

# Best Practices and Challenges in implementation of E-Waste Policy and Regulatory Framework in Rwanda (Stand-Alone Solar Sector Perspective).

March 2021



**Foreign, Commonwealth and Development Office (FCDO)  
Africa Clean Energy Technical Assistance Facility**

**March 2021  
Tetra Tech International Development**

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## ABBREVIATIONS

<b>ACE TAF</b>	Africa Clean Energy Technical Assistance Facility
<b>DFID</b>	Department for International Development
<b>EACO</b>	East African Communications Organisation
<b>EEE</b>	Electrical and Electronic Equipment
<b>EMPs</b>	Environment Management Plans
<b>EnDev</b>	Energising Development Partnership
<b>FCDO</b>	Foreign, Commonwealth and Development Office
<b>GOGLA</b>	Global Off-Grid Lighting Association
<b>GoR</b>	Government of Rwanda
<b>MINICOM</b>	Ministry of Trade and Industry
<b>NGOs</b>	Non-Governmental Organisations
<b>PPP</b>	Public-Private Partnership
<b>REG</b>	Rwanda Energy Group
<b>REMA</b>	Rwanda Environment Management Authority
<b>RSB</b>	Rwanda Standards Board
<b>RURA</b>	Rwanda Utilities Regulatory Authority
<b>SAS</b>	Stand-Alone Solar
<b>SHS</b>	Solar Home Systems
<b>SPL</b>	Solar Portable Lamps

## EXECUTIVE SUMMARY

The legal and regulatory framework for e-waste management in Rwanda is relatively advanced compared to other countries in Africa. This report brings to light Rwanda's experience in the implementation of the National Sanitation Policy, which includes Rwanda e-waste policies and regulations. The research identified best practices and challenges in implementing policy actions on e-waste and related regulations and can be considered for use in other countries in Africa.

Following the signing of the public-private partnership (PPP) agreement between the Government of Rwanda (GoR) and Enviroserve Rwanda Green Park in 2017, e-waste collection and recycling infrastructure has been expanded to cover the entire country. As of February 2021, 20 collection points had been established in different districts of the country. This comes after a treatment facility with recycling capability of processing 10,000 tonnes of e-waste annually was established in Bugesera District in January 2018.

The challenges of e-waste management in Rwanda can be clustered in four categories: limited awareness by the population on e-waste management practices; limited facilities and human resources for proper management of hazardous waste; gaps in the e-waste regulatory framework; and sub-optimal utilisation of the recycling facility.

This report highlights four key best practices from e-waste management in Rwanda:

- ❁ Private Public Partnerships (PPPs) increase ownership and sustainability due to the binding commitments each partner has to adhere to in the agreement. The PPP between the GoR and Enviroserve allocates clear responsibilities. While the Government of Rwanda (GoR) built the e-waste recycling plant, Enviroserve manages its operations and is responsible for upgrades.
- ❁ All key stakeholders are involved in generation, collection, transportation, recycle or reuse and final disposal, which contributes to more sustainable e-waste management.
- ❁ Use of various communication methods, including social media, is paramount to raising awareness among the public about where they can responsibly dispose of their e-waste. In Rwanda's case, radio and TV shows were used during the first awareness campaign organised by Rwanda Utilities Regulatory Authority (RURA) and Enviroserve.
- ❁ The government of Rwanda collected baseline information well before the collection points and the recycling plant were established. As such baseline data is needed to put in place proper infrastructure for sustainable e-waste management.

# 1: E-WASTE CONTEXT AND METHODOLOGY

## 1.1 Background

According to the Global E-waste Monitor 2020, 53.6 million tonnes of electronic waste (e-waste) were generated worldwide in 2019. The report also predicts global e-waste – discarded products with a battery or plug – will reach 74 million tonnes by 2030. This makes e-waste the world's fastest-growing domestic waste stream, fuelled mainly by higher consumption of electrical and electronic equipment (EEE), short life cycles of the EEE and few options for repair.<sup>1</sup>

The demand for EEE has increased significantly in Rwanda due to economic growth and modernisation. According to the National Sanitation Policy, the utilisation, purchase, and importation of EEE is expected to grow substantially, with estimates of 20 per cent annual growth. The increased usage of the equipment will subsequently generate higher volumes of e-waste,<sup>2</sup> which is generated from discarded mobile phones, computers, stereos, light bulbs as well as large household appliances such as televisions, refrigerators, washing machines and air conditioners. It was projected that the country's e-waste will reach 12.4 tonnes per year in 2020 up from 8.8 tonnes per year in 2014.<sup>3</sup>

Conscious of its monetary value on one hand and contamination<sup>4</sup> effects on the other, the Government of Rwanda (GoR) has initiated e-waste management initiatives and mechanisms to support the promotion and implementation of its sound and sustainable management. In this regard, and on top of previously existing overall environmental management tools,<sup>5</sup> Rwanda published a draft e-waste policy in 2015, which was subsequently incorporated into the National Sanitation Policy. The Rwanda Cabinet approved the Sanitation Policy and its related implementation strategy in December 2016. This was followed by the approval of the Regulation Governing E-waste in Rwanda in April 2018.

To ensure sustainable management of e-waste, GoR, in partnership with Enviroserve Green Park Rwanda, established a modern environment-friendly e-waste dismantling and recycling facility in Bugesera Industrial Park in January 2018. Previously, GoR and private institutions had been renting warehouses to store their e-waste, which was expensive and unsustainable. The adoption of the e-waste policies and regulations, as well as the establishment of this facility, put the country at the forefront of e-waste management in sub-Saharan Africa. Rwanda is the second country in Africa to have an e-waste dismantling and recycling facility after South Africa.

E-waste management has become a major challenge facing many African countries because of lack of awareness, lack of environmental legislation and limited financial resources. Currently, e-waste in Africa is predominately disposed through open dumping, burning and landfilling, but with heavy metals and other hazardous substances present in electronics, these methods have potentially serious implications for human health and the environment.

Given the advanced nature of the Rwandan e-waste policy and regulatory environment, and the challenges that other African countries are facing, Africa Clean Energy Technical Assistance Facility (ACE TAF) initiated a study to document Rwanda's experience in implementing e-waste policy and regulations with a focus on stand-alone solar (SAS) products. The information is to be shared with other African countries for reference as they establish plans and facilities for management of their e-waste.

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1 UNU/UNITAR (2020). *The Global E-Waste Monitor 2020*.

2 MININFRA (2016). *Rwanda National Sanitation Policy*.

3 MINICOM (2015). *A detailed inventory of electrical and electronic waste in Rwanda*.

4 Refers to environmental contamination and associated hazards.

5 Encompasses general environmental management tools like environmental laws and associated regulations, laws establishing institutions like REMA, FONER-WA and several standards and guidelines.

## 1.2 Objectives and Scope

### 1.2.1 Objectives

The main objective of the study was to assess ongoing e-waste management practices in Rwanda and document best practices and challenges that need to be resolved by GoR to ensure enforcement and sustainability of e-waste regulations. This study also entails dissemination of the information to other countries within the East African Community and all ACE TAF programme countries.

### 1.2.2 Scope

This study was limited to Rwanda's management of e-waste, with emphasis on analysing the impact of e-waste resulting from SAS product obsolescence. The study was conducted through two main phases:

**Phase 1:** Desk-based research on the e-waste landscape in Rwanda with emphasis on SAS products.

**Phase 2:** Detailed analysis and stakeholders' consultations regarding the current Rwanda e-waste landscape.

## 1.3 Methodology

### Data Collection

#### 1. Literature review

Secondary data sources were reviewed and insights obtained from various materials. These include national policies, strategies, guidelines and standards, international agreements, regional guidelines and strategies and previous study reports relevant to e-waste management. The detailed list of materials reviewed is provided in Annex 2.2.

#### 2. Consultations

The insights obtained from the desk review and qualitative research were confirmed through exploratory interviews with stakeholders relevant to the study. Prior to consultations, respondents were categorised into government institutions, development partners, financial institutions, private sector (including the industry association), waste management companies and individual experts.<sup>6</sup> Face to face interviews were prioritised, but because of the COVID-19 pandemic, some interviews were conducted virtually.

#### 3. Field visits

Field visits were made to five collection points: one in Kigali city and the others in Eastern, Western, Northern and Southern provinces. The e-waste dismantling and recycling plant in Bugesera was also visited. This enabled close observation of how e-waste is collected, transported and treated at the plant, which helped in the identification of areas of improvement for the process. Information was provided by officers in charge of the facilities.

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<sup>6</sup> Mostly from existing list of practitioners accredited by the Rwanda Association of Professional Environmental Assessment Practitioners (RAPEP) and University lecturers/researchers.



## Data analysis

Quantitative and qualitative data collected through desktop study and consultations through exploratory interviews and field visits was analysed and interpreted to get the results that address the study objectives. All the information was summarised and key messages captured and reported (refer to Annex 1).

Comparative analysis was done with previous studies on the subject. For example, a review of the Sustainable Management of E-Waste in the Off-Grid Renewable Energy Sector in Rwanda report enabled comparison with the newly collected information to determine whether there has been progress on implementation of previous recommendations. It also helped to establish whether opportunities for improvement previously identified are still valid.

Quantitative information, such as number of SAS systems sold and associated waste, was compared with validated information available in the e-waste inventory of 2016 and to the data from Energising Development (EnDev) activity reports of 2016 and 2017. This established the rate at which e-waste from solar products has been growing.



## 2: UNDERSTANDING THE E-WASTE REGULATORY FRAMEWORK IN RWANDA



At the heart of the e-waste regulatory framework in Rwanda is the E-Waste Policy, which is part of the National Sanitation Policy adopted in 2016. The policy provided guiding principles in dealing with e-waste and roles and responsibilities for institutions. In addition to clarification of the National Sanitation Policy, this chapter provides insight on the National Environment and Climate Change Policy and legal instruments subsequently created, such as laws and regulations, and international conventions ratified by Rwanda to handle the increasing generation of e-waste.

### 2.1 E-waste Management Policy Framework in Rwanda

#### 2.1.1 National Sanitation Policy

Rwanda began policy discussions around how to manage its e-waste in 2008. After consulting those involved in the sector, with support from the Enhanced Integrated Framework (EIF),<sup>7</sup> GoR, through the Ministry of Youth and ICT and the Ministry of Trade, Industry and East African Community Affairs (MINEACOM), formulated the Draft National E-waste Policy (2015). The policy was to provide comprehensive guidance for the efficient and effective management of discarded EEE through appropriate legal and regulatory instruments. It was meant to control the end-of-life EEE, which would result in protection of human health, conservation of the environment, development of a business niche in e-waste management and recycling, and creation of employment.

However, following high-level consultations, the Prime Minister's Office recommended that the Ministry of Infrastructure (MININRA) incorporate policy actions on e-waste in the wider sanitation policy. As such, the draft e-waste policy was never adopted as a stand-alone policy but was instead incorporated in the National Sanitation Policy (2016). In addition, GoR decided that detailed separate strategies for e-waste management and other waste classified as hazardous under the National Sanitation Policy would be developed.

The Sanitation Policy and its related implementation strategy, which was approved by the Cabinet in December 2016, provides guidance on all aspects of waste management and recognises the uniqueness of e-waste, which requires guidelines for its proper management.

Objective 6 of the Sanitation Policy is to ensure safe management of e-waste, industrial waste, nuclear/ radioactive waste and health-care waste. Specific policies and tools to provide detailed direction for managing such waste is to be developed by the respective ministries and institutions.

The policy also mentions the "Establishment of an e-waste collection and management framework" to ensure safe management of e-waste. It stipulates that the Rwanda Utilities Regulatory Authority (RURA) will develop regulations for e-waste collection and management in consideration of the waste management hierarchy approach of the 3Rs (reduce, reuse, and recycle). It also adds that GoR will establish strategically located e-waste collection centres, drop-off points and a dismantling facility through public-private partnership (PPP).

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<sup>7</sup> The multilateral partnership dedicated to assisting least developed countries (LDCs) use trade as an engine for growth, sustainable development and poverty reduction.

## 2.1.2 National Environment and Climate Change Policy

This policy was adopted in 2019 and highlights e-waste among the key emerging challenges and as the fastest growing source of environmental pollution. Specifically, the policy's Objective 5 is to improve environmental well-being for Rwandans while emphasising standardisation and effective monitoring and enforcement of laws against all types of pollution. This is to be achieved through implementation of the policy's statement on prevention and promotion of integrated pollution control and waste management (including SAS waste as part of e-waste) with the following priority actions for GoR to focus on:

- 🌐 Develop a profile of all categories of waste in Rwanda
- 🌐 Promote the sound management of chemicals and hazardous wastes in accordance with agreed international e-waste frameworks
- 🌐 Set up waste management information systems
- 🌐 Domestic chemical and chemical waste multilateral environmental agreements
- 🌐 Support technology development and innovation around e-waste management.

Both the Sanitation Policy and the Environment and Climate Change Policy are silent on SAS related e-waste, but the same is covered in the legislation framework as detailed in the next section.

## 2.2 Rwanda E-Waste Management Legal Framework

### 2.2.1 Ministerial Guidelines No1 of 25/10/2011 Related to Importation of Used Electronics/ICT Equipment

The Ministry of ICT and Innovation, in collaboration with the Rwanda Standards Board (RSB), established Ministerial Guidelines No1 of 25/10/2011 Related to Importation of Used Electronics/ICT Equipment. The guidelines are aimed at restricting and regulating importation and distribution of used computers and electronic parts to minimise EEE disposal's potential adverse effects on human health and the environment.

Articles 6 and 7 clarify importation and distribution of used computers and electronic parts. Article 6 stipulates that no used computer shall be imported for commercial purposes while Article 7 stipulates that used computers shall only be allowed if they are intended for education purposes, personal use, church organisations or orphans' centres.

### 2.2.2 Environment Law (2018), officially Law N°48/2018 of 13/08/2018 on Environment

The Organic Law of 2005 was revised in 2018. One of the main reasons for revision was to include provisions related to e-waste. The resultant Environment Law (2018), officially Law N°48/2018 of 13/08/2018 on Environment, includes Article 20 on e-waste management. The law recognises e-waste as hazardous and toxic and must be collected, treated and changed in a manner that does not degrade the environment so as to prevent, eliminate or reduce adverse effects on human health, natural resources and environment. It also limits the collection, transportation, trading, importation, dismantling and recycling of e-waste to those who are authorised by a competent authority.

Article 20 also states that modalities for the processing of e-waste are determined by an order of the minister. The draft Ministerial Order for this purpose is under discussion at the Law Reform Commission before being forwarded to the Prime Minister's office for Cabinet approval.

It follows that solar products – solar portable lights (SPL) and solar home systems (SHS) – are considered in the scope of the e-waste management legislation in Rwanda as equipment that is used to generate, transfer and measure electrical currents.

Under the law, producers are obliged to organise and finance the e-waste management systems in the country. It defines the producer as **“Any person or entity who introduces or causes to be introduced new and used electrical and electronic equipment into the market by sale, donation, gifts, inheritance or by any such related methods and can either be a manufacturer, importer, distributor or assembler”**. Under this definition manufacturers, importers, distributors or assemblers of solar products have the obligation to ensure proper management of end-of-life solar products.

## 2.3 Rwanda E-Waste Management Standards, Regulations and Guidelines

### 2.3.1 Rwanda E-Waste Regulation

RURA issued **Regulation N°002 of 26/4/2018 Governing E-Waste Management in Rwanda**, which establishes a regulatory framework for e-waste management and reiterates that any person carrying out activities related to e-waste management activities must hold an appropriate license issued by RURA. In general, the regulation provides for the issuance of general authorisation for importation and supply of EEE, as well compliance and enforcement. Article 5 on General Requirements for authorisation stipulates that any person who wishes to carry out activities of importation and supply of EEE must accompany his or her application with a duly signed application form, a copy of a valid business registration certificate and proof of license fee payment.

### 2.3.2 E-Waste Management Standard

In addition, RSB has developed and published several standards for various EEE and a dedicated<sup>8</sup> standard on e-waste management. This standard prescribes handling, collection, transportation, and storage of various categories of e-waste.

The Standard covers segregation of e-waste and appropriate personal protective equipment (PPE) and containers to be used. On collection, it covers requirements for collectors/ transporters, conditions for establishment of collection and storage systems, collection modalities (producers take-back and storage, consumers take-back and storage, and door-to-door) and requirements for collection centres. When it comes to transportation, the Standard covers requirements and responsibilities of a transporter as well as conditions and requirements for e-waste storage.

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<sup>8</sup> RS 276-1: 2016 Electrical and electronic waste handling, collection, transportation, and storage — Code of practice, and RS 276-2: 2016 Electrical and electronic waste treatment and disposal — Code of practice


### 2.3.3 2019 Ministerial Guidelines

To avoid an influx of poor-quality products and resulting e-waste in the market, GoR published the 2019 Ministerial Guidelines, which provide minimum standards for SHS to be imported into Rwanda in form of service level requirements as follows:


- (a) Three lamps of at least 120 lumens each, operating at least four hours per day
- (b) Mobile phone charging supply for at least two hours per day
- (c) Radio charge supply for at least five hours per night
- (d) Supply the above loads for at least one day without input from the solar module when there is no sunshine
- (e) Dismountable system parts and system compatibility to allow for spare parts replacement.

## 2.4 International Conventions Related to E-Waste Management and their Domestication Status

Rwanda is a signatory to and has ratified some international conventions and agreements relating to the environment, both regionally and globally. Conventions and agreements of relevance to e-waste management that Rwanda has signed are:

 **Basel Convention:** In the late 1980s, a tightening of environmental regulations in industrialised countries led to a dramatic rise in the cost of hazardous waste disposal. Searching for cheap ways to get rid of the waste, unscrupulous traders began shipping hazardous waste to developing countries.<sup>9</sup> When this was exposed, international outrage led to the drafting and adoption of the Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal on March 22, 1989. It entered into force on May 5, 1992. Rwanda ratified the Convention through Presidential Order N°29/01 of 24 August 2003. Presently, 181 countries are parties to the Convention.

As a signatory to the Convention, GoR, through the Rwanda Environmental Management Authority (REMA) established the **National Implementation Plan (NIP) of the Convention in 2013** in order to address issues related to transboundary movement of hazardous wastes and their disposal within the country. The NIP implementation has been underway since 2014 and runs until 2021. It outlines national priorities and targets, including establishment of repair centres for EEE and construction of an appropriate e-waste storage and recycling plant.

 **The Bamako Convention,** adopted under the auspices of the then Organisation of Africa Unity (OAU), prohibits hazardous waste imports into Africa and was adopted on January 30, 1991. The Convention also covers waste considered hazardous under the domestic laws of the state of import, export, or transit, including e-waste.

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<sup>9</sup> *History of the negotiations of the Basel Convention.*

# 3: SITUATION ANALYSIS OF THE SOLAR E-WASTE MANAGEMENT LANDSCAPE IN RWANDA



## 3.1 Volumes of Solar E-Waste in Rwanda

Rwanda is one of the most densely populated countries in Africa with a population 12.66 million.<sup>10</sup> Seventy per cent of this population lives in rural areas. GoR has set an ambitious target to provide every Rwandan with access to electricity by 2024 as per the Energy Sector Strategic Plan (ESSP, 2017–2024), with 52 per cent connected via the grid and 48 per cent connected via off-grid technologies. Access to electricity has increased rapidly over the last few years from 14 per cent in 2012 to 56 per cent in 2020.<sup>11</sup>

GoR adopted a Rural Electrification Strategy in 2016 that emphasised private sector participation and indicated how the objective of off-grid electrification would be achieved in rural areas and less densely populated areas where grid connection would not be cost-effective in the short-term. In these areas, SHS solutions appear to be the preferred solution for households while larger systems could also provide access to small productive users and social institutions including schools and health facilities.

Solar technology for electrification has been deployed in Rwanda since the 1980s, often through the support of donors and non-governmental organisations (NGOs). More than 800,000 solar products have been sold in Rwanda since 2014.<sup>12</sup> These numbers are expected to grow exponentially to achieve the off-grid electrification target. The adoption of the pay-as-you-go (PAYG) business model has also been found to be a key booster of solar products adoption.<sup>13</sup>

While solar products are the promising solution to providing rural areas with electricity, they also have challenges related to e-waste disposal and recycling. Solar e-waste contains hazardous materials that require special treatment and disposal to protect the environment and human health. The Foreign, Commonwealth and Development Office (FCDO) – (formerly DFID) – study on solar e-waste in Rwanda showed that nearly 400 tonnes of solar products were put on the market in Rwanda in 2017 and 183 tonnes of e-waste was generated in the same year. In 2022, this is projected to grow to 1,169 tonnes of solar products and 625 tonnes of e-waste (see Figure 1).



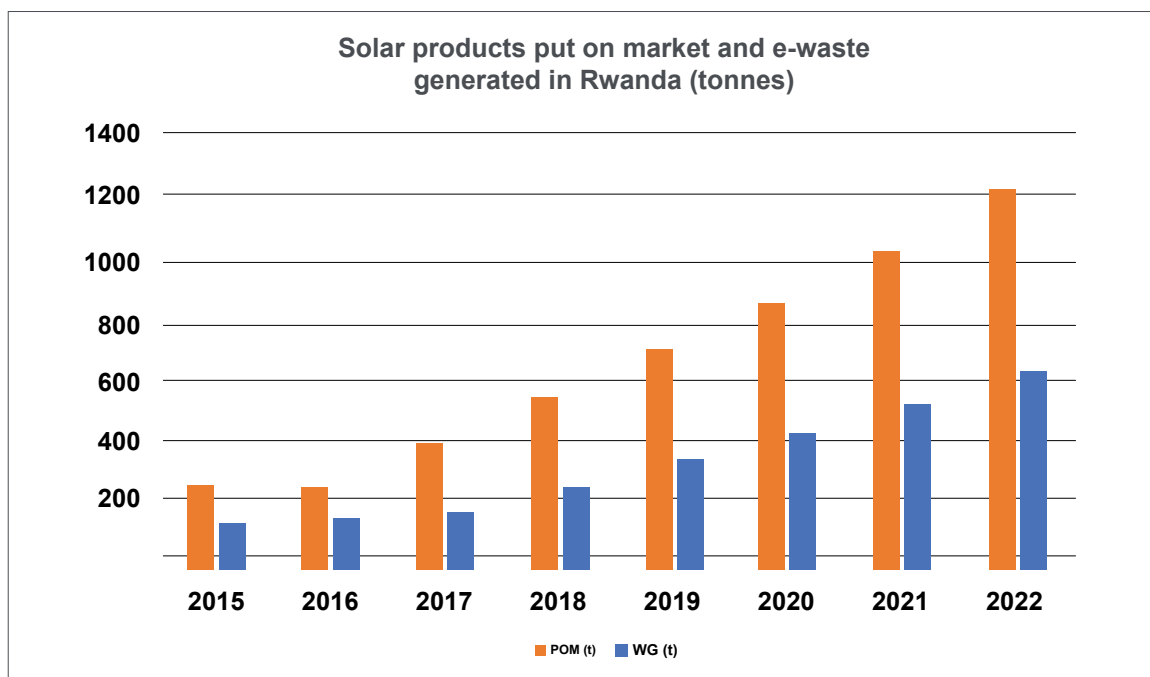
**More than 800,000 solar products have been sold in Rwanda since 2014. These numbers are expected to grow exponentially to achieve the off-grid electrification target. The adoption of the pay-as-you-go (PAYG) business model has also been found to be a key booster of solar products adoption.**

<sup>10</sup> National Institute for Statistics 2020 projection.

<sup>11</sup> MININFRA (2020). Energy Sector Performance Report: Backward Looking Joint Sector Review Report for FY 2019/2020.

<sup>12</sup> Power Africa (2019). Off-Grid Solar Market Assessment: Rwanda.

<sup>13</sup> DFID (2017). Sustainable Management of E-waste in the Off-grid Renewable Energy Sector in Rwanda.



Note: POM – put on market; WG – waste generated

Figure 1: Evolution of solar products put on market and e-waste generated (t) in Rwanda <sup>14</sup>

In the 2016 study by FCDO, it was noted that there was some level of recycling in Rwanda. Table 1 presents the main components retrieved from solar products and their markets. Hazardous materials have been incinerated in local and international incinerations and valuable materials recovered and sold on local and international market.

Table 1: Material composition and downstream markets for main fractions <sup>15</sup>

Material	Solar Products (SPL & SHS)	Market
Ferrous/steel/stainless steel	13 - 17 %	Local
copper	0-17%	Local
Aluminium	TBC (Mostly in large solar modules)	Local
Plastic	TBC (Mostly in SPLs)	Plastic
Glass	TBC (Mostly silicon)	Local/International
Printed circuit boards (PCBs)	TBC (mostly in SHS)	International
Lead-acid, lithium-ion, lithium-phosphate	Batteries	Local/International

<sup>14</sup> DFID (2017). Sustainable Management of E-waste in the Off-grid Renewable Energy Sector in Rwanda.

<sup>15</sup> *ibid.*

## 3.2 Collection and Recycling Infrastructure for Solar E-Waste in Rwanda

Rwanda is striving to build a sustainable e-waste management value chain for three core reasons:

- ☉ To effectively manage the toxic elements that form part of EEE that can be a source of danger to human health and the environment in general.
- ☉ The value of some embedded parts that can serve as raw materials for certain factories and be a real source of money.
- ☉ Creation of job opportunities in e-waste collection, repair and recycling and promotion of the economy and environment in Rwanda.

Following the PPP agreement between the government of Rwanda and Enviroserve, an e-waste collection system and recycling infrastructure have been developed in the country. The Bugesera facility has solar e-waste recycling capacity.

On November 12, 2020, RURA, Enviroserve, GIZ Eco-Emploi Programme and REMA launched the Rubavu e-waste collection centre, which is the central point for collection and interim storage of e-waste from Rubavu District. In addition to the Rubavu one, there are 19 e-waste collection points located in Musanze, Huye, Nyanza, Muhanga, Rwamagana, Kayonza, Kirehe, Ngoma, Nyagatare, Karongi, Nyamasheke, Bugesera, Gakenke, Rusizi, Burera, Rulindo, Ruhango, Nyamagabe and Kicukiro districts. This falls short of the 416 centres proposed by the private operator to cover all the administrative sectors of the country.

The 20 existing collection points are a combination of door-to-door collection and customer-to-business collection services where members of the public can drop off their unwanted electronic goods. There is target of a total of 30 centres by the end of 2021 – one in each district and at border posts (Eastern Democratic Republic of Congo, Burundi, Uganda and Tanzania). The most common collection channels in place for the solar e-waste are:

- ☉ Business to business: Enviroserve collects e-waste from big businesses (including solar companies such as Ignite Power, Mobisol, BBoxx and One Acre Fund) as well as small and medium enterprises (SMEs), NGOs, government agencies and international organisations.
- ☉ Drop off: Solar companies or individuals deposit e-waste at the established collection points.
- ☉ Door-to-door collection: Direct pick up of e-waste at the household or institutional level. This is currently done mainly by two companies (COPED and AGRUNI), which are contracted to collect both solid waste and e-waste.
- ☉ Informal collection: Informal waste pickers, small repair and refurbishment shops who take their waste to established collection centres.





Figure 2: Front view of an e-waste collection centre in Musanze District

### Bugesera E-Waste Facility

The e-waste facility in Bugesera is managed and operated by Enviroserve as per the PPP with GoR. The facility was constructed by the Ministry of Trade and Industry through a Rwanda Green Fund (FONERWA) investment of more than USD1.5 million. The facility has the capacity to collect and treat 10,000 tonnes of e-waste annually. The facility's management indicated that it has collected and treated over 3,000 tonnes per year, including 300 tonnes of solar e-waste and batteries in the last three years, which implies it is operating below its capacity.

The facility houses 18 dismantling stations, a complete plastic shredding and washing line, a cathode ray tube (CRT) cutting and depollution line and a metal compactor/baler. It also has specialised equipment for solar e-waste treatment such as small cables crusher and stripping machines, batteries testing, discharging and recharging equipment and lamp crushers. The management of the facility aims to expand and become the first lithium battery recycling facility in Africa. They are currently conducting a feasibility study with the support of the Ministry of Trade and Industry (MINICOM) and the European Union (EU) with hope of attracting significant investment.

Once the e-waste reaches the facility, it is separated, weighed and recorded. Enviroserve keeps records of where the waste comes from and whether the client has requested refurbishment, or their data wiped. If they can refurbish the equipment, they then either sell it at a heavily discounted price or donate it to local schools. To date, Enviroserve have sold or donated nearly 2,000 refurbished computers to schools.

If the item is beyond repair, it is dismantled into different parts. Valuable materials are recovered while hazardous materials are responsibly disposed of. Plastic is crushed into small pellets and sold to other industries to make new plastic materials. Recovered steel is processed into high quality iron bars by a facility next door to the recycling plant. These bars are being used in the construction of schools and the new airport. Circuit boards are exported to Enviroserve Dubai, which has higher technology to remove precious metals.

The facility has led to major environmental gains like prevention of soil and surface pollution around the country. In addition, the installation and operation of the recycling facility resulted in the creation of more than 400 direct and indirect green jobs from collection to refurbishment and construction. Also, the high-tech facility is run by an expert investor who is transferring skills to local staff to manage and operate the facility, in addition to providing the raw material to other industries, such as steel industries in line with Rwanda's resolve to build a green economy.



Figure 3: Lithium-ion batteries and charging and discharging cabinet at the Enviroserve facility

### 3.3 Public-Private Partnership for E-Waste Management in Rwanda

The Sanitation Policy prioritises PPP in the establishment and operation of e-waste management infrastructure, including e-waste dismantling facility and collection points. This arrangement combines the strengths and abilities of both government and private sector. GoR recognises that PPPs offer the advantage of private sector expertise and cost reducing technologies as well as efficiencies in operation and maintenances of infrastructure.

In accordance with the PPP Law in Rwanda, MINICOM initiated the process of engaging a private partner to establish, manage and operate a state of art and environmentally friendly e-waste dismantling facility, the first of its kind in East Africa, and collection points. A competitive tendering process was used and Enviroserve emerged as the successful bidder. The company is a subsidiary of Enviroserve Dubai, which has over 15 years of experience in e-waste management.

The PPP deal was worth USD2.6 million, an amount that surpasses the initial investment of USD1.5 million by FONERWA. The agreement has the following key components:

- The PPP is based on a revenue sharing model between GoR and Enviroserve. Revenues are generated from selling recovered valuable fractions (such as steel, copper, aluminium, plastics and circuit boards), refurbished items (such laptops, desktops and printers) and repurposed batteries.
- The facility is owned by GoR through MINICOM and run by Enviroserve on a 10-year renewable lease. The lease fee paid to GoR will be reinvested in environmental and green growth initiatives through FONERWA.
- During the lease period, the investor will transfer skills to local staff to manage and operate the facility in addition to providing raw materials to other industries, such as the steel industry.
- GoR is responsible for monitoring and enforcing compliance with the provisions of the PPP and as such has the right to intervene in case Enviroserve defaults or breaches the terms of the agreement. GoR also avails e-waste from its agencies for recycling.
- The role of Enviroserve includes:
  - Operate and manage the facility.
  - Develop e-waste collection points/centres around the country.
  - Expand the e-waste facility by introducing new machinery and equipment such as refrigerant gas recycling machinery, data destruction machinery and others.
  - Pay GoR a lease fee over the 10-year period.
  - Conduct regular public awareness about the proper management of e-waste and its impact on human health and the environment.

The agreement is based on a set of environmental performance criteria including but not limited to: having undertaken and certified the facility's environmental impact assessment study; and the facility should be state of the art and comply with all environmental standards in terms of air emissions, noise, effluents, waste treatment and disposal. It is the responsibility of the government to continue to monitor the environmental performance compliance at the facility.



Figure 4: One of the e-waste management awareness campaigns conducted by Enviroserve



Figure 5: Staff at the lead-acid batteries testing and regeneration station (on the left) and regenerated batteries (on the right).

## 4: CHALLENGES AND OPPORTUNITIES FOR SOLAR E-WASTE MANAGEMENT IN RWANDA

E-waste management in Rwanda faces several challenges. Most cut across all categories of e-waste, but there are some that are specifically associated with SAS waste, such as high disposal costs and difficulties of processing lithium-ion batteries. The challenges can be categorised as follows:

- Challenges associated with limited public awareness of sustainable management of end-of-life electrical and electronic waste.
- Financial and human resources constraint to establish and manage facilities.
- Challenges related to enforcement of e-waste regulatory framework in the country.
- Suboptimal utilisation of the recycling and dismantling plant.

### 4.1 Limited Public Awareness of Sustainable Management of End-of-Life EEE

Consultations with officials from REMA revealed awareness of environmental protection issues among the public is generally low. There is even less awareness of e-waste challenges and management, especially disposal of SAS products that have reached end-of-life.

People do not want to dispose their EEE for emotional reasons and therefore prefer to keep them at home even if they are no longer working. Others do not know that the equipment contain hazardous chemicals that can be detrimental to their life or the environment. In addition, most people do not have enough information on where and how to take back the used EEE, resulting in very small numbers in the e-waste stream.

### 4.2 Financial and Human Resources Constraint to Establish and Manage Facilities

Financial constraints limit ability to manage collection and transportation of e-waste. There are few collection centres and an inadequate transportation system from the collection point or from the consumers to the treatment plant in Bugesera. Officials from Enviroserve confirmed that the target was to establish 30 collection points in 2020, but they could only manage 20 because of the COVID-19 pandemic. In addition, Enviroserve maintains only one truck, which is insufficient to collect e-waste from all 20 collection points. This drives up the risk of increased dumping of e-waste.

REMA officials confirmed that human resource capacity to handle e-waste is still a challenge since Rwanda does not have enough technicians trained and exposed to this kind of work. This is one of the reasons why Enviroserve is expected to facilitate transfer of knowledge and technology in e-waste handling. As of December 2020, Enviroserve officials revealed they had created 413 green Jobs.

Solar companies interviewed complained that the disposal cost is hampering efforts to collect and supply the waste to recycling companies. They acknowledged having solar e-waste, but having to transport the waste to the recycling facility at their own cost and being charged about RWF500 (USD0.5) per kilo of lithium batteries and RWF150 (USD0.15) per kilo of other solar e-waste discourages them.

### 4.3 Shortfalls In Enforcement Of The Regulatory Framework

Rwanda has made significant steps by adopting the Sanitation Policy, enacting the Environment Law of 2018 and establishing regulations for service providers in the e-waste management business. What is missing is practical guidance in the form of a ministerial order to clearly distribute roles and responsibilities throughout the e-waste management chain. In addition, the Draft E-Waste Management Strategy is yet to be approved. Once approved, it is likely to provide concrete action points and distribute roles and responsibilities to relevant e-waste stakeholders. Furthermore, adequate enforcement mechanism to ensure stakeholders comply with the already established policies, laws and regulations is missing.

It appears that several government agencies are involved in e-waste management, increasing the risk of overlapping of activities and hence confusion. The e-waste management agenda was pioneered by MINICOM. This culminated in construction of the e-waste facility, after which MINICOM's involvement ceased. MININFRA initiated the publication of the Sanitation Policy that covers e-waste and related regulations, but enforcement seems to be shouldered by REMA under the Ministry of Environment and RURA (under MININFRA). RURA and REMA have also been involved in a nationwide awareness campaign to build a sustainable e-waste management ecosystem in Rwanda.

Article 20 of the Environment Law states that modalities for the processing and treatment of e-waste are determined by an order of the minister and the Draft Ministerial Order is still under discussion. This order, once in place, will clarify roles in e-waste management.

While solar modules are specifically mentioned as a separate category in the e-waste regulations, it appears that solar batteries and solar lights are broadly grouped into battery and lighting products categories, respectively. This may create confusion on whether solar batteries and solar lights are included in the regulatory framework.

EnviroServe Rwanda signed a partnership agreement with Energy Private Developers (EPD), which brings together all private companies operating in the energy sector in Rwanda to create a framework to ease disposal of solar e-waste. Despite the existence of this agreement, none of the four solar companies interviewed had an environmental management plan (EMP) in place to facilitate collection and take-back of products that have reached end of life. Current regulations and laws on e-waste do not make EMPs compulsory. Even the Pro-Poor Subsidy scheme for SAS and its recently scaled-up version implemented as part of the Renewable Energy Fund (REF) have not included having an EMP as one of the eligibility criteria.

### 4.4 Suboptimal Utilisation of the Recycling Plant

The recycling facility is currently operating at only 30 per cent of the installed capacity since not all available e-waste in the country ends up at the facility. There are two key reasons for this:

- Low public awareness and motivation to take back e-waste (including SAS waste) for recycling. While the recycling operator is set to buy some kinds of e-waste, such as telecommunications equipment, it appears a large part of the population is not aware.
- The facility does not have the capacity to process lithium-ion batteries, yet they are the most hazardous e-waste from SAS. As Rwanda strives to meet the 48 per cent off-grid connection target, such waste is set to increase.

## 5: RECOMMENDATIONS

This chapter outlines key recommendations related to the current e-waste management landscape in Rwanda and in line with highlighted challenges. The recommendations can serve as a guide to other countries that are still at the early stages of solar e-waste management initiatives.

### Limited public awareness on e-waste management

Stakeholders should set up and utilise government-led off-grid coordination platforms to discuss and deliberate on e-waste management issues. This enables establishment of good working relationships between governments and companies, generating opportunities for incubation incentives or participation in funded waste management projects by government entities or international funds. Joint efforts to proactively engage and build relationships with local communities could enhance collection and take-back schemes.

### Financial and human resources constraint to establish and manage facilities

In line with the waste hierarchy, stakeholders should be incentivised and encouraged to undertake refurbishment and reuse of their e-waste before deciding to recycle. Reuse and refurbishment are not only easier to implement compared to recycling, but they are also more economically viable as they extend the lifespan of products.

### Shortfalls in enforcement of the regulatory framework

- ❁ Governments should follow up and ensure companies (including SAS companies) have EMPs in place that cover e-waste. To further motivate compliance, fiscal incentives (tax exemptions, grants, subsidies) should be tied to development and implementation of EMPs.
- ❁ In a context where specific legislation is already in place like Rwanda, relevant stakeholders (including private sector) should be encouraged to have a mechanism that ensures they stay up to date with legal developments and comply with them. Awareness campaigns and initiatives to enforce compliance must go hand in hand.
- ❁ SAS companies should be encouraged to maintain proper records of their inventory. This will help them to make projections of their waste generation and associated costs. In addition, technical assistance and training for staff on e-waste management is helpful when waste management plans are being drawn up for companies to assess options. This, in turn, helps the government to monitor and enforce e-waste management laws and regulations.

### Sub-optimal utilisation of the recycling plant

- ❁ E-waste collection can be improved by encouraging the private sector (including SAS companies) to establish voluntary e-waste drop-off points at their shops. This is convenient and cost effective as no further logistics are required. The drop-off points can be setup in partnership with the solar companies or distributors/retailers.
- ❁ Lead-acid batteries and lithium batteries have distinct characteristics compared to other SAS system components. Ideally, they should be recycled since they cannot be refurbished or re-used. In the absence of proper and reliable recycling infrastructure, the choice of lithium over lead acid batteries makes sense from an environmental protection perspective as they have less pollution potential and a longer lifespan. The lasting solution, however, is for the recycling and dismantling facility to have dedicated processing facilities for batteries.
- ❁ Solar companies need incentives to reduce disposal costs and motivate them to take the waste to the recycling plants. Disposal costs include transport cost to the recycling plant.

## 6: CONCLUSION

Based on the challenges and recommendations from the study, the following conclusion are made.

- PPP has been key to the success of e-waste management in Rwanda. Having GoR build the e-waste facility and Enviroserve upgrade and operate it has increased ownership and sustainability, especially due to the binding commitments each partner has and is adhering to.
- E-waste management in Rwanda has involved all key stakeholders. This includes regulators, policymakers, producers, retailers, importers, collectors, dismantlers, transporters, consumers and recyclers. It is paramount to involve everyone in the whole supply chain to achieve sustainable e-waste management.
- The recent use of various methods for messaging and communication, including social media, aims at improving awareness levels to build a sustainable e-waste management ecosystem in Rwanda. RURA, in partnership with Enviroserve, GIZ Eco-Emploi Programme and REMA have been involved in a nationwide awareness campaign. The main aim of the campaign is to sensitise and facilitate informal e-waste practitioners to operate within the confines of national laws and regulations governing the business.
- Baseline data is needed to be able to put in place proper infrastructure for sustainable e-waste management. In Rwanda, this study found that the country had the potential to generate 10,000 to 15,000 tonnes of e-waste per year.

The model that Rwanda has adopted for its e-waste recycling is applicable to other countries and is a good example of how the circular economy can work in Africa. E-waste is often looked at as a problem, but as highlighted in this report, it is also a resource in terms of environmental gains, job creation and income generation if effort is put into its management.





## Annex 1: Summary of Findings from Stakeholders' Consultations

Key Suggestions	Stakeholder feedback
Which legal instruments govern solar e-waste in Rwanda?	Most of respondents stated that no legal instruments are specific to solar e-waste. All e-waste is governed by the same policy, laws and regulations: National Sanitation Policy, Environment and Climate Change Policy, Environment Law, RURA regulations and RSB e-waste standards.
Is there a legal instrument requiring solar e-waste collection and take-back?	Some say yes, with reference to the Draft E-Waste Policy. Others say no, explaining that it would be the e-waste policy through the extended producer responsibility (EPR) principle, but they say the policy was never adopted.
Is there an advance recycling fee, eco-levy or treatment fee in the legal instruments?	Stakeholders are not aware of the existence or not of such a fee and explain that no one has ever charged them such a fee.
Are there any technical guidelines and standards for treatment and recycling?	Stakeholders from the government say there are no standards for treatment and recycling while others have no idea about the existence of such standards and guidelines.
Does your company implement an environmental management plan?	None of the 5 companies visited had EMPs in place.
Does your EMP cover waste management, especially e-waste?	N/A
How is the disposal of solar e-waste currently handled at your company?	Most of the respondents said they organise collection and have an agreement with Enviroserve for transportation and disposal.
Are you aware of the environmental hazards caused by solar e-waste?	All respondents were aware.
Does your company keep inventories of the end-of-life solar equipment it discards/stores?	Many keep inventories, but a few do not.
Are you aware of licensed e-waste treatment facilities in the country?	All respondents were aware.
Was the company involved in development and adoption of e-waste policy and regulations?	No, the company was not yet in existence. But the general manager actively participated when he was working at MINICOM
What is the duration of the PPP agreement?	10 years, renewable.
Was the company involved in development and adoption of e-waste policy and regulations?	The main role of GoR in the agreement period is to conduct and support awareness raising programmes, ensure compliance with the provisions of the PPP agreement and avail e-waste from public institutions.
Key Questions	
What are the roles and responsibilities of the private partner company?	The main role of GoR in the agreement period is to conduct and support awareness raising programmes, ensure compliance with the provisions of the PPP agreement and avail e-waste from public institutions.



## Annex 2: Desktop Study Reference Materials

Category	Name	Year of publication
<b>At national level</b>		
Legal and regulatory documents	Environment and Climate Change Policy	2019
	Environment Law	2018
	Rwanda e-waste regulations	2018
	National Sanitation Policy and its related implementation strategy	2016
	Ministerial Guidelines No1 of 25/10/2011 Related To Importation of Used Electronics/ ICT Equipment	2015
Standards	RS 276-1:2016 on Electrical and Electronic Waste Handling, Collection, Transportation and Storage.	2016
	RS 276-2:2016 on Electrical and Electronic Waste Treatment and Disposal.	2016
Reports on previous studies	Electronic Waste (E-Waste) Impacts and Mitigation Options in the Off-Grid Renewable Energy Sector (Nigeria, Kenya and Rwanda)	2016
	Sustainable Management of E-Waste in the Off-Grid Renewable Energy Sector in Rwanda	2017
	Rwanda Off-Grid Sector Status Report	2016 & 2017
<b>At international level</b>		
Strategy	East African Communications Organisation (EACO) Regional E-Waste Strategy	2017
Toolkit	GONGLA E-Waste Toolkit	
Convention	Basel Convention on Control of Trans boundary Movements of Hazardous Wastes and their Disposal	1989
Previous studies	E-Waste Management Recommendations for Beyond the Grid Fund for Africa (BGFA)	2020

### Annex 3: List of Key Stakeholders in E-Waste Management in Rwanda

Stakeholder	Comments
Ministry of Trade and Industry (MINICOM) <a href="http://www.minicom.gov.rw">www.minicom.gov.rw</a>	Has taken the lead in spearheading the e-waste discussion in Rwanda. Led the development of the recycling plant and actively participated in the drafting of the e-waste policy that was later incorporated in the National Sanitation Policy.
Rwanda Utility Regulatory Authority (RURA) <a href="http://www.rura.rw">www.rura.rw</a>	RURA is charged with the development and enforcement of regulations.
Ministry of ICT and Innovation (MINICT)	MINICT drafted the e-waste policy.
Rwanda Standards Board (RSB) <a href="http://www.rsb.gov.rw">www.rsb.gov.rw</a>	Developed e-waste management standards to be used by operators.
National Fund for Environment and Climate Change (FONERWA) <a href="http://www.fonerwa.org">www.fonerwa.org</a>	An environment and climate change investment fund that has an independent board and is charged with mobilising and harmonising funds across various areas to support Rwanda's green growth and sustainable development.
Ministry of Infrastructure (MININFRA) <a href="http://www.mininfra.gov.rw">www.mininfra.gov.rw</a>	The lead ministry responsible for developing the National Sanitation Policy, the Energy Policy and Strategy as well as monitoring and evaluation of energy projects and programmes. The ministry is in charge of setting an enabling policy and legal framework for the energy sector, including off-grid.
Energy Access Technical Working Group (TWG)	Forum through which government meets its development partners to discuss matters influencing the sector.
Energy Sector Wide Approach (eSWAP)	Key coordination mechanism for the sector in Rwanda with a secretariat within MININFRA.
Ministry of Environment <a href="http://www.environment.gov.rw">www.environment.gov.rw</a>	Responsible for ensuring the sustainability of natural resources exploitation including water, and has the mandate for developing and managing compliance to environment policy and law. It is the country's custodian of environmental welfare.
Rwanda Environment Management Authority (REMA) <a href="http://www.rema.gov.rw">www.rema.gov.rw</a>	Has the mandate to coordinate, oversee and implement environmental policy. It is the focal point for the Basel Convention and authorising transboundary shipments of e-waste.
Rwanda Development Board (RDB) <a href="http://www.rdb.rw">www.rdb.rw</a>	Plays the lead role in investment mobilisation and promotion for the energy sector. It actively promotes private investor participation in the energy sector, including local financial institutions. RDB also issues Environmental Impact Assessments for energy projects as required. Hosts a centralised authority or advisory agency for PPPs across government.

Stakeholder	Comments
Rwanda Energy Group (REG) <a href="http://www.reg.rw">www.reg.rw</a>	Helps to implement energy policy and strategies and support day-to-day monitoring of energy projects' implementation. Operating under company law, it will have a more corporate orientation and greater autonomy from political interference whilst still being accountable to MININFRA and RURA in terms of project development activities, utility services and performance standards.
Development partners	United States Agency for International Development (USAID), German Corporation for International Cooperation (GIZ).
Energy Private Developers Association (EPD)	A group advocating the needs of energy private companies.
Private solar companies	Private companies distributing SAS systems. They include Ignite Power, Nots Solar, Mobisol, One Acre Fund, BBoxx and Greenlight Planet.
Enviroserve Rwanda Green Park	Registered in Rwanda in 2017. In partnership with GoR, it operates the e-waste dismantling and recycling facility in Bugesera.



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