RWANDA RENEWABLE ENERGY FUND (REF) PROJECT

Environmental Code of Practice (Used/Spent Battery Management and Disposal under the REF Project)

July,2021

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REVISION HISTORY

Version	Period	Action	Authors (Name and Title)
1.0/2019	August, 2019	Document development	• **NKURANGA Egide** (Environmental Consultant) • **KABANDA Philbert** (Environmental Consultant)
2.0/2021	July, 2021	Document revision	• **HABAMENSHI Didace** (BRD Environmental and Social Safeguards Specialists) • **KANANGIRE Ruti Rubis** (BRD Environmental and Social Safeguards Specialists)

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ACRONYMS

BRD	**:** Banque Rwandaise de Developement (Development Bank of Rwanda)
ECOP	**:** Environmental Code of Practice
ESMF	**:** Environmental and Social Management Framework
ESS	**:** Environmental and Social Standards
E-waste	**:** Electronic Waste
E&S	: Environmental and Social
ERGP	**:** Enviroserve Rwanda Green Park
GoR	**:** Government of Rwanda
GGGI	**:** Global Green Growth Institute
FONERWA	**:** Environment and Climate Change
Li-ion	**:** lithium-ion
LAB	**:** Lead Acid Batteries
MININFRA	**:** Ministry of Infrastructure
Ni-Cad	**:** Nickel-Cadmium
NiMH	**:** Nickel Metal Hydride
Ni-Cad	**:** Nickel Cadmium
OSC	**:** Off-grid Solar Companies
Pb	**:** Lead
PbO_2	**:** Lead Dioxide
PPE	**:** Personal Protective Equipment
PAD	**:** Project Appraisal Document
PPP	**:** Public Private Partnership
REMA	**:** Rwanda Environment Management Authority
RPF	**:** Resettlement Policy Framework
RURA	**:** Rwanda Utility Regulatory Authority
REF	**:** Renewable Energy Fund
REG	**:** Rwanda Energy Group
SACCO	**:** Saving and Credit Cooperative
TVETs	**:** Technical and Vocational Education and Trainings

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1 INTRODUCTION

Access to energy is considered as one of the critical factors of achieving sustainable development globally. The deficiency of electricity is a significant constraint of economic growth and development of rural areas in developing countries. Globally, power generation mostly depends on exhausting fossil fuel sources and according to the International Energy Agency (IEA), over 1.1 billion rural people in the developing world have no access to grid electricity. Additionally, many of them continue kerosene usage for the light-generating purpose and the usage of fossil fuel is associated with many adverse environmental and health problems because of indoor air pollution. Hence, there is a consensus that a shift from traditional energy sources to modern renewable clean energy such as Solar Home Systems (SHS) would relieve the pressure on the environment, improve the living standards of society, and accelerate green economic development that many countries aim to achieve.

It is in this regard that the Development Bank of Rwanda (BRD) is currently implementing the Renewable Energy Fund (REF) Project whose objective is to increase access to electricity in Rwanda through off-grid technologies and facilitate private sector participation in renewable off-grid electrification. The REF aims at financing 445,500 new off-grid connections expected to benefit approximately 1.8 million Rwandans (52% of whom are women) through stand-alone Solar Home System (SHS) and mini-grid technologies. The project is structured around two main components: (1) the Renewable Energy Fund (REF) and (2) Project implementation support.

Despite numerous socio-economic and environmental positive impacts expected to be gained through the adoption of Solar Home Systems (such as carbon dioxide emission reduction, increased monetary income through extra working hours at night, longer study hours of children, less kerosene lamp fatal accidents, and increased use of television, radio, and mobile phones amongst others); management of E-waste from Solar Home Systems (mostly used Ni-Cad and Lead Acid Batteries) and other electronic devices is a major challenge facing many African countries including Rwanda because of lack of awareness, lack of adequate E-waste management regulations and limited financial resources and recycling facility plant. Currently, E-waste is predominately disposed of through open dumping, burning and landfilling. These methods have potentially serious implications on human health and the environment since most of the E-waste contains heavy metals and other hazardous substances present in electronics.

To address the risk of poor battery disposal and the lack of formal procedure for E-waste management in the country, the BRD was required to develop project-specific Environmental Code of Practice (ECOP) as a guideline on the approach for collection, transportation, storage and disposal of spent batteries with the aim of ensuring that risk to the environment and human health are prevented or mitigated. The ECOP will also contribute on the safe battery disposal strategy for the Government of Rwanda (GoR) as it has an ambitious target of electrifying all remaining households by 2024 with 48 percent of this target to be covered by off-grid solutions mainly Solar Home Systems (SHS) and Solar Mini-grid that contain environmentally harmful batteries.

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2 PROJECT DEVELOPMENT OBJECTIVES

The Project Development Objective (PDO) is to increase electricity access in Rwanda through off-grid technologies and facilitate private-sector participation in renewable off- grid electrification.

3 POSITIVE IMPACTS OF SOLAR HOME SYSTEMS AND CONSTRAINTS

Despite anticipated negative impacts caused by the poor disposal of spent Ni-Cad and Lead Acid batteries, and constraints caused by ineffective after-sales facility by solar system providers, the project is expected to have considerable positive environmental and socio-economic impacts reflected in the following sub-sections.

3.1 Socio-economic Impacts

Adoption of Solar Home Systems (SHS) is expected to provide the following positive socio-economic impacts at household level and the community at large:

3.1.1 Lighting Impacts

Lighting is the main application of Solar Home System, and all packages under an SHS include Light-Emitting Diodes (LED) bulbs. LED bulbs are power-efficient and easy to use. Additionally, it provides a brighter light than a traditional kerosene lamp. This facility offers rural families, especially women, extra time to do household work as well as allowing them to work at night, and students are allowed more time to study and improve their educational qualities.

SHS eliminates the dependency of finishing household work before night. Additionally, it plays a significant role in improving the security of the household by reducing the number of criminal activities in the respective areas after the installation of SHS.

3.1.2 Recreational and Information Impacts

Solar electricity increases the use of television, radio, and mobile phones with internet facilities, any of which can be used as a medium of entertainment as well as a collection of valuable information. E.g: about the latest agricultural production process, market information, and credit facilities which develop the farm production system with income upgrade.

Through the adopted solar system, rural people can gather to watch different programs, movies and matches on the television which helps them in relaxing after hard-working times. Nowadays, government organizations and NGOs disseminate health, nutrition, family planning issues, and environmental development information through television, radio, and mobile phones. Using this type of technology through SHS plays a vital role in rural development.

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3.1.3 Economic Impacts

The Solar Home System is considered an economically viable technology for rural people in Rwanda. The SHS increases monetary income and the probability of employment via new income generating activities. Around 83% of microenterprise respondents in a study carried in Bangladesh informed that SHS extended the business time up to 4 hours, and it brings more customers as well as more income. Both money and time gains from SHS, as well as better lighting facility increase the involvement in commercial works such as electric sewing machines, small shop related businesses (barbershops), and small cottage businesses such as bars.

3.2 Environmental and Health Impacts

Some of the positive impacts of adopting Solar Home Systems when it comes to environmental and health aspects are:

3.2.1 Health Impacts

In most cases, the Solar Home Systems influence a shift from the kerosene lamp which has a bad side effect on the atmosphere and indoor air quality. In comparison with a kerosene lamp, solar lighting systems are free from harmful greenhouse gas emissions with brighter lights to comfort the eyes. It protects the eyes from low-quality light of kerosene lamps. Additionally, it increases indoor air quality and prevents some health problems such as lung infection, asthma, and cancer amongst others.

3.2.2 Environmental impacts

The Solar Home System technology reduces the usage of the kerosene lamp and small diesel generator, which has a direct positive impact on the atmosphere as a SHS generates electricity with no discharge of carbon monoxide (CO), nitric oxides (NO), or sulfur dioxide (SO_2), which negatively affect air quality and amplifies the impact of global warming and climate change.

Moreover, SHS users directly benefit not only through the reduction of kerosene use but also environment protection through carbon dioxide (CO_2) reduction. One kerosene lamp releases approximately 103.2 g of CO_2 per hour in the atmosphere and this is mitigated through the adoption of Solar Home System which is generally a clean source of energy.

3.3 Constraints of Solar Home Systems

Solar Home Systems have considerable positive impacts when it comes to environmental protection and socio-economic benefits. However, when the disposal and recycling of spent batteries is not well managed, and when there is lack of technological proficiency and poor after-sales facility. The following constraints are suspected to take place:

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3.3.1 Poor Disposal of spent Batteries

In most cases due to poor after-sale facility by Solar Home System providers and lack of knowledge about proper disposal of E-waste by SHS users, spent batteries end up in landfills and open dumping. As the battery casing corrodes, chemicals end up leaching into the ground water from where they contaminate the water bodies. Acid and lead particulates could also contaminate the soil and become airborne when dry.

Health-wise, cadmium and nickel are known human carcinogens, lead has been linked to birth defects and to neurological and developmental damage, and mercury is also highly toxic, especially in vapor form. Excessive levels of lead can affect a child's growth, cause brain damage, harm kidneys, impair hearing and induce behavioral problems, and in adults, lead can cause memory loss and lower the ability to concentrate as well as harm the reproductive system.

Old batteries collection from SHS users is therefore important and should be done effectively by system suppliers to make sure that mentioned risks of poor disposal on the environment and human health are mitigated.

3.3.2 Lack of Technical Support

Solar Home Systems are anticipated to have technical problems such as power failures caused by poor battery quality, bad solar panel positioning, over-usage of the system, and many more. After-sale facility by system providers should be effective enough to avoid any case where users complain that awaiting the time for fixing a SHS difficulty is too large. Insufficient technical personnel and poor technical knowledge about the system by users can easily decrease the chance of SHS adoption.

3.3.3 High Initial Investment and Repair Cost

The initial down payment investment cost can become a huge investment to poor households. Furthermore, the costs of battery replacement after 3-5 years might be a crucial financial problem to the poor users. The cost of a SHS could be identified as one of the main difficulties especially when it comes to the initial down-payment and monthly payments.

A notable limitation of the poor users could be that the smallest monthly installment can be a comparatively immense amount for the poor rural peoples, while kerosene can be bought easily in lesser amounts at low prices day-to-day.

3.3.4 Technical and Maintenance Problems

Solar panels can face a problem of not generating electricity up to its optimum capacity because of several issues including bad quality of silicon cell, shaded by trees, solar panels slowly facing damage by UV rays, rains, mud, temperatures variations, storm, and winds. In addition, maintenance problems

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such as not cleaning the panel surface frequently can occur and consequently cause deep layers of dirt to gather on the panel surface, hence causing a fall in power production. It is also anticipated that some users will not be able to fully charge their batteries throughout the rainy season or foggy weather conditions. Thus, the user is required to consume carefully and sometimes experience power failure. This can be a setback to users and can easily slow the adoption of the system.

4 E-WASTE GUIDING PRINCIPLE AND WORLD BANK SAFEGUARD POLICIES

4.1 E-waste management guidelines

The Article 20 of the Environmental law N°48/2018 of 13/08/2018 states that any electronic waste must be collected, treated and changed in a manner that does not degrade the environment in order to prevent, eliminate or reduce their adverse effects on human health, natural resources and environment.

As per the Article 28 of the regulation N^0 002 of 26/04/2018 governing E-waste management in the country, no person is allowed to carry out activities of collecting, transportation, trading, import, dismantling and recycling electronic waste unless he/she holds an authorization issued by a competent authority. If obligations under the article 28 are breached, the breaching party is liable to an administrative fine of between one million (1,000,000) and five million (5,000,000) Rwanda francs and suspension of activities. However, since legislation and regulations on disposal of solid wastes especially E-wastes, such as lead acid batteries, is in early stage of development, this project-specific ECOP has been developed to guide the collection, transport, storage and disposal of used batteries. Moreover, no activities or products under the current project will be "qualified" for, and included in, the activity or product catalogue until processes for the collection, transport, storage and final disposal of the batteries associated with the activities or products are established in accordance with this ECOP and other existing national regulations, guidelines or procedures.

Beside the general ECOP, it is expected that registered vendors in this project will have to ensure that they have procedures in place to meet the requirements of this ECOP whether they are through central or industry established processes or vendor and product specific processes.

4.2 World Bank Environmental and Social Safeguard Policy (OP/BP 4.01)

OP/BP 4.01 helps to ensure the environmental and social soundness and sustainability of investment projects and also supports the integration of environmental and social aspects of projects into the decision-making process.

It uses a screening process for each proposed project, as early as possible, to determine the appropriate extent and type of environmental assessment (EA) so that appropriate studies are undertaken proportional to potential risks and to direct, and, as relevant, indirect, cumulative, and associated impacts. Use sectoral or regional environmental assessment when appropriate.

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By supporting integration of environmental and social aspects of projects into the decision making process, it allows to assess potential impacts of the proposed project on physical, biological, socio-economic and physical cultural resources, including transboundary and global concerns, and potential impacts on human health and safety and provide for assessment of feasible investment, technical, and siting alternatives, including the "no action" alternative, potential impacts, feasibility of mitigating these impacts, their capital and recurrent costs, their suitability under local conditions, and their institutional, training and monitoring requirements associated with them.

The International Finance Corporation (IFC) Environmental, Health and Safety (EHS) guidelines for waste management apply to projects that generate, store, or handle any quantity of waste across a range of industry sectors.

These guidelines provide good practices for facilities or projects that generate and store wastes as follows:

- Establishing waste management priorities at the outset of activities based on an understanding of potential Environmental, Health, and Safety (EHS) risks and impacts and considering waste generation and its consequences;
- Establishing a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes;
- Avoiding or minimizing the generation of waste materials, as far as practicable;
- Where waste generation cannot be avoided but has been minimized, recovering and reusing waste;
- Where waste cannot be recovered or reused, treating, destroying, and disposing of it in an environmentally sound manner.

IFC Environmental, Health and Safety provides recommendations related to good practices and to general waste management and planning, waste prevention, recycling and reuse, treatment and disposal of wastes, hazardous materials management, wastes storage and transportation, treatment, disposal and monitoring.

In the context of REF activities, it is expected that by the time the first bunch of batteries needs replacement (at least 3 years after installation and operation begins), the environmental frameworks will be much stronger. Adopting the precautionary approach however, this ECOP defines minimum requirements and shall also base on the IFC Environmental, Health and Safety Guidelines.

The International Environmental Technology Centre's vision is for countries to implement sustainable solutions to environmental challenges with focus on holistic waste management. In order to realize this vision, IETC provides technical and advisory support to national and local governments toenhance their use of environmentally sound strategies and approaches. IETC also implements in-country demonstration projects using innovative waste prevention and waste management methods and technologies to reduce the impact of climate change, increase resilience, create jobs and improve

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human well-being. In addition to governments, IETC works with academia, civil society and the private sector. IETC provides learning opportunities around the world as well as organize public outreach activities, expert groups and policy dialogues. Working with a wide range of partners, and in line with relevant multilateral environmental agreements, IETC's mission is to serve as a global centre of excellence on environmentally sound technologies with focus on holistic waste management.

IETC has undertaken various efforts to assist national and local governments and stakeholders to develop strategies and policies toward the sound management of wastes including waste electrical and electronic equipment (E-waste), hence it can be useful in establishing the e-waste management policy for Rwanda.

5 ENVIRONMENTAL CODE OF PRACTICE - OBJECTIVES

Solar energy systems/power plants do not produce air pollution or greenhouse gases. Using solar energy have considerable positive impacts on the environment when solar energy replaces or reduces the use of other traditional energy sources that have larger negative effects on the environment (E.g Fosil fuel).

However, some toxic materials and chemicals are used to make the photovoltaic (PV) cells that convert sunlight into electricity. Some solar systems use potentially hazardous fluids to produce electricity. Poor disposal and recycling of used Ni-Cad and Lead Acid batteries can cause leaks of these materials, hence instigating harm to the environment.

Large solar power plants and mini-grids facilities can also affect the environment of their locations through clearing land for construction. The excavation work and placement of the power plant/mini-grid are anticipated to cause loss of biodiversity. Furthermore, it will create a pile up of soil and waste materials on an open ground that is likely to be washed away by rain.

Some solar power plants/mini-grid may require water for cleaning solar collectors and concentrators or for cooling turbine generators. Using large volumes of ground water or surface water for cleaning collectors in some locations may affect the ecosystems that depend on these water resources. In addition, the beam of concentrated sunlight a solar power tower creates can kill birds and insects that fly into the beam.

In the context of REF, to ensure effective application of the World Bank's environmental and social safeguard policies and Good International Industry Practices (GIIP) to support the national regulatory requirements, the ECOP provides guidance on the approach to be taken for the collection, transport, storage and disposal of all types of batteries, especially Ni-Cad and Lead Acid batteries at the end of their useful life. Importantly, this project specific ECOP seeks to address the management of spent/used batteries as the country strives to develop specific guidelines for the management of e-waste including for batteries. To this end, this ECOP beyond the current project would seek to inform the debate and discussion on spent battery and E-waste management but also on building citizens'

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awareness around E-waste management to assist the continual improvement in battery management in Rwanda. It is likely that by the time the first batteries under the project need to be disposed 3-5 years' time, Rwanda would have developed, approved, and rolled out an effective regulatory framework and the requisite institutional capacity building initiative to effectively manage spent batteries and E-waste in the Country.

6 CURRENT STATUS OF E-WASTE IN RWANDA

6.1 Current operations and practices

There are growing numbers of personal electrical and electronic devices' use in institutions, households and business facilities in the Country. Furthermore, with the growth of the telecommunication sector, the number of citizens subscribing to the mobile network is steadily increasing. In addition, with the target of the GoR to increase access to electricity for the population of Rwanda, the use of batteries in the solar energy system is increasing as well.

The national E-waste management policy of 2016 and the regulation N° 002 of 26/04/2018 governing E-waste management in Rwanda were put in place to provide guidance on E-waste management to protect the environment and human health by preventing or reducing the adverse impacts of poor E-waste disposal and promoting resource efficiency methods such as reuse, recycling and other forms of E-waste recovery. However, the lack of citizens' awareness/education and technical capacity to handle e-waste in Rwanda has resulted in poor management of E-waste with institutions and individuals indiscriminately storing or in some cases disposing E-waste along with other types of waste without any proper segregation.

The current situation is that solid waste contractors simply collect waste from different places and dump them at allocated landfills without any distinct segregation of E-waste. In some instances, valuable components of E-waste are recovered and non-valuable components, which are in most cases toxic, are left mixed with other types of waste, causing health and environmental hazards.

The public sector, one of the key contributors of E-waste in Rwanda, has over years accumulated enormous amounts of E-waste while awaiting the state to develop guidelines for its proper management and disposal. On the other hand, due to the general economic growth and modernization in the country, an increase in the demand for electrical and electronic equipment by the private sector resulted in steady growth of E-waste production. Between November 2014 and January 2015, a survey was carried out to determine the status of E-Waste in Rwanda. The survey revealed that Rwanda had an E-Waste annual generation potential of 9,417 tons of which, 7,677 tons (81.52%) are contributed by individuals, 1,143 Tons (12.14%) by public institutions, and 597 tons (6.34%) by private institutions. It was projected that Rwanda could reach an annual E-waste generation of 20,000 tons by 2020 (Enviroserve analysis, 2015).

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Collection infrastructure of E-waste is still a major issue in Rwanda and this is the reason why the majority of E-waste end up being disposed through open dumping, burning and landfilling. According to the survey conducted by GGGI (2018), the main reason for not using available waste collection services was summarized as unaffordability of waste collection services. The insufficient enforcement of the legal framework coupled with poor collection infrastructure and inadequate financial means by collection companies are other major issues hindering effective and regular collection of E-waste because most collection companies are unable to own adequate and appropriate vehicles/trucks which leads to non-partitioned collection, poor quality service and mixed waste collection.

The Enviroserve Rwanda Green Park (ERGP), the only private entity in E-waste treatment in Rwanda, has been dismantling (de-manufacturing) solar devices and other E-waste since January 2018. ERGP, a United Arab Emirates based E-waste recycling plant, has partnership with some OSCs. Partner OSCs collect non-functioning batteries/solar devices and send them to ERGP plant in Bugesera. Out of the total E-waste production, the ERGP can collect around 4,000 Tons and then sends recovered valuable E-waste components to its Headquarter for further recycling.

Though Rwanda has the state of art e-waste dismantling and recycling facility to treat e-waste, there is need to upgrade and expand the existing Rwanda e-waste dismantling facility to properly collect and treat end of life solar products and establish waste batteries recycling lines (lead acid recycling line and pre-treatment line for Lithium based batteries) in the existing e-waste dismantling and recycling facility to avoid the negative impacts of waste from solar products and lead pollution on human health and environment and ensure resource efficiency through recovery of valuable material. The ERGP is in the process of establishing such a dedicated recycling unit.

7 LEGAL AND POLICY FRAMEWORK

7.1 Current Legal framework

There exist policies, legal and regulatory framework in Rwanda to address E-waste management. The National E-waste Management policy of 2016 and the regulation N° 002 of 26/04/2018 governing the E-waste management in Rwanda were adopted. Furthermore, the environmental law N° 48/2018 of 13/08/2018 also gives provisions for e-waste management.

It is worth noting that Rwanda is a signatory to many agreements and conventions on environmental management. These include support for the provisions of Agenda 21 amongst other declarations and statements of principles, such as the Rio Declaration in 1992 on Environment and Development. Rwanda is also a party to the Basel Convention on the control of trans-boundary movements of hazardous wastes and their disposal, which was developed with the purpose to ensure that the generation of hazardous wastes and other wastes are minimized; adequate disposal facilities exist for sound environmental management of wastes; and that managers of waste minimize the risk to human health.

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The weak enforcement of existing legal framework on E-waste and insufficient infrastructure for the disposal of E-waste have immensely contributed to the current inadequate E-waste management. Therefore, increased national awareness/education, law enforcement and capacity will be of great importance in E-waste management.

7.2 Current institutional framework

E-waste is generated by activities at the public, private sector and community level. The Rwanda Utilities Regulatory Agency (RURA) is the competent organ to implement E-waste legal frameworks. It has the overall responsibility for enforcing this policy by (i) issuing regulations governing E-waste management in Rwanda; (ii) issuing E-Waste technical guidelines for handling and disposal of E-waste; (iii) enforcing licensing regime for entities dealing with collection, transportation, dismantling, refurbishment and recycling of electrical and electronic equipment (EEE). As the implementation of the E-waste management policy involves various stakeholders (MICT, MINICOM, MINISANTE, MINEDUC, MININFRA, REMA, RISA, RURA, RSB, RRA, PSF and EEE users), the policy requires a steering committee to fast-track and facilitate the implementation of the policy and coordinate all procedures geared towards enhancing proper management of E-waste in Rwanda. The Minister in charge of ICT in collaboration with the Minister in charge of Environment will respectively chair and co-chair this committee.

However, due to limited enforcement of existing legal frameworks and limited awareness on E-waste management, most E-waste management activities in the private sector are done in an informal way. Therefore, there is an urgent need to develop a clear framework addressing, in a sustainable manner, the emerging problems of E-waste generation.

8 ENVIRONMENTAL CODE OF PRACTICE REQUIREMENTS

A central component of any remote solar power system such as those proposed under the project is the use of rechargeable batteries. These batteries store the power generated during the daylight hours for later use. Rechargeable batteries include lithium-ion (Li-ion), nickel metal hydride (NiMH), nickel cadmium (Ni-Cad) and lead acid batteries (LAB).

Lithium-ion and nickel metal hydride batteries (as well as standard AA, AAA, C-cell and D-cell etc. dry cell batteries) are suitable for disposal in standard landfill and therefore are not covered by this ECOP. Accordingly, this ECOP applies specifically to LAB and Ni-Cad batteries. These batteries, if improperly transported, stored and disassembled/recycled, can create long lasting environmental impacts due largely to the chemical and heavy metals such as mercury, lead, cadmium and nickel which are central components of these batteries. If released into the environment (via incineration and/or leakage and leeching etc.) these chemicals and heavy metals can create a number of health impacts including headaches, abdominal discomfort, seizures and comas.

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The main components of a lead-acid battery are lead (Pb) electrodes and lead dioxide (PbO2) electrodes immersed in a solution of water and sulphuric acid. These are generally contained in a plastic case made from polypropylene. In addition, the lead-acid battery can create a wide range of biological effects including the following dysfunctions (kidneys, gastrointestinal tract, reproductive system and the nervous system) and is a recognized developmental and reproductive toxicant. Lead acid batteries also contain sulfuric acid which is highly corrosive and can cause burns and damage to skin, eyes or the respiratory system. Both nickel and cadmium which are the central components to Nickel-Cadmium (Ni-Cad) batteries have potential negative impacts on both the environment and on human health. While the effects of nickel are generally less severe (in the absence of long-term exposure to airborne nickel dust) and limited to skin irritations, cadmium is a carcinogen, which can lead to renal dysfunction and bone defects.

Effective management of batteries can ensure that these potential negative impacts are not realized as a result of the REF project. Indeed, through the increased awareness activities proposed, it is expected that the project, guided by this ECOP, will have the potential to have long-term positive impacts on communities and public health since many batteries of this type are used by these communities outside this project.

9 E-WASTE MANAGEMENT APPROACH

The approach adopted seeks to avoid the potential environmental and social negative impacts created by improper management of LAB and Ni-Cad batteries. The mitigation measures proposed are composed of two fundamental stages or approaches namely (i) Community and user awareness and (ii) Direct management of used nickel- cadmium (Ni-cad) and lead acid batteries (LABs) by the system suppliers.

Figure1 reflected below illustrates a framework for the proposed management of E-waste generated from provided Solar Home Systems (SHS). The proposed framework starts with the supply of the Solar Home System to the recipient (Household). When the provided SHS is experiencing defects or needs a battery replacement, the recipient will inform the supplier. Generated E-waste, including the spent battery, should be collected back by the Solar company and transported carefully to their collection center or nearby ERGP collection site, if any. Temporarily disposed E-waste at the companies' warehouse should then be transported to the ERGP collection center at District level to organize transportation of collected E-waste to the recycling plant located in Bugesera District.

Service fees for the collection and recycling will be paid by the solar company as per the service agreement for E-waste collection and disposal signed between ERGP and approved solar companies partnering with REF project. Failure to comply with the mentioned agreement can lead to disbursement cancellation or termination of the contract between BRD-REF and approved solar companies.

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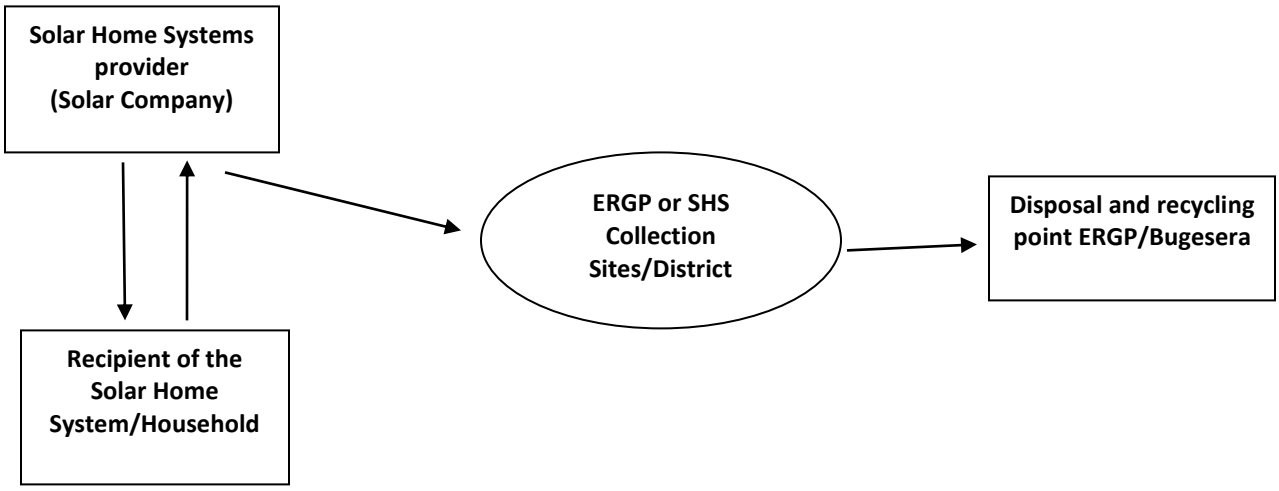

Figure1: E-waste management Framework

9.1 Community and user awareness

The assessment of E-waste management status and trends in Rwanda revealed that there is limited awareness of the risks associated with inadequate handling and disposal of E-waste within the public and private sector as well as the general Rwandan community. Increasing the national awareness and capacity of E-waste management has the potential to stimulate investment and create green jobs in the E-waste re-use and recycling industry.

In response to this need, the GoR plans to:

- Promote the education and awareness on how to safely handle and dispose produced E-waste;
- Encourage the procurement of environmentally friendly EEE's across the Public and Private Sector as well as the community at large;
- Support technology development and innovation in the field of E-waste management and control;
- Include E-waste management in educational curriculum at various levels especially in TVETs schools;

It is important to highlight that for the REF project, the OSCs in partnership with the E-waste recycling plant and other stakeholders (Districts, REMA, etc) are required to provide awareness and training to community with the aim of improving knowledge of environmental and health issues associated with the entire battery and other e-wastes lifecycle including end-of-life management of batteries. This campaign will not only focus on project participants and beneficiaries but also all community members and as such will result in improved knowledge of the environmental, health and safety issues associated with spent batteries and other e-waste.

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The awareness materials and training shall provide information on:

- The differences between the battery types in terms of battery life and reliability;
- The safe handling of batteries including installation, removal, transport, storage, maintenance and disposal;
- The environmental, health and safety aspects of poor e-waste disposal; and
- Focused information on the environmental, health and safety issues associated with high toxicity content of batteries and explanation as to why they must be stored, transported and disposed of in certain ways and therefore why it is in the interests of individuals, the community, the environment (and therefore future generations in communities) that the methods outlined in this ECOP be followed.

9.2 Direct management of used nickel-cadmium (Ni-cad), lead acid batteries (LAB) and other E-waste by the system suppliers

When Solar Home Systems (SHS) supplied to the recipient (Household) experience defects or needs a battery replacement, the generated E-waste, including the spent battery, should be collected back by the accredited Solar company (system supplier) and transported carefully to their collection center in not more than 10 days from the day the defect was communicated to the company by the recipient. Temporarily disposed E-waste at the companies' warehouse should then be transported directly to the recycling plant in Bugesera or to the ERGP collection center at District level to organize transportation of collected E-waste to the recycling plant located in Bugesera District.

Service fees for the collection and recycling will be paid by the solar company as per the service agreement for E-waste collection and disposal signed between ERGP and approved solar companies partnering with REF project. Failure to comply to the mentioned agreement can lead to disbursement cancellation or termination of the contract between BRD-REF and approved solar companies.

No system supplier (Solar Company) is allowed to carry out activities of dismantling and recycling electronic waste including spent batteries unless it holds an authorization issued by a competent Authority in Rwanda. The RURA regulation n°002 of 26/4/2018 governing E-waste management in Rwanda shall be observed to guide the disposal and recycling of E-waste including spent batteries to comply with Rwanda national laws.

10 SPECIFIC DIRECT REQUIREMENTS FOR SOLAR SYSTEM PROVIDERS UNDER THIS ECOP

Supplied Solar Home Systems are expected to experience various technical defects and replacement of some electronic parts including batteries. Repairs and generated electronic waste should be properly managed by the system provider to make sure that environmental and human health aspects are effectively observed.

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The following requirements listed below should be complied by solar system providers and users:

10.1 Battery and other E-waste handling procedure

a) Solar Systems Users

The Solar system users should observe the following:

- Separate E-waste from other household wastes to facilitate collection, treatment and recycling;
- Safely keep E-waste generated from solar systems to ease their collection by SHS suppliers or dispose them to licensed E-waste collection centers or drop-off point

b) Suppliers

Technicians/electronic engineers from solar system providers should observe the following measures:

- Consult battery owners' manuals for instructions on battery handling and hazard identification before doing any repair;
- Wear Personal Protective Equipment (PPE) such as chemical splash goggles and a face shield;
- Wear acid-resistant equipment such as gauntlet style gloves, an apron, and rubber boots;
- Do not tuck pant legs into boots because spilled acid can pool in the bottom of boots and burn feet;
- Place protective rubber boots on battery cable connections to prevent sparking on impact if a tool does accidentally hit a terminal;
- Clean the battery terminals with a plastic brush because wire brushes could create static and sparks;
- Always remove watches and jewelry before working on a battery. A short-circuit current can weld a ring or strap of metal and cause severe burns;
- Cover maintenance tools with several layers of electrical tape to avoid sparking.

10.2 Occupational Health and Safety

The solar systems under REF shall be installed by qualified and experienced staff from the selected solar energy companies in order to avoid or minimize electrocution and other health and safety issues associated with working with solar batteries.

10.3 Chemical hazards posed by batteries

Sulfuric acid (electrolyte) in lead-acid batteries is highly corrosive and acid exposure can lead to skin irritation, eye damage, respiratory irritation, and tooth enamel erosion. Solar companies shall train their technicians and system beneficiaries to comply to the following principles to minimize risk:

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- Never lean over a battery while boosting, testing or charging it;
- If acid splashes on the skin or eyes, immediately flood the area with cool running water for at least 15 minutes and seek medical attention immediately;
- Always practice good hygiene and wash hands after handling a battery and before eating;
- When handling the lead plates, hands should be washed properly after repairs. Signs of lead exposure include mood swings, loss of appetite, abdominal pain, difficulty sleeping, fatigue, headaches and loss of motor coordination;
- The chemical reaction by-products from a battery include oxygen and hydrogen gas. These can be explosive at high levels. Overcharging batteries can also create flammable gases. For this reason, it is very important to store and maintain batteries in a well-ventilated work area away from all ignition sources and incompatible materials. Cigarettes, flames or sparks could cause a battery to explode;
- Before working on a battery, disconnect the battery cables. Be careful with flammable fluids when working on a battery-powered system. The electrical voltage created by batteries can ignite flammable materials and cause severe burns;
- Any activity related to wiring changes to the solar system should be carried out by qualified personnel.

10.4 Proper and safe battery movement

10.4.1 Collection

Collection of E-waste including spent batteries generated from supplied SHS should be organized by REF loan borrowers (Solar Companies) where they should collect batteries door-to-door and transport them carefully to their collection center/warehouse.

10.4.2 Transport

Collected E-waste kept at the companies' storage facility should then be transported to the ERGP designated collection sites at nearby Districts or at the recycling plant located in Bugesera District.

10.4.3 Proper handling

Lifting and moving batteries needs to be undertaken with care so as to avoid personal and environmental harm. Key principles include:

- Use proper lifting techniques to avoid back injuries,
- Battery casings can be brittle and break easily; they should be handled carefully to avoid an acid spill,
- Make sure that a battery is properly secured and upright in the vehicle,
- If a battery shows signs of damage to the terminals, case or cover, it should be replaced with a new one by qualified personnel.

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10.5 Battery disposal and recycling

The major options for disposal of E-waste (including batteries) in the absence of any treatment option are land filling and incineration. However, the presence of hazardous elements and compounds in E-waste offers the potential of increasing the intensity of their discharge in environment due to land filling and incineration. Therefore, the major approach to treat E-waste is to reduce the concentration of hazardous chemicals through decontamination and dismantling. Items of economic value are recovered through this process and remaining parts of E-waste such as plastic are then recycled.

The solar companies approved by REF will ensure that a system is in place to obtain and properly dispose spent batteries at the time of battery replacement. Licensed companies by RURA under regulation n°002 of 26/4/2018 governing e-waste management in Rwanda shall be allowed to dispose and recycle spent batteries only if they comply with Rwanda national laws.

11 CAPACITY BUILDING, MONITORING AND RESPONSIBILITIES

11.1 Capacity building and monitoring of ECOP Implementation

As part of the capacity building to be provided for the implementation of the ECOP, solar products providers under REF, the end users, financial institutions staff (such as Umurenge and Umwalimu SACCO and others in the future), Sector and Districts engineers and relevant staff of the concerned line institutions shall be trained on the ECOP's application by the Environmental and Social Safeguards specialists (ESS) of REF. Additionally, Solar system providers under REF will provide a brief training to each system beneficiary on the management approach of E-waste, anticipated negative impacts of poor E-waste disposal, incident management and basic maintenance technical skills of the solar system. Capacity building provided by system providers is expected to be continuous as the adoption of solar systems is still expanding.

BRD-REF will monitor and provide guidance in the implementation of the ECOP. The Environmental and Social Safeguards specialists (ESS) of REF will be responsible, besides other functions, for monitoring and supervising the implementation of the ECOP. BRD will closely collaborate with RURA, REMA and REG as well as other relevant stakeholders involved with the implementation of the ECOP. It will carry out random checks on each contractor/suppliers to verify compliance with the ECOP and provide progress reports to REMA, REG and World Bank on a semi-annual basis. The key responsibilities of relevant stakeholders are depicted in the Table 1 below. For this purpose, the ESS will establish the ECOP monitoring mechanism as part of the project management system in compliance with national E&S legislation and World Bank Environmental and Social Safeguards Policies.

Through the monitoring exercise, it is expected that random visits will be done by REF Environmental and Social Safeguard specialists at various solar companies' warehouse/collection centers to assess how collected E-waste, including spent batteries, are stockpiled. Solar Companies after-sale services

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will be also assessed in these random visits to determine if the replacement and repairs of defects is done in a timely manner. Concerned system beneficiaries will be consulted in the process and assessment visits will be done quarterly or when urgent cases take place such as accidents and incident caused by the supplied system.

11.2 Responsibilities of stakeholders under this ECOP

During the implementation of the REF project, the following key stakeholders will execute the subsequent responsibilities/Roles:

Keys stakeholders	Responsibilities/Roles
World Bank	• Review and approve the ECOP; • As part of its supervision mission of the Project, the WB team will conduct random checks on the project's compliance to E-Waste disposal and management consistent with the national regulations and WB safeguard standards.
REF E&S specialists	• Provide training on the compliance and implementation of the REF-ECOP to solar companies under REF projects; • Responsible for monitoring and supervising the implementation of the ECOP by solar companies; • Carry out random field visits to each solar system suppliers under REF to verify compliance with the ECOP especially the E-Waste management approach; • Provide progress reports to REMA, REG and World Bank on quarterly basis; • Responsible of following up Grievances and effectiveness of set Grievance Redress Committees at Umurenge and Umwalimu SACCO level.
Solar system providers	• Will develop and provide an E-waste management plan to BRD-REF detailing the collection, transport, storage and disposal procedure; • Responsible to carry out effective after-sale services to solar beneficiaries (Replacement and repairs); • Responsible of providing training to solar beneficiaries on proper E-waste management and disposal, incident management and basic maintenance technical skills; • Provide status update reports on the compliance and implementation of the REF-ECOP to BRD-REF on quarterly basis; • Responsible of providing OHS training to its technicians for proper E-waste management and solar system repair; • Responsible of meeting electronic system quality standard set at National level.

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Rwanda Utilities Regulatory Agency (RURA)	• Issuing technical guidelines for handling and disposal of E-waste; • Issuing and enforcing the licensing regime for SHS dealing with collection and transportation of e-waste
Rwanda Energy Group (REG)	• Responsible of registering solar system vendors' products based on set National quality guidelines; • Assess the processes for compliance with the guidelines set out in this ECOP; • Monitor the implementation of the National Electrification Plan (NEP).
Rwanda Environment Management Authority (REMA)	• Assess REF project compliance with National Environmental and pollution control regulations; • Conduct checks on the solar system vendors' compliance with the ECOP.
MININFRA	• Monitor the implementation of the National Electrification Plan (NEP) by Mini-grids companies, including SHS suppliers; • In consultation with REMA and RURA, MININFRA will ensure that regulations for the collection and disposal of E-wastes, including LABs are observed by solar system providers.

Table 1: Stakeholders responsibilities

12 DISCLOSURE

Subsequent to its revision by BRD and clearance by the World Bank. The ECOP will be disclosed at the BRD/REF website and shared to the local government agencies (RURA and REMA) and other relevant stakeholders. The World Bank will also disclose the revised ECOP electronically through its external website.

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