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Analysis and Potential of Use of Biomass Energy in Canary Islands, Spain

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Abstract

Biomass has always been associated with the development of the population in the Canary Islands as the first source of elemental energy that was in the archipelago and the main cause of deforestation of forests, which over the years has been replaced by forest fossil fuels. The Canary Islands store a large amount of energy in the form of biomass. This may be important on a small scale for the design of small power plants with similar fuels from agricultural activities, and these plants could supply rural areas that could have self-sufficiency energy. The problem with the Canary Islands for a boost in this achievement is to ensure the supply to the consumer centers or power plants for greater efficiency that must operate continuously, allowing them to have a resource with regularity, quality and at an acceptable cost. In the Canary Islands converge also a unique topography with a very rugged terrain that makes it greater difficult to use and significantly more expensive. In this work all these aspects are studied, giving conclusions, action paths and theoretical potentials.

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1. Introduction

Biomass is synthesized by plants through the photosynthesis process that takes place in the presence of sunlight, plants absorb water and minerals from the soil and carbon dioxide from the air, leading to the formation of carbohydrates and oxygen, which is released in gaseous form and is returned to the atmosphere. Throughout this process absorbs energy, which is stored in plants.

Biomass has always been related to the development of humanity as the first source of elemental energy, which has been replaced by fossil fuels. Today natural biomass is the basis of energy consumption in many developing countries, although their overuse is leading to a greater increase in the degree of desertification (Jarabo et al., 1999).

In the Canary Islands, the use of biomass as fuel in the past resulted in the disappearance of important forest areas (mainly *Laurisilva*). Its main use was reached although domestic use in the industry of sugar cane and stills.

The Canaries have got the following sources of fuel for biomass exploitation:

- Municipal solid waste
- Sludge produced by sewage
- Agricultural waste
- Livestock waste
- Forest residues

On the islands municipal solid waste generally not used as an energy source. Thus, this waste compost produces a fertilizer that is made from the waste. In the Canary Islands there is only the possibility to incinerate this type of biomass energy for this process on the island of La Palma.

2. Energy Sources

In the Canary Islands there are basically the following types of forest formations: the pine forests, the laurel forests, the *Fayal Brezal*, thermophilic forests and *Tabaibales*, *Cardonales*. There are also non-native exotic species plantations of *Eucalyptus globulus*, *Acacia sp.* and *Cupressus sp.* Logging is very small and artisanal. The management of forests in the Canary Islands is under the principle of conservation, rather than a commercial value (Santamarta & Naranjo, 2013). Forest harvesting is almost testimonial with an essentially protective function. The forest cover in the Canary Islands is primarily an ecological importance extending over 13% of the total area of the archipelago. Curiously considered the largest mountain forest area is on the island of Fuerteventura.

The main timber forest resource comes from Canarian pine (*Pinus canariensis*). Canary pinewood is very good quality but has a very limited distribution, for carpenters in the area where the masses of pine forest are located and is not considered a luxury wood.

It is noteworthy that in the Canary Islands is a long tradition of use of charcoal, especially restaurants, however, virtually everything consumed is imported from South America. The price varies, but is around € 0.74/kg, although the final price is contemplated that the coal produced in the Canary Islands will incorporate a quality mark for its indigenously and environmental benefits, coming from short -regulated required of the Canary forests. This coal has been valued at 0.4 €/kg. (Foresmac, 2011). In the Canary archipelago, plus a unique topographical features converge with very rugged terrain that makes more difficulty raising their costs of harvesting.

For other types of waste to energy use, management is necessary because in island systems, is becoming more difficult to locate optimal sites for locating a landfill. So the optimization of waste management and energy recovery is a critical issue in these island regions as the Canary Islands.

3. Environmental issues

As for the environmental, energy use of biomass is highly beneficial, both during production and in its energy transformation activity. The most positive effects on the environment are related to the decrease in forest fires and pests associated with the management of forest residue. As for the emissions of facilities energy use, low hazard should be considered, due to the elemental composition of the biomass, which is essentially free of such items as chlorine or sulfur.

With respect to carbon dioxide emissions in a sustainable scheme for energy production from waste biomass, the CO₂ balance will be at least neutral when released into the atmosphere an amount of carbon equivalent to the set for biomass formation.

With regard to economic aspects, the states of maturity associated with the technologies required for transformation are very different from mature technologies for thermal uses in industry to emerging technologies in domestic thermal power generation uses or cogeneration. On the other hand, the use of forest biomass residues depends on, no energy, forestry activities in the mountains. These activities are scheduled as non-energy, so that criteria do not ensure the availability of biomass for the needs of energy production plants. The large variation of extraction costs by location, forest species and type of use result in a wide range of costs of the "raw material" which in most cases exceeds the limits for energy use. The existence, in some cases, of an alternative use, generally consolidated, not facilitate compete.

One of the obvious problems with respect to biomass production is the small size of the islands to produce a lot of biomass fuel, as the plants generating energy need a critical mass of fuel to be profitable and operate. However, in the market there are small boilers, which make a considerable saving on oil boilers, and in a short period of time the boiler is amortized.

Another problem, more related to the environment, assume that the extraction of biomass from forest residues, short or silvicultural treatments, causes increased erosion on slopes as steep slope is the general case of the Canary Islands, also causes decreased fertility and organic matter content, there is finally the danger of soil compaction, thereby increasing runoff is generated and hence water erosion (the rainfall regime in Canary Islands is torrential).

Table1. Costs of different biomass uses (PER, 2005-2010)

Use	Cost/Tm	Investment Cost / kW
Thermal Domestic	60 to 160 € (depending on the degree of fuel preparation)	282 €
Thermal Industrial	0 to 35 € (depending on the properties of fuel)	73 €
Biomass Electrical	31 a 43 € (natural – energy crops)	Non available

4. Technological Innovation

In summary, the analysis of forest resources and energy recovery has led to propose new lines of technological innovation spelled out in the Plan of Renewable Energies in Spain (PER) 2005-2010 and involving the following priority actions:

- Analytical methods for determining quality standards

- Physical and energetic characterization of biomass
- Development of systems and equipment for collecting biomass
- Logistics systems for the supply of biomass
- Methods and equipment for adequacy of biomass energy use
- Improved handling systems for biomass processing plants
- Development of efficient equipment for the use of biomass in the domestic sphere and technology to manufacture boilers for thermal and electrical applications
 - Development of techniques for cleaning gases
 - Development of gasification systems (thermal decomposition with limited oxygen supply) for combustible gases from biomass, adapting gas turbine engines and their characteristics
 - Developing systems pyrolysis (thermal decomposition in the absence of oxygen) for industrial scale charcoal

However, there appears to have been much progress in various subject areas, mainly due to the need for major investments needed, let alone in an island territory as Canary. Among the initiatives in this direction is the project "Cooperation and Synergies in sustainable forest harvesting in the Macaronesian region - FORESMAC", set in the Trans-Regional Cooperation Programme Madeira - Azores - Canaries 2007-2013, which under the initiative of the authorities relevant regions of the Macaronesian Islands, Azores and Madeira, to create a space for exchanging experiences about the need to develop a common forestry strategy to ensure the sustainability of the forest resources of the Macaronesian region long term. This project highlights the paper on the study of forests to provide biomass.

An interesting initiative is the future creation of a pilot biomass production and generation with the same electric power plant, using semi-arid areas, for example on the island of Fuerteventura, where conditions exist to develop a system of intensive agronomy without creating any environmental impact. Another initiative for the Canary Islands, driven by Guillermo Garcia - Blairisy Queen, is the proposal to cultivate biomass unused fertile soils without pesticides, without deforesting without monocultures, i.e., not using conventional production methods at present and use the sea as algae planting intensively also this marine biomass production has another advantage as the production of microalgae which are then packaged and sold on the market as food or food supplements with high demand. These cultures allow producing products with high quality protein and antioxidant

5. Biomass management in the Canary Islands

In the Canary Islands there are no plants or major investments in the biomass energy sector, having only small-sized facilities to manage own waste.

Forest characteristics of the Canary Islands determine the quantities and types of waste generated forest. According to details of the integrated waste management plan de Canarias (PIRCAN) 2000-2006, woodland forest floor is around 112,000 hectares, being more than 80 % under any of the categories set out in the Canary Protection of Natural Areas Law.

The traditional uses of forest residues are the use of needles (pine needles) and pine branches are chipped, for use in cattle bedding or spread them directly on crops; heather branches and brown are used in gardening and craft productions there charcoal in "coal" for home use (barbecues) . However, it can be realized that there is a clear tendency to decrease these traditional uses, given the development achieved by the agricultural and livestock sectors.

Lack of proper management of forest residues does not result in an organic pollution, so that there was no concern of the government to include these types of waste in the legislative requirements for management and disposal. However, the problems are related to the conservation of forests, namely the prevention of fires and

pests. So now if the forestry residues as a potential hazard are considered, so that its management should be considered within their own forestry work and can also serve as raw material for some production processes. As a result of this, there is no control as to show the volume of waste generated, although their use is still based on traditional uses.

Energy consumption in the form of biomass is very low compared to other regions, reaching estimated use of about 2,183 toe (tons of oil equivalent) per year.

Table 2 Approximate consumption of energy from biomass industry in the Canaries (2010)

Sector	Consume Ton/year
Primary (agriculture-forestry)	900
Industrial	83
Services (hotels – restoration)	1200

The problems identified in the use of this type of biomass in the Canary Islands are:

- Current technical high costs, under development and reduction.
- Importance of the economy of scale on site.
- Price per Kwh produced high compared to other types of generation used in the archipelago.
- Limited in size Territory.
- Topography steep, remote central production centers.
- High costs of transport.
- Complicated and difficult to access in some areas forest use.
- Compatibility with the category of use of the countryside.
- Total dependence on weather conditions.
- Ignorance and mistrust towards new unproven technologies deeply into the archipelago

6. Conclusions, lines of action and theoretical potentials

The theoretical potential of biomass from the forest in the Canary Islands, produced by forests of pine and laurel canary can be estimated at about 5,500 toe/year, if this potential is added the biomass from agricultural residues can reach the figure a potential of 15,000 toe/year approximately, hence the importance of adding both products.

Regardless of forest policy that applies in the Canary Islands and taking into account the powers assumed by the various island councils with regard to the management of forests, actions would need to be addressed such as:

- Development of a detailed census of forest residues by management
- Disseminate appropriate techniques for the use of biomass and, in turn, can be incorporated by the forestry service companies in Canary technologies
- To contribute to rural development by generating employment in forestry service companies and through the installation of forest biomass plants in the Canary Islands
- Evaluation of applications as traditional uses and possible alternatives.
- Removing obstacles and overcoming deficiencies that prevent the use of forest biomass as a renewable energy source.
- Reduced dependence on fossil fuels in energy production.
- Provision of road infrastructure and collection and storage in forests.

In this way and as recorded by the PIRCAN in a first phase, due to low production of forest residues (on which there are no reliable data) would not be necessary to take important measures, subjecting non-recoverable waste to crushed or chipped, for their better integration into the soil nutrient cycle, controlled burning or when there is danger of fire due to fuel accumulation at woodlands.

In a second stage, and in accordance with the action lines set out in the Forest Plan de Canarias, if a greater amount of forest residues are generated, they could implement other possibilities of recovery, such as re-use and recycling and its use energy, thus following the traditional line (employment in agriculture, charcoal) as following new lines (gardening jobs, manufacturing of fuel briquettes combustion processes).

Anyway, the main source of renewable energy in the Canary Islands should be using the sun and wind, while the biomass has to be used as a complement to the above conventional and currently provide the largest percentage of energy used in the archipelago. Although the biomass energy should not only be seen as another way of energy, but as an energy that keeps the environmental quality of the Canarian forests helping protection and generating jobs.

One of the problems seen in this type of energy resources is the lack of confidence in them, there is no confidence in changing the conventional way of generating energy and on the other hand there is no trust in a fuel supply in the medium to long term resist.

Different government should exercise Canary exemplary engines, working as a trusted source, using model plants to demonstrate the feasibility of using biomass generation projects.

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