

# **Barriers and Opportunities for Pellet Markets in Central and Eastern Europe**

Case Study – Bulgaria

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## **Abstract**

Pellets are a form of biomass used in highly efficient heating systems. Thus, development of pellet markets could improve energy efficiency, reduce emissions of greenhouse gases, create employment opportunities, increase energy security, and improve air quality. The present research explores the development of the domestic pellet market in Bulgaria. The research's objectives are to investigate barriers and opportunities for the development of the market. Findings from literature and conducted interviews establish the current status of the domestic market for pellets in Bulgaria. The study analyzes the political, economic, social, technological, legal, and environmental aspects of the market at present. It then, identifies barriers and opportunities for market development in Bulgaria. Changes in the forestry sector, in financial incentives for RES heating, and in energy strategy and policy making are suggested in order to overcome the barriers for market development. In addition, the market development in Bulgaria could be used as a case study for similar analysis in other Central and Eastern European countries due to identified shared trends and attributes.

**Keywords:** Pellets, Market, Barriers, Opportunities, Heating, Biomass, Policy

## **Executive Summary**

The topic of the present research is the development of the pellet market in Bulgaria, which is used as a case study for other Central and Eastern European countries. There is little written on pellet markets in Central and Eastern Europe in general. Nevertheless, the countries in this region have large forested areas and strong traditions of heating with firewood (World Bank, 2010; IEA, 2009). Pellets represent an innovative use of biomass for heating which is more efficient, cleaner, and more environmentally-responsible than simple burning of firewood. In addition, heating with pellets is cheaper than heating with heating oil, electricity, district heating, and gas (Erato, 2011; Technowood, 2012).

The focus of the present research is the pellet market in Bulgaria. Biomass is the RES with both the largest use and highest technical potential in the country, with 57% of the country's technical potential not currently utilized (MEET, 2011). In addition, most of the biomass in the country is used for heating – 34.1% of the population's heating supply was satisfied by wood in 2011 (NSI, personal communication, 17 August 2012). This utilization, however, is highly inefficient as about 60% of the energy is lost (MEET, 2011). At the same time, pellets supplied only 0.3% of the population's heating needs in 2011 (NSI, personal communication, 17 August 2012). The efficiency of using pellets for heating is superior to using wood, though, with efficiencies of 85-95% (REHES, 2007). Therefore, there is considerable room for more efficient utilization of the current use of biomass potential. In addition, pellets could allow more efficient utilization of the technically feasible biomass potential of the country.

The research's objectives are to identify the barriers and opportunities for the development of the domestic market for pellets in Bulgaria. The main target audiences of this research are decision-makers, followed by experts, academics, and business. The questions that the research addresses are:

- How does the present socio-economic-political context in Bulgaria hamper the development of the domestic market for pellets?
- How can the domestic market for pellets be further developed?
  - a. What opportunities are present for the development of the domestic market for pellets?
  - b. What mechanisms and support schemes are needed for the development of the domestic market for pellets?
  - c. Which is the likely short-term direction that the development of the internal market for pellets will take (i.e. which groups of customers will be mostly targeted by business?)?

Literature on the pellet markets in Central and Eastern Europe consists of mostly analyses and assessments conducted as part of projects, supported by the EC's Intelligent Energy Europe Programme. Therefore, numerous interviews with stakeholder groups took place to supplement the literature review, conducted as part of the research process. The goal of the literature review and the interviews was to study the current status of the pellet market in Bulgaria.

The analysis of the current pellet market's status in the country was organized around the PESTLE framework and thus, focused on the building blocks of the framework – analysis of political, economic, social, technological, legal, and environmental aspects of the pellet market in Bulgaria. In addition, Freeman's Stakeholder Theory was used to identify the relevant stakeholder groups to be interviewed. On the basis of the theory, four stakeholder groups

were created: Business (producers of pellets and pellet stoves), Institutions, Customers, and Experts. 21 interviews in total were conducted with representatives from all stakeholder groups with the highest number of interviewees coming from the Business stakeholder group. Thus, the present research strives to give a micro perspective of the pellets market in Bulgaria as most of the reviewed literature dealt with macro aspects such as technical potentials, aggregate supply, and export. Therefore, the present research fills in a research gap by exploring the domestic market for pellets in Bulgaria, instead of the export market, and by operating at the micro scale and analyzing the problems that businesses face, the developmental opportunities they see, and the changes in the status quo they would like to be implemented.

The domestic market for pellets in Bulgaria is still a nursing market, where less than 0.3% of the population's heat demand is satisfied through the use of pellets (NSI, personal communication, 17 August 2012). Nevertheless, demand for pellets has been continuously growing in recent years. This growth in demand has been witnessed mostly among households and municipalities, which are identified as important customer groups for future market development. There are some applications of pellets for industrial purposes (e.g. in greenhouses), but these do not represent a large market segment.

The Technological Innovation System (TIS) framework was applied in the analysis of the barriers for domestic market development. The use of pellets for heating is an innovative approach in Bulgaria and the market is still in its beginning stage of formation and thus, pellets could be regarded as a technological innovation in the case of Bulgaria. The TIS framework identifies seven factors that are important for market development. The findings from the conducted literature review and interviews were analyzed according to all seven factors. Another benefit of applying the TIS framework to analyze barriers to market development is the fact that including the seven TIS factors in the analysis provides ideas for how the identified barriers could be overcome.

Three major barriers to the development of the domestic market for pellets were identified. First, the insecure and often non-transparent supply of wood presents difficulties for the pellet business in terms of predictability of production costs, levels, and future investments. Wood is sold at yearly auctions, which also causes volatility of prices especially if a big investor or a new, large market actor enters the bidding process. Investors in CHPs on biomass are deemed to represent such large, new market actors in the near future. This would pose significant challenges for the supply of wood to pellet producers, which have less purchasing power than actors in the CHP business who benefit from lucrative feed-in tariffs.

Second, the largest upfront investment that a customer has to make if he/she wants to switch to heating on pellets is to purchase a pellet stove. Pellet stoves start at about BGN 5 000 (EUR 2 550) and are integral in the full utilization of the benefits of heating with pellets. At present there are no adequate financial support mechanisms for the purchase of pellet stoves. The existing funds for energy efficiency in households and credit lines for energy efficiency have a ceiling on investments for each energy efficiency measure which is rather low to provide an adequate incentive to purchase a pellet stove.

Third, Bulgarian energy policies, strategies, and support schemes are mostly concerned with the generation of electrical energy. Feed-in tariffs for energy produced from RES are also almost entirely targeted at the generation of electrical energy and completely exclude decentralized RES heating projects. Therefore, there are no support mechanisms for the use of RES for heating, insufficient institutional guidance for businesses to get involved in RES

heating projects, and lack of targets to achieve a certain level of RES use for the heating of buildings.

To overcome these barriers, some changes mostly in the forestry and policy sectors are needed. To address the issue of the insecure supply of wood, long-term contracts for the harvest and supply of wood must be implemented. The latest amendments to the Forest Act provide for the establishment of such contracts. In reality, though, such contracts are not being practiced at the moment. Long-term contracts will reduce the insecurity in wood supply as well as the volatility of wood prices. These contracts could also efficiently allocate wood to different market actors as long as the procedures are transparent and there is monitoring over the contracts. In addition to making production costs, production levels and long-term planning easier for business, long-term contracts could also contribute to the better management of forests, utilization of unused potential, the improvement and construction of roads in forests, and the modernization of forestry equipment.

The single, most influential measure that needs to be implemented in order to stimulate pellet demand from customers is to introduce financial support schemes for the purchase of pellet stoves. These support schemes could take the form of national subsidies, improved conditions of credit lines for energy efficiency and national funds for energy efficiency, and/or tax reliefs when one buys a pellet stove. These incentives should be combined with informational campaigns among the general population of the benefits of using pellets for heating. Moreover, establishment of association of the pellet producers could be involved in these campaigns, could serve as a body that will participate in policy discussions, and could provide for greater legitimacy of pellets as a reliable source of heating.

Last, but not least, the development of the domestic pellet market in Bulgaria should happen under the framework of coherent national policies, strategies, and support schemes that recognize the importance of using RES for heating and that provide incentives for small and decentralized RES heating projects. Energy used for heating represents the highest share of final energy usage in the country (MEET, 2011). Therefore, considerable benefits could be achieved through realization of energy savings, optimization of performance, improvement of air quality, and reduction of GHG emissions. In order for such coherent policies to be drafted, though, national authorities should collect reliable information on the RES heating sector and understand the workings of this sector. This could be achieved through better communication with municipalities, which are the authorities who are aware of local RES heating projects and who are also an active customer group on the pellet market. In addition, communication within the central administration should be improved, especially in the case of biomass utilization for energy. Biomass is the RES with both the highest usage and the highest potential in Bulgaria, but at least five different institutions and a number of different directorates within these institutions deal with various aspects of issues related to biomass utilization for the generation of energy. This leads to inefficient and burdensome communication, which could be avoided if a special Biomass directorate is created that will serve as a liaison between the different institutions and as a place of central storage of information.

To sum up, the domestic market for pellets in Bulgaria is in its early stages of development. There is significant market potential in its development, though, as evidenced by the more than doubled number of pellet producers since five years ago and by the constantly growing domestic demand for pellets. In order for the market to continue its development and expand even further some barriers with regards to the supply of wood, financial incentives for the purchase of pellet stoves, and institutional support and recognition of the business should be overcome.

Finally, the case of Bulgaria could serve as a stepping stone in the analysis of domestic pellet market development in other Central and Eastern European countries due to the similar socio-economic, energy, biomass, and biomass-use-for-energy contexts. Heating on pellets has been widely implemented in a number of Western and Northern European countries and has been demonstrated to provide multiple opportunities such as improvement of air quality, reduction of fuel poverty, reduced expenses for heating, increased local employment, etc. These are benefits that could lead the Central and Eastern European region to increased economic activity and reduced environmental damage. The development of domestic pellet market could also create external economies that could help the region towards its efforts to achieve development levels similar to those in Western and Northern Europe.



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## Abbreviations

AC – air conditioner

AERS – Act for the Energy from Renewable Sources

BGN – Bulgarian lev

EBRD – European Bank of Regional Development

EC – European Commission

EPC – European Pellet Council

EPER – European Plan for Economic Recovery

CO – Carbon Oxide  
CO<sub>2</sub> – Carbon Dioxide  
CCS – Carbon Capture and Storage  
CHP – Combined Heat and Power  
COP – Conference of the Parties  
EEA – European Economic Area  
EFA – Executive Forest Agency  
EIA – U.S. Energy Information Administration  
EU – European Union  
GDP – Gross Domestic Product  
GHG – Greenhouse gas  
ha – hectare  
IPCC – Intergovernmental Panel on Climate Change  
ktoe – kilo tons of oil equivalent  
kW – kilowatt  
kWh – kilowatt hour  
m<sup>2</sup> – square meter  
m<sup>3</sup> – cubic meter  
MAF – Ministry of Agriculture and Food  
MEET – Ministry of Economy, Energy, and Tourism  
MLSP – Ministry of Labour and Social Policy  
MOEW – Ministry of Environment and Water  
MW – megawatt  
MWh – megawatt hour  
NGO – Non-Governmental Organization  
NSI – National Statistical Institute  
OPEC – Organization of the Petroleum Exporting Countries  
PM – Particulate Matter  
REAP – Renewable Energy Action Plan  
RES – Renewable Energy Sources  
SEDA – Sustainable Energy Development Agency  
SME – Small and Medium Enterprise  
SO<sub>2</sub> – Sulfur Dioxide  
TIS – Technological Innovation System  
UNFCCC – United Nations Framework Convention on Climate Change  
USDA – United States Department of Agriculture  
WSP – Winter Supplement Program  
WWF – World Wildlife Federation  
WWT – Waste Water Treatment



# **1 Biomass as a Renewable Energy Source**

The use of fossil fuels and its consequential release of CO<sub>2</sub> is the biggest contributor to anthropogenic greenhouse gas (GHG) emissions (IPCC, 2007). GHG exacerbate climate change and thus, require swift global actions to curb their emissions. The largest user of fossil fuels and thus, the main emitter of CO<sub>2</sub> is the energy sector (IPCC, 2007). Therefore, one of the main approaches to mitigate climate change is to provide alternatives to the way most energy is generated today.

In its latest assessment report the IPCC suggests a number of mitigation practices to be implemented in the energy sector in order to reduce the GHG emissions from that sector and in that way to decrease the sector's impact on climate. These mitigation practices include: improved energy efficiency, increased use of renewable energy sources (RES), carbon capture and storage (CSS) systems, and reduced reliance on fossil fuels (IPCC IV, 2007).

Fossil fuels are the primary source of energy used worldwide and account for close to 80% of the primary energy production in the world (EIA, 2011). In addition to their contribution to climate change, fossil fuel use has a number of other negative implications. First, fossil fuels are non-renewable which means that it takes millions of years for them to be replenished. Thus, fossil fuels are a limited resource with some projections claiming that they will be exhausted in the present century or next century depending on the fossil fuel in question (Shafiee & Topal, 2009). Second, fossil fuels and especially oil and natural gas are unevenly distributed on the planet with high concentrations in some regions; for instance, the Middle East (EIA, 2011). This implies that the security of deliveries could be threatened, which could pose a challenge to import countries' energy security. For instance, in 2009 53.9% of EU's gross energy consumption came from imported sources and this figure is expected to increase to 67.5% in 2030 (EC, 2008; Eurostat, 2011). Such issues might also cause geopolitical problems and lead to conflicts among countries (Aad & Linde, 2006). Third, concentrated control over reserves in certain regions provides opportunities for price controls on fossil fuels as historically exercised by the Organization of Petroleum Exporting Countries (OPEC). The price of fossil fuels and especially oil, has been volatile through the years (EIA, 2011). This poses problems to a country's economy due to insecure planning of energy expenses.

A solution to these challenges is to replace fossil fuels with RES for the supply of energy. This has the effect of mitigating climate change by reducing GHG. In addition, it secures independent supply of energy and increases energy security (EC, 2005). The diversification of the energy supply also reduces the price volatility that is characteristic for most fossil fuels, including coal in recent years (EIA, 2011). Moreover, since the energy is produced locally, this also provides employment opportunities for the population (EC, 2011).

RES include: the energies of the sun, wind, water, biomass, and energy stored in the Earth's crust (geothermal energy). The main forms of final energy are: electricity, thermal energy, and fuels (e.g. gasoline, diesel, natural gas). The present research focuses on the use of biomass for the production of thermal energy in Bulgaria for three reasons.

First, Bulgaria is a country which economy is in a transition from a centralized economy to a market-based one. Moreover, Bulgaria shows socio-economic similarities to both new EU member states and states on the Balkans (Freedom House, 2011). Economies in transition in Central and Eastern Europe, like Bulgaria, are also highly dependent on energy imports – on average 39% of energy use in the region is supplied through imports (World Bank, 2009; also see Section 2.1.1 and Appendix D). In addition, these countries need development in sectors such as energy, forestry, agriculture, and environmental quality. The development of national

potential for energy produced from biomass can provide solutions to these issues (Voytenko, 2012). Moreover, the case of Bulgaria in utilizing biomass products for energy generation could be considered a representative case for most Central and Eastern European countries. An example of such energy utilization of biomass is the use of pellets for heating. Pellets are cylinders six to eight mm in diameter that are produced from biomass under high temperature and pressure and that are burned in highly efficient stoves to produce thermal energy (AEBIOM, 2008). In terms of pellet market development, Bulgaria demonstrates the trends that are observed throughout Eastern Europe: low domestic demand with projections for future increase, rapidly growing domestic pellet production, and high levels of export (Sikkema et al., 2011; WIP Renewable Energies, 2009).

Second, biomass is the RES with the highest use in Bulgaria with applications mostly in the heating sector (MEET, 2011). Over the period 1997 – 2005 the use of biomass in the country has almost tripled due to increased use of biomass for heating. Mostly wooden biomass is utilized for energy purposes, but it is used in inefficient combustion units (about 50% conversion efficiency on average) and is a major cause of air pollution (MEET, 2008; EEA, 2010). In addition, despite the increase in biomass usage, about 57% of the technical biomass potential in the country has not been utilized (MEET, 2011).

Third, energy for heating and cooling represents the largest part of final energy consumption in Bulgaria – 44.1% of final energy consumption in 2005 (MEET, 2011). The strategies and action plans drafted by the MEET project that energy used for heating and cooling is expected to remain the largest use of energy in the country. In addition, the decentralized heating sector (e.g. heating in households) has been identified to have the biggest potential for energy savings and energy efficiency measures. This is due to inefficient generation of thermal energy (using electric energy to generate thermal energy) and low efficiency of installations (low conversion efficiency of installations that burn solid fuels). However, there are hardly any support mechanisms and national policies for the use of RES for heating in Bulgaria (MEET, 2011). Thus, there is considerable room for policies and support schemes that target to increase the share of RES heating, which at the same time could reduce GHG emissions and contribute to sustainable development.

Bulgaria has been an EU member since 2007 and as such needs to transpose EU legislation into national legislation and abide to EU targets. One such target is the target for RES use in individual EU countries until 2020. In order to achieve the 16% national RES target Bulgaria has to significantly and quickly increase its RES use (9.4% according to Eurostat data) because at present domestic consumption is satisfied mostly through the use of fossil fuels (NSI, 2012). As far as final energy consumption is concerned, the residential sector accounts for about 26% of this consumption. Most of this energy is used for heating. The share of the sources used for heating in households in Bulgaria for 2011 is as follows:

- Wood: 34.1%
- Electricity: 28.6%
- Coal: 23.7%
- District heating: 15.1%
- Natural gas: 2%
- Heat pumps and pellets: 0.3%

- Heating oil: 0.2% (NSI, personal communication, 17 August 2012).<sup>1</sup>

This share of RES use in Bulgaria amounts to about 1 000 ktoe; 70% of the RES energy in Bulgaria is supplied by biomass, 24% by hydro power, and 6% by other RES (MEET, 2011). The Renewable Energy Action Plan (REAP) of Bulgaria states that the country has a technical renewable energy potential of 4 500 ktoe. Out of this technical potential, the biggest share is attributed to biomass – 36% of total RES potential (MEET, 2011). Thus, biomass is the most widely used RES and also is the one with the highest technical potential. A quick calculation using the figures above reveals that there is about 920 ktoe unutilized biomass potential in Bulgaria.<sup>2</sup>

On the other hand, the use of RES for heating and cooling purposes is poorly promoted not only at national level, but also at EU level. Directive 2009/28/EC on the promotion of the use of energy from renewable sources acknowledges that “[I]nformation and training gaps, especially in the heating and cooling sector, should be removed in order to encourage the deployment of energy from renewable sources” ((49), EC, 2009). Moreover, the Bulgarian Ministry of Economy, Energy and Tourism (MEET) recognized that the support mechanisms for heating and cooling energy supplied by RES are not sufficiently developed in Bulgaria (MEET, 2011). In the case of electric energy produced from RES, there are incentives established nationally to facilitate the development of RES for the production of electric energy. For instance, these include feed-in tariffs for electricity produced from RES, guaranteed purchase of electricity, guaranteed connection to the grid, etc. There are no such incentives when it comes to heating and cooling energy produced from RES (MEET, 2011).

86% of the utilized biomass for energy in Bulgaria is used to provide thermal energy, i.e. for heating purposes (Holzforschung Austria, 2009). However, this biomass is to a large extent of low quality and burned in highly inefficient facilities, where about 60% of the heat is lost, while efficient utilization of biomass for heating occurs in only 0.3% of the population (MEET, 2011; NSI, personal communication, 17 August 2012). Therefore, there is considerable room for improved efficiency, energy and GHG savings in utilizing biomass, already inefficiently used by a large part of the population. This is why the national authorities place a high priority on promoting high-quality heating using RES as a way to reduce GHG emission and improve energy security nationally (MEET, 2011). Moreover, there are various recommendation and measures planned in the REAP to stimulate the use of modern biomass sources for heating in Bulgaria.

Particularly good modern biomass products for heating are pellets. Pellets are a solid fuel, produced from biomass by processes of milling, drying, and compacting. The final products are pellets that have high energy content and that are burned in efficient stoves (even up to 95% efficiency) and thus, provide high-quality heating, using RES (AEBIOM, 2008).

There are Bulgarian producers of pellets and some of them even produce efficient stoves where pellets could be burned. However, about 80-90% of the national pellets production is exported (Holzforschung Austria, 2009).

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<sup>1</sup> The sum of the share of sources exceeds 100% because some households use more than one heating source (e.g. electricity and wood).

<sup>2</sup> Unutilized potential = Technical potential – current usage

Unutilized potential = (36% \* 4 500) – (70% \* 1 000)=920 ktoe

Moreover, the topic of RES is a relatively new one for Bulgaria. It was not really touched upon before the country's accession to the EU. Hence, national laws, policies, and strategies are in their early stages of development. For example, the *Energy Strategy of Bulgaria till 2020* and the latest version of the *Act for Energy from Renewable Sources* were only drafted in 2011. In addition, there is insufficient research on the pellet market in Bulgaria and in other economies in transition in Central and Eastern Europe (Holzforschung Austria, 2009; Voytenko, 2012). Therefore, the present research will fill in the research gap on the topic of the development of the pellet market in Bulgaria.

## 1.1 Aim and Objectives

The present research aims to contribute to the development of the pellet market for heating in Bulgaria. The improved knowledge of the pellet market in Bulgaria could promote cooperation between market actors, utilization of existing opportunities, and increased efficiency of the market due to improved information about the actors operating in it. The research's objectives are to explore the barriers for the development of the Bulgarian market for pellets and to identify the opportunities for future market development. In doing so, the present research takes a micro perspective by analyzing the viewpoints of different market actors, instead of only considering macro aspects such as technical potential and opportunities. Through the fulfillment of the research's objectives, the present work strives to help businesses and institutions identify the barriers and opportunities for the development of the pellet market in Bulgaria and establish adequate support mechanisms for its sustainable operation. In addition, the findings from the present research could also be used when analyzing pellet markets in other economies in transition in Central and Eastern Europe.

## 1.2 Research Questions

In order to achieve the objectives outlined above, two research questions were formed; with three sub-questions attached to the second research question:

- How does the present socio-economic-political context in Bulgaria hamper the development of the domestic market for pellets?
- How can the domestic market for pellets be further developed?
  - a. What opportunities are present for the development of the domestic market for pellets?
  - b. What mechanisms and support schemes are needed for the development of the domestic market for pellets?
  - c. Which is the likely short-term direction that the development of the domestic market for pellets will take (i.e. which groups of customers will be mostly targeted by business?)?

The answer to the first research question will provide information on barriers to the development of the domestic market for pellets. Since there is a high percentage of domestically produced pellets that are exported that means that there are some barriers or unfavorable conditions for the development of the internal market that need to be investigated.

The second research question and its sub-questions will shed some light on the business' perspective on how the domestic market for pellets could be developed. Key issues to consider in developing this market are to:



- analyze what opportunities exist for the development of the domestic market for pellets. Has there been increased demand for pellets on the domestic market? Is there foreseen establishment of more favorable conditions for the development of this market?
- investigate what measures and support schemes exist or are planned to be implemented which can provide incentives for the development of the domestic market for pellets. Such measures and support schemes could play a big role in the promotion of a relatively new technology for Bulgaria such as the use of pellets for heating and could provide a strong motivation for business to develop the domestic market.
- explore, in business' view, where the development of the domestic market for pellets is likely going to evolve in the short-term and in terms of types of customers: industry, district heating networks, households, municipal buildings, etc.

### 1.3 Scope

The geographical scope of the research is Bulgaria. In terms of economic sector, the Bulgarian market for pellets will be the focus of the research. Thus, the reviewed literature is heavily skewed towards political and economic analysis of the pellet market. EU policies and examples regarding the use of pellets for heating will also be explored. The research's scope is illustrated in Figure 1-1:

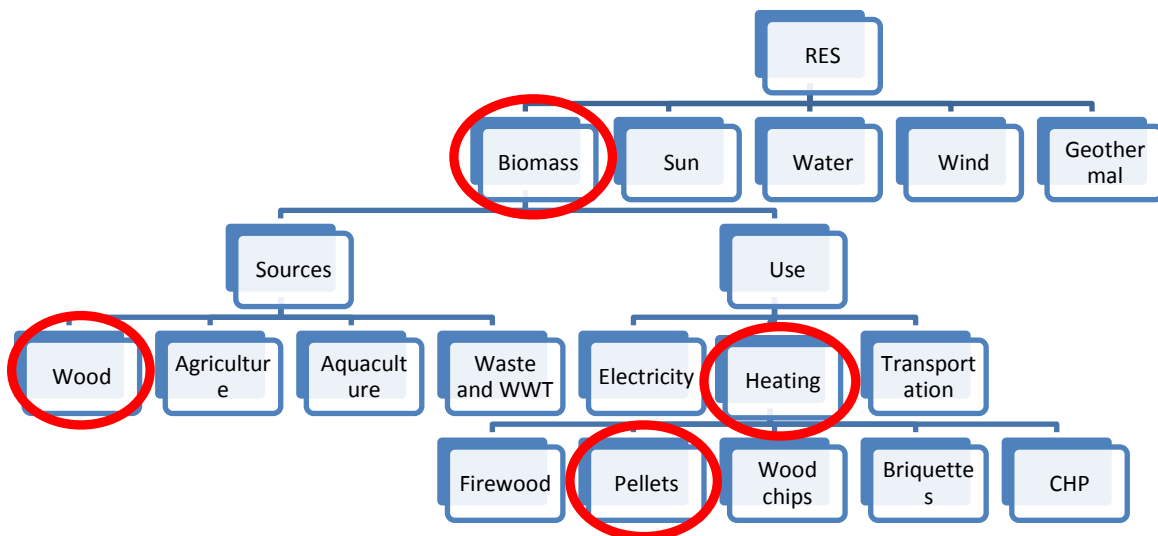


Figure 1-1. Research scope.

Source: Author

The present research does not analyze the complete set of energy services that could be provided by biomass. In addition, the research does not consider pellets that are produced from agricultural products or residues from agriculture. It is possible to produce pellets from these raw materials and there are countries (e.g. Denmark) that have a high utilization rate of this resource for the production of pellets (ECF, 2010). However, it is not appropriate to burn pellets produced from agricultural residues in small-scale, residential stoves because of the high ash content and the damage that these pellets cause to the stove. Pellets made from agricultural residues are more suitable for industrial applications and for combustion in boilers

(USDA, 2009). Hence, pellets produced from agricultural residues are excluded from the scope of this research because its goal is to consider small-scale RES heating (e.g. in households), as well.

Moreover, the research neither analyzes the Bulgarian export of pellets in detail nor the EU market in general.

## 1.4 Target Audience

The main target audiences of this research are decision-makers, followed by experts, academics, and to a lesser extent business. The present research will be of use to decision-makers and experts in the RES area and specifically to those, working in the field of biomass for heating. Their enriched knowledge could be especially useful at a time when the national RES policy is being revised and when it seems like biomass will be the RES with the most intended future use and development. In addition, the research fills in a research gap due to the lack of extensive studies in the area and hence, could improve the academic knowledge on the topic. Last, but not least, the present research will be useful for the actors in the pellet market in general as it relies heavily on information obtained from them and as it summarizes barriers and opportunities common for them.

## 1.5 Methodology

The main objectives of the research are to identify barriers and opportunities for the development of the domestic market for pellets in Bulgaria. These objectives will be achieved through:

- understanding the workings of the market for pellets (driving forces, stakeholders, logistics, raw material supply, customers, producers, etc.);
- learning about the characteristics of pellets and their use for heating;
- exploring incentives needed for the development of the domestic market for pellets;
- investigating legal, political, economic, technological, and environmental measures and support schemes that have been or are planned to be implemented for the development of the domestic market for pellets;
- understanding the progress of measures and support schemes for the development of the domestic use of biomass for heating put forward in the Bulgarian REAP;
- identifying which groups of customers use pellets for heating in Bulgaria.

### Data collection:

Data was collected through a review of relevant literature as well as interviews with key stakeholders. Reviewed data consisted mostly of policy and legal documents, strategies, and market studies. The legal framework of the EU and its transposition into Bulgarian law was considered, as well as Bulgarian energy, RES (and in particular, biomass), forestry, and climate change strategies. In addition, EU and Bulgarian market studies on the biomass market in general and the pellet market in particular were reviewed.

As far as interviews are concerned, Stakeholder theory was used for the identification of relevant stakeholders. Freeman states that a stakeholder is “any group or individual who can affect or is affected by the achievement of the organization’s objectives” (Freeman, 1984). On the basis of that definition four groups of potential interviewees were formed which represent the main stakeholders related to the pellet market. The first one consists of pellet and pellet stoves’ producers as they obviously could affect and are affected from the development of the market. The second one includes customers (people or institutions who use pellets for

heating) as they are also affected and could affect the market's development with their demands and feedback. The third group represents authorities – institutions who can affect the market development by enforcing policies, laws, and support schemes. They could also be affected by the market's development – it could help or hinder the fulfillment of targets outlined in those institutions' plans and programs. The fourth group consists of experts, NGOs, and clusters that can affect the development of the market for pellets by being outspoken, by educating the general public and by influencing the decision-making process. Interviews were conducted in person or over the phone. Two personal communications were conducted over e-mail and one interview over Skype.

For each stakeholder group there were a set of questions that were asked to all the interviewees from the particular stakeholder group. The questions were based on the building blocks of the PESTLE framework of analysis and on the informational needs of the research due to the fact that information on various aspects of the pellet market is missing in Bulgaria. Often, other questions emerged during the interviews themselves.

Overall, 21 representatives from these stakeholder groups were interviewed (for a list of interviewees, see Appendix II). The largest numbers of interviews (nine) were conducted with the Business stakeholder group as the present research aims to analyze the pellet market mostly from a business perspective.

#### Limitations:

Research on the development of pellet markets and on the Bulgarian market in particular, is limited. The main sources contributing to research on the topic are projects funded by the Intelligent Energy Europe program.

A significant limitation of the present research is the lack of centrally collected information on the Bulgarian pellet market such as number of domestic producers, number of implemented projects, supply chains, logistics, etc. Such information was acquired informally through interviews and personal communications and had to be verified by asking the same questions to different stakeholders. In addition, often when information is present, it is not publicly available and it could only be obtained through personal communication.

A major concern when reviewing Bulgarian policy documents is the fact that often when calculations, estimates, and forecasts are conducted, the methodologies, assumptions, and references used are not articulated and thus, it is hard to double-check the figures. Moreover, not all final policy documents and strategies are publicly available as it should be the case.

In addition, the topic about RES in general has been developed recently in Bulgaria; in particular in the years following the country's accession to the EU in 2007. This means that RES policies and laws are relatively new ones and most of the support schemes and mechanisms outlined in them have not been fully put into action yet.

#### Methodological frameworks:

The research uses the PESTLE framework to organize and analyze the gathered data and answer the research questions that were posed earlier.

PESTLE stands for Political, Economic, Social, Technological, Legal, and Environmental. It is difficult to establish the origin of the PESTLE framework. Some scholars track the framework's origin to the ETPS model by Francis Aguilar or later to the STEP framework by

Arnold Brown (BA Resources, 2012). The PESTLE framework is a tool to analyze the external macro environment and to draw the “big picture” a business operates in (Rapidbi, 2011). The factors that are included in the PESTLE framework are often outside of the scope of a particular business (such as laws and policies), but are nevertheless, important to take into account when analyzing any market.

The PESTLE framework sketches directions for one’s analysis. For example, the PESTLE framework structures the analysis around the political, economic, and social environments a business operates in. The framework also considers laws and regulations, as well as impact on the environment. In that sense, it is a suitable tool to use for the analysis of an emerging market such as the pellets one which is branded as a more environmentally and socially-responsible than other markets for heat energy, but one which also has to consider the political and economic context, as well as abide to/be stimulated by the existing laws and regulations.

Innovation Systems Theory was used in the analysis of findings from the literature review and the conducted interviews. In particular, the framework of Technological Innovation System (TIS) was used as the definition of TIS fits the present research and its objectives: “a network or networks of agents interacting in a specific technology area under a particular institutional infrastructure to generate, diffuse, and utilize technology.”(p. 586, Hekkert & Negro, 2009). Using pellets for heating is relatively new in Bulgaria and so could be regarded as a technological innovation. In addition, the market is developing under a specific institutional infrastructure and involves a number of agents and in that way it fits the TIS definition.

The scheme of analysis that the TIS framework suggest could be used to identify key policy issues and develop solutions to these which are key objectives of this research (Bergek et al., 2008). According to Bergek et al. (2008) there are three main steps in the analysis. The first step of the analysis involves defining the TIS in question. The second step is to identify the key actors in the system (in this case, the stakeholders identified in the interviews’ process). Finally, the third step is to construct the analysis around the functions of the TIS. There are seven main functions that describe and explain the dynamics of TIS. These are: Knowledge Development, Guidance of the Search, Entrepreneurial Activities, Resource Mobilization, Market Formation, Legitimation, and Knowledge Diffusion/External Economies (Bergek et al., 2008; Hekkert & Negro, 2009). Thus, the development of the pellet market in Bulgaria will be analyzed according to the progress made in each of these functions. This will allow the description of where the market is at the moment and at the same time the identification of actions needed to further develop it.

## 1.6 Outline

The document is structured into five main chapters. Chapter 1 introduced the issue of pellets’ utilization for heating in Bulgaria, elaborated the research’s aims and questions the study answers, and explained the scope of the study and the applied methodological frameworks of analysis. Chapter 2 summarizes the findings from the conducted literature analysis and the data obtained through interviews. Chapter 3 analyses the gathered information and data according to the TIS framework and investigates barriers to the development of the domestic market for pellets in Bulgaria. Chapter 4 discusses the findings, identifies opportunities for the future development of the domestic pellet market, and suggests changes needed to stimulate market development. Finally, Chapter 5 summarizes and concludes the most important findings of the overall process and the conducted research and provides ideas for further research on the topic.

## 2 The Bulgarian Biomass-for-Heating Sector: Current Status

The following sections summarize the reviewed literature and the findings from the conducted interviews according to the building blocks of the PESTLE framework – political, economic, social, technological, legal, and environmental aspects.

### 2.1 Political Aspects

Since the present research deals with producing energy from wood, it is important to look at policies, strategies, incentives and proposed actions to develop the pellet sector from both energy and forestry perspectives. Although, the two could often be closely connected, this is not necessarily the case. Therefore, this section will be divided into parts that consider energy and forestry policies independently. Before that, though, the case of Bulgaria as a representative case study for other Central and Eastern European countries will be established. Finally, the section concludes with an overview of civil participation in decision-making.

#### 2.1.1 Bulgaria and Other Central and Eastern European Countries

Bulgaria is a parliamentary republic that joined the EU in 2007. The political, economic, and social development of Bulgaria shows similarities with the local situations in other countries in Central and Eastern Europe (see Table 2-1 and Appendix I for explanation on the compilation of the data in the table).

Freedom House analyzed 29 countries in transition in Central and Eastern Europe and Eurasia. For the purposes of the research seven categories were used in the analysis of each country, five of them are represented in the Table 2-1 (the others are independence of media and scores of national and local government, which are aggregated in the overall democracy score). The ratings were based on a scale from 1 to 7, with 1 representing the highest level of democratic process and 7 – the lowest.

Table 2-1. Socio-economic comparison between Bulgaria and countries in the region.

Country Group	GDP per capita (USD)	Electoral Process	Civil Society	Judicial Framework and Independence	Corruption	Democracy Score
Bulgaria	13 800	1.75	2.5	3.00	4.00	3.07
New Member States (average)	20 240	1.73	1.93	2.33	3.33	2.43
Balkan countries (average)	10 557	3.54	3.00	4.43	4.68	4.07

Sources: CIA, 2011; Freedom House, 2011.

The New Member States are: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. That covers most countries in Central and Eastern Europe.

The Balkan countries are: Albania, Bosnia & Herzegovina, Croatia, Kosovo, Macedonia, Montenegro, and Serbia.

As seen in Table 2-1, the scores of Bulgaria lie in between those of the New Member States and the Balkan countries and are close to both set of countries when it comes to socio-economic characteristics.

In addition to the similar socio-economic context, Bulgaria shows common characteristics with Central and Eastern European countries with regards to energy import dependency, forested area, share of biomass in total RES use, and use of solid biomass in households (see Table 2-2 and Appendix I for explanation on the compilation of data in the table). The same grouping of countries is applied in Table 2-2 as in Table 2-1.

Table 2-2. Energy and biomass-for-energy comparison between Bulgaria and countries in the region.

Country Group	Energy imports (% of total energy use, 2009)	Forested area (% of total area, 2010)	Biomass share of total RES use, 2009 (%)	Use of solid biomass in households, 2009 (% of total use of biomass)
Bulgaria	44	36.2	91.3	88.8
New Member States (average)	39.8	39.5	82.7	71.3
Balkan countries (average)	36.4	36.1	No data	88.3

Source: IEA, 2009; World Bank, 2010, Eurostat, 2009.

As seen in Table 2-1 and Table 2-2 Bulgaria shows considerable similarities with other Central and Eastern European countries in terms of socio-economic characteristics, energy dependence on imports, biomass potential, biomass use, and biomass use in households. Based on these figures and on cultural observations, the author argues that the general context in Bulgaria is much similar to that in other Central and Eastern European countries and thus, could be used as a case for pellet market development in these other countries, as well.

## 2.1.2 Energy Policies and Strategies

The section first presents the EU context of RES and biomass policies and regulations. As an EU member, Bulgaria's national policies and strategies are established within the general EU framework of directives and targets. Following the review of relevant EU regulations, the section outlines the specific provisions for RES, biomass, and energy used for heating outlined in Bulgarian energy policies and strategies that are relevant to the present research.

### EU context:

The main document of the EU that deals with RES is Directive 2009/28/EC. According to Directive 2009/28/EC, Bulgaria must have 16% of its gross final energy consumption produced by RES by 2020 (EC, 2009). In addition, another EU directive – Directive

2006/32/EC sets targets for energy savings for EU Member States. The indicative target for Bulgaria is 9% savings from the final energy consumption in the period 2008-2016 (EC, 2006). The energy efficiency targets are voluntary, though, and they do not represent binding agreements (MOEW, 2012). Nevertheless, the presence of this energy saving target is important in the context of this study as switching to heating with pellets provides energy savings especially compared to heating on firewood, coal, heating oil, and electricity.

Directive 2009/28/EC sets a number of recommendations and requirements specifically for the use of biomass for energy purposes. Thus, it states that Member States' local and administrative bodies should encourage the use of RES for heating and cooling in the planning of cities' infrastructure; where this is appropriate (Art. 13(2), EC, 2009). The Directive defines biomass as follows:

‘biomass’ means the biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste. (Art.2, e)

In addition, the Directive states that biomass cannot be utilized from areas with high biodiversity or from natural reserves (Art. 17(3)).

To get the full environmental and economic benefit from utilizing biomass for heating, one should have a proper combustion installation. In this respect, the Directive stipulates that Member States should clearly define technical specifications of the equipment that utilizes RES in order to for this equipment to be able to benefit from support schemes. These specifications should also be in line with existing EU standards and reference systems (Art. 13(2)). Especially in the case of biomass, Member States should promote equipment with conversion efficiency of at least 85% for residential and commercial applications and 70% for industrial ones (Art. 13(6)). Directive 2005/32/EC establishes requirements for the performance of energy-using products to which biomass installations should adhere, as well (EC, 2005). There is also an EU standard (EN 303-5) for heating boilers with output of up to 500 kW. The EN 303-5 standard sets performance characteristics, design requirements and technical heating requirements (EU Standards, 2012). Moreover, by 31 December 2012 Member States should make available certification schemes for installers of small-scale biomass boilers and stoves (Art. 14(3)).

#### Bulgarian context:

The main responsibility on the Bulgarian energy policy lies with the Ministry of Economy, Energy, and Environment (MEET). The newly established Sustainable Energy Development Agency (SEDA) is a governmental body that should promote the national policies at local level, serve as a liaison between municipalities and the central government, and monitor and control RES installations. SEDA has just started been involved in activities since the beginning of 2012, so the processes of establishing an organizational structure and staff selection have not been finished yet (P. Nesheva, personal communication, 31 July 2012). The Ministry of Environment and Water (MOEW) is responsible for national environmental matters and environmental quality.

Two main policy documents, drafted in 2011, form the base of Bulgarian policy with regards to RES. These are the *Energy Strategy for the Republic of Bulgaria till 2020* (called hereafter the Energy Strategy) and the *Renewable Energy Action Plan (REAP)*.

The Energy Strategy puts forward five main priorities for the development of the Bulgarian energy sector (MEET, 2011). These are:

- Security of energy supply;
- Reaching the targets for renewable energy;
- Increase in energy efficiency;
- Development of a competitive energy market that meets the country's energy needs;
- Protection of the customers' interests.

The focus in terms of energy sources is on clean and low-emitting ones – nuclear and RES, as well as on efficient use of indigenous coal (including utilizing CCS technologies). Expansion of the use of gas is also envisioned (MEET, 2011).

The Energy Strategy considers increased production of energy from the existing nuclear power plant in Kozloduy, as well as building new capacities (MEET, 2011). However, the latter looks unlikely in the near future as the project to build a new nuclear power plant in Belene was stopped in 2012 (Dnevnik, 2012).

Coal is the energy source that is used the most in Bulgaria and that also has the most domestic reserves (MEET, 2011). The Energy Strategy places a high importance on the use of indigenous sources of coal and emphasizes that this will be done using low-emitting technologies and utilizing CCS (MEET, 2011).

Another priority for the Bulgarian energy sector's development is the expansion of the gas network. Currently gas is used mostly in industrial applications. Only 1.5% of the population has access to the gas network. The government's goal is that percentage to increase to 30% in 2020 (MEET, 2011). This could increase even more the country's energy dependence on the import of oil and gas – from 38% in 2008 to 48% in 2020 (MEET, 2011). The construction of new gas transit networks that will pass through Bulgaria is also planned in order to diversify the supply of gas; now coming from Russia only (MEET, 2011). In 2012 a moratorium on the extraction of shale gas was enforced (Trud, 2012).

The increased utilization of RES is one of the main priorities in the Energy Strategy (see Table 2-3). A higher use of RES is envisioned that will even allow the country to surpass its target of 16% energy from RES in 2020 according to Directive 2009/28/EC (MEET, 2011).



Table 2-3. Expected energy generation by RES by sectors (thousands of toe)

Indicator	2010	2012	2014	2016	2018	2020
Energy for heating and cooling <sup>3</sup>	741	794	884	956	985	1019
Electricity	332	366	468	553	576	602
Transport	30	62	99	129	62	92
TOTAL	1103	1222	1451	1638	1623	1713

Source: MEET, 2011

In order to achieve these goals and support the national government, local authorities will also play an active part in the promotion of RES not only in public buildings and in industrial plants, but also at an individual and decentralized level (MEET, 2011). A number of support mechanisms are proposed to create incentives for the development of RES. These are articulated in more detail in the REAP. The proposed support mechanisms and the concrete measures with regards to heating with biomass proposed in the REAP are summarized below. Section 2.5 reviews the legislative measures as outlined in the REAP.

#### Financial support mechanisms:

There are several existing and planned financial support mechanisms to promote the use of biomass for heating. The existing ones make use of external financing from the EU and the European Bank for Regional Development (EBRD). The EBRD provides funding for loans for energy efficiency that also allow purchase of biomass stoves (MEET, 2011). Loans for energy efficiency measures are also provided by the state Fund for Energy Efficiency (MEET, 2011). Other existing sources of funding for biomass heating projects are the Operational Programmes “Development of Rural Regions” and “Regional Development”, funded by the EU (MEET, 2011). These programmes provide funding in infrastructure and equipment in rural regions, including funding for utilizing RES for heating. Funds from the European Plan for Economic Recovery (EPER) are also available which include funding for RES projects and specifically projects on biomass (MEET, 2011). EPER could provide up to 35% funding for projects. This funding could be increased by 10%, though, in few cases; one being if the project deals with energy production from biomass (MEET, 2011).

Moreover, it is institutionally recognized that the upfront investment for the use of biomass for heating (i.e. purchasing the proper stove) is a major barrier for the development of the resource. Therefore, there is political inclination for the introduction of support schemes and mechanisms to remove this barrier. For instance, the activities covered by the Fund for Energy Efficiency are planned to be expanded and the fund to be renamed into the Fund for Energy Efficiency and Renewable Energy to reflect that development (MEET, 2011).

Proposed measures in the REAP aim to promote small-scale systems for the production of RES heat in households, public buildings, and industry by providing financial incentives (MEET, 2011). The types of financial incentives are not clearly articulated, however.

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<sup>3</sup> Refers to centralized generation of energy for heating and cooling.

Another measure targets small-scale district heating systems that use RES. Financial incentives for the establishment of such systems are envisioned in the REAP. These incentives include subsidies for the equipment purchase and low-interest loans (MEET, 2011).

The last financial support mechanism outlined in the REAP suggests tax reliefs for households who use RES for heating. These include no increase on property taxes for five to ten years after the energy efficiency measures have been implemented or reduction on income taxes when an efficient biomass stove has been purchased (MEET, 2011).

#### Information and administrative mechanisms:

One of the key responsibilities of the newly established governmental body SEDA is to promote the use of RES for heating. Informational campaigns about the benefits of using RES for heating and of energy efficiency in general are planned. In addition, the REAP proposes rules for the use of cost-benefit analysis to be established which internalize external costs (pollution, resource scarcity, etc.). These rules have to be jointly outlined by MEET and SEDA (MEET, 2011).

### **2.1.3 Forest Strategy**

The Bulgarian forest policy is relevant because it could ensure secure and sustainable supply of biomass for the energy sector. A recent study by the EBRD concluded that the lack of development in the biomass energy sector in Bulgaria is due to:

- Lack of active state policy promoting that development;
- Risks related to obtaining the raw material;
- Unregulated logging. (EBRD, 2012).

The forestry sector in Bulgaria falls under the responsibilities of the Ministry of Agriculture and Food (MAF). The body within MAF that deals explicitly with forests is the Executive Forestry Agency (EFA). EFA manages the state-owned forests (76% of all forests) and the municipally-owned ones (11% of all forests), as well as regulates private forests (13% of all forests) (V. Chakarov, personal communication, 3 August 2012).

Recently EFA underwent a structural reform. Now EFA is split into two parts – a commercial and an administrative branch. Six Forest Enterprises form the commercial part that deal with the sale of wood from state-owned forests, the management of the forests, and the setting-up of auctions for the sale of wood. The administrative branch acts as EFA's control body. There are 26 regional branches of EFA that control the management of forests in their respective regions. The most effective tool for control of the forestry sector that EFA possesses is that EFA approves the management plans of state-owned and municipally-owned forests and makes sure that they abide to the law. These management plans stipulate how the forest is used, how much will be harvested each year, how much will be replanted, etc. (T. Tzenov, personal communication, 3 August 2012).

The *National Strategy for Sustainable Development of the Forestry Sector in Bulgaria, 2006-2015* is the most recent policy document that outlines a vision for the development of the Bulgarian forests. It analyses the current state of the forests, as well future actions to ensure the forests' sustainable development. Section 2.4 summarizes the technical aspects (such as yield, growth, expected use, etc.) that are included in the strategy. The main highlights of the strategy that concern the use of wood biomass for energy purposes are briefly presented below.

Promotion of the use of wood biomass for energy purposes is one of the planned activities in the forestry sector (EFA, 2006). These include not only the establishment of capacities for processing of wood for energy purposes, but also the harvest of wood for energy purposes from plantations grown specifically for energy use (EFA, 2006).

In addition, a specific goal for the certification of sustainable management of forests (e.g. FSC certification or other) is put forward in the strategy. At least 30% of Bulgarian forests should be certified by 2015 and there are planned financial incentives for the certification of forests (EFA, 2006; MOEW, 2012). With respect to sustainable management of forests, a legislative guarantee for the management of private forests through independent experts has been suggested (EFA, 2006).

Other actions proposed in the strategy that directly influence the biomass energy sector are: reform of the policy of allocation of wood for use by the general population and tightened control over the trade and harvest of wood from forests (EFA, 2006). These propositions are expected to be included as amendments in the Forest Act in 2012.

#### **2.1.4 Participation of the Civil Sector in Policy-Making**

The participation of the civil sector in policy-making is an important indicator of the democratic process in a country. It can also suggest whether policies are popular or not and whether they have been widely discussed with actors across sectors or not (Depoe, S., Delicath, J. & Elsenbeer, M., 2004; Renn et al., 1993). Thus, the presumption is that if the civil sector had direct involvement in the policy-making process, then the subsequent policy would be more widely accepted and would be recognized as one that had been broadly discussed and transparently put in place. This is especially true for countries in Central and Eastern Europe where public participation in decision-making is a new phenomenon, but which nevertheless, has been shown to have a significant impact on decisions related to the environment (Richardson, T., Dusik, J. & Jindrova, P., 1998).

In general, there is a consultative process in Bulgaria before policies, strategies, and laws are drafted that involves NGOs. However, the demands of NGOs are often not taken into account or further discussed. Working on the national level is reported to be a difficult task, especially if one is not part of a network and does not have good contacts. An additional problem is that a strategy or an action plan has no authors and hence, it is hard to address one's comments and recommendations to someone. Nevertheless, recently there has been improvement in NGOs' participation in decision-making. The latest examples are the role of NGOs in amending the Forest Act and in drafting the Bulgarian Energy Strategy as well as the National Action Plan on Climate Change. Moreover, the environmental movement could be regarded as the best developed civil movement in Bulgaria (G. Stefanov, personal communication, 13 August 2012).

In general, the NGOs that work in the RES field in Bulgaria are fewer than the nature-preservation NGOs. The latter have to often fight against big RES projects that threaten the existence of some species and hence, there could be some initial doubt among nature-preservation NGOs when it comes to RES projects. Overall, though, all NGOs are in favor of RES provided that such projects are implemented in a sustainable way (G. Stefanov, personal communication, 19 August 2012).

## 2.2 Economic Aspects

This sub-section addresses the economic aspects of energy and forestry independently. The pellet market is at the intersection of the markets of energy and forest products and thus, is influenced by both of them. In addition to the reviews of the energy and forestry sector, a market overview of the biomass sector is presented in this sub-section.

### 2.2.1 Role of Energy in the Economy

The energy sector is one of the leading branches of Bulgarian economy (18.2% of GDP), including its contribution from foreign trade of energy (22% of Bulgaria's trade flow) (Donchev, 2004; MEET, 2011; CSD, 2010). A measure of how energy is used within a country is the energy intensiveness of GDP. The energy intensity of Bulgarian GDP is 89% higher compared to the EU average accounting for purchasing power parity (MEET, 2011). One of the objectives of the Bulgarian Energy Strategy is to reduce the energy intensiveness of GDP by 50% until 2020 (MEET, 2011). The planned investments in the energy sector until 2020 are 6.1 mil BGN<sup>4</sup>, which represents 2.9% of the total investments in the economy for the whole period. These investments also aim to reduce the level of GHG from the energy sector at the price of 97.4 BGN/t (MOEW, 2012). Compared to other economic sectors, the energy sector's abatement cost is the third lowest sectorial abatement costs among seven considered economic sectors (MOEW, 2012). This fact provides opportunities for GHG emission reductions in the energy sector at a reasonable cost compared to abatement costs in other economic sectors.

Another characteristic of the Bulgarian energy sector is the high dependence on energy resource imports. In 2008 Bulgaria met 76% of its energy demands through imports of mostly crude oil, natural gas, and nuclear fuel from Russia (MEET, 2011).

As far as heating is concerned, the use of firewood is the predominant energy source used for heating in the country (MEET, 2011; NSI, 2012). Its use is based on traditions, low prices, accessibility, and low control on logging (Holzforschung Austria, 2009). The use of wood for heating has grown more than three times in absolute terms in the last eight years and now about 35% of heat demand in Bulgaria is supplied by wood (EFA, 2006; NSI, 2012). Wood is mostly used in households in the rural areas for a number of reasons. First, it is relatively easy to access and it represents a traditional use of a local resource. Second, it is a cheap source (sometimes free) for heating which use is also caused by the low incomes of the rural households. Third, rural areas have poor connections to district heating networks and gas distribution networks (REHES, 2007). In general, it has been estimated that around 1 million Bulgarian households (out of 3 005 589 households in total (NSI, 2011)) use unprocessed wood for heating (MEET, 2011).

### 2.2.2 Role of Forestry in the Economy

36% of Bulgaria's land area is covered by forests, which accounts for 3.4 mil ha. The wood reserves from these forests in 2004 were 598 mil m<sup>3</sup> with annual growth of 14.5 mil m<sup>3</sup> (EFA, 2006). According to the National Forestry Strategy the forested area is expected to increase even further due to the development of the biomass sector and the cultivation of new forested areas (EFA, 2006). About 80% of the forests are state-owned; the remaining 20% are municipal (10%) and private forests (10%). Private forests are mostly of small area, not bigger than 50 ha (EFA, 2006).

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<sup>4</sup> 1 BGN = 0.51 EUR (fixed exchange rate of the Bulgarian National Bank)

Around 35 000 people are employed in the forestry sector (EFA, 2006). The contribution of the forestry sector to the national GDP is rather small – 2.2 % (EFA, 2006). Most types of production that utilizes wood are performed in Bulgaria. The prevailing number of enterprises is small and medium enterprises (EFA, 2006). Bulgaria is also an exporter of wood. For instance, about 10% of the harvested wood in Bulgaria is exported, mainly to Turkey and Greece (V. Chakarov, personal communication, 3 August 2012).

### **2.2.3 Pellet Market**

Today biomass accounts for about two thirds of the RES used in the EU and the ECF considers biomass as a proven, but underdeveloped RES. This is so because there is a large potential for the utilization of available biomass resources and also of ones that have not been significantly used up until now such as forest residues (ECF, 2010). Moreover, there is a considerable potential in increasing the amounts of utilized biomass through the use of agricultural by-products and through the cultivation of energy crops or fast-growing plantations (EC, 2005; MEET, 2008; Voytenko, 2012). The efficiency of biomass utilization could also be improved as at present in many countries in Central and Eastern Europe, biomass is used in inefficient installations (MEET, 2011; WIP Renewable Energies, 2009). Therefore, it has been estimated that there is a substantial cost improvement potential (15 to 40%) in using biomass for energy (ECF, 2010).

Even without this cost improvement, biomass in the form of pellets could already be competitive with other sources used for heating on the market. In August 2008 the cost of wood pellets on average in EU was 60% less than that of heating oil (AEBIOM, 2008). It should be noted, though, that oil prices were high in 2008 and that they are prone to considerable volatility in prices (EIA, 2011). In this respect heating with pellets could also reduce the uncertainties in yearly expenditures when using heating oil, for instance. However, the upfront cost for buying the equipment to burn pellets is high and represents a market barrier (AEBIOM, 2008). Nevertheless, if costs are calculated per unit of energy and when the efficiency of the equipment is taken into account, heating with pellets could be cheaper than heating with electricity, oil, and natural gas.

#### Production of pellets

The oldest producer of pellets in Bulgaria – Erato – started producing pellets in 1998 (N. Vangelov, personal communication, 30 August 2012). The rest of the pellet producers interviewed started producing pellets around 2006 and later.

It is hard to say exactly how many pellet producers (both companies whose sole activity is pellet production and companies where pellet production is a complementary business activity) operate in Bulgaria. Few years ago there were about 17 producers of pellets, now their number has at least doubled with new ones constantly entering the market (G. Mihov, personal communication, 6 August 2012). The latest data suggests that there are over 40 pellet producers in Bulgaria (N. Vangelov, personal communication, 30 August 2012).

The production capacities of different companies in Bulgaria vary. The company with the highest production capacity and highest actual production is Ahira that produces 2 t/hr and produced 11 700 t in 2011 (G. Mihov, personal communication, 6 August 2012). Production levels of the other interviewed pellet manufacturers were much lower around 1 000 – 2 000 t/yr. The views on the total production capacities in Bulgaria and the actual production also vary. Different interviewees claimed that the installed capacity in Bulgaria is 200 000 – 500 000 t/yr, whereas actual production is 80 000 – 150 000 t/yr.

### Cost competitiveness of pellets

The table below shows average heating costs for one month (31 days) for an 80 m<sup>2</sup> apartment in Bulgaria (200 m<sup>3</sup> volume) with average working time of the heating unit of 8 hours and daily load of 8 kW<sup>5</sup> (see Table 2-3).

Table 2-4. Comparison of heating costs by source

Fuel	Calorific value (kWh/kg)	Conversion efficiency of stove (%)	Fuel price	Specific price of heat (BGN/kWh)	Heating costs for 1 month (BGN)
Lignite coal	3.72	70	150 BGN/t	0.058	157.1
Firewood	3.14	70	145.28 BGN/t	0.066	180.3
Electricity	1 kWh	99	0.171 BGN/kWh	0.172	470.6
Natural gas	9.01 kWh/m <sup>3</sup>	90	804 BGN/1000nm <sup>3</sup>	0.099	270.5
Propane-butane	12.8	90	2,101.56 BGN/t	0.182	497.5
Diesel	11.63	88	2,057.41 BGN/t	0.201	548.4
Heating oil	10.98	88	1,900.29 BGN/t	0.197	536.6
Wood pellets	4.88	88	380.05 BGN/t	0.088	241.2

Source: Adapted from Erato, 2011 & Technowood, 2012.

Table 2-4 shows that immediately after coal and firewood, pellets are the cheapest heating fuel<sup>6</sup>. Coal and wood, however, have a number of drawbacks such as mechanical work to supply the fuel and to clean the stove, odor, ash, and emissions. It must also be noted that the figures provided in the table might differ in other sources. For instance, a number of sources state that the average efficiency of coal and firewood stoves in Bulgaria is 40-50% (MEET, 2011; Holzforschung Austria, 2009), whereas the figure of 70% is used in the table above. Other sources also suggest that the efficiency of pellet stoves can reach 95%, compared with the 88% used in the calculations above (AEBIOM, 2008; ECF, 2010). In addition, pellet prices could also be lower – 360 BGN/t). Taking all these considerations into account, heating with pellets could come out even cheaper than it is represented in the table. The figure in the table should thus, be regarded as a conservative cost estimate for heating with wood pellets.

<sup>5</sup> The figures represent average prices for Bulgaria with the assumption that the building has no thermal insulation.

<sup>6</sup> Prices for district heating vary among municipalities and are also quite volatile with changes every heating season. For 2012, prices of district heating are 0.08-0.1 BGN/kWh (SEWRC, 2012c).

Production costs

The biggest expenses in producing pellets are the supply of raw material and the energy costs for grinding, pelletisation, cooling (and drying if needed) (see Figure 2-1) (E.V.A., 2002).

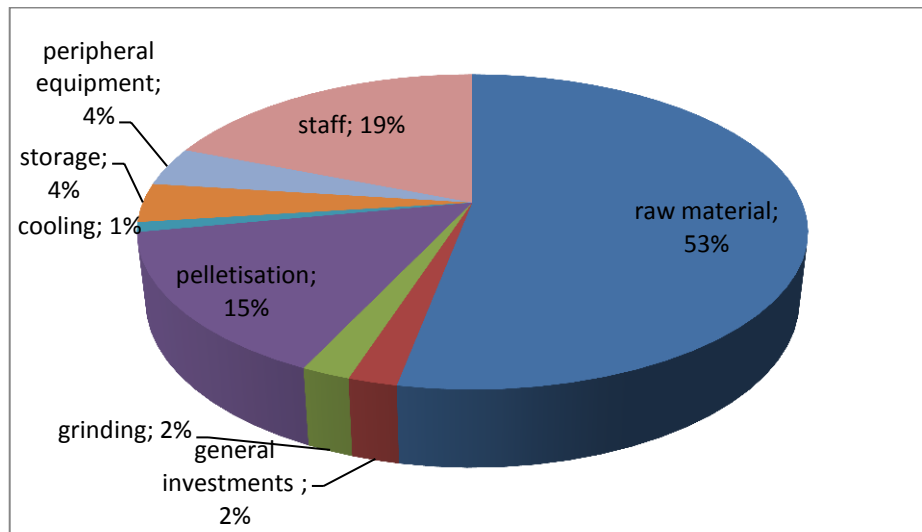


Figure 2-1. Shares of production costs for pellets.

Source: E.V.A., 200

Securing the raw material is the biggest expense in producing pellets and accounts for about 50% of the overall costs (G. Mihov, personal communication, 6 August 2012). As far as energy costs (including grinding, cooling, pelletisation) are concerned, the energy costs for the production of 100-130 t of pellets are about 3 000 BGN (V. Stoilov, personal communication, 25 July 2012).

Supply chains

In the case of wood pellets the general structure of the supply chain begins with the harvest of wood and forest residues (sometimes also residues from industry such as the furniture industry). The raw material is then transported to a production facility to be turned into pellets. The pellets from the production facility are then sold to resellers, residential users, public buildings, industry or CHP (EBRD, 2012).

The only study about supply chains in Bulgaria was performed by the EBRD. The EBRD study (2012) modeled the supply chain costs for sawmilling residues to pellet export in Bulgaria based on data from Western Europe. These calculations were based on a bottom-up approach which took into account technology, staff costs, energy costs and biomass prices. The known costs from Western Europe were then applied to the Bulgarian context. The technological costs were the actual costs in Western Europe, whereas staff costs, energy costs, and biomass prices were the ones observed in Bulgaria. In that way the application of the model provided the theoretical supply chains costs in Bulgaria (EBRD, 2012). The theoretical supply chains costs in Bulgaria estimated using the Western model are presented in Table 2-5 below.

Table 2-5. Supply chain sawmilling residues to pellet export – actual Western costs compared to Bulgarian local costs.

Model type	Unit	Supply Chain Segments				Total
		Obtaining sawing residues	Transport	Pelletising & Storing	Ship loading	
Actual Western costs	BGN/t	127.13	8.78	129.16	7.39	272.45
	BGN/MWh	26.48	1.82	26.91	1.55	56.76
Theoretical Bulgarian costs	BGN/t	19.56	6.73	56.31	6.53	89.13
	BGN/MWh	4.07	1.41	11.73	1.37	18.56

Source: EBRD, 2012.

As seen from Table 2-5, the costs of the supply chain segments (raw material, transportation, processes, including energy and staff costs) are lower in Bulgaria than in Western Europe. This could explain the fact that the Bulgarian pellet industry started as mostly producing pellets for export and as branches of Western European pellet producing companies (Holzforschung Austria, 2009). It is important to note, however, that an assumption made in the model is that Western technology is used in the Bulgarian supply chain, as well. This, however, might not represent reality accurately as the available technology in Bulgaria is often old and less efficient which could also affect the cost of obtaining residues and also operational costs.

#### Market for pellets:

Apart from Erato, which policy is to sell pellets at the domestic market only, just one other producer of those interviewed claimed that the manufactured pellets by his company are mostly placed on the Bulgarian market. The production of all the others (80-100% of their production) is exported to two general destinations – Italy and Greece. All the producers who export to Italy and Greece stated that the primary reason for the export to these countries is the fact that the market there is more developed than in Bulgaria. In Italy, for instance, there is high demand for pellets, but not enough local supply (G. Mihov, personal communication, 6 August 2012). Recent changes in Greece have caused a surge in the demand for pellets there, as well; namely, the fact that preferential prices for heating with heating oil were abolished in the country and most households are switching to heating with pellets because it is cheaper (V. Dichev, personal communication, 24 July 2012). In addition, some of the biggest producers, such as Ahira, have long-term contracts for export (G. Mihov, personal communication, 6 August 2012).

Nevertheless, all the interviewees claimed that demand on the Bulgarian market has soared in recent years. The demand in Bulgaria is growing every year with some producers claiming that it doubles every year; others state that the annual increase is between 10% and 30%. About 80% of the houses/buildings with newly constructed residential boiler houses utilize pellets now (V. Pashaliiski, personal communication, 1 August 2012). In addition, many places that typically sell wood and coal for heating, now also offer pellets, which is another sign of the increased demand for pellets (V. Pashaliiski, personal communication, 1 August 2012). Moreover, in 2011 there was shortage of pellets on the domestic market because of the increased demand and decreased production due to the cold winter (G. Mihov, personal communication, 6 August 2012).



This increased demand for pellets has led pellet producers to also place some of the manufactured pellets on the domestic market. The market price of pellets has also increased in recent years, but so have the prices of the other heating sources; so pellets are becoming a cost-effective heating source. The price of pellets that the interviewed producers are selling at is 320-380 BGN/t. Moreover, there are two types of pellet prices – summer and winter ones. The summer one is valid from 01.04 to 30.08, whereas the winter one runs from 01.09 to 31.03. The winter price is 20-30 BGN/t higher than the summer one, but summer pellets are of better quality due to the larger intake of sunlight (G. Mihov, personal communication, 6 August 2012).

The main groups of customers on the domestic market are: resellers, households, municipalities, hotels, and some industrial users. Some amount of pellets is sold to resellers who later sell the pellets to the final customer. This is so because resellers buy big quantities and can even buy the entire production of a factory (V. Stoilov, personal communication, 25 July 2012). It is also a good business for resellers as they add 30-60 BGN/t on the price they purchased the pellets for, which is about the amount of pure profit producers make (V. Stoilov, personal communication, 25 July 2012). Another big customer group is the household sector with demand constantly growing in this sector (G. Mihov, personal communication, 6 August 2012). Hotels and municipal buildings are other customer groups where demand is growing. The pay-back time on the investment in a municipal building (e.g. a school, a hospital) is short (even as short as one year) and many municipalities are implementing projects for heating on pellets. For instance, half of Ahira's domestic customers are municipalities with which they have contracts for the delivery of pellets for use in their buildings (G. Mihov, personal communication, 6 August 2012). Moreover, pellet use is growing in some industrial applications, as well. For example, a number of farmers started using pellets to heat their greenhouses because it is cheaper than using gas or coal (A. Angelov, personal communication, 3 August 2012; V. Pashaliiski, personal communication, 1 August 2012).

### Competition on the market

The main competitor to heating with pellets, identified by the pellet producers, is the air conditioner (AC). A number of households purchased ACs which could be used both for heating in the winter and cooling in the summer. ACs are easy to work with, require no manual work, and have low price per kWh at the moment (A. Angelov, personal communication, 3 August 2012). However, when the temperature drops below -5°C (which often happens in the winter in Bulgaria), ACs work inefficiently and consume more energy (A. Angelov, personal communication, 3 August 2012). In addition, the price of electricity is expected to rise in the future, so ACs might not be competitors in the long-term (G. Mihov, personal communication, 6 August 2012). Potential competitors in the long-term are ground source heat pumps, but their number in Bulgaria is low at present and upfront costs are high (G. Mihov, personal communication, 6 August 2012).

In terms of competition for raw material, there is not much competition from the furniture-making industry, because it uses types of wood that are not that suitable for pellet production (A. Angelov, personal communication, 3 August 2012). A potential big competitor for wood in the future could be power plants that use biomass for the production of energy (G. Mihov, personal communication, 6 August 2012).

## 2.3 Social Aspects

The development of the biomass for energy market raises important social issues that are primarily connected with the use of forest products for the generation of energy. Hence, the social challenges when developing the utilization of biomass for energy are mainly concerned with the use and preservation of forests.

Bulgarian forests play a number of important social functions:

- provide employment for the population – 35 000 people work in the forestry sector;
- provide recreational value – more than 65% of the Bulgarian population use forests for recreational purposes;
- are a source of herbs, berries, mushrooms, and other edible plants and such used in medicine;
- are a source of wood used for heating;
- provide soil protection, erosion control, and water regulation functions;
- have existence, cultural, historical, and educational values (EFA, 2006).

An important challenge when developing the harvesting of wood and forest residues is to prevent land use changes (ECF, 2010). This could happen if large forest areas are used for the cultivation of wood for energy through change of the status of the forest areas. The latter was a topic of a recent hot debate that was inspired by amendments in the Forest Act and that a number of NGOs saw as opportunities for increased and more liberal construction and harvesting of wood on forest land (WWF, 2012).

Increased harvesting of wood for energy purposes might also reduce the area available for recreation, education, and hunter-gathering activities. Therefore, the use of forests should be regulated in order to prevent land use change and in order to ensure sustainable development of Bulgarian forests.

Bulgarian forests are managed through short and long-term management plans that are approved each year by EFA (EFA, 2006). These plans are evaluated by EFA and should clearly state how the forest in question will be used, how much wood will be harvested, how much will be planted, etc. These plans serve as guarantees that forests are managed in a sustainable way.

Increased biomass utilization for energy purposes could not only cause social problems, but also provide opportunities. The activities along the supply chain for producing pellets described in the previous sub-section can create direct and indirect employment. This is especially important in poor rural areas where there are high rates of unemployment (ECF, 2010; MOEW, 2012). Direct employment opportunities could include employment in the processes of producing pellets – acquiring the raw material, processing it, transporting it, and producing pellets. Moreover, the increased utilization of biomass could also lead to indirect employment opportunities. Higher rates of biomass utilization could create a need for more infrastructure and hence opportunities for employment in the construction and transport sectors (ECF, 2010; WWF, 2012). Biomass is often used locally and could help reduce energy dependency and fuel poverty (MOEW, 2012).

The process of higher biomass utilization is hampered by low social awareness in Bulgaria about methods and technologies for efficiently converting biomass to energy (EBRD, 2012). Educational institutions still do not offer specialized courses for biomass utilization for energy

purposes. In addition, there are no national certification schemes for installers of biomass equipment (MEET, 2011).

This lack of awareness for the potentials of biomass utilization for energy purposes is further exacerbated by the lack of provision of information about the costs and benefits of using biomass for the production of energy and of using RES for energy in general (MEET, 2011). The establishment of a centralized system that provides information about the benefits of using RES, including biomass, is another main responsibility of the newly created governmental body SEDA (MEET, 2011).

Another positive effect from the increased biomass utilization is that if it is managed responsibly, it could also lead to improved health of the forests and could maintain biodiversity (WWF, 2012). These are important provisions for the fulfillment of some of the social functions of Bulgarian forests such as recreational, existence, cultural, historical, and educational values, as well as the steady provision of herbs and food for individual and medicinal uses.

One of the primary social functions of the Bulgarian forests is the provision of wood for heating and for households' needs. In addition, there are two ways in which the use of firewood for heating is stimulated – through the Winter Supplement Programme that provides financial aid to support the payment of energy bills in the winter and through the preferential harvest of wood by the local population (V. Chakarov, personal communication, 3 August 2012). The preferential harvest of wood, through which households from areas close to forests could get wood at preferential prices, is an indication of the strong tradition of using wood in households (EFA, 2006). This reduces the fuel costs of households and makes wood a natural first choice for a heating source in such areas.

The provision of wood for heating is an important social function of Bulgarian forests because, according to data from the National Statistical Institute (NSI), Bulgarian households on average spend about 14% of their annual disposable income on energy in which heating represents a big part of the expenses for energy. The NSI calculates that this figure could reach 17% and more during the winter months. In addition, the trend is the share of the disposable income spent on energy to increase; it has been increasing each year from 154 BGN/household on average in 1999 to 493 BGN/household on average in 2011, which represents a 220% increase, whereas households' annual disposable income has increased by only 118% during the same period<sup>7</sup> (NSI, 2012). This increase in the share of disposable income spent on heating presents equity issues, as well. Pensioners are much more sensitive to such increased expenses because pensions have risen by only 67% since 2004, while average salaries have risen by 120% since 2004 (NSI, 2012). Thus, the most vulnerable section of the population experiences the greatest hardships from the increase of heating costs.

In addition, households, in particular in cities with access to district heating, are also looking for alternatives to district heating (MEET, 2011). The cost of district heating at the beginning of the last heating season (October 2011) increased by 13% compared to the costs in October 2010 (NSI, 2012). One such alternative is the use of pellets for heating. Heating with pellets could be cheaper than heating with coal, gas, or electricity due to the high efficiency of the stove (V. Pashaliiski, personal communication, 1 August 2012).

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<sup>7</sup> Inflation has not been accounted for. The average inflation for the period January 1999 – December 2011 was 5.9%. Average annual disposable income per household was BGN 4416 in 1999 and BGN 9629 in 2011 (NSI, 2012).

Another alternative is using wood for heating during the winter. The considerable amount of illegal logging for firewood (see Figure 2-2 below) in Bulgarian forests pushes the cost of acquiring wood further down and thus, using wood for heating represents significant potential cost savings for households. The acts of illegal logging for firewood and illegal use of wood from forest has kept a steady, high level in recent years (EFA, 2006). A survey conducted by EFA shows that 71% of the population considers illegal logging as the most serious problem in the management of Bulgarian forests (EFA, 2006).

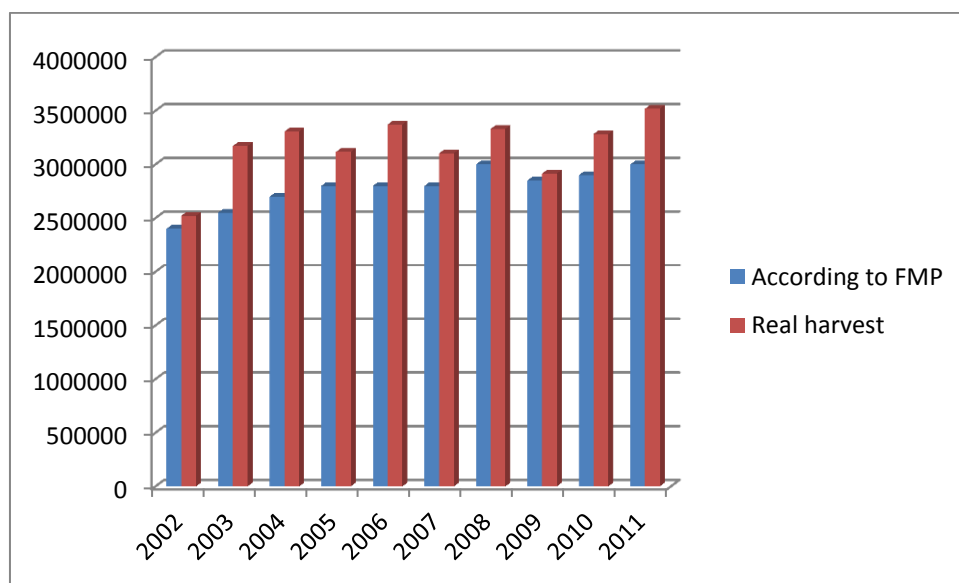


Figure 2-2. Comparison between firewood harvest (in m<sup>3</sup>) according to Forest Management Plans (FMP) and real wood harvest (2002-2011)

Source: EFA, 2012

## 2.4 Technical Aspects

The present research deals with pellets made of wood. Thus, an important aspect to look into is the technicalities of the wood supply in Bulgaria. Following that, a short overview of pellet and pellet stoves' characteristics is presented.

### Wood harvest in Bulgaria

Wood has the highest energy content per weight from all other sources of biomass (MEET, 2011). The total forested area in Bulgaria amounts to 3 651 243 ha which represent about 36% of the territory of Bulgaria (MEET, 2008). The total wood capacity of these forests is 644 mil m<sup>3</sup> standing wood with an average annual growth rate of 14.4 mil m<sup>3</sup> (MOEW, 2012). The average wood harvest in recent years, however, has been around 5.2 mil m<sup>3</sup> out of which 4.5 mil m<sup>3</sup> roundwood. Out of the harvested wood, around 72% is utilized in industry and 28% - for the needs of the local population. This use of wood is about 40% of the annual forest growth (EFA, 2006). The total amount for harvested wood and forest residues suitable for energy purposes was 3.3 mil m<sup>3</sup> in 2010 (MEET, 2011).

In addition to the fact that the harvested wood in Bulgaria is significantly below the annual forest growth, there is a large amount of unutilized wood biomass in the form of branches, twigs, and industrial wood residues. MEET (2008) calculated that there are 315 000 m<sup>3</sup>/yr

(420 000 m<sup>3</sup> in 2010) unutilized branches and twigs and 50 000 m<sup>3</sup>/yr unutilized industrial wood residues. The energy potential of these unutilized sources amounts to almost 1% of the gross final energy consumption in Bulgaria (MEET, 2008). The main barrier to the utilization of these forest products and residues is the lack of adequate technology in Bulgaria for the harvest of wood and forest residues (EBRD, 2012). Nevertheless, due to the introduction of some modern technology for the utilization of the forest residues, the rate of utilization has more than doubled in 2010 compared to 2009 levels (MEET, 2011). Nevertheless, it is not possible to collect 100% of the forest residues for two reasons: first, it is not technically possible to do so and second, because some residues and stumps have to be left to provide nutrients. It is also the practice to leave the stumps when felling trees (V. Chakarov, personal communication, 3 August 2012).

The EBRD (2012) estimates that the total potential from forest-based bioenergy in Bulgaria is 1.8 Mtoe/yr. Moreover, EFA (2006) calculated that wood harvest could reach 7 mil m<sup>3</sup>/yr by 2015 and 8.5 mil m<sup>3</sup>/yr by 2020. Plantations of new forests are included in these calculations, but the major increase comes from a better utilization of the available potential.

The main technical barriers to utilizing the full potential of wood from Bulgarian forests are:

- Old and inefficient equipment;
- Lack of drying equipment for trees;
- Insufficient road network (density of 7.9 m/ha);
- Bad condition of the existing road infrastructure, which makes it unusable for certain parts of the year. (EFA, 2006; MEET, 2008; EBRD, 2012).

All these barriers lead to unreliable supply of raw material and could hamper industrial processes that use wood such as furniture making, construction, etc. (EFA, 2006). As far as forest residues are concerned, there are lack of technologies to collect these and low stakeholder interest to utilize that resource because it is thought to be economically ineffective (MEET, 2008; EBRD, 2012). Therefore, the full utilization of the national bioenergy potential from forests depends mainly on the expansion and improvement of the road infrastructure and the acquisition of modern technology for the harvesting, collection, and processing of wood (EBRD, 2012). At present, there are 2 000 private companies and 7 000 experts registered in the public register to have the right to work in forestry, but EFA is looking into further improving the qualification of those working in the forestry sector through approved qualification schemes (T. Tzenov, personal communication, 3 August 2012).

#### Pellet production and characteristics

Pellets are a solid fuel produced from biomass (for the purposes of this research from wood biomass) by processes of milling, drying, and compacting (see Figure 2-3). Modern efficient technologies can ensure about 90% efficiency in executing these processes (AEBIOM, 2008). Pellets represent small cylinders six to eight mm in diameter which have been produced by pressing of wood under high temperature and pressure. Under these conditions, a natural tissue in the wood acts as a binding agent and thus, no glue is required in the process of pelletising (WWF, 2012). On average, pellets have the following properties:

- Humidity level of under 10%;
- Energy content – 4.7 – 4.8 MWh/t;
- Length around 2 cm;
- Diameter between 6 and 8 mm;

- Ash content between 0.9% and 1.5 % (AEBIOM, 2008; EBRD, 2012; WWF, 2012).



Figure 2-3. Pellets

Source: Author

For more detailed description of pellets' properties, see Appendix III.

The main advantages of pellets is their high density and energy content, mechanical stability, low ash content, and reduced costs for transportation and storage (AEBIOM, 2008; E.V.A, 2001). Heating with pellets also requires less manual work, is cleaner (not compared to air conditioners (AC), though), and produces less emissions (A. Angelov, personal communication 3 August 2012; V. Pashaliiski, personal communication, 1 August 2012). In terms of predictability of heating expenses, pellets could be superior in that respect because they are of a certain quality and one knows the quantity he needs for the heating season. For example, to heat a 100 m<sup>2</sup> apartment with no thermal insulation, one needs about 3.5 tons of pellets for the entire heating season, which in Bulgaria is October to April (C. Zeggio, personal communication, 27 July 2012). Moreover, heating with pellets does not require big infrastructural investments which are found in district heating and gas distribution networks (G. Mihov, personal communication, 6 August 2012).

Pellets have different quality classes that are distinguished mainly based on their energy content, humidity, and ash content (MVV Consulting, 2007). There are national certification schemes that were established long ago and that ensure the quality of pellets in countries like Germany, Austria, and Sweden. Only recently an EU standard for pellets, the EN 14961-2, had been put in place which to a large extent is modeled after the above-mentioned standards (EPC, 2011). There is no Bulgarian national standard for pellets, with most of the pellets produced in Bulgaria, meeting the German standard DIN 51731 (Holzforschung Austria, 2009). Most of the new member states have started the implementation of standards, but that process has not reached a high level yet. In general, standards are a good way to communicate the quality of a product to the consumers and to let them know what to expect from a product. Thus, in a growingly diversified market, such as the pellets one, certification of pellets could be a good tool for producers (MVV Consulting, 2007).

Most of the pellets produced in Bulgaria use wood as raw material. In addition, the wood used by the interviewed producers is coniferous wood. This is also good in terms of competition for wood from different economic sectors as broad-leaved wood is mostly used for firewood and in furniture-making (A. Angelov, personal communication, 3 August 2012). The producers get the wood from sellers and distributors of wood. Some producers have thought of using forest residues as feedstock, but the problem is that forest residues are not really collected in Bulgaria and the pellets produced from forest residues are of lower quality (G. Mihov, personal communication, 6 August 2012).

Some producers who also manufacture furniture use to a small extent the residues from the furniture-making processes, but the pellets that come out could be of lower quality compared to the ones made from unprocessed wood, depending on what types of residues are used (V. Dichev, personal communication, 24 July 2012). However, N. Vangelov from Erato, the first pellet company in Bulgaria, claims that dry shavings from the furniture-making industry is the best raw material for pellets because it is dry and pure (contains no additives or bark) and does not require additional processing (e.g. removal of bark). In addition, dry shavings are a product that cannot be utilized in furniture-making and thus, provides a good opportunity for synergies between industries. For instance, Erato obtains dry shavings from a furniture-plant with which it has an agreement with for the material (N. Vangelov, personal communication, 30 August 2012).

### Pellet stoves

There are a number of problems that could occur if the quality of pellets is compromised such as:

- Overheating of the boiler;
- Slagging of the boiler;
- Corrosion;
- Efficiency loss;
- Noise (E.V.A., 2001).

Thus, an integral part in using pellets for heating is to ensure not only the quality of the pellets themselves, but also the quality and proper operation of the stove/boiler where they are burned. As far as stoves for residential buildings are concerned, the quality of the pellets is of utmost importance. Wood pellets are of the highest quality and thus, are the ones most suitable for residential applications. Straw pellets or pellets from other agricultural products have high ash content, cause damage to the stove (clogging, slagging, etc.), and have higher emissions (especially, for pellets from sunflower seeds). Therefore, pellets produced from agricultural products are more suitable for combustion in bigger, industrial installations.

There are stoves on the market with efficiency over 85%. They are about twice as efficient as the stoves that are traditionally used, but nevertheless have a short payback time (could be as short as two or three heating seasons) due to the decreased fuel consumption (REHES, 2007). There are small pellet stoves (20 kW capacity) and big ones (above 1 000 kW capacity), but they can work in large power ranges (V. Pashaliiski, personal communication, 1 August 2012). Such stoves have been gaining popularity in Bulgaria, as well. The total installed capacity (including for municipal and industrial use) of such boilers in 2000 exceeds 200 MW (MEET, 2008).

As in the case of pellets, there is an EU standard for stoves/boilers. The EN 303-5 standard specifies the performance of such stoves and boilers and serves as a guarantee that they meet the requirements for efficient operation (REHES, 2007). New member states, including Bulgaria, are also adopting the standard. In addition to the EN 303-5 standard, all energy-using products that are placed on the EU market have to bear the “CE” marking that sets eco-design requirements for energy using products (EC, 2005).

## 2.5 Legal Aspects

This section considers Bulgarian laws, action plans, and strategies with relation to development of the RES and forestry sectors. As far as pellets in particular are concerned, there is an interesting debate within MOEW about the status of pellets. At the core of the debate is the question whether pellets are “recycled products” or “utilized waste” since they can be produced from forest and agricultural residues (A. Peychev, personal communication, 26 July 2012). The outcome of this debate could have implications on the legal status of pellets and on their eligibility for getting funding from different schemes.

### Bulgarian Act for the Energy from Renewable Sources:

The latest amendment of the Bulgarian Act for the Energy from Renewable Source (AERS) entered into force on 3 May 2011 and in this sense is a relatively new law. One of the main objectives of the AERS is to create incentives for the inclusion of energy from RES for heating and cooling in the transmission grids (Art. 2(1), 4). This will be executed through the introduction of support schemes for the production of heating and cooling energy from RES; in particular, local and executive authorities have the responsibility to initiate such schemes (Art. 2(2), 1, 3). The newly established SEDA has been appointed as the governmental institution that governs the national policy on promoting the use of RES for heating (Art. 7(1)).

The use of RES for heating will be promoted through:

- Support for construction of local district heating networks (Art. 18(3), 1);
- Support for the construction of decentralized systems for the production of energy for heating (Art. 18(3), 2);
- Inclusion of RES installations that produce thermal energy into distribution networks and purchase of the produced energy (Art. 18(3), 3).

When it comes to biomass, the AERS defines “biomass” in the same way as Directive 2009/28/EC discussed earlier does. Moreover, when designed, the support schemes for the use of biomass for heating have to be tied to the use of efficient technologies (Art. 17, 2). There has been some development in the types of biomass eligible to benefit from feed-in tariffs. In 2009 only three types of biomass could benefit from feed-in tariffs, whereas in 2011 there were 21 eligible biomass categories, including animal and agricultural by-products (MEET, 2011).

In addition, the AERS stipulates that new buildings and newly renovated ones should make use of RES for heating whenever this is technically and economically possible (Art. 20(1)). When such sources are utilized at a building level, their share has to be at least 15% of the total demand for heating and cooling (Art. 20(2)). This could be achieved through local district heating on biomass or geothermal energy or with biomass installations with at least 85% efficiency for residential and commercial applications and 70% for industrial ones (Art. 20(2), 1, 2). However, at the moment there is no way to monitor and enforce that. In the future, this



could be done through the planned technical and energy efficiency audits of buildings that will be mandatory for all buildings. Moreover, there are no penalties put forward in the law if this percentage is not reached (A. Dimitrova, personal communication, 8 August 2012).

In addition, the Act for Local Taxes provides tax reliefs for three to ten years for owners of buildings, built before 1 January 2005 and having certificates for energy efficiency classes A or B. Owners of class A buildings who have, in addition to the energy efficiency measures, adopted RES sources at the building scale qualify for the maximum tax relief of ten years. Owners of class B buildings who have implemented both energy efficiency and RES measures qualify for the maximum tax relief period of five years (MEET, 2011). The municipalities, though, are not in favor of that measure because it decreases their tax income (V. Ilieva, personal communication, 8 August 2012).

Another planned measure to promote the use of RES for heating is the set-up of a National information system for the potential and production of energy from RES (Art. 7). SEDA is responsible for the set-up, maintenance, and update of this system (Art. 52(1)). The goal of this system is to compile information about RES potential and use in Bulgaria in one place so that it is easier to track progress and make strategic decisions.

#### National energy strategies and RES action plans:

The two main strategy documents when it comes to use of RES are the *Energy Strategy of Bulgaria till 2020* and the *Renewable Energy Action Plan*. They outline the current state in terms of RES use and propose measures to increase the share of RES in the energy mix of the country.

At present various administrative support mechanisms are provided for producers of electricity from RES. These include: priority connection to the grid, guaranteed purchase of electricity, credit incentives, feed-in tariffs, and relieved administrative procedures (MEET, 2011). The Energy Strategy acknowledges that these support mechanisms are targeted at the production of electricity from RES, whereas there are no such support mechanisms for the generation of heat by RES (MEET, 2011).

The reason why there are no feed-in tariffs for the generation of RES heating, as it is with electricity is that it is hard to establish such schemes for centralized generation of RES heat. The reason is that someone has to consume the generated heat, but households can choose other heating sources – wood, coal, electricity, gas, etc. In this respect, the market for heating is more decentralized than the one for electricity and it is hard to establish feed-in tariffs for centralized RES generation of heating because there is no guarantee that someone will consume the generated heat. There is also no universal distribution network as is the case with electricity (A. Dimitrova, personal communication, 8 August 2012).

It should be noted that most of the legal requirements and specific RES targets can be found at the municipal level. A new development in the policy area is the expected drafting of a Climate Change law. A central part of this law will be the presumption that individual municipalities must act on climate change mitigation (G. Stefanov, personal communication, 13 August 2012).

In addition, each municipal building within a municipality has an individual energy saving target that should be reached until 2016 (P. Nesheva, personal communication, 31 July 2012). Thus, each municipality should submit a yearly report on the state of each municipal building and what has been implemented in terms of energy efficiency and RES use. However, SEDA has not received the full informational package from municipalities because the ordinance that mandates the submission of these reports by municipalities has not been enforced yet (P.

Nesheva, personal communication, 31 July 2012). At present reports are needed for municipal buildings with area above 1 000 m<sup>2</sup>, but starting in 2012 reports will be required for municipal buildings with area above 500 m<sup>2</sup> and later – above 250 m<sup>2</sup>. Individual RES targets for municipal buildings like the ones for energy efficiency have not been put in place yet (P. Nesheva, personal communication, 31 July 2012). Moreover, some funding for municipal projects is tied with requirements for energy efficiency and RES use (A. Dimitrova, personal communication, 8 August 2012).

Other proposed regulatory mechanisms in the Energy Strategy to promote RES heating are: adoption of minimum requirements for efficiency of domestic heating appliances, as well as certification of installers of solar-thermal and biomass installations so that the quality of the installations could be ensured. In addition, the Action Plan on Climate Change envisions introduction of RES, mainly biomass, in district heating networks with the share of RES in these networks reaching 10% of the generated thermal energy in 2020 (MOEW, 2012).

A planned measure in the REAP is to switch the use of fuel oil and electricity for heating in public buildings with biomass or other types of RES heating. It is the responsibility of the SEDA to develop plans for the introduction of biomass for heating in all public buildings until 2020 (MEET, 2011).

Another measure to increase the share of RES for heating is the requirement for new buildings to mandatory use some RES sources for heating (MEET, 2011). This measure is planned and has not been initiated yet. Another planned measure with respect to RES use in buildings proposes that all existing renovated buildings should get at least 15% of their energy from RES (MEET, 2011). These minimum levels for use of RES in renovated buildings should be enforced from:

- 1 January 2012 for public buildings;
- 31 December 2014 for the rest of the buildings (MEET, 2011).

A proposed measure in the REAP that aims to promote the use of RES for heating is to increase the share of modern biomass (woodchips, pellets, briquettes) in the so-called social aid for heating (MEET, 2011). The social aid for heating represents financial support to low-income households so that they can afford thermal comfort during the winter. The financial support is given out either in the form of contributions directly to energy bills or through vouchers for the purchase of wood and/or coal (MLSP, 2008). The proposed measure is planned and strives to reduce the financial aid for wood and coal and instead provide aid for modern sources of biomass (MEET, 2011).

In terms of certification of installers of biomass installations and of the installations themselves, there are two measures that are planned and that are outlined in the REAP. The first one establishes a scheme for professional certification of installers of biomass installations; including such used in households (such scheme is non-existent at present). This will be the responsibility of the State Agency for Meteorological and Technical Control for RES Installations. The companies that install biomass installations will be monitored every two years. The qualification scheme will be run by the Ministry of Education, Youth, and Science. The ordinance that should set the procedures for the qualification scheme should have been enforced by 10.06.2012 and the scheme has to be proposed in its final form until 31.12.2012 (P. Nesheva, personal communication, 31 July 2012). The ordinance, however, has not been issued yet.

The second measure regarding biomass installations strives to create norms and certifications procedures for biomass installations in order to guarantee minimum levels of efficiency and performance of the installations (MEET, 2011). The proposed efficiency levels for the biomass installations are at least 85% for residential and commercial applications and at least 70% for industrial ones (MEET, 2011).

#### Bulgarian Forest Act:

The latest revision of the Forest Act entered into force on 9 April 2011 with the latest amendments dating from 18 May 2012. The act is still being hotly debated and new amendments are expected to be put in place (WWF, 2012).

Important aspects in the Forest Act for the current topic of the development of the pellet market in Bulgaria are the ways wood is traded according to the law. The annual use of state and municipally-owned forests (altogether almost 90% of Bulgarian forests) is approved by the regional EFA branch according to the submitted forest management plans for each forest plot (MAF, 1998). Each plot of state-owned or municipally-owned forest with area above 1 500 ha must submit a forest management plan. These are long-term (ten-year) as well as annual forest management plans. State-owned and municipally-owned forests with area less than 1 500 ha must be managed by a management company (V. Chakarov, personal communication, 3 August 2012). Management companies sometimes manage bigger state and municipally-owned forests, as well. Private companies or persons involved in activities in forests (regardless of the forest's ownership) have to be registered in a public register. This is a way to ensure that these private companies and people have the right qualifications because according to the law the people working in the forestry sector have to be qualified; and in the case of employees of private companies, this is an obligation of the private companies for which they work.

The use of wood from state or municipally-owned forests is conducted in two ways: through sale of standing wood or through harvest and sale of wood (Art. 112(1)). In any case, the sale of wood is conducted through auctions (MAF, 1998). The auctions are not held at particular dates each year, but are spread out through the year. The procedures for the auctions are stipulated in the Law for Public Tenders. There are some requirements for the participation in the auctions, but these are not overly restrictive and almost anyone could participate. These auctions are led by the Forest Enterprises if the wood for sale comes from a state-owned forest and by a municipality's trade structure if the wood is from municipality-owned forest. There is no regulated starting price for wood. Each enterprise sets the starting price for the auction. The auctions could be by types of wood, for standing wood, for part of the wood harvest from one enterprise or the wood harvested in several enterprises combined, etc. These are defined by the enterprise or the seller. The ways in which wood from privately-owned forests is utilized is defined by the forest owners (Art. 112(2)).

The Forest Act also allows the state Forest Enterprises that manage state-owned forests as well as municipalities that own forests to provide one third of the harvested wood to local traders of wood as long as these traders are situated and operate on the territory of the Forest Enterprise or municipality in question (Art. 115(1)). In addition, Forest Enterprises and municipalities that own forests can sign contracts for the harvest and sale of wood for up to 15 years (Art. 116(1)). There are also provisions for signing contracts for the rent of state or municipally-owned forests for a period of up to 30 years (MEET, 2011). The purpose of these provisions are to provide incentives for private companies that harvest wood to invest in efficient technology, develop infrastructure, and train their employees (MEET, 2011). The maximum amount of wood that can be contracted long-term is either one fourth of the annual

use of the Forest Enterprise in question or one third of the annual use of the municipality in question (Art. 116(3)).

At present, forest certification in Bulgaria is voluntary (Art. 20). However, as seen in Section 2.1 the *National Strategy for Sustainable Development of the Forestry Sector in Bulgaria, 2006-2015* proposes that at least 30% of Bulgarian forests should be certified by 2015 (EFA, 2006). Moreover, plantations of tree and bush species with the purpose of accelerated production of biomass for energy are not regarded as forests (Art. 88(5)). This means that these plantations do not have to submit forest management plans, could harvest earlier, and have fewer restrictions on the management of these plantations (T. Tzenov, personal communication, 3 August 2012). In addition, a new amendment to the Forest Act would stipulate that roundwood of certain size could not be used for energy purposes (V. Chakarov, personal communication, 3 August 2012).

## 2.6 Environmental Aspects

As explained in the Introduction chapter, the combustion of fossil fuels is a major source of GHG emissions. The energy sector accounted for 40% of all GHG emissions in Bulgaria in 2008 (MEET, 2011). Out of that more than 90% of the emitted GHG are attributed to burning coal to produce electricity and thermal energy (MOEW, 2012). One of the main strategies to reduce GHG emissions is to adopt RES for the generation of energy (MEET, 2011). In the period after 1997 the use of RES in the country has been increasing with biomass contributing the most to such increase (MEET, 2008).

Biomass has a considerable potential to reduce GHG emissions compared to fossil fuels. ECF (2010) estimated that the use of biomass for heating could reduce GHG emissions compared to the fossil fuels it replaces with between 55 and 98% even when transport is accounted for and as long as biomass production does not cause land use change. This variation in estimates of GHG emission reductions when using biomass originate from potential differences in logistics, type of feedstock, and efficiency of combustion technologies (ECF, 2010). For instance, the use of tree species, represented in Bulgaria and utilized for energy purposes, have emission values along their supply chains of just 1 gCO<sub>2</sub>eq/MJ (EC, 2010).

Heated debates have been held over the sustainability of biomass and whether the use of biomass should be considered carbon-neutral as it is considered now. The issue of sustainability of biomass is dependent on factors such as: type of biomass used, production methods, geography, logistics, equipment's efficiency and environmental and social context (ECF, 2010). The European Commission (EC) is preparing a proposal for sustainability criteria for biomass which should be completed by the end of 2012. It is suggested that attempts will be made to make these standards global. As of now, however, each EU Member State deals with the issue independently (G. Stefanov, personal communication, 19 August 2012). According to D. Mladenov, there is a governmental guidance for the sustainable use of biomass (D. Mladenov, personal communication, 19 August 2012). On the other hand, I. Hinovski thinks that the sustainability of biomass could be ensured through forests' certification. In addition, sustainable forestry policies are needed similar to those drafted in some Western European countries (I. Hinovski, personal communication, 9 August 2012).

A major issue when considering the sustainability of biomass is the question whether biomass causes land use change or not. Land use change could involve changes in the plant types and density at a particular plot of land and might imply regular plowing which also releases GHG (BSPB, 2011). Thus, it might take years for the carbon debt accrued from land use change to be paid back (ECF, 2010). The main challenges in carbon accounting in instances of land use change are the calculation of the carbon debt (how much time it will take for the released

carbon from the land use change to be offset) and carbon laundering (carbon emissions that are currently not taken into account when analyzing direct and indirect land use changes) (BSPB, 2011). In addition, land use change might have a broader social impact, as well. For example, Bulgarian forests have a relatively low economic contribution to the country's GDP – 2.2% (EFA, 2006). However, they are mostly used for recreational and cultural services which are important to Bulgarian society (EBRD, 2012). Therefore, when a particular plot of land is converted for biomass utilization, this could reduce the social value of the forest.

A related issue is the potential reduction in biodiversity when a certain land area is used for biomass utilization. As in the case of land use change, this implies regular harvesting and treatment of the land so that the maximum yield of biomass could be achieved. This might lead to the elimination of certain species from the land in question which will limit its biodiversity (ECF, 2010). Moreover, some biomass utilization practices use forest residues and stumps which removal can reduce the available nutrients, cause acidification and soil erosion and thus, negatively affect biodiversity (ECF, 2010). This is the reason why many countries have established regulations that limit the amount of forest residues and stumps that could be extracted from forests (ECF, 2010). The Bulgarian Action Plan on Climate Change also proposes limits for the amount of utilized forest residues to be established (MOEW, 2012). Other regulations to ensure low environmental impact of biomass utilization include: restrictions on growing biomass on carbon-rich lands and on lands with high biodiversity and on preservation territories (EBRD, 2012). A problem in Bulgaria in that respect is that in some forest areas the wood harvest (most illegal) is higher than the annual forest growth (MOEW, 2012). On the other hand, increased biomass utilization could also promote biodiversity. For instance, better thinning practices could improve the habitat conditions for many species (ECF, 2010).

Other issues related to the sustainability of biomass that need consideration are the harvest of wood (including the origin and certification of wood) and impacts on soil (erosion, decreased soil quality) and on the water balance (BSPB, 2011; MOEW, 2012). In the case of Bulgaria, a low percentage of forests are certified (FSC) which implies that there is no independent evaluation of how sustainably forests are managed in the country (EBRD, 2012). EFA claims that 22% of forest are FSC certified (none private forest) and that EFA promotes and supports the process of forest certification (V. Chakarov, personal communication, 3 August 2012). In addition, EBRD's study (2012) concluded that the area suitable for biomass cultivation in Bulgaria is mainly affected by water erosion.

As far as pellet use for the production of thermal energy is concerned, it also has some impact on the environment. On one hand, heating with pellets can provide solutions to a number of problems such as to: alleviate climate change, improve air quality, and decrease fuel poverty (G. Stefanov, 13 August 2012). On the other, pellets are burned to produce thermal energy and as in any combustion process, this releases emissions into the atmosphere. The emission levels are highly dependent on the efficiency of the installation and the quality of the fuel (MOEW, 2012). This is why the efficiency and the proper functioning of the combustion unit are of utmost importance in the case of pellet use. The pellet combustion process emits mainly steam, CO<sub>2</sub>, CO, dust, and SO<sub>2</sub> (REHES, 2007). However, in comparison with other fuels used for the production of thermal energy, pellets have an overall lower environmental impact (see Figure 2-4) and the lowest ash content compared to other biomass-based fuels (REHES, 2007). In addition, the ash content in a ton of pellets is 88 times lower than the one in a ton of coal (WWF, 2012).

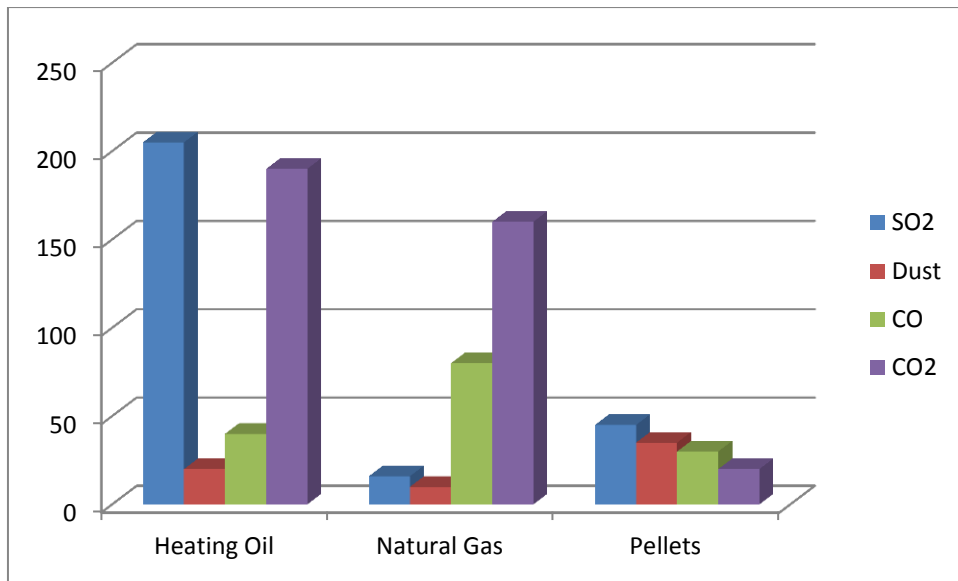


Figure 2-4. Annual emissions from the entire life cycle (kg, CO<sub>2</sub> in tonnes) per unit fuel

Source: E.V.A.

### **3 Analysis of Barriers to Pellet Market Development**

This section analyses the collected data from the literature review and the interviews using the TIS scheme of analysis. Bergek et al. (2008); Hekkert & Negro (2008), among others, characterize a TIS by seven main functions and this section describes the current status of the pellet market in Bulgaria and the barriers to its further development with regards to these seven functions.

#### **3.1 Knowledge Development**

Knowledge is integral for any TIS and is important in all cases (Hekkert & Negro, 2009). This function captures the level of existing knowledge about the TIS in question. Types of knowledge can include: technological, production, market, logistic, public, etc. (Bergek et al., 2008).

Using pellets for heating is a relatively new technology for the Bulgarian customer. There is strong tradition of heating using biomass in the country; however, the type of biomass that is mostly used is firewood. Therefore, there is low public awareness of what pellets are, what their benefits are and what the real cost of heating with pellets is. Public knowledge has been increasing in recent years as evidenced by the growth of the domestic market for pellets. Nevertheless, there are still some misconceptions about the raw material that pellets are made from, types of pellets and their application for different users, stoves needed for the burning of pellets, expenses for heating with pellets, benefits of heating with pellets, and payback time of the initial investment.

The interviewed people from the Business stakeholder group exhibited good knowledge of the manufacturing process for pellets, their stand at the market for heating, the barriers and the opportunities for the market's development. Nevertheless, there were some gaps in the knowledge level of the interviewees from the Business stakeholder group. For instance, differing views were presented on questions such as the estimated number of pellet producers in Bulgaria, the installed capacity for pellet production, and the actual production in the country. This shows the lack of sufficient data on the industry, the growing number of producers, and the limited interaction between companies in the sector (especially between small and large pellet producers). In addition, there is not sufficient understanding of the technology for producing pellets, especially by new producers. New entrants often are rushing to enter the market and are using inadequate technology to produce pellets (N. Vangelov, personal communication, 30 August 2012).

Heating on pellets is mentioned as a source of heating with substantial potential environmental benefits in all reviewed energy strategies and action plans. In addition, the interviewees from the Institutions stakeholder group expressed the opinion that it is desirable to stimulate the use of that source of heating for a number of reasons – environmental, economic, and strategic. However, the lack of information about the market and its operation is a significant barrier to the better understanding of the situation by institutions. None of the interviewed institutions knew how many pellet producers are there in Bulgaria, what their market share is or how much is produced in the country. In addition, at least five institutions (MEET, MFA, MOEW, EFA, SEDA) deal with different aspects of the biomass-for-energy sector. It is also often the case that different directorates within the same institution are responsible for various issues of the same general topic – utilization of biomass for energy. For instance, there is a directorate within MEET that deals with RES in general, but there is a different directorate within MEET that negotiates funding schemes for RES without the participation of the former directorate in the process. Thus, communication among

institutions is inefficient and further hinders knowledge building about the pellet market in Bulgaria.

### 3.2 Guidance of the Search

The development of any TIS requires market actors to enter the system. However, in order to do so there must be sufficient incentives put in place (Bergek et al., 2008). This function analyzes the incentives that are present at the moment and that can influence one's decision to enter the market. An example is a policy goal that stipulates the achievement of certain share of RES and which implies that RES projects to reach that target will be supported (Hekkert & Negro, 2009). Nevertheless, the incentives do not have to be present at the moment; they could also be envisioned or expected. Thus, expectations are also included in the analysis of this TIS function such as: growth potential of the market, technological opportunities, future regulations, and interest by customers (Bergek et al., 2008).

Bulgaria has adopted a RES target of 16% of final energy consumption by 2020. Thus, the use of RES for the generation of energy is institutionally recognized and supported. The most direct means of support are the established feed-in tariffs for the generation of energy from RES. These, however, concern mostly installations for the generation of electricity. Small-scale, decentralized heating installations are included to a lower degree.

In addition, a number of interviewees claimed that there is lack of coherent national policy with respect to RES heating and lack of state policy to stimulate pellet production. In the case of biomass-specific policies, these are mostly concerned with large projects such as CHPs on biomass and in that way heating with pellets is underprivileged at the expense of using the energy from CHPs for heating. These are projects that attract big investors, but do not necessarily solve important local issues like fuel poverty or environmental quality. Large RES projects are the ones with the highest negative impact on the environment from all RES projects and a number of them have been allowed to be implemented despite suspicions of inaccurate environmental assessments.

The main way through which RES heating is supported at an institutional level is through various legal stipulations for mandatory share of RES in new and newly renovated buildings, in municipal buildings and tax reliefs if RES projects are implemented at the building scale. The mandatory RES targets, however, are hard to enforce and monitor and do not represent a sufficient incentive for the adoption of RES technologies for heating. Another regulatory mechanism that promotes the use of pellets for heating is the proposed change in the ordinance for the Winter Supplement Program (WSP) that will limit funding for wood and coal for heating in the winter and will instead provide finances for the use of pellets and eco-briquettes. This amendment has been proposed as part of a package of measures that aims to improve air quality in cities because residential heating is a primary source of air pollution in cities. Again, this measure could prove hard to enforce as the households who benefit from the WSP are low-income ones and they are not likely to invest in a pellet-burning stove which is a prerequisite for the utilization of the full benefits from heating with pellets.

A major institutional barrier for guiding the direction in which the pellet market develops is the lack of information about pellet production, capacity, potential, market data, etc. For example, municipalities are expected to provide data about small, decentralized projects for RES heating on their territory. However, there are no people in municipalities who deal with energy efficiency and RES only because there is no capacity for that. Thus, contact between municipalities and the central government is insufficient and hinders the institutional understanding of the workings of the market, which is essential if institutions are to guide and stimulate the pellet market development.



### 3.3 Legitimation

In order to develop, a new technology needs to get recognition as a legitimate one (Hekkert & Negro, 2009). This could be an important driving force for the development of a market. Thus, describing the functional dynamics of legitimation includes analyzing both the legitimacy of the TIS according to relevant stakeholders and the activities that are needed to increase this legitimacy (Bergek et al., 2008).

Important stakeholders that can promote the legitimacy of a new technology are institutions. Heating on biomass is legitimized at an institutional level as a way to reduce GHG emission, alleviate fuel poverty, achieve energy savings, improve air quality, and stimulate local employment and use of resources. The institutions recognize pellets as an efficient fuel that is superior to heating with coal and wood on a number of characteristics. This is evidenced by the recommendations for the increased use of pellets for heating as a way to save energy, money, and reduce impact on the environment in various strategies and action plans. Moreover, the interviewees from MEEET mentioned Austria as a prime example of good national pellet utilization that provides considerable legitimation for pellets through policies, established incentives, supply chains, and logistics.

There are also EU standards for the quality of pellets. The control over the quality of pellets and hence, on the standardization of pellets in Bulgaria is low, however. Many of the Bulgarian pellet producers also certify their pellets according to German and Austrian standards because they deem that these standards are thorough, recognized, and reliable. In addition, implementing RES heating projects in buildings helps towards the certification of buildings according to an energy efficiency classes. Achieving a certain energy efficiency class can allow the owner(s) of a building to benefit from tax reliefs for the implementation of RES projects.

On the other hand, legitimacy on a social level is less universal. There are still prevailing misconceptions about the benefits of heating with pellets and in particular about their real cost. Many people still think that heating on pellets is prohibitively expensive and do not express interest in that heating source. This is exacerbated by the long tradition and familiarity with using firewood for heating, especially in rural areas.

Relevant actors that can influence the legitimacy of pellets are NGOs and lobby groups. A few of the interviewees stated that there are powerful coal and heating oil lobbies that prevent the market development of using pellets for heating. Coal and heating oil have a long tradition of being cheap and easily accessible heating sources. This situation is changing, but nevertheless, the coal and heating oil lobbies attempt to present heating with pellets to be expensive and of low quality. Moreover, it is understood that certain people working in municipalities often benefit personally when signing long-term contracts for heating municipal buildings with heating oil.

It was identified during the interviews' process that the lack of pellet association has a negative effect on the legitimation of pellets as a reliable and affordable heating source. There is a biomass association (AUEB) where all pellet producers were invited to participate, however, a more focused and specialized association that deals with pellets only does not exist.

### 3.4 Resource Mobilization

The development of any TIS involves the mobilization of different resources. Therefore, this function analyzes the extent to which the TIS is able to mobilize resources: human, financial, and assets (Bergek et al., 2008).

The raw material for the types of pellets investigated in this research is wood. According to a number of conducted studies, Bulgaria has a high potential for the utilization of woody biomass for energy purposes. However, the utilization of this potential is hampered by inefficient management of forests, old forestry equipment, and bad quality and in cases lack of road infrastructure. The mobilization of raw material is further complicated by non-transparent practices in the sale of wood, low control over these sales, and monopolized structures that control the sale of wood.

The supply of raw material was identified to be the main barrier towards further development of the market for pellets in Bulgaria. The supply of wood is highly insecure because there are no long-term contracts to ensure this supply. Even though, there are provisions for such in the Forest Act, the procedures for the establishment of long-term contracts have not been developed yet and in reality such contracts do not exist. In addition, the price of wood has doubled in recent years – from 50-60 BGN/t to 110 BGN/t. Thus, the production costs of pellets cannot be foreseen in advance, which on the other hand prohibits long-term planning and the development of business strategies.

Pellet producers purchase wood from companies that have won auctions to harvest and sell wood or only to sell wood. A big concern of pellet producers is that there is considerable amount of corruption in the way auctions are executed and in the way rights to harvest and sell wood are granted. The majority of forests are state-owned and producers see a political umbrella over the trade with wood; namely, wood is provided to people with political ties. Related to this, is the concern of producers that there is a strong political lobby for the use of biomass for the production of energy in big power plants. The growing financial incentives for using biomass for energy in power plants or CHPs will limit the supply of wood available for pellet production and will instead shift wood to these big projects that benefit from the high feed-in tariffs for electricity produced from biomass. In this way, big power plants and CHPs on biomass will have the purchasing power to outbid pellet producers when buying wood. Producers saw the recent propositions for amendments in the Forest Act that were heatedly protested by civil organization as a way to protect the interests of big investors in the biomass-for-energy sector, among others. On the other hand, I. Hinovski thinks that a conflict for wood between the CHP and pellet industry will not occur as there is not much overlap in the raw materials the two use. For instance, high-quality wood is needed for pellet production, while almost any biomass could be burned in a CHP. There is some overlap in types of raw material needed for the two industries, though, which could lead to increased competition for feedstock (I. Hinovski, personal communication, 9 August 2012).

In order to cope with the issue of insecure supply of wood, some synergies and partnerships have been formed. For instance, in some cases pellet production is a complimentary manufacturing process in a furniture-making plant; thus, benefiting from the bigger purchasing power that such plant has and also utilizing some by-products from the furniture-making process. Another example is the inclusion of Forest Enterprises and forest management companies as stakeholders in a pellet-producing company.

The issue with the insecure supply of wood for the production of pellets has implications for the mobilization of financial resources, as well. The inability to show proof of raw material supply and long-term projections for key business indicators is an obstacle when bank loans

are sought after by business. Otherwise, funding for projects could also be secured through the various Operational Programmes of the EU, EBRD loans, and financial schemes targeted at investments in RES. Some barriers to the applications for funding from such schemes claimed by business are: the burdensome bureaucracy involved with them, the specific and detailed requirements, corruption, and the administrative issues connected with such funding schemes.

As far as human capacity for the utilization of the raw material is concerned, there is a big number of people working in the forestry sector. In addition to their own employees, EFA reports some 2 000 private forest management companies and 7 000 experts that work in forestry. Each person who works in the forestry sector needs to have the appropriate qualification. Competence levels are deemed to be sufficient, but EFA seeks to further raise the level of competence through regular qualification assessments and further training.

### **3.5 Market Formation**

It is often hard for new technologies to compete with already established ones. Therefore, some intervention by governments or other market actors is needed (Hekkert & Negro, 2009). In addition, Bergek et al. analyze three different types of markets:

- Nursing markets – they are in an early stage of development and need to evolve;
- Bridging markets – it allows volumes to increase and the market to develop;
- Mature markets – it is the mass market that has emerged after the technology has successfully competed with previously existing ones.

The analysis of this function takes into account the phase that the market is currently in, the demand for the TIS, customer groups, and governmental actions needed/implemented (Bergek et al., 2008).

Even after data was collected from various sources, it is hard to establish the exact number of pellet producers in Bulgaria as new entrants on the market appear constantly. At present there are about 40 pellet producers in Bulgaria, which is more than twice compared to several years ago. The actual annual production and the production capacity in Bulgaria are also hard to identify. The estimates are in the range of 80 000 – 150 000 t/yr actual production and 200 000 – 500 000 t/yr installed capacity. A big percentage of the pellets produced in Bulgaria is exported, mainly to Italy and Greece (according to collected data, this percentage is about 80%). Some producers have stated that this big share of export causes problems for the domestic market; namely, not enough domestic supply, which leads to higher price for pellets. However, producers are also exploring to develop the domestic market for pellets. According to pellet producers, the demand for pellets in Bulgaria is constantly growing with differing suggestions about the actual annual growth, which has been stated to be between 10% and 50% every year.

Despite this growing demand, the share of heating energy supplied by pellets for heating is less than 0.3% (NSI, personal communication, 17 August 2012). The price of pellets is still deemed to be relatively high to that of firewood, mainly used in rural areas (D. Mladenov, personal communication, 19 August 2012). The considerable amount of illegal logging drives the price of firewood further down and makes it even cheaper to use firewood for heating (A. Dimitrova, personal communication, 8 August 2012). In addition, the price of electricity in Bulgaria is considered to be low, which allows electricity to be used for heating even in rural areas. The price of electricity is set to increase, though (A. Dimitrova, personal communication, 8 August 2012).

There are also a number of municipal buildings and industrial applications that use pellets. Some producers also stated that the demand in Bulgaria, although growing, is not sufficient for them to place all their produce on the domestic market. Therefore, it could be concluded that the Bulgarian pellet market is still a nursing market and needs to develop significantly to become a mature market. Nevertheless, pellet producers reported that the demand from households is steadily growing and that for example, most new residential heating systems run on pellets. So, it might not take long before this nursing market turns into a bridging market.

A significant barrier to market's development is the lack of adequate financial support towards the purchase of a pellet stove. The biggest cost segment in heating with pellets is the upfront investment for the stove which could be BGN 5 000 and higher. This represents a significant cost to households, for instance. At present, households could either use own financing, apply for a bank loan, or use the credit line for Energy Efficiency that supports projects in the area. However, the funding that could be received from the credit line is 20% of the project's costs, which are mostly spent on administrative expenses on the loan. In addition, the funding of each energy efficiency measure has a co-financing ceiling. This ceiling is about BGN 1 000 for pellet stoves, which does not represent a big enough incentive for households to purchase such a stove. G. Mihov thinks that the most a household should pay for a stove out of its own pocket should be BGN 2 000, but the present support schemes require higher payments by households (G. Mihov, personal communication, 6 August 2012).

Another concern is that there is a large number of pellet producers now and in the context of insecure wood supply, this drives the price of wood further up and is also a reason for insufficient supply of wood for some pellet producers. Moreover, some of the new pellet producers are "shadow" producers in the sense that they are not registered and do not pay taxes and benefit from not having to pay these expenses, but at the same time compete for wood with the legal producers (C. Zeggio, personal communication, 27 July 2012). However, other interviewed pellet producers stated that the increased number of participants on the market raises competition and is good for market formation.

Other concerns stated by producers deal mainly with corruption and low control. For example, a barrier for the use of pellets in municipal buildings is that there are contracts for the supply of heating oil to a certain municipality and people within that municipality are benefitting illegally from such contracts and they prevent the switching of heating sources (G. Mihov, personal communication, 6 August 2012).

### 3.6 Entrepreneurial Activities

A TIS involves a certain degree of uncertainty and the primary way to reduce that uncertainty is through entrepreneurial experimentation (Bergek et al., 2008). The existence of entrepreneurial activities is a prime indicator that a TIS is progressing (Hekkert & Negro, 2009). In this sense, the analysis of this function includes: number of new market entrants, number of different applications (Bergek et al., 2008).

The strongest evidence that the Bulgarian pellet market is growing is the constantly increasing demand for pellets. This has also led to a growing number of new pellet producers and has caused reorientation of market activities for some producers. For instance, the Bulgarian pellet industry started its development as almost entirely export-oriented. Still, export represents a large component in the pellet producers' activities, but recently some producers that used to export all the pellets that they manufactured have started placing their entire produce on the domestic market.

A number of pilot projects were also implemented. For example, in 2008 the Municipality of Chepelare changed the heating source for six municipal buildings from heating oil to pellets. In addition, the Municipality of Bansko started using biomass in its TPP. The Municipality of Pazardzhik switched to heating with pellets for one school and is now planning to do the same in four other. In addition to these pilot projects, a number of other municipalities, hotels, and even private households have switched their heating source to pellets. Pellets have found their way into industrial applications, as well. A number of farmers in the Plovdiv region started using pellets to heat their greenhouses. In sum, it could be concluded that an increasing number of projects is being constantly implemented. This provides confidence in the technology, promotes its use and has a multiplier effect that could aid the development of the domestic pellet market.

### **3.7 Knowledge Diffusion/External Economies**

The success of any TIS could be ensured through diffusion through networks and the generation of external economies that develop positive externalities. The analysis of this function considers the information and knowledge flows within the system, the potential development of external economies, the emergence of new labor markets and other positive externalities (Bergek et al., 2008).

It is difficult to establish the progress of this TIS function because it is one that is hard to measure. The sheer number of new entrants in the market (both businesses and customers) suggests that knowledge about the benefits of using pellets for heating is quickly being disseminated. This is especially relevant in the case of municipalities where often a pilot project for heating with pellets of a municipal building generated more such projects in other municipal buildings. However, households still learn about the benefits of heating with pellets mostly through word of mouth and through friends who have switched to heating with pellets. Some of the bigger pellet producers use some advertising tools like billboards, flyers, and brochures, but such campaigns are not widespread.

This increased interest and implementation of projects for heating with pellets could lead to the creation and stimulation of some external economies such as: the optimization of existing industries, the creation of direct and indirect employment, environmental and health benefits. The potential for the emergence of external economies will be discussed in Section 4.

In order to develop external economies, though, some market barriers identified in this section have to be overcome. The pellet market is still a nursing market and its development will depend on issues like supply of raw material, institutional support, improved information and awareness, and cooperation. The following section provides recommendations on how to address these issues.

## 4 Discussion – Opportunities and Changes Needed

In order for the Bulgarian pellet market to make the transition from a nursing market to a mature one a number of issues have to be taken into account. This section will explore the role of pellets in the biomass-for-energy sector in general. It will then focus specifically on opportunities for the development of the pellet market in Bulgaria and will identify changes needed for this development to happen. Finally, the chapter will highlight the similarity of the Bulgarian case with those in other Central and Eastern European countries.

### 4.1 Pellets in the Biomass-for-Energy Sector

Biomass is the RES with the highest identified potential in Bulgaria. There are still 920 ktoe unutilized biomass in Bulgaria, which represents about 57% of the total technical biomass potential in the country. Moreover, the current use of biomass for heating could be significantly optimized since the average efficiency of the combustion units for biomass for heating is 40-50% (MEET, 2011), compared to 85-95% efficiency that can be achieved when burning pellets in pellet stoves. This improved efficiency also implies that less fuel is needed to achieve the same level of comfort, which could save money and energy. Energy savings are particularly important for municipal buildings because all municipal buildings in Bulgaria have individual targets for energy savings. In addition, pellets have lower ash content than firewood and thus, replacing heating with firewood with heating on pellets could improve local air quality. Finally, interviewed customers have mentioned that the thermal comfort of pellets is superior to other heating sources they have tried. Therefore, even with the existing level of biomass use for heating, substantial improvements in performance efficiency, energy used, thermal comfort, costs, and emissions could be achieved by switching from heating with firewood to heating with pellets.

In addition, recent events in the RES sector in Bulgaria that took place in the summer of 2012 (namely, the revision of the feed-in tariffs for various RES technologies) demonstrate that the use of biomass for the generation of energy will be a priority RES in the near future. The feed-in tariffs for the generation of energy from different biomass sources using various technologies were increased (some have been almost doubled), while the feed-in tariffs for the other RES sources of energy were decreased. In the case of solar energy the decrease in feed-in tariffs was about 40%, for example (SEWRC, 2012). Moreover, biomass could be used as a balancing fuel to compensate for the intermittencies of other RES such as solar and wind.

As long as woody biomass is concerned, the highest feed-in tariff is for CHPs up to 5 MW – 267.39 BGN (SEWRC, 2012). This has attracted the attention of investors who see CHPs on biomass as a lucrative business to get involved in. This is evidenced by the fact that there are a number of planned CHPs on woody biomass for 2012, compared to none in 2011 (A. Dimitrova, personal communication, 8 August 2012). However, these projects are mainly concerned with the generation and sale of electric energy; there is no legal requirement to show proof of use of the generated thermal energy as is the case in Austria, for instance (IEA, 2012). Thus, thermal energy is disregarded once again in the design of feed-in tariffs and incentives for RES use.

Such disregard of thermal energy in existing RES incentives represents a major concern not only because energy for heating has the largest share of energy consumption in the country, but also because a substantial part of the population's heating needs is satisfied through the use of woody biomass (see Section 1 and Section 2.1.1). 34.1% of the Bulgarian heating energy supply was provided by wood in 2011; thus, making woody biomass the largest source of heating in the country (NSI, personal communication, 17 August 2012). The use of inefficient and old technology, though, hinders the achievement of the environmental and social benefits

that the utilization of biomass for heating could provide. In addition, large part of the use of woody biomass for heating can be found in the rural areas that lack district heating distribution networks. Thus, a good way to realize the environmental and social benefits of biomass for heating is to use pellets burned in highly efficient stoves (85-95% COP) for residential heating. In comparison, the analysis of policy documents and the findings from the conducted interviews demonstrates that policy-makers are focused on the use of biomass for heating from CHPs. Despite the acknowledgement that the use of biomass for decentralized residential heating is also an efficient way to utilize biomass, incentives for such utilization are lacking. The lack of financial incentives for the use of pellets for heating is a major reason why pellets were used to supply less than 0.3% of heating energy in Bulgaria in 2011 (NSI, personal communication, 17 August 2012).

## **4.2 Domestic Pellet Market – Potentials for Development**

Despite the fact that less than 0.3% of residential heating needs was supplied by pellets in 2011, the demand for pellets has been steadily increasing each year as revealed through the interviews with market actors (pellet and stove producers). There are a number of reasons why more customers are looking into using pellets for heating. These include: costs, manual work involved, quality of heat, convenience<sup>8</sup>.

The main groups of customers where producers see potential for the development of the domestic market are households and municipalities. Households are reported to be showing increased interest in heating with pellets; especially young, working families, who do not have the time to run heating systems on wood or coal or families living in buildings with newly constructed local heating systems. There is some potential in the use of pellets in greenhouses, as well, as demonstrated by a number of implemented projects (A. Angelov, personal communication, 3 August 2012; G. Mihov, personal communication, 6 August 2012). Widespread use of pellets in TPP is unlikely, though, as these plants can also utilize forest residues and wood chips at a lower price and the demand for fuel of a TPP is hard to be satisfied by pellets only (A. Angelov, personal communication, 3 August 2012).

Even though most of the absolute increase in demand occurs at the household level, municipalities represent an interesting case for increased pellet utilization and could be a particularly important customer group for the development of the domestic market for pellets. First, the pay-back time on the investment in a municipal building is much lower compared to an investment in a private household<sup>9</sup>. This is so because of the lower cost per unit of thermal energy; higher cost for the pellet boiler is offset by a larger heated space. Second, the majority of municipal buildings still use heating oil for heating which in recent years is the most expensive heating source (see Table 2-3). Thus, heating on pellets provides considerable cost savings for municipal budgets. Third, each municipal building has an energy saving target that has to be achieved by 2016. Moreover, these targets are expected to be complemented by mandatory requirements for RES use in municipal buildings (so far these requirements are just recommendatory). Thus, increased utilization of pellets for heating could help reach both energy efficiency and RES targets. Fourth, implementing innovative projects in municipal and public buildings in general attracts more attention from the media and the general public. In addition, municipalities could lead by example when new technologies are trying to establish themselves on the market. In this respect, it will be beneficial to implement some projects on

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<sup>8</sup> A number of producers stated that once a customer had started using pellets, they never go back to anything else.

<sup>9</sup> Interviewees working in municipalities who have implemented pellet-heating projects report a pay-back time of around one year.

heating with pellets in a number of municipal buildings which could also serve as dissemination tools to communicate the benefits of using pellets for heating.

As far as industrial applications are concerned, the use of pellets is minimal. This is so because industrial boilers could efficiently burn lower quality biomass products such as wood chips and forest residues which are cheaper than pellets. Nevertheless, pellets have been introduced in a number of greenhouses mainly due to reduced costs and operational expenses.

To sum up, the customer groups with the highest potential for utilizing pellets for heating are households and municipal buildings. The sheer number of households who already use biomass (wood supplied 34.1% of the heating energy in Bulgaria in 2011), but could do so more efficiently, makes that group an important potential customer pool. On the other hand, projects in municipal buildings are bigger in terms of volume, have a short pay-back time and could be incentivized easier than projects in individual households. Nevertheless, in order for the demand from these customer groups to increase even further, a number of changes to the status quo and incentives for the use of pellets for heating should be established. These will be discussed in the following section.

### **4.3 Development of Domestic Pellet Market – Changes Needed**

Changes in various sectors have to be introduced to provide incentives for both domestic pellet production and consumption. Therefore, this section is divided into smaller sub-sections each dealing with changes needed in specific sectors.

#### **4.3.1 Forestry Sector**

The cost of supplying raw material for the production of pellets represents the biggest expense in the whole manufacturing process (see Section 2.2.3). The problem of the supply of wood is further exacerbated by non-transparent practices in the sale of wood and insecurity of long-term supply because wood is purchased each year through auctions. A much needed change and one that is also included in the latest amendments of the Forest Act is the provision for long-term contracts for the supply of wood. The establishment of long-term contracts for the harvesting and supply of wood would bring multiple benefits.

First, since Bulgarian forests are mostly state-owned and the state does not have enough resources to manage them all, then long-term contracts for the management of forests with private companies should provide incentives for the sustainable management of forests, the improvement of infrastructure, and reduction of corruption. This has been demonstrated already with the commissioning of some state and municipally-owned forests to private companies. They have been reported to react to change quickly and to optimize the forest management because they have the incentive to do so (T. Tzenov, personal communication, 3 August 2012).

Second, improved management of forests could mean that forests' potentials are better utilized and that forests are managed sustainably. On one hand, this will provide more raw material for the pellet manufacturing (and biomass in general) industry. On the other, it will reduce doubts over the sustainability of using biomass for the generation of energy.

Third, long-term contracts for the supply of wood will make production costs of pellets more predictable and less volatile. This will also help in long-term planning and strategy making for the business. Such long-term planning and predictability of costs and production levels will allow increased access to bank loans to pellet producers – something that is hard at present due to inability to show long-term development plans for the business.



Fourth, long-term contracts will optimize supply chains due to increased predictability and co-operation among market actors. The optimization of supply chains includes improvement of the road infrastructure, as well. As mentioned above, if the management of a forest is contracted long-term to a private company, the latter will have incentives to improve and develop the existing road network. At the moment, the only planned mechanism in that respect is the establishment of an Investment Fund that will provide money for the improvement of the forest road infrastructure. The Investment Fund will utilize some revenues from the sale of wood from state-owned forests towards investments in infrastructure (T. Tzenov, personal communication, 3 August 2012). The details of this fund have not been finalized yet, though.

In general, long-term contracts for the supply of wood are a good way to allocate the harvested wood among the different market actors who utilize wood in their operations and will also provide some security for an emerging industry like the pellets one. The biggest competitors of the pellets production business for wood are the use of wood for firewood and to a much lower extent the use of wood in furniture-making. However, a big potential competitor could be demand for wood from CHPs on biomass. Thus, long-term contracts for the supply of wood could allow different market segments to satisfy their needs for wood without the creation of unhealthy competition in the form of non-transparent deals for wood, corruption, and use of lobbying and political influence<sup>10</sup>. Such competition could also be avoided with tightened control on the trade with wood and better enforcement of the law. For instance, it has to be ensured that the legally stipulated percentage of wood for local use from forests is indeed supplied to traders and businesses on the territory of the forest in question.

### **4.3.2 Financial Incentives**

The single, most influential financial measure that could aid the development of the domestic market for pellets in Bulgaria is to provide adequate financial support for the purchase of an efficient pellet stove. The cost of the stove represents a considerable investment and is the largest upfront cost that needs to be paid by customers if they want to switch to heating with pellets<sup>11</sup>. At present, there are bank loans and energy efficiency funds that could be used to finance the purchase of a pellet stove, but these are deemed to be not sufficient as they still require payment by the customer of at least 80-90% of the stove's cost.

The financing for the purchase of an efficient pellet stove could be more rigorously financed by national funds so that customers pay no more than 50% of the stove's cost. Another way to incentivize the purchase of pellet stoves is to reduce taxes (e.g. property, income) on individuals who have purchased such a stove.

Other European countries have provided guidance for the utilization of pellets in various forms. For example, there are national subsidies for the purchase of pellet stoves in Austria and Germany (E.V.A., 2001). In addition, there are propositions for emission limits of each residential chimney in Germany that would provide incentives for using clean, low-emitting fuels in households. Moreover, in Italy there are tax reliefs if one purchases a pellet stove, which allows for a quicker pay-back time of the investment (C. Zeggio, personal communication, 27 July 2012). Another way to guide the adoption of a new technology is to change the status quo on the market. For example, heating oil subsidies were abolished in

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<sup>10</sup> Historically, corruption has been an underlying issue in the forestry sector and has been mentioned by a number of interviewees as an obstacle to obtaining wood. In addition, due to the high state ownership of forests, the trade with wood is seen as a highly political issue that often benefits groups with political ties.

<sup>11</sup> The cost of a pellet stove for residential use starts at around BGN 5 000.

Greece which has led to soaring demand for pellets in Greece in recent years (G. Mihov, personal communication, 6 August 2012).

In addition, pellet companies on the market could provide alternative services to reduce costs for the customers. For instance, instead of providing a certain amount (in weight) of pellets, there could be contracts for the supply of a certain amount of thermal energy (in kWh). This has already been successfully implemented in some municipalities. For instance, the Municipality of Pazardzhik paid nothing for the pellet boiler for an installation in a school and in return signed a six-year contract for the provision of thermal energy with the company who supplied the boiler (G. Dundarov, personal communication, 7 August 2012). The company is also responsible for the pellets' delivery. Thus, both sides benefit – the municipality benefits from a lower heating bill and no upfront costs, whereas the company benefits from a long-term contract that will allow it to offset the cost of the boiler and make some additional profit

Moreover, financial incentives have to also be coupled with informational campaigns among households and municipalities of the benefits of using pellets for heating. The use of pellets for heating is a new technology and there are still some misunderstandings among the general population about its cost, implementation, logistics, etc.

### 4.3.3 Policy Making

A major drawback of Bulgarian RES policies is that to a large extent they do not consider RES heating and thus, provide no incentives for the use of RES for heating. Therefore, a coherent national energy policy that considers the generation and use of both electric and thermal energy is needed. Especially in the case of biomass which traditional use is to provide heat, there should be incentives and legal provisions established for the generation of thermal energy, including decentralized generation. Such policies and strategies could also include provisions for providing households with efficient stoves that utilize modern biomass fuels. In drafting such policies, though, the influence from powerful stakeholders should be avoided as could be the case with big investors in the biomass sector which are predominantly interested in the generation of electricity from biomass in large CHPs or power plants. Before such large projects go online, the required by law Environmental Assessments should be carefully evaluated, including by a third party as some interviewees raised doubts on the reliability of Environmental Assessments of some RES projects that were allowed to be implemented.

In addition, the approach of incentivizing large projects that is noticeable in RES policies and strategies has to be reversed. Large RES project are often the ones with the highest negative impact on the environment from all RES projects. In addition, their benefits are often materialized by the investors of the projects. In contrast, small, decentralized RES installations could benefit the local population in terms of reduced costs, improved air quality, increased energy independency, and decreased fuel poverty. Therefore, increased attention should be given to small-scale, decentralized RES projects.

Moreover, bottom-up approaches could help achieve societal and environmental goals at a lower price. Thus, to address fuel poverty it might be more beneficial to nationally stimulate decentralized heating projects on biomass, for instance, than initiate costly expansion of the gas distribution networks as planned in the Bulgarian *Energy Strategy*. Connection to the gas network for households costs between BGN 280 and BGN 741 per household<sup>12</sup> (SEWRC, 2012). In addition, the costs of the gas connection and the required gas facilities depend highly on the specific context. The average costs are around BGN 2 500, but could reach over BGN

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<sup>12</sup> Depends on which gas company operates in the area in question.

5 000 (Overgas, 2012). Therefore, the initial installation for a pellet boiler is comparable to that for connection to the gas network, but avoids the problem of dependency on import fuel and significant price volatility. In addition, the gas distribution network has not been fully developed in Bulgaria. Thus, if the whole life-cycle cost is included, heating on pellets is considerably cheaper than heating with gas in terms of overall national expenditures.

As far as the achievement of environmental goals is concerned, soft measures such as energy efficiency have a much lower abatement cost compared to hard, infrastructural measures such as construction of a gas distribution network, for example (see Table 4-1).

Table 4-1. Comparison of CO<sub>2</sub> abatement costs for different measures

Measure	Abatement cost (BGN/t saved CO <sub>2</sub> )
Energy generated in CHP	494
Increased energy efficiency in 3% of public buildings annually	168
Securing access to gas distribution network to 30% of households	322.5
“1000 solar roofs” initiative	1 308

Source: MOEW (2012)

However, in order for a coherent policy to be created and to be efficient, good data and information on biomass potential and use has to be collected. Such information is largely non-existent at the moment, especially in the area of heating with biomass. The newly established SEDA has the responsibility to start collecting that information. With respect to the use of biomass for heating, municipalities will play a crucial role in gathering this information as they are more aware of such initiatives on their territory. Thus, a special position on staff that deals specifically with energy efficiency and RES should be created in municipalities.

Municipalities play a crucial role in the adoption of RES for heating because most legal requirements are targeted at them. In addition, it is expected that municipalities will get additional targets and responsibilities under the Climate Change Law that is being drafted at the moment. An added responsibility could be a specific RES target for individual municipalities/municipal buildings similar to the energy efficiency one. Such mandatory targets could also help to discontinue practices of individuals illegally benefiting from heating oil contracts in municipalities as pointed out during few interviews.

In addition, there is substantial room for improvement of the communication within the administration when it comes to the utilization of biomass for energy purposes. Since biomass is the RES with both the largest use and the largest potential in Bulgaria, it might be useful to establish a directorate that deals with biomass only and that serves as a liaison between different administrative branches that work with various issues in the utilization of biomass for energy. At present, there are at least five institutions and a number of different directorates within them that deal with various aspects of the utilization of biomass for energy purposes, which makes the communication among them tedious and inefficient.

Last, but not least, wider participation of NGOs and civil organizations in the policy-making process should be ensured. It has been the norm for public consultations regarding policy decisions to be fictitious and/or the demands of the NGOs and other organizations to not be taken into account. Moreover, actors in the civil sector often do not have information available and means to keep track of the policy-making process.

#### **4.3.4 Pellet Association**

Another measure that will aid the development of the domestic pellet market is the establishment of a pellet association. There is an Association for the Energy Utilization of Biomass; however an association of pellet producers specifically will be beneficial for business for three reasons.

First, having a pellet association by itself puts pellets on the map of possible heating sources. In addition, it gives the impression that the technology has sufficiently developed and the market is in the process of formation since there is a specific association put in place. Second, a pellet association could cooperate with other associations, NGOs, and stakeholders to further legitimize heating with pellets through the implementation of pilot projects, the drafting of policy proposal or the development of informational campaigns. Third, a pellet association could act as a lobby group to counterbalance the actions of other lobby groups and to attain some leverage power before decision-makers. In this way, pellet producers could influence decision-makers and spur them to provide clear guidance for the development of the market.

### **4.4 Case Study for Central and Eastern European Economies**

The present research could be regarded as a case study to guide similar research on the topic in other countries in Central and Eastern Europe due to similarities of the Bulgarian context with the Central and Eastern European one (see Section 2.1.1 and Appendix I). Thus, the TIS and PESTLE frameworks of analysis could be applied in research in these countries to explore the barriers for the development of the pellet market. The PESTLE framework is useful in illustrating the general context in which the pellet market develops in a country. This is especially relevant for situations when there is not much information available regarding the pellet market, market actors, logistics, etc. as it was the case with the present research. In addition, the use of pellets for heating is a relatively new and unfamiliar technology in the Central and Eastern European countries, so it is helpful to analyze the market's development through the prism of the TIS framework.

In addition, the recommendations and suggested changes that have been identified in this research are applicable for other countries in Central and Eastern Europe and could aid the development of the pellets market there. The similar historical, socio-economic, and cultural background presents a number of challenges when conducting this kind of research common for the region and therefore, it is important to keep in mind specific limitations that could occur in the process (see Section 1.4).

In general, some of the most important issues to take into account when developing the pellet market in other Central and Eastern European countries is to ensure secure supply of wood, financial incentives for the use of pellets for heating, and coherent national policy that considers the generation of heating from RES. This is especially important in the case of biomass as biomass is the RES with the highest share of all RES in all the countries in the region and is also one that is traditionally used for heating and not for electricity generation (see Section 2.1.1). Nevertheless, with some of the countries in the region being EU members, there are increased incentives to use biomass for the generation of electricity and biofuels in

order to reach EU RES targets. Such use of biomass, though, should be carefully evaluated and guided so that it does not compromise the traditional use of biomass for heating that could hinder the development of a potentially more efficient RES market. In addition, the proper development and functioning of the pellet market could solve a number of local problems in the region and provide opportunities for the emergence of external economies discussed in the following section.

## **4.5 External Economies**

The development of the biomass-for-energy sector, including the use of pellets for heating, could bring multiple economic, environmental, and societal benefits. It could also aid the establishment of external economies that develop because of the increased, cleaner and more efficient utilization of biomass for the generation of energy.

For instance, increased demand for wood from pellet manufacturers could lead to optimized management of forests so that the growing demand for wood could be sustainably satisfied. This could mean the construction of new roads that would allow for untapped biomass resources to be utilized. In addition, employment opportunities could be created in the forestry sector itself – for the harvest and processing of wood, for maintenance of forests (cleaning, collection of forest residues, etc.), for the transportation of material and for other activities within the supply chain. Moreover, similar employment opportunities could be generated in the agricultural sector as it could also provide raw materials for the production of pellets.

This newly created employment could be an important driving force for the economic development of many regions in Central and Eastern Europe. Rural regions that are mostly involved in forestry and/or agricultural activities are among the poorest regions in Central and Eastern Europe (WHO, 2010; Rural Poverty Portal, 2012). In these regions forestry and agriculture are the main sources of employment for the local population. Increased opportunities within these sectors could diminish the migration from these regions to the bigger cities and thus, stimulate the development of poor, rural regions. This revitalization of rural regions could enhance the economic activity within them, revive abandoned industries, attract investors, and improve the living standard of the population.

Moreover, the use of local resources for the supply of energy could drive municipalities towards energy independency. This would free financial resources, previously spent on securing energy, for investments in infrastructure, education, healthcare, culture, sports, etc. which will have a positive effect on the overall development of these municipalities. In addition, each municipal building in Bulgaria, for example, has an energy savings target by 2016. Implementation of projects that utilize pellets for heating will help municipalities reach their energy efficiency and energy saving targets. This is not a trivial and superficial goal as some funding for municipalities in Bulgaria is tied to requirements for energy efficiency and energy savings. Thus, through the implementation of RES projects for heating, the municipalities could get additional funding from the central government or through various funding schemes.

Apart from decreased dependence on energy imports/purchase, increased energy efficiency and energy savings, heating on pellets has other environmental benefits, as well. Heating on pellets emits less CO<sub>2</sub> compared to other conventional heating sources – coal, electricity, wood. In this respect pellets could be used as a source to mitigate the effects of climate change. In addition, as demonstrated in Section 2.4 pellets are superior to most heating fuels (except natural gas when it comes to emissions of dust) on emission levels of different air pollutants. This is an important characteristic of pellets as a number of Central and Eastern

European cities show elevated levels of particulate matter (PM) which in Bulgaria, for instance, is mainly caused by the (inefficient) burning of coal and firewood for heating (EEA, 2010). Heating on pellets could reduce PM and SO<sub>2</sub> levels and improve air quality, which will have long-term effects on quality of life because air pollution is projected to become the single largest environmental threat to human life by 2050 (OECD, 2012).

## **5 Conclusion**

The objectives of the present research were to identify barriers and opportunities for the development of the domestic market for pellets in Bulgaria. In doing so, the study could be used as a stepping point for the analysis of pellet markets in other countries in Central and Eastern Europe due to the similar socio-economic, energy, and biomass-for-energy context. Thus, the present research has implications outside of Bulgaria and on to the region in general.

A mature pellet market could provide numerous benefits. It could open new employment opportunities in the forestry and agriculture sectors. It could also lead to better forest management and improved infrastructure. Heating on pellets could reduce heating expenses for customers and help alleviate fuel poverty. In addition, the benefits from using pellets are mostly realized at local level – through improved air quality, increased thermal comfort, and in some places through creation of jobs. Moreover, heating with pellets could not only generate energy savings, but could also reduce GHG emissions, while utilizing local resources.

The biggest barriers to the development of the Bulgarian market for pellets are: the insecure supply of wood, the lack of financial incentives for heating with pellets, and the overall exclusion of RES for heating from national energy strategies, policies, and support schemes. The supply of wood in Bulgaria is deemed highly insecure and subject to corruption and political influences. Therefore, this issue hinders long-term planning of production costs, production levels, and investments for the pellet business. On the other hand, heating with pellets is a relatively new technology in Bulgaria and the general public is unaware of its benefits. This coupled with the fact that some upfront investment is needed to implement heating with pellets puts a number of people off pellets when considering different heating options. In addition, Bulgarian RES and energy policies, strategies, and supports schemes are highly focused on the generation of electrical energy and mention little about heating. On one hand, this is to be expected as 22% of Bulgarian trade flow in 2008 came from the export of electricity. On the other hand, though, energy for heating represents the biggest use of energy in the country and as such provides opportunities for energy savings, improved efficiency, and reduction of GHG. The lack of support mechanisms for RES heating could also be explained by the fact that RES heating initiatives are usually small-scale and decentralized, while Bulgarian policies and strategies deal mostly with large projects.

To overcome these barriers changes in the forestry and policy-making sectors are needed. Long-term contracts for the harvest and supply of wood must be introduced not only on paper, but also in practice. Such contracts will ensure secure supply of wood for different market sectors, will allow long-term planning, will contribute to better management of forests, and to improved forest infrastructure and equipment. These contracts should be transparent and able to be independently monitored, though. In addition, in order for pellet companies to reach to a growing number of households and municipalities – the primary potential customer groups for future market development – financial incentives for the purchase of pellet stoves must be introduced. At present, the existing support schemes for energy efficiency in buildings do not provide enough incentives to switch to heating with pellets. All these changes should be performed in a framework of coherent national energy policies, strategies, and support schemes that recognize the importance of using RES for heating and of optimizing the heating methods of the population with respect to costs and environmental concerns. Only in this way a sustainable transition from inefficient and polluting heating methods (electricity, coal, heating oil, inefficient burning of wood) to cleaner and optimized ones could be achieved.

## 5.1 Future Research

Future research could focus on gathering information on all aspects of the Bulgarian pellet market – potentials, costs, current situation, market actors, trade, logistics, infrastructure, technology. There is only limited research on all these aspects and therefore, information on them for the present research was obtained mostly through interviews. Such research would also aid national authorities in their initiative to establish a centralized database of biomass installations in Bulgaria, including such for heating. At present, MEET does not have reliable data on decentralized biomass installations in the country, which seriously impedes policy making.

In addition, standards for different solid biomass products have been implemented recently. Thus, research on the standards' implications for market development could be conducted. Moreover, studies could be performed that investigate the different types of pellets according to the raw materials they are produced from – how the raw material affects quality, which kind of pellets are most suitable for which kind of applications, what are the costs of producing pellets from various raw materials, etc.

An interesting topic for future research is calculations of abatement costs for CO<sub>2</sub> savings of different technologies, including pellets. Then, a comparison among technologies and their abatement costs could be performed that would allow the identification of the most efficient way to reduce CO<sub>2</sub> emissions. Similar calculations could also be performed with regards to air quality to highlight the most appropriate technologies to reduce air pollution.

Apart from research that explores achievement of environmental goals, research that considers the achievement of societal goals could also be performed. For instance, analyses could be conducted on the cost and effectiveness of different technologies to alleviate fuel poverty, which is a growing and increasingly recognized problem in Europe.

In general, the pellet market in Central and Eastern Europe is a faintly researched area. Therefore, research of the market's development in the region and in particular countries in the region could be conducted. This could highlight similarities and differences and could also aid co-operation and the drafting of policies to incentivize the pellet market's development.



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## Appendix I: Bulgaria in Central and Eastern European Context

The following represents comparisons between Bulgaria and other countries in Central and Eastern Europe based on characteristics such as: socio-economic context, energy situation, biomass potential, overall biomass use, and solid biomass use in households. This Appendix also explains how the data in Table 2-1 and Table 2-2 was compiled.

Table 2-1. Socio-economic comparison between Bulgaria and countries in the region.

Country Group	GDP per capita (USD)	Electoral Process	Civil Society	Judicial Framework and Independence	Corruption	Democracy Score
Bulgaria	13 800	1.75	2.5	3.00	4.00	3.07
New Member States (average)	20 240	1.73	1.93	2.33	3.33	2.43
Balkan countries (average)	10 557	3.54	3.00	4.43	4.68	4.07

Sources: CIA. 2011; Freedom House. 2011.

The information in the table was compiled using CIA’s *World Factbook* and the research done by Freedom House in the book *Nations in Transit 2011: Democratization from Central Europe to Eurasia*.

The data about GDP per capita was taken from CIA’s *World Factbook*, whereas the remaining information rests on research conducted by Freedom House. Freedom House analyzed 29 countries in transition in Central and Eastern Europe and Eurasia. For the purposes of the research seven categories were used in the analysis of each country; five of them are represented in the table above (the others are independence of media and scores of national and local government, which are aggregated in the overall democracy score). The ratings were based on a scale from 1 to 7 with 1 representing the highest level of democratic process and 7 – the lowest. The analysis of the countries involved four steps:

1. Authors of the individual country reports suggest country ratings on each of the seven categories. These ratings are based on substantial research.
2. Each country’s ratings were then sent to national and regional experts who commented on the ratings.
3. The Freedom House’s academic and advisory board discussed and evaluated the ratings.

4. The authors of the reports had the opportunity to dispute any revised rating that differs from their original one by more than .50 points. The final ratings were then established by Freedom House (Freedom House. 2011).

The New Member States are: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. That covers most countries in Central and Eastern Europe.

The Balkan countries are: Albania, Bosnia & Herzegovina, Croatia, Kosovo, Macedonia, Montenegro, and Serbia.

Table 2-2. Energy and biomass-for-energy comparison between Bulgaria and countries in the region.

Country Group	Energy imports (% of total energy use. 2009)	Forested area (% of total area. 2010)	Biomass share of total RES use. 2009 (%)	Use of solid biomass in households. 2009 (% of total use of biomass)
Bulgaria	44	36.2	91.3	88.8
New Member States (average)	39.8	39.5	82.7	71.3
Balkan countries (average)	38.8	37.6	No data	88.4

Source: IEA, 2009; World Bank, 2010; Eurostat, 2009.

The data in Table 2-2 was compiled using the databases of IEA, World Bank, and Eurostat. Data for each country within each country group was compiled and then averages based on the groups' definition were calculated. The data about each country in the New Member States country group is presented in the table below:

Country	Energy imports (% of total energy use. 2009)	Forested area (% of total area. 2010)	Biomass share of total RES use. 2009 (%)	Use of solid biomass in households. 2009 (% of total use of biomass)
Bulgaria	44	36.2	91.3	88.8
Czech Republic	26	34.4	91.2	71.5
Estonia	12	52.3	97.8	79.6
Hungary	56	22.4	No data	73.0

Latvia	50	53.9	80.7	73.7
Lithuania	50	34.5	93.3	79.4
Poland	28	30.7	93.9	63.2
Romania	18	28.6	73.8	90.9
Slovakia	65	40.2	68.1	8.9
Slovenia	49	62.2	54.3	84.2
<b>Average</b>	<b>39.8</b>	<b>39.5</b>	<b>82.7</b>	<b>71.3</b>

The data about the Balkan Countries was compiled using the same data sources as the ones used for the New Member States. On the basis of data about individual countries, averages for the Balkan Countries group were calculated. The data about each country in the Balkan Countries group is presented in the following table:

Country	Energy imports (% of total energy use. 2009)	Forested area (% of total area. 2010)	Biomass share of total RES use. 2009 (%)	Use of solid biomass in households. 2009 (% of total use of biomass)
Albania	27	28.3	No data	87.7
Bosnia and Herzegovina	25	42.8	No data	100
Croatia	53	34.3	37.6	83.5
Macedonia	42	39.6	No data	91.2
Montenegro	No data	40.4	No data	No data
Kosovo	No data	No data	No data	No data
Serbia	35	31	No data	79.0
<b>Average</b>	<b>36.4</b>	<b>36.1</b>	<b>Not applicable</b>	<b>88.3</b>

## Appendix II: List of Conducted Interviews

### List of Interviewees

#### Business Stakeholder Group:

Furniture Plant Izkuvstvo Ltd., 24 July 2012

Vasil Dichev, Technowood, 24 July 2012

Veselin Stoilov, Mega Energy, 25 July 2012

Progetto Ecologia, 26 July 2012

Carlo Zeggio, Eko Bio Calor, 27 July 2012

Vladimir Pashaliiski, J Term, 1 August 2012

Angel Angelov, Ecoconcept, 3 August 2012

Grigor Mihov, Ahira, 6 August 2012

Nikolay Vangelov, Erato, 30 August 2012

#### Customers Stakeholder Group:

Petar Pashaliiski, household, 1 August 2012

Nadezhda Hristeva, Municipality of Chepelare, 3 August 2012

Georgi Dundarov, Municipality of Pazardzhik, 7 August 2012

#### Institutions Stakeholder Group:

Anton Peychev, Ministry of Environment and Water, 26 July 2012

Vladimir Tchakarov, Executive Forestry Agency, 3 August 2012

Tzenko Tzenov, Executive Forestry Agency, 3 August 2012

Aleksandrina Dimitrova, Ministry of Economy, Energy and Tourism, 8 August 2012

Valentina Ilieva, Ministry of Economy, Energy and Tourism, 8 August 2012

National Statistical Institute, Administrative Affairs, 17 August 2012



*Experts Stakeholder Group:*

Ivan Hinovski, Bulgarian Energy Forum, 9 August 2012

Georgi Stefanov, WWF – Bulgaria, 13 August 2012

Dimitar Mladenov, Association for the Energy Utilization of Biomass, 19 August 2012

## Appendix III: Pellets' Characteristics

Pellet characteristics according to the newly established EU EN 14961-2 standard for pellets:

Parameter	Meaning	Notes
Origin and source	It has to be clearly stated according with the different sources allowed by each standards.	
Diameter	It is a physical value that could influence the stove/appliance feeding system.	Diameter could vary from 6 to 8 mm $\pm$ 1 mm. A higher diameter could affect the correct functioning of the stove.
Moisture	This parameter mainly affects the energy content and the storage. Moreover it is often used to define the contractual price of the biofuel.	It has to be lower than 10%
Ash	Ashes are the mineral residues remaining after a complete combustion. Their amount has to be as low as possible. A high value means bad quality of biomass or a bad management during the production of the biofuel. A high ash content leads to a more frequent maintenance of the stove/appliance/boiler (removing of ashes in the combustion chamber or cleaning of the glasses).	High quality pellets (class A1) have ash content lower than 0.7%. Pellets from the A2 class could have ash content up to 1.5%. Class B pellets could have ash content up to 3%.
Mechanical durability	It represents the capability of pellets to resist crumbling and breaking down to sawdust. It is one of the main requirements for pellets since it affects their storability and integrity especially if pellets are subjected to several handling steps.	Higher than 97.5%
Fines at factory gates	It represents the percentage of sawdust in the package. Sawdust can't be handled by the feeding systems of pellet appliances.	No more than 1%
Additives	Additives are materials which should improve the efficiency of pellet production. Pellet producers generally use starch, corn or potato flour, vegetable oil.	Type and amount have to be clearly stated. In any case a maximum amount of 2% is allowed.
Net calorific value	It represents the energy content of the biofuel and is strongly connected with moisture content. Attention has to be paid for the unit used to declare this parameter. A typical mistake is to declare the	A high calorific value could mean that pellet is made by other material than wood (plastics, glues, etc.).

	gross value instead of the net, giving an overestimation of the fuel energy content.	
Bulk Density	It is a key parameter since it allows the calculation of "quantities". It represents the weight (mass) of the bulk for unit of volume.	Has to be higher than 600 kg/m <sup>3</sup>

*Source: FOREST project, 2011.*