Eco Design Notes

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Renewable Energy Product Repair Part I: Overview

This Eco Design Note examines the issue of product repair and highlights challenges and opportunities that exist in the formation of a viable repair market for renewable energy products. Potential benefits of repair for consumers and manufacturers are highlighted. This is the first part in a series of Notes on repair topics.

See also http://www.lightingglobal.org for additional Eco Design and Technical Notes

Introduction

The many benefits that modern, renewable energy products bring to people without adequate access to electricity have long been discussed by Lighting Global and others. Improving energy access is recognized as a key element of poverty reduction, and the rapid growth of the renewable energy product market has shown that small technological solutions are capable of performing important functions for the customers they serve. "Pico-powered" lighting products are increasingly evolving into renewable energy products that serve many diverse consumer needs, from communication to health services and many applications in between.

A critical aspect of the renewable energy product market is that of product lifetime. All of the benefits brought by these products are intrinsically tied to the useable life of the product. Many of Lighting Global's Technical and Eco Design Notes have been focused on improving the quality of these products with the direct or incidental intention of increasing their service life.

The topic of product repair occupies an interesting space within the discussion of product lifetime. Competing interests often argue for and against the development of a robust product repair market, and manufacturers must balance the demands of product sales with customer satisfaction and trust in their brand. As of 2016, the repair market for renewable energy products is small and many challenges exist to large scale implementaion. This Eco Design Note will discuss these challenges and attempt to highlight opportunites that can benefit manufacturers, customers, and the local economies and environments where these products are sold.

Benefits of repair

When a renewable energy product ceases to operate, the materials used to manufacture that product become waste. Some of that waste is electronic waste (e-waste). In the vast majority of countries where these products are sold, this waste will be thrown into landfills or open-air trash pits. Repairing these products before they are discarded will temporarilly divert this waste and lowers its environmental impact on local landfills and waste streams.

The reality, however, is that renewable energy products make up a small fraction of the e-waste in these environments. This proportion will grow as the market grows, but in the near-term the benefits of repair are more likely to be seen in the relationship of the manfacturer and the confidence and trust of its customers.

"Emotional durability" is a design concept that explores a customer's relationship with a particular product. A stronger relationship results in improved care for the product, a longer service life, and ultimately in a reduction of the waste generated by these products. The availability of repair services can serve as a key element in this relationship.

Repair services provided by local community members offer the prospect of providing local jobs while also helping to support the emotional durability of a particular brand or product that can be repaired and returned to service. These shops help to communicate

knowledge about renewable technologies, help to promote information on the proper use and care of products, and can serve as marketing avenues for specific brands.

Building trust with a customer base is a critical element of branding for any manufacturer. Performance, value, and durability are all critical factors to a successful branding effort. All of these can benefit from a product that has been repaired and returned to service, from the increased storage capacity of a new battery to a repaired switch that salvages a product from failure and provides the owner with more time to reap the savings of their investment.

A strong desire exists in the market for repair services

A look at local electronics technicians' experience in East Africa is discussed in Lighting Africa Market Intelligence Notes 3[1] and 4[2] available at www.lightingafrica.org. The research conducted for these Notes suggests a considerable desire in local communities for a robust repair capability. In many circumstances, repair is a better consumer option than warranty replacement.

Warranty service for renewable energy products may or may not be available to consumers depending on several factors, including adequate distribution channels and agreements between distributors and local retail outlets. Some of the challenges associated with warranty service can be handled locally if repair services are available. There is a strong desire from both consumers and retailers to provide these services on a walk-in, same-day basis.

[1] https://www.lightingafrica.org/publication/sales-service-electronics-service-technicians-kenya-tanzania/

[2] https://www.lightingafrica.org/publication/sales-service-warranty-practices-retail-market/

The time and expense of a product repair can be more affordable than replacement regardless of warranty or out-of-warranty coverage. People understand repair. They understand when they are able to bring a product into a repair shop and have it restored to a working condition. Warranties, however, are less tangible and rely on trust in a contract. This may be foreign to people who do not have positive experiences with this consumer model.

Replacement parts, product schematics, and technical training are needed to allow local communities and entrepreneurs to establish repair businesses. Given access to parts and information, local repair technicians appear ready and eager to establish these repair networks. In order for them to be successful, however, they need manufacturer support.

Challenges of repair

Substantial challenges exist to the development of a robust repair market. Low product costs, component availability, proprietary product design elements, and anti-tampering protections can be significant impediments to cost-effective repair models. Manufacturers are more likely to actively support repair efforts if they perceive benefits to repair that outweigh these impediments. Technicians must also be in a position to overcome challenges in order to successfully repair products. They need adequate access to spare parts, relevant tools, and information about the products that enables successful repair (e.g. product schematics, repair guides, and/or specialized training).

Low-cost products

Low-cost products are much more likely to be discarded than repaired in many market situations. The time required to diagnose an electronic failure combined with the low component count in these products can often be an insurmountable barrier to any

logical repair scenario. The purchase of a new product, and the disposal of the old one, becomes the economically viable path for most consumers.

Larger, more costly products start to present a different scenario. The higher initial investment creates a greater incentive to preserve the equipment, and simple repairs that can return a system to full function can be of great benefit to consumers. The ability of a technician to make the repair remains dependent on the availability of compatible components and information that facilitates product repair such as schematic diagrams and repair manuals.

Intellectual property

Electronic schematics that describe the system topology are frequently necessary to diagnose a malfunction. System voltages, test points, and component identities allow a technician to make quick measurements and understand the source of the error, at which point a decision can be made as to the best method of repair. Manufacturers, understandably, may be resistant to reveal this type of technical information and may instead regard detailed system design as proprietary. In these cases, the only viable option may be for the manufacturer to paticipate in developing a repair manual that can assist a technician in making a repair without revealing proprietary information.

Warranty and pay-as-you-go

Warranty issues and pay-as-you-go systems will sometimes create incentives for manufacturers to include anti-tampering elements into their designs. Encapsulation of batteries and electronics, permanently sealing enclosures, and mechanically removing component identifiers are typical means by which a design may impede any and all attempts at modification, including repair. When present, anti-tampering design elements actively resist and may effectively prevent the ability to repair a product, leaving replacement (at least of a particular system component) as the only option.

Repair opportunities

The individual technical components in a renewable energy product exhibit a remarkable capacity for outstanding longevity. LEDs, when properly managed, can deliver high lumen maintenance values for many years. So too can crystalline silicon solar modules. Batteries, previously the weak link, have improved greatly as lithium chemistries have gained traction in increasingly larger (and more efficient) systems. When assessing the underlying technologies, there are no inherently limiting technical issues that would prevent a product from lasting five (5) years or potentially much longer. The ability to repair a product, from simple battery replacement to a more complex connector or electronic component repair, could greatly increase the service life of the system and allow the many components in a renewable energy product to live up to their full potential.

Battery replacement

Battery replacement is perhaps the first repair consideration for a product and presents one of the simplest mechanisms for a viable repair market. Replacement batteries and battery packs, when available, can often be installed in a product with minimal effort and time and do not require a detailed knowledge of the product electronics. These repairs do, however, require the ability to access the battery without damanging the product and that the new battery has the proper compatible connector (although the old wires and connector could be re-used with a new battery after a relatively simple wire-to-wire patch).

The connector systems used for battery attachments are typically two or three-wire plug/header products. There are a vast array of systems that could be used for

this purpose, but in practice it appears that manufacturers are using a smaller number of common conectors that have seen widespread use in the portable electronics industry. Most are crimp-style plug connectors used with 0.2 - 0.08 mm^2 (24-28 AWG) wires and (male pin) board mount headers (Figure 1).

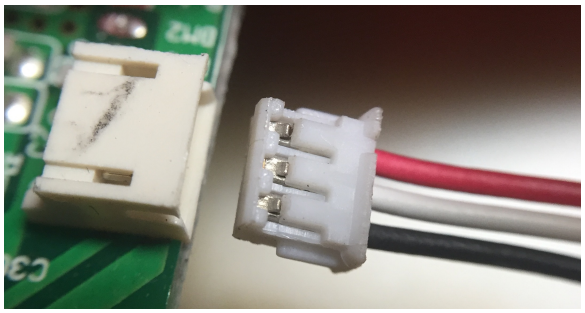

Figure 1. Wire-to-board battery connector

Wire/cable repair

Repair of a broken conductor is another repair category that can be diagnosed and fixed without a detailed knowledge of the product. Damage to a cable can sometimes be visually identified by a simple inspection. Wire and/or connection continuity can be non-destructively tested with a multimeter or by testing the output voltage of the connector (for example, the plug connector of a solar module).

When detected, product cables can be repaired by either splicing in a new connector or by removing the damaged section of cable. Simple tools and standard parts are capable of adequately performing these types of repairs.

Most renewable energy products that have wires/cables use DC (barrel) power plugs to connect the solar module and/or applicance cables to a central power control unit that houses the batteries and charge control circuits (Figure 2). Common sizes for these plugs are 1.35 mm, 2.1 mm, and 2.5 mm, although several other industry standard sizes exist. Size is determined by the inner diameter of the plug 'hole' that receives the pin of the mating connector (called the 'jack'). Many, but NOT ALL products are pin positive, meaning that the inside of the plug is positive and the outer sleeve or collar is negative – this MUST be confirmed before a replacement plug can be installed.

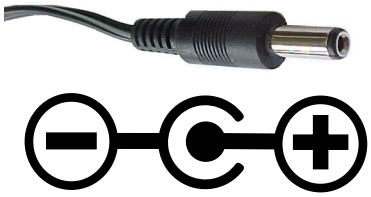

Figure 2. DC barrel plug connector with a center pin positive polarity marking

Given the prevalence of these connector types, there exists a large range of connector quality and tolerance issues that complicates this aspect of product repair. Replacing a damaged connector with a low-quality part does not serve the ultimate purpose of restoring reliability and longevity. Original equipment manufacturer (OEM) parts are preferred when replacing components, but these must be made available by the manufacturer.

Circuit board repairs

Some repairs to an electronic circuit board, including component replacements, may be possible for a skilled technician. Fixing brocken solder joints on component leads or a broken wire-to-board connection is the easiest type of board repair as these faults can often be visually identified and the solder joints can be quickly reflowed with a soldering iron. No knowledge of product operation is necessary. Replacement of connector components, primarily the DC power jacks common in many products, may be another circuit board repair opportunity as these can be easily tested for functionality, and replacement is not overly difficult.

Mechanical switches are also capable of being replaced when broken. There is, however, more diversity in

these components and switch types are not standard (in contrast with DC power plugs and jacks). This requires that components are available, which in turn places reliance on manufacturers to provide component information and replacement parts.

Component and circuit board replacement

Complete replacement of an appliance or a circuit board is a possible middle-ground solution to saving a product from being discarded. For an appliance (for example a light point or fan), replacement is simple if additional appliances are available for sale. For a circuit board inside an enclosure (i.e. a subcomponent), the issue is more complex as a more complicated diagnosis is required and the subcomponent must be available. Again, this requires some level of involvement from the manufacturer to make these parts available.

Many products have two or more circuit boards inside the enclosure(s) that comprises the product, although very simple products may have only one. A main control unit receives power from the PV module and manages the battery charging functions as well, providing power to peripheral appliances. An auxilliary circuit board sometimes supports the LED and heatsinking. There may be one or more circuit boards that support connectors, switches, or battery functions.

Repair support from manufacturers

Many of the repair scenarios outlined in this Note require some level of support from the product manufacturer. The availability of components is critical and a major challenge to remote communities with limited access to shipping services. Product (design) life cycles must be long enough that repair components can be available and consistant over a reasonably long time frame, not constantly changing as with quick changes in product designs. Some level of product schematics, component listings, or repair manuals provided by the manufacturer would help to facilitate a viable repair situation for a product or a family of products.

In order for the benefit of such a repair market to justify support efforts from manufacturers, product sales and branding would need to be strong enough to encourage an emotionally durable relationship between owner and product, one that would build confidence in the company's brand and create loyal customers. This relationship would support repair efforts, reduce waste, and strengthen the overall consumer attitude toward renewable energy products.

Conclusion

Several developments need to occur before a robust repair market can be established for renewable energy products. First among these is a recognition that product repair holds value for both consumers and manufacturers as the market for these products continues to grow and more systems and system components are placed into service. The environmental benefits of a viable repair market are unlikely to be the primary driver of a repair market – there must be a more direct financial benefit. For consumers, this benefit already exists. For manufacturers, the benefit will manifest in brand recognition and increased confidence in a particular product line. With foresight and proper planning, there exists an opportunity for manufacturers to develop mechanisms that allow their products to garner a reputation for reliability and longevity that speaks to the underlying promise of renewable technologies. Repair can play an important role in fostering this reputation as consumers learn to recognize the differences in quality that exist among the products available to meet their growing energy needs.

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