proforbiomed
Promotion of residual forestry biomass in the Mediterranean basin

GUIDELINES AND OPERATIONAL RECOMMENDATIONS FOR KEY STAKEHOLDERS CONCERNING THE IMPLEMENTATION OF A FOREST BIOMASS CHAIN AND THE DEVELOPMENT OF CLUSTERS

Work Package 3: Capitalization and Long Lasting Effects

September 2014

"This publication is co-financed by the ERDF within the Project "PROFORBIOMED, Promotion of Forest Biomass in the Mediterranean Basin" No. Ref. (1S-MED 10-009).

The sole responsibility for the content of this publication lies with its authors. It does not necessarily reflect the opinion of the European Communities or the MED Programme.

The European Commission is not responsible for any use that may be made of the information contained therein."

Authors:

Valter Francescato[1], Jesús Alcanda[2], Carola Pérez[2], Clara González[2], Sophie Vallée[3], Marine Lovero[3], Pierre Girard[3], Rajko Leban[4], Janez Petek[5], Anja Kostevsek[5], Evanggelos Karlopoulos[6], João Martins[7], Roque Pérez Palazón[8], David Sancho Cabrero[9], Yannis Fallas[10].

Institutions involved:

1.- Associazione Italiana Energie Agroforestali (AIEL)

2.- Grupo SACYR, S.A.

3.- Association Internationale Forets Mediterraneennes (AIFM).

4.- Goriška Lokalna Energetska Agencija, Nova Gorica

5.- Local Energy Agency Spodnje Podravje (LEASP).

6.- Centre for Research and Technology Hellas/Chemical Process and Energy Resources Institute

7.- External expertise

8.- Servicio de Gestión y Protección Forestal. Dirección General de Medio Ambiente. Consejería de Agricultura y Agua. Región de Murcia

9.- Grupo Generala, S.L.

10.- University of West Macedonia, Department of Mechanical Engineering.

INDEX

1. Analysis of Strengths, Weaknesses, Opportunities and Threats Concerning the Forest Biomass Chain (FBC)

1.1. General introduction

This report is a methodological guide concerning the implementation of forest biomass chains (FBC). As part of the PROFORBIOMED project, it is focused on the case of the Mediterranean forests in the Northern rim of the Mediterranean basin.

Mediterranean forest vegetation may refer to many forms of forests and other wooded lands: scrubland with kermes oak, shrub land, green oak forest, cork oak forest, downy oak forest, Aleppo pine forest, cedar forest, inter alia. The main characteristic of these forests is that they are submitted to the Mediterranean climate, which means warm and dry summers (the plants need water above all to grow), and wet autumns and winters.

Mediterranean forests have always set the framework for human activities. There is no clear separation between the economic activity and natural environment: the dynamics of Mediterranean forests have always been closely linked to the human societies that have grown up around it. Mediterranean forests are particularly multifunctional ecosystems:

- Mediterranean forests have outstanding ecological particularities: biodiversity hotspots (great specific richness, endemic species pools, remarkable habitats), flood and erosion prevention, functioning as a bulwark against desertification, carbon sinks, …
- Mediterranean forests have an intrinsic economic value and generate various products such as timber and cork as well as non-timber products (medicinal plants, truffles and other mushrooms, acorns, fruits, honey, pine resin, …)
- Mediterranean forests are under a great social demand: serving as the living environment for a lot of forest communities and recreational functions (increase in outdoor activities in forests, particularly in urban and peri-urban forests).

In this way, Mediterranean forests are ecosystems of great interest but fragile and not nearly promoted enough. They are submitted to various threats: intrinsic threats such as natural hazards (including wildfires), poor soil, difficult climatic conditions (including climate changes) and external threats such as an increasing social and economic pressure and a general lack of forest and wood culture. This leads to a difficulty to value the wood and to structure a market.

In that context, the European Union has funded projects to promote the valuation of wood products, notably through the MED programme (a transnational cooperation programme, funded by the ERDF).

The PROFORBIOMED project is one of the 7 projects that have been selected during the call for strategic projects funded by the European Union under the MED programme. As an answer to the objective 2.2: "Promoting renewable energy and improving energy efficiency", the PROFORBIO-MED project is linked to the promotion of the use of renewable energies by the development of an integrated strategy for the use of the forest biomass as a renewable energy source that demonstrates, applies and transfers sustainable management systems adapted to the different MED forest conditions.

The strategy relies on the valorisation of Mediterranean forests and their consideration as a potential source of incomes in rural areas that need proper management and maintenance (in environmental terms). It implies the involvement of all stakeholders of rural areas, the development of clusters and networks and the strengthening of the cooperation between public and private actors by developing political and social commitments and joint initiatives.

The project involves 18 partners, spread across 6 EU countries: Spain, Greece, Italy, Portugal, Slovenia and France. They cover a whole range of partners at the national, regional and local levels, with good complementarity between local public authorities, private actors, managers of natural forest areas, research centres, and associative actors.

This methodological guide aims to provide guidelines and operational recommendations for the implementation of forest biomass chains (FBC), from socio-economic and political aspects to environmental requirements via communication tools and local awareness while also giving examples of good practice in each country. It is completed by a second guide focused on the public & private opportunities for financing FBC.

Although FBC in the Mediterranean shares the same global frame, the context varies widely between the MED regions involved in this project. It has been particularly well highlighted by a SWOT analysis, as shown in the second part of this introduction.

1.2. SWOT analysis

A S.W.O.T. (Strengths, Weaknesses, Opportunities and Threats) analysis of the Forest Biomass Chain has been conducted in France (FR), Greece (GR), Italy, (IT), Portugal (PT), Slovenia (SI) and Spain (SP).

STRENGTHS	WEAKNESSES
-High availability of forest biomass and an inexhaustible resource (FR, GR, IT, SI, SP, PT) -Creation of added value and "green jobs" (FR, IT, SI, SP) -Existence of modern technology with very high efficiency and low emission factors (FR, GR, IT) -Competitive prices when compared to fossil fuels (FR, IT) -Neutrality in terms of CO2 emissions. Each MWh replaced with biomass permits to save about 300 kg CO2-eq (FR, IT) -Support from public authorities (tax refunds, regional funds) (FR, IT) -Existence of all actors of the chain (FR) -Stable prices of materials (forest chips, pellets…) (FR) -Region readily accessible through transport infrastructure (GR) -Critical mass of knowledge due to the existence of research and academic facilities within the region (GR) -Pre-existence of industrial clusters for paper pulp production and wood furniture (PT) - Stock of forest residue (from forest fire prevention works) (PT) -Experience acquired with some existing power plants and some research centres (PT). -Existence of a few experiences with firewood and woodchip commercialization meeting with public support that include some treatment parks and specific equipment presenting the possibility to serve as pilot projects in the future (PT)	-Low forest mechanization level (FR, GR, IT, SI, SP) -Lack of forest exploitability and forest infrastructures (forest accessibility) (FR, IT, PT, SI, SP) -Difficulties financing forest biomass actions (FR, GR, SI, SP) -Lack of a lasting and effective coordination between potential suppliers and the demand side of the fuel chain (FR, GR, IT) -High percentage of private forests and highly fragmented forest properties (FR, IT, PT, SI) -No clear plans for funding or supporting the promotion of forest biomass (IT, SI, SP) -Difficulty obtaining long term biomass supply contracts (FR, IT) -Low social acceptability of forest harvesting (clear cuts) (FR, SP) -Poor professional skills concerning biomass utilization chains (GR, IT) -Small number of manufacturers of biomass systems and fuels (GR, IT) -Forest management plans not oriented to the extraction of biomass (PT, SI, SP)). Deficiency of forest management (SP) -Difficulties to secure the supply (FR). Supply difficulties related to the existence of multiple biomass sources and forest chain actors that are not exclusively dedicated to biomass exploitation (PT) -Weak relationship between research and business activity (GR) - Central planning at the national level, often not taking into account the specific regional needs (GR) -Supply of biomass not based on proper contracts and referred to EN 14961:2011 (IT) -Lack of infrastructures for controlling the quality of biomass produced (IT) -Lack of a strategic national plan for the use of forest biomass (PT).

STRENGTHS	WEAKNESSES
-Excellently organized forest management (SI) -Existence of commercial ports with the capacity to export forest biomass (SP) - Opportunity to develop rural areas: job creation, strengthening local industries, reduction of rural exodus (PT) -Local resource -More independence from external sources. Increased security and diversity of the energy supply	-Inexistence of property registry in a large percentage of the territory (PT) -Lack of knowledge regarding technologies involved in the energetic use of forest biomass (PT). -Potential conflict of interests between wood milling industries (paper pulp, sawmills) and forest biomass use (PT) -Lack of collecting equipment specifically adapted to biomass exploitation (PT) -High incidence of forest fires in the country (PT) -Import of pellets and wood chips from neighbouring countries (SI) -Low opportunities for biomass district heating systems implementation. The energy needs are unsuitable for private investors (SI) -Decrease by a factor of four in forestry jobs between 1990 and 2013 (SI) -Heterogeneous material (species, origin, humidity) and management of logging area (SP) -Lack of a real market for forest biomass/residues (SP, PT) -Lacking knowledge of Mediterranean species biomass production and quality -Low productivity of Mediterranean forests -Difficult traceability -Too much fuel and CO2 emissions for biomass mobilisation

Table 1. Strengths and weaknesses of the forest biomass chain in the Mediterranean basin.

OPPORTUNITIES	THREATS
-National or regional programs (FR, GR, IT, PT, SI): a target of 23 % of renewable energy being in the national energy mix by 2020 (Grenelle de l'environnement in France), intergraded biomass utilization will be a basic pillar towards the Smart Specialisation Strategy within the next framework program 2014-2020 in Greece, the Rural Development Programme, with its new scheduling (2007-2013), offers very interesting opportunities to strengthen biomass production (forest mechanization, roads, biomass infrastructures…) in Italy; at least 25% of building must be constructed using wood. -Political and financial attitudes at the European, national and local levels (FR, GR, IT, PT, SI) - Development of biomass clusters (GR, PT, ES, IT, SI, FR) -Source of local rural employment (FR, SI, SP) -Increasing demand for biomass heating within the domestic sector (FR, GR) -Probable increase of fossil fuel prices and future scarcity of resources (FR, IT, PT) -Friendly public opinion on renewable energies and particularly in the case of biomass energy (FR, IT, PT) -Reduction of forest fuel and risk of fire (FR, SP) -Increase of the forest product value (GR) -Research capacity in advanced processes for the upgrading of biomass fuels (e.g. gasification, pyrolisis, torrefaction) (GR) -Attractive sector inspiring new business (IT) -Increasing in forest exploration with management plans may contribute to a better articulation of multiple forest uses, thus increasing biomass use as a	-Decrease or end to investments, grants and financing plans (FR, GR, IT, SI) -Bureaucratic procedures (GR, SI, SP) -Indifference of public administration (IT, SI, SP) -Intense competition with the other renewable energy technologies (FR, GR, PT) -Environmental threats (pollutants emissions of NO2, dioxin, small particulates; risks of soil fertility decreasing, over cutting) (FR, GR, PT) -Lack of a relationship between supply and demand (FR, IT) -Lack of control and quality standards (GR, SP) -Overly severe emission limits and environmental restrictions for biomass plants (IT, SP) -Priority too often focused on new plants and not on the local biomass mobilization (IT, SP) -Expected increase of VAT on energy wood (from 5 % to 10 % in 2014) (FR) -Loss of one or more actors of the chain (FR) -Discontent in other parts of the wood industry (timber industry, pulpwood, etc.) (FR); Lack of cooperation between the main players in the sector, namely the large milling industries that consume the greatest percentage of the forest residues (PT) -Illegal and circumstantial logging due to the economic crisis (GR) -Poor economic situation (SI) -Governmental priority for fossil fuels (SI) -No development of aid for the promotion of biomass (SP) -Increasing price of wood -Competition with other products (food production…) -Different market conditions in different EU countries/regions -Global climate change (possible lower productivity)

OPPORTUNITIES	THREATS
way to promote the sustainability of forest properties (PT) -The articulation of both the forest biomass use and the forest fire prevention strategies (at a national, regional and local level) may promote the development of biomass use strategies (PT) -Increasing associationism of private forest owners. Adoption of cooperating strategies to mitigate small property and low income problems (PT) -One of the highest feed-in tariffs for electricity production from wooden biomass in EU (SI) -A lot of low cities use forest biomass for district heating (SI) -Established energy bionic institute and College of bionics in Ptuj (SI) -Establishment of the first biomass consortium in the northern Primorska region and reflections for another consortium in Podravje region (SI) -Ability to create synergies with the timber industry (SP) -Improvement of forests requires appropriate forestry (SP) -Decreased costs in public institutions/buildings -Exchange of experiences and knowledge -Transferability of good practice	

Table 2. Opportunities and threats of the forest biomass chain in the Mediterranean basin.

2. Identification of the forest areas suitable for the implementation of biomass chains.

2.1. Quantification of forest biomass potential: tools and methods

2.1.1. *Development of the GIS-based model*

First of all, it is necessary to collect the information needed to carry out the analysis of the potential supply; most of the data can be gathered and elaborated on with the support of GIS tools.

The required data mainly consists of:

- Cartographic and geographic databases that are usually available from the regional government offices responsible for the management of forests (Table 3)
- Forest related studies, as well as interviews for the main forest enterprises.

THEMATIC MAPS	VECTOR DATABASE
• CORINE Land Cover Map • Forest Map • Limits and altitudes of forests • Current status and future challenges of forest services • …	• Regional boundaries • Municipal boundaries • Boundaries of the mountain communities • Land registry • Roads administration • Forest Roads (current and planned) • Forest Management Plans • Technical Regional Maps and Orthophotos • Digital Terrain Model • …

Table 3. **Most significant cartographic and geographic databases required to develop the GIS model.**

Geo-databases and thematic maps can be used to calculate the following 3 indicators:

1. **Habitat Suitability Index (HSI)**: it indicates the availability per hectare of biomass suitable for energy purposes. It is based on forest maps and the ratios (%) of biomass to be used for energy purposes, depending on the forest type and recovery.
2. **Accessibility index**: it is based on availability and slope level of public and forest roads. Very steep areas are to be considerate unsuitable (e.g. >45°). This indicator is used to measure the accessibility of biomass depending on its proximity to the street (Table 4).

Index value	Accessibility	Proximity the road
1	Easily recoverable	75 m
2	Adequately recoverable	150 m
3	Hardly recoverable	300 m
0	Non-recoverable	>600 m

Table 4. Area classification based on their accessibility.

Accessibility sets limits to the machinery that can be used for timber harvesting from which biomass fractions are obtained. Choosing the right working system and estimating the biomass fraction are key elements in evaluating the feasibility of forestry related projects.

Selecting the most suitable harvesting system depends on:

- the slope and rough level of the ground
- the presence and accessibility of the forest routes
- feasible routes for timber hauling
- the features of the stand
- the felling intensity
- the size of the material used

3. **Indicator of woodchip quality:** it allows a differentiation in the quality of the available forest biomass according to the characteristics of the raw material and logistics processes. The woodchip quality determines both the sales price and the type of plant that it can be reserved for. The indicator refers to the European Standards EN 14961-4 (quality class A and B). High quality biomass is suitable to feed small and medium size plants (quality class A1 and A2), whereas biomass quality class B is usually reserved for larger plants.

2.1.2. *Quality requirements and reference standards*

The European Standard EN 14961-1:2010 provides regulatory information affecting supply contracts and the relative Declarations of Quality for the woodchips supplied. Reproduced below are the main features and specifications that define the quality classes of woodchips (Table 5, Figure 1).

	Quality class	A1	A2	B1	B2
NORMATIVE	Origin and source	1.1.1, 1.1.3, 1.2.1, 1.1.4.3	1.1.1, 1.1.3, 1.2.1, 1.1.4.3	1.1, 1.2.1	1.2, 1.3
	Particle size (P)	To be selected from the table below			
	Moisture (M%) UNI EN 14774: 2009	M10 ≤ 10 M25 ≤ 25	M35 ≤ 35	To be specified	
	Ash (% on d.b.)	A1.0 ≤ 1.0	A1.5 ≤ 1.5	A3.0 ≤ 3.0	
	Net Calorific Value (NCV) (kWh/kg)	Q3.6 ≥ 3.6	Q3.1 ≥ 3.1	To be specified	
	Bulk density (kg/m^3)	BD150 ≥ 150 BD200 ≥ 200	BD150 ≥ 150 BD200 ≥ 200	To be specified	

Table 5. Classification of woodchips for non-industrial use (EN 14961-1:2010).

Dimensions (mm), FprEN 15149-1			
	Minimum 75 w-% in main fraction, mm [a]	Fines fraction, w-% (< 3,15 mm)	Coarse fraction, (w-%), max. length of particle (mm), max. cross sectional area (cm^2)
P16A	3.15 ≤ P ≤ 16 mm	≤ 12%	≤ 3% > 16 mm, and all < 31.5 mm The cross sectional area of the oversized particles < 1 cm^2
P16B	3.15 ≤ P ≤ 16 mm	≤ 12%	≤ 3% > 45 mm, and all < 120 mm The cross sectional area of the oversized particles < 1 cm^2
P31.5	8 ≤ P ≤ 31.5 mm	≤ 8%	≤ 6% > 45 mm, and all < 120 mm The cross sectional area of the oversized particles < 2 cm^2
P45A	8 ≤ P ≤ 45 mm	≤ 8%	≤ 6% > 63 mm and maximum 3.5% > 100 mm, all < 120 mm The cross sectional area of the oversized particles < 5 cm^2

[a]The numerical values (P-class) for dimension refer to the particle sizes (at least 75 w-) passing through the mentioned round hole size (FprEN 15149-1).

Table 6. Particle size of woodchips.

Figure 1. Appearance of chips belonging to classes A2 and B (EN 14961-1:2010).

Logistics operations may affect the quality of woodchips. After the felling process and depending on the hauling system, the residual woody biomass is divided into varieties depending on its destination.

High quality material, such as small diameter, branchless, conifer long-wood, is transported to a storage facility to be dried or seasoned and then chipped. High quality material is therefore oriented to produce **high quality woodchips** (class A1 and A2) meant for non-industrial plants (< 500 kW, EN 303-5:2012) or fixed-bed gasifiers. On the other hand, low quality material like branches and toppers with needles is directly chipped at the roadside to then be transported to industrial plants, district heating plants and combined heat and power systems (Figure 2).

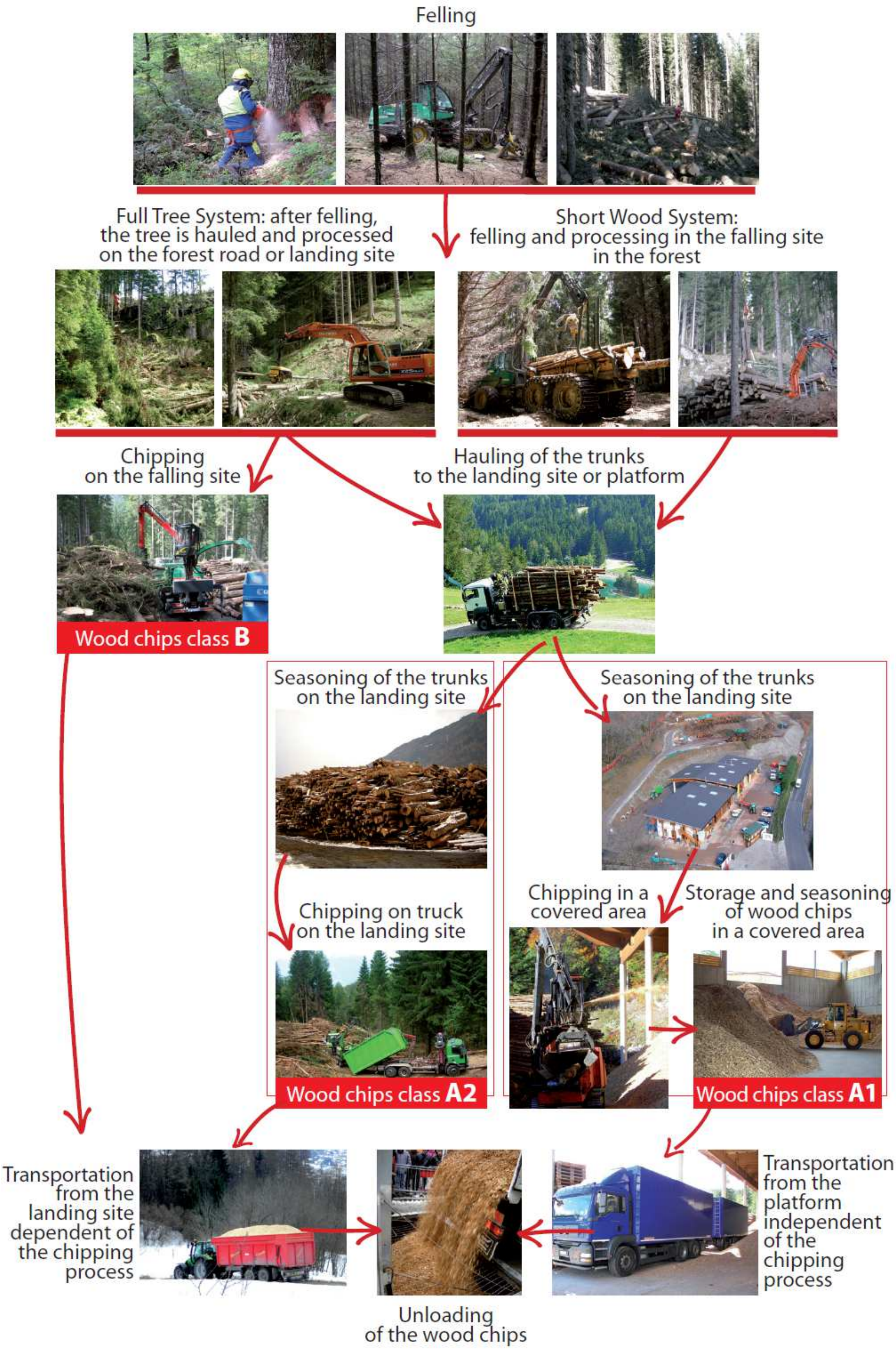
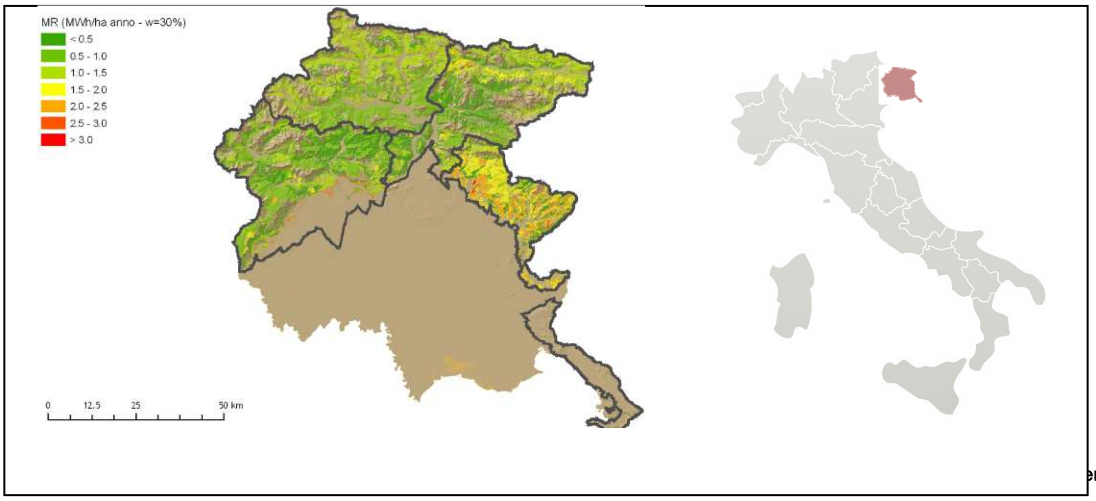


Figure 2. Supply chain and production patterns of A1, A2 and B woodchips.

2.2. Examples of the quantification of regional biomass potentials

2.2.1. *Quantification of regional biomass potentials in Italy*

The following Figure 3. is an example of the quantification of biomass potentials in the forest-mountain area of Friuli Venezia Giulia (North-Eastern region of Italy). It is measured in primary energy (MWh/ha/year with moisture of 30%).



ergy

By using the **accessibility and quality indicators** it is possible to quantify the available biomass, respectively depending on the ease of access to the forest and the quality of wood assortments.

For instance, Figure 4. shows the distribution of high quality chip (class A) availability based on stock accessibility (tons/ha/year). The forest area within the red circle has the most appropriate conditions for the implementation of a biomass supply chain based on high quality chips, meant for small-medium plants. Such conditions mean high biomass potential for high quality chips as well as good viability and accessibility.

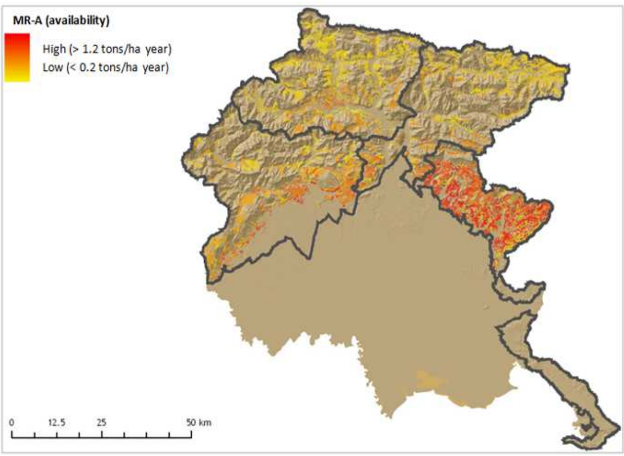


Figure 4. Biomass potentials based on quality and accessibility.

Table 7 attests to the close connection between **accessibility** and the potential biomass effectively available per year. Considering the areas which serve as forest roads, the potential biomass is reduced to 53,700 tons instead of 72,600 tons per year. As a consequence, forest viability has to be considered as a relevant indicator while choosing the harvesting systems and planning actions to optimize forest management.

Besides quantifying biomass potentials, it is important to define its quality. This information suggests what type of plants should be grown in the surrounding areas.

Accessibility	Chips quality	tons/year (M30)
Total potential	A	49,431
	B	23,163
Total		**72,594**
Potential of areas without roads		**18,917**
Potential of areas with roads		**53,677**
Well-served areas	A	27,524
	B	8,718
Total		**36,242**
Poorly-served areas	A	9,501
	B	7,935
Total		**17,435**

Table 7. Biomass potential based on forest viability

Figure 5. Forest viability considerably affects the availability of forest biomass

2.2.1.1. Quantification of biomass potentials on a supra-regional scale

While working on a supra-regional scale, the greatest areas for the implementation of a biomass forest chain are generally identified by using the available data on a district scale. The estimation of woody biomass is based on forest surface data, divided by the silvicultural system (coppice or high forest stands), dominant species and the current annual increment. The annual effective availability of biomass can be obtained by using dedicated indexes, which take into account the reduction of total potential biomass. Reduction parameters are also considered in the case of favourable and stationary conditions for harvesting operations. Moreover, the estimation of the effective availability of biomass must consider the reduction due to the presence of forest stands, where accessibility is limited. Such limitation may affect the cost effectiveness of such forest exploitation. Figure 6 provides the estimation of forest biomass availability in some regions of Southern Italy. The study was made on a district scale. The estimation of the annual productivity is measured in primary energy (MWh/year). Annual productivity comes from the sum of the production potential of wood fuels (conifers and broadleaved) adjusted by reduction indexes, based on accessibility and site factors. In the top 4 Southern Italian regions (Calabria, Campania, Puglia and Sicilia), the total forest biomass reaches **355,000 tons of dry material**, 88% of which come from broadleaved forests and the remaining 22% from conifers. In terms of primary energy, it corresponds to about **1,775 GWh/year**, that is **152,650 toe** (tons of oil equivalent).

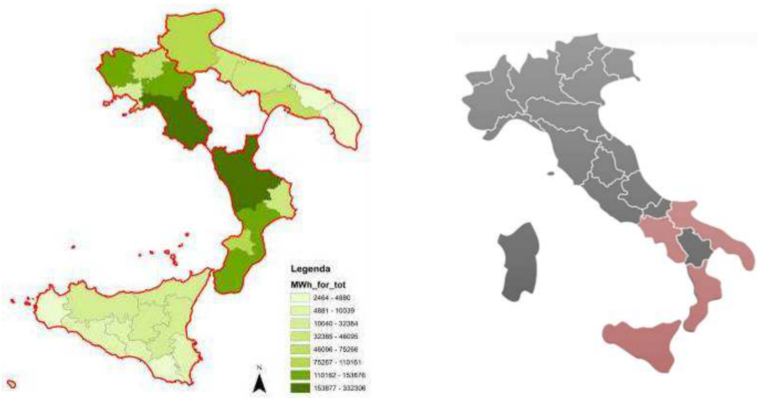


Figure 6. **Southern Italian areas with the greatest forest biomass potentials**

2.2.2. *Quantification of regional biomass potentials in Spain*

For the quantification of the existing biomass in an area, each analyst has their own methodology and data sources.

In Spain there is a lot of cartographic and documented public information, available on the websites of public agencies. The principal information source, for a general estimate of forest resources in a Spanish area, is, without a doubt, the National Forest Inventory; although, for a better resource estimate, it is advisable to carry out surveys to supplement the inventory data. Different methodologies of forest inventory design can be used to complement the existing data. Within the Proforbiomed Project, different methodologies have been developed for the design of forest inventory as the basis for the development of forest management plans.

Some of these documents are:

- the "design of forest inventory methodology using the LIDAR application to the forestry management project, V095: the "Sierra Negrete" forest, in the region of Valencia" (2012). (http://proforbiomed.eu/publications/project-deliverables/deliverables-workpackage-4/pilot-action-17)
- the "methodology for the design of forest inventory by the use of specific software, for the elaboration of forest biomass management plans in the Murcia region" (2013). (http://proforbiomed.eu/publications/project-deliverables/deliverables-workpackage-4/pilot-action-17)

Another example of a specific methodology for estimating the biomass available for energetic use was developed in a TIMBER project's document, titled "***Biomass potential analysis of the province of Cadiz for energy purposes***". The project TIMBER (Tools for Integrated Management of Biomass Energy Resources) is a European initiative developed within the framework of the "POWER Programme: Economies of Low Carbon (INTERREG IVC)", whose main objective has been to design a standard model for the regional development of sustainable and renewable energy based on biomass resources. Five European public entities work closely to develop this tool detecting barriers and constraints, performing feasibility studies and identifying the best practices in each of the participating regions. Finally, the results and experience accumulated during the project will lead to the implementation of this model for the development of Biomass Action Plans at the regional level. The **POWER Programme** is co-financed by the European Regional Development Fund (ERDF) though the INTERREG IVC Programme (www.powerprogramme.eu).

In addition, different GIS tools have been developed to facilitate the estimation of the potential biomass in an area. Some of them are:

- BIONLINE: www.idae.es/index.php/relcategoria.1037/id.712/relmenu.321/mod.pags/mem.detalle
- CUBIFOR: www.cesefor.com/cubifor/index.asp
- BIORAISE: http://bioraise.ciemat.es/bioraise
- GLOBALLOMETREE: www.globallometree.org

2.2.2.1. Spanish GIS tools

- **BIONLINE** is a program developed by IDAE (Spanish Institute for Energy Diversification and Saving) It is part of the strategy to evaluate the biomass potential in Spain, according to their different origins and possibilities for introduction in the energy market, depending on the estimated costs for production and availability in the market. It is a ready tool for quantifying forest biomass from the geographic area that the user chooses. It can be used for consultations and studies concerning different types of biomass (forest harvesting residues, agricultural crop residues and biomass from mass capable of implementation in a forest land).

  BIONLINE gives cartographic output about: the availability of different types of biomass in different territories, the extraction or collection costs, and the average cost of biomass located in determined specific points for each study. It was developed from the methodologies, diagrams and data selected by Spanish experts from a forested and agricultural area.

- **CUBIFOR** It is a tool to scale, classify products, and calculate biomass and CO2 for the most important timber species in the forests of the Castilla y León region. It consists of an Excel file that can be downloaded for free from the website and it is an update produced by MatDendro (Rodriguez and Rodriguez, 2000) and Cubic (Rodriguez and Broto, 2002). The biomass calculation is based on equations developed by Montero et al. (2005) and the density computations were developed by Cesefor (Rodriguez et al., 2006).

2.2.2.2. International GIS tools

- **BIORAISE**: a GIS tool for Biomass Resources Assessment in Southern Europe.
- **GLOBALLOMETREE** : GlobAllomeTree is an international web platform for tree allometric equations to support volume, biomass and carbon stock assessment.

2.2.3. *Quantification of regional biomass potentials in France*

2.2.3.1. Description of the methodologies used to calculate and estimate the biomass available for energy.

To meet the ambitious objectives of the Grenelle Environment (reaching a level of 23 % renewable energy by 2020), it was necessary to estimate, both at national and regional levels, the woody biomass available for energy in 2020.

Various studies have attempted to assess the potential energy wood in various French regions, particularly in the PACA region.

Three studies with different approaches are presented below:

- A national study on regional potential sources made by the National Forest Inventory (IFN);
- A regional study by the Union of Forest Townships (URCOFOR), based on the unused conifer production in the PACA region;
- A departmental study funded by the General Council of Var and the Ministry of Agriculture (DRAAF) based on usable surfaces of conifer stands in the Var.

2.2.3.2. National study on potential regional sources

The Ministry of Food, Agriculture and Fisheries and the Agency for Environment and Energy Management (ADEME) commissioned a study in 2008 on the additional potential sources of energy wood that could be mobilised. This study was conducted by the National Forest Inventory (IFN), the Cemagref, the Forest Cellulose Wood Construction and Design Technological Institute (FCBA) and Solagro (an association specialised in conducting environmental audits and studies on renewable energies). For this study, various parameters were taken into account in the calculations, like forestry, economy, techniques and the environment. The results relate to the amounts of wood biomass that can actually be mobilised as energy. As shown in Figure 7, the PACA region is little concerned by hedges and poplar stands. Therefore, these two parameters are not significant, and they do not appear in the table.

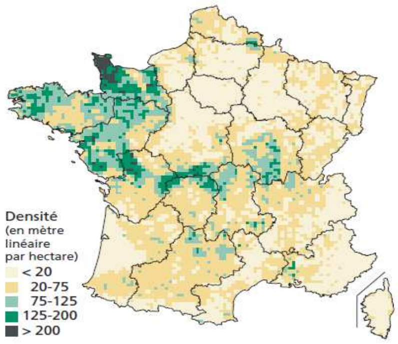


Figure 7. Density of hedges and alignments in France (IFN, 2007)

Some of the results of the study are presented in the table below.

	Lumber and wood energy		Wood residue
	Technical and economic availability	Additional availability	Additional availability
	Forest	*Forest*	*Forest*
Alsace	267	66	32
Aquitaine	1068	90	118
Auvergne	483	187	51
Bourgogne	844	493	127
Bretagne	329	108	42
Centre	887	498	117
Champagne-Ardenne	625	200	100
Corse	55	-68	7
Franche-Comté	591	245	96
Ile-de-France	279	30	38
Languedoc-Roussillon	243	32	33
Limousin	550	217	69
Lorraine	727	232	98
Midi-Pyrénées	599	178	88
Nord-Pas-de-Calais	111	-64	16
Basse Normandie	149	-27	16
Haute Normandie	243	28	31
Pays de la Loire	308	94	36
Picardie	336	40	49
Poitou-Charentes	340	80	49
Provence-Alpes-Côte d'Azur	200	-82	28
Rhône-Alpes	491	23	79
Total (France)	9726	2598	1318

Table 8. Regional availability of pulpwood, energy wood and wood residue, depending on their availability type (ktoe/year(5)) (Source: IFN, 2008).

1) Pulpwood and energy wood. Stem biomass from wood of a diameter > 7cm and not usable as timber and branch biomass of a diameter > 7cm

(2) Wooden residue for chips and pellets. Stem and branches biomass of a diameter < 7cm

(3) Availability taking into account technical (physical accessibility, operating losses, hauling radius), environmental (soil fertility) and economical (cost of operations, prices of extracted products) criteria.

(4) Correspond to the technical and economical availability minus the volumes already mobilised by the actors (pulp and energy)

(5) Kilo ton of oil equivalent per year

Although the PACA region is the second region in France in terms of forest area, it has little available forest biomass compared to other French regions (19th out of 23 for technical and economic availability of pulpwood and energy wood in forests). In addition, the negative figure for additional availability illustrates **that woodcuts currently outweigh the biological potential** and also highlights the difficult profitability and feasibility of logging in the PACA region (see Figure 8). However, taking the national data (average sale prices, for standing wood and fallen wood, average operating costs) into account to assess regional availability does not guarantee a result that represents a local reality.

This figure can also be explained by the fact that the study considered timber wood to be wood of low quality, which is preferably used as energy wood. This could lead to an underestimation of the raw availability of pulpwood and energy wood and lead to a negative result for extra availability.

Finally, the technical and economical availability has also been underestimated because of the specificity of the operating systems in the Mediterranean region that is poorly represented by economic models.

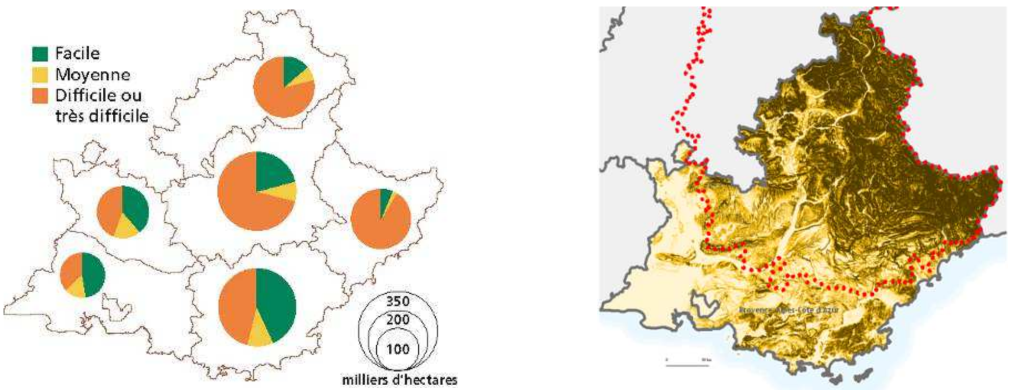


Figure 8. Physical operability (Source: IFN)/ The slopes (Source: Observatory of Mediterranean Forest (OFME))

This study provides a general indication of the resource. It especially helps identify critical parameters for the evaluation of potential sources as well as to compare the results obtained through different assumptions.

In addition to this study, ADEME has developed a website (www.dispo-boisenergie.fr; Figure 9) to assess the volume of wood (in cubic meters, in tons of oil equivalent (toe) or in dry material tons) according to three parameters: gross availability, technical-economical availability and additional availability.

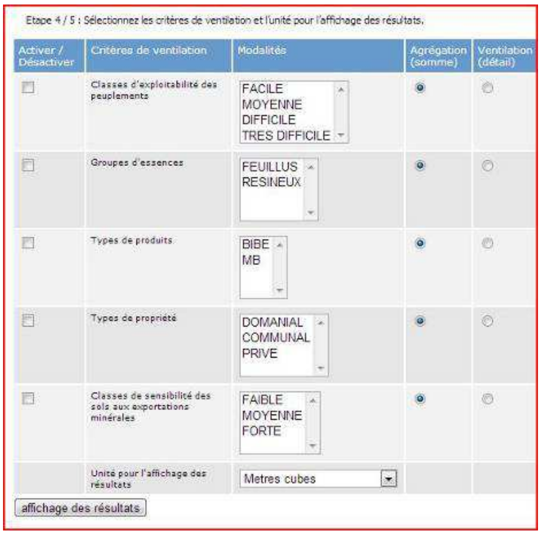


Figure 9. Website used to calculate volume of energy wood (Source: ADEME).

The Observatory of Mediterranean Forests has also created an interactive map (www.ofme.org/cartotheque-interactive.php3) which provides valuable information on the PACA region.

2.2.3.3. Regional study on conifer production in PACA

Energy assessments of the source were conducted in 2009 and are based on an average net calorific value (NCV) of 2500 kWh/m3 with moisture of 50%. As part of sustainable management, it is agreed that the removal of wood in the forest may not exceed the annual production of the conifer pulpwood industry. Harvested conifer pulpwood is then deducted from the annual production of the forest.

Hardwoods are not taken into account in the evaluation of sources. All exploitable coppices are already being exploited either by forest owners or by loggers. In addition, hardwood logs are more expensive than conifer woodchips.

The final assumption is that only 75% of the untapped production can lead to wood energy development, given the difficulties of both access to and the fragmentation of private forests. According to the National Forest Inventory (IFN), the annual production of conifer pulpwood amounted to 1.276 million m3 in the PACA region. The Regional Directorate for Food, Agriculture and Forestry (DRAAF) estimates that 312,000 m3 is used each year as conifer pulpwood. The wood energy sector can therefore rely on an additional theoretical resource of 723,000 m3/year, or 1,650 GWh/year, or 144,000 toe/year.

In 2009, the regional wood boilers were consuming 10,000 tons per year, or 35 GWh/year or 3055 toe/year. Taking into account new wood energy projects, the Regional Union of Public Forest (URCOFOR) foresees a demand for wood amounting to 30,000 tons/year, or 100 GWh/year in 2013.

According to this study, the forest is a significant resource for energy wood, provided that the market price of wood is greater than the operating costs.

The potential of pulpwood (category A waste, considered "clean" such as crushed pallets and crates) represented, in 2009, a potential of 15,000 tonnes or 54 GWh/year, which has almost all already been valued. The green waste compost and pruning provide important volumes available to be used as wood energy.

2.2.3.4. Departmental Study: the Var

The departmental study was conducted in 2008 at the CEMAGREF Laboratory of Remote Sensing in Montpellier. This study focused on the estimation, by remote sensing (visible infrared imaging), of the forest resources in the department of Var as well as on the potential volumes available for use as energy.

Three terms are used to identify resources that can be mobilised:

- Sufficient volumes: stands with low density are not profitable for logging (volume cut per hectare is too low);
- Accessibility: the steepest areas (> 60%) are considered inaccessible;
- Road service: beyond 40 % slope, only 100 m on either side of the access roads can be exploited.

294,516 hectares of conifer stands in the Var could be considered for wood energy use. According to this study, only 64% of the resource is exploitable (80,000 ha easily usable, 110,000 ha moderately usable).

Despite strong operating constraints, studies agree to affirm the existence of large amounts of additional wood that can be mobilised for energy wood in the PACA region. This resource, widely available and managed in a sustainable way will ensure the supply of existing biomass installations as well as many other future wood energy projects for a long period of time.

2.2.3.5. Tools for the evaluation of the local wood resources

Two mechanisms have been put in place: the Plans for the Development of Forested Area for Private Forests (PDM - plan de développement de massifs) and the Territorial Supply Plans (PAT) (Figure 10). They have the following characteristics.

Plans for the Development of Forested Area (PDM)

The PDM address various points, going through them as follows:

- Diagnosis of private forests, based on data from IFN (National forest information),
- On site validation,
- Classification of the areas in one of the following categories: priority, pending and difficult to exploit, in an objective working towards silviculture improvement:
- Consideration of the various issues during a negotiation with the local authorities,
- Multifunctionality (not only wood harvesting valuation),
- Definition of a strategy to involve the many owners in the actions to be taken.

PDM should lead to an animation phase of contacting and recruiting owners.

Territorial Supply Plans (PAT)

PAT concern the following points:

- Study of the wood resource, in order to feed the wood energy sector after a study of existing management documents (most public forests, 1/10th of the surface in private forests) or statistical census.
- Estimates of operating and transportation costs,
- Analysis of the road services.

The plan leads to a mapping of available resources of energy wood, with information on technical mobilisation costs (figure 12). It enables the simulation of the platform location.

This is not a full supply plan because it does not include the essential phase of owner recruitment (in private forests), so as to obtain their consent on the sale of wood and logging.

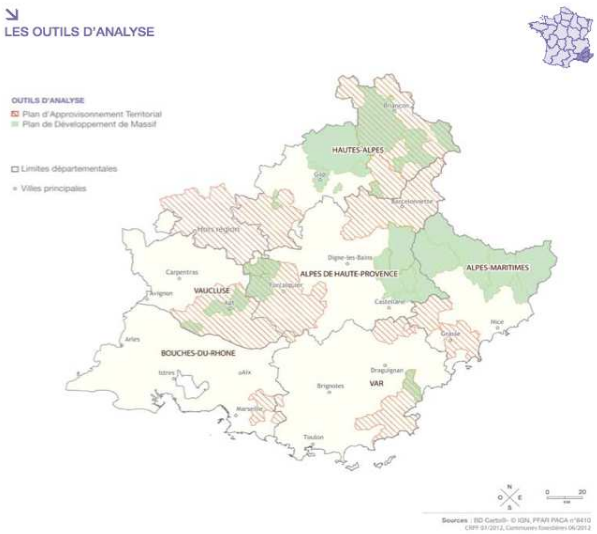


Figure 10. Map of PATs and PDMs in PACA region (Source: OFME, 2012).

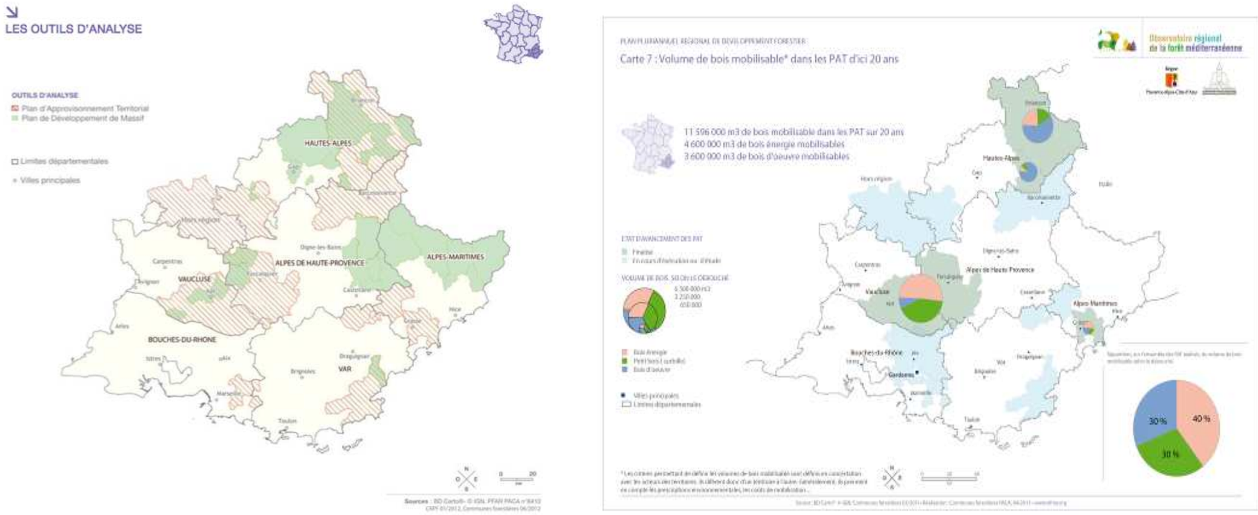


Figure 11. Map of wood volume that can be mobilised in PATs in the next 20 years (Source: OFME)

2.2.4. *Quantification of regional biomass potentials in Greece*

Forests in Greece, as in other Mediterranean countries, are characterised by shrub dominance. These are formations of evergreen shrub species (keep their foliage during winter) the most important of them being kermes oak (*Quercus coccifera*), strawberrytree (*Arbutus* spp.), lentisk (*Pistacia lentiscus*), mock privet (*Phillyrea latifolia*) and junipers (*Juniperus oxycedrus*, *J. phoenicea*).

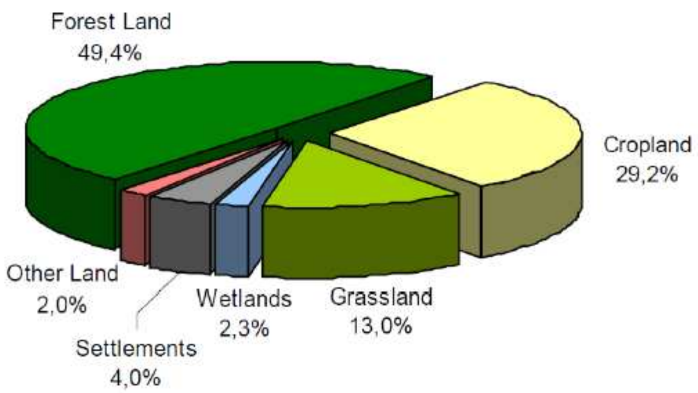


Figure 12. Greece area distribution in 2000 by land-use category (MEPPPW, 2008)

Overall, they cover approximately half of our forests with main presence in areas of low or medium altitude, being able to reach about 1000 m. The other species however (oak, pine species, fir, beech, plane tree, chestnut) are very important as they cover extensive mountainous areas giving various products, protection to the soil and value to the landscape.

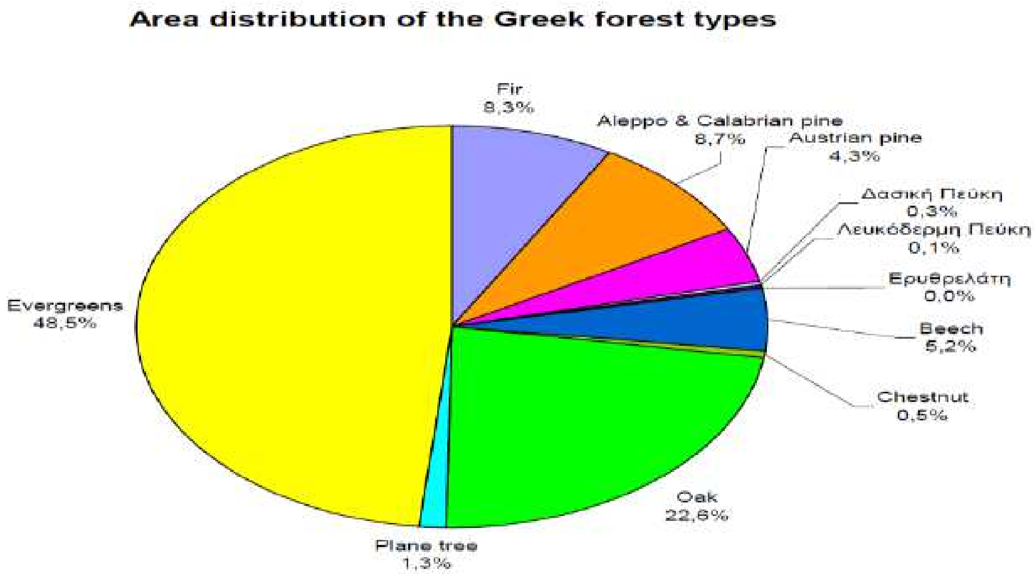


Figure 13. Area distribution of the Greek forest types (Yli, 2011)

In Greece, the only nationwide census of the forest areas was contacted in 1992, by the General Directorate for the Forests and the Natural Environment, Ministry of Agriculture (GDFNE, 1992). According to this, forests covered 6.513.068 Ha or 49.3% of the total area of the country in 1992. From this, 3.359.000 ha are marked as industrial forests, whereas 3.153.882 are non-industrial.

Land Use in country	ha	%
Industrial forests	3.359.186	25,40%
Non-Industrial forests	3.153.882	23,90%
Total Forest Lands	**6.513.068**	**49,30%**
Misc. lands	4.863.930	36,90%
non-inventory lands	1.818.740	13,80%
TOTAL country area	**13.195.738**	**100,00%**

Land Use in W. Macedonia region	ha	%
Industrial forests	275.421	29,14%
Non-Industrial forests	142.400	15,07%
Total Forest Lands	**417.821**	**44,21%**
Misc. lands	527.329	55,79%
TOTAL region area	**945.150**	**100,00%**

Table 9. Land use in Greece and in the Western Macedonian region

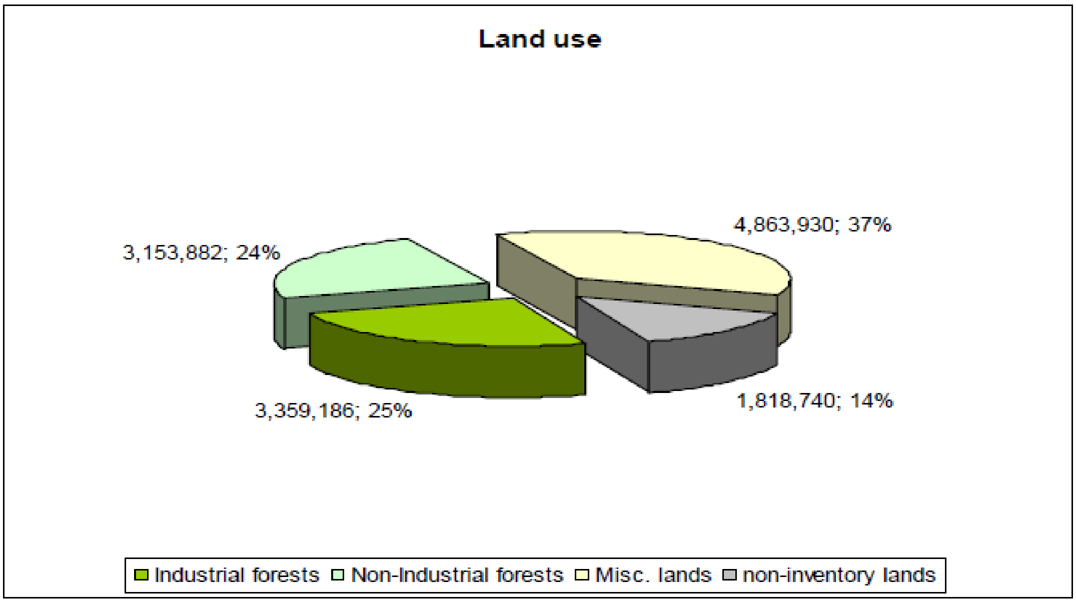


Figure 14. Land use in Greece (1992)

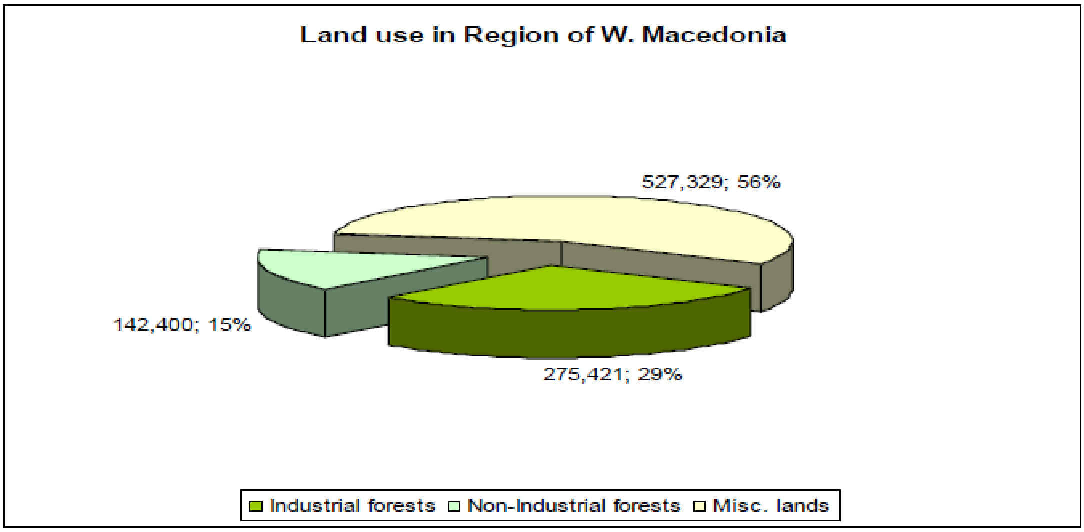


Figure 15. Land use in Region of W. Macedonia (1992)

The region of Western Macedonia is divided into 5 forest districts: Kozani, Tsotyli, Grevena, Kastoria and Florina. The forest cover in the region comprises 417.821 ha or 44,2% of the total area. The largest portion of forests exist in the Grevena district (57,3%) while Kozani and Tsotyli, combined, contain the least amount of forested area.

Land Use in W. Macedonia region	Industrial forests (ha)	Non-Industrial forests (ha)	Total forest (ha)	Total area (ha)	% forest area
GREVENA Forest District	77.277,00	55.431,00	132.708,00	229.090,00	57,93%
KASTORIA Forest District	64.260,00	14.996,00	79.256,00	172.010,00	46,08%
FLORINA Forest District	62.022,00	6.831,00	68.853,00	192.460,00	35,78%
KOZANI + TSOTYLI Forest District	71.862,00	65.142,00	137.004,00	351.590,00	38,97%
Total Forest Lands	**275.421,00**	**142.400,00**	**417.821,00**	**945.150,00**	

Table 10. Land use in W. Macedonia Region

The major tree species in the region are Austrian pine, Beech, Oak and Evergreen. These add up to almost 97% of the whole forest area of the region.

Worth noting is the fact that the area is the major producer of Austrian pine (20,51% of the whole country), white bark pine (31.25% of the whole country) and beech (17.36% of the whole country).

Tree species	Forest Districts (Area in ha)				Total region	Total country	% of country
	GREVENA	KASTORIA	FLORINA	KOZANI + TSOTYLI			
Fir	359	0	277	794	1.430	543.308	0,26%
Aleppo pine	0	229	0	106	335	567.731	0,06%
Austrian pine	32.860	8.881	108	15.933	57.782	281.692	20,51%
Scotch pine	0	0	318	106	424	20.955	2,02%
White bark pine	2.270	65	259	0	2.594	8.300	31,25%
Pinus pinea	0	0	0	0	0	108	0,00%
Fir pine	0	116	0	0	116	4.762	2,44%
Beech	6.370	22.249	18.988	10.840	58.447	336.640	17,36%
Chestnut	0	1.120	0	1.730	2.850	33.081	8,62%
Oak	34.168	30.202	40.906	40.733	146.009	1.471.839	9,92%
Evergreen	55.431	14.996	6.831	65.142	142.400	3.153.882	4,52%
Plane	1.250	1.398	1.166	1.620	5.434	86.579	6,28%
Spruse	0	0	0	0	0	2.754	0,00%
Birch	0	0	0	0	0	1.437	0,00%
Total region	**132.708**	**79.256**	**68.853**	**137.004**	**417.821**	**6.513.068**	

Table 11. Tree species

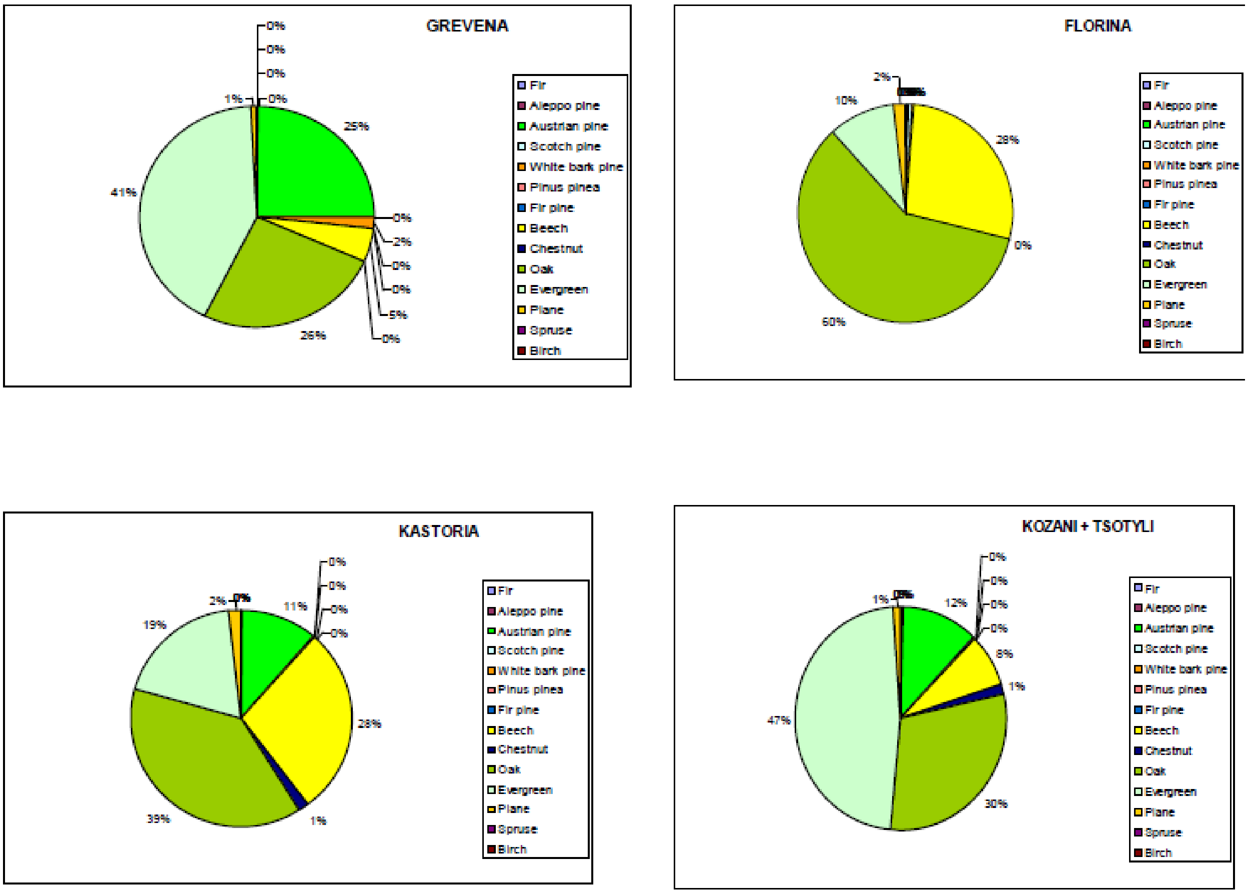


Figure 16. Tree species per forest district in region of W. Macedonia (1992)

In comparing the total forest areas (417.821 ha) in 1992 with those (forest and partly forest lands combined) in 2008 (319.596 ha) a 23,5% reduction was observed. A major cause of this is wild fires.

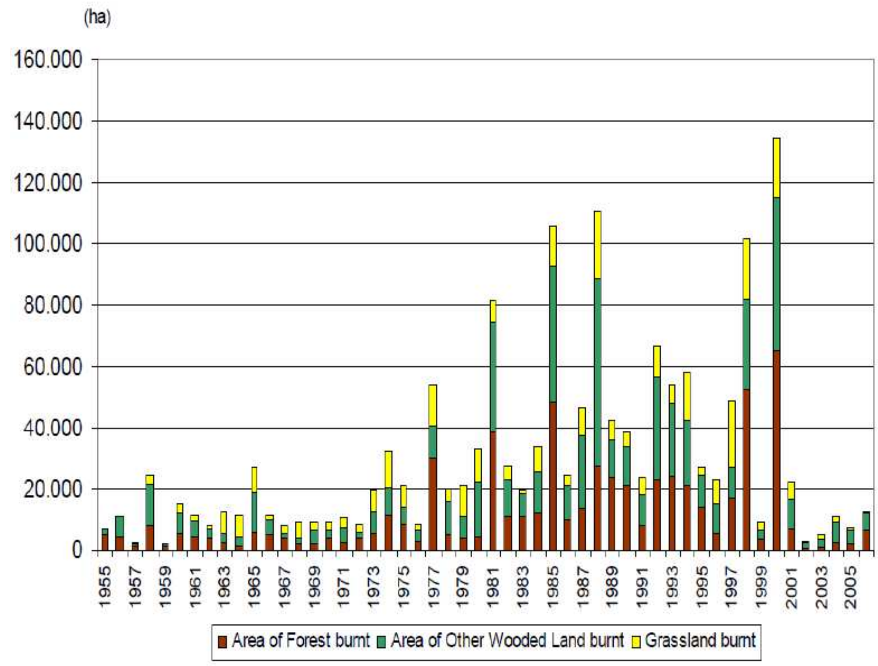


Figure 17. Areas of forest, other wooded areas and grassland burnt since 1955 (MEPPPW, 2008)

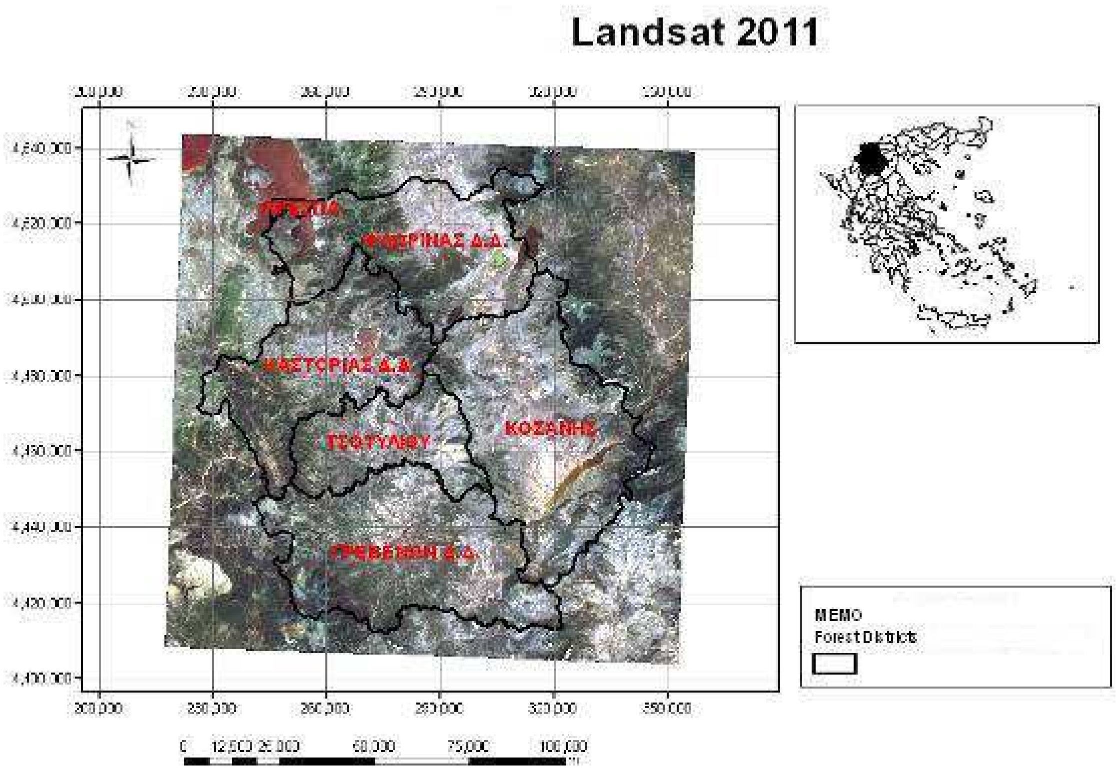


Figure 18. Forest Districts on top of the Landsat satellite orthoimagery layer (2011). High anaglyph and forested areas are clearly depicted.

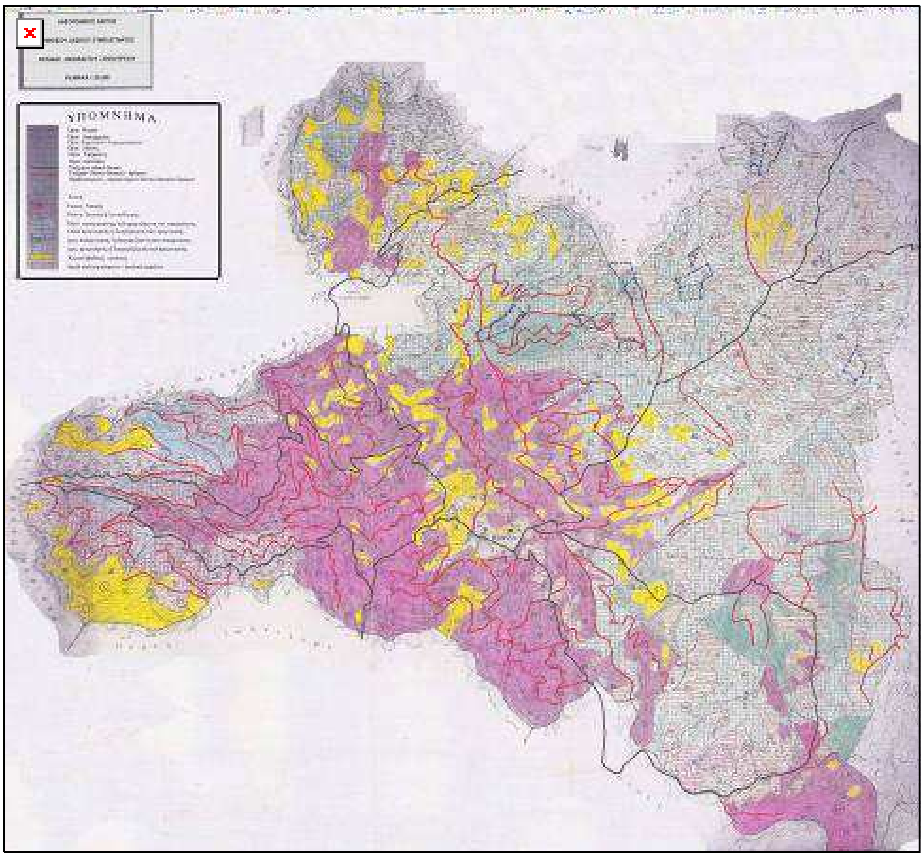


Figure 19. An example of a forest management plan

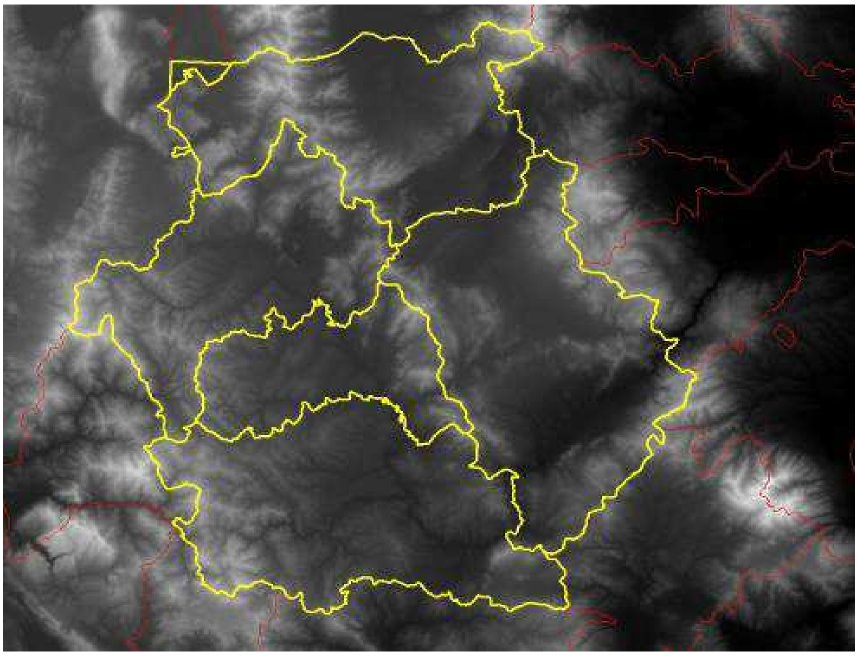


Figure 20. Forest Districts on top of the global Digital Terrain Model. High elevations and steep slopes are depicted.

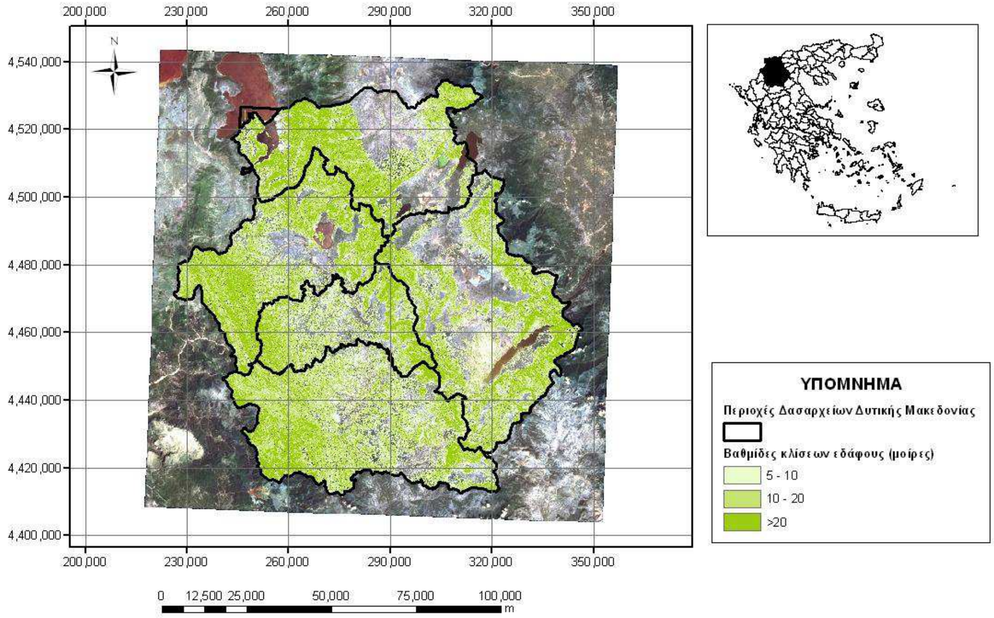


Figure 21. Slope map

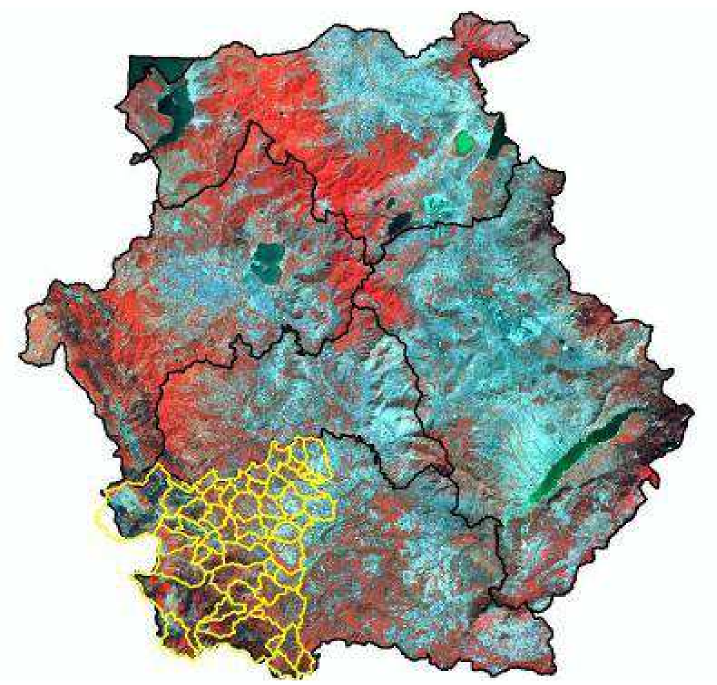


Figure 22. The Near Infrared band (NIR) of the satellite imagery provides a good approximation the forested areas (seen here in red)

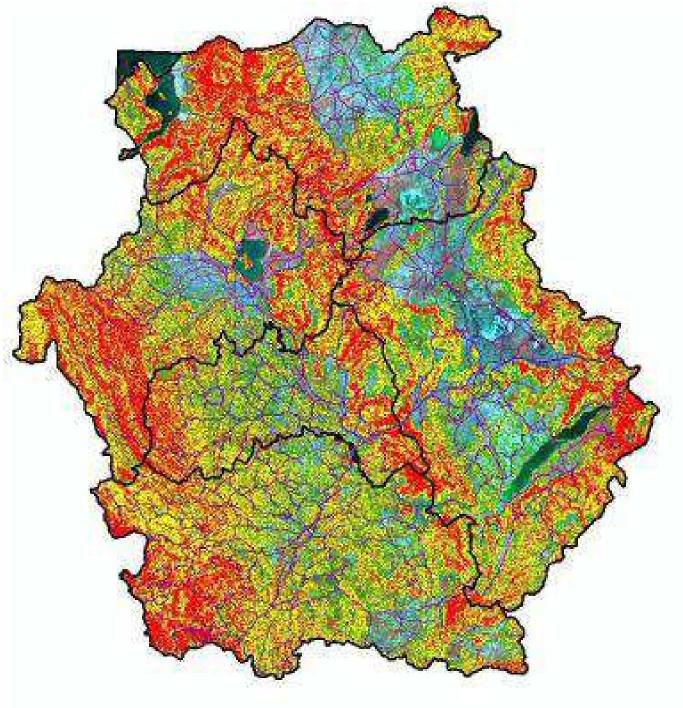


Figure 23. Road network (in purple) overlaid over slope map and over IR imagery. The area is characterized by a thick road network (here in blue) which is useful for wood transport.

2.2.5. *Quantification of regional biomass potentials in Portugal*

The main source of information on forest occupation in Portugal is the National Forest Inventory (NFI), the last one having been published in 2010 (with data referred to 2006) and a new one being undertaken in 2013 and 2014. This is the only national study providing information on biomass availability in Portugal. The values are presented at the regional level.

The methodology of the NFI is divided into two main stages. The first one intends to obtain area values and is based on the interpretation of aerial photographs, resourced to a network of 500 meter spatial resolution points. In the second stage, a set of parameters are evaluated at the forest areas level, using a group of predefined field plots.

The information obtained from these two stages of evaluation permit the estimation of areas and volumes of the main forest species. Resourcing to a set of biomass equations, the values of the existing quantities of this raw material are also obtained. The next table presents the areas, volumes and biomass determined for the country and the Algarve region (AFN, 2010).

Species	Area (ha)	Volume (x 1000 m3)	Biomass (k ton)
Pinus pinaster	885019	85756	49690
Eucalyptus globulus	739515	45828	36252
Quercus suber	715922	24773	34925
Quercus rotundifolia	412878	7566	10671
Other oaks	150020	5405	6527
Pinus pinea	130386	4330	5325
Castanea sativa	30029	1631	2407
Acacia spp.	4098	521	716
Other broadleaf	82383	4325	4989
Other resinous	25099	1639	963

Table 12. Areas, Existing Volume and Estimated Biomass for Portugal (AFN, 2010)

Species	Area (ha)	Volume (x 1000 m3)	Biomass (k ton)
Pinus pinaster	5973	336	198
Eucalyptus globulus	25049	958	760
Quercus suber	33250	774	1158
Quercus rotundifolia	13215	-	-
Other oaks	82	-	-
Pinus pinea	30044	175	214
Castanea sativa	0	-	-
Acacia spp.	25	-	-
Other broadleaf	12922	-	-
Other resinous	1118	-	-

Table 13. Areas, Existing Volume and Estimated Biomass for Algarve (AFN, 2010)

Some other studies have been developed in recent years, specifically dedicated to the evaluation of the biomass potential, both at the national and regional level. Within the first group, the studies associated with a national tender for the attribution of 15 licenses for the establishment of biomass power plants are particularly important. Most of these studies are not public. The ones that are, focus mainly on the forest residues of the exploitation of Eucalyptus globulus and Pinus pinaster. This two species are the main ones responsible for wood production and milling uses (mainly as paper pulp and wood mills). Some of them include approaches to the biomass production potential of the bush dominated areas.

The data used is, in many cases, that provided by the NFI. On some occasions, additional field data is gathered, for regional adaption purposes. The main difference between these studies is the use of a growth model to obtain future production values and establish production cycle information. The two species mentioned above have associated growth models. These models were developed through the cooperation between the industry and the university. For Eucalyptus globulus, the model used is known as **Globulus 3.0**[1] (TOMÉ, et al., 2006) while the model for Pinus pinaster is known as **PBravo**[2] (PÁSCOA, 2001).

With the NFI and the equations of the models, it is possible to obtain the potential production values for several regions of Portugal. The below tables and maps present the results of one of these studies (CAMPILHO, 2010).

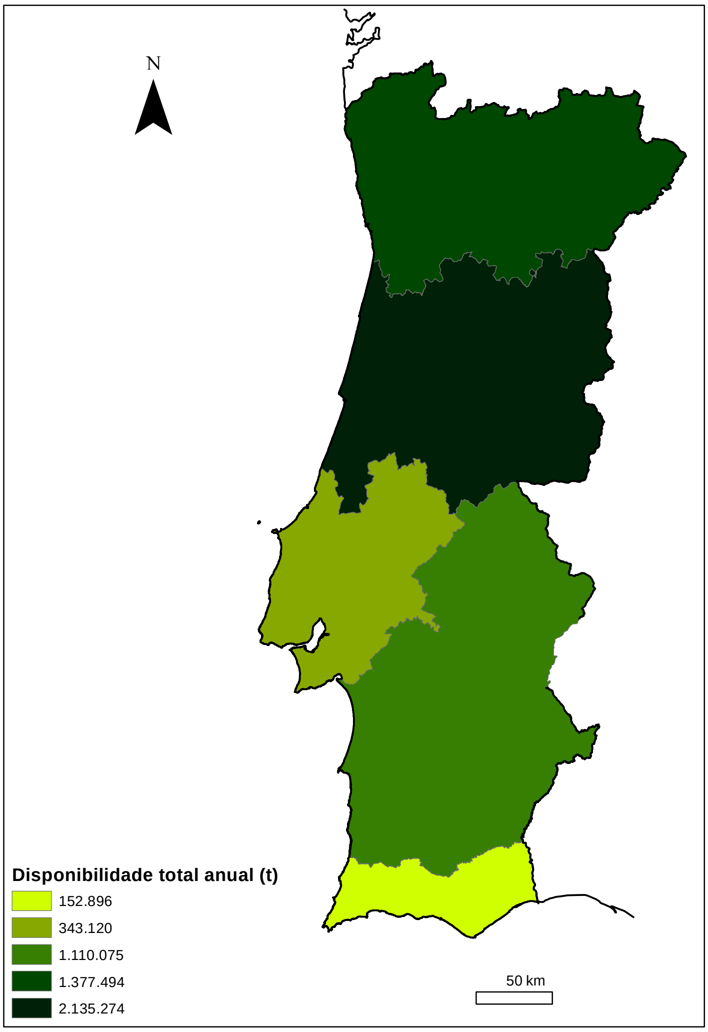


Figure 24. Total biomass availability (ton) in Portugal, by zone (CAMPILHO, 2010)

[1] http://home.isa.utl.pt/~joaopalma/modelos/globulus30/
[2] http://home.isa.utl.pt/~joaopalma/modelos/pbravo/

Country Zone	Biomass (ton)			
	Bush dominated areas	Pinus pinaster	Eucalyptus globulus	TOTAL
CENTER	959595	792439	383240	2135274
ALENTEJO	806934	85680	217461	1110075
NORTH	680760	376793	319941	1377494
ALGARVE	83241	7998	61657	152896
LISBON	42761	177108	123251	343120

Table 14. Total biomass availability (ton) in Portugal, by zone (Campilho, 2010)

Several studies have been carried out at a regional level. These studies were mainly developed within the scope of graduation essays. The work of Netto (NETTO, 2008), developed for three municipalities of the Santarém district (center Portugal), is a good example of this type of work.

A study was publicized in 2006, specifically for the Algarve, that dealt with the evaluation of the bio-mass potential of the region (AREAL, 2006). This work included the evaluation of several sources of biomass: agricultural residues, forest biomass, solid waste and biogas from landfills. In the case of forest biomass, the data presented with the use of NFI data adapted accordingly to a series of wood production presuppositions concerning a set of species present in the region: *Pinus pinaster*, *Quercus suber*, *Eucalyptus globulus* and *Quercus rotundifolia*. The analysis also included data from bush dominated areas and a particular focus on the use of biomass from burned areas. The final results are presented in the following tables.

Species	Biomass residues (ton)	Heating power (kcal/kg)	Energetic potential (tep)
Pinus spp.	7989	4000	3196
Quercus suber	24948	3400	8482
Eucalyptus globulus	8061	3500	2741
Quercus rotundifolia	3647	3400	1240
Total	44645		15659

Table 15. Energetic potential from biomass residues in forested areas (AREAL, 2006)

Species	Biomass residues (ton)	Energetic potential (tep)
Forested areas	44645	15659
Bush dominated areas	50000	16720
Burned areas	18200	8695
Total	112845	41074

Table 16. Energetic potential from biomass residues (AREAL, 2006)

More recently, within the scope of the PROFORBIOMED Project, an evaluation of the forest biomass potential was developed. This work focused on the three main wood production species existing in the region: *Eucalyptus globulus, Pinus pinaster* and *Pinus pinea*, and was directed specifically at wood exploitation residues. For each of these species, a set of scenarios based on several local management schedules were selected. Each of these scenarios was then used within mathematical growth models to simulate the dimension of the trees in the thinning and final cut moments. The two models referred to above and another developed in Andalucía (Spain) for *Pinus pinea* (SAINZ, et al. 2007) were used for this calculus. The values (of height and diameter) calculated by the models were then used within a set of biomass equations to calculate the biomass production of each tree component. Once the study was only meant to analyze the residues. The components used were the branches, leaves (or needles) and roots (exclusively in the *Eucalyptus* case and only 30 % of the volume calculated). The biomass values obtained were then divided by the growth period to obtain a yearly value of potential production for each species. Once several management scenarios were used, the previous process was repeated for each one of them, obtaining a set of potential production values. For each species the minimum and maximum values were selected and treated as the conservative and optimistic scenarios of production. The territorial dispersion of the biomass production was then evaluated resourcing inventory data produced for the region (to assist the Algarve Forest Regional Plan). This way it was possible to obtain regional values of production potential and, using a Geographical Information System (GIS) the values for each of the municipalities of the region (or other administrative or management unit) were possible to obtain. In the following tables and maps it is possible to analyze the results of this study.

Species	Forest Residual Biomass (ton/ha.year)	
	Conservative	Optimistic
Pinus pinea	0.25	0.41
Pinus pinaster	0.58	0.7
Eucalyptus globulus	0.76	1.24

Table 17. Forest Residual Biomass Potential (Conservative and Optimistic scenarios) for each species

Municipality	Forest Residual Biomass (ton/ha.year)	
	Conservative	Optimistic
Albufeira	293.6	942.7
Alcoutim	10896.7	35703.5
Aljezur	9668.5	23821.5
Castro Marim	4618.0	15049.3
Faro	351.6	1131.1
Lagoa	244.5	817.5
Lagos	3457.3	9318.9
Loulé	8776.3	28500.0
Monchique	14182.4	30781.3
Olhão	132.4	428.4

Municipality	Forest Residual Biomass (ton/ha.year)	
	Conservative	Optimistic
Portimăo	2692.9	7173.8
Săo Brás de Alportel	1939.0	6379.4
Silves	9462.0	28645.9
Tavira	11146.6	36162.6
Vila do Bispo	2706.2	8343.7
Vila Real de Santo António	615.6	1537.1
TOTAL (Algarve)	**81183.4**	**234736.9**

Table 18. Forest residual biomass potential in each of the Algarve municipalities (Conservative and Optimistic scenarios)

2.2.6. *Quantification of regional biomass potentials in Slovenia*

Slovenia is among the most forested countries in Europe. In 2010 there were 1,185,169 hectares of forest, covering 58.5% of the country (Figure 25).

Many of the Slovenian forests in the area consist of beech, fir-beech and beech-oak forests (70 %), which have a relatively high production capacity. The growing stock in Slovenia is approximately 337.82 million m^3, of which 46.43 % are coniferous and 53.57 % are non-coniferous. The average growing stock is 285 m^3/ha (Figure 26). The annual increment is about 8.42 million m^3 (7.1 m^3/ha), but in the last few years, the annual cut was from 3.7 to 3.9 million m^3, of which 60 % were coniferous and 40 % were non-coniferous (SFS, 2012). The difference in numbers shows that, in Slovenia, the potential of our forests is not optimally exploited and that there are still unused potentials.

The production of wood chips from forest residues is not a common practice and the main obstacles standing against the use of forest residues are economics and harvesting technology. In the case of producing wood chips from forest residues, an important question involves the economy of the production (transport of forest residues to skidding trails or forest roads, producing wood chips on a forest road or trail).

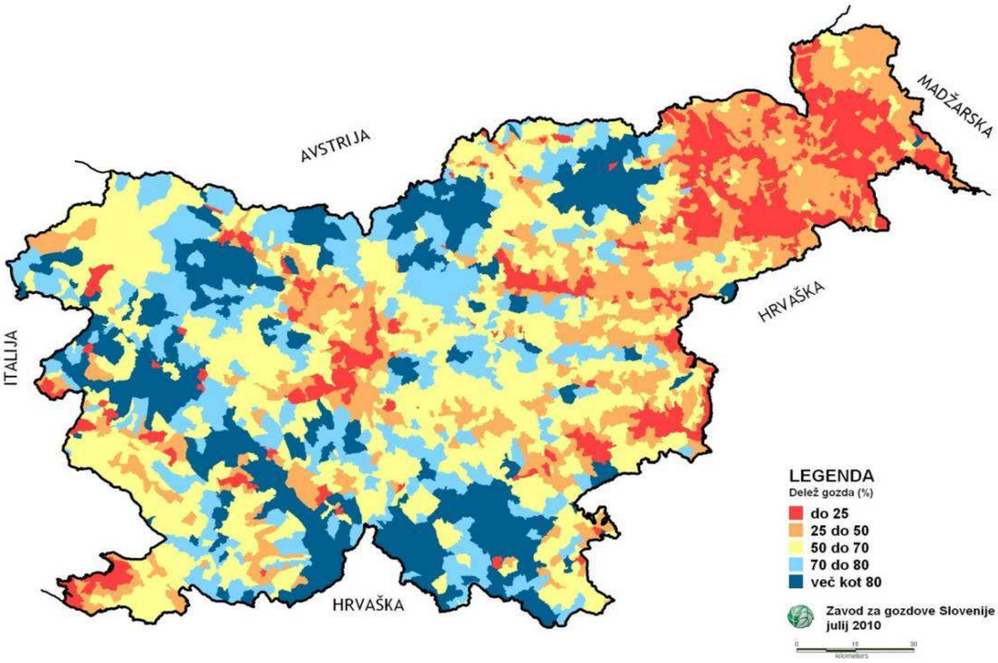


Figure 25. The proportion of forest surface (in %) in Slovenia.

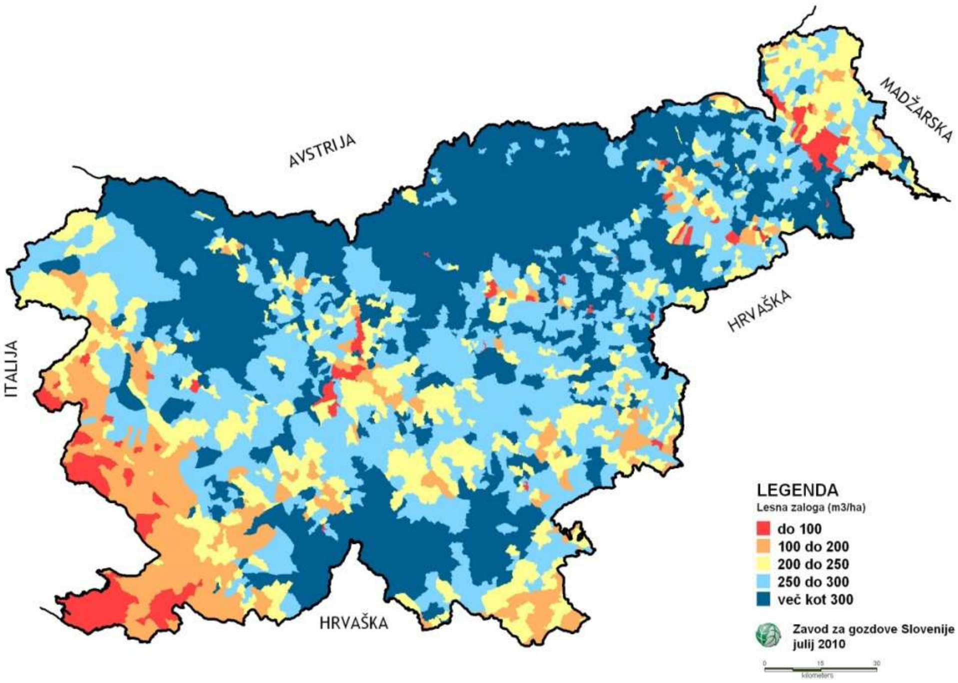


Figure 26. Growing stock (m3/ha) in Slovenia.

The Slovenian Forest Service-SFS (Zavod za gozdove Slovenije) is responsible for the country's biomass potential, particularly that of the forest biomass in Slovenia. SFS was established by the Ministry of Agriculture and performs public forestry services in all Slovenian forests, irrespective of its ownership.

The state level is organised in Ljubljana by its central unit, at the regional level by 14 regional units, and at the local level by 93 local units and 408 forest districts. Therefore, it is responsible for the development and implementation of the forest management plan which includes:

- the regional forest management plans and forest management units' plans;
- sivilcultural plans;
- regional hunting management plans.

Forest management planning includes:

- the elaboration of forest management plans;
- collecting data on the state and keeping databases;
- monitoring the biological balance of forests;
- giving consent to interventions in the forest and forest space;
- co-operation in open-space planning.

In the planning stage, a map of the forest is used, developed in 2001, which is regularly updated at the renewal of plans in forest management units (Figure 27).

Figure 27. Forest management map.

2.2.6.1. Development of the GIS-based model

The Slovenia Forest Service collected data regarding the annual growth of the forest biomass. Every year they take sample forms, the sample surface being 250 m X 250 m and covering 10 % of Slovenian forests. The next year they repeat the procedure with the next 10 % of sample surfaces. 10 years later, they have complete data regarding the biomass potential. On the basis of the data obtained from the 10 % of the sample surfaces the growing stock and biomass potential is calculated and on this basis, the entire potential is estimated and the forest management plan is annually developed.

A similar procedure was developed by the Slovenian Forest Institute in the year 2000. The Slovenian forests are divided on grid (4 km X 4 km) of the sample surfaces. The samples are taken and the estimation of the annual growing stock is estimated as well.

Slovenia does not have a developed GIS model for forest management or for the qualification of the wood potential. In 2011, SFS participated in the IEE project WISDOM Slovenia, MAKE IT BE, in order to establish a model and methodology for collecting all relevant data available in Slovenia from all institutions dealing with forests and wood potential. This data includes:

- data regarding the demand and supply of wood;
- the number of the inhabitants in the municipalities;
- data regarding the availability of the wood biomass for energy production from agriculture;

- data on the main users of wood biomass in Slovenia;
- data regarding forest management costs including the costs of felling and skidding to the nearest roads;
- data on suitable locations for wood biomass plants.

2.3. Analysis of biomass supply potentials

2.3.1. *Analysis of biomass supply potentials in Italy*

The availability of forest biomass in the regional market is conditioned by the presence of local players, such as forest entrepreneurs and qualified biomass producers. As a consequence, the production capacity (current and future) of the local biomass producers must be estimated.

For this purpose, market studies are tools allowing us to:

- define the number and location of local forest biomass producers
- characterize their professional skills and the availability of machinery
- estimate their production capacity, logistical services and facilities (including both storage and transport logistics)

As an example, Figure 28. shows the location of forest biomass producers of wood, log and chips in the Veeto Region (Italy), according to their production capacity level (tons per year).

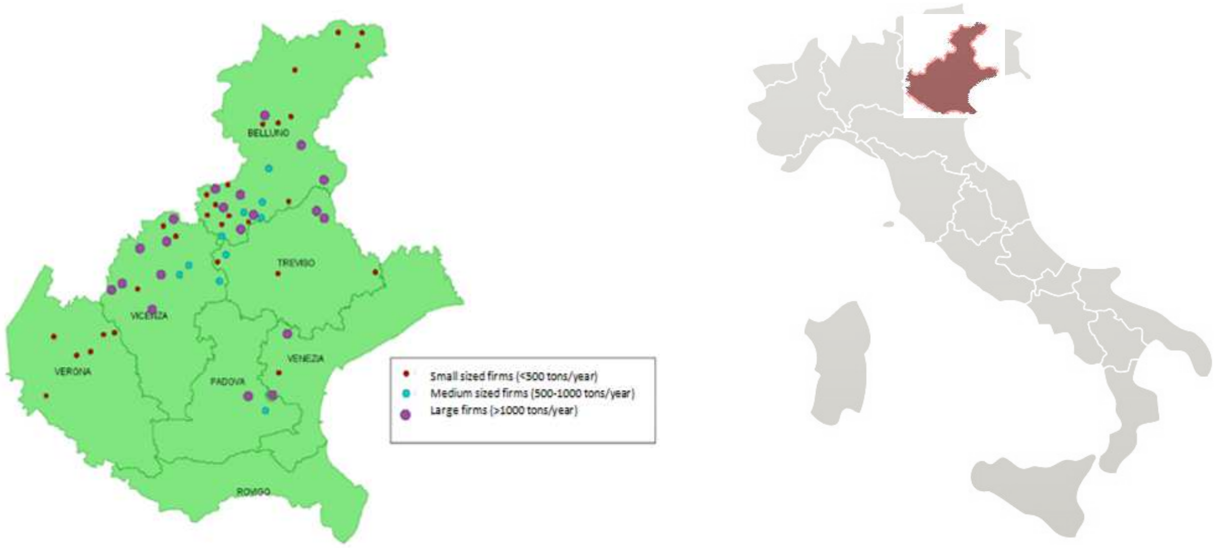


Figure 28. Position and production capacity of forest biomass producers in the Veneto region.

2.3.1.1. Location and production capacity of wood chippers

In order to complete the study of a forest chips supply chain, a wood chipper census should be taken. The survey should quantify their production capacity (potential and effective) and their potential range of activity. This information can be used to estimate the potential production of wood chips and, by counting the effective hours of use, to evaluate the correspondence between chip availability and the local market demand and supply. Figure 29Figure 29. provides the location of 17 wood chippers in the Veneto Region, indicating their production capacity range. The production potential of these chippers is about 220,000 tons/year, corresponding to 70% of the potential biomass availability on regional scale. Furthermore, taking into account the chippers effective working hours the result is that only 50% of their potential working hours are exploited.

Based on the aforementioned results, the region adjusted its incentive scheme (Rural Development Programme), focusing on measures to increase the exploitation capacity (with the aim of increasing the biomass supply) and to optimize the logistics and operations/distribution of forest enterprises and woodchip producers.

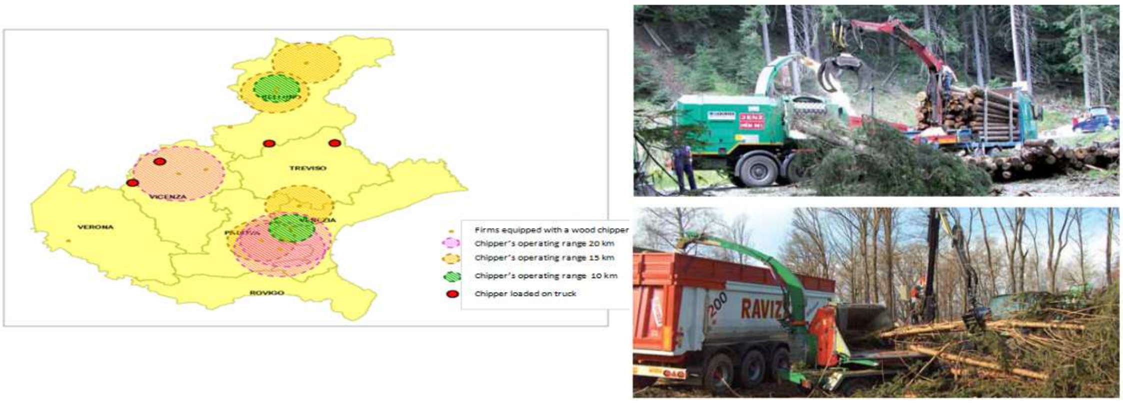


Figure 29. Location and production capacity of wood chippers in Veneto.

2.3.1.2. Professionalization of forest biomass producers

Designing a forest biomass supply chain assumes the presence of a network of professional producers, organized to supply biomass that meets the expectations of the local market. For this reason it is recommended to organize **training and retraining courses** to assure that biomass producers receive the required knowledge about production techniques, cost analysis, the quality control of solid biofuels and contracting aspects (Figure 30).

Figure 30. Professional Biomass Producers Group training course, established by AIEL (2012).

The programme includes both theoretical and practical sessions. The latter is taken in a laboratory, where participants can learn how to determine the quality of wood,logs and chips and also how to set up a biomass-delivering contract.

2.3.1.3. Marketing the forest biomass producers

Another relevant matter is the promotion of the professional producers network, referring to the creation of promotional tools to facilitate business, matching local demand with supply. To achieve this goal, it is recommended to set up **promotional and marketing tools** such as catalogues or directories reporting the location, products and services provided by biomass producers (Figure 31).

Figure 31. **The "AIEL biomass directory" is an example of a promoting and marketing tool. It involves the Italian producers who joined the AIEL Group of Professional Biomass Producers (2013).**

Within the BiomassTradeCentre Project II (www.biomasstradecentre2.eu), 10 catalogues have been published on the web to promote biomass producers and forestry companies located in 9 different European Countries (Figure 32). On the project web site, a section called "service providers" provides users with a tool developed to find European biomass producers or service providers by selecting the biomass category and location.

Figure 32. Three of nine downloadable catalogues referring to Slovenia, Spain and Greece.

2.3.2. *Analysis of biomass supply potentials in Slovenia*

2.3.2.1. Location and production capacity of wood chippers

In July 2011, a study about the state of the art of wood chip and firewood production was performed within the *Biomass Trade Centre 2* project. The Slovenian Forest Institute database lists 122 wood chippers all around Slovenia and 125 firewood processors and wood splitters. SFI annually collects information regarding locations and production capacities of the wood chippers in Slovenia.

Wood chippers in Slovenia are divided into 3 categories according to their power: low powered wood chippers, medium powered wood chippers and high powered wood chippers. In Slovenia, 60 % of the wood chippers are middle sized (with a capacity from 5 to 50 loose m^3/h), 36 % are large and only 4 % are small. The largest number of chippers can be found in the Osrednjeslovenska region, followed by the Gorenjska and Savinjska regions. The domestic manufacturer Bider Bojan s.p. - Kmetijski stroji (Figure 33) and Austrian manufacturer Eschlböch dominate the local market for small and medium chippers with 53 registered machines and 26 chippers respectively. In the case of large chippers, we have Mus-Max with 11 Austrian chippers.

Figure 33. Slovenian manufacturer of wood chippers: Bider Bojan s.p. - Kmetijski stroji.

Despite the fact that medium chippers dominate the market in sheer number, the vast majority of all woodchips are produced with large chippers. The data shows that the largest producer of woodchips is the Savinjska region, followed by Osrednjeslovenska, Jugovzhodna, Pomurska, Notranjsko-kraška and the Gorenjska region (Figure 34). The result is logical given that these are the regions with a high number of large chippers with a capacity over 50 nm3/h. The production in other statistical regions is significantly smaller. The analysis also showed that the actual production of small chippers is negligible.

Figure 34. Statistical regions and recorded wood chippers in Slovenia.

The production of woodchips in 2010 came to an approximate 850,000 nm3, and, since then, the production of woodchips has increased significantly. In 2007, the production of woodchips was estimated at 460,000 nm3. Thus, over the past four years, the number of chippers has increased (97 %) from 62 to 122 recorded chippers as well as the production of wood chips (for 85 %). In 2010, 31 % of the input raw material for the production of woodchips consisted of low quality wood, while the remaining 69 % consisted of wood removals and wood residues from the wood processing industry.

According to SORS and SFI estimates, some 180.818 tons of wood biomass, 30 % less than in 2008, was used for the energy and heat production of the larger energy systems in 2010. The main reasons for this decrease included a reduced use of wood biomass in the two largest thermal power plants in Slovenia (co-incineration of wood and coal) as well as a reduced use of wood biomass in industry (predominantly the wood processing industry). We estimate that the decreasing trend of wood biomass use in the wood processing industry has ceased and shall remain constant over the next few years.

2.3.2.2. Professionalization of forest biomass producers

Following substantial subsidies to the investments in the biomass sector, mostly from Cohesion funds, forest biomass began to be used for energy production. Before Slovenia was included in EU and following the first GEF project, several feasibility studies were carried out. For example, the working group at the Ministry of Environment and Physical Planning issued the first professional literature regarding biomass use for energy production:

- Q-navodila za kakovost (Q-quality Instructions);
- Standardne vezave kotlov (Standardized Biomass Bboiler Connections);
- Vzorčni razpisi za kotle na les (The Examples of the Tenders for Biomass Boilers);
- Priročnik za načrtovanje (Guidelines for the Biomass Boiler Plants Design).

The first step towards the professionalization of the use of biomass for energy production is international projects and case studies, mostly lead by the government and chief stakeholders. After the government accepted the Biomass Action Plan and started allotting subsidies within wood sector (generally for the establishment of trade centres) meant for investments in wood chippers and other equipment, the biomass sector started developing. The professionalization of the forest biomass producers was enhanced through several paths:

- through national and international (EU) projects;
- through workshops within the framework of EU projects and at government institutions (e.g. Slovenian Forest Service, Slovenian Forest Institute, other institutes and universities);
- with the development of the internet and literature published online. For example, SFI has a public library on its web site, where a number of biomass publications are available.

Another important fact concerning the professionalization of the biomass producers cames in the form of establishing biomass cooperatives and professional companies for woodchips, wood pellet production and trading.

2.3.3. *Analysis of biomass supply potentials in Portugal*

2.3.3.1. Forest producers and associations

There is no organized statistical information regarding biomass suppliers in Portugal. The majority of the forested areas are private and small in dimension. Therefore, the association of forest producers is very important as they work to obtain better management results and also the capability to produce wood materials for the industries and biomass of an acceptable quality in sustainable quantities. There are 177 forest producer associations in Portugal (4 national, 6 regional, 26 complementary and the rest municipal). In Algarve, there are 3: one in Monchique, one in Serra do Caldeirão and other in Alcoutim. These associative structures are the closest entities to the forest producers and therefore, an essential actor in establishing a wood biomass supply chain.

2.3.3.2. Wood supply and biomass products

A great majority of the wood supply is assured by these private forest producers and is processed by several industries to obtain biomass products. There is no specific data on the production and commercialization of the main forest biomass products: firewood, woodchips, wood logs, pellets or briquettes. The Portuguese Statistical Institute produces aggregated information for this type of industry but little data is available for each of the products individually. The forest biomass is mainly commercialized in the form of firewood (from forest residues, dry branches, dead trees, agriculture tree pruning, among others) and woodchips (resulting mainly from sawmills and as forest exploration residues) and wood logs (mainly from *Pinus pinaster* plantations in the central and northern parts of the country). Firewood is the most widely used fuel for heating purposes, but there isn't an organized market system (mainly commercialized by family based companies with few employees, low mechanization and no associated infrastructures). The wood logs and woodchips (particularly those coming from wood processing industries and presenting a high level of quality) have, in recent years, been used by the pellets industry. This activity has been growing in recent years and is turning out to be one of the main biomass supply industries in the country.

2.3.3.3. The pellet industry

The national market of biomass fuel for heating suffered a substantial change in the last years. Traditionally, firewood and wood briquettes were used in manual feeding equipment. The arrival of a national pellet producing industry, together with an increasing search for viable alternatives to replace fossil fuels like diesel for heating, created the perfect conditions for the pellet equipment's market penetration. The principal pellet consumption sectors in Portugal are the domestic, public and services buildings and small industries with heat requirements such as bakeries. There are no power facilities that use pellets. The district heating concept is unknown in Portugal, mostly due to having a warmer climate than, for example, central Europe. Thus, heating requirements are reduced for 5-6 months of the year. Such a concept also remains uncharted due to the financial investments that would need to be made into public infrastructures and buildings. The Portuguese pellet market is based heavily upon small and medium consumption and is mostly centered on the heating period, from October to April. For this reason, the national pellet consumption approximately 10% of the total production. Above all, the pellet market in Portugal enjoyed development from 2005 on, starting with one plant and moving up to around 20 in 7 years. Now, the pellet market represents a business volume of around 85M€. The total capacity of pellet production in Portugal remains at around 850kton, effective production being approximately 650kton per year. The quantity sold in Portugal for the uses enumerated above, levels around 50 kton, which is about 9% of the total production. This ratio confirms that the pellet market, in Portugal, is still very underdeveloped and showing little demand, but also shows that there is a great acceptance for the Portuguese pellet in markets that are very demanding, such as Norway, Sweden or Germany, which indicates that the pellets produced for exportation are of good quality. The main market of all of the larger national pellet companies is in exports, as it is not possible for the Portuguese market to absorb the national production capacity. Although, the needs of the Portuguese market are almost exclusively covered by national production, imports are almost non-existent. There are two distinct types of pellet producers in Portugal:

- the larger ones, who have their target market in north and central Europe,;
- the smaller ones, which supply the national market.

The pellet plants are almost all located above the Tejo river line, where there are more forested areas. The primary transformation wood activity is derived from that fact.

Main pellet producers in Portugal:

To follow is a list of the main pellet producers, their main features and distance from the Algarve region.

Enermontijo (http://www.enerpar.pt/enermontijo)

- Established in 2008 in Pegões (73 km east of Lisbon and 169 km from Algarve);
- Production capacity of 80000 ton/year;
- 15 % increase in production from 2010 to 2011;
- Over 97 % of their production is exported;
- Use 100 % national wood, mainly from Pinus pinaster (mostly round wood but also woodchips).

Enerpellets (http://www.enerpellets.pt/)

- two industrial facilities for waste disposal (Pedrogão Grande e Alcobaça);
- the one in Pedrogão Grande (367 km from Algarve) was started in 2009;

- produce 150000 ton/year, exclusively for industrial purposes;
- use mainly Pinus pinaster wood;
- the Alcobaça unit (287 km from Algarve) began working in 2012;
- has a smaller production capacity (around 100000 ton/year), but a better technical capacity;
- produce not only for the industrial segment, but also for the domestic one;

José Afonso e Filhos, S.A. (JAF)(http://www.jaf-madeiras.com/)

- established in Oleiros (392 km from Algarve);
- production capacity of 70000 ton/year;
- 100% Pinus pinaster use;
- this company also commercializes wood briquettes;
- it disposes of its own transport fleet;

Pellets power (http://www.gesfinu.com/index.php?cat=11&item=25&PHPSESSID=211ef2d53a1685450ff201d26d59c1ba)

- established in Mortágua (423 km from Algarve) in April 2008;
- production capacity of approximately 100000 tons/year;
- owns a fully automatic package line (20 ton/hour in 15 kg bags);

Vimasol (http://pellets.vimasol.pt/)

- located in Celourico de Basto (554 km from Algarve);
- started production in 2008;
- result of a partnership between Minho University and Centro para a Valorização de Residuos (Residues Valorization Center);
- produce 9000 tons/year;
- use exclusively sawmill sawdust from Pinus pinaster;




2.4. Analysis of the regional potential demand

2.4.1. *An Italian case study in the FVG region*

The feasibility study for a forest biomass energy chain development includes the analysis of the demand. Demand (potential and effective) depends on the number, capacity and location of the biomass plants, including the ones entering the operation in a short-medium term. As the demand is calculated, it is possible to estimate the annual biomass consumption and its development trend. This can be done with the support of the data gathered by public institutions, biomass boiler and CHP trade associations.

The Figure 35 shows the primary source of biomass heating and CHP plants fed with chips located in the Friuli Venezia Giulia region. They are ranked in terms of rated thermal input (kW) and represent a demand of approximately 10,000 ton/years of woodchips (moisture 30%).

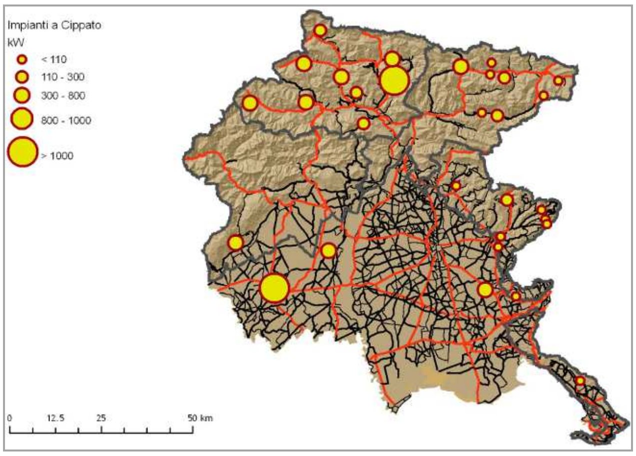


Figure 35. Regional woodchip demand ranked by the rated thermal input.

2.4.2. *A French case study in the PACA region*

As of early 2013, 225 automatic wood boilers were operating in the PACA region, with a consumption of 50,000 tonnes of fuel per year and a total capacity of 68.5 MW. In 10 years, their number was multiplied by 10 (see Figure 36.). The first boilers were installed in the late 1990s for the needs of wood processing companies in the northern part of the region. Since 2008, installations in public projects have taken over, but these companies still account for two-thirds of the wood consumption.

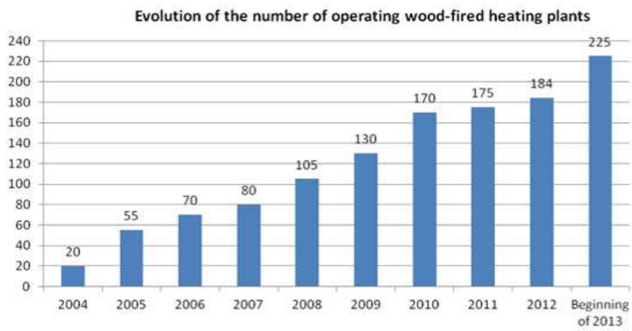


Figure 36. Evolution of the number of operating boilers in PACA (Source: OFME, 2012 and 2013).

The majority of operating boilers (83%) are supplied locally, mainly with forest products (wood chips, sawmill by-products). The supply is, in particular, provided by platforms (24 in operation in 2013), within the immediate vicinity of the boiler (less than 40 minutes for 88% of them) (Figure 37.).

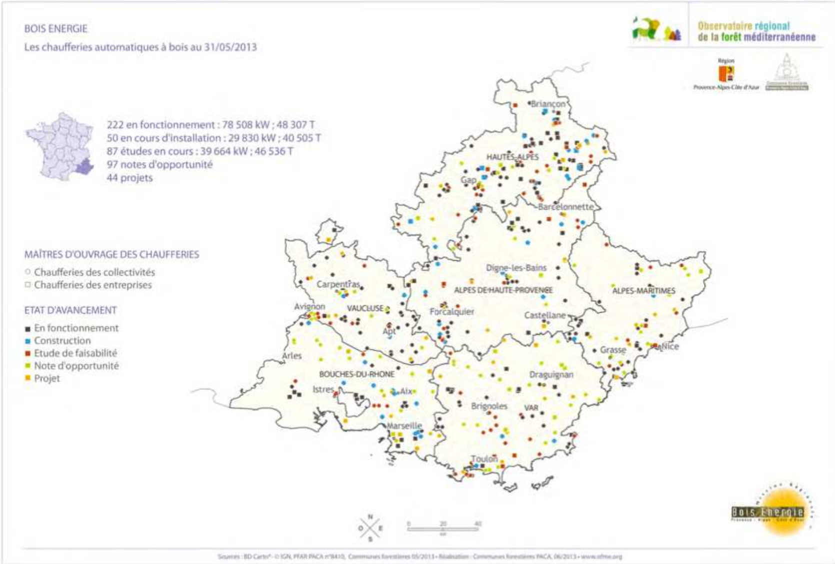


Figure 37. Automatic wood boilers in PACA (Source: OFME, 2013).

Future level of use

It is reasonable to estimate that the number of wood boilers will increase further in the coming years, especially due to the strong involvement of the energy wood regional mission (MRBE) and the associations of forests townships in the "1000 Wood Boilers in Rural Areas" project. Nearly 150 projects have already been identified and are in different stages of advancement.

Finally, several cogeneration projects of varying sizes are under way:

- small, usually in the absence of funding (sawmill Coulomp)
- very large (E.ON, Innova), within the framework of CRE projects (Commission for Energy Regulation).

2.4.3. *A Slovenian case study*

The Statistical Office of the Republic of Slovenia collects data on the biomass consumption for household heating every 5 years. Table 19. contains the data collected in the last two years.

Year	Heating	Hot water	Cooking	Total
2011	13,703	3,376	295	17,374
2012	15,786	3,664	282	19,733

Table 19. Biomass consumption in households in TJ (Statistical Office of the Republic of Slovenia).

In the industrial sector, the largest biomass consumers are obliged to report to the Statistical Office of the Republic of Slovenia every year concerning the wood consumption for production (wood processing). The Slovenian Forestry Institute is regularly collecting data on wood pellets and woodchip production.

In 2002, Slovenia began running the first biomass project, supported by the Global Environment Fund (GEF) - Removing Barriers towards the Increased Use of Biomass as an Energy Source (www.aure.si). Several biomass boiler houses using the district heating systems were then actualized in Gornji Grad, Preddvor, Logarska dolina, Nazarje, Vransko and Kočevje, consuming 80.000 m³/a of the woodchips. In 2004, Slovenia had 5 biomass CHP plants with a 5.2 MWe. The yearly electricity production was measured at 15.4 GWh/a and 190.5 GWh of thermal energy. All CHP plants are located in the wood processing industry for covering their energy needs.

Over the last 5 years, the number of sites with biomass boiler plants have increased dramatically. For example, in the Spodnje Podravje region the following biomass boiler plants and boilers include:

- the Lenart biomass district heating system (Figure 38). The installed thermal power of the boiler house is 7 MW, the capacity of the biomass boiler is 3.5 MW. The district heating grid is 4.8 km. The yearly heat consumption is 7.5 GWh. Heat consumers comprise public buildings (24 %), households (51 %) and other consumers (25 %). The investment costs of the entire system was 6 million EUR.
- the Hajdina woodchip biomass boiler plants with 200 kW installed thermal power for the heating of greenhouses and two buildings (Figure 39). The investment was implemented in 2013 and was designed by LEA Spodnje Podravje. The heated surfaces of the greenhouses and the two buildings come to 2,500 m2 and the heated volume was measured at 7,500 m3. The technical data is presented in Table 20. The investor decreased the thermal power of the boiler to 200 kW and increased the heat storage volume to 10 m3.

Heat power required	193,96	kW
Boiler thermal efficiency	0,80	
Heat losses	10,00	%
Designed power of the boiler	250	kW
Heat storage	7.000	L
Operating time	2.160	h/a
Heat consumption	465.504	kWh/a
Wood chips consumption	882	m3/a
Cost of the woodchip	15.870	EUR/a

Table 20. **The designed data of the boiler house for the Hajdina greenhouses.**

- the 1,3 MWth woodchip boiler plant, Revital Kidričevo (Figure 40). The total greenhouse surface area is 9,000 m2 and the administrative building (approx. 200 m2). The yearly consumption of woodchips is 5,800 m3 with an additional 53,000 L of the heating oil from boilers located in the greenhouses.
- the 200 kW wood pellet boiler at the Cirkulane Primary School (Figure 41). The power of the boiler is 201 kW and its efficiency was measured at 89,7 %.The capacity of the wood pellet storage is 5 t and the heat storage volume is 3,000 L.

- the 300 kW wood pellet boiler at the Makole Primary School. The existing boiler was replaced by this new one. The efficiency of the boiler is 90.9 % and has a heat storage capacity of 3,050 L. The boiler supplies heat to the primary school, sport facility and kindergarten.

Figure 38. Woodchip boiler plant in Lenart.

Figure 39. Greenhouse heating woodchip boiler plant.

Figure 40. 1.3 MW woodchip boiler plant, Revital Kidričevo.

Figure 41. Wood pellet 200 kW boiler at the Cirkulane Primary School.

Also analysed was the potential of other wood biomass boiler plants either with or without CHP plants. Table 21 contains all relevant data concerning the planned biomass systems which would be supplied by local resources through the established biomass consortium signed on December 20, 2013 in the Municipality of Žetale.

Name	Type	Power	Remark
Ormož	CHP	5.14 MW	ORC, heating of the nearby industry and the city of Ormož
Ptuj	CHP	8 MW	Gasification, heating industry, hotel and the city of Ptuj
Cirkovce	Thermal	300 kW	Micro district heating system
Dornava	Thermal	1 MW	District heating for public buildings in Dornava
Žetale	Thermal	300 kW	Micro district heating system for three public buildings
Podlehnik	Thermal	800 kW	District heating system for a public building
TOTAL		15.540 MW	

Table 21. Planned investments in the biomass energy sector in the Spodnje Podravje region.

2.4.4. *A Portuguese case study*

The biomass markets are still very much undeveloped in Portugal. The major players are located, as stated before, in the northern part of the country where the main forested areas are situated. As there are not any industrial facilities related to wood in Algarve, the demand for biomass is greatly reduced and concentrated within the (undeveloped) domestic market. Nevertheless, due to the Serra de Monchique region (in the eastern part of the region) containing a very important forested area (mainly dominated by Eucalyptus plantations), the Portuguese government included the region in a package of 15 Biomass Power Plants in 2006. A 15 MVA Plant was awarded to EDP, but the construction has ceased. The responsible company maintains the will to establish the power plant and, when this happens, the demand for biomass in the region will most certainly change.

As referred to above, the district heating concept is still unexplored in Portugal and consequentially, in Algarve. On the other hand, the region, due to its touristic vocation, has a great number of infrastructures (mainly hotels) that could adopt biomass generator solutions or even cogeneration solutions to produce cost reduction and alter ecological impacts.

In recent years, several public facilities were built within the numerous municipalities of the regions. These infrastructures (swimming pools, libraries, public schools) have heating needs that are normally addressed by diesel boilers. If some (or all) of these facilities adopted biomass solutions, the feedstock demand in the region would witness a large scale change. This fact could also promote the establishment of supply chains and increase the management of forested areas.

Within the scope of the PROFORBIOMED project, an economic viability study was carried out for the heating system replacement at the São Brás de Alportel Swimming Pool Complex.

2.4.5. *Detailed analysis of the demand at the forest district scale area*

First of all, an area with a high potential for the development of a forest biomass supply chain has to be identified (for e.g. a forest district). It is then recommended that the local demand potentials, in the short term, are examined starting from the buildings with a higher energy demand (e.g. public buildings, swimming pools, nursing homes, hotels, etc.)

Figure 42 provides some evidence acquired through a census of private and public buildings (mainly hotels) situated in a mountain and tourist area off the gas grid and utilizing oil heating systems. A technical-market feasibility study verified the economical convenience of the conversion to a modern chip heating system.

The installation of 40 chip heating systems (ranging between 50-600 kW) would create a local demand for class A wood chips of about 2,000 tons/year. It would be entirely covered by the local forest biomass supply.

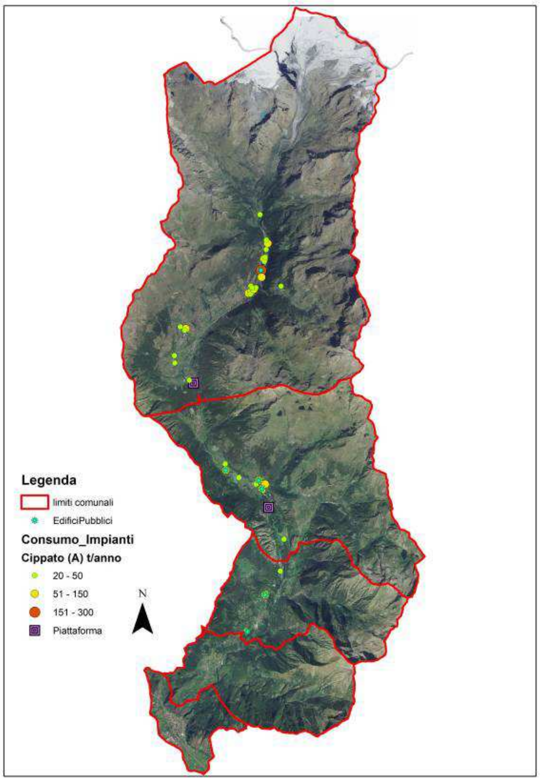


Figure 42. Quantification of the demand potentials of woodchips in a mountain area in Italy.

2.5. Demand-supply intersection. Biomass trade centers location

The spot used for logistics operations should be situated on a strategic site, matching the local demand and supply of woodchips. The choice has to be sustainable as far as both the technical and economical sides are concerned.

Figure 43 shows the distribution of woodchip plants, the aggregate demand on a municipal scale and the potential supply coming from the forest biomass available in the local forest area. The picture also suggests the possible locations for a **Biomass Logistic & Trade Centre (BLTC)**, where raw material (residual wood biomass) can be collected, stored and chipped before being delivered to the local biomass heating plants.

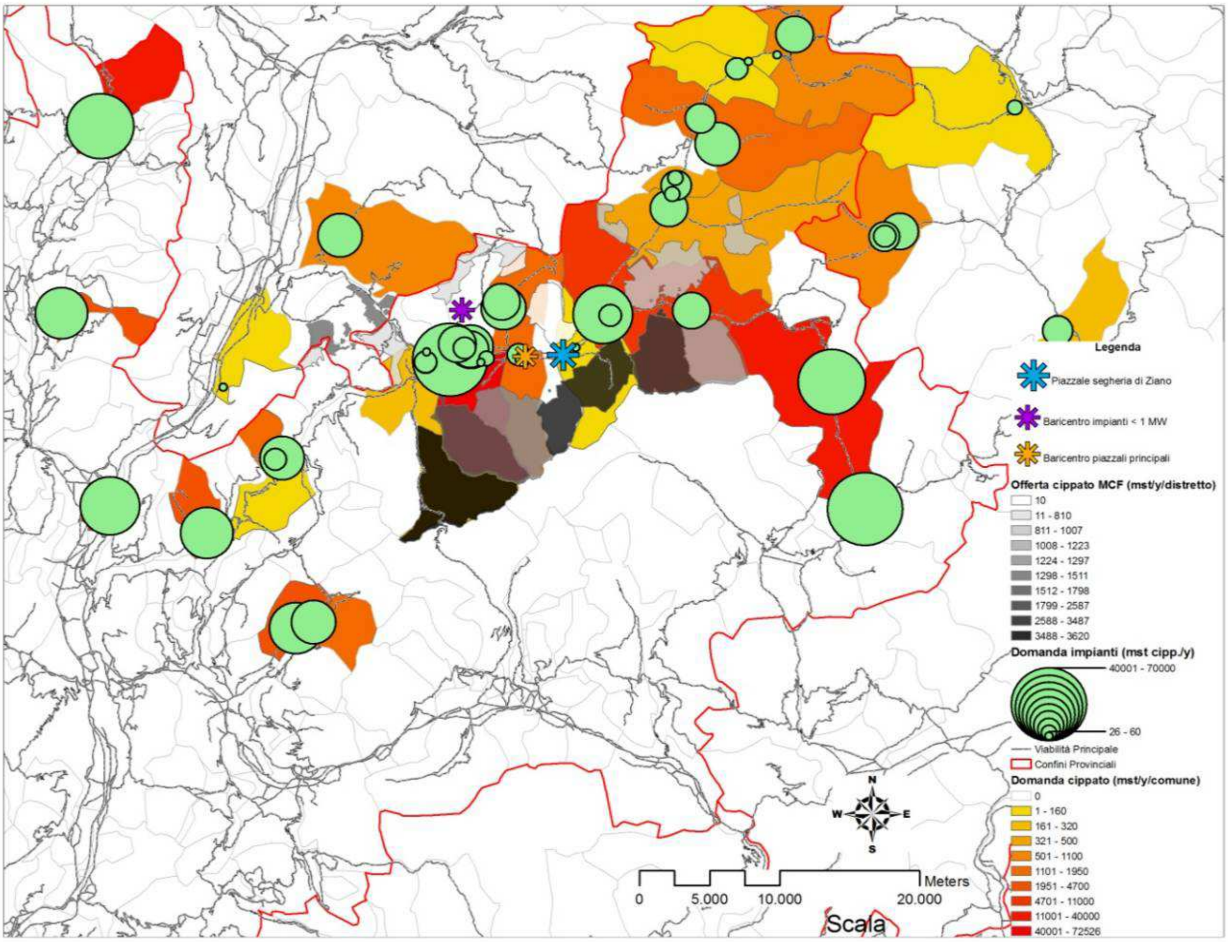


Figure 43. Hypothesis of BLTC locations depending on the local supply and demand of chips (bulk m³/year).

2.5.1. *The location of a biomass platform, the French approach*

The storage platform represents the crossroads between the different wood resources and their valuations. It allows the client to structure its supply, according to the needs and challenges of its territory.

A platform should be considered when a network of boilers exists. Otherwise, the platform is useless and will not pay for itself. In the emergence phase of boilers, neighbouring territories and regional companies can deliver the wood to the new boiler. The platform will eventually relocate the supply.

From the geographical origin of the wood resource to the delivery to the boiler, the transformation process goes through several successive operations:

- wood harvesting in the forest
- wood transport to the platform,
- direct grinding in the shed,
- drying of the woodchips,

- delivery to the boiler.

The platform should ideally be located at the intersection of major roads within the territory to allow easy delivery to different boilers. The implementation thinking should take into account the location of boilers in the area, their potential development, and other existing platforms. The new structure should complement the existing network.

The density of the woodchips being lower than that of the logs makes it more reasonable to build a platform near the boilers rather than near the geographical area of the wood's origin.

Figure 44 below shows the locations of some wooden platforms in PACA and connects them to the boiler they supply.

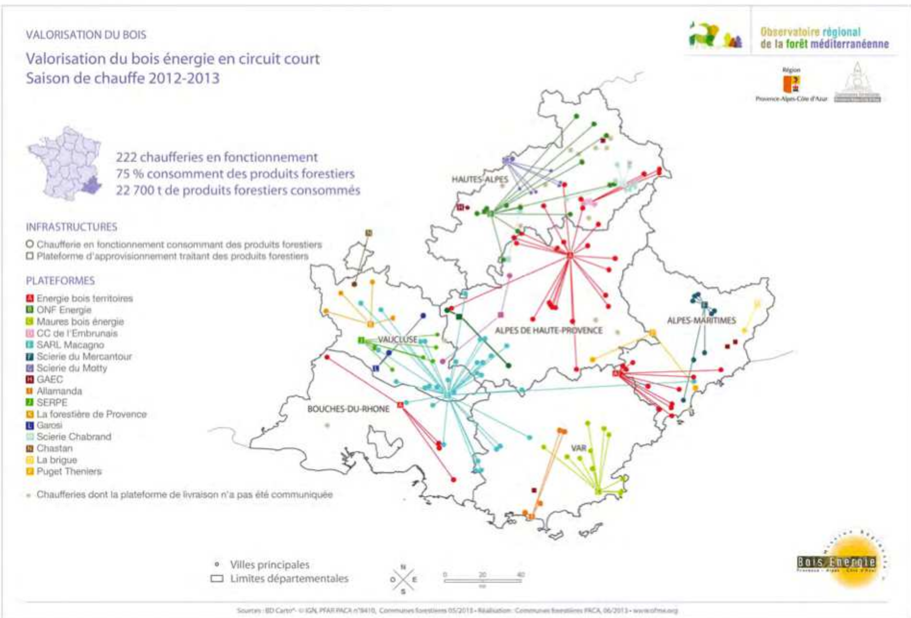


Figure 44. Location of PACA energy wood platforms (Source: OFME, 2013)

2.5.1.1. The right size of a biomass platform

In general, the total area of the platform must not be less than 3 square meters per ton of wood delivered (including 1 m² for the shed). Experience shows that a proper ratio is of one ton of fuel per square meter hangar of shed. Depending on the volumes stored on site, in France, the construction needs to be either declared or authorized by the prefecture, according to the regulation on Classified Installations for the Protection of the Environment (ICPE).

Stored volume	ICPE scheme
Higher than 1 000 m3	Declaration
Higher than 20 000 m3	Registration
Higher than 50 000 m3	Authorization

2.5.1.2. Census in PACA

In 2011, 26 supply infrastructures were in operation, of which 24 delivered forest product, 2 were under construction, and 4 were within the project (Figure 45 and Figure 46). 90% of the operating platforms have a shed with a storage capacity of 10,000 tons. 15 cutting mills (industrial machines for grinding woodchips) are listed in the area, giving a total crushing capacity of over 200,000 tons/year. Finally, 15 identified providers deliver forest product in the region. The crushing capacity is currently more than enough in the area, however, the storage capacity is very poor, and it is all the more critical that some platforms are now underused.

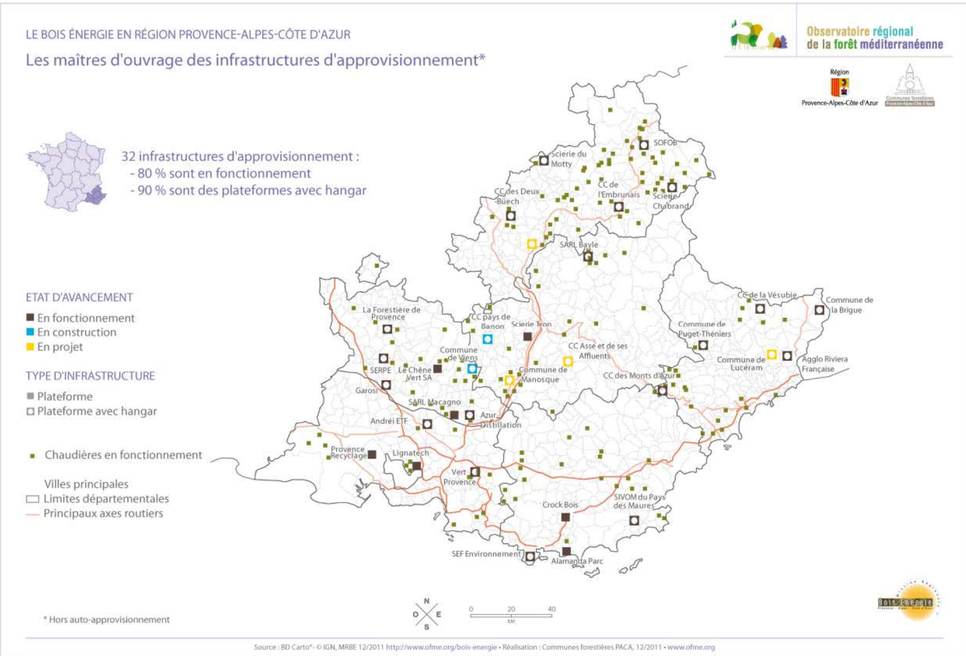


Figure 45. The supply infrastructures in PACA (Source: OFME, 2011).

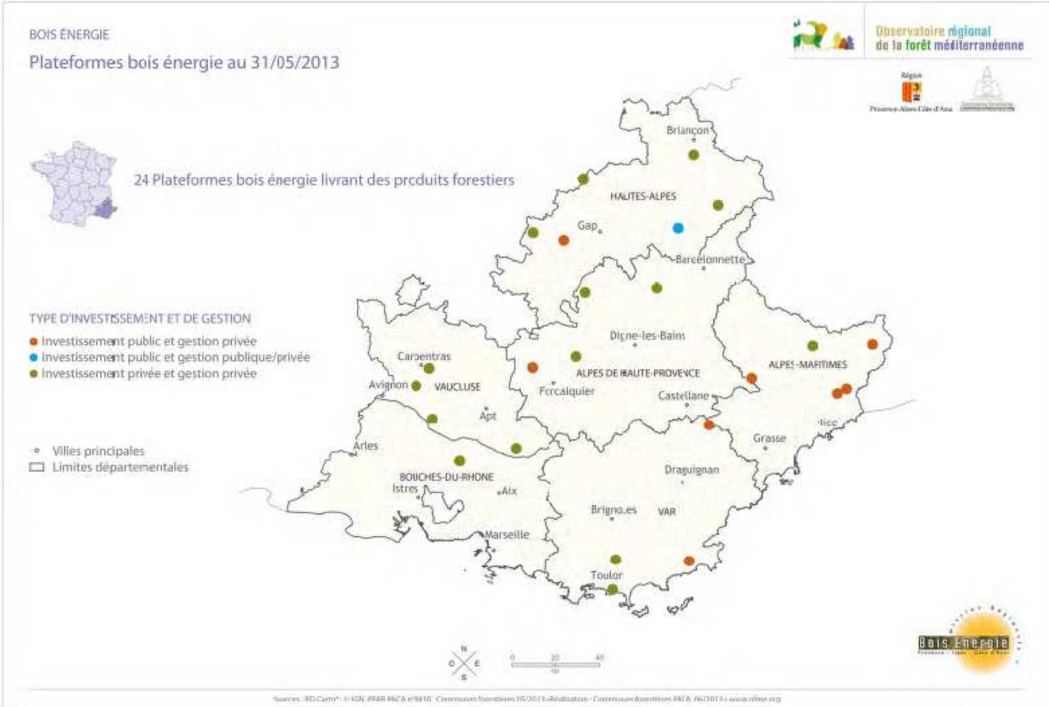


Figure 46. The wood energy platforms in PACA (Source: OFME, 2013).

2.6. Implementation of Biomass Logistics & Trade Centres

A Biomass Logistics & Trade Centre (BLTC) is a regional "service station" for top-quality wood fuels, which is run by a group of local farmers and/or forest entrepreneurs. The platform is provided with equipment and facilities suitable for support from the Quality Management Systems (QMS). This assures the production and marketing of wood-logs and chips responding to the European quality standards (EN 14961) and the implementation of traceability systems (EN 15234). The centre should offer to consumers friendly-distribution solutions and support them with competent advice on all issues relating to the proper use of wood fuels. Through a spread network of biomass centres, customers can be sure that supplies for their biomass heating systems are guaranteed over the long term.

This way the BLTCs will encourage new customers and investments to switch fossil fuel devices in favour of heating systems fed with local forest biomass, creating the conditions for the implementation of a decentralized energy system based on local renewable resources produced with sustainable criteria.

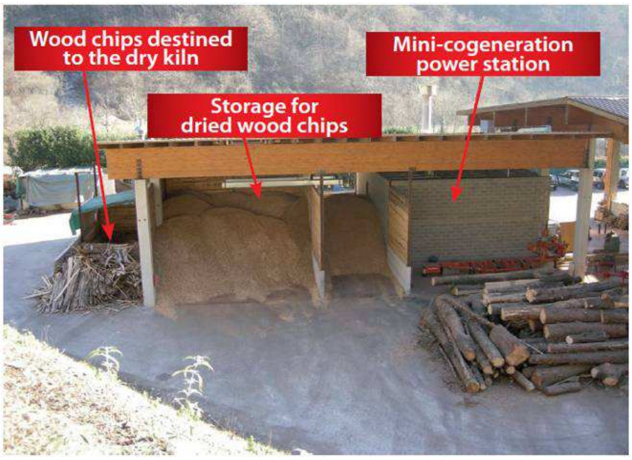
2.6.1. *Main aims of BLTC*

- Implementing regional spot markets for the professional production and trading of biomass as well as providing **energy contracting** services.
- Development of **marketing & communication strategies** to gain the confidence of the local consumers concerning issues like the security of supply, the origin of the raw material and the sustainability of the forest exploitation.
- Guaranteeing the required **quality standards** of wood fuels
- Offering **transparent and customer-friendly trade systems**

- Setting up **comfortable supply solutions**
- Providing competent advice on the **proper use of wood fuels**

2.6.2. *Infrastructures and facilities*

- Covers for the **storing and seasoning of biomass**
- **A paved handling area** next to the covered storage area where biomass can be handled, processed and tracked



- An **area with a stable floor** for the storing and seasoning of biomass

- Reliable instruments to measure the **moisture content** of biomass
- A **calibrated weighbridge** situated at the entrance of the site

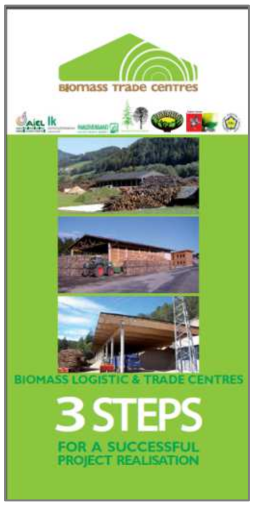
The presence of a **calibrated weighbridge** and instruments for the **moisture measurements** determine the **energy value** of the traded chips. It represents the most transparent trading procedure. While platforms handle more than 5-6,000 tons of forest biomass annually, a technical-economical feasibility study may be carried out to evaluate the installation of a biomass dryer. The most fascinating solutions consist of a driers supply with by-heat produced by the CHP processes (ORC cycles, gasifiers, biogas) (Figure 47).

Figure 47. On the left, a dryer-container supply with by-heat from a small CHP based on wood gasification. On the right the same solution applied to a CHP-biogas plant.

2.6.3. *Technical-economic feasibility*

The technical-economical feasibility study analyses all potential impacts and problems that could occur during the implementation of the project and verifies the economical and financial sustainability of the investment.

Initially, pre-feasibility conditions are examined: building permission, authorisation, etc. Secondly, the planning of production, storing, distribution, service provisions and all activities related to the platform operations occurs, including a description of the current and future raw material market. Therefore, it is necessary to gather data on the regional raw material supply and the potential raw material suppliers (e.g. forest owners, private and public forest consortium). At this point the potential and future costumer market, the customers' requirements and price trend analysis should be carefully analysed.



In short, this part of the feasibility study includes:

- an analysis of regional biomass availability and potentials,
- the identification of potential suppliers of raw materials,
- the identification of potential customers,
- and an analysis of machinery (e.g. wood chippers) and service (e.g. transport of wood fuels) availability in the region.

With the support of calculation tools, annual costs and revenues are estimated for a finite period of time (duration of the investment) and then the main financial indicators are determined: NPV, IRR, NOM, PbT.

The final evaluation of the feasibility study determines the financial viability of the project. The technical-economical feasibility study is therefore the main decision-making tool for operators and potential investors (such as forest enterprisers), showing all of the positive and negative sides of the planned investments.

A guide for the implementation of a technical-economical feasibility study has been created within the EU BiomassTraceCentre Project. The guide is dedicated to the implementation of a Biomass Logistics & Trade Centre, downloadable at www.biomasstradecentre2.eu.

2.6.4. *The chip production costs: results of a French analysis*

Using the information from several studies, CEMAGREF has determined a breakdown of the woodchip cost.

It shows that there are two dominant items involved in explaining the price. The most important is the transport, going up to nearly half the price of the chips. Shredding is the second highest item: it can exceed 40 % of the price and that depends on wherever the shredding occurs (forest, roadside, special area).

Expenditure items	Part of the item in the wood energy price
Raw material	1 to 19%
Logging	7 to 29%
Skidding	1 to 24%
Shredding	12 to 41%
Reloading	0 to 3%
Storage	0 to 4%
Transport	19 to 48%
Drying	0 to 8%
Management costs	0 to 20%
Amortization of equipment	0 to 10%

Table 22. Breakdown of the price of energy forest chips (synthesis of data found in various surveys). (Source: Cemagref study - Forest biomass available for new energy and industrial markets).

The cost of raw materials is also a key component in the final price of wood energy. However, it is difficult to distinguish, through literature, the price of the standing raw material from the price of roadside raw material, which includes, at the very least, the logging and skidding, or the price of the inclusion of the boiler, which also comprises transportation.

National prices of wood energy for October 1st-5th, 2011 (selling price as of June 2011), collected by the Study Center of Wood Economy (CEEB).

		Price €/t	Calorific value (MWh)	Price €/MWh
Forest wood chips Wood chips from forest woods, sold in all lengths, then ground on the logging site or on the platform	C1: small size, Humidity <30% C2: medium size, moisture between 30 and 40% C3-C5: coarse size, moisture >40%	77	3,70	20,81
		50	3,10	16,13
		42	2,55	16,47
Sawmill wood chips Wood chips from a sawmill, produced by the residues of sawing	C3: medium size, moisture >40%	38	2,55	14,9
Urban wood chips Ground wood from urban tree pruning and landscape maintenance	C2: medium size, moisture between 30 and 40% C3: coarse size, moisture >40%	NS	3,10	-
		NS	2,55	-
Ground recycled class A wood Ground wood without pieces of iron, a compatible size for the wood-fired heating plants	C4: medium and coarse size, moisture <25%	34	4,00	8,5
Mix Mix of different components with different moistures, ground to a compatible size for the wood-fired heating plants	C3: medium size, moisture between 30 and 40% C3-C5: coarse size, moisture >40%	42	3,10	13,55
		39	2,55	15,29

* NS = Not Significant (Source: CRPF PACA inventory)

Table 23. National prices of wood energy for October 1st-5th, 2011 (Selling price as of June 2011), collected by the Study Center of Wood Economy (CEEB).

From the study of territorial supply plans, the regional mission for energy wood announces the average production cost of wood chips at 30 % moisture of 99 €/ton, or 28 €/MWh.

2.6.5. *Traceability of forest biomass: the protocol developed by PROFORBIOMED*

The development of a system for tracing the origin of wood biomass along the forest biomass supply chain is functional to the promotion of the sustainable use of wood resources. This will also allow feasible and reliable checks as well as the support of supply chain planning and optimisation.

Past and ongoing experiences from different initiatives and applied researches across the EU suggest a wide set of requirements and approaches that may be needed within the sector. While looking for a system that is technically and scientifically consistent, however, simplicity, inclusiveness and workability shall not be forgotten. Working from this perspective, FLA (Fondazione Lombardia per l'Ambiente) has developed a specific protocol with the aim of integrating existing documents at the European and local levels, in regard not only to normative references, but also to technical norms, guidelines and the best practices implemented in this field.

This protocol is intended to promote the principles and technical requirements for the traceability of forestry biomass along the entire supply chain, i.e. from the supply of raw materials to the final delivery point. By promoting traceability, the protocol wishes to contribute to the promotion of responsible use of forest resources for energy purposes.

For the purposes of the present protocol, a forestry biomass supply chain consists of the following 4 main stages (Figure 48.):

- **a source** of biomass classified according to the structure of origin and sources as defined by EN 14961-1.
- biomass **processing** (chipping, milling, cutting, production of pellets).
- intermediate **transport** and/or **storage** of the forest biomass.
- **a delivery point** (e.g. heating biomass plant).

The scope of the protocol includes:

- **Stages**: all the stages (Figure 48) along the biomass production chain. Checks will consist of tracing biomass along each segment to allow complete traceability.
- **Organisations**: all individuals, companies or other legal entities (producers, suppliers, traders, transporters) directly or indirectly participating in the supply chain (without any spatial definition or limitation).
- **Time**: traceability does not only consist of control, it is an approach to be continuously implemented, therefore, it shall be in place at the same time as the delivery of the material occurs.

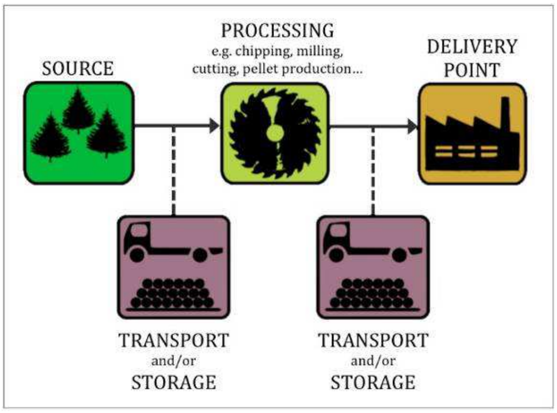


Figure 48. **Simplified biomass supply chain scheme.**

For more details please refer to the original documents: **"Technical protocol for traceability of wood biomasses for energy"** (**WP4 – Axis 1 – Pilot Action 1.5**) (http://proforbiomed.eu/publications/project-deliverables/deliverables-workpackage-4).

2.7. Technical-economical feasibility study of a modern chip heating system

The first step is the evaluation of the market penetration potentials of wood chips within the regional heating market. The market price for fuels is expressed in different units of measurement, so the best way to make an instant comparison is through the primary energy costs.

Table 24 and Figure 49 show the primary energy costs registered in January 2013 in a mountain area (off the gas grid) in Italy. Class A1 chips are strongly competitive in comparison to gas oil or LPG, even though these fuels have relevant tax benefits in areas off the gas grid.

Figure 50 shows a comparison of chip prices (€/t, 2013) among some EU countries (Source: www.biomasstradecentre2.eu).

	MWh	Price (€)	Primary Energy Cost €/MWh
1 ton of chips (M25, P16-45)	3.69	115	31
1 ton of fuel wood (M20, P330)	3.98	140	35
1 ton of bulk pellets (M 10)	4.7	280	60
1000 litres of heating gas oil	10	1200	120
1000 litres of LPG	6.82	1000	147

Table 24. Primary energy costs comparison

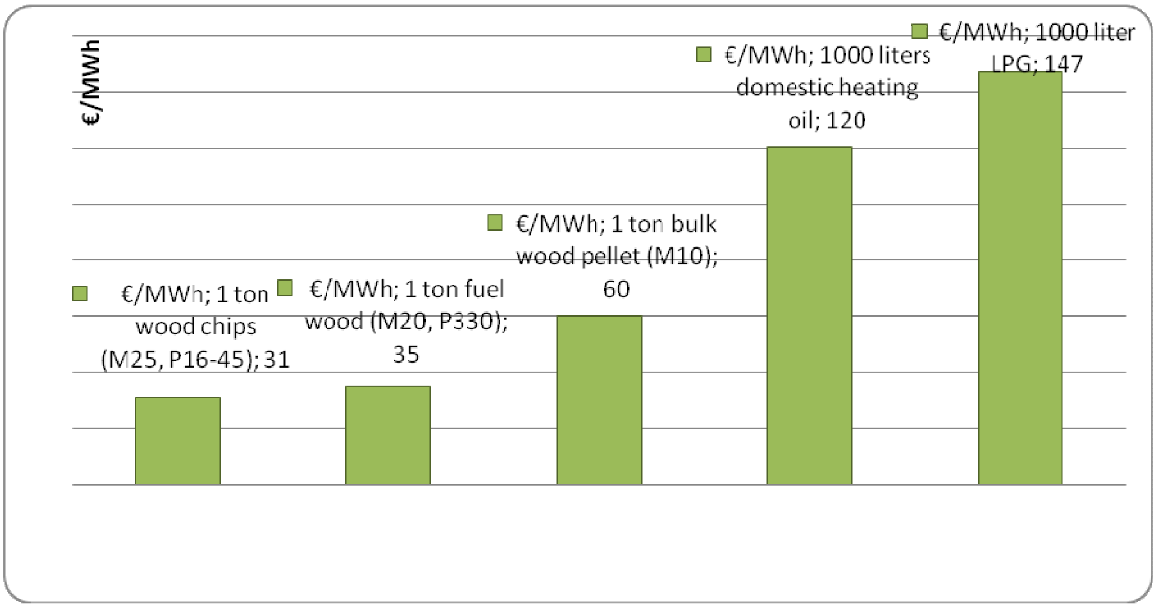


Figure 49. A comparison between wood fuel and fossil fuel primary energy costs.

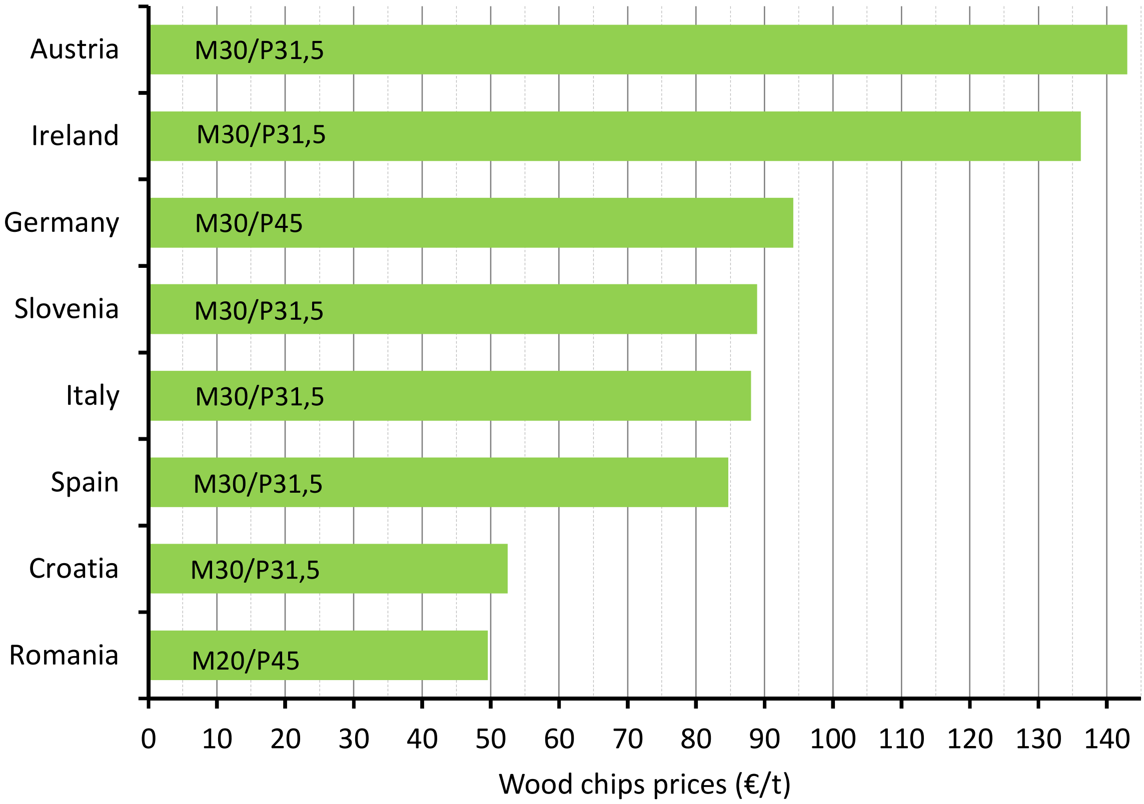


Figure 50. Woodchip prices (€/t M30 - Romania M20) in different European Countries.

2.7.1. *Technical evaluation and viability of the investment*

The next step is the evaluation of the technical feasibility of the project. Adequate space and hydraulic components are required for the installation of the boiler and for chip storage.

The choice of the location of the new biomass heating system should be based on:

- the location of the old oil heating boiler
- the heating charge of potential end-users
- the accessibility of transport vehicles for the chip supply

It is therefore necessary to carefully set up a **technical feasibility study**. Depending on the estimated costs, a **cost-benefit assessment may then be carried out**.

Reproduced below is a simplified example of the conversion costs of a heating oil boiler and modern biomass plants in a **public building** located in a mountain area in North Italy (Figure 51.).

Technical characteristics of the plant:

- Moving grate chip boiler 500 kW
- Puffer tank 20 litres/kW (=10.000 litres)
- Chip storage volume: 120 m3 with rake extraction
- Heating oil consumption: 100.000 litres/year
- Primary energy produced: 1.000 MWh/year
- Oil price: 120.000 €/year (= **120 €/MWh**)

Cost benefit analysis

- Total investment: **380.000 €**
- Wood chip consumption (M35, NCV 3,11 MWh/tons): 1.000 : 3,11 = 322 tons/year
- Wood chip price: 115 €/ton x 322 tons = 37.000 €/year (= **37 €/MWh**)
- Cost saving for the use of chips vs. oil: 120.000 - 37.000 = 83.000
- Extra costs in maintenance and electricity: 5.000 €/year
- Annual net saving: 83.000 - 5.000 = **78.000 €**
- Debt retirement time: 380.000:78.000 = **5 years**

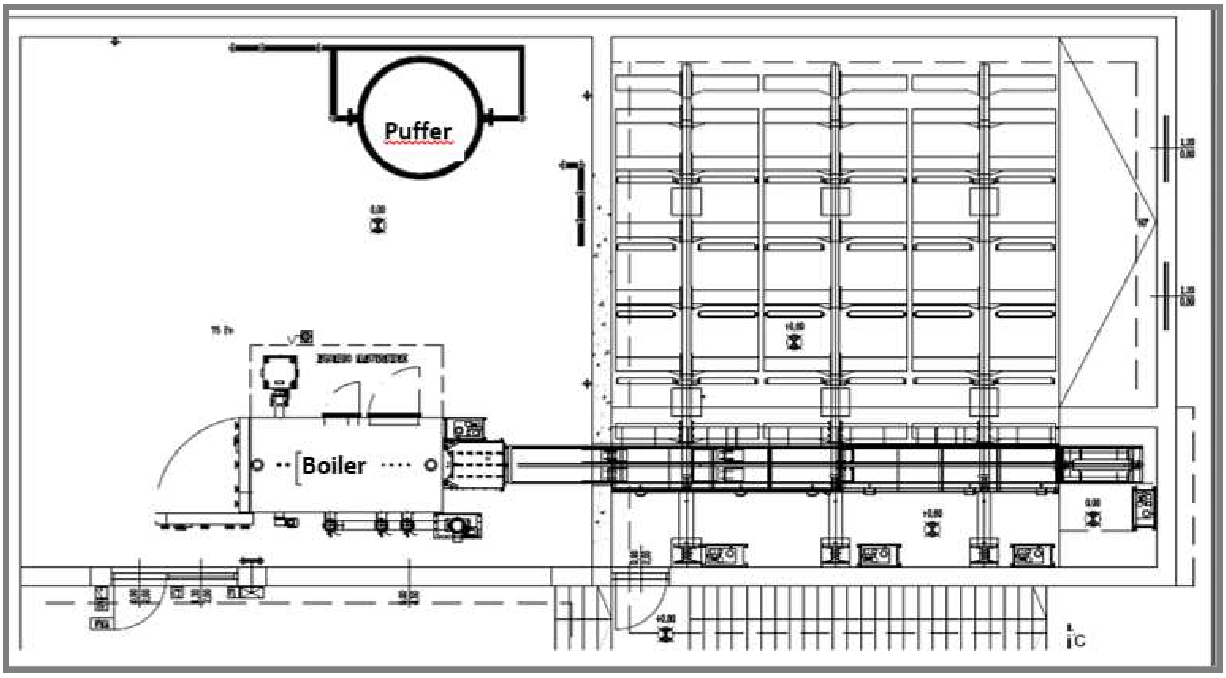


Figure 51. Layout of the considered modern chip heating system.

3. Strategies for developing the biomass clusters/consortium

3.1. Introduction

Clusters are geographic concentrations of interconnected companies or institutions that manufacture products or deliver services to a particular field or industry. Clusters typically include companies within the same industry or technology area that share common infrastructure, suppliers, and distribution networks. Supporting firms that provide components, support services, and raw materials come together with like minded firms in related industries to develop joint solutions and combine resources to take advantage of market opportunities. These are groups of related businesses and organizations—sometimes direct competitors, but more often operating in a complementary manner. They may comprise more than just one industry classification and a true cluster is more than just a supplier producer-buyer model.

An economic cluster (or several clusters) serves as the driving force in most regional economies. Examples include Detroit's auto industry concentration, computer chip production in California's Silicon Valley, London's financial sector, Napa Valley's wine production, and Hollywood's movie production industry.

The clustering concept was popularized by Harvard Business School professor Michael Porter (1990). His techniques teach communities to analyze their existing businesses and industrial bases and build their economic development on those strengths. From the identified clusters in an area, the next step is to develop a marketing plan for industry. By developing a massive database of companies, county by county, Dr. Porter's research has statistically grouped businesses together in clusters. A strong cluster will include the suppliers of raw materials and the distributors, as well as primary producers. But it will also include specialized services in finance, marketing, packaging, education and more, including specialized trade associations. In general, the broader the base of related businesses, the better for the cluster for that often reflects the specialization that comes with concentrated resources.

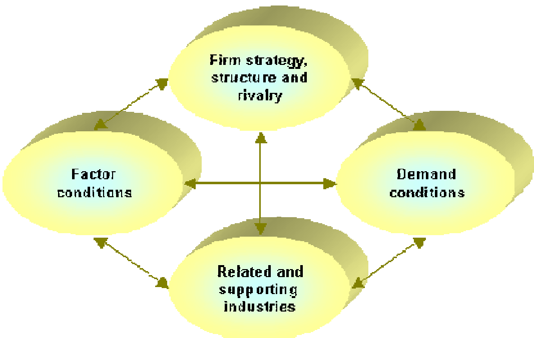


Figure 52. Pict. M. Porter's Diamond Model

Related firms and industries have tended to locate in close geographical proximity to one another for a number of reasons. In his 1916 economic text, Alfred Marshall was one of the first to see the benefits of spatial clustering: the existence of a pooled market for specialized workers, the provision of specialized input from suppliers and service providers, and the rapid flow of business-related knowledge among firms, which results in technological spill-overs. It may be difficult to predict where clusters will emerge beforehand, but their growth is easier to predict due to the benefits gained from the strategy. A variety of terms are synonymous to a cluster; these include co-location, industrial districts, and innovative milieus.

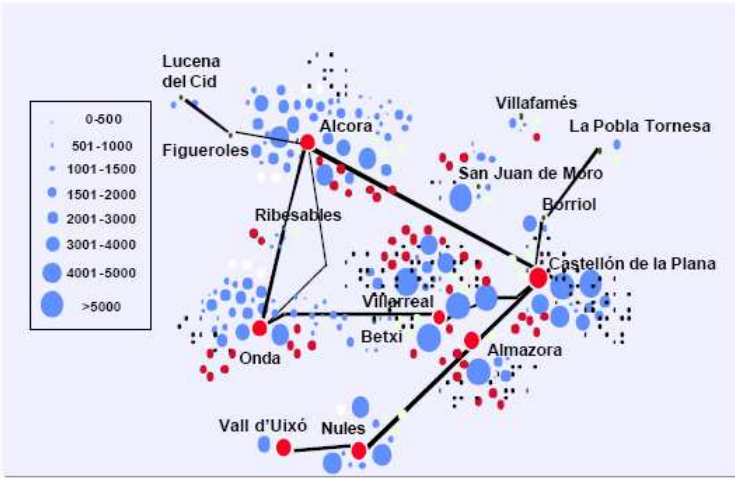


Figure 53. Pict. Clustering: geographical concentration of companies

3.2. Emergence and growth of clusters

Clusters often go through a history of emergence, growth, decline or transformation. Although individual clusters develop differently, the six step model of cluster development is outlined below.

Firstly, the birth of a cluster can often be traced to historical circumstances, such as the availability of raw materials, specific knowledge in R&D organisations or traditional know-how, the specific or sophisticated needs of a certain group of (geographically concentrated) customers or firms, and the location of firms or entrepreneurs performing some important, new technological innovations that stimulate the growth of many others. Unintended reasons may also affect the growth of a cluster. However, the growth is often set off by some explicit location factors, in particular, the long-term development of specific knowledge that may be turned to new productive usage (Pinch and Henry 1999). Emerging clusters can often be traced back to a history of events that led to the 'sudden' rise of clusters in more recent years. The first stage in cluster development often involves new firm spin-offs leading to a geographical concentration of firms in nearly the same production stage. The agglomeration is followed by local competition that is an essential driver of innovation and entrepreneurship (Porter 1998b).

Secondly, once an agglomeration of firms becomes established, progressively more external economies are created, forming a cumulative process. The first external economies often include (i) the creation of a set of specialised suppliers and service firms, frequently originating from the vertical disintegration of firms, and (ii) the creation of a specialised labour market (Storper and Walker 1989). The development may lower the cost of shared inputs as savings in production costs are passed from specialised suppliers (serving numerous local firms) to client firms.

The client firms will then derive a benefit not available to similar firms in less highly localised settings (Harrison et al. 1996). Cost saving also occurs through the presence of a pool of experienced and skilled workers.

A third step may be the formation of new organisations that serve several firms in the growing cluster, e.g. knowledge organisations, specialised education establishments and business associations. The organisations advance local collaboration, learning processes and technological knowledge spill-overs, as well as the creation of localised forms of knowledge by key personnel in the local industry. An example is the set up of centres for real services in some industrial districts in the 'Third Italy' during the 1980s. These centres hold specialised competence (on market development, technology, strategy etc.) and are able to supply the system of firms with professional competence that small firms seldom acquire themselves, but which is often necessary in order to accomplish larger innovations. Brusco (1990) claims that the introduction of the centers has raised the innovative capability in the local network of small producers.

Fourthly, the development of external economies and the emergence of new local organisations increase the visibility, prestige, and attractiveness of a cluster. This may result in more firms and skilled employees moving into the cluster, thus raising the attractiveness even further, as well as resulting in a fertile breeding-place for new local companies.

A fifth step relates to the creation of non-market, relational assets that foster an untraded circulation of information and knowledge, through (e.g. informal collaboration) and help with coordinating economic activity. Thus, mature regional clusters may contain ensembles of specific, differentiated, and localised relations between persons and organisations that are coordinated by routines or conventions that often only work in the context of proximity (Storper 1997). Communication that contains flows of non-codified knowledge and which is complex and uncertain, frequently involves dense human relations, which, in turn, are stimulated by proximity between individuals, firms, and organisations.

Lastly, although a cluster can renew its success for decades or become part of a new cluster, many regional clusters will sooner or later enter a period of decline. Cluster decline is often seen to reflect a situation of technological, institutional, social and/or cultural 'lock-in' in business behaviour. Regional industrial development may become 'locked in' by the very socio-economic conditions that once made the region into the core region of a specific industry.

The initial strength of a regional cluster in the past - be it a well educated or experienced workforce holding unique know-how and skill, a highly developed and specialised infrastructure of firms, knowledge organisations, and education and training institutions, close inter-firm linkages, or strong political support by regional institutions - may turn into an inflexible obstacle to innovation (Grabher 1993). Clusters may fall into a trap of 'rigid specialisation'. Cluster development sometimes tends to reinforce old behaviours and suppress new ideas, which in particular is a danger for the continued survival of a cluster when technological and global economic conditions change (Porter 1998b).

3.3. Benefits of clustering

A well developed concentration of related business spurs three important activities: increased productivity (through specialized inputs, access to information, synergies, and access to public goods), more rapid innovation (through cooperative research and competitive striving), and the formation of new business (filling in niches and expanding the boundaries of the cluster map).

Clusters are always changing. They respond to the constant shifting of the marketplace. They usually begin through entrepreneurship. Silicon Valley is a relatively new cluster of computer-related industries; in the past, Detroit was the same for automobiles. Nothing sparks productive innovation better than having your competitor across the street.

Clustering helps cities and counties direct their economic development and recruiting efforts. It also encourages communities to refocus efforts on existing industries. Communities understand that the best way to expand their own economies and those of the surrounding region is to support a cluster of firms rather than to try to attract companies one at a time to an area. Chambers of Commerce, business incubators, and some universities work with companies to develop clusters and synergies in business communities.

Strong domestic clusters also help attract foreign investment. If clusters are leading centres for their industries, they will attract all the key players from both home and abroad. In fact, foreign-owned companies can enhance the leadership of the cluster and contribute to its upgrading, according to research by Julian Brikinshaw (2000).

For small and developing businesses, relocating to a cluster near competitors and related industries may aid the firm in faster growth, recognition, and status within the market. Economies of scale can be gained through group purchasing within the cluster. There can be discussions among cluster members about their unique competitive advantages and future challenges. Linked supply chain networks can naturally be created within a tightly-linked cluster. Informal day-to-day contact with similar companies is also important, according to Natasha Muktarsingh. Of course, the physical proximity of a location is not always required for a cluster. Many firms, including retailers and publishers, can be grouped together on an Internet site.

3.4. Industry and government (national, regional and local) policies

Even if governments follow a non-interventionist policy, they affect the economy with a number of competencies such as subsidies, legislation, creation of infrastructures (technology parks, etc.) or with public purchases.

Government influence is unquestionable and it either can or cannot be used from a cluster perspective. On the other hand, the action capabilities of governments in the European Union are limited within the fields of monetary policies, subsidies and tax breaks. There is an increasing emphasis on strengthening local firms' networks. This has been particularly true since 1990 when Prof. Michael E. Porter described how clusters or locally based networks of firms in the same industry could constitute a source of competitive advantage. Many advanced economies are increasingly using cluster policies because they are market driven.

Some tools governments have are the identification of existing or potential clusters in their region, providing clusters with strategic information such as benchmarking or trends, investing in technologies and capabilities that are beneficial to cluster firms, filling in gaps in the cluster with FDI or others, linking firms to training programs from local universities and centres, foster networking, service centres and associations, etc. Support to firms in clusters, directly or through suitable supporting structures, is a basic priority in the economic development and industrial policy of political agendas.

Having clusters is no guarantee of a solid economy, though. A cluster's size (in terms of market share in their specialization) can be a determinant in the mid-term. For example, in the United States there is one relevant furniture cluster in North Carolina in Spain there are around fifteen. As trade barriers disappear and capital and labour flow freely, firms that were protected must reconsider their sources of competitive advantage.

Cluster-based initiatives provide governments with a better perspective of their territory's economic reality as well as:

- a better understanding of the industry needs and a direct dialog with the cluster firms

- a new way to create awareness of existing support programs to firms and associations in the industry
- designing tailor made support for the industry, involving the private sector in their financing and management
- coordination within different government departments to support the industry

3.5. Example of a Proforbiomed cluster

Among the Clusters developed through the Proforbiomed Project, one of the examples of the Triple Helix platform of cooperation is the Bioenergy and Environment Cluster of Western Macedonia (Clu.B.E.)

Bioenergy and Environment Cluster of Western Macedonia

Background

The establishment of the Bioenergy and Environment Cluster of Western Macedonia (Clu.B.E.) has been a long and demanding process that built upon various efforts previously undertaken in the region; from the Regional Innovation Strategy (RIS) and the Regional Innovative Actions Programme "knowledge Clusters", through the Regional Innovation Pole focused on Energy, to the BioClus FP7 project, as well as the BioEnArea Interreg IVC project and lately to the Proforbiomed Strategic Med project. The cooperation paths among the various actors have strengthened the institutional and personal relations among the actors and persons involved and have created a network of cooperation at the regional level. This issue has served as the grounds for the official establishment of CluBE. However, this stage has not been easy at all, as it required continuous discussions and interaction among all of the actors involved, in smaller or bigger groups, in order to reach a consensus on scope, objectives and actions envisaged.

Legal establishment

CluBE was established as a non-profit company under Greek Law. Its statute was signed by the 21 initial members and was submitted to the Court of First Instance in Kozani, capital of the Region of Western Macedonia, for its official establishment.

Objectives and areas of intervention

CluBE aims to develop R&D and business activities in the fields of bio energy and the environment, aiming at reinforcing a green economy in Western Macedonia and the neighbouring area. Within this framework, the primary topics of intervention include:

- energetic exploitation of biomass for household and industrial use, but mainly for district heating systems in small, medium or large towns.
- co-firing with lignite in existing power stations and/or future heating plants
- the optimization of heating systems
- the improvement of energy efficiency for households, public and private buildings, etc

Initial members

The initial members cover a range of partners from the three pillars of the Triple Helix: the public sector, academia and entrepreneurship, as depicted below:

Public sector

- The Region of Western Macedonia
- The Regional Development Fund of Western Macedonia
- The Regional Union of Municipalities of Western Macedonia

R&D

- The University of Western Macedonia, Department of Mechanical Engineering
- The Institute for Chemical Processes and Energy Resources (CPERI/CERTH)
- The Centre for Technological Research of Western Macedonia (CTR)
- The Centre of Environment of Western Macedonia
- The Wood and Furniture Lab/Technical University of Larisa

Entrepreneurship

Municipal District Heating

- The Municipal Enterprise for District Heating of Ptolemaida (DETIP S.A.)
- The Kozani Municipal Enterprise for Water and Drainage (DEYAK S.A.)

Cooperatives

- The Pentalofos Forest Management Cooperative
- The Agricultural Cooperative DIMITRA

Wood companies

- Alfa Wood S.A.
- GIOTAS S.A., Wood Pellet Producer, Grevena
- ZIOGAS G.P., Wood Pellet Producer
- CHLIAPAS S.A., Wood Pellet Producer

Biomass logistics

- BIOZONE IKE

Boiler manufacturers

- THERMODYNAMIKI SA, Boiler and fireplace manufacturer

Waste management

- Waste Management of Western Macedonia (DIADYMA S.A.)

Consulting companies

- Hellenic Forests Ltd

Supporting institutions

- The Regional Development Agency of Western Macedonia (ANKO)

Structure

CluBE comprises of three levels of management:

- General Assembly
- Board of Directors
- Administrator

The General Assembly of all the members is the ultimate body of Clube, taking all major decisions for the Cluster. It convenes regularly once per year, or whenever needed for special cases. The G.A. elects its Board of Directors (B.D.) comprising 7 members for a three year period.

The Board of Directors (B.D.) is responsible, among other issues, for the strategic direction of the Cluster. It undertakes major tasks and carries out the control of the company, convening once every six months, or as often as necessary, in order to perform its tasks. The B.D. elects among its members a President, a Vice President, a General Secretary, a Vice General Secretary and a Treasurer. The B.D. also nominates an Administrator of the Cluster. The B.D. also has the right to appoint individuals to other positions, according to the needs and demands of the growing work of the Cluster.

The Administrator is responsible for the day-to-day management of the Company, for its interaction with services, the implementation of all guidelines set by the G.S. and/or the B.D., etc. The Administrator keeps track of all activities related to the subject of the company and is entitled to sign all documents on behalf of the Cluster.

3.6. Example of a Proforbiomed Consortium

While clusters are used to develop synergies among the members, consortia can also be formed by a group of entities which have a common interest to act together or perform common activities towards common goals. All participants sign the consortium contract where purpose, goals and activities are determined including obligations, financial support and leadership.

Consortium of the Slovenian Local Energy Agencies

The consortium of the Slovenian Local Energy Agencies was established in 2007 by the six local energy agencies: ENERGA P, LEA Pomurje, LEA Spodnje Podravje, KSSENA, GOLEA, LEAD and, in 2010, LEAG was the last agency to join the consortium. SI LEAs consortium tasks are:

- exchanging knowledge, know-how and information between the agencies.
- cooperation on common projects (national and international).
- borrowing the measuring equipment needed for the energy analysis of the buildings.
- representing the municipality's interests at the national government, ministries and governmental agencies.
- influencing the legislation preparation and legislation adoption in the energy sector.

- cooperation in the preparation of energy sector regulations (ESCO, energy management, energy bookkeeping).

In the new Energy Law adopted in February 2014, Local Energy Agencies adopted the public power stations as municipality energy managers responsible for implementation of local energy concepts.

Strategy for developing the biomass clusters/consortium

The strategy for the establishment of the biomass consortiums in Slovenia consists of the following phases:

1. **Commitment to consortium development**

The initiation to establish the cluster/consortium was demanded by the PROFORBIOMED project. The purpose of developing the biomass consortium was to connect all interested parties in order to enhance sustainable forest management and to establish the biomass chain. This step requires an assessment of the:

- availability of the biomass for energy production.
- number of entities willing to contribute to biomass production (forest owners, saw mills, municipalities, public and private companies dealing with biomass, wood processing plants, farmers etc.).
- possibilities for woodchip and wood pellets production (number of companies, farmers, capacities, machineries, equipment etc.).
- possibility of using biomass for energy production, implementation of the district heating systems, and biomass CHP plants.
- assessment of the public sector: number of public buildings, energy supply and consumption, power of their boiler plants, possibilities for CHP plants etc.
- prefeasibility studies for biomass district heating systems and/or biomass CHP plants.
- preparation of the biomass policy in the region.

2. **Marketing and partner development**

Publishing the intention to establish a consortium/cluster would have to include the news in local newspapers, internet, articles in journals, presentations on the workshops and conferences.

The implementation a the data base of the interested entities/partners is required (municipalities, research and development organisations, regional and local research agencies, local energy agencies, cooperatives, forest management organisations, woodchip and wood pellet production plants, saw mills, wood processing plants, farmers, forest owners and their organisations).

All possible partners would need to be visited and presented with the purpose and goals of the biomass cluster/consortium, while also taking into the account their interests, etc. and deducing their commitment to join the consortium.

Preparing the necessary documents would include a decision-making process for the local council of the municipalities, consortium/cluster contract etc.

3. **Decision-making for the biomass consortium/cluster establishment**

Formal approval of the documentation would be required for the establishment of the cluster/consortium by the invited/interested parties (mayors, directors, managers).

Formal approval is needed from all interested partners. At the formal session, the approval of the establishment is accepted and the decision would then be published.

4. Signing the biomass consortium/cluster contract.

The contract has to define the obligations of the signatories, activities, lead contractor, financing, incorporation of new members and other procedures important for running the cluster/consortium.

5. Cluster/consortium operation: good practice developed in Slovenia

Country		Slovenia
Region		North Primorska region
Name of the consortium/cluster		North Primorska Biomass Consortium
Year of establishing		2013
No.	Phase	Description
1	Commitment	An analysis of the forest biomass in Slovenian regions has been done. Then two regions were chosen for the establishment of a biomass consortium. The Goriska Local Energy Agency has been contacted in order to present them with the PROFORBIOMED project and its purpose and goals for the establishment of a biomass consortium. Following the GOLEA commitment, the next step has been taken.
2	Marketing	Several articles in the Finance Magazine, Energetic Journal have been published, and the presentation made at workshops and national conferences (e.g. SLOBIOM conference, Slovenian Chemical Event etc.). The PROFORBIOMED project and biomass consortium have been presented to all 11 Mayors of the North Primorska municipalities, to the Forest Management Company in Tolmin and also to possible private investors for biomass district heating systems.
3	Partners developing	The PROFORBIOMED project and biomass consortium have been presented to all 11 Mayors of the North Primorska municipalities, to the Forest Management Company in Tolmin and also to possible private investors for biomass district heating systems.
4	Formal approval	The mayors of the North Primorska municipalities accept the decision of the biomass establishment at a regular meeting of the Development Council of the North Primorska region.
5	Contract signing	The ceremonial signing of the North Primorska Biomass Consortium following a regular session of the Development Council of the North Primorska region.
6	Operating	GOLEA is a lead partner in the North Primorska Biomass Consortium in which LEA Ptuj and SFI are also included. After the consortium establishment, the new members participated in the consortium and several prefeasibility studies have been carried out. In several municipalities, public buildings switched from non-renewable to biomass heating systems and some biomass micro district heating systems have also been implemented.

Table 25. Strategy for developing the North Primorska Biomass Consortium (Slovenia)

4. Strategies for triggering investments and matching offer and demand sides (public and private stakeholders) at the local level

4.1. The involvement of local chain actors and their matchmaking: how can we do it?

Biomass chain actors are forest owners, forest owner associations, farmers, forest management companies, wood processing plants, woodchips and wood pellet producers, traders, municipalities, investors, forestry cooperatives, local energy agencies and other local/national organisations. All of these stakeholders have their particular interests:

- Forest owners: the efficient management of their forest, sale of surplus biomass at higher prices, their own woodchip/pellet production, sustainable forest management.
- Forest owners associations: similar purposes and goals as those mentioned above. The forest owners are organised in these associations/organisations in order to achieve common goals which should be approached by a cluster/consortium or a biomass chain.
- Forest management companies have a state concession for state owned, forest management. They take care of the forest, cut down trees according their plans and sell the timber on the market at the highest price. They are interested in supplying timber to the local wood processing industries and saw mills. They also produce woodchips from low quality forest biomass and waste wood after cutting the trees.
- Woodchips and wood pellet producers are interested in buying forest biomass at appropriate prices from local resources and selling their products at appropriate prices to local and other users/traders.
- Traders operate along with warehouses for forest biomass and logistics centres for the further exportation of the surplus woodchips/pellets selling to other markets at higher prices.
- Municipality owned public buildings are mostly heated by non-renewable energy sources (heating oil, natural gas and LPG). In order to enhance local economies and establish green jobs on the local level on the one side and to decrease energy costs on the other side, municipalities allow investments in biomass boiler plants, biomass CHP and district heating systems.
- Investors offer investments in biomass boiler plants, biomass CHP and district heating systems through ESCO and PPP.
- Forestry cooperatives can be trade organisations (buying biomass from forest owners and selling this biomass on the market as well as representing their members in biomass production and selling.
- Local energy agencies provide a connection between all stakeholders in order to enhance sustainable forest biomass exploitation, establish biomass consortiums, connect biomass stakeholders, promote forest biomass use for energy production, support municipalities, perform prefeasibility studies, promote sustainable energy management, etc.

All stakeholders should acquire their aforementioned interests in biomass clusters/consortiums or through other types of the organisations in order to achieve the aforementioned goals, and to create local green jobs, decrease energy costs and to increase profit without comprising sustainable forest development.

4.1.1. *Specific tools to support the balance between the supply and demand of wooden biomass on a local level*

There are various tools available to support the balance of the supply and demand of wooden biomass. Several examples of such tools available in Slovenia are presented in Table 26. Nevertheless, there are research and development activities performed to improve support activities in this field.

Tool	Description	Example
Local web portals	Local web portals: municipalities, energy agencies and other interested parties offer relevant information regarding investment possibilities and energy demands from local communities and public buildings.	SFI (Slovenian Forest Institutes) Web portal for woodchip and pellet producers
Local/Regional energy concepts	The local/regional energy concept consists of a 10 year energy policy for municipalities and regions. It contains the energy balance of the municipality/region and the planned investments in the energy sector including renewable energy sources.	Municipality Energy Concepts, Regional Energy Concept (are obligatory according to SLO legislation).
Letter of intent	A letter of intent signed by the municipality and/or investor for the planned biomass district heating investment or other related activities.	A letter signed by the mayor of a municipality with the intent to connect public buildings to the biomass district heating system in the case of its formation.
Commercial agreement	An agreement between two or more partners to prepare and implement biomass project(s) in an area in which all pro partner activities are defined including the financing of those activities and investments.	A contract between the Local Energy Agency and investors regarding the enhancement of investments in forest biomass district heating systems within particular area.
Consortium/cluster	Several geographical and local oriented organisations establish the biomass consortium or cluster in order to enhance the biomass chain, biomass extraction and its use in energy production.	E.g. North Primorska and Spodnje Podravje biomass consortiums with energy agencies, forest management companies, forest cooperatives and municipalities.
Local or regional energy council	Several interested parties establish a local/regional council to invest in the renewable, biomass sector in order to provide investment means and to invest, on the local level, into biomass CHP and heat production plants.	The Styrian Chamber of Commerce in Maribor with its energy companies, equipment producers, traders and local energy agencies established a regional energy council to enhance investments in the energy sector.
Local energy cooperative	The local energy cooperative should balance the supply and demand of wooden biomass in a specific geographical area and should connect the interest of different parties.	An objective exists to establish a local energy cooperative under the Spodnje Podravje consortium. The local energy cooperative would be established as a social enterprise, including different stakeholders in the biomass chain.

Table 26. Specific tools for creating and matching the offer and demand at the local level (Slovenia).

Other examples of tools can be found in the remaining Mediterranean countries (Table 27.)

Tool	Italy	Spain	France	Greece
Local web portals	Web catalogue of the professional Italian chips, fire wood, agripellets producers https://dl.dropboxusercontent.com/u/111513989/Biocombustibili%20solidi/Manualibrochure/Pag_AIEL/PagineAIEL_apertura.pdf Web catalogue of the producers, traders and retailers of pellet certified according to EN plus http://www.enplus-pellets.it	BIOPLAT - Plataforma Tecnológica Española de la Biomasa http://www.bioplat.org/ Mercado Biomasa http://www.mercadobiomasa.com/ Mercado Biomasa http://www.mercadobiomasa.com/ Observatori Forestal Català http://www.observatoriforestal.cat/ ADABE – Asociación para la Difusión de la Biomasa en España http://www.adabe.net/ APROPELLETS http://www.apropellets.es/ INFOBIOMASSA http://infobio.ctfc.cat/	No specialised portal in place at the moment. ADEME website contains information regarding grants and aids available for biomass projects.	www.energeiakozani.gr/ www.biomassenergy.gr www.mech.uowm.gr/ www.lignite.gr
Local/Regional energy concepts	-	Andalusian Sustainable Energy Plan (PASENER 2007-2013). It establishes as main objectives for the autonomous region of Andalucia the industrial and technological development based on sufficiency in energy. It also establishes as guiding principles the promotion and development of renewable energy, energy efficiency and savings. For this purpose, it urges Public Authorities to promote renewable and clean energy, and implement policies that promote sustainable use of energy resources, energy sufficiency and saving in order to prevent climate change.	Schéma régional climat air énergie (Regional scheme climate, air, energy) – fixes regional energy orientations until year 2050	In the programming period 2014-2020, and in the frame of the SMART SPECIALIZATION progress, the Region of Western Macedonia is planning, in a wider strategic frame, to minimize the use of petroleum as a heat source. Therefore, biomass will become significantly important towards this direction. In addition, small scale (2-10MWth) district heating systems are planned and designed to be fed with forest biomass, in order to cover heat demand for small communities. Furthermore there is a concept for the utilization of forest biomass residues in a co-firing process in the existing large scale lignite power plants.
Letter of intent	There are a lot of examples in Italy, during last 15 years about 100 biomass district heating were built in Nord Italy with a total power output of about 450 MWth	Collaboration agreement for promoting the use of biomass in Lleida province: Agreement between the Province Council of Lleida and CTFC for promoting the use of renewable sources of energy in the province.	-	There is a letter of intent available for stakeholders who intent to participate in the 'Cluster of Bioenergy and Environment in Western Macedonia'.
Commercial agreement	-	Collaboration Agreement framework in order to promote and boost the energy use of forest biomass in Murcia Region: among Murcia Region, forest owners associations, association of forestry enterprises and Power Generation companies	Supply contract between the local forest cooperative and a biomass based energy plants	Not available
Consortium/cluster	CIFORT: consortium of the forest entrepreneurs of the Veneto region CONAIBO: consortium of the forest entrepreneurs of the Veneto region	25 organisations constitute the Valencian Forestry Platform. It wants to become a true "Valencian" bioenergy cluster" in order to promote the bioenergy value. It has joined different kind of stakeholders and has several working groups. http://www.plataformaforestalvalenciana.com/plataforma-forestal-valenciana/	No biomass based consortium or cluster existing right now	'Cluster of Bioenergy and Environment in Western Macedonia'. This cluster is a non-profit company and in general terms, is focused on the utilization of local biomass sources. The cluster aims mainly to develop business and research activities and initiatives through partnerships and synergies of the three pillars of Cluster (public sector, business and research and academia), primarily in region of Western Macedonia.

Tool	Italy	Spain	France	Greece
Local or regional energy council	-	-	The French state has created a local energy agency (ADEME) in each region to help enhance energy efficiency and promote renewable energies (including biomass). The PACA region has a local mission (mission régionale bois énergie) dedicated to wood energy uses	Not available
Local energy cooperative	The biomass association was joined by several stakeholders along the biomass chain: biomass producers, biomass boilers, installers, ESCo, planners, public institutions, banks, etc.	ARGEB: a regional association in Murcia that brings together the managers of biomass. They are beginning to organize a regional market of indigenous biomass.	No cooperative dedicated to energy in France. However, a great part of the work of the forest cooperative, Provence Forêt, revolves around producing wood chips for heat and energy uses	The role of local energy cooperatives in the near future will be upheld by the cluster mentioned above.
Other	-	BIOPLAT - Plataforma Tecnológica Española de la Biomasa http://www.bioplat.org/ Mercado Biomasa http://www.mercadobiomasa.com/ Observatori Forestal Català http://www.observatoriforestal.cat/ ADABE – Asociación para la Difusión de la Biomasa en España http://www.adabe.net/ APROPELLETS http://www.apropellets.es/ INFOBIOMASSA http://infobio.ctfc.cat/	-	

Table 27. Specific tools for creating and enhancing both offer and demand at the local level in Spain, Greece, Italy and France.

4.2. How to encourage networking among market actors to creating the best conditions for new investments

The organisation of the biomass consortium or cluster needs to be defined in order for it to accomplish successful networking and, consequently, the final installations. Within the organisation of the consortium or cluster, specific roles need to be defined. The proposed concept is divided into three sections, namely supply, demand and technology,, due to their different purposes and objectives. In Figure 54 it can be seen that the organisation of a biomass network consisted of stakeholders from all three sections (supply, demand and technology), covering entire biomass value chain.

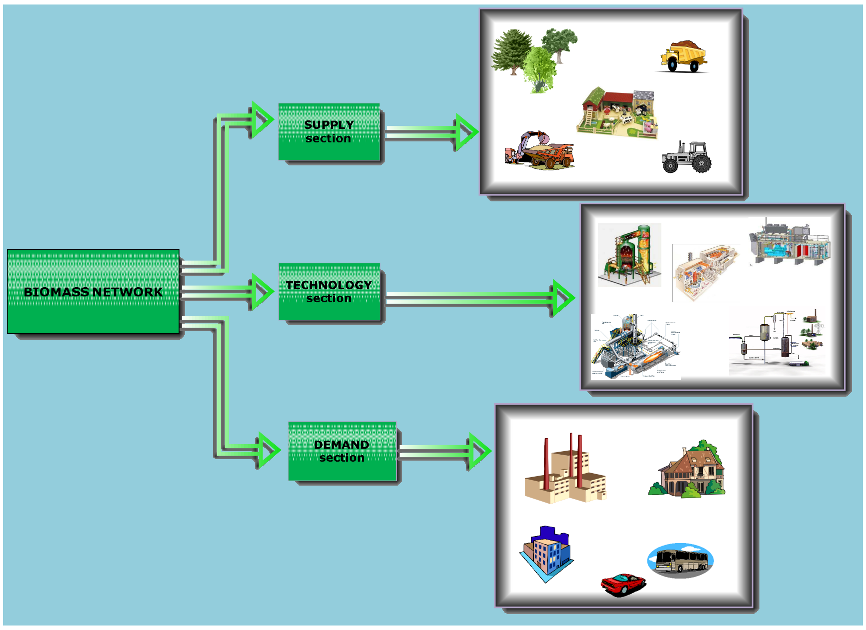


Figure 54. Organisation of a biomass network divided into supply, technology, and demand sections, acknowledging their related stakeholders.

In the following text, each of the network sections and their role is presented. The presented organisation is meant to accelerate better cooperation among stakeholders and increase the use of wooden biomass. The intention is also to improve the conditions of the biomass chain in general.

Supply section

The organisation of the supply section needs to be comprised of a database containing the present energy consumption, biomass potentials, identification of potential biomass suppliers, and the formation of special suppliers' groups. The main objective is to provide the optimal organisation of the supply section in order to achieve effective operation.

Planning the appropriate supply section corresponds to the requirements of the demand section. Therefore, the initial step is to recognise and analyse the present energy consumption. The local biomass potentials are then defined upon the completion of the feasibility studies. The focus should lie on the integration of the biomass' local resources. The identification of the related biomass suppliers and any connections between them is crucial for the establishment of an organisational supply infrastructure. In regard to this, the relationships amongst suppliers have to be defined together with their roles within the biomass network. The formation of specific suppliers' groups such as farmers, foresters, and utility companies could provide more efficient application of the supply section.

The supply section should operate in unison with the demand section. The specific renewable options are more appropriate for certain groups of end-users than others. For instance, industrial demands and consumption patterns differ from those of households as do decisions based on distinguishing between proper renewable resources according to their availability, technical potentials, and even economic aspects. The specific parameters for an energy supply have to be identified for different end-users, whilst accounting for end-user consumption patterns, demand requirements, and the availability of biomass.

Technology section

The technology section demands a database covering the available technologies for biomass deployment. It is important for the municipal energy systems that the constitutors become familiar with all of the technologies. Only in this manner can they depict the most suitable solutions for the particular RES installations. The main objective is to support decision-makers by providing knowledge on the available renewable technologies in order for them to decide upon the optimal options. Therefore, the support, both technical and informational, of external experts is highly recommended. In addition, an analysis of the technology platforms and technology roadmaps is encouraged in order to provide connections to a variety of RES networks and clusters. Distinctions between technologies should be stressed as well as the corresponding infrastructures for biomass deployment. Both of these issues have to be considered during the decision-making process, as one cannot function without the other. During the decision-making process, those technologies within the 'research phases' also need to be considered as renewable technologies are constantly evolving. Installation times differ according to the decision-making periods. After all, there are long-term investments on the horizon and cutting-edge technologies should be supported as implemented novelties. On the other hand, the economic aspect also has to be considered when making appropriate decisions for specific technologies. In practice, assessments of the various technological options have to be performed in order to find the optimal solutions.

Demand section

The main objective of the demand section is to form certain end-users' groups in accordance with their consumption patterns, and accelerate the deployment of biomass. End-users have different consumption patterns regarding their requirements and preferences. Preparing action programmes targeted at specific end-users would be more successful in comparison with more generally oriented ones.

Firstly, the present energy consumption has to be analysed together with proposals for decreasing energy consumption. Within the LECs of municipalities and energy audits of different buildings the obtained information regarding end-users, energy consumption and possibilities for lowering energy consumption can be found. Connections between all sections should be established in regard to some interrelated functions such as energy consumption analysis. Some energy needs are already being satisfied using existing renewable energy solutions. This further proposed step correlates with the depiction of the proper structures regarding renewable sources for certain groups of end-users, whilst considering the technical limitations.

A division into certain end-users' groups with similar energy consumption patterns is proposed to obtain the optimal operation of the demand side. Energy consumption patterns depend on the sector, behavioural patterns, and on the properties and requirements of specific end-users. In addition, those action plans containing a planned biomass share in the future energy balances of municipalities should consider the specifics of each end-user group in order to plan effective future development.

The economics of the project have to be considered after depicting the proper structures of biomass and suitable technologies for biomass deployment. Only economically viable solutions can be accepted. The economics of investment should also be conducted with the inclusion of operating and maintenance costs. Special support should be available for encouraging end-users, regarding biomass deployment, as renewable sources are still considered to be the more costly option in comparison with fossil fuels.

The best conditions for new investments in the biomass sector are not clear. All market actors are faced with the issue of how to generate the maximum profit at the minimum costs. Private investors are interested in making a profit and to pay back their investment in a shorter period of time. Energy consumers want to buy heat at the lowest prices and biomass producers like to sell biomass (timber, forest biomass, woodchips and pellets) at a higher price. All of these interests have to be met in order for the best conditions for new investments to be created. One of the best practices to offer state subsidies for biomass production and investments in equipment and district heating systems:

- Farmers can grant subsidies for tractors and woodchip production equipment.
- Private investors can be subsidized by the government for investments in biomass district heating systems.
- Wood pellet producers are subsidized by the governments for investing in wood pellet production equipment.
- All EU countries offer a high feed-in tariff for electricity produced from biomass.

4.3. Activities for encouraging local investments and concrete implementation of the forest biomass chain (from the forest to the plant)

The local sector, municipalities and local energy agencies have to establish a biomass value chain, biomass consortium or biomass cluster. The next very important step is the assessment of the possibilities of the investment in biomass energy production and supply so that the private investors get accurate information on the investment opportunities (number of the heat consumers, distances, power of their boilers, plans for energy renovation of the buildings, possibilities to connect new heat consumers, etc.). Local energy agencies play the most important role in providing data, connecting stakeholders, the promotion of biomass, developing prefeasibility studies, etc.

The next very important fact is the availability of the subsidies for biomass investments and energy production (investment subsidies, bank credits available, feed-in tariff for electricity produced from biomass). The procedures for permit granting have to be clear and quick (under 6 months) and the public sector has to prepare all documents and offer a concession for heat production, distribution and supply in regular time. The public sector can also demand to use local biomass resources at the granting of the concession in order to support the development of green jobs at the local level.

In Figure 55, the main operations of biomass are represented and divided into the supply, demand and technology sections.

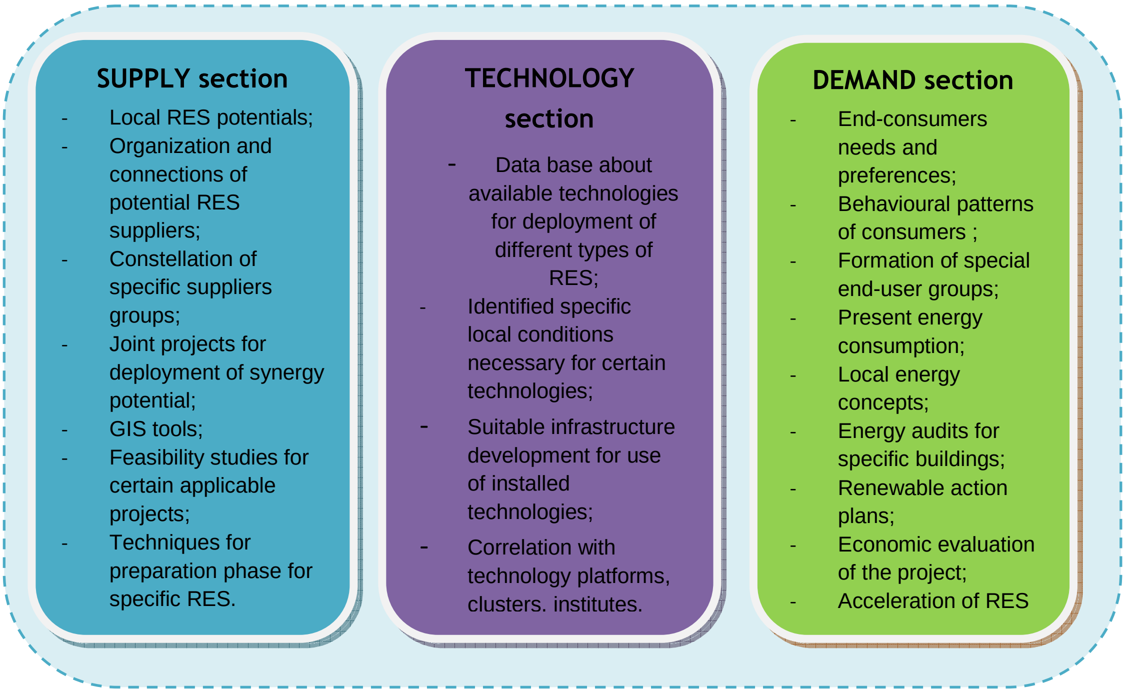


Figure 55. Biomass network operations divided into three sections: supply, technology, and demand

The proposed concept to accelerate the implementation of the biomass network and also increase investment in the biomass field is to establish a virtual, local biomass energy cooperative managed by an expert organisation in this field.

Virtual local biomass energy cooperative

Virtual energy cooperatives support the optimal functioning of a biomass network. These operational units enable the implementation of an intelligent energy management system. Virtual energy cooperatives will be presented as a tool for managing the supply and demand of biomass within a specific region by also addressing various technological options. However, information communication technologies (ICT) should be implemented for establishing virtual space in order to maintain the balance between supply and demand. Another important activity of the virtual energy cooperatives is to connect all relevant stakeholders within the biomass value chain. Therefore, there is a need to divide the functioning of the virtual energy cooperative within the supply, demand and technology sections to specifically address the stakeholders from different sections and also provide connections among them. In this manner, the effective functioning of the biomass network could be established on technical, environmental, economic and also social terms.

Figure 56 depicts the conceptual organisation of the virtual biomass energy cooperative meant to establish a balance among supply and demand and to bring interested parties together.

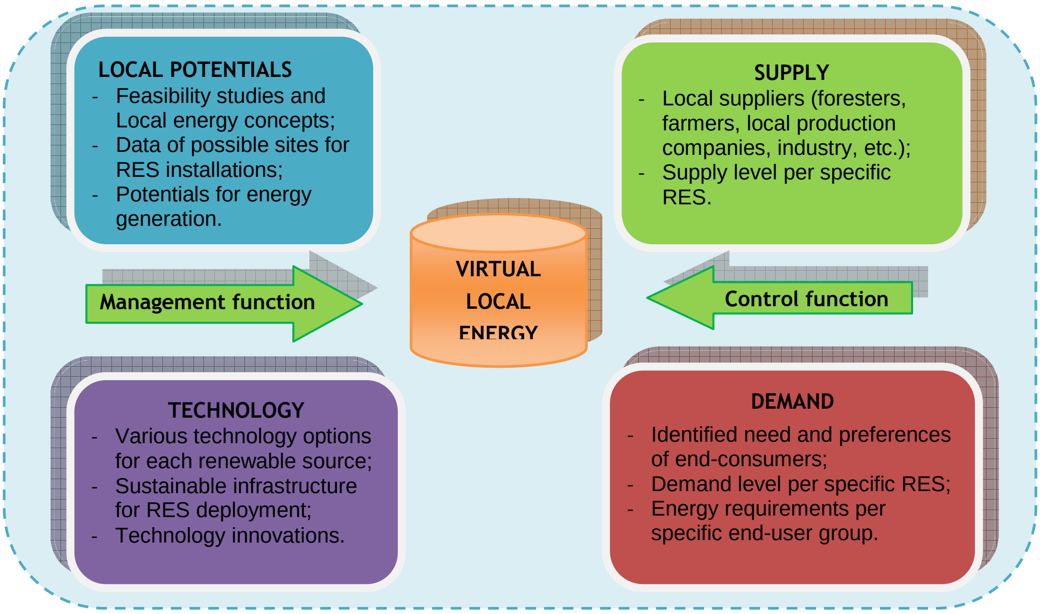


Figure 56. The organization of virtual local biomass energy cooperatives

5. Modern Biomass heating and cogeneration plants: state of the art and environmental requirements

5.1. Modern heating installations fed with forest biomass

5.1.1. *Technical requirements for modern heating devices*

In order to obtain high efficiency and harmless emissions, design and engineering techniques must consider the various qualitative characteristics of the solid biomass. The most important one is the volatile content.

Basic concepts for the full combustion of firewood are:

- providing an oxidation medium (air) in excess;
- achieving a sufficient residence **time** in the reaction zone;
- reaching a combustion **temperature** high enough;
- ensuring a good mix of the combustible gas with the combustion air through high **turbulence**.

On this basis, it is possible to regulate both the power and the course of combustion, while trying to keep the area of decomposition and gasification of biomass separate (double combustion).

These requirements are sometimes summarized in the "Rule of 3-T" (Time-Temperature-Turbulence) concisely indicating the fundamental role in optimizing the intensity of the mixing process, residence time and temperature of combustion.

Thermal appliances fed with biomass fuels are divided into generators with manual loading (wood, briquettes) and **automatic** loading (wood chips, pellets). This chapter deals solely with the automatic generators fuelled by **forest chips** (Figure 57).

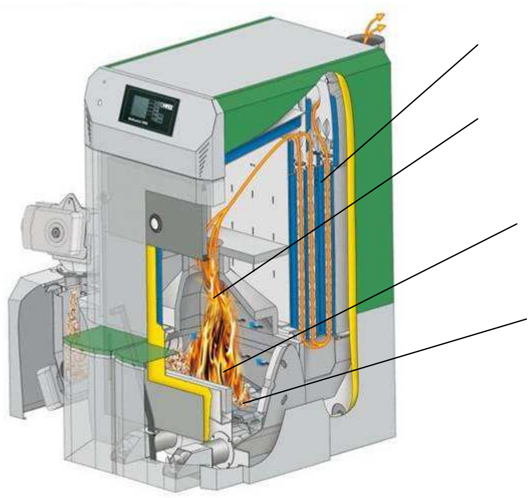


Figure 57. Stages of combustion in a modern wood chip boiler.

5.1.2. *Modern boilers with automatic loading*

Automatic boilers are designed to use combustion technology called *grid*. Within this group there are several types of fireboxes designed for specific bio fuels. Further variants also have been developed such as the rotary grate, overturning grate and rolling grate. These developments are aimed at shaking the bed of embers, consequently improving the combustion process in its final stage, and removing from the grid.

These devices are particularly effective when using fuels with a **high ash content** and a **low ash melting point**.

Fixed grate boilers

The fixed burner can be fed laterally from a loading screw or underfed. It is suitable for the use of solid, **dried biomass** (M <35 %) and also with a **low ash content** (A <3 %).

In the case of lateral feeding, the presence of a mechanical shaker would favour the evacuation of ash that falls into a drawer located below the grid. In the case of fuels rich in ash, the ash can be extracted with an auger and then transported in a special container.

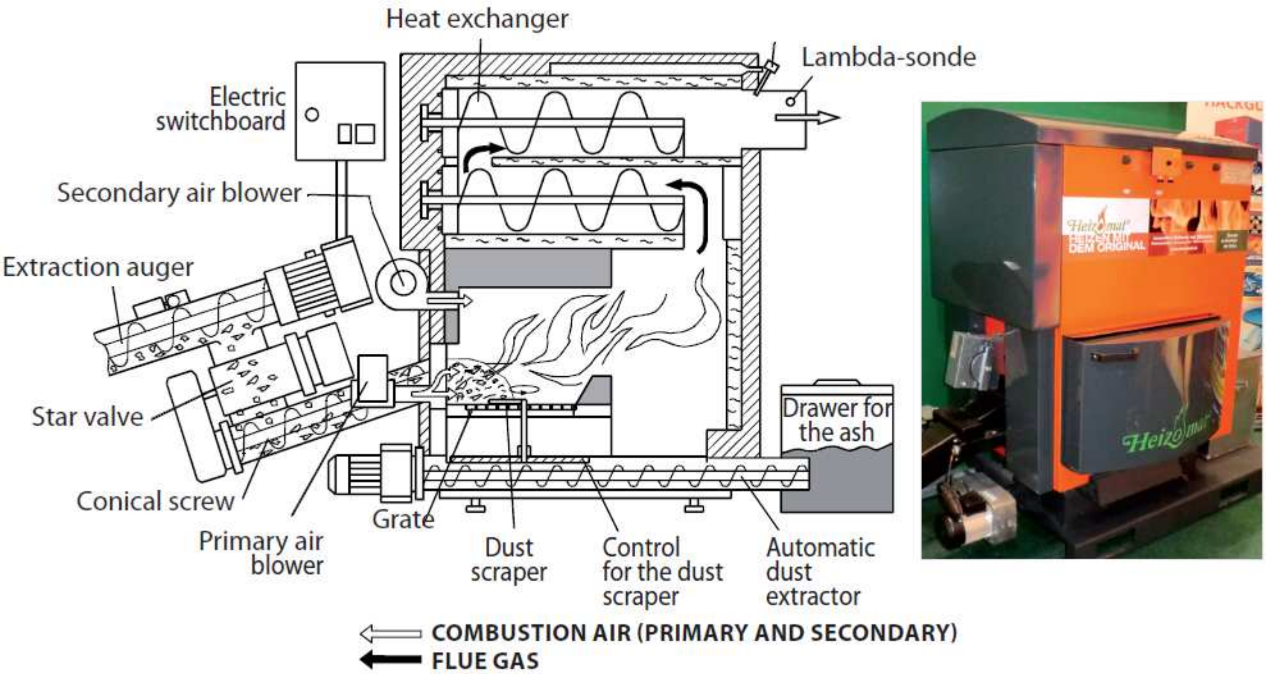


Figure 58. Modern solid biomass boiler loaded automatically and laterally with a fixed grid.

Moving grate boilers

Moving grate boilers are medium-large power generators starting from about 150 kW and going up to several MW, installed both for residential and industrial use. The grid is made up of mobile elements (plates, steps, cetenary) that facilitate the advancement of the biomass along a plane which is more or less inclined. The moving furnace is suitable for the use of **solid, wet** biomass (M 40-50 %) with a **high ash content** (A> 3 %). The grid can be equipped with a water cooling system to minimize the phenomena of melting ash that disturbs the combustion process and may compromise the functional lifetime of the construction materials; this is especially true of the refractory. Recently, new furnaces <150 kW have been introduced into the market. They are equipped with a moving grate that responds to the need to employ bio fuels (also on small scale devices) which possess a relatively high water content (M40) and are full of ashes.

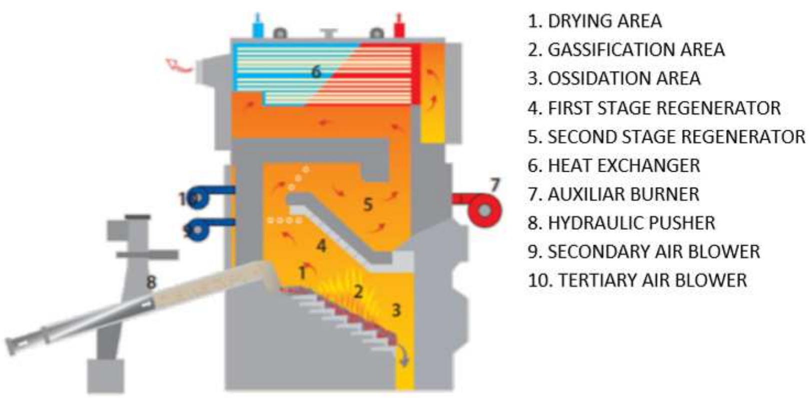


Figure 59. Boiler with a moving and sloping grate and a feed pusher

Biomass storage, conveyors, silo dimensioning

The silo for biomass storage is a critical element for the proper operation of the system. Table 28 describes the main characteristics of the conveyor systems, the feasible dimensions of the silo and the types of biomass that can be used (Figure 60).

Extraction system	Base of the silo	Base measures of silo	Maximum height of silo (m)	Type of biomass stored
Inclined rotating screw	circular, angular	Ø up to about 4 m	> 20	Wood pellets
Extractor with leaf springs	circular, angular	Ø 1,5 up to 4 m	6	chips P16-P45/briquettes
Sliding bar conveyor	rectangular	Without limit (parallel tracks)	10	chips P16-P100/grind wood/briquettes

Table 28. Main characteristics of the conveyor systems, the feasible dimensions of the silo and the types of biomass used.

Figure 60. Sliding bar conveyor used for the discharge of silos.

Before designing the biomass silo, it is very important to meet the potential suppliers and verify their available means of transportation (cargo volume, type of discharge).

In the presence of a professional supplier, it is recommended to draw up a supply contract in order to agree upon conditions such as qualitative requirements, delivery terms and price calculation.

Basically, the silo should be dimensioned so that the silo can be emptied within 15 working days allowing the delivery of a new load of biomass. The calculation should be based on the capacity of the means of transport that will deliver the biomass. Tipping farm wagons have a capacity that varies from 10 m³ up to 30 m³, containers can carry from 25 m³ to 70 m³ and sliding caissons can reach 90 m³.

The biomass should be stored as close to the heating plant as possible. The most convenient solution is that of an underground silo adjacent to the heating system, with a top discharge. The most economical solutions are those in which the silo is prepared in an existing storage space with suitable technical volumes or, as an alternative, is realized above ground and equipped with a mechanical or pneumatic loading system, depending on the type of the biomass. Also available on the market are plug & play heating stations which are preassembled in the container (Figure 61).

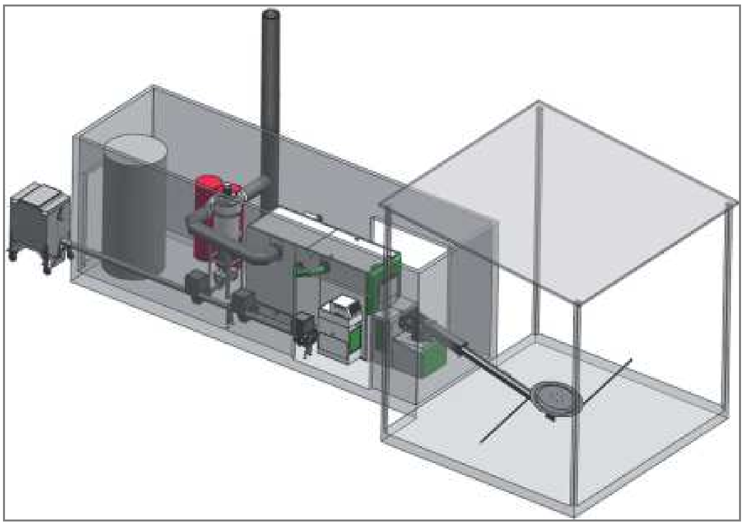


Figure 61. Plug & play wood chips/pellets heating station.

5.1.3. *Guidelines for the choice of the heating system*

Briefly discussed below, are some important aspects to consider when choosing a biomass boiler and heating system.

Quality and certification of the boiler

The first important aspect is the quality of the technology and construction of the biomass boiler. The boiler must be characterized by:

- top-quality construction materials (boiler's body, combustion chamber, mechanical parts);
- adjustable power and combustion (regulating sensors, electronic control panel);
- power modulation in the range of 30-100 %;
- high efficiency and low emission factors (guarantee of compliance within the limits of the law);
- the presence of appropriate hydraulic and mechanical safety systems both in the silo and the boiler;
- low consumption of electricity of the boiler.

It is always recommended to purchase boilers from manufacturers that can provide a third party, quality certificate. In case of boilers with a power range of <500 kW, it is advisable to refer to class 4 and 5 mentioned in the UNI EN 303-05:2012.

The manufacturer must guarantee assistance and a quick response in case of failure and malfunctions. Visiting various plants and contacting qualified designers and installers (references) is also suggested before purchasing a boiler.

Choice of the heating system depending on biomass requirements

The choice of the mechanical and construction features of a biomass plant depends on **three properties** of the solid bio fuel:

- water content (M);
- dimensions/size class (P);
- ash content (A).

These characteristics are defined by the technical specifications for solid bio fuels: UNI EN 14961:2011.

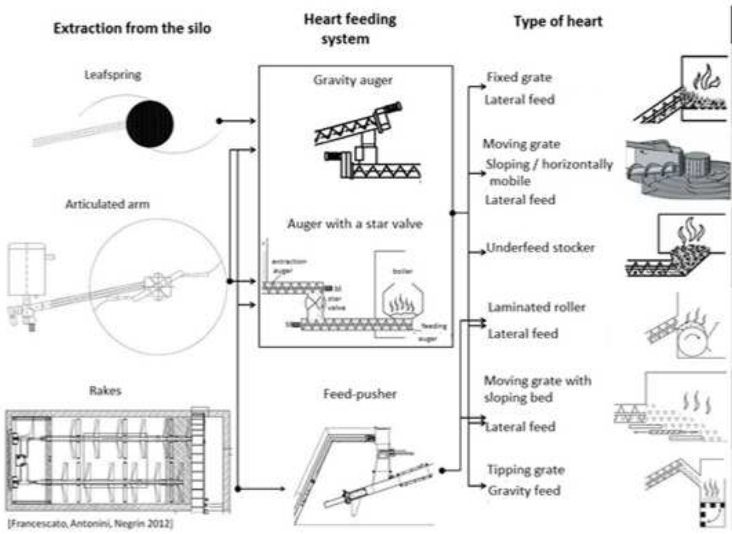
The biomass plant has **three** main **mechanical components**:

1. **a conveyor system**: spring, articulated arms, sliding bar;
2. **a furnace feeding** system: gravity screw, screw with rotary valve, feed-pusher;
3. a **burner**: fixed, underfeed, inclined or horizontally moving grate.

Figure 62 gives some guidelines to support selecting the best combination of the three components of the plant depending on the quality of the biomass (wood chips from forest biomass), also giving an overview of the power classes on the market.

Below are two examples of the application of the proposed scheme.

- In the case of **high quality forest woodchips** (classes A1 and A2): low moisture (M <30 %), homogeneous size class (P 16-45) and low ash content (A<1.5 %). Up to about 300 kW. I It is possible to choose a boiler equipped with a spring conveyor system, fed with a gravity screw and with a fixed burner.
- In the case of **low quality woodchips** (class B): high water content (M 40-55 %), inhomogeneous size class (P 63-100, shredder), high ash content (A>3 %). It is recommended to opt for a silo equipped with sliding bar, a pusher or double screw feeding system and a moving grate.



M	P	A	Class	Power (kW)
20-30	16-45	0,7-1,5	A1 (A2 M30)	25-400
20-40	16-45	0,7-3,0	A1-A2 (B M40-P45)	30-300
20-55	16-45	0,7-1,5	A1-A2 (B P45)	10-2.500
20-55	16-100	0,7-6,0	A1-A2-B	4-450
20-55	16-100	0,7-6,0	A1-A2-B	15-20.000+
20-55	16-100	0,7-6,0	A1-A2-B	15-20.000+

Figure 62. The loading, extraction system and heart selection based on woodchip quality.

Dimensioning and possible combinations with other heat sources

Proper sizing and hydraulic attitude play a critical role in the success of a biomass plant. Unlike conventional fossil-fired boilers, biomass boilers have a low modulation capacity and a high thermal inertia. The design phase should always take account that the rated power of the heating system should never be oversized. In the case of medium-high power, the splitting of the rated power between two or more cascade boilers as well as the proper sizing of the inertial water volume should always be considered (puffer, indicative volume > 20-30 L/kW (the normal size in Slovenia is 50 L/kW to 80 L/kW) in the case of automatic boilers). A combination with fossil fuels, including methane, or with a present boiler (if still in good condition) may be convenient, mostly in the case of medium-large size plants. Investment costs can be reduced if the plant is designed to cover heat load peaks with a natural gas or oil boiler and, at the same time, the woodchip boiler used in the heat charge area is functionally more favourable (base load). In this case, the two boilers must work simultaneously, i.e. the sum of the individual powers allows the maximum thermal load to be covered. However, in the case of the minimum load period with a natural gas boiler (e.g. production of DHW during summertime), the two generators do not work simultaneously, but alternatively. The combination of the biomass and methane avoids or minimizes the working period at a partial/very low load. In covering peak loads (winter time) and minimum loads (summer time) with a natural gas boiler, the woodchip heat generator will provide the largest proportion of the heat required, as shown in the typical curve of the thermal load (Figure 63.). It is recommended (especially in small plants and particularly in the case of radiant heat distribution) to integrate the system with solar thermal energy. This has the double advantage of reducing the demand for biomass as well as the emission factor of the heating system.

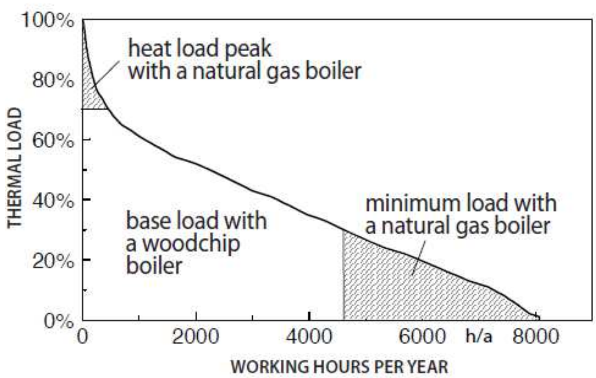


Figure 63. Annual heat load curve using the woodchips-natural gas combination, peak and minimum loads. On the right a plant equipped with a woodchip boiler 540 kW is provided.

5.2. Mini cogeneration from forest biomass

5.2.1. *ORC processes*

Similar to the conventional cycle of steam-based power production, the ORC process (Organic Rankine Cycle) is based on the Clausius-Rankine process. In this case, however, an organic working fluid is used instead of water. Unlike water, it is characterized by lower boiling and condensation temperatures. Therefore, electric power can be produced by heat characterized by low temperatures and low pressure levels. These processes typically enhance the thermal waste of production processes, such as geothermal heat and solar heat. Thus, in these systems, electric power can already be produced from 70-100°C, where efficiency increases while the temperature grows.

The cogeneration of heat and electricity (CHP, Combined Heat and Power) from biomass-based ORC takes place through closed thermal processes. Here, the biomass combustion cycle and the electric power generation cycle are separated by a stage where the heat coming from the hot gases is transferred to the organic working fluid used in the second cycle. The transfer gives better control and adjustment options over the overall process. In the field of forest biomass, two ORC processes have been successfully commercialized, in virtue of their proven reliability: a high-temperature process, based on thermal oil boilers, and a low temperature one, based on saturated steam boilers or superheated water boilers.

High temperature ORC

The first cycle requires a thermal oil boiler that heats the oil to a certain temperature (ca. 300 °C). The oil is then pumped into the evaporator at a low pressure, where the heat is transferred to the second thermal cycle. At this point, the organic fluid turns to steam and, similar to what happens in the cycle based on a steam turbine, it expands in the turbine. In this way, it performs mechanical work that is first transferred to the turbine shaft and then to the electric generator. In cogeneration plants, the expanded working fluid is condensed so that the latent heat can be valorised in a district heating network or in production processes (e.g. drying). The organic working fluid is then transferred from the condenser to the evaporator with a special pump, by closing the thermodynamic cycle. To increase the yield of the process, the hot fumes coming from the boiler are conducted into an economizer. Part of the heat is recovered and employed to preheat the water flow output to the network or the production process in which the cogenerated heat can be enhanced (Figure 64).

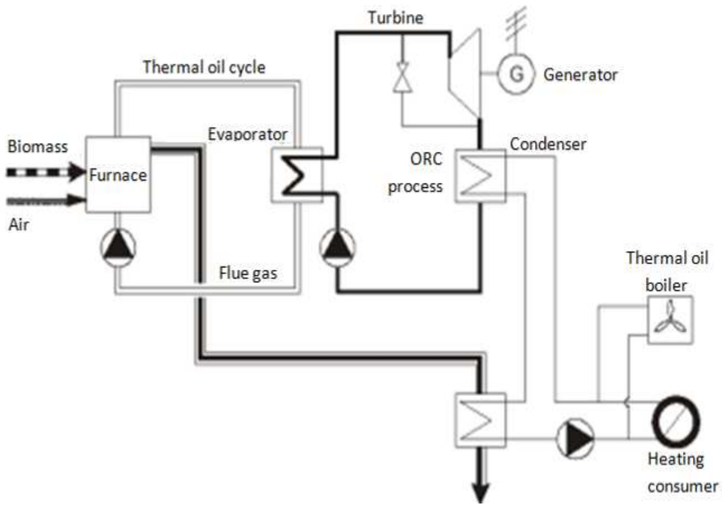


Figure 64. Simplified scheme of the ORC process.

The attested electrical efficiency of the high temperature ORC process is between 15 % and 19 %, depending on the system configuration. In Europe, there are several hundreds of power plants within the 200-2,000 kWe range (Figure 65).

Figure 65. Thermal oil boiler rated 2 MW(th) and combined with a ORC 200 kWe turbo generator installed in a pelletizing plant in Italy. The plant is fed with class B1 woodchips; its consumption is approx. 7,000 t/year.

Low temperature ORC

A solution suitable for low quality forest chips (class B) is the ORC cycle based on a permanent magnet high-speed generator equipped, with magnetic bearings. It is a small sized generator (125 kWe) activated by an organic eco-coolant evaporated at low temperatures (120-150 °C). In the field of forest biomass, the ORC group can then be combined with a hot water or saturated steam boiler (24 bar). In this case, it is possible to insert a small single-stage turbine (60 kWe), apt to operate with saturated steam, which supports one or more 125 kWe preassembled generators, assembled on a small skid. This configuration combines the advantages of the two working fluids - steam and organic - obtaining an interesting electrical efficiency (Figure 66). In the case of the use of a saturated steam boiler, by properly sizing the generator and the inertial accumulations, it is possible to direct part of the steam to be exploited in the production processes. In addition, it is possible to obtain hot water that can feed small district heating networks, such as an integration of low temperature water exchanged at the condenser (30-35 °C). In particular, this is a solution that suits the agricultural sector, especially the heating of flower and horticultural greenhouses.

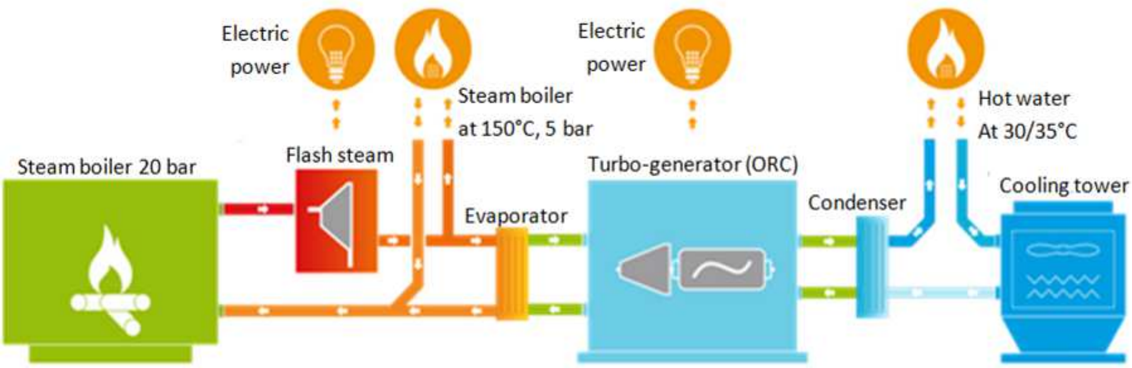


Figure 66. ORC plant (185 kWe) with micro turbine combined with a saturated steam boiler (20 bar, 2.5 MWth).

5.3. Technical and environmental requirements for modern biomass plants

Technical-environmental indicators are available to evaluate the performance of biomass plants. The most relevant are efficiency and the level of harmful emissions, the records of which are obtained by uniformed tests and coded according to the European technical regulations in force.

5.3.1. *Thermal efficiency*

Figure 67 compares the efficiency of rated output of boilers fed with logs, chips and pellets. Below are the results of a 10 year testing period (1996-2006) at the TFZ Straubing (www.tfz.bayern.de). The modern woodchip boilers achieve an average efficiency of 89 %.

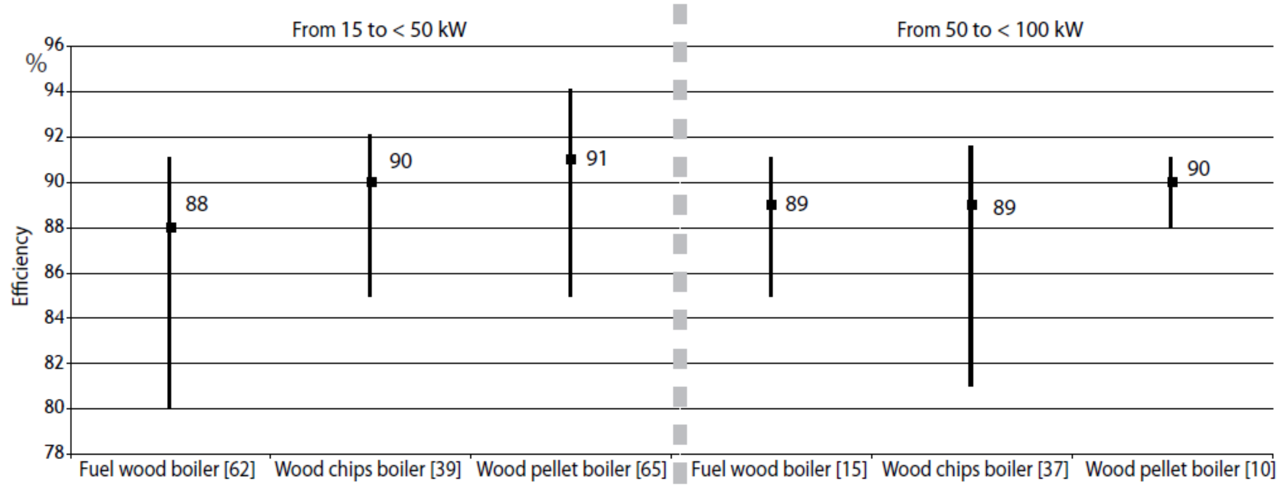


Figure 67. Thermal efficiency comparison within small biomass boilers.

Development of the efficiency trend

Data published by the certification bodies show that, in the last 25 years, the efficiency of biomass boilers has increased by approx. 30 percentage points (Figure 68).

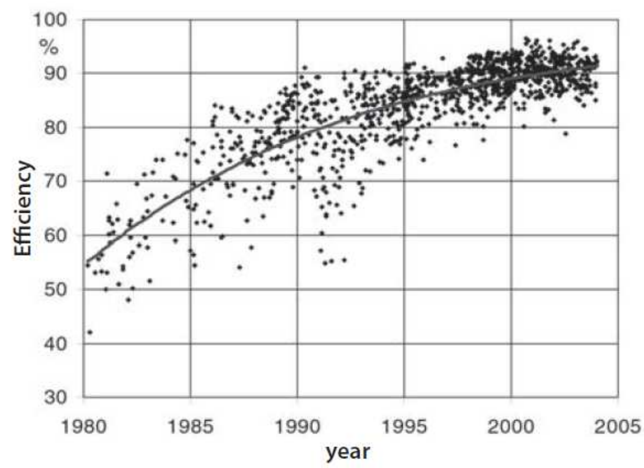
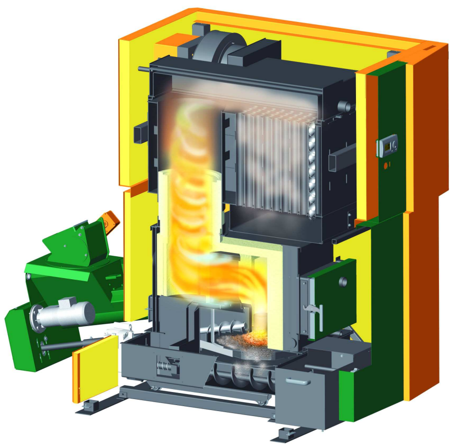


Figure 68. Development of the efficiency rate of small size boilers, including both manual and automatic systems. Evidence from certification tests carried out by the BLT Wieselburg (www.blt.josephinum.at).

5.3.2. *Emission factors of modern automatic boilers fed with woodchips*

The emission factor of small and medium scale boilers fed with woodchips typically varies within the range **50-100 mg/MJ** (75-150 mg/Nm^3), while the top products guarantee values of <40 mg/Nm^3. Even if the feeding is automatic, the management of the system strictly influences its performance (quality of woodchips, maintenance, sizing of the boiler, hydraulic configuration of the system).

The range of the boiler emission factor depends on the technological level reached by the target market. Below is the most recent data published by two of the most prestigious research teams dealing in this field on a European scale. Figure 69 shows the mean values of the emissions of wood fuelled boilers (woodchips and pellets), measured by the TFZ institute of Straubing (Bavaria) during the 1996-2006 period.



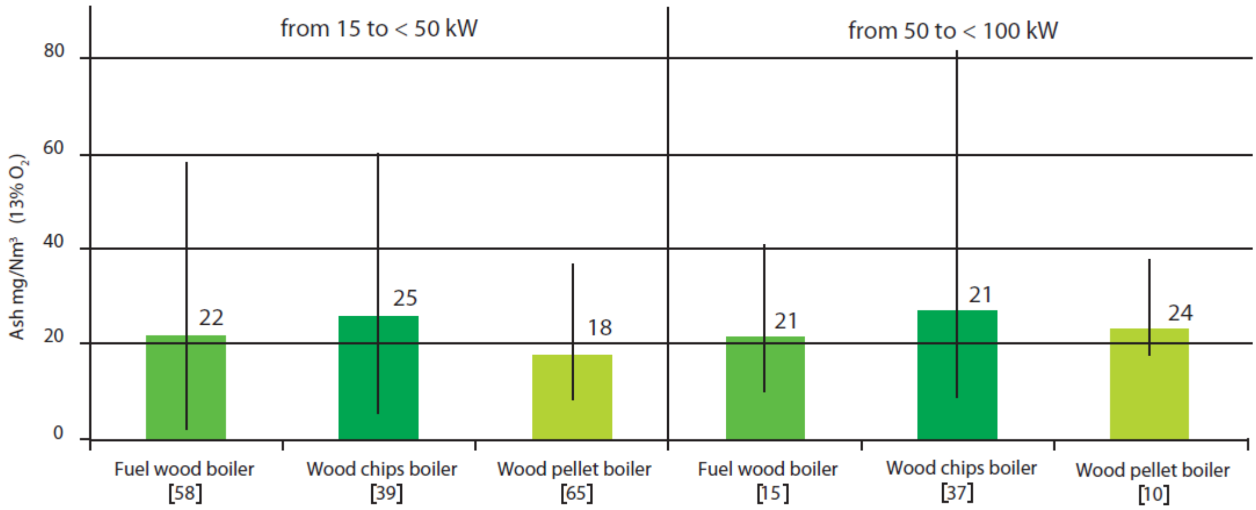


Figure 69. Comparison of the emission factor in different solid biomass boilers.

Table 29 shows the average values registered in small-medium scale boilers in over 169 combustion tests carried out at the BLT Wieselbug (Austria) in the 1999-2004 period.

	NOx	COV	CO	Dust
Wood boiler	131	5	100	**22**
Chip wood boiler	155	<2	28	**28**
Pellet boiler	125	<2	48	**17**

Table 29. Emissions expressed in mg/Nm3 at 10 % of O2.

In plants exceeding 500 kW, the emission factor is influenced by the system filter. The gravity systems (cyclone and multi-cyclone) have no effect on the particulate separation. So, downstream of the multi-cyclone, fabric filters or electrostatic precipitators are to be installed (Figure 70).

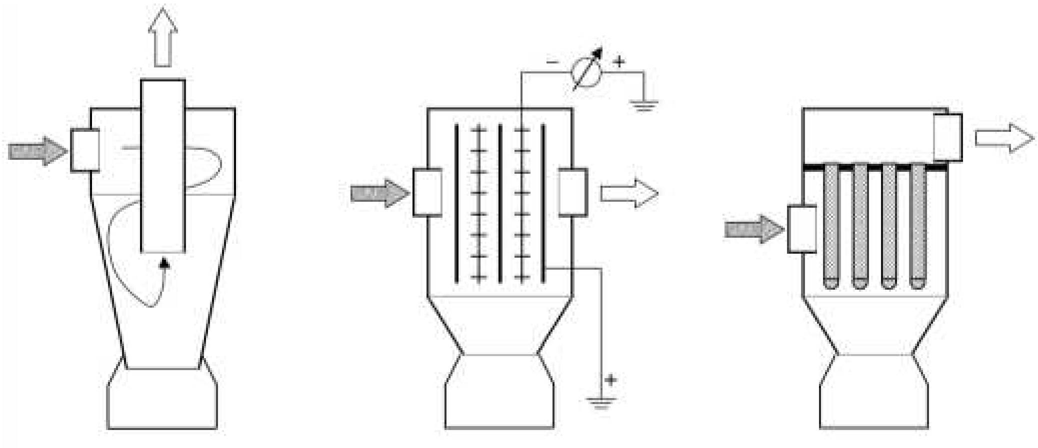


Figure 70. Operating principles of gravity filters (cyclone and multi-cyclone on the left) of the electrostatic precipitators (in the middle) and fabric filters (on the right)

In the short term, further restrictions on emissions will be imposed in several European countries. As a consequence, the recent technological research focused on the implementation of new electrostatic and fabric filters applicable in plants < 1 MW, keeping the emission of dust respectively under 20 and 5 mg/Nm3.

5.3.3. *The new EN 303-5:2012*

Part 5 of the new EN 303-5:2012, published in June 2012, defines terminology, requirements, testing and the marking of solid fuel boilers, including automatic boilers for wood chips, up to the rated power of 500 kW .

In comparison to the previous standard (1999) there are several changes, including the introduction of two new performance classes. Currently the performance class for top boilers is "class 5". Up to 100 kW, the minimum level of efficiency is considered equal to 87+log(Pn); over 100 kW it is required to exceed 89 %.

Table 30 shows the emission limits of class 5 in relation to the rated power of automatic boilers fed with solid biomass (woodchips and pellets).

Nominal Heat Output	Carbon Monoxide CO	Organic Gaseous Carbon OGC	Dust
Up to 500 kW	500	20	40

Table 30. Emission limits for boilers EN 303-5:2012, class 5. Values expressed in mg/Nm3 at 10 of O_2.

The performance requirements of class 5 are becoming an important reference model over all European countries to define the technical and environmental characteristics of a modern solid biomass boiler. For example, in Italy new thermal renewable energy incentives only refer to class 5 boilers, certified by a laboratory accredited to EN ISO/IEC 17025.

Technological development

Thanks to the recent technological developments concerning biomass boilers, there has been a steady reduction in the emission factor of fine particulates (PM). While the old traditional stoves and boilers emit more than 100 mg/MJ of PM, the most recent studies show that the values registered by the modern devices are within the 47-28 mg/MJ range and those of the modern boilers with automatic control systems are between 18 and 6 mg/MJ (Figure 71).

It is important to consider that, while encouraging a further reduction in the quantity of PM emissions is a priority, it is even more important to be aware of the fact that the level of danger to the PM health is strongly related to their quality, i.e. to their chemical composition.

Old appliances usually perform combustion badly, as the PM produced are mostly (over 90 %) organic particulate and soot. The aforementioned unburned organic compounds disappear almost completely in the case of **modern boilers** fed with **logwood, woodchips and pellets**. The PM that they produce is composed almost entirely of inorganic salts (mainly sulphates and potassium chlorides), producing much lower toxicity levels. Evidence coming from in vitro tests carried on lung cells including all types of PM and collected from biomass devices, show the effect of cellular inflammation as being negligible or very low, contrary to the PM emitted by diesel and encountered in urban areas.

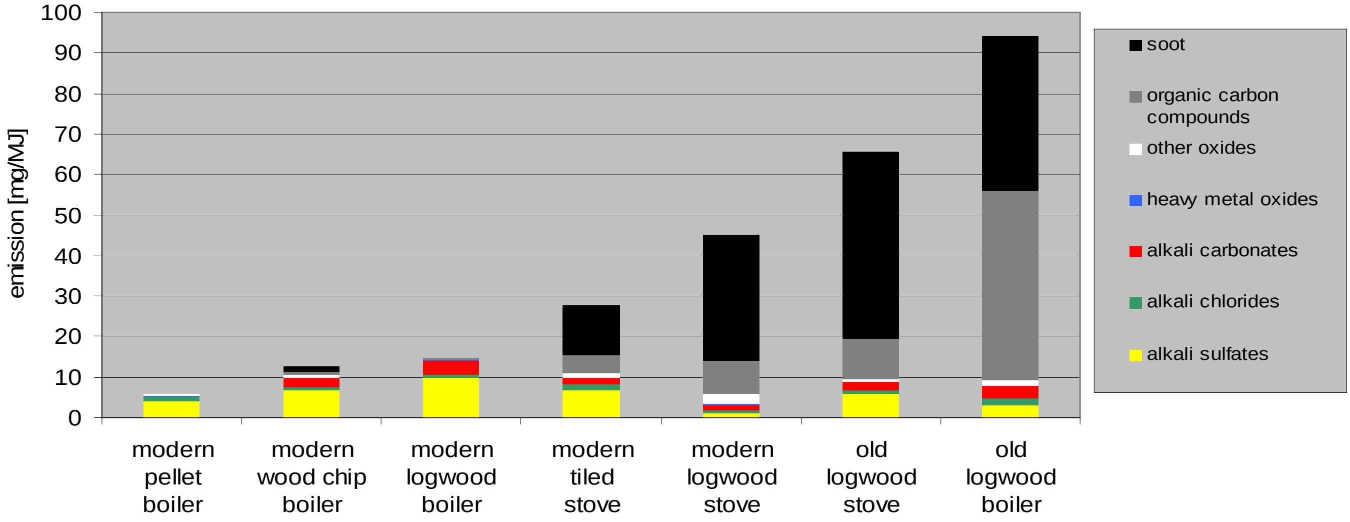


Figure 71. PM1 emission factor and particulate composition, comparing old and new technologies.

Replacing old devices with modern boilers to improve air quality

Currently, modern biomass boilers produce a quantity of PM **70-90 % lower** than the old ones. The PM produced by modern devices has an much lower **toxic effect** than either old appliances or the PM produced by urban traffic. Modern boilers installed properly and equipped with advanced systems for the automatic regulation of combustion, are able to achieve an almost complete combustion. Thanks to that, they produce a PM almost free of unburned carbon and thus, the effect of toxicity is almost entirely negligible for human health. The promotion and financial support of "replacing" old residential appliances with modern, efficient and technologically advanced fuel-burning devices can lead to a considerable reduction in the PM emissions from the combustion of wood and, therefore, making a substantial improvement in the quality of the air. This also concerns the valleys already on the gas grid where, firewood is (understandably) still the heat source preferred by the local population, given the high levels of PM and PAHs detected in winter.

R&D projects currently in progress will enable, in the future, a further significant reduction of the emission factor of PM produced by small appliances, which are expected to decrease from 50 % to 90 % in comparison with current records (Obernberger, 2011). In addition, the implementation of secondary measures for PM reduction (filters) plays an important role, as emission limits are becoming even stricter.

5.3.4. *The emission of $CO_{2\text{-}eq}$*

Wood and forest biomass combustion is generally considered neutral in terms of greenhouse gas emissions. This is only true if the wood energy is produced a short distance from the end user and if the exploited forest area can regenerate. Nevertheless, wood energy is very advantageous in terms of CO_2 emissions in comparison with conventional energy balance (Figure 72).

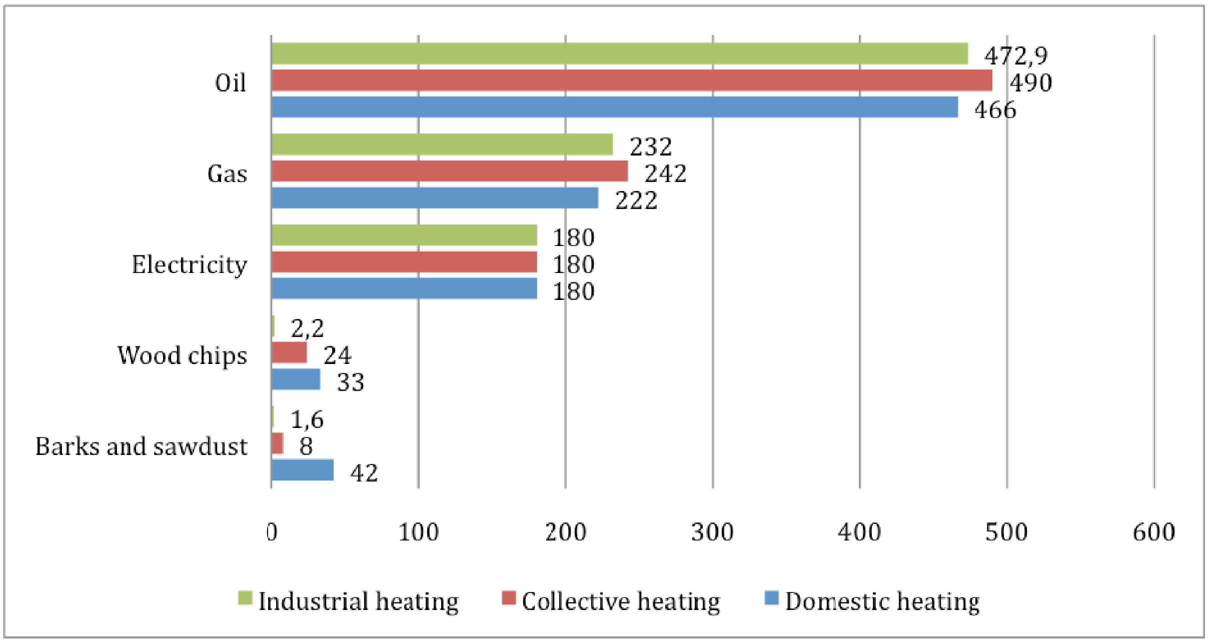


Figure 72. Greenhouse gas emissions in France (in CO2-eq kg/MWh) (Source: ADEME, 2009)

Figure 72 also shows that the more wood energy is used in large quantities for collective and industrial heating, the less the amount of CO2 released per 1 MWh is important.

5.3.5. *The impacts on forest soil fertility*

The consumption of energy wood has environmental consequences for air quality, but it can also have serious consequences for soil fertility and ecological environments.

With the increasing demand for wood energy, uncontrolled harvesting and unmeasured residual cutting could lead to a significant decline in forest soil fertility. Indeed, two-thirds of the mineral elements (nitrogen, phosphorus, potassium, calcium and magnesium) taken from the soil by the tree for its growth are concentrated into thin branches, leaves and bark. Harvesting this biomass thus means a massive export of minerals and a diminution of soil fertility.

However, Mediterranean forest soils already have a fairly low fertility. Thus, it is important to:

- determine the richness of the soil and therefore its ability to support a slash harvest;
- spread the harvest over time and observe intervals during which no biomass will be extracted.
- let slash dry on site for at least 4 months for softwood and at least 6 months for hardwood, in order to allow the leaves, which gather 10 to 50 % of minerals, to fall to the ground.

Finally, a control of the amount and dates of slash harvesting is necessary as they also play important roles in biodiversity, the protection of regeneration or reducing soil compaction.

6. The socio-economic acceptability of biomass installations

This chapter will be mainly concerned with "**appropriation**" (that is, when a citizen take matters in their own hands) rather than "**acceptability**".

Indeed, "*the notion of acceptability implies a "top-down" approach, that is to say a policy imposed by a government, and generally more or less well received by the population. In contrast, the term "appropriation" means a willingness to involve [citizens] in the making of national environmental policy, either through incentives or dialogue, or by innovative financing structures.*"

6.1. Motivations and main socio-economic benefits from the establishment of local biomass installations

The main motivations are economic (especially in times of crisis).

Biomass installations represent **long term saving**, in a context of prices rising for "classic" forms of energy, stemming from fossil fuels (gas, oil or coal heating systems). In addition, wood energy installations receive both support as well as direct and indirect financial assistance for the installation of individual or collective wood boilers (e.g. financial grants, soft credits). Moreover, the evolution of technology has brought down the price of installation equipment, making them **affordable** today for even the smallest municipalities.

The motivation of citizens and elected officials are then environmental.

First, biomass installations contribute to **acting for the planet**, either locally (air quality, ecosystems protection) or globally (the fight against greenhouse gas emissions, which cause major climate changes). Furthermore, using a local supply of forest biomass allows for an enhancement of nearby forest resource value, through **sustainable management and controlled harvests**. Finally, the exploitation of biomass today (namely the use of by-products) is a way **to start or restart more active forestry** in the future (the clearing or cleaning of abandoned stands, exploitation of newly afforested areas due to the abandonment of agricultural lands).

The motivation is also social and political.

With regards specifically to local elected officials, they use these installations as a political showcase to give a "greener" corporate identity to their policy. In addition, the establishment of local biomass installations enables a **true political expression of the territory**, through the control of the energy budget and traceability of the entire supply chain (local heat supply and production). Moreover, the development of a local wood energy sector creates many direct and indirect jobs.

In the current context of the promotion of **short supply chain and local** production (e.g. the trademark "Made in France" is being publicized a lot at the moment in France), the use of local, raw, French materials is preferred over wood exported from countries like Finland, Sweden and Norway.

Finally, regarding tourists and forest owners, the concept of a "clean" forest involves the removal of slash from thinning or cuts that may later enter the local wood energy circuit.

6.2. Major socio-economic obstacles to the implementation of local biomass installations

There are many socio-economic obstacles to the implementation of local biomass installations, either upstream or downstream of the wood industry.

Upstream:

- There is a real issue of **social acceptability** (psychological, cultural, environmental and landscape acceptability) of **tree cutting** (particularly clear cuts and large areas cuts), notably in touristic areas and in areas of public welcome;
- Many forest owners develop **mistrust towards forest subcontractors** (deterioration of roads and forest paths, damage to reserve trees, payment problems);
- Few forest owners are **aware of the potential** of their forest plots and their heritage value;
- The wood energy sector is relatively **recent** - it is still relatively **unknown** to forest owners, who are often elderly (the average age is 66 years old, according to the résofop, CREDOC, 2009 survey);
- Using this resource as a raw material for energy is **considered unworthy and unprofitable** compared to the exploitation of timber.

Downstream:

- Although many local authorities today can develop wood energy installations, the **installation and return on investment costs** remain relatively high for them;
- In the light of electricity costs, particularly sourced by nuclear energy, the **production of electricity** (and not heat) from forest biomass is still uncompetitive;
- Finally, due to the current economic crisis, the **direct and indirect financial support** tends to decrease or disappear. For example, in France, the government plans to increase VAT on raw material (pellets, logs, wood chips) from 5 to 10% in 2014.

6.3. Model of biomass chain maximising socio-economic benefits for local communities

See: scheme (Figure 73) presenting the current model of the biomass chain in France.

The four main elements for a model of biomass chain maximizing socio-economic benefits for local communities include the following:

- **a control of the harvest**: knowing the resource and its potential, sustainable logging in the context of local, limited and appropriate output;
- **short supply chain**: local supply for local consumption;
- **local development**, notably through the creation of direct and indirect local jobs, at different stages in the supply chain;

- **the political expression of the territory**: people, forest owners, entrepreneurs and politicians are fully involved in their territory, and everyone's opinion can be taken into account for harmonious local development, reflecting good governance.

It should be noted that forest biomass use will be even more appropriate if the instigator community were part of a broader **energy efficiency and energy diversification approach**, including other sources of energy (Figure 73.).

It should be noted that forest biomass use would be even more accepted and bought by actors if the leading community takes part in a broader **energy efficiency and energy diversification approach**, including other sources of energy.

From a financial aspect, countries could work on:

- creating a **Biomass Fund**, to fund forest owners or managers as an inducement towards better forest management. This fund could be supplied by taxes (both local and national).
- taking environmental services and their payments into account (PES systems).

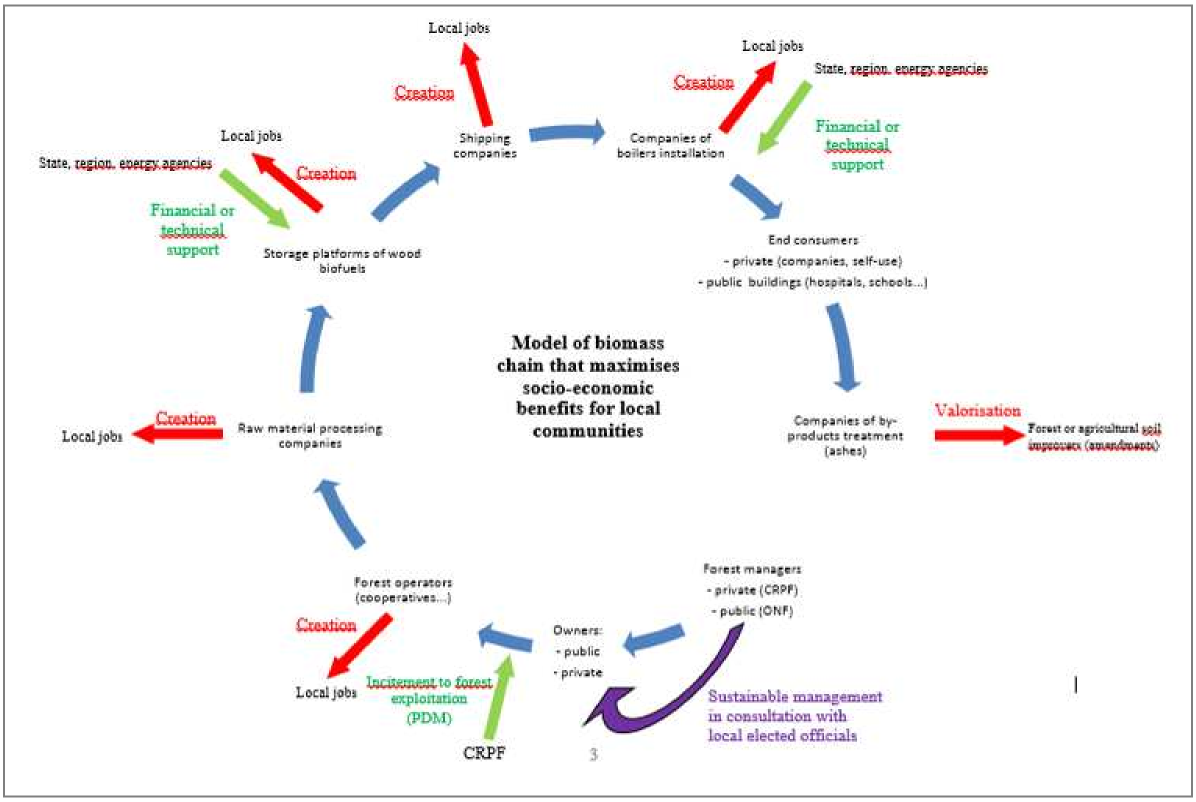


Figure 73. Current model of the biomass chain used in France

7. Development of common approaches to integrate the recommendations into mainstream policies

According to Article I of the **Aarhus Convention** (adopted by the Economic Commission for Europe UN-ECE Nations on June 25th, 1998, entering into force on October 30th, 2001 and ratified in France on July 8th, 2002), "in order to contribute to the protection of the right of every person of present and future generations to live in an environment adequate to his or her health and well-being, each Party shall guarantee the **rights of access to information, public participation in decision-making, and access to justice in environmental matters** in accordance with the provisions of this Convention".

Thus, in legal terms, the principle of citizen participation in decisions related to the environment is protected: the stakeholders at the local level can and should be considered by policy makers in various environment policy areas (ecology, food, energy, transportation, etc.).

This Convention has been translated into French law through the Article 7 of the Environment Charter, adopted in 2004, and through the Law of December 27th, 2012 on the implementation of the Principle of Public Participation, drawing the consequences of the jurisprudence of the Constitutional Council. This law of December 27th, 2012 aims at giving Article 7 of the Environment Charter its full scope in order to enable citizens to get involved in a practical and useful way in the process of public decision elaboration about the environment.

The Slovenian parliament ratified the Aarhus Convention in 2004 with the Order for the Declaration of the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Official Gazette 62/2004). According the Construction Act both neighbours and interested public are included in the procedure for the construction of buildings, enterprises, boiler houses, district heating systems and other objects for which a building permit is needed. During the procedure the investor is obliged to declare and calculate the impact on the environment.

In Greece, there is a complete legal framework regulating access to environmental information and access to information, ensuring that officials and authorities assist and provide the required guidance. The Aarhus Convention was ratified by the Greek Parliament in December 2005 through Law 3422/12-12-2005 (Official Journal of the Government (OJG) A 303 /2005).

According to Article 3, Paragraph 9 (a), of the Joint Ministerial Decision (JMD) 11764/653/2006 (OJG 327B/17-3-2006) through which the Directive 2003/4/EC, on Public Access to Environmental Information was transposed, officials are required to support the public in seeking access to information.

The Aarhus Convention was translated into Spanish law in July 2006, through Law 27/2006 of July 18th.

Portugal signed the Aarhus Convention in June, 1998 and ratified it in June, 2003. The Law of Access to Administrative Documents (LADA) governs access to environmental information. In 1998, the European Commission issued a reasoned opinion that Portugal was not complying with the 1990 EU Directive on Access to Information. It closed the proceedings in 2000 after Portugal made modifications to the LADA. The National Assembly approved a new law implementing the Convention and 2003 EU Directive in April, 2006.

There are two main types of approaches in decision-making:

- Bottom-up approaches, i.e. initiated by the bottom,

- Top-down approaches, i.e. initiated from the top.

The **bottom-up approach** is a participatory steering where leadership begins with the perceptions and initiatives of the "field" (at the local level, for example) in order for them to be transmitted and taken into account at higher levels (national or international level for example). In a way, it is a synthesis (from specific to general).

The **top-down approach** is a directional steering where the hierarchy manages the leadership and where the "subordinate" levels have to fit to, perform, deduct and improve the prescribed instructions. This is a work of analysis (from general to specific).

In addition, two **participatory approaches** exist and are widely used nowadays:

- Consultations at the local and regional level (work of lobbies, unions, consumers' and users' groups), driven by the bottom, which are real bottom-up approaches,
- Public consultations ("participatory democracy"), promoted from the top, which are actually top-down approaches.

7.1. Dialogues at the regional level (bottom-up approach)

These participatory processes consist of "**complaints**", **suggestions** from the bottom (local stakeholders) to the top (policy makers, national and international institutions) or "**lobbying**" activities conducted by pressure groups.

In the case of this guide, local stakeholders who are likely to consult and work together in order to improve public policy in the area of environment and energy are:

- trade unions, at the local or European level,
- users' and consumers' associations, at the local or European level,
- owners' associations, at the local or European level,
- other associations, at the local or European level, for the promotion of biomass, renewable energy, ecology, etc.,
- wood energy companies.

The following table (Table 31.) summarizes the stakeholders who are likely to consult one another, at the local and European levels, over policy decisions on energy and environment.

	EUROPE	FRANCE	SPAIN
TRADE UNIONS			
USERS' AND CONSUMERS' ASSOCIATIONS		- UFC Que choisir	
OWNERS ASSOCIATIONS	- CEPF (Confédération Européenne des Propriétaires Forestiers) - ArcMED (Association for Mediterranean Forest Owners) - USSE (Unión de Silvicultores del Sur de Europa)	- Union Régionale de la Forêt Privée du Languedoc-Roussillon - Union Régionale de la forêt privée de Provence Alpes Côte d'Azur - Union Régionale de la forêt privée de Corse	-COSE (Asociaciones de Propietarios Forestales Privados d'España) -AFOCA (Asociación de propietarios Forestales del Macizo del Caroig) -AFOVAL (Asociación de propietarios forestales de la Comunidad Valenciana) -APFTP (Associació de Propietaris Forestals Tinença-Ports) -PROFOMUR (Asociación de propietarios forestales de la Región de Murcia) -CFC (Consorci Forestal de Catalunya) -APROMAL (Asociación de Propietarios de Monte Mediterráneo con Alcornoque de Andalucía)
OTHER ASSOCIATIONS	- AEBIOM (European Biomass Association) - EUBIA (European Biomass Industry Association) - EUROSOLAR (European Association for Renewable Energy) - EnR (European Energy Network)	- AERE (Association pour les énergies renouvelables et l'écologie) - Equilibre des énergies	-AMUFOR (Asociación de Municipios Forestales de la Comunitat Valenciana) -AVEBIOM (Asociación Española de Valorización Energética de la Biomasa) -ASERMA (Asociación Española de Gestores de biomasa de Madera recuperada) -ADABE (Asociación para la Difusión de la Biomasa en España) -APPA (Asociación de Productores de Energías Renovables) -AFUSER (Asociación para el Fomento y Uso Social de las Energías Renovables) - ASEMFO (Asociación nacional de Empresas Forestales) - AAEF(Asociación de Empresas Forestales y Paisajísticas de Andalucía) - APROPELLETS (Asociación de productores de pellets de madera del estado español)
WOOD ENERGY COMPANIES	- E. On		-Valoriza Energía Operación y Mantenimiento, S.L. -Iberdrola Renovables, S.A. -Acciona Energía, S.A. -Ence Energía, S.L. -Gestamp Biomass España -Enel Green Power España
NGOs	- AIFM (Association Internationale Forêts Méditerranénnes)	Forêt Méditerranéenne	

	ITALY	SLOVENIA	GREECE	PORTUGAL
TRADE UNIONS		-Sindikat kmetov Slovenije (Slovenian Farmers Union) -Sindikat gozdarastva Sovenije (Slovenian Forest Union)		- CAP Confederação dos Agricultores de Portugal (Portuguese Farmers Confederation); -CONFAGRI Confederação daq Cooperativas Agrícolas e do Crédito Agrícola de Portugal (Portuguese Cooperative and Agricuture Credit Confederation) - SETAA - Sindicato da Agricultura Alimantação e Florestas (Agriculture, Food and Forests Union)
USERS' AND CONSUMERS' ASSOCIATIONS	-Adiconsum (Italian Association of Consumers)	-Društvo za zaščito potrošnikov (Consumers Protection Society) -Urad za zaščito potrošnikov (Office for Consumers Protection).	- General Federation of Greek Consumers - General Secretariat for the Consumer / Ministry of Development and Competitiveness	-DECO Associação Portuguesa para a Defesa do Consumidor (Portuguese Association for Consumer Defense)
OWNERS ASSOCIATIONS	-Federforeste (Italian Federetaion of Forest Communities)	- Agriculture and Forestry Cooperatives (Koroška, Logatec, Škofja Loka, Sloga, Ribnica, Bled, Krpan) -Forestry Cooperative Slovenj Gradec -Society of Forest Owners TIS	-Hellenic Property Federation	- FORESTIS Associação Florestal de Portugal (Portuguese Forest Association) -Forum Florestal Estrutura Federativa da Floresta Portuguesa (Federational Structure of the Portuguese Forest);
OTHER ASSOCIATIONS	-AIEL (Italian Agriforestry Energy Association) -CONAIBO (National Consortium of Forest Entrepreneurs) -FREE (Coordination of Renewable Energy Association) -FIPER (Italian Federation for Renewable Energies) -ITABIA (Italia Biomass Association)	-Koroška Agricultural and Forestry Cooperative, Agriculture and Forestry Cooperative Logatec, Agriculture and Forestry Cooperative Škofja Loka, Agriculture and Forestry Cooperative Sloga, Agriculture and Forestry Cooperative Sloga, Agriculture and Forestry Cooperative Ribnica, Agriculture and Forestry Cooperative Bled, Forestry Cooperative Slovenj Gradec, Agriculture and Forestry Cooperative Krpan, Society of Forest Owners TIS	- General Directorate for the Protection of Forests and the Natural Environment -Geotechnical Chamber of Greece -Society of Forest Science of Greece -Greek Biomass Association -Hellenic Biofuels and Biomass Association -Wood Energy Companies	- APREN - Associação de Energias Renováveis (Renewable Energies Association); -ANPEB Associação Nacional de Pellets Energéticos de Biomassa (National Association of Biomass Pellets) - APEB Associação dos Produtores de Energia e Biomassa (Energy and Biomass Producers Association)
WOOD ENERGY		-TE_TOL Ljubljana	-Sakkas SA	- EDP;

	ITALY	SLOVENIA	GREECE	PORTUGAL
COMPANIES		-Bioenergija Lenart	-Angelousis SA -Bioenergy Hellas -MAKI SA -Alfa Wood -Ecoa	- Endesa; - IBERDROLA Portugal; - GALP Energia;
NGOs	Legambiente	-Umanotera -SLOBIOM		-Quercus -LPN Liga para a Protecção da Natureza (Nature Protection League)

Table 31. Stakeholders influencing policy makers on the local, regional, national and EU levels

A focus on two stakeholders is presented below: an association focused on the biomass industry, working on a European scale, and a regional forest owners association.

EUBIA – The European Biomass Industry Association (http://www.eubia.org):

EUBIA, the European Biomass Industry Association, was established in 1996 as an international non-profit association in Brussels, Belgium. It groups together market forces, technology providers, and knowledge centres, all of them active in the field of biomass.

Its main objective is to support the European biomass industries at all levels, promoting the use of biomass as an energy source, developing innovative bioenergy concepts and fostering international co-operation within the bioenergy field.

EUBIA has a permanent office at the Renewable Energy House, very close to the European Parliament and the European Commission.

EUBIA aims at influencing key European policies affecting the biomass industry; it intends to represent and promote the European biomass industry interests:

- EUBIA participates in several policy initiatives aiming to encourage and maintain a positive framework for the bioenergy sector;
- EUBIA is a founding member of EREC (European Renewable Energy Council), which is an umbrella organisation of the leading European renewable energy industry. Through EREC, EUBIA has the opportunity to submit sectorial inputs to the EU institutions and has also supported a number of position papers on renewables;
- EUBIA is currently supporting, as a Campaign Associate, the Sustainable Energy Europe Campaign 2009-2011.

ARCMED - The Association of Mediterranean Forest Owners (http://www.arcmed.eu)

ARCMED is a European Association dedicated to Mediterranean Forest Owners. Its goals are the following:

- to have a strong forest owners organization which represents itself by explaining, defending and monitoring initiatives, projects and policies orientated towards its preservation, support and promotion;
- to have a strong voice and an active presence at the European level in order to defend the economic, social and environmental values of Mediterranean forests;

- to have a tool which draws together forest owners associations, whether they are regional or nationwide, in order to facilitate the coordination of efforts through the trans-regional and trans-national cooperation.

ARCMED expresses the private forest owners associations will to have a **legal body which represents and promotes knowledge of the Mediterranean forest and its functions** before the administrations or organizations which defend the forest in the EU.

ARCMED has the vocation to act in close coordination and collaboration with nationwide and European private forest organizations (like CEPF), within which it will express the voice of the Mediterranean Private Forest Owners'.

These consultations at the local and regional levels can take many forms, with a gradation from diplomatic to directive:

- idea box, brainstorming,
- forums and round-table debates,
- letters to higher levels of decision,
- petitions,
- proposition of amendments (see amendments to the CAP during the PROFORBIOMED project),
- demonstrations, events, gatherings,
- political or economic boycotts, strikes.

It should be noted that any consultative approach requires both animation and moderation by a resource person or group of people.

One example of Slovenian bottom-up operations is the Consortium of the seven Slovenian Local Energy Agencies, which have influence over energy policies on both the local (municipality - by developing the Local Energy Concepts) and national level. They negotiated with the Ministry of the Infrastructure and Spatial Planning in order to include the role of the Local Energy Agencies into the Energy Act. This public power includes the energy management of the municipalities, consultations upon the implementation of the energy policy on the local level, energy bookkeeping, etc. The last meeting in November was at the Energy Directorate (part of the ministry) where it was decided that the Slovenian Local Energy Agencies were to be included into the preparation of the national guidelines for energy contracting and ESCO models.

Propositions and complaints are eventually taken into account, in part or in whole, by governments and international decision-making bodies.

7.2. Public consultations (top-down approach)

Opposed to the previous dialogues, public consultations are driven by the "top" (by a government, for example). In a given context, with a chosen background (and clear definition of topics for discussion, definition of implementation means, etc..), the "top" incites discussion and debate in order to reach conclusions and suggestions so as to improve or redirect public policy, in the environment and energy area, for example.

Depending on the **degree of participation and involvement** required from citizens, it can range from simple consultations to real deliberations:

- public information campaigns,
- polls,
- organisation of round-table debates,
- organisation of thematic workshops.

7.2.1. *The case of the EU*

The European Commission regularly seeks out input from citizens and stakeholders when developing policies or legislation.

All public consultations launched by the European Commission are available on the website "Your Voice in Europe" (http://ec.europa.eu/yourvoice/index_en.htm); in particular, consultations are available in the following fields:

- the environment:

http://ec.europa.eu/environment/consultations_en.htm

- energy:

http://ec.europa.eu/energy/consultations/index_en.htm

- agriculture and rural development:

http://ec.europa.eu/agriculture/consultations/index_en.htm

7.2.2. *The case of France:*

Two examples will be given here:

- the national level,
- the regional level - the PACA Region.

The national level: participatory process for the Grenelle Environment

The Grenelle Environment (*Grenelle de l'Environnement* in French) is an open multi-party debate in France that brought together representatives of national and local government and organizations (industries, professional associations, trade unions, non-governmental organisations) on equal footing with the goal of unifying a position on a specific theme. Its aim is to define the key points of public policy on ecological and sustainable development issues and to draw up a plan of action consisting of concrete measures to tackle the environmental issue. Specifically, it consisted of a series of political meetings held in France from September to December 2007, to make long-term decisions on issues such as the environment, sustainable development and, in particular, restoring biodiversity through the establishment of green and blue corridors as well as regional schemes of ecological coherence while reducing greenhouse gas emissions and improving energy efficiency. The name "Grenelle" comes from the first conference to bring all of the stakeholders together, which took place in May, 1968 in the Rue de Grenelle.

Step 1 - Dialogue and development of propositions for action - July 15th to September 25th, 2007

A debate was organized through six thematic working groups, each involving 40 members divided into five colleges. Each college was intended to represent the actors of sustainable development: the state, local authorities, NGOs, employers and employees.

These groups were:

- Group 1: "Fighting against climate change and controlling the energy demand".
- Group 2: "Preserving biodiversity and natural resources".
- Group 3: "Building an environment respectful of health".
- Group 4: "Adopting sustainable production and consumption methods".
- Group 5: "Building an ecological democracy ".
- Group 6: "Promoting sustainable development modes favourable to employment and competitiveness ".

Each group then worked in "workshops". For example, in Group 1, there were three workshops:

- Workshop 1: Transport and travel.
- Workshop 2: Building and urban planning.
- Workshop 3: Energy and carbon storage.

Step 2 - Public Consultation - July 28th to October 19th, 2007

One month national consultation: 19 regional meetings, 8 internet forums, 2 debates in the Parliament, 31 advisory bodies seized. More than 30 000 participants in total have taken part in it.

Step 3 - Negotiations and decisions - October 24th to 26th 2007

Three days of negotiations in the form of 4 round-table debates chaired by the State Minister to get the five colleges together about 268 commitments carried out by the President of the Republic.

Step 4 - Operational implementation

Since December 2007, 34 operational committees were launched with the mission of offering concrete solutions to implement the commitments.

Step 5 – Legislative Implementation

Adoption of the programming law related to the implementation of the Grenelle Environment and of the law concerning the national commitment to the environment.

Within the dynamics of the Grenelle Environment and following the round-table debate of stakeholders whose propositions have been arbitrated by the President of the Republic on October 25th, 2007, operational committees provided a list of propositions from the various decisions made, theme by theme and as concretely as possible.

The working groups held their last meeting on September 25th, 2007. Summaries and reports from each group were made public on September 27th, 2007. Following this, local meetings in the different regions and a public consultation on the Internet took place before the Grenelle "round-table" on October 24th-25th, 2007.

Local level: regional "Agri-Food & Wood Meetings- Let's produce the future"

The French government (through various Ministers in charge of Agriculture, Food and Economy), in partnership with the Association of Regions of France, launched the Regional Meetings for the future of Agri-Food and Wood on September 25th, 2012.

The methodology is common for these two sectors, but the initiative is split into two parts: one related specifically to food industries and the other to timber industries.

The food and timber industries are major economic players in France, but these industries are currently facing several structural weaknesses within the context of strong international competition. The role of the French Government in this process is to help these two industries to promote their products, long-term international competitiveness and to help achieve the ecological transition of the economy. Moreover, within this process, the different **regions are reinforced in their roles as leaders of economic development in the territories**.

Concretely, 140 **thematic workshops with professionals and services of the State and the regions** were conducted in each region leading to the establishment of hundreds of propositions to be implemented at the regional, national and European levels. In the case of the wood industry process, the following steps have been made:

- October - November 2012: Launch **interregional and open conferences**. For the PACA Region, it took place on October 18th, 2012.
- November 2012 - February 2013: **thematic regional workshops**. These thematic regional workshops are jointly organised by regional councils and the secretariat of the State services and led **by industry and timber professionals**. The 4 topics dealt with included:
    - Topic 1: Develop employment and training, increase the attractiveness of trades.
    - Topic 2: Help companies in order to boost market competitiveness.
    - Topic 3: Support the emergence of collective strategies and collaborative projects.
    - Topic 4: Strive for a more complete recovery of wood (timber wood, pulpwood, energy wood).
- March 2013: **interregional conferences of restitution and synthesis**. Discussions on the propositions of regional workshops and summary of the work of the French State interregional services.

- April 2013: A **presentation by the ministers of a proposition for a concerted National Plan for wood industries** to the Higher Council of forest, forest products and wood processing will conclude this participatory process.

This National Plan for wood industries is a concerted plan, which originated at the "top" (by the government), under the leadership of key stakeholders, and offers concrete, pragmatic and operational solutions. This National Plan is part of a wider scope approach: the French "Law for the future on Agriculture, Food and Forest" was launched in September, 2013.

7.2.3. *The case of Slovenia*

In 2011, the Ministry responsible for the energy sector (as for 2013, it is the Ministry of the Infrastructure and Spatial Planning) started a public debate on the draft of the National Energy Program valid until the year 2030. The draft was published on the official Ministry web page where two documents regarding national energy policy were published:

- The Draft of the National Energy Program to the Year 2030 - Active Energy Management;
- Environmental Impact Assessment Report for the National Energy Program 2010 - 2030.

The public debate lasted for four months. During this period, the ministry presented the draft at 20 workshops and meetings for the public. Seven meetings and presentations of the program for the general public were prepared by governmental and non-governmental organisations. The draft was also sent to all seven Slovenian Local Energy Agencies, which responded with written propositions and suggestions for change that were then discussed at the common meeting at the Ministry.

From the general public, organisations and experts, the ministry accepted 52 written suggestions, propositions for change and amendments:

- 13 from environmental non-governmental organisations;
- 12 from other non-profit research institutions;
- 14 from energy enterprises;
- 6 from interest stakeholders;
- 2 from the Regional Councils;
- 1 from a municipality and
- 8 from individuals.

The Ministry prepared the report and included relevant propositions in the document, which was then accepted by the Slovenian Parliament and government.

7.2.4. *The case of Spain*

An example of a top-down approach in Spain is the presentation (given in February, 2014) by the minister of Agriculture, Food and Environment, Miguel Arias Cañete, of the "Socioeconomics Activation Plan for the Forestry Sector" in force from 2014 until 2020. This plan aspires to be an instrument of National implementation, closely linked to FEADER programming. It introduces 85 specific measures, among which the priority interest relies on those contributing to environmental preservation and the prevention and mitigation of climate change and followed by those promoting biomass energetic valorisation in rural areas and community buildings.

Useful links:

http://www.cepf-eu.org

http://www.aebiom.org

http://www.eurosolar.de

http://www.enr-network.org

http://ec.europa.eu/energy/renewables/links_fr.htm

http://www.oecd.org/newsroom/21684464.pdf

http://www.respublica-conseil.fr/IMG/pdf/intro_guide.pdf

http://www.aere-asso.com

7.2.5. *The case of Greece*

In Greece, the policy on energy, in general, and, in particular, on RES is regulated by the central government. Regional authorities do not have the institutional role in order to hold consultations on issues related to the subsidization of renewable energy technologies or the optimal production mix. Thus, their role regarding the energy policies is entirely advisory.

The most recent Public Consultation on Greek policy concerning renewable energy took place in December, 2012, under the responsibility of the Ministry of Environment, Energy & Climate Change. Both the entities and citizens, as legal entities, had the right to participate. The Region of Western Macedonia, in the aforementioned consultation, forwarded concrete proposals concerning the support of policies in favour of renewable energy that focus on large-scale renewable energy plants and hybrid systems (combining two or more types of RES).

At the regional level, we can also mention the procedure that was followed before the establishment of the Bioenergy and Environment Cluster in Western Macedonia. The Region and the University of Western Macedonia, both partners in the Proforbiomed Strategic Project, initiated a discussion with groups of stakeholders, which resulted in a consensus on the need to establish the cluster.

8. APPENDIX – GOOD PRACTICE: Forest biomass chains across partner countries

8.1. Italy: Bioheat for the Borgotaro Parma-Italy Hospital

BIOHEAT FOR THE BORGOTARO PARMA-ITALY HOSPITAL

Biomass helps local economy and mitigates climate change

Valter Francescato AIEL (on behalf of FLA and Regione Sicilia)

Hospital of Santa Maria

The Local Health Authority of Parma (Italy), with the support of the Province of Parma, the financial support of the Rural Development Programme (2007-2013) and the Programme for Integrated Rural Country (Measure 321, Action 3), installed a modern boiler using locally produced woody biomass at the Hospital Santa Maria in the municipality of Borgo Val di Taro (Parma province, about 400 metres above sea level). It has been integrated into the existing thermal heating plant, running on natural gas. The hospital has 121 beds and a surface of over 18,000 square metres.

Heating system

The biomass heating output has been set up with the aim of covering the thermal base-load with the woodchips (in winter), keeping the already existing natural gas system to cover the peak-load in wintertime and the minimum load, which occurs in summertime (mainly for hot water). In this way, it is possible, on the one hand, to reduce the investment costs as the generator has a lower installed capacity and, secondly, the woodchip boiler is running more suitably and with some technical and management advantages: combustion is always optimized, a minimization of the stand-by phases and less maintenance.


Boiler


Feeding system


Multi-cyclone

Woodchip storage

It is located next to the boiler room and provides appropriate access for the discharge of woodchips. The load runs from the top by a truck equipped with a tipping flap. The loading docks are closed by two doors with a mechanical driving system. The net storage volume is about 90 cubic meters. The silo discharge system has a sliding bar conveyor, driven by hydraulic pistons, exploiting the entire volume of the deposit. The consumption of chips over this period was 784 tonnes (about 3,000 bulk cubic metres) with an average moisture content of 40%. Therefore, the primary energy supplied was 784 t x 2.81 MWh/t = 2,203 MWh, with an average conversion performance of plant at about 70%. Since the contract for the purchase of woodchips is based on heat measurements, its water content is not measured, so the value of the efficiency of plant calculated here is purely indicative.

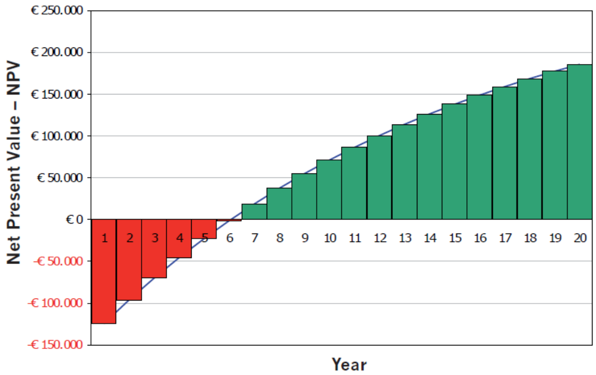
Woodchip production and energy supply

The supplier of chips, "Comunalie Parmensi", is a forestry consortium and operational public-private body with more than 50 years of history, managing nearly 7,000 ha of forest owned by 29 old "collective forest domains" and nearly 8,000 hectares of forest belonging to six Private Forest Associates of Consortia. The woody raw material comes from forests located within a radius of 15 km of the boiler. After an intermediate stage of seasoning, wood logs as such, are chipped and woodchips are delivered to the hospital's plant. The Consortium of "Comunalie" has planned the realization of biomass trade centres, a logistics infrastructure that will allow the short term improvment of the production and quality of the delivered forest woodchips. The woodchip supply contract is based on its energy content, measured with specific tools that have been installed downstream of the boiler. The current (selling) energy price of woodchips is 36 €/MWh and is intended as a primary energy price.

Investment evaluation

To assess the financial suitability of the investment, the typical, projected finance cash-flows over a period of 20 years have been used, accounting for current running costs and revenues. For the calculation of the Net Present Value (NPV) a discount rate of 7%was used. The reimbursement period is seven years with a NPV upon the 20th year of 185,000 €; the internal rate of return (IRR) is about 23%.

Investments cost	
Central heating, plumbing and electrical accessories, technical planning, installation	502,700
Public subsidy RDL (67%)	337,216
Hospital net investment (33%)	**165,484**
Annual running costs	
Woodchips (1.539 MWh output x 36 €/MWh)	55,404
Maintenance, management, administration, electricity	4,800
Total	**60,204**
Missing (avoided) costs	
Natural gas as missing costs (1,539 MWh x 60 €/MWh)	92,340



Environmental and socio-economical benefits

The introduction of the woodchip heating plant annually replaced about 172,000 cubic metres of natural gas with 784 tonnes of locally produced woodchips. This has generated two important benefits, the first being a socio- economic benefit, saving 92,340 € that was previously "lost" in terms of purchasing power. This means that this amount of money was previously paid for a non-local energy source, and now this amount remains largely "in the hands" of local woodchip producers and also "in the hands" of the owners of the forests from which they come. The forests can now be managed in a more convenient way, since the woodchips enhance wood products that previously could not find an appropriate and economical allocation on the market. The substitution value of fossil fuel over the next 20 years amounts to about 2 million Euros, of which 55,400 €/year, or 1.1 million in 20 years will "flow" into the primary local economy. Let us not forget that Italy as a whole "lost" about 60 billion Euros every year for the purchase of imported fossil fuels; in other words, this is Italy's annual global energy bill. The other benefit is that of not sending climate-altering gases into the atmosphere, which is normally expressed by the parameter: CO2-eq. Europe has set a specific target for reducing these emissions by 2020 (-20%). The European Council, in February 2011, stated that Europe should aim to reduce CO2 emissions by 80 to 95% compared to the 1990 reference levels, in order to contain the global temperature rise to below 2 °C by 2050. At the global level, this means limiting CO2 emissions to 750 billion tons by 2050, but, as noted by the International Energy Agency (IEA) CO2 emissions in 2010 have reached a new record of 30.6 billion tonnes/year. So at this rate, the set limit of 750 billion tonnes will be broken as early as 2035 . To try to reach the goal of mitigating climate-altering emissions, EU countries should aim for an emission target value of 2.7 t per capita CO2/year. Currently Italy emits about 3 times this value. As recently acknowledged by the IEA, in the absence of effective interventions in the short term on the model of development and production cycles, we are passing serious problems related to climate change on to future generations, some of the effects of which are already very evident. The woodchip boiler at the Santa Maria Hospital helps to reduce about 360 tonnes of CO2-eq (7,200 t in 20 years) annually, or, in other words, the amount emitted by 100 cars that running 2.6 million km per year.

8.2. Greece: forest biomass chains implemented across Greece

Biomass supply chain actors within the supply chain

A short description of the actors involved in the supply chain:

- forest owners (mainly state forests)
- forest cooperatives (harvesting of timber)
- transportation companies
- end user

Chain 1:
Starting point: Storage at a timber supplier, End point: Storage at a wood processing company (heating for its own purposes)

Description:

The case of Alfa Wood (medium-density fiber board (MDF) producer) with ORC

The major suppliers of Alfa Wood are wholesalers, trading forest timber, and the local Rural Forest Cooperatives, which both transport products to the premises of the plant.

The round wood that is delivered by truck to the company should have a size of 2 m length and 50 cm diameter.

The round wood is stored at the plant's yard. The logs are cut to a more manageable length (if over 2 m in length or over 50 cm of diameter), debarked and then sent to the chippers. If necessary, the round wood is washed to remove dirt and other debris. Woodchips 4x4 cm in size are produced. The produced woodchips, designed for the production process, are stored in a silo and the wood waste, for thermal utilization, in another.

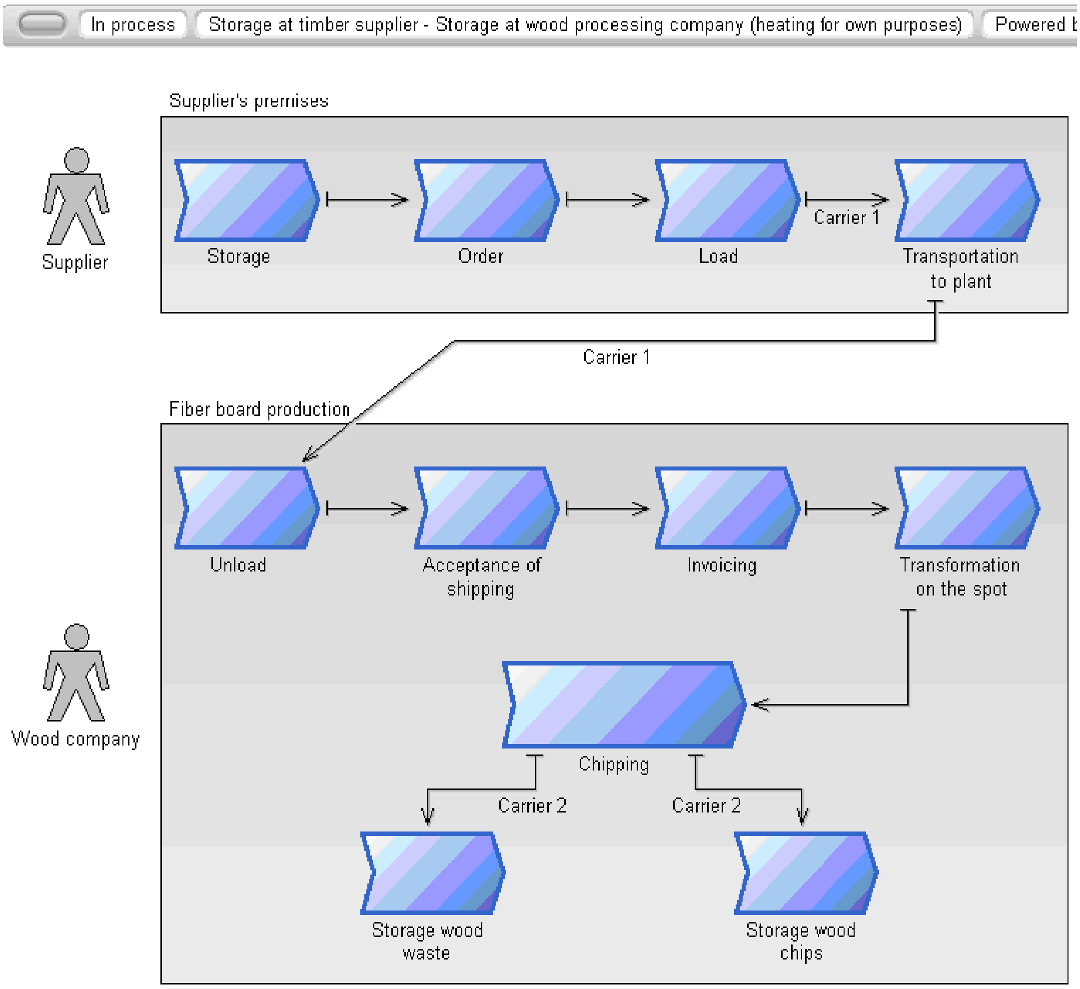
The general steps used to produce MDF include mechanical pulping of the woodchips into fibers (refining) and drying and blending the fibers in order to transform the material to mat MDF. The material is then hot pressed, cooled, trimmed and sanded before it is ready for shipping.

Energy recovery from wood waste

The wood waste is used to produce thermal energy in order to support the production process. The factory combines conventional methods of biomass energy utilization, cogeneration of electricity and heat based on the principle of the organic RANKINE cycle (ORC). The exploitation of the residual thermal energy is used for drying and pressing the fiber board as well as for space heating and producing domestic hot water for the plant.

Flow chart

· Storage of timber on either the wholesaler's or Rural Forest Cooperative's premises
· Loading of round wood by crane lorry (20tn)
· Transportation to plant (MDF factory with ORC)
· Unload at factory by crane lorry
· Transformation on the spot (washing if necessary)
· Chipping (4x4 cm)
· Storage of woodchips for fiber board production
· Storage of wood waste for cogeneration



Chain 2:
Starting point: pellet plant
End point: end consumer

Description:

Storage at the Pellet Factory

The pellets are bagged in small bags (15- 25 kg, sold and delivered on pallets of 800 kg each).

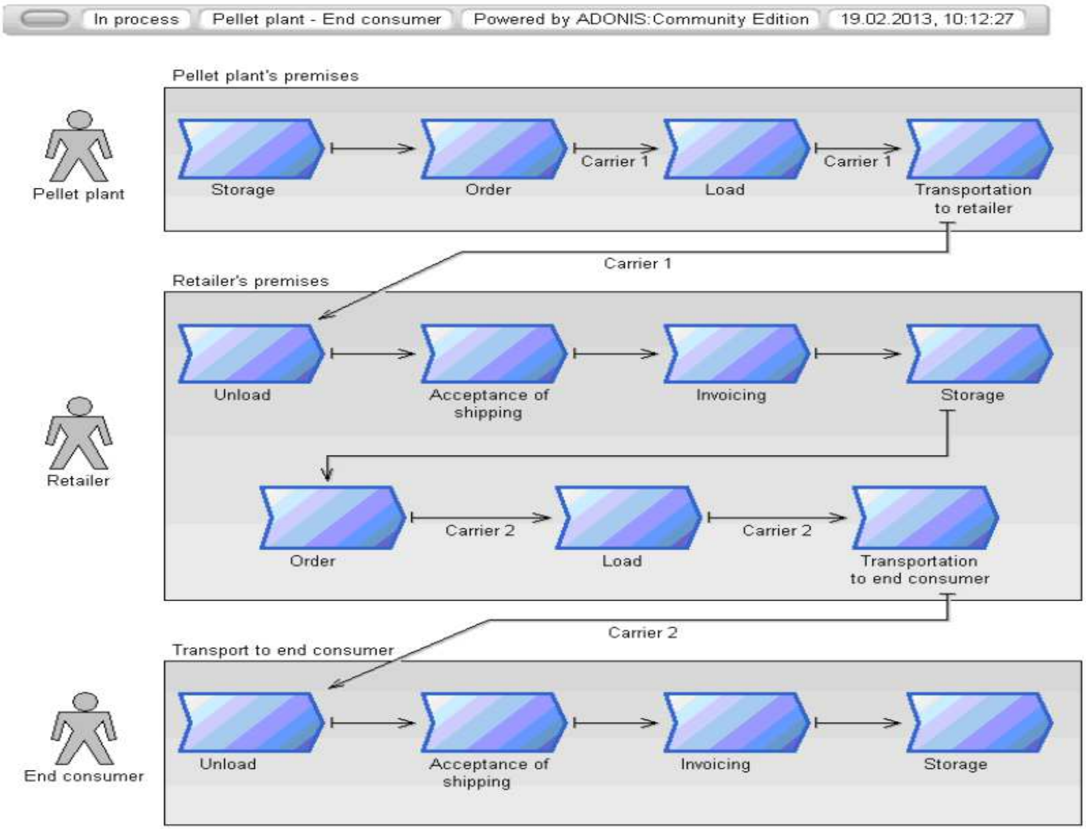
The bagging process is composed of 3 steps:

- The bag is filled, weighed and welded.
- The bags are placed on a pallet.
- The pallet is enclosed in plastic.

This type of package is used for small pellet consumption in households, e.g. pellet stoves for heating purposes.
The bags are generally distributed as follows:
- 42 pallets/vehicle
- 832 kg/pallet
- Crane lorries unload the pallets within a radius of 8 meters
Consumers buy the pellets at DIY markets, filling stations or agricultural supply stores and transport them to their homes on their own or have them transported by means of the retailer. No large bags are used and no pellets are transported in bulk.

Flow chart

- Storage of pellets in bags packed on interchangeable pallets (small bags with max. weight of 25 kg, most commonly 10-15 kg).
- Loading of pallets on trucks (20tn)
- Transportation to intermediate storage (retailer)
- Unload at retailer by crane lorry
- Storage at retailer
- Transportation to end consumer
- Unloading by crane lorry
- Storage at end consumer



Chain 3:
Starting point: standing tree
End point: storage at end consumer

Description:

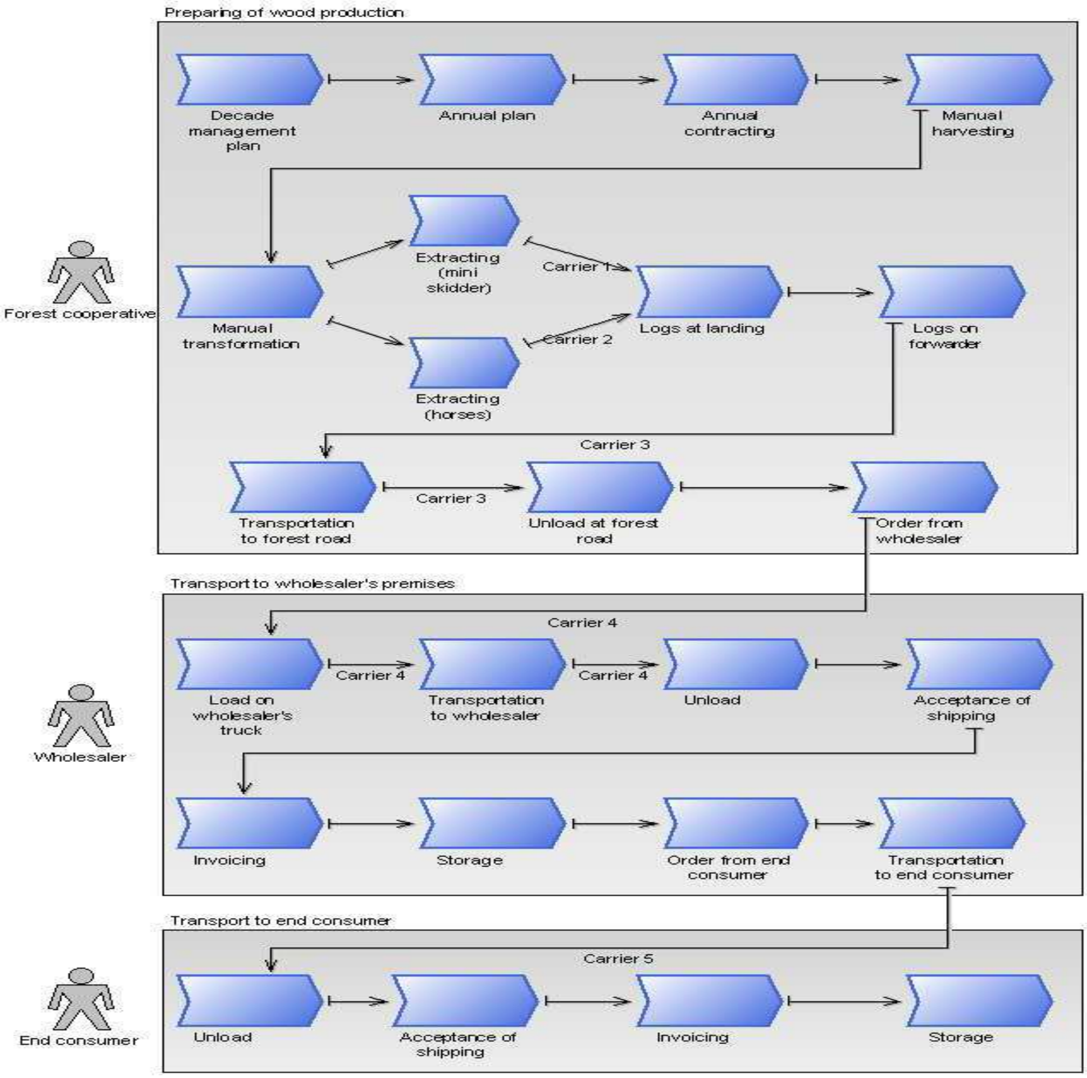
The domestic use of biomass

In W. Macedonia, oak, beech and Austrian pine forests are the dominant forest types. The main use of oak forests is the production of fuel wood and charcoal. Thus the quantities of the fuel wood produced by oak wood are greater than those produced by beech and other coniferous species (spruce, fir, pines). The prices of all the wood categories (long length round wood, fuel wood, etc.) produced and supplied by the state forest farms (sellers), are formatted within a free competition (in the wholesale market) among the buyers and is takes place by means of auctions organized by the Regional Forest Services within the framework of the state forest exploitation. The state forest farms organize auctions of the fuel wood in different parts of the Greek region. The mean annual prices of those auctions are the negotiation prices for the wood supply produced by non-state forestry, as well as / or wood cut, harvested, and transported by the Rural Forest Cooperatives.

Flow chart

- Manual harvesting by chain saw
- On the spot transformation (manually)
- Extracting by mini skidder or by horses (only firewood)
- Collection of round wood/ processed logs at landing
- Loading of round wood/ processed logs on forwarder

- Transportation to forest road
- Unload at forest road
- Load onto truck
- Transportation to storage space at wholesaler
- Unload at wholesaler
- Transportation to end consumer
- Unload at end consumer
- Storage at end consumer



8.3. France

8.3.1. *The la Môle wood energy platform*

The wood energy platform (la Môle)

The multiple vocation inter-communal association (SIVOM) for the Pays des Maures and the Saint-Tropez Gulf has initiated the creation of a forest biomass chain for the Maures Massif, on the basis that, for now, wood energy is an opportunity. The wood energy is indeed one solution to recycle forest residues from regional fire prevention works and to develop the Mediterranean forest. To succeed, the association has invested in a production tool (the platform) which responds to the existing market and assists in the development of a very local forest biomass chain, specific to the Maures Massif.

General information

Township : La Môle
Department : Var (83)
Territoire : Pays des Maures
Altitude : 20 m
Population : 2 000
Forest cover : 5 000 ha

Platform's characteristics

Total surface of the platform: 4 000 m²
Surface of the storage shed: 400 m²
Circulation and open air storage surface: 1 600 m²
Round wood storage surface: 2 000 m²
Wood chip storage volume: 1 600 SCM*
Number of rotations: 1
Type of structure: frame built with local timber
Commissioning: 2008
Weighbridge on site: yes
Other activities on the site: green waste composting

**stacked cubic metres*

Platform management

Maures Bois Energie

Maure Bois Energie is an association which aims to master all the jobs of the forest biomass chain (from supply to wood-fired heating plant maintenance).
At the same time, the local authority wants to control its initial investment by keeping an important decisional role in the association. The elected officials have thus chosen a specific kind of association (*association par collège*, in French) to exploit the platform. This association could evolve towards a cooperative structure (*Société Coopérative d'Intérêt Collective*, SCIC, in French).

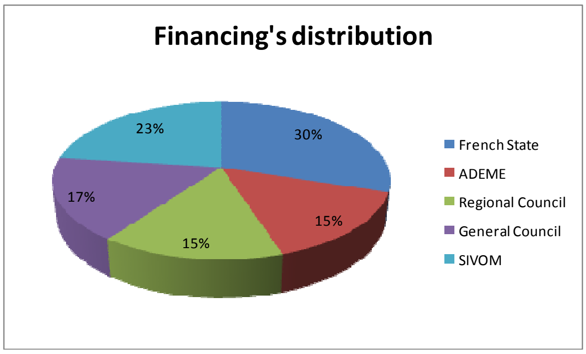
The supply and the sale of wood fuel

Nature: woodchips
Origin of the supply: the Maures Massif
Humidity: M20-M30 (humidity between 20 and 30 %)
Lower calorific power: 3 500 kWh/ton
Granulometry: P25 (maximum granulometry of 25 mm)
Annual territory consumption: 750 ton
Number of wood-fired heating plants supplied: 4 in 2010
Price of the wood fuel when it leaves the platform: cleaned wood chips* 76 € (before taxes); uncleaned wood chips 70 € (before taxes).

** The first cleaning eliminates bark and sap whereas the second cleaning eliminates the elements that can degrade the wood-fired heating plant (heavy wood…).*

The investment

Global investment	€ (before taxes)	
Accesses	77 000 €	28%
Earthwork	40 000 €	14%
Shed	103 000 €	37%
Common loader	40 000 €	14%
Supervision and studies	14 700 €	5%
Various	3 850 €	1%
Total for the wood platform	**278 550 €**	**100%**



• A part of the SIVOM's investment was financed by a bank loan.

• The pooling of a large amount of equipment with a storage platform (loader, weighbridge) allowed for crucial savings.

8.3.2. *The Barbentane's schools' wood-fired heating plant*

The Barbentane's schools' wood-fired heating plant

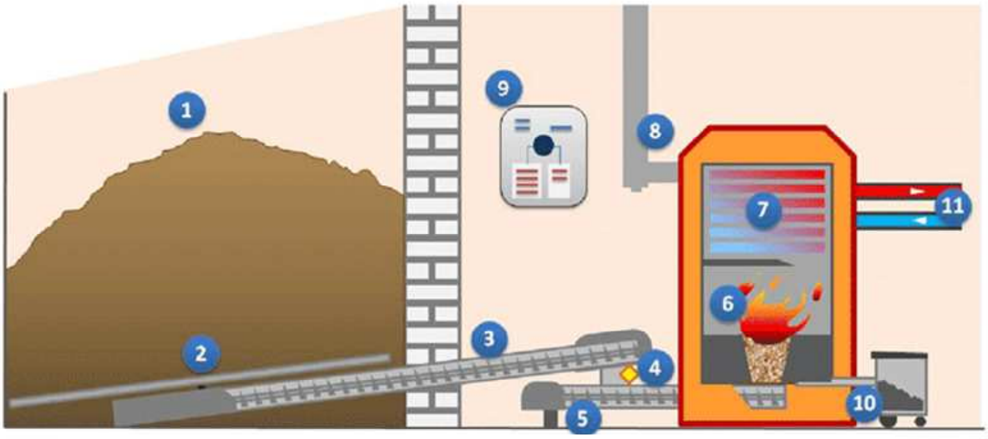
The city of Barbentane is located in the Bouches-du-Rhône. In 2011, the Municipal Council decided to build a wood-fired heating plant to heat the nursery and primary schools as well as several municipal halls. This project was very well accepted by the population.

General information

City : Barbentane
Department : Bouches-du-Rhône
Territory : Pays d'Arles
Altitude : 40 m
Population : 3 760
Forest cover : 960 ha

The wood-fired heating plant

Power : 100 kW
Type : volcano firebox
Commissioning : 2011
Alimentation : articulated arm and worm gear
Operation : automatic
Complement : gas
Use of heat : only heating



1. Silo
2. Articulated arm
3. Transfert screw
4. Stop fire system
5. Worm gear
6. Combustion chamber
7. Heat exchanger
8. Chimney
9. Regulation cupboard
10. Ash extractor
11. Heat for radiators, hot water or heating floor

The wood-fired heating plant supplies the nursery and primary schools of the township and several municipal halls.
Total heated surface : 2 577 m²
Total heated volume : 6 445 m^3

The supply

Kind : wood chips
Humidity : 25%
Lower calorific power : 3 500 kWh/ton
Annual consumption: 36 tons*
Volume of the silo : 30 m^3
Autonomy : 40 days (in winter)
Number of deliveries per year : 3*
Supplier : Energie Bois territoire

** Data for 2011/2012*

• This project brings important social, economic and environmental benefits.

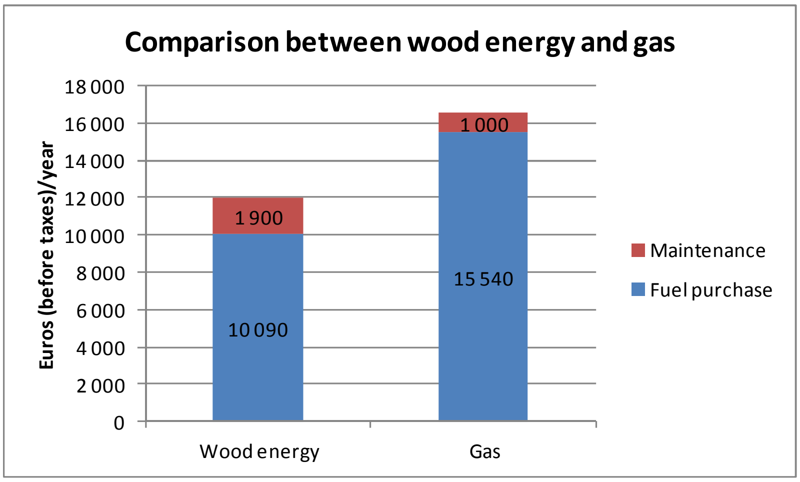
• In fact, for the same amount of consumption, the wood energy creates, on average, 4 times more local jobs than fossil fuels.

• From an environmental point of view, with a woodchip consumption of 36 tons per year, more than 22 tons of CO_2 is prevented from polluting the atmosphere each year.

Financial aspects

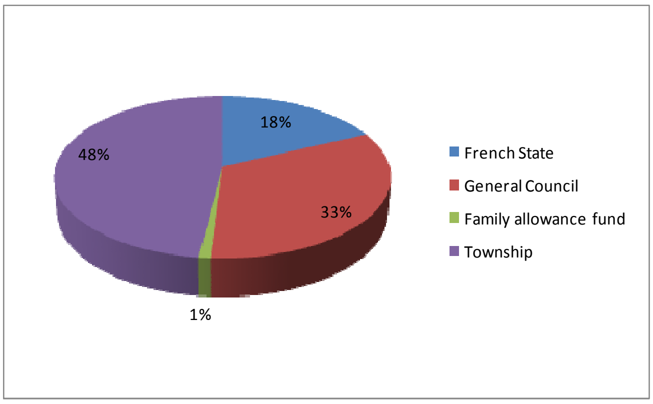
Each year, thanks to the wood energy (rather than using gas), the township saves **4 550 €**.
This may seem to be a small amount, but it is vital to small townships.

Wood-fired heating plant (€ including taxes)		**Reference solution (€ including taxes)**	
Wood for 0,026 €/kWh (2012)	3 550 €	Gas for 0,065 €/kWh (2012)	15 540 €
Gas (complement)	6 540 €		
Maintenance	1 900 €	Maintenance	1 000 €
Annual total	**11 990 €**	**Annual total**	**16 540 €**



The investment

Global investment	€ (before tax)	Percentage
Wood-fired heating plant	86 133 €	61%
Structural engineering	10 100 €	7%
Gas boiler (complement)	43 967 €	32%
Total investment	**140 200 €**	**100%**

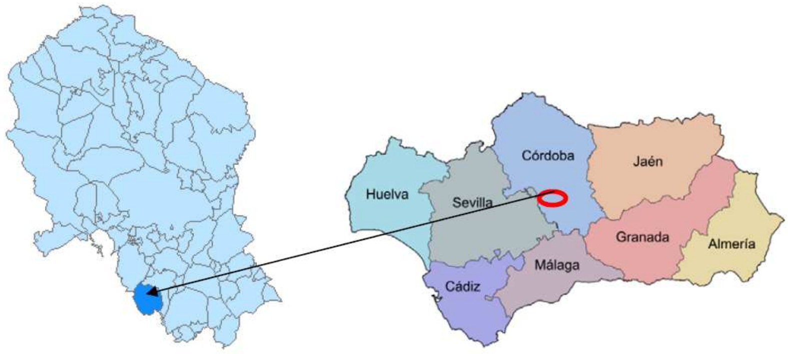


Funding distribution (for construction)

8.4. Spain: Integral olive-waste treatment with combined-cycle cogeneration and bio-mass-fuelled electricity generation. (Puente Genil,Córdoba)

Location

It is a project developed in Puente Genil, in the province of Cordoba (Andalucía, Spain).



Puente Genil Plant

It is an excellent example of the comprehensive utilization of biomass in the olive industry.

Built in 2005 by Valoriza Energía, S.L and Alvaro Espuny, S.L with a budget of 46 million Euros, was inaugurated in January, 2006. The plant has been in operation without interruption since then.

It has the capacity to incinerate 80.000 tons of olive marc every year. It is organized around three companies:

Secaderos de biomasa (SEDEBISA) is a company that develops activities related to the production of olive pomace from rests of the first extraction of oil from olives (called alperujo) and also to the drying process meant to obtain fat-free, dried pomace (called orujillo).

This includes storing the pomace (crushed pits and flesh) in basins and obtaining two types of olive pomace oil, from centrifugation and from the chemical extraction process.

Compañía Energética Pata de Mulo (CEPALO) is the cogeneration plant for drying alperujo. The combustion gases from the gas turbine, provides the necessary heat to dry it in order to get orujillo.

Biomasas de Puente Genil (BIPUGE) is dedicated to the exploitation of a biomass energy plant which is fuelled with orujillo, other agricultural waste and forestry biomass.

It basically consists of a boiler and a steam turbine of 9.8 MW.

Biomass

The initial idea was to make a biomass plant that was supplied with waste from the olive mill (alperujo) due to the fact that, in Andalucía, the olive industry is essential to the economy of the region.

Andalucía has nearly 1,600,000 olive trees that produce between 150,000 and 300,000 tonnes of alperujo per year.

In 2008, other types of biomass started to be used in order to improve both the productivity and the plant supply.

Agricultural waste (pruning, straw, strains, etc.) and gardening waste were incorporated as well as forest biomass since the Spanish regulatory framework started supporting forest biomass energy.

A policombustible is burned in the boiler. This policombustible is elaborated in the biomass plant and It is made of a mixture of different fuels. A specific fuel design has the objective of improving the energy efficiency, adapting to the seasonality of biomass used and improving air emissions and ash quality.

Currently it is being approximately employed as:

30% forest biomass

70% agricultural biomass

In late 2011, the process of "certification of the chain of custody" was completed, for a greater guarantee and transparency for the administration. The certification is audited annually.

Certification is a process that certifies the tour performing raw materials, processed materials and products from the forest to the final consumer, including all stages of the process: collection, transport, processing and distribution.

The objective of this "chain of custody" is that the end user of a product made of wood recognizes that the wood comes from FSC or PEFC certified forests, mixed in some cases with wood from forests, which, though not certified, meet the minimum requirements: legality and basic social and environmental responsibility.

Orujillo

Pruning

Olive leaves

Chips

Strains

Fine chips

Straw

Wood industry waste

Production

The Puente Genil Biomass Plant generates 70.000 MW / year, which requires an approximate consumption of 80.000 tons of biomass per year.

Environmental and socio-economic benefits

Apart from the benefits of using biomass as an energy source, the Puente Genil Biomass Plant has the upside of being a high-tech plant for the integral processing and waste-to-energy conversion of olive-oil industry by-products.

The liquid residue from the first extraction of oil is used, not only for the extra production of olive-oil products, but is also valued as a fuel (olive stones and alperujo).

It also means that pruning (necessary to maintain the productivity of the olive grove) has a waste-to-energy value.

The energy assessment of agricultural residues improves the olive industry profitability, allowing for further development and improving competitiveness of the sector.

Moreover, the mobilization of 24.000 tons of forest biomass for energy purposes is contributing to the improvement of the forestry sector, as it makes some forestry work needed in the forests of the region economically viable, which would not be the case without the possibility of it being employed as biomass.

Therefore, the use of forest biomass contributes to improving the productivity and stability of forests according to their management plans and it is also extremely beneficial as it enhances the protection against forest fires and pests.

At last, the combination of the valuation of agricultural and forest resources to produce electric power in Andalucía contributes to the economic development in the region, a policy objective of the convergence of the European Union.

8.5. Slovenia: Biomass boiler plants in the North Primorska Region

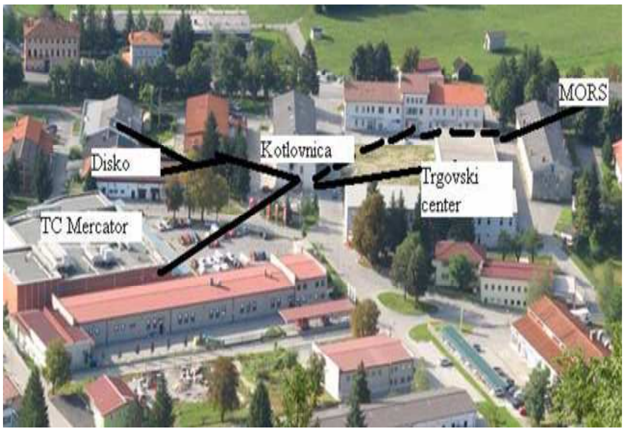
BIOMASS BOILER PLANTS IN SLOVENIA

Biomass boiler plants contribute to the local economy of the North Primorska Region

Rajko Leban (GOLEA)

The Podbrdo Retirement Home

The Podbrdo Retirement Home (during its construction in Petrovo Brdo) invested in a woodchip boiler in 2006 . The boiler's power is 220 kW. The investment was financed by their own financial sources.
In 2008, a micro district heating system was built for the Podbrdo Retirement Home, an apartment block and primary school. In the boiler plant, two woodchip boilers were also installed (500 kW and 110 kW).



The City of Tolmin Biomass Heating System

In 2013, the Tolmin Municipality invested in a biomass boiler plant as part of an initiative by the Cohesion Fund. The boiler plant is equipped with two biomass boilers (500 kW and 110 kW). The first one is a basic boiler and the second one meant for covering the pick consumption. The length of the grid is 377 m with 12 consumers connected to it. The annual heat consumption is up to 830 MWh and the specific heat flow is 2,189 kWh/m of grid pipe.

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

GORIŠKA LOKALNA ENERGETSKA AGENCIJA NOVA GORICA

The Postojna Biomass District Heating

The biomass district heating system in Postojna was built in two phases. In the first phase, the Comprehensive music school replaced the its oil boiler (500 kW) with a biomass one. The investment, including the boiler house, cost 626,500 EUR. In Postojna, a new biomass boiler plant was implemented by the private biomass processing company Javor Pivka. The boiler plant installed has a heating power of 1.95 MW. The following consumers are connected to the boiler plant: a hospital, a comprehensive school center and the Javor Pivka company.

In the second phase, the new boiler plant in Postojna was built:

- a boiler plant (1,5 MW) with a heat storage tank;
- the length of the grid is 800 m;
- 2.8 GWh/a of heat distributed and sold;
- 5 public buildings connected to the grid.

8.6. Portugal: São Brás de Alportel indoor swimming pool complex

BIOMASS HEAT SYSTEM

SÃO BRÁS DE ALPORTEL INDOOR SWIMMING POOL COMPLEX

Recently, societies have observed an increase in swimming pool demands as the population is being encouraged to take part in sport and recreational activities while also taking advantage of the therapeutic benefits found in such facilities, therefore, resulting in a significant growth in the pools in operation in recent years.

The energy evaluation of this kind of building should take a variety of factors into account such as the economic / financial context, energy efficiency and operational costs.

The São Brás de Alportel District (map below) Indoor Swimming Pool building ,with a total area of 2,300 m^2, has a sports pool (25,0m by 12,5m) and a “learning pool” (12,5m by 6,0m).

São Brás de Alportel
(municipality)

Area: 150 km^2
Population :10.600
Forested area : 9750 ha
Main species: *Quercus suber, Arbutus unedo, Quercus rotundifolia*

Given the current economic context, the successive oil price rise and growing environmental concern, the sustainability of the swimming pool complex is a major concern of the São Brás de Alportel Municipality.

To face this challenge, a heat production system, based on forest biomass was adopted.

Heating needs
(swiming pool complex)

Interior climatization (total air volume - 9990 m^3)

Sanitary hot water heating

- Competition pool (800 m^3 volume);
- “Learning” pool(100 m^3)
- Bath water accumulation pools (7000 liters)

Med L'Europe en Méditerranée Europe in the Mediterranean
Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

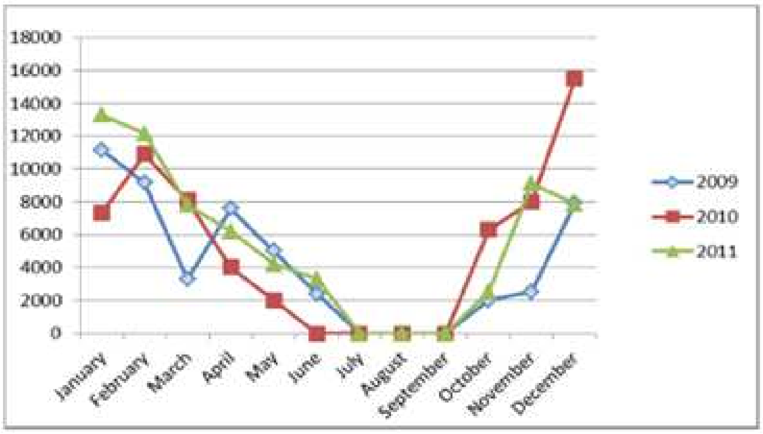
BIOMASS HEAT SYSTEM

SÃO BRÁS DE ALPORTEL INDOOR SWIMMING POOL COMPLEX

Initial situation

The heating was assured by 126 solar panels installed on the roof (left photo). The auxiliary heating mechanism came in the form of two diesel boilers (Die Dietrich GT339) with an installed power of 280 kW each (right photo). There is also an accumulation deposit of 4000 l (heated by the solar panels) and another one (with 3000 l) that works in cascade with another for bath water heating (lower right photo)

A normal operation is based on the use of one diesel boiler in service while the other is kept as a reserve with a switch being made from time to time. According to the data records, each boiler has a nominal power of 280 kW and has been meeting the maximum power demands.
The variation throughout the year in diesel consumption has had a clear seasonal behaviour either due to weather conditions or due to the annual operation schedule, as in the months of July, August and September the swimming pool is closed (graph below).



Diesel Consumption (liters)

BIOMASS HEAT SYSTEM

SÃO BRÁS DE ALPORTEL INDOOR SWIMMING POOL COMPLEX

Present situation

The current system consists of the substitution of one of the diesel boilers with a biomass one (minimum lower heating power of 3000 kcal/h) fed constantly by a system using water as the transport fluid (at a maximum temperature of 109ºC). This system consists of a series of components:

350 kW Power Boiler

The combustion chamber is coated with refractory concrete and built within the boiler. This solution creates very good conditions for the fuel and combustion air blend and also for the stable combustion temperature. The boiler allows for the combustion of wood with a maximum hash content of 4 % and a humidity content lower than 30 %.

Hash depurator

The hash depurator consists of three parts: a gas entrance, centrifugal separator body and hash collector hopper with a bucket. The separator body is formed by a swirl tube type with several wings that projects the particles into the periphery, reducing their speed and forcing them into the bucket.

Ventilator

The ventilator vacuums the smoke gases and pushes them out the chimney. This provokes a depression in the combustion chamber, forcing an automatic admission of air, needed by the combustion process. The ventilator has a 2.2 kW / 3 CV / 3000rpm motor, a motor group formed by an electric engine and a turbine, an exhaust conduct and a motorized valve for depletion control .

Air In Breath Cistern

The air in breath systems allow the regulated air entrance to the combustion chamber of the boiler, which consists of: a ventilator with a 1.1 kW / 1.5 CV / 3000rpm motor and motorized butterfly valves for combustion control.

BIOMASS HEATING SYSTEM

SÃO BRÁS DE ALPORTEL INDOOR SWIMMING POOL COMPLEX

Present situation

The current system consists of the substitution of one of the diesel boilers with a biomass one (minimum lower heating power of 3000 kcal/h) fed constantly by a system using water as the transport fluid (at a maximum temperature of 109ºC). This system consists of a series of components:

Chimney

The chimney privides the smoke with an outlet to the atmosphere and measures in a a height of 15 meters and a diameter of 250 mm

Automatic Feed System

The automatic feed system consists of a constantly functioning system that receives fuel from the silo, activated by a 1,5 kW/2CV engine and another constant double entrance metering that loads the fuel into the combustion chamber of the boiler.

Pre-built Silo with Mobile Floor Discharge

The silo has a capacity of 24 m3. The bottom of the silo consists of a set of mobile and push-pull type, fixed knives that allow the feul to be loaded into the continual transport system. It is equipped with a two cylinder activated cover that allows the deployment of large bags of biomass

BIOMASS HEATING SYSTEM

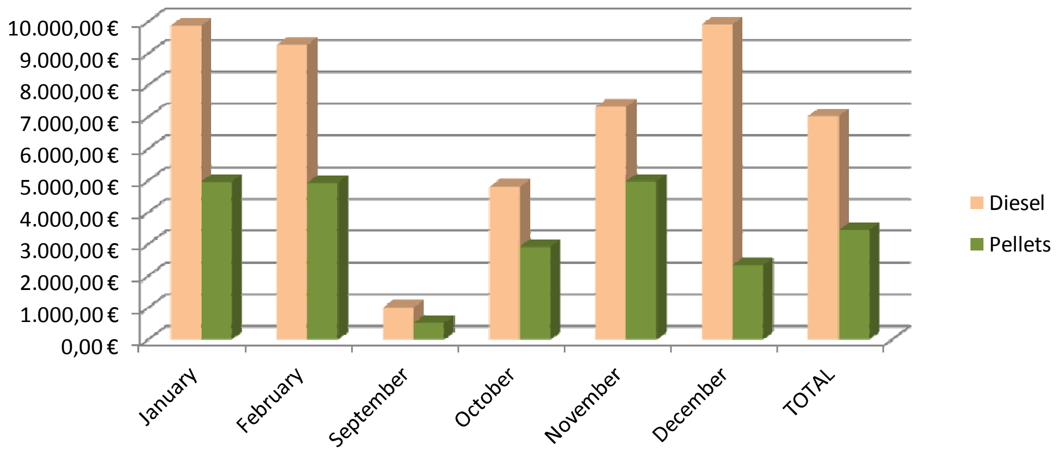
SÃO BRÁS DE ALPORTEL INDOOR SWIMMING POOL COMPLEX

Present situation

Consumption analysis

Month	2009 Consumption (l)	2009 Value (€)	2010 Consumption (l)	2010 Value (€)	2011 Consumption (l)	2011 Value (€)	2012 Consumption (l)	2012 Value (€)	2013 Consumption (l and kg)	2013 Value (€)	2014 Consumption (kg)	2014 Value (€)
January	11150	7.021,35 €	7300	5.410,00 €	13300	12.725,00 €	11200	14.336,00 €	10400	13.658,00 €	22425,37	4.964,98 €
February	9150	5.790,05 €	10900	7.987,50 €	12150	11.678,25 €	9000	11.655,00 €	4500	5.875,50 €	22271,64	4.930,94 €
March	3277	1.971,15 €	8100	6.230,70 €	7800	8.130,30 €	15500	19.910,50 €	7600	10.109,35 €		0,00 €
April	7600	4.854,20 €	4000	3.264,00 €	6200	6.670,70 €	8000	10.612,50 €	4060	5.267,74 €		0,00 €
May	5000	3.190,00 €	2000	1.660,00 €	4200	4.410,00 €	8600	10.754,70 €	6300	7.928,52 €		0,00 €
June	2410	1.578,55 €	0	0,00 €	3300	3.150,00 €	1000	1.269,00 €	(Last diesel refuel May 2013 - Pellets begin Sep.2013)			0,00 €
July	0	0,00 €	0	0,00 €	0	0,00 €	0	0,00 €				0,00 €
August	0	0,00 €	0	0,00 €	0	0,00 €	0	0,00 €				0,00 €
September	0	0,00 €	0	0,00 €	0	0,00 €	3000	4.050,00 €	2351,47	520,61 €		0,00 €
October	2000	1.340,00 €	6300	5.415,60 €	2500	2.647,50 €	7300	9.824,00 €	13207,42	2.924,12 €		0,00 €
November	2500	1.800,00 €	8000	6.990,00 €	9100	9.921,10 €	8000	10.560,00 €	22472,00	4.975,30 €		0,00 €
December	7915	6.205,00 €	15500	14.933,40 €	7900	8.615,00 €	Pool closed Dec.2012		10553,60	2.336,57 €		0,00 €
TOTAL	**51002**	**33.750,30 €**	**62100**	**51.891,20 €**	66450	**67.947,85 €**	71600	**92.971,70 €**	**48584,49**	10.756,61 €	**44697,01**	**9.895,92 €**
									(Peletes)			

DIESEL
PELLETS



9. References/Literature

9.1. SWOT analysis and introduction

- Anastácio, Dina; Santos, Cristina; Leite, António. "Enquadramento na política florestal nacional da valorização da biomassa florestal como energia alternativa". Lisboa.
- Carneiro, Maria. *Avaliação económica da biomassa para produção de energia*. Universidade do Minho. Braga. 2010. 66 - 77.
- Ministerio de Agricultura, Alimentación, y Medio Ambiente - Gobierno de España. "Plan de Activación Socioeconómica del Sector Forestal 2014-2020". *EUMEDIA*. October 2013. Web. 16 December 2013. <http://www.eumedia.es/portales/files/documentos/PAcEcForestal.pdf>
- Proforbiomed Project. *Promotion of Residual Forestry Biomass in the Mediterranean basin. Setting up of Integrated Strategies for the Development of Renewables Energies. Situation Report on Forest Biomass use in the Mediterranean Region. Wood biomass potentials, production and use - State of the art report.* Ljubljana, January 2012. Print and web.

9.2. How to identify a "forest region" with high potential for the implementation of a FBC

- ADEME. Le Bois énergie et la qualité de l'air, Note de synthèse. Jul 2009.
- ADEME. Etat de l'art de la réglementation européenne sur la valorisation des déchets de bois et des cendres de bois, SYNTHESE. Nov 2007.
- AFN, 2010. Inventário Florestal Nacional - Portugal Continental (2005 - 2006). Autoridade Florestal Nacional. Lisboa. 2010.
- AFOCEL. La récolte raisonnée des rémanents en forêt, Guide pratique. April 2005.
- AIEL - Associazione Italiana Energie Agroforestali. Progetto per la realizzazione di piattaforme biomasse logistico-commerciali in Regione Friuli Venezia Giulia. Legnaro (PD): AIEL, 2007. Print.
- AIEL - Associazione Italiana Energie Agroforestali, TeSAF - Università degli studi di Padova, Unità di Progetto Foreste e Parchi della Regione del Veneto. Settore biomasse legnose. Energia termica ed elettrica. Ruolo delle biomasse legnose agroforestali per il raggiungimento degli obiettivi al 2020 del PAN per le FER in Regione del Veneto. Legnaro (PD): AIEL, 2011. Print.
- ALGAR. Evaluation of economic, environmental and social returns on the heating system replace diesel burners with biomass at the São Brás de Alportel District Indoor Swimming Pool. ENERTASK - Expert Energy Advisory. Gesto Energy. Faro. 2013.
- Andrade, André; Lopes, Gabriel. Planeamento e Produção de Electricidade - Biomassa. Faculdade de Ciências e Tecnologia da Universidade de Coimbra. Coimbra

- AREAL - Agência Regional de Energia e Ambiente da Região do Algarve. Avaliação do Potencial de Biomassa da Região do Algarve. Projecto ENERSUR. INETI - Instituto Nacional de Engenharia, Tecnologia e Inovação. I.P. Faro. 2006.
- "Arrêté du 23 juillet 2010 relatif aux chaudières présentes dans les installations de combustion d'une puissance thermique supérieure ou égale à 20 MWth autorisées ou modifiées à compter du 1er novembre 2010". Journal Officiel de la République Française 0214 (15 sept 2010).
- "Bois-énergie. Les forêts ont de la ressource … à mobiliser !!", L'IF (supplément d'IGN magazine) 24 (Jan 2010).
- Campilho, Pedro. Avaliação do Potencial Nacional para o Aproveitamento de Biomassa Florestal para Fins Energéticos. Universidade Nova de Lisboa. Lisboa. 2010.
- Cabrera Bonet, Miguel. Methodology for the Design of Forest Inventory by the Use of Specific Software, for the Elaboration of Forest Biomass Management Plans in the Murcia Region. Murcia: Proforbiomed, March 2013. Print and Web.
- COA Energia, AIEL, IPLA. Studio delle potenzialità della filiera legno energia in Valle d'Aosta. Valle D'Aosta: COA Energia, 2013. Print.
- "Comment les CRPF s'impliquent-ils dans la contribution au développement des filières bois énergie ?" Forêt entreprise 206 (sept 2012): 54-59.
- Corentin LEVESQUE, Patrick VALLET, Christian GINISTY, Biomasse forestière disponible pour de nouveaux débouchés énergétiques et industriels - Partie 1: Analyse et synthèse des études existantes recensées au niveau national. Oct, 2007.
- Direction Générale de l'Energie et du Climat. Biomasse énergie, Définition et technologies existantes, L'industrie des énergies décarbonées en 2010. 2011.
- Diputación de Cádiz - Agencia Provincial de la Energía: TIMBER Project. "Análisis del Potencial de Biomasa de la Provincia de Cádiz con Fines Energéticos". Power Legacy. Web. 16 December 2013 www.powerprogramme.eu
- Ferreira, João; Ferreira, Manuel. Portugal - Pellet Report. ANPEB - Associação Nacional de Pellets. Universidade do Minho. Guimarães. 2011.
- Francescato, et al. Legna e cippato, produzione, requisiti qualitativi e compravendita. Legnaro (PD): AIEL - Associazione Italiana Energie Agroforestali, 2009. Print.
- Francescato, et al. Creazione del Sistema Informativo Territoriale per il monitoraggio delle filiere legno-energia nella regione Friuli Venezia Giulia. Legnaro (PD): Progetto PROBIO Woodland Energy, 2006. Print.
- Kaltschmitt, Martin, et al. Energie aus Biomasse. Grundlagen, Techniken und Verfahren. 2. Auflage. New York: Springer Heidelberg Dordrecht London, 2009. Print.
- "Le rôle écologique des rémanents de coupe" Info DFCI 68 (June 2012): 4.

- Ministerio de Industria, Energía y Turismo and IDAE. Informe de Precios Energéticos: Combustibles y Carburantes. Datos a 26 de Agosto del 2013. Secretaría General: Departamento de Planificación y Estudios, 2013. Web.
- Miñaña Mira, José Luis. Design of the Forest Inventory Methodology with the LIDAR Application to the Forestry Management Project of V095 "Sierra Negrete" Forest in the Region of Valencia. Valencia: Proforbiomed, November 2012. Print and Web.
- Netto, C. Potencial da biomassa florestal residual para fins energéticos de três concelhos do distrito de Santarém. Universidade Nova de Lisboa. Faculdade de Ciências e Tecnologia. Departamento de Ciências do Ambiente. Lisboa. 2008.
- Observatoire de la Forêt Méditerranéenne. Données et chiffres clés de la forêt méditerranéenne (en PACA), 2012. 2013.
- ONF. Achetez votre bois chez ceux qui le connaissent le mieux. 2013
- Páscoa, F. PBravo v.2.0. Modelo de produção para o pinheiro-bravo. Federação dos Produtores Florestais de Portugal. Lisboa. 2001. 47.
- Proforbiomed Project. Promotion of Residual Forestry Biomass in the Mediterranean basin. Setting up of Integrated Strategies for the Development of Renewable Energies. Situation Report on Forest Biomass use in Mediterranean Region. Wood biomass potentials, production and use - State of the art report. Ljubljana, January 2012. Print and web.
- Sainz, R.; Garcia, E.; Bachiller, A.; Alonso, J.; Gomez, L.; González, G. "Pinea2: Un modelo integrado para la gestión de las masas regulares de Pinus pinea L. en la Meseta Norte". Actas de la II Reunión sobre aspectos prácticos de la Modelización Forestal. 2007. 147 - 152.
- Tomé, Margarida; Oliveira, Tânia; Soares, Paula. O modelo Globulus 3.0. Dados e equações. Instituto Superior de Agronomia. Lisboa. 2006.
- Union régionale des Communes forestières PACA. Charte qualité bois déchiqueté PACA. 2013.
- Union régionale des Communes forestières PACA. Les plateformes bois énergie avec hangar de stockage. 2011
- Slovenian Forest Service. January 2014. <http://www.zgs.si/eng/events/index.html>.
- Zavod za gozdove Slovenije. "Caring for the Forest to Benefit Nature and People". 2005. Slovenian Forest Service. Web. 10 January 2014 <http://www.zgs.si/fileadmin/zgs/main/img/PDF/PDF_BROSURE/Brosura_ANGL.pdf>
- Rudi Drigo, Zivan Veselic. "WISDOM Slovenia". 2003. Ministry of Agriculture, Forestry and Food. Republic of Slovenia, Slovenia Forest Service. Web. 10 January 2014. <http://www.zgs.si/fileadmin/zgs/main/img/CE/biomasa/BIOMASA_ANG_PROJEKTI/Wisdom_Slovenia.pdf >
- Andrej Grum, Rudi Drigo. "Potenciali lesne biomase in moznosti za aktiviranje lastnikov gozdov". June 2011. Slovenian Forest Service. Web. 10 January, 2014. <http://www.google.si/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=5&cad=rja&ved=0CDwQFjAE&url=http%3A%

2F%2Fwww.afo.eu.com%2FGetItem.asp%3Fitem%3Ddigistorefile%3B302469%3B1303%26params%3Dopen%3Bgallery&ei=oBf6UrfhE6rnywPb3IDICg&usg=AFQjCNHZDp1PJC4DIUwwaDlLEYBwvd4m4Q >

- AURE. "Projekt GEF Biomasa". 2002. Web. 10 January, 2014. <http://www.aure.gov.si/index.php?MenuID=114&MenuType=E&lang=SLO&navigacija=on>
- Statistični urad Republike Slovenije. Statistical Yearbook 2013. 2013. Web. 10 January, 2014. <http://www.stat.si/letopis/letopisprvastran.aspx>
- Revija Varčujmo z energijo. "Primerjava cen energentov, končne in koristne energije". Boštjan. 8.06.2011, Web. 10 February, 2014. <http://varcevanje-energije.si/informacije/primerjava-cen-energentov.html>

9.3. Strategies for developing the biomass clusters/consortium

- Comissão de Coordenação e Desenvolvimento Regional do Algarve. Algarve*. Estratégia de Desenvolvimento (2007 - 2013)*.Faro. 2006.
- Suf IDF - CNPF. Fiche Facteurs de réussite pour la mise en place d'une structure d'approvisionnement en bois énergie en circuit court. 2012.
- Porter, Michael E. *The Competitive Advantage of Nations*. New York: Free Press, 1990.
- Yannis Fallas. May 2012. PROFORBIOMED Project. Work Package 3: PROMOTION OF RESIDUAL FORESTRY BIOMASS IN THE MEDITERRANEAN BASIN. CLUSTERS REPORT. University of Western Macedonia

9.4. Strategies for triggering investments and matching both offer and demand (public and private stakeholders) at the local level

- Anja Kostevšek, Leon Cizelj, Janez Petek. Aleksandra Pivec. "A novel concept for a renewable network within municipal energy systems". *Renewable Energy 60* (2013): 79-87. Print.
- Anja Kostevšek, Janez Petek, Lidija Čuček, Aleksandra Pivec. "Conceptual design of a municipal energy and environmental system as an efficient basis for advanced energy planning". *Energy 59* (2013): 1-11. Print.

9.5. Environmental requirements of biomass installations

- Francescato V. "Combustione del legno e polveri fini, fattori di emissione ed effetti sulla salute delle moderne caldaie di piccola e media taglia." *Sherwood* May 2007,Italian ed.: 133. Print.

- Kaltschmitt, Martin, et al. *Energie aus Biomasse. Grundlagen, Techniken und Verfahren. 2. Auflage*. New York: Springer Heidelberg Dordrecht London, 2009. Print.
- Nussbauer T., et al. *Particulate emissions from Biomass Combustion in IEA Countries, survey on measurements and emission factors*. Zürich: on behalf of IEA Task 32 and Swiss Federal Office of Energy, 2008. www.ieabcc.nl or www.verenum.ch.
- Schwarz, Markus. *Argumentazionsleitfaden Feinstaub*. Wieselburg: Austrian Bioenergy Centre GmbH, 2006. Print.

9.6. Socio-economic acceptability of biomass installations

- Assemblée nationale (France). Rapport d'information déposé [...] par la mission d'information sur la biomasse au service du développement durable. Paris: Assemblée nationale, 2013
- CREDOC. "Les propriétaires forestiers sont attachés à leur patrimoine mais peu motivés par son exploitation commerciale" *Consommation et Modes de Vie* 228 (April 2010).
- Gouvernement français. Rapport énergie 2050 - Rapport du groupe de travail présidé par Jacques Percebois. Paris, 2012.
- Zelem, Marie-Christine. "Les énergies renouvelables en transition: de leur acceptabilité sociale à leur faisabilité sociotechnique". *Revue de l'Energie* (December 2012).

9.7. Development of common approaches to integrate the recommendations into mainstream policies

- Agence pour le développement durable de la région nazairienne. Vues d'Estuaire, Tout sur le Grenelle de l'environnement. 2010. Print.
- Préfecture de la Région Provence-Alpes-Côte d'Azur. Rencontres régionales pour l'avenir du bois - Compte-rendu de l'atelier thématique « Valorisation complète du bois ». Gardanne, 2013.
- Préfecture de la Région Provence-Alpes-Côte d'Azur. Rencontres régionales pour l'avenir du bois - Diaporama de l'atelier thématique « Valorisation complète du bois ». Gardanne, 2013.
- Rayssac, Gilles-Laurent, and Christian de La Guéronnière. Guide de la concertation locale, pour une meilleure définition du "vivre ensemble" au niveau local. Lettre du cadre territorial, Feb. 2006.

9.8. Appendix: Good Practice

- Consejería de Economía, Innovación y Ciencia: Agencia Andaluza de la Energía. *La Biomasa en Andalucía. AAE*, September 2011. Web.
- ENCROP. *Best Practice Business Models for Bio-energy Success Stories. ENCROP*, March 2009. 26-37. Print and Web.
- InfoPOWER. *An Exclusive Plant Report: Integral Olive-Waste Treatment & Reduction with Combined-Cycle Cogeneration and Biomass-Fuelled Electricity Generation in Puente Genil (Córdoba, Spain). InfoPower*, October 2006. Print and Web.
- Mission régionale Bois énergie Provence-Alpes-Côtes d'Azur. "Chaufferie des écoles de Barbentane (13), Référentiel des chaufferies bois énergie en Provence-Alpes-Côte d'Azur". Fiche technique n°13/440. June 2012.
- Mission régionale Bois énergie Provence-Alpes-Côtes d'Azur. "Plateforme bois-énergie de la Môle (83), Référentiel des plateformes bois énergie en Provence-Alpes-Côte d'Azur". Fiche technique n°01. June 2012.
- Requena, Virginia. "Podemos abastecer de energía de la biomasa a 1.800 hogares cada hora". *ABC Córdoba: Balance y Negocio*, 3 November 2009: 38. Web edition.