



Development of an E-waste Management Plan for the State of Goa



Inventory Report

by The Just Environment
Charitable Trust (Toxics Link)

Abbreviations

BFR: Brominated Flame Retardants

CPCB: Central Pollution Control Board

COP: Conference of the Parties

EEE: Electrical and Electronic Equipment

EoL: End of Life

HBBD: hexabromocyclododecane

PBDE: Polybrominateddiphenyl ethers

PCB: Polychlorinated biphenyl

POP: Persistent Organic Pollutant

PVC: Polyvinylchloride

TBBPA: tetrabromobisphenol A

WEEE: Waste Electrical and Electronic Equipment

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1. Background

E-waste or the Waste Electrical and Electronic Equipment (WEEE) is the worlds' fastest growing waste stream. Several factors, including the high 'obsolescence rate' and replacement market, rapid technological advances and increased 'market penetration' have led to this humungous growth. The Global E-Waste Monitor (2017) estimates 44.7 million metric tonnes of worldwide E-waste generation in 2016 which is equivalent to 6.1 kilogram per inhabitant. According to this global statistic, Asia generates the largest amount and in the same year India's generation of E-waste was estimated to be around 2 million metric tons. India's electronic industry is one of the fastest growing industries in the world. In its 2015 report UNEP predicts that the amount of E-waste generated from computer will become 5 times and mobile phones will become 18 times in India by 2020. While the global rise in E-waste is 23.5 per cent for the period of last thirteen years for India it is 26 per cent for the period 2015-2019.

Interestingly, only 20% of this global waste amount was documented to be collected and properly recycled, rest is undocumented. Of the undocumented, about 4% is thrown into the residual waste in higher income countries and the remaining 76% takes unknown pathways, mostly, dumped, traded or recycled under inferior conditions (Balde, Forti, Gray, Kuehr, & Stegmann, 2017), that is, routed to the informal markets. The amount of E-waste being controlled by the informal sector in India could be as high as 95% - thriving with both domestic and imported E-waste (Lines, Garside, Sinha and Fedorenko, 2016). Thus, the country, without having efficient technologies, adequate infrastructure or proper eco-system to deal with this waste stream, is bearing the burden of waste dumped from developed countries as well as its own growing waste.

The Indian State of Goa is also saddled with E-waste problem without any system to handle this in environmentally safe manner..In the first country level assessment of WEEE study carried out in 2005 by IRG Systems South Asia Private Limited (IRG-SSA), the quantity of WEEE generated in Goa was estimated to be 427.4 tones. Another assessment carried out in 2015 by Goa State Pollution Control Board (GSPCB) through UPL Environmental Engineers Ltd estimated total E-waste generation as 1000 tonnes of which 333 tonnes from personal computers and rest of the 667 tonnes from all other EEE products. This study had limitation of considering limited product range in its inventorisation also did not have the details on geographical spread of the waste generation. The Global E-waste Monitor 2017 estimates per capital E-waste generation in India as 1.5 kg with much larger e-waste product categories. Going by this per capita generation (which does not consider regional context), Goa would have E-waste

generation of 2,700 tones, considering the 2018 population of Goa. But the waste could be much higher as the State has very high penetration of EEE across different economic groups. The GSPCB annual report (2017-18) mentions only 13 E-waste producers in the State and the quantity of E-waste being collected as 449,300 kg/annum or 449 tonnes/annum. This report also suggests the existence of informal market in the State where most of the WEEE is getting channelized currently clearly suggesting absence of any sound mechanism to deal with the E-waste generated in the State.

Sustainable management of E-waste, at global, regional and local level, therefore, needs a clear understanding of the magnitude of the problem its quantification and the documentation of current practices. Current initiative of WEEE inventorisation in Goa is an effort to quantify e-waste considering all the waste categories and understanding the role of major stakeholders in the State— and first step towards safer management of E- waste.

1.1. Definition of E-waste

In the European Union directive on WEEE (2012), ‘Electrical and electronic equipment’ or ‘EEE’ is defined as any equipment ‘which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields and designed for use with a voltage rating not exceeding 1000 volts for alternating current and 1500 volts for direct current. Further the definition and categorisation of E-waste differs from country to country. The E-Waste(Management) Rules, 2016 in India defines ‘electrical and electronic equipment’ as those dependent on electric current or electro-magnetic field in order to become functional .E-Waste according to the same rule are electrical and electronic equipment, whole or in part discarded as waste by the consumer or bulk consumer as well as rejects from manufacturing, refurbishment and repair processes. It includes a wide range of products and is categorised in the rule into 21 equipment codes.

1.2. Policy Framework

Electronic waste has been recognised as the fastest growing hazardous waste stream of this century. But along with the hazardous toxic substances, this waste stream contains valuable and precious resources embedded in it. As developed countries have a strict environmental governance mechanism making recycling and handling of waste expensive, it leads to their global flow and treatment in informal industries in developing countries (Khan, 2016). However, the environmental and health risks associated with their exposure and vulnerability are many but still not fully understood.

Currently, 67 countries are covered by E-waste legislations (national), accounting for 66 per cent of the world population.

1.2.1. International: Basel Convention

The Basel Convention is an international treaty on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal designed to reduce the shipment of hazardous waste between nations. In particular, it is meant to prevent the shipment of hazardous waste to developing countries, where less strenuous or non-existent environmental laws could allow for the processing of waste in ways that would be forbidden in the waste's country of origin. The Convention started addressing e-waste issues since 2002, including among others, 'environmentally sound management, prevention of illegal traffic to developing countries and building capacity around the globe to better manage E-waste'. India has ratified the Basel convention in 1992 which restricts the countries (who have ratified the treaty) from transit of hazardous waste without consent or notification. However, reports suggest that developed countries continue to export their E-waste to developing countries in the garb of repair or reuse.

1.2.2. National: Indian Rules and Regulations

Following the introduction in Basel Convention, E-waste first came under regulatory framework in India in the year 2003 as part of the Hazardous Waste (Management and Handling) Amendment Rules, 2003. These rules specified the waste from electronic industry as hazardous and their handling and disposal shall be the responsibility of the generator ensuring no adverse effects. Also, electronic assemblies and their scraps were restricted for import. The first precise rule on E-waste in the country came into effect from 2012 as E-waste (Management & Handling) Rules, 2011. This rule introduced the concept of Extended Producer's Responsibility (EPR) for the producers to manage their end of the life electrical and electronic products. This rule was further replaced by the E-waste (Management) Rules, 2016 (came into effect from October, 2016) mandating targeted collection responsibilities to the producers and the maintenance of national registry. These rules aimed to ensure effective implementation and clear delineation of the role of producers. Manufacturer, Dealer, Refurbisher and Producer Responsibility Organization (PRO) have been introduced as additional stakeholders in the rules with specific roles. Compact Fluorescent Lamp (CFL) and other mercury containing lamp were brought under the purview of rules for the first time. The Rules set responsibilities for consumers & bulk consumers, collection centres, dismantlers, recyclers and regulatory agencies (SPCBs/PCCs) for effective compliance/implementation of these rules as well. Deposit Refund Scheme was introduced as an additional economic instrument wherein the producer can charge

an additional amount as a deposit at the time of sale of the electrical and electronic equipment. The rules were further amended as *E-Waste (Management) Amendment Rules, 2018* with relaxation in the EPR plan by reducing E-waste collection targets for industries.

1.2.2.1. Important Definitions under the rule: E-waste (Management) Rules, 2016

1. Bulk Consumer –It refers to bulk users of electrical and electronic equipment such as Central Government or State Government Departments, public sector undertakings, banks, educational institutions, multinational organisations, international agencies, partnership and public or private companies that are registered under the Factories Act, 1948 (63 of 1948) and the Companies Act, 2013 (18 of 2013) and health care facilities which have turnover of more than one crore or have more than twenty employees.
2. Collection centre –It means a centre or a collection point or both established by producers individually or as association jointly to collect E-waste for channelizing the e-waste to recycler and play such role as indicated in the authorisation for Extended Producer Responsibility granted to the producer and having facilities as per the guidelines of Central Pollution Control Board, including the collection centre established by the dismantler or refurbisher or recycler which should be a part of their authorisation issued by the State Pollution Control Board where the facility exists.
3. Consumer - It refers to any person using electrical and electronic equipment excluding the bulk consumers.
4. Dealer –It refers to any individual or firm that buys or receives electrical and electronic equipment as listed in Schedule I of these rules and their components or consumables or parts or spares from producers for sale.
5. Dismantler - It refers to any person or organisation engaged in dismantling of used electrical and electronic equipment into their components and having facilities as per the guidelines of Central Pollution Control Board and having authorisation from concerned State Pollution Control Board.
6. End of Life- For the product it means the time when the product is intended to be discarded by the user.
7. E-Retailer – It refers to an individual or company or business entity that uses an electronic network such as internet, telephone, to sell its goods.
8. Extended Producer Responsibility – It means responsibility of any producer of electrical or electronic equipment, for channelization of E-waste to ensure environmentally sound management of such waste. Extended Producer. Responsibility may comprise of

implementing take back system or setting up of collection centres or both and having agreed arrangements with authorised dismantler or recycler either individually or collectively through a Producer Responsibility Organisation recognised by producer or producers in their Extended Producer Responsibility – Authorisation.

9. Manufacturer - It means a person or an entity or a company as defined in the Companies Act, 2013 (18 of 2013) or a factory as defined in the Factories Act, 1948 (63 of 1948) or Small and Medium Enterprises as defined in Micro, Small and Medium Enterprises Development Act, 2006 (27 of 2006), which has facilities for manufacture of electrical and electronic equipment.
10. Producer – It refers to any person who, irrespective of the selling technique used such as dealer, retailer, and e-retailer.
11. Recycler - It means any person who is engaged in recycling and reprocessing of waste electrical and electronic equipment or assemblies or their components and having facilities as elaborated in the guidelines of Central Pollution Control Board.
12. Refurbisher - For the purpose of these rules, means any company or undertaking registered under the Factories Act, 1948 or the Companies Act, 1956 or both or District industries centre engaged in refurbishment of used electrical and electronic equipment

1.2.2.2. Applicability of the rule

Manufacturer: Collect E-waste generated during the manufacture of any electrical and electronic equipment and channelize it for recycling or disposal;

Producers: Implementing the Extended Producers Responsibility with the frameworks as mentioned in the E-Waste (Management) Rules, 2016. However the collection targets under Extended Producer Responsibility were relaxed according to the E-Waste (Management) Amendment Rules, 2018. Extended Producer Responsibility targets for producers, who have started sales operations recently, i.e. number of years of sales operations, is less than average life of their products mentioned in the guidelines is further reduced.

Table 1: E-waste collection targets for producers according to the E-waste (Management) Amendment Rules, 2018

Year	E-Waste Collection Target (Weight)
2017-2018	10% of the quantity of waste generation as indicated in Extended Producer Responsibility Plan.
2018-2019	20% of the quantity of waste generation as indicated in Extended Producer Responsibility Plan.

2019-2020	30% of the quantity of waste generation as indicated in Extended Producer Responsibility Plan.
2020-2021	40% of the quantity of waste generation as indicated in Extended Producer Responsibility Plan.
2021-2022	50% of the quantity of waste generation as indicated in Extended Producer Responsibility Plan.
2022-2023	60% of the quantity of waste generation as indicated in Extended Producer Responsibility Plan.
2023 onwards	70% of the quantity of waste generation as indicated in Extended Producer Responsibility Plan.

Table 2: E-waste collection targets for producers who have started their operation recently according to the E-waste (Management) Amendment, 2018

Year	E-Waste Collection Target (Weight)
2018-2019	5% of the sales figure of financial year 2016-17.
2019-2020	5% of the sales figure of financial year 2017-18.
2020-2021	10% of the sales figure of financial year 2018-19.
2021-2022	10% of the sales figure of financial year 2019-20.
2022-2023	15% of the sales figure of financial year 2020-21.

Collection Centres: Collect E-waste on behalf of producer or dismantler or recycler or refurbisher including those arising from orphaned products; Provided the collection centres established by producer can also collect E-waste on behalf of dismantler, refurbisher and recycler including those arising from orphaned products

Dealer: In the case the dealer has been given the responsibility of collection on behalf of the producer, the dealer shall collect the E-Waste by providing the consumer a box, bin or a demarcated area to deposit E-waste, or through take back system and send the E-waste so collected to collection centre or dismantler or recycler as designated by producer. Every dealer shall ensure that the E-waste thus generated is safely transported to authorised dismantlers or recyclers;

Refurbisher: Collect E-waste generated during the process of refurbishing and channelize the waste to authorised dismantler or recycler through its collection centre;

Consumer or Bulk Consumer: Consumers or bulk consumers of electrical and electronic equipment listed in Schedule I shall ensure that E-waste generated by them is channelized through collection centre or dealer of authorised producer or dismantler or recycler or through the designated take back service provider of the producer to authorised dismantler or recycler.

Dismantler: Ensure that the facility and dismantling processes are in accordance with the standards or guidelines prescribed by Central Pollution Control Board from time to time.

Recycler: Shall ensure that the facility and recycling processes are in accordance with the standards or guidelines prescribed by the Central Pollution Control Board from time to time.

State Government: Department of Industry in State or any other government agency authorised in this regard by the State Government, to ensure earmarking or allocation of industrial space or shed for E-waste dismantling and recycling in the existing and upcoming industrial park, estate and industrial clusters. State Government to prepare integrated plan for effective implementation of these provisions, and to submit annual report to Ministry of Environment, Forest and Climate Change.

1.3. E-Waste Categories& Life-span

E-waste (Management) Rules, 2016 categorises electrical and electronic equipment into two broad sections as, a) Information technology and telecommunication and b) Consumer electrical and electronics. There are further 21 product categories with respective codes in the rule to be considered as EEE (Table 3).

The UNEP E-waste Inventory Assessment Manual defines the Average life cycle/ obsolescence rate of electrical and electronic items as the time span after which the items come to their “end of life”. Average life time/ obsolescence rate is also an indicator of the ‘consumer behaviour’. This definition of average lifespan include storage time of EEE as well which might reflect a higher than actual lifespan of a product from consumer perspective. Also, the manual prescribes to carry out primary assessments for evaluating the average life of different products (EEE) as it depends on the consumer behaviour and varies from country to country, region to region. The Implementation Guidelines for E-Waste (Management) Rules, 2016 by the Central Pollution Control Board gives an estimate of the average life of the EEE-product categories in India (Table 3).

Table 3: Electrical and Electronic Equipment with life spans (CPCB Guidelines)

Categories of electrical and electronic equipment	Equipment code	Average Life(Years)
Information technology and telecommunication equipment		
Centralised Data Processing		
Mainframes	ITEW1	10

Minicomputers		5
Personal Computing: Personal Computers (Central Processing Unit with input and output devices)	ITEW2	6
Personal Computing: Laptop Computers (Central Processing Unit with input and output devices)	ITEW3	5
Personal Computing: Notebook Computers	ITEW4	5
Personal Computing: Notepad Computers	ITEW5	5
Printers including cartridges	ITEW6	10
Copying equipment	ITEW7	8
Electrical and electronic typewriters	ITEW8	5
User terminals and systems	ITEW9	6
Facsimile	ITEW10	10
Telex	ITEW11	5
Telephones	ITEW12	9
Pay telephones	ITEW13	9
Cordless telephones	ITEW14	9
Cellular telephones	ITEW15	
Feature Phones		7
Smart Phones		5
Answering systems	ITEW16	5
Consumer electrical and electronics		
Television sets (including sets based on (Liquid Crystal Display and Light Emitting Diode technology)	CEEW1	9
Refrigerator	CEEW2	10
Washing Machine	CEEW3	9
Air-conditioners excluding centralised air conditioning plants	CEEW4	10
Fluorescent and other Mercury containing lamps	CEEW5	2

However, the average life for some of the products was observed to be high in the guideline when compared to other inventories including those within the country. The E-waste inventory

in Karnataka and Andhra Pradesh (2009) has estimated the average life of personal computers as 3 years, printers as 4 years and mobile phones as 2 years. High rate of obsolescence often causes personal computers, mobile phones and even television to reach the E-waste collectors before their end-of-life. And hence these shorter life spans would most likely be end of first use and not really end of life.

1.4. Resources of Electrical and Electronic Waste

The potential of E-waste recycling depends on the elements that are used in the Electrical and Electronic Equipment. These elements are diverse, complex in nature and have both hazardous and non-hazardous ingredients including many precious and even rare earth metals. The European Topic Centre on Sustainable Consumption and Production mentions the E-waste in average being commonly comprised of steel and iron (about 50% of the weight), plastic (21%), various non-ferrous metals including precious ones (13%) and glass (5%). While these percentages may vary product to product and may change with time (due to changing of the technologies) but the elements are undeniably recoverable and resourceful. For instance, a typical mobile phone can contain over 40 elements including base metals like copper(Cu) and tin (Sn); special metals such as lithium (Li) cobalt (Co), indium(In), and antimony (Sb); and precious metals such as silver (Ag), gold (Au),and palladium (Pd). Electronics market now consumes almost 80%of the world's demand of indium (transparent conductive layers in LCD glass); over 80% of ruthenium (magnetic properties in hard disks) and 50%of antimony (flame retardants).Table 5, 6, 7 and 8 gives the type and amount of recoverable elements in Personal Computers, Television and Refrigerator respectively.

Table 4: Amount of Recoverable Elements in Personal Computer (Flat Display Monitor)

Personal Computer (Flat Display Monitor)				
Elements	Content (%) of total weight)*	Content (kg)*	Recycling efficiency (%)*)	Recoverable weight of element (kg)[#]
Plastics	23	3.49692	20%	0.699384
Lead	6	0.91224	5%	0.045612
Aluminum	14	2.12856	80%	1.702848
Germanium	0.0016	0.000243	0%	0
Gallium	0.0013	0.000198	0%	0
Iron	20	3.0408	80%	2.43264
Tin	1	0.15204	70%	0.106428
Copper	7	1.06428	90%	0.957852
Barium	0.0315	0.004789	0%	0
Nickel	0.8503	0.12928	0%	0

Zinc	2	0.30408	60%	0.182448
Tantalum	0.0157	0.002387	0%	0
Indium	0.0016	0.000243	60%	0.000146
Vanadium	0.0002	3.04E-05	0%	0
Terbium	0	0	0%	0
Beryllium	0.0157	0.002387	0%	0
Gold	0.0016	0.000243	99%	0.000241
Europium	0.0002	3.04E-05	0%	0
Tritium	0.0157	0.002387	0%	0
Ruthenium	0.0016	0.000243	80%	0.000195
Cobalt	0.0157	0.002387	85%	0.002029
Palladium	0.0003	4.56E-05	95%	4.33E-05
Manganese	0.0315	0.004789	0%	0
Silver	0.0189	0.002874	98%	0.002816
Antimony	0.0094	0.001429	0%	0
Bismuth	0.0063	0.000958	0%	0
Chromium	0.0063	0.000958	0%	0
Cadmium	0.0094	0.001429	0%	0
Selenium	0.0016	0.000243	70%	0.00017
Niobium	0.0002	3.04E-05	0%	0
Yttrium	0.0002	3.04E-05	0%	0
Rhodium	0	0	50%	0
Mercury	0.0022	0.000334	0%	0
Arsenic	0.0013	0.000198	0%	0
Silica	24.8803	3.782801	0%	0

Table 5: Amount of Recoverable Elements in Television

Elements	Content (% of total weight)*	Recoverable weight of element (kg)[#]
Aluminium	1.2	0.4344
Copper	3.4	1.2308
Lead	0.2	0.0724
Zinc	0.3	0.1086
Nickel	0.038	0.013756
Iron	12	4.344
Plastic	26	9.412
Glass	53	19.186
Silver	20 (ppm)	0.000724
Gold	10 (ppm)	0.000362

Table 6: Percentage of Recoverable Elements in Refrigerator

Material Type	% body weight	Recoverable weight of Element (kg)
CFCs	0.2	0.075616
Oil	0.32	0.1209856
Ferrous Metals	46.61	17.6223088
Non-Ferrous Metals	4.97	1.8790576
Plastics	13.84	5.2326272
Compressors	23.8	8.998304
Cables/Plugs	0.55	0.207944
Spent PurFoam	7.6	2.873408
Glass	0.81	0.3062448
Mixed	1.3	0.491504
Total	100	37.808
Materials disposed of to incinerator	0.2	0.075616
Materials disposed of to landfill	8.9	3.364912
Materials sent for Recycling	90.9	34.367472

*UNEP E-waste Inventory Assessment Manual (2007)

#Recoverable weight calculated against the average weight from:Fortiet al.2018. United Nations University

1.5. Hazards of E-waste

The hazards of E-waste are associated with the hazardous elements, metals, toxic chemicals used in EE items or produced as by-products during their processing. These elements vary from toxic heavy metals (lead, cadmium, arsenic, mercury, etc.), to polychlorinated biphenyls (PCs), brominated flame retardants (poly-brominated diphenyl ether, etc.). Exposure can happen at any stage if not managed properly and handled crudely during its collection, transport, storage, repair or refurbish and recycling. Given the current situation in India as well as in Goa, E-waste is managed (including recycling) mostly informally leading to severe environmental and human health implications. The workers engaged in informal E-waste management work without any safety measures and are directly exposed to alarmingly high degrees of such hazardous elements.

Table 7: Possible Hazardous Contents of E-waste, the Source of hazard and their Impact

E-Products	Possible Hazardous Content	Source of Hazard	Impacts
Computer	BFR, Lead, Mercury, Cadmium, Beryllium, PVC, PCB, Arsenic	1. Landfill – Leaching of heavy metals (Lead, Cadmium, Copper, Nickel, Zinc, Tin) and organic compounds. Evaporation of mercury and methyl mercury, formed as a result of reaction with the surroundings. 2. During the lifespan of EEE products – PBDE and Phthalates are released into the atmosphere as the EEE product gets heated, such as Laptops, Computer and Phones. 3. Collection and Dismantling – Dust containing heavy metals is released during dismantling. Broken CRT release Dust containing Lead and Barium oxide. Even volatile compounds, such as Mercury are released from broken components. Dismantling with bare hands also leads to exposure to toxic components. 4. Shredding – Dust containing various compounds (Including BFR, Phthalates, and Cadmium). Unsafe shredding practices also lead to exposure to toxic elements. 5. Acid Extraction – Harmful acidic fumes are released due to reaction with hazardous components.	1. BFR – Possible disruption of thyroid functioning. Decrease in the fecund ability in women. 2. PCB – Used in EEE because of its high stability when comes in contact with the environment contaminates air, water and soil as it does not break down easily. 3. PVC - Its combustion releases hydrogen chloride which is a toxic gas and also dioxin which is a man-made carcinogen. 4. Mercury –In humans it can cross the placenta barrier and affect the developing system of the baby. Inorganic mercury can convert to methyl mercury, which is toxic and a possible carcinogenic in nature. 5. Lead - Children and pregnant women are particularly susceptible to lead
Laptop	BFR, Lead, Mercury, Cadmium, Beryllium, PVC, PCB, Arsenic		
Printer	BFR, Lead		
Photocopy Machine	BFR, Beryllium		
Mobile Phones	BFR, Lead, Beryllium, Cadmium		
Television	Lead, Antimony, Mercury, Phosphorous, Cadmium (LED, LCD)		
Refrigerator	PCB, CFC Based coolants		
Air-Conditioner	PCB, PVC, Cadmium		
Tube lights	Mercury-		

	Phosphorous amalgam, Flame Retardants	6. Open Burning – All hazardous components of the product are released directly into the air. 7. Dumping of residual	poisoning. Lead being a neurotoxin interferes with development, especially at a tender age and cause brain damage.
CFL Bulbs	Mercury- Phosphorous amalgam, Flame Retardants	Materials – Leaching of elements in the dumping site. Secondary exposure via contaminated water and air. 8. PC-board heating – Exposure to fumes containing BFR, Lead, Mercury, Cadmium, Beryllium, PVC, PCB,	6. Cadmium – In humans, Cadmium accumulates in the kidneys where it damages filter mechanism. When released as fine airborne particles then
Microwave	Lead, Beryllium, PCB	from the PC-boards and solders of Laptop and Computer.	react almost immediately with oxygen to form cadmium oxide, which is a carcinogen, polluting the air.

2. Objective and Methodology

The purpose of this study is to obtain an indication of the volume of E-waste generation in Goa and the ways in which waste electrical and electronic equipment (WEEE) are managed in the State. The survey is intended as a basis for the relevant government agencies to formulate further solutions for the environmentally sound management of used and end-of-life EEE. The assessment will help in determining the requirements for developing the collection, storage and disposal plans for E-waste in the State.

Specific Objective

- To assess the category wise generation of E-waste in Goa – both current and projected estimations considering the major stakeholders in the State.
- To evaluate the current E-waste disposal practices and systems by households and bulk consumers.
- To understand the current practices in informal sector

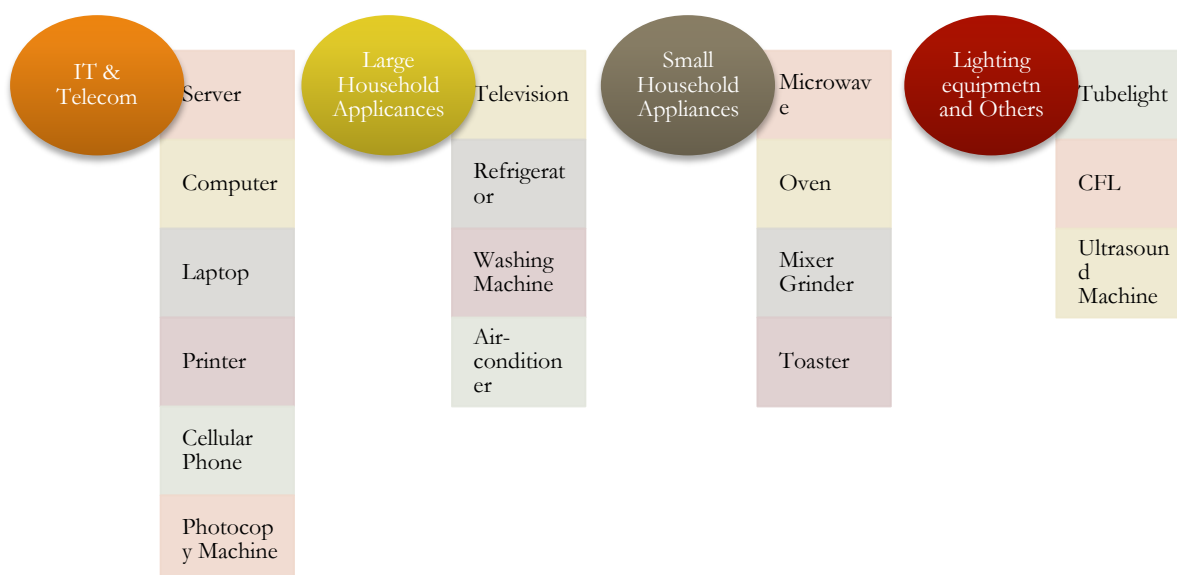
Globally, various methodologies have been used to assess WEEE – both in developed and developing countries. All of these are based primarily on ‘Material Flow’. According to UNEP’s Manual on E-waste Inventory Assessment, the following methodologies can be used, depending on data availability-

1. The Time Step Method.
2. The Market Supply Method.
3. The Carnegie Mellon Method.
4. Approximation Method 1.
5. Approximation Method 2.

Each of these methods has its own requirements and limitations. Therefore, the selection of E-waste inventory assessment methodology of the State of Goa is based on the availability and reliability of data.

2.1. Target Equipment

This survey is focused on mainly four categories of electrical and electronic equipment (EEE) only i.e. IT & Telecom, Large Household appliances, small household appliances and mercury bearing lighting equipment but also included medical equipment like ultra sound machine. The list of equipment included in the inventorisation is as indicated in the figure below.



2.2. Target Audience

E-waste (Management) Rules, 2016 applies to every manufacturer, producer, consumer, bulk consumer, collection centres, dealers, e-retailer, refurbisher, dismantler and recycler involved in manufacture, sale, transfer, purchase, collection, storage and processing of E-waste or electrical and electronic equipment. To understand the quantum of E-waste generation in the State, current inventorisation has considered all the major generators of the waste in the State and has also included other select stakeholders to understand the current practices. There are three main target respondents included in the survey study

- Households
- Offices (business entities and institutions)
- Recyclers (Including collectors, second-hand shops, repair shops, dismantlers of used EEE).

2.3. Geographic Distribution

The respondents were required to be geographically diverse and to cover the socio-economic spectrum to reflect as closely as possible the potential E-waste generation trend in Goa. Hence surveys were conducted in both the Districts, covering all the major Talukas. The basis for the selection of the survey location is based on the population density and also the socioeconomic status of the areas.

2.4. Secondary Research

Review of secondary information, international and national reports, inventories and other literatures was carried out as a first step toward making the inventory. This helped in,

- Identifying the different source categories of stakeholders existing/operating in the State to be considered for estimation
- Formulating an inclusive methodology and to generate baseline information on product wise obsolescence rate/average life span, average weight considering the change over time and possible resource recovery.
- Devising the questionnaires to carry out interviews with different stakeholders.

Alongside collecting primary data, the process of accurately estimating the amount of E-waste that will be generated in the current year and the course that it will take, included collating secondary data base from reliable sources. The following data was collected from secondary sources,

- Demography of Goa – The total population and total number of households in Goa were sourced from the census data 2011. Population of Goa, according to the Census of India, 2011, is 1,458,545 of which 739,140 and 719,405 are the male and female population respectively. The Taluka wise population was also included to assess Taluka wise waste generation, especially from households.

Table 8: Goa- Population

Total Population	1458545
Total Number of Households	343611
Taluka	Population
North District	
Bardez	237440
Bicholim	97955
Pernem	75747
Ponda	165830
Satari	63817

Tiswadi	177219
South District	
Canacona	45172
Dharbandora	35000*
Mormugao	154561
Quepem	81193
Salcete	294464
Sanguem	30147

- **Average Life** – The average life was sourced from the Implementation Guidelines for E-waste (Management) Rules, 2016 (Table 3). For the products which were beyond the scope of the Rules (Microwave, Oven, Toaster and Mixer Grinder) their life spans were calculated in accordance with the data collected from the survey (Household/ Bulk Consumer) and also looking at previous inventory studies.
- **Average Weight** – The average weight was sourced from E-waste Statistics: Guidelines on Classifications, Reporting and Indicators, second edition. United Nations University. For products which have not been included in this study or Inventory Manual by UNEP (Oven, Toaster and Mixer Grinder) their average weights were sourced from other inventories if available, otherwise information was collected from market to arrive at an average weight. The average weights, taken into consideration, have been listed in the table below Table 9.
- **Growth Rate** – The growth rate were determined by doing an extensive research on Market penetration rate available across various sources. Annual Reports from Ministry of Electronics and Information Technology (MEITY), Associated Chambers of Commerce and Industry of India (ASSOCHAM), India Brand Equity Foundation, Price Waterhouse Coopers (PWC) and International Data Co-operation (IDC). (Table 10)

Table 9: Average Weight and Growth Rate used for Electronic Products

Electronic Product	Average Weight	Growth Rate
Server	40	24
Computer	15	-9
Laptop	3.00	40
Printer	5.00	24
Photocopy Machine	22	24
Mobile Phone	0.10	20
Television	15.00	14

Refrigerator	38.00	11
Air-conditioner	27	11
Tube lights	0.11	-10
CFL bulbs	0.08	-10
Microwave*	5	11
Ultra Sound**	67.04	15
Oven*	5	11
Toaster*	1	11
Mixer Grinder*	3.3	11

* Only included for the Household Survey

** Only included for the Bulk consumer Survey

2.5. Primary Research

2.5.1. Interviews

Structured and unstructured interviews/surveys were conducted with various stakeholders depending on the group requirements. These interviews were conducted over a period of 3-4 weeks in Goa by a trained team.

2.5.2. Questionnaire based Survey

Four principal types of questionnaire were designed by the Project Team for data collection purposes. The questionnaires were designed with different content and format depending on the respondent group. Before the questionnaires were administered to the respective target groups, a pre-test was conducted to ensure the suitability and the relevance of the questions to this survey. Some questions were removed from the original questionnaires that were deemed to be redundant or that would not be useful in the data analysis. Where it is relevant, additional information was included in the questionnaires to enable the analysis to reflect the ground reality. While most questionnaires were administered in person, in case of some bulk consumers, it was also sent via e-mails as getting appointment for personal interviews was proving to be a challenge.

2.2.1 Data Collection

In order to have an inclusive and representative data base ensuring the E-waste generation across various stakeholders, surveys, interviews, interactions and observations were carried out for consumers, bulk consumers, dealers/distributors and collectors/recyclers. The methodologies for primary assessment were devised considering the secondary information researched and using the organisational expertise of working on E-waste and E-waste inventories across the

country. Total sample size for the primary survey is 400. Of this 200 consumer survey (households), 180 bulk consumers, 10 dealers and 10 informal E-waste collectors/ repair shops survey were carried out (Questionnaires in Annexure 1, 2 & 3). A real-time geo-tagged app developed by United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA) was used for carrying out the surveys for authentication purpose.

Household Survey

- Sample size- Determining a sample size to be surveyed is crucial as it has to be representative of the population size. The formula used for calculation is Cochran's Sample Size Formula –

$$n_0 = \frac{Z^2 pq}{e^2}$$

Where, e is the margin of error

p is estimated proportion of population which has the attribute in question

q is 1-p

Z is the z-score,

According to the Census 2011 96.9% of households have electricity in Goa therefore the value of p is safely considered to be 0.9 and q thus becomes 0.1. The margin of error is 4.5%

Z-score for 95% confidence interval is 1.96

Using these values the value $n_0 \approx 171$

For convenience of calculation **200** households were surveyed. Assuming a non-response rate of 10% the value of $n_0 \approx 220$

- The household survey was designed in stratified random sampling method in order to take into account the following factors:
 - i. Type and number of products, product usage time period and product lifespan might differ in different income group households contributing to the reason why the survey was conducted equally in all income groups.

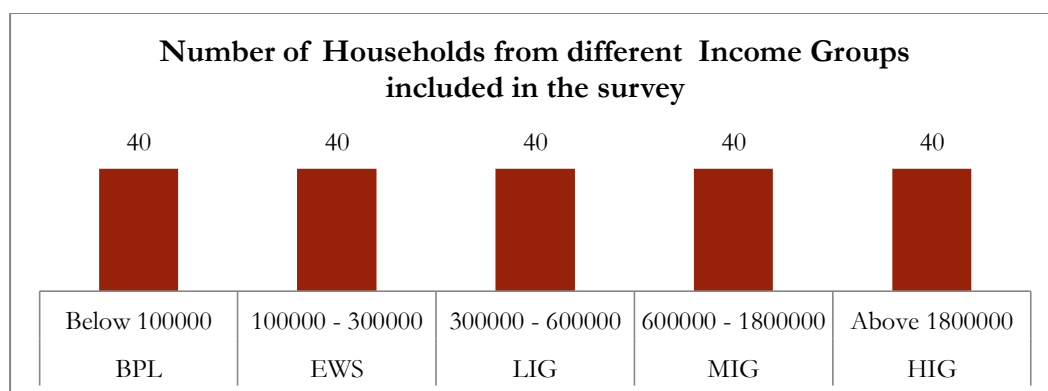


Figure 1: Survey across different economic section in households

- ii. In order to have more accurate and representative data, the household survey was conducted in both Rural and Urban areas, across both North and South Goa Districts (100 household survey in each District).
- The current stocks in households in Goa were tabulated through the questionnaire.
 - The current practices, including disposal practices (both for functional and non-functional EEE), was also tabulated and further analysed.

Table 10: List of Stakeholder Categories and sub-categories considered in the primary study

Stakeholder Categories	Sub-categories (strata) covered in survey
Consumer	a. Urban, Rural b. North & South Districts c. Different income group households: BPL, EWS, LIG, MIG & HIG
Bulk Consumers	• Central Government • State Government Departments • Public Sector Undertakings • Banks: a) Nationalised, b) Private • Educational Institutions: a) Secondary Government School, b) Secondary Private School, c) College, d) University • Private Companies/Offices: a) Pvt. Ltd Companies b) GST Registered Entities • Health Care Facilities: a) Government; b) Private

	- Hotels: a) Category A, b) Category B, c) Category C, d) Category D - IT Companies - Industrial Areas
Dealers/Retailers	Dealers dealing with all categories of electrical and electronic products
Processors	E-waste Collectors, E-waste dismantlers

Bulk Consumer Survey

Different types of bulk consumers are already defined in the E-waste (Management) Rules, 2016. Taking into consideration the Rules categories, along with the regional context in Goa, the sub-categories of bulk consumers were created for collection of data.

Table 11: Number of survey done category wise in Bulk consumers

Bulk Consumer	Number surveyed	Total Number of Bulk Consumer
Hospitals	9	152
Hotels	16	4399
Bank	2	817
IT companies	8	150
Industries	50	2183
Colleges	8	79
Schools	7	1729
Private Offices	5	35474
Central Government	3	30
State Government	72	148

Data collection for each category (and subsequent sub categories) was done as follows –

- Hospitals** – There are total 103 Private Hospitals and 49 government hospitals in Goa (Toxics Link, 2018), government hospitals included medical college, District hospital, Sub-district Hospitals, Primary Health Centres, Central Health Centres and Urban Health Centres. Data was collected from one hospital from each category in order to be more inclusive in approach. Rest of the survey included five private hospitals.
- Hotels** – According to the Tourism website of Goa, Hotels are divided into four categories A, B, C, D. This categorisation is according to the amenities provided by the hotels therefore the electronic products being used and waste generated are in

proportion to their categories , therefore data was collected from 4 hotels in each category is inclusive and representative of all classes. .

- **Banks** – In Goa most banks do not have branches spread out uniformly across all Districts rather concentrated few populous cities like Panaji, Mapusa, Margao, Ponda and Vasco. Therefore data was collected from one bank for their 53 branches spread across the State and other was collected from Panaji. The sample size and data is representative of banking sector and provides a comprehensive data on holding of EEE. This sample size has been further analysed to represent the complete sector.
- **IT companies** – Given the difficulty in obtaining data from IT companies there was a restriction in collecting the data therefore number of employees and their surveys were taken into consideration and the calculation was done accordingly. IT companies was divided into two categories, big IT firms with employees around 1500 or greater and small IT firms with lesser number of employees. There are four big companies and survey was conducted from individual employees from each of these companies and four surveys were conducted for smaller IT firms. The data so obtained during survey was analysed and computed for the total number of personnel employed in this sector.
- **Industries** – Industries were divided into four categories based on shed sizes - <1000 sq.mt, 1000-10000 sq.mt, 10000-25000 sq.mt and >25000 sq.mt, as obtained from the Goa Industrial Development Corporation website. The data was collected from 51 of these industries representing each of these categories and calculations were done accordingly.
- **Colleges** – They were divided into 4 categories as per data available from the Education Department website. Colleges were grouped into
 1. Non professional
 2. Professional
 3. Technical
 4. EngineeringIn each category two surveys each were conducted, and data so obtained was further computed to obtain the total holding of the sector.
- **Schools** – Schools were sub categorised further into four categories as per data available from Education Department website,
 1. Government high/ higher secondary school – 1 school was surveyed
 2. Government aided/unaided high/higher secondary school- 2 schools were surveyed
 3. Government Primary Schools – 1 school was surveyed

4. Government aided/unaided primary schools – 3 schools were surveyed,

- **Private Offices-** Private offices were further sub categorised on the basis of two categories registered private limited office (bigger companies) in which five survey were conducted and 20 surveys was conducted in the category of registered companies for GST (smaller companies and data so obtained was computed for both large and small offices.
- **Central Government-** Survey was conducted at three departments and further calculated for 42 departments present across the State.
- **State Government -** IT data of 72 departments was obtained from records provided by the Department of Information Technology (DoIT). As this data also included data from government colleges hence the number of colleges was omitted and the total EEE holding was computed for 148 State departments.
- Number of Electronic Products being used and their average life were tabulated through the questionnaire for calculating the quantity of waste being generated.
- The current practices, including disposal practices (both functional and non-functional), present awareness level on E-waste and preferences on disposal were also tabulated and further analysed.

2.2.2 Estimation of the waste: Data Analysis and Data Projection

Depending on the data availability, Estimate method, also known as ‘consumption and use’ or ‘Approximation 1’ method (Wilkson S. et al, 2001), was found to be most suitable for E-waste inventory. The same method was used to calculate WEEE in the Netherlands (Bureau B&G, 1993) and was also used by NGS for WEEE estimations for the German Federal State of Lower Saxony (Mertins & Strobel, 2000). Estimate method calculates WEEE generated by calculation stock, which in this case is divided into two categories stock household and stock bulk consumer with an assumption of average lifetime (which in this case has been taken from CPCB guidelines). Stock of each product was calculated which was then divided by average lifetime and the summation gave us the waste generated in the current year. The market growth rate was applied to the ownership for 7 subsequent years (starting 2018) and the ownership records were used to calculate waste.

Household

The household survey results were exported into excel sheets for convenience and were used to arrive at the EEE ownership in the surveyed households. These were then extrapolated to the

total number of households in Goa- taken from the Census data. This gave us the total ownership of EEE in household in both the Districts of Goa. Taluka wise ownerships were also arrived using the available Taluka wise population. Individual product weights were then used to arrive at the EEE ownership by weight in Goa. This gave us the stock data at the household levels. The calculations were done individually for each product category. Waste Generated for each product was obtained by using the estimation method. This was then summed to tabulate the total waste generated in the current year.

The stock data (by weight and number) was project till 2025 by using the tabulated growth rates for each product category. These stock data were then used to calculate projected waste till 2025.

$$\text{WEEE Generated}_h (\text{Current Year}) = \sum \text{WEEE Generated}(\text{Product})_h$$

$$\text{WEEE Generated}_h (\text{Product}) = \text{Stock Weight (Product)} / \text{Average life}$$

$$\text{Stock Weight (Product)}_h = \text{Stock Number (Product)}_h * \text{Average Weight}$$

$$\text{Stock Number (Product)}_h = \text{Number of households} * \text{Saturation level of each product}$$

$$\text{Saturation (Product)}_h = \text{Total Number of product in the survey} / \text{Total number of Households surveyed}$$

Bulk Consumer

In each category of Bulk consumers there were subcategories considered. Bulk consumer survey across these subcategories gave us the average usage in that subcategory. This average was then

$$\text{WEEE Generated (Current Year)}_{BK} = \sum \text{WEEE Generated (Product)}_{BK}$$

$$\text{Total WEEE Generated (Product)}_{BK} = \sum \text{WEEE Generated (Product)}_{BK}$$

$$\text{Total Stock Weight (Product)}_{BK} = \sum \text{Stock Weight (Product)}_{BK}$$

$$\text{Total Stock Number (Product)}_{BK} = \sum \text{Stock Number (Product)}_{BK}$$

For Bulk consumer individually-

$$\text{WEEE Generated (Product)} = \text{Stock (Product)} / \text{Average life}$$

$$\text{Stock Weight (Product)} = \text{Stock Number (Product)} * \text{Average Weight}$$

$$\text{Stock Number (Product)} = \text{Total Number of bulk consumers} * \text{Saturation level (product)}$$

$$\text{Total Saturation level (Product)} = \sum \text{Saturation Level Sub Category (Product)}$$

For subcategories in Bulk Consumer:-

used to arrive at the total number of EEE stock (product wise) in that subcategory, which was then added to get a total EEE stock in a particular category of bulk consumer. For example if Schools were the considered category, these were subcategorised into a) Government high/higher secondary, b) Government aided/unaided high/higher secondary c) Government Primary and d) Government aided/unaided primary. For each of these, surveys gave us average usage of EEE in numbers (for each product category) and these were then extrapolated to arrive at the total number in each of those. The total of all these four subcategories were added up to arrive at total EEE stock in schools. The subcategories for each category were first calculated and that gave us the total for each category, which was then added to get the total EEE stock for the entire bulk consumer.

The estimation method has been applied to the Bulk consumer stock (by weight) to arrive at the WEEE generated by this segment in Goa. This was done for each product category, which was then summed up to arrive at the total amount of WEEE.

The Waste generation of subsequent years was done according to the growth rate of each product as explained in households.

$$\text{WEEE Generated (i+1)} = \sum_1^x \text{WEEE Generated Product}(x) + \text{Growth Rate (x)} * \text{WEEE Generated Product (x)} * 0.01$$

Where ‘i’ refers to the previous year on whose basis the calculations are being done in the current year and x refers to each product and accordingly the waste generated and growth rate. The same formula was applied for calculating WEEE generated in subsequent years.

The total WEEE in Goa was calculated by adding the WEEE from both households and bulk consumers.

$$\text{Total WEEE for each year} = \sum \text{WEEE Generated(Product)}_h + \sum \text{WEEE Generated (Product)}_{BK}$$

3. Result & Analysis

This chapter describes the E-waste inventory and scenario for E-waste management system in the two Districts of Goa. The inventory assessed waste generation in the State from individual as well as bulk consumers, as this will form the basis of planning for E-waste management system in the State. The current practices related to usage and disposal have also been documented and analysed.

3.1. Market Size Assessment of Electrical and Electronic Equipment in Study Area

Households

It is evident from the survey that EEE, especially mobile phones, laptops, television, Refrigerator, washing machines and mixer grinder have a high penetration among the households in Goa with more than 90% households owning at least one of each of these. The figure below (Figure 2) clearly shows that mercury bearing lamps are also a product of common usage among households in the State, with CFL more popular but tube lights which are seen as slowing down also have a penetration of 86.5%. Surprisingly, computers and printers, at 22.5% and 24.5%, have a low penetration among households.

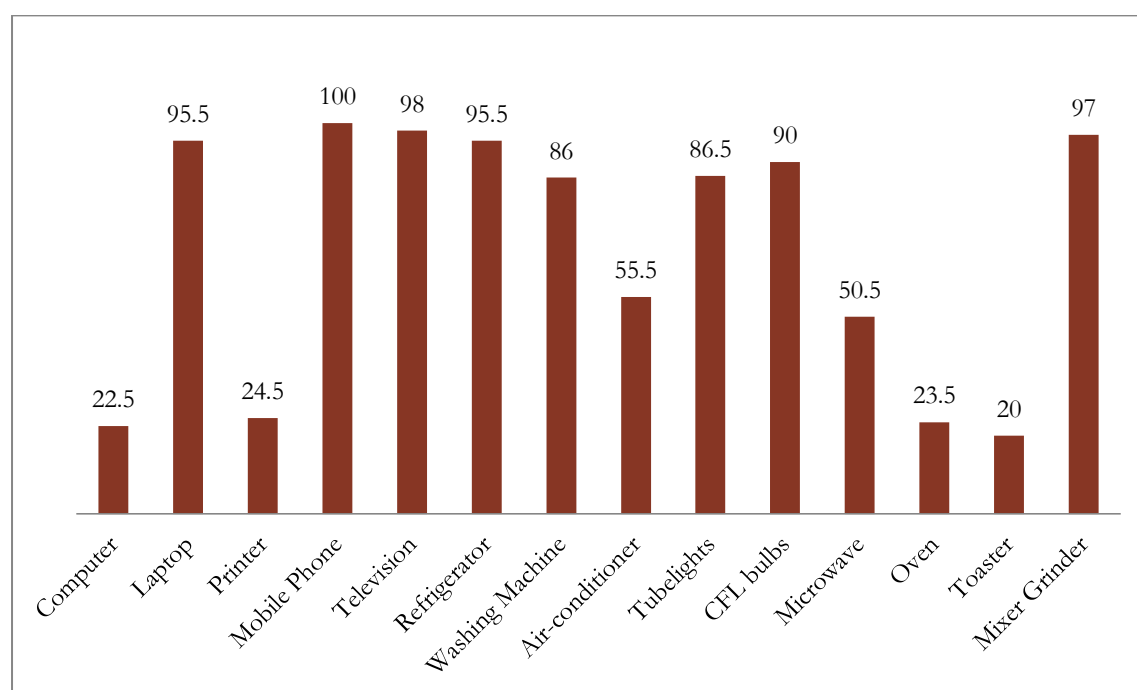


Figure 2: Usage Pattern of Electrical and Electronic Equipment (in percentage of households)

Though the figure above gives an idea of the household wise penetration of EEE, the absolute numbers for each product is much higher on account of multiple numbers of same products owned by some households, varying with economic status. For example, a higher income group

household has multiple air conditioners, televisions or laptops. The time series data related to market ownership of each of the EEE items among households has been computed from data obtained from different agencies as well as from trend analysis. The EEE market size for air-conditioners, refrigerators, washing machines, personal computers, cellular telephones, TVs, mercury bearing lamps and other items as per Schedule 1 and additional equipment like microwave, oven and toaster is shown in the table below-providing the ownership numbers for different equipment among households in Goa. This takes into account the national growth rates (in certain case reverse growth) for different equipment as explained in the methodology section but in actual it may differ slightly for Goa.

Table 12: Installed base of EEE (in numbers) in Goa Households

Electronic Product	2018	2019	2020	2021	2022	2023	2024	2025
Computer	91057	82862	75404	68618	62442	56822	51708	47055
Laptop	599601	839442	1175218	1645306	2303428	3224799	4514719	6320606
Printer	96211	119302	147934	183438	227464	282055	349748	433687
Mobile Phone	1594355	1913226	2295871	2755046	3306055	3967266	4760719	5712862
Television	469029	534693	609550	694887	792171	903075	1029506	1173637
Refrigerator	357355	396665	440298	488730	542491	602165	668403	741927
Washing Machine	321276	356617	395845	439387	487720	541369	600920	667021
Air-conditioner	542905	602625	668914	742494	824169	914827	1015458	1127159
Tube lights	1279951	1151956	1036760	933084	839776	755798	680218	612197
CFL bulbs	2889769	2600792	2340712	2106641	1895977	1706379	1535741	1382167
Microwave	183832	204053	226499	251414	279070	309767	343842	381664
Oven	84185	93445	103724	115134	127798	141856	157460	174781
Toaster	85903	95352	105841	117483	130406	144751	160674	178348
Mixer Grinder	410615	455783	505919	561570	623343	691910	768021	852503

Analysis of the table above (Table 12) shows that CFL have the highest installed base in numbers; followed by cellular phone, tube light, laptop, air-conditioner, television and mixer grinder. But the scenario is different when we take into account the equipment weights. The average weight of equipment, as explained in the methodology section, has been used to calculate per household EEE ownership in tonnes. As evident from the table below (Table 13), refrigerators and air -conditioners have the highest

ownership by weight in Goa households. The table (Table 13) also estimates the ownership till 2025. Prominently, laptop ownership shows a huge jump over time.

Table 13: Installed base of EEE (in tonnes) in Goa Households

Electronic Product	2018	2019	2020	2021	2022	2023	2024	2025
Computer	1365.85	1242.93	1131.06	1029.27	936.63	852.34	775.63	705.82
Laptop	1883.95	2637.53	3692.54	5169.55	7237.37	10132.32	14185.25	19859.34
Printer	481.06	596.51	739.67	917.19	1137.32	1410.27	1748.74	2168.44
Mobile Phone	162.62	195.15	234.18	281.01	337.22	404.66	485.59	582.71
Television	7035.44	8020.40	9143.25	10423.31	11882.57	13546.13	15442.59	17604.55
Refrigerator	13510.89	14997.09	16646.77	18477.92	20510.49	22766.64	25270.97	28050.78
Washing Machine	9638.29	10698.50	11875.34	13181.62	14631.60	16241.08	18027.60	20010.63
Air-conditioner	14495.57	16090.09	17860.00	19824.60	22005.30	24425.88	27112.73	30095.13
Tube lights	140.79	126.72	114.04	102.64	92.38	83.14	74.82	67.34
CFL bulbs	231.18	208.06	187.26	168.53	151.68	136.51	122.86	110.57
Microwave	919.16	1020.27	1132.50	1257.07	1395.35	1548.84	1719.21	1908.32
Oven	420.92	467.23	518.62	575.67	638.99	709.28	787.30	873.90
Toaster	85.90	95.35	105.84	117.48	130.41	144.75	160.67	178.35
Mixer Grinder	1355.03	1504.08	1669.53	1853.18	2057.03	2283.30	2534.47	2813.26
Total Installed EEE	51726.66	57899.89	65050.60	73379.04	83144.33	94685.15	108448.43	125029.16

This calculation of ownership does not take into account population growth and hence there could be some increase in the amounts of EEE ownership in projection.

Bulk Consumers

Ownership of equipment in the bulk consumer segment took into account different categories like Government and Private offices, Hospitals, Hotels, Banks, IT companies, Industrial areas and Educational Institutions. Tube light followed by CFL and computer recorded the highest numbers in the Bulk consumer segment. Specialised equipment like Ultrasound records the lowest.

Table 14: Sector wise Installed EEE (in numbers) among Bulk consumers in Goa

Bulk consumers	Central govt.	State govt.	Private Offices	Hospitals	Hotels	Banks	IT	Industries	Schools	Colleges	Total
Servers	180	441	3074	128	1450	3268	176	1392	443	126	10678
Computer	5040	15830	116228	1412	11203	9804	2294	33082	17466	8210	220569
Laptop	1420	1425	21767	150	2873	200	882	18160	1529	512	48918
Printer	1800	6490	19914	402	3713	2451	265	10916	2873	1036	49860
Photocopy	120	592	1015	119	848	613	0	1700	1075	1036	7118
Mobile	30	148	2029	155	1696	817	108	3467	0	1036	9485
TV	360	294	11091	1692	50455	450	88	2606	1086	150	68272
Refrigerator	150	0	8499	961	36048	170	88	2442	543	176	49077
Air Conditioner	3150	1900	40626	2148	54063	4085	441	18066	1086	1865	127430
Tube light	12660	16170	144724	19617	91730	13072	1059	97704	58759	16512	472007
CFL	5250	5586	172636	4634	149275	11438	706	92464	23139	1470	466598
Ultrasound	-	-	-	300	-	-	-	-	-	-	300

Private offices and Industries were the largest users of computing equipment, and Hotels saw the maximum installation of televisions, air conditioners and refrigerators among the bulk consumers. The time series data related to market ownership of each of the EEE items among the bulk consumers has been also computed, both in numbers and weight wise.

As expected, some equipment like Server, Photocopy Machine and Ultrasound are found to be installed in the bulk consumer segment, whereas household appliances like mixer grinder, washing machine and Toaster are missing in this segment.

Table 15: Installed base of EEE (in numbers) in Goa Bulk Consumers

Electronic Product	2018	2019	2020	2021	2022	2023	2024	2025
Server	10678	13240	16418	20358	25244	31302	38815	48131
Computer	220569	200717	182653	166214	151255	137642	125254	113981
Laptop	48920	68488	95883	134236	187931	263104	368345	515683
Printer	49860	61826	76664	95064	117879	146170	181251	224751
Photocopy Machine	7352	9116	11304	14017	17382	21553	26726	33140
Mobile Phone	10694	12833	15400	18480	22176	26611	31933	38320
Television	68272	77830	88726	101148	115308	131451	149855	170834
Refrigerator	49077	54476	60468	67119	74502	82698	91794	101892
Air-conditioner	127430	141447	157006	174277	193447	214727	238346	264565
Tube lights	472007	424806	382326	344093	309684	278715	250844	225759
CFL bulbs	466598	419938	377944	340150	306135	275521	247969	223172
Microwave	0	0	0	0	0	0	0	0
Ultra Sound	300	345	397	456	525	603	694	798

Table 16: Installed base of EEE (in tonnes) in Goa Bulk Consumers

Electronic Equipment	2018	2019	2020	2021	2022	2023	2024	2025
Server	427.1	529.6	656.7	814.3	1009.8	1252.1	1552.6	1925.2
Computer	3308.5	3010.8	2739.8	2493.2	2268.8	2064.6	1878.8	1709.7
Laptop	146.8	205.5	287.6	402.7	563.8	789.3	1105.0	1547.0
Printer	249.3	309.1	383.3	475.3	589.4	730.9	906.3	1123.8
Photocopy Machine	161.7	200.6	248.7	308.4	382.4	474.2	588.0	729.1
Mobile Phone	1.1	1.3	1.6	1.9	2.3	2.7	3.3	3.9
Television	1024.1	1167.4	1330.9	1517.2	1729.6	1971.8	2247.8	2562.5
Refrigerator	1864.9	2070.1	2297.8	2550.5	2831.1	3142.5	3488.2	3871.9
Air-conditioner	3440.6	3819.1	4239.2	4705.5	5223.1	5797.6	6435.4	7143.2
Tube lights	51.9	46.7	42.1	37.9	34.1	30.7	27.6	24.8
CFL bulbs	37.3	33.6	30.2	27.2	24.5	22.0	19.8	17.9
Ultra Sound	20.1	23.1	26.6	30.6	35.2	40.5	46.5	53.5

Computer and air-conditioner were the highest installed EEE, weight wise, among bulk consumers. Even with large number in use, CFL and tube lights formed a small segment as they are very less in weight.

Total Market Size of EEE in Goa

Across households and bulk consumers, mercury bearing lighting equipment is installed in highest numbers. Mobile phones, air conditioners, laptops are next in terms of numbers used. Ultrasound machines and Photocopy machines are used in the lowest numbers.

Table 17: Total Installed Base of EEE in Goa (in numbers)

Electronic Product	2018	2019	2020	2021	2022	2023	2024	2025
Server	10678	13240	16418	20358	25244	31302	38815	48131
Computer	311626	283579	258057	234832	213697	194464	176962	161036
Laptop	648521	907930	1271101	1779542	2491359	3487903	4883064	6836289
Printer	146071	181128	224598	278502	345343	428225	530999	658438
Photocopy Machine	1605049	1926059	2311271	2773526	3328231	3993877	4792652	5751182
Mobile Phone	537301	612523	698276	796035	907479	1034526	1179361	1344471
Television	406432	451141	500766	555849	616993	684863	760197	843819
Refrigerator	311626	283579	258057	234832	213697	194464	176962	161036
Washing Machine	448706	498064	552851	613664	681167	756096	839266	931586
Air-conditioner	1014912	1027431	1051240	1086587	1133853	1193542	1266302	1352918
Tube lights	1746549	1571894	1414704	1273234	1145911	1031319	928187	835369
CFL bulbs	2889769	2600792	2340712	2106641	1895977	1706379	1535741	1382167
Microwave	183832	204053	226499	251414	279070	309767	343842	381664
Oven	84185	93445	103724	115134	127798	141856	157460	174781
Toaster	85903	95352	105841	117483	130406	144751	160674	178348
Mixer Grinder	410615	455783	505919	561570	623343	691910	768021	852503
Ultra Sound	300	345	397	456	525	603	694	798

Weight wise, the scenario is different, as the lighting equipment, though used in huge numbers, are, light in weight and hence do not constitute a large proportion of installed base. Even mobile phones, though installed in large numbers, contribute to a small percentage of installed base by weight.

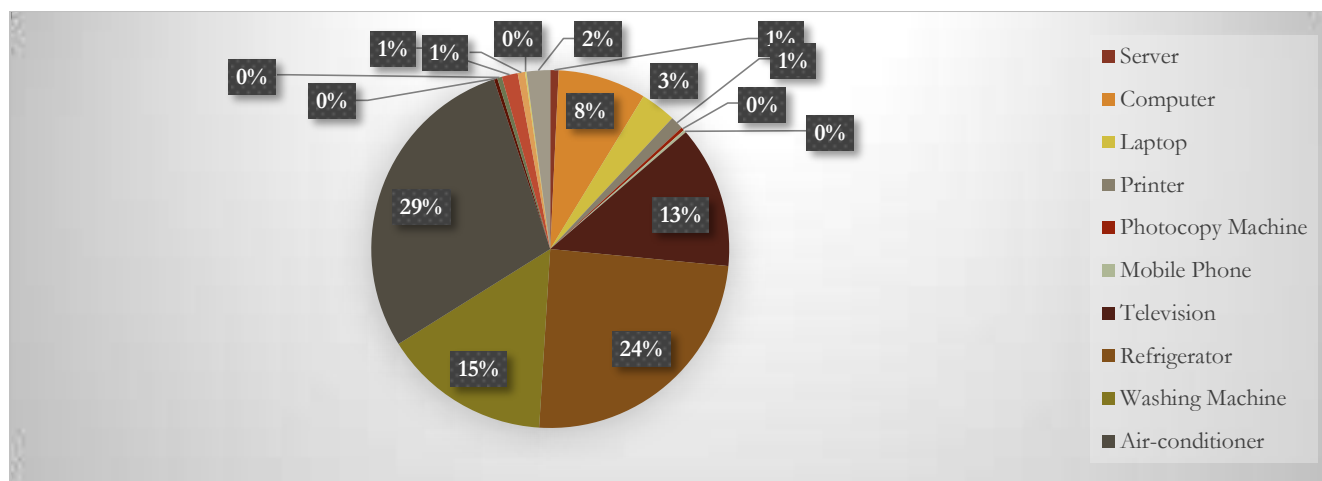


Figure 3: Total Installed Base- Weight wise

Table 18: Total Installed Base of EEE in Goa (in tonnes)

Electronic Product	2018	2019	2020	2021	2022	2023	2024	2025
Server	427.1	529.6	656.7	814.3	1009.8	1252.1	1552.6	1925.2
Computer	4674.4	4253.7	3870.9	3522.5	3205.4	2916.9	2654.4	2415.5
Laptop	2030.7	2843.0	3980.1	5572.3	7801.2	10921.6	15290.2	21406.3
Printer	730.4	905.6	1123.0	1392.5	1726.7	2141.2	2655.0	3292.2
Photocopy Machine	161.7	200.6	248.7	308.4	382.4	474.2	588	729.1
Mobile Phone	163.7	196.4	235.8	282.9	339.5	407.4	488.9	586.6
Television	8059.5	9187.8	10474.2	11940.5	13612.2	15517.9	17690.4	20167.0
Refrigerator	14535.0	16164.5	17977.7	19995.1	22240.1	24738.4	27518.8	30613.3
Washing Machine	11503.2	12768.6	14173.1	15732.1	17462.7	19383.6	21515.8	23882.5
Air-conditioner	17936.2	19909.2	22099.2	24530.1	27228.4	30223.5	33548.1	37238.3
Tube lights	192.7	173.4	156.1	140.5	126.5	113.8	102.4	92.1
CFL bulbs	268.5	241.7	217.5	195.7	176.2	158.5	142.7	128.5
Microwave	919.2	1020.3	1132.5	1257.1	1395.3	1548.8	1719.2	1908.3
Oven	420.9	467.2	518.6	575.7	639.0	709.3	787.3	873.9
Toaster	85.9	95.4	105.8	117.5	130.4	144.8	160.7	178.3
Mixer Grinder	1355.0	1504.1	1669.5	1853.2	2057.0	2283.3	2534.5	2813.3
Ultra Sound	20.1	23.1	26.6	30.6	35.2	40.5	46.5	53.5

3.2. WEEE or E-waste Inventory

WEEE from Households and bulk consumers in Goa has been calculated, based on the Estimate Method. The projected category wise E-waste inventory starting from 2018 till 2025 has been detailed in the tables and figures below.

Household

Table 19: WEEE estimation from households in Goa (in tonnes)

Electronic Product	2018	2019	2020	2021	2022	2023	2024	2025
Computer	227.64	207.15	188.51	171.54	156.11	142.06	129.27	117.64
Laptop	376.79	527.51	738.51	1033.91	1447.47	2026.46	2837.05	3971.87
Printer	48.11	59.65	73.97	91.72	113.73	141.03	174.87	216.84
Mobile Phone	32.52	39.03	46.84	56.20	67.44	80.93	97.12	116.54
Television	781.72	891.16	1015.92	1158.15	1320.29	1505.13	1715.84	1956.06
Refrigerator	1351.09	1499.71	1664.68	1847.79	2051.05	2276.66	2527.10	2805.08
Washing Machine	1070.92	1188.72	1319.48	1464.62	1625.73	1804.56	2003.07	2223.40
Air-conditioner	1449.56	1609.01	1786.00	1982.46	2200.53	2442.59	2711.27	3009.51
Tube lights	70.40	63.36	57.02	51.32	46.19	41.57	37.41	33.67
CFL bulbs	115.59	104.03	93.63	84.27	75.84	68.26	61.43	55.29
Microwave	399.23	443.15	491.89	546.00	606.06	672.73	746.73	828.87
Oven	144.87	160.80	178.49	198.13	219.92	244.11	270.96	300.77
Toaster	15.49	17.20	19.09	21.19	23.52	26.11	28.98	32.17
Mixer Grinder	215.89	239.63	265.99	295.25	327.73	363.78	403.80	448.21
Total WEEE	6299.81	7050.11	7940.01	9002.55	10281.61	11835.97	13744.90	16115.92

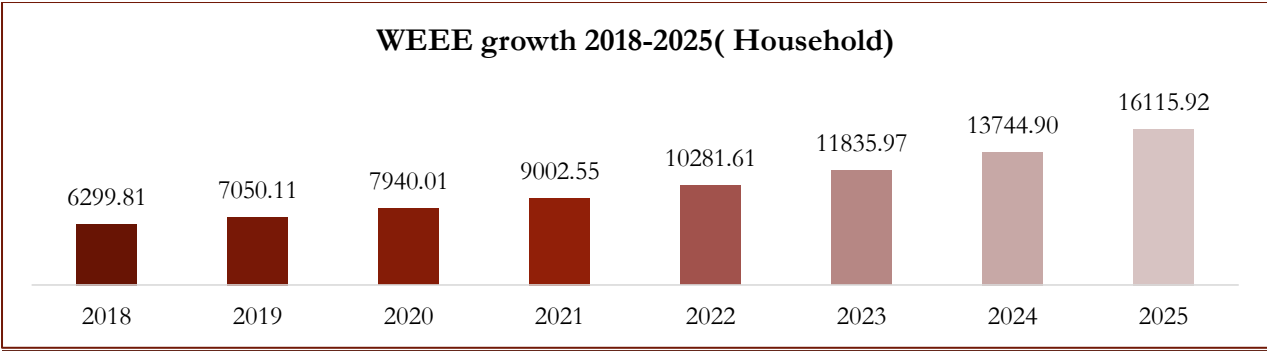


Figure 4: WEEE Growth in Goa Households

The figure above (Figure 4: WEEE Growth in Goa Households) shows that around more than 6200 tonnes of WEEE was generated in 2018 from households in Goa and is projected to grow steadily to around 16000 tonnes in 2025.

The waste from household differs in the two Districts. North, with larger population has larger share

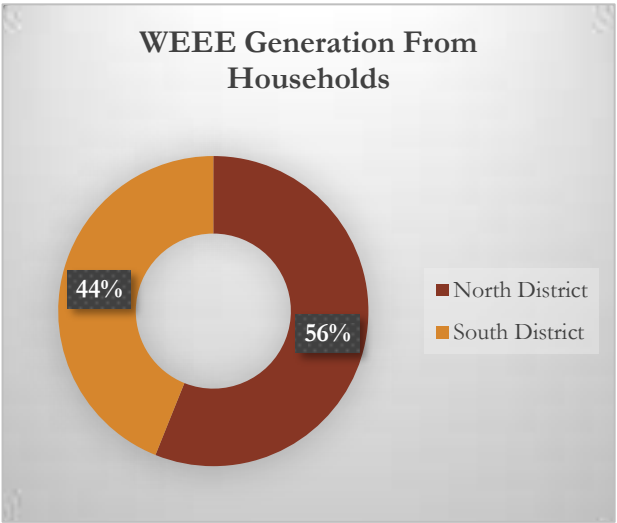


Figure 5: District share of WEEE from Household in Goa

of the waste, though there is not substantial difference. The North District generated 3533.18 tonnes of WEEE, whereas South District generated 2766.64 tonnes in 2018. But if we look at the household WEEE generation Taluka wise, there is lot more variation observed. Salcete in South and Bardez in North were the highest household WEEE generating Talukas in Goa as these are the most populated Talukas. The new Taluka of Dharbandora and Cancona (both in South) were the lowest household WEEE generators.

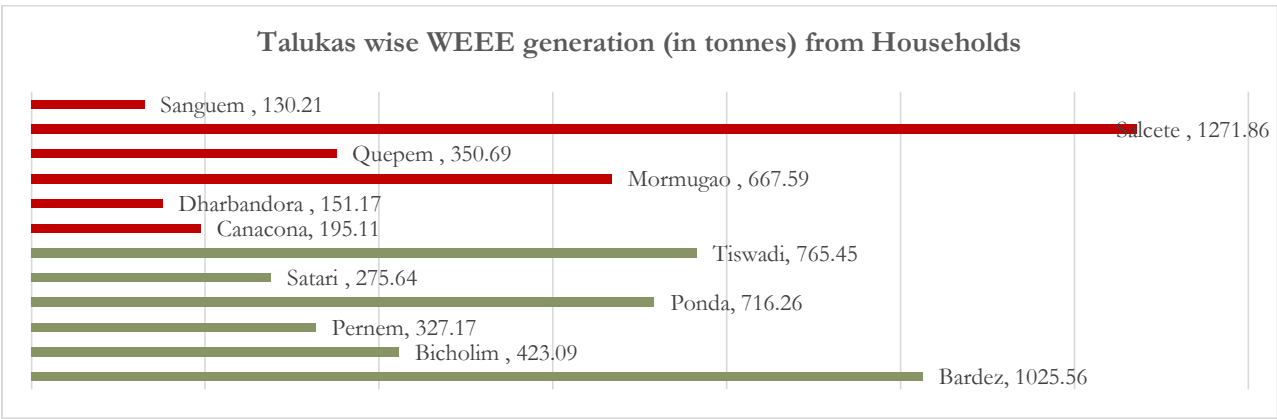


Figure 6: Taluka wise WEEE generation from Households in Goa

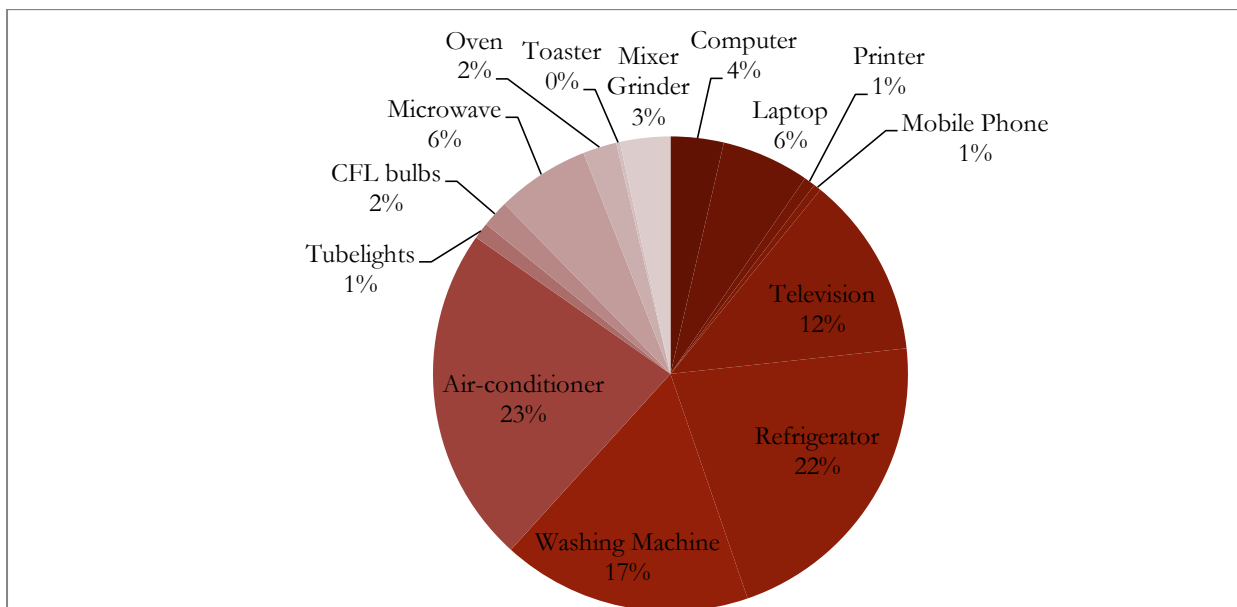


Figure 7: WEEE from Household by Category (2018)

The study results show that air-conditioner and refrigerator at 23% and 22% respectively form the largest share of Goa's WEEE in 2018, weight wise, whereas toaster, printer, oven, mobile phone, mixer grinder, computer are at the lower end ($\leq 4\%$). But it is important to see that this mix is changing gradually. For example, waste from laptop is expected to go up substantially in the next few years. But this is a rough estimation as design changes which may lead to equipment weight changes have not been accounted for.

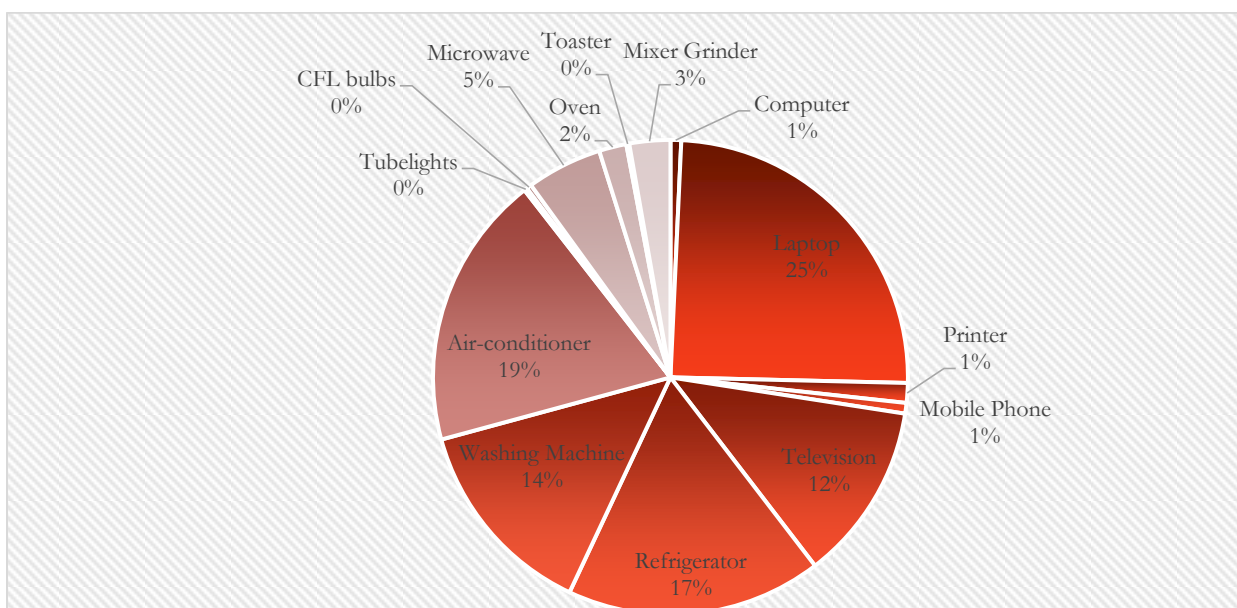


Figure 8: WEEE from Household by Category (2025)

Bulk Consumers

The total WEEE generated from bulk consumers in 2018 was 1382.43 tonnes, which goes up to 1441.18 tonnes this year. The waste sees an increase to more than 2500 tonnes by 2025.

Table 20: WEEE generated from Bulk consumers in Goa (in tonnes)

Electronic Product	2018	2019	2020	2021	2022	2023	2024	2025
Server	52.68	65.33	81.01	100.45	124.56	154.45	191.52	237.48
Computer	551.42	501.79	456.63	415.54	378.14	344.10	313.14	284.95
Laptop	29.35	41.09	57.53	80.54	112.76	157.86	221.01	309.41
Printer	24.93	30.91	38.33	47.53	58.94	73.09	90.63	112.38
Photocopy Machine	32.35	40.11	49.74	61.68	76.48	94.83	117.59	145.82
Mobile Phone	0.22	0.26	0.31	0.38	0.45	0.54	0.65	0.78
Television	113.79	129.72	147.88	168.58	192.18	219.09	249.76	284.72
Refrigerator	186.49	207.01	229.78	255.05	283.11	314.25	348.82	387.19
Air-conditioner	344.06	381.91	423.92	470.55	522.31	579.76	643.54	714.32
Tube lights	25.96	23.36	21.03	18.93	17.03	15.33	13.80	12.42
CFL bulbs	18.66	16.80	15.12	13.61	12.25	11.02	9.92	8.93
Ultra Sound	2.51	2.89	3.32	3.82	4.40	5.06	5.82	6.69
Total E-waste	1382.43	1441.18	1524.60	1636.65	1782.59	1969.38	2206.17	2505.09

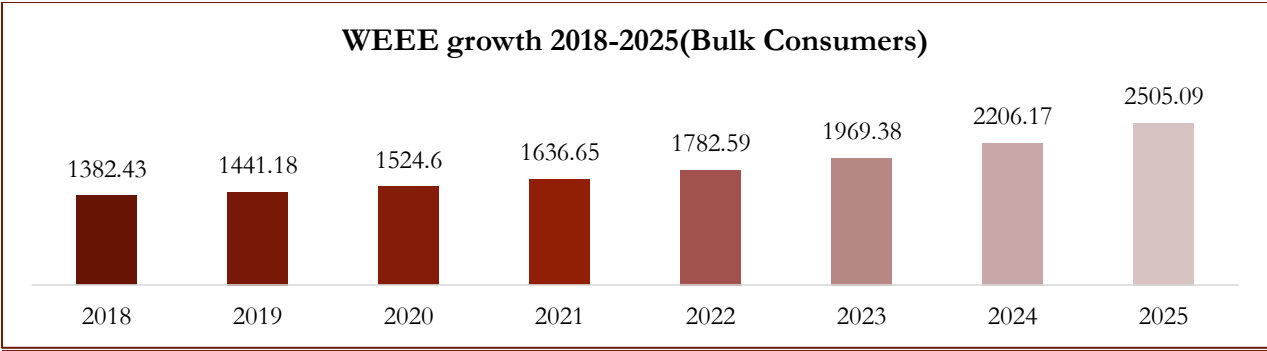
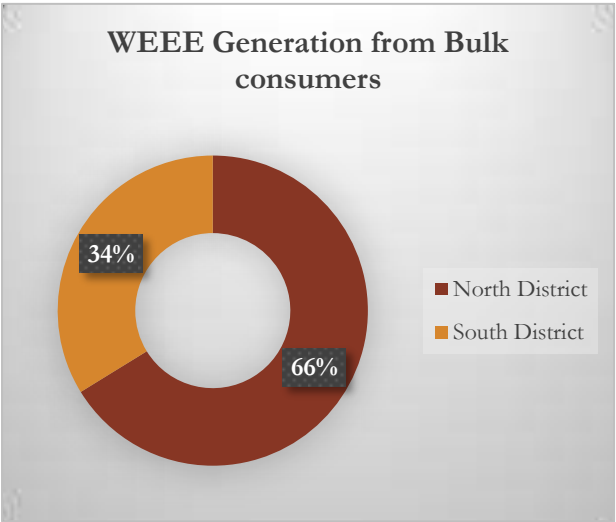
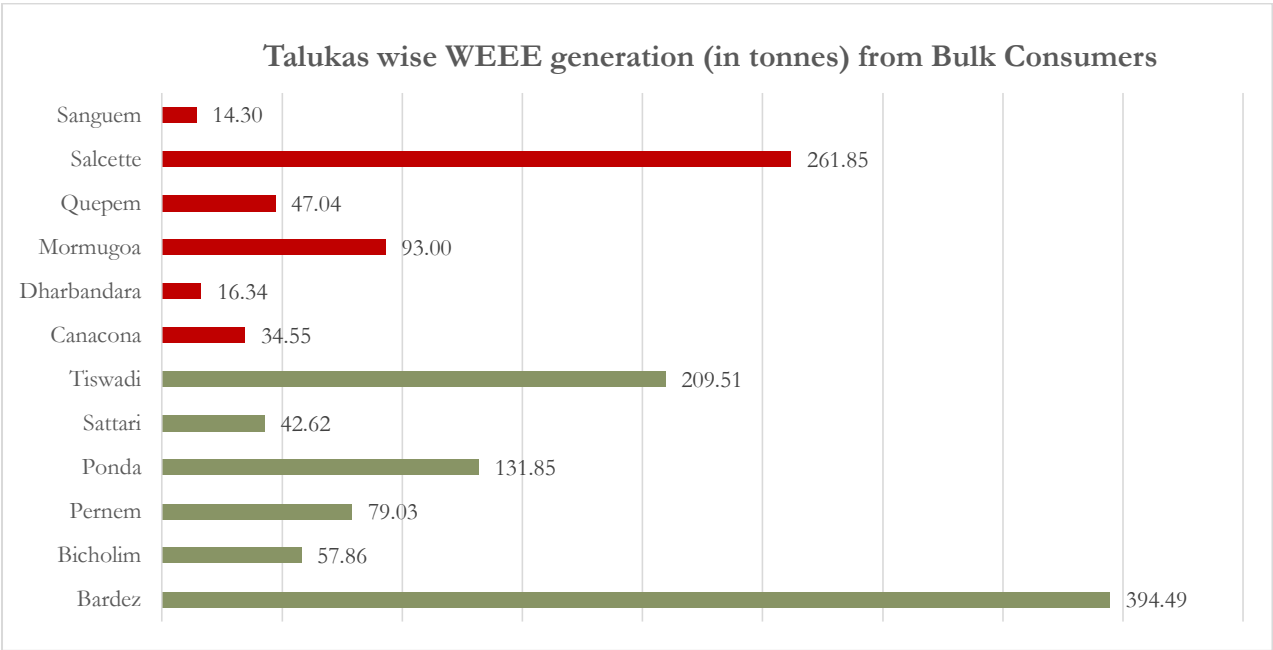


Figure 9: WEEE growth from Bulk consumers



District wise, unlike households, a large majority of WEEE from bulk consumers is generated in North District (66%). Bardez and Tiswadi, which have a large number of commercial spaces, account for more than 65% of the waste generated in this District. Sattari has the lowest waste generation in North. Bulk consumers from south District, with 34%, generate a smaller portion of the total waste. Only Salcete in South has a sizable generation of WEEE from Bulk consumers, with other Talukas

generating small quantum.



Sanguem and Dharbondra have the lowest WEEE generation among all Talukas across both Districts.

The waste mix in the bulk consumer segment is also completely different from households. PCs, Air-conditioner form the largest chunk (by weight). Though the number of cellular phones and lighting equipment in the waste pile is quite high, by weight they account for a very small percentage.

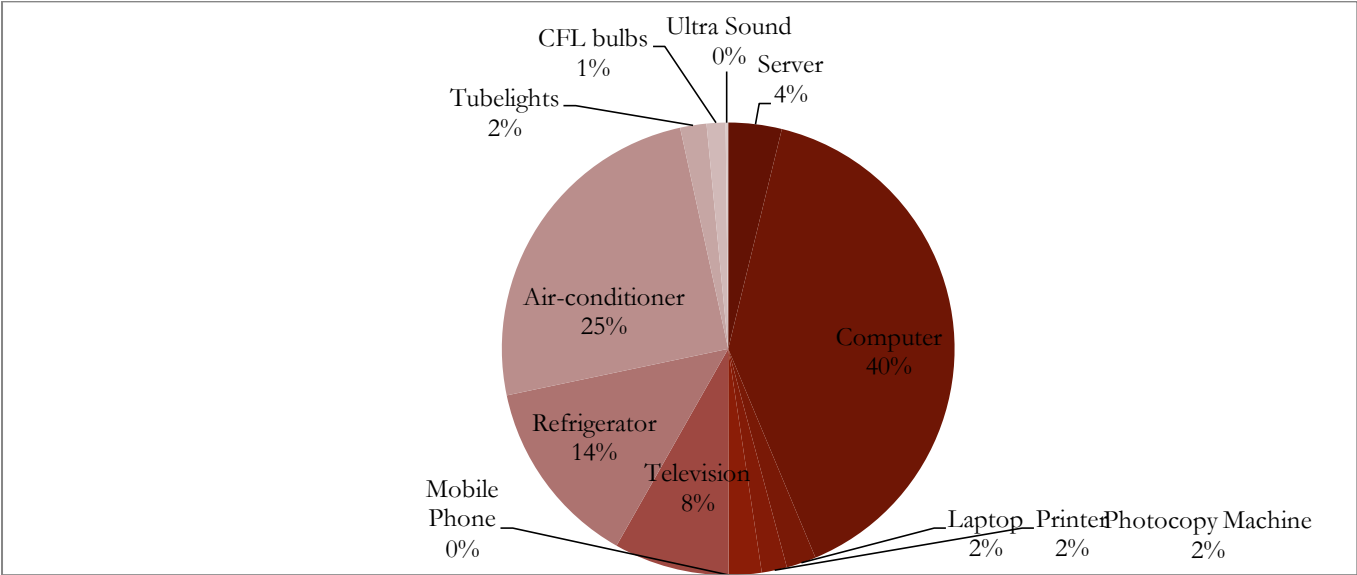


Figure 10: WEEE from Bulk consumers by category (2018)

The waste mix changes substantially over the year and in 2025. Laptop, from 2% share in 2018, jumps to 12% in 2025. Computers see a significant change as it comes down to 11% of the waste share in 2015 from 40% in 2018.

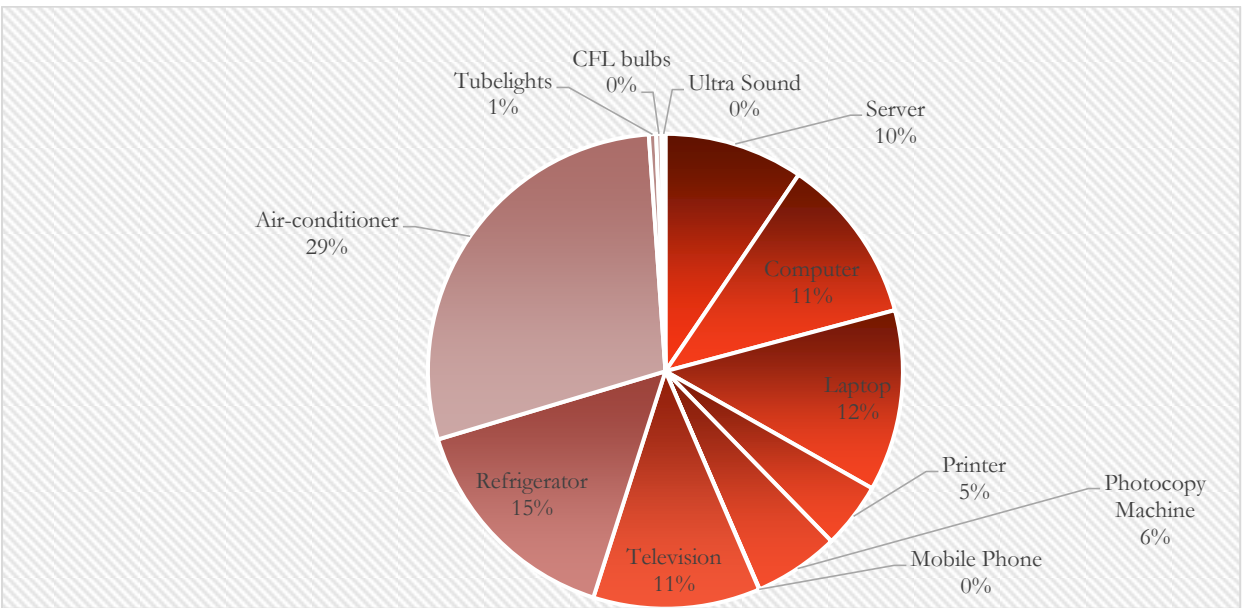


Figure 11: WEEE from Bulk consumers by category (2025)

Total WEEE

The total WEEE generated in Goa, from households and bulk consumers, is estimated to be 7682.24 MT in 2018 and is projected to go up to 18621.01 MT in 2025. This, as mentioned in the methodology section, includes four major category of equipment namely, IT and telecom, consumer electronics, mercury bearing lamps and small household appliances. The waste grows at CAGR of 13.5% annually from 2018 to 2025.

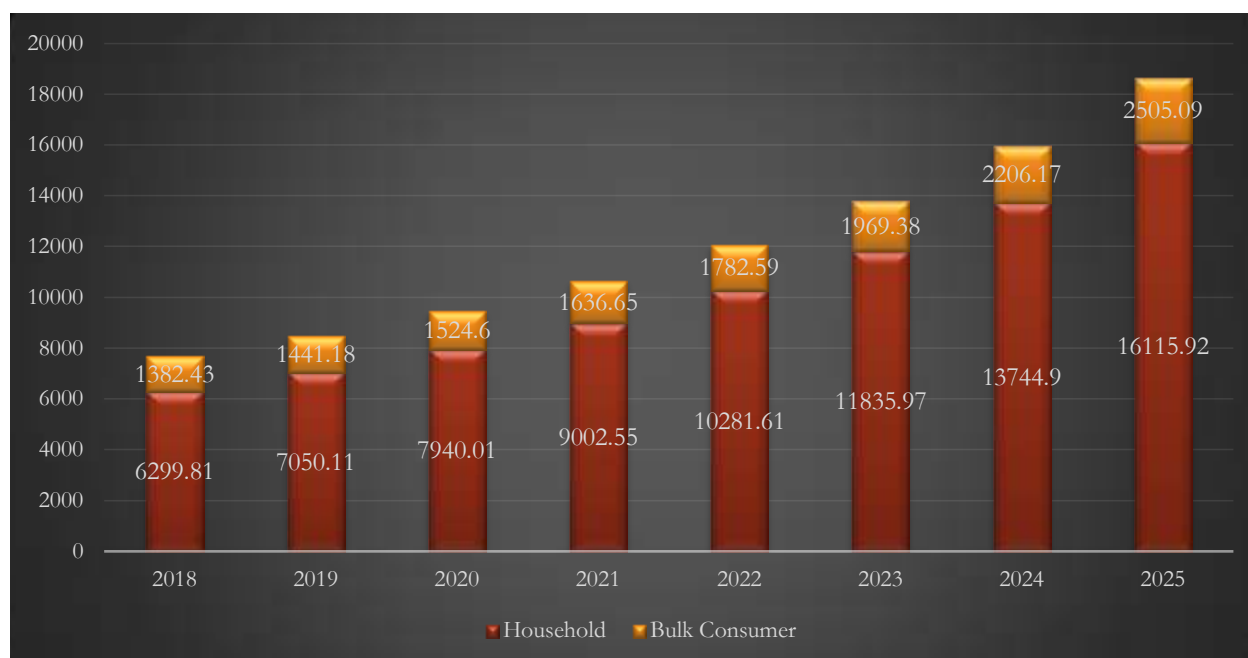


Figure 12: WEEE Growth in Goa

The total quantity does not take into account waste from tourists, as stakeholder interaction during the study period indicated that there is hardly any waste being discarded by tourist and even if there is, it is

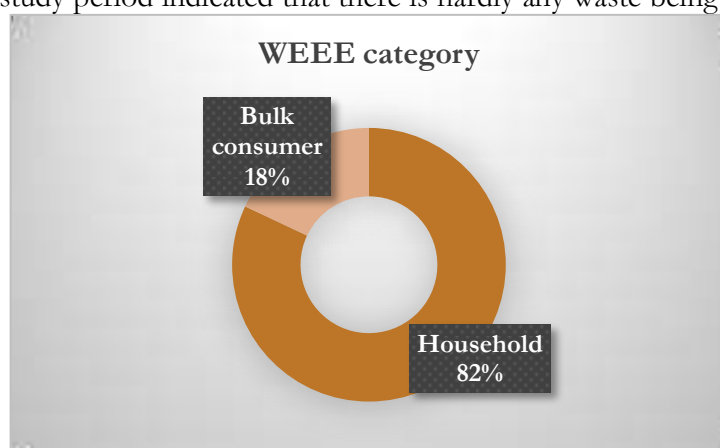


Figure 13: WEEE by segment

primarily very small equipment like cellular phones.

As evident from the figure above, the waste from Households form the major part of total WEEE generated in Goa. Bulk consumers generate only 18% of the total generation, whereas households have 82% share in waste generation. This is mainly on the account of high usage of

electronics in Goa homes and also on account of limited commercial activities in the State.

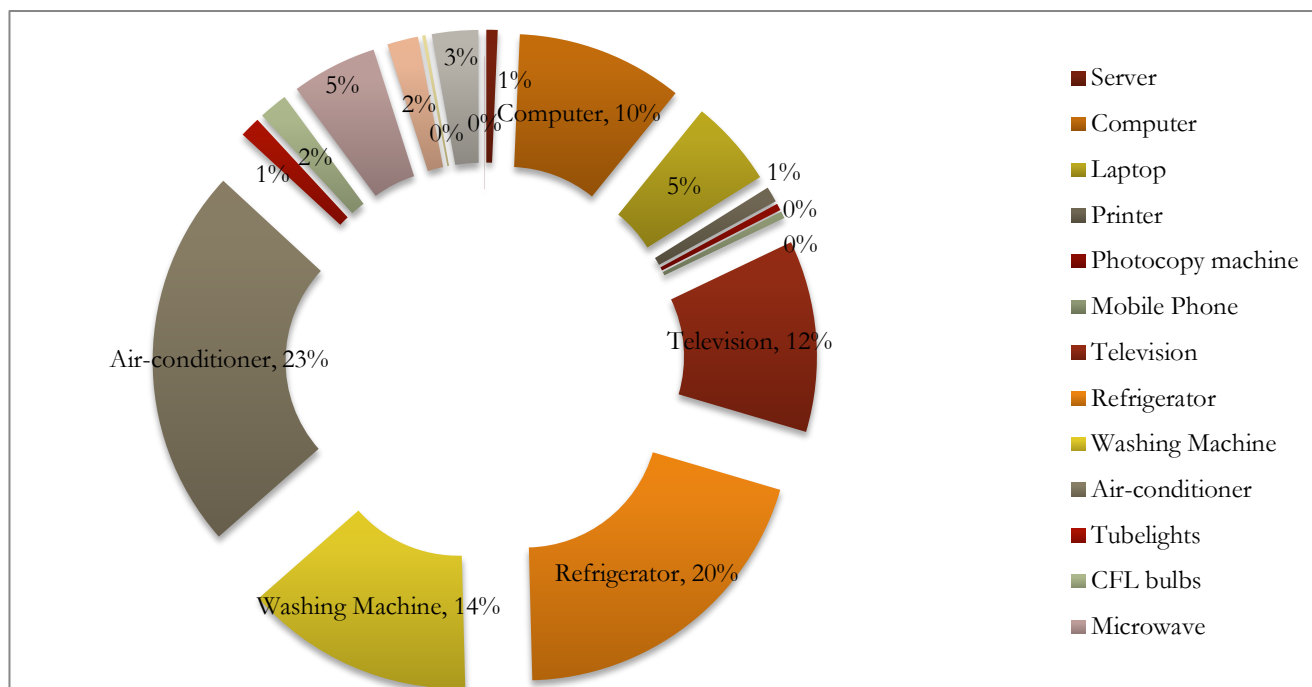


Figure 14: Total WEEE in Goa- by category

If you look at the figure above, it is clear that WEEE in Goa mainly comprises of Air conditioner, Refrigerators, Washing Machines, Televisions and Computers. This is primarily because these are heavier appliances. This will need to be kept in mind while planning the collection system, as bulky or bigger items may not be easy to transport and consumers will expect pick up services. This split across categories obviously changes over the years, but the large household appliances still form the bulk.

North District of Goa, as expected, generates the larger quantum of waste. Among the Talukas,

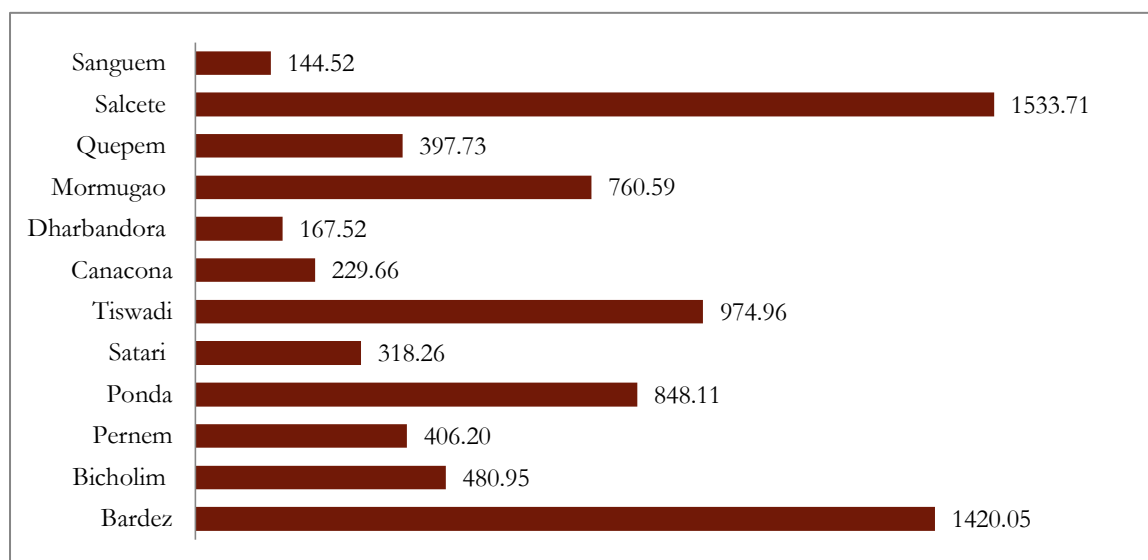


Figure 15: Taluka wise WEEE generation in Goa

Salcete in South, Bardez and Tiswadi in North generate the maximum amounts, whereas Sanguem and Dharbandora (both in South District) generate the least amounts.

3.3. Current Practices of E-waste Usage & Disposal in Goa

The study also looked at the current disposal practices, both in households and bulk consumers. The figures below indicate the preferences. The households seem to prefer to sell functional EEE, which they want to discard, as second hand electronics as 52% of the respondents chose that as a current practice. A large percentage of the population (around 25%) store it for future use. Also, 15% were passing on the functional EEE to relatives, a common practice in India, whereas a small percentage (8%) was also giving it out as charity. In contrast a large percentage of bulk consumers were storing the equipment. Though a small percentage of the commercial establishment were returning it to company or the dealers, almost 9% preferred to donate the working equipment. Auctioning and returning to company also seemed like options used by bulk consumers.

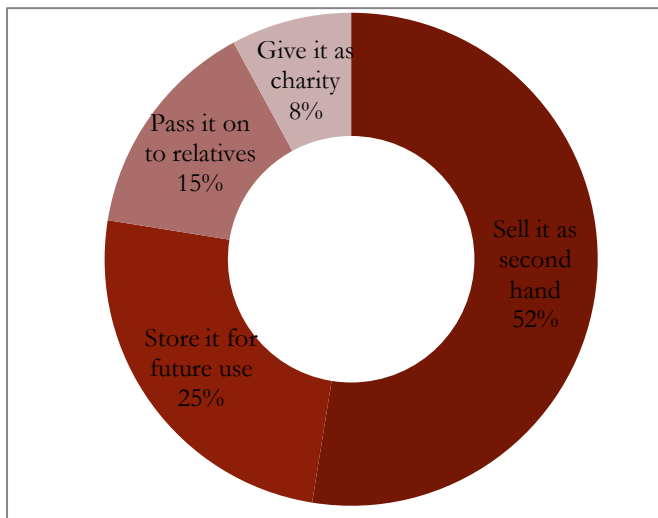


Figure 17: Household Practice for not-in-use functional EEE

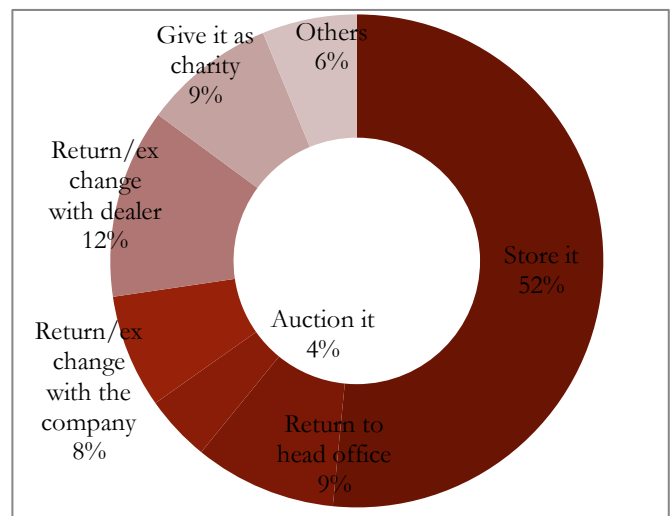


Figure 16: Bulk consumer Practice for not-in-use functional EEE

For the non-functional goods, the practices were slightly different as most households preferred to sell it to scarp dealers or the dealers selling EEE. Surprisingly, many households during the survey study mentioned that they throw the WEEE in dustbin- which is probably truer for smaller products like mouse or keyboard or headphones. 3% of the households gave it back to the company (probably under EPR) and a same percentage also gave the discarded electronics to registered collectors.

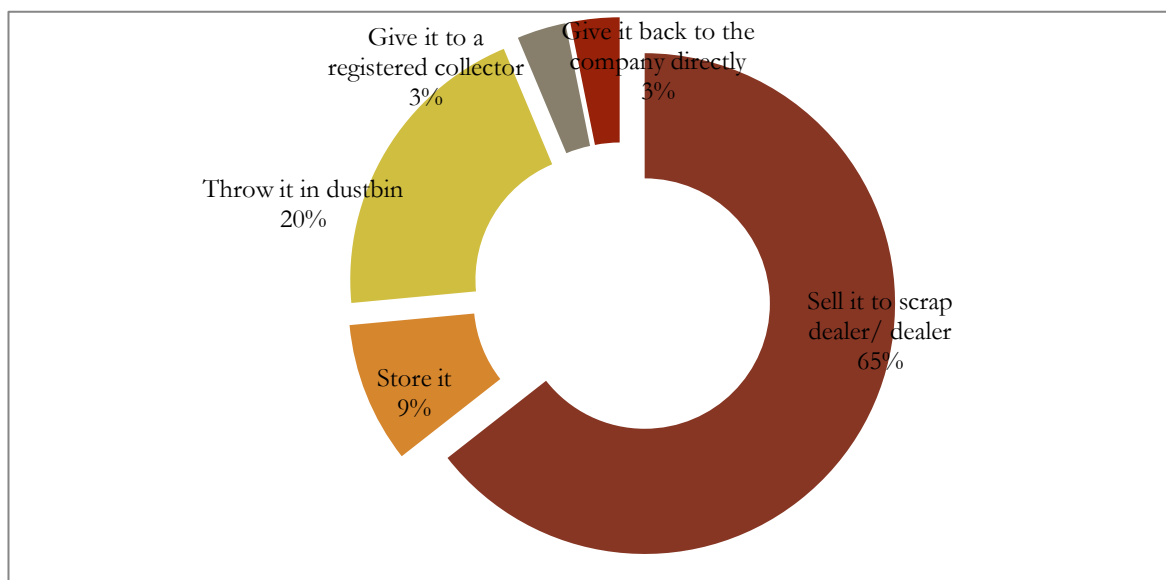


Figure 18: Households disposal of non-functional WEEE

The preferred practice among the bulk consumer to dispose off non-functional or end-of-life equipment was a bit different as though 30% preferred to sell or auction it to dealers or scrap dealers, 27% of them in the State of Goa were giving it to registered collectors. A large section was also either exchanging it with dealer or companies while purchasing new equipment.

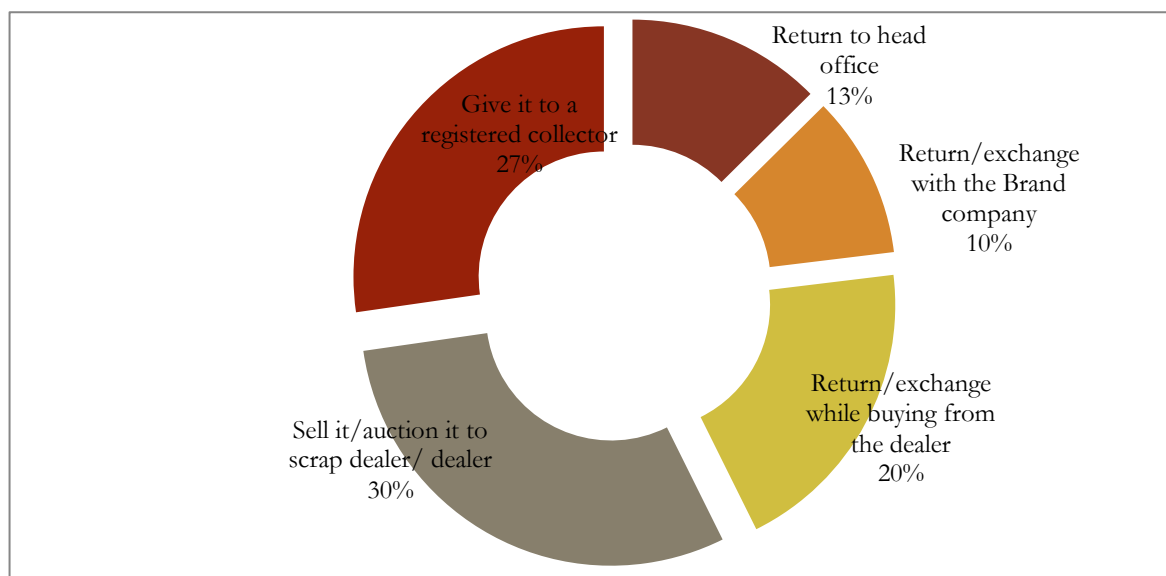


Figure 19: Bulk consumer disposal practice for end of life EEE

3.3.1. Informal sector in Goa

According to information from the Goa Scrap Dealers Association President, Akbar Khan, there are over 700 scrap dealers across Goa of which around 350 are registered. Not a single of these scrap dealers deal solely with electronic waste.

A report titled 'Status of E-waste Management and Generation in Goa' prepared by Gujarat based M/s UPL Environmental Engineers Ltd., in 2011, made a mention of about 300 scrap dealers in Goa. They were found to collect E-waste and send it whole, without dismantling, to places like Selampur in Delhi for recycling in the grey market. The situation today is quite different. As it happens in other places, the incoming E-waste is dismantled and the copper, plastic, glass, aluminium and iron are sent to various recyclers while the PCB's are sent to Delhi to be recycled by the informal sector.

As per Karim, owner of Navbharat Scrap Dealers, one of Goa's largest scrap dealers, located at Karaswada in Mapusa, the minimum estimated quantity of PCB's leaving Goa is around 50 tonnes per month. He himself generates around 300 kgs per month at his facility. Through his network of waste pickers, tie ups with municipalities and those contracted to provide waste collection services at Panchayat level, Karim gets mainly refrigerators and washing machines ranging from 150-200 each per month. A vast majority of these are procured from households and electronic dealers. That is followed by AC's ranging from 15-50 per month while IT equipment and TV's are between 10-15 each in number. Asked if the E-waste Rules have impacted the quantum of E-waste received by him due to a push for authorized disposal among bulk consumers, he says on a contrary volumes have increased significantly. He attributes this to the fact that scrap dealers in Goa largely depend on households and electronic dealers for their e-waste which are the least impacted by the rules. In addition, increasing purchasing power of the common man, dropping prices and a wide range of appliances in the market has also led to consumerism and larger penetration among the masses, he says. Nazar, the biggest scrap dealer in the South operating from Margao tells a similar tale. There are also big scrap yards located at Batlem, at the outskirts of Panaji and in the Vasco/Mormugao area.

On the other hand, Abdul, from the Panaji Market area, who largely depends on selling of PCB's to recyclers in Delhi tells a different story. Reluctance to sell IT equipment by the Government and larger offices to scrap dealers, which was the primary source of PCB's has led to a significant decline in volumes exported from the State. Furthermore, he states that dropping rates of obsolete electronic equipment coupled with improved technologies which have reduced the sizes

of PCB's to a large extent; make their trade far less profitable. Of the over 20 people dealing with PCB's in the Panaji area, a mere 8 remain.

Another aspect of the informal E-waste sector in Goa is the absence of refurbishing. Not a single of the 10 scrapyards owners interviewed, undertook refurbishing. They only undertake dismantling after which the various fractions are sold to their respective recyclers in and around Goa. It was however unfortunate to see some of them manually breaking bulbs in order to retrieve the recyclable portions. These include CFL's which contain toxic mercury. Workers in the scrapyards are completely unaware of the hazards and toxins they are exposed to which is why they do not feel the need to wear any personal protective equipment (PPE).



Figure 20: Bulb Dismantling at Karaswada



Figure 21: Dismantled Fridge and Washing Machine Cases



Figure 22: Dismantled E-waste from which PCB's will be segregated



Figure 23: TV's and Motors for dismantling at Vasco

Observations:

1. Consumer electronics such as washing machines, fridges, TV's and AC's were the most commonly observed at scrapyards. IT equipment was not as common.
2. It was interesting to note that almost all the scrap dealers visited didn't seem to have any mobile phones at their yards. This is probably due to the fact that they don't take up much space so are easily stored. Also, it was found that mobile repair shops would collect and segregate the plastic, battery and PCB's from mobiles and directly sell it to the respective recyclers. This negated the need for dismantling by a scrap dealer.
3. The prime source of collection of E-waste by scrap dealers were from waste pickers. Households and dealers made up the next two areas, followed by collection from offices.
4. Functional and non-functional equipment is not distinguished due to the absence of refurbishing in the State. It is all therefore treated as waste. The informal sector in Goa is therefore restricted to collection, sorting and dismantling.
5. The electronic items are dismantled into largely – circuit boards, plastic (which is further segregated based on quality and value), copper, aluminium, iron and glass. These individual fractions are then sent to the respective recyclers
6. Problem materials arising from E-waste for most scrapyards are thermocol, glass and some types of plastics. These are either burnt or disposed off with municipal solid waste. None of the scrap dealers mentioned dumping it at open spaces. Some registered and bigger players send their glass to Kolhapur and the surrounding areas to be used in brick kilns.
7. It was noted that all units except one had children working in it. Women were also very few with male workers were paid around 6000-8000 per month.
8. While many of the owners were aware of the hazardous nature of E-waste, the workers were blissfully unaware, all working without any PPE whatsoever.

Conclusion

Waste electrical and electronic equipment (WEEE) has emerged as a major concern in most countries in the world, especially in the countries where WEEE is processed in an unregulated fashion creating significant adverse environmental impacts. The indications are that the volume of WEEE will continue to rise year on year and the State of Goa is no exception. The analysis from this study shows that **in 2018 the total WEEE generated in Goa is estimated to be 7682.24 MT and is projected to go up to 18621.01 MT in 2025**, from the 17 categories of WEEE that were included. The study findings also indicate quite a dispersed generation as most Talukas have substantial amount of waste.

Considering the huge generation of waste currently and steep increase in future, it becomes crucial that the State should have a robust collection and downstream management of WEEE.

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4. Annexures

Annexure I: Questionnaires

A. Household Survey for E-waste Inventorisation in Goa

By Toxics Link

For Goa Waste Management Corporation (GWMC)

Household Information

1. Name of the Surveyor
2. Survey Taluka
3. Name of the respondent
4. Contact information (email or phone)(Enter NA if not shared):
5. How many family members live in the household:
6. In which category does your annual household income fall?
 - a. Below INR 100000 (BPL)
 - b. INR 100000 – INR 300000 (EWS)
 - c. INR 300000 – INR 600000 (LIG)
 - d. INR 600000 – INR 1800000 (MIG)
 - e. Above INR 1800000 (HIG)

Electrical and Electronic Equipment

7. Which of the following are you using in your house and how many of each? (Enter '0' if they don't own one)
 - a. Computer
 - b. Laptop
 - c. Printer
 - d. Mobile Phone
 - e. Television
 - f. Refrigerator
 - g. Washing Machine
 - h. Air-conditioner
 - i. Tube lights
 - j. CFL bulbs
 - k. Microwave
 - l. Oven
 - m. Toaster
 - n. Mixer Grinder
8. How many years do you use the following (only the items that you own) electronics or electrical?
 - a. Computer
 - b. Laptop
 - c. Printer
 - d. Mobile Phone
 - e. Television
 - f. Refrigerator
 - g. Washing Machine
 - h. Air-conditioner
 - i. Tube lights

- j. CFL bulbs
 - k. Microwave
 - l. Oven
 - m. Toaster
 - n. Mixer Grinder
9. What do you do with the electronic/electrical products that are functional but you don't want to use?
 - a. Sell it as second hand
 - b. Store it for future use
 - c. Pass it on to relatives
 - d. Give it as charity
 - e. Others (indicate)
 10. How do you discard your non-functional electronic/electrical products?
 - a. Exchange it while buying new
 - b. Sell it to scrap dealer/ dealer
 - c. Store it
 - d. Throw it in dustbin
 - e. Give it to a registered collector
 - f. Give it back to the company directly

Knowledge levels and Attitude

11. Have you heard about 'e-waste'?
 - a. Yes
 - b. No
 - c. Not sure
12. If yes, what is e-waste according to you?
 - a. Everyday waste
 - b. Engineering waste
 - c. Waste from Electronics and Electricals
 - d. Effluent waste
 - e. Don't know
13. From where did you get the information about e-waste?
 - a. Newspaper
 - b. Internet
 - c. Social media
 - d. Shop keepers of electronic products
 - e. Product manual
 - f. Friends
 - g. Other, please mention _____
14. E-waste is safe. True or false?
 - a. True
 - b. False
 - c. Don't know
15. Are you aware if there are any impacts of improper disposal of e-waste?
 - a. Yes
 - b. No
 - c. Don't know
16. Are you aware if there are any government rules on e-waste?
 - a. Yes

- b. No
 - c. Not sure
17. Are you willing to give your functional electronic waste (not of use to you) free of cost?
- a. Yes
 - b. No
18. Are you willing to give your non- functional electronic waste free of cost?
- a. Yes
 - b. No
19. What will be most convenient method of discarding not in use (old) electronics and electrical?
- a. Exchange offer by the company
 - b. Company Drop off points
 - c. Door to door pick up
 - d. Panchayat or Municipal collection drop boxes
 - e. Moving 'collection day' events
20. What is your preferred frequency for collection of E-waste?
- a. Weekly
 - b. Monthly
 - c. Quarterly
 - d. Half Yearly
 - e. Annually
21. What will be most convenient method of receiving information about e-waste
- a. Television
 - b. Radio
 - c. Social Media
 - d. Newspaper
 - e. Pamphlets
 - f. Events

B. Bulk-Consumer Survey for E-waste Inventorisation in Goa

By Toxics Link

For Goa Waste Management Corporation (GWMC)

Information on the organization

1. Name of the Surveyor: _____
2. Name of the organization: _____
3. Address of the organization: _____
4. Type of bulk consumer
 - ☐ Central Government
 - ☐ State Government Department
 - ☐ Public Sector Undertaking
 - ☐ Bank
 - ☐ Educational Institution
 - ☐ Private company
 - ☐ Health care facilities
 - ☐ Hotel
 - ☐ IT Company

5. Sub-type of bulk consumer
- Bank: ☐ Nationalised ☐ Private
 - Educational Institution: ☐ Secondary government school ☐ Secondary private school ☐ College ☐ University
 - Private company: ☐ 0-20 employees ☐ 20-50 employees ☐ 50 and above
 - Hospital: ☐ Private ☐ Government
 - Hospitality: ☐ 5 star ☐ 4 star ☐ 3 star ☐ 2 star ☐ No star
6. Number of employees: _____
7. Name of the respondent: _____
8. Contact information (email or phone): _____

Procurement and use of electronic/electrical equipment

9. Where/how (procedure) does your organization procure its electronic items?
- ☐ Direct companies
- ☐ Local Dealers
- ☐ Done by headquarters
- ☐ Online
- ☐ Others (pls specify): _____
10. Which of the following are you using in your office and how many of each? (Enter '0' if they don't own one)
- ☐ Server : _____
- ☐ Computer : _____
- ☐ Laptop : _____
- ☐ Printer : _____
- ☐ Photocopy machine : _____
- ☐ Mobile Phone (not personal): _____
- ☐ Television : _____
- ☐ Refrigerator : _____
- ☐ Air-conditioner : _____
- ☐ Tube lights : _____
- ☐ CFL bulbs : _____
- ☐ Microwave : _____
11. How many years do you use the following (company policy) (only the items that you own) E-items
- Server : _____
 - Computer : _____

- c. Laptop : _____
- d. Printer : _____
- e. Photocopy machine : _____
- f. Mobile Phone (not personal): _____
- g. Television : _____
- h. Refrigerator : _____
- i. Air-conditioner : _____
- j. Tube lights : _____
- k. CFL bulbs : _____
- l. Microwave : _____

Disposal

12. What is the percentage of Functional E products that you discard?

- a. Server:
- b. Computer:
- c. Laptop:
- d. Printer:
- e. Photocopy machine:
- f. Mobile Phone (not personal):
- g. Television:
- h. Refrigerator:
- i. Air-conditioner:
- j. Tube lights:
- k. CFL bulbs:
- l. Microwave:

13. What do you do with the E products that **are functional** or working but the organization does not intend to use?

- ☐ Store it
- ☐ Return to head office
- ☐ Auction it
- ☐ Return/exchange with the Brand Company
- ☐ Return/exchange while buying from the dealer
- ☐ Give it as charity
- ☐ Others (indicate):

14. How do you discard your non-functional electronic/electrical products?

- ☐ Store it
- ☐ Return to head office

- ☐ Return/exchange with the Brand Company
- ☐ Return/exchange while buying from the dealer
- ☐ Sell it/auction it to scrap dealer/ dealer
- ☐ Give it to a registered collector

15. How often do you discard E- products

- ☐ Annually
- ☐ Half yearly
- ☐ Quarterly

Awareness and attitude

16. Does your organization have a policy or strategy for the management of E-waste?

- ☐ Yes
- ☐ No

17. How many (kgs) of electric and electronic equipment have you discarded from 2016-2018?

18. Are you aware of the existence of the e-waste rules of 2016?

- ☐ Yes
- ☐ No

19. Have you filed annual returns to the GSPCB? If no, why not?

- ☐ Yes
- ☐ No

Improvement of the system

20. Are you willing to give your functional electronic waste (not of use to you) free of cost?

- ☐ Yes
- ☐ No

21. Are you willing to give your non- functional electronic waste free of cost?

- ☐ Yes
- ☐ No

22. What will be most convenient method of discarding not in use (old) electronics and electrical?

- ☐ Exchange offer by the company
- ☐ Company Drop off points
- ☐ Door to door pick up
- ☐ Panchayat or Municipal collection drop boxes
- ☐ Moving 'collection day' events

23. What is your preferred frequency for collection of E-waste?

- ☐ Weekly
- ☐ Monthly
- ☐ Quarterly
- ☐ Half Yearly
- ☐ Annually

24. What will be most convenient method of receiving information about e-waste

- ☐ Television
- ☐ Radio
- ☐ Social Media
- ☐ Newspaper
- ☐ Pamphlets
- ☐ Events

C. Dealer/ Distributer Survey for E-waste Inventorisation in Goa

By Toxics Link

For Goa Waste Management Corporation (GWMC)

Basic Information

1. Name of the Dealer/Distributer company
2. Address
3. Number of employees
4. Name of the respondent
5. Contact information (email or phone):

Sale- electronic/electrical equipment

6. Which of the following equipment do you sell or deal with
 - a. Server
 - b. Computer
 - c. Laptop
 - d. Printer
 - e. Photocopy machine
 - f. Mobile Phone
 - g. Television
 - h. Refrigerator
 - i. Washing Machine
 - j. Air-conditioner
 - k. Tube lights
 - l. CFL bulbs
 - m. Microwave
 - n. Oven
 - o. Toaster
 - p. Mixer Grinder
 - q. Ultrasound Machine

7. Do you run exchange schemes for
 - a. Server
 - b. Computer
 - c. Laptop
 - d. Printer
 - e. Photocopy machine
 - f. Mobile Phone
 - g. Television
 - h. Refrigerator
 - i. Washing Machine
 - j. Air-conditioner
 - k. Tube lights
 - l. CFL bulbs
 - m. Microwave
 - n. Oven
 - o. Toaster
 - p. Mixer Grinder
 - q. Ultrasound machine
8. Do any of the following equipment you take back are in working condition when you get it
 - a. Server
 - b. Computer
 - c. Laptop
 - d. Printer
 - e. Photocopy machine
 - f. Mobile Phone
 - g. Television
 - h. Refrigerator
 - i. Washing Machine
 - j. Air-conditioner
 - k. Tube lights
 - l. CFL bulbs
 - m. Microwave
 - n. Oven
 - o. Toaster
 - p. Mixer Grinder
 - q. Ultrasound machine
9. What is the percentage of functional and non-functional equipment that you receive?
 - a. Functional-
 - b. Non-functional-
10. Do you make any economic gain by taking back old equipment?
 - a. Yes
 - b. No
11. What is, in your estimate, life span of the following products, including second hand or after repair

- a. Server
- b. Computer
- c. Laptop
- d. Printer
- e. Photocopy machine
- f. Mobile Phone
- g. Television
- h. Refrigerator
- i. Washing Machine
- j. Air-conditioner
- k. Tube lights
- l. CFL bulbs
- m. Microwave
- n. Oven
- o. Toaster
- p. Mixer Grinder
- q. Ultrasound machine

Disposal

12. What do you do with the E products that are functional
 - a. Repair it and sell
 - b. Sell it to repair shops
 - c. Sell it scrap dealers
 - d. Give it back to the company
 - e. Any other (specify)
13. How do you discard the non-functional electronic/electrical products?
 - a. Sell it to scrap dealers
 - b. Give it back to the company
 - c. Any other (specify)
14. How often do you discard the non-functional electronic/electrical products
 - a. Annually
 - b. Half yearly
 - c. Quarterly
 - d. Monthly

Awareness and attitude

15. How many (kgs) of electric and electronic equipment have you discarded from 2016-2018?
16. E-waste is safe. True or false?
 - d. True
 - e. False
 - f. Don't know
17. Are you aware if there are any impacts of improper disposal of e-waste?
 - d. Yes
 - e. No

- f. Don't know
- 18. Are you aware of the existence of the e-waste rules of 2016?
- a. Yes
- b. Not

Improvement of the system

- 19. Are you willing to collect old equipment free of cost and then hand it over to authorized agency
- a. Yes
- b. No
- 20. What will be most convenient method of discarding not in use (old) electronics and electrical?
- f. Company Drop off points
- g. Door to door pick up
- h. Panchayat or Municipal collection drop boxes
- i. Moving 'collection day' events
- 21. What will be most convenient method of receiving information about e-waste
- g. Television
- h. Radio
- i. Social Media
- j. Newspaper
- k. Pamphlets
- l. Events
- m. Which is the department in charge of e-waste disposal?

D. Repair Shop Survey for E-waste Inventorisation in Goa

By Toxics Link

For Goa Waste Management Corporation (GWMC)

About the unit

- 1. Name of the Surveyor
- 2. Name & address of the repairing shop (Location in map)
- 3. Name of Respondent
- 4. Contact Number of Respondent
- 5. Are you
- ☐ Owner ☐ Worker at the unit
- 6. How many workers are engaged in the unit?

Operations

- 7. What are the various items the unit deals with
- a. Computer
- b. Laptop
- c. Printer

- d. Mobile Phone
- e. Television
- f. Refrigerator
- g. Washing Machine
- h. Air-conditioner
- i. Tube lights
- j. CFL bulbs
- k. Microwave
- l. Oven
- m. Toaster
- n. Mixer Grinder

8. Who do you repair for

- a) Households
- b) Office
- c) Company (OEM)
- d) Local dealers
- e) Any other

9. Do you buy old equipment?

☐ Yes ☐ No

10. If yes, from where do you buy it from?

- a) Households
- b) Offices
- c) Companies (OEM)
- d) Dealers/ Retailers
- e) Kabadiwalas
- f) In auction or tender
- f) Any other, specify _____

11. How many of the following (from what you buy) are repairable and non-repairable? (In %)

Items	Repairable	Non-repairable
a) Computer		
b) Laptop		
c) Printer		
d) Mobile Phone		
e) Television		
f) Refrigerator		
g) Washing Machine		
h) Air-conditioner		
i) Tube lights		
j) CFL bulbs		

k) Microwave		
l) Oven		
m) Toaster		
n) Mixer Grinder		

12. Do you sell the repairable items?

☐ Yes ☐ No

13. How many years do you think the following items last (including after repairing)?

- a) Computer
- b) Laptop
- c) Printer
- d) Mobile Phone
- e) Television
- f) Refrigerator
- g) Washing Machine
- h) Air-conditioner
- i) Tube lights
- j) CFL bulbs
- k) Microwave
- l) Oven
- m) Toaster
- n) Mixer Grinder

14. What do you do with non-repairable items?

- a) Dismantle
- b) Use the component in other items
- c) Given to other for dismantling or recycling
- d) Throw
- e) Sell it further
- f) Any other, specify _____

15. Is there any waste generated during the repair process. If yes, please list

16. What do you do with the waste?

- a) Burn it
- b) Dump it in municipal bins
- c) Throw it in nearby areas/fields
- d) Give it to authorised recycler/dismantler
- e) Any other, please mention _____

Financials

17. How much does the unit earn monthly?

18. How much do the workers get paid / month?

Knowledge

1. In your opinion, is electronic waste harmful to humans and environment in any way?

☐Yes ☐No

2. What are the problem material/component in the e-waste you handle (list)?

3. Are personal protective equipment provided to workers at the unit? [OBSERVATION]

☐ Yes ☐No

If yes, then please tick ☐ Gloves ☐ Mask ☐Boots ☐Apron

4. Are you aware that there are rules governing recycling and disposal of e-waste

☐Yes ☐No

5. Are you willing to give your e-waste free of cost in case of door to door collection

Annexure II: Equipment Information

Electronic Product	Average Weight (kg)	Weight per capita	Average Life	Growth Rate
Computer	15	0.810397554	6	-9
Laptop	3	1.067278287	5	40
Printer	5	0.285423038	10	24
Mobile Phone	0.102	0.096489297	5	20
Television	15	4.174311927	9	14
Refrigerator	38	8.057084608	10	11
Washing Machine	30	5.718654434	9	11
Air-conditioner	27	8.697247706	10	11
Tube lights	0.11	0.083537207	2	-10
CFL bulbs	0.08	0.137166157	2	-10
Microwave	5	0.545361876	6	11
Oven*	5	0.249745158	6	11
Toaster**	1	0.0509684	4	11
Mixer Grinder***	3	0.73088685	5	11