

## Summary of Best Practices to Enhance Efficiency, Extend the Life Span and Improve Waste Management of Off-Grid Solar-Home-Systems (SHSs)

[Part of the Resource Efficiency and Waste Management for Off-grid Solar Products in Kenya (REWMOS) Project]

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This document summarises the “Best Practices” gathered from consultation with various stakeholders in the REWMOS Project. Consultations happened in 3 Phases:

- I. Introductory workshop with local stakeholders
- II. SHS users’ survey and high-level stakeholder questionnaires
- III. High-level stakeholder workshop

Further details on these consultations are available at our website at <https://www.rewmosproject.com/>

The Best Practices in this document are divided with a focus on the four main categories of stakeholders within the SHS life-cycle, namely:

1. Manufacturers and retailers
2. SHS users
3. SHS installers and repair entities
4. Recycling & Disposal Entities

The best practices for each category are listed below.

### **1. Best Practices for Retailers & Manufacturers**

#### **1.1. Best practices for retailers & manufacturers to enhance efficiency and extend the life-span of off-grid solar products**

- i. Provide clear and contextual instructions and support material with each product*
  - Many products do not have good user manuals, and those that do often have complex manuals written in English. It is important to provide not only manuals written in the right language for every region, but to also tailor these manuals to the context where they will be used.
  - Recommendations from consultations suggest the increased use of diagrammatic and pictorial manuals to highlight the most critical aspects of the SHS ownership process.
  - Online, SMS and app-based sharing of instructions and information is also important.
- ii. Provide firmware and software update where applicable*
  - Regular updates mean proper kit/system functionality that may enhance user experience and help to prolong the life span of the SHS

### **Resource Efficiency and Waste Management for Off-grid Solar Products in Kenya**

**[ Implemented in Partnership by myclimate & Solibrium ]**

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- Many manufacturers and retailers have a once-sold, never-revisited approach, particularly those with products aimed for the low end of the market. This creates a negative perception about SHS among users.
- iii. *Use expandable battery management technology to link up old Lithium ion batteries with new one to enhance their charging.*
- Because of low volumes of obsolete Lithium ion batteries and high cost of take-back transportation costs back to the manufacturers for recycling, it can be expensive to manage obsolete batteries.
  - Recommendations from consultations indicated that there is an ongoing experiment on expandable battery management technology that will enable users to link and charge the old and new battery effectively, and also expand the batteries lifespan.
- iv. *Establishment of regional repair centres*
- Many SHS are used in rural areas and when they or some of the components become faulty, it is a challenge for the users to take them back to the manufacturers or retailers for service/repair. Also, most retailers lose touch with the SHS users after expiry of the warranty period.
  - Recommendations from the surveys and workshops suggested that there is need for manufacturers and retailers to establish regional repair centers where clients can easily take their faulty SHS for after sales service and repairs with ease and within their reach.
- v. *Use of biodegradable materials during manufacture of products*
- Some of the SHS components are packaged in non-biodegradable materials e.g. plastics. These end up being disposed in inappropriate ways that are hazardous to the environment.
  - SHS users recommended that manufacturers should embrace the use of biodegradable materials for manufacturing of all packaging materials.
- vi. *Provision of spare parts*
- Most repair shops/technicians extract parts from obsolete SHS or buy from local shops and replace them to faulty ones during repair work. Some of the replaced parts are either not compatible, extracted from counterfeit gadgets or are too old. This reduces the lifespan of the refurbished SHS.
  - Recommendations from the stakeholder consultations suggest that all manufacturers need to make genuine and recommended spare parts for their respective SHS readily available and accessible to repair shops and technicians.
- vii. *Establishment of research and development departments to explore life extension mechanisms*
- Many SHS life can be extended by improvement on materials and technology used during manufacture. Knowledge for these improvements can be obtained through collecting information from users, retailers, technicians through research. For instance,

one manufacturer identified that rodents were attracted to the materials used in the manufacture of wires, and this resulted to the rodents cutting the wires

- Manufacturers need to establish working research departments which can look into ways to extend the lifespan of SHS.

*viii. Providing warranty for products*

- Some manufacturers provide warranty of their products with effect from the date of manufacture. These kits are distributed to wholesales and other middlemen and by the time the kits are sold to the end user, the warranty period has significantly reduced.
- Stakeholders, especially users recommend that the warrant period for the kits and their components to start counting from the date of purchase.

*ix. Avoidance of storing SHS for excessively longer periods in the warehouses*

- When batteries are kept for long period in stores/on shelves without charge, this leads to reduction in their charging efficiency or even permanent loss of their capacity due sulfation. This negatively affects their overall useful lifespan.
- It is recommended that batteries and other SHS components to be released soon after their manufacture. If not, battery life can be prolonged on shelf life without charging by storing then under controlled conditions of not more than 10 degrees Celsius

**1.2. Best practices for retailers & manufacturers to improve recycling & disposal of obsolete SHS components & other off-grid solar products**

*i. Call for return of the products to the suppliers at the end of life*

- Most SHS do not know what to do with the kits and where to dispose components once they reach their end of life. Some of the users have obsolete components stored in their storerooms as junks.
- It is recommended that manufactures and retailers to provide information at the point of sale to the SHS users to return the components to them once they become obsolete.

*ii. Introduction of Advanced Recycling Fee (ARF)*

- SHS systems lose value significantly once they become obsolete and thus, users are not willing to pay for proper disposal and recycling.
- An Advanced recycling fees that is charged to the end user at the time of purchase of the SHS can be useful for covering takeback and recycling costs when the kits reach their end of useful life. This will help users return the components to retailers/manufacturers for disposal and recycling.

*iii. Recyclability and reparability be considered during design of the products*

- When SHS components reach their end of life, some parts are still useful and can be reused during repair. These components/parts can remain useful for a longer time even after the SHS becomes obsolete

- Recommendations from consultation meetings suggested that manufacturers need to design the SHS in a way that components/parts can be separated successfully without damage for use in repair work.
- iv. *Engaging in waste management projects (such as REWMOS) that aim to deal with proper disposal*
- Most of the retailers and manufacturers are interested with only sale of kits as a business in an aim of making profit, and rarely consider proper disposal when the SHS become obsolete.
  - It is recommended that Manufacturers and retailers partner and participate in waste management initiatives that will address the negative environmental impacts and identify the best practices for disposal/recycling at the end of a SHS lifespan.
- v. *Partnership with recycling companies*
- Some manufacturers and retailers are not aware of any recycling companies and do not know where to take obsolete components since they do not have any reverse logistic mechanisms.
  - Recycling companies to be proactive on awareness and marketing and provide incentives to manufacturers and retailers for disposal and management of SHS once they reach of their end of life.
- vi. *Establishing proper take-back logistics linking users/retailers/repair technicians and recycling plants*
- Manufacturers and retailers do not have any reverse logistics of taking back the components once they reach the end user and after the warranty period. This is due to lack of ways on tracking down the components.
  - It is recommended that manufacturers and retailers engage in ways that they can be able to take back the components from users to retailers/technicians and recycling companies for the right ways on proper disposal and recycling. These reverse logistic mechanisms should be included in their framework and ability to track down the components.

## **2. Best Practices for SHS users**

### **2.1. Best practices for SHS users to enhance efficiency and extend the life-span of off-grid solar products**

- i. *Use of components that are designed/recommended for the SHS*
- Some clients plug into their SHS components that were not supplied for the SHS. Some of the component have higher electricity requirements than what SHS can support. This reduces the lifespan of the batteries as well as efficiency of the SHS.

- It is therefore recommended that at the time of purchase, SHS users are sensitized about the importance of using SHS as directed by the manufacturer, including plugging only recommended components.
- ii. *Regular cleaning of solar panels and other system components*
  - When solar panels are not cleaned up, dust particles and bird droppings accumulate on the surface blocking sunlight and thus reducing charging efficiency. Inefficient charging can reduce the lifespan of the battery and the panel as well.
  - Recommendations made during the surveys and consultation meetings indicate that SHS users need to be sensitized on proper maintenance practices for SHS including cleaning solar panels for effective charging.
- iii. *Use of correct charging ports*
  - Most SHS come with several ports meant to serve specific functions e.g. USB ports for charging, media, plug in for components etc. When these ports are interchanged, this may cause short-circuiting, or even the SHS to become faulty.
  - It is recommended that SHS users be adequately and properly instructed by the sellers at the time of purchase. Also, provision of manuals with pictorial/graphic guidelines about location of ports for specific functions can be useful for the users.
- iv. *Properly charging the SHS battery*
  - One of the issues that was highlighted was Undercharging of batteries which may cause sulfation and acid stratification. This has a negative impact on the lifespan of batteries. Also, when solar panel is installed in an area with shade in whole or part, for example, by tree branches or a building, the overall charging efficiency reduces
  - It is recommended that SHS users to be adequately and properly instructed to properly charge their SHS at the time of purchase. Also, provision of manuals with pictorial/graphic guidelines showing clients how to monitor charging of their SHS can be useful. SHS should have screen meters that show percentage of charge, and when the SHS is fully charged.
- v. *Keep the SHS and the battery in a well-protected location and away from children*
  - Most of SHS are located in rural homes where they get exposed to dust and other forms of dirt. The dust can clog on battery terminals and thereby decreasing SHS efficiency. Also, the components are kept within reach of children which can be dangerous due to risks of interference with their connectivity.
  - It is recommended that the SHS to be kept in a well-protected area away from children. If they battery becomes dirty or has dust accumulation, only a dry cloth should be used for cleaning.
- vi. *Installing solar panels at an inclination angle relative to position of the sun*

- Some users have their panels permanently fixed on their house roofs while others move the panels outside to the sun every morning. For maximum charging, a solar panel need to be placed at an inclination angle relative to the position of the sun. This can reduce the number of hours needed to fully charge the battery. However, some of the users are not aware on this.
- It is recommended that the solar panel to be installed in an angle that allows maximum exposure to sunlight, especially at peak hours (around midday).
- In cases where solar panels are installed permanently on rooftops, it is also recommended that adequate space to left between the solar panel and the rooftop if the rooftop is metallic. This increases air circulation and maintains low temperature around the panel, improving efficiency of charging. Panels installed right against metaling roofs can reach very high temperatures during the day, significantly affecting their ability to charge SHS batteries.

*vii. For flooded batteries, periodically top up battery acid*

- Some clients have customized solar kits with flooded batteries. These batteries require regular maintenance including topping up with battery water after a period of use. If this is not done, the level of the electrolyte reduced hence exposing of the plates. This can reduce the lifespan of the battery.
- It is recommended that flooded batteries to be topped up with the recommended fluid when the level drops below the recommended level.

*viii. Read, understand and safely keep user manuals for future reference*

- User manuals are in most cases issued to users at the time of purchase of the SHS. However, these are written in languages that users do not understand, yet they (manuals) are nearest advisor for basic troubleshooting and maintenance
- It is recommended that users are helped to understand the content of the user manuals through increased use of diagrammatic and pictorial manuals to highlight the most critical aspects of the SHS troubleshooting process. Also, online, SMS and app-based sharing of instructions and information is important.

*ix. Contact qualified technicians for repair and advice.*

- There exist many untrained and unlicensed technicians of SHS. They fail to properly identify issues on faulty kits which sometime render them obsolete.
- It is recommended for SHS users to consult with qualified technicians for advice or repair when their kits become obsolete.

## 2.2. Best practices for SHS users on Disposal of obsolete SHS/components

*i. Taking back the components at designated collection points.*

- Lack of awareness and disposal bins on where to take the kits once they become obsolete is a one of the main challenges for SHS users



- Solar users to take back obsolete components at designated collection points. If the collection points are unavailable, then they should consult retailers and relevant authorities such as NEMA on where to dispose. More awareness should also be done on the negative impacts of SHS if not disposed well.
- Under no circumstances should components be disposed of in domestic fires, gardens or pit-latrines, and obsolete SHS components, especially batteries, should not be given to children as toys.

### **3. Best Practices for SHS installers and repair entities**

#### **3.1. Best practices for SHS installers and repair entities to enhance efficiency and extend the life-span of off-grid solar products**

- For customized solar installations, use the right components that match the size of the system*
  - Some clients require customized solar kits to meet specific electricity requirements. As such, technicians design for them solar kits to meet their needs. This requires good knowledge to do proper estimation of sizes of required components e.g. inverters and charge controllers. When proper components are not used, then the efficiency of the solar kit becomes compromised and as such, problem of quick discharging/drainage of the batteries is experienced which can reduce the lifespan of the batteries
  - SHS installers and repair entities are advised to do accurate sizing of components for customized solar kits and also provide adequate instructions on proper use of the kit.
- Technicians should have right tools and use recommended spare parts during repair*
  - During repair, technicians sometimes extract parts or components from other faulty or obsolete SHS which they use to replace in other SHS. It was noted that some of the spare parts used are extracted from counterfeit components and as such, this reduces efficiency and lifespan of the repaired SHS. Also, use of the correct tools ensures high quality of repair work
  - It is recommended that repair entities and SHS installers use recommended components and parts for repair, and also proper tools during installation.
- Continuous training to remain competent and updated on new designs*
  - Technology used in SHS manufacturing continues to improve with time. This also calls for improvement in skills for both SHS installers and repair entities for them to remain relevant and do quality work.
  - It is recommended that both SHS installers and repair entities undertake training to better understand new designs of SHS, their repairs and how best to advise their clients.
- Acquire proper certification and licenses to undertake installation and repair work*

- Due to increasing number of SHS and increasing number of those that become faulty, many people are engaging in to repair and SHS installation work. However, some of these people are not qualified to do this work. Involvement of quacks and non-professionals in this raise concerns on quality or repair work and SHS installation.
- Stakeholders recommended that only trained, qualified and certified technicians should be allowed to do this work. The government agencies e.g. NEMA and Energy Regulatory Commission(ERC) should certify qualified technicians and put in place proper laws and regulations to remove quacks.

v. *Educate the users on use, maintenance of SHS after installation*

- SHS installers and repair agencies interact closely with SHS users. SHS installers & technicians are trained professionals and therefore have vast knowledge about the do's and don'ts on SHS that can help increase their lifetime. During installation and repair work, they can educate the users on best practices that can increase lifespan and efficiency of their SHS.
- It is recommended that SHS installers and repair entities to do awareness creation to SHS users about best practices that can ensure increase lifespan of their SHS

3.2. **Best practices for SHS installers and repair entities on Disposal of obsolete SHS/components**

i. *Extraction of useful components/parts form obsolete and/or faulty SHS*

- Repair entities and technicians extract parts e.g. diodes that can be reusable in other repairable electronic accessories. This makes such parts useful beyond the lifetime of the SHS. This reduce the total volume of disposable SHS.
- If the SHS users cannot reach manufactures or retailers, they can seek advice from repairs entities and installers for reuse of components/parts from their obsolete SHS

ii. *Partnership with recycling companies*

- Repair shops have huge volumes of obsolete SHS. Through partnership with recycling companies, they can channel these to recycling companies at a small fee. This will ensure proper disposal of the obsolete SHS.
- The consultation workshop recommended for partnership, linkages between recyclers, retailers, repair entities and SHS uses to create a good network that can ensure efficient take back of obsolete SHS and subsequent recycling or disposal.

iii. *Buy-back of components*

- There are large volumes of obsolete SHS with users. However, the users are hesitant to give them out free for proper disposal and /or recycling. A buy-back mechanism where repair entities pay a small fee can encourage SHS users to deliver their obsolete components to the collection centres or repair shops.

4. **Best Practices for Recycling & Disposal Entities**



#### 4.1. **Best practices for Recycling & Disposal Entities to enhance efficiency and extend the life-span of off-grid solar products**

i. *Awareness creation to SHS users and manufacturers about what faulty components are predominant.*

- It was identified that lack of awareness to the end user about proper maintenance, use, and disposal of SHS is a pertinent issue.
- All stakeholders including recycling and disposal entities need to do awareness creation to SHS users about the importance of proper disposal of obsolete components and risks that are associated with keeping obsolete components (some have quite toxic materials) at home

#### 4.2. **Best practices for Recycling & Disposal Entities on Disposal of obsolete SHS/components**

i. *Provision of e-waste collection centres*

- There are large volumes of obsolete SHS with users. One way for making it easier for users to release them is by providing e-waste collection centers at strategic locations.
- Establishment of e-waste collection centres especially in rural and urban areas is highly recommended to make it easier for SHS users to surrender obsolete components for proper disposal and recycling

ii. *Buy-back of components*

- There are large volumes of obsolete SHS with users. However, the users are hesitant to give them out free for proper disposal and /or recycling. A buy-back mechanism where repair entities pay a small fee can encourage SHS users to deliver their obsolete components to the collection centres for recycling and proper disposal
- A buy-back mechanism act as an incentive for SHS users to surrender their obsolete SHS or components for recycling and proper disposal.

iii. *Create partnership with retailers to link them to SHS users with obsolete SHS*

- Many obsolete SHS are located in areas that are far away from recyclers and disposal entities. A good network of stakeholders is required to access the components that users, repairs shops have. Through partnership, linkages and networking, these obsolete components can reach recyclers and disposal entities easily.
- Networking and partnership is recommended among stakeholders involved in use, recycling and disposal of SHS.