DEPARTMENT OF WASTE MANAGEMENT

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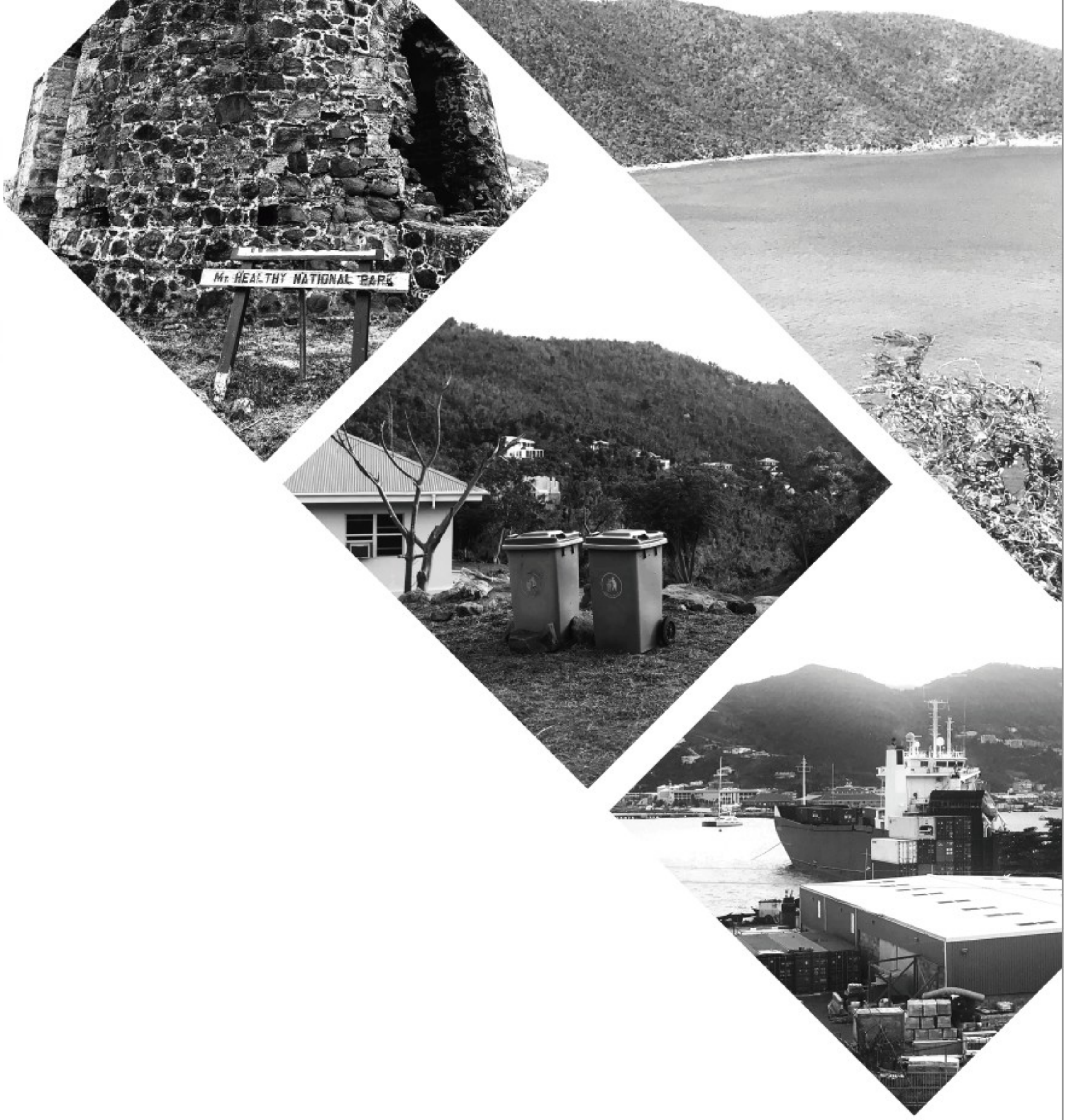

FINAL REPORT ON WASTE CHARACTERISATION

JULY 2019

WASTE MANAGEMENT STRATEGY FOR THE BRITISH VIRGIN ISLANDS

RED
Agency for Resilience, Empowerment and Development

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List of Acronyms

BVIG	British Virgin Islands Government
DDM	Department of Disaster Management
DWM	Department of Waste Management
DR	District Representative
H&S	Health & Safety
IR	Inception Report
JVD	Jost Van Dyke
MCW	Ministry of Communications and Works
MHSD	Ministry of Health & Social Development
NGO	Non Governmental Organisation
TCPD	Town and Country Planning Department
PWD	Public Works Department
SWM	Solid Waste Management
USD	US Dollars
USVI	US Virgin Islands
VI	Virgin Islands
VG	Virgin Gorda

1 Introduction

1.1 Background of the Study

In the aftermath of Hurricanes Irma and Maria, The Government of the Virgin Islands is seeking to review and amend the BVI's existing Comprehensive Solid Waste Management (SWM) Strategy dated of 2013. The revision must take in consideration the impact of climate change on hurricane seasons that will bring weather which is more severe than before and that they will be more frequent hence any long term. Thus, the SWM Strategy must include aspect of Disaster Risk Reduction and emergency preparedness in terms of debris management but also aspects related to good waste management practices in order to ensure the sustainability of the environment and their health and wellbeing.

1.2 Subject of the present report

The present report covers two one-week waste characterisations, done in February and June 2019, on the islands of Tortola, Jost Van Dyke, Virgin Gorda and Anegada.

1.3 Objective of the Waste Characterisation

Waste characterisation allows us to know better the nature of waste generated in the British Virgin Islands and to establish a reference database both for policy making and for technical design of solid waste management infrastructures.

The table below summarises the different objectives of waste characterisation:

Table 1: Objectives of waste characterisation

Purpose	Use of waste characterisation results
Planning	Quantification of different waste streams
	Identification of waste collection and management approaches best suited for the waste generated in a specific location
	Identification of priority waste streams according to quantity, hazardousness, recyclability etc. criteria
Technical design	Calculation of capacities required for infrastructure and equipment to treat the different waste streams
	Determination of technical parameters for design and construction of infrastructures and equipment
Evaluation	Assessment of trends in waste generation (in comparison with previous waste characterisation studies)
	Evaluation of the success of waste policies aiming at a change in waste generation (reduction of certain waste streams, separate collection etc.)

2 METHODOLOGY

2.1 ORGANISATION AND IMPLEMENTATION OF THE WASTE CHARACTERISATION

Two waste characterisation campaigns have been implemented from 08th – 18th February 2019 and from 17th - 24th June 2019, covering waste from the islands of Tortola, Jost Van Dyke, Virgin Gorda and Anegada. The first waste characterisation campaign represents the touristic season, the second one the low season between May and October 2019. The Department of Waste Management facilitated the waste characterisation study by making available a team of 10 waste workers, who took turns at contributing to the analysis. Moreover, the NGO GreenVI as well as a student volunteer participated to the analysis of some samples. During the second campaign, less workers and no volunteers participated, the consequence of which being a smaller sample size.

For each sample, the mission team carried out at first a granulometric analysis for the purpose of getting data necessary for the evaluation of mechanical separation options. This is especially important for mixed household waste, since it is not realistic to assume that separate collection at the source would reach the required performance at short term[1], even if introduced in the British Virgin Islands by the Department of Waste Management. Sieving was done manually by wooden sieves with wire mesh. Since it was not possible to obtain sieves with the standard mesh openings of 20 mm respectively 80 mm, available mesh sizes of 2” x 4 “ and 1“[2] were chosen. The photo below shows the sieves used for granulometric analysis.

1 This assumption is based on European experiences. Even in countries where separate collection is operational since over 20 years, like Belgium or Germany, the performance is often still deficient. A recent study in Germany shows that there are still 40 – 60 % of « wrong throws » for plastic waste (source : http://www.zeit.de/wirtschaft/2018-04/muelltrennung-deutschland-verpackungsmuell-gelber-sack)

Figure 1: 1"² sieve (front) and 2" x 4" sieve (back)

Subsequently to the sieving analysis, the Consultant carried out a sorting analysis, separating the gross fraction (Wastes remaining above the 2" x 4" sieve) and the medium fraction (wastes between 1 "² and 2" x 4") in different fractions and sub-fractions. The sorting analysis aimed at identifying the proportional weight of each waste stream, in view of quantifying the overall waste streams that might be recycled, recovered by biological treatment, that might need to be collected separately or might need to be subject to preventive measures.

The following table gives an overview over the samples taken per stratum and day. The following strata were covered:

Table 2: Sampling strata

Stratum	Samples
Residential waste	Tortola, collection zones 1 - 6
Mixed residential and commercial (restaurant) waste	Jost Van Dyke Anegada
Commercial waste	Virgin Gorda, restaurant waste Tortola, supermarket
Separate collection (residential/ restaurant)	Virgin Gorda

Table 3: Overview over samples taken during the waste characterisation campaigns

Sample size	Unit	Tortola	Jost Van Dyke	Virgin Gorda	Anegada	BVI
1st waste characterisation	kg	1084.15	155.53	118.61	173.42	1531.71
	lb	2385.13	342.17	260.94	381.52	3369.77
2nd waste characterisation	kg	669.29	140.12	0.00	0.00	809.41
	lb	1472.44	308.26	0.00	0.00	1780.70
Total	kg	1753.44	295.65	118.61	173.42	**2341.12**
	lb	3857.57	650.44	260.94	381.52	**5150.47**

2.2 Limitations and Difficulties

The summary table shows that it was, unfortunately, not possible to achieve the sample sizes of 300 kg (660 lbs) indicated in the waste characterisation methodology (Annex 1 of the Inception Report).

The main reason for this is the composition of waste, especially on Tortola. Waste is very complex, with a high percentage of lightweight plastic sub-fractions, which slows down considerably the sorting process. The organic waste content is rather low.

The most important limitation of the waste characterisation is the size, both of the overall sample and of some single samples. Usually, the approach pursued by the Consultant is to discard any sample below 100 kg (220 lbs), since measurement errors become too important if the sample is too small. This was not possible in the present characterisation, given that 6 out of 13 samples were smaller than 100 kg in the first campaign, and one in the second campaign.

The size of the overall sample is 2.341 kg (5.150 lbs). The sample size is too small to ensure a random sampling error < 10 % for the main waste streams (see also sub-chapter 3.4. on statistical analysis). Random sampling error is between 15 – 30 % for the most important waste fractions.

Strong wind affected the granulometric analysis during several days. Especially the lightweight 2D plastic fractions were sometimes partly blown away. In consequence, the proportion these fractions are probably underestimated. In general, however, we think that the weight of the plastic fractions is overestimated, due to the high percentage of impurities in discarded food containers, plastic bags and similar packaging items.

Time constraints and unavailability of workforce reduced the scope of the second characterisation campaign. Overall sample size was smaller, and it was not possible to repeat the characterisation exercise on Virgin Gorda and Anegada.

Detailed results of the waste characterisation are given in Annex 1 (separate excel file).

3 RESULTS

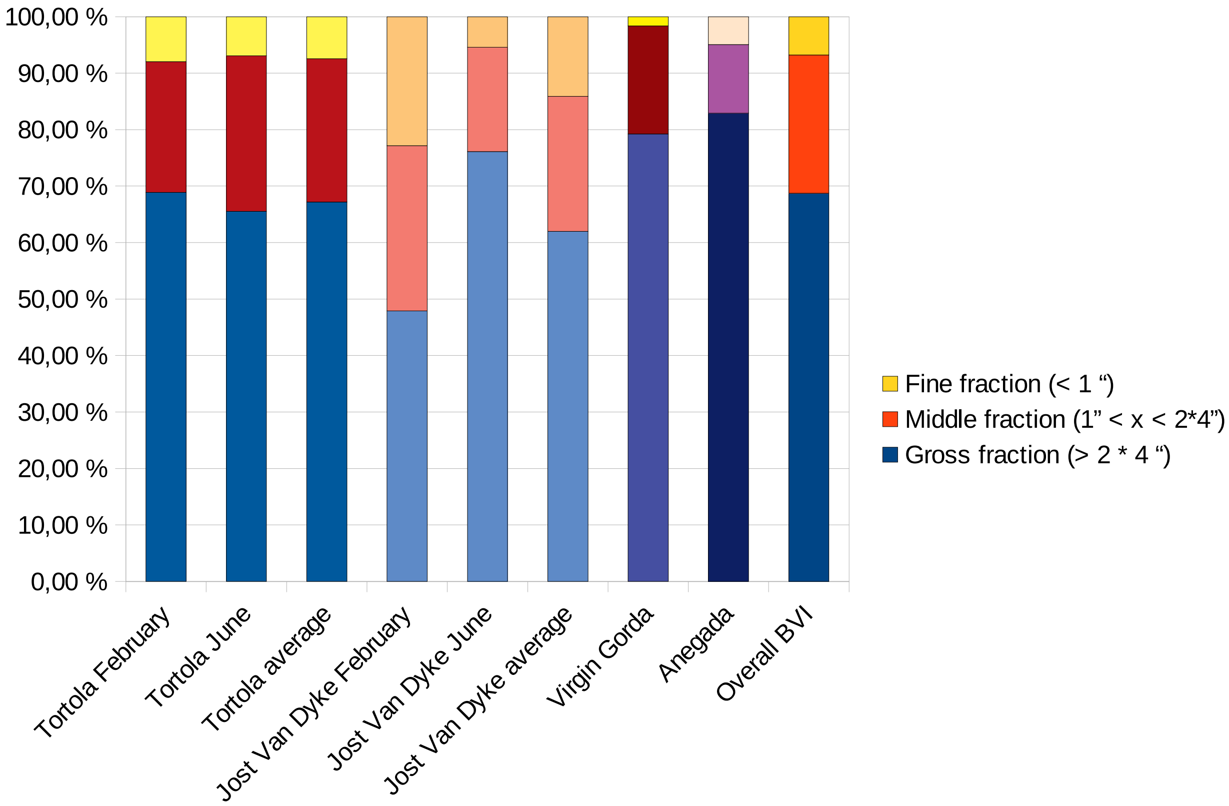
3.1 GRANULOMETRY

The distribution of the three granulometric fractions as well as their characteristics change according to the habitat stratum, i.e. the island from where waste is collected. Residential waste from Tortola has been considered a single stratum.

Table 4: Distribution of granulometric fractions on the different islands

	Tortola February	Tortola June	Tortola average	Jost Van Dyke February	Jost Van Dyke June	Jost Van Dyke average	Virgin Gorda	Anegada	Overall BVI
Gross fraction (> 2 * 4 “)	68.89	65.54	67.22	47.91	76.13	62.02	79.26	82.92	68.78
Middle fraction (1” < x < 2*4”)	23.17	27.55	25.36	29.27	18.47	23.87	19.10	12.16	24.45
Fine fraction (< 1 “)	7.94	6.92	7.43	22.82	5.40	14.11	1.65	4.93	6.78

Figure 2: Granulometric distribution of waste in the British Virgin Islands



The table and the figure show that the gross fraction is by far the most important fraction in BVI waste, whereas the fine fraction, which consists generally mostly of organic waste, is often negligibly small. The Jost van Dyke island seems to be an exception, having a considerably more important fine fraction during the February campaign. However, visual observations showed that the fine fraction from Jost Van Dyke is not mostly organic, as it is in the purely residential areas, but that it contains large amounts of crushed bottles, since waste is collected in compactor bins at the island's transfer station. The proportion of crushed bottles was significantly lower during the June campaign, which may be explained with a lesser amount of tourists during the latter campaign.

However, in overall Tortola, Anegada and separately collected waste from Virgin Gorda, the gross fraction constitutes over 70 % of the overall waste. This is the fraction expected to contain most of the recyclable material. In the Tortola supermarket waste, no medium or fine fraction was observed.

3.2 Granulometry

Both the gross fraction (> 2" x 4") and the medium fraction (1 "² < X < 2" x 4") were subject to sorting analysis. The objective of the sorting analysis was

a) to determine the overall amount of recyclable and compostable sub-fractions

b) to assess in how far an efficient separation of recyclable and compostable material is ensured by sieving. The general assumption is that recyclable waste as well as non recyclable non biodegradable material remains above the sieve due to the bigger size of the items, and biodegradable waste falls through.

3.2.1 Overall waste composition

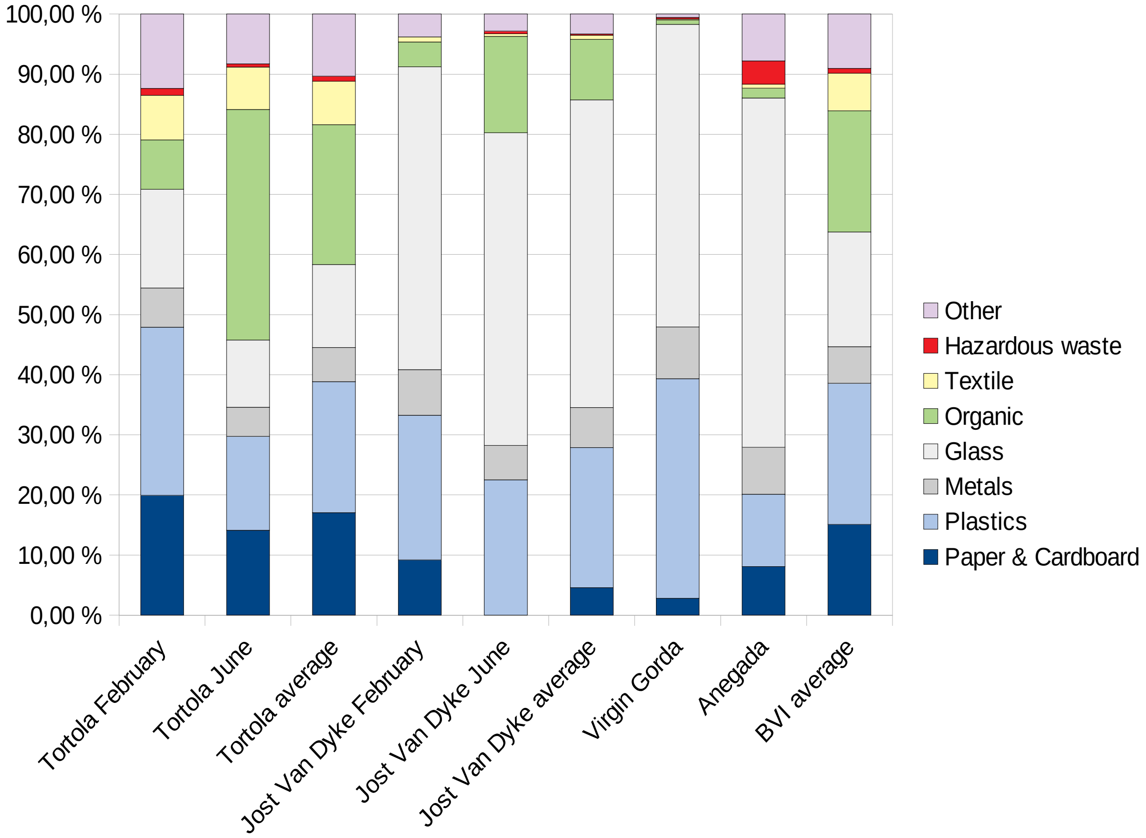
The tables and the graphic below show the overall waste composition for the residential, commercial and mixed waste samples in the British Virgin Islands. The presence of bulky waste being very haphazard given the size of samples, the proportional weight of waste (sub-) fractions has been calculated without bulk waste. Medium sized bulk waste is often delivered together with residential/ commercial waste; large size bulk waste should be delivered separately, even if many citizens do not yet comply with this requirement.

In the figures, **recyclable** waste is indicated in **fat blue**, **biodegradable** waste in **fat green** letters. Paper and cardboard are both recyclable and biodegradable; the preferred recovery option depends on the cleanness of these materials. Paper and cardboard in the fine and medium fraction has been considered under organic/ biodegradable, since it is generally torn, soiled with wet waste and no more good for recycling.

Table 5: Summary of waste composition in the British Virgin Islands

	Tortola February	Tortola June	Tortola average	Jost Van Dyke February	Jost Van Dyke June	Jost Van Dyke average	Virgin Gorda	Anegada	BVI average
Paper & Cardboard	**19.96**	**21.67**	**20.81**	**9.19**	**.97**	**5.08**	**2.81**	**8.06**	**18.34**
Plastics	**27.95**	**21.20**	**24.58**	**24.08**	**23.89**	**23.98**	**36.56**	**12.07**	**25.89**
Metals	**6.52**	**5.86**	**6.19**	**7.59**	**6.10**	**6.85**	**8.61**	**7.81**	**6.51**
Glass	**16.42**	**16.71**	**16.57**	**50.35**	**63.49**	**56.92**	**50.32**	**58.10**	**21.50**
Organic	**8.21**	**14.69**	**11.45**	**4.13**	**2.80**	**3.47**	**0.67**	**1.64**	**9.96**
Textile	7.41	9.85	8.63	.84	.56	.70	0.19	0.66	7.44
Hazardous waste	1.18	.29	.74	.00	.58	.29	0.28	3.88	0.71
Other	12.36	9.72	11.04	3.82	1.60	2.71	0.56	7.78	9.65

Figure 3: Summary of BVI waste composition



The detailed waste composition is given in the following table.

Table 6: Waste composition per stratum - without bulky waste

Fractions	Sub-fractions	Tortola February	Tortola June	Tortola average	Jost Van Dyke February	Jost Van Dyke June	Jost Van Dyke average	Virgin Gorda	Anegada	Overall BVI
	Cardboard	**9.81**	**9.62**	**9.72**	**4.14**	**0.00**	**2.07**	**1.85**	**5.92**	**8.64**
	Paper	**4.15**	**4.49**	**4.32**	**0.26**	**0.74**	**0.50**	**0.38**	**0.76**	**3.77**
Textile		5.20	7.06	6.13	0.40	0.43	0.42	0.15	2.43	5.31
Plastic	**PET**	**7.47**	**5.47**	**6.47**	**4.08**	**5.15**	**4.61**	**22.50**	**2.45**	**8.35**
	HDPE film	**3.57**	**0.94**	**2.26**	**1.34**	**1.66**	**1.50**	**0.91**	**0.60**	**2.07**
	HDPE 3D	**1.89**	**1.36**	**1.62**	**1.67**	**2.80**	**2.23**	**3.74**	**1.80**	**1.88**
	PVC	**0.25**	**0.01**	**0.13**	**0.13**	**0.00**	**0.07**	**0.00**	**0.23**	**0.11**
	LDPE clear	**3.04**	**3.75**	**3.40**	**4.65**	**5.04**	**4.84**	**1.30**	**1.93**	**3.14**
	PP film	**1.02**	**0.44**	**0.73**	**0.08**	**0.39**	**0.24**	**0.22**	**0.31**	**0.66**
	PP 3D	**2.00**	**2.35**	**2.17**	**5.45**	**6.94**	**6.19**	**3.81**	**3.77**	**2.43**
	PS	1.86	1.33	1.59	0.25	0.55	0.40	0.22	0.36	1.40
	Other	0.00	0.44	0.22	0.00	0.00	0.00	0.00	0.00	0.19
Glass	**Transparent**	**4.90**	**5.44**	**5.17**	**21.95**	**33.54**	**27.75**	**18.80**	**29.76**	**7.31**
	Coloured	**7.02**	**5.75**	**6.39**	**17.13**	**18.51**	**17.82**	**28.26**	**22.28**	**9.32**
Metal	**Fe metal**	**2.71**	**3.40**	**3.05**	**2.73**	**2.82**	**2.78**	**4.01**	**3.15**	**3.17**
	Al containers	**0.93**	**0.97**	**0.95**	**1.30**	**2.21**	**1.75**	**3.07**	**1.71**	**1.22**
	Al film	**1.11**	**0.46**	**0.78**	**0.36**	**0.66**	**0.51**	**0.76**	**3.06**	**0.80**
	Copper	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.15**	**0.00**
Hazardous waste	WEEE	0.52	0.12	0.32	0.00	0.00	0.00	0.22	3.22	0.33
	Medical waste	0.07	0.01	0.04	0.00	0.00	0.00	0.00	0.05	0.03
	Chemical waste	0.31	0.27	0.29	0.00	0.44	0.22	0.00	0.00	0.25
	Batteries/ accumulators	0.00	0.13	0.06	0.00	0.00	0.00	0.00	0.00	0.05
Organic waste		**32.04**	**38.13**	**35.09**	**31.40**	**15.28**	**23.34**	**6.35**	**2.60**	**31.15**
Wood		**0.04**	**0.20**	**0.12**	**0.00**	**0.00**	**0.00**	**0.00**	**0.34**	**0.11**
Bulky waste (Tyre, furniture, toilet seat…)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Baby diaper, pads and hygienic tissue		4.33	2.74	3.53	1.45	1.11	1.28	0.15	2.98	3.09
Shoes		0.89	1.14	1.01	0.00	0.00	0.00	0.00	0.65	0.88
Ceramic and inert waste		0.08	0.01	0.05	0.00	0.00	0.00	0.00	5.79	0.10
Complex/ composite	Packaging	2.02	2.11	2.07	0.80	0.99	0.90	1.57	1.51	1.99
	Other	0.52	0.58	0.55	0.00	0.00	0.00	0.00	0.02	0.47
Other		2.28	1.29	1.78	0.43	0.73	0.58	1.71	2.15	1.77

The assessment shows that the most important waste fractions in residential areas (Tortola) are organic waste, plastics and paper. The quality of organic waste, however, is quite poor, since a significant amount of plastic and composite waste as well as broken glass is found in the medium and fine fraction. Organic waste in the medium and fine fraction consists to an important amount of soiled paper.

Plastic waste in residential areas is often soiled with organic waste, and an important amount of the non-separated plastic sub-fractions (up to 2/3) does consist of water and sticky organic waste.

Separately collected waste at Virgin Gorda is of very good quality, near to no organic waste has been found to be mixed with the different recyclable fractions.

For the mainly touristic destinations (Anegada, Jost Van Dyke and Virgin Gorda restaurant waste), it can be observed that coloured and transparent glass constitute the most important fraction. These are mainly beer bottles, often intact. Seafood wastes are the main component of organic waste in Jost Van Dyke island.

Hazardous waste identified in the samples is mainly WEEE (waste electrical and electronic waste) and chemical waste, mostly brushes and containers contaminated with paint rests. Very few medical syringes and only one single battery were found; the syringes were very small syringes meant for injections at home (diabetes or similar); the battery was an alkali battery containing no heavy metals. Separation at the source of biohazardous waste in hospitals seems to work well.

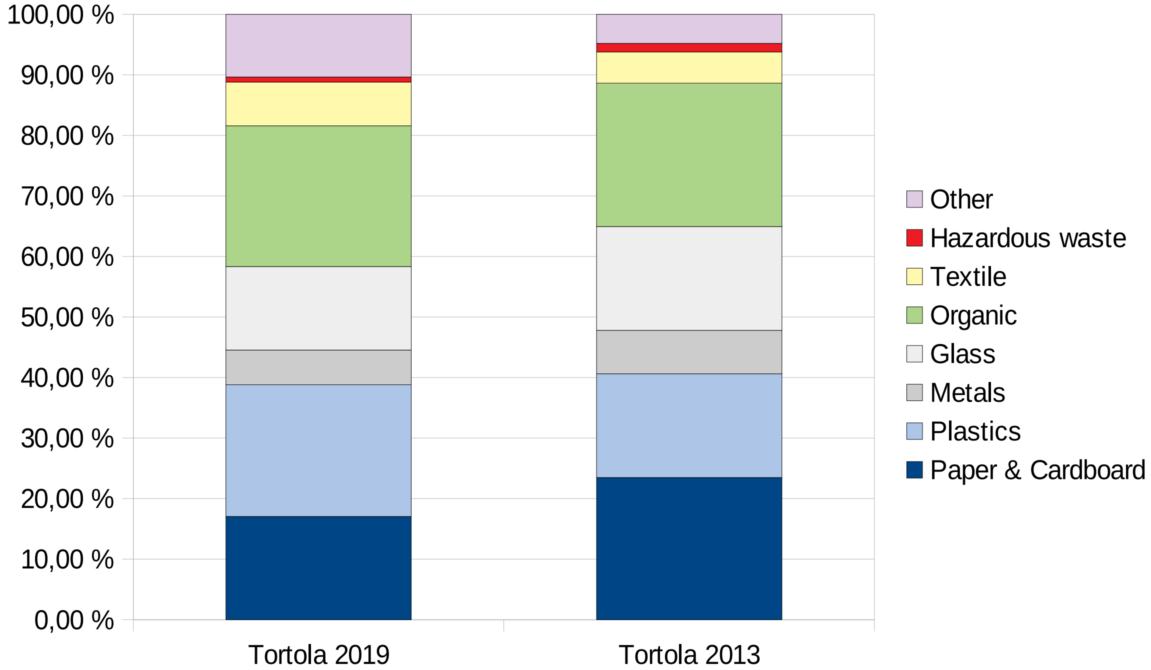
3.2.2 Development of waste composition over the years

The detailed waste composition table in the BVI waste management strategy of 2013 allows a comparison between solid waste composition in 2013 and 2019 for Tortola. Waste from the other islands was not analysed separately in 2013. The differentiation into sub-fractions being different during the 2013 assessment, only main fractions can be compared. The following table and graph show the waste composition in Tortola for 2013 and 2019.

Table 7: Waste composition in Tortola, 2013 – 2019

	Tortola 2019	Tortola 2013
Paper & Cardboard	**17.04**	**23.47**
Plastics	**21.80**	**17.14**
Metals	**5.67**	**7.19**
Glass	**13.81**	**17.14**
Organic	**23.27**	**23.69**
Textile	7.23	5.13
Hazardous waste	0.85	1.42
Other	10.33	4.81

Figure 4: Waste composition in Tortola, 2013 and 2019



The table shows an increase in organic waste, and a decrease in the generation of paper waste in Tortola. However, this is not to be considered a real increase, since no granulometric analysis was done in 2013, and all types of paper and cardboard were subsumed under this category, whereas paper and cardboard < 2” x 4” was listed under “organic” during the 2019 characterisation. This explains most probably of this apparent change.

The most noticeable development is the increase in “other” waste, which comprises items like baby diapers & hygienic pads, but also composite packaging, shoes and other complex materials.

The importance of glass waste seems to have decreased from 2013 to 2019. A decrease in the overall amount of glass consumption being very improbable, this may be an indicator for an important increase in the overall generation of the other waste fractions, which reduces the importance of the glass fraction. However, this hypothesis cannot be verified since the weighbridge register at the incinerator does not provide reliable data for the last two years.

An extrapolation has been made in order to exclude construction waste and other bulky waste measured in the 2013 characterisation from the comparative assessment.

3.2.3 Waste composition per fraction

The following table and figures show the composition of the gross fraction > 2” x 4”.

Table 8: Detailed waste composition - gross fraction

Fractions	Sub-fractions	Tortola February	Tortola June	Tortola average	Jost Van Dyke February	Jost Van Dyke June	Jost Van Dyke average	Virgin Gorda	Anegada	Overall BVI
Paper/ cardboard	**Paper**	**5.83**	**7.07**	**6.45**	**0.54**	**0.97**	**0.75**	**0.47**	**0.91**	**5.61**
	Cardboard	**14.13**	**14.64**	**14.38**	**8.65**	**0.00**	**4.32**	**2.33**	**7.14**	**12.74**
Textile		7.41	9.85	8.63	0.84	0.56	0.70	0.19	0.66	7.44
Plastic	**PET**	**10.11**	**6.94**	**8.52**	**6.73**	**6.27**	**6.50**	**27.60**	**2.96**	**10.75**
	HDPE film	**4.13**	**1.30**	**2.71**	**2.79**	**0.15**	**1.47**	**1.06**	**0.72**	**2.48**
	HDPE 3D	**2.50**	**1.78**	**2.14**	**1.69**	**3.27**	**2.48**	**3.86**	**1.32**	**2.34**
	PVC	**0.31**	**0.01**	**0.16**	**0.23**	**0.00**	**0.12**	**0.00**	**0.28**	**0.14**
	LDPE clear	**4.58**	**5.45**	**5.01**	**6.14**	**5.72**	**5.93**	**1.64**	**2.30**	**4.59**
	PP film	**1.27**	**0.53**	**0.90**	**0.18**	**0.52**	**0.35**	**0.28**	**0.37**	**0.81**
	PP 3D	**2.54**	**2.72**	**2.63**	**6.02**	**7.24**	**6.63**	**1.83**	**3.69**	**2.58**
	PS	2.52	1.84	2.18	0.30	0.72	0.51	0.28	0.43	1.92
	Other		0.63	0.32		0.00	0.00			0.27
Glass	**Transparent**	**6.84**	**8.27**	**7.55**	**27.98**	**39.18**	**33.58**	**21.96**	**35.89**	**9.86**
	Coloured	**9.58**	**8.45**	**9.01**	**22.37**	**24.32**	**23.34**	**28.37**	**22.21**	**11.64**
Metal	**Fe metal**	**3.89**	**4.28**	**4.08**	**5.48**	**3.14**	**4.31**	**3.97**	**3.28**	**4.06**
	Al containers	**1.32**	**1.14**	**1.23**	**1.82**	**2.58**	**2.20**	**3.78**	**1.51**	**1.55**
	Al film	**1.30**	**0.45**	**0.88**	**0.30**	**0.38**	**0.34**	**0.86**	**2.84**	**0.89**
	Copper	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.19**	**0.00**
Hazardous waste	WEEE	0.73	0.09	0.41	0.00	0.00	0.00	0.28	3.88	0.43
	Medical waste	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	waste	0.45	0.19	0.32	0.00	0.58	0.29	0.00	0.00	0.28
	Batteries and accumulators	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Organic waste		**8.16**	**14.38**	**11.27**	**4.13**	**2.80**	**3.47**	**0.67**	**1.23**	**9.80**
Wood		**0.05**	**0.31**	**0.18**	**0.00**	**0.00**	**0.00**	**0.00**	**0.41**	**0.16**
Baby diaper, pads and hygienic tissue		5.50	3.24	4.37	3.04	0.89	1.96	0.19	3.60	3.83
Shoes		1.41	1.66	1.53	0.00	0.00	0.00	0.00	0.79	1.32
Ceramic and inert waste		0.13	0.00	0.06	0.00	0.00	0.00	0.00	1.04	0.06
Complex/ composite	Packaging	2.56	2.44	2.50	0.79	0.40	0.59	0.28	0.41	2.19
	Other	0.09	0.83	0.46	0.00	0.00	0.00	0.00	0.03	0.39
Other		2.69	1.56	2.12	0.00	0.31	0.15	0.09	1.92	1.85

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Figure 5: Summarised composition of the gross fraction

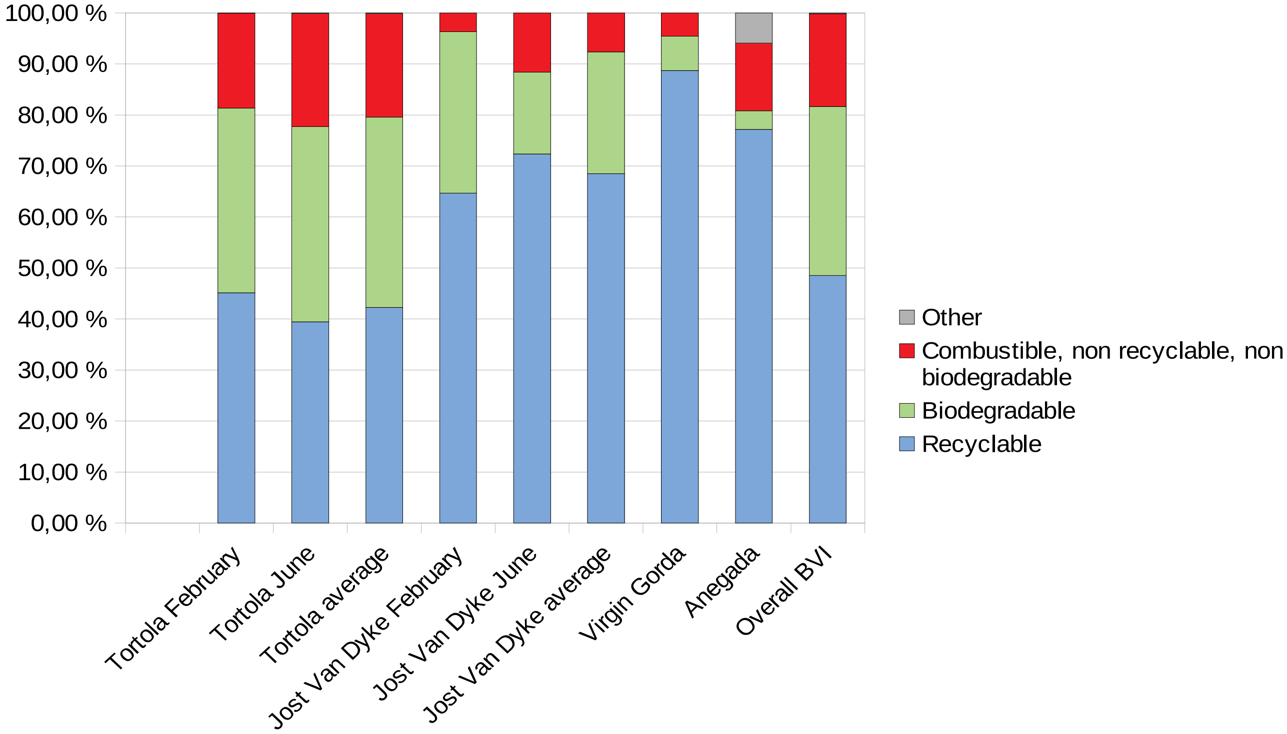
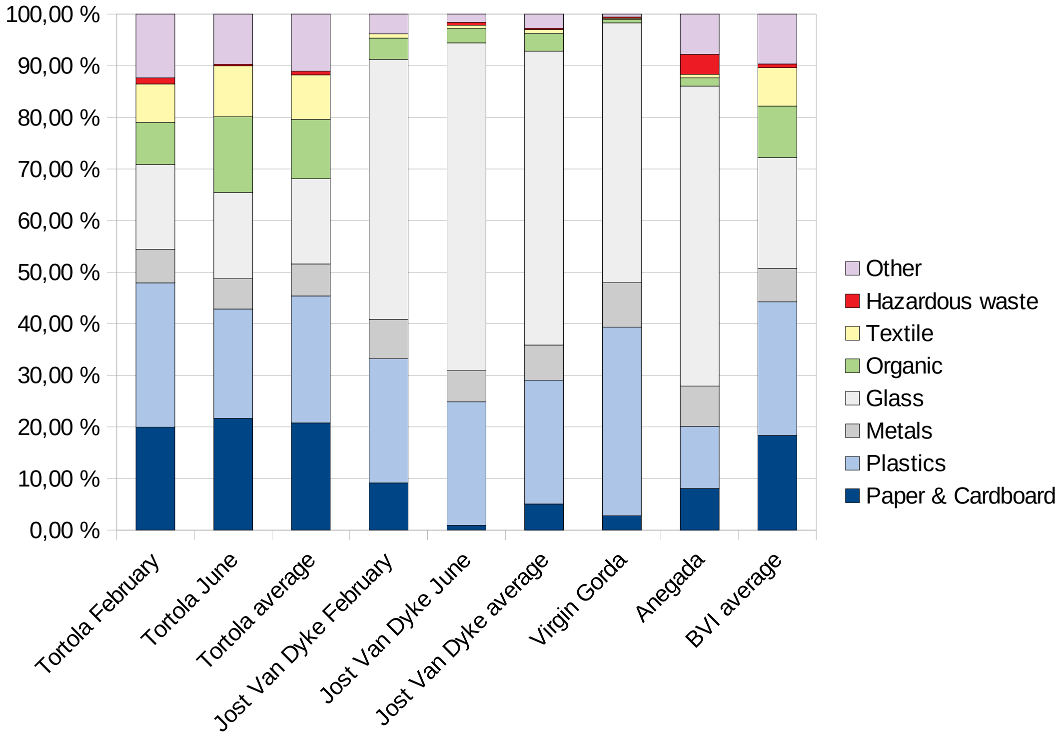


Figure 6: Composition of the gross fraction



Waste composition of the gross fraction is very similar to the composition of the overall waste produced in the British Virgin Islands, with the only difference that organic waste is nearly not present in the samples other than Tortola. The reason for this similarity is the comparatively small importance of the fine and medium fraction.

Glass is the most important fraction in all samples expect Tortola, where plastics and cardboard are the first and second biggest fraction.

The supermarket sample of the gross fraction is identical to the overall sample, since the fine and medium fraction were absent in this sample.

The table and figures below give the waste composition for the fine and medium fraction between 1 "² and 2" x 4".

Table 9: Detailed composition of the medium fraction

Medium fraction		Tortola February	Tortola June	Tortola average	Jost Van Dyke February	Jost Van Dyke June	Jost Van Dyke average	Virgin Gorda	Anegada	Overall BVI
Paper/ cardboard	**Paper**	**0.93**	**0.00**	**0.47**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.40**
	Cardboard	**1.69**	**0.00**	**0.84**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.72**
Textile		0.92	1.49	1.20	0.00	0.00	0.00	0.00	15.50	1.19
Plastic	**PET**	**4.95**	**4.88**	**4.92**	**2.92**	**2.01**	**2.47**	**3.28**	**0.00**	**4.64**
	HDPE film	**4.74**	**0.43**	**2.59**	**0.00**	**8.39**	**4.19**	**0.40**	**0.00**	**2.31**
	HDPE 3D	**1.26**	**0.93**	**1.09**	**2.92**	**1.68**	**2.30**	**3.53**	**5.84**	**1.45**
	PVC	**0.01**	**0.00**	**0.01**	**0.07**	**0.00**	**0.04**	**0.00**	**0.00**	**0.00**
	LDPE clear	**0.85**	**1.45**	**1.15**	**5.84**	**3.69**	**4.77**	**0.00**	**0.20**	**1.04**
	PP film	**0.88**	**0.00**	**0.44**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.38**
	PP 3D	**1.89**	**4.10**	**2.99**	**8.76**	**0.00**	**4.38**	**12.35**	**5.84**	**4.17**
	PS	1.14	0.56	0.85	0.37	7.72	4.04	0.00	0.00	0.77
	Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Glass	**Transparent**	**1.70**	**0.45**	**1.07**	**29.20**	**0.00**	**14.60**	**7.31**	**0.00**	**1.96**
	Coloured	**2.69**	**2.23**	**2.46**	**21.90**	**20.13**	**21.02**	**30.24**	**31.76**	**6.32**
Metal	**Fe metal**	**0.91**	**0.00**	**0.46**	**0.37**	**0.00**	**0.18**	**4.54**	**3.56**	**0.98**
	Al containers	**0.06**	**3.40**	**1.73**	**1.46**	**0.00**	**0.73**	**0.40**	**3.81**	**1.58**
	Al film	**1.45**	**1.19**	**1.32**	**0.73**	**2.35**	**1.54**	**0.40**	**5.84**	**1.26**
	Copper	**0.00**	**0.79**	**0.40**	**0.00**	**1.34**	**0.67**	**0.00**	**0.00**	**0.35**
Hazardous waste	WEEE	0.00	0.00	0.00	0.00	2.01	1.01	0.00	0.00	0.01
	Medical waste	0.37	0.00	0.18	0.00	0.00	0.00	0.00	0.41	0.16
	waste	0.00	1.11	0.56	0.00	0.00	0.00	0.00	0.00	0.48
	Batteries and accumulators	0.00	0.61	0.31	0.00	0.00	0.00	0.00	0.00	0.26
Organic waste		**61.34**	**70.29**	**65.82**	**22.54**	**41.95**	**32.24**	**30.49**	**13.01**	**60.65**
Wood		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Baby diaper, pads and hygienic tissue		5.31	2.33	3.82	0.00	2.35	1.17	0.00	0.00	3.29
Shoes		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ceramic and inert waste		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Complex/ composite	Packaging	2.98	2.52	2.75	1.46	3.69	2.58	7.06	9.65	3.34
	Other	2.24	0.00	1.12	0.00	0.00	0.00	0.00	0.00	0.96
Other		1.68	1.24	1.46	1.46	2.68	2.07	0.00	4.57	1.32

Figure 7: Summarised composition of the medium fraction

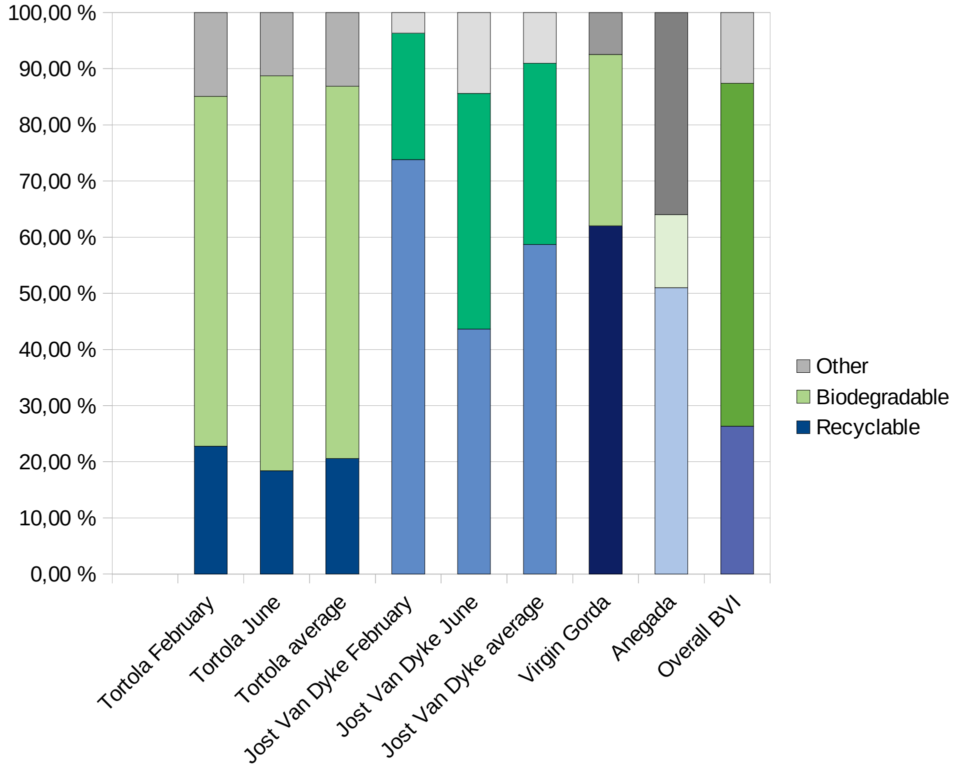
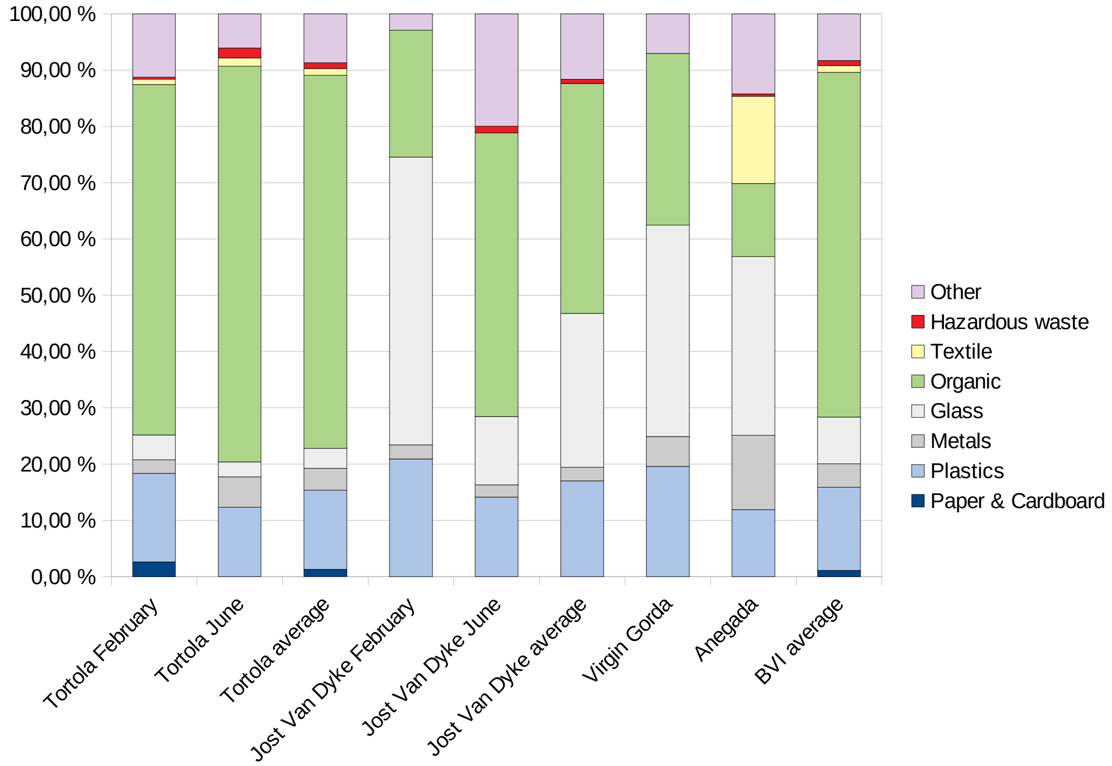


Figure 8: Composition of the medium fraction



In Tortola, 66 % of the medium fraction consist of organic waste. Soiled paper is also counted as organic waste, since small paper and cardboard pieces are difficult to sort out and not adequate for recycling.

The organic fraction is much less important in the samples taken from Jost Van Dyke and Virgin Gorda; organic waste is between 30 – 37 % in the Virgin Gorda samples, and 32 % in the Jost Van Dyke samples. It should be noted here that the medium fraction is very small in the two Virgin Gorda samples, and that 1/3 of organic waste in this fraction does not represent much in the total sample. In Jost Van Dyke, organic waste consists mostly of seafood shells, and the medium and fine fraction amounts to over 50 % of the total sample. Both in Tortola and in Jost Van Dyke, the organic fraction becomes more important during the non touristic season. This effect is more marked in Jost Van Dyke, which has a very small resident population.

Broken glass is the most important component in the medium and fine fraction of Jost Van Dyke waste. This is nearly exclusively green glass from beer bottles, which has been broken in the compactor bins. Considering that the medium + fine fraction constitute 51 % of the overall waste during the touristic season, and broken bottle glass is again 51 % of the medium fraction, we can conclude that approximately ¼ of waste coming from Jost Van Dyke consists of broken green glass. During the non touristic season, this proportion is significantly reduced.

For Anegada and the Virgin Gorda samples, broken glass and small bottles constitute also the most important element in the medium fraction. However, the medium fraction is far less important, especially in Anegada. Compactor bins being not available in these islands, crushing of bottles is less frequent.

3.3 Statistical Analysis

A statistical analysis of the reliability and representativeness of the waste characterisation campaign has been carried out for the overall sample. The results are given in the following tables.

The statistical analysis reflects the great heterogeneity of waste in the British Virgin Islands. The variation coefficient lies between 46 % and 80 % for the main fractions. In consequence, with the number of samples taken, a random sampling error of

- 15 – 20 % for Fe waste

- 20 % for HDPE 3D waste

- 20- 30 % for PET, LDPE and PS waste

- 30 % for organic waste and PP 3D

> 30 % for coloured glass, Al containers and baby diaper

has to be accepted.

Table 10: Statistical assessment per sub-fraction

Material		Variance	Standardd eviation	Variation coefficient	Confidence interval	
Fractions	Sub-fractions	kg²	kg	%	maximum	minimum
Paper & Cardboard	Cardboard	902,87	30,05	117,84	26,02	25,39
	Soiled paper	104,90	10,24	142,75	7,80	7,04
Textile		159,19	12,62	114,11	11,56	10,95
Plastic	PET	73,69	8,58	57,22	15,25	14,95
	HDPE film	24,56	4,96	91,57	5,81	5,33
	HDPE 3D	4,89	2,21	52,10	4,47	4,20
	PVC	0,58	0,76	241,42	1,37	0,09
	LDPE clear	17,22	4,15	57,27	7,50	7,19
	PP film	2,60	1,61	101,27	2,04	1,50
	PP 3D	21,98	4,69	71,04	6,91	6,53
	PS	2,82	1,68	56,94	3,20	2,90
	Other	2,59	1,61	467,86	2,40	-0,09
Glass	Transparent	790,68	28,12	117,90	24,37	23,74
	Coloured	381,28	19,53	81,52	24,31	23,88
Metal	Fe metal	10,07	3,17	46,55	7,02	6,77
	Al containers	5,03	2,24	83,16	3,06	2,62
	Al film	4,79	2,19	102,60	2,58	2,04
	Copper	0,01	0,12	460,36	2,05	-0,40
Hazardous waste	WEEE	1,70	1,30	101,21	1,73	1,19
	Medical waste	7,12	2,67	1530,18	6,89	-1,25
	Chemical waste	0,85	0,92	190,04	1,32	0,31
	Batteries and accumulators	0,24	0,49	473,30	2,18	-0,34
Organic waste	Biodegradable	887,19	29,79	69,21	43,34	42,97
	Wood	15,04	3,88	413,71	2,75	0,55
	Packed food	10,72	3,27	110,99	3,44	2,85
Baby diaper		47,70	6,91	93,64	7,79	7,29
Shoes		4,29	2,07	132,91	2,14	1,43
Ceramic		8,91	2,99	1057,51	4,93	-0,70
Complex/ composite	Packaging	59,01	7,68	206,62	4,63	3,53
	Other	46,80	6,84	360,29	3,48	1,56
Other		43,17	6,57	151,02	5,01	4,21

Table 11: Assessment of sample size

Variation coefficient	Required and real number of sample units for a 95 % confidence level and a random sampling error of:					
	3%	5%	10%	15%	20%	30%
15	138	35	9	4	2	1
20	246	61	15	7	4	2
25	384	96	24	11	6	3
30	553	138	35	15	9	4
35	753	188	47	21	12	5
40	983	246	61	27	15	7
45	1.245	311	78	35	19	9
				22 samples		
50	1.537	384	96	43	24	11
					22 samples	
55	1.859	465	116	52	29	13
					22 samples	
60	2.213	553	138	61	35	15
70	3.012	753	188	84	47	21
80	3.934	983	246	109	61	27
90	4.979	1.245	311	138	78	35
100	6.147	1.537	384	171	96	43
120	8.851	2.213	553	246	138	61
140	12.047	3.012	753	335	188	84
160	15.735	3.934	983	437	246	109
200	24.586	6.147	1.537	683	384	171

4 CONCLUSIONS

Conclusions of the waste characterisation study are listed below:

- Waste composition is, in all four islands, very complex. The medium and fine fraction, which consist mainly of organic waste in many countries, are very mixed and do **not allow a mechanical separation** of the organic (biodegradable) fraction from recyclable and other waste.

  For this reason, **separate collection is a conditio sine qua non for the introduction of efficient waste stream management, recovery and recycling** in the British Virgin Islands.

- Waste generated in the islands of Virgin Gorda, Jost Van Dyke and Anegada is much less complex than waste from Tortola. Due to the importance of touristic infrastructure, glass is the preponderant waste fraction. This situation is less marked during the low season. **Separate collection of recyclable materials from restaurants, bars and hotels is expected to** be introduced and monitored comparatively easily, and to **yield good results** in terms of quantity and quality of collected materials.

- In the island of **Jost Van Dyke, separate collection of glass waste and storage in a non compacting bin** would be necessary to allow recovery of this important waste stream. Moreover, glass being not combustible, this would alleviate greatly the charge of non combustible wastes to the incinerator.

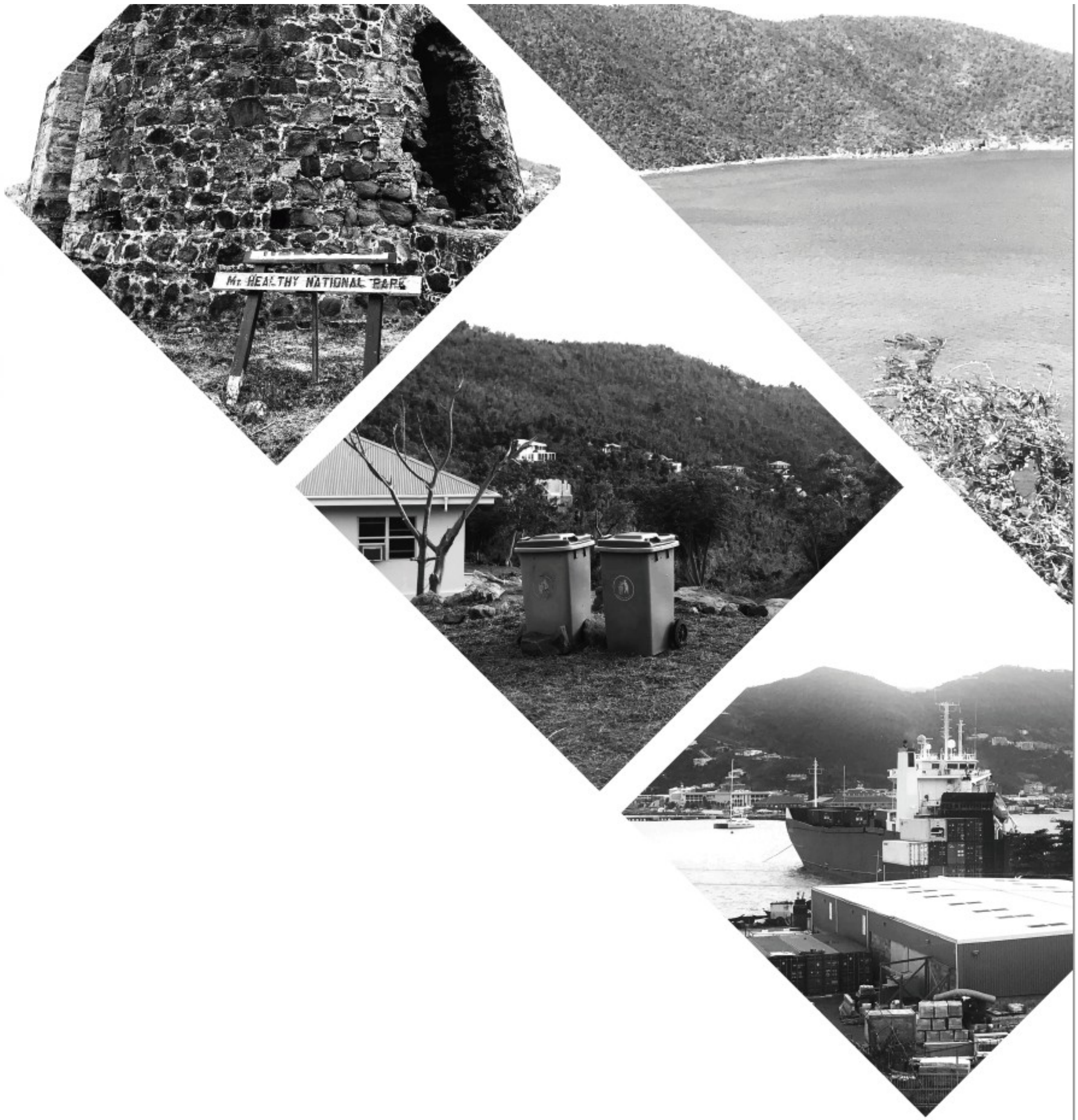
  Similarly, separate collection of **organic waste from restaurants might allow to implement a medium size, decentralised biogas production facility** on the island.

- **Separately collected waste in Virgin Gorda is of very good quality**; the performance of the separate collection in that island is to be highlighted. Materials are separated efficiently and are clean.

- The introduction of **separate collection of recyclable materials from restaurants, bars and hotels in Tortola** would probably allow to recover an important amount of glass and metal for recycling also in this island. Given the size and the mix between residential and touristic infrastructure in Tortola, the introduction and monitoring of separate collection will be more challenging than in the smaller islands.Supermarket waste is very clean and easy to sort. **Separate collection of secondary and tertiary packaging from supermarkets** will yield an important quantity of clean recyclable materials.

- The analysis of waste from all islands underlines the **importance of the proposed ban of single-use plastics**. Polystyrene food packs and single-use mugs, plates and cutlery constitute an important waste fraction.

Department of Waste Management
Together, We CAN Keep the BVI Clean and Green!



ACTION PLAN

DRAFT VERSION

SEPTEMBER 2019

Waste Management Strategy for the British Virgin Islands

RED
Agency for Resilience, Empowerment and Development

CLIENT

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REPORT STRUCTURE

Title	Final Report
Number of pages	60
Number of annexes	0

CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

ARS	After shredder residues
BA	Building Authority
BVI	British Virgin Islands
BVIG	British Virgin Islands Government
DDM	Department of Disaster Management
DEH	Department of Environmental Health
DFID	Department for International Development
DWM	Department of Waste Management
DRR	Disaster Risk Reduction
DR	District Representative
ELB	End of Life Boat
ELV	End of Life Vehicles
EPR	Extended producer responsibility
FTE	Full-Time Employee
H&S	Health & Safety
IR	Inception Report
JVD	Jost Van Dyke
MCW	Ministry of Communications and Works
MHSD	Ministry of Health & Social Development
MNRL	Ministry of Natural Resources and Labour
NEOC	National Emergency Operations Centre
PA	Planning Authority
QS	Quantity Surveyor
THIRA	Territorial Hazard Identification and Risk Assessment
TCPD	Town and Country Planning Department
ToR	Terms of References
PWD	Public Works Department
RDA	Recovery and Development Agency
SWM	Solid Waste Management
USD	US Dollars
USVI	US Virgin Islands
VI	Virgin Islands
VG	Virgin Gorda
WEEE	Waste Electrical and Electronic Equipment

1 INTRODUCTION AND SUMMARY

The present action plan gives an overview over the proposed governance, legal, financial, organisational and technical measures, their logical connection, cost and timing. Proposed measures, their interconnection, timing and budget are presented in the figure and table below.

Figure 1: Solid waste management action plan- logic tree

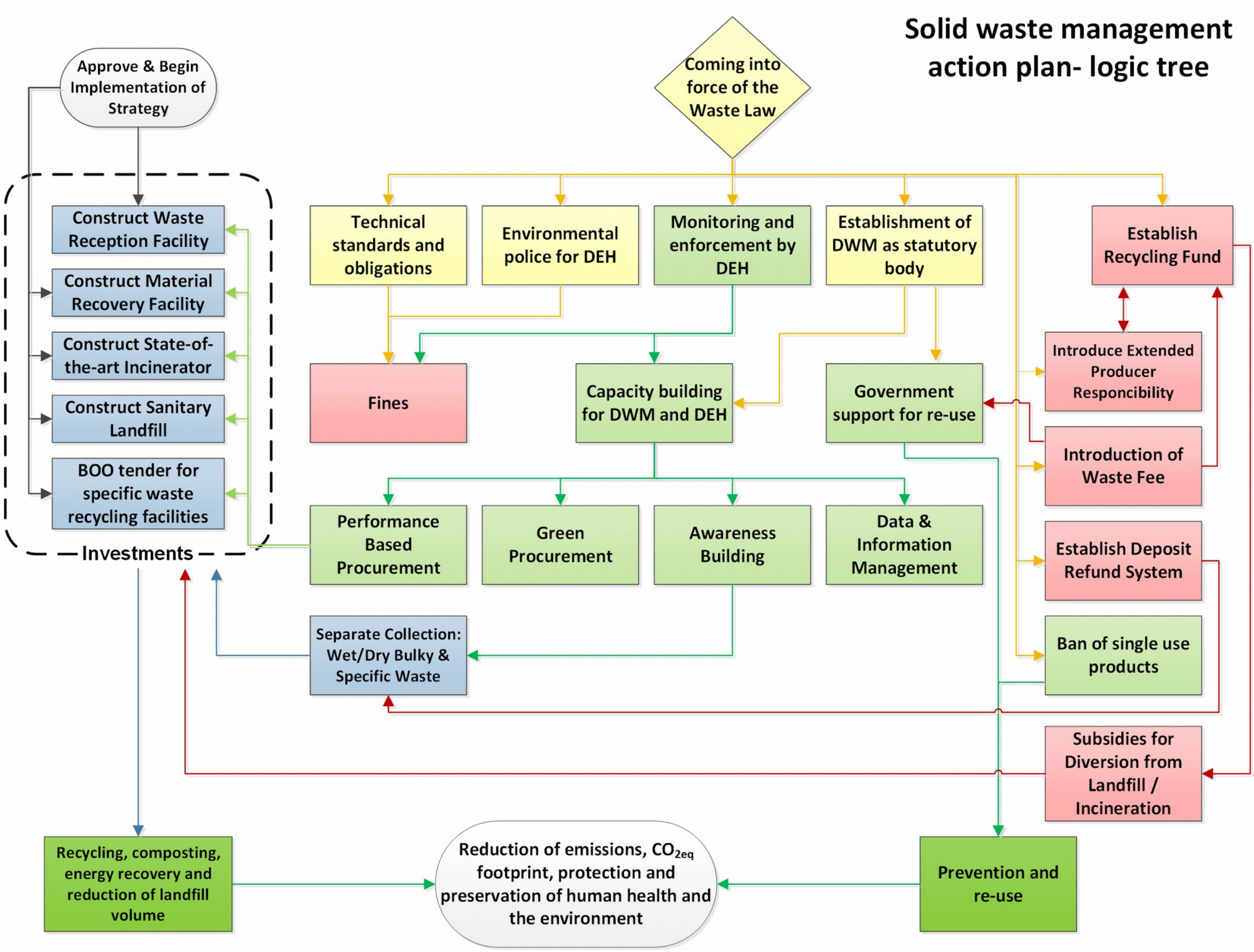


Table 1: Summary of proposed measures, their timeline and cost

Measure		Start	End	Budget (US$)
Governance	Set-up of DWM as statutory body	With coming into force of waste law	Continuous	First 5 years: 25,000 p.a. consultancy 250,000 US$/year specialised staff
	Monitoring and enforcement by DEH	With coming into force of waste law	Continuous	150,000 p.a.
	Capacity building	Immediately – coming into force of waste law	Formal training to be completed after 2 – 4 years Lifelong learning to continue	1,500,000 DWM 150,000 DEH
	Cooperation with private sector	Immediately	Continuous	Covered by DWM capacity building
Data and information management	Baseline study	1st year of strategy implementation	3 months after start	25,000
	Waste characterisation	2024, 2029, 2034, 2039	Same year as start; 2 seasons campaign	25,000 each (with workers provided by DWM)
	Interim evaluation	2026, 2031, 2036	3 months after start	40,000 each
	Data collection, reporting, SWM statistics public access to information	Immediately	Continuous	Covered by DWM capacity building
Regulatory and legislative framework	Ban of single use plastics and pallets	With coming into force of waste law	Continuous	200,000 p.a. (decreasing)
	Establishment of waste fee	With coming into force of waste law 5 years transition to real cost coverage	Continuous	100,000 consultancy 50,000 p.a. staff
	Extended producer responsibiltiy	With coming into force of waste law	Continuous	250,000 p.a.
	Technical standards	With coming into force of waste law	Technical standards completed 5 years after coming into force of waste law. Continuous review and updating	225,000 p.a. for Ministry staff and consultancy
	Technical obligations	With coming into force of waste law	Continuous	Covered by DEH monitoring
	Obligatory registration for vehicles and vessels	With coming into force of waste law	Continuous	Covered by ERP for vehicles and vessels
	Green procurement	With the assignment of a trained procurement expert	Continuous	To be determined
Economic instruments	Deposit-refund system	With coming into force of waste law	Continuous	To be financed by importers/ retailers
	Subsidies for sustainable substitutes	5 – 10 years after start of strategy implementation	Continuous	To be determined
	Subsidies for diversion from incineration/ landfill	With the establishment of the Recycling Fund	Continuous	

Measure		Start	End	Budget (US$)
	Fines	With coming into force of waste law	Continuous	
	Government support for re-use	With the establishment of: - Waste fee - Statutory body	Continuous	200,000 investment + 150,000 p.a. (decreasing)
Awareness building and information	For the introduction of financial and legal measures	With coming into force of waste law	Continuous	50,000 p.a.
	For waste prevention	With the establishment of the statutory body	Continuous	
	For segregation at the source	With the introduction of wet/ dry collection	Continuous	
Substitution of fossil energy supply and transition to renewable energy sources		With the planning of the first investment	Continuous	Included in investment costs
Waste collection	Separate collection wet/dry	Immediately	Continuous	150,000 investment 25,000 consultancy 50,000 p.a.
	Purchase of a barge	With the implementation of the strategy	0,5 years after tendering	500,000
	Construction of waste reception facilities	With the establishment of the recycling fund	1 year after start of construction	1,700,000 investment
	Mobile collection of special wastes	Immediately Switch to electrical collection vehicle after 5 years	Continuous	Use of existing truck 180,000 electrical truck
	Reverse logistics	With the establishment of extended producer responsibility	Continuous	To be financed by ERP
	Construction of material recovery facility	With the establishment of the recycling fund	1 year after start of construction	1,350,000 investment
Treatment of special recyclable wastes	Installation of ELV / ELB treatment facility and contracting of ASR treatment	With the establishment of the recycling fund	1 year after tendering	Investment by private recycler ERP subsidy 100 US$/ELV average 10,000 US$/ELB
	Acquisition of concrete crusher	With coming into force of waste law	1 year after tendering	Private investment
Recovery of organic waste	Worm composting facility	Immediately	Continuous extension and adaptation to changing waste streams	Private investment
	Small composting facilities in Jost Van Dyke, Virgin Gorda and Anegada	With the establishment of the recycling fund	0,5 year after tendering	100,000
	Anaerobic co-digestion project	With coming into force of waste law	Investor found after 1 year Project operational after 3 years	Private investment
	Biodiesel production from waste	With the establishment of the recycling	1 year after tendering	Private investment

Measure		Start	End	Budget (US$)
	vegetal oil	fund		
Treatment of non recyclable, non biodegradable waste	Repair of existing incinerator and installation of stack gas treatment	Immediately	2019	In course, outside strategy scope
	Acquisition of state-of-the art incinerator with full stack gas treatment and energy recovery	Start of procurement: 3 years after start of strategy implementation	Start of operation: 5 years after start of strategy implementation	25,000,000 100 – 120 US$/t operation cost
	Sanitary landfill	With coming into force of waste law	2 years after tendering	3,700,000 90 US$/ton operation cost
	Rehabilitation of old dumps by landfill mining	Completion of new landfill site	9 years after start	Private investment

2 GOVERNANCE

2.1 STRUCTURE AND ORGANISATION

2.1.1 Set-up of DWM as a Statutory Body

The set-up of DWM as a statutory body will grant more autonomy to the waste management entity. Most important mandates are:

- procurement of infrastructure, equipment, material and services

- budget administration.

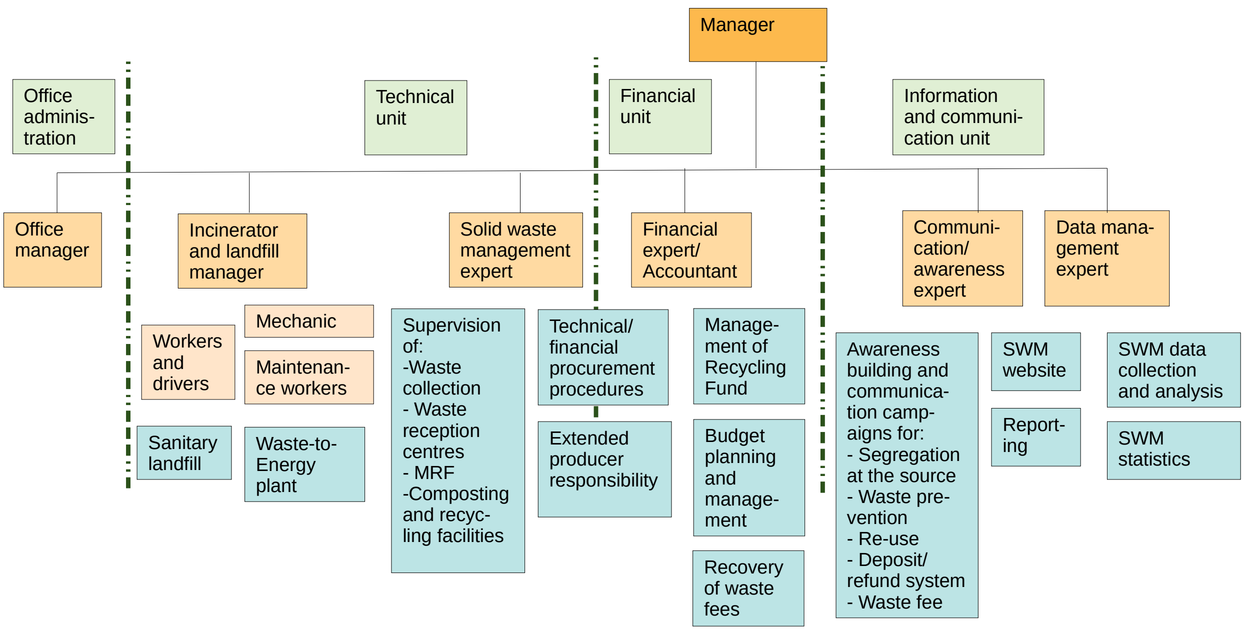
Doing its own procurement is important for the future statutory body in order to shorten the duration of the procurement procedure, to prioritise acquisitions according to technical criteria and own planning, and to ensure that tender documents and awards be done according to the technical requirements and with the technical expertise of the solid waste management entity.

Autonomous budget administration is necessary to ensure real cost coverage of solid waste management. The solid waste management administration should receive and manage revenues from waste fees and use them to cover operational and capital expenses for all waste management activities not covered by extended producer responsibility.

Moreover, the solid waste management authority should also be mandated to manage the recycling fund, which will be the instrument for transferring revenues from extended producer responsibility to recyclers, to make the deposit-refund system work and to subsidise recycling and composting of waste streams that are not profitable and not covered by extended producer responsibility.

The figure below indicates a schema how the statutory body could be organised in different, specialised units.

Figure 2: Exemplary set-up of statutory waste management body



2.1.2 Separation of Monitoring and Enforcement Functions from Technical Implementation

With the coming into force of the Solid Waste Law, it is recommended to mandate Department of Environmental Health with the monitoring and enforcement of solid waste management related issues. This covers:

Incorporation of environmental police (two police officers assigned to Department of Environmental Health) for monitoring and enforcement in the following areas:

- littering,

- violation of obligatory segregation at the source (hazardous and bulky wastes)

- violation of deposit/ refund system or extended producer responsibility rules

- violation of emission limits and technical standards

- Announced or random control of vehicles, retailers, imports, waste skips etc. to verify the correct application of the law's previsions.

A technical expert of the Department of Environmental Health should be assigned to carry out the inspection of private solid waste treatment facilities (in cooperation with DWM/ the future statutory body).

2.2 Capacity Building

2.2.1 Department of Environmental Health: Monitoring and Enforcement of Solid Waste Legislation

Department of Environmental Health will need more competence in monitoring of solid waste management activities. This covers both the activities of the environmental police and the inspection of solid waste treatment facilities. The table below gives an overview over training and

Table 2: Personnel and training needs for Department of Solid Waste Management

Site	Personnel needed	Qualification/ training needs	Term
All sites/ office	Inspector responsible for monitoring, supervision and enforcement of solid waste management law	- Solid waste management legislation - General knowledge of solid waste treatment and disposal standards - Basic technical knowledge	Coming into force of new SWM act
Field	Environmental police	- Offences under solid waste management legislation - General knowledge of solid waste treatment and disposal standards	Immediately

2.2.2 Department of Waste Management (future Statutory Body): Implementation of Solid Waste Management

Although the Department of Waste Management has long term experience in solid waste management, specialisation is needed for some areas. Currently, the Department is functioning without any engineer. The incinerator and the dump sites are operated by workers without formal technical training.

With the implementation of the waste management strategy, the Department of Waste Management will need more capacities in the following areas:

- Procurement

- Monitoring and supervision of waste management operations (own and private operators)

- Management of incinerator

- Landfill management

- Awareness building and communication (related to segregation at the source)

- Data management

Department of Waste Management needs to employ more qualified personnel and ensure regular training for technical operators and other key personnel. However, given the smallness of the island and the corresponding size of the authority dealing with solid waste management, similar responsibilities might be combined in order to avoid over-staffing.

The following table gives an overview over personnel and training needs for the implementation of the integrated solid waste management strategy:

Table 3: Personnel and training needs for Department of Solid Waste Management

Site	Personnel needed	Qualification/ training needs	Term
Incinerator	Manager of incinerator and sanitary landfill: Civil, mechanical, environmental engineer or equivalent	- Waste incineration technology and operation - Waste reception criteria - Stack gas treatment - Sanitary landfill technology and operation - Leachate treatment - Labour/ environmental security - Data management	Taking into operation of new incinerator/ of new landfill site
	Mechanic	- Maintenance and repair of heavy duty vehicles used at the incinerator and on the landfill	Immediately
All sites/ office	Technical expert responsible for monitoring of facilities and extended producer responsibility and for the technical part of procurement	- Extended producer responsibility - General knowledge of solid waste treatment and disposal technology and standards - Preparation of terms of reference for procurement of equipment, service and infrastructure - Construction supervision and acceptance of finished works - General knowledge of solid waste treatment technologies	Coming into force of new SWM act
Community/ office	Social/ environmental expert responsible for monitoring and implementation of awareness campaigns for waste prevention, re-use and separate collection at the source	- General knowledge of solid waste prevention and recovery approaches and technology - Design, implementation and monitoring of waste prevention campaigns/ segregation at the source systems - Communication techniques for awareness building	Immediately
Office	Accountant/ financial expert	- Management and planning of SWM budget - Fee recovery - Cost centre accounting/ documentation of real cost for each waste management operation - Management of recycling funds - Financial/ administrative parts of procurement	Creation of the statutory body

Formal technical training and university education not being available on the British Virgin Islands, up to four staff members should be sent abroad in order to obtain the following qualifications:

- mechanical or civil engineer with specialisation in solid waste management

- mechanic specialised on maintenance of heavy duty vehicles

- electrician/ electronic technician specialised on system maintenance

- Data and information management (this could be a postgraduate qualification for someone with a diploma in management/ environmental management/ environmental sciences)

During the absence of the staff in question, temporary contracts might be given to foreign experts in order to replace DWM staff during their qualification.

In-house training is recommended for:

- Communication and awareness building

- (Green) public procurement

2.3 Cooperation with the Private Sector

Cooperation with the private sector is essential to ensure a smooth implementation of the different activities along the waste management chain, and to foster private initiative and innovativeness. The modalities of cooperation, rules and responsibilities need to be laid out clearly and comprehensively in order to provide planning security and reliability.

The table below gives an overview over the relationship between government and the private sector for the different operations along the waste hierarchy.

Table 4: Public-private cooperation in waste management

Activity	Operation	Owning	Financing
Waste collection	Private collectors + recyclers	Vehicles owned by private sector. Collection zones tendered by government Government should provide framework, contracts and adequate payment	Users (households, administrations and commerces) via waste fee
Repair and re-use	NGOs, charity organisations	NGOs and charity organisations Government might provide location	Volunteer work Subsidies by government (financed by waste fee)
Waste reception centres	Private NGO/ government	Government owns and tenders operation open both to commercial enterprises and NGO	Extended producer responsibility for wastes covered by ERP Income from recycling
Material recovery facilities	Best bid	Government owns and tenders operation open both to commercial enterprises and NGO	Extended producer responsibility for wastes covered by ERP Income from recycling Waste fee financed subsidy for non profitable wastes not covered by ERP
Specialised (ELB/ ELV/ WEEE/ C&D waste) recycling	Private with supervision of government	Private investment. Land to be provided by government	Extended producer responsibility for wastes covered by ERP Income from recycling
Composting/ anaerobic digestion	Private with supervision of government	Private investment Land to be provided by government	Waste fee financed subsidy Income from compost/ biogas/ digestate sales
Incineration	Government or BOT contract	Government	Waste fee Income from electricity/ heat/ cold sales
Landfill facilities	Government	Government	Waste fee
Landfill mining	Private	Private	Income from scrap sales Subsidies by government (financed by waste fee)

Contracts with private organisations will be awarded by a public tendering process relying on clear technical specifications and transparent, real cost based pricing. In case of private investments, government will support the investor by providing land in an adequate location if so needed. For recycling operations that need subsidising, the government will tender a BOO investment based on subsidies per ton, which will be subject to an annual revision based on real cost assessment.

2.4 Data and Information Management

In order to guarantee the sustainability and efficiency of solid waste management, systematic collection and analysis of solid waste related data is necessary. This covers waste related information, processes and installations as well as financial data related to real cost coverage of the different waste management operations.

2.4.1 Baseline study

All financial scenarios presented in the current Action Plan are relying on the 2019 waste characterisation, extrapolations from international experience, equipment supplier values and 2019 BVI unit prices for utilities.

Recommendations for fees under extended producer responsibility, subsidies for recyclers and household waste fees are based on these assumptions. In order to avoid a deficit in specific solid waste management operations, or an overcharging of users and commerce, a comprehensive baseline study needs to be carried out for each type of infrastructure one year after its taking into operation. On basis of the results of the baseline study, main parameters will be determined for annual reporting of each infrastructure. The baseline study should cover at least the following information:

Table 5: Parameters to be verified in the baseline study

Infrastructure	Parameters to be assessed
Waste prevention	- Existing instruments - Performance and efficiency of the instruments in application Qualitative assessment: obstacles and problems observed, success stories
Technical obligations, standards and licensing	- Presence of grease traps in restaurants, gas stations, motor workshops etc. - Waste streams collected separately from commerces and administrations - Registration and deposit/ refund payment for vehicles and boats - Existence of licensed recycling and waste treatment plants - Technical and environmental standards for solid waste treatment installations
Extended producer responsibility	- Unit fees applied per material or product covered by extended producer responsibility - Revenues from extended producer responsibility - Subsidies accorded by extended producer responsibility (per waste stream, per recycler) Qualitative assessment: obstacles and problems observed, success stories
Waste fee	- Amount of waste fee paid by households and commerces - Coverage of waste fee Qualitative assessment: obstacles and problems observed, success stories
Waste collection	- Quantities of waste collected per zone - Complaints related to waste collection - Cost of waste collection per tonne - Observations related to compliance with segregation at the source rules
Waste reception centres	- Incoming waste quantities per fraction and sub-fraction - Cash flow per waste fraction - Operation costs per category (personnel, electricity, fuel, lubricants, spare parts...) - Electricity generation by solar panels and consumption
Material recovery facility	- Incoming waste quantities per fraction and sub-fraction - Performance of separate collection (% of wrong throws in recyclable fraction) - Cash flow per waste fraction - Sales revenues per waste fraction and sub-fraction - Operation costs per category (personnel, electricity, fuel, lubricants, spare parts...) - Electricity generation by solar panels and consumption
Composting and biogas facilities	- Incoming waste quantities per fraction and sub-fraction - Performance of separate collection (% of wrong throws in biodegradable fraction) - Quantities produced and sold: compost/ digestate/ biogas/ electricity/ worm tea - Sales revenues for compost/ digestate/ biogas/ electricity/ worm tea… - Compost/ digestate/ worm tea quality (analysis parameters) - Operation costs per category (personnel, electricity, fuel, lubricants, spare parts...) - Electricity generation by solar panels and consumption Qualitative assessment: production/ management/ commercialisation problems, success factors
Special waste recycling facilities including landfill mining	- Incoming and outgoing waste quantities per fraction and sub-fraction - Sales revenues per fraction and sub-fraction - % of recycling residues, destination and quantities per fraction - Destination of sales, quantities per destination, freight cost, % of local recycling - Operation costs per category (personnel, electricity, fuel, lubricants, spare parts...)

Infrastructure	Parameters to be assessed
	- Electricity generation by solar panels and consumption Qualitative assessment: production/ management/ commercialisation problems, success factors
Incineration	- Incoming waste quantities and calorific input - Production of heat/ steam/ cold/ electricity and sales thereof - Quantities, type and destination of incineration residues - Revenues from sales of incineration residues/ cost of their treatment - Operation costs per category (personnel, electricity, fuel, lubricants, spare parts…) - Emission data (monitoring of treated stack gas) Qualitative assessment: production/ management/ commercialisation problems, success factors
Sanitary landfill	- Incoming waste quantities - Operation costs per category (personnel, electricity, fuel, lubricants, spare parts…) - Emission data (monitoring of treated leachate/ of leachate evaporation) Qualitative assessment: production/ management/ commercialisation problems, success factors

The baseline study should verify all assumptions made for the present strategy and action plan, and confirm them or replace them with values derived from the 1st year operation experience. All extended producer responsibility related data should be thoroughly revised and updated in cooperation with the respective stakeholders.

The baseline study is also the key instrument to verify, and if necessary, adjust, the targets set in the Solid Waste Management Strategy, relying on more realistic data from the implementation of the different measures.

2.4.2 Waste characterisation

In order to improve knowledge of the waste streams generated in the British Virgin Islands, and to monitor the performance of the different instruments implemented to prevent certain waste streams, segregate, recover and recycle others, the waste characterisation study should be repeated every 5 years with a similar methodology as the 2019 characterisation (see Annex 1 for details), in order to allow comparison of the results, measure progress achieved and identify bottlenecks in the implementation of the solid waste management strategy.

The waste characterisation should aim at obtaining a holistic image of all waste streams, taking into account:

- Registers of waste reception centres, material recovery facilities and composting plants

- 2 season characterisation of waste from the separate household collection (wet/ dry)

Analysis of the results should cover:

- efficiency of waste prevention (presence of undesirable fractions in the general waste streams)

- efficiency of segregation at the source (% of wrong throws)

- general development of waste composition: which fractions become more important, which fractions decrease?

Findings of the next waste characterisation are especially important

2.4.3 Interim Evaluation and Re-Orientation of the Solid Waste Management Strategy

Every five years after the start of implementation of the measures proposed in the strategy, an independent interim evaluation should be carried out to compare the progress of solid waste management in the British Virgin Islands with the targets set in the strategy and reviewed by the baseline study.

The interim evaluation may confirm or recommend re-adjustment of the solid waste management strategy, depending on the general development of the British Virgin Islands' policy, socio-economic, and environmental situation, and the adequateness of the response the proposed measures provide to the needs of the country.

The interim evaluation is also an instrument to assess the effectiveness and efficiency of the different measures implemented under the solid waste management strategy. The OECD evaluation criteria of relevance – effectiveness – efficiency – impact – sustainability and the standard OECD scoring should be applied to ensure completeness and easy understanding of the evaluation.

In addition to the assessment of targets reached, all criteria listed for the baseline study should be covered in the interim evaluation to facilitate a comparison between the staus quo ante, the baseline situation and the status reached at the time of the interim evaluation.

The final evaluation at the end of the 20 years period covered by the present strategy should aim at developing new orientations for a follow-up strategy basing on the achievements of the actual one.

2.4.4 Transparency, Reporting and Public Access to Solid Waste Management Information

Prior to Hurricane Irma, Department of Waste Management published annually a report presenting the solid waste collection data, events and achievements of the year. This good practice is recommended to restart, gradually integrating data from waste management installations, analysis of SWM data, environmental information (emission, compost quality etc.) and information of public interest, such as coverage of waste fee, real cost of solid waste management, requirements and rules of segregation at the source, technical obligations etc.

Solid waste management statistics, annual reports, waste characterisation data, emission data and other relevant information should be systematically published on the Department of Waste Management (future statutory body) website to facilitate public access to this information.

3 Legal, Financial and Organisational Instruments of Solid Waste Management

3.1 Regulatory and Legislative Framework

3.1.1 Ban of certain packaging and single-use products

In the explanatory memorandum for its proposal for a Directive on the reduction of the impact of certain plastic products on the environment, the EU indicates that “Single Use Plastic (SUP) items represent about half of all marine litter items found on European beaches by counts. The 10 most found SUP items represent 86% of all SUP items (constituting thus 43% of all marine litter items found on European beaches by count). Fishing gear containing plastics accounts for another 27% of marine litter items found on European beaches. This initiative focuses therefore on the 10 most found SUP and fishing gear, which together represent around 70% of these marine litter items by count.”[1]

1Source: 2018/0172 (COD)

Although no data on single use plastics found in BVI marine litter is available, the waste characterisation results indicate that the same items identified by the European Commission constitute also an important part of waste in the British Virgin Islands. Due to the residents' lifestyle and the strong presence of day tourism, single use food containers, straws and cutlery have a much more prominent place in British Virgin Islands' waste than in the EU average, but small items such as beverage caps, tobacco filters or cotton bud sticks are equally found. Plastics from fishing gear have not been identified during the waste characterisation but are highly probable to form part of marine litter, since sport and hobby fishing is an important activity both for residents and the tourism sector.

Among the 10 most found single use plastic items, the Commission counts the following items and considers the following prevention measures (see Table); for the British Virgin Islands, slightly different measures are proposed given the island situation, the lack of producing industry and the country's small scale. More detailed recommendations and reasoning are given in the following sub-chapters.

Table 6: Overview over financial and legal instruments for waste prevention

Item/ Measure	Consump-tion reduction		Market restriction (ban)		Product design requirements		Marketing requirements		Extended producer responsibility		Separate collection objective		Awareness raising measures	
	EU	BVI	EU	BVI	EU	BVI	EU	BVI	EU	BVI	EU	BVI	EU	BVI
Food containers														
Cups for beverages														
Cutlery, plates, stirrers, straws														
Cotton bud sticks														
Sticks for balloons and balloons			Sticks only				Bal-loons						Bal-loons	
Packets and wrappers														
Beverage containers, caps & lids, beverage bottles											Bottles			
Tobacco product filters														
Sanitary items: - Wet wipes - Sanitary towels									Only wipes					
Lightweight plastic carrier bags														
Fishing gear														

<u>Ban of plastic shopping bags</u>

A complete ban of plastic shopping bags is recommended. The ban should cover indiscriminately all plastic bags, with no exceptions regarding to size, weight or material. In the Caribbean, a ban of plastic bags is already enforced in the following countries:

Table 7: Overview over ban of plastic bags in the Caribbean[23]

Country	Notes	Country	Notes
Antigua and Barbuda	Since 2016	Aruba	January 2017

2Source: https://en.wikipedia.org/wiki/Phase-out_of_lightweight_plastic_bags#cite_note-auto1-26
3Source: UNEP, Report on the Status of Styrofoam and Plastic Bag Bans in the Wider Caribbean Region, 11 July 2018

Country	Notes	Country	Notes
Barbados	Since April 2019	Bahamas	Planned for 2020
Dominica	Since 2019	Haiti	2013, difficult enforcement
Jamaica	Since January 2019	Puerto Rico	Since 2016
St. Vincent and the Grenadines	Since 2018	Turks and Caicos	Since 2017
US Virgin Islands	Since 2017		

Experiences with a complete ban of plastic bags have been made in various European, South American and African countries, as well as in China and Australia. With exception of Rwanda, most countries faced considerable difficulties due to:

- lobbying activities from industry and commerce

- insufficient institutional capacities for monitoring and enforcement

- black market and smuggling of plastic bags

In the Caribbean, the island situation and small size of the countries reduces the chance for success considerably, given that producers' lobbies are in foreign countries, the number of entry ports into the countries are limited, and communication and awareness building are easier to achieve thanks to the small scale of the islands.

A general exemption for biodegradable plastics is not recommended, for several reasons[4]:

- there are different types of bioplastics; not all of them are biodegradable, and not all of them are bio-based. The sheer multitude of bioplastic types leads to confusion, and often to acceptance of non biodegradable and/ or fossil based plastic bags. The figures below give an overview over the different types of bioplastics and their different characteristics.

- bio-based plastics are often mixed with fossil plastics, which affects the biodegradability of the material in question.

- not all plastics labelled “biodegradable” are biodegradable in a composting or anaerobic digestion facility, which finally leads to them being incinerated or landfilled. PLA packaging, for example, is biodegradable only by specific industrial composting processes and cannot be collected together with organic waste.

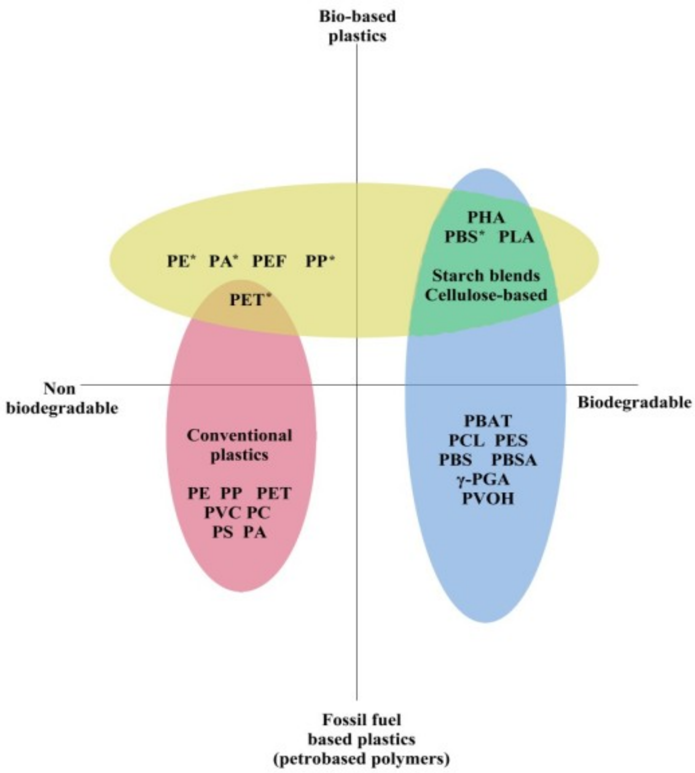
- there is no laboratory capacity in the British Virgin Islands allowing a random check of biodegradable plastics upon importation, which might lead to abuse.

- the ecological footprint upstream of the production of bio-based plastic often annihilates the ecological gain by substitution of fossil plastics, since fossil fuels are used in cultivation of corn, potato or sugar cane, which are the main raw materials for bio-based plastics, agricultural land is used for bioplastics production instead of food production, and water quality is affected by industrial fertilisers.

- Biodegradation of bioplastics leads to the production of CO_2 and H_2O, and does not contribute to the creation of soil enriching elements in the composting process. In fact, composting products and incineration products are identical for biodegradable plastics. In consequence, there is no added value in the biodegradability of these products.

4Summarised from: https://www.umweltbundesamt.de/themen/tueten-aus-bioplastik-sind-keine-alternative

Figure 3: Origin and biodegradability of main bioplastic categories



If, however, bioplastic packaging, shopping bags and single-use food containers or cutlery are to be used for a transition phase, the following alternatives are recommended:

- Thermoplastic starch based bioplastics without non biodegradable blends

- Bagasse based single-use food containers; these are produced from an industrial by-product in the Caribbean and therefore constitute a local alternative[5]; this organisation offers also fibre based products.

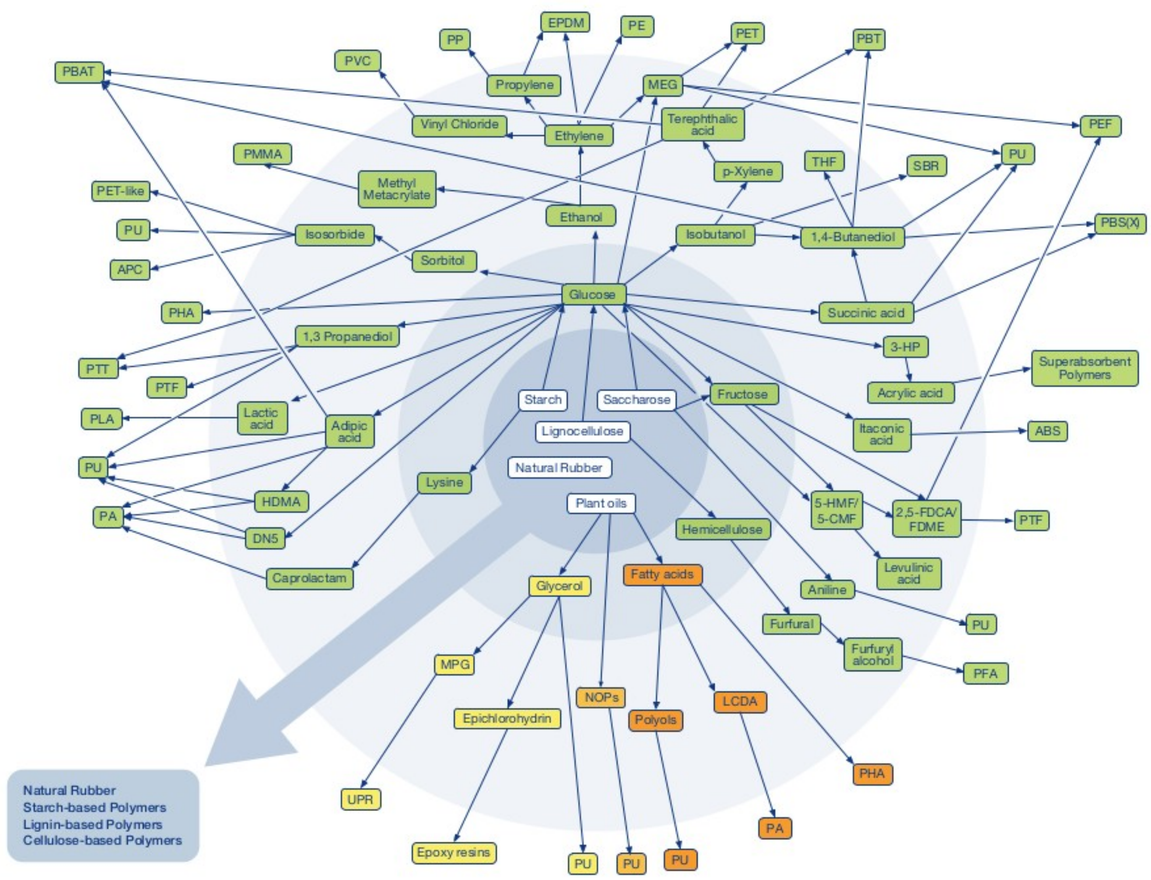
- Any biodegradable bioplastic for which the compostbility is certified according to ASTM D6400 (in the U.S.) or EN 13432 (in Europe) for biodegradation in an industrial composting facility environment.

Materials certified according to ASTM D6400 or EN 13432 will disintegrate within 12 weeks and biodegrade at least 90% within 180 days in a municipal or industrial composting facility. Approximately 10% of solid material will be left at the end of the six-month-long process in the form of valuable compost, or biomass and water. These standards also ensure that the leftover compost will be free of toxins, so the compost will not cause harm when the facility sells it for gardening or agricultural applications[6].

It should be noted that the worm composting facility is not designed to reach the temperatures required for composting of bioplastics. The composting process should therefore be tried in one of the smaller composting facilities before admitting a certain plastic type as compostable.

5 See: www.caribecompostables.com
6 Last two paragraphs quoted from: https://www.greendotbioplastics.com/biodegradable-vs-compostable-vs-oxo-degradable-plastics-a-straightforward-explanation/

Figure 4: Detailed overview over bio-based plastic types



Similarly, an exemption for very light LLDPE bags often used for weighing of loose fruit, vegetable etc. is not recommended. Directive 2015/0720/EU on plastic bags allows member states to make an exemption for very lightweight plastic bags, and the result is that in many countries, although the consumption of LDPE and HDPE shopping bags has considerably decreased, some consumers compensate the non availability of these shopping bags by more intensive use of LLDPE bags[7].

Ban of single use food and beverage containers, straws, cutlery

Several Caribbean states are already implementing a complete ban of styrofoam and other plastic food/ beverage containers and utensils as follows:

Table 8: Overview over bans on single use plastics in the Caribbean region[8]

Country	Notes	Country	Notes
Antigua and Barbuda	From 2017: plastic food containers and beverage cups From 2018: Ban of plastic cutlery, straws, trays and egg boxes => 1st year, 15,1 % of decrease in landfilled plastics	Barbados[9]	Complete ban of single-use plastic cups; cutlery, including plastic knives, forks and spoons; stirrers; straws; plates; egg trays (both plastic and Styrofoam), and Styrofoam containers used in the culinary retail industry from April 2019

7https://www.spiegel.de/wirtschaft/service/plastiktueten-verbrauch-in-deutschland-sinkt-a-1267878.html
8Source: UNEP, Report on the Status of Styrofoam and Plastic Bag Bans in the Wider Caribbean Region, 11 July 2018
9Source: https://gisbarbados.gov.bb/blog/barbados-announces-plastics-ban-from-april-1/

Country	Notes	Country	Notes
	=> Major businesses conformed easily		on
Belize	Gradual ban of single use food containers and utensils; biodegradable substitutes are allowed	Dominica	Ban of plastic straws, plastic plates, plastic forks, plastic knives, Styrofoam cups, and Styrofoam containers (2019)
Guyana	Prohibition of manufacturing, importing and distribution styrofoam products. Fine for importing and manufacturing: US$ 50.000 Fine for selling food in styrofoam containers: US$ 100.000	Haiti	Ban of styrofoam containers since 2013 (but difficulties with enforcement)
St. Lucia	Ban of styrofoam food service containers (since 2018)	St. Vincent and the Grenadines	Ban on the importation and use of styrofoam products (2018)

In the British Virgin Islands, the use of polystyrene egg boxes, food and beverage containers, PP food and beverage containers, straws and cutlery is very widespread. Single use plastic containers are not only used for take-away food and drinks, but also found to be convenient in restaurants and bars of every price class. In consequence, polystyrene waste constitutes 1,77 % of all household and assimilated waste in Tortola, and PP 3D waste between 3.77 and 5.45 % of all waste in Jost Van Dyke, Anegada and Virgin Gorda. It may be assumed that an important number of take-away cutlery, food and beverage containers used on boats or on beaches ends up as marine litter.

The low quality and/ or small size of waste food and beverage containers, straws and cutlery make separate collection and mechanical separation difficult, and recycling unattractive due to high costs for cleaning. Given that most of these items could easily be replaced in takeaway gastronomy by cardboard or starch based biodegradable boxes, or glasses/ plates/ cutlery with deposit, and in restaurants and bars by glass/ earthenware/ porcelain plates and glasses and metal cutlery, a complete ban of these single use plastics is strongly recommended.

Ban of tertiary packaging: pallets

Pallets are re-usable tertiary packaging with a high number of return cycles. To make most efficient use of pallets, standardised pallets are often exchanged between or rented to freight companies (pooling). However, this system comes to its limits in the British Virgin Islands, for different reasons:

- the amount of outgoing products is very low in comparison to incoming products, so the need for pallets for exporting is near to nil

- standards of pallets are not compatible among neighbouring countries, which generally take back only pallets corresponding to their own standards.

In consequence, huge amounts of pallets are discharged on daily basis to the British Virgin Islands. With 15,524 20 ft containers entering the country in 2018, approximately 425 pallets/ day were disposed at the British Virgin Islands, assuming that only 50 % of the containers brought goods on pallets. This corresponds to 9.36 t/day. Except some handicraft recycling, no use is made of these pallets.

For this reason, it is recommended to ban the disposal of pallets on the British Virgin Islands:

- ban on single use pallets and on returnable, non standardised pallets

- take-back obligation: for every pallet delivered to the British Virgin Islands, an equal amount of pallets is to be taken back

3.1.2 Polluter Pays Principle 1: Establishment of a Waste Fee

Solid waste management costs are currently borne by the Department of Waste Management, financed by the general governmental budget and are not reflected on the individual waste generator: household, businesses, administrations, tourists…

To ensure the sustainability of integrated waste management operations, waste generators should contribute individually to the costs of the system. This is generally achieved by the legal obligation to pay a waste fee, service tax or whatever name seems appropriate to the legislating administration.

The waste fee should cover the costs of:

Waste collection

+ Waste treatment

+ Waste disposal

+ General costs (management and administration)

+ Awareness building

– Costs covered by Extended Producer Responsibility

– Revenues from waste treatment.

= Net total waste management costs

Waste fees can be fix monthly or annual levies according to the size and nature of a waste producer, or they can be connected to a utilities bill, to property taxes or other obligatory payments to be made by legal and natural persons.

3.1.3 Polluter Pays Principle 2: Establishment of Extended Producer Responsibility

Extended producer responsibility scheme' means a set of measures taken by the government to ensure that producers, importers and sellers of products bear financial responsibility or financial and organisational responsibility for the management of the waste stage of a product's life cycle[10].

In the British Virgin Islands, industrial producers of goods traditionally covered under producer responsibility are rare to non-existing; all major consumer goods are imported. For this reason, the implementation of an extended producer responsibility system needs to concentrate mainly on the implication of importers and retailers.

Given the small size of the country, its active recycling community and committed retail markets, it is recommended under this strategy to apply extended producer responsibility mainly to cover the gap between the revenues from recycling of the targeted waste streams, and the cumulated costs of separate collection, sorting, preparation for recycling and exporting/ recycling of the waste stream in question. The simplest way of covering these costs would probably be by an import levy, agreed with the different importers and paid to recyclers upon proof of recycled/ exported quantities.

Extended producer responsibility should be applied for the following waste streams:

- Paper and cardboard, plastic, metal, glass and composite packaging

- Textile and shoes

10Adapted from Article 3.21 of Directive 2008/98/EU

- WEEE

- Batteries and accumulators

Producers generally pay a compensation to waste collectors and recyclers, and recover the additional cost via by adding to the product price. Typical contributions are:

Table 9: Collection, recovery and recycling costs for extended producer responsibility (packaging)

Waste	Belgium, Fost Plus [11]		France, CITEO (former Eco-Emballages)[12]		Germany, Der Grüne Punkt[13]	
	(€/t)	(US$/t)	(€/t)	(US$/t)	(€/t)	(US$/t)
Glass	31.1	34.21	14.2	15.62	11.67	12.84
Paper	22.3	24.53	163	179.30	14.83	16.31
Fe > 50 %	52.9	58.19	44.3	48.73	52.25	57.48
Al > 90 %	33.9	37.29	103.8	114.18	71.50	78.65
PET	346.30	380.60	312.3	343.50	105.25	115.78
Opaque PET (application of malus for bad recyclability)			624.60	687.00		
HDPE	341.80	382.80	312.3	343.50	105.25	115.78
Other plastics	510.30	561.00	312.3	343.50	105.25	115.78
Tetrapak drink boxes	354.10	389.40	247.4	272.14	63.75	70.13
Polystyrene and bioplastics	618.10	679.80	312.3	343.50	105.25	115.78
Complex packaging, mostly paper	618.10	679.80	312.3	343.50	84	92.40
Complex packaging, mostly Fe or glass	781.80	860.20	312.3	343.50	84	92.40

Although these tariffs are highly variable from country to country, the prices indicated above correspond to less than 1 – 1,5 cents per bottle or can of beverages, and 1 – 5 cents per bottle of liquid soap, detergent etc.

Similar systems exist for other waste streams falling under extended producer responsibility, such as WEEE, waste oil, ELV, ELB etc.

Specific fees per waste stream need to be calculated and annually updated according to the British Virgin Islands' context.

Ideally, extended producer responsibility should also include an obligation for waste prevention. At medium term, importers and retailers should be obliged to determine annually targets for waste reduction. This might be done by choice of products with less hazardous components, larger or lighter packaging, less secondary packaging etc.

Recycling targets and the obligation for a design of products aiming at easier dismantling and better recyclability are also important features of extended producer responsibility. It should, however be considered that producers in the BVI context are mainly importers, who have a very limited market power. Eco-design obligations under extended producer responsibility cannot, as they may in larger markets, push producers to invest in research and development or to upgrade their factories in order increase the sustainability of their products. It is, however, possible to oblige importers to compose more and more sustainably the portfolio of products they offer to the British Virgin Islands' market.

11Source: https://www.fostplus.be/sites/default/files/Files/Bedrijven/GPtarieven/groenepunttarieven_fr_2019_low_v9.pdf
12Source: http://www.ecoemballages.fr/sites/default/files/files/resources/tarif_2018_citeo_septembre_2017.pdf
13Source: https://portal.gruener-punkt.de/onlinedsd

3.1.4 Technical standards

In addition to a framework waste law, technical standards are required to ensure that solid waste management operations be carried out sustainably, in state-of-the art facilities, emission reduction and control.

Technical standards will cover:

Recycling:

- Air emissions and effluents, labour security

Composting:

- Compost quality standards

- Odour and greenhouse gas emissions, effluents

Anaerobic digestion:

- Digestate quality (nutrients and hygienisation)

- Gas leaks

- Biogas treatment and quality

- Labour security

Incineration:

- Air emissions, effluents from stack gas treatment, treatment of hazardous solid residues

- Energy efficiency

- Waste input criteria

- Labour security

Landfilling:

- Soil protection (impermeable cover)

- Closure and rehabilitation

- Landfill gas extraction and recovery

- Leachate capture and treatment

- Compaction and daily cover

- Waste input criteria

As long as the British Virgin Islands do not have national technical standards and emission limits, it might be sufficient to make a binding reference to international standards in the framework law. These might be:

- EU BATC documents[14] setting emission and consumption standards corresponding to best available technologies. These documents are regularly updated.

- Emission limits for incinerators given in Directive 2010/75/EU (BATC document is in preparation)

- World Bank or EU standards for compost quality; Indian standards are recommended regarding nutrient content

- UK quality protocol for anaerobic digestate (not applicable for co-digestion of septic tank sludge)

14For waste treatment: Commission Implementing Decision (EU) 2018/1147 establishing best available techniques (BAT) conclusions for waste treatment

3.1.5 Technical Obligations

Some measures might be imposed on households or businesses in order to ensure the correct treatment or separation of specific wastes.

For adequate separation of waste vegetable and mineral oils, it is recommended to oblige all

- restaurants, canteens, food stands etc. to install a grease separator in order to collect waste vegetable and animal grease before discharge into the sewer system, the septic tank or the Sea; these oils should be stored and delivered to a recycling facility.

- motor workshops, garages, ELV and ELB recyclers, gasoline pumps and other businesses handling mineral oils and lubricants to install an oil and grease separator, to collect, store and bring waste mineral oil to a recycling facility.

Retailers, gasoline stations and motor workshops selling motor oil and lubricants as well as marinas should also be obliged to accept waste oil containers from particular citizens, transport or tourism operators in order to facilitate separate collection by reverse logistics.

Construction and demolition companies should be obliged to separate re-usable and recyclable waste streams during construction and demolition works and deliver them to a recycling facility.

3.1.6 Obligatory Registration and Insurance for Vehicles and Vessels

The Derelict Vehicle Act foresees the obligation that "there shall (…) be paid at the time of licensing, as a precondition to for the licensing of a motor vehicle, a fee, which shall be deposited into the fund (…).".[15]Similarly,the fee is to be paid upon renewal of licenses for older vehicles.

This fee varies between 60 – 125 US$ depending on the weight of the vehicle, and the fund is mainly destined to remove and dispose of vehicles the owner of which cannot be identified. If an owner sells or exports his vehicle, the fee shall be disbursed.

It is suggested to extend the derelict vehicle act also to boats and oblige all natural and legal persons registering a boat in the British Virgin Islands, to pay a similar licensing fee. Furthermore, the fee should be divided in two parts:

1) Refundable fee to cover collection of derelict vehicles

2) Recycling fee covering the costs of dismantling, recycling/ exporting for recycling minus the revenue from sales of recyclable material.

The table below gives an indication of costs for ELV recycling:

Table 10: Overview over ELV recycling costs[16]

Country	Cost (€/vehicle put on the market)		Cost (US$/vehicle put on the market)	
	Paid by producers to EPR organisation	Requested from buyer	Paid by producers to EPR organisation	Requested from buyer
Austria	2	4	2.2	4.4
Germany	Self financing	Self financing	Self financing	Self financing
Netherlands	113	45	124	49.5
Finland	8	3 - 19	8.8	3.3 – 20.9
Slovakia	287	66	315	72.6

15Derelict Vehicle Act, Article 5.
16Source: Bio/Deloitte, Development of Guidance on Extended Producer Responsibility, 2015

The high difference between unit recycling costs of different countries may be explained with the fact that Slovakia and the Netherlands also include collection and treatment costs, whereas Austrian and Finnish producer responsibility schemes do not fund operational expense. Moreover, the Slovakian fees also cover the investment into dismantling and recycling infrastructure.

The French environmental agency Ademe has calculated the average costs of ELV recycling in France and comes to the following results[17]:

Table 11: Costs of full ELV treatment in France

	US$/ELV	Comment
Collection	-64,68	Covered by Derelict Vehicle Act
Management of ELV stock	-199,87	This implies state of the art storage facilities
Procedures and legal obligations	-3,63	To be determined
Dismantling for recycling and recovery	147,73	Exporting + in country treatment
Dismantling of pieces for re-use	143,99	Sales to motor workshops in country
Administration and accounting	-49,94	Accounting system to be set up according to requirements of BVI government
Total	-26,40	Comparison: Costs for full treatment in St.Martin: 150 €/ELV

A full fledged ELV recycling centre including shredding and sorting of shredder residues, has been installed in St. Martin in the Caribbean. Shredding and sorting of shredder residues is done by the Guadeloupean company SNR, which is processing Hurricane Irma wrecks since one year. With a population of 35 000 inhabitants, an annual generation of approximately 1000 ELV and around 5000 accumulated car wrecks (historical and hurricane wrecks)[18], the island's situation is comparable to the British Virgin Islands. The number of cars treated being approximately 1/10 of the average ELV processing facility, the unit cost is, with 150 €/unit (165 US$/unit) distinctly higher than for average France. A similar order of magnitude can be expected for an ELV treatment fee in the British Virgin Islands.

In the British Virgin Islands, the Derelict Vehicles Act takes already into account collection of derelict vehicles, but dismantling and recycling still need to be covered. Extended producer responsibility is not proposed for end-of-life vehicles and boats, since owners can (should be) traced and identified, and producers are not in the country. Direct responsibility of owners, as already stated in the Derelict Vehicles Act is therefore the more practical approach.

For end-of-life boats, a similar dismantling and recycling costs are considerably higher and increase disproportionally with the size of the boat, the reason being the higher complexity of larger boats:

17Source for continental France: Evaluation économique de la filière de traîtement des véhicules hors d'usage (VHU), Terra SA/ Deloitte/Bio for ADEME, 2015

Source for St. Martin: http://www.soualigapost.com/fr/actualite/22755/d%C3%A9chets/depuis-irma-l%E2%80%99%C3%A9cosite-re%C3%A7u-1784-v%C3%A9hicules-hors-dusage

18Source: Volume 2 of same publication

Table 12: Unit costs for dismantling of end-of-life boat[19]

Size of boat	Dismantling and recycling cost (US$/boat)
7 m	880
11 m	1,650
15 m	16,500

The life span of fibre glass boats in colder water is about 50 – 60 years, but considerably lower in tropical seas. A realistic estimation for the British Virgin Islands is 30 years.

The long lifespan of recreational boats allows two options for leisure boats to be registered in the British Virgin Islands:

- Once-in-a lifetime fee at first registration

- Annual renewal of license upon payment of 1/30th of the dismantling and recycling fee.

A similar approach could be applied to small aircraft, leisure or professional, registered and operated in the British Virgin Islands.

Fees collected by the Department of Traffic or the Shipping Register could then be paid to recyclers upon proof of recycled/ exported quantities as well as to the Department of Waste Management for incineration of non recyclable ELB/ ELV sub-streams.

In addition to the obligatory registration/ licensing fee, boat, vehicle and small aircraft owners should be obliged to contract an insurance covering removal, dismantling and adequate recycling of the wreck in case of hurricanes or other natural disasters.

Such an insurance should also be made obligatory for foreign vessels and aircraft entering into the British Virgin Islands, depending on the length of their stay.

3.1.7 Green Procurement

With the inclusion of a green procurement clause in solid waste or environmental legislation, the Government might want to reduce its own environmental impact and provide an example to businesses and citizens.

3.1.8 Landfill Ban for Non Treated Wastes/ Phasing Out

In order to set a clear framework for the transition to a zero waste economy, the British Virgin Islands might set a target until when no more non treated waste will be accepted at landfill. Such legislation is in place for example in Belgium (implemented since 2012) or in India (since 2000, but with technical problems in implementation). Non treated waste means that any refuse from recycling, composting/ digestion or incineration/ pyrolysis/ gasification could be brought by the responsible entity to a landfill, but no waste coming directly from a waste producer (household, business, administration…).

Drafting a clear roadmap towards the phasing out of landfilling creates planning security for investors in recycling and recovery facilities and provides a self-obligation for the government to invest in the necessary infrastructure and soft components.

19 Source: https://linset.it/it/news/scheda.php?id=71&st=1&k=End-of-life-Boat-Disposal-Looming-Issue

3.2 Economic Instruments

3.2.1 Deposit-Refund System or Bottle Bill

A deposit-refund system helps to recover items that would otherwise end up in the waste bin or as litter, depending on the environmental awareness of their owner, since they do no more have any value for the owner.

Traditionally, the deposit system was often used to ensure the return of refillable water, soft drink, beer and wine bottles made of glass, which have largely been replaced by single-use plastic bottles in the last decades, mainly for two reasons:

- lighter weight of plastic bottles considerably reduces transport costs (and related emissions). This is especially important when filled and empty bottles are transported over a long distance.

- one-way packaging relieves the producer/ filler/ retailer from the organisation and financing of take-back logistics.

For secondary packaging (example: beer crate) and tertiary packaging (example: pallet), the deposit-refund system is still widely used.

However, the deposit-refund system does not only ensure re-use of primary, secondary or tertiary packaging, it is also increasingly used to ensure high collection rates for waste streams destined for recycling. An example might be the deposit on PET bottles, which is applied in several EU countries, or the Turkish deposit system for automotive batteries.

In the British Virgin Islands, distances are very short, and returning of waste either by reverse logistics or bringing the waste in question to a waste reception centre is economically feasible. A possible reverse logistics chain would not imply that a returned waste item be transported to its producer in another country, but simply that a retail store would accept the deliver of this item by a customer, and that separately collected wastes would then be picked up by a recycler.

The deposit-refund system needs not to be limited to beverage containers and bottles (whence the name “bottle bill”) but should ideally cover a wider range of wastes that have a minimum size, and are easy to separate at home. The following waste streams could be considered for a deposit-refund system:

- Single use glass, plastic and metal beverage bottles and cans

- Waste electrical and electronic equipment (all sizes)

- Hazardous waste (paint containers, pesticide containers, oil & lubricant containers etc.)

3.2.2 Subsidies for Sustainable Substitutes

For some products, environmentally sustainable alternatives are available, but often at a higher price, which discourages consumers to prefer the more ecological option.

This is often the case for textiles, which are more and more often produced with as a mix of natural and fossil polymer fibres. Polymer fibres have technical advantages in the production, and often ensure elasticity or easier wearing of the fabric, but make, on the other side, recycling difficult due to the diversity of components used. Moreover, plastic fibres in textiles constitute an important threat to the aquatic environment, since they come off as micro-particles due to abrasion during washing, and are then transported to surface waters and finally to the Sea. The situation is similar for shoes.

A tax on textile products and shoes containing fibres other than naturally grown might contribute to reduce the consumption of these textiles and shoes and might also reflect the environmental costs of these products. Revenues from this tax may be used to subsidise textiles from environmentally friendly production or to support re-use initiatives.

On the British Virgin Islands, textiles and shoes are two major waste streams, the environmental impact of which might be greatly reduced by financially nudging consumers towards a more sustainable alternative.

A similar application might be considered for single-use baby diapers, pads and wet towels, which also constitute an important, currently non recoverable waste stream. The currently commercialised wet wipes and sanitary towels are not biodegradable and cannot be composted, and since they are often disposed of in the toilet, they also contribute to marine litter and pollution of the Sea. However, more and more biodegradable alternatives are available for these products, and similar to the approach proposed for textiles and shoes, the environmental cost of the single-use, non recoverable product could be included into its sales price via a tax, the income of which might then subsidise a more sustainable alternative.

3.2.3 Subsidies for Diversion from Incineration or Landfill

Recycling and composting projects contribute to diversion of waste from incineration or landfilling and therefore reduce the costs for final disposal.

In order to encourage private and civil society recyclers and composters, the economies their activity ensures to DWM, and, in consequence, to the British Virgin Islands population, should be included into their revenues in form of subsidies. If a recycling facility economises 10 000 US§/year of landfill or incineration costs, this difference should be paid to them[20].

3.2.4 Fines

Fines for non-compliance with waste management obligations are a financial instrument pushing citizens and businesses towards environmentally sound practices not by conviction, but by fear of being penalised.

Fines should be only the *ultima ratio*, where awareness building, incentives and good service are not sufficient to ensure compliance. They should be applied only for major offences, and only for those that are easily detectable, and of which the perpetrator is easily traceable. Such offences might be:

- littering, wild dumping, open burning, discharge of sewage, bilge water or waste into the Sea (delinquent caught *in flagranti*)
- importing of banned product
- abandon of vehicle or vessel on public grounds or within a certain perimeter off the shore
- repetitive refusal to pay waste fee
- false declarations of (imported) product quantities under extended producer responsibility
- release of gaseous or liquid emissions from waste treatment installations exceeding legal limits

3.2.5 Government Support for Re-Use

In order to incite citizens to re-use materials, the government might chose to promote and support initiatives for repair, re-use and exchange of materials that might otherwise become waste. Such initiatives might be:

20In the chapters on technical measures, economies from landfill are included in the revenues to be expected from these activities

- Repair cafés (for bicycles, sporting gear, electrical equipment, furniture…) assisting citizens to repair or revamp items they would like to continue using, but do not have the knowledge to make them work or look good again

- Flea markets, local internet exchange market or a local for permanent exchange of goods: providing a space for citizens where they might sell or give away for free items they do not need any more but are loath to throw away

- Open neighbourhood exchange like openly accessible bookshelves where people may deposit read books and take out new ones; the same approach might work for other items.

Government support might consist in providing such spaces to local NGOs or neighbourhood initiatives, equipment and management of a physical or a virtual space or ensure maintenance of openly accessible spaces. Cooperation with sheltered workshops for disabled or long term unemployed people or people with other difficulties to integrate in the primary labour market might enhance the social added value of this initiative.

3.3 Awareness Building, Information and Sensitisation

3.3.1 Awareness Building Accompanying Financial and Legal Measures

All obligatory or prohibitive measures as well as financial steering instruments need to be accompanied by information, communication and awareness building. Acceptance of these measures is often linked to better comprehension of its purpose and functioning, as well as to transparency related to achievements and targets reached.

An example may be the levy on plastic bags, which is widely accepted in Ireland and Greece. In both countries, the amount of the fee has been increased after an initial success of the measure; in Greece, the revenues from the plastic bag charge are used to reduce litter and preserve the marine environment. In contrary, the less transparent introduction of a charge on plastic bags in some other countries has led to negative reactions like “fee to increase income of retailers”.

Similarly, a ban of single use plastic items needs to be preceded by an extensive awareness campaign, including information on alternative packaging, carrier bags, food containers etc. Commerces and restaurants need sufficient time to phase out their stock of single use items and replace them with more sustainable alternatives.

Awareness building should also touch habits of restaurant and bar operators, for example, the distribution of straws without even asking if a straw is wanted. Another issue would be the promotion of original and waste-free replacements for single use packaging, like wafers or other eatable packaging, use of vegetable wraps etc.

3.3.2 Awareness Building for Waste Prevention

Although BVI citizens are widely aware of the unsustainability of single-use plastics, the consumption habits are deeply rooted, and previous, individual attempts of supermarkets to phase out plastic bags and certain plastic products have been unsuccessful, partly because the initiative was not widely supported, but partly also because customers insisted on their accustomed convenience.

A ban of styrofoam and PP food containers, cutlery, straws and other single use plastics needs therefore to be introduced carefully in order to ensure widespread acceptance. Besides timely substitution with biodegradable products, long term awareness building is required to achieve not only the acceptance of the alternative products, but also a gradual change of habits away from single-use food containers and similar convenience products to re-usable containers and cutlery in restaurants, standardised deposit containers for take-away food and drinks, from single-use shopping bags to multi-use, more resistant bags etc.

Awareness building should be a continuous activity of Department of Waste Management (future statutory body), in cooperation with environmental NGOs, churches, schools, media and other civil society organisation. Similarly, tourism operators should be taken into the boat in order to communicate the same message to tourists and enhance the eco-friendly image of the British Virgin Islands, inviting tourists to contribute to the preservation of the BVI environment.

Campaigns should be based on the current objectives, and with an increasing efficiency of waste prevention, new waste streams could be targeted for reduction, substitution or prevention, in line with new, additional targets to be set during the implementation of the waste strategy.

Punctual, one-time awareness campaigns and conflicting messages need to be avoided. Government policy on waste prevention should be transparent, clear and coherent for citizens. Behaviour change takes a long time, and short term campaigns will not have more than an ephemeral impact.

3.3.3 Awareness Building for Segregation at the Source

Similar to waste prevention, an extensive awareness campaign for segregation at the source is required. Citizens need to be informed of the different options to dispose of separately collected waste:

- organic waste into the wet waste bin, non recyclable household waste into the dry waste bin

- recyclable waste, bulky waste and hazardous waste to waste bring centres and material recovery facility

- bulk waste and hazardous waste to special waste collection vehicle coming in certain frequency to every settlement

- recyclable waste covered by extended producer responsibility by reverse logistics back to the retailer (reverse vending machines)

The information on the different options should come over not as a complex, confusing system, but rather as a simple and convenient system, offering the citizen several options to chose from.

Awareness building for segregation at the source needs to be coupled with systematic monitoring of the performance of the different separate collection systems, in order to identify potential problems early and react proactively. For this purpose, the communication expert of DWM should also act as help desk, and the future statutory body’s website should also offer clear information on location, functioning, opening hours etc. of waste bring centres, timetable of the special waste collection vehicle, how to segregate waste, how to recognise which waste corresponds to which fraction etc.

Equally important is information on the purpose of separate collection at the source and of achievements reached thanks to citizens’ contribution.

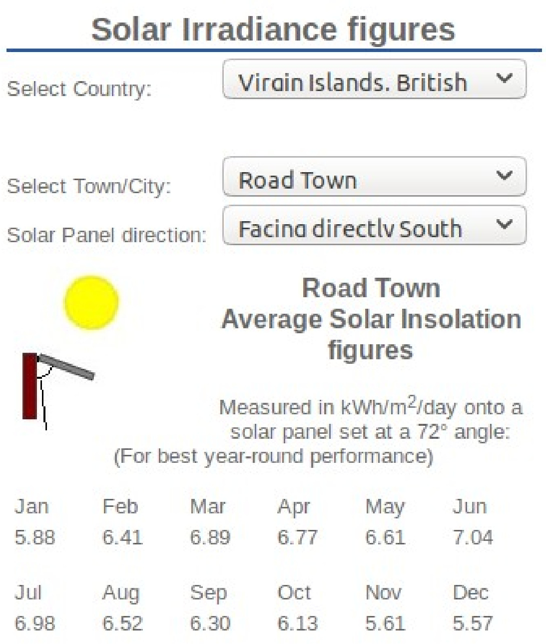
4 Technical Elements of Integrated Solid Waste Management

4.1 General Considerations

4.1.1 Substitution of Fossil Energy Supply for Waste Management Infrastructure and Collection Fleet

For all technical infrastructure, the strategy foresees standard equipment with solar panels in order to ensure energy autonomy and resilience against damages of the electricity distribution grid by hurricanes or other natural or man-made disasters.

Figure 5: Solar irradiation per m²



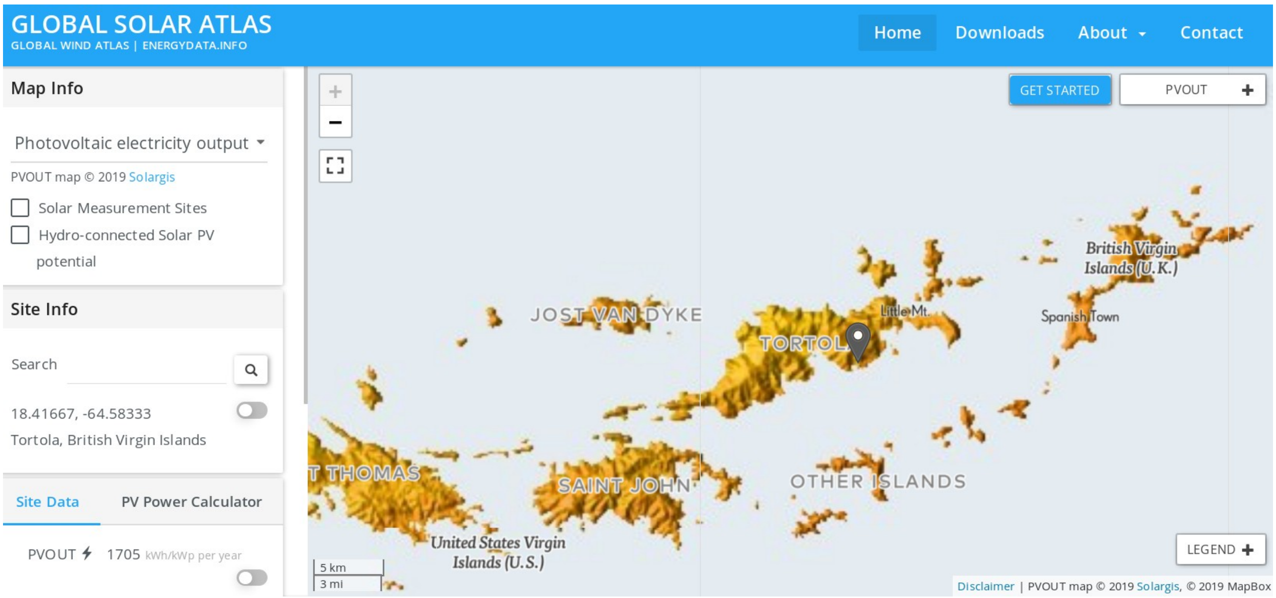
Solar irradiance in the British Virgin Islands being very strong, covering the roofs of hangars with solar panels will not only provide sufficient electricity to power standard electrical equipment, but also to replace fossil fuelled vehicles with electrical vehicles. This applies both for wheel loaders and forklifts to be used in the installations and to waste collection vehicles, which might gradually be replaced with electrical trucks and loaded in the different waste reception and treatment centres. Electrical waste collection trucks are equipped with 120 – 600 kWh batteries; the latter being applied for hauler trucks that need to lift heavy items like the waste skips used in the BVI.

The figures to the left[21] and below[22] give an overview over solar irradiance in the British Virgin Islands.

Obviously, to obtain optimum solar energy yield, orientation and roof shape of waste treatment facilities need to be planned in order to capture a maximum of solar radiation.

21Source: http://www.solarelectricityhandbook.com/solar-irradiance.html
22Source: https://globalsolaratlas.info/?c=18.437804,-64.62643,11&s=18.41667,-64.58333

Figure 6: Yield of solar panels in the British Virgin Islands



Electrical waste collection vehicles are still a novelty on the worldwide market, but are already in use in some cities, such as Basel, Switzerland, or the small city Sarpsborg in Norway. Despite the higher investment cost, operation costs including maintenance and repair are much cheaper, and the break-even point with a conventional diesel truck is reached after 7 years[23].

4.1.2 Other Considerations

Another standard consideration for all infrastructure is hurricane resistant construction. This implies explicit hurricane-proof design requirements for all tender documents, including hurricane-safe anchorage of solar panels to the roofs.

Endeavouring a zero waste approach, the re-use of waste material as well as equipment made of recycled material will be preferred. An example might be the standard use of wheelie bins, containers etc. of recycled plastic wherever this is appropriate. Rehabilitation and use of only slightly damaged solar panels from the hurricane, of pallets wherever wooden constructions are needed, of aggregate and sand made from construction & demolition waste or glass might be some examples.

4.2 Segregation at the Source and Separate Collection of Waste

Ideally, several parallel systems are established to ensure maximum facility for waste producers (citizens, businesses, administrations, tourists…). On the other hand, given the size of the British Virgin Islands, too complex a system would become too expensive and would consume too many resources (human and technical).

23Source: https://waste-management-world.com/a/in-depth-putting-nature-first-electric-waste-collection-vehicles

It could be imagined that only one approach be implemented in the smaller islands (e.g., bring centre + wet/ dry separation), whereas a more complex combination is applied in Tortola and possibly in Virgin Gorda.

4.2.1 Separate Collection Wet-Dry

To ensure good and reliable quality of recyclable material, separate collection of waste is indispensable. Although in many countries, mechanical separation of mixed waste provides acceptable results, this is not the case in the British Virgin Islands. Due to the high content of plastic waste of all sizes, granulometric separation does not yield satisfactory results. More sophisticated solutions, such as magnetic, eddy current, density and optical separation might deliver the desired performance but are very expensive and would not resolve the problem of contamination of recyclables with wet and greasy food waste.

In countries with segregation and the source and large waste streams, these technologies are used for the separation of waste streams in sub-categories, for example, in Brussels, a city with 1,1 million inhabitants, plastics+metals+beverage bricks are automatically sorted into the different plastic (PET, HDPE, PP etc.), metal (Al, Fe…) and other components. However, the overall waste generation in the British Virgin Islands does not justify this investment.

Segregation at the source is most successful when it is kept simple. People often have neither the space nor the time or willingness to separate their wastes into a large number of fractions. For this reason, it is recommended to introduce separate collection of

- wet (organic: kitchen, garden, food waste)

- dry (all other household wastes).

In addition to this, bulky waste and hazardous waste must be collected separately as an obligation, and this should be monitored and enforced, in order to avoid technical and environmental problems downstream.

Other instruments like the bottle bill (deposit-refund system) might contribute to incite citizens, businesses and administrations to further separate their wastes and thus increase the purity and cleanliness of the different materials.

However, even the simple segregation into wet and dry waste already ensures that recyclable material is not contaminated with wet and sticky waste and can be manually sorted in a simple and cost effective way.

For separate collection at the source, the simplest and technically easiest option would be to double the number of waste skips placed in public locations, where citizens dump their waste. Door-to-door collection is not feasible due to the hilly nature of the country and the dispersed habitat. Citizens are used to bring their waste to the skips and would have little difficulty to adapt to two skips with, ideally, a different colour code to make distinction easy.

It is true that space is often restricted and placing two skips instead of one might not be feasible everywhere. In these places, it might be contemplated to replace one large skip with a smaller one, or place a second skip inside the first, which might then be lifted and taken out.

4.2.2 Construction of Waste Bring Centres/ Reception Facilities and Material Recovery Facilities

In addition to the separate collection of wet/dry household waste, waste reception facilities need to be constructed to allow citizens to bring specific waste streams accumulated separately at home and deliver them without charge or, in case of wastes falling under the bottle bill, get refunded.

In principle, a waste reception facility is equipped with containers for different waste streams, with an access ramp, where people can drive in and drop off their waste at the adequate container. For refund of deposit, a reverse vending machine for packaging and/ or a small conveyor system with automatic scanning for larger items might be installed.

Operation of a waste bring centre is not personnel intensive; normally it should be sufficient to have one worker supervising that waste is dropped into the right container, and another one who registers incoming vehicles and handles the deposit refunds.

Typical fractions to the delivered separately to a waste reception facility are the following:

Table 13: Waste for bring centre

Waste stream	Sub-category	Handling	Container needed
PET bottles		Scanning for refund	5 or 8 m³ steel waste skip
Glass bottles	Transparent	Scanning for refund	5 or 8 m³ steel waste skip
	Coloured	Scanning for refund	5 or 8 m³ steel waste skip
Beverage and conserved food containers	Al	Scanning for refund	120 or 240 l plastic wheelie bin
	Fe	Scanning for refund	120 or 240 l plastic wheelie bin
Bulk waste	Large/ bulky WEEE	Scanning for refund On site separation	5 or 8 m³ steel waste skip
	Furniture	On site separation	
	Hard plastic boxes	On site separation	
	Treated Wood	On site separation	
Small WEEE	Smartphones	Scanning for refund On site separation	120 or 240 l plastic wheelie bin
	Fluorescent bulbs	Refund per unit On site separation	120 or 240 l plastic wheelie bin
	Cables	On site separation	120 or 240 l plastic wheelie bin
	Other small appliances	Scanning for refund On site separation	120 or 240 l plastic wheelie bin
Large organic waste	Garden waste	On site separation	5 or 8 m³ steel waste skip
	Non treated wood	On site separation	5 or 8 m³ steel waste skip
	Pallets	On site separation	5 or 8 m³ steel waste skip
Construction & demolition waste	PVC piping and fittings		5 or 8 m³ steel waste skip
	Metal piping and fittings, rods, beams		5 or 8 m³ steel waste skip
	Ceramic basins, toilets etc., tiles		5 or 8 m³ steel waste skip
Hazardous waste	Chemicals containers	Scanning for refund	120 or 240 l plastic wheelie bin
	Pharmaceutical waste		120 or 240 l plastic wheelie bin
	Batteries	Refund on weight basis	120 or 240 l plastic wheelie bin

Examples of waste reception facilities are give below[24].

24Sources: www.dh.be for photo from Brussels, courtesy of GreenVI for the transfer station with integrated bring centre at Jost Van Dyke

Figure 7: Waste reception centre at Forest, Brussels, Belgium

Figure 8: Transfer station at Jost Van Dyke (pre-Irma)

A waste reception facility can be conceived as a single unit or can be integrated into a materials recovery facility (MRF) where waste reception, sorting, pre-conditioning and recovery processes are grouped in one single plant.

For the British Virgin Islands, a combined approach is recommended. Simple waste reception facilities should be installed on Jost Van Dyke and Anegada, as well as in the West and East End of Tortola, and from there, full waste bins should be brought to central material recovery facilities on Virgin Gorda and in a central area of Tortola. Given the small population of the islands, waste reception centres need not to be staffed and operational full time; 2 – 3 opening hours per day would be sufficient for people to come and drop off their waste and would allow workers to rotate and fulfil also other duties.

It is suggested that all waste reception facilities be covered with solar panels. They will produce more electricity than they can spend, but this could be used to fuel electrical waste collection vehicles or other vehicles of DWM or recyclers' fleet.

4.2.3 Mobile Collection of Special Wastes

In addition to drop-off at waste bring centres, a mobile collection service for special wastes might motivate citizens to make some efforts for waste segregation at the source. Such a service needs not to pass very frequently, but it is important that citizens be informed in advance of the time and place where they can find the waste collection vehicle. Especially for less mobile people, such an additional service adds a lot to the convenience of waste segregation at the source.

Supermarkets and administrations generate important quantities of paper, cardboard and plastics (the latter is valid especially for supermarkets). With an obligation for segregation at the source, these materials can be collected directly and on a regular basis by recyclers.

Wastes to be collected by a mobile waste reception vehicle are typically:

- small hazardous wastes: batteries, small WEEE, receptacles of paint, pesticides and other chemicals

- bulk waste and furniture

- cardboard and paper from supermarkets and administrations, secondary plastic packaging (film, containers) from supermarkets

Vehicles collecting small hazardous waste are equipped with adequate containers for receiving different fractions. These might be shelved boxes or standard wheelie bins, depending on the type of vehicle used. A vehicle for bulk waste collection is ideally a simple dumper truck; the same type of vehicle can also be used for cardboard and paper collection.

4.2.4 Reverse Logistics

Supermarkets, specialised commerce and pharmacies should, either on voluntary or on obligatory basis, provide the opportunity for clients to drop empty packaging and waste products when coming to purchase new ones.

For packaging covered by the bottle bill, reverse vending machines could be placed to refund customers for empty packaging; items like WEEE could be received and, if a deposit is applied, refunded, by the vendor on purchase of a new product.

Equipment and infrastructure for reverse logistics should be funded by retailers and is not covered by this strategy.

4.2.5 Sorting, Pre-conditioning and Recycling of Household Waste

If the bottle bill is adopted, and citizens separate most of the recyclable waste streams in order to obtain a refund, waste would either be delivered and classified directly or collected from/ brought by supermarkets and specialised retailers (if brought back by reverse logistics system).

With pre-classified waste, the sorting operation would be considerably reduced, but a sorting line would still be necessary to increase the efficiency of separation into sub-fractions. In addition to that, the following equipment is recommended for a material recovery facility:

- Plastic crusher/ shredder

- Extruder to produce pellets for export or for local recyclers

- Glass crusher

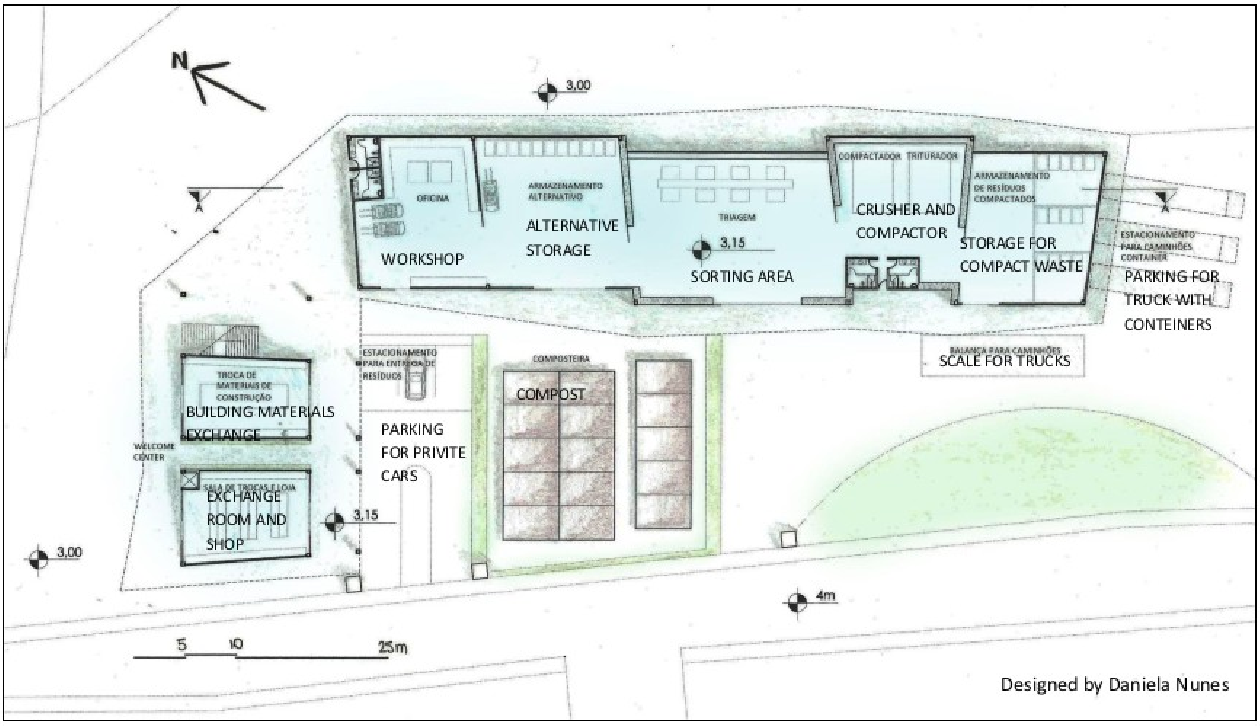
- Baling press for compacting metal, paper, cardboard and plastic destined for export.

If WEEE is also treated, a workshop for dismantling is necessary; plastic crusher and baling press can also be used for WEEE components.

The premises of a material recovery facility might also house a repair shop or a waste material exchange to promote re-use of old products.

The following drawing shows an example of a full material recovery facility including a waste bring centre.

Figure 9: Example of Material Recovery Facility (Courtesy of GreenVI)



A financial simulation of investment and operation costs for three waste reception centres, one of them being a complete material recovery facility (without composting) is given in the table below.

Table 14: Cost estimation for waste reception and treatment facilities in Tortola

Recycling facility and bring centres (Tortola)	Unit	Quantity		
		2.021	2.026	2.040
Overall area need (recycling facility)	m²	1.400	1.400	1.400
Overal area need (waste reception facilities)	m²	325	325	325
Quantity of waste treated	t/day	19	35	40
Investment cost	US$	1.068.206		
Operational cost (with amortisation)	US$/year	-739.039	439.909	758.962
Revenues	US$/year	1.241.917	2.313.513	2.605.029
Balance 1st year (with amortisation)	US$/year	-67.673	1.111.502	1.431.190
	US$/ton of waste	-11	100	115

The balance is expected to be negative during the first year of operation, but to improve quickly once the different separate collection schemes start to yield better results. It should be noted that the calculation also includes amortisation and operation costs for waste reception centres.

4.3 Treatment of special recyclable waste streams

4.3.1 Treatment of End-of-Life Vehicles

Two recyclers of end-of-life vehicles are active in the British Virgin Islands. They have been doted with compactor-balers by RDA and are currently exporting vehicles for recycling. However, to reach a sustainable management of end-of-life vehicles, more sophisticated treatment is required. This comprises:

1) Dismantling of ELV for de-pollution and recycling

De-pollution:

-removal of batteries and liquefied gas tanks,

-removal or neutralisation of potential explosive components, (e.g. air bags),

- removal of oil filter and catalysts

-removal, separate collection and adequate storage of fuel, motor oil, transmission oil, gearbox oil, hydraulic oil, cooling liquids and screenwash, antifreeze, brake fluids, air-conditioning system fluids[25] and any other fluid contained in the end-of-life vehicle, unless they are necessary for the re-use of the parts concerned,

-removal, as far as feasible, of all components identified as containing mercury.

Fluids need to be extracted into separate containers, in order to increase recycling potential for each different liquid.

2) Recycling

-removal of catalysts,

-removal of metal components containing copper, aluminium and magnesium,if these metals are not segregated in the shredding process,

-removal of tyres and large plastic components (bumpers, dashboard, fluid containers, etc.), if these materials are not segregated in the shredding process in such a way that they can be effectively recycled as materials,

-removal of glass.

3) Shredding of carcasses and sorting of:

- ferrous metals

- non ferrous metals

- shredder residue: energy recovery, recycling, landfilling

End of Life vehicles contain approximately the following items[26]:

25Special equipment needed due to flammability

26Source: Report summarising the analysis of End-of-Life Vehicle Chain, Near-Zero European Waste Innovation Network, ARN, 2016

Table 15: Contents of average US car produced in 2000

Materials	kg/unit	% of vehicle weight	Price (US$/t)
Cast iron	149	10,7	297
Conventional steel BOF	432	31,03	208
Conventional steel EAF	160	11,49	208
Stainless steel	22	1,58	551
HS steel	144	10,34	208
Cast aluminium	84	6,03	447
Wrought aluminium	20	1,44	1.139
Magnesium	3	0,22	
Copper/ Brass	19	1,36	4.630
Zinc	5	0,36	
Other metals	15	1,08	
Plastic	105	7,54	550
Rubber	61	4,38	
Glass	43	3,02	55
Fluids/ lubricants	84	6,03	-235
Other materials	47	3,38	

In many EU countries, over 95 % of ELV waste is recycled (including energy recovery). In Germany, non recyclable after-shredder-residue is increasingly used to make up for reduced incinerator input, which is a consequence of circular economy. A similar approach is recommended for the British Virgin Islands.

For the British Virgin Islands, the installation of a full fledged de-pollution station, manual dismantling and shredding of stripped carcasses is recommended. The investment into after-shredder separation technology is not justified given the low number of end-of-life vehicles and boats annually discarded. Furthermore, after-shredder sorting does not allow efficient recovery of valuable electronic components and precious metals, which will be increasingly important with the transition to electromobility. This approach has the following advantages.

- Reduction of land use by volume reduction
- Larger part of recycling value chain remains in the BVI
- Possibility to use the shredder also for end-of-life boats
- Adequate treatment of hazardous ELV and ELB components
- Combustible ELV and ELB residues can be used to compensate for incinerator losses once waste prevention and recycling measures become fully efficient
- Reduction of freight costs to other countries
- Higher prices to be obtained for metal shredder residues
- Possibility to absorb more efficiently legacy and hurricane ELV waste and to react flexibly in case of another hurricane.
- Acquisition of technical capacities and expertise on the islands

It should be noted, however, that manual dismantling is not possible for hurricane wrecks, which are often too much deformed to allow access and disassembly. These wastes should be shredded and stored; specialist private companies such as the Guadeloupean SNR active in St. Martin, could ship over their mobile separation equipment and treat the accumulated shredded cars during a certain period.

The ELV and ELB treatment plant will comprise the following elements:

Table 16: ELV and ELB recycling unit

Process	Units
De-pollution	Vacuum emptying of liquids Manual dismantling of catalysts, air bag, batteries ec. Storage area for separate stocking of hazardous components prior to shipping for treatment
Dismantling	Workshop for manual removal of all movable parts Small hydraulic shear to facilitate access if needed
Shredding	Hydraulic shear for cutting up of carcasses, containers, beams and other large metal items Crane for lifting of cut-up pieces ELV: Shredding of metal carcasses ELB. Shredding of fibreglass carcass, shredding of masts Hurricane debris ELV: Shredding of complete wreck
Storage	- Storage unit for shredded ELV carcasses (to be shipped abroad for sales) - Storage unit for barrels with hazardous components (to be shipped abroad for treatment) - Storage unit for shredded ELB carcasses (to be incinerated) - Storage unit for shredded Hurricane debris ELV (to be stored until temporary installation of mobile separation equipment for after-shredder residues) - Storage unit for dismantled recyclable material

The table below gives the key parameters of an ELV/ ELB treatment facility without complete de-pollution, manual dismantling and shredder. For hurricane debris and legacy wrecks, direct shredding and service rental for the sorting of after-shredder-residues is foreseen.

Table 17: Key parameters of ELV/ ELB treatment facility

ELV and ELB treatment	Unit	Quantity		
		2.021	2.026	2.040
Overall area need	m”	2.800		
Quantity of ELV treated	t/day	3,31	3,45	3,72
Quantity of ELB waste treated	t/day	0,91	0,95	1,03
Hurricane and legacy car wrecks	t/day	3,07		
Hurricane and legacy boat wrecks	t/day	5,48		
Investment cost	US$	1.150.000		
Operational cost (with amortisation)	US$/year	331.799	281.960	304.281
Revenues	US$/year	332.337	203.521	219.632
Balance (with amortisation)	US$/year	538	-78.439	-84.648
	US$/ELV	0,37	-99,69	-99,69
	US$/ELB	-10.000	-10.000	-10.000

The operation is expected to make a very small benefit during the first year of operation, when the throughput is higher due to the processing of hurricane debris and old wrecks. Operation costs comprise cost of abroad treatment for hazardous wastes, but not incineration and landfilling costs. These are accounted for in the respective calculations of the respective infrastructures.

4.3.2 Recycling of End-of-Life Boats

Legacy and hurricane related boat wrecks in the British Virgin Islands mostly consist of fibre glass recreational vessels, both sailing and motor boats. An amount of approximately 200 hurricane wrecks and abandoned boats as well as an annual number of around 30 boats need to be collected and prepared for recycling

Similar to end-of-life vehicles, end-of-life boats have to be dismantled and sorted according to different product categories. Batteries, oils, explosive materials (fire extinguishers) and other hazardous materials need to be removed and neutralised. Fenders often contain lead in PVC wrapping and are not suitable for recycling or incineration. Most boat hulls are coated with anti-fouling paints containing toxic substances. Although TBT[27] coating is prohibited for newer boats following the 1998 IMO decision to introduce a worldwide ban, it is still a common material for boats reaching the end of their lifespan in the years to come.

An estimation of boats to be treated is given in the following table[28], assuming that derelict boats leftover by the hurricane Irma and other accumulated boat wrecks would be processed within one year:

Table 18: Estimation of ELB quantities to be treated in the BVI

Material	Motor boat		Sailing boat		Weight of post Irma ELB (t/d)
	Weight (%)	Weight (t/day)	Weight (%)	Weight (t/year)	
Fibreglass	60	0,27	47,24	0,22	2,94
Ropes	0	0,00	1,57	0,01	0,04
Wood	5	0,02	3,94	0,02	0,24
Metal (Fe)	5	0,02	10,24	0,05	0,42
Al		0,00	3,15	0,01	0,09
Pb		0,00	10,24	0,05	0,28
Glass	0,05	0,00	0,04	0,00	0,00
Plastics	0,3	0,00	0,24	0,00	0,01
PVC/ elastomers	0,5	0,00	0,39	0,00	0,02
Electric wires	0,05	0,00	0,04	0,00	0,00
Motors	10	0,05	3,94	0,02	0,38
Electric components	3	0,01	2,36	0,01	0,15
Appliances	5	0,02	3,94	0,02	0,24
Bathroom fittings	5	0,02	3,94	0,02	0,24
Furnitures	5	0,02	3,94	0,02	0,24
Sails	0	0,00	3,94	0,02	0,11
Oils	0,05	0,00	0,04	0,00	0,00
Refrigerants	0,05	0,00	0,04	0,00	0,00
Batteries	1	0,00	0,79	0,00	0,05
TOTAL		**0,46**		**0,46**	**5,48**

The largest fraction of end-of-life boats is fibreglass rumps, generally consisting of glass fibre and epoxy resin or polyester. Although technical processes are existing for separating the plastic material from glass fibre, material recycling is not feasible at the very small scale. With 18 800 kJ/kg, fibre glass has quite a high calorific value and can be used after shredding as a substitute fuel for the incinerator, once the input quantities will decline. End-of-life boats can be shredded in the same machines as end-of-life cars, although they should not be shredded together in order to keep sorting of materials simple.

27Tributyl tin

28Source for composition of ELB: Recovery of obsolete vessels not used in the fishing trade, EU/ COWI 2011

4.3.3 Acquisition of Concrete Crusher to Produce Aggregate and Sand

No exact numbers are available for the overall production of construction and demolition waste in the British Virgin Islands. Extrapolating from the EU average of 200 kg/(person*year), we assume an overall C&D waste generation of 17 t/day in the British Virgin Islands. An unknown amount of C&D waste caused by the hurricane Irma is still dispersed over the islands’ territory.

Technically, construction and demolition waste is recyclable up to 95 %; in the Netherlands, 100 % of construction waste are recycled. However, not all technically feasible options make sense in a small scale, insular economy. Most important construction wastes are:

- Inert wastes: concrete, bricks, tiles and ceramics

- Metals and metal alloy

- Wood, glass and plastic

- Insulation materials

- Gypsum based construction materials.

Approximately 5 % of construction & demolition waste is expected to be hazardous waste. Given the small size of the British Virgin Islands, it makes no sense to invest into a treatment facility for the diverse hazwaste substreams; this waste needs to be separated at the source for exporting. 90 % of hazardous construction wastes are also recyclable, but this needs to be done in a specialised facility.

The main recycling objective for inert construction and demolition waste is the production of aggregate for the construction sector. Recycled aggregate can replace stone from quarries as well as sand, and an explicit demand for this material has been pronounced by the Tortola quarry owners. Separate collection at the source during construction and demolition works is essential to ensure a satisfactory quality of aggregate produced from recycled C&D waste.

It is therefore proposed to purchase a mobile concrete crusher that can either be placed into a recycling yard or be shipped to a demolition site in order to process concrete waste directly on site. Such an investment would also allow flexible and rapid intervention for debris clearing after another hurricane, as well as processing of existing debris accumulated on the BVI. The crusher could also be rented to tourism resorts on the smaller islands, some of which still having important quantities of hurricane debris to be cleared away. The figure below shows an example of a mobile crusher with integrated sieving elements to prepare different aggregate grains.

Figure 10: Example: Mobile concrete crusher RM 60 by Rubble Master

A similar crusher is already in operation at St. Martin, which has a similar size and number of inhabitants as the British Virgin Islands. The crusher is over-dimensioned for the quantities of waste to be treated on a daily basis, but smaller crushers are not capable of treating large size demolition wastes. Demolition waste then would need considerable pre-treatment, which would increase operation costs and make the recovery of construction waste less or not at all profitable. Moreover, the acquisition of the smallest size C&D waste hammer crusher would also allow rapid reaction for clean-up in case of another hurricane.

Recovery of construction waste is expected to be highly profitable, as the table below shows.

Table 19: Key data for C&D waste recovery

Construction and demolition waste	Unit	Quantity
Overall area need	ha	0,10
Quantity of waste treated (average)	t/year	4.290
Revenue from sales of aggregate	US$/year	171.616
Investment cost	US$	330.000
Operational cost (with amortisation)	US$/year	91.810
Balance with amortisation	US$/year	79.806
	US$/ton of waste	19

4.4 Recovery of Organic Waste

Organic waste is an important waste stream, both from household and assimilated sources, and from other sources, such as wastewater treatment plant, non-treated sewage (septic tank sludge) and Sargasso weeds. Vegetal oil and grease from restaurant/bar grease traps is also counted as organic waste.

For a zero waste approach, different options to recover organic waste need to be combined.

4.4.1 Worm Composting Facility in Tortola

A project for worm composting of organic waste in Tortola is planned by a local initiative. The project is named “Waste not”; it is a cooperation between the BVI company Green Tech and the Canadian company Green Science. The organisation intends to start with a 21 t/day factory, taking in initially organic waste collected separately from institutions and commerce, as well as garden waste and human waste currently dumped on the hills in Parraquita Bay.

With separate collection at the source, incoming quantities of organic waste could gradually be increased until the entire organic waste production of Tortola is covered. Residential waste will need sorting before being put to composting, but with an increasing efficiency of segregation in households, this will become less and less.

Worm casts are a high quality organic fertiliser that can be sold both on the local and the international market. If continuous flow beds are used, the space requirement of the facility will be quite low, and with an in-house operation, emissions will be negligible.

The figure below shows a view of a continuous flow worm composting operation[29].

Figure 11: Worm bed for continuous flow composting

Assuming that the worm composting facility will function with continuous flow beds and will take in all organic waste from Tortola, an estimation of costs and revenues is given below.

29Sources: *Abby O’Neal, e-mail of 25 June 2019*

Figure 12: Estimation of key parameters for worm composting facility in Parraquita Bay

Worm composting Tortola	Unit	Quantity		
		2.021	2.026	2.040
Overall area need	m²	3.317	3.317	3.317
Quantity of waste treated	t/day	21	55	62
Quantity of organic waste treated	t/day	32	53	59
Quantity of compost produced	t/day	5	8	9
Investment cost	US$	2.575.525	4.195.835	870.113
Operational cost (with amortisation)	US$/year	281.987	282.012	282.080
Revenues	US$/year	601.691	1.001.615	1.130.441
Balance (with amortisation)	US$/year	319.704	424.408	553.165
	US$/ton of waste	32	26	30
Balance (without amortisation)	US$/year	529.278	929.178	1.057.935
	US$/ton of waste	57	60	61

Investments have been calculated including a sorting line and the increase of continuous flow beds in function of the increasing quantities of incoming waste. Benefit from the process is expected to increase with the years, since the proportion of impurities in the incoming material will decrease with the improved performance of separate collection at the source.

4.4.2 Small Scale Composting Facilities in Jost Van Dyke, Virgin Gorda and Anegada Islands

Biodegradable waste from the other three main islands should not be transported to Tortola, as it is actually the case for Jost Van Dyke, nor should it be dumped. Once separate collection at the source is operational in the British Virgin Islands, small scale semi-manual composting facilities are recommended to be taken into operation on Virgin Gorda, Jost Van Dyke and Anegada.

It is not necessary to purchase wheel loaders for windrow turning. The largest of these three small facilities would be the Virgin Gorda composting facility, with less than 2 t/day of waste input. Rental of a commercial wheel loader once per week would be sufficient for windrow construction and windrow turning. Similarly, workers would not be needed full time at the facilities; two hours per day would be sufficient for sorting of incoming waste and sieving of mature compost.

In a climate like the Caribbean, open windrows need to be sheltered by a roof in order to prevent drying out by sunshine or leaching nutrients during strong rains. Similar to other waste management facilities, it is recommended to cover windrows with solar panels mounted on a metal structure; the electricity produced by the solar panels would be used for powering the drum sieve, and the excess could either be fed into the grid or used for charging electrical vehicles.

With the international market value for quality compost, it is expected that the small scale composting facilities will break even or make a small benefit, depending on the demand on the local market. The table below gives an overview over the expected costs and revenues for the Virgin Gorda composting facility.

Table 20: Key paramenters for semi-manual composting facility at Virgin Gorda

Composting Virgin Gorda	Unit	Quantity		
		2.021	**2.026**	**2.040**
Overall area need	m²	330	330	330
Quantity of waste treated	t/day	1,90	2,00	2,25
Quantity of organic waste treated	t/day	1,55	1,82	2,05
Quantity of compost produced	t/day	0,39	0,45	0,51
Investment cost	US$	50.894		
Operational cost (with amortisation)	US$/year	20.298	20.305	20.323
Revenues	US$/year	13.944	16.367	15.956
Balance (with amortisation)	US$/year	-8.877	-6.461	-4.417
	US$/ton of waste	-18	-11	-7
Balance (without amortisation)	US$/year	-4.926	-2.510	-465
	US$/ton of waste	-11	-5	-1

4.4.3 Introduction of Anaerobic Co-Digestion of Human Waste and Biodegradable Household Waste in New Tourist Resorts on Small Islands

Adequate centralised wastewater treatment is currently only available for residential areas in Road Town, Tortola. In all other settlements in the British Virgin Islands, either septic tanks are used, or small scale package wastewater treatment facilities are implemented.

A pilot project for co-digestion of human waste and organic residential waste is proposed to be carried out for a new tourist resort on any of the smaller islands, aiming at the demonstration of a novel technology economising water and recovering energy and nutrients.

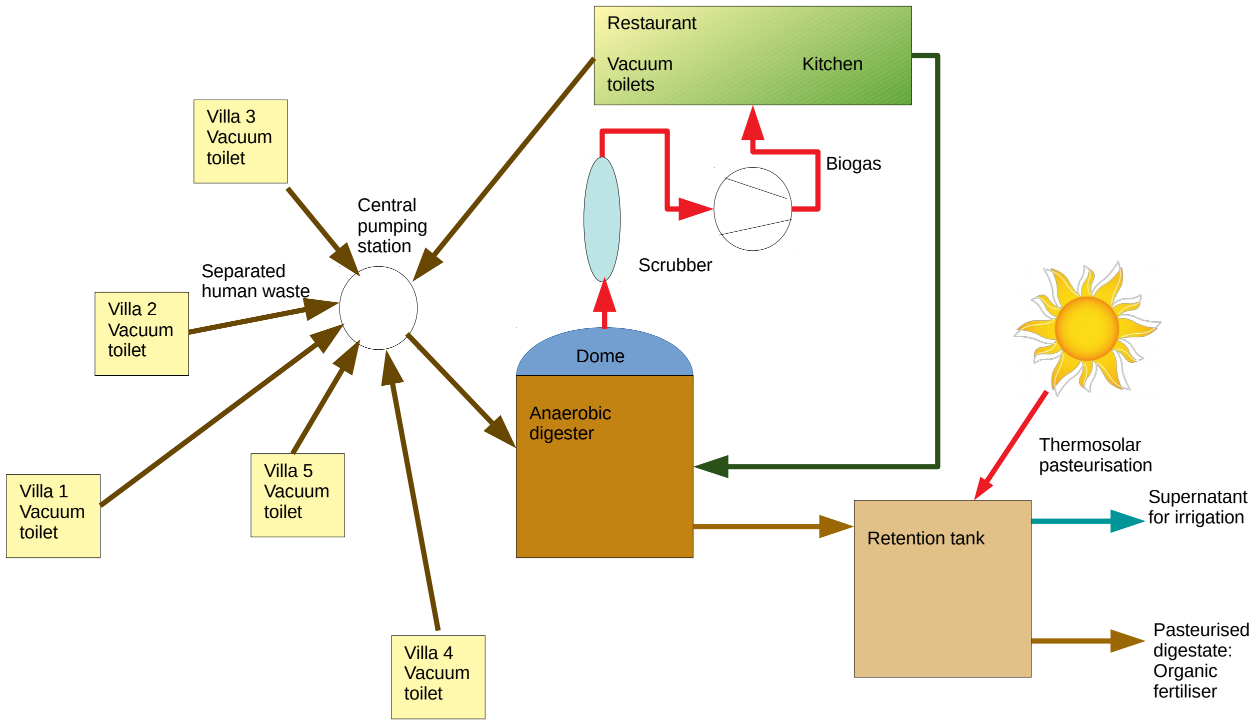
With the implementation of dry separator toilets and a central vacuum sewer system, it is possible to separate urine from excreta and aspire the latter to a centralised anaerobic digester, where they would be converted into biogas together with wet organic waste. In contrary to septic tank sludge, the biodegradation of which has already largely taken place in the septic tank, fresh human waste yields even more biogas than wet organic waste.

Separator toilets allow to segregate urine and thus eliminate the problem of high ammonia input. A thermosolar system can be used to pasteurise digestate from the anaerobic digestion process in order to use it as an organic fertiliser without worrying about pathogens originating from human waste.

This project is proposed in the context of the strategy in order to make one step forward in direction of an overall integrated waste management concept, that takes into consideration also sanitation and water saving aspects. Other indirect benefits would be the reduction of greenhouse gas emissions from Sea water desalination, reduction of the depletion of phosphorus resources by recovery of phosphorus in human waste, and the reduction of wastewater effluents.

The figure below illustrates the approach.

Figure 13: Schema of anaerobic co-digestion system for touristic resort



A pilot project for a touristic resort with 40 villas, total tourist capacity of 200 and estimated occupation rate of 70 % would cost approximately 120 000 US$. The main savings are not on bottled gas, as might be expected, but rather on water cost, given the high price of sea water desalination.

The table below gives an overview over expected costs.

Table 21: Estimated costs for a human waste + kitchen waste co-digestion project in a touristic resort

Co-digestion of organic waste and human waste (Touristic resort)	Unit	Quantity
		2,020
Overall area need	m²	600
Quantity of waste treated	t/day	0
Quantity of biogas produced	m³/day	5
Investment cost	US$	120,537
Operational cost (with amortisation)	US$/year	12,049
Revenues	US$/year	12,098
Balance 1st year (with amortisation)	US$/year	49
	US$/ton of waste	2

4.4.4 Refinery of Vegetal Oil for Biodiesel Production

Used vegetable oil can be converted into biodiesel relatively simply after filtration and transesterification. The process is expected to be profitable. Quantities of waste vegetal oil in the British Virgin Islands are unknown; it may, however, be assumed that consumption is similar to that in the US, where the average generation of waste vegetal oil is 4 kg/year[30].

Estimative key data for biodiesel production is given in the table below.

Figure 14: Key parameters for biodiesel production from waste vegetable oil

Biodiesel production	Unit	Quantity
Overall area need	m²	100
Quantity of waste oil treated	t/year	62,568
Revenues	US$/year	69,851
Operational cost (with amortisation)	US$/year	46,451
Investment cost	US$	25,000
Balance	US$/year	23,401
	US$/ton of waste	0.37

4.5 Treatment of Non-recyclable, Non Biodegradable Wastes

For non-recyclable, non biodegradable wastes, there are principally two options:

- thermal treatment

- landfilling.

Following the principles of the waste hierarchy, landfilling is considered an option only for residues from other treatments, for which no other recovery method is possible. This means in fact that the landfill will only receive ultimate residues, either non recyclable incineration residues or non recoverable inert wastes.

For all thermal treatment options, energy recovery and state-of-the art stack gas treatment are foreseen. Combination of the different thermal recovery alternatives is not possible given the comparatively small amount of waste input. The smaller an incinerator is, the higher is the unit cost (US$/ton of waste), so a decision needs to be made on the alternative most appropriate for the British Virgin Islands.

30 Source: Energy and cost analysis of biodiesel production from waste cooking oil, Ahmad Mohammad Shirazi, Shahin Rafiee, Elnaz Bagheri Kalhor, Renewable and Sustainable Energy Review, 2014

4.5.1 Thermal Recovery

4.5.1.1 Repair of the Existing Incinerator and Installation of Stack Gas Treatment Equipment

After a fire damage, the incinerator at Pockwood Pond has not yet been repaired, and the scrubber for flue gas treatment as well as the higher chimney have not been installed. It is not sure if the supplier company will or will not carry out the necessary reparations.

Technical documents on the incinerator were destroyed in the fire, and electronic documents are not available. Since the incinerator was conceived as a mass-burn machine with a 100 t/day throughput, it is probable that the Stoker diagramme describing the limits for heat and mass input looks approximately like the table below:

Tabelle 22: Input limits for mass-burn incinerator, 100 t/day

Capacity (%)	Waste throughput (t/h)	Heat input (GJ/h)				
		Min. calorific value: 5860 kJ/kg	Calorific value: 7911 kJ/kg	Nominal calorific value: 8371 kg/kg	Calorific value: 8665 kJ/kg	Max calorific value: 11720 kJ/kg
60 (min)	2,50	14,65	19,78	20,93	21,66	29,30
71	2,98	17,44	23,55	24,92	25,79	34,88
78	3,27	19,13	25,83	27,34	28,29	38,27
86	3,57	20,93	28,25	29,90	30,95	41,86
100 (nominal)	4,17	24,42	32,96	34,88	36,10	48,83
106 (overload)	4,42	25,88	34,94	36,97	38,27	51,76

Colour code:

grey	Heat and mass input too low for incineration
purple	Lowest input limit
green	Normal operation conditions
light pink	Acceptable continuous overload
pink	Acceptable temporary overload (1h/24h)
red	Limit of calorific overload

Inputs to the incinerator will decrease considerably with improvement of separate collection and recycling, as well as with the coming into force of the proposed bans on single use plastics and the reduction of pallet imports.

With the scenario proposed for the introduction of separate collection and prevention, the waste input for the incinerator is expected to decrease below the lower input limit of 60 % capacity within 5 years[31]. Moreover, the increasing valorisation of organic waste will result in higher calorific values exceeding the (estimated!) calorific input limits.

This means that the existing incinerator, if it were repaired and equipped with adequate stack gas treatment, could still process waste for five years, but would then either need additional fuel, which is an economic and environmental non-sense, or the waste prevention and recycling initiatives would have to be limited in order to maintain the incinerator going.

31This includes already compensation with other inputs as explained in the following sub-chapter.

In consequence, the decision on the future use of the existing incinerator is also decisive for the success of sustainable waste management and circular economy in the British Virgin Islands. It is recommended to rehabilitate the incinerator at Pockwood Pond and operate it during the procurement procedure for a new, state-of-the art, but smaller incinerator, and then keep it as a redundancy in case of accidents or failures of the new incinerator. The scrubber and chimney foreseen to reduce air emissions should be installed as foreseen.

The existing incinerator would perform until a new incinerator is purchased.

4.5.1.2 Acquisition of a State-of-the-Art Incinerator with Full Stack Gas Treatment and Recovery of Thermal Energy

Assuming that waste prevention and recycling rates will increase as foreseen in this strategy, procurement for an incinerator with a capacity of 55 t/day is recommended. Performance of the different measures proposed should be monitored carefully in order to assess if the decrease of waste to incinerate corresponds to the prognostic, and to adjust the capacity of the new incinerator if required. The amounts of waste generated in the British Islands are expected to continue decreasing after the start of operation of the incinerator.

To counterbalance the negative effects a reduced capacity will have on incineration unit costs, the following measures are proposed:

- Storage of incoming pallets on the Pockwood Pond landfill during the first five years for gradual incineration when the expected increase in the performance of separate collection at the source and waste prevention leads to a drop of waste quantities to be incinerated

- Dismantling of end-of-life boats including hurricane wrecks, shredding of glass fibre rumps and storage at Pockwood Pond landfill for gradual incineration to compensate the loss of material to be burned

- Collection and dismantling of derelict vehicles, shredding of non-metal parts and storage at Pockwood Pond landfill for gradual incineration to compensate the loss of material to be burned

- Landfill mining at Pockwood Pond and Cox Heath waste dumps to extract combustible material for incineration

Although the Government of the British Virgin Islands has not yet decided upon a feed-in tariff for large producers of renewable energy, and the current legislation does not cover waste-to-energy, the installation of turbines to produce electricity with the excess heat of the incinerator is strongly recommended. Electricity production being very expensive in the Caribbean, substitution of fossil powered fuel by renewable energy is not only environmentally sound, but will also contribute to reduce considerably the costs of incineration. The table below give an overview over net metering tariffs in the Caribbean, assuming that the future feed-in tariff for the British Virgin Islands might be similar to the tariffs implemented in the neighbouring countries.

Table 23: Net metering tariffs and conditions in other Caribbean countries

Country	Conditions	Feed-in tariff (US$/kWh)
Cayman Islands	Governmental entity, capacity between 20 – 100 kW	0,25 US$ (0,21 KYD)[32]
Dominican Republic	Urban solid residues waste to energy	0,085 US$
Grenada	Any customer, overall limit 500 kW for interconnectivity	0,16 US$ (0,45 XCD)[33]
St. Kitts and Nevis		0,18 US$[34]

32Source: www.carilec.org
33Source: www.grenlec.com
34Recommendation by Reiner-Lemoine-Institut

Country	Conditions	Feed-in tariff (US$/kWh)
US Virgin Islands	Photovoltaic systems between 10 – 500 kW	0,26 US$[35]

In addition to electricity conversion, it is also recommended to make use of the heat to be produced by the incinerator. Excess heat can be used to produce hot steam, which could be used for desalination by evaporation and thus contribute to environmentally sound, affordable drinking water production on Tortola. A desalination plant is existing in Pockwood Pond, but is currently not operational. This plant could be rehabilitated and used for production of drinking water for West End, where drinking water supply is currently a problem.

For stack gas treatment, a full-fledged flue gas cleaning system in compliance with Directive 2010/75/EU is recommended in order to avoid health hazards for the population of Tortola and, depending on the wind direction, of neighbouring islands, due to dioxin, heavy metals and other pollutant emissions.

The table below gives an overview over the key data of the proposed incinerator. All calculations regarding mass and calorific input are based on the results of the first waste characterisation, since no operational data is available. Values for the second decade of use include assumptions for combustible waste input from landfill mining. It should be noted that these are highly speculative since no data based on experience with landfill mining in the British Virgin Islands or in the Caribbean has been found.

Table 24: Key data for the proposed new and modern incinerator

Incineration	**Unit**	**Quantity**		
		2.026	**2.031**	**2.040**
Investment cost incinerator	US$	23.101.199		
Incinerated quantity	t/day	53	51	47
Energy efficiency	%	0,77	0,74	0,70
Energy production	MWh_{el}	14.876	13.296	11.761
	MWh_{therm}	13.637	12.188	10.781
Revenues	Electricity sales (US$/year)	1.211.206	1.191.610	1.084.226
	Steam sales (US$/year)	105.517	73.126	64.688
	Material sales (US$/ year)	217.685	144.116	143.391
Operational cost with amortisation	US$/year	4.278.909	3.372.490	3.317.928
Balance with amortisation	US$/year	2.744.501	1.963.639	2.025.623
	US$/ton of waste	100,80	105,94	121,46

The table shows that net incineration cost is expected to increase with the years. This is mainly due to an improved recovery of recyclable and biodegradable material. Inputs to the incinerator will decrease, revenues from electricity, heat and material sales as well, whereas the operation and amortisation costs will remain the same.

For comparison, the island of St. Barthélemy, a French overseas community, operates a waste to energy facility with co-generation and full fledged stack gas treatment. An overview over key process and financial data is given below.

35Source: https://www.energy.gov/savings/us-virgin-islands-renewable-energy-feed-tariff

Table 25: Key data of state-of-the art, small scale incinerator at St. Barthélemy[36]

Subject	Quantity	Subject	Quantity
Inhabitants	9,000	Operation cost of incinerator	3,243,900 US$/year 246.87 US$/t of waste
Tourists	300,000/year	Start of operation	2001
Waste to be incinerated	10,000 t/year 36 t/day	Investment cost (approximative)[37]	16,220,000 US$
Steam production	1,350 m³/day	Thermal energy produced	23.5 GWh/year

In the past, the BVI incinerator has always been operated by the Department of Waste Management. Similarly, the small scale incinerator at St. Barthélemy has been operated by the Municipality of St. Barthélemy, but the operation proved to be very challenging to the community, which expressed the desire to switch to service delegation by public tender[38].

It can be expected that operating a state-of-the art incinerator is similarly challenging for the BVI local authorities, and a tender for construction of this incinerator should foresee the option of Build-Operate-Transfer. In case that the incinerator will be operated by Department of Waste Management (the future statutory body), it is very important to require distant/ online control and troubleshooting by the supplier. Equally, the full budget autonomy of the solid waste management authority needs to be in place to ensure that necessary repairs, spare parts etc. can be ordered without any delay caused by approval procedures.

4.6 Final Disposal

4.6.1 Sanitary Landfill for Ultimate Residues

After recycling, composting, incineration of non-recyclable, non compostable waste and recovery of incineration residues, there will still be a small proportion of wastes to be landfilled. Moreover, inert waste and soil from the landfill mining activity will need to be disposed of adequately. With a nearly total recovery of organic waste, landfill gas emissions will be near zero, and no gas extraction and flaring will be needed. Leachate will still have to be collected and treated, and the construction of a sealed bottom will be necessary.

The table below gives an overview over the key data of the proposed sanitary landfill.

Table 26: Key data for proposed sanitary landfill

Sanitary landfill for incineration residues	Unit	Quantity
Overall area need	ha	13
Quantity of waste accepted (average)	t/year	12,838
Quantity of leachate produced (average)	m³/day	20
Investment cost (land purchase, auxiliary infrastructure, cells)	US$	3,670,796
Operational cost (with amortisation)	US$/year	202,523
	US$/ton of waste	90

36Source: Collectivité de Saint Barthélemy, Direction de Services Techniques, éléments financier s de la gestion des déchets, 2014
37 Amortisation costs estimated as 20 % of operation cost
38 Source: Communication 2015-034 of the Direction of Technical Services, Collectivité de Saint Barthélemy

Two sites are in discussion for the construction of a sanitary landfill: Cox Heath and Parraquita Bay. Given that Cox Heath did already host a landfill and is currently used for the storage of hurricane debris, and that Parraquita Bay is in vicinity of a college and is used for agriculture, the site at Cox Heath seems more appropriate for landfill construction. More investigation is needed, though, concerning soil and hydrogeological properties.

4.6.2 Rehabilitation of the Old Dumps at Pockwood Pond, Cox Heath, Virgin Gorda and Anegada

With the restart of incineration and the construction of a new sanitary landfill site, the different wild dumps on the British Virgin Islands can be closed down and rehabilitated. Instead of standard rehabilitation with gas wells, extraction and flaring, compacting and impermeable cover, it is proposed to use the old dumps for landfill mining. Apparently, there is already a local recycler interested in this operation. Non recyclable combustible outputs from landfill mining may be used to compensate for the reduction of input to the incinerator (see above); furthermore, landfill mining allows to recover valuable material from the dump and reduce its volume and environmental impact.

Closed dumps for municipal and assimilated waste are suitable for landfill mining. The Pockwood Pond site is accessible and large enough to justify the investment into equipment necessary for landfill mining. Dumps at Virgin Gorda and Anegada also can be exploited for landfill mining after closure. This would require shipping of non recyclable, non compostable waste to Tortola and is recommended at mid-term, when the integrated waste management is already well functioning.

Minimum equipment of a landfill mining site is an excavator, a performant double deck sieve with wind sifter & magnetic separator and a manual sorting line to separate:

- ferrous metal scrap
- stones, glass and inert waste
- combustible fractions

Hand sorting is required to retrieve glass and non-ferrous metal.

Waste recovered from the old landfill can partly be used for material recycling (metals), partly be used as substitute fuel for the incinerator, once the daily input is dwindling due to effective recycling and prevention measures, and the decomposed organic fraction and soil can be used as cover for the new landfill or backfilling material in construction.

With the biodegradation of organic waste, the composition of waste changes considerably from that of fresh waste. An average of 60 different landfill mining projects in Europe and Asia is given below. For the British Virgin Islands, glass and metal percentages are expected to be higher.

Table 27: Waste composition in old landfills[39]

Material	Average waste composition (%)
Plastic	4,6
Paper and cardboard	5,3
Glass	1,1
Fe	1,8
Al	0,1
Other metals	0,1

39Source: Feasibility and Viability of Landfill Mining and Reclamation in Scotland

Material	Average waste composition (%)
Wet organic	5,3
Wood	3,6
Leather and textile	1,6
Construction and demolition waste	9
Stones and other inert wastes	5,1
Soil	54,8
Other	6,1

Similarly, ELB, ELV and construction waste debris stored at Cox Heath and in the two ELV recycling yards can be used for landfill mining and recovery of combustible waste (boats and ELV shredder residue), metal (boats and ELV) and aggregate (concrete waste).

Landfill mining is expected to be slightly profitable, considering only the revenues from scrap and glass recovery. Incineration of combustible waste and landfilling of soil and inert waste are accounted under incineration and landfill costs. The table below summarises the main parameters of landfill mining:

Table 28: Main parameters for landfill mining

Landfill mining	Unit	Quantity
Overall quantity of waste treated	tonnes, Tortola	125,143
	tonnes, Virgin Gorda	74,989
	tonnes, Anegada	17,258
Average daily waste treatment	t/day	80
Overall duration of landfill mining	years	9
Investment cost	US$	764,175
Revenues from sales of scrap metal and glass	US$/year	301,594
Operation cost with amortisation	US$/year	271,396
Balance with amortisation	US$/year	30,198
	US$/ton of waste	1.21

5 Financial Management

5.1 Financing of Waste Management and Monitoring Authorities

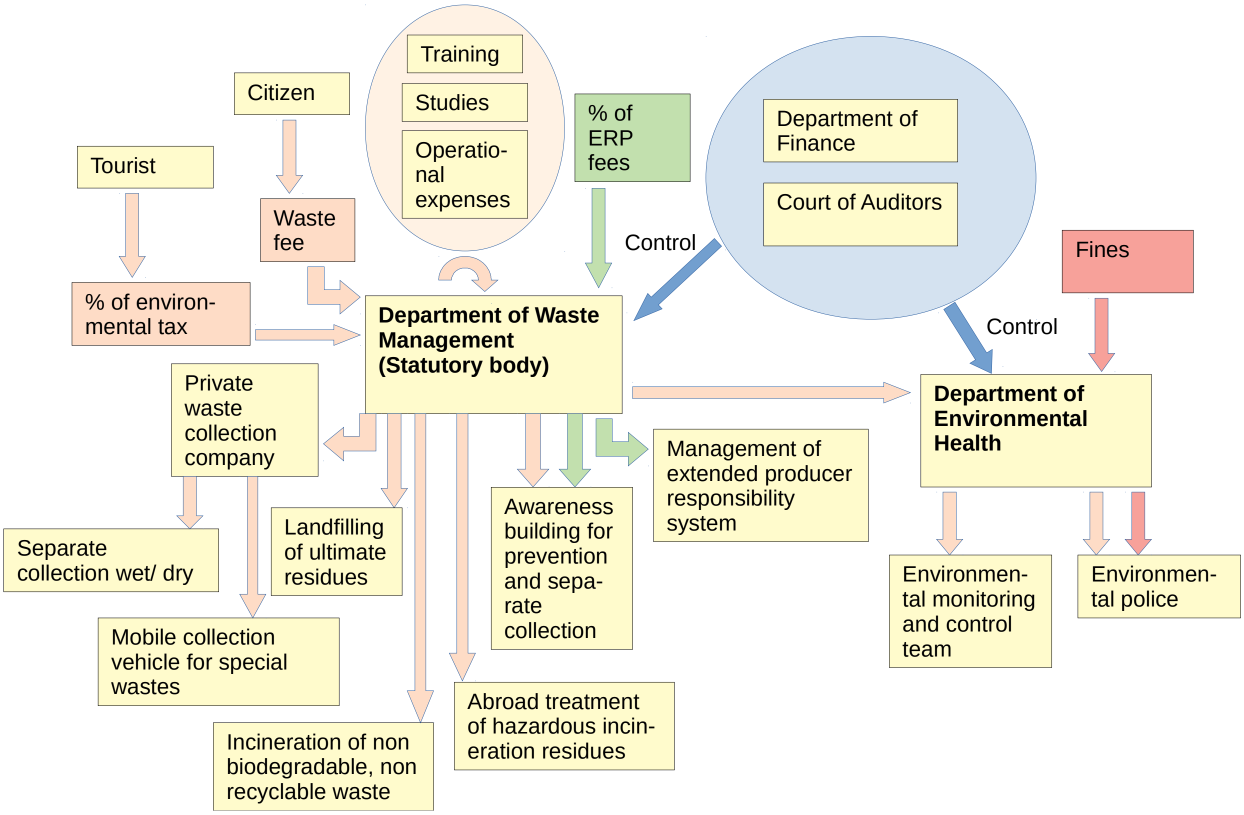
The solid waste management strategy aims at ensuring that financing of the Department of Waste Managment (future statutory body) and the Department of Environmental Health for their respective responsibilities in implementation and monitoring of the strategy be completely covered by financing instruments relying on the polluter pays principle.

Main instruments are the waste fee, extended producer responsibility and fines for infractions of solid waste management activities. Moreover, commerces and industries bringing their waste directly to the incinerator or, in case of inert wastes, to the sanitary landfill, shall pay a tipping fee per tonne of waste discharged.

Fees will be calculated on basis of real cost of all waste management operations, minus revenues from recycling, composting and incineration, and contributions from the extended producer responsibility system.

The figure below illustrates the flow of funds for financing of waste management and monitoring of it.

Figure 15: Real cost based financing of solid waste management administration



Waste management costs in the British Virgin Islands are expected to be quite high. The current expenses of the Department of Waste Management are 3,480,000 US$ (in 2018). With the introduction of integrated waste management, costs are expected to increase due to improved environmental protection, adequate technical management and awareness building/ communication activities, even if some costs can be shifted to extended producer responsibility.

The table below compares waste fees based on real cost for the 6th year of strategy implementation, with the new, state-of-the art incinerator in place and landfill mining being started. Only wastes not covered by extended producer responsibility are taken into consideration. Costs related to landfill rehabilitation are included in incineration and landfilling costs for landfill mining rejects.

Table 29: Waste fees based on real cost calculation - now and with SWM strategy

Waste without ERP		With strategy	Current situation
	t/year	US$/year	US$/year
Communication and awareness building		-262,094	0
Collection	33,760	-1,500,000	-2,147,188
Administration		-750,000	-361,696
Recycling/ composting	21,269	232,897	
Incineration	12,491	-1,259,088	-836,734
Landfilling	7,982	-721,102	-134,276
Total		-4,259,388	-3,479,894
Total per person and year		-136.15	-111.23

Current waste collection costs are very high. It can be expected that performance based collection tenders, CCTV surveillance of waste bins and introduction of waste bring centres and reverse vending, cost can be lowered by approximately 40 %.

On the other hand, administration costs will increase due to the employment of more qualified personnel, and additional costs will arise for communication and awareness building. However, the table shows that the implementation of integrated waste management will raise the financial burden to the citizen only by approximately 20 %, whereas the quality of the service and environmental health will improve considerably. The important difference is that currently citizens are not aware of the payments made, since it is made out of government's general funds. Solid waste management costs do therefore not have a direct impact on citizens' finances, but contribute to reduce available governmental funds in other areas.

5.2 The Recycling Fund

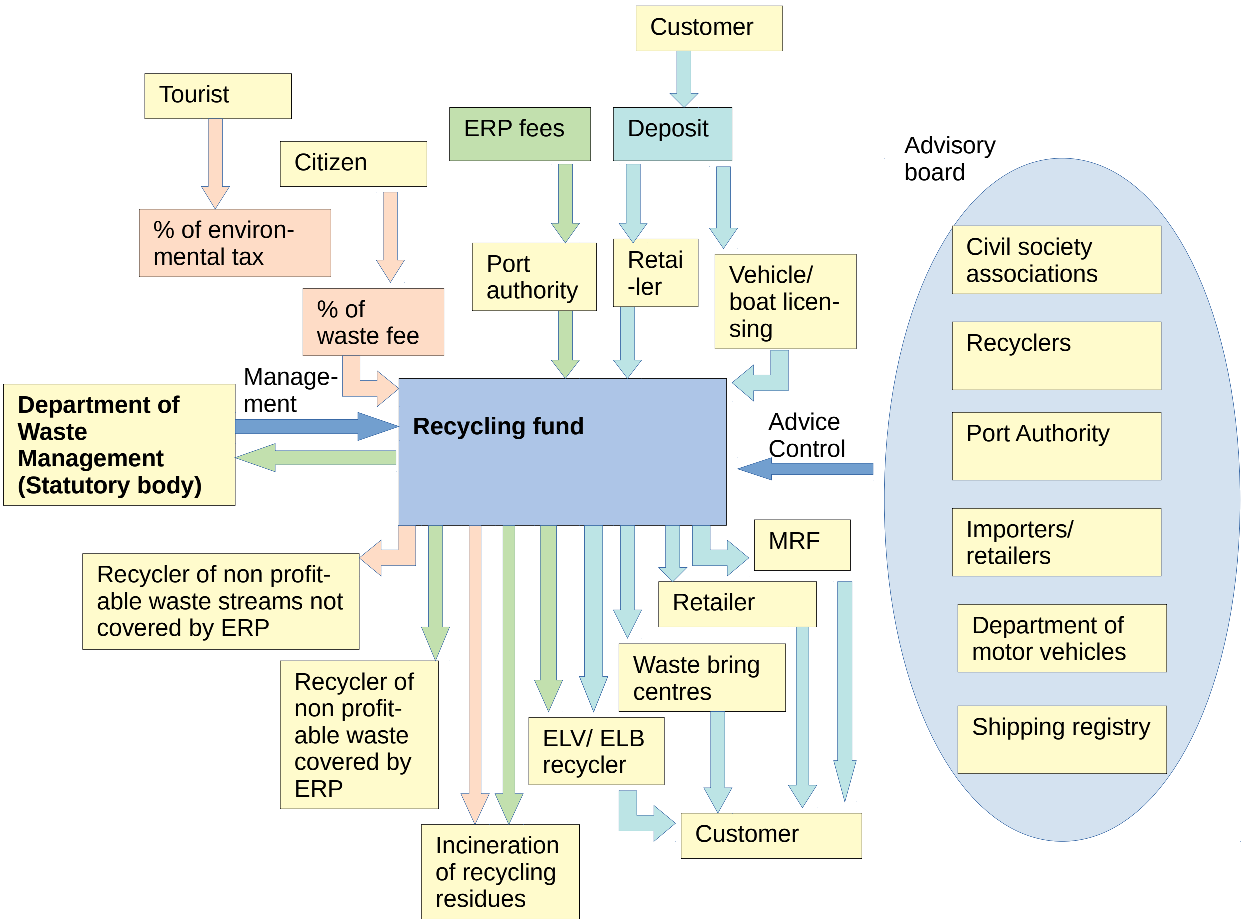
The Recycling Fund is the core instrument for the implementation of the deposit-refund system, of extended producer responsibility and of real cost based waste management. Revenues from different financial instruments are channelled to the Recycling Fund in order to be then distributed to waste treatment and disposal operators based on the nature and quantity of wastes treated.

Deposit paid by customers at retail shops for products covered by the bottle bill (deposit-refund system), for vehicles and boats at registration or license renewal are transferred to the Recycling Fund, in order to be transferred to retailers/ recyclers and paid back to the customer upon disposal of the waste product at a retailer or a waste reception facility, or the end of life vehicle/ boat at a recycling facility.

Extended producer responsibility fees are to be covered by the Port Authority at the entry of a product to the British Virgin Islands and then transferred to the Recycling Fund. These fees are used to finance separate collection and awareness building, subsidise recycling where necessary, and finance disposal of wastes covered by extended producer responsibility. Finally, a part of revenues from the waste fee and from the environmental tax needs to be used to finance collection, recycling and disposal of wastes not covered by extended producer responsibility.

The figure below gives an overview over the foreseen functioning of the Recycling Fund.

Figure 16: Financial flows to and from the Recycling Fund



6 Investment Plan

The investment plan for the overall strategy duration of 20 years is given in Annex 5; re-investments and investments in new infrastructure and equipment in order to treat new waste streams (example: textile recycling) are estimates and need to be calculated at the time of investment planning.

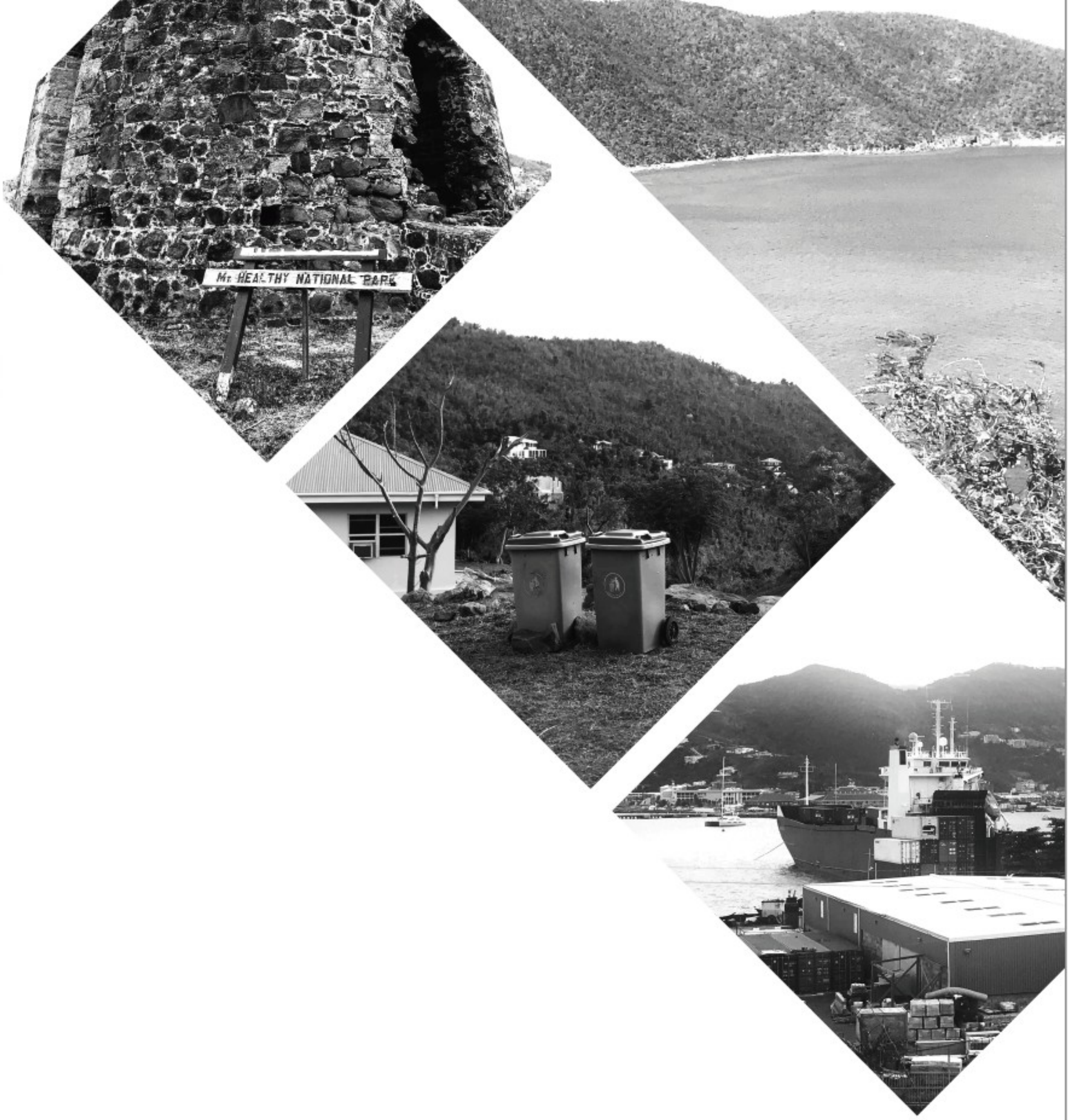
DEPARTMENT OF DWM WASTE MANAGEMENT

RED

DEPARTMENT OF WASTE MANAGEMENT

DWM

Together, We CAN
Keep the BVI Clean and Green!



FINAL REPORT

AUGUST 2019

MATERIALS MANAGEMENT PLAN FOR THE BRITISH VIRGIN ISLANDS

RED

Agency for Resilience, Empowerment and Development

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REPORT STRUCTURE

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The views expressed in this document are entirely those of the authors and do not necessarily represent the MHSD own views or policies.

CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

ASR	After shredder residues
BVI	British Virgin Islands
C&D	Construction and demolition
DEH	Department of Environmental Health
DFID	UK Department for International Development
DWM	Department of Waste Management
DRR	Disaster Risk Reduction
ELB	End of Life Boats
ELB&P	End of Life boats and planes
ELV	End of Life Vehicles
HDPE	High density polyethylene
H&S	Health & Safety
LDPE	Low density polyethylene
MHSD	Ministry of Health & Social Development
OPET	Oriented polyethylene terephtalate
OPP	Oriented polypropylene
PET	Polyethylene terephtalate
PVC	Polyvinylchloride
PP	Polypropylene
PS	Polystyrene
ToR	Terms of References
PWD	Public Works Department
RDA	Recovery and Development Agency
SWM	Solid Waste Management
USD	US Dollars
USVI	US Virgin Islands
VI	Virgin Islands
VG	Virgin Gorda
WEEE	Waste Electrical and Electronic Equipment
WWTP	Wastewater treatment plant

1 Introduction

The Materials Management Plan aims at laying out a roadmap for the sustainable management of each different waste stream, converting it into new material to be used preferably in the local economy, or to be upgraded for recovery abroad.

Waste streams are calculated relying on the two waste characterisation campaigns carried out in 2019. Regular updating of the values with actual registers from waste treatment installations and according to new waste characterisation campaigns will be necessary in the future.

The Materials Management Plan prioritises waste according to three main criteria:

1) Environmental impact of the waste stream (quantity and hazardousness)

2) Facility to target the waste stream (easy prevention, substitutes available, separate collection easy to implement etc.…)

3) Economic aspects: cost of substitution/ treatment/ disposal, value of recovered material, freight cost etc.

Recommendations for re-use and recycling of specific waste streams are based on today's scientific knowledge and best available technologies and need to be updated according to technical progress and international best practices.

2 Existing Waste Streams

2.1 Household and Assimilated Waste

Household waste streams have been identified and quantified by waste characterisation; several other important waste streams can be estimated relying on Trade, Port and Traffic authority registers. The following tables gives an overview over these waste streams and the options how they can be prevented, reduced and recovered.

The first table presents waste streams that are typically collected with household waste and do not have hazardous components.

Table 1: Household waste streams: Quantities and measures for prevention, separate collection and recovery

Waste Stream		Quantity (t/day)	**Measures to be taken**		
			Prevention/ Reduction	**Separate collection**	**Recovery**
Packaging	Paper	**5.74**	Awareness building Prevention targets linked to extended producer responsibility	Separate collection at the source or bottle bill/ deposit-refund system	Press/ baling for export, composting
	Cardboard	**13.18**			Press/ baling for export, composting
	PET	**12.73**			Shredding or press/ baling of metals for export Extrusion, pelletising and production of recycled plastic products in the BVI Incineration (waste to energy) of non separately collected quantities
	HDPE 3D	**2.87**			
	PP 3D	**3.70**			
	PP film	**1.01**			
	Fe	**4.83**			

Waste Stream		Quantity (t/day)	Measures to be taken		
			Prevention/ Reduction	Separate collection	Recovery
	Al 3D	**1.86**			Re-use of glass jars for homemade products Crushing of glass to produce substitute aggregate and sand for concrete production
	Al film	**1.22**			
	Transparent glass	**11.14**			
	Coloured glass	**14.20**			
	Composite	**3.03**			
	HDPE film	**3.15**	Import ban or levy on shopping bags and single-use cutlery/ food containers	Separate collection (wet/dry) for households	
	LDPE film	**4.79**			
	PP 3D	**3.70**			
	PS	**2.14**			
Other	Textile and shoes	**9.42**	Awareness building (“fast fashion”) Promote re-use, repair, exchange	Separate collection (wet/dry)	Re-use/ recycling by Red Cross or Family Support Network Stuffing of car seats, mattresses etc. Incineration (waste to energy)
	Baby diaper, pads, wipes	**4.72**	Awareness building Promotion of substitutes	Separate collection (dry/wet)	Incineration (waste to energy)
	Other	**3.41**			
	Ceramics, inert	**0.15**			Crushing for aggregate production
Organic	Kitchen waste	**47.65**	Awareness campaign	Separate collection (wet/dry)	(Worm) Composting Anaerobic digestion Donation to pig farmers
	Garden waste				
	Loose food waste in supermarkets		Price reductions Internal re-use	Separate collection in the supermarket	
	Packed food waste				Incineration (waste to energy)

Material recovery either by recycling or by biological processes is possible for most household and assimilated waste streams, but requires separate collection at the source in order to ensure quality of the waste stream (no impurities) and reduce sorting efforts.

For plastics, glass and organic waste, treatment projects and ongoing initiatives are existing in the British Virgin Islands. Separate collection will boost these projects, facilitating the access to higher quality and higher quantity of different waste streams. Metal, paper and cardboard waste is exported for recycling; separate collection of this waste stream will increase the quantities to be recovered.

Two principal options exist for separate collection of household waste streams (see also Annex 2, Action plan):

- segregation at the source and separate collection of wet/ dry fractions.

- application of a deposit-refund system inciting households to return waste packaging and products to waste reception centres

Prevention of waste is, for many materials, mainly based on awareness building for different target groups, aiming at more environmentally conscious consumption patterns, selection of purchased goods and better knowledge of alternatives. Requirements under extended producer responsibility might include the obligation to optimise packaging design with the objective to reduce weight and environmental footprint of the packaging material used.

However, for certain packaging items, a complete ban is recommended. This is applicable for packaging that is not necessary to preserve the quality of perishable food, for example plastic shopping bags. In the same logic, single-use food containers, cutlery, straws etc. are easily replaceable items with a considerable environmental impact.

2.2 Special Wastes

A summary table for special wastes is given below.

Table 2: Specific waste streams: Quantities and measures for prevention, separate collection and recovery

Waste Stream		Quantity (t/day)	**Measures to be taken**		
			Prevention/ Reduction	**Separate collection**	**Recovery**
	Other organic waste	**n.a.**			
	Sargasso weeds			Beach clean-up/ Sea-weed removal within the port	Mulching, co-composting/ co-digestion < 10 %
	Used edible oil (Restaurants)			Compulsory grease trap Separate collection	Biodiesel production Co-digestion with organic waste
	Septage			Pumping trucks	Co-composting Co-digestion with organic waste < 30 %
	WWTP sludge	**5.2**			
Bulk waste	WEEE	**0.51**	Promote re-use, ex-change and repair	Bring centre, reverse logistics, deposit system	Dismantling/ Exporting
Bulk waste	Pallets	**9.36**	Take-back obligation High entry tax	Sorting according to country of origin	Mulch production/ composting Hand crafted furniture
Bulk waste	Other	**5.36**	Promote re-use, ex-change and repair	Bring centre	Recycling/ Exporting Incineration (waste to energy)
Hazardous waste	Chemicals	**0.38**	Awareness building for substitution	Bring centres, deposit system	Exporting Incineration (Waste to energy)
Hazardous waste	Small WEEE	See WEEE	Promote re-use, ex-change and repair	Bring centre, reverse logistics, deposit system	Dismantling/ Exporting
Hazardous waste	Medical	**0.05**	Awareness building	Reverse logistics	Incineration (Waste to energy)
Hazardous waste	Batteries	**0.0004**[1]	Awareness building	Reverse logistics, bring centre, deposit system	Export for recycling
Hazardous waste	Accumulators	**0.0015**			
Hazardous waste	Oil and lubricants	**0.39**	Awareness building	Compulsory grease trap Reverse logistics, bring centre	Mineral oil: Exporting for refinery (St. Croix) Incineration (waste to energy) Vegetal oil: Biodiesel production
Other waste streams	ELV (End-of-life vehicles including tyres)	**3.31**	Affordable and sufficient public transport to reduce dependency from individual cars	Reverse logistics, disposal + refund at recycling yards, car register, insurance covering removal + recycling	Exporting for recycling of metals and hazardous components Incineration (waste to energy) Recovery of rubber from tyres and use for production of granulates for sports areas
Other waste streams	ELB (End-of-life boats)	**0.92**		Register + fine system, insurance covering removal + recycling	Export for recycling of metals and hazardous components Local recycling Incineration (waste to energy)

1 Estimation based on average battery consumption of 0.59 kg/(person*year) in the USA, and 0.31 kg/(person*year) in the EU

Waste Stream		Quantity (t/day)	**Measures to be taken**		
			Prevention/ Reduction	**Separate collection**	**Recovery**
	Construction waste	**17.14**			
	Concrete		Design and conception of new buildings in view of waste prevention and recycling Re-use of C&D waste in construction	Obligation for construction companies to separate materials during demolition/ reconstruction of houses	Crushing of concrete to produce aggregate and sand
	Metal				Exporting for recycling
	PVC (windows, piping)				Exporting for recycling

Special wastes are either not generated together with other waste streams, or can easily be separated and need specific treatment. These waste streams may be generated by households, but are not typical household wastes.

Although no detailed registers are held concerning the quantities of special waste generated in the British Virgin Islands, it is possible to estimate the different waste streams relying on trade registers, port registers, shipping register, annual reports of the Department of Waste Management (for ELV) or use factors describing typical waste generation per capita (WEEE, C&D wastes). Derelict vehicles and boats as well as houses demolished by Hurricane Irma are not part of the table above; the wastes accumulated after the hurricane have been considered separately for the dimensioning of technical infrastructure needed to deal with the different waste streams.

Most of the special waste streams are recyclable to an important degree. For WEEE, ELV and ELB, this requires dismantling, shredding and baling for export. A non negligible portion of these wastes is also combustible without being hazardous and may be used for energy recovery.

3 Waste Stream Management

3.1 Management of Household and Assimilated Waste - Packaging

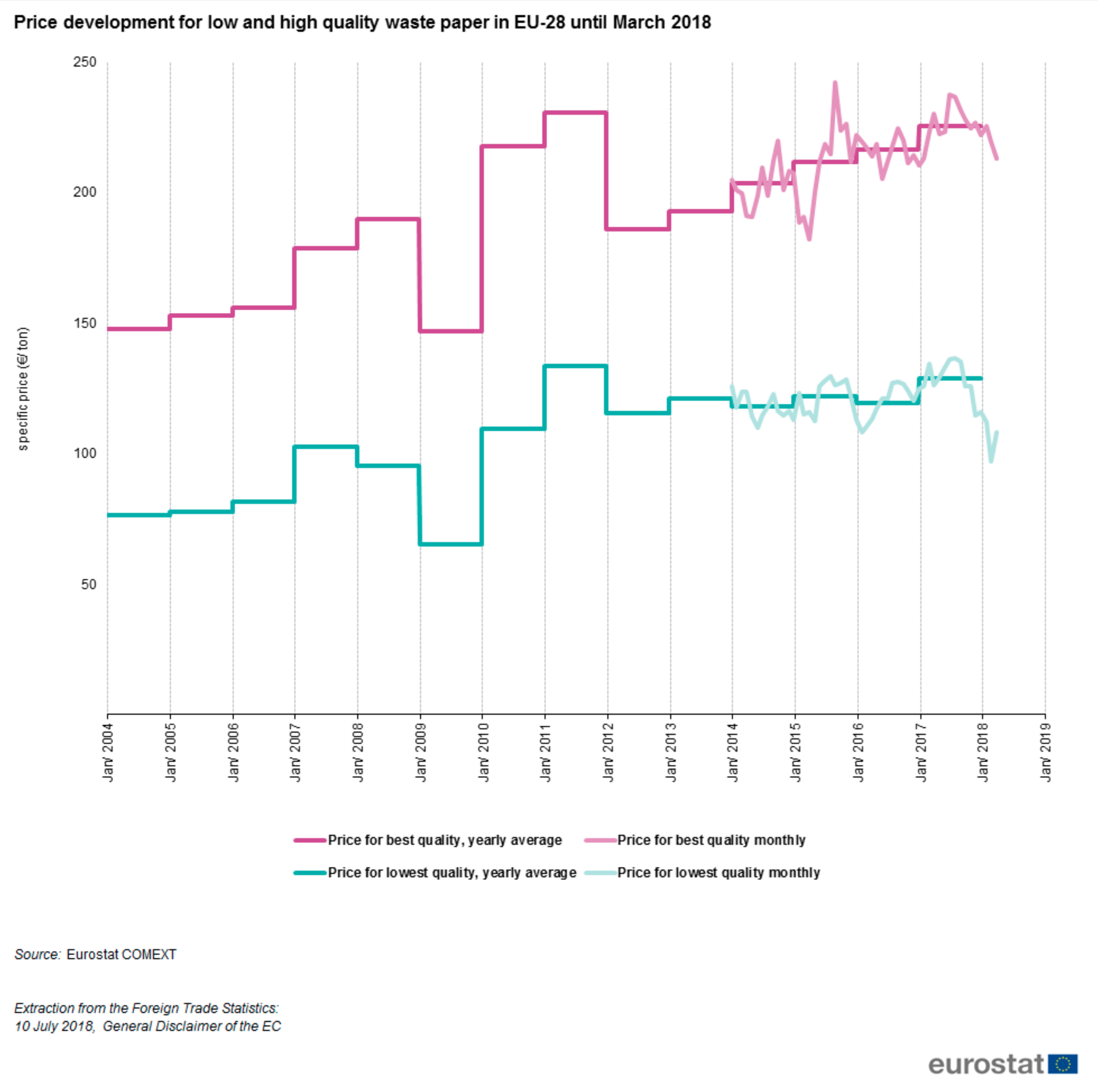
3.1.1 Paper and Cardboard

The total amount of paper and cardboard waste generated in the British Virgin Islands is estimated to be 18,92 t/day. Most of the waste is cardboard from packaging. Being currently collected together with organic waste, paper and cardboard waste from households and small shops is very humid. With separate collection, paper and cardboard would be kept dry, and the real quantity is supposed to be nearer 10 – 12 t/day.

Prices for waste paper and cardboard being highly volatile, export of paper for recycling is generally not an alternative, given the high freight prices. The figure below gives an overview over the development of waste cardboard prices in the EU during the last five years[2].

2 Source: Eurostat, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Recycling_%E2%80%93_secondary_material_price_indicator

Figure 1: Overview over fluctuation of the waste paper market



No capacities for paper production are currently existing in the British Virgin Islands. There are, however, manufacturers producing small capacity paper mills with a capacity of approximately 10 t/day. Another outlet might be the use of waste cardboard as worm beds in the worm composting facility.

Proposed measures for prevention, re-use and recycling of paper and cardboard are given in the tables below.

Table 3: Options for paper prevention, re-use and recycling

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	<u>Awareness building for consumers:</u> - Substitution of printed newspapers and magazines by online	Short term	Govern-ment	Reduction of paper

Waste hierarchy	Options	Timing	Responsibility	Expected result
	version - Reduction of paper consumption in offices - Prefer recycled paper instead of virgin paper		NGOs Schools	imports and consumption in the country
	<u>Paper prevention targets under extended producer responsibility:</u> - Importing products with less cardboard/ paper/ blister packaging - Offer a broad selection of recycled paper products instead of/ as an alternative to virgin paper products	Medium – long term	Government Commerce	
	<u>Financial incentive (government):</u> - Put a tax on virgin paper products to subsidise recycled paper (not included in current waste law; might be considered once	Long term	Government	
Re-use	 Produce fruit/ vegetable bags and pots for seedlings out of waste newspaper and other large paper sheets Substitution of plastic pots and single-use fruit/ vegetable bags with waste paper bags	Short term	NGO Protected workshops Prison Schools	Substitution of plastic with waste paper
Separate collection	<u>Obligatory segregation at the source</u> for supermarkets, large businesses and administrations <u>Wet/ dry collection plus sorting at material recovery facility</u> for paper and cardboard waste from households	Short – medium term	Private waste collector	Clean, dry material
Recycling/ Composting	<u>Composting:</u> Use of cardboard waste as worm beds for worm composting facility	Short – medium term	Private industry	Worm compost
	<u>Recycling:</u> Construction of small paper mill producing kraft paper, paper tissue or toilet paper from waste paper and cardboard. Investment cost: Approximately 300,000 US$	Medium term	Private industry (recycler)	New local paper products
Incineration	Incineration of paper not separately collected	To phase out	Government	Landfill diversion Electricity
Disposal	Not foreseen	To phase out	n.a.	Zero paper waste

Table 4: Geographic and economic aspects of paper and cardboard recycling

Criterion	Estimation		
Local recovery	√√√	Possible	Up to 100 %
Economically sustainable	√	Probable	Break-even or profit making

It seems to be possible that paper and cardboard can, at medium term, be completely recovered locally, with economically sustainable processes.

3.1.2 PET

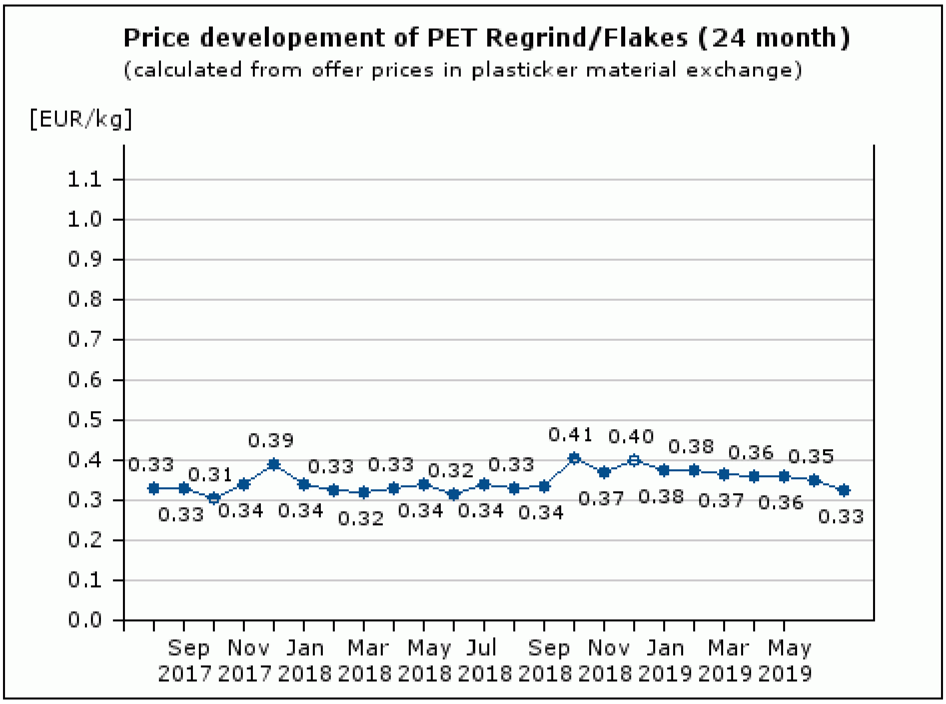
PET is mostly consumed in drinking water bottles. Tap water being perceived as of poor quality in the British Virgin Islands, drinking water is imported in bottles of different size. Since there are no fillers in the BVI, switching to multiple use, deposited glass bottles is not an alternative.

PET can be recycled to produce new PET bottles; this process is already largely implemented in the EU (Austria, Germany), where fillers and recyclers aim at substituting virgin PET completely with recycled PET by 2025[3]. In most processes, however, PET is downcycled, i.e., non or less recyclable products are produced with the recycled PET. PET flakes are used as the raw material for a range of products that would otherwise be made of polyester. Examples include polyester fibres (a base material for the production of clothing, pillows, carpets, etc.), polyester sheets, strapping. Although this process provides a solution for PET bottle waste and substitutes virgin polyester fibres in textile production, it contributes to another problem, that of polyester textile blends, which are difficult to recycle, and leach nanoplastics into wastewater during the washing process.

PET is already used in the manufacturing of plastic furniture and construction material, which is currently done at small scale by a private recycler in the East End of Tortola. However, PET inputs are limited to 10 %, and the furniture and beams produced are not further recyclable, since they are composed of a blend of different plastics.

Prices of secondary PET flakes on the market are relatively stable[4]:

Figure 2: Development of recycled PET prices in the last two years



They are also sufficiently high that exporting of PET for recycling might be envisaged despite the high freight costs.

The table below gives an overview over the different options to deal with PET waste according to the waste hierarchy.

3 See: www.pet2pet.at, www.repet.com
4 Source: https://plasticker.de/preise/preise_monat_single_en.php

Table 5: Options for PET prevention, re-use and recycling

Waste hierarchy	Options	Timing	Responsibility	Expected result
Prevention	Awareness building for consumers: - Use of large PET bottles instead of small ones - Drink filtered tap water - Use your own metal canteen when carrying water with you	Short term	Government NGOs Schools	Reduction of PET consumption in the country
	PET prevention targets under extended producer responsibility: - Importing products with lighter packaging - Prefer large and medium sizes to small and very small size bottles - Ban opaque PET bottles (very difficult to recycle)	Medium – long term	Government Commerce	
	Financial incentive (government): - Provide incentives to house owners upgrading water tanks and piping to improve drinking water quality	Long term	Government	
Re-use	Not recommended for health reasons: Proliferation of germs and leaching of antimony may occur in case of repeated PET bottle re-use	n.a.	n.a.	
Separate collection	Deposit-refund system for supermarkets, collection by reverse vending at retailers, drop-off at waste reception centres or material recovery facilities	Short – medium term	Commerce Private recycler	Clean, dry material
Recycling/ Composting	Exporting for recycling: Production of flakes for PET-to-PET recycling (very high purity needed)	Short – medium term	Private industry	PET flakes
	Local recycling: Extension and upgrading of furniture and construction material production from waste plastics	Ongoing	Private industry (recycler)	Recycled plastic products
Incineration	Incineration of PET not separately collected	To phase out	Government	Landfill diversion Electricity
Disposal	Not foreseen	To phase out	n.a.	Zero PET waste

Table 6: Geographic and economic aspects of PET recycling

Criterion	Estimation		
Local recovery	√	Possible	< 5 %
Economically sustainable	√	Possible	Exporting of flakes is expected to cover treatment and freight costs

3.1.3 HDPE 3D and 2D

HDPE (High density polyethylene) is mainly used as packaging for cosmetics, cleaning liquids, non beverage liquid food items (sauces, mayonnaises…) or motor oil. HDPE is also found in toys, but these are often complex items, consisting of more than one material and difficult to separate and recycle.

2D items are plastic shopping bags, mainly the more resistant, less elastic type.

Recycling of HDPE is comparatively simple, and a large number of items can be produced out of recycled HDPE[5]:

- Outdoor furniture (such as Adirondack chairs)

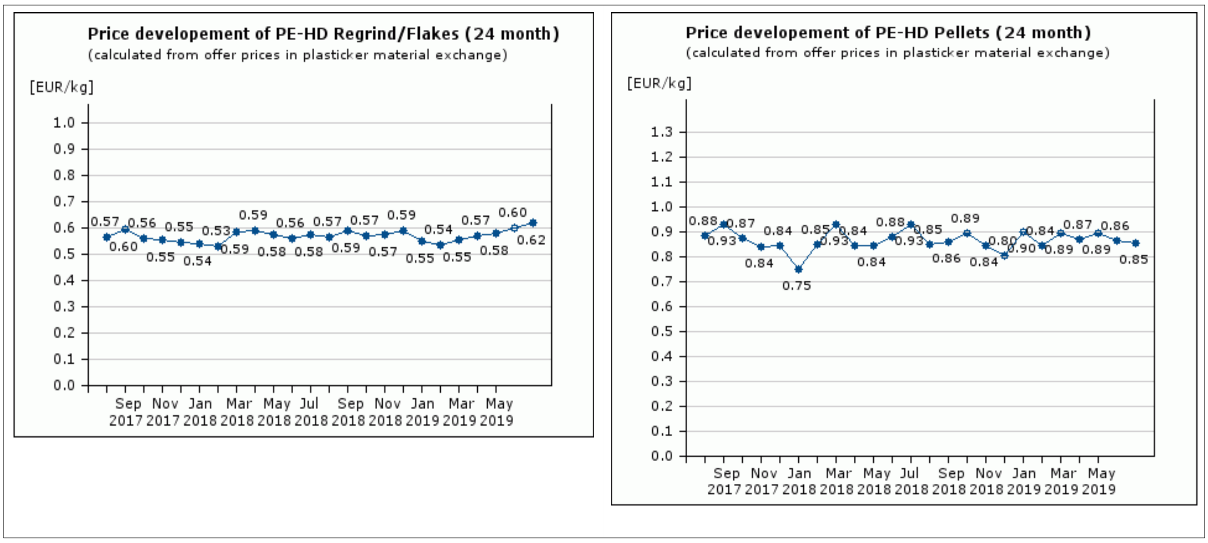
5 Source: http://www.recycledplastic.com/index.html%3Fp=10292.html

- Large drums (for storing oils and chemicals)
- Storage sheds
- Playground equipment
- Paint buckets
- Watering cans
- Cutting boards
- Lunch trays
- Recycled plastic furniture, folding tables and chairs
- HDPE Bottles and containers (non food/ non cosmetic)
- Folding tables and chairs
- Pipes (water, natural gas)
- High density polyethylene mortars (for pyrotechnic)

The recycling workshop in Tortola, East End, which produces furniture and construction beams from waste plastic mainly relies on HDPE and LDPE.

Exporting of HDPE is also an option, since the demand for plastic furniture and other recycled products will probably always be lower than the quantities produced if all HDPE was recycled. Market prices of secondary HDPE, especially if extruded into pellets, is quite high and rather stable.

Figure 3: Development of HDPE prices over the last two years



The tables below give an overview over the options to reduce, re-use and treat HDPE waste:

Table 7: Options to prevent, re-use and recycle HDPE

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	HDPE 2D: BAN The solid waste management strategy foresees a complete ban of plastic shopping bags.	Short term	Govern-ment	Zero HDPE bags

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
	<u>Awareness building for consumers:</u> - Use of large HDPE bottles instead of small ones - Workshops teaching how to make your own shampoo/ detergent/ mayonnaise/ sauce/ dressing etc. - Get into the habit of carrying one or two re-usable shopping bags	Short term	Govern-ment NGOs Schools	Reduction of HDPE consump-tion in the country
	Promote and encourage “no packaging” shops[6] Promote shampoo bars and other no-packaging items 	Medium term	Govern-ment NGOs Commerce	
	<u>HDPE prevention targets under extended producer responsibility:</u> - Importing products with lighter packaging - Introduction of re-usable/ refillable bottles	Medium – long term	Govern-ment Commerce	
Re-use	Offer open sales (big barrel with portioner) to refillable bottles and containers	Short term	Commerce	
Separate collection	Deposit-refund system for supermarkets, collection by reverse vending at retailers, drop-off at waste reception centres or material recovery facilities	Short – medium term	Commerce Private recycler	Clean, dry material
Recycling/ Compost-ing	<u>Exporting for recycling:</u> Production of high quality, colour sorted pellets for HDPE recycling	Short – medium term	Private industry	HDPE pellets
	<u>Local recycling:</u> Extension and upgrading of furniture and construction material production from waste plastics, introduction of new moulds for other products.	Ongoing	Private industry (recycler)	Recycled plastic products
Incinera-tion	- Incineration of HDPE not separately collected - Incineration of HDPE shopping bags escaping the ban	To pha-se out	Govern-ment	Landfill diversion Electricity
Disposal	Not foreseen	To pha-se out	n.a.	Zero HDPE waste

Table 8: Geographic and economic aspects of HDPE recycling

Criterion	Estimation		
Local recovery	√	Possible	< 15 %
Economically sustainable	√√	Possible	Pellet price is sufficient to cover treatment and freight cost

3.1.4 LDPE and LLDPE

(Very) Low density polyethylene is mainly used for shopping and grocery bags of different size and flexible film used for wrapping of products (mainly secondary packaging) or food. The material is also used for labels of PET bottles and soft lids or covers of reusable plastic containers.

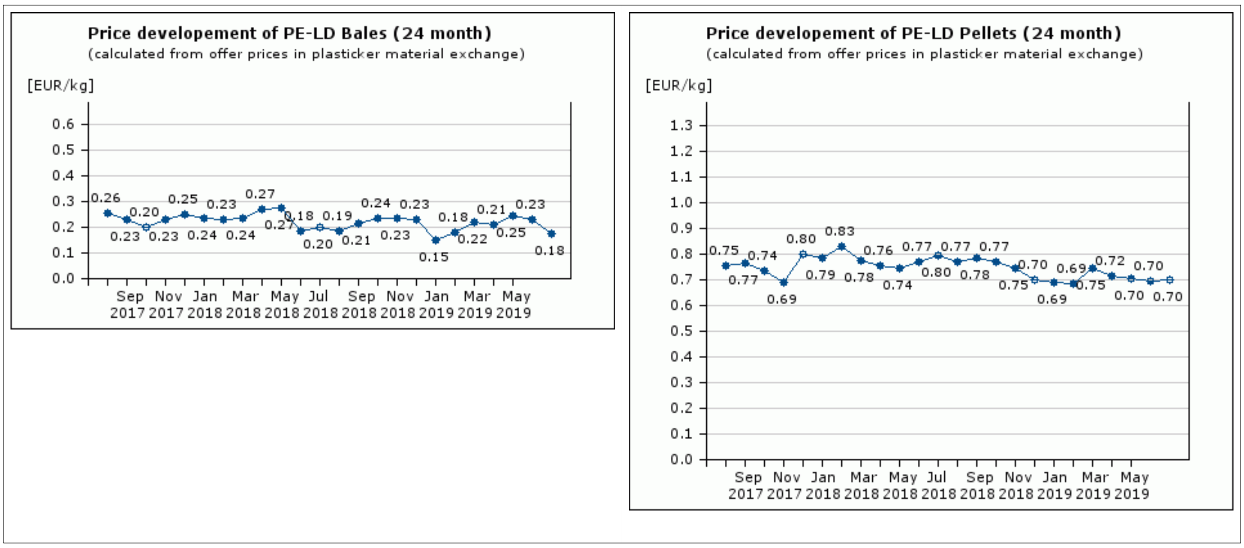
LDPE is recyclable, but in difference to PET, it is not possible to obtain products of the same quality as with virgin resin. Typical LDPE recyclates are:

6 Photo: www.unverpackt-mainz.de

- Shipping envelopes
- Garbage can liners
- Floor tile
- Paneling
- Furniture
- Compost bins
- Trash cans
- Landscape timber
- Outdoor lumber

The graph below gives an oversight over waste LDPE flakes and pellet prices[7].

Figure 4: Prices for bales and extruded secundary LDPE



For non extruded, only baled LDPE, prices are generally not sufficient to cover treatment and freight costs. If exporting for recycling is envisaged, the material needs to be extruded to increase density and market price.

Options for prevention, re-use and recycling of LDPE are given in the table below.

Table 9: Options to prevent, re-use and recycle LDPE

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	<u>LDPE shopping and grocery bags: BAN</u> The solid waste management strategy foresees a complete ban of single use plastic shopping bags.	Short term	Govern-ment	Zero LDPE shopping bags
	<u>Awareness building for consumers:</u> - Get into the habit of carrying one or two re-usable shopping bags - Purchase unpacked and non processed food; if packed food is needed, prefer more sustainable packaging alternatives	Short term	Govern-ment NGOs Schools	Reduction of LDPE consump-tion in the

7 Source: https://plasticker.de/preise/preise_monat_single_en.php

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
	LDPE prevention targets under extended producer responsibility: - Substitute LDPE secondary packaging (wraps, sixpack rings etc.) with compostable bioplastic or other sustainable alternatives - Substitute LDPE garbage bags with compostable bioplastic bags, preferably made of waste products	Medium term	Govern-ment Commerce	country
Re-use	Promote re-use of LDPE shopping bags by citizens : - Re-use existing LDPE shopping bags for other purchases, as garbage bags or for walking the dog	Short term	Govern-ment NGOs	Substitu-tion of virgin pla-stic bags
Separate collection	Wet/ dry collection and sorting at material recovery facility for LDPE not falling under the single use plastics ban	Short – medium term	Private collector Private recycler	Clean, dry material
Recycling/ compost-ing	Recycling abroad: Extrusion to pellets; subsidies might be needed under EPR if recycling prices do not cover freight costs	Medium – long term	Private industry (recycler)	Recycled plastic products
Incinera-tion	- Incineration of LDPE not separately collected	To pha-se out	Govern-ment	Landfill diversion Electricity
Disposal	Not foreseen	To pha-se out	n.a.	Zero LDPE waste

Table 10: Geographic and economic aspects of LDPE recycling

Criterion	Estimation		
Local recovery	X	Possible, but not recommended	Investing into new production lines for LDPE recovery does not make sense if LDPE is expected to disappear largely from the local market
Economically sustainable - local recovery - recycling abroad	X √	Not profitable Not profitable	Quantities expected to dwindle with ban Subsidies needed due to high freight prices

3.1.5 PP 3D and 2D

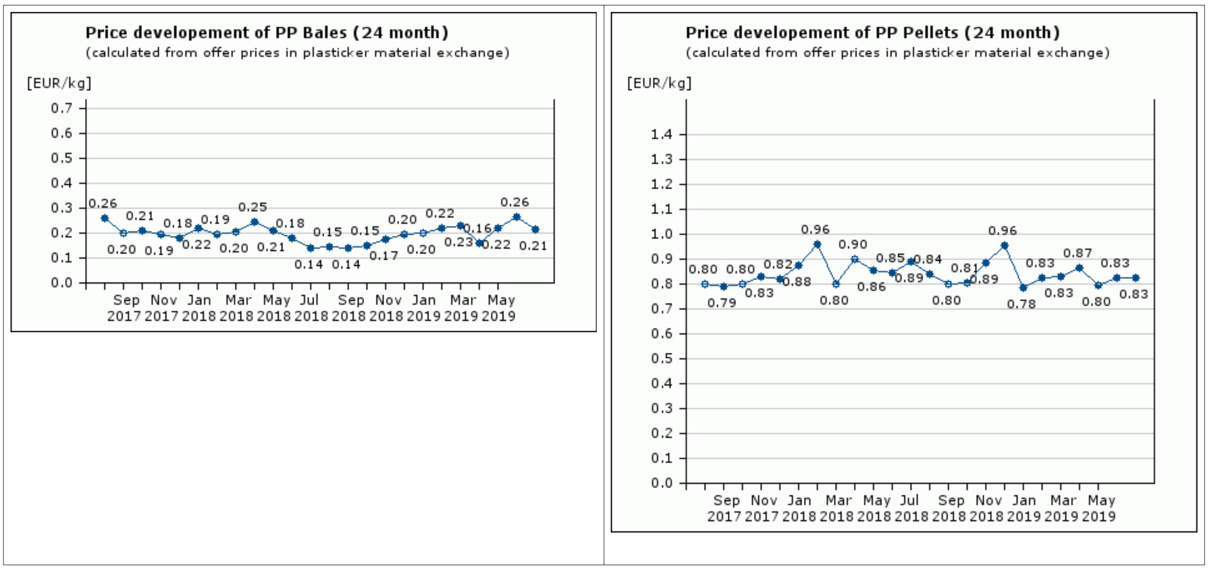
Polypropylene is mainly used in food containers (hard transparent or glossy, opaque containers), boxes, blisters and similar material. It is also used for the production of rope and woven bags. An important part of single-use drink and food containers as well as single-use cutlery, straws and plates is made of PP. 2 D polypropylene is hard, easy breaking, transparent film used in small grocery packaging, noodle/ rice bags, flower wraps, separators for ham/ salami slices etc.

Waste polypropylene can be recycled into the same products as HDPE, with addition of rope, woven bags and similar items. The recycling company in East End is using PP in the same proportion as HDPE for the production of plastic furniture and construction beams.

Similar as for HDPE, it cannot be expected that the demand for recycled plastic items reaches the quantity of waste PP produced. Exporting needs therefore to be envisaged. Prices for PP pellets are quite high and not very volatile. The figure below illustrates the added value of processing PP into pellets instead of simply baling and exporting the material[8].

8 Source: https://plasticker.de/preise/preise_monat_single_en.php

Figure 5: Development of PP prices over the last two years



The tables below give an overview over the options to reduce, re-use and treat PP waste:

Table 11: Options to prevent, re-use and recycle PP

Waste hierarchy	Options	Timing	Responsibility	Expected result
Preven-tion	<u>PP single use food containers, cutlery and plates: BAN</u> The solid waste management strategy foresees a complete ban of single use food containers, cutlery, straws and plates.	Short term	Govern-ment	Zero PP food con-tainers
	<u>Awareness building for consumers:</u> - Prefer home cooking/ restaurant eating to takeaway food, also for health reasons - Purchase flowers without wrapping - Prefer open ware when available	Short term	Govern-ment NGOs Schools	Reduction of HDPE consump-tion in the country
	Promote and encourage "no packaging" shops[9] 	Medium term	Govern-ment NGOs Commerce	
	<u>PP prevention targets under extended producer responsibility:</u> - Importing products with lighter packaging, without blister packaging - No PP wrapping of flowers, vegetables and bunches of herbs - Substitute PP packaging of products with more sustainable alternatives (vegetal based fruit and vegetable nets, sargassum based calcium alginate gel[10] etc.)	Medium – long term	Govern-ment Commerce	
Re-use	Promote woven PP shopping bags as a replacement for single use plastic shopping bags	Short term	Commerce	Substitute single-use items with re-usable ones
	Introduce island-wide standard deposit beakers, plates, cutlery etc. for takeaway food and drinks	Short-medium term	Commerce Tourism operators	

9 Photo: www.unverpackt-mainz.de
10 See: https://challenges.openideo.com/challenge/circular-design/ideas/delta/comments

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Separate collection	Wet/ dry collection and sorting at material recovery facility for PP not falling under the single use plastics ban	Short – medium term	Private collector Private recycler	Clean, dry material
Recycling/ Compost-ing	Exporting for recycling: Production of high quality, colour sorted pellets for PP recycling	Short – medium term	Private industry	PP pellets
	Local recycling: Extension and upgrading of furniture and construction material production from waste plastics, introduction of new moulds for	Ongoing Upgra-de: short term	Private industry (recycler)	Recycled plastic products
Incinera-tion	- Incineration of PP not separately collected - Incineration of PP food containers, cutlery, disposable plates etc. escaping the ban	To pha-se out	Govern-ment	Landfill diversion Electricity
Disposal	Not foreseen	To pha-se out	n.a.	Zero PP waste

Table 12: Geographic and economic aspects of PP recycling

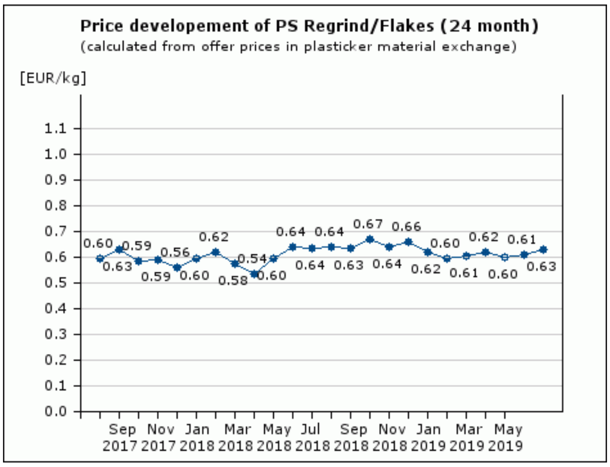
Criterion	Estimation		
Local recovery	✓	Possible	< 15 %
Economically sustainable	✓✓	Possible	Pellet price is sufficient to cover treatment and freight cost

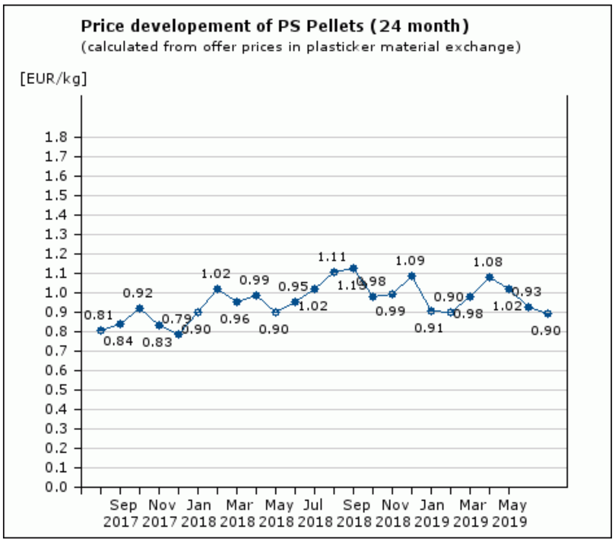
3.1.6 PS

The most common polystyrene item in household waste are single use hard foam PS food and soft drink containers. Other waste fractions are sponges, expanded PS buffer material in packaging of fragile products. Apart from hard foam and expanded polystyrene, there are general purpose polystyrene, extruded polystyrene and high impact polystyrene, none of these being generally found in household and assimilated waste.

Polystyrene is recyclable and obtains quite a high price, but the very low density of the material, consisting up to 98 % of air, leads to extremely high transport costs. For efficient recycling of polystyrene waste, the different types of PS need to be meticulously separated, since non food PS often contains flame retardants, which are classified as persistent organic pollutants.

The graph below gives an oversight over waste PS flakes and pellet prices.





Options for prevention, re-use and recycling of styrofoam are given in the table below.

Table 13: Options to prevent, re-use and recycle PS

Waste hierarchy	**Options**	**Timing**	**Responsi-bility**	**Expected result**
Preven-tion	PS single use food and drink containers: BAN The solid waste management strategy foresees a complete ban of single use food containers, cutlery, straws and plates.	Short term	Govern-ment	Zero PS food con-tainers
	Awareness building for consumers: - Prefer home cooking/ restaurant eating to takeaway food, also for health reasons - Purchase unpacked and non processed food; if packed food is needed, prefer more sustainable packaging alternatives	Short term	Govern-ment NGOs Schools	Reduction of PS consump-tion in the country
	PS prevention targets under extended producer responsibility: - Substitute EPS packaging of non food products with more sustainable alternatives (bio-styrofoam based on mushroom cultures[11], straw as buffer material, biodegradable chips and biodegradable bubble wrap...) - Substitute hard foam PS packaging for fruits, meat, vegetables etc. with more sustainable material (recycled cardboard, biobased fruit nets, compostable bioplastics containers...)	Medium term	Govern-ment Commerce	
Re-use	Promote re-use of styrofoam by citizens : - Re-use styrofoam packaging chips when sending a parcel - Use perlite (EPS) as plant beds	Short term	Commerce	
Separate collection	Wet/ dry collection and sorting at material recovery facility for PS not falling under the single use plastics ban	Short – medium term	Private collector Private recycler	Clean, dry material
Recycling/ compost-ing	Recycling abroad: Crushing + possibly extrusion to increase density; subsidies might be needed under EPR if recycling prices do not cover freight costs	Medium – long term	Private industry (recycler)	Recycled plastic products
	Local recycling: Crushing and de-dusting of styrofoam, use in construction industry (insulating plaster, styrofoam containing light concrete), extrusion of milled styrofoam into moulded products	Medium – long term	Private industry (recycler)	Recycled plastic products
Incinera-tion	- Incineration of PS not separately collected - Incineration of PS quantities that cannot be recycled due to insufficient demand	Phase out in long run	Govern-ment	Landfill diversion Electricity

11 See: https://ecovativedesign.com/

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Disposal	Not foreseen	To phase out	n.a.	Zero PS waste

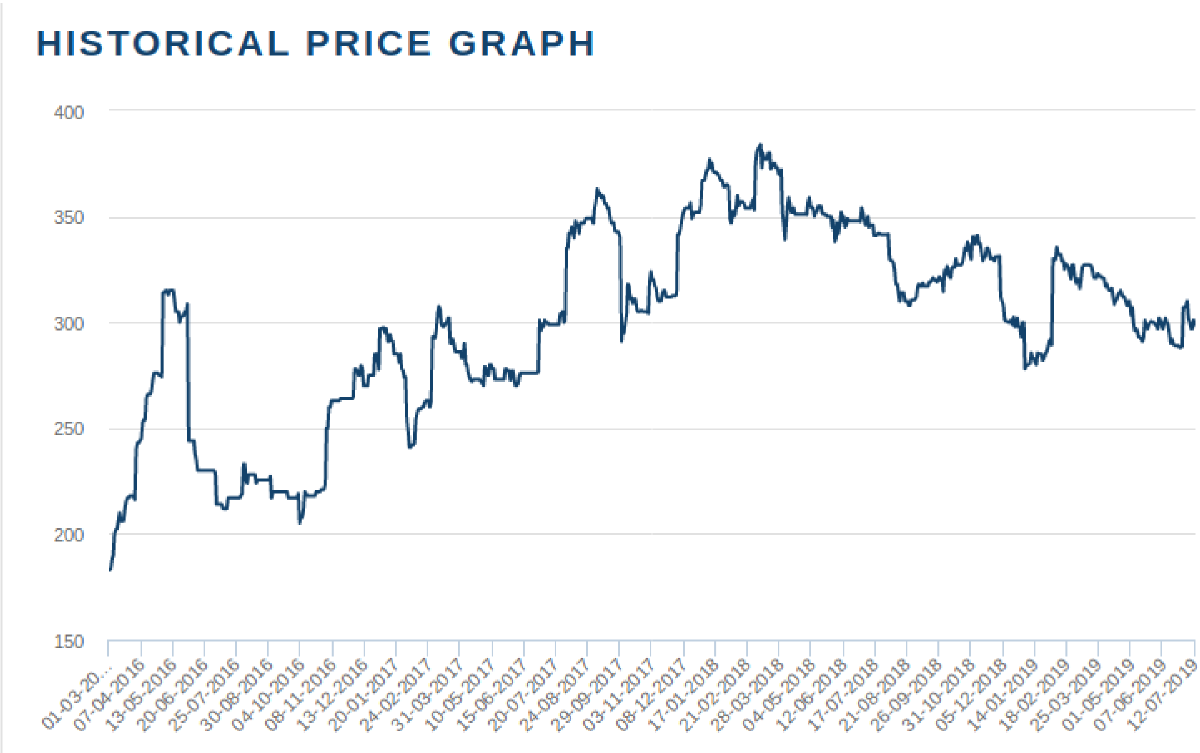
Table 14: Geographic and economic aspects of PS recycling

Criterion	Estimation		
Local recovery	√	Possible	Demand unknown
Economically sustainable - local recovery - recycling abroad	 √ X	 Possible Not profitable	 Demand unknown Subsidies needed due to high freight prices

3.1.7 Fe packaging

Most ferrous household waste is packaging waste, such as conserve containers. No foundry is operational on the British Virgin Islands, and such an investment would not be economically sustainable given the low grade of industrialisation and smallness of the country. Iron scrap prices are highly variable, as the graph[12] below shows. The current price of approximately 300 US$/tonne covers the costs of treatment and freight, but economic sustainability is in jeopardy if steel prices decrease again, which depends largely on market demand and existing steel production capacities.

Figure 6: Fluctuation of steel scrap prices from 2016 – 2019 (in US$/tonne)



12 Source: https://www.lme.com/Metals/Ferrous/Steel-Scrap#tabIndex=2

The tables below give an overview over the options to reduce, re-use and treat ferrous household waste:

Table 15: Options to prevent, re-use and recycle Fe packaging

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
	Awareness building for consumers: - Prefer fresh fruit and vegetables to conserve food; prepare your own conserves in re-usable glass jars	Short term	Govern-ment NGOs Schools	Reduction of ferrous packaging consump-tion in the country
Re-use	Re-use of conserve cans for storage and ranging purposes[13] (Cleaning + decorating for re-use) Re-use of large cans as plant pots Re-use potential is limited and not in line with conserve can consumption! 	Short term	NGOs Schools Protected workshops	Substitu-tion of other con-tainers with recycled cans
Separate collection	Deposit-refund system for supermarkets, collection by reverse vending at retailers, drop-off at waste reception centres or material recovery facilities	Short term	Commerce Private recycler	Clean, dry material
	Separation of Fe waste from incinerator slag for recovery and abroad recycling	Short-medium term	Private recycler	Separate waste fraction
Recycling/ Compost-ing	Exporting for recycling: Compacting and baling of scrap Fe in order to increase density and reduce freight costs	Ongoing	Private recycler	Recycled Fe (abroad)
Incinera-tion	Incineration of Fe not separately collected	To pha-se out	Govern-ment	n.a.
Disposal	Landfill mining for retrieving of Fe scrap from landfilled waste	Medium term	Private recycler	Landfill diversion Electricity
	Not foreseen	To pha-se out	n.a.	Zero Fe waste

Table 16: Geographic and economic aspects of Fe recycling

Criterion	Estimation		
Local recovery	✗	Not possible	-
Economically sustainable	✓	Possible	Scrap steel prices are sufficient to cover freight costs, but prices are highly variable. Subsidies might be needed when prices drop.

3.1.8 Al Packaging 3D and 2D

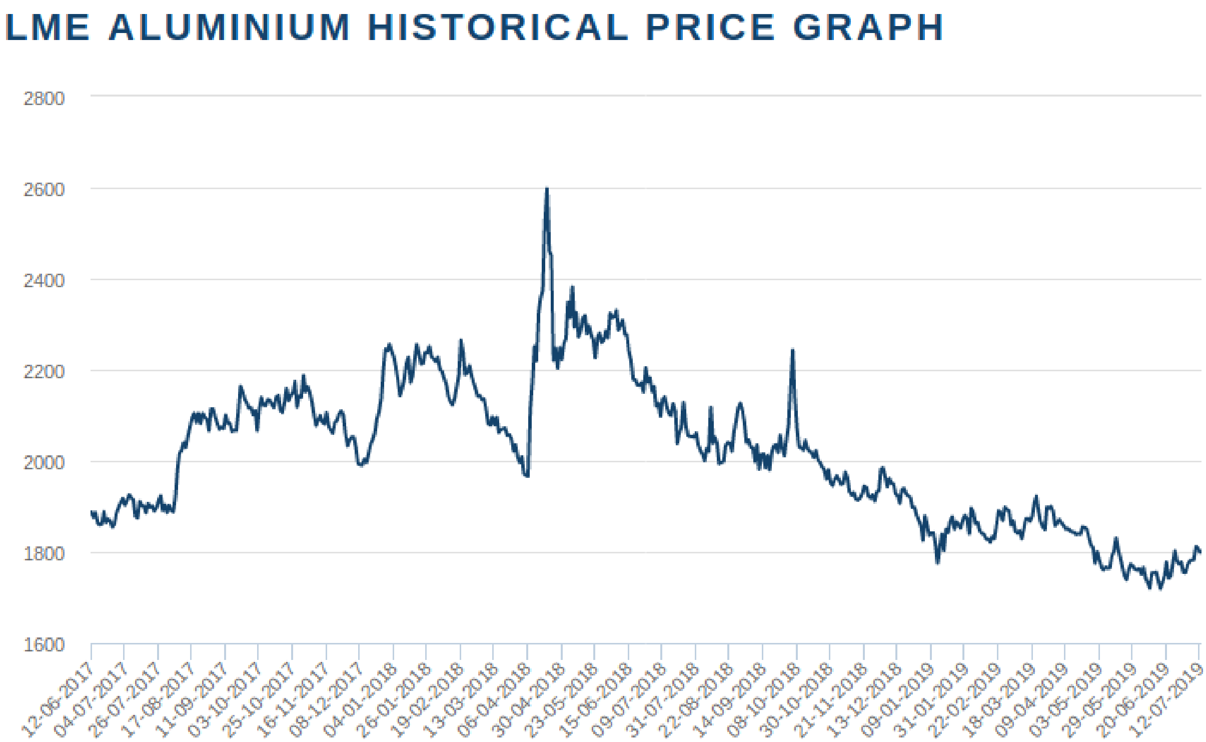
The most frequent aluminium packaging is the aluminium can used for soft drinks and beer, but aluminium is also used for coffee capsules, toothpaste and similar tubes, covers of PP food containers (yoghurt, cream etc. containers), rigid aluminium foil boxes for takeaway and industrially prepared food, aluminium foil used for food wrapping, barbecue or baking purposes.

13 Source of photo: https://www.genialetricks.de/dinge-aus-dosen/

Aluminium is 100 % recyclable, with a very important difference in environmental footprint between virgin and recycled aluminium products. The price of aluminium is also high enough to provide an incentive for scrap dealers and recyclers to recover a maximum of aluminium waste.

The table below[14] shows the fluctuation of scrap aluminium prices. Prices for scrap aluminium foil are distinctly lower, which is mainly due to impurities in the material. Aluminium foil scrap is sold approximately 60 – 75 % of the price for scrap coming from Al cans.

Figure 7: Development of scrap aluminium prices over the last two years



The tables below give an overview over the options to reduce, re-use and treat aluminium packaging waste:

Table 17: Options to prevent, re-use and recycle Al packaging

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	Aluminium single use food containers, cutlery and plates: BAN The solid waste management strategy foresees a complete ban of single use food containers, cutlery, straws and plates.	Short term	Govern-ment	Zero Al takeaway boxes
	Awareness building for consumers: - Reduce overall packaging amount by preferring draft soft drinks and beer if available, or purchase larger plastic bottles instead of	Short term	Govern-ment NGOs	Reduction of

14 Source: https://www.lme.com/Metals/Non-ferrous/Aluminium#tabIndex=2

Waste hierarchy	Options	Timing	Responsibility	Expected result
	0.33 litre cans - Reduce use of Al foil for barbecue, food wrapping etc; substitution with environmentally friendlier material (e.g. baking paper) - Use filter coffee or traditional espresso machines instead of coffee capsules		Schools	aluminium packaging consumption in the country
	Promote and encourage production of local craft beer[15] to reduce beer imports with disposable packaging 	Short term	Government NGOs	
		Ongoing (Cooper Island)	Gastronomy	
	Draft beer/ soft drinks instead of cans: - Promote and encourage importing of re-fillable pressure barrels for gastronomy (with take-back obligation for barrels, similar to the system proposed for pallets)	Medium term	Government Gastronomy	
	Promote marketing of baking paper and aluminium foil made out of 100 % recycled aluminium instead of virgin material	Short term	Commerce	
Re-use	Promotion and awareness building for re-use of clean aluminium foil in households	Short term	Government NGOs	Reduction of Al foil consumption
Separate collection	Al cans: Deposit-refund system for supermarkets, collection by reverse vending at retailers, drop-off at waste reception centres or material recovery facilities	Short – medium term	Commerce Private recycler	Clean, dry material
	Al foil: Wet/ dry collection and sorting at material recovery facility	Short – medium term	Private collector Private recycler	Separate waste stream
Recycling/ Composting	Exporting for recycling: Compacting and baling of Al cans and scrap aluminium foil in order to increase density and reduce freight costs	Ongoing	Private recycler	Recycled Al (abroad)
Incineration	Incineration of Al not separately collected	To phase out	Government	n.a.
Disposal	Landfill mining for retrieving of Fe scrap from landfilled waste	Medium term	Private recycler	Landfill diversion Electricity
	Not foreseen	To phase out	n.a.	Zero Al waste

Table 18: Geographic and economic aspects of Al recycling

Criterion	Estimation		
Local recovery	X	Not possible	-
Economically sustainable	√√ √	Possible	High price for scrap aluminium, both cans and foil. Low price fluctuation, high demand.

15 Source of photo: https://cooperislandbeachclub.com/gallery/main-gallery/

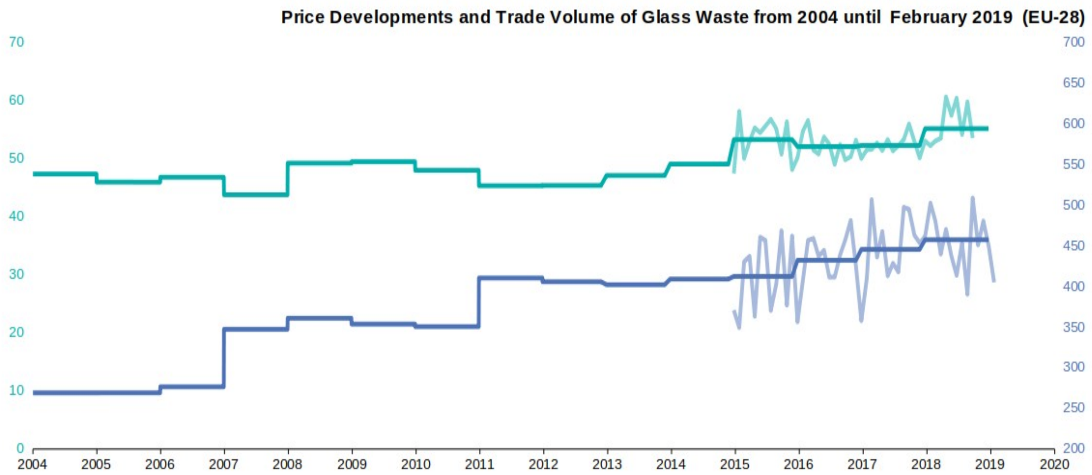
3.1.9 Glass

In household and assimilated waste, the most important fraction of glass waste consists of one-way beer bottles. Wine and soft drink bottles, glasses and jars are also present, but much less important. Flat glass has not been identified during the waste characterisation and belongs to another waste stream for recycling purposes.

Glass can be completely recycled within the British Virgin Islands; there is sufficient demand for secondary raw materials based on crushed glass, both for handicraft artisans and at large scale, for producers of construction material. In case that the demand for waste glass decreases, international waste glass prices are too low to allow exporting for recycling without subsidies.

The graph below [16] illustrates the price fluctuations for waste glass.

Figure 8: Development of waste glass prices over the last 15 years (in €/tonne)



Options for prevention, re-use and recycling of waste glass are given in the table below.

Table 19: Options to prevent, re-use and recycle glass packaging

Waste hierarchy	Options		Timing	Responsi-bility	Expected result
	<u>Awareness building for consumers:</u> - Prefer draft beer/ soft drinks and locally produced craft beer - Prefer water/ fresh juice over industrially produced soft drinks for health and environmental reasons		Medium term	Govern-ment NGOs	Reduction of glass packaging consump-tion in the country
	Promote and encourage prod-uction of local craft beer[17] to reduce beer imports with disposable packaging		Short term	Govern-ment NGOs	
			Ongoing (Cooper Island)	Gastrono-my	
	<u>Draft beer/ soft drinks instead of cans:</u>		Medium	Govern-	

16 Source: https://ec.europa.eu/eurostat/web/waste/prices-for-recyclates; in green: price in €/tonne; in blue: volume in 1000 t/month
17 Source of photo: https://cooperislandbeachclub.com/gallery/main-gallery/

Waste hierarchy	Options	Timing	Responsibility	Expected result
	- Promote and encourage importing of re-fillable pressure barrels for gastronomy (with take-back obligation for barrels, similar to the system proposed for pallets)	term	ment Gastronomy	
Re-use	Promote re-use of glass jars and bottles at home to store home-made liquor, marmalade, conserves etc.	Short term	Government NGOs	Substitution of other containers
	Collect, clean and use glass bottles in good state for filling craft beer into bottles	Medium term	Beer producers Recyclers	Substitution of virgin glass bottles
Separate collection	Deposit-refund system for supermarkets, collection by reverse vending at retailers, drop-off at waste reception centres or material recovery facilities	Short – medium term	Commerce Private recycler	Separate waste stream
Recycling/ Composting	Local recycling - Crushing of glass to aggregate/ sand specifications for construction industry - Crushing and polishing of coloured glass for decorative purposes	Short term Ongoing	Private recycler	Substitution of virgin sand/ stone
Incineration	Incineration of Glass not separately collected	To phase out	Government	n.a.
Disposal	Landfill mining for retrieving of waste glass from landfilled waste	Medium term	Private recycler	Landfill diversion Electricity
	Not foreseen	To phase out	n.a.	Zero glass waste

Table 20: Geographic and economic aspects of glass recycling

Criterion	Estimation		
Local recovery	√ √ √	Possible	Glass crusher already available on the islands, upscaling is necessary. Sufficient demand by construction industry
Economically sustainable	√ √ √	Possible	Aggregate prices and dwindling sand resources increase demand for substitute material

3.1.10 Complex (Composite) Packaging Items

Composite packaging are items consisting of more than one material, with materials difficult to segregate. Blisters or Tetrapak drink boxes are an example of these wastes. Although composite packaging is generally subject to extended producer responsibility, full recycling of these materials is still difficult due to the complexity of the material mix and the glueing of different layers. It is possible to recover paper fibres from composite drink boxes, but the recovery of plastics and aluminium from multilayer packaging is still in research/ demonstration stage.

Metallised flexible packaging (OPP, OPET, paper compounds) are especially difficult to recycle, but allow, on the other side, a significant reduction of packaging weight in comparison to single material packaging, thanks to the combination of different packaging features (protection against light/ air or gas barrier/ humidity…).

For food items needing aseptic packaging, i.e., conservation for six months or longer, composite packaging is generally the most adequate option. A sustainable reduction of this type of packaging can therefore be achieved only by a significant change of consumption patterns, away from industrially processed food to fresh food, but not by banning this type of packaging or substitution with other materials. Both options would probably lead to an increase in waste generation, either by shortening the life span of the food product in question, or by increasing the overall weight of packaging.

Options for prevention, re-use and recycling of complex packaging are given in the table below.

Table 21: Options to prevent, re-use and recycle complex packaging

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	Awareness building for consumers: - Prefer fresh food to processed food, also for health reasons	Short term	Govern-ment NGOs Schools	Reduction of complex packaging consump-tion in the country
Re-use	No re-use options identified	n.a.	n.a.	
Separate collection	Wet/ dry collection and sorting at material recovery facility	Short – medium term	Private collector Private recycler	Clean, dry material (other fractions)
Recycling/ compost-ing	Recycling abroad: No full recycling currently possible. EPR subsidised exporting for recycling might be possible in the future when emerging technologies[18] for multilayer separation have become fully efficient at commercial scale.	Long term	Private industry (recycler)	Separately recycled composite compo-nents
Incinera-tion	- Incineration of all types of complex packaging	Phase out in long run	Govern-ment	Landfill diversion Electricity
Disposal	Not foreseen	To pha-se out	n.a.	Zero complex packaging waste

Table 22: Geographic and economic aspects of PS recycling

Criterion	Estimation		
Local recovery	X	Not possible	Technology still in trial phase
Economically sustainable	X	Not profitable	Subsidies will be needed once the technology is available

3.2 Management of Household and Assimilated Waste – Organic Waste

3.2.1 Food Waste: Wasted Food, Kitchen and Restaurant Waste

Wasted food comprises leftovers from meals, food items rotting or expiring at home or at the shop, including expired packed food.

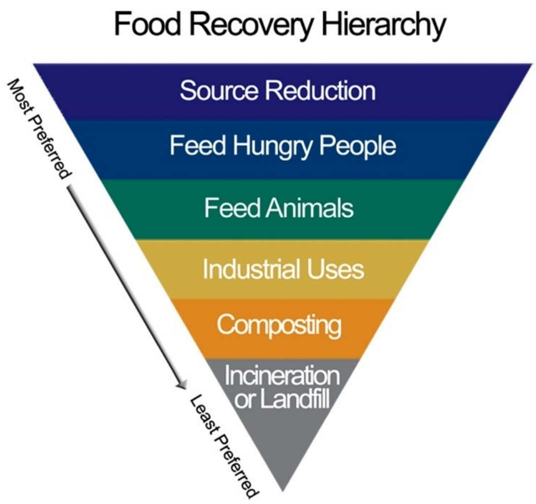
Amounts of wasted food are not known in the BVI. In the USA, which have a similar lifestyle, wasted food is estimated at between 30-40 percent of the food supply. This estimate, based

18 See for example: https://www.creacycle.de/en/the-process.html

on estimates from USDA's Economic Research Service of 31 percent food loss at the retail and consumer levels, corresponded to approximately 133 billion pounds and $161 billion worth of food in 2010. This amount of waste has far-reaching impacts on society:

- Wholesome food that could have helped feed families in need is sent to landfills.
- Land, water, labour, energy and other inputs are used in producing, processing, transporting, preparing, storing, and disposing of discarded food[19].

Extrapolated to the British Virgin Islands, a similar proportion of food waste would amount to 6.1 million tons/ year or 16.1 t/day (only residents), which represents approximately a third of the overall organic waste produced in the BVI. Before considering recovery of organic waste, awareness building for prevention is therefore essential (see food recovery hierarchy at the right[20]).



Kitchen and restaurant waste can be separated into fresh kitchen waste like fruit and vegetable peels, rotten fruit etc., which is easily compostable, food leftovers, oily, meaty, milky, fish or bread waste, which is better used for anaerobic digestion instead of composting. Worm composting can, however, take up this type of organic waste, too, as long as the proportion is not too high and worms can process the material before it starts rotting.

Good practices for recovery of household kitchen waste are already in place in the British Virgin Islands and should be reinforced to promote decentralised recovery.

Options for prevention, re-use and recycling of food waste are given in the table below.

Table 23: Options to prevent, re-use and recover food waste

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	Awareness building for consumers: - Purchase according to food intake of family - Consume quickly perishing products first - Learn to use leftovers in cooking next day's meal - Purchase products near to expiry date for today's cooking - Don't take expiry dates too seriously, food is often still good some time after	Short term	Govern-ment Schools NGOs	Reduction of waste food in the country
	Data and information on food waste - Keep and publish records of food waste (next waste characterisation, systematic exchange with retailers…) - Publish information on best practice for reduction of food wasting	Medium term	Govern-ment	
	Best practices in supermarkets: - Sell products near to/ at expiry date for half the price - Capacity building of personnel for efficient purchase/ storage/	Short term	Commerce	

19 Quoted from: https://www.usda.gov/foodwaste/faqs
20 Source: https://www.usda.gov/foodwaste/faqs

Waste hierarchy	Options	Timing	Responsibility	Expected result
	cooling management - Do not compromise food safety in the search for packaging reduction (technically motivated preferences)			
Re-use	<u>Supermarkets:</u> - Donate products near to/ at expiry date to charities/ orphanage/ prison - Allow containering (this helps also to reduce waste of packed food!)	Short term	Commerce	Substitution of virgin food
	<u>Households/ Restaurants:</u> - Use leftovers for tomorrow's cooking - Feed dogs, chicken or pigs with leftover food/ give kitchen leftovers to pig farmers	Medium term	Citizen Gastronomy	Substitution of virgin food
Separate collection	<u>Composting</u> Wet/ dry separate collection and delivery to (worm) composting facility	Short term	Private collector	Separate organic waste fractions
	<u>Anaerobic co-digestion</u> Separate collection of kitchen waste, food leftovers and human waste at the source (in touristic resort)	Short – medium term	Tourism operator	
Recycling/ Composting	<u>Home based</u> - Home composting - Mulching in own garden with fresh kitchen waste, coffee/ tea pulp etc.	Short term Ongoing	Citizen	Mulch/ compost
	<u>Production of animal food</u> Processing of leftover bread, meat, dairy etc. products to produce cat & dog food	Medium – long term	Private recycler	Substitute virgin food material
	<u>(Worm) Composting</u> Installation of composting facilities on Tortola, Virgin Gorda, Jost Van Dyke and Anegada	Ongoing Medium term	Private NGO	Compost
	<u>Anaerobic co-digestion pilot project</u> Installation of dry, vacuum based separator toilets connected to a biogas reactor for kitchen waste	Short – medium term	Tourism operator	Biogas Digestate
Incineration	Incineration of organic waste not separately collected	To phase out	Government	Landfill diversion Electricity
Disposal	Landfill mining for retrieving of decomposed organic waste from landfilled waste	Medium term	Private recycler	Use as soil cover
	Not foreseen	To phase out	n.a.	Zero organic waste

Table 24: Geographic and economic aspects of food waste recovery

Criterion	Estimation		
Local recovery	√ √ √	Possible	Worm composting project already ongoing Other initiatives likely to meet local demand
Economically sustainable	√√ √	Possible	High prices for quality worm cast

3.2.2 Garden Waste

Garden waste is currently collected together with mixed household waste or is privately burned in gardens. All types of garden waste including grass cuts in limited proportion are adequate for composting; grass cuts can also be used for anaerobic digestion.

Separate collection of bulky garden wastes is needed in addition to the proposed standard wet/ dry collection system in order to increase the efficiency of garden waste recovery. Garden waste produced by trimming of trees and maintenance of public gardens or touristic resorts should be delivered to composting facilities directly.

Prevention of garden waste as such is not an objective of the solid waste management strategy, but the reduction of hazardous components (pesticides) in garden waste should be contemplated under this headline

Options for prevention, re-use and recycling of garden waste are given in the table below.

Table 25: Options to prevent, re-use and recover garden waste

Waste hierarchy	**Options**	**Timing**	**Responsi-bility**	**Expected result**
Preven-tion	BAN of certain pesticides: - Prohibition of chlorinepyrifos and chlorinepyfiros methyl based pesticides, ban of glyphosate and of neonicotinoides Imidaclopride, Clothianidine and Thiamethoxame	Medium term	Govern-ment	Reduction of POP con-centration in garden waste
	NO pesticide use in public green spaces and gardens - Complete phase-out of pesticide use for the maintenance of public green areas, parks and gardens	Medium term	Govern-ment	
Re-use	Use of palm leaves as thatching material for huts, hangars, pavillions etc.	Short term	Citizen Tourism operator	Substitu-tion of con struction material
Separate collection	Composting - Wet/ dry separate collection and delivery to (worm) composting facility - Delivery of bulky garden waste directly to composting facility - Collection of bulky garden waste with mobile collection truck	Short term	Private collector	Separate organic waste fractions
Compost-ing	(Worm) Composting Installation of composting facilities on Tortola, Virgin Gorda, Jost Van Dyke and Anegada	Ongoing Medium term	Private NGO	Compost
Incinera-tion	Incineration of organic waste not separately collected	To pha-se out	Govern-ment	Landfill diversion Electricity
Disposal	Landfill mining for retrieving of decomposed organic waste from landfilled waste	Medium term	Private recycler	Use as soil cover
	Not foreseen	To pha-se out	n.a.	Zero organic waste

Table 26: Geographic and economic aspects of garden waste recovery

Criterion	Estimation		
Local recovery	√ √ √	Possible	Worm composting project already ongoing Other initiatives likely to meed local demand
Economically sustainable	√√ √	Possible	High prices for quality worm cast

3.3 Management of Household and Assimilated Waste – Other Wastes

3.3.1 Textile and Shoes

Textile and shoes are, after organic waste, paper/ cardboard and glass, the most important waste stream in the British Virgin Islands.

Although re-use and exchange of used textile is done with limited scope by non profit organisations like Red Cross and Family Network, no recycling of textile waste is currently in place. It needs to be stated that recycling of textile becomes technically more and more difficult, due to various factors:

- increasing frequency of changing fashion collections (fast fashion) leads to an oversaturation of the textile and shoe market

- increasing proportion of mixed fibre textiles and mixed material shoes makes separation of materials and adequate recycling more difficult

- decreasing textile fibre quality (motivated by the lack of consumers' interest in long-lived clothing) results in low quality input material for recycling.

For the same reason, repair of worn textiles and shoes becomes more and more difficult

Options for prevention, re-use and recycling of garden waste are given in the table below.

Table 27: Options to prevent, re-use and recover garden waste

Waste hierarchy	**Options**	**Timing**	**Responsibility**	**Expected result**
Prevention	<u>Awareness building for consumers:</u> - Prefer less, but long-lived, quality clothing ("slow fashion") over fast fashion - Prefer natural fibres from sustainable production to polyester or mixed fibre clothing - Prefer leather shoes to plastic or mixed material shoes - Instead of purchasing more clothes, prefer clothes exchange	Short term	Government NGOs	Reduction of textile and shoe waste
	<u>Awareness building for shops</u> - Promote novel textiles made of biodegradable material (nettle, bamboo, piñatex, lyocell, cupro…) or sustainably produced traditional fibres (linen,hemp…) - Prefer and advertise sustainably produced textiles - Propose leasing/ renting of high quality clothes - Promote and prefer locally produced handicraft clothes	Short term	Government NGOs	
	<u>Extended producer responsibility for textile and shoes</u> - Obligation to inform on sustainability, recycled fibre content, environmental footprint of the product etc.	Medium – long term	Government	
	<u>Prevention targets in extended producer responsibility for textile and shoes importers</u> - Financial incentives for substituting non recyclable/ non repairable textiles and shoes with long lived, quality products - Financial incentives for sustainably produced natural fibre and leather textiles and shoes	Medium term	Government	
Re-use	<u>Promotion of repair and exchange</u> - Repair cafés, clothes exchange/ renting and flea markets - Use old textiles as wipes, to stuff cushions and toys, for quilting… - Sewing courses to learn how to repair, change and upgrade old clothes - Renting and leasing of clothes	Short term	Government Charities NGOs	Substitution of new textile with existing ones
Separate collection	- Wet/ dry separate collection	Short term	Private collector	Separate waste

Waste hierar-chy	Options	Timing	Responsi-bility	Expected result
	Extended producer responsibility for textile and shoes - Take-back obligation (reverse logistics)	Medium – long term	Commerce	fraction
Recycling/ Compost-ing	(Worm) Composting Co-composting of biodegradable textile and shoe wastes (natural material) in the worm composting facility	Medium term	Private	Compost
	Exporting of textile waste for recycling - Subsidy of exports by EPR extended to textile and shoe importers	Medium – long term	Commerce Private recyclers	
Incinera-tion	Incineration of textile waste	Phase out in long run	Govern-ment	Landfill diversion Electricity
Disposal	Not foreseen	To pha-se out	n.a.	Zero organic waste

Table 28: Geographic and economic aspects of textile and shoe waste recovery

Criterion	Estimation		
Local recovery	√	Possible	Worm composting project already ongoing (only natural material) Small scale handicraft recovery
Economically sustainable	X	Not profitable	EPR subsidies needed for recycling abroad

3.3.2 Baby Diaper, Pads and Humid Wipes

Most of diapers, hygienic pads and humid wipes currently on the market are not biodegradable or otherwise recyclable. Although different producers are researching for the production of 100 % biodegradable nappies, there are still some challenges to be faced:

- the core of a nappie is a super absorbing gel, which is produced on fossil basis. First trials with starch based absorbers are ongoing[21].

- velcro fasteners to close nappies

- elastic band to prevent leaking

Most so-called biodegradable nappies available on the market are composed of 60 – 80 % biodegradable material, which is, however, biodegradable only under industrial composting conditions[22]. In order to be composted, the remaining non biodegradable components should be easily detachable, which is currently not the case.

Substitution with traditional re-usable nappies, sanitary napkins, flannels and face cloths is little accepted, given the higher convenience of disposable hygiene items.

Options for prevention, re-use and recycling of nappies, napkins and wipes are given in the table below.

21 Source: www.fairwindel.de
22 Source: https://www.madeformums.com/reviews/do-biodegradable-nappies-biodegrade/

Table 29: Options to prevent, re-use and recover nappies, napkins and wipes

Waste hierarchy	**Options**	**Timing**	**Responsi-bility**	**Expected result**
Preven-tion	Awareness building for consumers: - Reduce nappy consumption by baby-led potty training ("nappy free baby"[23]) - Prefer cloth nappies to disposable nappies - Use cloth flannels instead of disposable humid wipes - Use menstrual cups instead of sanitary napkins or tampons	Short term	Govern-ment NGOs	Reduction of non re-coverable nappie, napkin and wipe consump-tion
	Awareness building for shops - Offer and promote menstrual cups - Offer and promote fully biodegradable baby nappies when available on the market	Short term	Govern-ment Commerce	
Re-use	No re-use potential identified	n.a.	n.a.	
Separate collection	- Wet/ dry separate collection	Short term	Private collector	Separate waste fraction
Recycling/ Compost-ing	Composting No recycling/ composting potential identified at short term. Fully biodegradable nappies and sanitary napkins to be composted in high temperature industrial compost when available on the market	Medium term	Private	Compost
Incinera-tion	Incineration of baby nappies, sanitary napkins and wet wipes	Phase out in long run	Govern-ment	Landfill diversion Electricity
Disposal	Not foreseen	To pha-se out	n.a.	Zero wipe and nap-pie waste

Table 30: Geographic and economic aspects of nappie and napkin recovery

Criterion	Estimation		
Local recovery	X √	Impossible now Possible in the future	Composting possible in the future, once that fully biodegradable products are available
Economically sustainable	X	Possible	To be tested when available

3.3.3 Ceramic and Inert Waste

Household ceramic consists mainly of porcelain and stoneware. Recycling of porcelain is generally not done, since the main components, kaolin, quartz and feldspar, are very cheap as raw material, but impossible to separate from waste porcelain.

The situation is different for stoneware, which might be crushed and recovered together with ceramic waste from construction & demolition activities.

The table below shows the options for prevention, re-use and recycling of ceramic and inert waste.

Table 31: Options to prevent, re-use and recover ceramic and inert waste

Waste hierarchy	**Options**	**Timing**	**Responsi-bility**	**Expected result**
Preven-tion	Awareness building for consumers: - Reduce waste of household porcelain by conscious consumption - Repair slightly damaged porcelain and stoneware goods - Continue using tableware even if a set is no more complete	Short term	Govern-ment NGOs	Reduction of ceramic waste

23 See: Nappy Free Baby: A practical guide to baby-led potty training from birth, Amber Hatch, 2015

Waste hierarchy	Options	Timing	Responsibility	Expected result
Re-use	<u>Promotion of exchange and repair:</u> - Repair cafés, flea markets - Sales or giving as present of old (vintage) tableware	Short term	Government NGOs	Substitution of new by used ware
Separate collection	- Wet/ dry separate collection	Short term	Private collector	Separate waste fraction
Recycling/ Composting	<u>Stoneware</u> Recycling together with ceramic waste from construction & demolition activities	Medium term	Private	Aggregate
	<u>Porcelain</u> No recycling opportunities identified	n.a.	n.a.	
Incineration	Incineration of not separately collected inert wastes	To phase out	Government	Landfill diversion Electricity
Disposal	<u>Porcelain:</u> Final disposal in inert waste landfill; crushing and use as cover material in sanitary landfill	Short – medium term	Government	Volume reduction
	<u>Stoneware:</u> Not foreseen	To phase out	n.a.	Zero stoneware waste

Table 32: Geographic and economic aspects of nappie and napkin recovery

Criterion	Estimation		
Local recovery	X √	Impossible now Possible in the future	Composting possible in the future, once that fully biodegradable products are available
Economically sustainable	X	Possible	To be tested when available

3.3.4 Other Wastes

Other wastes are various materials that cannot be classified under any of the previous categories and for which, at the moment, no recovery option is existing. They are often composite products, but no packaging, such as toys, decoration objects, various containers etc.

Currently, incineration is the only option for these wastes.

3.4 Management of Special Waste – Organic Waste

3.4.1 Sargasso Weeds

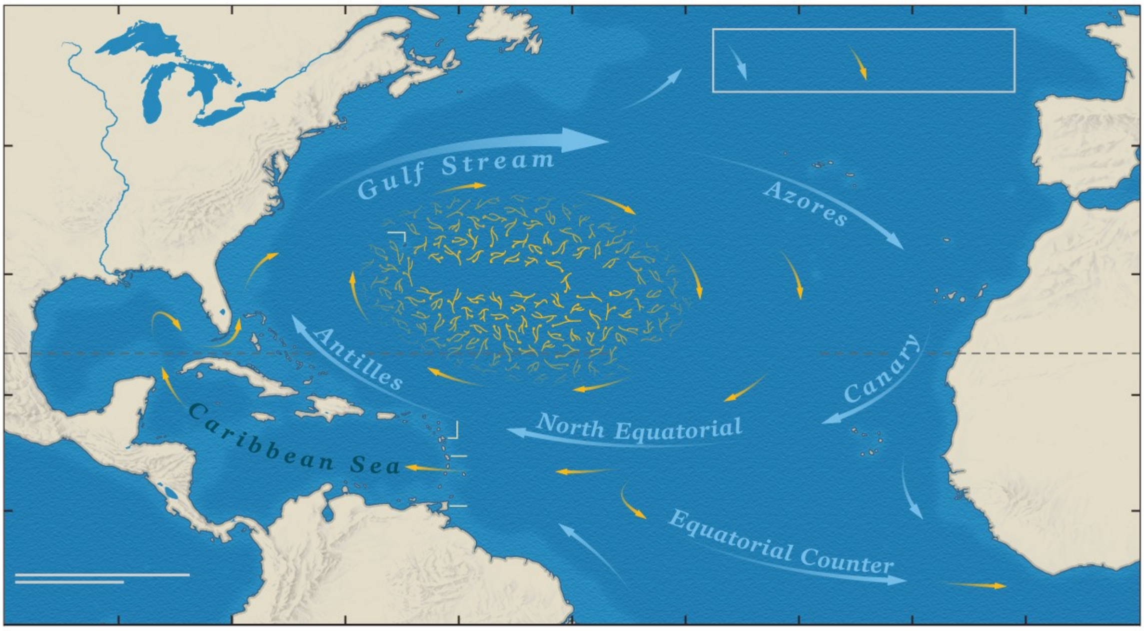
Large, pelagic mats of Sargassum in the Sargasso Sea act as one of the only habitats available for ecosystem development; this is because the Sargasso Sea lacks any land boundaries. The Sargassum patches act as a refuge for many species in different parts of their development, but also as a permanent residence for endemic species that can only be found living on and within the Sargassum[24].

The Sargassum ecosystem follows a cyclic movement in the Atlantic Ocean (see figure below[25]), and periodically undergoes intensive bloom periods. Sargasso weeds swept ashore in the Caribbean are perceived as an important nuisance both to tourism and to the

24 Quote from: https://en.wikipedia.org/wiki/Sargassum

resident population, due to the intense foul odour caused by hydrogen sulphide gas produced during the biodegradation of the weeds.

Figure 9: Cyclic movement of Sargassum



Decomposition of the brown algae releases hydrogen sulphide gas, which causes a very disagreeable smell, might lead to respiratory problems, rusting of metal items and is seen as a nuisance for population and tourism industry. Collection and treatment are challenging, the former due to unclear responsibilities, the latter due to sulphur and arsenic content of the weeds. Moreover, collection of sargassum needs to be done cautiously, in order not to affect sea turtles' hatching, and anaerobic decomposition needs to be prevented in order to avoid the production of hydrogen sulphide gas.

The table below gives an overview over options for prevention, collection and recovery of Sargassum weeds. The use of heavy machinery is not recommended for Sargassum removal at any stage, given the complexity of the ecosystem and its importance for marine life.

In different Caribbean countries, research is ongoing for recovery of Sargassum for various purposes. Although a first Sargassum treatment factory is in construction in Quintana Roo, Mexico, it needs to be said that Sargassum recovery is still in research/ demonstration stage, and that the alternative solutions listed below will most probably not respond to the problem of large, peak Sargassum influx. Government support is needed to promote and foster local research on Sargassum processing options.

25 Source: https://www.nationalgeographic.com/magazine/2019/06/sargasso-sea-north-atlantic-gyre-supports-ocean-life/

Table 33: Options for prevention, collection and treatment of Sargassum[26]

Waste hierarchy	Options	Timing	Responsibility	Expected result
Prevention	Containment with deflection booms: - To be applied at sensitive areas where clean-up would cause significant damages (e.g. mangroves, seagrass beds, beaches) - Use of modular, light-weight flexible booms that can easily be transported	Short term	Government Schools	Reduction of seaweed stranding
Collection	In-water collection close to shore - Collection to avoid stranding of large Sargassum quantities - Clear guidelines to preserve marine life and turtles - Use of reinforced fishing nets towed b light boats or by hand	Short term	Port authority Tourism operator	Separate collection of seaweed without taking sand and minimally affection sealife
	Manual clean-up wherever possible - Manual clean-up is less intrusive but more work intensive (not appropriate for mass strandings) - Removal of seaweed before decomposition in order to minimise health hazards. - Use of lightweight equipment for transport, use of special rakes/ forks to reduce impact on aquatic species trapped in Sargassum	Ongoing	Tourism operator NGO Government Citizens	
	Mechanical clean-up - only for mass strandings - Use machines with low bearing capacity, soft low pressure tyres and claw or harrow to limit pick-up of sand - Bucket-level control indicator for front loaders None of the existing clean-up systems is optimal; there is always a compromise to be made between efficiency/ rapidity and environmental protection	Ongoing	Government (Port authority) Tourism operators	Avoidance of anaerobic decomposition on the beach
Recycling/ Composting	Composting/ anaerobic digestion - Sargassum can be co-composted or digested in low proportion, and with regular control of heavy metal content. Rinsing needed to reduce salt content	Short term	Private investor	Compost
	Mulching Spreading and drying of Sargassum on farmland to stimulate plant growth	Ongoing	Citizen	Soil improvement
	Sargassum based bioplastics - Produce takeaway food/ drink containers based on Sargassum (with banana fibres and cassava starch) - Bioplastic film based on alginate gel - Production of organic glue with Sargassum	Short – medium term	Government Private	Substitute for fossil plastic
	Sargassum based biostimulant Conversion of sargassum into organic fertiliser[27]	Medium term	Private	Substitute chemical fertiliser
	Production of charcoal briquettes Sargassum to be dried, ground into powder and mixed with other carbon sources for briquette production	Short – medium term	Private recycler	Substitute combustible
Incineration	Incineration of mass influx of Sargassum	To phase out	Government	Landfill diversion Electricity
Disposal	Small Sargassum influx to be spread and left on beaches	Short term	Government Tourism operators	Beach stabilisation and sealife habitat
	Final disposal of Sargassum on landfill, burying in beach sand, piling up for rotting	To phase out	n.a.	Zero Sargassum waste

26 Partly summarised from: Prevention and Clean-up of Sargassum in the Dutch Caribbean, Dutch Caribbean Nature Alliance, 2019
27 See: www.algasorganics.com (St. Lucia)

Table 34: Geographic and economic aspects of sargassum recovery

Criterion	Estimation		
Local recovery	√ √ √	Possible; different options available	Composting, anaerobic digestion and production of innovative substitutes
Economically sustainable	√ √ ?	Possible To be tested	Part of sustainable composting project Not yet known for innovative products

3.4.2 Edible Oil

Edible oil is still often discharged together with wastewater, which constitutes an important problem for sewage maintenance and wastewater treatment. Vegetal oil is biodegradable and can also be converted into biofuel if separately collected.

Table 35: Alternatives for prevention, re-use and treatment of waste edible oil

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	Not applicable			
Re-use	<u>Filtration for re-use</u> - Awareness building for health conscientious re-use of edible oil by citizens and restaurants - Re-usable or biodegradable filters to separate frying leftovers from used vegetal oil	Short term	Govern-ment Restaurants canteens	Reduction of virgin edible oil consump-tion
Collection	<u>Waste reception centres</u> - Awareness building for citizens to separately collect waste oil and deliver it to waste reception centres - Obligatory separation at the source for restaurants, canteens, hotels...	Short term	Citizens Restaurants canteens Recycler	Clean waste stream
	<u>Door-to-door collection by recycler</u> - Agreement between restaurant/ hotel/ canteen entrepreneur and private recycler for regular door-to-door collection of separately collected waste edible oil	Short term	Restaurants canteens Recycler	
	<u>Obligatory grease trap</u> - Public and private restaurants, canteens and kitchens to install grease traps for separation of waste oil and grease from grey water. - Monthly emptying and maintenance by private service provider	Short term	Restaurants canteens Recycler Technician	Substitute combusti-ble
Recycling/ Compost-ing	<u>Biodiesel production</u> Refinery of waste edible oil for biodiesel production	Short term	Recycler	Substitute combusti-ble
	<u>Co-digestion in anaerobic digester</u> Co-digestion of grease recovered from grease trap in anaerobic digester (anaerobic co-digestion pilot project or new anaerobic digestion project)	Short – medium term	Private recycler Tourism operator	Biogas/ digestate
Incinera-tion	Incineration of waste from grease trap and biodiesel refinery residues	Phase out at long term	Govern-ment	Landfill diversion Electricity
Final disposal	Final disposal of waste oil in landfill	To pha-se out	n.a.	Zero edible oil waste

Table 36: Geographic and economic aspects of edible oil recovery

Criterion	Estimation		
Local recovery	√ √ √	Possible; different options available	Biodiesel production or anaerobic digestion are both feasible

Economically sustainable	√ √	Possible	Both anaerobic digestion and biodiesel production are expected to be financially lucrative.

3.4.3 Septage (Black water)

Septic tank sludge is produced in residences not connected to the sewage network. Septic tanks are functioning as non-controlled anaerobic reactors; part of BOD is biodegraded in the septic tank; another part remains and might be used for further anaerobic digestion.

If black waters are separately collected and immediately used for anaerobic digestion, valuable nutrients, especially phosphorous and energy can be recovered. Even partly biodegraded septic tank sludge can still be used for anaerobic co-digestion with more energy intensive material. The anaerobic co-digestion pilot project aims at demonstration of the technology, in order to replicate it for other grouped settlements.

Table 37: Options for recovery and treatment of black water

Waste hierarchy	Options	Timing	Responsibility	Expected result
Prevention	Not applicable			
Collection	Vacuum toilets - Reduction of water use and compaction of human waste - Transfer of "dry" excrements to centralised treatment by pumping	Medium – long term[28]	Citzens Schools Prison Tourism operators	Separate dry fraction Reduced water consumption
Collection	Pumping trucks - Evacuation of septic tanks and transport to anaerobic co-digestor	Medium – long term	Citizens Private collector Recycler	Diversion of septage from wastewater
Recycling/ Composting	Co-digestion in anaerobic digester Co-digestion of human waste from vacuum system or septic tank sludge in anaerobic digester (anaerobic co-digestion pilot project or new anaerobic digestion project)	Medium – long term	Recycler	Substitute combustible
Incineration	Not applicable	n.a.	n.a.	
Final disposal	Infiltration or discharge into nature	To phase out	n.a.	Zero septage discharge

Table 38: Geographic and economic aspects of septic tank sludge recovery

Criterion	Estimation		
Local recovery	√ √ √	Possible	Anaerobic co-digestion of raw human waste or septic tank sludge
Economically sustainable	√ √	Possible	Important economies on wastewater treatment. Co-digestion of raw human waste is expected to be profitable; septic tank sludge yields less biogas but still may make benefits.

28 Even if the anaerobic co-digestion project may be implemented at short - medium term, it is expected that replication at larger scale will take some time.

3.4.4 Wastewater Treatment Sludge

Currently, no wastewater treatment sludge is produced, since the wastewater treatment plants are not functioning. With the existing treatment capacity of 750,000 gal/day in Burt Point, and 45,000 gal/day in Cane Garden Bay[29], which corresponds to 3,000 m^3/day, approximately 5.2 m^3/day of wastewater treatment sludge[30] are to be expected if the wastewater treatment plants are taken into operation again.

Wastewater treatment sludge can be co-composted with other biodegradable waste, which is already foreseen at the worm composting facility in Tortola, and might be implemented on the other islands, too.

The table below provides an overview over options to handle wastewater treatment sludge.

Table 39: Options for recovery and treatment of black water

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	Not applicable			
Collection	Storage in skips After dewatering, wastewater treatment sludge is collected in skips until transport to its final destination.	Short term	Water se-werage de-partment	Separate dried WWTP sludge
Recycling/ Compost-ing	Co-composting Co-composting in Tortola worm composting facility or in small scalle composting facilities (once wastewater treatment is done) on the smaller islands	Short term	Private	Compost
Incinera-tion	Not foreseen	n.a.	n.a.	
Final disposal	Spreading on arable land without prior treatment	To pha-se out[31]	n.a.	Zero sludge discharge

Table 40: Geographic and economic aspects of WWTP sludge recovery

Criterion	Estimation		
Local recovery	√ √ √	Possible	Worm composting project on Tortola
Economically sustainable	√ √ √	Possible	Part of sustainable composting project

3.5 Management of Special Waste – Bulk Waste

3.5.1 WEEE

The category WEEE covers all waste electrical and electronic equipment. This equipment should be collected separately, brought to waste reception facilities and then be shipped overseas for adequate recycling. Waste electrical and electronic equipment contains too many different hazardous components to be dismantled and partially recycled at local level.

The table below gives an overview over options for WEEE prevention, collection and treatment.

29 Capacity of the 3rd non-operational wastewater treatment facility at Paraquita Bay not known.
30 After dewatering with filter press
31 Not to be taken up again once the wastewater treatment plants are rehabilitated

Table 41: Options for WEEE prevention, collection and treatment

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	Awareness building for consumers: - Prefer less, but long-lived, quality electrical appliances and equipment - Purchase only necessary items, no "nice to have" equipment - Select according to sustainability criteria (recyclability, easy dismantling, content of recycled material, energy and consumables consumption...)	Short term	Govern-ment NGOs	Reduction of WEEE
	Awareness building for shops - Promote and advertise sustainably produced, long-lived, easy-to-repair, easy to dismantle electrical and electronic equipment - Propose leasing/ renting of high quality EEE (e.g., gardening, construction, etc. specialised equipment)	Short term	Govern-ment NGOs	
	Extended producer responsibility for WEEE - Obligation to inform on sustainability, recycled material content, easy repair/ dismantling/ recycling, environmental footprint of the product etc.	Medium – long term	Govern-ment	
	Prevention targets in extended producer responsibility for EEE importers - Financial incentives for substituting non recyclable/ non repairable electrical and electronic equipment with long lived, quality products - Financial incentives for eco-design	Medium term	Govern-ment	
Re-use	Promotion of repair and exchange - Repair cafés, EEE exchange/ renting and flea markets - Courses to learn how to repair, update and upgrade old household appliances, computers, smartphones etc. - Renting and leasing of EEE	Short term	Govern-ment Charities NGOs	Substitu-tion of new EEE with exist-ing ones
Separate collection	Waste reception centres - Awareness building for citizens to separately collect WEEE and deliver it to waste reception centres	Short term	Private collector	Separate waste fraction
	Extended producer responsibility for EEE - Take-back obligation (reverse logistics)	Medium – long term	Commerce	
Recycling/ Compost-ing	Exporting of WEEE for recycling - Subsidy of exports by EPR extended to EEE importers	Medium term	Private	Recycled WEEE com ponents
Incinera-tion	Incineration of WEEE waste not separately collected	Phase out in long run	Govern-ment	Landfill diversion Electricity
Disposal	Not foreseen	To pha-se out	n.a.	Zero WEEE

Table 42: Geographic and economic aspects of WEEE recovery

Criterion	Estimation		
Local recovery	X	Impossible	Capacities for treatment of hazardous components not available
Economically sustainable	X	Impossible	Subsidies from extended producer responsibility are necessary

3.5.2 Pallets

The solid waste management strategy foresees a take-back obligation for pallets to be imported to the British Virgin Islands, in order to reduce the important influx of waste pallets to the country. Most probably, not all pallets will be returned for exporting, and the remainder will still need to be collected and recovered. The table below gives an overview over the measures proposed for prevention, collection and recovery of pallets.

Table 43: Prevention, collection and recovery of pallets

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	BAN of pallets entering the country: - Take-back obligation for freight companies bringing goods on pallets to the BVI (one pallet to be taken out for each pallet getting in) - Return obligation for businesses purchasing goods on pallets (deliver one pallet to the Port for each pallet accepted)	Short term	Govern-ment Retailers Freight companies	Reduction of pallet waste
Re-use	Repair and re-affect pallets - Repair of pallets and use for fabrication of boxes, furniture etc. (small scale, handicraft operations)	Short term	NGOs Artisans	Substitu-tion of vir-gin material
Separate collection	Separation according to material and country of origin - Obligation for users (commerce, freight companies) to classify pallets according to origin (US, other countries) in order to facilitate take-back abroad - Provision of separate storage areas in the Port	Short term	Port authority Retailers Freight companies	Separate standard pallets
Recycling/ Compost-ing	Co-composting of pallet chips Chipping pallets to small pieces and co-composting in worm composting facility	Short term	Private	Compost
Incinera-tion	Storage of chipped pallets to balance capacity losses due to decreasing waste input	Medium term	Govern-ment	Landfill diversion Electricity
Disposal	Not foreseen	To pha-se out	n.a.	Zero pallets

Table 44: Geographic and economic aspects of pallet recovery

Criterion	Estimation		
Local recovery	√ √ √	Possible	Worm composting project on Tortola
Economically sustainable	√ √ √	Possible	Part of sustainable composting project

3.5.3 Other (furniture)

Other bulk waste often consists of furniture, mattresses and similar large household items. Most of these wastes are recyclable, but need to be collected in an organised way to enable repair, re-use and recycling operations. No

The table below gives an overview over prevention, re-use and recycling options for furniture waste.

Table 45: Prevention, re-use and recycling of furniture waste

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	Awareness building for consumers: - Measure twice, buy once: avoidance of waste caused by impulse purchases of furniture not adapted to the house where it is used - Prefer multi-function furniture such as convertible sofas or futons - Use of slipcovers to protect furniture - Re-adjust existing furniture for other rooms/ other purposes	Short - medium term	Govern-ment NGOs	Reduction of furniture waste
	Awareness building for shops - Promote and advertise sustainably produced, long-lived, easy-	Medium term	Govern-ment	

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
	to-repair, easy to revamp furniture - Prefer producers with credible environmental policies and waste reduction strategies		NGOs	
	Extended producer responsibility for furniture - Obligation to inform on sustainability, recycled material content, easy repair/ dismantling/ recycling, environmental footprint of the product etc.	Long term	Govern-ment	
	Prevention targets in extended producer responsibility for furniture importers - Financial incentives for substituting non recyclable/ non repairable furniture with long lived, quality products - Financial incentives for eco-design	Very long term	Govern-ment	
Re-use	Promotion of repair and exchange - Repair cafés, furniture exchange/ renting and flea markets - Courses to learn how to repair, re-vamp, re-decorate used furniture - Businesses and administration: contract private service provider for maintenance and repair of office furniture - Promote protected workshops for dismantling, replacement of broken parts, and more consequent repair of old furniture	Short term	Govern-ment Charities NGOs	Substitu-tion of new furni-ture with re-newed items
Separate collection	Waste reception centres - Awareness building for citizens to separately collect waste furniture and mattresses and deliver it to waste reception centres	Short term	Private collector	Separate waste fraction
	Extended producer responsibility for furniture and mattresses - Take-back obligation (reverse logistics)	Long term	Commerce	
Recycling/ Compost-ing	Dismantling of waste furniture for recycling - Chipping and composting of non-treated wood - Shredding or baling and exporting of metal - Shredding and extrusion to pellets of plastic component (if plastic type is identifiable) - Crushing to sand of flat glass and mirror glass	Medium term	Private	Compost Recycled metal, plastic and glass
Incinera-tion	Incineration of furniture waste not separately collected and not recycled	Phase out in long run	Govern-ment	Diversion from landfill Electricity
	Incineration of components difficult to recycle: mixed plastics, textiles, mattress stuffing, treated wood, other components	Short – medium term	Govern-ment	
Disposal	Not foreseen	To pha-se out	n.a.	Zero waste furniture

Table 46: Geographic and economic aspects of furniture recovery

Criterion	Estimation		
Local recovery	√ √	Possible	Non treated wood, glass and pure plastic components can be recycled on the islands
	X	Impossible	Metals need to be exported; mixed plastics and textile parts are to be incinerated.
Economically sustainable	√ √	Possible	For metals, non treated wood, glass and pure plastic fraction
	X	Impossible	For all fractions to be incinerated

3.6 Management of Special Waste – Hazardous Waste

3.6.1 Chemicals

Chemicals in household waste are mainly packaging of hazardous products, such as solvent based paints, glues, varnishes, motor oil containers, pesticide bottles etc. In many cases, the empty packaging still contains rests of the product. Industrial chemical wastes are not produced on the British Virgin Islands; hazardous waste from boats is not accepted.

Hazardous wastes cannot be recycled on the islands and need to be separately collected for recycling abroad. For this reason, efficient separate collection with the deposit-refund system and coverage of recycling costs by extended producer responsibility are especially important.

The table below gives an overview over alternatives for prevention, collection and final disposal of chemicals.

Table 47: Options for chemical waste prevention, collection and treatment

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	Awareness building for consumers: - Substitute hazardous products by non hazardous ones (replace solvent based paints by water based ones, pesticides by organic plant protection…) - Always properly close lids of paints to avoid drying - Always completely empty containers before discarding	Short term	Govern-ment NGOs	Reduction of chemical hazardous waste
	Awareness building for shops - Promote and advertise substitute products containing no or less hazardous components	Short term	Govern-ment NGOs	
	Prevention targets in extended producer responsibility for importers of chemical products - Financial incentives for substituting products with hazardous components by non hazardous/ less hazardous ones - Quantitative substitution targets with timeline	Medium term	Govern-ment	
Re-use	Not applicable	n.a.	n.a.	
Separate collection	Deposit-refund system for supermarkets, collection by reverse vending at retailers, drop-off at waste reception centres or material recovery facilities	Short – medium term	Commerce Recycler	Separate waste fraction
Recycling/ Compost-ing	Exporting of chemical waste (containers) for recycling - Subsidy of exports by EPR	Medium term	Private	Recycled WEEE com ponents
Incinera-tion	Incineration of chemical waste containers not separately collected and not recycled	To pha-se out	Govern-ment	Diversion from land-fill, electricity
Disposal	Not foreseen	To pha-se out	n.a.	Zero chemical waste

Table 48: Geographic and economic aspects of chemical waste recovery

Criterion	Estimation		
Local recovery	X	Impossible	Capacities for treatment of hazardous components not available

Economically sustainable	X	Impossible	Subsidies from extended producer responsibility are necessary

3.6.2 Small WEEE

The same principles apply as for WEEE (see chapter 3.5.1.)

3.6.3 Medical Waste

Medical waste is not re-usable or recyclable, but needs to be separately collected in order to avoid abuse and contamination. The table below provides a summary of the measures to be applied for medical waste.

Table 49: Medical waste prevention and disposal

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	Awareness building for consumers: - Avoid thoughtless consumption of medication, also for health reasons - Never flush old medication in the toilet - Keep expired medication separately and return it to the pharmacy	Short term	Govern-ment Doctors Pharma-cies	Reduction of medical hazardous waste
	Substitution of PVC disposable items Substitution of PVC gloves with latex ones, of PVC infusion/ transfusion bags with			
	Awareness building for pharmacies - Sell the exact amount of tablets as prescribed by the doctor, cut blisters accordingly and don't distribute large packs	Short term	Govern-ment Pharma-cies	
Re-use	Not applicable	n.a.	n.a.	
Separate collection	Medication: Reverse logistics: take-back to pharmacies	Short – medium term	Pharma-cies	Separate waste fraction
	Infectious and other hazardous waste in hospitals and private clinics - Separate collection in standardised security boxes and containers: sharps and all items come in contact with body fluids - Separate collection of chemical (laboratory reagents etc.) - Separate collection of radioactive waste (marker fluids etc.)	Ongoing Short term	Hospital Dentists Clinics Veterinary	
Recycling/ Compost-ing	Not applicable	n.a.	n.a.	Recycled WEEE com ponents
Incinera-tion	Incineration of all medical hazardous waste	Short - Medium term	Govern-ment	Electricity Eliminna-tion
Disposal	Not foreseen	To pha-se out	n.a.	Zero medical waste

Table 50: Geographic and economic aspects of medical waste treatment

Criterion	Estimation		
Local recovery	X	Impossible	Hazardous medical waste cannot be recovered
Economically sustainable	X	Impossible	To be covered by medical treatment fees

3.6.4 Batteries and Accumulators

Batteries are a minor waste stream, and hazardous components are more and more substituted with more sustainable ones. Still, all batteries contain chemical electrolytes, and especially rechargeable batteries often contain heavy metals (nickel cadmium), and need to be separately collected. Recovery of metals is another reason why this waste stream needs, at medium term, also to be covered by extended producer responsibility. The table below gives an overview over the main types of household batteries, which are generally dry-cell batteries.

Table 51: Common battery types on the market

Type	Material	Common uses
Primary (non recharge-able)	Alkaline (AlMn, most common)	Mobile music players, radios, small electrical appliances (alarm clock, toys…), smoke detector, electrical scales
	Carbon-zinc (ZnC, phasing out)	Flashlights, toys, remote control etc.
	Lithium ($LiMnO_2$, $LiFeS_2$, $LiSOCl_2$)	Cameras, calculators, watches, computers (boot battery), smart cards, security, alarm and GPS systems, long lived appliances etc.
	Mercury	Hearing aids, pacemakers
	Silveroxyde (AgO)	Hearing aids, medical devices, watches, cameras, calculators
	Zinc-air	Hearing aids, pagers
Secondary (recharge-able)	Nickel-cadmium (NiCd, phasing out)	Cameras, portable power tools, handheld household appliances, drones...
	Nickel Zinc (NiZn)	
	Nickel metal hydride (NiMH)	
	Small sealed lead-acid	Camcorders, computers, portable radios and music player, cell phones, appliance starters

Combustion motor vehicles function with lead acid electrolytes, which are completely recyclable. A typical lead-acid battery contains up to 80 % recycled lead and plastic.

The current standard for batteries of electrical vehicles are lithium ion batteries, which have a weight of several hundred kg per vehicle. Raw material used for these batteries is rare and expensive (lithium, nickel, cobalt and copper), and its production has a high environmental footprint. Recycling technologies for electro-vehicle batteries are still in development, but quickly upscaling.

Table 52: Options for battery and accumulator waste prevention, collection and treatment

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	Awareness building for consumers: - Promote products with solar rechargeable batteries or equivalent: good rechargeable accumulators can be recharged up to 1000 times (and thus replace 1000 common batteries)	Short term	Govern-ment NGOs	Reduction of battery and accumula-tor waste Substitu-tion of hazardous compon-ents
	Progressive BAN of heavy metal containing and single-use batteries Start with a ban of mercury containing and NiCd batteries and proceed successively to banning heavy metal containing accumulators and single use batteries	Medium term	Govern-ment	
	Awareness building for shops - Promote and advertise products with rechargeable batteries	Short term	Govern-ment NGOs	

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
	Prevention targets in extended producer responsibility for batteries and products containing batteries - Quantitative heavy metal substitution targets with timeline - Quantitative targets for % of rechargeable batteries with timeline - Obligation to send electric car batteries to recyclers guaranteeing high recyclig ratio (> 95 %) and low CO_2 emissions	Medium term	Govern-ment	
Re-use	Awareness building for re-use Replace new batteries in appliances with low consumption (no mechanical movements, no light or sound; e.g., remote control) with used ones from high consumption appliances	Short – medium term	Govern-ment NGOs	Replace new with old batteries
Separate collection	Deposit-refund system for supermarkets, collection by reverse vending at retailers, garages and motor/ boat shops, drop-off at waste reception centres or material recovery facilities	Short – medium term	Commerce Garages Motor shop Recycler	Separate waste fraction
Recycling/ Compost-ing	Exporting for recycling Subsidy of exports by EPR for: - household batteries and accumulators - lead-acid accumulators used for vehicles with combustion motor - Lithium ion accumulators used for electrical vehicles	Medium term	Private	Recycled metals, electroly-tes and plastics
Incinera-tion	Incineration of not separately collected batteries and accumulators	To pha-se out	Govern-ment	Diversion from land-fill, electricity
Disposal	Not foreseen	To pha-se out	n.a.	Zero accu + battery waste

Table 53: Geographic and economic aspects of chemical waste recovery

Criterion	Estimation		
Local recovery	X	Impossible	Capacities for dismantling and treatment of hazardous components not available
Economically sustainable	X	Impossible	Subsidies from extended producer responsibility are necessary

3.6.5 Oil and Lubricants

Similar to edible oil, motor oil and lubricants are still often discharged together with wastewater, which constitutes an important problem for sewage maintenance and wastewater treatment. Motor oil and lubricants are 100 % recyclable and can be refined into combustible if separately collected.

Table 54: Alternatives for prevention and treatment of waste oil and lubricants oil

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	Awareness building for vehicle users - reduce oil consumption by avoiding overdynamic driving of new cars - prefer vehicles with low number of cylinders - regular control of oil level to detect overconsumption in time - use quality motor oil - regular technical control to avoid overconsumption due to technical problems	Short term	Govern-ment NGOs Garages	Reduction of oil and lubricants consump-tion
Re-use	Not applicable	n.a.	n.a.	
Collection	Waste reception centres	Short	Citizens	Clean

Waste hierarchy	Options	Timing	Responsibility	Expected result
	- Awareness building for citizens to separately collect waste oil and deliver it to waste reception centres - Obligatory separation at the source for motor shops, garages, marinas, gas stations...	term	Gastronomy Recycler	waste stream
	Door-to-door collection by recycler - Agreement between motor shop/ garage/ marina/ gas station and private recycler for regular door-to-door collection of separately collected waste edible oil	Short term	Gastronomy Recycler	
	Obligatory grease trap - All workshops and gas stations where motor oil is changed or motors are repaired/ changed to install grease traps for separation of waste oil and grease from grey water. - Monthly emptying and maintenance by private service provider	Short term	Gastronomy Recycler Technician	Substitute combustible
Recycling/ Composting	Exporting for refinery Refinery of used motor oil and lubricants in St. Croix or any other refinery	Short term	Recycler	Substitute combustible
Incineration	Incineration of waste from grease trap and waste oil not separately collected	Phase out at long term	Government	Landfill diversion Electricity
Final disposal	Final disposal of waste oil in landfill	To phase out	n.a.	Zero waste oil

Table 55: Geographic and economic aspects of waste oil and lubricants recovery

Criterion	Estimation		
Local recovery	X	Impossible	Too small scale for investment into refinery
Economically sustainable	?	Possible	To be negotiated with refinery

3.7 Management of Special Waste – Other Waste Streams

3.7.1 End of Life Vehicles Including Tyres

End-of-life vehicles are an important waste stream in the British Virgin Islands. Although a part of ELV can be locally dismantled, shredded and recycled or incinerated, it is not realistic to expect full scale ELV recycling on the British Virgin Islands. Given the high costs of dismantling and freight, ELV recycling will need extended producer responsibility subsidies to become feasible.

Options for prevention, collection and treatment of end-of-life vehicles are listed in the table below. For accumulators of combustion motor and electrical vehicles, see Table 54, chapter 3.6.4.

Table 56: Options for ELV prevention, collection and treatment

Waste hierarchy	Options	Timing	Responsibility	Expected result
Prevention	Awareness building for consumers: - Promotion of car sharing and active mode transport - Promotion of smaller and less resource intensive cars - Reduction of car number per family	Short term	Government NGOs	Reduction of WEEE
	Development of national transport policy and horizontal integration of SWM principles	Long – vry long	Government	

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
	- Transition to solar powered electromobility, promotion and financial incentives - Introduction and promotion of public transport including cable railway to the hills	term	NGOs	
	Extended producer responsibility for ELV - Obligation to inform on sustainability, recycled material content, easy repair/ dismantling/ recycling, environmental footprint of the product etc.	Medium – long term	Govern-ment	
	Prevention targets in extended producer responsibility for vehicle importers - Financial incentives for substituting non recyclable/ non repairable components with long lived, quality products - Financial incentives for eco-design	Medium term	Govern-ment	
Re-use	Capacity building for professional garages and workshops - Promotion of professional education as car/ truck technician (repair and maintenance of motors, car electricity and electronics, chassis etc.)	Short term	Govern-ment Garages	Improved professio-nal repair capacity
Separate collection	Deposit- refund system - Introduction of a deposit sufficient to guarantee that vehicle owners deliver their old car to a recycler in order to get it back	Short term	Govern-ment	Orderly ELV collection
Recycling/ Compost-ing	Dismantling, shredding and exporting of WEEE for recycling - Subsidy of exports by EPR applied to vehicle importers	Medium term	Private	Recycled ELV com ponents
	Crushing of windowpane glass and mirrors Flat glass can be crushed to aggregate or sand in order to be used in the construction industry	Medium term	Private	Aggregate Sand
	Recovery of (a part of) waste tyres to produce rubber granulate Dismantling and separation of metal wire in waste tyres in order to produce rubber granulate for sports facilities and similar purposes	Medium term	Private recycler	Rubber granulate
Incinera-tion	Incineration of non hazardous, non recyclable, combustible ELV fractions in order to compensate for capacity loss at the incinerator	Phase out in long run	Govern-ment	Landfill diversion Electricity
Disposal	Not foreseen	To pha-se out	n.a.	Zero ELV waste

Table 57: Geographic and economic aspects of ELV recovery

Criterion	Estimation		
Local recovery	√	Possible	Pre-conditioning (dismantling and shredding) is possible to reduce freight costs and increase the value of the different fractions. Tyre recycling is possible at small scale. Glass can be locally recycled.
	X	Impossible	Metals and hazardous components need to be exported; mixed plastics and textile parts are to be incinerated. Tyres exceeding the demand for rubber granulate can be shredded and exported as substitute fuel for cement factories.
Economically sustainable	√ √	Possible	For metals, tyres and glass
	X	Impossible	For all fractions to be incinerated

3.7.2 End of Life Boats and Planes

End-of-life boats can be treated similarly to end-of-life vehicles. The logic for dismantling, recycling and disposal and the economic aspects are comparable. Given the high costs of dismantling and freight, ELB recycling will need extended producer responsibility subsidies to become feasible. Register of boat owners and vessels entering the BVI for a short period is a special challenge.

Although the number of aircraft registered and operated on the British Virgin Islands is very small, it is recommended to subject end-of-life planes to the same rules and the same recovery system as end-of-life boats, in order to avoid being confronted with a new waste problem in some years.

Options for prevention, collection and treatment of end-of-life vehicles are listed in the table below.

Table 58: Options for ELB&P prevention, collection and treatment

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	Awareness building for boat and plane owners: - Promotion of boat and plane sharing/ leasing/ renting instead of owning - Promotion of smaller and less resource intensive boats/ planes	Short term	Govern-ment NGOs	Reduction of WEEE
	Extended producer responsibility for ELB&P - Obligation to inform on sustainability, recycled material content, easy repair/ dismantling/ recycling, environmental footprint of the product etc.	Medium – long term	Govern-ment	
	Prevention targets in extended producer responsibility for boat and plane importers - Financial incentives for substituting hazardous/ non recyclable/ non repairable components with long lived, quality products - Financial incentives for eco-design	Very long term	Govern-ment	
Re-use	Capacity building for marinas, boat and plane workshops - Promotion of professional education as motorboat/ sailing boat/ small aircraft (repair and maintenance of motors, electrical and electronic components, fibre glass rumps etc.)	Short term	Govern-ment Garages	Improved professio-nal repair capacity
Collection	Deposit- refund system - Introduction of a deposit sufficient to guarantee that vessel owners deliver their old boat/ aircraft to a recycler in order to get the deposit back	Short - medium term	Govern-ment	Orderly ELP&B collection No more derelict cars and boats
	Obligatory registration and insurance Obligation for ship and aircraft owners to get their vessel registered and licensed in order to identify owners of abandoned vessels; obligatory insurance to cover costs of collection and recycling of wrecks	Short – medium term	Govern-ment	
Recycling/ Compost-ing	Dismantling, shredding and exporting of ELB&P for recycling - Subsidy of exports by EPR applied to vessel importers	Medium term	Private	Recycled ELB/P com ponents
	Use of old sails to manufacture handicraft items Small scale manufacture of bags etc. out of old sails	Ongoing	Private	New cloth products
	Recovery of untreated wood Chipping and composting or handicraft manufacture of wooden utensils, plates or toys	Short – medium term	NGO Private Protected workshop	Compost Wooden products
	Crushing of windowpane glass and mirrors Flat glass can be crushed to aggregate or sand in order to be used in the construction industry	Medium term	Private	Aggregate Sand
Incinera-tion	Incineration of shredded fibre glass and other non hazardous, non recyclable, combustible ELB&P fractions in order to compensate for capacity loss at the incinerator	Phase out in long run	Govern-ment	Landfill diversion Electricity
Disposal	Not foreseen	To pha-se out	n.a.	Zero ELB/ &P waste

Table 59: Geographic and economic aspects of ELB&P recovery

Criterion	Estimation		
Local recovery	√	Possible	Pre-conditioning (dismantling and shredding) is possible to reduce freight costs and increase the value of the different fractions. Wood and sail recycling is possible at small scale. Glass recycling for construction sector.
	X	Impossible	Metals and hazardous components need to be exported; fibre glass, mixed plastics and textile parts are to be incinerated.
Economically sustainable	√ √	Possible	For metals and glass
	X	Impossible	For all fractions to be incinerated

3.7.3 Construction and Demolition Waste

Construction and demolition waste is an important part of overall waste generation in the British Virgin Islands. These wastes are nearly 100 % recyclable, and even if there is only very few hazardous waste among C&D waste, they are very space demanding. Local quarries are in search of affordable substitutes for aggregate and sand; recycling of construction and demolition waste is both an economically and environmentally sound solution.

The table below gives an overview over options for prevention, re-use, recovery and disposal of construction and demolition waste.

Table 60: Options for construction and demolition waste prevention, re-use, recovery and disposal

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Preven-tion	Awareness building for house owners/ builders: - Promotion of hurricane resistant construction schemes and materials - Promotion of long lived materials with a low environmental footprint - Promotion of biodegradable, solvent and pesticides free wood preservation/ varnish/ paints	Short term	Govern-ment NGOs	Reduction of WEEE
	Obligations for construction companies - Design of buildings for easy deconstruction - Substitution of hazardous materials with sustainable alternatives	Short – medium term	Govern-ment	
Re-use	Promotion of second-hand material exchange - Re-use of deconstructed material (tiles, doors, frames…) for repair and construction of other buildings - Sales of vintage or valuable components - Promotion of professional training in sustainable construction	Short term	Govern-ment Construc-tion companies	Replace new with old com-ponents
Collection	Obligatory segregation during repair and deconstruction - Obligation for construction companies to separate recyclable fractions and re-usable items during repair, rehabilitation or deconstruction works	Short - medium term	Govern-ment	Separate waste fractions
Recycling/ Compost-ing	Crushing of C&D waste to aggregate - Crushing of bricks, tiles and concrete waste to aggregate, which will be used by local construction industry	Medium term	Private recyclers	Aggregate
	Crushing of glass to sand or aggregate - Crushing of window and mirror glass to sand or aggregate, which will be used by local construction industry	Medium term	Private recyclers	Sand and aggregate
	Shredding and export of metal and plastic Metal beams etc. can be cut and shredded in the ELV/ ELB shredder in order to reduce costs for exporting; pure plastics can be shredded and granulated for export	Short - medium term	Private recyclers	Recycled Fe and plastics
	Export of hazardous components for recycling abroad	Short -	Construc-	Recycled

Waste hierarchy	Options	Timing	Responsibility	Expected result
	Hazardous construction wastes for which no local recycling capacities are existing, need to be exported for recycling; the cost needs to be covered by the rehabilitation or deconstruction contract.	medium term	tion companies	fractions
	Recovery of untreated wood Chipping and composting or handicraft manufacture of wooden utensils, plates or toys	Short – medium term	NGO Private Protected workshop	Compost Wooden products
Incineration	Incineration of non recyclable, non hazardous construction waste (treated wood, roofing, mixed plastics...)	Phase out in long run	Government	Landfill diversion Electricity
Disposal	Use of crushed concrete as cover material in the new landfill	Medium term	Government	Zero C&D waste
	Asbestos waste to be landfilled without crushing	To phase out	Government	

Table 61: Geographic and economic aspects of construction and demolition waste recovery

Criterion	Estimation		
Local recovery	√ √	Possible	Deconstruction, crushing/ shredding and pre-conditioning is possible
	X	Impossible	Hazardous components, metals and plastic pellets need to be exported; treated wood, roofing and mixed plastics are to be incinerated.
Economically sustainable	√ √ √	Possible	For metals, concrete, tiles, bricks, pure plastics and glass
	X	Impossible	For all fractions to be incinerated

3.7.4 Incinerator residues

Incineration of solid waste produces a number of waste fractions, most of which being recyclable. Typical incinerator residues are:

Table 62: Typical composition of incinerator residues

Component	Proportion
Slag and ash	78.0%
Filter dust	5.0%
Gypsum	1.0%
30 % Hcl	4.5%
Fe metal	11.5%

The table below gives an overview over prevention, recovery and disposal of incinerator residues.

Table 63: Options for prevention, recovery and disposal of incinerator residues

Waste hierarchy	Options	Timing	Responsibility	Expected result
Prevention	Optimisation of incineration parameters: - Continuous incineration with homogeneous waste input (quantity and calorific value) - Good maintenance and operation of incinerator - Control of incoming waste	Short – medium term	Government Private operator (possibly)	Reduction of residues

Waste hierarchy	Options	Timing	Responsi-bility	Expected result
Re-use	Not applicable	n.a.	n.a.	
Recycling	Crushing of slag to aggregate - Crushing of slag to aggregate, which will be used by local construction industry	Medium term	Govern-ment or private operator	Aggregate
	Sales of gypsum - Sales of gypsum to local construction industry	Medium term		Gypsum
	Exporting of HCl and recovered metal	Medium term		Recycled Fe and HCl
	Export of filter ash for cement industries Filter ash to substitute pozzolane input material for cement industry	Short - medium term		Recycled fractions
Incinera-tion	Not applicable	n.a.	n.a.	
Disposal	Landfilling of ash and of filter dust (if export is not possible)	Medium term	Govern-ment	

Table 64: Geographic and economic aspects of incinerator waste recovery

Criterion	Estimation		
Local recovery	√ √	Possible	Crushing of slag to aggregate, production of gypsum and HCl
	X	Impossible	HCl, recovered metals and filter dust need to be exported for recycling
Economically sustainable	X	Impossible	

4 Waste Flow Scenarios According to the Materials Management Plan

The figures on the following pages provide waste flow scenarios for the 1st, 6th and last year of strategy implementation. Future recovery options for waste streams that are currently not recyclable have not been taken into consideration. If these options become feasible, incineration of waste might be reduced and phased out at an earlier stage.

1st year: Separate collection and ban of certain materials have recently started. The old incinerator is rehabilitated, the waste reception centres, worm composting facility and material recovery facility are operational. The sanitary landfill is in operation.

Special waste processing facilities are not yet operational; landfill mining has not started. Waste from Virgin Gorda and Anegada is not yet shipped over to Tortola.

6th year: Separate collection and ban of certain materials are working well. The worm composting facility has nearly doubled its capacity. A new, state-of-the-art incinerator is operational, as well as ELV/ ELB treatment, edible oil treatment and other special waste treatment. The incinerator takes in non recyclable, non biodegradable waste from all islands.

Landfill mining has started, but combustible waste is not yet transferred to the incinerator.

20th year: Separate collection and ban are working well and have reached a stable peak. The capacity of worm composting, recycling and special waste treatment facilities keep track with the slow increase of waste generation. The input to the incinerator has considerably decreased and is compensated with waste from landfill mining. Landfill mining in Tortola is exhausted; waste from Virgin Gorda landfill mining is still shipped to the incinerator.

Figure 10: Waste flow scenario for the first year of strategy implementation

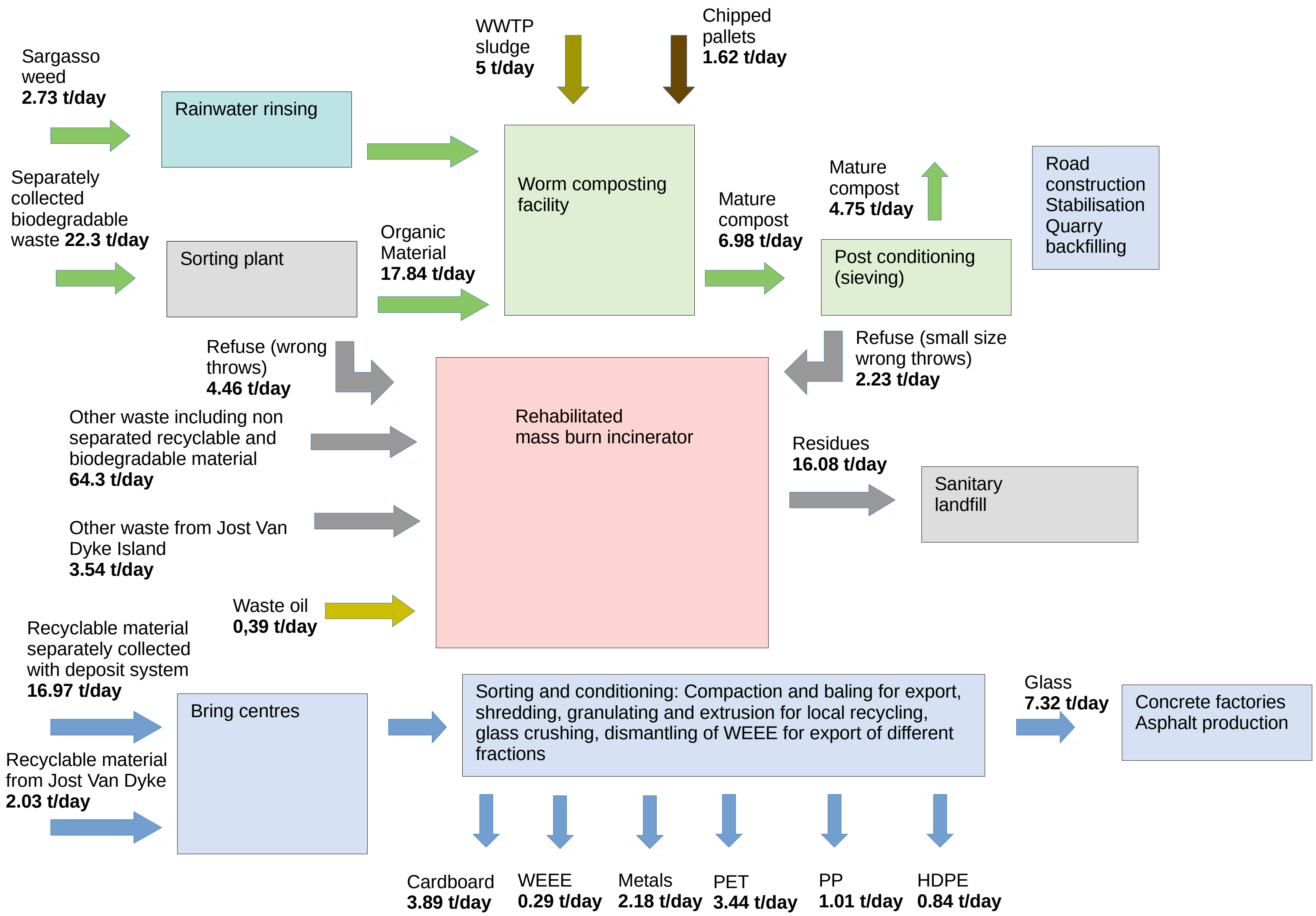


Figure 11: Waste flow scenario for the 6th year of strategy implementation

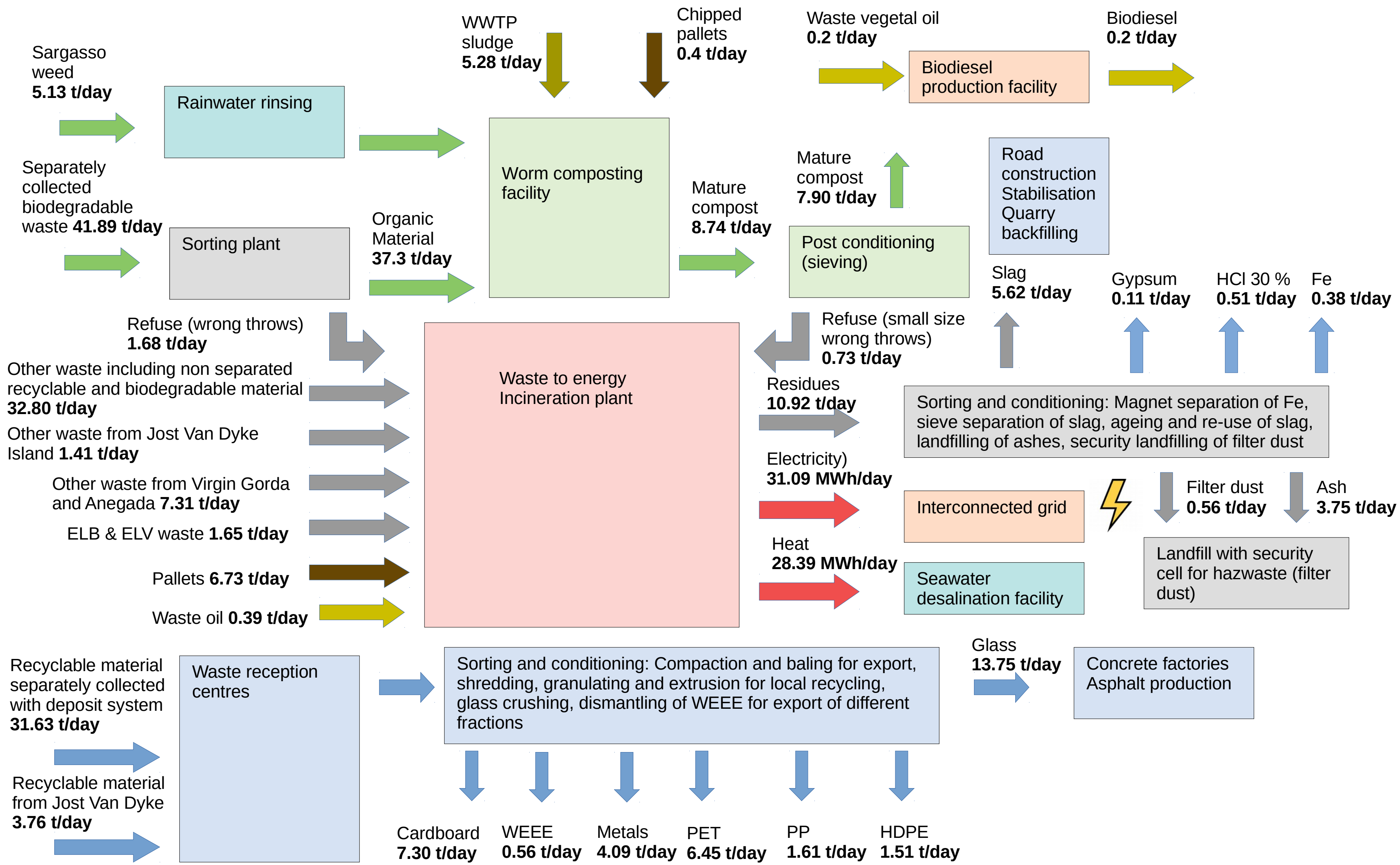
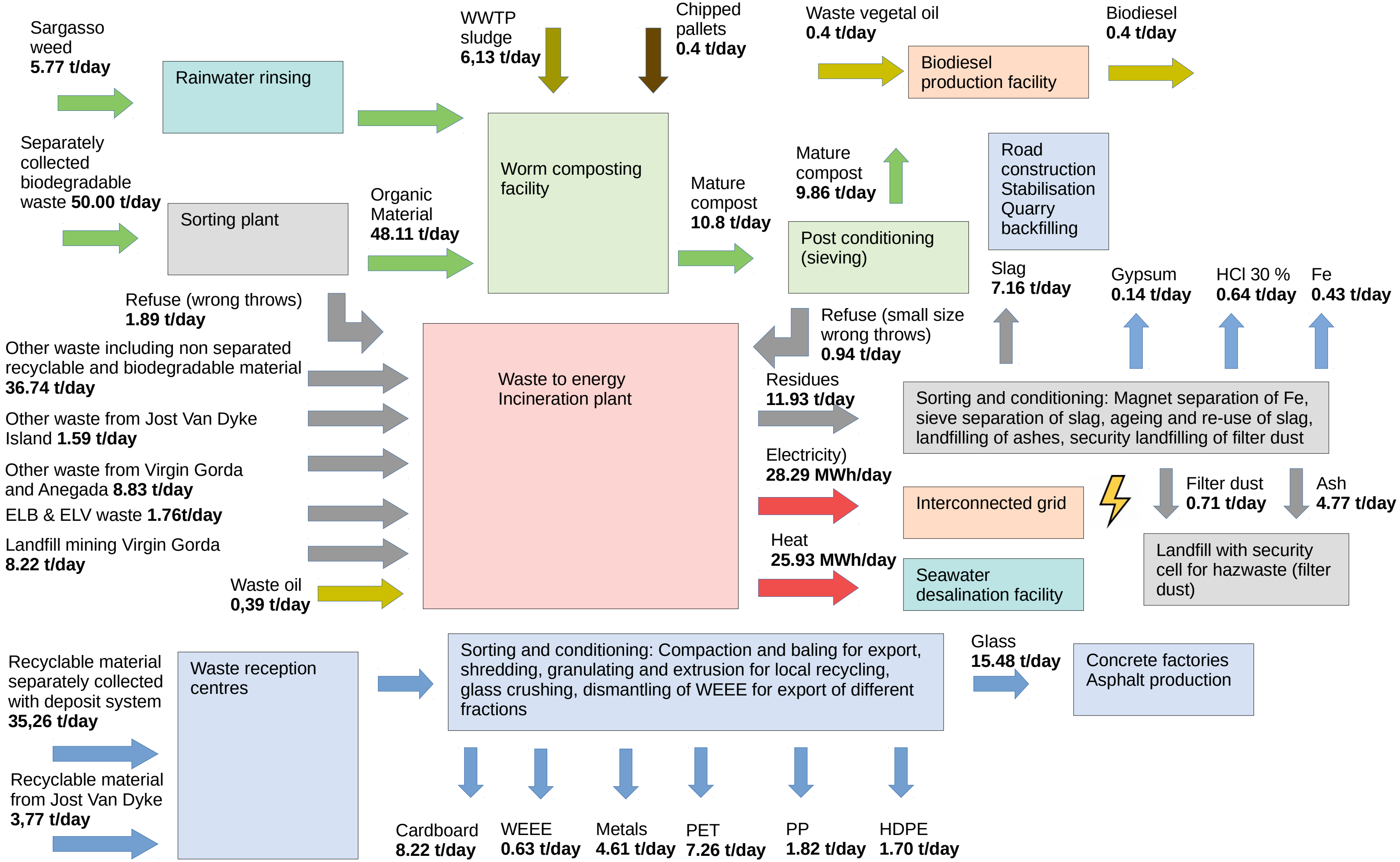


Figure 12: Waste flow scenario for 20th year of strategy implementation



DEPARTMENT OF
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WASTE MANAGEMENT

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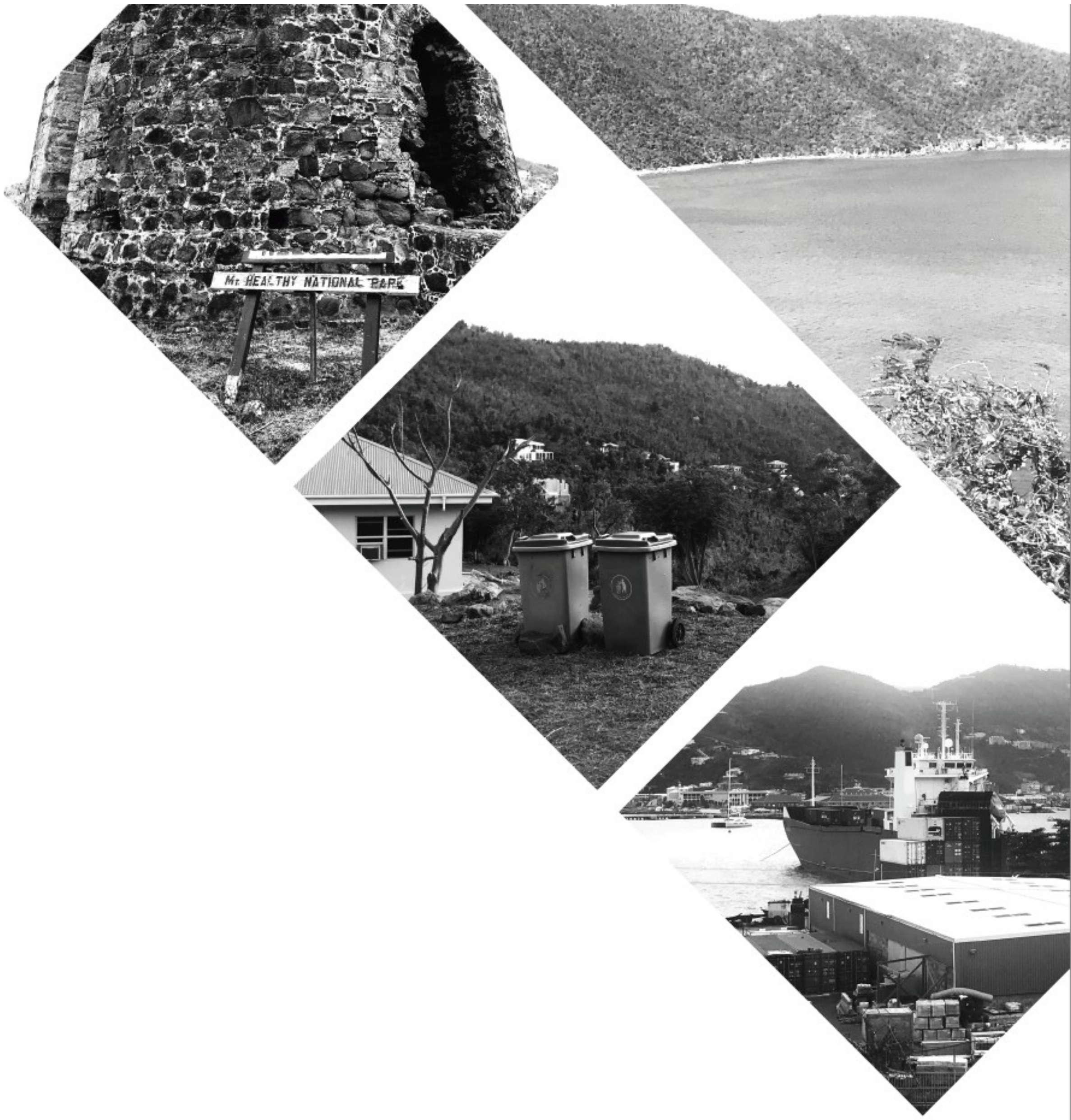

FINAL REPORT

DRAFT VERSION

SEPTEMBER 2019

Waste Management Strategy for the British Virgin Islands

RED
Agency for Resilience, Empowerment and Development

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The views expressed in this document are entirely those of the authors and do not necessarily represent the MHSD own views or policies.

First Published [July, 2019]

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LIST OF ABBREVIATIONS

BA	Building Authority
BVI	British Virgin Islands
BVIG	British Virgin Islands Government
DDM	Department of Disaster Management
DEH	Department of Environmental Health
DFID	UK Department for International Development
DWM	Department of Waste Management
DRR	Disaster Risk Reduction
DR	District Representative
ELV	E nd of Life Vehicles
FTE	Full-Time Employee
H&S	Health & Safety
IR	Inception Report
JVD	Jost Van Dyke
MCW	Ministry of Communications and Works
MHSD	Ministry of Health & Social Development
MNRL	Ministry of Natural Resources and Labour
NEOC	National Emergency Operations Centre
PA	Planning Authority
QS	Quantity Surveyor
THIRA	Territorial Hazard Identification and Risk Assessment
TCPD	Town and Country Planning Department
ToR	Terms of References
PWD	Public Works Department
RDA	Recovery and Development Agency
SWM	Solid Waste Management
USD	US Dollars
USVI	US Virgin Islands
VI	Virgin Islands
VG	Virgin Gorda
WEE	Waste Electrical and Electronic Equipment

1 Introduction

The present draft strategy for integrated solid waste management has been elaborated in order to update the British Virgin Islands' Solid Waste Management Strategy of 2013 in view of incorporating lessons learned from Hurricane Irma and increase the resilience of the solid waste management system against natural disasters.

The text presented hereinafter provides an analysis of the current situation and lays out the general principles, approach, objectives and targets of the solid waste management strategy. The Action Plan and Materials Management Plan are stand-alone annexes, which give more detail on the rationale, nature and extent of each measure, and on the different options to implement the waste hierarchy for each relevant waste stream. Legal measures are formulated in the Draft Waste Act. An investment plan covering investments, re-investments and operational costs over the 20 years of strategy implementation is equally provided as a separate excel annex.

2 Context

2.1 Description of the British Virgin Islands

The British Virgin Islands (BVI), officially simply the Virgin Islands,[are a British Overseas Territory in the Caribbean, to the east of Puerto Rico. The islands are geographically part of the Virgin Islands archipelago and are located in the Leeward Islands of the Lesser Antilles.

The British Virgin Islands consist of the main islands of Tortola, Virgin Gorda, Anegada, and Jost Van Dyke, along with over 50 other smaller islands and cays. About 15 of the islands are inhabited. The capital, Road Town, is on Tortola, the largest island, which is about 20 km long and 5 km wide. The islands had a population of about 28,000 at the 2010 Census, of whom approximately 23,500 lived on Tortola. For the islands, the latest United Nations estimate (2016) is 30,661.

The map below shows the four main islands and the larger cays[1].

1 Source: https://en.wikipedia.org/wiki/British_Virgin_Islands

Figure 1: Map of the British Virgin Islands

British Virgin Islanders are British Overseas Territories citizens and since 2002 are British citizens as well. Although the territory is not part of the European Union and not directly subject to EU law, British Virgin Islanders are deemed to be citizens of the EU by virtue of their British citizenship[2].

The economy of the British Virgin Islands mainly relies on financial services and tourism, which represent 51,8 % respectively 45 % of national income. Agriculture, fishery and industry account only for a small proportion of the islands' economy. Despite some fruit, vegetables and sugar cane cultivation and livestock and poultry farming, most food is imported.

Among the Caribbean countries, the British Virgin Islands are with an annual per capita income of 42,300 US$ one of the wealthier countries.

The islands have some small rum distillation, construction and boat building industry. The most important part of industrial products is imported. The following table provides an overview over imports to the British Virgin Islands:

2 Quoted from: https://en.wikipedia.org/wiki/British_Virgin_Islands

Table 1: Cargo tonnage - imports to the British Virgin Islands

Year	General Break Bulk	Containerized	Cement	Vehicles	Fuel	Sand/Gravel	Total
2000	16,443	53,624	29,666	1,779	7,366	20,228	**129,106**
2001	15,079	56,619	13,180	2,046	-1,290	22,902	**108,535**
2002	16,500	58,029	20,045	2,027	0	39,325	**135,926**
2003	18,505	64,514	23,892	2,562	-5,897	34,915	**138,490**
2004	21,012	77,329	7,834	3,323	548	31,898	**141,944**
2005	24,400	66,314	37,281	3,217	9,388	18,389	**158,989**
2006	28,626	65,608	28,567	3,216	9,947	29,608	**165,571**
2007	25,217	62,111	30,140	3,733	9,953	35,500	**166,654**
2008	27,798	66,101	13,845	3,099	5,516	15,000	**131,359**
2009	18,948	62,780	23,343	2,049	5,558	26,700	**139,379**
2010	17,345	60,617	25,019	2,266	4,818	15,163	**125,227**
2011	15,456	58,445	30,783	1,746	3,872	15,800	**126,102**
2012	13,180	53,689	22,809	1,811	3,718	15,350	**110,557**
2013	12,295	53,362	13,532	1,790	5,469	9,228	**95,676**
2014	19,884	62,395	15,252	2,040	36,803	26,000	**162,374**
2015	17,269	71,604	23,243	3,637	105,219	57,220	**278,191**
2016	17,114	67,385	16,749	4,100	0	110,508	**215,856**
2017	11,234	65,462	14,675	2,975	78,273	18,600	**191,219**

Containerised imports are mainly consumer goods; the main other imports are, as the table shows, cement, sand and gravel for the construction industry, fuel and vehicles. The British Virgin Islands import annually goods for approximately 200 million US$; exports are estimated to be around 23 million US$[3].

2.1.1 Climate of the British Virgin Islands

The climate of the British Virgin Islands is tropical, with little temperature variations over the year. Rainfall is less during the winter months and more important from April to December. Climate patterns have changed over the years, probably due to climate change impact. Both average monthly rainfall and temperature have increased.

The figures below shows the average monthly rainfall and temperature for the first decade of the last century and the decade between 2007 – 2016[4].

3 Source: https://www.indexmundi.com/british_virgin_islands/economy_profile.html
4 Source of data: https://climateknowledgeportal.worldbank.org/download-data

Figure 2: Average precipitation in the British Virgin Islands

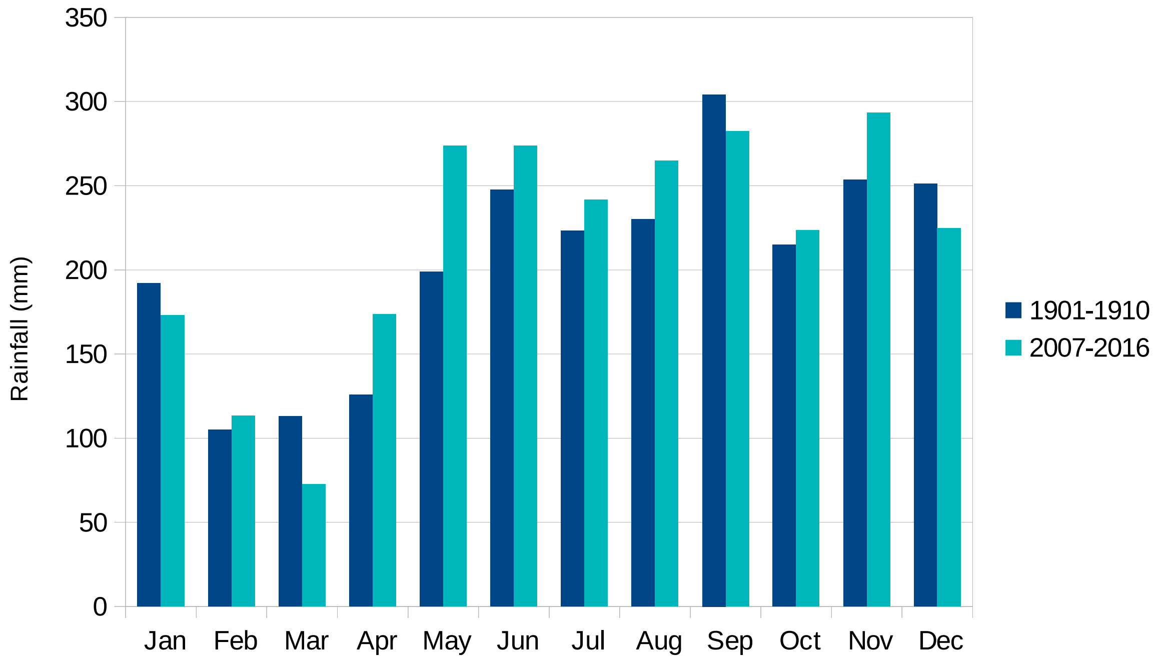
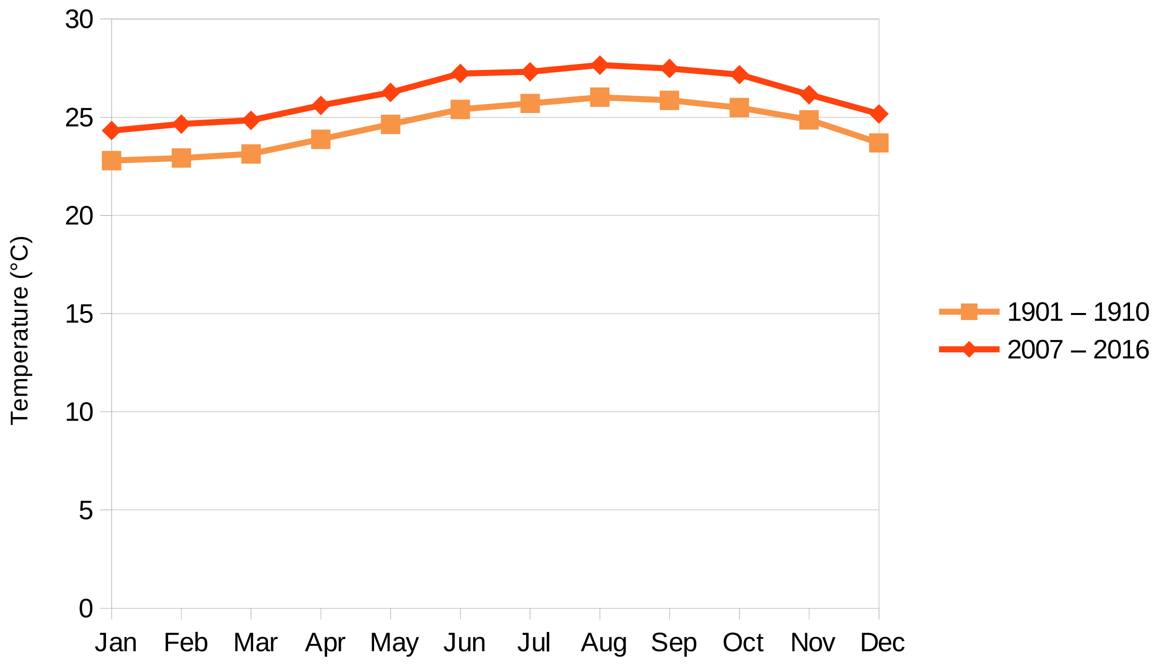


Figure 3: Average temperature averages in the British Virgin Islands



Average temperature between 1901 – 1910 has increased by 1.65 °C from an average of 24.5 °C between 1901 – 1910 to 26.15°C between 2007 – 2016.

The British Virgin Islands are in a high hurricane risk region and have repetitively been affected by hurricanes, the last and most devastating of which being Hurricane Irma in

2017. The table below provides a list of hurricanes touching the British Virgin Islands in the last decades.

Table 2: Hurricanes affecting the British Virgin Islands[5]

Date	Storm	Category	Wind speed (km/h)
August 1955	Hurricane Connie	4	220
August 1960	Hurricane Donna	4	230
29 August 1979	Hurricane David	5	280
4 September 1979	Hurricane Frederic	4	215
18 September 1989	Hurricane Hugo	5	260
19 August 1995	Hurricane Iris	2	175
6 September 1995	Hurricane Marilyn	3	185
8 July 1996	Hurricane Bertha	3	185
21 September 1998	Hurricane Georges	4	250
17 November 1999	Hurricane Lenny	4	250
22 August 2000	Hurricane Debby	1	140
16 October 2008	Hurricane Omar	4	215
29 August 2010	Hurricane Earl	4	230
8 October 2010	Hurricane Otto	1	140
13 August 2014	Hurricane Gonzalo	4	230
6 September 2017	Hurricane Irma	5	285
20 September 2017	Hurricane Maria	5	280

Here again, we observe an increase in the frequency of hurricanes in the last years, especially in the decade from 2010 – 2019, which is an indicator of the islands' increasing vulnerability to climate change:

Table 3: Increase in hurricane frequency and intensity

Decade	No. of hurricanes touching the British Virgin Islands	
	All hurricanes	Hurricanes category 4 and 5
1950 - 1959	1	1
1960 - 1969	1	1
1970 - 1979	2	2
1980 - 1989	1	1
1990 - 1999	5	2
2000 - 2009	2	1
2010 - 2019	5	4

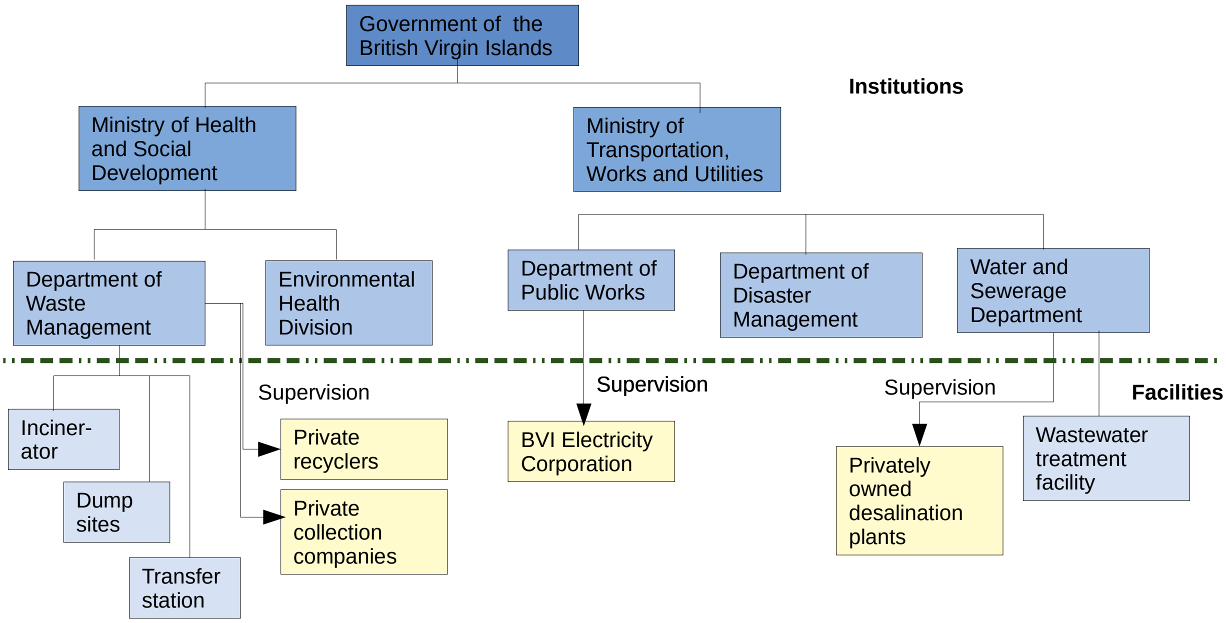
5 Source: An Environmental Profile of the Island of Tortola, British Virgin Islands,Island Resources Foundation, 2015 and: https://www.aoml.noaa.gov/hrd/hurdat/tracks-at-2018.png (2014 – 2018 data)

2.2 Solid Waste Management in the British Virgin Islands

2.2.1 Institutions and Responsibilities

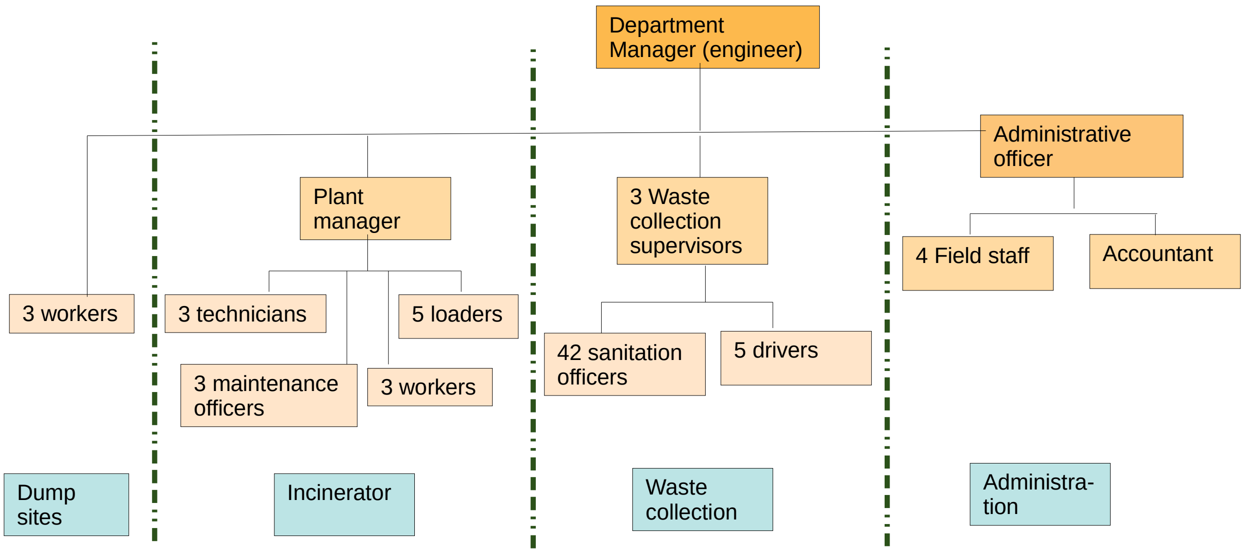
In the British Virgin Islands, solid waste management is under the responsibility of the Department of Waste Management, which is governed by Ministry of Health and Social Development. The chart below gives an overview over the governmental authorities responsible for environment, energy, water and disaster management and the facilities supervised by these authorities.

Figure 4: British Virgin Islands - Ministries and Departments related to environment



The Department of Waste Management counts with an overall staff of 74, 42 of which being sanitation officers responsible for the supervision of waste collection and litter prevention. 17 people are currently working at the incinerator and on the dump sites, 7 employees are office staff. The figure below gives an overview over the structure of the Department.

Figure 5: Staffing of Department of Waste Management



Although there is a clear distribution of responsibilities within the Department of Waste Management, no specialised units are established yet. Plant manager and collection supervisors are qualified workers, no engineers or equivalent specialists.

2.2.2 Legislation

Formal legislative authority to administer collection and disposal of garbage in the territory remains vested in the Chief Medical Officer, or any person duly appointed by him, pursuant to the **Public Health Ordinance** 1969 as revised 1977.[6] Despite solid waste management growing from a unit within the Public Health Department, to a division in 1987, and finally, upon commissioning the incinerator, to a full-fledged Department in 1995 reporting directly to the Minister, legislation has not been updated to reflect its present status.

Legislative provisions affecting waste management activities (policy objectives, administration, operations, environmental protection, licencing, polluter pays & financing, liability for wastes or lack thereof, education, offences and penalties) are spread across 11 departments and statutory boards in 5 Ministries.

The tables below list the different legislation, policy instruments and international treaties in the area of solid waste management.

Table 4: BVI legislation in the area of solid waste management

Direct	Indirect
Public Health Act 1977 and Public Health Regulations 1971	Constitution 2007 -Right to a healthy environment
Litter Abatement Act 1987 as amended	Planning Act 2004 and Building Regulations 1999 -Requirement for EIA and sanitary landfill
Derelict Vehicle Act 2000 and Regulations 2002	Trade Licence Act
	Criminal Code 1994
	Environmental Improvement and Tourism Levy Fund Act 2017

6 Public Health Act, Cap 194 of the Laws of the Virgin Islands.

Table 5: National policy instruments

Direct	Indirect
2019 MOU between Ministry of Health & Green VI	BVI Recovery & Development Plan 2018
	National Physical Development Plan 2019 (Draft)

Table 6: Binding international treaties

Direct	Indirect
European Convention Human Rights[7]	-
Vienna Convention for the Protection of the Ozone Layer (1985) and Montreal Protocol on Substances that deplete the Ozone Layer (1987)	

Table 7: International policy statements

Direct	Indirect
Agenda 21	
St. Georges Declaration	
UK-BVI Environment Charter	
Agenda 2030 – Sustainable Development Goals	

Existing solid-waste legislation is extremely outdated, fragmentary and provides insufficient regulation of waste management activities. The overarching legal framework for environmental protection, within which solid-waste management operates, is presently inadequate, and leaves BVI unable to deliver fully on international obligations and policies. There is a culture of partial compliance, lack of enforcement, and a growing risk of public interest environmental litigation.

2.2.3 Waste Generation and Composition

2.2.3.1 Waste Generation

Although the waste treatment and disposal site at Pockwood Pond is equipped with a weighbridge, no reliable registers are available from 2016 onwards. For this reason, waste generation data has been taken from the annual report issued in 2015 by the Department of Waste Management and has been extrapolated for 2019, taking into account demographic and economic development.

In summary, waste generation is as follows:

Table 8: Main waste streams in the British Virgin Islands

Type of waste	Unit	Tortola	Virgin Gorda	Jost Van Dyke	Anegada
Household waste	tonnes/year	35,320	8,662	2,217	1,489
	tonnes/day	112.86	27.69	7.09	4.76
Other wastes		**All islands**			
Pallets	units/day	435	End-of-life boats	units/year	30
	tonnes/day	9,36		tonnes/day	0,92
End-of-life vehicles	units/day	754	Construction waste	tonnes/year	6,257
	tonnes/day	3.31		tonnes/day	17.14

7 The European Convention on Human Rights was extended to the BVI in September 2009. Until Brexit takes effect, persons within the BVI have the right of individual petition to the EU court to bring a case against the UK Government.

In addition to the waste continuously generated, car and boat wrecks, building ruins and rubble produced by the Hurricane Irma are still present on the British Virgin Islands. Exact numbers are not known. Estimated quantities of end-of-life vehicles and boats are as follows:

- 700 derelict cars
- 200 derelict boats

2.2.3.2 Waste Composition

A two season waste characterisation campaign is being carried out in order to obtain the necessary data on waste composition in the British Virgin Islands. The first campaign took place from 08 – 18 February 2019 and covered the islands of Tortola, Jost Van Dyke, Virgin Gorda and Anegada; the second campaign was organised 17 – 25 June 2019 on Tortola and Jost Van Dyke. The first waste characterisation corresponded to the high touristic season from November to April, the second to the low touristic season from May to October.

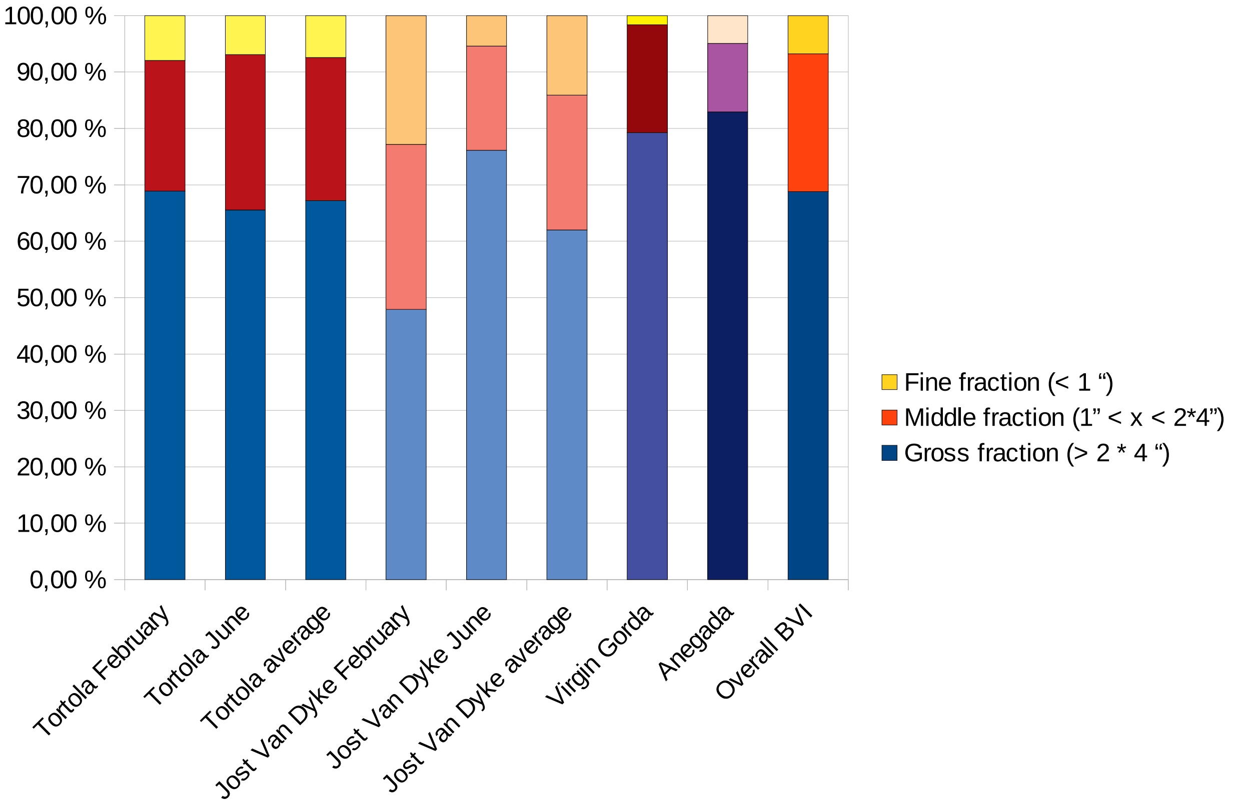
Analysed parameters were granulometry and waste composition in the gross and medium fraction. A total of 2.3 tons of waste (5,1500 lbs) was analysed.

The distribution of the three granulometric fractions as well as their characteristics change according to the habitat stratum, i.e. the island from where waste is collected. Residential waste from Tortola has been considered a single stratum.

Table 9: Distribution of granulometric fractions on the different islands

	Tortola February	Tortola June	Tortola average	Jost Van Dyke February	Jost Van Dyke June	Jost Van Dyke average	Virgin Gorda	Anegada	Overall BVI
Gross fraction (> 2 * 4 “)	68,89	65,54	67,22	47,91	76,13	62,02	79,26	82,92	68,78
Middle fraction (1” < x < 2*4”)	23,17	27,55	25,36	29,27	18,47	23,87	19,10	12,16	24,45
Fine fraction (< 1 “)	7,94	6,92	7,43	22,82	5,40	14,11	1,65	4,93	6,78

Figure 6: Granulometric distribution of waste in the British Virgin Islands

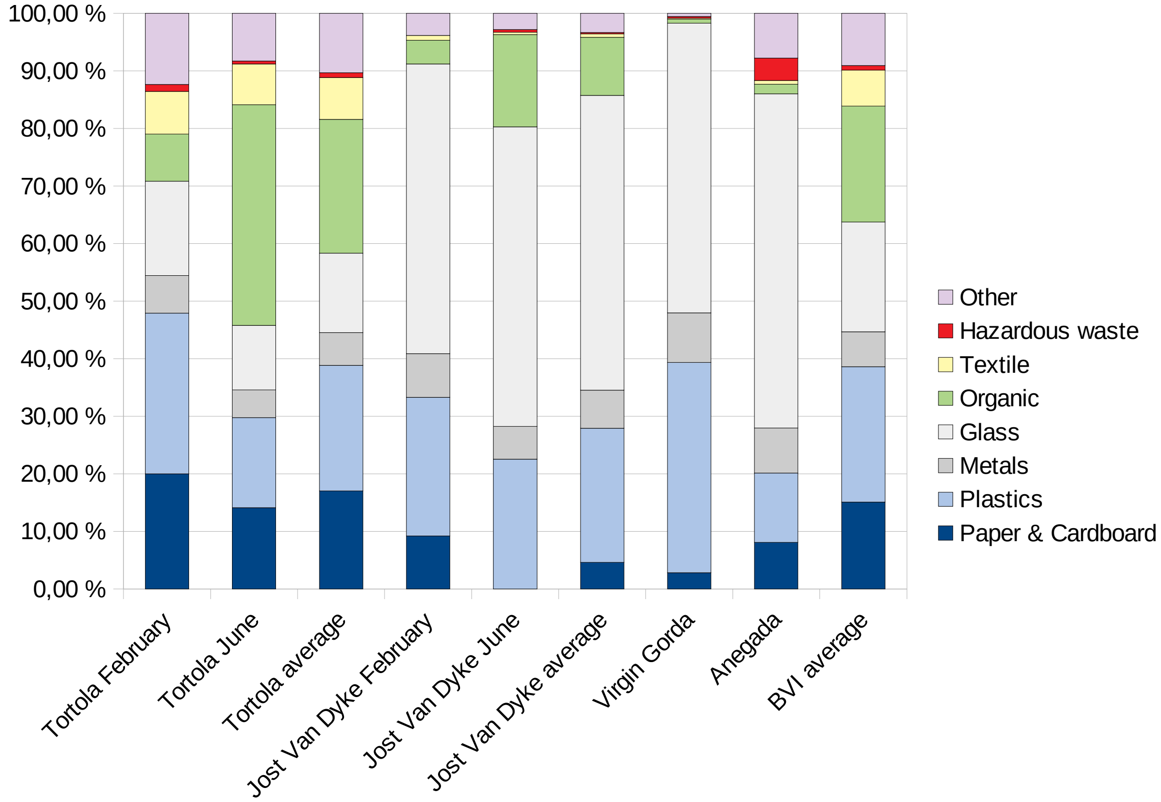


The table and the figure show that the gross fraction is by far the most important fraction in BVI waste, whereas the fine fraction, which consists generally mostly of organic waste, is often negligibly small. The Jost van Dyke island seems to be an exception, having a considerably more important fine fraction. However, visual observations showed that the fine fraction from Jost Van Dyke is not mostly organic, as it is in the purely residential areas, but that it contains large amounts of crushed bottles, since waste is collected in compactor bins at the island's transfer station. In June, the proportion of crushed glass in Jost Van Dyke waste was considerably less, which might be explained by the low touristic season.

However, in overall Tortola, Anegada and Virgin Gorda, the gross fraction constitutes over 70 % of the overall waste. This is the fraction expected to contain most of the recyclable material.

The tables and the graphic below show the overall waste composition for the residential, commercial and mixed waste samples in the British Virgin Islands. The presence of bulky waste being very haphazard given the size of samples, the proportional weight of waste (sub-) fractions has been calculated without bulk waste. Medium sized bulk waste is often delivered together with residential/ commercial waste; large size bulk waste should be delivered separately, even if many citizens do not yet comply with this requirement.

Figure 7: Summary of BVI waste composition



Paper and cardboard are both recyclable and biodegradable; the preferred recovery option depends on the cleanness of these materials. Paper and cardboard in the fine and medium fraction has been considered under organic/ biodegradable, since it is generally torn, soiled with wet waste and no more good for recycling.

Plastic waste in residential areas is often soiled with organic waste, and an important amount of the non-separated plastic sub-fractions (up to 2/3) does consist of water and sticky organic waste.

Separately collected waste at Virgin Gorda is of very good quality, near to no organic waste has been found to be mixed with the different recyclable fractions.

For the mainly touristic destinations (Anegada, Jost Van Dyke and Virgin Gorda restaurant waste), it can be observed that coloured and transparent glass constitute the most important fraction. These are mainly beer bottles, often intact. Seafood wastes are the main component of organic waste in Jost Van Dyke island.

Hazardous waste identified in the samples is mainly WEEE (waste electrical and electronic waste) and chemical waste, mostly brushes and containers contaminated with paint rests. Very few medical syringes and only one single battery were found; the syringes were very small syringes meant for injections at home (diabetes or similar); the battery was an alkali battery containing no heavy metals. Separation at the source of biohazardous waste in hospitals seems to work well.

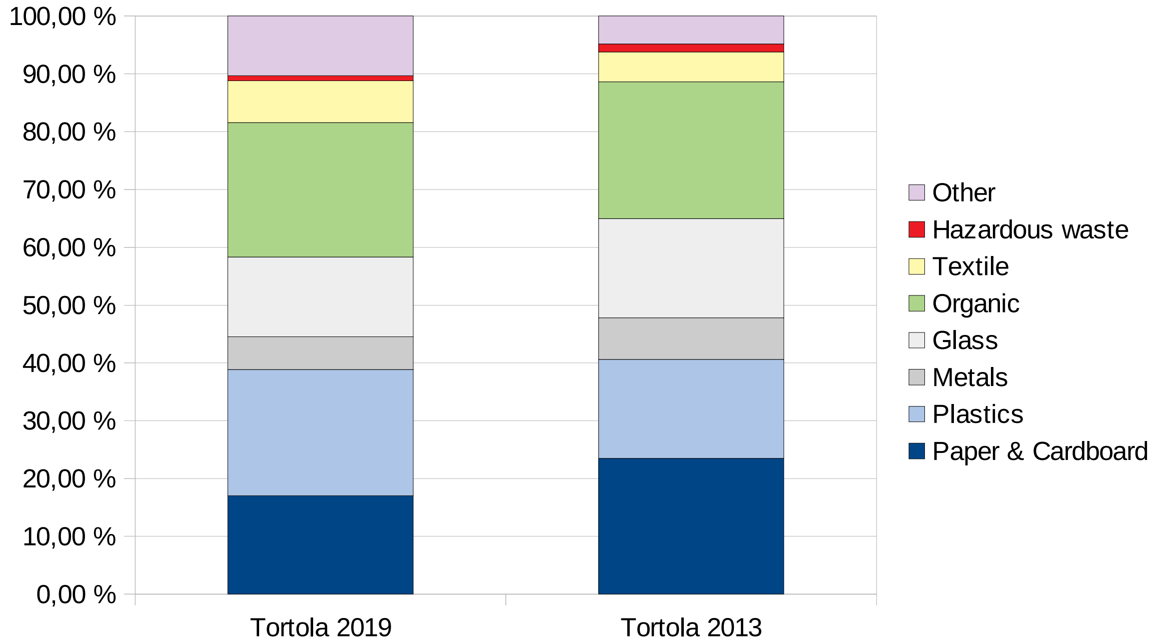
2.2.3.3 Development of waste composition over the years

The detailed waste composition table in the BVI waste management strategy of 2013 allows a comparison between solid waste composition in 2013 and 2019 for Tortola. Waste from the other islands was not analysed separately in 2013. The differentiation into sub-fractions being different during the 2013 assessment, only main fractions can be compared. The following table and graph show the waste composition in Tortola for 2013 and 2019.

Table 10: Waste composition in Tortola, 2013 – 2019

	Tortola 2019	Tortola 2013
Paper & Cardboard	17.04	23.47
Plastics	21.80	17.14
Metals	5.67	7.19
Glass	13.81	17.14
Organic	23.27	23.69
Textile	7.23	5.13
Hazardous waste	0.85	1.42
Other	10.33	4.81

Figure 8: Waste composition in Tortola, 2013 and 2019



The table shows an increase in organic waste, and a decrease in the generation of paper waste in Tortola. However, this is not to be considered a real increase, since no granulometric analysis was done in 2013, and all types of paper and cardboard were subsumed under this category, whereas paper and cardboard < 2” x 4” was listed under “organic” during the 2019 characterisation. This explains most probably of this apparent change.

The most noticeable development is the increase in “other” waste, which comprises items like baby diapers & hygienic pads, but also composite packaging, shoes and other complex materials.

The importance of glass waste seems to have decreased from 2013 to 2019. A decrease in the overall amount of glass consumption being very improbable, this may be an indicator for an important increase in the overall generation of the other waste fractions, which reduces the importance of the glass fraction. However, this hypothesis cannot be verified since the weighbridge register at the incinerator does not provide reliable data for the last two years.

An extrapolation has been made in order to exclude construction waste and other bulky waste measured in the 2013 characterisation from the comparative assessment.

2.2.4 Existing Waste Management System

2.2.4.1 Waste production and collection

In all islands of the BVI, waste generation is high, and waste prevention schemes are virtually non-existing. Single-use packaging (polystyrene boxes, polypropylene cups), cutlery and plates are ubiquitous; smaller restaurants use these not only for take-away, which is very common both for inhabitants and for tourists, but also for clients eating on the premises. Draft beer is not common; beer is sold in single-use glass bottles or metal cans; water and soft drinks are sold in PET bottles. Another very large waste stream is pallets. These are usually re-usable tertiary packaging (40 – 80 circles before discarding), but are not taken back by freight companies on delivery to the British Virgin Islands. Public awareness for waste prevention seems to be low; this might also be caused by the non-existence of alternatives.

A good practice, however, is the re-use of organic waste by BVI inhabitants. Although local farming has greatly dwindled, there are still some farmers taking organic waste to fertilise their gardens, to feed their chickens or their pigs, and it is common that citizens use organic waste for mulching in their own gardens. Together with the extremely high packaging waste generation, this explains the low proportion of organic waste in the overall waste stream.

The remaining solid waste is collected without any separation in the islands of Tortola, Anegada and Jost Van Dyke. Although the Department of Waste Management requires citizens and businesses to separate bulky waste, construction waste and glass in order to prevent the incineration of these items, this advice is very frequently ignored. The Department of Waste Management does not have the legislation necessary to enable enforcement of separate collection.

In Virgin Gorda, the NGO GreenVI has established a separate collection system, placing three-fraction waste bins in public areas and in schools. Businesses are also part of the separate collection scheme. Although not all Virgin Gorda adheres to this system, an important part of waste is collected separately.

2.2.4.2 Waste treatment infrastructure on the British Virgin Islands

Both private and public waste treatment and disposal facilities are operated on the British Virgin Islands. The table below gives an overview over the infrastructure.

Table 11: Existing waste treatment facilities in the British Virgin Islands

Type of facility	Site	Capacity (t/day)
Plastic recycling plant	Tortola, East End	1.5 t/day
Metal collection/ exporting company (Alkebulan minds recycling)	Tortola	No specific design capacity
Textile re-use/ recycling (Red Cross/ Family Support Network)	Tortola	Not known
ELV crusher	Tortola, Sea Cows Bay	Intermittently active
ELV crusher	Tortola, Pockwood Pond	Intermittently active
Waste incinerator	Tortola	100 t/day, not active
Dump site	Tortola, Pockwood Pond	No specific design capacity, oversaturated
Hurricane debris dumping site	Tortola, Cox Heath	No specific design capacity
Transfer station	Jost Van Dyke	10 t/day
Glass recycling (Green Crete)	Virgin Gorda	< 1 t/day
Glass, metal, plastic, WEEE collection/ exporting/ recycling company (Green and Clean VI)	Virgin Gorda	Glass crusher: 2.5 t/h
Dump site	Virgin Gorda	No specific design capacity
Dump site	Anegada	No specific design capacity

Several small scale recycling workshops are operating at Tortola; these either process plastic waste for local use (furniture, fence boards) or aim at exporting scraps for sale. Quarry operators have a manifest interest in obtaining glass waste as substitute for aggregate and/ or sand in concrete production. A private organisation plans to implement a worm composting facility.

A recycling company in Virgin Gorda (Green and Clean VI) receives all separately collected waste and processes it, mainly for exportation. This company also is currently erecting a small size biogas facility. Moreover, a local construction company (GreenCrete) re-uses glass waste for producing decorative surfaces. The NGO GreenVI advocates for the installation of an “Eco Park”, which would mainly function as a bring centre for separately collected waste, with integrated recycling, repair and social (education, training…) facilities.

In summary, despite the island location, it can be said that the British Virgin Islands have a great potential for recovery and recycling, provided that separate collection is introduced.

The overall waste throughput of the recycling facilities is currently very low, but all of them have plans to upgrade their equipment. The table below gives an overview over quantities actually recycled or exported for recycling[8].

8Information on quantities obtained from Green and Clean Vi’s annual report to DWM and from interviews with recycling operators.

Table 12: Quantities of material recycled or exported for recycling

Material		Recycling Method	Weight t/year	Weight lbs/year
Plastics	PET	Exporting/ polywood production	1.88	1,273
	HDPE 3D	Polywood production	5.85	5,850
	PP 3D	Polywood production	5.85	5,850
Metal	Al 3D (packaging)	Export	1.06	2,334
	Al 3D (other)	Export	0.94	2,081
	Fe	Export	1.02	2,245
	Cu	Export	2.03	4,472
Glass	Coloured glass 3D		1.39	3,063
	WEEE	Export	6.18	13,626
	Batteries and accumulators	Export	2.18	4,810
ELV	Crushed entire ELV	Export	0.00	
ELB	Aluminium masts	Export	3.67	8,087
	Steel	Export	0.23	513
Total			**24.59**	**54,204**

The table shows that there is, in comparison to the quantities of waste generated, an important potential for upscaling recycling operations for all materials, and introducing recovery schemes for those not yet covered by recyclers.

All other waste from Tortola and from Jost Van Dyke island goes to the Pockwood Pond dumpsite, where the incinerator is located. Touristic islands (Southern Cays) in the proximity of Tortola ship their waste to the Tortola marinas, from where it is also transported to Pockwood Pond. The islands of Anegada and Virgin Gorda have their own dump sites. The Tortola incinerator is currently out of service, due to a fire that set the incinerator building ablaze and destroyed the electrical wirings and the control room. The fire occurred due to explosions within the incinerator, probably caused by waste oil barrels.

The Department of Waste Management has requested the constructing company to repair the incinerator and supply the necessary spare parts; this has not yet been done. Communication with and reactivity of the supplier (Consumat, Virginia, USA) seems to be sub-optimal; the purchase of a stack gas cleaning unit also is pending since over two years. The Photo on the right side shows the incinerator unit. It is clearly visible that the stack height is insufficient to guarantee dilution of the treated stack gasses. An extension of the chimney should have been built together with the treatment unit (pending).


Photo 3: View of the incinerator

In meantime, all waste is brought to the Pockwood Pond dumpsite. Self-ignition due to heating of the organic fraction is frequent, and inhabitants of West End are often exposed to fumes coming either from the Pockwood Pond site or from the nearby Cox Heath debris disposal site. Hurricane debris have been disposed at Cox Heath. This probably includes a large number of fibreglass boat wrecks, that continue smoldering below a layer of rubble. The photos below show a view of Pockwood Pond dumpsite and Cox Heath debris storage site.

Photo 4 (left): Aerial view of the dump site at Pockwood Pond

Photo 5 (above): Smoldering waste at the Cox Heath debris storage site

The evacuation of hurricane debris is still not finished. Although waste from destroyed houses has largely been cleared, a large number of cars and boat wrecks is still scattered around all over the islands. Property issues and unclear rules about owners' responsibility are an obstacle to evacuation of these wastes. Car crushing operations seem to have come to a stop (it was unfortunately not possible to talk to the recycler operating the car wreck yard). The photos below show a car debris storage site and boat wrecks washed on the shore in West End.


Photo 6: Boat wrecks in West End


Photo 7: Car debris storage at Pockwood Pond (in the background: fumes from the dumpsite)

2.2.4.3 Waste management on the Southern Cays

Waste management in the touristic islands (Southern Cays) depends very much on the ambitions of the operators. This goes from a complete cradle-to-cradle approach (Cooper Island), which results in a very important waste reduction to mixed waste collection + no prevention measures in many others. It should, however, be said, that tourism operators generally declare that they are willing to introduce separate collection if a downstream handling structure was set up. Hurricane debris are still present on some of the islands; tourism operators have made an effort of clearing the islands but could not yet transport the complete amount of wastes. The photos below show some of the waste storage and processing sites on the islands:


Photo 1: Hurricane debris on Scrub Island

Photo 2: Composting site at Cooper Island (kitchen & craft brewery waste)

2.2.4.4 Costs of Solid Waste Management

Operational costs of solid waste management are summarised below. Department of Waste Management does not procure equipment and infrastructure on its own budget; for this reason no amortisation costs are included.

Figure 9: Summary of SWM operation costs for 2017 and 2018

Item		Expenses (US$) 2018				
		Dumpsite	Incinerator	Collection	Office	Total
Personnel		84,276	435,355	1,049,493	292,997	1,862,122
Consumables			251,431		68,599	320,030
Spare parts, wear parts, repair		50,000	149,947	54,000		253,947
Services				1,043,695	100	1,043,795
Equipment						0
Infrastructure						0
Total	US$/year	134,276	836,734	2,147,188	361,696	3,479,894
	US$/ton	3	18	45	8	73

Item		Expenses (US$) 2017				
		Dumpsite	Incinerator	Collection	Office	Total
Personnel		53,076	540,896	1,075,494	292,997	1,962,463
Consumables		10,400	162,642		7,989	181,030
Spare parts, wear parts, repair		40,000	112,053	25,000		177,053
Services			100	1,124,362	0	1,124,462
Equipment						0
Infrastructure						0
Total	US$/year	103,476	815,690	2,224,856	300,986	3,445,008
	US$/ton	2	17	47	6	72

Total operation costs are 73 US$/ton and do not vary much from year to year. Incineration costs are low with 17 – 18 US$/ton, which can be explained with the lack of flue gas treatment. The most important cost item is waste collection, divided in two main expenses: salaries for 42 sanitation officers and service contracts for waste collection by private companies.

With the breakdown of the incinerator, all waste is dumped at the Pockwood Pond site. This situation led to an increase in operational costs due to service contracting for internal transport, compacting and covering of waste. An important increase in waste treatment costs for 2019 is therefore expected.

2.3 Solid Waste Management System Diagnostic – Constraints and Opportunities

The following tables present a summary of the key characteristics of the existing system, and highlight the key constraints and opportunities for system improvements. This information is disaggregated according to key drivers of sector performance: (i) system governance and management; (ii) infrastructure and assets; (iii) tariff structure and cost recovery; (iv) revenue support; (v) the role of the private sector; and (vi) environmental and social protection.

Table 13: Assessment of governance and management

	Political will	Civil service institutional structures, mandates and capacity	Community and stakeholder engagement	Regulation and policy
Rating	**Good**	**Medium**	**Very good**	**Poor**
Constraints	Lack of experience with challenges of modern solid waste management concepts	Smallness of the country restricts number of employees. No specialisation of technicians on island possible, professional and academic qualifications are linked to studies abroad and therefore limited; in consequence, DWM does not count with a single fully qualified technical expert. Status of DWM as a department under Ministry of Public Health limits its autonomy and leads to lengthy approval procedures. DWM ıs currently not mandated for procurement or to receive funds.	Insular situation (importing of packed goods) and wealth have changed the population's lifestyle towards a more unsustainable, convenience oriented high consumption, high waste generation way of life.	A limited number of laws (Derelict Vehicle Act, Litter Act) exists, but is not efficiently enforced. Existing legislation does not cover the entire scope of solid waste management. A coherent framework, horizontal integration of waste management and environmental issues with other legislation is missing. No technical standards, emission limits etc. are applied. No legal obligation for monitoring, reporting and public access to waste related information.
Opportunities	New government after latest elections understands the urgency of improving solid waste management and seems very committed to take rapid and coherent action	Possibility for specialisation and full technical training for key personnel by transitional replacement with hired foreign technicians. Set-up of DWM as statutory body might allow more autonomy and shorten bureaucratic procedures	Very active private recycling sector and NGOs Good coordination, interaction and communication of SWM actors by national recycling board Awareness and willingness for improvement is high for main economic operators (tourism, supermarkets…) is high. Pressure from population to relieve the environmental and health burden of current unsustainable waste management. Tourism sector starts seeing environmental protection as an added value for high quality tourism	Opportunity to elaborate a coherent Waste Act covering all waste streams and state-of-the art technologies in a single framework text. Adoption of EU technical standards and best available technology approach instead of onerous elaboration of own standards. Follow experience of other Caribbean countries with innovative instruments like ban of specific obnoxious products

The following table provides an assessment of the availability, suitability, use, labour capacity and financing of existing infrastructure and equipment to deliver SWM services and outcomes: Constraints and Opportunities.

Table 14: Infrastructure and assets

	Built infrastructure	Equipment
Rating	**Very poor**	**Medium**
Constraints	**For all solid waste management infrastructure, land availability is a serious constraint.** Recycling and composting Only very small, low-tech recycling workshops and scrap yards are operational Incineration Simple mass-burn incinerator without stack gas treatment installed but not operational; supplier is not reactive Landfilling Open dumpsites are in operation on Tortola (Pockwood Pond and Cox Heath), Anegada and Virgin Gorda. Frequent open fires are observed at Pockwood Pond. The site is oversaturated and very steep; access is difficult. Danger of landslide.	Vehicles: Waste collection and waste handling vehicles are sufficient, but often old and in bad repair. Recycling equipment Recycling workshops use simple, small scale equipment, which is sufficient for their current throughput, but not for upscaling. Workshops treating end-of-life vehicles are using crusher-balers. No equipment for de-pollution and dismantling is available. In-house capacities for repair and maintenance are very low (DWM). For all equipment, procurement of spare parts is difficult, expensive and lengthy due to insular situation. State-of-the art, specialised recycling equipment is often available only in overcapacity, due to the small scale of BVI waste operations.
Opportunities	Large scale worm composting facility planned Government agreement with the NGO Green VI to establish material recovery facilities Reduction of need for incineration and landfilling capacities by comprehensive waste prevention and recycling system	Private recycling companies are willing and capable to upgrade their capacities. Use of regionally available capacities for treatment of specific waste streams (ELV, ELB)

The table below gives an assessment of the suitability of the current tariff structure, and its enforcement: Constraints and Opportunities

Table 15: Tariff structure

	Fiscal instruments	User fees
Rating	**Very poor**	**Not existing**
Constraints	No fiscal instruments are applied by government to recover solid waste management costs, with exception of the deposit foreseen, but not enforced, in the Derelict Vehicle Act. Waste collection and disposal are completely subsidised; recycling is feasible if the private sector can make a benefit.	Political reluctance to introduce new taxes
Opportunities	Introduction of extended producer responsibility to cover the gap between recycling costs and revenues from recycled material for waste streams that are currently not profitable.	Introduction of real cost based user fees to cover waste collection, composting (if not self-sustaining) and disposal costs. Most households are able to afford realistic waste fees.

The next table evaluates existing state revenue support, income generation and enforcement capacity: Constraints and Opportunities.

Table 16: Revenue support

	Income from waste	Ability to enforce
Rating	**Not existing**	**Very poor**
Constraints	No cost recovery exists for DWM: - no tipping fees for incinerator/ landfill (from private sector) - no income from fines - no income from fiscal instruments or user fees (see above) Waste management is completely dependant from government subsidy.	Department of waste management does not have any enforcement capacity related to fines from violation of the litter act. Environmental policing has been tried but abandoned. No environmental standards are applicable for waste treatment operations; therefore no convictions and no fines are possible No legislation enables DWM to cover user fees.
Opportunities	Inclusion of polluter pays principle in the Waste Act and establishment of different complementary instruments to recover the total cost of waste management including administration, awareness raising, monitoring, data treatment and training related activities.	Permanent assignment of at least two police officers to DWM for monitoring and enforcement of waste related infractions. Streamlining of waste management with other relevant authorities (Department of Motor Vehicles, Port Authority etc.) to ensure a common approach and cooperation to ensure compliance. Linking solid waste related fees to electricity bill or equivalent in order to ensure complete coverage Installation of CCTV cameras at waste skips to register and fine litter offenders

An assessment of the current role, performance and sustainability of private sector in delivering services and outcomes, constraints and opportunities is given in the table below.

Table 17: Role of the private sector

	Collection and transport	Re-use	Recycling and composting	Final disposal
Rating	**Poor**	**Medium**	**Good**	**Very poor**
Constraints	Waste collection from open skips is done by the private sector. Performance of the waste collection service is not monitored. Collection is regular, but no control of bulky/ hazardous waste is done to prevent damages at the dump site or the incinerator. Waste collection companies do not take charge of litter besides the dump sites. Inter-island transport of waste is done by private barges. Prices are prohibitive; the sector is not controlled. Car wrecks and building debris resulting from Hurricane Irma are collected slowly; boat wrecks are still not collected.	No systematic encourage-ment of re-use	Land availability for the construction of adequate recycling facilities is a limiting factor. "NIMBY" attitude of neighbours restricts the options for recyclers to establish a plant. High shipping fees and small quantities restrict current recycling operations to a very limited number of materials. Recycling of special wastes (WEEE, ELV, ELB) is often not done according to the state of the art; no systematic depollution of appliances is done.	No private sector participation to incineration and final disposal operations. Technical capacity of private sector on the island is insufficient for these tasks.
Opportunities	Performance based service contracts with waste collection companies Purchase of a DWM barge to reduce dependence from barge owners	Initiatives like Red Cross or Family Network are already operating second hand shops for clothing; this initiative might be extended and replicated for other waste streams.	Several private recyclers are active on Virgin Gorda and Tortola and have, until now, carried out their operation without any government support or subsidies. Separate collection of recyclable fractions delivers already good results in Virgin Gorda; extension of separate collection to Tortola will increase the potential for private recyclers. Large worm composting project is ongoing. Identification of local outlets for recycled materials and increase of material value by advanced pre-treatment can make recycling more profitable. Implementation of environmental and quality standards for recycling and composting operators	International, performance based contract for operation of state-of the art incinerator.

The following table provides an assessment of the current system to manage negative environmental and social impacts and deliver benefits: Constraints and Opportunities

Table 18: Environmental and social protection

	Social protection and benefits	Environmental protection and safeguards
Rating	**Poor**	**Very poor**
Constraints	Workers and the surrounding population are exposed to emissions from the incinerator and the dumping sites. Workers are also exposed to health risks from handling of mixed waste in the dump. Basic protection kits are made available. Hazardous waste and infectious medical wastes (the incinerator at Peebles Hospital is out of order) are not separately collected and increase the health risk. The vicinity of the open dump at Pockwood Pond to the fuel powered thermal power plant constitutes an additional risk. Training opportunities and environmental/ risk primes for workers are limited. Motivation is often low.	High landscape use due to open dumps: - Pockwood Pond dump is highly visible from the Sea and occupies an entire hillside - Virgin Gorda dump is located in a natural park. Emissions from incineration and dumping are released to air, soil and water without any mitigation. Open burning and smouldering are additional emission sources Uncontrolled release of cooling fluids, hydraulic oil etc. liquids from WEEE, ELV and ELB High CO_{2eq} emissions due to uncontrolled biodegradation of organic waste in the dumping sites Lack of waste prevention and recycling leads to high resource consumption with associated CO_{2eq} emissions Litter contributes to marine pollution with plastics
Opportunities	Diversion from incineration and landfill by effective waste prevention and recovery measures; state-of-the art incineration and landfilling of non recyclable, non biodegradable waste streams.	Reduction of environmental burden by comprehensive integrated waste management and introduction of circular economy.

3 INTEGRATED SOLID WASTE MANAGEMENT STRATEGY

3.1 GENERAL APPROACH

The Strategy and Action Plan builds upon:

1-. The system diagnostic and related constraints and opportunities summarised above, which are in turn informed by the waste characterisation and option analysis workshop

2-. The political will of the British Virgin Islands' government to provide a sustainable solution for solid waste management, that will increase resilience to natural disasters, preserve the islands' natural beauty and reduce the country's environmental footprint

3-. Application or adaptation of solid waste management strategies and initiatives that work, drawn from an evaluation of experience from other small Caribbean countries, and from elsewhere in small island states and globally.

In order to succeed and be sustainably implemented, the strategy must

- be owned by the BVI Government, and by extension, by DWM

- be supported by the key stakeholders in the system – including its customers;

- be achievable within the institutional, social and economic constraints of the British Virgin Islands

Kano;

- recognise the need for a progressive approach which combines a sequenced set of activities, which at the same time enables system improvements to advance on parallel fronts – in the domains of governance and policy, institutional, technical and operational, human resources, financial, social and environmental.

3.1.1 Aims and Objectives

The overarching goals of the strategy seek to ensure social benefits, environmental safety and economic returns as well as reduce the CO_{2eq} footprint of the British Virgin Islands . These goals have informed the development of the following strategic objectives[9]:

a. To sensitize and empower the population with information and public education to elicit gradual change towards long-term commitment and participation;

b. To increase waste minimisation, segregation and diversion activities;

c. To strengthen the institutional arrangements, technical capacities and the legislative framework.

d. To establish an state-of-the art, integrated solid waste management system covering all waste streams generated in the British Virgin Islands, minimising environmental and health impacts at affordable cost;

e. To develop modern technical standards, guidelines and management information systems for solid waste management;

f. To reduce the CO_2 footprint of solid waste management

9Aims and objectives have been taken over from the 2013 strategy and slightly updated.

g. To create resilience towards natural disasters and reduce climate change induced vulnerability

3.1.2 Guiding Principles

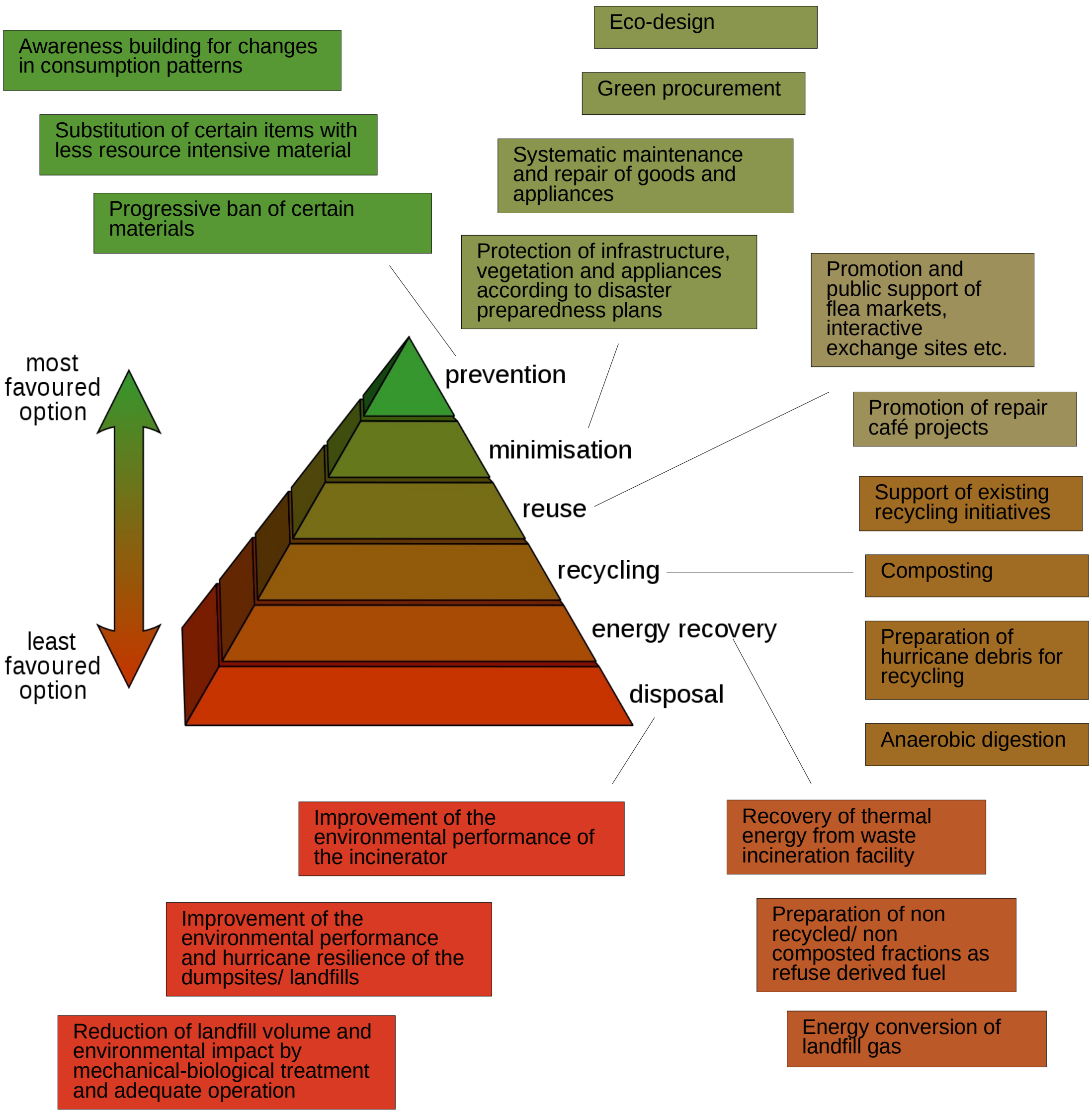
The integrated solid waste management strategy is based on several guiding principles, that aim at ensuring horizontal integration with environmental, social, financial and climate change related policies as well as with essentials of disaster resistance and resilience building.

3.1.2.1 Waste Hierarchy and Circular Economy

The waste hierarchy sets clear priorities for waste management, aiming at minimising the generation of waste, the depletion of resources, emissions and land use caused by waste management, and at maximising the lifetime of products and materials by conscious planning and management along the waste chain.

The figure below gives an overview over the waste hierarchy concept in the British Virgin Islands context.

Figure 10: Waste hierarchy concept



The integrated waste management strategy aims at ensuring a gradual transition from a consumption => disposal approach towards a circular economy system, where the concept of "final disposal of waste" will phase out with the extension of waste recovery possibilities.

3.1.2.2 Waste Stream Management

The integrated solid waste management strategy endeavours the transition from mixed waste collection and mass-burn technology to an approach where each waste stream is considered according to its specificities, aiming at identifying the most environmentally, economically and technically sound option to deal with this waste.

3.1.2.3 Climate Change

Given the increasing urgency of climate change mitigation and adaptation, all measures proposed under the integrated waste management strategy are assessed upon their climate change impact and their potential to reduce CO_{2eq} emissions, prioritising to options with the least climate footprint.

This covers valorisation of thermal energy produced by waste treatment operations, reduction of the energy consumption of installations, reduction of climate relevant emissions by planning and by technology, substitution of fossil energy resources with solar or waste generated energy to the maximum possible extent.

3.1.2.4 Polluter Pays Principle

Instead of covering solid waste management related expenses by the general governmental budget, a clear link needs to be established between the production of waste and the payment for its treatment, attributing the financial responsibility for environmentally friendly collection and treatment of waste to those who have generated the respective waste.

The polluter pays principle covers:

- <u>Waste service fees:</u> Households, commerces, businesses, administrations, tourists and tourist operators who produce waste and have it collected. Citizens and enterprises are responsible for waste generation by their consumption patterns and choices.

- <u>Extended producer responsibility:</u> Industries, importers, gross and retail merchants who produce and put on the market products, which will be used, converted into waste and need to be treated. Producers are responsible for waste generation in terms of product conception, choice of packaging and marketing of products.

Ideally, the price paid by waste producers should be linked to the nature of the waste produced:

- quantity

- re-usability/ recyclability

- hazardous substance content.

This can be achieved with a combination of financial instruments.

3.1.2.5 Real Cost Based Pricing

To ensure sustainability of the waste management system, the total of fees to be paid by waste producers need to cover the total of integrated waste management costs, including administration, capacity building, monitoring & control and awareness building.

This requires exact knowledge of the costs of each waste management operation, and an annual update and adaptation of tariffs to avoid unfair pricing.

3.1.2.6 Social Equity

Financial, environmental, organisational or other burdens from solid waste management are to be distributed is the possibly most equal way. This comprises:

- affordability of waste fees and extended producer responsibility charges (especially for small producers)

- distance to waste reception centres

- equal opportunities for businesses in the waste management sector

- consideration of the interests of people and businesses in the vicinity of waste treatment infrastructures

- participatory decision making

3.1.2.7 Protection of public health and the environment

All infrastructures for solid waste management need to be designed in a way to reduce health and environmental risks. For all areas where national standards do not (yet) exist, EU emission limits are taken into consideration in the definition of specifications for infrastructure and equipment.

Emission reduction may have a greater direct investment and operation cost than the current waste management system in the British Virgin Islands, but it avoids important indirect costs related to diseases caused by emissions and the related loss of work force, environmental damages affecting the country's economy, and loss of nature assets providing welfare to the country (biodiversity, clean air, clean water, good soil…). An economic assessment of solid waste management in the Caribbean has shown for two example cases that the environmental and health benefits outweigh the costs of investment and operational cost of adequate solid waste management by the factor 1 - 10[10].

3.1.2.8 Local Approach

The strategy supports local initiatives in the waste management sector, local technology and local commercialisation of recovered materials, also in view of substituting imports and reduce the dependency of the British Virgin Islands from outside goods and expertise.

3.1.3 System Governance

Efficient and sustainable solid waste management depends on a sound governance system, which relies mainly on the following pillars:

<u>Separation of waste policy from waste services regulation, and from waste service provision</u>: SWM systems work better where the roles and responsibilities of the key institutions are clearly separated and defined: For instance the Ministry in charge of Environment responsible for policy, legislative and guideline provision; Department of Environmental Health responsible for oversight, quality control and quality assurance; and a separate autonomous or semi-autonomous agency responsible for solid waste service management and (in some cases) provision, including taking responsibility for some elements of the service and for managing private service providers to carry out others. This separation of roles enhances the rigour of enforcement. Although the size of the British Virgin Islands limits the number of governmental institutions and restricts to a certain extent professional specialisation, this type of separately implemented mandates is recommended.

<u>Autonomy of the Waste Management Institution</u>: It is preferable if the operator is an autonomous or semi-autonomous institution to the extent that it is solely responsible for oversight and management of the solid waste value chain from planning a working model, through implementation, selection and monitoring of private service providers, procurement of assets and technologies, operations, disposal and (possibly) revenue generation. This reflects the need for the operator to have some level of responsibility across the entire SWM value chain.

<u>Comprehensive and adapted legislation</u>: Main principles of integrated solid waste management including polluter pays principle, environmental and technical standards,

10Source: Municipal Solid Waste in the Caribbean, a Benefit Cost Analysis, ECLAC Sub-Regional Headquarters for the Caribbean, Willard Phillips, Elizabeth Thorne, 2013 distribution of responsibilities and essential financing mechanisms need to be anchored in waste framework legislation and technical decrees taking into consideration the specific small island geography and socio-economic context of the British Virgin Islands.

Enforcement: Enforcement needs to be vigorously pursued and all stages in the governance chain; standards and targets established and measures, and in the event of warnings being ignored, offenders sanctioned – eventually in a court of law.

3.2 Action Plan and Targets

A comprehensive option analysis has been carried out and was reviewed during the option analysis workshop, regarding the different possibilities to be implemented at each level of the waste hierarchy as well as financing of waste management. Options may be combined to reach higher efficiency, or applied according to the specificities of each waste stream. The table below gives an overview over the different measures.

Table 19: Option analysis matrix

Purpose	Measure			
Financing	Waste fee for households and commerce √	Extended producer responsibility √	Recycling funds √	Non-compliance fines √
	Subsidies for diversion from landfill √			
Prevention	Ban of certain products √	Financial incentives for reduction (levy/ tax) X	Substitution of products or components by waste-free alternatives √	Green procurement √
	Obligatory prevention plans and targets under extended producer responsibility √	Eco-design law or decree √		
Separate collection	Deposit-refund system (bottle bill) √	Obligatory or voluntary segregation at the source √	Construction of waste reception centres (part of MRF) √	Reverse logistics √
	Itinerant collection vehicle for special wastes √	Legal obligation for construction/ demolition companies to separate waste during infrastructure works √		
Re-use	Establishment and support of repair cafés √	Establishment of material exchange places (physical and/ or virtual) √		
Recycling	Construction and equipment of sorting and treatment centres (part of MRF) √	Exporting for recycling (√)	Construction of composting plant (windrow, vessel, worm composting…) √	Anaerobic co-digestion pilot projection √
	Eco-design law or decree √	Recycling targets under extended producer responsibility √	Construction of ELV/ ELB recycling plant with de-pollution facility and shredder (√)	Acquisition of a concrete crusher for production of aggregate from C&D waste

Purpose	Measure			
				√
Energy recovery	Rehabilitation of existing incinerator and addition of energy recovery √	Construction of new, smaller and more performant incinerator with advanced stack gas treatment, heat and electricity production √	Exporting of waste for incineration to US Virgin Islands X	Mass burn gasification project by private investor X
Landfilling	Rehabilitation of old dumps with biogas and leachate extraction and treatment √	Landfill mining for recovery of recyclable and combustible material √	Landfill ban for non-treated wastes √	Discouraging high landfill tipping fees X

Colour code:

(yellow)	Legislative measure	√	Validated during option analysis workshop
(pink)	Financial measure	X	Rejected during option analysis workshop
(green)	Organisational measure		
(blue)	Technical measure		

The following tables summarise

1) the key targets to be achieved by the solid waste management strategy

2) the action plan comprising drafting and enforcement of solid waste management legislation, financing of the solid waste management activities, waste prevention and waste stream management, capacity building and governance, private sector and community involvement.

Table 20: Measures and targets - governance

Sector aspect	Current situation	Within 1 year	Within 2 years	Within 5 years	Within 10 years	Within 20 years	Involved budget	Verification and monitoring
Governance								
Separation of SWM functions	Basic separation effective, DWM depending on ministry, monitoring and control are weak	Monitoring system set up and personnel trained in DEH 2 environmental police officers assigned	Regular monitor-ing of SWM quality and related offen-ces. Data registration system working	Monitoring and control fully operational. Emission, waste stream and offence related data is registered, analysed and publicly accessible	Targets are set for environmental offences, and development of offence frequency is recorded. Policy for reduction of offences elaborated	Steady decrease in environmental offences is observed.	75,000 US$/year for environmental police 50,000 US$/year for trainings and consultancy 25,000 US$/year for equipment and material	Annualreports: No.of environmental police officers No. and nature of offences registered Amount of fines Scope and quality of emission and waste stream data
		Ministry assigns/ outsources expert/ team for SWM policy and law making	Technical decrees and detailed legislation available	Interim evaluation of SWM strategy and adjustment of baseline values and targets. Definition of new targets	Eco-design legislation is elaborated, targets for new waste streams are defined. Extended producer responsibility covers more waste streams	New, more ambitious circular economy strategy is elaborated.	75,000 US$/year for in-house SWM law specialist 100,000 US$/year for framework legal support contract 50,000 US$/year for other consultancy and training	Number of technical decrees and standards issued. Waste streams covered Prevention, re-use and recycling targets issued
		DWM set up as statutory body	DWM manages own budget and does procurement		DWM is financially autonomous	Continuous improvement of service quality and technical proficiency	First 5 years: 25,000 US$/year for procurement consultancy 250,000 US$/year specialised staff	Number and quality of procurement acts DWM cash flow Citizen satisfaction
Capacity building	No specialisation within DWM	Four experts assigned for full cycle specialised professional training abroad. Temporary replacements (international) found	Specialised temporary experts in place for incineration/ landfill, procurement, data management/ monitoring and re-pair/ maintenance	Trained DWM experts resume their specialist posts	DWM and DEH plan and organise specialised staffing efficiently and attract trained SWM specialists and technicians	Continuous improvement of service quality and technical proficiency	1,500,000 US$ for abroad university/ professional education and replacements	Permanent presence of SWM engineer, procurement specialist, qualified mechanic and data management specialist
	Weak monitoring and enforcement expertise within DEH	Necessary monitoring equipment acquired Two experts assigned for full cycle		Trained DEH experts assume their specialist posts		Continuous improvement of service quality and technical proficiency and prosecution	750,000 US$ for abroad training of monitoring specialists 50,000 US$ for	No.of environmental police officers No. and nature of offences registered

Sector aspect	Current situation	Within 1 year	Within 2 years	Within 5 years	Within 10 years	Within 20 years	Involved budget	Verification and monitoring
		specialised professional emission monitoring training, Two persons assigned for full legal training to barrister level. abroad.					consultancy and in-house training	Amount of fines Scope and quality of data

Table 21: Measures and targets - financing

Sector aspect	Current situation	Within 1 year	Within 2 years	Within 5 years	Within 10 years	Within 20 years	Involved budget	Verification and monitoring
Financing								
Real cost coverage	None	10 %	20 %	100 %	100 %	100 %	100,000 US$ for consultancy and training	Annual balance of revenues (user fees, ERP, fines, other) and costs.
User fees	None	50 US$/ (household*year)	100 US$/ (household*year)	120 US$/ (household*year)	120 US$/ (household*year) inflation adjusted	120 US$/ (household*year) inflation adjusted	50,000 US$/year for permanent assigned staff (DWM)	Revenues from user fees
		25 % coverage	50 % coverage	100 % coverage	100 % coverage	100 % coverage		
Extended producer responsibility	None	Concept introduced and framework set	Introduced for packaging, EEE and vehicles	Fully functional for packaging, EEE, vehicles and boats	Introduced for additional product groups	Covers all products with potential for circular economy	180,000 US$/year for permanent assigned staff (DWM/ ministry/ Port Authority) 20,000 US$/ year for consultations and working groups 50,000 US$/year for consultancy (first introduction and extension years)	Presence of ERP logo on target products Revenues at BVI entry from import fees Existence and budget managed by recycling funds Cash flow to support recycling operations
		0 revenues	25 % of target revenues	100 % of target revenues	100 % of target revenues	100 % of target revenues		% of target materials recycled

Table 22: Measures and targets - waste hierarchy

Sector aspect	Current situation	Within 1 year	Within 2 years	Within 5 years	Within 10 years	Within 20 years	Involved budget	Verification and monitoring
Waste prevention								
Plastic bags, cutlery and take-away/ single use food containers	No prevention	Ban issued	50 % effective	95 % effective	95 %	95 %	150,000 US$/year (decreasing) control, registration, recovery and labelling staff at Port Authority 50,000 US$/year administration/ overhead (DWM/ DEH)	Random verification of incoming containers Port Authority registers Verification in supermarkets/ restaurants Waste characterisation
Pallets	No prevention	Take-back obligation issued	50 % effective	95 % effective	95 %	95 %		
Waste re-use								
Repair cafés	None	1 repair café in Tortola, 1 repair café in Virgin Gorda installed and staffed	Repair and fitting of > 2 devices and objects/day Known by 5 % of population	Repair and fitting of > 10 devices and objects/day Repair service included in MRF Known by 10 % of population	Repair and fitting of > 20 devices and objects/day Repair service included waste bring centres Known by 20 % of population	Repair and fitting of > 50 devices and objects/day Repair service included waste bring centres Known and used by 80 % of population	100,000 US$/year for staffing of repair cafés (increasingly to be replaced with volunteers) 100,000 US$ for equipment of each repair café	Registers of products repaired Citizen survey
Second hand shops and flea markets	Red Cross and Family Network	Cooperation for extension to other materials	Two second hand shops and two regular flea markets operational in Tortola and Virgin Gorda	Second hand shops and flea markets known and used by 10 % of population	Second hand shops and flea markets known and used by 20 % of population Data register of re-used products available	Second hand shops and flea markets known and used by 50 % of population 50 % increase in re-use	50,000 US$/year subsidies for non profit organisations and for promotion, awareness building etc.	Number of flea markets organised per year, size ofstands Register of products sold in second hand shops
Waste collection								
Separate collection at the source	None	Obligatory separation of hazardous and bulky waste introduced	50 % effective	80 % effective	95 % effective	95 %	50,000 US$ equipment of waste bins with CCTV	Number of fines Observation at disposal site
		Separate collection wet/dry (two bin system) introduced	25 % effective	50 % effective	90 %	90 %	100,000 US$ renewal of waste bins 50,000 US$/year awareness build-	% of wrong throws Waste characterisaton

Sector aspect	Current situation	Within 1 year	Within 2 years	Within 5 years	Within 10 years	Within 20 years	Involved budget	Verification and monitoring
							ing and promotion 50,000 US$/year monitoring and help desk staff	
		3 Waste reception centres constructed in Tortola 1 waste reception centre constructed each in Anegada, Jost Van Dyke and Virgin Gorda 50 % of citizens know the centres	Waste reception centres are operational and receive 50 % of wastes targeted by extended producer responsibliity and 80 % of bulk waste 75 % of citizens know and use the centres.	Waste reception centres receive 80 % of wastes targeted by extended producer responsibility and 90 % of bulk waste 90 % of citizens know and use the centres	Waste reception centres receive 90 % of wastes targeted by extended producer responsibility and 95 % of bulk waste 95 % of citizens know and use the centres	Waste reception centres receive 95 % of wastes targeted by extended producer responsibility and 95 % of bulk waste 95 % of citizens know and use the centres	1,700,000 US$ for 6 waste reception facilities 22,500 US$/month for staff costs (part time operation)	Physical presence of centres Citizen survey Waste registers of each reception centre
		Bottle bill/ deposit refund system applied to packaging, EEE, ELV	80 % effective Extension to batteries and products generating hazardous waste	90 % effective	90 % effective Extension to textile, shoes, furniture	95 % effective	12,500 US$ for bar code scanners 120,000 US$/year for workers Reverse vending machines to be acquired under EPR	Registers of reverse vending machines Registers of waste
Improvement of waste collection services	Standard service contracted to private sector according to collection zones	Performance based waste collection tenders Wet/dry collection with separate bins (colour code) Mobile truck for collection of special waste	Regular control of hazwaste and bulk waste deposits Regular litter removal Improved maintenance of collection vehicles	Citizen satisfaction 80 %	Citizen satisfaction 90 % Introduction of solar powered electric collection vehicles or equivalent (tender obligation)	Continuously good, efficient, cost and resource efficient waste collection service	25,000 US$ for consultancy (performance based collection tenders) 1,000,000 US$ for transition to electrical collection trucks	Observation of litter at waste bins Waste control at incineration/ composting plant Citizen satisfaction survey
Naval waste transport	Expensive and unreliable transport per private barge	Purchase of small barge for inter-island transport and shipping of recyclables to Puerto Rico	Shipping of non recyclable, non biodegradable waste from Anegada and Virgin Gorda to Tortola	Use of barge for inter-island transport of mobile waste processing equipment	Continuity of waste shipping services at cost price	Continuity of waste shipping services at cost price	500,000 US$ for purchase of barge	Physical presence of barge Frequency of use by private sector Absence of dumps on Anegada and Virgin Gorda
Recycling and composting	Small scale initiatives (< 5 % of overall recyclable	Worm composting facility is operational in Tortola	Upscaling of worm composting facility: 39 t/day	100 % of organic waste delivered by separate col-	100 % of organic waste delivered by separate col-	100 % of organic waste delivered by separate col-	Worm composting 2,500,000 US$ for initial investment	Waste characterisation Input/ output reg-

Sector aspect	Current situation	Within 1 year	Within 2 years	Within 5 years	Within 10 years	Within 20 years	Involved budget	Verification and monitoring
	waste) Composting initiative in preparation	(21 t/day)	The composting facility makes a benefit. Construction of composting plants in Virgin Gorda and Anegada	lection system is composted. Capacities of composting plants are adapted to increasing organic waste flow. Anaerobic co-digestion project operational	lection system is composted. Small scale organic agriculture is promoted in the BVI. Anaerobic co-digestion approach adopted for grouped settlements	lection system is composted. Quantities of organic local products on the market has increased by 100 % 10 % reduction of sewage related emissions	(private sector) Total of 3,800,000 US$ for successive upgrading Small scale composting: 50,000 US$ per facility	isters of composting facilities Survey of local agriculture initiatives
		Material recovery facility constructed in Tortola and Virgin Gorda	Material recovery facility is operational and breaks even. Export materials are treated as far as possible. Local recycling is promoted wherever possible	Material recovery facility is operational and makes a benefit	Material recovery facilities are upgraded to receive additional waste fractions under extended producer responsibility	Material recovery facilities treat all fractions to be handled for a full circular economy	1,100,000 US$ in Tortola 250,000 US$ in Virgin Gorda Operation costs to be borne by private sector. Subsidies by EPR for certain waste streams	Physical presence of material recovery facilities Degree of material conditioning to increase export prices Proportion of material locally valorised
		Land and attractive financing are made available to private recyclers upon submission of convincing business plan Private recyclers extend their capacities for local treatment and full recycling of: - glass - plastic	Private recycling lines are operational for - Construction & demolition waste - Vegetal oil - ELV/ ELB - WEEE and comply with environmental standards. Management and data treatment capacities are improved.	The full quantity of separately collected specific waste streams is treated by private recyclers. Waste related, financial and environmental data is regularly collected, analysed and communicated to DWM/ DEH	New waste streams (paper, textile, furniture…) are taken up by private recyclers	Full fledged circular economy is operational. Private recyclers keep track of the state of the art and regularly update and upgrade their operations.	Depends on technology chosen by private investor and on the size of the operation.	Physical presence of recycling facilities input/ output registers Site visits
Waste to energy	Simple mass-burn incinerator without stack gas treatment existing, but not operational	Existing incinerator is repaired, chimney height is extended and basic stack gas cleaning system installed.	Tender documents for new, state-of-the art waste to energy co-generation facility are elaborated taking into account actual numbers for efficiency of waste	New incinerator is constructed and operational. Excess heat is used to produce electricity + provide heat for rehabilitated desalination plant at	Input to the new incinerator decreases continuously with improved recycling and waste prevention. Compensation for capacity losses by	Phasing out of incineration. Stock of combustible material is used up, substitution of non-recyclable, non-biodegradable products and materials	25,000,000 US$ for state-of-the art incinerator with full stack gas treatment. Incineration cost estimated approximately 85 – 95 US$/tonne of wa-	Physical presence of incinerator Registers of steam/ heat/ electricity generation Registers of stack gas analysis system Waste input regis-

Sector aspect	Current situation	Within 1 year	Within 2 years	Within 5 years	Within 10 years	Within 20 years	Involved budget	Verification and monitoring
			prevention and recycling measures	Pockwood Pond (Alternative: central cooling). Old incinerator used as stand-by	landfill mining, incineration of stocked pallets and post shredder ELB/ ELV waste	allows transition to zero incineration system	ste	ters
Landfill	Open dump at Pockwood Pond in Tortola Hurricane debris dump in Cox Heath, Tortola Open dump in Virgin Gorda Open dump in Anegada	Construction of sanitary landfill in flood-safe land in Cox Heath for non recoverable incineration residues and inert waste	Open dumps at Pockwood Pond, Cox Hath, Anegada and Virgin Gorda are closed. Incineration residues are transferred to new sanitary landfill	Old dump sites are rehabilitated by landfill mining; combustible material is stocked to compensate for reduced input of incinerator	Subsequent termination of landfill mining, closure and complete rehabilitation of old landfill sites		770,000 US$ for landfill mining equipment (private investor) 3,700,000 US$ for construction of sanitary landfill	Physical presence of new landfill Installation of landfill mining equipment Material registers of landfill miner Plans, projects and physical realisation of rehabilitation

Annexes

Annex 1: Waste Characterisation Report

Annex 2: Action Plan

Annex 3: Materials Management Plan

Annex 4: Draft Waste Act

Annex 5: Household Waste Regulation

Annex 6: Commercial Waste Regulation

Annex 7: Financial and Technical Model (separate Excel table)

Annex 8: Waste Characterisation Results (Separate Excel Table)

Annex 9: Investment Plan (Separate Excel Table)

DEPARTMENT OF
DWM
WASTE MANAGEMENT

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