Regional Profile of the Biomass Sector in *Greece*

Authors:

Chrysovalantis Ketikidis

Maria Christidou

Petros Dallas

Panagiotis Grammelis

Yannis Fallas

Ptolemais, July 2013

Contents

1 Introduction

The Greek electricity production system has been developed on the principle of utilising indigenous energy sources from 1960. Therefore, lignite fired power plants and hydroelectric power stations cover the electricity demand of the interconnected system in the mainland while the numerous islands are covered by oil fired autonomous power stations.

Electricity in Greece is mostly produced from indigenous lignite (63% in 2000). Natural Gas appeared in electricity generation for the first time in 1998, following the gas pipeline interconnection of Greece with the network of Eastern Europe, whereas its share is expected to rise considerably in the following years.

However, there is a great potential for the development of RES in Greece: according to Law 3851/2010 (in the adoption of specific development and environmental policies set by Directive 2009/29/EC), the national target for participation of RES in final energy consumption comes up to 20%, which is further analyzed in 40% proportion of renewable in electricity generation, 20% in heating and cooling needs and 10% in transport.

Today the total gross energy consumption in Greece is estimated at 22.4 Mtoe. According to the Greek Ministry of Environment, Energy and Climate Change, bioenergy in 2010 held approximately 9% of total consumed energy (biomass and biofuels are, together, about 5% of total).

2 Condition and structure of regional/national forests

Table 1: Land use in Greece (Source: Δασική Υπηρεσία και ΕΣΥΕ, forest service and National Statistical Service of Greece)

Land use	ha	%
Forests	2.512.418	19.0
Other wooded land/ Shrubland	3.242.140	24.6
Pastures	2.472.878	18,7
Water	272.862	2,1
Barren land	734.851	5,6
Arable land	3.963.850	30
Total country	**13.198.999**	**100**

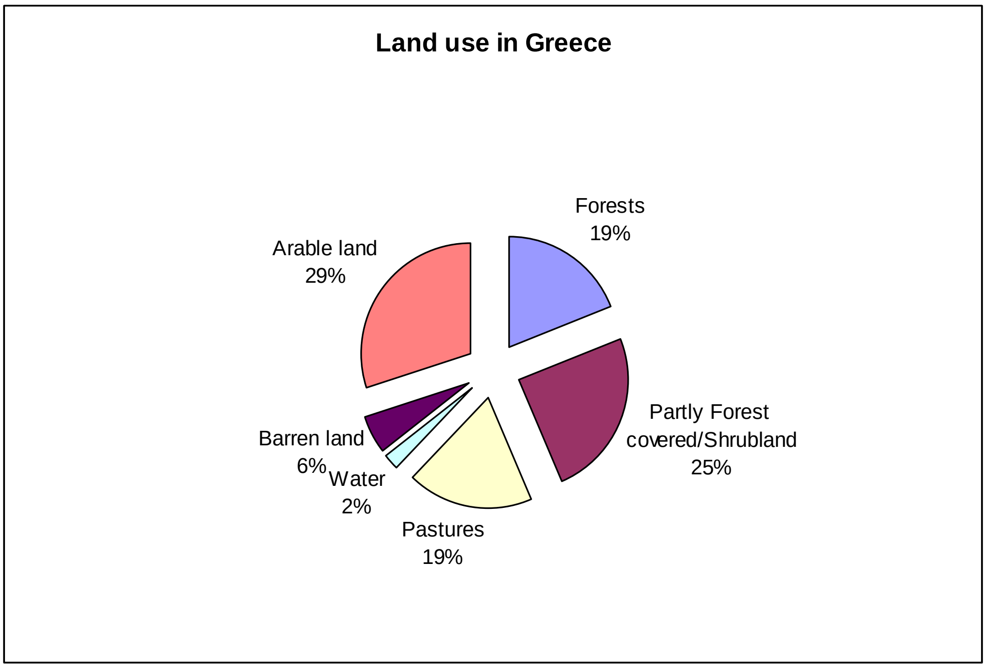
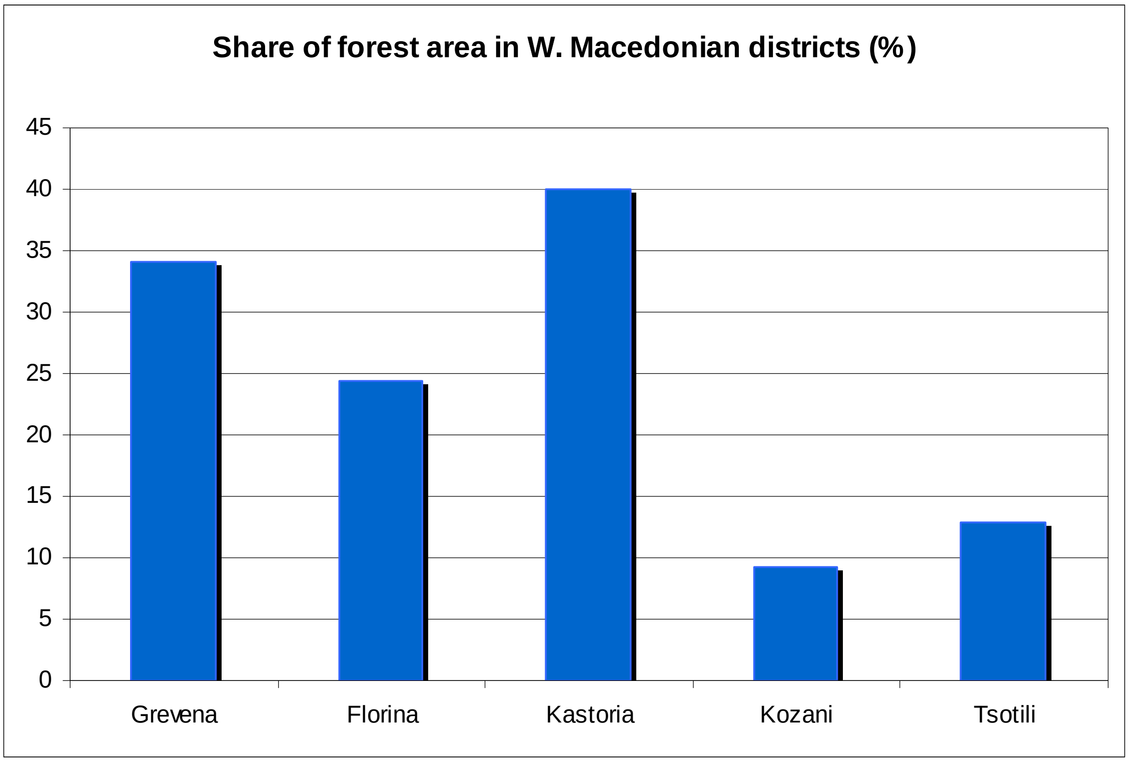


Table 2: Silvicultural species in Greece

Silvicultural species in Greece	ha	%
A. Conifers		
1. Fir, Spruce	329.762	13,1
2. Pinus halepensis, Pinus brutia Ten.	475.777	18,9
3. Pinus nigra	137.047	5,5
4. others	23.787	0,9
Total conifers	**966.373**	**38,4**
B. Broadleaves		
5. Oak	747.549	29,8
6. Beech	219.070	8,7
7. others	101.765	4,1
8. Forest understory (bushes and small diameter trees)	477.661	19
Total braodleaves	**1.546.045**	**61,6**
Total	**2.512.418**	**100**



The region of Western Macedonia is divided into 5 forest districts: Kozani, Tsotyli, Grevena, Kastoria and Florina. **The forests cover 228.179 ha or 23% of the total area**. Most of the forests exist in Kastoria and Grevena district and the least in the combined area of Kozani and Tsotyli.

Table 3: Forests in W. Macedonia

Forests in W. Macedonia	Share (%)
Grevena	34.07
Florina	24,37
Kastoria	40,00
Kozani	9,26
Tsotili	12,88

Greek forests in terms of productivity

The Greek forests as regards their productivity are divided into three categories:

- Category 1: productive forests (productivity 3 - 5m^3 per year per ha), mainly comprised of conifers, which are subject to systematic and intense exploitation. These forests cover 21.07% of the surface of the country's forests

- Category 2: middle range productive forests (productivity 1 - 3m^3 per year per ha, mainly comprised of broadleaves (oak, beech, but also pines, firs). The reduced productivity is due to human interference (pasturage, excessive exploitation) and natural causes (erosion). These forests cover 59.87% of the surface of the country's forests
- Category 3: low range productive forests/forest understory (bushes and small diameter trees, also called "evergreen broad-leaved brushlands"), which occur at low altitudes with a very low productivity (productivity 1m^3 per year per ha). These forests cover 19.06% of the surface of the country's forests

Forest productivity

The annual increment is ca. 1.2m^3/ha or 1.6% of the total growing stock.

2.1 Geography and topography

The appearance and growth form of the vegetation is greatly influenced by the topography of the area. The slope and the aspect play a decisive role on site quality along with the historic and the prevailing demographic and economic conditions of the area.

The above mentioned features play an important role on the appearance of a variety of microenvironments and, consequently, on a great number of natural forest types.

These forests present in general a natural irregularity and often mixtures of different species, conifers and broadleaves as well. The vegetation zones become frequently vague, whereas the inversion of the vegetation zones is not an unusual phenomenon, as it is clearly expressed by the "ecological counterbalance law".

Conifers extend in almost all altitudes; from sea level up to the timberline. The evergreen broad-leaved brushlands and forests occupy the lower areas, while the forests consisting of deciduous broad-leaved species along with a variety of mixed forests cover the slopes of the mountains in a considerable part of the country.

2.2 Forest condition

The basic principle, upon which the management of the Greek forests relies on, is the principle of sustainability, in the form of providing perpetually equal volumes, annually or periodically. However, before this principle became valid, two other principles must be applied: a) the principle of preservation of the forest as an ecosystem, and, b) the principle of conservation and improvement of soil productivity.

Greek forests today suffer from wildfires and, sometimes, from overgrazing, despite being protected by many laws and the Greek Constitution. Nevertheless, many forests in Greece, even coppice ones, seem to have been improved, especially in areas where overgrazing and other irrational human activities have ceased over the last years.

The Greek forests, as already pointed out, are characterized from an irregularity, as a result of the site variability in small areas and their inappropriate use in the past. This irregularity, which is usually accompanied by a poor quality composition, creates many silvicultural and management problems.

Mixed stands are of special ecological and aesthetic value and, especially, the uneven-aged stands composed of broadleaves and conifers.

The priorities of silviculture in Greece are set as follows:

- The maintenance of the existing high forests in the most appropriate species composition and stand structure.
- The rehabilitation of the degraded high and coppice forests with special care in the conversion of the coppice forests.
- Reduction, to the extend possible, of cut to growth ratio, aiming at a better ecological and economic result. The best economic result will come out from the future higher prices of wood products, while the ecological one from the deposition of large amounts of carbon dioxide (CO2) and the achievement of a better bioecological balance.
- The prohibition of clear-cuttings in coppice forests. Clear-cuttings are prohibited in high forests in Greece but not in coppice ones. However, an effort of converting oak and beech coppices into high forests has begun many years ago. The first results are very optimistic and the application of the acquired knowledge and experience towards a better result is a political choice. The oak and beech coppices are more than one third of the Greek forests.
- The use of natural regeneration. The Greek forests are naturally regenerated. This happens relatively easily and is accompanied by a number of advantages: the maintenance of the existing indigenous forest species and provenance, the formation of stands with a desirable composition and structure (which ensures ecological balance and stability), and a network of habitats which is very important for maintaining the biodiversity.
- The conservation of characteristic natural forests of special interest. Some forests in Greece are under protection with special laws while others are about to be placed within the frame of the "Natura 2000" network. These forests are expected to play a multi-functional role in accordance to the modern ideas of the forestry science and the future social demands as well.

2.3 Forest ownership structure

Forests in Greece cover 25.4% of the country's total area (3.359 thousand ha). Of these, approximately two thirds (65.5%) belong to the state and the remaining 34.5% belong to private entities, local authorities, monasteries, and other welfare institutions.

Table 4: Forest ownership in Greece

Forest ownership in Greece	ha	%
State	1.644.005	65,5
Municipality properties	301.527	12
Church	109.946	4,4
Welfare institutions	11.225	0,4
Joint ownership	245.845	9,7
Private	199.870	8
Total	**2.512.418**	**100**

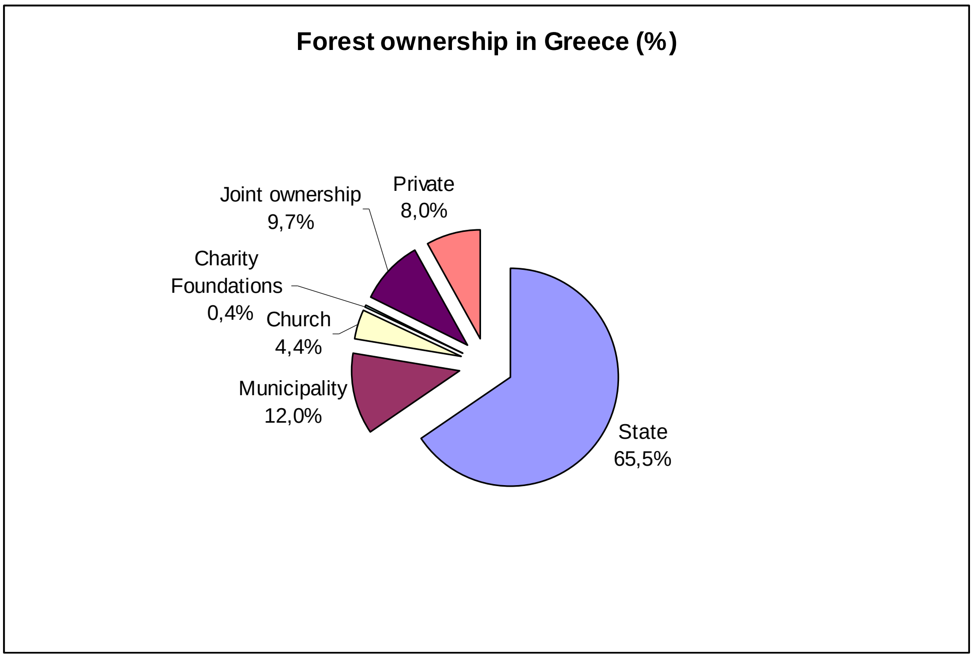
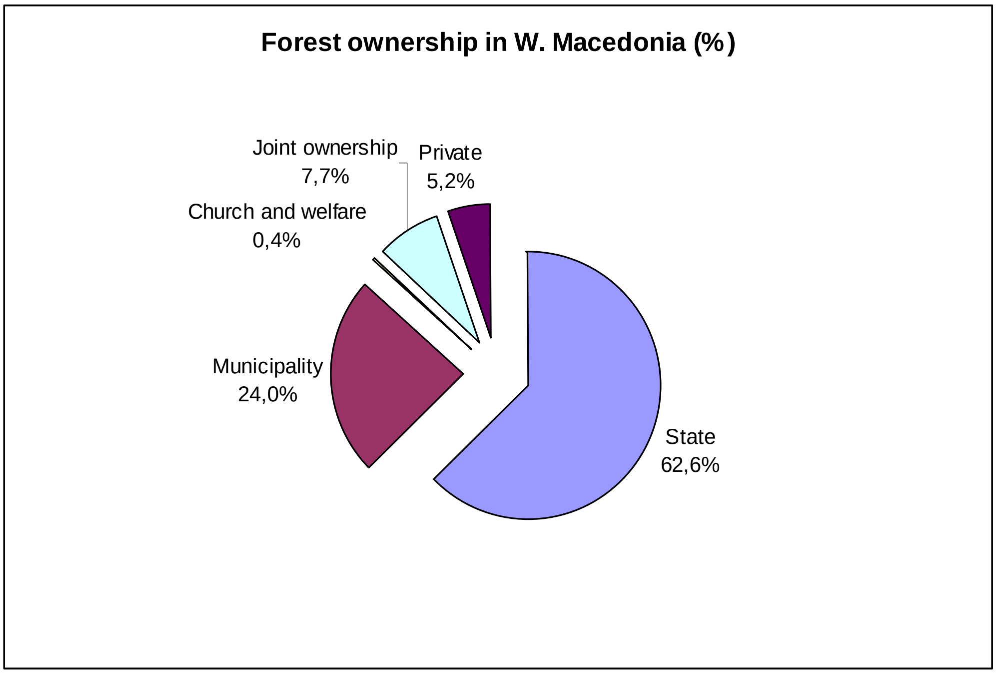


Table 5: Forest ownership in W. Macedonia (Source: δασαρχεία κατά τόπους, regional forest management agencies, 2007)

Forest ownership in W. Macedonia	(ha)	(%)
State	142.828,85	**62,60**
Municipality	54.820,9	**24,03**
Church and welfare	933,9	**0,41**
Joint ownership	17.635,9	**7,73**
Private	11.959	**5,2**
Total	228.178,55	**100,00**



2.4 Forest owner cooperations (FOCs)

There are no Forest owner cooperations in Greece, due to the limited number of private forest owners and the respective small area of forests they are in possession of.

3 Biomass resources

3.1 Forest biomass

Table 6: Production of wood (1000m^3 solid round wood) in Greece (2000-2010)

Assortments/Year of production	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Industrial Timber	440	410	383	401	381	390	384	384	416	240	258
Fuel wood	808	806	725	845	845	915	878	889	845	794	790
Fire wood tax free*	724	313	477	405	467	296	404	316	205	233	790
Total	1972	1529	1586	1650	1693	1601	1666	1587	1466	1267	1838

Source: Δ/νση Διαχείρισης Δασών και Δασικού Περιβάλλοντος / Directorate of Forest and Forest Environment Management

*Fire wood tax free is the wood which may be assigned to communities next to public forests.

The regional forestry services may allow to residents to collect firewood from adjacent forests with or without any permission and tax attribution, on some conditions.

Condition 1, without a permission of the local forestry service: in most cases residents are allowed to collect branches of trees, bushes etc. without the use of chain saws. The daily amount of collected material should be below 1 loose cubic meter per resident.

Condition 2, with a permission of the local forestry service required: in most cases it is allowed to collect fire wood from trees, which cannot be utilized for commercial purposes, in the presence of a forest warden. The amount collected should be e.g. 4 loose cubic meters of fire wood per family per year in the period from November – April.

Table 7: Production of wood from public forests (m^3) in 2010

Forest species	Technical timber	Industrial timber	Fuel wood	Total
I. Coniferous				
Fir	39.889	3.198	2.327	45.414
Spruce/Picea abies	8.259	65	0	8.324
Pinus	95.992	51.387	40.121	187.499
Subtotal	144.140	54.650	42.448	241.237
II. Broadleaves				
Beech	30.289	7.825	149.082	187.196
Oak	980	1.374	249.497	251.851
Poplar	19.868	6.895	6.111	32.874
Chestnut	3.371	577	220	4.168
Others	301	43	21.136	21.480
Subtotal	54.809	16.714	426.047	497.569
Total	**198.949**	**71.363**	**468.494**	**738.806**

Table 8: Production of wood from non public forests (m^3) in 2010

Forest species	Technical timber	Industrial timber	Fuel wood	Total
I. Coniferous				
Fir	15.365	1.156	4.696	21.217
Spruce/Picea abies				
Pinus	26.975	675	24.628	52.278
Subtotal	**42.340**	**1.831**	**29.323**	**73.495**
II. Broadleaves				
Beech	7.649	71	49.678	57.397
Oak	1.087		138.923	140.010
Poplar	3.215	4.988	342	8.546
Chestnut	4.934		3.545	8.479
Others	53		21.176	21.230
Subtotal	**16.939**	**5.059**	**213.664**	**235.662**
Total	**59.280**	**6.890**	**242.987**	**309.156**

Non public forests

Non public forests have a lower density of forest roads, few afforestation initiatives were performed in the past and the fire protection infrastructure in insufficient in comparison to the public forests. These forests have the same productive potential as the public forests, but their productivity is lower due to a series of factors, such as:

- insufficient investments in silviculture due to their low and unpredictable productivity
- small size of forest properties
- sloppy forest area

3.2 Short-rotation coppice

There is currently a small production from short rotation forests of approx. **4.080.70** ha although there was in the past a long-term policy for plantation of agricultural areas with wood forestry species. After 20 and 30 years of the relevant policy which resulted into the creation of privately owned forests with wood biomass potential (mainly willow and pseudoacacia), the produced wood is utilized mainly as fuel wood.

3.3 Wood residues

The existence of steep slopes and the lack of mechanization in forest works in Greece, as well as the overall system of exploitation of forests by forest workers' cooperatives based on cost per unit (m^3) of raw wood produced do not encourage the removal of logging residues from the forest.

There are no extensive studies for the quantification of this residual biomass so far. Estimations from CRES raise the overall logging residue to a quantity of 1.7 million tons per year. However, since the harvesting of logging residues may cause nutrient depletion and affect long-term productivity of forest land, the actual availability is much lower.

The forest residue availability for the region of Western Macedonia has been evaluated with data from the National Informational System for Energy.

Table 9: Logging residues characteristics in Greece

Crop	Residue	Residue/Product ratio	Moisture (%)	Availability (%)	Harvesting period	Higher Heating Value (MJ/kg)
Conifer forests	Log residues	0.15	45	100	June – August	20
Broadleaved forests	Log residues	0.1	45	200	June – August	19.4

Table 10: Logging residues availability in Western Macedonia - Broadleaves woods

Prefecture	Total logging quantity (tn/year)	Available Residue (wet tn/yr)	Available residue (dry tn/yr)	Energy (GJ/yr)
Kozani	13.152	1.315	723	14.033
Grevena	10.428	1.043	573	11.127
Florina	42.846	4.285	2.357	45.717
Kastoria	23.159	2.316	1.274	24.711
TOTAL	**89.586**	**8.959**	**4.927**	**95.588**

Table 11: Logging residues availability in Western Macedonia - Coniferous woods

Prefecture	Total logging quantity (tn/year)	Available Residue (wet tn/yr)	Available residue (dry tn/yr)	Energy (GJ/yr)
Kozani	929	139	77	1.533
Grevena	3.032	455	250	5.003
Florina	129	19	11	213
Kastoria	6.324	949	522	10.435
TOTAL	**10.414**	**1.562**	**859**	**17.183**

3.4 Agricultural biomass

Several surveys indicate that agricultural residues are the most abundant biomass source for Greece. Agricultural residues are divided in two main categories: a) herbaceous residues from annual crops (e.g. straw, maize, cotton, etc.) and b) pruning from perennial crops, mostly trees.

In order to evaluate the actual quantities of the most promising agricultural residues for energy production, a survey, following a specific research methodology was performed. The survey was conducted with data supplied from the Annual Agricultural Statistics of the Ministry of Agriculture. The data concern the cultivated areas and the produced quantities of biomass types which were available at a prefectural level. The four most recent years for which data were available (2004 – 2007) were used, in order to obtain average values, less responsive to productivity fluctuations due to market trends, climatic factors or Common Agricultural Policy (CAP).

The comparison of the residue availability in W. Macedonia with the rest of the country makes evident that many residues that are abundant as a country total are absent from the area. Cotton, olive and citrus trees are such examples, mostly due to climatic reasons. Cereals (soft wheat, durum wheat, maize, barley) are the most important cultivation, the residue availability of which is 85.9% of the total. The rest of the available residue quantity consists of vineyard pruning (4.8%), apple tree pruning (3.2%), peach tree pruning (2.5%) and sugarbeat leaves (2.05%). The most definite trend is the reduction in the cultivated area for tobacco, which has been reduced in 2007 by 85% compared to 2004.

Overall, Western Macedonia produces 6.46% of the available residue quantities of Greece, which amount to 6.68% of their energy potential (on dry basis). 48.2% of those quantities come from Kozani Prefecture, followed by Florina and Grevena.

Table 12: Main crops and residue availability in Western Macedonia (total)

PRODUCT	AVERAGE 2004 - 2007			Total quantity (dry tn/year)	Residue Yield (dry tn/ha)	Available quantity (dry tn/year)
	Land (ha)	Quantity (wet tn)	Yield (wet tn/ha)			
WHEAT SOFT	39.811	129.356	3,25	109.952	2,76	54.976
WHEAT DURUM	60.576	145.739	2,41	123.878	2,04	61.939
RICE	0	0	0,00	0	0,00	0
MAIZE	22.342	233.834	10,47	95.872	4,29	57.523
OAT	210	444	2,11	297	1,41	149
BARLEY	21.038	69.406	3,30	47.196	2,24	23.598
SUGARBEAT	1.988	94.536	47,56	9.454	4,76	4.727
TOBACCO	1.696	2.869	1,69	430	0,25	258
COTTON	9	0	0,00	0	0,00	0
SUNFLOWER	61	83	1,36	165	2,72	99
PEAR TREE	210	2.009	9,58	402	1,92	321
APRICOT TREE	26	41	1,56	9	0,33	7
CHERRY TREE	198	636	3,22	318	1,61	254
APPLE TREE	2.750	51.967	18,90	9.354	3,40	7.483
PEACH TREE	1.048	30.367	28,96	7.288	6,95	5.830
NECTARINE TREE	181	4.018	22,20	804	4,44	643
LEMON TREE	0	0	0,00	0	0,00	0
TANGERINE TREE	0	0	0,00	0	0,00	0
ORANGE TREE	0	0	0,00	0	0,00	0
ALMOND TREE	390	1.065	2,73	2.268	5,81	1.814
VINES	2.694	19.375	7,19	13.756	5,11	11.005
OLIVES	243	34	0,14	27	0,11	16
TOTAL	**155.472**			**421.470**		**230.644**

Cereal residues, such as wheat and oat, are mostly used for livestock feeding, bedding and mushroom production. Some quantities are also used for paper production, although exact data do not exist. The vast majority of the herbaceous residual biomass however is either burnt in the field or ploughed under to be used as an organic fertilizer. Small size tree pruning are burnt in open fires. Exploitation of agricultural residues for production of electricity is not being practiced at the moment.

Since most residues do not currently have market prices, there have not been efforts in the establishment of mechanized systems for their collection or for an extended logistics chain. Wheat and corn are a notable exception; after harvesting of the crop, a linear pile of the straw from threshing of the combine harvester is created. Then, bales of straw of about 40kg each are made using a baler. The bales are loaded on tractor-pulled trailers and transported to neighbouring livestock facilities. Larger branches from pruning are transported via trailers to the producer's household; excess production is sold in average market prices.

Table 13: Biomass prices as nutriment and big size tree branches price

Biomass type	Price (€/ton)
Wheat (in bales of 35-40 kg)	80-90
Corn	130-150
Cotton	110-140
Trefoil/Alfalfa	100-110
Big size tree branches	100-120

Source: National Statistical Service of Greece (2006 data)

4 Wood and Biomass use in country/region

4.1 Production and demand of biomass in country/region

The Greek RES support scheme appears to have produced substantial positive and measurable results, as far as development, construction and operation of commercial-scale RES power capacity in Greece is concerned. **From only 71 MWe in 1997, the RES installed capacity in the whole country reached 500 MWe in 2004 and 1100 MWe in 2007.** The largest part of RES capacity concerns wind parks as shown in the table below.

Table 14: Electricity production in Greece from RES (Data for the interconnected grid)

	Installed capacity in 2012 (MW_e)	Installed capacity in June 2013 (MW_e)
Wind parks	1466	1495
Photovoltaic	1126	1922
PV on rooftops	298	348
Small hydro	213	218
Biomass/Biogas	45	45
Total	**3148**	**4028**

Source: Hellenic Transmission System Operator & Regulatory Authority for Energy (RAE)

- Large hydropower plants (>15 MW) have an installed capacity of 3020 MW (2008) and are not included in the table.

- The installed capacity of RES on the non-interconnected islands amounts to 309 MW. In detail 259 MW of wind energy and 50 MW of solar energy (2011)

The 2009/28/EC Directive sets an overall target of 20% share of energy from renewable sources in the gross final energy consumption by 2020. For each country there are individual binding targets depending on the renewable energy potential and energy mix.

In Greece the final bioenergy consumption in 2005 was 4.4% (0,94 Mtoe) and is expected to be 10.1% in 2020. Out of this 0,7 Mtoe was produced by fuelwood, while the rest 0,24 by agricultural/forest/industrial (agro and wood) residues and biogas.

Lignocellulosic biomass is already demanded by established markets. Large quantities of wood harvested in forests are used by forest industries (eg. saw-mills, particle and fibre board industries) and their residues are directly converted to heat.

As far as biomass is concerned, although it accounts to 17% of the overall energy consumed for space heating in the residential sector (Source: Odyssee – Mure IEE Project, "Energy efficiency Policies and measures in Greece 2006") the Greek biomass market is not considered to be widely developed. Consumers have only few choices when it comes to biomass suppliers and biomass boiler installers. A crucial reason for the immaturity of the biomass market is a barrier that existed in the Greek legislation. Specifically, according to a Ministerial Degree of 1993 (MD 103/1993/B-369), biomass boilers were not allowed to be installed in the two major cities of Greece, Athens and Thessaloniki. Due to this restriction a very large part of the Greek population could not choose biomass as their energy source for space heating. The aforementioned restriction was banned in 2011 to boost the biomass consumption throughout the country.

4.1.1 Wood chips

Wood chips are produced in small quantities in Greece and only upon request (mostly for experimental and not for commercial purposes). The price should range at 90 €/tn (moisture content max. 30, VAT 23% included).

4.1.2 Firewood

See section Forest biomass.

4.1.3 Pellets

The Greek pellet market just started to develop. The first production plant started in late 2006 when there was no consumption in the country. The total production during 2008 was 27.800 tons, while the installed production capacity was 87.000 tons.

There are some wood industries that have already started pellet production mostly by using their own wood by-products. Some other companies started their involvement in the market in 2009 by installing pellet producing machinery with the help of European subsidies.

However, pellet consumption in Greece, especially in households, remains on very low levels. Wood by-products are usually being used without any processing, mainly for heating purposes in the agricultural sector. There are many small and medium manufacturers producing boilers for biomass, which supply this market, also with pellet boilers.

The total consumption in 2008 was about 11.100 tons, which means that the per capita consumption was about 1 kg, one of the lowest in Europe. In order to underline how small these numbers are it is worth mentioning that Sweden, which has the largest European growth of biomass pellets, produced in 2008, approximately 1.4 million tons of pellets, while per capita consumption amounted to 201,5 kg. The lacking domestic pellet demand in Greece forced the pellet producers to target European markets and to export the largest share of their production, Italy being the most important import market.

Nowadays, the pellet market is rapidly growing in Greece, due to the increase in the petrol and natural gas taxation. This fact has led many households to consider space heating utilizing pellets apart from fuelwood, also due to the removal of the ban of burning biomass in large urban centres.

Table 15: Biomass Pellet Producers in Greece

Company Name	Location	Biomass production (tn)	Region
Sakkas SA	Karditsa	25.000	Thessaly
Angelousis SA	Velestino	25.000	Thessaly
Bioenergy Hellas	Larissa		Thessaly
MAKI SA	Larissa	40.000	Thessaly
Alfa Wood	Nevrokopi	70.000	Macedonia
Ecoapellets	Katerini		Macedonia

Quality

There is a quality standard based on the German standard DIN 51731, produced by the Greek Standardization Organization (ELOT) which indicates the biomass specifications for combustion use. However, there is no quality standard for pellet properties, which poses problems to the companies.

Quality standards are not applied in the Greek production industry, but the plants follow a certain production procedure provided by pelletizing equipment manufacturers. However, they are not certified officially. In addition, none of the companies assure the quality of their logistics. They do not provide official quality certifications which lowers the competitiveness of their products on the international markets.

4.2 Energetic use of Biomass

4.3 Costs of solid biofuels

In Greece, The National Statistical Service does not keep any data either on fuelwood prices nor on refined wood fuels (pellets). The only information available is on wholesale prices of fuelwood provided by the General Division of Forests.

Fuelwood is one of the main products of Greek forests and represents over 65% of total timber production. The successive oil crises and the use of fireplaces in houses both in rural and urban areas have contributed to increase the demand for fuelwood. The domestic use of biomass (wood) (755,000 tons oil equivalent), mainly for cooking and heating purposes for residential use, accounted for about 75.1% of the estimated energy (1,005,000 tons oil equivalent) produced from biomass in 2007, while the rest is used in the industrial sector for the same needs.

Furthermore, the price explosion of oil and gas prices has given a push to the use of renewable energy resources. The share of renewable energy resources (RES) in energy supply presents an increasing trend.

4.3.1 Price for wood chips

Wood chips are produced in small quantities in Greece and only upon request (mostly for experimental and not for commercial purposes). The price should range at 90 €/tn (moisture content max. 30, VAT 23% included).

4.3.2 Price for wood pellets

Wood pellets range from 260 - 330 €/tn (VAT 23% included), depending on the origin and the quality.

4.4 Technical standards for solid biofuels

Table 16: Description of relevant national/international standards regarding biomass

Testing of solid biofuels	Analytical Method
Elemental Analysis to determine the C, H, N, S and O content of solid fuels	EN 15104
Atomic Absorption Spectroscopy for determining the concentration of a particular metal element in a liquid sample.	EN 15290
Determination of the HHV of solid fuels	EN 14918
TGA to determine the absorbed moisture, volatiles and ash content of solid fuels	EN 14774 EN 14775 EN 15148
Determination of the durability of pellets	EN 15210-1

5 Forest Infrastructure and logistics

5.1 Forest road infrastructure

A basic step towards the protection of the environment is the definition of the lower road density and the reduction of clearing and road width to save forestland for production purposes and environmental reasons. According to literature review, the economic optimum road density is 25m/ha and the mean distance of wood translocation is 400 - 500m. Despite that, in Greek forests the road density is 8 - 10 m of forest roads/ha.

5.2 Biomass supply chain

5.2.1 Actors in the supply chain

Short description of the actors involved in the supply chain:

- *forest owner (mainly state forests)*
- *forest cooperatives (harvesting of timber)*
- *transportation company*
- *end user*
-

5.2.2 Chain 1:

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

Description:

Case of Alfa Wood (Medium-density fibreboard (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 yard of the plant. The logs are cut to a more manageable length (if over 2 m of 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. Wood chips of a size of 4x4 cm are produced. The produced woodchips designed for the production process are stored in a silo and the wood waste for thermal utilization in another.

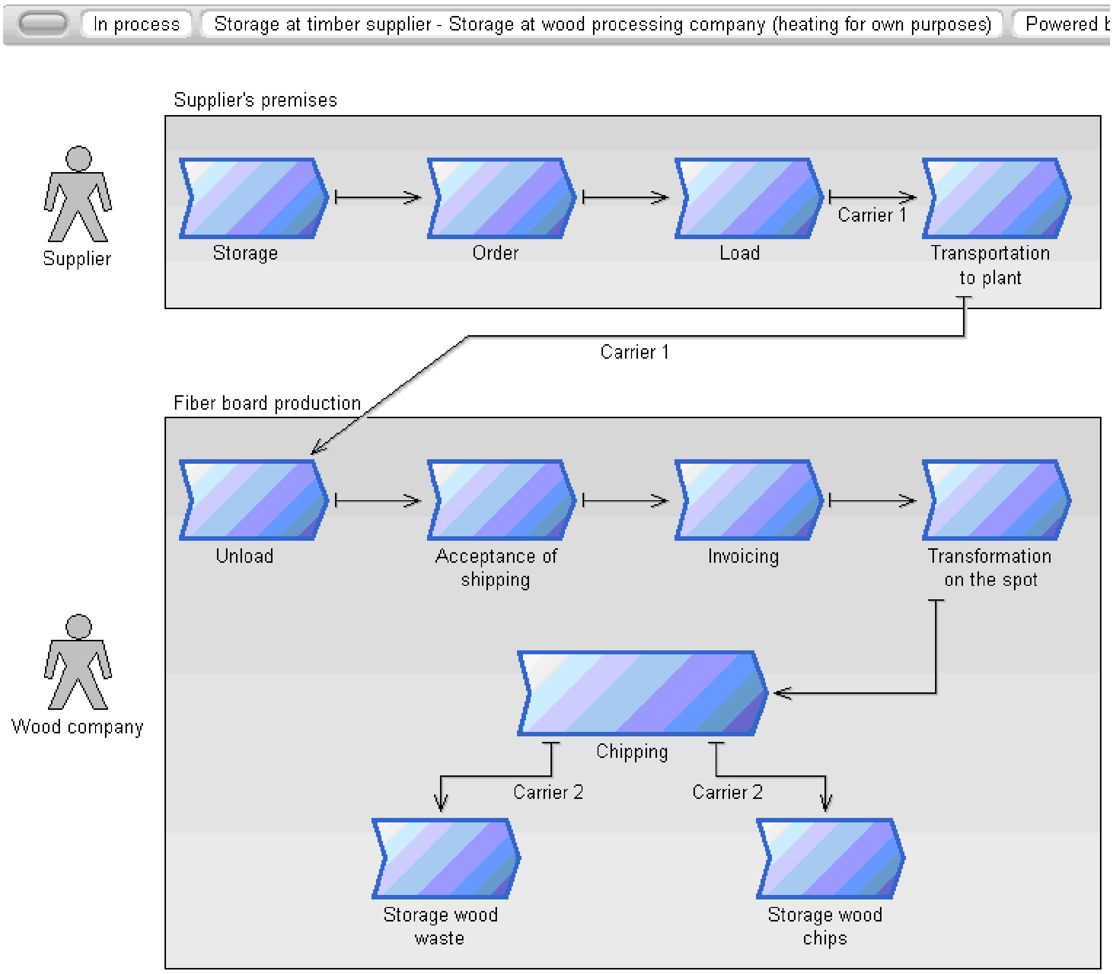
The general steps used to produce MDF include mechanical pulping of wood chips to fibers (refining), drying and blending the fibers, in order to transform the material to mat MDF. Then the material is hot pressed, cooled, trimmed, sanded and is ready for shipping.

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 fibreboard and for space heating and producing domestic hot water for the plant.

Flow chart

- Storage of timber at 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 wood chips for fibreboard production
- Storage of wood waste for cogeneration



5.2.3 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). The bagging process is composed of 3 steps:

- The bag is filled, weighted and welded.

- The bags are placed on a pallet.

- The pallet is enclosed in plastic.

This kind of package is used for small pellet consumption at households, e.g. pellet stoves for heating purposes.

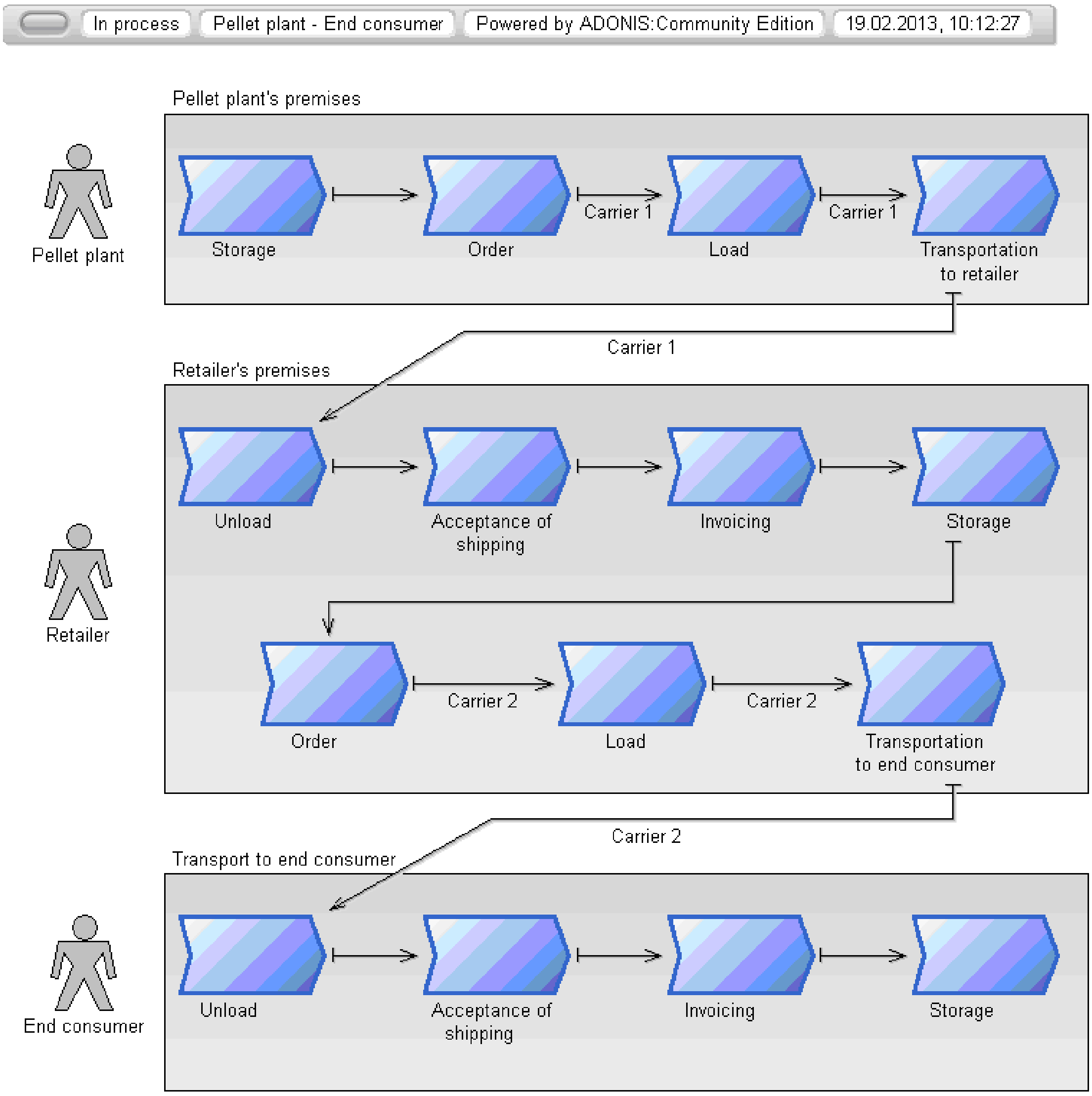
The bags are generally distributed as follows:

- 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



5.2.4 Chain 3:

Starting point: Standing tree, End point: Storage at End consumer (production of firewood)

Description

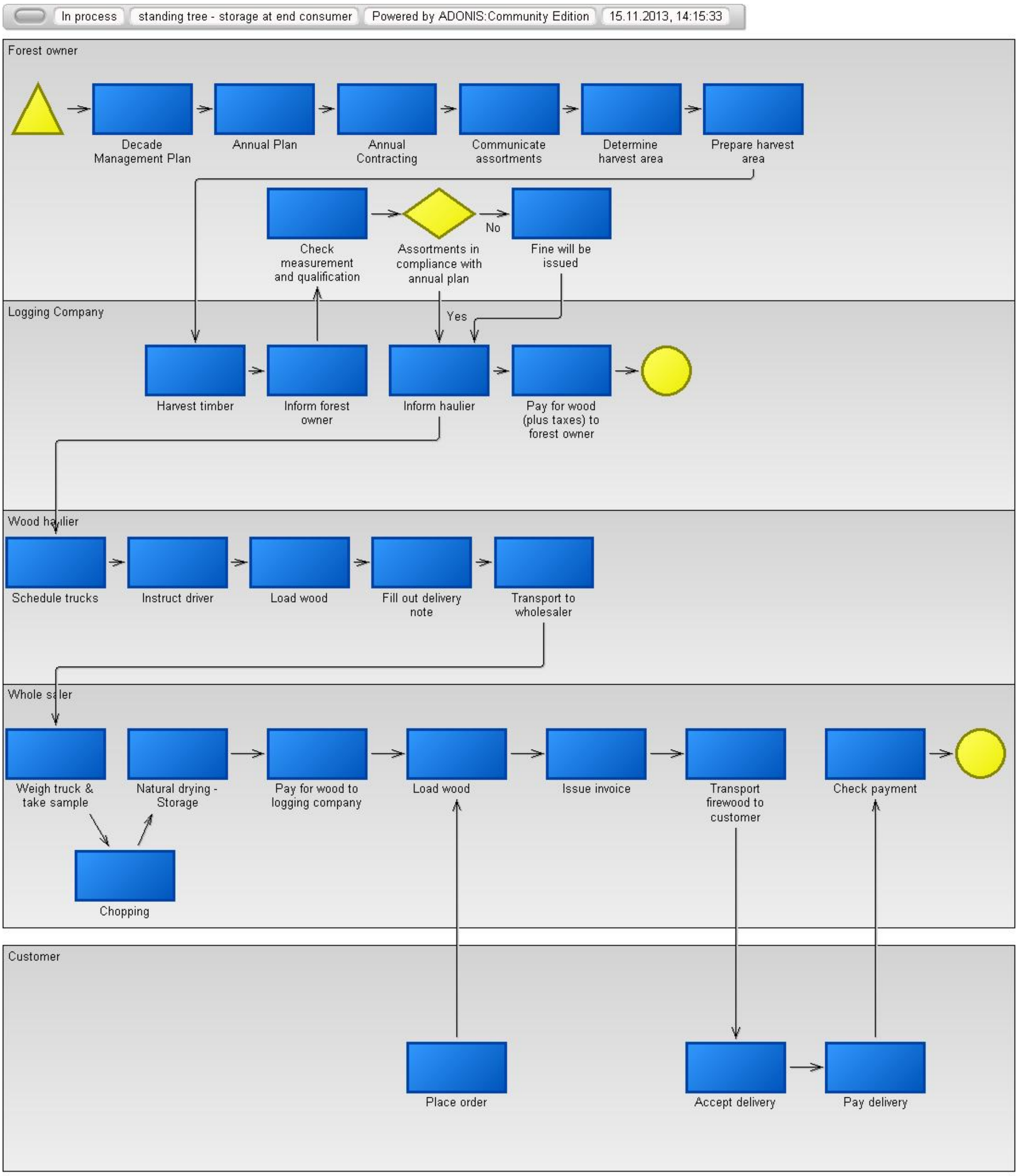
Production of firewood

The price explosion of oil and gas has given a push to the use of biomass, which has an increasing trend over the last years. Many wood trading companies have taken this opportunity and are dealing with firewood in Western Macedonia. Some of them are buying wood logs either from forest cooperatives which are active in each forest district or from private forest owners. The wood purchased is in the form of logs not suitable for industrial use and mainly from beech and oak wood or pine in smaller quantities.

The wood is usually manually harvested by motor saw and transported to the forest road by means of a mini skidder (round wood) or mules (sawn logs of 1m length). The wood is bought at the forest road by the firewood trader and then transported to the company's facilities by trucks of 20tn capacity. After unloading at the company's premises, the logs are chopped (cross cut and split) into firelogs of 25 – 33 cm length and afterwards stored for natural drying for a period of min. 2-3 months.

Flow chart

- Manual harvesting by chain saw
- On the spot transformation (manually)
- Extracting by mini skidder (roundwood) or by mules (sawn logs)
- Transportation to forest road
- Unload at forest road
- Load on truck
- Transportation to storage at wholesaler
- Unload at wholesaler
- Chopping
- Natural drying
- Storage
- Transportation to end consumer
- Unload at end consumer
- Storage at end consumer


In process
standing tree - storage at end consumer
Powered by ADONIS:Community Edition
15.11.2013, 14:15:33
Forest owner
Decade Management Plan
Annual Plan
Annual Contracting
Communicate assortments
Determine harvest area
Prepare harvest area
Check measurement and qualification
Assortments in compliance with annual plan
No
Fine will be issued
Logging Company
Yes
Harvest timber
Inform forest owner
Inform haulier
Pay for wood (plus taxes) to forest owner
Wood haulier
Schedule trucks
Instruct driver
Load wood
Fill out delivery note
Transport to wholesaler
Whole saler
Weigh truck & take sample
Natural drying - Storage
Pay for wood to logging company
Load wood
Issue invoice
Transport firewood to customer
Check payment
Chopping
Customer
Place order
Accept delivery
Pay delivery

6 Stakeholders

Short description of relevant stakeholders in the biomass sector

6.1 National stakeholders

The General Directorate for the Development and Protection of Forests and the Natural Environment, organises info-days, workshops and conferences on various scientific issues of interest. The same General Directorate publishes leaflets, booklets as well as the proceedings of the info-days, the workshops and the conferences and distributes them to all the local forest services as well as to other authorities involved and interested bodies.

- Similar activities are also carried out by the forestry departments of the universities, the technical educational institutes on forestry, as well as by the Forest Research Institute.

- The Geotechnical Chamber of Greece publishes a monthly newsletter which covers all aspects including the scientific, and also the Geotechnical Scientific Issues, a scientific journal published every two months.

- The Society of Forest Science of Greece is organising a scientific conference on a biannual basis, where people dealing with forestry from the universities, the research institutes, the ministries, the forest services and other authorities participate. The proceedings from these conferences are widely distributed.

7 Annex

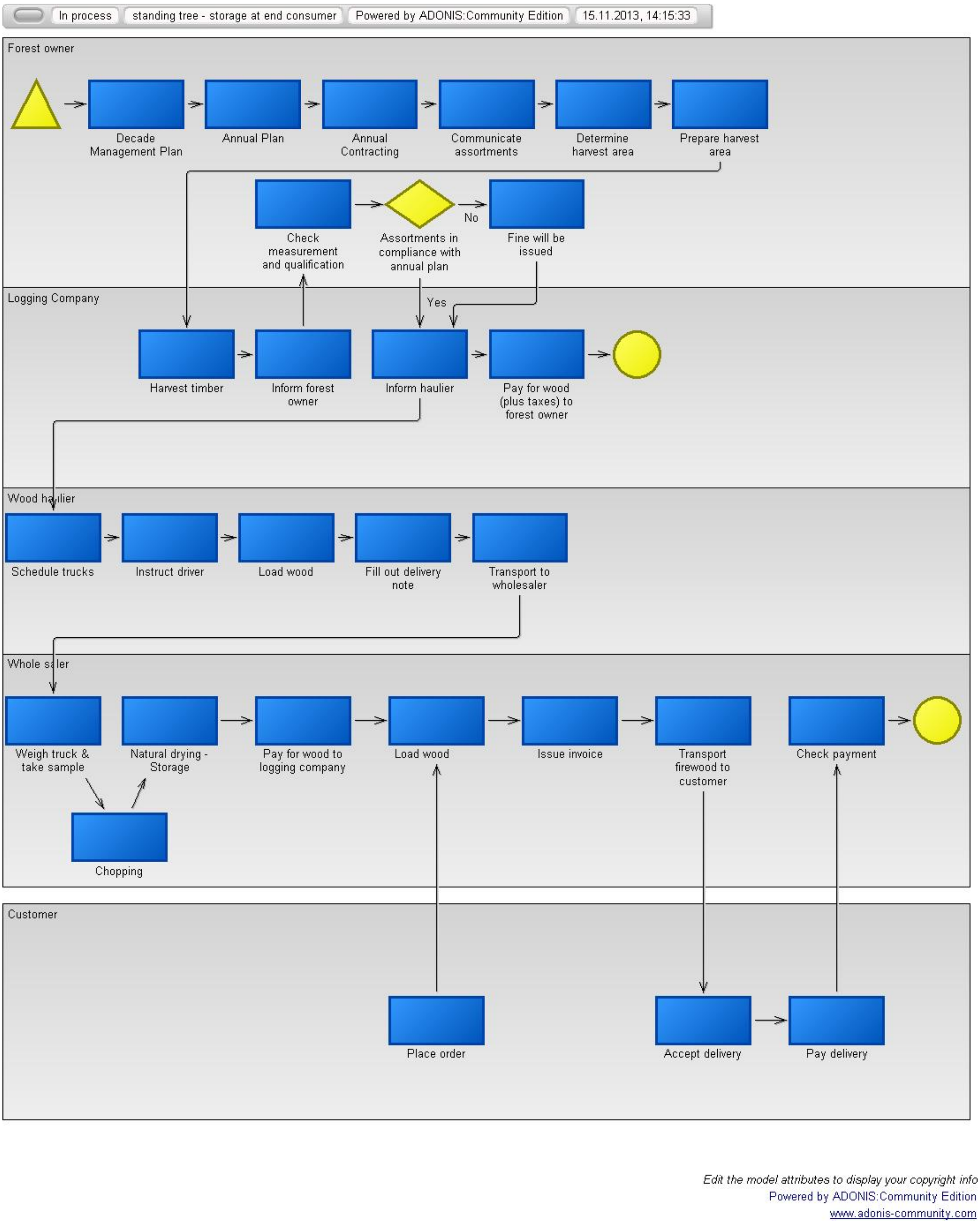
7.1 Annex 1: regional SWOT

Table 17: Result of the SWOT analyses, internal and external issues characterising biomass supply chain *3. Starting point: Standing tree, End point: Storage at End consumer (production of firewood)*

Internal strengths	**Internal weaknesses**
S1. Bordering – strategic position, introduction of raw materials from the neighbouring countries S2. Increasing demand from the domestic sector for biomass heating S3. Urban areas located very close to rural areas (reduces logistical problems for domestic and small scale supply) S4. The quantity of wood harvested from a forest per year, is always less than the annual increment (sustainability) S5. Local/regional availability of feedstock S6. Short transport routes in procurement and distribution	W1. Uncertainty of regular biomass yield (due to forest wildfires, illegal logging etc) W2. Low training and specialization of manpower W3. Lack of mechanized harvesting for wood (difficulties in establishment of supply chains) W4. Most promising biomass value chains, including current/future market volumes/prices, not clear W5. Old legal framework. Wood harvesting is only allowed to forest cooperatives in public forests W6. Small amount of manufacturers of biomass systems(e.g. boiler manufacturers)
External opportunities	**External threats**
O1. Scope for increase and more efficient use of the regional biomass resources O2. Promotion of education and training programs emphasizing on new technologies and skills O3. Emerging fire wood market also due to the high petrol taxation O4. Oil and gas suppliers exposed to the insecurity and price fluctuations of international markets	T1. Development efforts often restricted due to lack of financing instruments T2. Public is neglecting principles of sustainable development T3. Fast implementation of other renewable energy technologies feeding the market requests T4. Perception that technology is old and unattractive T5. Changing governmental policies T6. Economic change and volatility in fossil fuel prices T7. Illegal logging due to the economic crisis

7.2 Annex 2: Process model(s)

3. Starting point: Standing tree, End point: Storage at End consumer (production of firewood)



8 References

- Zafeiriou E., Arabatzis G., Koutroumanidis T., The fuelwood market in Greece: An empirical approach, , Renewable and Sustainable Energy Reviews 15 (2011), 3008-3018
- Zagas T*.,* Tsitsoni T*. and* Gkanatsas P*., 1999.* Perspectives of silviculture as discipline in Greece*. Silva Gandavensis 64: 17-23*
- Motesnitsa F., Silviculture in Greece, available in Greek at http://www.epipleon.gr/
- Report of Activities (2010) of the Forest Service issued by the Department of Forestry Planning and Development Division of Forest Resources Development (in Greek)]
- PROFORBIOMED "Promotion of residual forestry biomass in the Mediterranean basin", www.proforbiomed.eu
- BIOCLUS: Developing Research and Innovation Environment in five European Regions in the field of Sustainable Use of Biomass Resources, www.bioclus.eu
- BIOMASS TRADE CENTRE2: Development of biomass trade and logistics centres for sustainable mobilisation of local wood biomass resources, www.biomasstradecentre2.eu
- Pellets@tlas – Development and promotion of a transparent European Pellets Market Creation of a European real-time pellets Atlas", www.pelletsatlas.info
- EUBIONET, Biomass survey in Europe, Country report of Greece, CRES 2003
- Karapanagiotis N.K, Tsoutsos T., 2002, Data collection on pellets utilisation in Greece, Pellets for Europe, www.pelletcentre.info
- General Directorate for the Forests and the Natural Environment, Ministry of Agriculture, GDFNE, 1992
- Centre for Renewable Energy Sources, An overview of the Greek energy market, 2002
- National Informational System for Energy, available at: http://195.251.42.2/
- Ericsson K, Nilsson LJ (2006) Assessment of the potential biomass supply in Europe using a resource-focused approach, Biomass and Bioenergy 30(1): 1-15.
- Skoulou V, Zabaniotou A (2007) Investigation of Agricultural and animal wastes in Greece and their allocation to potential application for energy production, Renewable and Sustainable Energy Reviews, 11: 1698-1719
- http://biomassenergy.gr/en/articles/technology/biomass/440-biomass-pellets-market-in-greece-overview-and-features-agora-pellets-ellada
- Eskioglou P. Ch., THE REDUCTION OF THE DESTRUCTIVE ELEMENTS OF FOREST ROAD CONSTRUCTION PROJECTS, available at: http://users.auth.gr/pxeskio/papers/50.pdf
- Koutsianitis D. (2010) Comparison of harvesting system by the State Forest Exploitation and the Presidential Decree 126/86 in Elatia Western Rhodope, Aristotle University of Thessaloniki – Faculty of Forestry and Natural Environment