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BIOMASS ENERGY FOR PRODUCTIVE USE IN THE OLIVE OIL AND OTHER AGRICULTURE SECTORS IN ALBANIA

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Keywords:

Biomass; Olive; Renewable energy; Technology; Agriculture residues.

A B S T R A C T

The paper is focusing on demonstrating technical and financial viability of biomass projects and enhancing awareness and strengthening capacities for key actors in the policy and industrial sector (in the olive oil and other sectors with high replication potential such as wood processing, wine production, jam-fruit production), as well as supporting tailored policy actions and scale-up activities including preparation of a detailed assessment of the biomass potential for industrial uses. The key local challenges are linked with: development of market surveys related to theoretical, economic and market potential; introduction of the appropriate bio-energy technology applications based on the lowest cost strategy and other relevant considerations; information of the key financial institutions and local suppliers on the specific features and opportunities provided by the Albanian industrial bio-energy technology market; and design of a sustainable strategy for replication and scale up through the national partners.

1. INTRODUCTION

In the current circumstances the renewable source of energy are becoming unevenly and insufficiently exploited in the European Union. Although many of them are abundantly available, and the real economic potential considerable, renewable sources of energy make a disappointing small contribution to the Union's overall gross inland energy consumption, which is predicted to grow steadily in the future (COM (97)599). The EU has a clear framework to steer its energy and climate policies up to 2020. This framework integrates different policy objectives such as reducing greenhouse gas (GHG) emissions, securing energy supply and supporting growth, competitiveness and jobs through a high technology, cost effective and resource efficient approach. These policy objectives are delivered by three headline targets for GHG emission reductions, renewable energy and energy savings. In owns path towards full EU integration Albania has to show both political and technical ability in coping with forthcoming EU regulations and commitments.

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The EU is making progress towards meeting the 2020 target of 20% renewable energy in gross final energy consumption. In 2010, the renewable share in the EU was 12.7% compared to 8.5% in 2005. During the period 1995-2000 when there was no regulatory framework, the share of renewable energy grew by 1.9% a year (COM (2013) 169). Agriculture is a key sector for the European strategy of doubling the share of renewable energies in gross energy demand in the European Union by 2010. New activities and new sources of income are emerging on-farm and off-farm. Among those, the production of renewable raw materials, for non food purpose in niche markets or the energy sector, can represent a new opportunity for agriculture and forestry and contribute to job creation in rural areas (COM (97)599).

A number of studies in the literature conclude that agro-industrial residues are a suitable source of biomass for electricity production (Caputo et al., 2003; Kuiper et al., 1998; Boateng et al., 1992; Malaspina et al., 1996; Mussatto et al., 2006); however, its use as an energy source is hindered by several limitations, such as for instance the seasonal supply of waste (correlated to the seasonality of the main product); or the high investment costs required for waste pre-treatment (IDAE, 2005).

The scientific and technical approaches for evaluation of bio-energy resources in Albania do almost not exist. According to AKBN (2011) the sources of biomass have not been made approximate assessments conducted by scientific research institutions of our country, because they have not begun yet to be used as an energy source. Biomass potential from agricultural residues is approximately estimated 2300GWh/year. While potential prevision of urban waste for some of the largest towns of the country in 2010 is approximately estimated 1460 GWh/year.

Albania is one of the fewest countries in the Mediterranean that has optimal conditions for olive growing and olive oil production. Since 2010 the olive and olive oil sectors are among the top priorities of the Albanian Government policies, but the olive oil producers suffer from insufficient technological and managerial assistance. Together with the poor state of rural infrastructure, this makes for high production costs and low margins. Production technology is available, but securing and storing a fresh supply of olives and later on of olive oil is difficult for a number of reasons, including poor infrastructure, processors' unfamiliarity with proper bottling, storage and packaging techniques that prevent quality loss, and their insufficient knowledge of modern marketing techniques such as labeling. Producers recognize the need to upgrade their skill profiles and there is high demand for skilled personnel such as technicians to serve production lines or chemists to analyze final products. Presently, however, Albania lacks the vocational training infrastructure necessary to improve professional and technical skills. International and bilateral aid is coming in to bridge this gap. As far as the competitiveness of the sector is concerned, experiences of olive oil producers in other countries can serve as good indicators of how Albanian producers may need to adapt their business conduct and skill profiles in order to become more competitive.

2. IMPLEMENTED METHODOLOGY

This methodology has been designed to meet the requirements for the assessment of the biomass potential for industrial uses in Albania and to develop the way forward for replication. For the assessment of energy potential of agro-industrial waste were used a methodology that estimates the maximum amount of energy available from each source of residues. Generally, the energy potential of a source of residues results from two basic estimations: the amount of residues generated in a given temporal cycle (typically 1 year) with a certain geographical disaggregation, and the energy content of the material (Gómez et al., 2010; Celma et al., 2007).

In case of Albania were considered: (i) Olive mill residues; (ii) Winery residues; (iii) Non alcoholic industry (mainly fruits) residues; (iv) Residues from forest operation and wood processing industries; (v) Brewery residues.

3. RESULTS AND DISCUSSIONS

3.1 The sectoral assessment of the biomass potential with a focus on the olive oil industry

Climatic-soil conditions in the western, central and south-western zone of Albania favor the cultivation of olives and are exactly these zone where olive cultivation is widespread, and which it also relates to the production of olive oil, olives grain for conservation, the use of olive trees for the wood processing industry as well as for other aspects of the use as olive residues for energy production, the use of olive leaves for the cosmetic industry, etc. All these usages increase the value added of olive and positively affect in the value chain.

In Albania, due to the appropriate ecological conditions, the olive oil is planted today and grows successfully in large blocks of old and new micro-zones of 17 districts of the Mediterranean area plains and hills that have the largest share of the population. The perennial observations show that in the present area the climate is appropriate and suitable specifically on its elements, such as temperature, solar lighting and air humidity.

The height above sea level and the regime of the precipitation, relative air humidity, solar radiation and other factors conditioning the microclimate components,

in their entirety are found to be optimal in size, thus allowing growth and regular olive production (Table 1). Under these conditions the extent of olive in the depths of the country, being up starting from the coast, starts from the South to Konispol, extends into the eastern hills of the basin Vurg of Saranda district passes east of the Dropull and Lunxhry fields In the district of Gjirokastra, and following the micro-climate of the Vjosa river valley, goes up to Berat. Continues on the low hills that limits Permet with Tepelena of Berat and through the valley of the Osumi River, runs up to Skrapar.

Table 1. Surface, number and production of olive during 2000 - 2015

	2000	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Total (/000 trees)	3,611	4,264	6,255	7,443	8,000	8,620	8,994	9,225
In production (000 trees)	3,256	3,488	4,298	4,576	4,829	5,277	5,803	6,332
Yield (kg/tree)	11,1	8,6	16,3	14,3	25,9	14,7	16,9	16.1
Production (/000 ton)	36,2	30,2	70	65,4	108.0	92	98	96

The olive grove continues in the hills of Sulovë of Elbasan and through the valley of the Devoll River, goes far beyond Gramshi, and continues extending to the second slope of Elbasan and through Valley of the Shkumbin River passes to Labinot-field to Xibrak. The area of Zaranika, is thrown at Krrabë and on the eastern side of the Tirana district, traversing the area near the mountain of Dajti, stretching to Kruja. It further passes to the lower parts of Mat River, passes by the northeastern hills of Lezha district, goes further horn Zadrimë and passes to the hills of Bardhajve of the district of Shkodra, beyond the lake of Shirok to stretch out to the great mass of form climbing to the north of the city Shkodra to Great Malesia.

In 1990 the total olive volume was nearly 4.8 million roots, of which about 1.1 million new olives. Following the drastic political changes in the 1990s with the redistribution of agricultural land, a large number of new olive groves were degraded by the lack of welfare cultivation services and another was died due lack of pruning and irrigation. So, in 1995 the number of olive groves was reduced; their total number was about 3.9 million or nearly 1 million less than in 1990 (Table 1). In 2000 the number of olive groves continued to be reduced by about 300,000 other olives and the total number was only 3.6 million. After 2000, their number increased considerably and in 2010 their number was almost two time more compared with year 2000 (6.2 million) and in 2015 the number reached 9.2 million or about 3 times more than in 2000 and 2.1 times more than 1990. Olives in production (> 10 years) doubled for the same period (3.2 vs. 6.33 million root for 1990 and 2000, respectively). Olive harvesting is variable and varies from 8.6 kg roots (2005) to 25.9 kg / roots (2012) depending on climatic conditions; Progressive increase in productivity in recent years is the result of better technologies and added maintenance services such as irrigation and fertilization. Also, the introduction of new production varieties, from an early age, has improved the variance structure and has reduced the phenomenon of periodicity.

Table 2. Energy (in Kjoul, G Joul, GWh and Toe butane) of Oil Mill Solid Waste produced in Albania (2015)

Prefecture	**Oil**	**Soild Waste (ton mill)**	**Kjoul**	**Gjoul**	**Energy (GWh)**	**Energy (Toe butane)**
Berat	2017.2	5339.7	8.54E+10	85435.2	37.13	1732.99
Durrës	852.8	2257.4	3.61E+10	36118.4	15.70	732.63
Elbasan	2192.9	5804.7	9.29E+10	92875.2	40.37	1883.90
Fier	3598.8	9526.3	1.52E+11	152420.8	66.25	3091.74
Gjirokastër	393.1	1040.6	1.66E+10	16649.6	7.24	337.72
Lezhë	257.5	681.5	1.09E+10	10904	4.74	221.18
Shkodër	148.7	393.6	6.30E+09	6297.6	2.74	127.74
Tiranë	910.3	2409.6	3.86E+10	38553.6	16.76	782.03
Vlorë	2400.1	6353.1	1.02E+11	101649.6	44.18	2061.89
Total	**12771.3**	**33806.5**	**5.41E+11**	**540904**	**235.10**	**10971.83**

Types of press are generally Italian and Greek, and a few others imported from Spain. Types of centrifugal units are Pieralisi, Alfa Laval, Amendum. The number of olive processing plants is concentrated in the western part of the country, in the main olive production area. Most of them are concentrated in Durrës-Tirana, Vlorë-Sarandë and Berat. Their capacity varies from 0.6 to 1.2 tonnes / h of olives and their functioning during the year was only 22% while the season of harvesting and olive processing ranged from 35 to 45 days a year. Most of the press is mainly imported from Italy and Greece, have been used and a technology of the 70s. The same can be said for a part of the three - phase decanter. By 2005, olive oil production units' purchased accounted for 67% of their old purchases and only 33% of them were bought new. After 2005-2006 the trend of factories was the purchase of new units.

The Mediterranean region represents 98% of the world's olive tree population and for Albania it represents the most important agricultural product. In a series of studies investigating the combustion performance and drying characteristics of olive mill solid waste (OMSW), it was found that the energetic characteristics of this biomass compared to other types of biomasses like corn, sunflower, soy, teasel, etc. are relatively high. The superiority of olive mill solid waste OMSW relies on the fact that it can be found in much larger quantities, in most of the cases, with a lower cost or for free. Furthermore, considering the recent trend of new plantations of olives, stimulated by a Governmental policy which will heavily subsidy this sector in the next decade, such biomass will be readily available. However, there are also some restrictions in the availability of this specific biomass. Olive is characterised by a strong biannual production, i.e. one year it has a high yield and the next year has a very lower yield.

In Albania the olive residues that are present in the western part of the country are important energy sources. Until 2007 OMSW was not used or used very little; they often became a concern for the processors themselves who were constantly confronted with the problem of eliminating these wastes. Currently, their main use focuses on energy supply for the olive transformation unit, heating boilers in small production units, restaurants, and the primary school / nursery school near their source and the heating of greenhouse vegetables. Today, they can be an important energy alternative to the supply of consumers whether these individuals (private service restaurants, etc.) or social (school, kindergartens), both in their raw form and in their form processed (briquetting).

3.2 The Energetic Value of OMSW in Albania

Based on the *Toolbox 4 energy units, conversions, thermo - Wiley* (Morris *et al*, 2011)and the power mill value of approximately 16,000 Kjoul / kg, the energy converted to GWh and toe - butane is variable between the prefectures, according to the quantities of olives produced. The total amount of mill produced in Albania was about 34 thousand tons in 2015 and prefectured with the largest quantities were Fier, Vlora, Berat and Elbasan with> 5,000 tons per year. The total amount of energy converted to GWh was 235 and converted to Toe - butane was about 10971.83 tons (butane) (Table 2), a quantity not negligible to consider.

This energy source is distributed through processing plants, far from being used in large energy production facilities, but very efficient for small social economy units that need hot water, such as self-consumption, for self-consumption Olive processing factories and other small food industries, for heating schools of kindergartens and hospitals, as well as for heating of greenhouses and other uses in the production of electric power.

3.3 The sectoral assessment of the biomass potential with a focus on wine production and jam-fruit production industry

Agricultural sector is one of the main sectors of residues production which can be used for the production of energy. Thus, based on the evaluations of National Agency of Energy, in the future we will have a considerable quantity of agricultural residues which will increase up to 1.4 MToe/year (MoEI, 2005b). These evaluations also suggest that the quantity of energy that can be obtained yearly from the animal remnants is 350 Toe and from the animal manure 25 Toe.

The results of these evaluations show that the residues of biomass reach to a total energy of 1 – 1.5 W Toe/year.

The energy obtained is considerable, and this fact should serve to stimulate the scientific research studies in these fields. It is of great importance for the production of electric and thermal energy is the lignin-cellulose biomass. The increases of agricultural production in Albania lead to the formation of large residues which can be used for energy production (MoE, 2009).

Actually, the use of agricultural residue for energy production is very limited but it is a great potential for the future. The main agricultural sectors in Albania of biomass production are cereals, olive, wine, fruit tree, vegetables and citrus.

The figure 1 shows a considerable increase of fruit tree, vine and citrus production in Albania from year 2000 to 2010 due to the increase of planted surface area and yield of these plant species. After the year 2010, it is observed a slight increase of production especially for fruit and citrus tree.

Based on these obtained data, the trend of fruit tree, vine and citrus production in Albania is in increasing from year to year with an approximate amount of 15 ton/year for fruit tree, 4 ton/year for vine and 3 ton/year for citrus. Further, based on the potential of available agricultural area that can be planted with fruit tree, vine and citrus tree in Albania a predictive estimation of production was performed.

The calculation of predictive production trend in short and long term in Albania, was based on actual production trend, potential of available surface area for plantation, the intensification of applied technology of plant production and potential of agricultural farms to increase production and plant yield. A polynomial model of third order was used for calculations of predictive production trend for short term of the year 2020 and for long term of the year 2025.

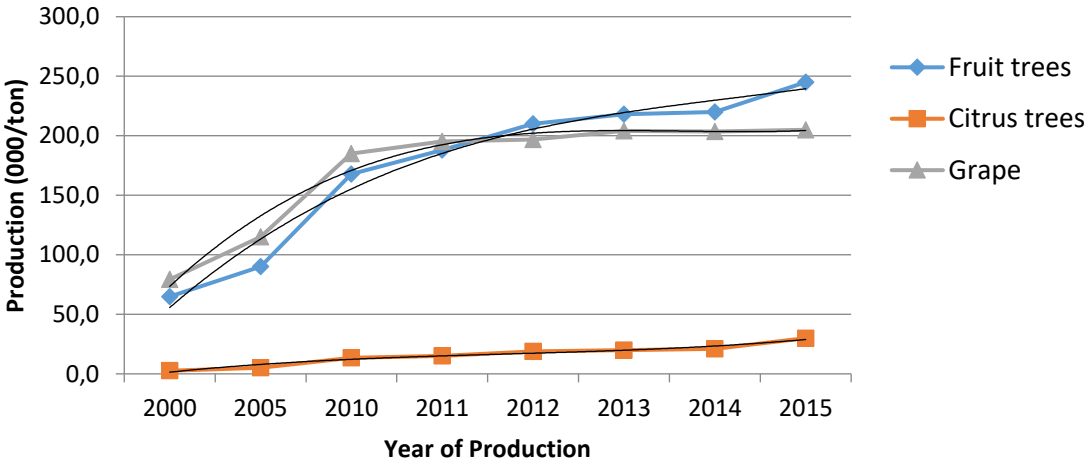

Figure 1. The trend of fruit tree, vine and citrus production in Albania

Thus, the predictive estimation of fruit tree, vine and citrus production in short term (2-5 year) indicate that production in 2020 will be about 310 ton/year fruit tree, 220 ton/year grape and 40 ton/year citrus.

The estimation of production in long term (6-10 year) indicate that production in 2020 will be about 370 ton/year fruit tree, 240 ton/year grape and 56 ton/year citrus.

3.4 Processing of fruit tree, grape and citrus and waste production

Produced fruits can be fresh consumed, exported and processed in agro-industries. The part that is processed varies according to presence of agro processing lines in different regions of Albania and type of fruit species. Actually, a small amount of fruit production is processed in Albania, in amount of 10-20 %. This amount is very low compare to the processing potential and farmer interest for increasing of economic value of fruits. The main activity of agro-processing lines are on wine and grape production and on fruit, vegetable and olive processing.

The stone fruits such as plum, cherry and peach are processed more than other fruits in different region of Albania. The processing of stone fruits is related with formation of residues that can be used as biomass for energy production.

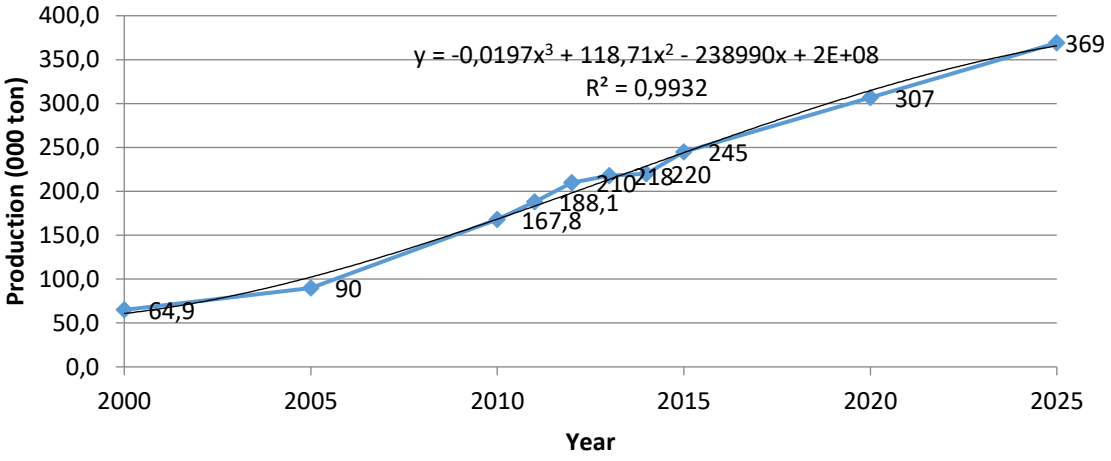

Figure 2. The trend of fruit production in Albania

The citrus fruit are not processed actually in Albania, as the processing lines of citrus fruit do not exist, but the processing of citrus fruit can be developed in the future as the production of citrus will increased up to 85% in the year 2025 compare to the year 2015.

The processing of grape in Albania varies from 50 to 70% of the production. These residues can be further processed and used as biomass source for energy production.

The fruit residues or waste left after milling and pressing of fruits for cider, juice or puree production are called pomace. Fresh fruit pomace contains usually 15-30% DM and pressed pomace 30-40% DM.

In the Table 3 are presented actual data of amount of processed fruit and grapes and the potential amount of pomace production.

Based on scenario of the increase of fruit and grape production will be also increased the amount of processed fruit and grape. Thus, the predictive amount of processed fruit in the year 2020 will be about 75000 ton or 25% of production and in the year will be about 130000 ton or 35% of production. The amount of residues from fruit processing will be about 30000 and 52000 ton, respectively.

The increase of grape production will lead to the increase of processed amount of grape and production of grape pomace. Thus, the predictive amount of processed grape in the year 2020 and 2025 will be about 135000 and 155000 ton, respectively. Thus, the amount of produced grape pomace will be about 27000 and 31000 ton for the year 2020 and 2025.

The use of fruit tree, citrus and vine tree biomass for bioenergy production encompass use of fruit processing waste or fruit pomace and use of pruned tree biomass for heating or energy production. Thus, in following are present the potential of bioenergy production from the use of fruit pomace and pruned tree biomass in Albania.

3.5 Existing barriers/risks/opportunities for the olive-oil market and other key sectors

Following sectoral assessment of the biomass potential with a focus on the olive oil sector and other key sectors in Albania, there has been indentified the following barriers: (i) Lack of availability of spaces and capital in cities to store feedstock or to build a biomass energy plant in Albania; Applications as a cooking gas, fuel for electricity generation and heat production are more accessible to individuals in the rural areas, particularly in case of olive oil production industry. In addition, residential and businesses in the cities are already connected to the grid, hence a heat and electricity generating biomass plant or stove in most of the cases is not a necessity; (ii) Public perception: the public perception of biomass energy plant is not a positive one. It is placed in the same group as a coal plant in terms of environmental pollution, which is incorrect. Contrary to that the CO_2 emissions are not well known; (iii) Community concerns in relation to the use of food produced for human consumption for bio-fuels leading to food scarcity, particularly in the rural areas where industry is mostly based; (iv) Large capital and resources are required to develop and manufacture bio-fuels from biomass that is not a food source and (v) The lack of national mechanism with Albania for supporting the biomass energy use, incentives, soft bank credits, etc.

Table 3. Production of residues (waste) from fruit and grape processing of the year 2015

No.	Region	Quantity (Ton)			
		Processed fruits	The residues (pomace) fruits	Processed grapes	The residues (pomace) grapes
1	Berat	4881	1464	15893	3179
2	Diber	4665	1399	5623	1125
3	Durrës	3221	966	9019	1804
4	Elbasan	3279	984	16528	3306
5	Fier	2513	754	18816	3763
6	Gjirokastër	228	69	8240	1648
7	Korçë	5706	1712	6419	1284
8	Kukës	532	160	3229	646
9	Lezhë	420	126	4141	828
10	Shkodër	2095	629	6487	1297
11	Tiranë	1081	324	5361	1072
12	Vlorë	298	89	15938	3188
Total		**29919**	**8676**	**115694**	**23139**

4. CONCLUSION

The situation analysis reveals that the biomass energy sector is generally not organized in Albania: there is scattered and inadequate data with not organized data collection, archiving and updating mechanisms; information about biomass energy and its contribution to Albanian's social, economic and industrial growth are not well known; there are few or no renewable energy awareness campaigns but some parts of the advice e.g. government entities, policy makers, legislature are relatively targeted; Key responsible government agencies are highly concentrated in small and medium scale hydropower plant production in Albania, while not having in place a biomass regulatory mechanism, etc.

The national mitigating the effects of climate change and securing sustainable energy and raw material supplies are two of the key challenges that country face (similarly to the global ones). These elements and issues are taken into consideration in the revised National Strategy for Development and Integration for the period 2014-2020. The strategy is looking on (i) fostering a viable, high quality food production by developing a competitive and innovative agro-food sector, able to sustain the competitive pressure in the domestic and EU markets and meeting EU standards and market requirements; (ii) sustainable management of natural resources and climate adaptation actions through smooth management of forests and water and application of environmental-friendly agricultural production methods; (iii) Balanced territorial development of rural areas, promoting diversified economic activity, creation of jobs, social inclusion, and improved living conditions; (iv) Diversify tourism products extended in the whole territory to ensure integrated tourism development.

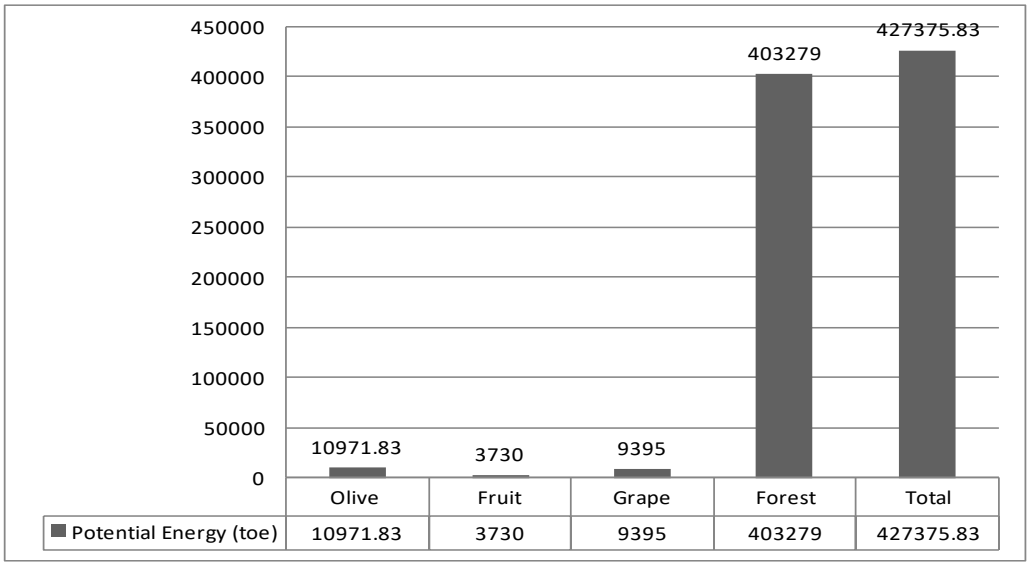

Figure 3. Theoretic, technical and economic potential of each category of biomass

Substantial development of bio-energy technologies is needed in Albania, mainly to improve the rate of production, efficiency, reliability and sustainability of bio-energy chains. In the energy sector, improvement would lead to cleaner, more reliable systems linked to higher quality fuel supplies. In the electricity sector, the development of smaller and more cost-effective electricity systems could better match local resource availability.

Following the sectoral assessment of the biomass potential with a focus on the olive oil sector and other key sectors in Albania, including wood processing, wine production and jam-fruit production, it can be concluded that theoretical, technical and economic potentials for biomass for energy generation are estimated to be about 4.27 Mtoe, with biomass of fruit and olive waste & agricultural production biomass contributing up to 1.52 Mtoe of the theoretical potential and about 1.35 Mtoe to the economic potential (Figure 3).

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