"A strategy for the sustainable use of wood and its implementation as base for legislative measures on regional level"

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Logistics and distribution concept for the three participating regions: Sierra de Gata (ES), Cova da Beira (PT) and Belovo (BG)

Project ASTWOOD. – "A strategy for the sustainable use of wood and its implementation as base for legislative measures on regional level"

WP3. – Concept development

D3.3. – Logistics and distribution concept for the three participating regions: Sierra de Gata (ES), Cova da Beira (PT) and Belovo (BG)

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1. Purpose of the concept and general information

1.1. General information on ASTWOOD

- Summary

In the Iberic peninsula, the use of wood as energy carrier for heating purposes is common in villages and rural areas. Wood is collected in form of large pieces and used for heating in common fireplaces / chimneys. Modern heating systems working on pellets or wood chips have not managed to be implemented.
This is in part due to the image of wood: the image of this energy carrier within the population is in contrast to other European countries, not that positive, although it is a renewable energy source: people see wood as a “dirty” technology, possibly due to the smoke and ashes.
Portugal, and especially Spain, has a strong contrast in relation to vegetation and climate. Many regions of the peninsula suffer relative cold winters, and relative large areas are covered by strong vegetation. Due to the dry summers and the forests which are mostly not cleaned of dead wood and dry bushes, large surface are lost due to uncontrolled bush fires. This has obviously devastating effects on the flora and fauna, as well as on the rural economy and life quality.
The region of Extremadura, bordering with Portugal, which intends to create an official legal frame favoring the collection of wood of the local forests, its valorization into pellets and its use in effective and modern heating systems. This concept, although commonly used in other centre or northern European countries is whether known neither in Spain nor in Portugal. The reasons therefore are among others: wrong image of the technology, no market interest for potential companies, no locally available pellets, which are not cost competitive with conventional fuels due to high transport costs.
The aim of the project is therefore to develop a strategy paper which will serve as a base for implementing a legal frame work on political level for enhancing the use of biomass for pellet or chip production and their use in modern heating systems on domestic level. The concept shall be integrated into the local environment system. The Spanish partner in Extremadura will make a first step and install in at least one governmental building a modern heating system using local pellets or wood chips. The neighboring Portuguese region will implement in a parallel way this technology and integrate this concept in its legal incentives for the promotion of renewable energies. The Bulgarian partner will transfer the implementation strategy developed in Spain and Portugal to its region.
The Austrian partner (OFI) will transmit its expertise in the area of wood, pellets and heating systems. By this way, it will be possible to establish codes of good practice, applicable in both regions.

- List of participants

Role	N°	Participant name	Short name	Country
CO	1	Mancomunidad Municipios Sierra de Gata	MMSG	Spain
CB	2	Associação de Municipios da Cova da Beira	AMCB	Portugal
CB	3	Österreichisches Forschungsinstitut für Chemie und Technik	OFI	Austria
CB	4	Biomasa Peninsular S.A.	BPE	Spain
CB	5	Protecma Energía y Medio Ambiente S.L.	PROTECMA	Spain

CB	6	Regional Energy Agency of Pazardjik	REAP	Bulgaria
CB	7	Municipality of Belovo	MB	Bulgaria

• Expected Results and Potential Impacts

(a) Direct outcomes to be achieve by the end of the duration of the project
The consortium expects following outcomes:
- A policy (legislative measures) in the three regions of Portugal, Spain and Bulgaria promoting the regional production and use of wood pellets and chips. This policy shall be replicable in any other region and will serve for policy makers on public level as guide for implementing funding and promotion campaigns.
- A demonstration at the three participating regions for the use of the pellets consisting of modern wood burners, installed in a way, that dissemination can be made.

(b) Potential impacts of the action – in case of a broader scale of implementation as well as in the longer run after the end of the project/contract
The main project impact is the fact of the use of renewable energy in the following territories: Spain, Portugal and Bulgaria.
In other countries of Europe the use of pellets has already certain importance, however, in the three target territories, in a particular case the project leader zone, the population is averse to use any kind of non traditional energy. In this sense, the project will have a significant impact within the local population, but also in the neighboring zones. This is the reason why ”Astwood” is led and it is promoted by the own Local Administration through a grouping of Municipalities, because in addition, it is attempted that the use of pellets for the heat production is experienced in the own building of the district at the first time.
The project will also have a sensibly higher impact and projection in a short and a long term, because it will impose **changes in the legislation** and in the administration budgets. The project leader predicts, after this experimentation phase, to have budgetary applications for the concession of aids or grants directed to the population for the use of intelligent energies, so that these are implemented step by step into the territories.
In this way it will be produced an effect of awareness in the population by the city councils use of renewable energies. The city councils will cause an effect of mimicry in other sectors of the society helping it with legislation and economic incentives for the implantation of these energies.

The wood potential in form of waste residue is extremely high (43 Mtoe of forest residues– EU biomass production potential for 2010)[1]. There is hardly any use of this wood. Therefore we estimate that the project can trigger the valorization of this wood and its subsequent use on domestic level. The same happens with the wood burners, which are technologically seen well developed in other European countries, but are not present in Spain. This means that as soon that there is a demand for such technology, the market will be able to make the needed equipment available to a cost competitive price.

As in other countries like Austria, Germany, Finland, Sweden,… the wood sector has created many jobs. This can and will be replicated in other countries further behind. There is a large potential for

[1] Biomass action plan, Communication from the Commision (COM (2005) 628 final). Annex 2.EU biomass production potential, conservative estimations.

job creation[2]**.** ASTWOOD can catalyze this, contributing additionally to efficient and clean use of renewable energy and in that way to the Kyoto Protocol.

The three partners will demonstrate the success of their policies for the enhancement of the use of wood in efficient and modern burners, so that other regions in their countries can replicate with no problem their experience.

• Target Groups and Key Actors

The target groups are:

- the **regional and local population** as domestic end users of this RE
- **Politicians** and local **lobbying groups** who may influence the decision- making in the area of environmental and energy policies /legal framework both at local and regional level.
- Parallel **town councils** on national level including their **lord mayors**
- Another target group is the **wood industry and agriculture sector**, which can find on the biomass production an opportunity for diversification: the collection and valorization of wood, producing the raw material for pellets and chips, and the logistic and sales networks at regional and local scale.
- Finally, another target group is the **industrial** sector. The production of equipment, the assembling and the operation and maintenance of biomass fuelled power plants offer opportunities for business creation and development and for the creation of new jobs.

The key actors identified on this project are:

- City councils,
- Provincial and regional institutions
- Farmers, particularly through Cooperatives and Associations.
- Timber Industry

Local Authorities are seriously involved in the project, as they have been the ones who have proposed it. The project coordinator and leader of the "Astwood" Project is the Mancomunidad de la Sierra de Gata; the Portuguese partner cooperates since years in transnational cooperation projects with its Spanish comparable in the framework of projects financed by structural funds.

The institutions at regional level will be one of the project "target groups" since we try they get the agreement of the regional governments in the adoption of suitable legislative measures for the promotion and use of the renewable energies, which have very low or even null implementation in our territories.

Social groups, like farmers, have not participated in the initial project idea – the project tries to encourage and make them aware – but they will participate as beneficiaries in the project since with its necessities and worries we will implement the studies and diagnosis and we will spread the use of these energies in their organizations. The project also wants to make aware the wood Industry

[2] If the biomass potential is fully exploited, the European Biomass Association (AEBIOM – www.aebiom.org) estimates that the employment in the sector will increase up to 1.000.000 jobs by 2010. In particular the production of raw material would create large number of jobs (500,000 jobs in the agricultural industry to provide the primary biomass fuels)

and show that these new ways of energy can help to the economic development of a territory and create new jobs.

This candidacy has been proposed by local institutions so that they are seriously involved in the project. The project idea has arisen from them and they will implement it with the appropriate co-financing.
Social and economical organizations, as the Timber Industry, will be one of the priorities of "Astwood". It will take part in the foreseen seminars. We hope the local population will be the most favoured with the project. It will take part in the debates and in the conferences we will hold on the framework of the project.

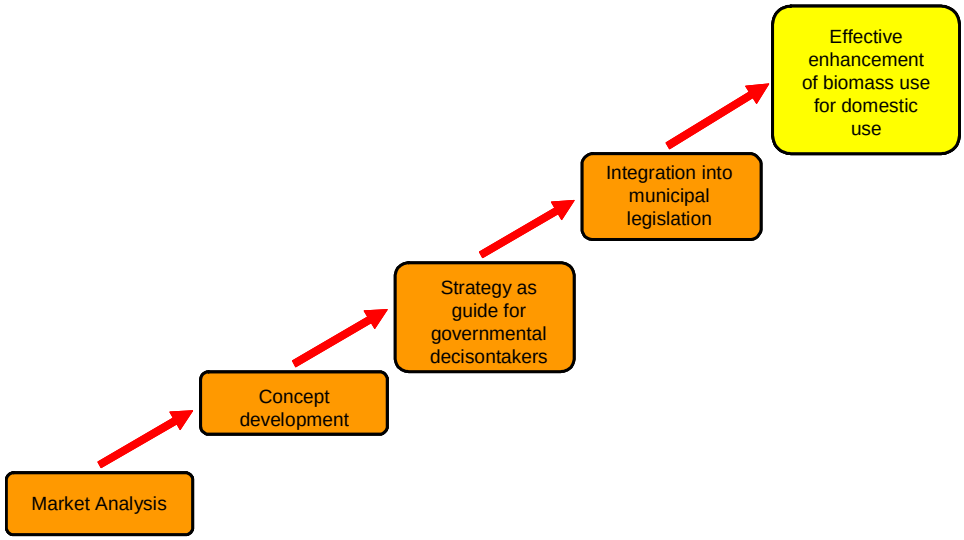
1.2. Work package 3 (Concept development) and Deliverable D.3.3. (Logistics and distribution concept)

- Description of WP3

The precise description of WP3 is *"Concept development for the regional and sustainable use and valorization of wood as raw material for pellets and chips, including logistics and distribution of the pellets, and their use in new and efficient burners".*

The sequence of work packages in the ASTWOOD project was planned as follows:

Figure1. Diagram for project development



Based on results from WP2 a feasible - economically and technically – concept will be developed for the regional and sustainable use and valorisation of wood as raw material for pellets and chips, including logistics and distribution of the pellets, and their use in new and efficient burners. The consortium will in all cases study other regional strategies which have been implemented and will then study their results. The information gained will help to pinpoint bottlenecks and potential problems, so these can be tackled in time. If these initiatives are still on going, we will study the form to integrate them into ASTWOOD. This will happen on a regional and national level in Spain,

Portugal and Bulgaria. On the other hand, other positive initiatives taken in other countries, will be analyzed and studied, and if possible, integrated into the project.

Further, the partners will foresee to create synergies and cooperation with projects, which address similar issues and aims at promoting regional RES-Heat markets based on biomass. Networking and communication with the coordinators of these projects could allow learning and avoiding possible mistakes and bottlenecks and can be integrated in the concept development. As a fruit of the work done in this WP, the consortium will be in the position to describe clearly the barriers which might hinder the use of the tool to be developed in ASTWOOD. By the way, the concept development for the tool will be orientated in a way that bottlenecks are overcome, guaranteeing a successful market introduction.

- Tasks within WP3.

In this work package there are 4 major tasks:

1. Networking and communication with the coordinators of similar projects.
   The partners will contact the coordinators of similar projects for learning and avoiding possible mistakes, so the knowledge is integrated in the concept development. These lessons learnt will be adapted to national and regional situations. Some examples are the IEE projects: "5 EURES", ELVA, BIO-SOUTH.
2. Definition of bottlenecks.
   The aim of this task is to define in this early stage of the project the usual bottlenecks for the implementation of the wood pellets and chips, which have appeared in the other EU countries.
3. Logistics and distribution concept.
   The end users want a raw material for their domestic heating systems which is always available, which price shall not vary, and which is especially easy to handle. Pellets in sacks are only interesting if the end user needs small amounts. Wood chips need larger tanks for their storage. This has all a direct impact on the logistics necessary for the distribution of the material.
4. Concept for raw material collection and processing
   The partners will base their work package on the data and results of the previous WP. Depending on the location, availability of the raw material, a concept will be developed for an optimal collection strategy. Further, the processing itself will be targeted, meaning to analyze the most suitable end product in dependence of the amount and state of the raw material: possibly pellets might be more suitable than wood chips for certain raw materials. The aim is to be able to achieve with the developed concept a guide of which processing technology is most appropriare. The concept will contain financial considerations.

- Outcome of this work package.

A concept which includes different scenarios for a sustainable implementation of the wood and heating market, which provides an example of how biomass can be used in a most sustainable way in domestic heating systems. This concept will be based on the previous WP, and is the base for the tool. Its input comes from different levels: from EU level, based on the input from the international partners who know the developments other countries have undergone in the past years concerning the implementation of the wood chips and pellets. Further, it is based in national level, taking the current legislation into account, and from regional basis, depending on the circumstances. Special consideration will be paid towards job creations and involvement of the rural sector on the examples of other more experienced EU countries.

- Deliverables of this work package:
  - Overview of similar ongoing projects in Europe

- Definition of the barriers to be addressed and the process of engagement of the other market actors
- Concept for raw material collection, logistics, and processing
- Overall concept for the tool

• Role and contribution of each partner in this WP

OFI (WP Leader) offers technology and experience transfer from Central Europe, so the test locations can learn of positive examples on the topic.
Biomasa Peninsular will provide assistance in the topic of biomass collection.
REAP will develop the logistics and distribution concept.
Protecma will provide input in the area of amalgamating all the concept and bringning together the differences of the different regions.

2. Logistics and distribution concept for the Belovo region, Bulgaria

The present Logistics and Distribution concept aims to describe, foresee, and recommend all stages of the following processes: collection, processing, and shipment of biomass to wooden fuel production enterprises (i.e. production of pellets and/or chips), as well as to define the target groups who would consume this fuel. It is very important for the concept to define the actual quantities of biomass in the region Belovo. Also, the concept must answer the following questions:

1. Is the biomass extraction in the three regions sustainable, and
2. What is its energy content?

Quantities and energy estimation of the current biomass potential determine economical profitability for production of wooden fuel. Another, very substantial factor is the cost of biomass extraction – this is a complex index, which is influenced mainly from the territory specifications, condition of forest roads, availability or unavailability and price of technical equipment for wood biomass processing, etc.

Main objectives of the concept are:

- Analysis of the structure and condition of forests in Municipality of Belovo, including forest roads condition;
- Study and analysis of wood biomass in MB;
- Definition of technical characteristics, energy content of the existing biomass and its fitness for pellets/chips production;
- Identification and analysis of the municipal energy consumption;
- Study and determination of suitable technology and technical equipment for extraction and processing of wood biomass into chips;
- Determination of appropriate storehouse for storage of chips;
- Analysis of chips/pellets market;
- Analysis of market for heating systems, which use wooden fuel;

- Defining the priorities in setting up a distribution network which will supply wooden fuel to end users;
- An overview of legislative norms which are stimulating the use and distribution of wooden fuel and respective heating systems.

2.1. Study and identification of existing forest biomass stock /Municipality of Belovo/.

Total forest area in the Municipality of Belovo is 24 784,30 ha, and it has the following division by purpose:

- Economical purposes: 16 751,70 ha.
- Special purposes: 4 721,20 ha
- Recreation forests and territories: 1 296,60 ha
- Afforested areas (excluding dwarf pine – *Pinus Montana)*: 19 565,70 ha

Total timber stock, including branches, is 4 791 930 m^3, and average stock on 1 ha, including branches, is 245 m^3 / ha.
Total average annual growth, including branches, is 69 088 m^3, and average annual growth on 1 ha, with branches, is 3,5 m^3 / ha.
Annual extraction from primary wood cutting (with branches) is 24 885 m^3.
Annual extraction from secondary and sanitary wood cutting (with branches) is 16 782 m^3.
Total annual extraction from reconstruction activities (with branches): 2 205 m^3,
Total annual extraction (with branches): 43 871 m^3,
Annual extraction towards total stock: 0.9 %,
Annual extraction towards annual growth: 64 %,
Average annual extraction on 1 ha is 2,20 m^3,
The medium age of trees (all sorts included) is 68 years, average corpulence is 0,71, and average bonitet is 2,90.

The following table shows the annual extraction of forest biomass by sorts in MB:

	Coniferous		Broad-leaved	
	dense m^3	ton	dense m^3	ton
Brushwood	230	132.25	100	79.0
Branches	1560	897.00	420	331.8
Firewood	1 900	1 092.50	3 030	2 393.7
Bark	1560	897.00	420	331.8
Stubs	1000	575.00	650	513.5
Total:	6 250	3 593.75	4 620	3 649.8

These quantities of biomass are within the average annual forest felling, which is in conformity with the natural forest growth. There are also quantities of "lying" forest biomass, because of bad cleaning of forests. According to experts' estimation, these quantities of biomass amount to around 35 % of the average annual forest wood extraction.

The structure of tree species in % is as follows:

Beech	30.8
Pine-tree	14.3
Winter oak	12.8
Spruce	11.0
Fir	5.8
Black pine	4.5
Hornbeam	2.1
Aspen	1.5
Other	17.2

2.2. Determination /calculation/ of energy potential of forest biomass.

The energy potential of forest biomass can be calculated using appropriate software, taking into consideration the type and condition of forest biomass. As a result, referring to Municipality of Belovo, the situation is as follows:

Energy potential of the existing forest biomass in MB	
Biomass from coniferous trees	Biomass from broad-leaved trees
8 984,4 MWh	11 550 MWh
TOTAL: 20 534,4 MWh	

2.3. Estimation of the forest road condition.

The total length of forest roads on the territory of Belovo State Forestry is around 84 km. They are relatively in good condition, but the passability in some sections is difficult because of the lying biomass, which has not been cleaned, as mentioned above. But this problem will gradually be resolved as the forest biomass is becoming a market product.

2.4. Stimulating measures for wood processing companies to collect the overall forest biomass.

The gradual conversion of forest residues into a market product will stimulate companies to take biomass out of forests and to sell it or to produce wooden fuel by themselves. Except the profit margins for companies performing forest work, there will be also other advantages:

- Dry lying biomass is one of the major reasons causing forest fires during summer periods. There have been noted cases of self-ignition of dry lying forest biomass;
- Reproduction of many tree species is impeded, if on the ground, above, below, and around them there is decaying wood mass.

Introduction of biomass in traditional product range, offered by wood processing companies would change there profile into a direction of broadening the activities they perform. Many of them will easily transform part of their activities into chips supplying; and that chips can be used directly for energy production, or it could be a raw material for pellet production. In this case, extraction of wood can be classified as follows: extraction of wood for construction and furniture industry, and extraction of **energy wood.**

At the same time, it is necessary to make further efforts in order to reduce the consumption of energy wood for direct combustion in primitive combustion installations, which have very low efficiency, i.e. it is necessary to stimulate the conversion of energy wood into raw material for production of wooden fuel.

2.5. Technical specification of the raw material for production of wooden fuel.

In principal, the main source for chips is local forestry, and more precisely, the residual lignin-cellulose biomass, which remains after forest woodcutting. Energy wood includes: firewood, twigs (with diameter less than 3 cm), brushwood (leafage with small branches), stubs, and bark. Currently, in Municipality of Belovo, there is interest only to firewood, twigs, and part of brushwood. Their share in the annual quantity of broad-leaved forest biomass represents 45 %. Low-quality wood, extracted at sanitary felling could also be used as a raw material for chips production. Such sanitary felling is repeated periodically in 10 years. It must be mentioned that currently very big part (over 50%) from forest waste biomass is not being used at all (mainly brushwood with leaf mass, bark removed at cutting, stubs, and wood shavings).

The following products are obtained during wood cutting: large-round or construction timber (lumber obtained from the stalk part of a tree); small-round timber and logs (with standard dimension of diameter between 3 to 7 mm); brushwood (small branches with leaf mass). Energy source represents bigger part of firewood, overall brushwood, and part of small-sized round timber, which is of no interest to industry (cellulose and wooden slabs).

Broadly speaking, all round and chopped wood material with diameter below 70 mm can be referred to firewood, and which represent branchless stalk, small branches, brushwood, and cut roots.

Firewood is mainly measured in volume units such as: solid cubic meter or space cubic meter. One solid cubic meter is equal approximately to 2,17 space cubic meters. Conversion of volume units into weigh units is shown in the table below:

Measure	Coniferous wood, tons	Broad-leaved wood, tons
Solid m^3	0,575	0,792
Space m^3	0,265	0,365

Transformation of forest waste biomass into energy wood shavings is more efficient when performed during wood cutting. The quantity extraction of energy wood shavings from whole low-stalk trees is with 20-35 % higher than the quantity extraction of energy wood shavings from trimmed trees.

Chips is an wood product, extracted from forest, and has a first class of transformation – fragmentation. It is a renewable fuel and is actually a very serious alternative of fossil fuels. CO_2-emmissions are very low. Price is competitive, and it gives opportunity for automation and high efficiency of combustion installations which use such fuel.

One thousand liters of boiler oil fuel can be substituted by 10-15 m^3 chips. Heating capacity of chips with moisture content up to 40 % is from 3 to 4,3 kWh/kg, i.e. 1 m^3 chips will give around 750 kWh of energy.

Bulky density of chips depends on the type and moisture content of wood and may vary between 160 to 250 kg/m^3. For chips extracted from heavy broad-leaved wood (beech, oak, hornbeam, etc.) with moisture content of 40 %, the average bulky density is around 230 kg/m^3. One solid cubic meter wood will give 2,8 m^3 of chips.

According to the Austrian standard ÖNORM 7133, temporary adopted in Bulgaria, chips is classified by several components: dimensions, moisture content, bulky density, and ash content. The table below shows information about different dimensions of chips, and their classification.

Size parameters of chips in accordance to ÖNORM 7133 with an average moisture content of 45 ±5 % and average length of 30-50 mm.

Class	Fraction content, mm			
	Max. 20 %	60-100 %	Max. 20 %	Max. 40 %
G 30	> 16	16-2.8	2.8-1	< 1
G 50	< 31.5	31.5-5.6	5.6-1	< 1
G 100	> 63	63-11.2	11.2-1	< 1

According to that standard, classes for ash content of chips are two: A1 – ash content < 1 %, and A2 – with ash content 1-1,5 %.

2.6. Wood extraction methods and chips equipment

Small timber is extracted as non-trimmed. Wood cutting is performed mainly by hand with chain-saw. Chips, obtained in this way, has a high content of bark (over 20 %), and it is suitable to be used as fuel for small heating systems (below 200 kW).
Extraction of chips from whole trees, sanitary felling, and reconstruction is performed by agricultural tractors. With their assistance, through coupling, mobile cutting machines are put into motion, and manipulators for collection, loading, and feeding the stalks for grinding.

Grinding is performed on temporary platform in the area of wood cutting by a mobile chipping machine or by hammering grinders, which are put into motion by the tractor's engine or by an independent power supply. Cutting (grinding) machines are mainly of disk-type or screw-type. Knives are 2 to 4, radially fixed on the disc. Productivity of such machine is from 10 to 40 m^3 per effective working hour, and it depends on the way of power supply.

Forest practice predicts organizing different wood cuttings on definite time intervals. It depends on the growing cycle of young forests (normally these intervals are 10 years). Moreover, periodically cuttings are being organized for shattered trees in order to transform forests in high-stalk forests. Special cuttings are also sanitary felling for dragging out forest wood, which has rotten or/and burned stalks. If no roads exist near fallen wood material, rope lines are used, as well as winch and animal traction. Stalks are being dragged out on temporary platform, where trimming will be performed and then grinding of branches.

In primary wood cutting mainly timber for construction is being extracted, and the trimmed branches are being cut and used as firewood, technology timber, and brushwood. These treatments are performed on a temporary platform, where another operation could be organized as well – feeding the material using a hydraulic crane in order to facilitate chips production.

Wooden fuel can be transported grinded or non-grinded. However, because of the very low density of wooden residues, it is advisable to grind it at small splinters before transportation at long distances. For short transport distances (under 20 km) it is possible to use agricultural tractors. For longer distances, trucks with superstructure of carriages and storage capacity of up to 40 m^3 or container trucks are being used.

Equipment must be high-passable with mechanized loading at the felling spot, and able to pass through sloped and barred territories.

2.7. Equipment and technology for extraction and transportation of chips at distance up to 20 km.

Described technology is based on complex equipment for chips production from a Bulgarian company – Diavach Ltd.

This equipment contains the following: truck with chassis and grinding machine installed, truck with self-discharging trailer (container); stationary grinding machine. Trucks are high-passable models, URAL type (Russian). They are driven by gas-generators, which work on chips. At the storage, situated near the end consumers, chips is stored in cells frontal-loading machine type FADROMA. For performing secondary operations, the truck with chassis is equipped with a hydraulic manipulator and winch. .

There are four possible technologies for extraction and transportation of chips from the storage, situated in forest, to intermediate depot, and eventually to the end-consumer:

Technology A: grinding is performed on a temporary platform in the forest by a grinding machine, supplying the truck's carriage for transportation of chips. Grinding machine is driven by the power of truck's engine. Its charging with material is performed by a hydraulic manipulator. Its productivity per hour is around 15-20 m^3. Truck which is transporting chips has capacity of around 25-30 m^3.

Technology B: grinding wooden residues is performed by a grinding machine, installed on the truck's chassis (truck type – URAL) on a temporary platform at the primary storage in forest. The chips, obtained in this way, is loaded in 2 self-discharging containers with loading capacity of 20-30 m^3, and when these two containers are filled up, they are loaded on the second truck (type URAL) for transportation to the intermediate storage (the depot), and from there to the end-consumers. In this depot, chips is arranged in piles inside sheltered cells in sequence of their arrival. Piles are formed by the frontal-loading machine type FADROMA.

Technology C: grinding of wood residues is performed on the depot, and the chips obtained is arranged in piles, which are loaded on the truck's trailer at a later stage. This technology is a variety of Technology A.

Technology D: wood residues are transported to the consumer's store, where they are grinded to chips by a stationary grinding machine.

These four proposed technologies are possible to be implemented by means of high-passable equipment for narrow roads and bad weather conditions. And this equipment is based on 2 trucks, URAL-type 6x6, one of them equipped with chassis, stationary grinding machine, loading manipulator, and winch. The winch is necessary to drag timber when performing sanitary felling. Second truck is equipped with two self-discharging trailers (containers) situated on own cart. This truck could carry also and timber.

Fuel systems of both trucks are adapted to burn bio-fuels through gas-generators, which work on chips or pellets as fuel.

2.8. Chips storage.

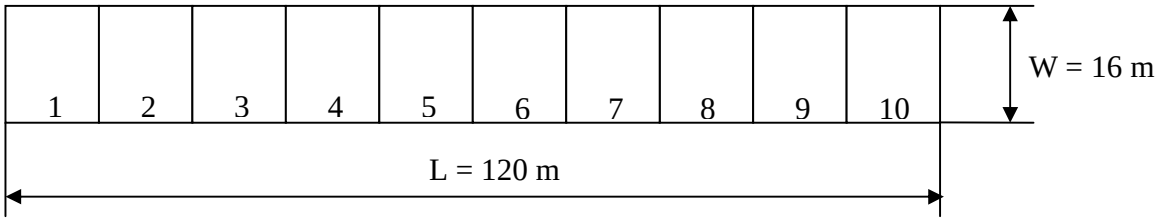
Storage is essential part from the technology chain - extraction and supply of chips to consumers, as it must provide the necessary fuel quantities through the active-working period of heating installation, and it must improve the fuel quality. The reason for ensuring stocks of chips is also defined by the seasonal extraction of wood material. The active working period of heating systems is 6 months (from 15 of October to 15 of April). The top of fuel consumption by regional and local power stations is during winter period. Respectively, consumption during summer period is very low. On the other hand, moisture content of raw material during winter is high (above 60 %), while in summer period it might reach levels of 20-30 %.

Starting point for chips storage design must take into consideration the following: stocks quantity, storage time, storage regime, and capacity of consumers. It is advised to make an open-air shelter with multi-cellular storage. Shredded wood is stored in piles by a front-loading machine in order of entering the store. Factors, which could influence the quality of fuel stored in this way, are: geographical location and orientation of the store, i.e. the store must be situated towards prevailing winds, and sun-shine; and storage equipment for regular mixing the chips. It is necessary to build up a wall on the wind side.

Example: a chips store with capacity of around 4000 m^3 (1000 tons), formed by 10 cells. Measurements of such store must be: L=120 m, W=16 m, H=4 m, with space volume of 7 680 m^3.

Measurements of cells must be: L=16 m, W=12 m, H=4 m. The volume of one chips pile in one cell is around 400 m^3.

Other points for chips storage are the so called buffer tanks right before fuel chambers. Their volume depends on boiler capacity and must ensure stock quantities for a one-week continuous work of the heating installation. From the chips store to consumers, transportation is performed by a truck with trailers, and it is the same truck which performs transportation of chips from the place of wood-cutting to the storage.



Horizontal plan of an open-air chips store

Total price of the equipment mentioned above is € 240 000.

2.9. Economic estimation for conversion of biomass into chips

From the above analyses, it is evident that in Bulgarian conditions most appropriate is to consume chips at maximum distance of 20 kms from the place of extraction. In the table below, all costs incurred during chips production are shown:

	Costs are in EUR / ton
Collection of branches, bark, and other forest biomass	9
Costs of treatment, i.e. grinding (chipping) forest biomass with mobile chipper	8
Loading on truck (including 1st haulage, roadside storage and truck load)	8
Transport cost , € / ton / 20 kms	10
Storage, conditioning and final transport	5
TOTAL :	40

Remark: Transport costs are calculated for distance of 20 km.

The amount of waste wood residuals from wood processing companies in Municipality of Belovo is relatively small – around 640 tons/year. Its composition, separated by sorts is shown in the table below:

Structure of the waste biomass from wood processing companies in the region					
sawdust		barks		wood shavings	
%	tons	%	tons	%	tons
45	288	35	224	20	128

Chips conversion of these wood residuals could be performed by a stationary shredding machine, installed in the wooden fuel store. Price of chips produced in this way, must not exceed € 30 /ton.

From the calculations above, it is evident that the annual extraction of biomass in Municipality of Belovo is 7 884 tons which is equal to 19 710 MWh.

2.10. Energy consumption of Municipality of Belovo.

In municipal buildings and appliances the following energy sources are being used: boiler oil fuel, coal, electricity, and firewood. Annual consumption by quantities and energy sources is shown in the following table:

Energy source	Quantity	Energy, MWh
Boiler oil fuel	56 ton	648,9
Electricity	224,8 MWh	224,8
Coal	74,5 ton	303,2
Firewood	88,7 ton	278.5
	TOTAL:	1 455,4

From this data it can be concluded that chips, produced from the available biomass, could fully eliminate usage of boiler oil fuel, coal, and firewood. Electricity consumption will drop down by around 40 % because there will be no need to additionally heat the municipal premises with electricity during the coldest winter period. For this purpose, of course, it is necessary to replace the old heating systems with new ones, which work on wooden fuel. Very effective when substituting heating systems is the complex approach: energy refurbishment of building, new heating systems, and automated installation, which will keep the required-by-law temperatures in premises. The return period for costs incurred for energy refurbishment (alone, without heating system replacement) is 8-10 years. Because of the big price difference between chips and other fuels, especially boiler oil fuel, the return period will shortened to 4 years if complex approach is accepted, i.e. substitution of heating systems will support financially the other energy save measures. On Bulgarian market one ton boiler oil fuel costs € 950, and the energy equivalent quantity of chips (4,5 tons) costs € 180. REAP has performed many energy audits in different public building so far, and they all show that when using the complex approach, return period of investment do not exceed 5 years.

All mentioned so far, concerns public energy consumption. Households in Belovo use firewood and coal for heating purposes. Pellets are a very good alternative to conventional fuels. But in order to convince this target group to start using this type of fuel, a good practice in the field of wooden fuel is needed. Undoubtedly, this could be substitution of fuel systems in municipal building, although in that sector will be more appropriate to use chips as fuel. Another important factor which is forcing households to search for another energy source for heating purposes is the constant growing of prices for coal and firewood.

The above made identification of annual biomass extraction shows that it can ensure energy for heating purposes in the public sector of Belovo municipality, but quantities are insufficient for a pellet factory. But distances in town of Belovo are short, and for this reason a central heating installation is very appropriate. This central heating installation will use chips as fuel and will supply heating energy to all municipal buildings, and some other buildings such as banks, insurance agencies, etc. The rest quantity of chips is creating interest to an operating in the region of Plovdiv

(at distance of around 60 km) pellet factory, as well as to a new pellet factory, which is currently being constructed in the region of Pazardjik (at distance of around 30 km).

A very important element from the group of measures for stimulation of wooden fuel usage is informational and advertising activities. Very helpful might be to organize workshops with representatives of different target groups, who have direct or indirect relations to the issue. These are representatives from business, local administration, ecological organizations, end-consumers, etc. Big interest will create the so called energy calculators, integrated in relevant web sites. They will allow users (even if they are not specialists) to input their own energy costs, and to receive as results from the energy calculator comparison and potential energy and cost economies if transition to wooden fuel is undertaken. Press releases, brochures, and participation in radio/TV programs on relevant topics would also raise public awareness about wooden fuel use.

2.11. **Study of the market for fuel systems on pellets/chips for domestic users and public sector**.

Currently, the Bulgarian market offers relatively wide range of heating systems, which work on pellets and chips:

- Stoves with capacity of 4 to 12 kW
- Pellet burners with capacity up to 45 kW, which can be integrated in existing boilers, working on boiler oil fuel
- Fuel systems with capacity up to 45 kW
- Fuel systems with capacity from 45 to 500 kW
- Fuel systems with capacity from 500 to 2 000 kW

Standard components of such fuel system include: tank with volume which must ensure one-week continuous work of the heating system, conveyor for feeding the burner with fuel, boiler, and electric panel for controlling the system. The conveyor is driven by an electric engine, and the circles of this engine are regulated lightly by a frequency inverter, thus changing the quantity of fuel fed to the burner in order to keep a constant, preliminary assigned temperature of outgoing boiler water.

European and Bulgarian combustion systems are offered on the Bulgarian market. Bulgarian manufacturers offer complex servicing, which include delivery, installation, and introduction in work, as well as personnel education, who would undertake exploitation and maintenance of the heating system.

It could be concluded that the market offers combustion a variety of systems and the appliances needed for operation of such systems for all potential consumers. Particularly for municipal buildings, most appropriate are combustion systems with capacity between 380 to 500 kW.

2.12. State of the pellets/chips market.

As mentioned above, using chips is economically profitable when distance between extraction and consumption is not longer than 20 km. The technology of storing and supply to end-consumer is as follows: the described multi-section store is charged with chips at the beginning of summer period with quantities which will be enough for the whole heating period: for Bulgaria this is the interval between 15 of October and 15 of April. During summer period, wooden fuel is drying, and if regular stirring is performed, the moisture content of chips could drop down to 20 – 30 %. The

delivery to fuel tanks (which have to ensure one week continuous work of the heating system) is performed by specialized trucks, and unloading to these tanks from the trucks is performed by pneumatic system, installed in the truck. Because of the special features of this type of fuel, it is most appropriate the production and distribution to be performed by a local company, i.e. the market of such fuel has a clearly expressed **local character**. For small towns and villages, like Belovo, where a central heating system is very appropriate, exist and other options: the store could be positioned on the territory of the heating central, and chips producer supplies only this store, and end-users are receiving heating energy through a heating central network. This approach would facilitate the owners of single-family houses, and they are predominant in Belovo, in joining their local heating systems to the network of municipal heating central, and to discharge their old inefficient combustion boilers, which work on firewood or coal. In this case, there is actually a market of heating energy, which is obtained by wooden fuel. Because of local character of this market, costs of chips or heating energy would differ in different regions, and it will depend on the quantities produced, relief special features, etc.

Pellet market has a significant difference compared to chips market, and has a **national character.** Currently, 50 000 tons/year of pellets are being produced in Bulgaria, and raw material for this production are mainly residues from wood processing industry. Pellets in Bulgaria are two types, both of them meeting the European quality standards: for domestic use, with less ash content after combustion (<0,5%), and for industrial use with more ash content after combustion (<5%). In both cases, moisture content is less than 8 %.

It will be good for the Bulgarian market to make unification between pellet producers and wood processing companies in one association. Thus wood processing companies would obtain effective fuel, which will diminish their heating costs, and they will receive additional profits from pellets' sales. On the other hand, pellets manufacturers will have a sustainable supply of raw material at preferential prices.

Pellet price is determined as in most of the European countries: one ton of pellet fuel is equal to 70 % price of the equivalent-by-energy content quantity of natural gas. In the next 1,5 – 2 years several pellet factories, which are currently being erected, will start operating. And it is expected that the total annual production will exceed 100 000 tons. Now, biggest part of pellets, produced in Bulgaria, are being exported mainly to Italy or sold out mainly to mountainous resort hotels, but it is observed a slight increase in consumption of the public sector. There is a trend in pellet production increase and reduction of export, because pellet manufacturers pay around € 40-43 / ton as transport cost to deliver to Western Europe. With current price of around € 120-130 / ton, the transport cost add-on sharply stimulates pellet producers to sell their products on internal market. Another important condition which plays role in production increase and limit export are the constantly growing prices of conventional fuels. Transport costs inside Bulgaria are relatively low, especially referring to rail-way transport which is currently offering lowest prices for transportation of large freights.

2.13. Setting up a distribution network

Taking into account Bulgarian conditions, the most appropriate way to distribute pellets and chips is to use the existing distribution network of logwood and coal. Packets of 25, 50, and 100 kg are being offered on the market, which are mainly addressed to households. Bigger quantities, which are needed for municipal buildings, neighborhood central heating systems, hotels, enterprises, and others, are being delivered by specialized trucks from retailers' warehouses to heating system tanks. Wooden ash obtained upon pellet combustion must not be thrown away – it is a necessary component for production of vegetables in greenhouses. This is one traditional and

well-developed branch in Bulgaria. Pellet retailers could take the ash back from their customers, pack it and sell it to market-gardeners.

2.14. Legislative measures on regional and national level to promote production and consumption of fuel made from forest biomass.

The following documents have been adopted on national level:

National long-term program for stimulation of RES applications, 2005-2015.

The program predicts a number of measures and financial mechanisms, which have to stimulate everybody who is producing and/or using RES, and more specifically, fuels extracted by biomass and wood residues. It is predicted an obligatory buying up at preferential prices of electricity made from RES. This incentive is termed 12 years after starting the installation to operate. Another incentive is the lower VAT with which alternative fuels are being taxed.

Higher buying up prices of electricity produced from biomass are predicted in the resolution of the State Energy and Water Regulatory Agency from December 2006.

A very important incentive will be the RES Law, which is supposed to be fully adopted at the beginning of 2008. It will unify all governmental acts, adopted so far, for stimulation of RES application and implementation. This law predicts subsidies for installation of heating systems based on RES in state and municipal objects.

It is observed higher interest on alternative wooden fuels on regional level too. After energy audits performed by REAP, it always includes in the recommendations the complex approach in order to resolve energy problems in municipalities. Local authorities are already convinced that maximum effect from energy efficiency measures will be obtained only if combination between substitution of fuel base and energy refurbishment is performed simultaneously.

As a conclusion, it could be deemed that in spite of the big interest and quick installations of wind and photovoltaic energy generators in Bulgaria, the interest to wooden fuels, and respective heating installation has not dropped down at all amongst the public administration and business. It is realized that different types of RES do not compete each other, moreover, they are complementary to one another through raising up energy sustainability and preparing the country for the end of petrol era.

3. Logistics and distribution concept for the region of Sierra de Gata, Spain

The present Logistics and Distribution concept aims to describe, foresee, and recommend all stages of the following processes: collection, processing, and shipment of biomass to wooden fuel production enterprises (i.e. production of pellets and/or chips), as well as to define the target groups who would consume this fuel. It is very important for the concept to define the actual quantities of biomass in the region of Sierra de Gata. Also, the concept must answer the following questions:

1. Is the biomass extraction in the three regions sustainable, and
2. What is its energy content?

Quantities and energy estimation of the current biomass potential determine economical profitability for production of wooden fuel. Another, very substantial factor is the cost of biomass extraction – this is a complex index, which is influenced mainly from the territory specifications, condition of forest roads, availability or unavailability and price of technical equipment for wood biomass processing, etc.

Main objectives of the concept are:

- Analysis of the structure and condition of forests in the region of Sierra de Gata, including forest roads condition;
- Study and analysis, logistics and distribution of wood biomass fuels at SG;
- Definition of technical characteristics, energy content of the existing biomass and its fitness for pellets/chips production;
- Identification and analysis of the municipal energy consumption;
- Study and determination of suitable technology and technical equipment for extraction and processing of wood biomass into chips;
- Determination of appropriate storehouse for storage of chips;
- Analysis of chips/pellets market;
- Analysis of market for heating systems, which use wooden fuel;
- Defining the priorities in setting up a distribution network which will supply wooden fuel to end users;
- An overview of legislative norms which are stimulating the use and distribution of wooden fuel and respective heating systems.

3.1. Study and identification of existing forest biomass stock (and biomass agricultural stock)

The agricultural surface occupies 36.730,86 ha, the rivers and swamps occupy 1.532,44 ha and the other surface is of 890 ha, covered by the cities, services, industrial areas, roads and so on.

Of 87.019,76 ha of total forest land at the *Sierra de Gata*, only 70.698,75 ha are useful for biomass generation, if excluded the *dehesas* and Riverside forests.

In the last Spanish National Forest Inventory, regarding *Sierra de Gata*, only 43,46 ha appear registered for logging, showing the very low intensity of the forestry exploitation and conservation works.

Classification of forest lands by groups for biomass supply availability

Forest groups	Total FOWL	Dehesas and AFM	Other FOWL (Low density forest and bushes)	Forest available for biomass supply
Surface (ha)	87.019,76	16.321,01	6.776,42	63.922,33

Distribution of tree species by surface

Tree species	*Surface (ha)*	*Surface (%)*
Alnus glutinosa	100,90	0,16
Arbutus unedo	1.440,83	2,25
Castanea sativa	399,33	0,62
Eucalyptus camaldulensis	1.540,33	2,41
Eucalyptus globulus	1.643,19	2,57
Pinus pinaster	27.683,05	43,31
Pinus pinea	52,24	0,08
Pinus sylvestris	20,94	0,03
Other pines	96,03	0,15
Other species	23,46	0,04
Populus nigra	199,69	0,31
Quercus ilex	13.762,02	21,53
Quercus pyrenaica	10.791,38	16,89
Quercus suber	6.030,88	9,43
Salix caprea	137,98	0,22

Total timber stock, including branches, is 563.625 m^3, and average stock on 1 ha, including branches, is 9 m^3 / ha.

Total average annual growth, including branches, is 116.118 m^3, and average annual growth on 1 ha is 1,27 m^3 / ha.

The average annual growth on 1 ha, without branches, is 8 m3 / ha.

The medium age of trees (all sorts included) is 20-25 years, average diameter is 0,06_0,07 m.

Average annual extraction on 1 ha is 3,48 m3.

Average stock on 1 ha, including branches, is 160 m3 / ha.

The estimation of biomass potential from woody agricultural crops is 25.561,8 ton.

3.2. Determination /calculation/ of energy potential of forest biomass

Estimation of total biomass potential in Sierra de Gata (t/year)

BIOMASS SOURCE		% H_2O	L.C.V. (MJ/kg)	Total quantity (t/y)	Total energy (GJ/y)
Forest residues		40	13,50 (average)	81.282	1.097.315
Agricultural Woody		30	12,54 (average)	19.265	241.585
Industrial organic residues	**Olive stones**	10	20,09		
	Alperujo	15	13,50		
	Orujillo	50	7,78		

3.3. Estimation of the forest road condition

The width of the forest roads of the area is 3 m, are well conserved and with clean fringes of 8-10 m to each side.

The quantity of roads in general is good, although in specific places is scarce, coinciding with the less favourable places for this activity due to the steep slopes on that areas.

3.4. Stimulating measures for wood processing companies to collect the overall forest biomass

To stimulate the use of biomass in the area, we think that it is important that the public administrations support actions that guarantee a good, complete and integrated forest administration.

The helps to the proprietors could be the following ones:

- To reduce the necessary administrations so that the necessary permits can be obtained for the forest works.
- Economic helps for the cleaning and collection of the forest and agricultural residuals.

Necessary helps for the companies:

- Helps for formation of companies and cooperatives that take charge of this type of works.
- Creation of small industrial centers of transformation and transport of biomass become profitable product by the great industry or the domestic sector.

The popularization works would be also very important for help to make aware the population of the area that the use of the biomass like fuel is beneficial economic and ecologically.

3.5. Specifications of the raw material for production of wooden fuel

When tree felling trees lumbermen, 20% of the wood is profitable residuals (branches and props).

For trees of small size different rates are applied depending on the species.

After extracting the biomass, the lost of humidity makes that the weight diminishes until being in 65% of the rough weight.

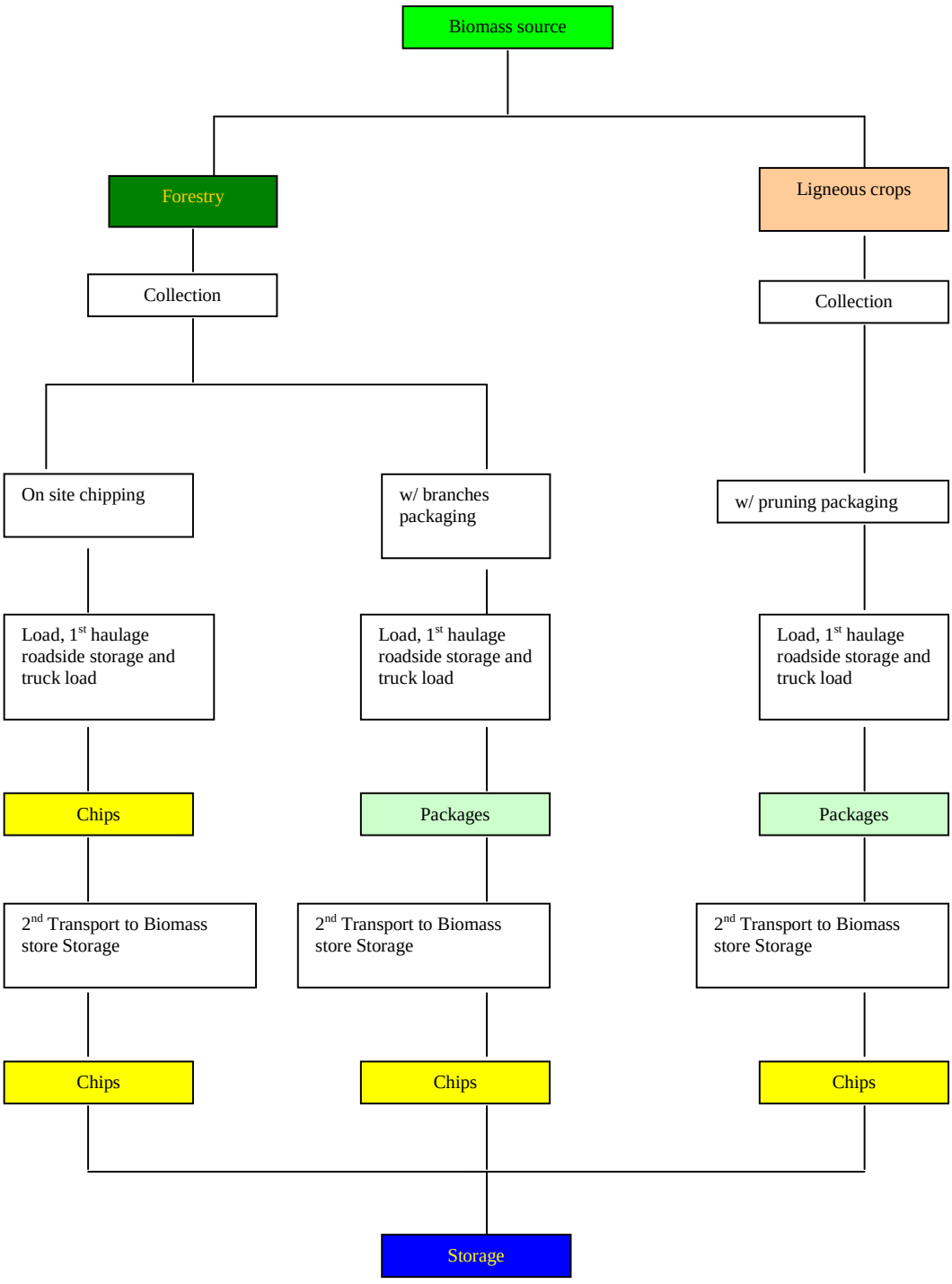
Rates of biomass residues production per effective forest surface

Tree species	Biomass residues generation rate (t/ha.year)
Riverside trees	1,0
Castanea sativa	0,05
Fagus sylvatica	0,46
Juniperus thurifera	1,0
Pinus halepenis	1,76
Pinus nigra	1,98
Pinus pinaster	3,48
Pinus pinea	1,76

Pinus sylvestris	1,98
Other pine sp.	1,0
Quercus ilex	0,53
Quercus pyrenaica	0,36

3.6. Wood extraction methods and chips equipment

The wood is extracted in the following way: pruning with saw machine and intersects to the necessary measure in situ, intersect the branches in the mount and the clean trunks is loaded in a tractor to take them out of the place. The branches and the props are in the mount, where weeks later (when they have lost humidity) it passes a chipper coupled to a tractor to crush it and to leave it that in chip form, break down in the mount.



3.7. Equipment and technology for extraction and transportation of chips at distance up to 20 km

Equipment to pick up forest residuals (they shred in the forest):

- shredder
- collection tractor
- tractor with tow, autoloader

Equipment in plant:

- shovel loader and shredder
- truck with semi-tow
- shovel-loader
- sieve line

Equipment to pick up forest residuals (they shred in plant):

- collection tractor
- packer of high pressure
- tractor with tow, autoloader

Equipment in plant:

- loader
- truck with semi-tow
- loader
- shredder
- shovel-loader
- sieve line

Equipment to pick up agricultural residuals (they shred in plant):

- collection tractor
- packer of high pressure
- tractor with tow, autoloader

Equipment in plant:

- loader
- truck with semi-tow
- loader
- shredder
- shovel-loader
- sieve line

3.8. Chips storage

At the present time, chip warehouses do not exist in the area, but if in the future they are needed it was not be very complicated to build them because: there are near areas to the big forest masses that are almost plane, the regime of rains in this area it is very seasonal, and the temperatures in the times of collection of the forest residuals, are high, for what the drying takes place in a natural way. Alone a roof, drainages in the places where they will be located the chip heaps and a digger that turns them was needed.

In the future, the intention of the city councils is to create 3 or 4 areas along the Sierra to make storing and trituration of forest and agricultural remains.

In the plants all the necessary works will be made to transform the residuals in chips to be able to provide to all the industries that need this material.

The storage of the packed material and without being crushed can make in the own mount, when it is not summer (to avoid forest fires) or in the factory outdoors.

The storage of the material become chips is made to place setting to avoid that when it rains it is wet again, and always have the good humidity (6-15%)

3.9.Economic estimation for conversion of biomass into chips

Cost calculation for forest and agricultural biomass extraction

Biomass sources	**$C_{obtaining}$**					**$C_{transp\ CA}$ $C_{stor-pretr\ CA}$**		**$C_{transp\ CT}$ $C_{cond\ CT}$**	**Total costs**
	Collection	**Treatment**	**Load, 1st haulage roadside storage and truck load**	**Total $C_{obtaining}$**	Presentation	**2nd Transport to Biomass store Storage**	Presentation	**Storage, Conditioning and final transport**	**€/t**
Forestry									
On site chipping	9,2	-	22,43	31,63	Chips	22,45	Chips	8,05	62,13
w/ branches packaging	9,2	6,90	6,37	22,47	Packages	20,34	Chips	8,05	50,86
Ligneous crops									
w/ pruning packaging	2,96	16,56	10,55	30,07	Packages	33,45	Chips	8,05	71,57

3.10. Energy consumption of Mancomunidad de Sierra de Gata

3.10.1. Households demand at SG

In the *Sierra de Gata* a developed market of biomass to supply households does not exist because the population is usually self-sufficient for getting the logwood at low prices to heat their houses. Due to the mild climate, heating is needed only for a 5-6 months season.

Except for new buildings, the heating system of the houses is the chimney, and the firewood supply comes from pruning of olive trees, oaks and cork oaks.

Because people still carry out traditional uses of the logwoods from their own properties, the energy demand of the single-houses (considering families formed by 4 people) corresponds to a monthly consumption of 2 gas butane cylinders to cook and to have sanitary hot water and an complementary expense in the electric invoice of 25-30 € / month due to some electrical stoves that are used too.

The potential demand of energy for heating at *Sierra de Gata* is around 20% of the total consumption.

This demand increased in the winter time because in some of the houses, complementary stoves that are fueled with firewood or gas butane like fuel exist.

3.10.2. Public buildings demand (schools, hospitals, …) at SG

A preliminary analysis has been performed in order to calculate the potential savings and market size of public buildings and services at the *Mancomunidad de Sierra de Gata*.

The energy consumption data facilitated by the *Mancomunidad de Sierra de Gata* indicates that the diesel consumption and electricity of the public services (illumination of streets, schools, third age residences, welcome houses, etc...) is of 4,47 l/person/year (2,68 €/person.year) in diesel and of 96,25 kWh/person.year (17,43 €/person/year).

In these estimates are not included the hospitals neither the other services that depend on the regional administration (Junta de Extremadura).

Table 10.1.- Electricity and diesel consumption at public buildings and services at Sierra de Gata

Number Inhabitants	**23.903**
- Diesel	
Consumption rate (l/person.year)	4,47
Consumption rate (€/person.y)	2,68
Total Annual consumption (l/y)	106.906,83
Total Annual expenses (€/y)	64.144,10
- Electricity	
Consumption rate (kWh/person.y)	96,25

Consumption rate (€/person.y)	17,44
Total Annual consumption (kWh/y)	2.300.659,7
Total Annual expenses (€/y)	416.804,37

3.10.3. Hotel business demand at SG

The main market for the biomass fuel for boilers could be the tourism sector, since it is one of the main economic sectors of the area with new and newly refurbished facilities.

The tourism sector in this area is very important; there are 55 hotel establishments that have some 932 beds and 39 restaurants. The energy demand on the part of these establishments it is important and it is usually covered with diesel for the heating system and electric power for the rest of the uses. The diesel estimated consumption for bed/year is of 43 l, and the annual estimated consumption is of 23.966 €, and that of electricity for bed/year is of 107,14 €, what gives 100.000 €/year as total electricity consumption.

3.11. Study of the market for fuel systems on pellets/chips for domestic users and public sector

No information available currently for the market of fuel systems in the region. To be determined further.

3.12. State of the pellets/chips market.

There is not pellets or chips market in this area, this product has to be brought from other regions of Spain, urging the costs of the product.

3.13. Setting up a distribution network.

In Spain there is a recent and still weak distribution network of solid biofuels. The main products are wood briquettes and pellets that are sold out through fuel stations, supermarkets and big malls and commercial stores.

This kind of network covers mainly metropolitan areas and big and middle size cities, but it doesn't reach rural or mountain areas that are consuming cheap free wooden fuels as local logwood.

The competitive price of logwood supply for the consumers of Sierra de Gata is a strong barrier for the setting up of a new distribution network of solid biofuels (chips, pellets…).

Anyway the new distribution network should take into account the agri-business market stores, such as farmer union stores, fertilisers and pesticides stores etc. There is also room for logwood stores, suppliers and transportation companies to get into this new solid biofuel distribution business, through new production facilities (chips, pellets) and and transportation and distribution equipment (pneumatic tanks).

For big consumptions the best thing is that the producer has small trucks, and distributes the product directly to the consumer low order.

For big industrial consumers (CHPs plants, biomass boilers…) the supply is typically covered by big suppliers like wood transformation industries, plywood industries, forestry works companies, wood recycling companies etc.

The ashes can be taken advantage of by the consumers to correct the acidity of the soils of holders, gardens and properties.

3.14. Legislative measures on regional and national level to promote production and consumption of fuel made from forest biomass

Spanish legislation on forests

- Law 10/2006, of April 28 for which modifies the law 43/2003, of November 21, of Mounts

- Law 43/2003, of November 21, of Mounts

- Real ordinance 6/2001, of January 12, on development of agricultural lands forestation

- Order of July of 1997, 28 have more than enough helps for actions of development of ordination of the forests in rural areas

- Decree 485/1962, of February 22, regulation of Forest Law

- Law 4/1989 of March 27, of conservation of the Natural Spaces and of the Flora and the Wild Fauna

- Law 41/1997, of November 5, which modifies the law 4/1989

Spanish legislation on cogeneration, renewables and biomass

- Royal Decree 2366/1994, 9th of December, on electric power production for the hydraulic facilities, of cogeneration and others supplied by resources or renewable sources

- Law 54/1997 21st of November, on the Electric Sector

- Royal Decree 436/2004, 12th of March, for which the methodology settles down for the upgrade and systematizing of the juridical and economic régime of the activity of electric power production in special regime

- Order PRE/472/2004, 24th of February, for the one that the Interministerial Commission is believed for the energy use of the biomass

- Royal Decree 616/2007, 11th of May, on development of the cogeneration

- Royal Decree 661/2007, 25th of May, for which the activity of electric power production is regulated in special regime

Extremadura legislation

- Decree 122/2007, of May 22, the Plan of Defense of the Area of High Risk is approved or of preferent Protection of Sierra de Gata

- Decree 83/2004, of June 1, to lay de foundation for grant in the frame of the sustainable administration of the mounts

- Decree 122/1996, of June 4, for which a regime of helps settles down to foment the afforestation and other forest improvements of agrarian lands in Extremadura.

4. Logistics and distribution concept for the region of Cova da Beira, Portugal

The present Logistics and Distribution concept aims to describe, foresee, and recommend all stages of the following processes: collection, processing, and shipment of biomass to wooden fuel production enterprises (i.e. production of pellets and/or chips), as well as to define the target groups who would consume this fuel. It is very important for the concept to define the actual quantities of biomass in the region of Cova da Beira. Also, the concept must answer the following questions:

1. Is the biomass extraction in the three regions sustainable, and
2. What is its energy content?

Quantities and energy estimation of the current biomass potential determine economical profitability for production of wooden fuel. Another, very substantial factor is the cost of biomass extraction – this is a complex index, which is influenced mainly from the territory specifications, condition of forest roads, availability or unavailability and price of technical equipment for wood biomass processing, etc.

Main objectives of the concept are:

- Analysis of the structure and condition of forests in the region of Cova da Beira, including forest roads condition;
- Study and analysis of wood biomass in AMCB;
- Definition of technical characteristics, energy content of the existing biomass and its fitness for pellets/chips production;
- Identification and analysis of the municipal energy consumption;
- Study and determination of suitable technology and technical equipment for extraction and processing of wood biomass into chips;
- Determination of appropriate storehouse for storage of chips; .
- Analysis of chips/pellets market;
- Analysis of market for heating systems, which use wooden fuel;
- Defining the priorities in setting up a distribution network which will supply wooden fuel to end users;
- An overview of legislative norms which are stimulating the use and distribution of wooden fuel and respective heating systems.

4.1. Study and identification of existing forest biomass stock

In all of the municipalities that make up the AMCB, those with populations greater area of forest are Sabugal, Fundão, Penamacor Guarda and where are 59.2% (101 068 hectares) of the total forest areas of AMCB. Of the 170 611,6 ha of forest areas, 49.5% (84 422,3 ha) are of maritime pine, 27.2% (46 349 ha) of oak and 8.1% (13 870, 3 ha) eucalyptus (Table I).

The maritime pine is concentrated mainly in Fundão (20.2%), Sabugal (16.2%), Guarda (14.4%) and Penamacor (10.6%). Regarding the area of oak forest, 29.1% is in the municipality of Sabugal, 26.3% in Trancoso, 13.4% in Almeida and 12.5% in Guarda. For the area of eucalyptus, 61.4% are concentrated in Penamacor and 27.3% in the municipality of Fundão as we can see on the next tableI.

TABLE I - Forest species in the municipalities that make up the AMCB

Municipalities	Surface of tree species (ha)										
	Q. ilex	*Q. robur*	*C. crenata*	*C. sativa*	*E. globolus*	*Q. suber*	*Other leafy*	*P. pinaster*	*P. pinea*	*Other pine*	**Total**
Almeida	1.601,1	6.229,8	0,0	17,1	2,0	198,6	267,1	2.760,2	1,3	0,0	**10.736,2**
Belmonte	0,0	675,2	0,0	4,3	4,3	0,0	101,0	1.883,0	0,0	33,2	**2.701,1**
C. da Beira	0,0	402,3	22,0	78,0	0,4	0,0	260,4	5.572,0	2,7	173,9	**6.511,8**
F Castelo Rodrigo	674,6	1.514,9	0,0	236,4	1.131,8	1.304,5	442,1	2.526,2	0,0	245,1	**8.075,6**
Fornos de Algodres	0,0	72,6	0,0	26,7	0,0	0,0	159,1	5.559,2	0,0	0,0	**5.817,5**
Fundão	191,4	1.751,5	248,7	147,4	3.781,9	604,6	423,7	17.049,8	1,2	15,6	**24.215,8**
Guarda	0,0	5.811,4	67,6	1.958,2	64,6	0,0	521,3	12.144,5	5,2	1.458,1	**22.030,8**
Mêda	54,1	846,1	0,0	207,6	256,1	173,1	144,8	5.687,3	0,0	0,0	**7.369,0**
Manteigas	0,0	175,2	73,8	0,0	3,4	0,0	825,0	2.966,0	0,0	1.498,1	**5.541,7**
Penamacor	516,1	843,6	0,0	49,7	8.522,9	1.303,4	1.679,6	8.911,3	81,5	2.016,9	**23.925,1**
Pinhel	367,4	2.306,1	0,0	0,0	0,2	551,3	416,5	4.916,9	0,0	0,0	**8.558,4**
Sabugal	58,9	13.510,3	0,0	1.710,0	102,8	0,0	417,0	13.692,7	5,2	1.399,4	**30.896,3**
Trancoso	0,0	12.209,9	42,1	0,0	0,0	0,0	0,0	753,3	262,1	965,0	**14.232,3**
Total	**3.122,7**	**46.349,0**	**454,1**	**4.435,4**	**13.870,3**	**4.135,6**	**5.657,5**	**84.422,3**	**359,2**	**7.805,3**	**170.611,6**

4.2. Determination /calculation/ of energy potential of forest biomass.

The forest areas contribute with 58% to the energy potential of the forest all the municipalities that make up the AMCB. The maritime pine is a species that most contributes to this value, and its energy potential is about 33 thousand toe. The cork and oak with 9734 and 7417 toe respectively (Table II).

Table II - Potential energy of forest species existing in the municipalities that make up the AMCB

Municipalities	FOREST SPECIES (TOE)										
	Q. ilex	*Q. robur*	*C. crenata*	*C. sativa*	*E. globolus*	*Q. suber*	*Other leafy*	*P. pinaster*	*P. pinea*	*Other pine*	TOTAL
ALMEIDA	165,2	996,9	0,0	3,5	0,6	467,4	36,5	1 074,3	0,0	0,0	2 744,6
BELMONTE	0,0	108,0	0,0	0,9	1,3	0,0	13,8	732,9	0,0	2,0	858,9
CELORICO DA BEIRA	0,0	64,4	0,4	16,0	0,1	0,0	35,6	2 168,8	0,1	10,2	2 295,6
FIG. CASTELO RODRIGO	88,4	242,4	0,0	48,6	340,2	3 070,6	60,4	983,3	0,0	14,4	4 848,5
FORNOS DE ALGODRES	0,0	11,6	0,0	5,5	0,0	0,0	21,7	2 163,8	0,0	0,0	2 202,6
FUNDÃO	25,1	280,3	4,1	30,3	1 136,9	1 423,2	57,9	6 636,2	0,0	0,9	9 595,0
GUARDA	0,0	930,0	1,1	402,9	19,4	0,0	71,3	4 727,0	0,1	85,9	6 237,7
MÊDA	7,1	135,4	0,0	42,7	77,0	407,4	19,8	2 213,7	0,0	0,0	2 903,0
MANTEIGAS	0,0	28,0	1,2	0,0	1,0	0,0	112,8	1 154,5	0,0	88,3	1 385,8
PENAMACOR	67,7	135,0	0,0	10,2	2 562,0	3 068,0	229,6	3 468,5	2,1	118,9	9 661,9
PINHEL	48,2	369,0	0,0	0,0	0,0	1 297,7	56,9	1 913,8	0,0	0,0	3 685,7
SABUGAL	7,7	2 162,0	0,0	351,8	30,9	0,0	57,0	5 329,5	0,1	82,5	8 021,6
TRANCOSO	0,0	1 953,9	0,7	0,0	0,0	0,0	0,0	293,2	6,6	56,9	2 311,3
AMCB	409,4	7 417,0	7,5	912,6	4 169,5	9 734,3	773,3	32 859,4	9,1	460,0	56 752,1

Table III - Biomass potential from forest residues at Cova da Beira

Tree species	Biomass residues (t/year)	Calorific value (MJ/kg)
Pinus pinaster	82.148,4	16.75
Quercus suber	28.630,2	14,24
Eucalytus globolus	11.912,9	14,65
Quercus ilex	1.204,1	14,24
Quercus robur	21191,4	14,65
Pinus pinea	22,8	16.75
Castanea crenata	21,5	14,65
Castanea sativa	2.607,4	14,65
Other leafy	2.209,4	14,65
Other pine	1.149,9	16.75
TOTAL	**151.098,0**	
TOTAL (n = 70%)	**105.768,6**	

The forest of the municipalities that integrate Cova da Beira present an annual energetic power of:

- 57,8% coming of forest settlements
- 12,5% coming of bushes and
- 29,7% according to the data of the forest fires that happened in 2003

Table IV – Energetic Power of biomass forest residues

	Biomass residues (t/year)	Energetic power (toe/year)
forest settlements	151.098	56.752
Bushes	52.400	12.265
Biomass from forest fire areas	87.208	29.167
TOTAL	**290.706**	**98.184**
TOTAL (n = 70%)	**203.494,2**	**68.728,8**

Summary of updated situation and potential generation of wood (and biomass for fuel)

For the purpose of homogenisation of the different parts of the Report, there have been considered only biomass residues from forests and tree species, not including the calculated burned areas.

Table V - Estimation of total biomass potential at Cova da Beira

	% H_2O	LCV (MJ/Kg)	Total quantity (t/y)	Total energy (GJ/y)
FOREST RESIDUES	40	13,50 (average)	105.768,6	1.427.876,1

4.3. Estimation of the forest road condition.

During the characterization of forest biomass in the region have made some localizations of points of water and the forest and rural roads where in general reasonable for easy movement of forest machines, agricultural vehicles and to the fire-fighters Vehicles.

However were registered and we have informed the authorities about some critical points of access to forest areas that are somewhat damaged and lack of maintenance.

4.4. Stimulating measures for wood processing companies to collect the overall forest biomass.

Unfortunately the cleaning and manuals cuts of weeds is a very expensive activity which costs at least 500 euros/ha every four years. This cost is not supported by income from forestry activity. It means, Portugal would be better without forests than with forests, with the cost for the management of fuels. Thus we believe that the priority is to create a market for combustible materials that promote the use of weeds and reduce the costs of cleaning up the forest.

A promising activity to promote the reduction of the fuel material, especially with the current cost of oil, is the use of forest biomass for energy production. It is therefore proposed that in addition to supporting the use of forest biomass in power plants, is carried out positive discrimination in this activity outside the area of influence of plants, provided that the material that is consumed are forest biomass from the management of bio-fuel in a measure of preventive forestry and farm forestry (installation, transportation and extraction).

The production of energy from renewable sources is very important geo-strategic and is in line with the objective energy policy to reduce dependence on oil. The increase in the use of renewable energy sources will also help to achieve the commitments made under the Kyoto Protocol to reduce emissions of greenhouse gases with the purpose of (GHG), whose measures are implemented in Portugal by the National Plan for Climate Change (PNAC).

There are many other possibilities for the use of forest biomass that require proper investigation. Among these possibilities are systems of energy production located (for example, the heating of school's). Given the availability of raw material in Portugal, the negative externalities (the fires) to make this raw material collect in the forest, and the various European or global environmental policies to which Portugal joined, in our opinion we recommended as priority of strategy the

funding investigation of procedures for the adoption of technologies using forest biomass for the production of energy located. It is proposed to be funded research and experimentation to scale through public tender.

In Portugal, the innovative nature of which is the use of biomass for energy gives this work a potential risk. It should thus be set up an observatory to monitor the use of biomass for energy per region.

4.5. Performance of the raw material for production of wooden fuel.

The main source of biomass we think that will be in forest residues from cleaning forest and weeds as well as in waste from agriculture.

Regarding the amount of agricultural waste produced in the area of intervention of AMCB annually are produced up than 106 386 tonnes, 25.1% (26 696,9 tons) from the city of Fundão, 12.4% (13 147,1 tons) from Pinhel and 8.8% (9 396,4 tons) from Figueira de Castelo Rodrigo. This amount of waste has an energy potential estimated on 29 112,7 toe, 47.7% resulting from cereal crops, 23.0% of vines agriculture, 14.9% of fresh fruit agriculture and 10.4% from olive agriculture.

Regarding to the forest of the municipalities that make up the AMCB, these area presents a potential annual energy 68 728,8 toe, and 57.8% (56 752 toe) from forestall areas, 12.5% (12 265 toe) from shrubs and 29,7 (29 167 toe) from forest burnt.

4.6. Wood extraction methods and chips equipment.

In Portugal there are some procedures regarding to the processing of wood extraction using different equipment which are described

Processing in forestry area

Small timber is grinding in place of cut by mechanical processes and transported in container. The equipment includes a machine coupled to a agricultural tractor adapted to the forest work, in which the wastes are collected and processed immediately in chips accumulated in a container. Once this one is full, the chips is brought to the truck or container existing in a place that calls area of loading.

Processing in loading areas – System Operation of whole trees

This method is lower costs of treatment/extraction of forest residues compared to other systems of exploitation, but a system of exploitation little used.

The area of loading normally is prepared to allow the operations of cut's and use of waste. Normally in these places is considered the space to allow the proper management of waste, or at the level of either receipt of operations that follow processing this waste. To this effect it is designed a system to feed the destroyer machine (with manual crane), and provided the direct loading to the transport unit, consisting by a truck and container.

Processing in Industrial unit

This process entails high costs of transport. The efficiency of transport of forest residues in the form of waste or gross, for example, chips, it is very different being greater efficiency in the transport of

waste treated. To overcome this problem are used trucks with the highest volume possible or useful then chooses by the transport of waste already treated.

The cost of transport depending on the distance, progressive decreases with the increase of distance, and is dependent on conditions of land and access. However this method has the advantage of the unit to decide when destroyed the small timber that was denominate by forestry waste, avoiding problems with the storage of chips that can ferment resulting by combustion.

Concerning to the use of the shell's of pinus and eucalyptus as forestry waste the option is held by the method of shucking done in loading areas or from the paths of extraction. The operation of collecting becomes more economical since the waste is more concentrated, which will facilitate operations for the collection and subsequent loading.

Regarding the process more appropriate to its use, the solution adopted is using a crane with mechanized collection, which follows its loading for the drive industry.

Processing to the Waste that Remain in the forest area

Whenever is impossible to collect the forest residue we try to grinding them and should remain in place, because they act as barrier, preventing the negative effects of bleeding surface, increasing infiltration and reducing soil erosion.

Please note that the branches, and wood with low quality and with irregularities, it is not exploited for the realization of furniture but it suffers a grinding and sent to the industry of plywood for destruction of the same and then build boards of wood that will be used in the construction of furniture less refined and for other types of effects, as we saw in the visit in the Fundão.

4.7. Equipment and technology for extraction and transportation of chips at distance up to 20 km.

The transport of chips in the forest is normally carried out by tractors whose characteristics fit the needs of the work they do. Move with very heavy loads in difficult situation where often there are no roads, requires that the forest tractors have a robust construction large wheels or tracks, traction at all wheels, total protection of the parts exposed,

There is a great diversity of machines that can perform the collection, processing and transport of forest residues;

- Tractor with grinding and crane and trailer with container
- Unit of collection and processing, transport (extraction) and deposition of forest residues.
- grinding of large capacity mounted on truck,
- grinding fixed with large capacity

There are still on the market, machines to collect and compacted the forest residue - are coupled to a tractor carrier, and the waste is compacted with cylindrical shape. These machines have some limitations in rough terrain (slope, stone, as well as rocky outcrops).

4.8. Chips storage.

The chips storage are normally destined local concentration of material that is resulting from forestry works, with the aim of facilitating the operations of loading and transport to the end user or to the parks of loggings.

These sites typically have the following characteristics, to consider well installed and reduce the potential negative impacts;

- Located in land stable and plans or/in reduced slopes;
- They are the smallest possible, taking into consideration the system of exploitation using the maximum quantity of wood material to be stored and efficient conduct of operations, be well drained and kept dry as much time as possible.

They must place itself away from the lines of water, maintaining at least a distance of 40 m from these areas.

4.9. Economic estimation for conversion of biomass into chips.

In economic terms, the choice between grinding or burn depends on the combination of the slope of the land with the amount of waste per hectare. It looks to be more favourable treat the waste to a slope up to 20% and in approximate quantities of 35 tons/per hectare. Grinding is always more expensive than shredding, if the quantity of waste for a high average, and these are comparable to low densities.

After consulting several studies we determine the following values;

- Collection of branches, bark, and other forest biomass: 24 €/ton
- Storage and Transport cost €/ton/20 kms: 14 €
- Total: 38 €/ton

4.10. Energy consumption of the 13 municipalities

In municipalities that belong to AMCB are consumed annually around 180 thousand tons of fuel derived from oil, while diesel represents 73% of this amount (Table VI). In terms of electricity consumption, in AMCB geographic area are consumed thousands of 431716 kW/h (Table VII), which 35% are consumed by the domestic sector and 25% in industry.

Table VI - Fuel consumed annually in the municipalities that make up the AMCB

Fuel	Ton (t)
Butane Gás	7 334
Propane Gás	8 979
Gás auto (LPG)	13
Unleaded petrol 95	9 938
Unleaded petrol 98	5 757

Gasoline additive with	6 525
Diesel	132 428
Fuel oil	10 045
Total	181 019

Table VII - Annual electricity consumption by sector in the municipalities that make up the AMCB

SECTOR	THOUSANDS KW/H
Household	150 096,9
Agriculture	12 606,7
Industry	109 549,7
Public Buildings	26 479,8
Public Lighting	33 778,0
Other	99 205,2
Total	431 716,4

4.11. Study of the market for fuel systems on pellets/chips for domestic users and public sector.

At the present time the municipalities of *Cova da Beira* they are making a study of viability for the installation of boilers of biomass in **sport centers** to obtain sanitary hot water and to heat the water of the municipal pools.

This study will extend to the rest of the buildings that depend on the city councils if the experience is good and the pellets market guarantees the supply of the fuel.

The inhabitants of this area are aware that it is an important alternative to reduce the expense of their energy invoice.

As it happened 20 years ago with the solar energy, these people are willing to experience with the new technologies, but in that moment, the solar energy was not so developed as at the present time and the prospective results were not obtained.

We have already a Study of the market for systems on fuel pellets/chips for home users and in the public sector that are,

Fireplaces for heat using pellets

Power (Kw): 9.5
Weight (kg): 101
Dimensions: 100.5 x 46.7 x 46.7 cm
Yield (%): 90

Power (Kw): 5 ou 7
Weight (Kg): 78
Yield (%): 87

Power (Kw): 20
Weight (Kg): 149
Dimensions: 111,6 x 68,8 x 49,5 cm
Yield (%): 90

Power (Kw): 13,5
Weight (Kg): 105
Dimensions: 80,5 x 63 x 52 cm
Yield (%): 90

Boilers for central heating

Power(Kw): 24
Weight(Kg): 190
Dimensions:: 108,8 x 67,5 x 60,6 cm
Yield (%): 85

Power(Kw): 28 a 50
Weight(Kg): 190
Yield(%): 85

Power (Kw): 24
Weight(Kg): 189
Yield: (%): 85
Dimensions: 108,8 x 67,5 x 60,6 cm

Power(Kw): 20
Weight(Kg): 10
Yield(%): 85

These are the kind of some boilers that the Portuguese market especially in the central region, it offers to consumers.

This type of boilers can be used in homes and in public institutions, public buildings, necessitating previously to be developed a study of energy optimisation that means appropriate the boiler to the space that we intent to heat.

There are boilers of greater power, with production capacity of 45 to 500 kW and between 500 to 2000 kW which can be installed for the production of electrical energy in micro-generation.

It should be noted that the current price for the purchase of pellets is around € 0,170/kg but the prices may fall to 0,125 € to 0,140 € per kg for large consumers and most used in the packaging market is the packaging:

- Big bag's, 650 kg
- Bag's with 15 kg

State of the pellets/chips market.

As the firewood, "pellets" are considered a renewable energy. The forests regenerate themselves, always grow new trees, while others will disappear. With the implementation of these systems, it is no longer necessary to kill trees to produce "pellets" to the extent that the cleaning of forests and waste from the timber industry provides all the material needed. This product has many benefits. It is abundant resource, though little explored, in Portugal, now that forests cover more than a third of the national territory, forming an immense energy resource that should be explored and protected.

Setting up a distribution network.

AMCB wants through another project called Biorural to encourage the creation of a network of collection of forest for further processing into pellets and feeding of boilers for heating that already beginning to be installed in the region

The implementation of this network utilization require, the creation of networks of supply of a product, and new economies of export of natural resources indigenous.

Thus, the aspects of innovation and added value that the project will entail:

- The inclusion of the best available technologies for use of thermal biomass and its distribution network as to the use of this energy source renewable terminating in itself an innovation, by allowing manage the resources of the municipalities where they implement such systems;
- Furthermore, the dependence of these zones for traditional sources of energy, fossil fuels decrease of origin, bringing a greater variety of energy sources used, thus increasing the security of energy supplies in the area, and patent important factor in Book Green on security in energy supply;
- significant decrease of gaseous contaminants, as a result of the use of a source of renewable energy such as biomass, thus helping to reduce the greenhouse effect caused by emissions resulting from the burning of traditional fuels;

Insertion labour and essentially participation of women and young people, thereby avoiding the depopulation emigration by the most disadvantaged areas, in search of work;

At the end of the project it is intended to further a distribution network in partnership with the hyper markets - distribution companies, as well as study the possibility and the technical/economical viability of installing a production unit of pellets/briquettes in the region, using forest and agricultural residues that are collected.
Note also that on the collection centres of biomass created from the project BioRural are also for sale to users in the municipalities pelletes and briquettes that are produced with the waste of biomass deposited in these centres.

4.13. Legislative measures on regional and national level to promote production and consumption of fuel made from forest biomass.

National Program on Climate Change
There is the National Program on Climate Change which aims to encourage the production of electricity from renewable energy sources (the Council of Ministers Resolution No. 119/2004)

The iCentro aims to:

"Making clear the bet in the region in renewable energy and in environmental technologies as leverage for development and business competitiveness".
Action Line III.1. -- Environmental Innovation and Competitiveness "wants to support projects that value, business and socially, the regional natural resources, promoting renewable energy and environmental technologies, in terms of strengthening regional competitiveness"

Operational Program for the Central Region 2007-2013

Encourage the emergence of micro businesses for the collection of forest biomass
Support of mini central biomass at local and regional level