

STATE AND TRENDS FOR UTILIZATION OF THE WOOD BIOMASS FOR BIOFUELS IN BULGARIA

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ABSTRACT

The total wood resource in the forest of Bulgaria is 650 Mio m³ approximately, and in the course of the last years, 6-7,5 Mio m³ of standing dead wood mass (5-6 Mio m³ of laying dead wood) have been yearly produced from, with the possibilities of an increase up to 14 Mio m³ yearly. The largest share of wood is in the primary and the end energy consumption in our country, as compared to all the other renewable energy sources. According to the evaluations made by us, the most favorable climate for the development of the wood biomass utilization should be created by the production of briquettes for the home market and of the pellets for the foreign one while charcoal goes well for both of the markets.

The mean annual volume of production achieved by the companies varies among 250-10000 t of pellets, 400-1100 t of briquettes and 100-5000 t of charcoal, respectively. The low volumes are typical for the small firms while the high ones are achieved by the large scale producers as plants. The plants have put in their business plans a twice greater production than that one which has been indicated therein. There are about 60% of the manufacturers of pellets, using small press machines. That kind of press machines could be considered as "pick up anything you find" ones where refuses deriving from proper production: saw-dust are used as a raw material, and that leads to no else but a unfair competition resulting from a undeclared production of pellets and their lower purchase prices. The reason should be found out in the unregulated and vague market, in some unfair companies dealing with pellets production; on the one side, it is due to the low possibilities for business development in the country and on the other - to a scarce production and purchasing control, the small-scale business objectives for such companies included. It is expected that such a negative situation would be only temporary.

There are 3 maps of manufacturers proposed in Bulgaria, which ones contain the producers' denominations, the location and the volume of production: pellets, briquettes and charcoal included. The most common problems occurring in the bio-fuels production in Bulgaria are pointed out therein, as following ones: a miss of a contemporaneous optimization of wood biomass use for bio-fuels in Bulgaria and of equal criteria as regards to indices when a certificate is issued by the respective testing laboratories; unfavorable business background for the small and the medium business, which does not guarantee an easier access to financing and, especially, in that part which regards the credit disbursement and its repayment, etc.

Key words: wood biomass, bio-fuels, briquettes, pellets, charcoal, map of manufacturers, problems

INTRODUCTION

One of the most important advantages and benefits, resulting from the energetic utilization of the ecologically pure solid biofuels like wooden pellets, briquettes, charcoal and chips, is the reduction of the energy consumption which is a granted economic effect. The specific price of the energy for heating, generated from the wood biomass utilization is lower, compared to the specific price of the energy for heating, generated from the fossil fuels combustion and the electric energy. The heating comfort in the buildings, the maintenance of the normative air temperature in the rooms, the reduction of the greenhouse gases emissions are guaranteed. Conditions are created for achieving of a sustainable development both at the local and regional levels. Along with that, the specific investment in the construction of

heating plants of 1 kW heating power, - where wood biomass fuels are used, - is significantly lower than the specific investment of heating powers using conventional fuels and energy.

The biofuels market is scarce in Bulgaria as no conditions have been created therein for a complex use of the forest wood biomass and for subsidies of the heating systems which are relatively expensive. There is also a rather poorly developed distribution. Market conditions have to be created there for a supply of home produced biofuels. As a whole, the waste biomass potential has been calculated to amount to 91, 5 PJ/year. The forest potential is equal to 19%, approximately, of the whole biomass potential, in our country, and it is expected to go on rising. The technical potential of the forest biomass for energetic utilization has been assessed to about 44, 4 PJ/year (Dinev, Trichkov, 2010; Trichkov, Dinev, 2013).

According to Korpunen et al. (2011), the increasing use of the forest raw materials for the energy production gives a rise to a necessity of an effective system of planning for the management and planning of the supply chain. Such system includes decisions on how, when and where wood and its waste could be processed and how, when and where it could be stored and transported to the consumers.

As the forest wood biomass is generally spread within a large geographic region, the supply chain simulation requires a precise information on the biomass location and accessibility (Sokhansnj et al., 2006 and Alam et al., 2012). The quality management of forest biomass is relevant to the functioning of the entire supply chain and economy (Hillebrand and Raitila, 2013). The conformity of the business processes to the supply chain demonstrates that the number of the supply chain processes varies significantly, depending upon the different operational environments (Windisch et al., 2013).

It has been established by Baker, Westbrook and Greene (2010) that the integration of small –sized chippers systems (< 300 kW) could be successful within a restricted range of logging conditions, depending upon the volume of the produced biomass, compared to the volume of the round wood.

The basic objective of this study is to expand the range of the previous ones related to the potential of the forest wood biomass and its utilization for biofuels production in Bulgaria.

MATERIALS AND METHODS

Taking into consideration the assortment and age structure, the tree species and other specific characteristics of the Bulgarian forests, nationwide, there are 70%, approximately, of the harvested wood which is used for technological and energetic purposes, i.e. for plates, cellulose and firewood production. In the last years, the share of the wood belonging to category “wood” and “brushwood” was about 50% of the entire amount of the wood harvested in Bulgaria. The wood biomass, firewood, wood waste and their derivatives included have a high energetic potential but a low degree of quantitative concentration; and, besides, that resource is often distant from settlements.

Regardless of the fact that different kinds of forests are available, which presumes the use of various forestry systems, there are the clear cuttings conducted on relatively small areas, which result to be appropriate for a complex utilization of wood. That same kind of cuttings can be applied to areas of intensive poplar cultures and, to a certain extent, also performed in sites of acacia and lime tree cultures. As a result from such cuttings, coppice plantations have grown with increasing rotation number. Thus, for example, after cuttings carried out in poplar cultures which grow along river of Danube and on its islands, in the next 8-10 years, another cutting can be performed, but that time – in coppice plantations which normally are of a $d_{1,3} = 10-15$ cm and a $H = 10-12$ m.

When a preference has to be given to one or another kind of biofuel, usually the fuel price, the price and the costs for the combustion equipment installation, and the price for services are taken into account. The cheapest is that energy which is released from chops, charcoal and firewood. The tree species influences, to a significant extent, on the calorific value and, consequently, to the energy price. Wood is sold by spatial cubic meters.

Energetic chips are usually sold by ton; their calorific value depends, to the largest extent, upon their moisture. Yet, it is much easier, at their supply, as well as at wood one, to control

their volume. And again, the tree species and the fraction size are of a great importance. The most serious problem in chips production, considered by the firms dealing with wood chips harvesting in our country, is the value of chips transportation. The wood chips are too voluminous, of a low specific weight, and all that results unprofitable on road transportation, at a distance of more than 1500 km. That is why for local utilization, i.e. for short-distance transport, it is appropriate to use wood chips for burning. The future trend will be wood chips incineration. The market of chips market in our country is still underdeveloped, compared to that one in other states, even though certain good practices already exist, in the recent years. Such kind of heating is applicable mostly to houses where people still use to store firewood. By the current date, the population in Bulgaria uses predominantly firewood for heating; and it is really a pity that wood is burnt in incineration facilities which energetic efficiency is low (efficiency up to 50-60%). If such incineration facilities are replaced by a high energy efficient ones, the quantity of the used combustibles, i.e. wood, can be 3-4 times reduced. The highest potential is that one in the public sector premises: schools, hospitals, kindergartens comprised. Besides, there are 5 thermal power stations in our country, where wood chips of moisture content up to 45% are utilized. There is also logistics which plays a very important part, taking into account the way of performing such operations as packing, loading and unloading which raise the fuel cost.

For the time being, the most economic kinds of fuels produced from the forest wood biomass are briquettes and wood, but some defects can also be found out therein, as following: a need of a larger areas or rooms for storage; wood chopping and subsequent piling; a larger quantity of ash released in burning; a longer and harder operations related to the boiler; there is also a lower efficiency of the boiler for firewood or briquettes, compared to that one of the boiler for pellets: such fact shall not be neglected.

As regard to charcoal, it is the restrictive legal frame in Bulgaria, which shall be put at the very first place as a hindrance because it puts under a ban the open-ended method for charcoal production. There are also the economic aspects of production, where the retort method is used, which shall be taken into consideration. By the retort method, the wood consumption for the production of 1 ton charcoal decreases from 30 to 50%. Such process under oversight permits a performance of a strict control on quality, a choice of the charring level, even a creation of different classes of products: from low to top quality ones, and the relative different prices.

The crisis in economy has also reflected on the producers themselves, as the greatest part of them use as a raw material technological waste generated from wood processing enterprises. And with the reduction of the material requisitions delivered to the above said factories, the waste products, used as a raw material for the production of the pellets, have decreased, as well.

For keeping the biomass on as a competitive energy source, it is very important to provide for the optimization of the chain from the source to the end consumer.

This study identifies the trends of utilization of the main wood biomass kinds in Bulgaria, regards to their quantity and spread, demonstrating how the forestry waste utilization can be optimized.

RESULTS AND DISCUSSION

The contemporaneous trends to waste less technologies and economically efficient uses in depth of raw materials impose the necessity of a complex and full value utilization, even of the limited biomass resources. In logging, conducted in the cutting areas or stacks, there are branches of a different size, known by the common denomination of brushwood or twigs, which are not used: they get burnt or are left in the cutting areas, instead, and then decay. A part of them which diameter is greater than 3 cm can be used as firewood, while boughs of a diameter less than 3 are left unused in the cutting areas. Taking into consideration the mountain scenery of our forest massifs, and not only it, along with what above said, it has to be added that there are also some quantities of usable raw material dropping, mainly consisting of branches and thin-size stems left in the cutting areas after cutting, and it is due

to the fact that the transportation leads to a decrease in machinery productivity, hence, to a worsening of the economic indices. For that reason, there is a trend to increase such dropping material.

In that relation, there is a need of optimization consisting of a preliminary preparation by collecting of waste piles, chipping and transportation of chips to the end consumer: i.e. to the factory for pellets or briquettes production. When the logging technology misses to be followed, it reflects on the biomass utilization chain and leads to a pile processing of less quantities of wood waste; hence, the device (machine) shall be continuously moved from one point to another, during the operation, which causes a significant increase of the operating costs.

In the recent years, the cutting area residues utilization has been starting in our country, and it is a very important step to the assimilation of that biomass which consists of about 1, 1 млн. м³. Technologies are adopted, being already in the process of exploitation, for the post cutting assimilation of branches, chipped by movable chippers in the cutting area. Chippers as „Vermeer BC 1500”, „Schliesing 220 MX”, „Caravaggi”, „Droepelmann” and others are used for that purpose. The chips are directly loaded on adapted trailers or trucks. The yield is of 10-18 solid cubic meters per day (m³/day). That same technology is furtherly applied to work in stationary conditions; and the chips, obtained in the forest and subsequently processed, are used for the production of the briquettes made from forest waste. For example, when such technology is applied, 1 ton of briquettes can be obtained from an average quantity of 5 m³ waste wood, using 3 presses. Annually, only in the summer, 350-400 tons or about 1200 solid cubic meters of forest waste branches are processed. A positive effect is also the use of unutilized – even considered unnecessary - undergrowth: South European flowering ash (*Fraxinus ornus* L.), European hornbeam (*Carpinus betulus*) and others, parallelly to the forest waste removal from the cutting areas.

Experiences have been conducted on the islands in the river of Danube, consisting of whole tree harvesting from poplar cultures sprouts, tugboats haulage across the river and chipping of the materials by a movable chipper. The chips have been delivered to some enterprises for pellets production or for burning. It is considered as more appropriate that wood should be chipped directly in the cutting area but, due to the missing possibilities for a direct transportation of the chips, especially across the river, it is still a problem to be solved. Easier solutions could be found out regard to the poplar and acacia sprouts along the river where whole trees are harvested and hauled. Usually, before chipping, huge piles are prepared which volume is of 150-250 tons. „JENZ HEM 581” or „Doppstadt DH 608” chippers are used which productivity is of 70-180 tons/daily. The problem is that the working capacity of these machines cannot be sufficiently exploited. For keeping the biomass on as a competitive energy source, it is very important to provide for the optimization of the chain from the source to the end consumer.

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

Three maps of Bulgaria have been made, which contain the main companies-producers, their location and the volume of production: pellets, briquettes and charcoal, respectively (s. figures 1, 2 and 3). The maps have been elaborated on the basis of the data provided by Bulgarian National Statistical Institute and by a WS survey, after site visits to the firms-producers. The reasons for which we have resourced to different sources are that we have had some doubts about incomplete information given to us by the firms.

The average annual production volume of the companies vary from 250-10000 tons of pellets, 400-1100 tons of briquettes and 100-5000 tons of charcoal, respectively. The low volumes produced by small-scale firms while the high ones by large-scale producers: i.e. factories. The factories have put in their business plans production which is about twice higher than its volume indicated in documents. There are 60%, approximately, of the pellet producers (where the pellet share amounts to 15-20% of the total production) who use small-

size presses. Such pressing machines belong to the so called type of “pick up anything you find and use it” where waste remained from the proper production: saw-dust, for example, are used as raw materials, and, consequently, it leads to unfair competition because of a non declared production of pellets and their lower purchase prices. The reasons for that are: unregulated and vague market, unfair firms and companies dealing with pellet production; on the one hand, it is due to the low business opportunities in our country, and, on the other one, to a scarcely provided control not only on production but also on purchase; besides, the small goals set for the firms shall also be taken into account.

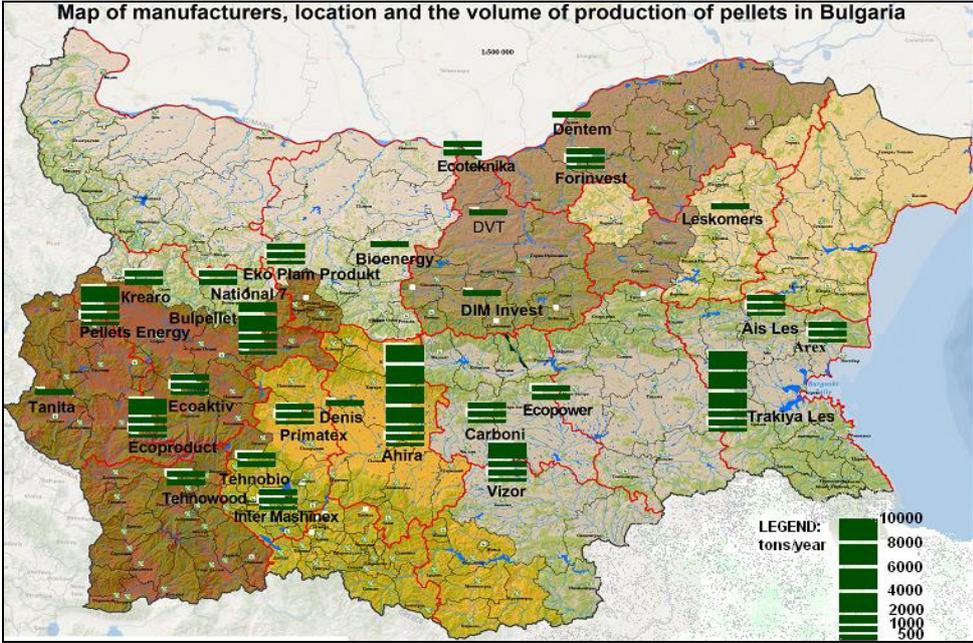


Fig.1. Map of manufacturers, location and the volume of production of pellets

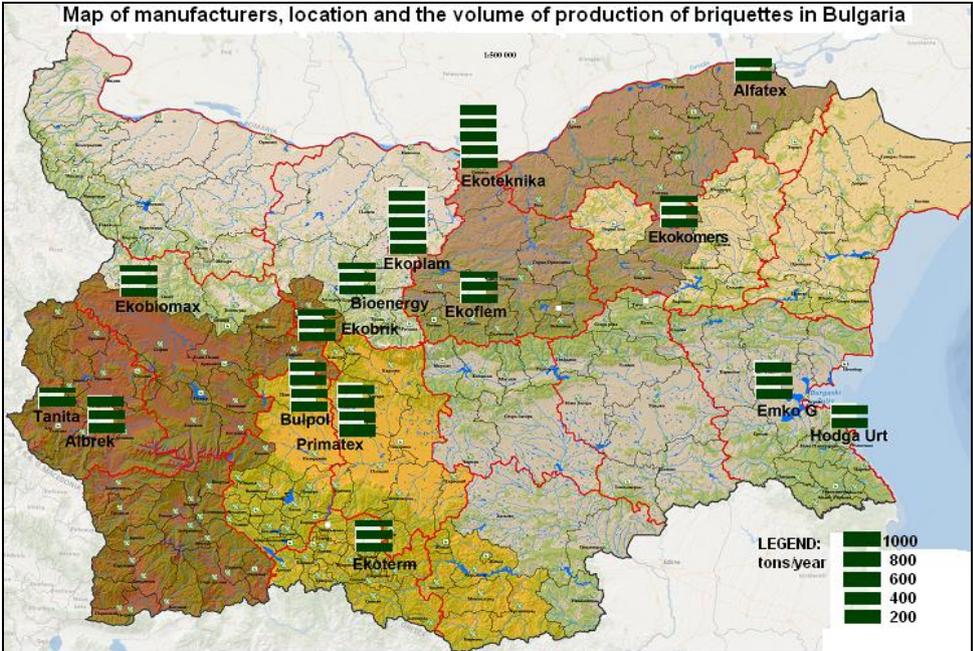


Fig.2. Map of manufacturers, location and the volume of production of briquettes

Figure 4 shows the distribution of biofuels in Bulgaria. Data on 60-70% of the production of pellets, eco briquettes and charcoal in Bulgaria have been indicated therein. The rest 30-40% are shares belonging to the shadow economy. There are, for example, too many enterprises (factories) for wood processing and furniture production, missing to declare their entire production of pellets and eco briquettes.

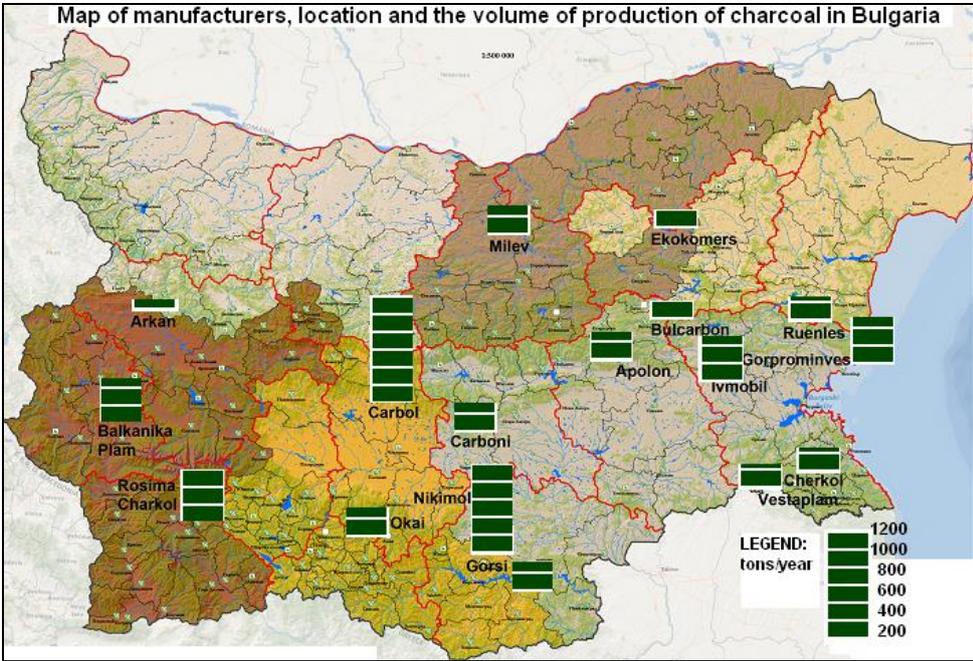


Fig.3. Map of manufacturers, location and the volume of production of charcoal

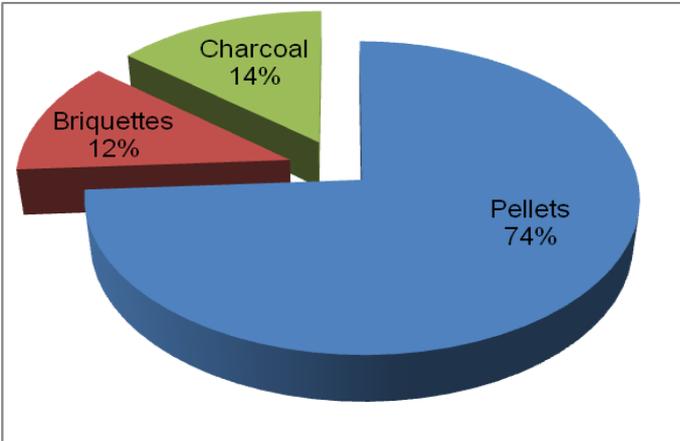


Fig.4. Percentage distribution in the production of pellets, briquettes and charcoal

The same behavior is also kept up by the small-scale saw-mill shops 100% of which do not indicate that are dealing with biofuel production and that the real amount of biofuels is of 150-300 tons/year at a workshop.

The most frequent is the use of Bulgarian and Chinese machines (a small-size pressing machine and a small-size dryer) with some modifications (improvements) introduced by producers. Usually, it is possible to find a niche for such machines at our home market and to sale the production.

There is an enormous difference between the operating conditions in large-scale and small-scale firms. For example, in contemporaneous plants the process of production is dustless and completely automated while the operations in small workshops (most of which are no

else but reconstructed ex-agricultural premises) are sordid and suffocating. As about the operational control, it is provided for the large-scale enterprises, but it is highly undervalued for the small-scale ones.

The total analysis of wood pellets and briquettes sales shows that about 2/3 of sales have been and are being - realized at home market, under previously concluded contracts, especially after quality requirements adoption. The most frequent exports are for Greece, Turkey and Italy.

Observations have been conducted where the costs for raw materials are considered to take the main part in the prime cost of production of pellets production. Other basic components of the costs and expenses are payroll and manufacturing costs where costs for drying are included: of 25% and 20%, respectively. In principle, two workers only are necessary for the whole process of production.

The best quality of the pellets is obtained when pellets are produced from deciduous wood: from logs and not from waste. More bark is left in wood, more pellets quality gets worse; so, the best pellets are mad from logs while the worst ones from cuttings, shavings, branches etc.

According to our assessments, the most favorable climate for the development of biofuels production is the production of briquettes for home market and of pellets for foreign ones while charcoal production is good for both of the markets.

Figure 5 shows the production of pellets in Bulgaria, in 2013, in dependence of wood used for the purpose.

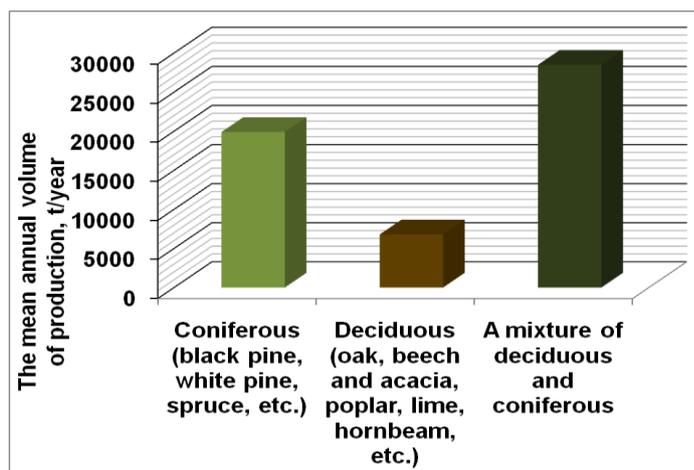


Fig. 5. Production of pellets in dependence of wood used for the purpose

In that relation, it can be stated that there are serious problems, in our country, regard to the construction of the plants and the production of biofuels from wood biomass, as, for example, the following below:

- Incorrect suppliers of machines and equipment.
- It has been proved that during the tests of the plants either suppliers or buyers are often not too familiar with the process; hence, such an incomplete knowledge leads to a delay in the credit allotment and repayment; subsequently, the amounts of the interests rise creating pecuniary embarrassments for both of the parties.
- Missing services for maintenance.
- The large-scale companies are provided of raw material while the small-scale firms often miss it.
- The small-scale firms have no VAT registration; that is why their purchase prices are lower.
- It is very hard to find quality workers. Preliminary training should be provided but it is not regulated.

- When raw material is purchased, especially if it is a root purchase, that raw material or wood is not separated to wood designed for pellets, briquettes and charcoal: as a minimum, it is mixed, instead, with the technological wood designed for plates and cellulose production.
- There is also unfair competition in the field of charcoal production and sale both at home and foreign markets, especially, by countries which are not EU members, as the method applied to charcoal production is the open-ended one.
- To start building a plant, one shall also rely on one`s own funds, and not on 100% crediting by banks.

This study has examined mainly the aspects relative to production and some economic ones regard to indentifying the trends in the use of the basic types of wood in Bulgaria, in quantitative aspect, and their spread.

Further studies shall be performed on ecological and social consequences resulting from forest wood biomass use. Regardless of the fact that the quality of the materials is an important parameter of the precarious forest wood biomass supply chain, reflecting on the quantity and the price of the produced biofuels, we intend to make it the object of our next study.

CONCLUSIONS

- There is a need of State Policy, purposeful and large-scale, which shall be conducted with the aim to affirm and popularize, among the society, the technologies and the processes relative to the forest biomass utilization and the possibilities for its use, with the objective to reduce the energy dependence of the market subjects in Bulgaria by investment in realization of efficient ecological technologies for thermal and electrical energy production.
- Amendments shall be introduced into legal framework with the purpose to give priority to the use of the wood biomass for heating of public premises (State, Regional and Municipal premises, schools, hospitals, post offices etc.). It is also necessary to stimulate and increase the investments in the production of pellets and briquettes with the purpose to provide for subsidies for costs and expenses and to create and promote incentive policies directed at assisting investors.
- Grant schemes and preferences shall be provided for consumers-households for investing in fuel and energy produced from forest wood biomass, with the purpose to replace the conventional fuels with biofuels, or in building of new plants for biomass utilization.
- Favorable conditions shall be offered for clustering of gathered market subjects united by common interests: i.e. firms and enterprises dealing with logging and wood processing, transport and logistics structures, producers of biofuels from waste wood biomass, companies offering efficient facilities for biomass utilization, experts, advisers, non governmental organizations and others.
- Establishment of simpler and clearer administrative procedure applicable to investment in biofuels production, in technologies and facilities for biomass utilization. Reduction of the corporate taxes paid by companies producers of fuels from wood biomass and firms producers of ecological and efficient facilities for biofuels utilization.
- It is necessary to conduct further biological and ecological studies in permanent forest plots located in cutting areas, intending especially areas where cutting operations are of a higher intensity, with the purpose to determine the long-term effects of waste removal after logging.

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