

## An assessment of potential forest biomass production for energy in South Italy

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### **Abstract:**

*The biomass for energy purposes, coming from forestry and timber industry for energy, can provide various environmental and socio-economic benefits. Among all renewable energy sources, forest biomass represents both an important alternative source to fossil fuels and an opportunity for the socio-economic development of various marginal mountain areas in Calabria. This survey aims at estimating the potential revenue from timber harvest in Calabria region, which is showing a great interest in forest biomass production. According to the carried out analysis, forest lands, covering an area of about 82.000 hectares, show a significant productive capacity for each timber product typology, the main quota deriving from round wood assortments. A GIS decision support system has been developed, which implements the method and provides the tools to identify the geographic distribution of the economically exploited biomass potential.*

**Keywords:** biomass, South Italy, extraction, renewable energy

### **1 Introduction**

As Italy belongs to the countries with the highest forest cover in Europe, forest management has been of central importance in this country. Challenges in forest management arise particularly from the fact that the main part of the Italian forest is located in steep terrain. The forest cover of Calabria, a region of Southern Italy particularly rich in forests (Figure 1), is equal to 31.8%; they are also often highly productive; indeed, every year, in Calabrian forests, the average increase in wood volume, which is equal to 6-8 m<sup>3</sup> ha<sup>-1</sup>, exceeds and sometimes doubles the increase estimated in the other forests of Southern Italy (Zimbalatti and Proto 2009). In particular, sixty percent of beyond 600.000 hectares of Calabrian forest surface are situated in lands with classes of slope between 20 and 60%. Beech, Corsican pine and silver fir are the most spread tree species. Calabria supplies numerous sectors of southern Italian wood industries. The annual amount of harvested timber in 2009 was 544.431 m<sup>3</sup> (ISTAT 2010), about the 13% of the national amount and the 41% of the total amount of timber harvested in southern Italy. In the last fifteen years an increase of the harvested timber has been recorded: from the analysis of the national statistical database (ISTAT 2010), firewood harvesting increased more than roundwood harvesting (Cavalli et al. 2008).

In the last years public and scientific debate about the reduction of CO<sub>2</sub> and polluting emissions has intensified and the importance of renewable energies and fuel has increased. Scientific researches on the economic possibility to use wood and biomass to obtain electric and thermal energy has shown contrasting results. In the last ten years in Italy several companies of the bio energy industry, attracted by generous Government subsidies planned to build dedicated power that use biomass as their main fuel (Neri and Piegai 2007).

The biomass for energy purposes, coming from forestry, timber industry and Short Rotation Forestry (SRF) for energy, can provide various environmental and socio-economic benefits (Neri and Brunori 2008). First of all, the production of forest biomass for energy involves the reduction of CO<sub>2</sub> emissions (Nishizono et al. 2005; Hellrigl 2006) and the improvement of forest functions, such as hydrogeological and biodiversity conservation. Moreover, forest biomass consumption could contribute to the socio-

economic development of rural areas (Ciccarese 2005), through the restoration of agro-forest activities and technological advances in the bio-energy field.

In such a context, it is important the implementation of a small scale forest-wood-energy chain using local raw material and carrying out conversion phases in loco. The production of forest biomass for energy is assuming particular importance in Calabria for the forest vocation of its territory. In this context, an important issue regards the assessment of the potential availability of forest biomass, in order to calculate the proper dimensions of a plant. This paper estimates the potential production of forest biomass in the province of Reggio Calabria, where, recently, local authorities have shown a growing interest in forest biomass production.



**Figure 1: Geographical position of Calabria**

## 2 Material and Methods

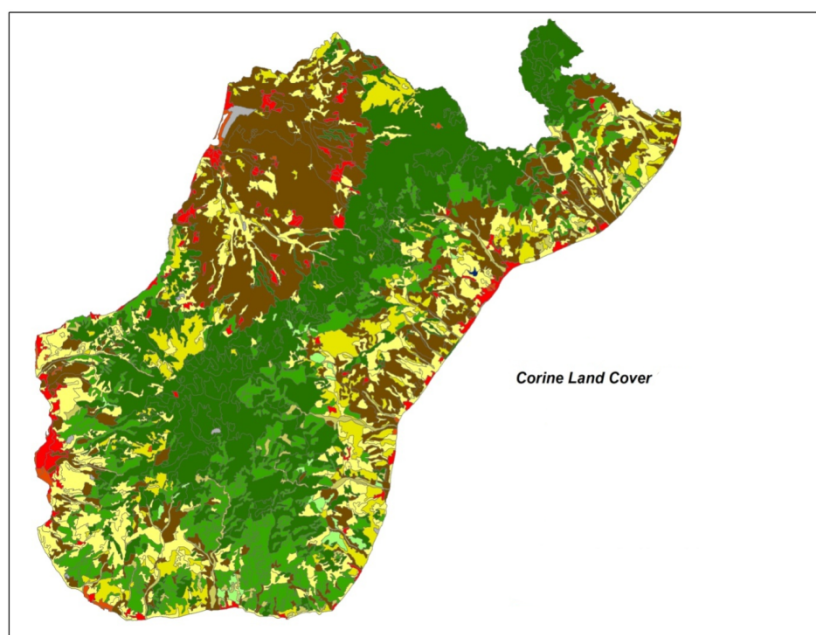
The study has been considered besides all the elements that can hinder the forest utilization (average and maximum slope, roughness) and the processes of growth (species, density of the plants, age, etc). Knowing therefore the extension and the different typologies of woodland, through note of different cartography fonts (National Forest Inventory, Corine Land Cover, Digital Model System), has been so possible to determine the location of the resources, the typology of the same and the accessibility to the woodland (Figure 2).

In order to assess the potential availability of woody biomass coming from forest resources, both the residual wood obtained from primary conversion in forests and the assortment percentages retrievable from utilization and destined for energy uses, have been taken into account (Table 1). In the first case, residual wood has been observed by applying an aliquot - expressed in percentage terms - to the potentially utilizable mass in every hectare of woodland. It is important to underline that the identification of the aliquot is quite complex, as it depends on several factors, including the woody species, the characteristics of the area, the age and the social position of each tree and for this reason, it has been necessary the use of the values reported in literature (Giordano G. 1981, Stillitano and Marcianò 2009).

In this regard, it has been assumed that all forests are utilized each year without decreasing the standing timber stock (Ciccarese 2006). Therefore, from the product between the waste volume retrieved for energy purposes and the utilizable area for each year of interventions, it is calculated, for each forest typology, the quantity of biomass that could be obtained annually from residual wood. Similarly, it has been decided to assess the biomass that can be achieved from utilization, first, by multiplying the percentage of assortments for each species with the retrievable mass per hectare and later, and then by multiplying the obtained volume with the annually utilizable area (Stillitano and Marcianò 2009). The

data about the annual increment of the different trees has been obtained from Italian National Forestry Inventory (2005). In fact, the biomass represents a product of discard and therefore the biomass always identifies a least part of the primary product “wood.”

For example, in a wood of beech tree, governed to high forest, the biomass represents only the 10% of the product wood because from this woodland the primary product will surely be represented by roundwood with a near percentage to 60-70% while 20-30% will be constituted by firewood by to burn and the remainder note from biomasses.



**Figure 2: Province of Reggio Calabria**

**Table 1: Hectares and percentage of timber retrievable assortments in the Province of Reggio Calabria**

Main woodland crops in Province	Total (ha)	Potentially utilizable (ha)	Percentage	Annual increment (m <sup>3</sup> /ha)
Holm oak	16.044	6.570	40,9%	3.33
Pubescent hoak, Turkey hoak	7.800	4.259	54,6%	3.84
Beech	22.014	8.871	40,3%	5.76
Chestnut	12.127	6.371	52,5%	4.65
Exotic broadleaved	2.519	2.412	95,7%	10.3
Corsican Pine	10.074	66	2,4%	4.3
Silver fir	2.239	223	10%	4.33
Mediterranean Pines	373	318	85,1%	3.29
Exotic conifers	746	656	88,0%	7.3
Forests of beech and silver fir	2.525	252	10%	5.6
Forests of beech and corsican pine	1.119	76	6,8%	4.9
<b>Total</b>	<b>77.580</b>	<b>30.074</b>		

### 3 Results

The first phase of GIS elaboration has been finalized to identify the forest where the harvesting of biomass could be possible and compatible with normative of environmental safeguard. In the second moment the study has established the percentage of biomass usable from the several forests (Table 2). Through the analysis of the different timber assortment typologies that can be obtained from the forests of the province, it emerges that the different species provide roundwood, firewood and biomass for energy uses. In particular, in order to assess biomass for energy uses, the forest typologies under examination are exotic conifers, hoak forest and coniferous reforestation from which it is derived biomass.

**Table 2: Percentage of biomass retrievable from forests in the Province of Reggio Calabria**

Main woodland crops in Province	Assortment typology	Percentage
Holm oak	• Firewood	90%
	• Biomass	10%
Pubescent hoak, Turkey hoak	• Firewood	90%
	• Biomass	10%
Beech	• Roundwood	60%
	• Firewood	30%
	• Biomass	10%
Chestnut	• Roundwood	80%
	• Biomass	20%
Exotic broadleaved	• Roundwood	60%
	• Biomass	40%
Corsican Pine	• Roundwood	70%
	• Biomass	30%
Silver fir	• Roundwood	70%
	• Biomass	30%
Mediterranean Pines	• Roundwood	70%
	• Biomass	30%
Exotic conifers	• Roundwood	70%
	• Biomass	30%
Forests of beech and silver fir	• Roundwood	60%
	• Firewood	20%
	• Biomass	20%
Forests of beech and corsican pine	• Roundwood	60%
	• Firewood	20%
	• Biomass	20%

The results concerning the estimation of the total amounts of biomass potentially available every year from the forests belonging to the Province of Reggio Calabria are reported in Table 3. In conclusion, the volume of biomass that can be obtained from forests is estimated at 15415 (w 40%) tons year-1. To see increased the production of forest biomass, therefore, will be necessary to intervene on the recovery of abandoned areas with the reforestation of appropriate trees. Besides it will always need to watch over, so that an excessive demand of biomass doesn't push the wooded enterprise to convert the destination of final use of the woody products in biomass, dispersing so the real value of the woody assortments primary.

The estimate identifies the main woodland where there is a good supply of biomass without affecting the value of the forest itself. Since in the northern region, there are four large power plants fueled by biomass. The research will raise the need for a local use of biomass through the implementation of small-scale energy conversion in the province of Reggio Calabria. In fact, the forestry companies must also support

large transport costs to send the biomass produced in plants in the northern region to a distance of 200/300 km.

The possibility to use forest biomass for energy production can be realistic only where its supply is economically feasible. Cost-efficient wood chips supply in mountainous area depends on chipping and transport interface, transport cost and, where forest biomass for chips production is not considered a by-product, on harvesting and extraction operations (Stampfer and Kanzian 2006).

As the efficiency of forest operations largely depends on forest road network characteristics, therefore chipping and transport interface and biomass transportation also are influenced by forest road network characteristics.

**Table 3: Annual biomass in Province of Reggio Calabria**

Main woodland crops in Province	Fresh Biomass (m <sup>3</sup> /ha)	Fresh Biomass (tons/year)	Biomass w 40% (tons/year)
Holm oak	0.33	2406.6	1444
Pubescent hoak, Turkey hoak	0.38	1962.5	1177.5
Beech	0.57	5109.7	3065.8
Chestnut	0.46	2962.5	1777.5
Exotic broadleaved	4.12	10931.2	6558.7
Corsican Pine	1.29	76.6	46
Silver fir	1.3	266.5	159.9
Mediterranean Pines	0.98	282.5	169.5
Exotic conifers	2.19	1293.0	775.8
Forests of beech and silver fir	1.12	254.0	152.4
Forests of beech and corsican pine	0.98	67.0	40.2
<b>Total</b>		<b>25649</b>	<b>15415</b>

The study shows that the province of Reggio Calabria can produce a good amount of forest biomass if companies know how to effectively manage these forest resources. Despite being such a conspicuous woodland resource, the most common working method in Calabria can be considered as being traditional and still at an early stage of mechanisation. It is based mainly on the use of agricultural tractors, sometimes equipped with specific forest machines like winches, hydraulic cranes, log grapples but also, the use of animals for gathering and yarding is still widely used. Chainsaws are the most common machinery for timber cutting operations. The low level of mechanisation in Calabrian forests can be attributed to their site features, the characteristics of the property, the small areas of many of the enterprises, the scant knowledge of modern machinery, and the scarcity of relevant studies relating to the use of modern machinery (Zimbalatti and Proto 2010).

#### 4 Discussion

The role of forest biomass as a renewable source of energy is encouraging an increasing interest in environmental, social and economic issues. Indeed, the use of wood as fuel can contribute to reducing atmospheric emissions of greenhouse gases, to ensuring the public utility functions of forests and to providing an opportunity for a socioeconomic development in rural areas. A fundamental condition for

the development of such chain and for the use of forest biomass for energy purposes is knowing the qualitative characteristics and the potentialities of forest lands (Stillitano and Marciandò 2009). Therefore, this study has examined the potential availability both of forest resources at timber harvesting and of their retrievable biomass in the Province of Reggio Calabria. The achieved results show how the area under investigation presents a good potential for an energetic enhancement of forest resources. However, the increase of biomass must be supported from a fit mechanization. The increase of productivity, both for the forest firms and for all the wood row companies, is due to a constant search of production efficiency, a proper selection of machinery and integration among the different sections of the row. The acquisition of new means will allow the firms to operate also in those woodlands where the lack of roads and infrastructures, useful for the passing of the means, and the unevenness of the terrain lower the income of utilization operations (Zimbalatti and Proto 2009). Therefore, the results shown that the assessment of potential forest biomass developed for this study can be used to know biomass in the forest of Calabria Region. Institutions like the local government and other national or international agencies who are interested in knowing the standing forest resource and carbon stock in this region will particularly benefit from the result of this study.

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