The International Journal Of Engineering And Science (IJES)
|| Volume || 4 || Issue || 11 || Pages || PP -19-32|| 2015 ||
ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805

Analysis of Economic Market and Energy Potential Indicators for Biomass in Sicily

Matarazzo Agata - La Pira Federico
Department of Economics and Business, University of Catania , Corso Italia, 55 – 95129 Catania (Italy)

----------ABSTRACT----------
The word biomass refers to organic matter, mainly vegetable, terrestrial or marine matter both wild and cultivated by man, produced by using the process of chlorophyll photosynthesis with the help of energy from solar radiation, water and nutritive substances.
The aim of this paper is to understand, by using the statistics produced for the purpose, the performance and potential of the biomass market in all the Italian regions, especially in the region of Sicily, where there are still unexploited areas particularly suitable for production of biomass.
By processing the data, it has been possible to give a detailed description of the Sicilian energy scene in order to investigate energy production from renewable sources more deeply both in terms of the number of plants as well as in terms of installed power. In particular, emphasis is given to the present diffusion of biomass in the region, identifying the criticalities which exist, the evolutionary dynamics and future potential that the island can offer in this innovative energy sector in terms of employment, environmental impact and development of the market.
The analysis carried out can be useful as a basis in implementing strategy of development for the production of biomass in different Italian areas, in order to contribute to a sustainable and balanced development of the territory revitalizing some agricultural sectors and the creation of agro-energy districts.
KEY WORDS : Bio-energy - biomass plants- productivity- market segments- economic index- Environmental impacts- Sicilian economy

---

Date of Submission: 23 October 2015 Date of Accepted: 31 October 2015

I. INTRODUCTION

The term biomass refers to organic matter, mainly vegetable , terrestrial or marine matter, both wild or cultivated produced by chlorophyll photosynthesis with the aid of solar radiation, water and nutritive substances Biomass therefore refers to all those products from farming, forestry, farm production waste and food industry waste products, all the organic products coming from biological animal activity, the organic part of solid urban waste and sea-weed(1). Depending on the chemical-physical features , biomass can be burnt directly or transformed into solid , liquid or gaseous fuels. Therefore , among the different types of biomass , agricultural ones like waste products from crops intended for human or animal consumption or plants specifically grown for energy purposes like false acacia trees or Spanish broom stand out. Energy farming which assumes the selection of the most suitable species to be used, on quick rotation , for the exclusive production of energy in order to maximise returns and minimize the production cycle is of particular interest.
If ,on the one hand biomass is a renewable energy source or neutral as far as the green house effect is concerned, in as much as the carbon dioxide emitted during production is more or less the same quantity which is absorbed by the same plants during the process of photosynthesis, however their burning introduces substances like dust, hydrochloride acid, sulphur dioxide, nitrogen oxide and carbon monoxide into the atmosphere. On the other hand biomass is not available all year round and therefore plants using biomass as fuel need large areas to store the material that is made available only once a year. Moreover, in comparison to fossil fuels which are basically found in large scale underground beds, biomass production generally takes place in very high areas. This perhaps is the main limit to their exploitation and the place where the biomass comes from is often very far from the plant; all this certainly constitutes a disadvantage in the use of such fuels. The energy contained in biomass can be used directly for the production of thermal energy in the combustion process, traditional or dominant use, or for the production of electricity combined with thermal energy or concentrated in a variety of solid, liquid, gaseous fuels so as to make the transport and final usage easier. The most suitable biomass to undergo thermodynamic conversion are wood and all its by-products (sawdust, wood shavings), the commonest cultivation by-products of cellulose woody type (straw from crops, waste from vines and fruit orchard cuttings) and also production waste. Instead, water culture ,(some crop by-products leaves and pieces of beetroot,

potatoes), livestock waste, production waste as well as some types of urban and industrial waste are suitable for biochemical conversion .

The burning of vegetable biomass to produce heat is definitely the best-known process for producing energy. In order to produce electricity from combustion it is necessary to perform other conversions, usually by heating water which by producing steam drives a turbine connected to an alternator; thus thermal energy as steam is turned into mechanical energy by a turbine, as well as electricity, making large quantities of heat available that can be used for district heating networks. In order to heat residential areas it is however necessary to build a transportation and distribution plant which has very high costs(2).

Anaerobic digestion is a typical process of biomass biochemical conversion used for producing energy, a process using bacteria which has as its final result the production of biogas, with a mixture that contains about 60% methane gas.

II. THE PRODUCTION OF BIOMASS IN ITALY.

The ministerial decree "Burden sharing" issued on 15th March 2012 (3) implemented the provisions of Article 37 of the ministerial decree number 28 of 2011 (4) and fixed the targets both thermal and electric for renewable energy production for each source and for each region, defining : methods for deciding on and achieving the targets for the regions and the independent provinces, the methods of monitoring and checking the achievement of these targets and the methods of handling cases of non-achievement of these targets. Most of the plants fuelled by bio-energy are in the North of Italy with an important percentage equal to 74%. Of the 544 new plants surveyed a good 158 of them are in Lombardy , which has doubled the size of its plants compared to the previous year. On analyzing the situation from the point of view of generating capacity it can be noted that about 60% of the power is found in the northern regions of Italy. Lombardy excels again with 655 megawatt. Friuli-Venezia-Giulia stands out for the increase in terms of percentages both in the number of plants and for the generating capacity, respectively +314% and +230%.In Central Italy , the Marche region records an increase in power by 31% compared to 2010 while in the South the Abruzzo region records a growth in power of 62%(5).Sicily made significant progress from 2010 to 2011, increasing its plants by 209% with a significant increase in bio-energy power at the end of 2011, illustrated in detail in the table here below, it can be seen how the highest number of plants exists in Lombardy with 26.3%, followed by Emilia Romagna with 12.7%. In Central Italy, Tuscany and Lazio have respectively 4.8% and 3.4%, while Sicily in the South of Italy is the leader with 2.8%.

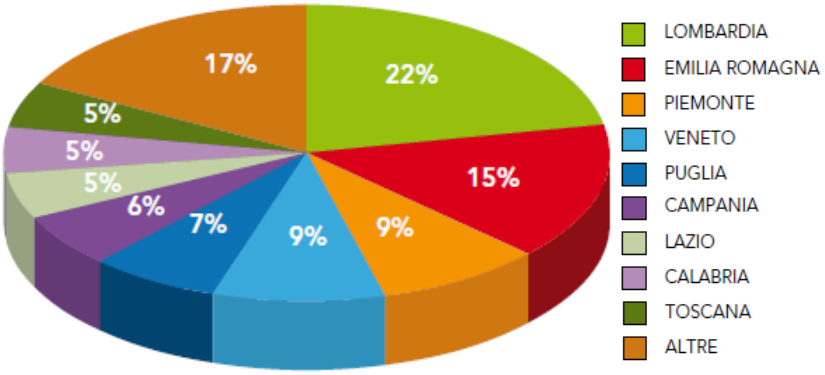
Table 1: Numbers of plants and Bio – energy Power in the Italian Regions

Regions	2010		2011		2011 / 2010		Variation %
	n°	MW	n°	MW	n°	MW	
Piemonte	62	119,9	129	175,4	108,1	46,3	
Valle d'Aosta	2	0,9	2	0,9	0,0	0,6	
Lombardia	161	525,1	319	655,4	98,1	24,8	
Trentino Alto Adige	69	47,5	111	70,6	60,9	48,5	
Veneto	71	142,3	149	209,7	109,9	47,4	
Friuli Venezia Giulia	7	23,1	29	76,3	314,3	229,6	
Liguria	10	17,0	10	19,6	0,0	14,8	
Emilia Romagna	90	423,2	154	477,5	71,1	12,8	
Toscana	41	125,3	58	134,2	41,5	7,2	
Umbria	13	27,7	21	35,5	61,5	27,9	
Marche	22	18,4	33	24,0	50,0	30,6	
Lazio	24	128,0	41	160,2	70,8	25,2	
Abruzzo	7	6,4	14	10,3	100,0	61,7	
Molise	3	40,7	5	42,2	66,7	3,7	
Campania	22	214,8	26	210,3	18,2	-2,1	
Puglia	25	220,6	32	228,6	28,0	3,6	
Basilicata	5	32,2	6	32,7	20,0	1,4	
Calabria	12	121,9	22	130,6	83,3	7,2	
Sicilia	11	42,2	34	53,9	209,1	27,9	
Sardegna	12	74,3	18	77,6	50,0	4,3	
ITALIA	669	2.351,5	1.213	2.825,3	81,3	20,1	

Source: MES – Managers of Energy Services – Report 2011

According to regional distribution of installed power in 2014, Sicily is last in the national rankings with a modest 1.9%, managing to overtake only the smaller regions like Basilicata, Molise, Umbria, Marche, Abruzzo , Liguria and the tiny Valley of Aosta. Instead, in the North there is the dominance of Lombardy with a percentage of 22% and Emilia Romagna with a value equal to 15%.(5) , as shown in the graph n.1.

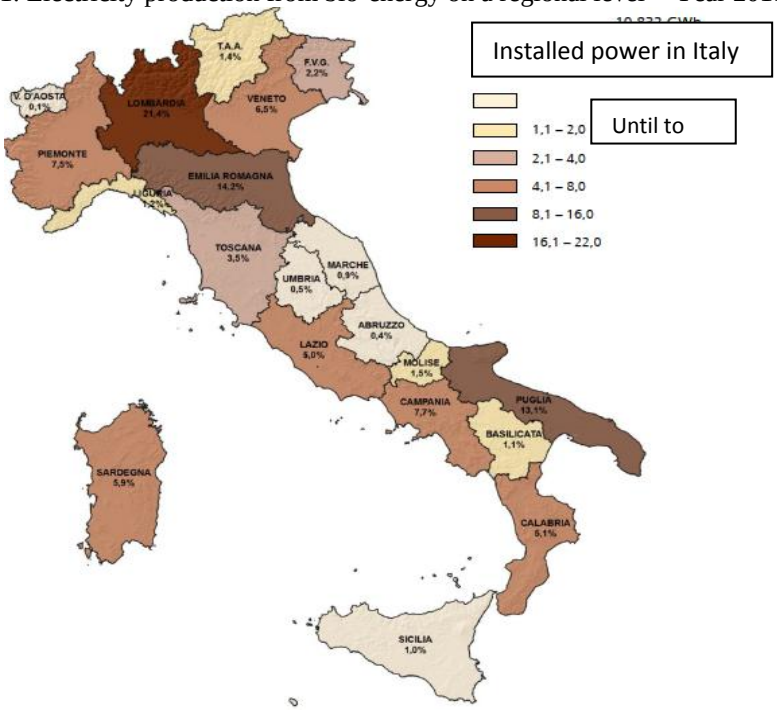
Graph 1:Biomass Power Distribution in Italy (in %) – Year 2014



Source: Politecnico di Milano – Renewable Energy Report – 2015

In 2011 electricity production from bio-energy on a regional level, shown in the figure below, see Lombardy as the national leader in total production with 21.4% followed by Emilia Romagna with 14.2% and Puglia with 13%. Sicily has a total production from bio-energy equal to 1% and is only higher than the Valley of Aosta and Abruzzo straggling at the bottom of the list. Sicily , moreover, is one of the few Italian regions together with the Valley of Aosta and Umbria that does not manage to convert waste-to-energy of biodegradable urban waste or manage to exploit any other type of biomass.

Figure 1: Electricity production from bio-energy on a regional level - Year 2011

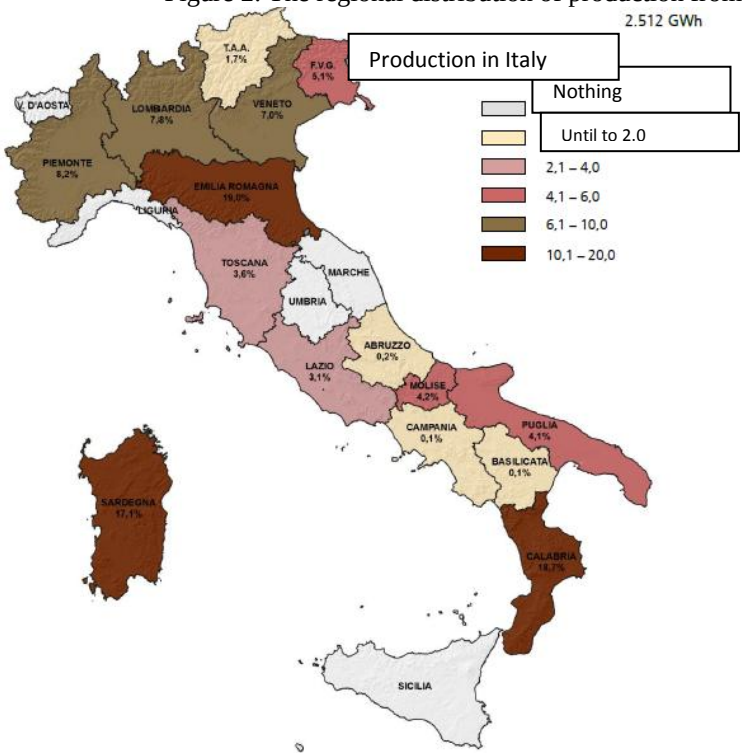


Source: MES – Managers of Energy Services – Report 2011

Further details can be gained about most widely used bio-energy sources in each region by examining each type of biomass individually on a national level. In order of regional production of bio-energy, the North of Italy always has the regions with the highest values, Lombardy with 21.4% and Emilia Romagna with 14.2% but 13.1% in Puglia and 7.7% in Campania demonstrate that the South also makes a significant contribution. Both Lazio and Veneto's percentage weight improve, bringing their quotas respectively to 5% and 6.5%. Unfortunately, Sicily manages to do very little, the region contributes just 1.1% to national production demonstrating its technological backwardness.

The regional distribution of production from other biomass (Figure n.2) shows a good spread of this type of fuel in northern Italy where Emilia Romagna stands out with 19%. In central Italy Tuscany with 3.6% and Lazio with 3.1%have the highest values. Among the southern regions Calabria stands out with 18.7% of the national production. Sardinia accounts for 17.1%. Sicily is totally absent from the production of other biomass demonstrating , also in this sector, a total inability to diversify its own supply of energy sources and an energy planning which is basically ineffective.

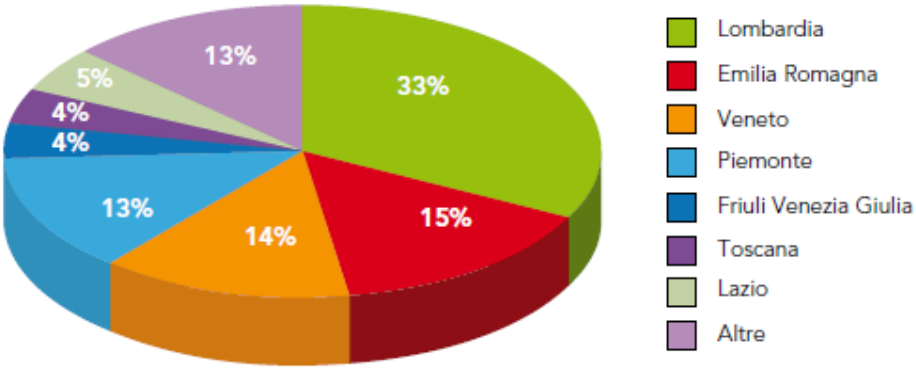
Figure 2: The regional distribution of production from other biomass – Year 2011



Source: MES – Managers of Energy Services – Report 2011

As far as the exploitation of biogas energy in 2015 is concerned, the regional distribution is as widespread as for the other types of bio-energy examined beforehand, in the north of the country. Northern Italy contributes 78.3% of the national production and Lombardy manages to produce almost a third of the national production with its 33%, but Emilia Romagna is also worth noting with 15% and Piedmont with 13%. In central Italy there is a modest contribution from Lazio with 5% and Tuscany with 4%. Sicily, with other regions, contributes to the national production with a modest 2.6%, notwithstanding an unexploited potential that could guarantee at least three times the current production levels.

Graph 2: Regional distribution of biogas Production – Year 2014

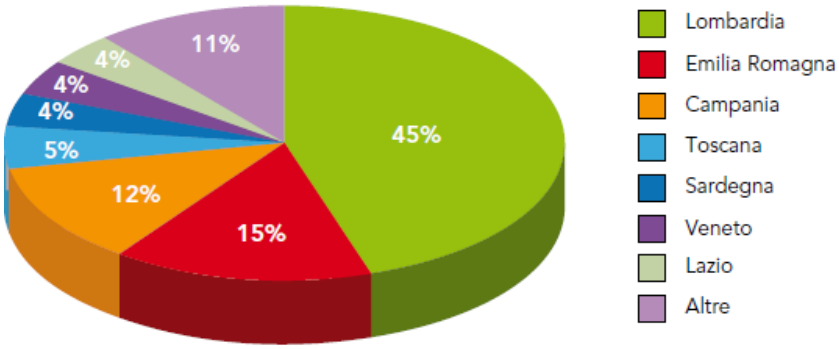


Source: Politecnico di Milano – Renewable Energy Report - 2015

The regional exploitation of solid urban waste is another national source of energy used and supported by infrastructures, such as waste-to-energy plants, essential for the energy exploitation of solid urban waste. The regional leader of biodegradable urban waste production is once again the north of Italy (graph 3). Lombardy has the highest percentage with 45%, while in central Italy Lazio has 4% and in the South Campania has 12%.

The production of biodegradable urban waste is totally absent in the regions of the Valley of Aosta, Umbria and Sicily. Despite three Sicilian projects for the conversion of waste-to-energy planned by the provinces of Siracusa, Palermo and Catania, Sicily is totally lacking in the ability to take advantage of this opportunity because of a totally inadequate management on behalf of the Regional government of the projects in accordance with the feasibility of these same projects.

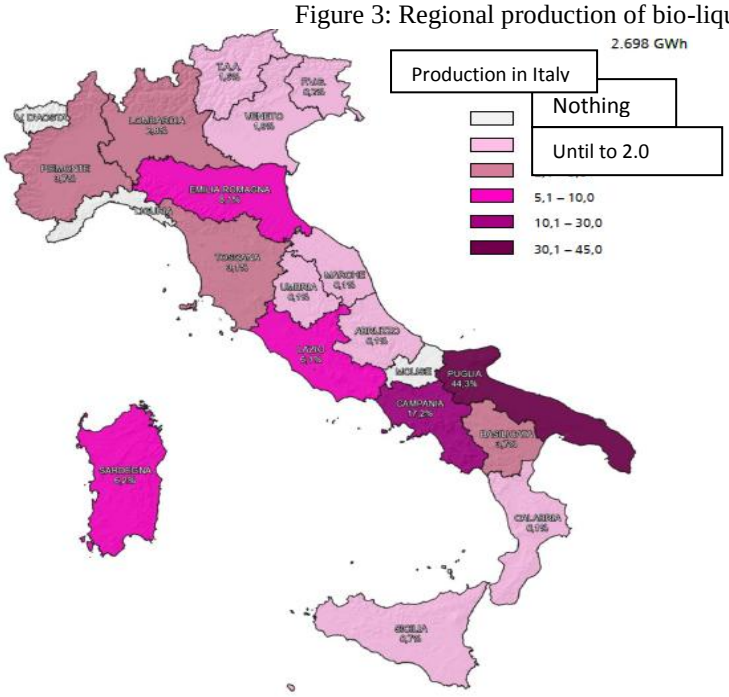
Graph 3: Regional exploitation of solid urban waste



Source: Politecnico di Milano – Renewable Energy Report – 2015

The last source of energy to examine from the point of view of regional production is that of bio-liquids . Their regional production in 2011 sees as leader not a region from the north but rather one from the South: Apuglia. With 44.3%, Apuglia is the main producer in our country followed by another southern region such as Campania with 17.2%. Sicily with its modest 0.7% is straggling behind in this field on a national level. It is, moreover, interesting to underline the largest production of this bio-energy source is in the southern regions while it has a modest diffusion in regions in the north of Italy and point out that it is totally absent in the Valley of Aosta and Liguria.

Figure 3: Regional production of bio-liquids – Year 2011



Source: MES – Managers of Energy Services – Report 2011

III. PROSPECTIVES FOR THERMAL ENERGY FROM BIOMASS SOURCES

The national plan of action for renewable includes by 2020 a contribution to energy production by biomass equal to 5720 Ktep for the thermal component and 3580 Ktep for electricity. After the territorial recognition of available biomasss in Italy, however, the really available potential for the thermal component is 1537 Ktep with a decrease of 70%. As for electricity, the original forecast of the NPA (National Plan of Action, PAN in Italian)

of 3580 Ktep turns out to be , after territorial checks, over 5400 Ktep with an increase of 52% compared to predictions. In order to manage to exploit the whole thermal potential obtainable from biomass by 2020 it would be necessary that installed power by 2020 reaches 4.4.GW and the investment necessary would be equal to €5.5billion. Calabria, Puglia, Emilia, Tuscany and Sicily would count, on the basis of this perspective , for about 55% of the total of plants on a national level. If thermal production is looked at only in the region of Calabria it has exceeded the set target of the Burden Sharing decree while Puglia is about to do so.
As far as electricity is concerned , in order to be able to exploit the entire potential obtainable from biomass by 2020, it would be necessary to install from the period 2012-2020 another 3.2 GW, thus doubling the installed power which exists today. The investment necessary to achieve this target mentioned above would be equal to €12 billion. Lombardy, Puglia, Piedmont, Veneto and Sicily would be able to contribute for 60% of the new installations on a national level on the basis of this perspective. Most regions would be able to substantially exceed targets for electricity production from biomass. Only Trentino and the Valley of Aosta, as shown in table 2 here below, would be significantly far from reaching the fixed target for electricity production from biomass, being theoretically able to produce respectively 28% and 12% compared to the target (7).

Table 2: Electrical Energy Regional production and relative objectives

Regions	Total Electrical Energy potential productive (ktep)	Objective Electrical Energy from biomass (ktep)	Achievement Objective in 2020 (%)	% Achievement Objective
Puglia	726.2	144.9	501	Regions over objective (>100%)
Campania	444.4	173	257	
Emilia	489	201.6	243	
Lazio	301.3	133.1	226	
Liguria	50.2	24.3	206	
Lombardia	912.6	457.8	199	
Veneto	365.5	194.9	188	
Calabria	269.3	144.4	186	
Sicily	432.7	245.2	176	
Piemonte	530.7	307.4	173	
Abruzzo	108.7	76.8	141	
Marche	74.4	56.2	132	
Sardegna	188.8	175.9	107	
Molise	47	53.3	88	Regions near objective (100-60%)
Basilicata	74.9	98.2	76	
Umbria	57.7	76.8	75	
Toscana	231.7	322.9	72	
Friuli	60	89.4	67	
Trentino	89.6	317.9	28	Under objective (60-20%)
Valle d'Aosta	12.6	100.8	12	Far to objective (<20%)
Total in Italy	5467	3571.6	152	

Source: Biomass Energy executive report

At the end of 2020 if all the potential was exploited we could produce 29,236 GW for electricity from biomass with a +152% compared to the target and 17,870 GW for the thermal part with a +26.8% of the target (8).
In conclusion, thermal production is less critical from the point of view of convenience but it is more so if actual potential is looked at. Above all it is evident how the South, or rather the least needy areas of heating is the only one to be able to respect the commitments foreseen by Burden Sharing, Electricity production is instead decidedly less critical for potential but will be greatly penalised by the revision of the incentive system. The regional imbalance shown will make it necessary moreover to rethink the distribution of burdens in order to effectively direct the plants in the areas to greater potential.

IV. ENVIRONMENTAL IMPACT OF BIOMASS PLANTS.

Data recently released by the MES – Managers of Energy Services(GES in Italian)show how the number of biomass plants in Italy has increased considerably in the last three years and how the production of biogas has grown at a growth rate of 17.7%.However, it must be said that Italy still undervalues biomass resources

notwithstanding the high potential which the offer. To talk today about biomass means therefore to try to give a boost to a sector that could represent an important source of wealth for the Italian economy, not only from the point of view of energy but also for employment with the creation of new jobs and professional roles. It is fundamental to start up a development strategy for short production biomass , or rather biomass that allows really ecological green energy to be obtained, safeguarding at the same time the specificity of the Italian situation. Indeed, only through drawing together waste and the plants that transform this into energy is it possible to avoid the environmental impact that the transport of this material entails.(9). As far as the first generation "renewable" fuels are concerned, both the agricultural and the industrial interests of alcohol fuel that can be produced , in fermentation plants even from by-products and agricultural waste of from the same agro-food industry, from scrap lumber and even from scrap paper that cannot be recycled should kept in mind. The subsequent refining could take place in existing and under-used distilleries with the help of technology.

This would contribute to a sustainable and balanced development of the territory , it would allow for the improvement of the rural sector, a revitalization of some agricultural sectors, as well as the creation of new industrial initiatives and/or agro-energy districts. From the point of view of the use of biomass and its by products can take on a strategic role in the development of many areas also in inland areas of the North and of the South of Italy with positive repercussions for employment. From the environmental point of view the use of bio-diesel , for example, means among other things a reduction in the emissions into the atmosphere of carbon dioxide and of un-burnt hydrocarbons. Not containing sulphur, sulphur dioxide- a pollutant -is not produced, and there is a greater efficiency for catalytic converters. Compared to diesel, bio-diesel has less smoke from exhaust pipes and from heating systems, it does not entail dangers like self-combustion , during transport and storing and its production it can take place using biomass from agricultural crops. Finally in the production cycle of bio-diesel by-products are formed which are real products and secondary materials with high added value both in terms of energy and of cost.

However, it should not be forgotton that the production of first generation bio-fuels made from sugary, starchy or oily crops could cause competition for the land and water taken from food production causing a rise in prices of agricultural products; in this regard, it should be noted that the Food and Agriculture Organization (FAO) has expressed strong doubts about the sustainability of agricultural crops dedicated to the production of bio-fuels, notwithstanding the undeniable advantage that the latter have compared to fossil fuels due to their lower emissions of green-house gas. A convincing answer to the prospects of bio-fuels can only be given by a careful balance of the benefits compared to the costs that can be entailed with the loss of biodiversity and perhaps also even by a negative balance of the emissions of carbon dioxide, if the stages of transport, processing and the whole life cycle are taken into consideration(10).

Every biomass power plant project should present a careful analysis of the life cycles of the plant with reference to the balance of green house gas, carried out using established procedures: emissions of green house gas in the cultivation phase, harvesting and transport of the biomass to the plant; during the use of fossil fuels included in the start up stages of the boilers; in the pre-treatment and transport of the ashes to their final destination; in the construction and the dismantling of the plant and during the reclamation of the area at the end of the plant. In the balance of green house gas related to the activity of the plant, the carbon present in waste from agricultural activity and not buried should also be counted , according to established agricultural practices designed at maintaining an adequate and continual content of humus and carbon in farm land. In favour of the construction of the plant, of course, the green house gas saved from avoiding the use of fossil fuels to produce electricity should be counted, on the basis of the renewable sources and non renewable sources used in Italy to produce electricity.

Biomass used as fuel , even after the purification of the flue-gas produced, causes emissions into the environment of undeniable quantities of several macro and micro ultra-fine pollutants, nitrogen oxide, polycyclic aromatic hydrocarbons, dioxins, in proportional quantities to the biomass treated, with potentially dangerous effects for the health of the population exposed to them. And in the environmental balance , the emissions produced by heavy traffic caused by the plant starting to work and by the main working of the plant itself should also be counted, or rather all the vehicles necessary for the transportation of biomass and for the removal and disposal of the ash.

The management of the ash produced by biomass is not a simple issue. The biomass plants inevitably produce ash of about 0.5 and 0.7% in weight compared to the quantity of material treated, but if dried lumber is burnt, but percentages are higher if biomass like straw that leaves a residue equal to 15.5% of the weight of the straw burnt is used, clearly a higher value of ash is produced from carbon equal to 7%. Another crucial problem is the level of toxicity of the ash and in particular flying ash collected by the flue gas purification plant which contain metal pollutants like cadmium, chromium, copper, lead and mercury. Moreover, the content of these metals aforementioned and the content of the flying ash coming from the burning of lumber , specifically beech, oak and fir turn out to be higher quantities than those found in the ash produced by the burning of carbon. The burning of woody biomass entails the emission into the environment of important quantities of

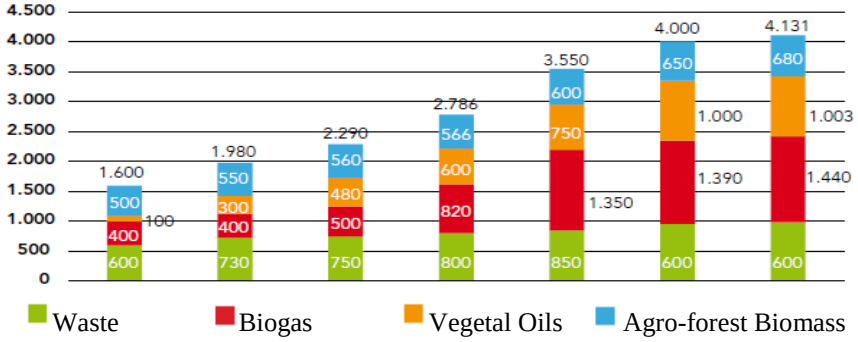
polycyclic aromatic hydrocarbons that vary depending on the fuel and the type of plant used. The highest concentrations of APH aromatic hydrocarbons between 2.225 and 4.999 ug/m have been recorded in plants feed by dry birch.

V THE BIOMASS MARKET

The use of biomass is spreading in Italy. Notwithstanding the problems tied to legislation that pays little attention to the sector, it continues to record noticeable growth trends at least in some sectors. Biomass is a source with very interesting potential, shown for example by the increasing spread of small and medium size plants throughout Italy and , in particular, in the northern regions. One development that has come up against an obstacle: that of government incentives, ineffective, and they create a barrier for the construction of even bigger structures. In order to better understand the biomass market and its performance, it is useful to have the support of statistics in terms of production. In 2010 for example biomass agro-forestry supplied 5.6 megatons of oil in energy , about 2.9% of the country's total energy requirements, recording a 7% increase compared to 2009.The total installed power is 8140 thermal megawatts and 550 electric megawatts.70% of the installed power comes from plants with a higher megawatt, currently supported by incentives from green certification. The sector has a turnover of more than €2.1 billion , growing by more than 15% annually compared to 2009.This data, however, remains difficult to assess given the great weight of the hidden economy, especially in the use of thermal power. Biogas is the sector which is booming.. The installed power in Italy during 2010 grew by 20% compared to the previous year and the number of plants by 13%. Turnover is estimated at more than €900 million , recording a surprising 60% more than 2009, a growth that is almost entirely due to farm and livestock biogas (80% of the plants); the installed power of the plants from dumps has remained constant , a clear sign of the saturation of this sector of the market(11). Among the biomass , however, the fastest growing source is that of vegetable oils. At the end of 2010 there were more than 620 electric megawatts actually installed, recording a leap of 60% compared to 2009. Another controversial source which is strongly based on imports is that of bio-fuels. The Italian production capacity , third in Europe, has remained steady as far as diesel is concerned while it has collapsed as far as ethanol is concerned. About 700,000 tons were produced while consumption has almost doubled, passing to 740,000 tons in 2008 and more than 1.32 million tons in 2010. Imports are increasingly important: in 2008 29% of the total used was imported, in 2009 36% and in 2010 it reached 51%. Italian companies are substantially at a standstill and somewhat incapable of grasping the potential that bio-ethanol also can hold. In 2011, the biomass market, instead, showed that it was moving at three different speeds; sustained growth in the new farm bio-gas and pellet boiler installations , a slight growth in the district heating plants and those feed by woody and farm waste and finally, almost zero growth for the plants using vegetable oils and those related to the recovery of energy from solid urban waste. The differences in performance are attributable to three different factors: significant differences in costs and in performance inherent to the varied technology for the production of energy from biomass, differences in features of the various segments of the market which the technology is used for, difference in impact of incentives and regulations currently in force.

The regions with the most installed power, as shown by the graphical divisions (Graph 4), are those in the north such as Lombardy, Piedmont and Veneto also due to the availability of raw materials.

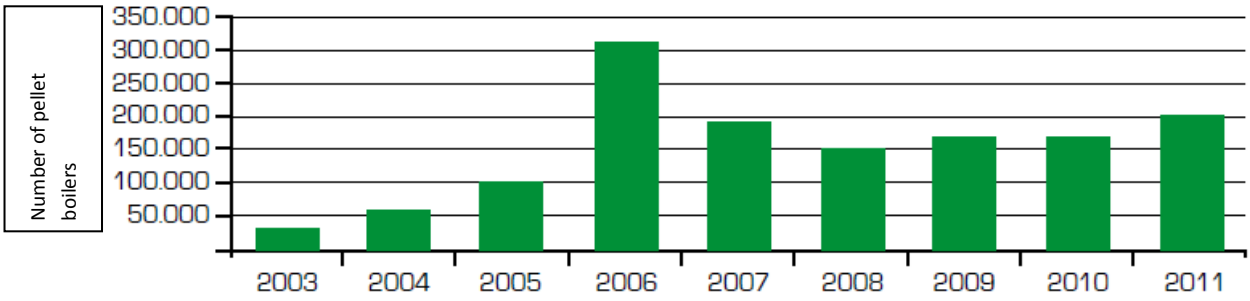
Graph 4: Installed power biomass in Italy – Year 2014



Source: Politecnico di Milano – Renewable Energy Report - 2015

The other market which is booming is that of the pellet boilers. After the boom of installations in 2006 and the subsequent tensions in the pellet market , the number of new stoves and boilers was relatively stable at around 150,000 units a year, even if in 2011 as shown on the bar chart below the last three years have set a record with about 200,000 units being sold. In 2011, in Italy pellet production reached 500,000 tons. The whole national production was totally committed but it was not, as shown on the graph, enough to meet domestic demand that exceeded 1.9 tons per year.

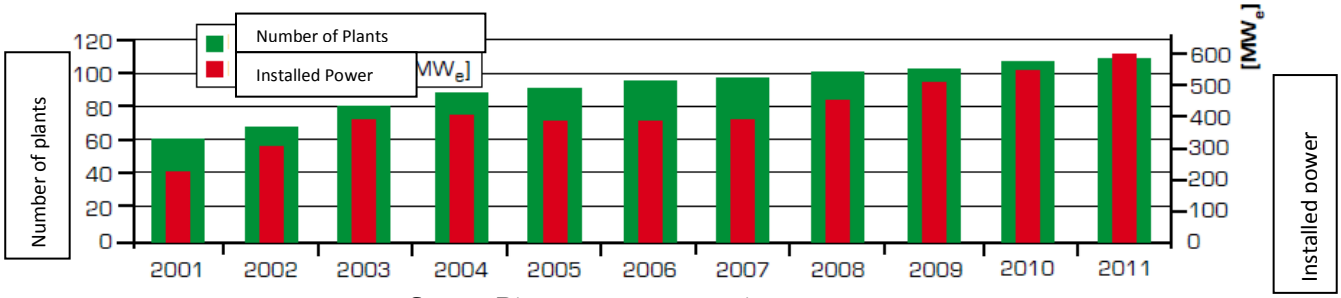
Graph 5: Pellet boiler market in Italy – Year 2011



Source: Biomass Energy executive report

The agro-forestry and district heating markets , however, have been those relatively at a standstill. The agro-forestry biomass market did not record any significant changes during 2011. The growth in the last year caused above all by medium sized plants-a small growth, that is less than 5 megawatts, as shown by the histogram (Graph 6), stood around 5% and has reached a quota of 600 electric megawatts of installed power.

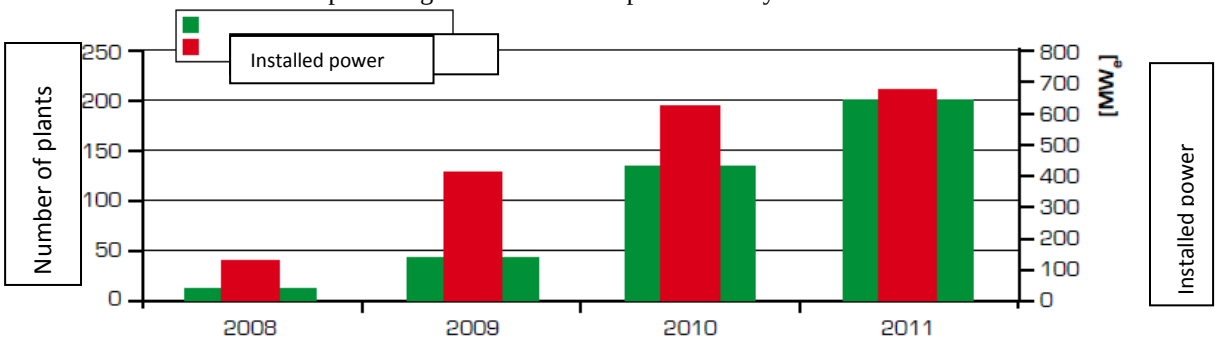
Graph 6: Agro-forestry installed power in Italy – Year 2011



Source: Biomass energy executive report

The district heating networks at the end of 2011 were more than 250 and produced thermal energy fed by agro-forestry biomass for a total power of over 470 megawatts. The markets of vegetable oil and exploitation of solid urban waste underwent a sharp slowdown. The market for the production of energy from vegetable oils experienced a real boom between 2008 and 2010. During 2011, due to the instability of the price of raw materials on international markets together with increased constraints on the origins of oils, as shown in the graph n.7 below there was a sharp slowdown with a decrease of 75% , installations for only 50 electric megawatts and also extremely fractioned unit power.

Graph 7: Vegetal Oils installed power in Italy – Year 2011



Source: Biomass energy executive report

VI. MARKET SEGMENTS

There are four market segments that exist or rather the type of clients that can adopt such technology in order to satisfy their needs : They are: domestic clients; non residential clients; industrial clients; energy producers.

Domestic clients use energy supplies produced by biomass essentially for average thermal consumption for heating and hot water in the home. The horizon of reference along which these clients assess the investment in technology for the production of energy from biomass is typically long-term and is not significantly affected by variations in profitability. These users are , however, particularly sensitive to the invasiveness of the technological solution used, bearing in mind both the reduced space which is usually available and the independency of the individual user.

Less than 1% of these, above all in the South and in general in rural areas, is nonetheless autonomous from the point of view of satisfying the thermal needs, while most of the domestic users in the North , or rather those with a higher energy demand for heating, is concentrated in highly urbanised areas.

The second segment of the market observed is that related to non-residential clients or farm-house hotels and country houses. As far as this segment of the market is concerned , the direct availability or however direct proximity of agro-forestry raw materials to be used represents a distinctive feature , while there are fewer limitations on space and freedom of action than for the domestic users. Beside the economic aspect that begins to play an important role, the connotation of green technology for the production of energy from biomass becomes a marketing tool for this type of structure. If the average size of a farm house or country house in Italy is considered the relative thermal needs of about 165KWh thermal/m²/year and 140kwh/m²/ year for electricity can be estimated .

Among the non-residential clients are not only those of farm houses and country houses but we also find shopping centres, sports centres and service centres. For these structures the use of biomass for the production of energy can be functional both to cover thermal and electric needs. For this type of structure, there are no limits either of space or on decision making, the supply of the biomass can only take place through the activation of an *ad hoc* supply process. The activation of an advantageous supply process of biomass also influences the choice of the size of the plant to build, taking on an economic value , in terms of *pay-back* of the investment, extremely significant in deciding whether to adopt or not such an option. If we only consider the shopping centres, which an updated survey is available for, it is possible to identify in over 2,000 buildings belonging to this segment of the market in Italy with an average size over 5,000 square metres.

Among the non residential clients, however, the buildings which can exploit the potentials of biomass the best are those of the public administration. State offices, schools, hospitals can use biomass to satisfy both the thermal needs as well as the electricity needs. On average schools and offices consume, for an average surface area of 3,000 square metres, 110 KWh/m²/year for electricity needs and 105 KWh/m²/year for heating needs. However , the needs of hospitals is higher even with reference to an average surface area of 5,000 metres square which reaches about 120 KWh/m²/year for electricity and 180 KWh/m²/year for heating(11).The sizing of these plants is based on the availability of biomass which the companies have or which it is possible to have supplied by using sustainable and economically advantageous supplies. The cost is decisive in the choice of investment, while the procedural aspect if on the one hand is slimmed down by the easiness in obtaining authorizations and also by the possibility of intervening on the network infrastructures, on the other hand is made more problematical by the necessity to use a selection procedure of state tenders for works of significant importance . The public administration buildings in Italy represent an important part of the non- residential real estate property. In particular there are 15,000 state offices, 55,000 school buildings and universities and 1,500 hospitals. Compared to the total number of buildings used as offices in Italy those of the state represent about 20% of the total.

Another segment that merits being analysed is that of the industrial clients or producers and processors of raw materials. Producers of raw materials are firms like farms, livestock enterprises, farming activities or forestry firms that produce agro-forestry raw materials at the origin necessary as input for the technologies of energy production of biomass. The energy needs of these companies is relatively limited and comparable to that of a small residential complex(12). The decision to invest in bio-energy is closely linked to economic profits guaranteed by the savings on supplies of fuel for thermal production or electricity and which are used to sustain farming activity or livestock breeding, bearing in mind the availability of the raw material needed.

The processing firms of agro-forestry raw materials that can exploit on the one hand, just like the producing companies, the availability of the raw material and on the other hand have greater energy requirement tied to the industrial processes of manufacturing. Examples of firms belonging to this segment are those of the food industry, wood working, nurseries, greenhouses and wine producing companies. The number of businesses and their geographical localization is strongly influenced by their specific type of production process. For example, the wine producing companies are over 380,000 for a total surface area of about 632,000 hectares and an average surface area of 1.6 hectares.

Finally, the last segment of the market to analyse is that of the energy producers themselves. Here we find the firms whose main aim is both the production and sales of electricity or thermal energy. Considering that this type of operator is not tied to supplies, but that biomass input must be obtained through an *ad hoc* supply channel it is only the cost factor, as opposed to alternative investments in renewable resources, that guides the choice of a particular technology.

VI. BIOMASS POTENTIAL IN SICILY.

Sicily has a land surface area of 2.6 million hectares of which 15.2% of the land is on lowland, 61.4% on hills and the remaining 24.2% on mountains. The territory is very mixed, influencing the types of farming carried out (13) as a result. Indeed it varies from systems of intensive farming along the coastal areas , represented by the

fruit and vegetable growing , flower growing and to a lesser degree citrus fruit growing, then moves to inland areas where an extensive farming exists, mainly made up of crops and livestock farming. On this basis a whole series of problems arise defined by the excessive fragmentation of the farms, by the insufficient and reduced maintenance of the infrastructures in existence, by the lack of processing and manufacturing plants for local produce. All this contributes, together with the isolated situation of the island, to explaining the reduced profitability of agriculture. Structural difficulties often force farmers to plan production plans that reduce the running costs as much as possible, penalizing the operations which require a greater use of labour. So, despite good agronomic practice suggesting annual pruning cycles which don't use pruning shears too dramatically , it is common to witness situations where pruning is carried out twice, three-times or even five times a year. Conversely , there are local situations such as the olive trees in the Valley of Belice (TP) or in some areas on Mt. Etna , where the establishment and recognition of quality brands, for example that of olive oil , have contributed to developing techniques of cultivation towards more rational systems, with pruning of trees yearly and not drastically, often limiting the pruning to the shortening of the branches. The geographical differences and the different business choices have created and lead to quite varied management of the policies related to the main destination of waste from pruning or agro-food in order to eventually exploit them for energy. The lack of a reference market and the high incidence of costs for harvesting the residual biomass are the main reasons why this residual biomass is exploited for energy. In the inland areas all this is worsened by the limiting conditions of altitude that prevent mechanical harvesting.

Nonetheless, in different areas it has been found that the same final users sustain the costs for harvesting and storage especially for the largest remainders as in the case of olive trees, almond trees, peach trees and to some extent citrus fruit trees. Initially, for example it was common that during the pruning period the owners of wood-fired ovens and pizza parlours were willing to pay temporary workers to harvest the remainders in the fields. In these cases the farm company owners had an absolutely free cleaning service for their fields. In the last decade, above all for the specialist wine growers and some fruit growers, the practice of shredding these remains in the fields has become widespread , using working machinery often supplied by the fleet of larger companies. Other widespread practices concern burning the remains in the fields in order to reduce any phyto-sanitary risk due to inoculated pathogens or the use the remainders for home heating by the same company, especially when this corresponds to the main home of the farmer. In Sicily , full of olive groves, there is a significant diffusion of the full use of products from olive pulp produced by the oil producing industry for energy purposes. Indeed after the extraction of the oil pulp, that represents about 60% of the incoming product i.e. the olives , the olives are sent to the olive pulp factory that takes care of the operation of the extraction of the oil obtaining as waste at the end of the process the used pulp residue characterised by its good heat producing qualities. The use of nut shells is very widespread across Sicily which also has a real market run by the same processors of nuts before sending the de-shelled product to the market for consumption(14). A very common use that is made of these left-overs is for the firing of new generation stoves in mountainous areas. Below is a table showing the availability of biomass in Sicily.

Table 3: Total values of residual biomass quantities on a regional scale

Products	**Tonnes annually assigned and/or used in the Energy sector**	**%**	**Tonnes annually assigned and/or used in the Energy sector**	**%**	**TOTAL**
Cereal straw	849.775,84	100%	0,00	0%	849.776
Prunings	683.012	69%	304.381	31%	987393
Vegetable oils	86.267,16	100%	0,00	0%	86.267
Marc	197.546,39	100%	0,00	0%	197.546
Olive pulp	0,00	0%	152.703,33	100%	152.703
Fruit stones	11.150,92	100%	0,00	0%	11.151
Nut shells	9.832,87	15%	56.312,88	85%	66.146
TOTAL	1.837.585	78%	513.397	22%	2.350.982

Source: Report ENEA 2012

Table 1 explains very clearly the huge unexploited potential of the region compared to the existing capacity actually used for Energy purposes. Sicily is a large biological nest of biomass that would allow for significant savings in terms of supplies from fossil fuels and a better profitability for the farms that manage to diversify their own production and invest in the bio-energy sector (15).

Table 2 instead shows all the unused potential biomass in the region by a qualitative and quantitative description on a provincial level of each individual type of biomass in each individual Sicilian province; the largest potential available is that of the by-products from farming, that is to say cereal straw and prunings: pruning of vines, olive branches and citrus fruit tree prunings.

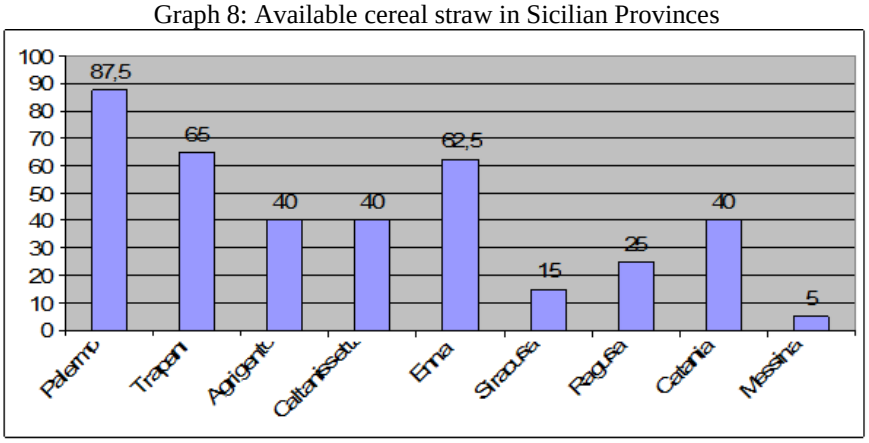
Table 4: Maximum availability of pruning waste for biomass in the Sicilian provinces in 2011 in Ktonn/year

PROVINCE	CEREAL STRAW	OLIVES	VINES	FRUIT TREES	ARBOREAL CULTIVATION
Palermo	87,5	25	25	15	40
Trapani	65	25	87,5	5	150
Agrigento	40	40	40	25	62.5
Caltanissetta	40	15	5	15	25
Enna	62,5	25	0	25	25
Siracusa	15	15	0	40	40
Ragusa	25	0	0	5	15
Catania	40	15	5	40	62.5
Messina	5	40	0	40	63

Source: Data processing of the Enama Biomass Project

As shown in Table 4 , the province where cereal straw is available in significant quantities is that of Palermo with 87.5 kilo tons a year followed by that of Trapani with 65 kilo tons yearly. Instead, as far as the quantities of prunings from olive trees present in the region are concerned , as shown on the chart below ,this type of biomass can be identified in large quantities in the province of Agrigento and Messina with an average of 40 kilo tons per year instead the total absence of this type in the province of Ragusa is to be found (Graph n.8).

Graph 8: Available cereal straw in Sicilian Provinces



Source: ENAMA Project

The presence of pruning remains from vines is also important . The province of Trapani is regional and national leader with a quantity equal to 87.5 kilo tons per year while in other provinces a total absence is recorded for this biomass.

Sicily, however, has a significant availability of a particular type of biomass and precisely that related to the pruning of fruit trees where it stands out as having the regional and national leadership. The region manages to produce 210 kilo tons per year which represent 20% of the national production.

Another type of biomass that should not be neglected for its ready availability in the region is that related to the remains from prunings of the arboreal cultivations which exist in Sicily where the territorial supremacy is held by the province of Trapani with more than 150 kilo tons per year.

VII. CONCLUSIONS

The challenge which the ministerial decree Burden Sharing of 15th March 2012 envisages for the region of Sicily , if well-run, directed and accompanied, will be able to produce positive effects both for the management of the region's energy system and in the sphere of the environmental , social and economic context. As the Sicilian industrial fabric is strongly characterised by energy intensive industries such as refineries, petrochemicals , cement works present on the territory that are not likely to be able to, reduce their consumption because of their production needs, a certain degree of analysis will be necessary in order to understand what the

margins for improvement might be. Consequently , it emerges that, in order to achieve the targets assigned by the Burden Sharing decree it is necessary to intervene in the other sectors that make up about 65% of the whole energy consumption of the region: transport, residential and tertiary sector, especially in the light of the new technologies for sustainable mobility, for energy saving and for an energy production distributed by renewable sources. As said beforehand, local government with the support of regional government can become fundamental in order to achieve the targets assigned to the Sicilian region. Therefore it becomes essential, to empower individual local governments towards action of both the local and the regional interest, through work aimed at the reduction of consumption in the given community and the implementation of the exploitation of renewables and in particular the biomass, seeing the under exploited high potential. The achievement of the Burden Sharing targets assigned to the Sicilian Region is not believed possible with action directed exclusively by the single regional government. The most important role , in the change and the improvement of the region's energy system can be exercised by the citizens themselves and by those who have the management of the individual local entities. Only through action of raising awareness on a local level will the efforts the regional government makes have any concrete results. Therefore a hypothesis that aims at the application of the above mentioned principles can be made through the quantifying, dividing, and distribution to every single local government, of part of the regional target, changing the same criteria already adopted by the state in the regions' concerns. Such a subdivision should occur by using a shared method with the same local governments, in order to overcome possible problems that can arise in the estimation of the energy data of the individual towns themselves, as for example the decision about local energy consumption. State resources, moreover must be sufficient to give a substantial impulse to plants, for the creation of energy with a low environmental impact, without weighing on the budgets in un unsustainable way, and assuring an equal division of the added value of all the plants. The role of the local and regional governments will be decisive. They must promote the starting up of the plants on their own territory and activate agricultural and industrial business. The Region, however, cannot sustain all this without the help of the national government. It needs a managerial class capable of assuming responsibility together with the world of business in addressing in a sustainable way the growth of the country. Therefore, it is indispensible that efficiency should grow and the effectiveness of the regulatory instruments on all levels in order to supply definite and fixed rules, easily applicable with simple procedures, unalterable to supply the growth of the country also by the exportation of our best technology , to contribute to the independence of the country's energy, changing the income of the agro-industrial system and producing environmental benefits. In conclusion the building of plants of energy conversion , measures of support like incentives and tax relief for virtuous initiatives as well as scientific and technological research are the cornerstones which cannot be disregarded in order to achieve an efficient, sustainable energy system capable of fostering the development of the territory.

Sicily has a priceless treasure of biomass which continues to be under- used with the consequent economic damage but above all environmental damage which this entails. If the biomass is the future of green production in Europe, then Sicily is snoozing, spending only 22% of its own patrimony of biomass and leaving a patrimony that foreign companies would be ready to pay €180 million for on its own soil. (16). The Sicilian Region would have at least two chances to make money from its own land. Firstly it could tackle the exploitation of its resources , being able to count on 2 million tons of biomass a year. At the moment , however, the energy production from biomass in Sicily is still minimum with a great potential which is available but unexploited. Alternatively this immense treasure could be sold, because a production already existing equal to 2 million tons a year, several companies in North Europe would be willing to pay up to €90 per ton for the island's waste , creating about €180 million from Sicilian agriculture. The latest data about Sicilian renewables, published in MES mark some improvements, but it is still early to talk about a green revolution in Sicily. Biomass , indeed, has the installed capacity equal to 25MW and 114 GW of production. Sicily is the real loser in the race for biomass, a treasure with extraordinary potential which it keeps in a drawer. The island could, indeed, exploit an extraordinary patrimony and revive a sector in serious crisis. In conclusion agriculture could become the link between the economic recovery of the sector and electricity production by using vegetable biomass (12).

REFERENCES

[1] LANZAVECCHIA G., *L'energia verde*, in "la termotecnica", nov.2011, n.11, pp. 34-36.

[2] CANDOLO G., *Energia dalle biomasse vegetali: le opportunità per le aziende agricole*, in "Agronomica", Aprile 2006, n.4, pp.28-30.

[3] Decreto ministeriale del 15 marzo 2012, *Definizione e qualificazione degli obiettivi regionali in materia di fonti rinnovabili e definizione della modalità di gestione dei casi di mancato raggiungimento degli obiettivi da parte delle regioni e delle province autonome (c.d. Burden sharing)*.

[4] Dlgs n. 28 del 3 Marzo 2011, *Promozione sull'uso dell'energia da fonti rinnovabili, recante modifica e successiva abrogazione delle direttive 2001/77/CE e 2003/30/CE*, pubblicato in G.U. del 28 Marzo 2011 numero 71.

[5] GSE, *Rapporto Statistico 2011 Impianti a fonti rinnovabili*, GSE, 2011.

[6] Assessorato dell'energia e dei servizi di pubblica utilità – Dipartimento dell'energia, *Rapporto Energia 2012 Dati sull'energia in Sicilia*.
[7] Cristiani M., *Il mercato delle biomasse in Italia: criticità e sviluppi futuri*, in AT del primo convegno "La filiera foresta-legno-energia in provincia di Trento", Trento, 26 maggio 2011, pag.25.
[8] Energy and Strategy group, *Biomass energy executive report, Le bioenergie in Italia alla prova del decreto rinnovabili*, Politecnico di Milano, 2012, pag.68.
[9] Consorzio italiano del bio – gas, *L'appello del mondo biogas al nuovo governo*, 28 Febbraio 2013.
[10] Bertolotto A., *Le biomasse sono eco, ma solo se davvero si garantisce la filiera corta*, in "Tekneco", Giugno, 2011, numero 3, articolo pag. 22.
[11] Bassi G., *La promessa delle biomasse. Buone prospettive, frenate, però, da scarsi incentivi e dal nodo degli approvvigionamenti*, in "Il sole 24 ore" del 11/09/2012.
[12] www.progettobiomasse.it.
[13] CIUFFI A., *Rilievo indici di relazione tra produzioni agricole a biomassa residuale associata, analisi del mercato della biomasse residuale nelle province delle regioni Molise, Campania, Puglia, Basilicata, Calabria, Sicilia, Sardegna,* Enea, Aprile, 2009
[14] RAEE, *Rapporto annuale sull' efficienza energetica,* ENEA, 2011.
[15] Battiato R., *L'Europa punta sulla biomassa. La Sicilia non sfrutta il tesoro,* in "Quotidiano di Sicilia" del 18/08/2011.
[16] Battiato R., *Biomasse, l'alta potenzialità della Sicilia rimane nel cassetto. L'agricoltura costituirà l'asse strategico per la riduzione delle emissioni nocive all'ambiente,* in "Quotidiano di Sicilia" del 24/12/2010.