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Waste Management and Territorial Impact in the Canary Islands

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Abstract: Insularity presents several challenges in the development of Europe's outermost regions. In the case of the Canary Islands, one of these challenges is waste management, which faces a series of difficulties inherent to territorial disparities, including land use and availability, a high percentage of protection, a large number of annual tourists and a high level of product imports. The archipelago is made up of eight islands, and waste management is significantly different in the two capitals, Tenerife and Gran Canaria, and the rest of the smaller islands. European targets for adequate waste management have not been achieved in those areas. As an example, only 16% of the collected waste is recycled currently, mainly due to a lack of infrastructure and a lack of agility on the part of the corresponding institutions. There is also pressure exerted on this sector by tourism, which accounts for approximately 40% of employment in two of the islands. As a general conclusion, valorized waste management is proposed, where the use of by-products, such as biogas or compost is implemented in sectors where they can be used, i.e., as electricity, potentially of 19 GWh/year, and agricultural supply, thus promoting recycling and the circular economy in the Canary Islands.

Keywords: circular economy; separate collection; regional development; recycling

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1. Introduction

To highlight the benefits of energy recovery, both the new European Union Circular Economy resolutions and the State Waste Plan (PEMAR) 2016–2022 fully support energy recovery from the non-recyclable fraction of municipal solid waste (MSW), following the application of the European Union (EU) three Rs principle, including material separation, in which each waste category is disposed of in separate containers, as well as recovery for reuse, this principle promotes waste reduction at the highest level of hierarchy, reuse (through product life cycle extension) and recycling [1–6].

Established as a priority objective of PEMAR, the transformation into a raw material efficient society in Spain progresses from a linear economy based on disposable consumption to a circular economy, in which waste becomes a value-added material. As such, this plan foresees the encouragement of preemptive preparation for reuse by the consumer and alternatives such as recycling, energy recovery and other recovery methods. These latter processes are expected to reduce the amount of waste sent to landfill, increasing from the current rate of 10% of municipal waste generated to 15% [4,5].

In addition, governments have established a hierarchy for the various stages of municipal waste management, as a necessary element for effective oversight. In a more restrictive interpretation of the inverted pyramid, recycling is only considered after all other efforts have been made to reduce the amount of waste from its origin to post-consumption [7].

Simultaneously, waste conversion is considered only after the maximum amount of recycling is reached [8]. Finally, the lowest and least desirable position is occupied by landfill as final disposal, due to its negative health and environmental impacts, e. g., contamination of soil and water bodies, and proliferation of diseases. Insularity increases susceptibility to these impacts [9–11]. With this in mind, the priorities for waste management operations are highlighted: (1) preventing and reducing waste generation, (2) preparation of waste for reuse, in which the concept of the circular economy plays a key role, (3) recycling, (4) adding value to waste and its conversion to obtain energy, and (5) transportation to/disposal of in a landfill [9].

A current comparative study by Mena-Nieto et al. (2021) analyzes the EU targets for municipal waste in the archipelagoes of the Balearic and Canary Islands and, for example, measures the growth needed to reach the targets [12]. There are other studies in this field in the same archipelago, specifically in one of the Canary Islands, La Gomera [6], where an efficiency model for a Waste-to-Energy System is defined. In two other islands, Gran Canaria and La Palma, illegal landfills were evidently mapped using the Normalized Difference Vegetation Index (NDVI) method and attributes related to the characterization of a waste disposal area [13]. The problem of waste management in island sites, such as the Canary Islands, has been addressed in the recovery of landfills, in a project carried out in Tenerife in an abandoned site that was recovered as a Botanical Garden [14].

The objective of this work is to achieve the goals projected at the European Union level in its waste policy and its Agenda 2030. This includes improving integrated management of solid waste, complemented by mitigation of environmental impacts and valorization of resources, and emphasizing potential territory capacities. This would result in a reduction of greenhouse gas emissions, applying exceptionally to the situation of insular areas such as the Canary Islands archipelago.

The study is divided into five sections: 1. Introduction of the work, with its motivations, justifications and objective; 2. Materials and Methods, where the methodology is presented along with a case study; 3. Results, where the most relevant data to this article are described; 4. Discussion, where the references to the case study are compiled; and 5. Conclusions, with a summary of the article and evaluation of the suggested actions to achieve the projected targets.

2. Materials and Methods

Based on the principles of the Strategic Environmental Impact Assessment, a holistic analysis of this work was undertaken to investigate the current situation, encompassing the social, economic, and environmental spheres, with reference to the circular economy in order to compare the current waste management situation with the goals and strategies of public policies and regional, national and international regulations, to identify the main components and impacts and agents involved, and to emphasize the weaknesses and key elements for improvement [15].

To analyze the case study as an Integrated Waste Management System, in terms of its priority stages described above, a review of quantitative data was carried out. The data was published by responsible organizations and related to waste generation and its characterization, economics, and geographical data in their respective ambits. It also includes a review of case studies, such as the problematic insularity and successful projects that contribute to the regional development of the Canary Islands.

As final disposal and last step of a linear economy may be a transfer element to a circular system, landfills contribute considerably to greenhouse gases and, consequently, to global warming, mainly because they contain methane CH_4 and carbon dioxide CO_2 [16–18]. The current situation becomes more critical in urban areas, due to the increasing amount of solid waste generation and the consequent increase in demand for new sites for final disposal and pressure on rural zones [19,20]. Proportionally to this conjuncture, population growth, consumption and the need for energy resources result in the need for continued evaluation of different treatment technologies [21,22].

In addition, promoting reuse and recycling, thus extending the life cycle of products, and setting specific targets for 2035, the new European Circular Economy package advocates reducing landfills to a maximum of 10% of all municipal waste [9]. In this regard, the document clearly states that it is economically and ecologically preferable to recover energy from waste rather than sending it to landfills, when it is not viable for reuse or recycling. Synergistically with EU climate and energy policies, it also considers that energy production from the non-recyclable fraction can play an important role [4,5].

Among the numerous technologies available to reduce generated waste are the most common processes: incineration, pyrolysis, gasification and plasma, which are driven via thermal treatment [23,24]. The first process is highly supported by public policies because it provides advantages such as sufficient reduction of pollution afterwards, exemption from stockpiles and long distance transport, and the possibility of energy generation, while the volume of material is reduced [25,26]. In addition, some research argues that controlled municipal solid waste (MSW) combustion is a definitive solution to the problem, when performed in facilities with adequate air pollution control devices [27]. Other energy conversions, based on anaerobic digestion (AD), fermentation and composting produce biogas from organic matter. In the case of AD, the transformed fuel usually consists of 55–75% pure methane [28].

However, the reality is that factors other than air pollution must be accounted for; for example, impacts on water, soil, landscape, ecosystems, and urban and rural areas themselves. This serves as a holistic approach to strategic environmental and socioeconomic impact assessment into strategic territorial planning, including required popular approval, of available waste treatment options for possible sustainable management [6,29]. In a case study conducted in the Abruzzo region (Italy), Cucchiella, D'Adamo & Gastaldi [30] analyzed the performance of a plant for energy conversion from municipal solid waste. The results showed an ambitious energy recovery percentage, between 21% and 25%, and reduced emissions values of approximately 55,500 tons of CO_2 per year.

There is a sense of global urgency to prioritize development of energy policy strategies with viable solutions in the realm of electricity and heat or biofuel generation from renewable sources, in order to combat adversities such as climate change and political and economic instability [31]. For reduction of greenhouse gas emissions, the use of unsorted waste as an energy resource is estimated to be effective [32]. Tackling these two important current problems helps to avoid polluting more non-renewable sources and adds value to waste matter. The waste-to-energy (WtE) concept demonstrates a great opportunity, compared to using landfills [33].

In May 2015, approximately 20 environmental sector organizations, including the association Aeversu, represented by its president, Rafael Guinea, endorsed the Zero Waste Manifesto, considering it vital to study and analyze the implementation of instruments to ban landfilling, in order to maximize its potential in terms of materials and energy [4,34].

Study Area: Canary Islands

The Canary Islands are an archipelago of eight islands—Tenerife, La Palma, La Gomera, El Hierro, Gran Canaria, Fuerteventura, Lanzarote and La Graciosa—with two capitals (Tenerife and Gran Canaria) and a population of 2.2 million people. In 2018, the residents of these islands generated waste of 1.54 kg per day or 564 kg per year, and in 2019, 1.49 kg per day or 545 kg per year [3,35]. Tourism growth on the two largest islands, Tenerife and Gran Canaria, has led to an increase in MSW production, which has not been accompanied by development of treatment infrastructure and facilities. The archipelago has not been successful in meeting the targets set in the Spanish National Waste Management Framework [5,36].

At the residual source and after collection, MSW discarded in containers as non-recyclable are not sorted before further treatment [10]. Illegal, inappropriate and undesirable practices such as uncontrolled burning and pollution, along with dumping in forbidden or environmentally important places are consequences of inadequate logistics.

These negatively influence the waste management pathway, so for a sustainable system, collection and transportation is a key element [13,37,38].

The contrast of infrastructure on the islands is observed. In Gran Canaria or Tenerife, infrastructure is poorly developed, while in other areas, waste is disposed of in unsanitary locations, with collection via obsolete transportation on very narrow or inaccessible roads. For these reasons the Canarian system presents health and environmental risks, due to the spread of toxicity from illegal disposal and generation of gas emissions from uncontrolled combustion [6].

The Canary Islands have their own waste law, Law 1/1999 of January 29, whose purpose is to manage the waste generated in this region. Treating selective collection in 2018, 7.8% was recyclable (paper, glass and plastic, and metal packaging) and bio residue was 8.2%, already at the national level. In 2019, 19.7% was considered recyclable [35,36].

Waste treatment occurring on the islands is mainly recycling of materials, composting, and bio stabilized manufacturing on the main islands, with final disposal in landfills. However, there is also evidence of the proliferation of irregular deposits, identified by Quesada-Ruiz et al. [13] in Gran Canaria (286 illegal areas), 38 locations in agriculture fields and, in La Palma, 2 sites out of 153 illegal landfills. Those in rural areas are included where, with the ongoing abandonment of plantation fields, especially greenhouses, they have become a depository mainly for plastics, exemplifying the retreat of the agrarian sector, despite internal support for the consumption of local products [35].

3. Results/Data Analysis

Tourism is the most important source of income on the islands, but this includes several problems with sustainability and management of resources. One of the biggest factors is the large generation of waste, which has always created significant problems regarding its proper management [39]. Table 1 outlines the significance of the touristic sector in Spain and in some regions where, separately, the highest importance may be observed in their Gross Domestic Product (GDP) and their employment influence in this country.

Table 1. Comparison of tourism activity and impacts for some regional economies [40].

	Canary Islands (%)	Balearic Islands (%)	Valencian Community (%)	Andalusia (%)	Spain (%)
GDP	35.0	44.8	14.6	12.5	10.9
Employment	40.0	32.0	15.1	11.9	12.7

The contribution of the tourism sector to waste generation may be proved after analysis of the exceptional period of the pandemic. Since 14 March 2020, tourism and hotel activity were totally closed due to COVID-19. As a projection, Table 2 shows the comparative quantities generated during 2019 and the projection for 2020, based on data from April of this year, for the islands of Lanzarote, Fuerteventura, Gran Canaria, Tenerife and La Palma. The data to be compared correspond directly to the period from March 15th to April 14th in both years and show a clear drop in generation, even more pronounced on the islands of Lanzarote and Fuerteventura, with a large tourist population [35].

A second analysis shows per capita generation, referring to the total equivalent population in 2019, including the tourist population, and referring exclusively to the resident population in 2020, which is shown in Table 3. These data allow us to observe the influence of commercial and service activity, associated mainly with the tourism sector, on waste generation. Specifically, we can see the residual fraction, concluding that the domestic consumption model generates a lower amount of waste per capita than that associated with the current sector, approaching the national and EU per capita generation [35].

Table 2. Variation in production of mixed municipal waste fraction based on April 2020 data in tons [35].

Island	2019 (T)	April 2020 (T)	Projection 2020 from April Data (T)	Percentage Variation (%)
LANZAROTE	96,469.72	4759.31	58,063.58	−39.81
FUERTEVENTURA	85,933.36	3878.64	47,319.41	−44.93
GRAN CANARIA	377,732.24	25,011.54	305,140.79	−19.22
LA PALMA	28,183.46	2089.00	25,485.80	−9.57
TENERIFE	48,403.61 [1]	36,729.64	-	−24.12

[1] Data from the period of 15 March 2019–14 April 2019.

Table 3. Per capita variation in production of mixed municipal waste fraction based on April 2020 data [35].

Island	Per Capita Generation 2019 (kg/inhab.year)	Per Capita Generation 2020 (kg/inhab.year)	Percentage Variation (%)
LANZAROTE	468.50	381.27	−18.62
FUERTEVENTURA	543.00	404.83	−25.44
GRAN CANARIA	405.15	358.47	−11.52
LA PALMA	322.44	308.28	−4.39
TENERIFE	561.31	472.46	−15.83

Waste management and planning includes instruments such as eco-design engagement, investment in infrastructure projects in selective waste collection, and promotion of campaigns for minimization, as well as establishment of fees and taxes for waste producers [33]. One of the challenges in implementing these programs is that, although solid supranational policies are well founded, execution at a local scale may cause delays. In terms of organic matter, composting may be a requirement target that is related to effective segregation of food streams; otherwise, its nutrients may be lost in mixed containers and afterwards in landfills [33,41].

As reference, in the EU, in 2018, 47.5% of municipal waste was recycled, 23% was disposed of in landfills (in clear decline compared to previous years), and 28% was processed by incineration, although this average figure hides quite different realities among the countries of the European Union. Referring to per capita data and to the evolution of waste management, 1995 to 2018, it is highlighted that landfilling has been reduced from 145 Mt to 57 in absolute (63%), incineration has increased from 32 Mt to 70 Mt in absolute (103%), recycling of materials has increased from 25 Mt to 75 Mt (83%), and composting increased from 14 Mt to 43 Mt (186%) [35].

The recycling rate in Spain has reached 33.9%, including waste recovered from separately collected fractions: 15.2% of total waste generated, 2.4% composted biowaste from separate collections, and 16.3% materials and bio stabilized waste recovered from the residual fraction in mechanical biological treatment plants. For non-recycled waste, 18.9% was dumped directly without prior treatment and 12% of the total waste generated was destined for incineration, sum 7,576,718 tons of plant rejects (35.2% of the total generated). Considering the 2020 target of 50% recycling, it would seem difficult to achieve [36].

Currently in these islands, consumers mainly dispose of waste in four containers (paper and cardboard, glass, mixed packaging and unsorted). A fifth container for biowaste is available. After collection of the waste, since there is no incineration facility, with or without energy recovery, treatment is restricted to recycling, the manufacture of bio-stabilized compost (in Tenerife, Gran Canaria, Lanzarote and La Palma only) and, as final disposal, a landfill area [10,35]. Outside the islands, hazardous waste is controlled, which means that management is significantly more expensive. Special waste such as tires gradually increases due to the boosted number of vehicles, and reuse and recycle are complex [14].

The latest available data, from 2019, for collected waste in the archipelago shows 1,282,486 tons as the total amount of both sorted and unsorted residues. The latter,

1,071,767 tons (83.57%), is characterized by domestic and public road waste (1,029,102 tons—80.24%), and heavy equipment (42,665 tons—3.33%) [42].

In terms of composition of the waste, Figure 1 shows components in samples of waste, on average, which are divided into organic fraction (27%), paper and cardboard (25%), packaging (25%), and other (non-packages) and subcategorized in Figure 2, in summary, characterized by the greatest fractions of organic waste (19%), plastic (18%) and paper (15%) [35].

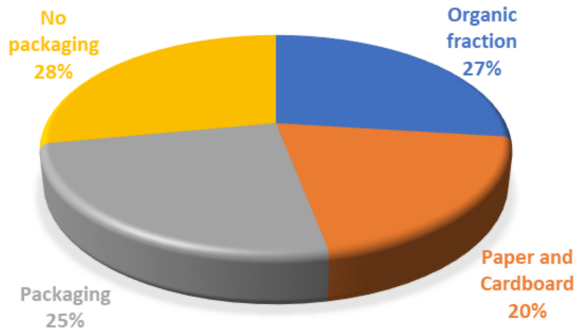

Figure 1. Characterization of the waste in fractions.

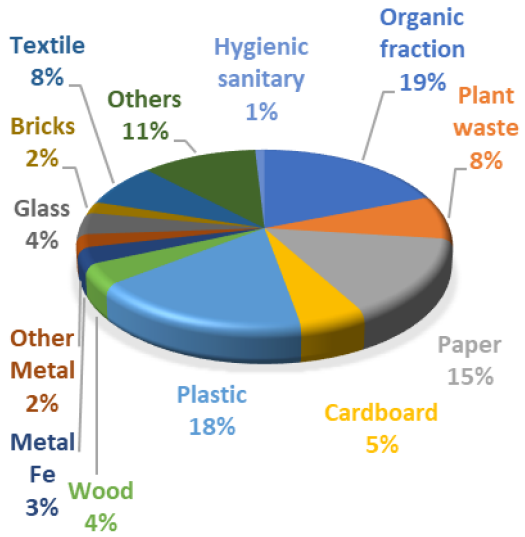

Figure 2. Average composition of the waste.

Analyzing the individual situations in the islands, illustrated in Table 4, in Lanzarote and La Graciosa, 27% of the total equivalent population, more than 55,000 people, refers to tourism. Its per capita generation of 709 kg/inhabitant per year is much higher than the average for all the islands, which is 583 kg/inhabitant per year [43]. With a value much higher than the Canarian average, Fuerteventura has a per capita waste generation of 663 kg/inhabitant per year. This is the highest amount ever historically recorded, accompanied by a rise in equivalent population, with a percentage of 29% respective of tourists and total waste.

Table 4. Evolution of municipal waste production 2011–2018 [35,43,44].

Island	Year	Total Waste (T)	Equivalent Population (Inhab.)	Per Capita Generation (kg/inhab.year)
LANZAROTE AND LA GRACIOSA	2011	124,678	187,290	666
	2012	116,528	186,132	626
	2013	114,094	188,803	604
	2014	117,819	192,072	613
	2015	124,048	194,572	638
	2016	132,317	200,852	659
	2017	146,181	204,393	715
	2018	144,703	204,194	709
FUERTEVENTURA	2011	82,528	149,138	553
	2012	75,681	148,666	509
	2013	74,058	153,452	483
	2014	79,426	153,012	519
	2015	88,730	152,584	582
	2016	97,698	155,795	627
	2017	102,567	158,715	646
	2018	105,980	159,785	663
GRAN CANARIA	2011	521,247	926,269	563
	2012	519,562	924,536	562
	2013	475,165	925,108	514
	2014	499,555	924,546	540
	2015	482,276	925,246	521
	2016	496,611	930,482	534
	2017	493,532	930,819	530
	2018	495,967	931,293	533
TENERIFE	2011	528,870	998,279	530
	2012	495,961	987,639	502
	2013	476,725	990,339	481
	2014	496,188	985,573	503
	2015	506,779	982,553	516
	2016	529,892	994,214	533
	2017	552,343	996,445	554
	2018	557,509	1,003,274	556
LA PALMA	2011	38,226	90,830	421
	2012	35,929	88,983	404
	2013	32,736	88,420	370
	2014	33,632	87,046	386
	2015	34,025	86,607	393
	2016	35,007	86,420	405
	2017	35,930	86,802	414
	2018	37,254	86,880	429
LA GOMERA	2011	10,988	25,525	430
	2012	9817	24,611	399
	2013	9795	23,336	420
	2014	10,224	23,048	444
	2015	10,646	23,207	459
	2016	10,381	23,667	439
	2017	10,825	23,762	456
	2018	10,579	24,084	439
EL HIERRO	2011	3670	11,154	329
	2012	3159	11,146	283
	2013	4057	11,113	365
	2014	3886	10,874	357
	2015	3698	10,758	344
	2016	3695	10,801	342
	2017	4279	10,928	392
	2018	4404	11,024	400

A similar situation may be observed in La Palma, Gran Canaria and Tenerife, exemplified by stability in the number of residents, the former ratio of 533 kg/inhabitant per year being lower than the general average of the islands and, of the total population, 9% is represented by tourism. In the latter, 10% represents tourism, with a generation of 556 kg/inhabitant per year. The island of La Palma has individual production of waste of 429 kg/inhabitant per year, much lower than the Canarian average (583 kg/inhabitant per year) and even lower than the national average of 475 kg/inhabitant per year [44]. Like La Palma, La Gomera generates waste below both national and local averages, 439 kg/inhabitant per year, because tourism is characterized by short tours with overnight stays in Tenerife. In El Hierro, waste generation is lower than average, 400 kg/inhabitant per year, because some of the inhabitants do not reside on the island, despite being registered, and they generate waste outside the island [35].

Regarding the collection of waste, much of the continued evolution has occurred in the percentage of selective collection, separated into paper, metal and plastic packaging, and glass and bio residues, including pruning. In 2018, in the Canary Islands, a total of 11.6% was reached, well below the national average of 2015 (14.08%). That percentage was only surpassed by Lanzarote and El Hierro (Figure 3) [35].

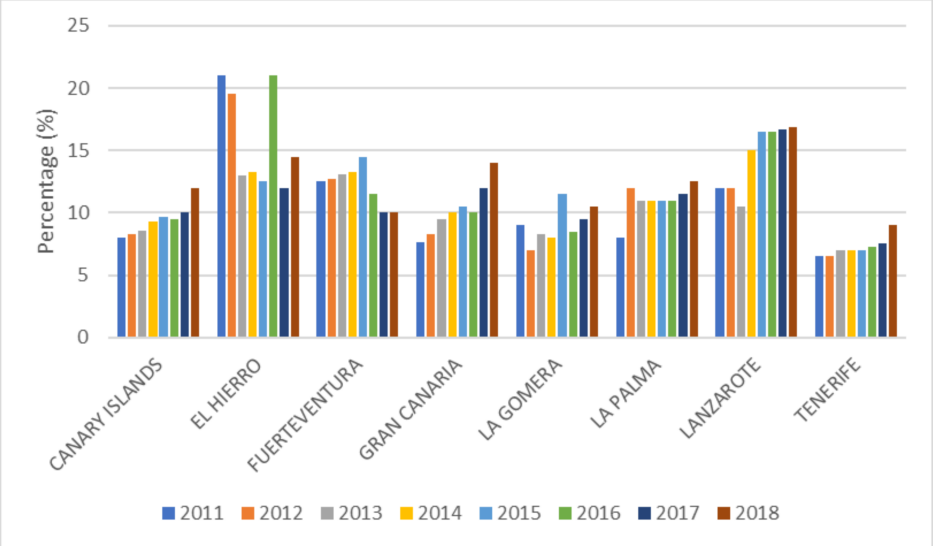

Figure 3. Sorted waste collection in the Canary Islands [35].

In summary, the Canarian integrated waste management plan may consider diverse types of waste: municipal, special, industry, health, livestock, agriculture, forestry and hazardous. In regard to urban residues, the following basic objectives are established, according to Santamarta et al. [14]: (i) Insularity of urban waste management (collection, transportation, treatment, and disposal); (ii) Integration with other waste streams (e.g., processing of plastics from greenhouses in conjunction with those from urban waste); (iii) Recovery of hazardous waste in municipal waste; (iv) Recovery and valuation of those waste fractions that are feasible from a technical, economic, and environmental stand point; and (v) Safe disposal of irrecoverable fractions and (vi) Conduct communication campaigns and training.

4. Discussion

In the case of Canary Islands waste management is affected by many factors: the environmental consciousness of waste generators, the tourism sector, limited facilities for treatment, high density population and protection areas [13], as well as the level of economy, education, and technology accessibility [6]. This density, much higher than the Spanish average, puts pressure mainly on the island of Tenerife and, to a lesser extent, on Fuerteventura. Pressure is also due to the protection and conservation of many areas

of interest such as historical, environmental, and socio-cultural heritage, thus benefiting attractions and the growth of tourism [35].

In addition, the scarcity of accurate and current data hinders development of the system, which is already precariously served by waste disposal, due to limited recycling in a few containers and without subsequent sorting and, consequently, demand for more final disposal areas [14]. Furthermore, the data of waste generation is directly correlated to the influence of number of tourists (equivalent population), resulting in too high individual average amounts of generated residues.

Respecting the hierarchy of steps for an integrated system, the prevention of consumption is not considered under control in island areas, due to the substantial importation of products. There is taxation on plastics, such as bags, and on use of biodegradable materials. As well, there is a conflict with the growth of tourism, a temporary and high turnover population in all seasons, without defined high and low seasons. One of the methods for waste reduction is awareness campaigns for the local population, but they do not reach the significant non-resident consumers [45].

In Mauritius, there are some other exemplary initiatives that include: reimbursement for glass bottles, which are destined for reuse in factories, after proper sanitization; residential composting, encouraged with the distribution of compost bins; the promotion of exchange and communication between companies for the sale of waste from one as resources to others; as well as the export of PET bottles already granulated [38].

As the collected waste is characterized by larger portions of organics and recyclables, paper and plastic, composting, recycling, and energy recovery technologies are recommended for improving municipal waste management [46]. In the same circumstances, in Galapagos, another strategy is addressed—composting in a combination of wastewater and organic solid waste, as they are complementary, bringing savings benefits in the process compared to when they are performed separately [47].

According to the waste hierarchy, recycling is one of the most requested alternatives, a solution that may be widely improved from an energy and environmental point of view. However, the development of recycling in the Canary Islands is deficient, in minimal destined quantities, as already mentioned, caused mainly by factors in education issues and financial statements [48]. For the same reasons, the selective collection system is not fully developed on the island, and neither is the transport of waste over long distances, resulting in energy consumption and environmental/greenhouse gas impacts [6]. It is difficult to achieve the minimum recycling rates on islands due to the lack of available space to store recyclable materials, as there are many protected areas and declared natural heritage sites [49].

Among the technologies applied as WtE, incineration does not receive support in the transition to a circular economy because it emits air pollution, and the interest is in other alternatives to generate a new attractive product for reuse in energy systems at a prominent level [1]. Plasma processing, still considered recent in its operational experience, requires high investment capital and cost of operations because of the elevated temperatures involved, for instance. Its implementation requires a higher residual volume capacity than the actual demand. Gasification, on the other hand, is more recommended for the successful processing of solid waste, due to its longer experience and the possibility of using structures already implemented in the waste system, decreasing transitional costs. If the installation of a gasifier is close to a landfill, the gas from this deposit may be used in the process of waste treatment [28]. This thermal treatment requires waste without glass and metal remnants; these materials should be led to other forms of recovery through sorting, as a pre-treatment [33].

As final disposal, landfilling is indeed a reasonable measure when compared to illegal dumping [50]. Although this method, reduces the negative impacts on the environment, under controlled conditions of decomposition and slurry, it is definitely not recommended in the long term, because of its atmospheric emissions and increasing land use, in addition to the waste of compost with possible valorization either by recycling, reuse or recovery [14].

The use of landfills is only acceptable after the processing of waste as energy resources [9]. While in operation and likely extension, and after its full decommissioning, the landfill is defined as a generator of gases that may effectively be a source of energy for potential implementation of a thermal power plant, with a potential capacity of 1.1 MW and annual generation of 19 GWh. This is already active on the island of Mauritius, as a model [38,51].

As proposed for the area of La Gomera by Uche-Soria & Rodríguez-Monroy [6], a plant to process solid waste and generate a gasified fuel would occupy a maximum area of 6000 m^2. A modular arrangement is recommended to minimize the space occupied, adapted to smaller flows, consisting of separation and treatment process. In terms of waste management, the island would become autonomous, so no transport to another island would be necessary. Thus, the reintegration of a currently wasted material into the value chain as energy or fuel also facilitates reduction of import dependency, while avoiding the required freight and consequent burden for its service, such as gas emissions and other environmental impacts.

5. Conclusions

By valorizing the waste, converting it into gasified fuel, electricity is generated and energy costs are considerably reduced in an isolated system such as that of the islands. On the other hand, in reference to the current European directive, it is necessary to consider the need to gradually reduce the amount of biodegradable municipal waste going to landfills. Based on this objective, the implementation of a waste to energy valorization process is mainly proposed to address the current situation of the islands, in transition from a linear to a circular system. In turn, it can be extrapolated to other similar environments, complemented by strategies to increase the amount of waste destined for reuse and recycling.

Reducing waste generation and making better use of the energy produced by waste through biogas are priority objectives for the Canary Islands as an outermost European region. The islands, having limited space, face significant challenges when it comes to treating their waste and this may hinder the correct ecological transition of the islands if this sector is not sufficiently taken into account.

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