D0%BE%D1%82%D0%BE%D0%BF%D0%BA%D0%B5%D0%BD%D0%B8%D0%B5-%D0%BF%D0%B5%D0%BB%D0%B5%D1%82%D0%B8-%D0%B3%D0%BE%D1%80%D0%B8%D0%B2%D0%B0-2014/](http://kuoreterm.com/%D1%80%D0%B0%D0%B7%D1%85%D0%BE%D0%B4-%D0%BE%D1%82%D0%BE%D0%BF%D0%BA%D0%B5%D0%BD%D0%B8%D0%B5-%D0%BF%D0%B5%D0%BB%D0%B5%D1%82%D0%B8-%D0%B3%D0%BE%D1%80%D0%B8%D0%B2%D0%B0-2014/)

3.4 Straw and other agricultural residues

The straw for energy consumption still is of marginal importance in Bulgaria.

Table 8 shows an overview of technical potentials of main agricultural by-products and residues for 2006 in Bulgaria. Data in Table 8 are presented according to the publication of ACCESS. Most promising residues are straw, stems and cubs of maize and of sunflowers. Corncobs can be chipped and used for heating purposes in larger plants, similar to wood chips. The energy equivalent for heat generation of the listed residues is 12,500 GWh, of which 5 640 GWh is from straw.

Table 8: Agricultural by-products and residues – biomass potential in Bulgaria

<table>
<thead>
<tr>
<th>Crop</th>
<th>Total agricultural residues t/year</th>
<th>Technical potential for energy utilization t/year</th>
<th>Energy content MWh/t</th>
<th>Energy equivalent for heat generation TWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straw</td>
<td>1,650,833</td>
<td>1,385,754</td>
<td>4.07</td>
<td>5.64</td>
</tr>
<tr>
<td>Maize (stem and corn-cob)</td>
<td>1,750,741</td>
<td>1,545,669</td>
<td>2.79</td>
<td>4.31</td>
</tr>
<tr>
<td>Sunflower (stem and cob)</td>
<td>1,349,666</td>
<td>1,079,733</td>
<td>2.325</td>
<td>2.5</td>
</tr>
</tbody>
</table>


The price of straw varies widely across Bulgaria. Data for the last three years lie between 35 €/t and 130 €/t.
3.5 Development stage of domestic biomass supply side

In Bulgaria

Figure 13 presents the distribution of forest territories in Bulgaria according to their ownership, as per 31.12.2013. About 70% of total forest area is owned by the state; about 12.4 % are municipal forests, about 10% are owned by private persons.

![Distribution of forest territories according to the ownership, 31.12.2013](image)

Figure 7: Distribution of forest territories in Bulgaria according to their ownership, as per 31.12.2013.

Source: National Strategy for Forestry Sector Development 2013-2020

Figure 15 presents the distribution of wood logging in Bulgaria for 2011 by ownership cathegory. More than 75% of total wood logging is from state forests, about 14 % - from private ones.
### 3.5.1 Changes in the forest territory

The changes in the forest territories in Bulgaria for the period 1960-2013 are presented on Fig 16.

Some figures concerning Bulgarian forests:

- 4 180 000 ha forest territories (about 37% of the country’s territory);
- approximately 67 % broadleaved forests;
- 650 000 000 m³ total volume;
- 14.4 million m³ annual increment;
- 3.8 m³ – average annual increment per ha;
- 8 000 000 m³ annual harvesting (standing timber);
- Bulgaria is third richest in biodiversity country in Europe;
- Forest territories include 3 National parks, 11 Nature parks and more than 700 protected areas;
Figure 16: Changes in the forest territory in Bulgaria for the period 1960 – 2013

Source: Forest sector in the Republic of Bulgaria, Ministry of Agriculture And Food. Executive Forest Agency
https://www.google.bg/search?q=cut+wood&oq=cut+wood&aqs=chrome..69i57&sourceid=chrome&es_sm=93&ie=UTF-8&q=Forest+sector+Bulgaria
4 Bulgaria’s solid biomass boiler market beyond 100 kW heat load

According to the official information from Sustainable Energy Development Agency in Bulgaria, solid biomass boilers fuelled by wood-chips, by-products of wood-based industries and bark, as well as with pellets are totally 543. This number includes also combined boilers, alternatively burning wood/oil or wood/coal. Only 45 of these boilers have power 100 kW and beyond, which means about 8%. All these boilers are used for heating of primary schools, kindergartens and governmental and municipal offices (municipalities are obliged to develop and submit for approval of programs promoting the use of energy from RES and biofuels in line with the NREAP). One is installed in a hospital and five in hotels. The number of installed boilers has risen after the start of the use of pre-accession funds (from 2000), Bulgarian Energy Efficiency and Renewable Energy Credit Line (from 2004), and operational programs (from 2005).

4.1 Number of installations of solid biomass boilers

In Bulgaria small size boilers with heat load less than 100 kW predominate. The number of solid biomass boilers with heat load 100 kW and higher installed annually in Bulgaria is presented on Fig.17. The first registered biomass boiler having heat load 100 kW has been installed in 1988. There is only one boiler with the highest power 1500 kW which was installed in 2005.

![Figure 17: Development of the number of annually installed biomass boilers (≥ 100 kW heat load) in Bulgaria. Source: SEEA](image)

Most of the installed boilers are in regions close to the afforested areas: 13 in the region of Burgas, close to Strandzha Mountain, 11 in the region of Kardzhali, 7 in the region of Smolyan, 6 in the region of Haskovo – all regions close to Rodopi Mountain. The rest number of boilers is installed in the regions close to Balkan
Mountains. The reason is that there is considerable lumbering in these afforested areas. This assures that cheap wood residues can be used as fuel for boilers.

The data provided by SEEA show that in Bulgaria the boilers using wood chips predominate as in the boilers sized under 100 kW, as well as in those sized 100 kW and larger. Boilers fuelled by wood chips are 55% of all solid biomass boilers. In the list there are only four boilers fuelled by pellets, three of which having size higher than 100 kW. Furthermore, there are more four boilers on biomass that is not with woody origin, all having heat load capacity over 100 kW.

Figure 18 shows the cumulative number of annually installed biomass boilers beyond 100 kW heat load. According to the information from SEEA 41 solid biomass boilers were installed in Bulgaria by the end of 2013. It can be seen that the number of installed boilers for the period of about 15 years has risen about 20 times. The development of the number of annually installed boilers has linear character with change of the slope in 2005, when started the project “Forestry sector: fuel switch” financed by the Japanese Trust Fund of the World Bank program “Initiatives related to climate change” and executed by the Ministry of Agriculture and Forestry and the National Forestry. It is implemented in three municipal buildings Ardino - Multipurpose municipal hospital, the school "Vasil Levski" and Primary school "Hristo Botev". The aim of the project is the utilization of wood biomass to encourage afforestation activities in forests, reduce greenhouse gas emissions and achieve economic and social impact of the replacement of conventional fuels.

Only one of the installed solid biomass boilers has a capacity beyond 1,000 kW (namely 1,500).

Figure 18: Development of the cumulative number of biomass boilers (≥ 100 kW heat load) installed annually in Bulgaria.
Source: SEEA

4.2 Heat load capacity of installed solid biomass boilers

The development of the capacity of annually installed biomass boilers (≥ 100 kW heat load) in Bulgaria after 1988 is presented on fig. 19.
It can be seen that after 1989 there is a break in the installation of biomass boilers. This is related to the period of political disturbances and very frequent changes of governments. These changes caused instability in national and financial policies. The situation began to improve after 1998, when Bulgarian governments started the negotiations for entering in European Community and special adhesion programmes for financing turn to be available. After that the orientation to more intensive development of Renewable Energy Sources (RES), including biomass, started to grow, which reflected also to the installation of solid biomass boilers.

![Figure 19](image1)

Figure 19: Development of the capacity of annually installed biomass boilers (≥100 kW heat load) in Bulgaria. Source: SEEA

Figure 20 shows the development of the cumulative capacity of biomass boilers (≥100 kW heat load) installed in Bulgaria after 1988. Both figures 3 and 4 show linear increase in the development of solid biomass boiler installation with change of the slope in the year 2005, after the start of the pilot project "Forestry sector: fuel switch" which popularized the implementation of measures for reduction of greenhouse gas emissions, as well as the economic and social impact of the replacement of conventional fuels.

Most of installed solid biomass boilers according the information of SEEA are situated in municipal buildings – municipality offices, kindergartens, primary schools, hospitals (the biggest boiler with heating capacity of 1,500kW). One solid biomass boiler is installed in wood processing plant (most wood processing plants use old co-fired boilers), another biomass boiler is installed in engineering corpus, one - in shopping centre, other five are installed in hotels.
Further the distribution of wood fuel consumption in Bulgaria for the period 2007-2013 according to the data of National Statistical Institute is presented on fig. 21. As it can be seen, wood fuel is consumed predominantly in households. The input of industry for all the period represents hardly 25% of the total consumption.

The heat energy sector has the largest share in the Renewable Energy Sources (RES) mix of Bulgaria due to the generated energy for heating purposes from biomass.

According to EUROSTAT data, 95% of the biomass for heating purposes is non-grid and is used for own consumption by individual plants and households. The low price of the raw material and the equipment are a prerequisite for the mass consumption of solid biomass in the sector.

The production and use of briquettes and pellets, as well as the use of organic waste is less developed.
The share of RES and waste in gross heat production in Bulgaria for the period 2007-2013 is presented on fig. 22.

The input of solid biomass fuels in district heating plants according to the data from the Energy balances sheets 2013 of NSI, Bulgaria, is about 0.4% of the gross heat production for last three years. This would amount to about 0.22 PJ/year.

Source: Based on data from National Statistical Institute, Energy Balances Sheets, 2013
5 Result of Stakeholder Interviews

The main objective of the stakeholder interviews performed was to identify at least 3-4 market segments in total, where a business case for commercial “in-house” or district heating with solid biomass seems to be most likely. In every country 2-3 biomass boiler manufacturers and 2-3 district heating developers/operators were interviewed for this purpose. Where those target groups were not existing domestic representatives of foreign biomass boiler manufacturers or domestic biomass associations and biomass experts were interviewed instead.

5.1 List of interviewees

Table 9: Overview of interviewed key stakeholders to identify promising market segments for Bioenergy4Business activities.

<table>
<thead>
<tr>
<th>Name</th>
<th>Function</th>
<th>Company</th>
<th>Type of business</th>
<th>Interview details</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gergana Miteva</td>
<td>Client service</td>
<td>EVN</td>
<td>Biomass district heating</td>
<td>30. March</td>
<td><a href="http://www.evn.bg">www.evn.bg</a></td>
</tr>
<tr>
<td>Nikola Angelov</td>
<td>Owner of private house with pellet heating</td>
<td>Agricultural University</td>
<td>Forestry and Agricultural Associations</td>
<td>30. March</td>
<td><a href="http://www.au-plovdiv.bg">www.au-plovdiv.bg</a></td>
</tr>
<tr>
<td>Krasimir Peychinov</td>
<td>Owner of pellet /biomass production</td>
<td>Peychinov Ltd.</td>
<td>Pellet-/ biomass fuel representative</td>
<td>06. April</td>
<td><a href="http://www.peychinovltd.com">www.peychinovltd.com</a></td>
</tr>
<tr>
<td>Angel Ivanov</td>
<td>Professor, consultant</td>
<td>Agricultural University</td>
<td>Training, Higher education</td>
<td>3. April,</td>
<td><a href="http://www.au-plovdiv.bg">www.au-plovdiv.bg</a></td>
</tr>
<tr>
<td>Boyan Lekov</td>
<td>Director</td>
<td>Ahira JSC</td>
<td>Pellet production and supply</td>
<td>7. April,</td>
<td><a href="http://www.ahira.eu">www.ahira.eu</a></td>
</tr>
<tr>
<td>Nikolay Vangelov</td>
<td>procurist</td>
<td>Erato Holding</td>
<td>Boiler manufacture</td>
<td>17. April</td>
<td><a href="http://www.greene">http://www.greene</a> cotherm.eu/</td>
</tr>
</tbody>
</table>

All interviewees were asked the same following four questions.

- What are the most promising bioenergy sources being available in larger quantities locally (at reasonable prices) in Bulgaria?
- What are promising market-segments (where a business case seems to be most likely) in Bulgaria?
- Due to which technical, economic etc. criteria did you select these promising market segments and which influence do these criteria have regarding market penetration?
- In case you sell biomass boilers abroad: To which countries do you export and what are the promising market segments there?

The interview guide that was used for all interviews can be seen at ANNEX xx of deliverable D2.2 “Summary overview of promising market segments for bioenergy.”
The identified market segments are those on which national project activities will be focused on throughout project lifetime. The market segments identified may vary from partner country to partner country.

5.2 The most promising bioenergy sources

Please give, for every of the following chapters, a summary of all interviews on an anonymous basis.

Most of the interviewees share the opinion that pellets, briquettes and wood chips are the most promising sources of bioenergy in Bulgaria. Some of them underline that solar energy and geothermal energy are also available and give good opportunities.

In support of their opinion the following figure 23 represents accessible energy potential in ktoe for different energy sources. Accessible energy potential is defined as that share of technical potential which can be really utilized in the limits set by technical and non-technical (financial, legislative) barriers.

Figure 23: Accessible energy potential from different renewable energy sources in Bulgaria.


5.3 The most promising market segments

Bioenergy use in Bulgaria has largest occurrence in private homes, hotels, and wood-processing factories. Most of wood processing factories use old co-firing boilers. They are not included in the information on Figures 19 and 20. From the new installed boilers on figs. 19 and 20 only four are co-firing wood/oil boilers. The lowest share of bioenergy use is accounted in cogeneration installations.
Currently hotels and wood-processing factories have the biggest perspective for development of bioenergy use. This is because this type of consumers benefit from EU financial aid. For private homes this possibility does not exist yet.

The best options presently have been developed in some municipalities that are located in areas near the forest and far away from gas pipelines and other heat sources. The fossil fuel used for heating (black oil) has been successfully substituted for with woody biomass in some of these municipalities. There are, however, still considerable numbers of small municipalities that could profit from this opportunity of fuel switch.

In the future biofuels would be used in public buildings such as hospitals, schools centres of nursing homes, etc. Municipalities are obliged to develop programs promoting the use of energy from RES and biofuels in line with the NREAP. For example, measures for RES-use in municipal buildings, support schemes for district heating networks etc. shall be included. The Renewable Energy Act (ZEVI) which entered into force in 2011 provides mechanisms encouraging the use of renewable energy in administrative, industrial and residential buildings.

In Bulgaria there are many municipal forests disposing wood waste (sanitary timber) which, if used rationally, could reduce the costs for heating of public buildings.

The municipalities, which have their own forests, having an annual growth sufficient to power the designed capacity, are most suitable for implementation of joint projects. Forest owners, large farms and producers of biomass boilers are stakeholders in the construction of facilities for the production and use of wood energy and wood pellets.

Most of the interviewees connected with bioenergy production assess as good perspective for the bioenergy use in newly built commerce- and service buildings as well, while people working in the field of agriculture and forestry evaluate as good possibility the use of bioenergy in greenhouses, breeding farms and drying facilities.

5.3.1 Criteria for selection of promising market segments and their influence regarding market penetration

5.3.1.1 State Risk and –support

Answers of questions show that corruption is evaluated as not very important as well as the time and cost to start company, to get electricity and to register property. Procedures, time and formalities for construction are evaluated as more important as well as the procedures, time and cost for export and import. As most important the role of heat from biomass in national energy strategy is evaluated. This fact can be interpreted that the positive mentioning is related to financial support, previewed in the national strategy. Unfortunately, recent changes in prices of energy from wood residues are not positive for the development of bioenergy.

5.3.1.2 Technical questions

Fuel quantity and fuel quality are evaluated as most important, followed by space requirements in the building.

The role of water pipe system and installers of hardware is evaluated as most important. Less important factor is the problem related to dust/odour.

5.3.1.3 Economic questions

As most important factor in economic field the future availability of investment subsidies and feed-in-tariff for district heating producers is evaluated. Low- & zero energy buildings do not prevent the investment in heat from bioenergy (this kind of building is not well known in Bulgaria). Local availability of fossil competitor is not
important (Bulgaria has not enough local fossil fuels). There is no subsidy for fossil fuels. The importance of bank support of bioenergy for heat is evaluated as very important. Unfortunately, the credit line BEERECL (Bulgarian Energy Efficiency and Renewable Energy Sources Credit Line) was closed in the end of 2014.

5.3.1.4 Organisational questions

In this section most important for the interviewees is creation of new employment, availability of service experts, the time necessary for permitting procedure. The lowest importance is accounted for the assistance of district heating associations – it does not exist in Bulgaria, landlord-tenant problem - not relevant for Bulgaria.

5.3.1.5 Motivation of investors

Most important arguments in this factor are: the possibility to use fuel from the region – lower price, guaranteed and secure supply; on the second place the importance of the benefit to national and regional economy and applied information policy are positively evaluated; the possibility to pay for visits in demonstration plant is evaluated as less important.

5.3.2 Summary of the most important factors that influence the success of market introduction at the most promising market segments

The most important factors that influence the success of market introduction of bioenergy for heating are:

State risk and support – the recognition of biomass heating in national energy strategy

Financial – availability of subsidies and bank support, as well as tax concession

Technical – providing convenient fuel quantity and quality

Organizational – possibility for creation new employment, social acceptance

5.4 Most promising market segments abroad – view from Bulgarian market actors

Currently, the main export market for boilers, pellets and briquettes produced by Bulgarian entrepreneurs, are:

- Greece and Italy - for pellets
- Balkan countries, Ukraine, Russia - for boilers.
6 Characterisation of promising market segments (facts & figures)

6.1 Selection of most promising market segments

6.1.1 Amount of fossil fuels being both, used in promising market segments and most likely for a fuel-switch to solid biomass

The propositions of interviewees of most promising market segments could be generally attributed to the sector of industry, where the factories belong, the sector of Agriculture and Forestry, where the greenhouses and farms belong, and the sector of Households, Trade, Public authorities and others, where the public buildings such as hospitals, municipal offices and private houses belong. As it can be seen from the diagram on Fig.4, the biggest consumption of oil in Bulgaria is accounted for the transport – 87%. But there is not possibility to substitute the oil with wood residues except for biogas produced by pyrolysis.

Table 10 presents the oil and petroleum products used in these sectors for heating, average for the period 2010-2013, in GWh.

Table 10: Usage of oil and petroleum products, Average from 2010 to 2013 in GWh.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Oil in total</th>
<th>CO$_2$-eq. savings*</th>
<th>Selection/ Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>2 745</td>
<td>200 387</td>
<td>1</td>
</tr>
<tr>
<td>Agriculture, forestry and fishing</td>
<td>1 492</td>
<td>108 916</td>
<td>2</td>
</tr>
<tr>
<td>Commerce &amp; Public buildings</td>
<td>287</td>
<td>20 951</td>
<td>3</td>
</tr>
<tr>
<td>Residential</td>
<td>287</td>
<td>20 951</td>
<td>3</td>
</tr>
<tr>
<td>In total</td>
<td>4 811</td>
<td>351 205</td>
<td></td>
</tr>
</tbody>
</table>


* GHG-reduction potential

Data on Table 10 allow to give a ranking of sectors, according to the relevance of the corresponding sector for Bioenergy4Business related activities to substitute oil and petroleum products by solid biomass. According to the ranking most relevant sector is the industry, but recent information shows that a number of industrial enterprises switch from oil to natural gas. However, it can be expected that at least 15% of oil used in the industry might be substituted by biomass fuels. In the agriculture the oil substituted by biomass fuel can be estimated to be about 15% too. This makes more attractive the sectors on second and third position where the switch from oil to woody biomass is already proven.

The competitiveness of bioenergy with other energy sources used for heating can be assessed from Fig.24, where the fuel structure of transformation input in district heat plants in Bulgaria is presented.

The figure shows that the input of petroleum product as well as coal decreases progressively in the last three years 2011-2013. Solid fuels including wood, wood residues, industrial waste have very limited input in the
period 2007-2011 with slight rise in the last two years 2012-2013. The main role in heat production in Bulgaria plays natural gas.

Figure 24: Fuel structure of transformation input in district heat plants


The contribution expected of each technology (Biomass, Solar thermal, Geothermal and Heat pumps) to meet the binding 2020 target for Bulgaria and the indicative trajectory for the share of RES in heating and cooling (in terms of installed capacity and final heating and cooling consumption) is presented on Fig. 25.

Figure 25: Contribution of renewables to heating and cooling, ktoe

Poduced Energy for Heating and Cooling in ktoe

Figure 25: Contribution of renewables to heating and cooling, ktoe
From Fig. 25 it can be seen that biomass predominates in the present time as well as in the future prognosis over the other renewables used for heating. In 2007 the contribution of biomass for heating and cooling was 17% of total final consumption, in 2020 it is planned to achieve 12.8% of final consumption because of enlarging the use of natural gas, solar and geothermal.

Heat energy REALIZED in 2012 amounted to 11.6 TWh, which is by 4.2% more as compared to 2011 (heat energy realized in 2011 is basis 100%). In the structure of consumption of heat energy the largest share belongs to industrial and commercial consumers - 59.6% of total heat consumption, followed by residential - 34.5 % and governmental and municipal organizations - 5.9%. Compared to 2011, heat consumption of industrial and commercial consumers increased by 12.7%, the one of budgetary consumers decreased by 9.6% and of households decreased by 5.7%.

In 2014 the heat consumption is Total end consumption of heat energy in 2014 amounted to 12.4 TWh, which is by 0.1% less compared to 2013. In the structure of consumption of heat energy the largest share belongs to industrial and commercial consumers - 67%, followed by households - 28% and budgetary organizations - 5%.

6.1.2 Historical development of GHG-emissions

The information concerning estimation of GHG-mitigation potential in this sub-chapter is based on National Inventory Report 2013 for Greenhouse Gas Emissions.

Figure 26 presents the trend in total GHG emissions in Bulgaria in the period 1988-2011 by subcategories. The general trend shows a notable drop in the country emissions after 1990-1991 due to the transition from planned economy to market economy, which happened in the country. The decrease of the GHG emissions continued up to 1999, followed by a slow increase after 2000, after the national economy started to grow.
It can be seen that the biggest contribution is for the Energy industries, which does not represent interest for project B4B. The second biggest contributor are Manufacturing industries and Construction, but in last 4 years (2008-2011) its contribution decreases. Manufacturing industry and construction is the sector, which changed drastically – compared to 1988 the emissions decreased by 79.1% in 2011. Transport is the sector placed at third place and its contribution last years is bigger than that of industries, but there the switch to bioenergy is under discussion. Subcategory Other Sectors includes Agriculture/Forestry/Fishery, Commerce & Public buildings and Residential. The emissions of this subcategory are rather lower than the previously discussed.

In general there is an increase in the usage of solid fuels, mostly due to the energy industries growth, decrease in liquid fuels due to the decrease of the industry sector and increase of gaseous fuels due to the on-going gasification of industrial plants, residential sector and transport.

Figure 27 presents the trend in total GHG emissions from Agriculture in Bulgaria. In the year 2011 the sector agriculture contributed 9.3% to the total of Bulgaria’s greenhouse gas emissions. The trend of GHG emissions from 1988 to 2011 shows a decrease of 69.57% for this sector due to decrease in activity data.

Figure 27: Trend in Total GHG emissions from Agriculture in Bulgaria for the period 1988-2011.

A comparison of the emissions of GHG from subcategories Agriculture/Forestry/Fishery, Residential and Commercial/Institutional Buildings is presented on Fig. 28. It can be seen that the input of Residential buildings is bigger than this of two other subcategories.
Figure 28: Total emissions from sectors Agriculture/Forestry/Fishery, Residential and Commercial/Institutional buildings.


The general trend in subcategory Other Sectors (including Agriculture/Forestry/Fishery, Residential and Commercial/Institutional buildings) is a decrease of 64.9% compared to base year (1988) and an increase of 13.5% compared to last year.

Residential covers emissions from fuel combustion in the residential sector. The emissions from subcategory Residential decreased by 70% compared to base year (1988), which is mostly due to the drastically decreased consumption of liquid and solid fuels, which were substituted mostly by biomass.
Literature


National Inventory Report 2013 for Greenhouse Gas Emissions


National Statistical Institute, Energy Balance Sheets, 2013


Pellet prices http://kuoreterm.com/%D1%80%D0%B0%D0%B7%D1%85%D0%BE%D0%B4-%D0%BE%D1%82%D0%BE%D0%BF%D0%BB%D0%B5%D0%BD%D0%B8%D0%B5-%D0%BF%D0%B5%D0%BB%D0%B5%D1%82%D0%B8-%D0%B3%D0%BE%D1%80%D0%B8%D0%B2%D0%B0-2014/

REPAP_-_RES_Industry_Roadmap_Bulgaria 30.10.2010

SECOND NATIONAL REPORT ON BULGARIA’S PROGRESS IN THE PROMOTION AND USE OF ENERGY FROM RENEWABLE SOURCES drawn up under Article 22(1) of Directive 2009/28/EC on the promotion of the use of energy from renewable sources, Dec.2013

SEEA – private communication

The EC, Energy Prices and Costs report, 2014
8 Abbreviations

EU – European Union
AT - Austria
DE - Germany
BG - Bulgaria
CR Croatia
FI-Finland
GR - Greece
NL -Netherlands
PL - Poland
RO - Romania
SK -Slovakia
UA - Ukraina
BE -Belgium
DK –Denmark
GHG – Greenhouse Gases
RES – Renewable energy sources
ANNEX I – Bulgarian Wood flows

Such a graph is not available yet.
ANNEX II – Greenhouse gas emission factors

DEFAULT AND COUNTRY SPECIFIC EMISSION FACTORS USED IN BULGARIA.


2. The default CH4 emission factors - EF CH4 [t/MWh] for different fuels. For CH4 are applied the default emission factors referenced in IPCC 1996 Reference Manual, Ch.1, Table 1-7, p. 1.35. For sludge gas and black liquor are used the new emission factors referenced in IPCC 2006 guidelines, Vol. II, Ch. 2, Table 2-2, Table 2-3, Table 2-4, Table 2-5, since emission factors for sludge gas and black liquor are not available in the 1996 Guidelines.

3. The default N2O emission factors - EF N2O [t/MWh ] for different fuels. For N2O are used the default emission factors referenced in IPCC 1996 Reference Manual, Ch.1, Table 1-8, p. 1.36. For sludge gas and black liquor are used the new emission factors referenced in IPCC 2006 guidelines, Vol. II, Ch. 2, Table 2-2, Table 2-3, Table 2-4, Table 2-5.


Table 1. Country-specific EFs excl. oxidation factor for CO2 for solid fuels [t/GWh]

<table>
<thead>
<tr>
<th>Solid Fuels</th>
<th>EFs CO2 excl. oxidation [t/GWh]</th>
<th>EFs CO2 incl. oxidation [t/GWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthracite</td>
<td>354.878</td>
<td>347.781</td>
</tr>
<tr>
<td>Lignite</td>
<td>386.409</td>
<td>378.681</td>
</tr>
<tr>
<td>Other Bituminous Coal</td>
<td>349.259</td>
<td>342.273</td>
</tr>
<tr>
<td>Petroleum Coke</td>
<td>339.277</td>
<td>332.491</td>
</tr>
</tbody>
</table>

Source: BNIR (2013)

5. Country specific emission factors for CO2 for gaseous fuels
Table 2. Country-specific carbon contents and EFs for CO2 for gaseous fuels [t/GWh]

<table>
<thead>
<tr>
<th>Gaseous Fuels</th>
<th>EFs CO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>EF excl. oxidation factor</td>
<td>198.946</td>
</tr>
<tr>
<td>EF incl. oxidation factor</td>
<td>197.951</td>
</tr>
</tbody>
</table>

Source: BNIR (2013)

Table 3: Estimates and forecasts for the EFs of GHG for national electricity grid (Bulgaria), 2014 – 2020.

<table>
<thead>
<tr>
<th>Power station</th>
<th>TPS</th>
<th>TPHS</th>
<th>TPHS at a plant</th>
<th>REPS (incl. Hydroelectricity)</th>
<th>NPP</th>
<th>PSPS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission factor, tCO2/MWh</td>
<td>1.278</td>
<td>0.669</td>
<td>0.885</td>
<td>0</td>
<td>0</td>
<td>0.616</td>
<td></td>
</tr>
</tbody>
</table>

Source: MOEW (2014).

TPS - thermal power station hard coal, (49.6%)
TPHS - thermal power and Heatboiler station (5.2%)
TPHS at plant - thermal power and Heatboiler station at a plant (3.9%)
REPS (incl. Hydroelectricity)- Renewable energy power stations incl. Hydroelectricity (7.3%)
NPP- nuclear power plant (32.2%)
PSPS- Pumped Storage Power Station (1.8%)

% - percentage in electricity production (процент в производството на електроенергия)

6. Typical specific and default emission factors for GHG for Primary solid and gaseous biomass fuels

Table 4: Typical specific and default emission factors for GHG for Primary solid and gaseous biomass fuels

<table>
<thead>
<tr>
<th>Biofuel production pathway</th>
<th>Typical GHG emitted (g CO2eq/MWh)</th>
<th>Default GHG emitted (g CO2eq/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood chips from forest residues (EU forest)</td>
<td>3.6</td>
<td>3.6</td>
</tr>
<tr>
<td>Wood chips from short rotation forestry (EU forest)</td>
<td>10.8</td>
<td>14.4</td>
</tr>
<tr>
<td>Wood briquettes or pellets from forest residues (EU forest) – wood as process fuel</td>
<td>7.2</td>
<td>7.2</td>
</tr>
</tbody>
</table>

ABOUT THE AUSTRIAN ENERGY AGENCY

The Austrian Energy Agency is the national centre of excellence for energy. New technologies, renewable energy, and energy efficiency are the focal points of our scientific activities. The objectives of our work for the public and the private sector are the sustainable production and use of energy and energy supply security. We are an independent think tank that manages knowledge, provides the basis for well-founded decision making, and develops suggestions for the implementation of energy-related measures and projects. We advise decision-makers in politics, science, and the industry on the basis of our mainly scientific work. We prepare political, energy and economic expert opinions, economic feasibility analyses, social analyses, feasibility studies, and evaluations.
<table>
<thead>
<tr>
<th>Source: SEC(2010)</th>
</tr>
</thead>
</table>

| Source: SEC(2010) |

| Wood briquettes or pellets from forest residues (EU forest) – NG as process fuel | 61.2 | 72.0 |
| Wood briquettes or pellets from short rotation forestry (EU) - wood as process fuel | 14.4 | 14.4 |
| Wood briquettes or pellets from short rotation forestry (EU) - NG as process fuel | 68.4 | 79.2 |
| Charcoal from forest residues (EU) | 122.4 | 147.6 |
| Charcoal from short rotation forestry (EU) | 136.8 | 165.6 |
| Wheat straw (EU) | 7.2 | 7.2 |
| Biogas from wet manure | 25.2 | 28.8 |
| Biogas from dry manure | 21.6 | 25.2 |
| Biogas from wheat and straw (wheat whole plant) | 64.8 | 75.6 |
| Biogas from maize as whole plant (maize as main crop) | 100.8 | 122.4 |
| Biogas from maize as whole plant (maize as main crop) – organic agriculture | 57.6 | 68.4 |

Source: SEC(2010)

Literature

BNIR (2013). Bulgaria’s National Inventory Report 2013 – Submission under UNFCCC and under the Kyoto Protocol


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ABOUT NATIONAL BIOMASS ASSOCIATION (BGBIOM)
NBA promotes renewable energy sources, mainly biomass, plant residues and animal manure as energy source for sustainable society. BGBIOM consolidates professionals and students interested in the field of industrial and power producing use of the biomass. NBA propagates the growth of different plants for non-food use. NBA aims also to co-ordinate and facilitate the research and development works in the fields of biomass resources, biofuel production technologies, biofuel market in the transport, heat and energy sector, as well as in the field of biomass non-energy products.

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