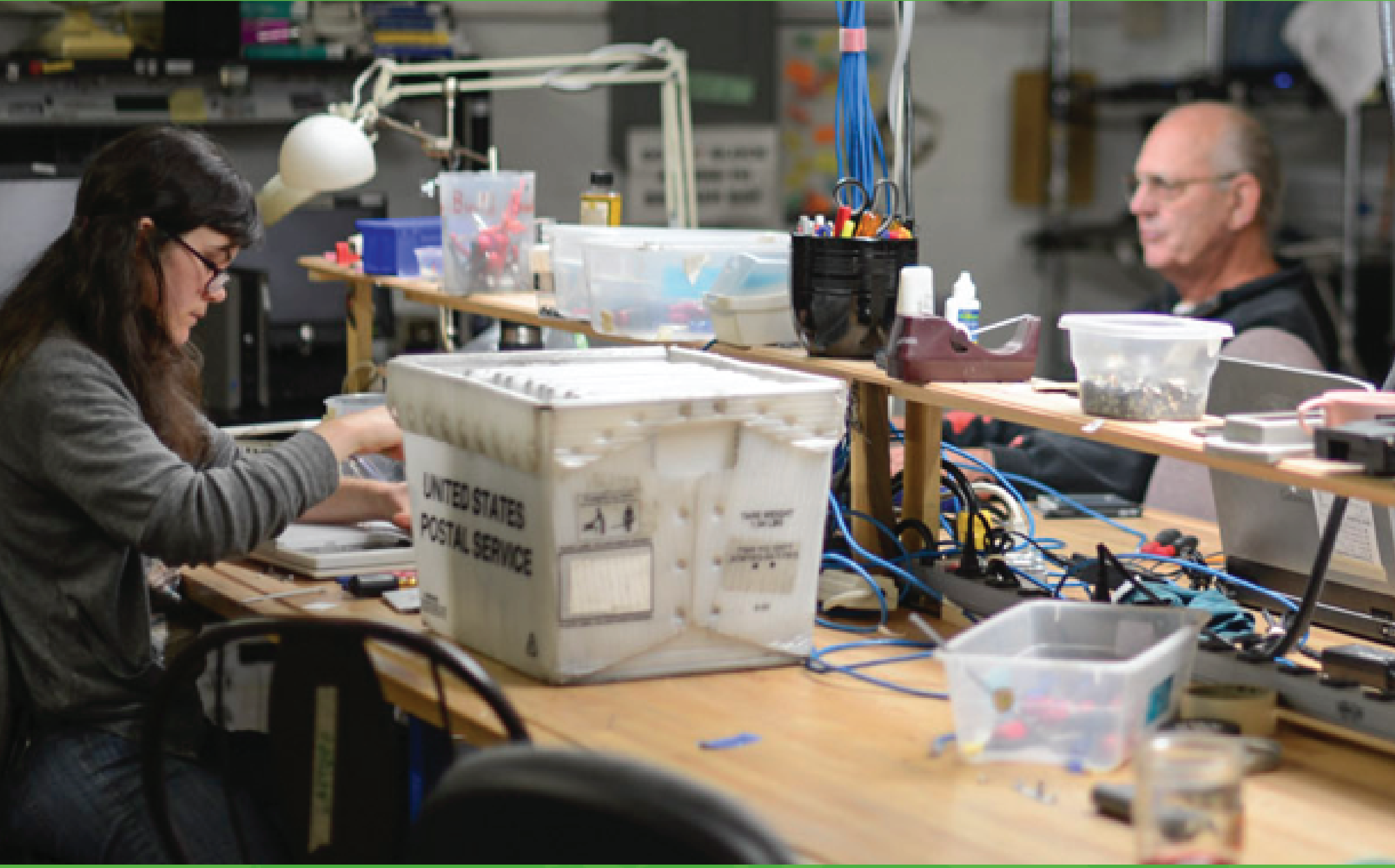


Electronics Standards Are In Need of Repair

Manufacturers Have Weakened U.S. Green Electronics Standards by Resisting Repair Criteria

Mark Schaffer

August 2017

repair.org

"Research has identified reuse, repair, and refurbishment as key to lengthening the lifetime of electronics."

About the author

Mark Schaffer has 20 years of experience designing and manufacturing sustainable electronics. He is a well-regarded electronics engineer and consultant, providing supply chain, environmental and sustainability consulting and project management services to organizations around the world. He has been involved in standards development for the last 14 years.

Prior to starting Schaffer Environmental LLC, Mark managed environmental programs for Dell. While at Dell, Mark advocated for the creation of the initial green standard for computers. He served on the board of advisors of the Green Electronics Council for two years during its creation, leading Dell's internal adoption of EPEAT for their institutional products.

His consulting firm conducts Life Cycle Assessments of electronic products for manufacturers. These assessments involve teardowns and material analysis to determine a product's overall environmental impact, including their ability to be repaired and recycled. He audits organizations' supply chains for compliance to EPEAT requirements—as well as national and international conflict mineral, RoHS, and REACH regulations. Mark has a BS in Materials Science & Engineering from North Carolina State University and has also worked for IBM, Static Control Components, Canon, and NASA.

Executive summary

Green standards are meant to lead the IT industry—but U.S. electronics standards have become too easy for manufacturers to meet.
U.S. electronics standards of the past have pushed manufacturers toward **more recycled plastics**, fewer hazardous materials, smarter end-of-life management, and better energy efficiency.
But now, manufacturers hold so many positions on green electronics standards boards that they can effectively **resist leadership standards**.
When the first EPEAT standard for computers (IEEE 1680.1) was released in 2006, only 60 products on the market were able meet the "silver" and "bronze" levels. No product achieved the highest "gold" level. By 2011, of the 3500+ unique registered products, **over 2000 products were "gold."** The marked increase speaks to the widespread adoption of the registry by purchasers and manufacturers, but also suggests that high-level criteria have become too easy for manufacturers to achieve.
Environmental progress of electronics manufacturing is stalling. For it to improve again, standards would need to include inspiring, challenging criteria that research has demonstrated to reduce electronics' environmental footprint—such as **design for repair, reuse, and disassembly.**

Ideally, green standards for electronics establish a consistent set of environmental leadership criteria for the design, use, and end-of-life phases of electronics. Since their initial development, green U.S. electronics standards have successfully pushed manufacturers to incorporate key performance criteria, including requirements for recycled plastics, the reduction of hazardous materials, end-of-life management, and energy efficiency. Historically, by setting a high bar and rewarding significant advances in green design, electronics standards have shaped electronics design for the better.

Yet these standards—both in and out of development—have become increasingly ineffectual, as electronics manufacturers now constitute a large voting bloc on most U.S. green standards groups. Standards are arduous to update, and the criteria are often too easy for manufacturers to achieve. Thus, electronics standards, more and more often, fail to function as tools of environmental leadership. Industry and purchasers rely on these standards for guidance in identifying sustainable products—which further perpetuates the low bar that has been set.

"Green electronics standards now fail to function as tools of environmental leadership."

The electronics market evolves quickly; thousands of new models and products are released every single year. Product designs have changed drastically over the years, far outpacing the development of the standards. Some of those design changes are for the better, environmentally speaking—others are for the worse. For example, devices are increasingly more energy efficient, but many incorporate difficult-to-recycle batteries and feature non-upgradeable storage. Products weigh less and have reduced material demands, but they also use rare earth materials that are virtually impossible to recover in the current electronics recycling infrastructure. U.S. green standards have not kept up with the rapid pace of innovation in the electronics market, and many standards are in need of rigorous updates.

U.S. green standards could again lead, were they to integrate challenging, inspiring green design criteria, including (but not limited to) guidelines for increased reuse and repair. In the last five years, environmental research and lifecycle analysis conducted by both NGOs and government organizations have identified reuse, repair, and refurbishment as key strategies for lengthening the lifetime of electronic products—substantially reducing the environmental footprint of the electronics industry and making it easier for electronics recyclers to process e-waste. In accordance with this research, members of standards development committees for electronics have proposed enhancements to standards that would encourage reuse-friendly strategies and product designs for electronics.

Unfortunately, manufacturers have **consistently opposed stronger reuse and repair criteria**. And though manufacturers often claim they design for durability, no durability criteria is included in US electronics standards. As a result, green standards have systemically failed to incorporate strong policies that would enable repair, reuse, and product life extension for electronics.

Introduction

A brief primer to green electronics standards	
Who makes the standards?	Standards boards are organized by professional associations, such as the Institute of Electrical and Electronics Engineers (IEEE), Underwriters Laboratories (UL), and NSF International. These boards—which are comprised of industry representatives, including manufacturers—draft, discuss, and ballot standards.
Who regulates standards?	Third-party groups such as Green Electronics Council (GEC) review products and evaluate their adherence to standards' criteria, providing conformity assurance so that products can be included on the EPEAT registry. All of the criteria used in EPEAT are based on ANSI (American National Standards Institute) approved public standards. Funding for GEC and EPEAT primarily comes from manufacturers.
Who uses them?	Groups—including schools, businesses, and government organizations—use standards to guide institutional purchasing decisions. For example, the Department of Defense, General Services Administration, and National Aeronautics and Space Administration require that new electronics purchases are EPEAT-certified, which in turn requires that products meet the IEEE 1680 standard.

This report draws heavily on its author's nearly fifteen years of experience participating in the standards organizations that draft and develop green standards for electronics. It aims to provide an overview of leadership electronics standards and considers how the best industry-leading standards have effectively led to environmental change. Because repair and reuse strategies have been consistently undervalued by these standards—despite their outsized environmental potential—this report will also demonstrate the environmental benefits of incorporating strong reuse incentives into sustainable electronics standards.

It is worth noting that repair and reuse criteria are relatively new additions to the discussion of green standards. In fact, repair was not actively considered at all during the early years of standards development. From 2004 to 2012, standards largely focused on recycling and recyclability of materials, which was in line at the time with the desires of the institutional purchasers—such as schools and government organizations. Large-scale purchasers were the primary users of the standards, and large purchasers—including US government

"Repair is an essential pathway to extending product lifespans."

organizations[1]—continue to use green standards to guide their electronics purchasing decisions today. However, in the last five years, standards developers have recognized the need to support product life extension. Repair is an essential pathway to extending product lifespans. According to IEEE itself, the world's largest technical professional organization (and organizer of the 1680 family of electronics standards), increasing the lifespan of a phone from one to four years reduces its environmental impact by 40 percent.[2] Ethical phone-maker Fairphone has also determined that design-for-repair is a key strategy for reducing environmental impact. Due to modular design, availability of spare parts, and public repair instructions, Fairphone estimated the environmental impact at "a 30% reduction in global warming potential (GWP) across the entire life cycle of the Fairphone 2"—a phone that was designed to be highly repairable.[3]

Unlike recycling, where some materials are lost when electronics are shredded and melted down, repaired products retain nearly all of the materials and energy expended in production. Proposed strategies for enabling the repair of electronics in green electronics standards have included **design-for-disassembly, replaceable batteries, usage of common fastener types, and the availability of service documentation for devices.** In order to facilitate the broad use of service documentation across platforms, many standards are also considering the inclusion of oManual—an open XML-based standard for procedural manuals.[4]

Despite the clear environmental benefits of strong repair and reuse incentives, the repair criteria in forthcoming environmental standards are relatively weak (see Table 1, "Current Status of Green Electronics Standards" on pg. 8, for a brief overview of specific standards and associated repair criteria). While strong repair and reuse incentives have been proposed, these requirements have been strongly opposed by manufacturers who participate in standards development groups. Manufacturers generally cite their concerns over user safety, sharing of

---

[1] United States, Congress, The Federal Register. *Notice of Availability of Implementing Instructions for Planning for Federal Sustainability in the Next Decade*, 15 June 2015. https://www.federalregister.gov/documents/2015/06/15/2015-14501/implementing-instructions-for-planning-for-federal-sustainability-in-the-next-decade-executive-order (see pg. 65)

[2] "IEEE Experts Identify the Fourth R-Word in Sustainability: Repair." IEEE, 22 Apr. 2013, http://www.ieee.org/about/news/2013/22april_2013.html

[3] Ballester, Miquel. "How Sustainable Is the Fairphone 2?" Fairphone, 17 Nov. 2016, https://www.fairphone.com/en/2016/11/17/sustainable-fairphone-2-weve-got-results/

[4] For more information, see *IEEE 1874-2013 Standard for Documentation Schema for Repair and Assembly of Electronic Devices* at https://standards.ieee.org/findstds/standard/1874-2013.html and http://www.omanual.org/

confidential information, and/or lack of environmental benefit as reasons for opposing criteria in support of repair enablement. Their opposition has been enough to preclude strong, effective repair and reuse incentives in today's electronics standards.

Table 1: Current Status of Green Electronics Standards

Standard	Status	Last Update
IEEE 1680.1 (Computers including tablets, Monitors)	Ready for IEEE recirculation ballot; Design for End-of-Life and Product Longevity criteria, as written, will not appreciably enable repair or measure durability.	Ongoing work
IEEE 1680.2 (Imaging Equipment)	Completed. No specific repair criteria. Repair included only as part of overall End-of-Life plan. Update with End-of-Life management criteria changes approved in July 2017.	10.19.2012
IEEE 1680.3 (Televisions)	Completed. No specific repair criteria. Repair included only as part of overall End-of-Life plan. Update with End-of-Life management criteria changes approved in July 2017.	10.19.2012
IEEE 1680.4 (Servers)	Merged with NSF 426 standard. Three balloting rounds have been conducted but, as of July 2017, all have failed to achieve the necessary 75% approval required by IEEE in order to publish. Currently seeking additional input to resolve balloting comments from previous rounds.	05.31.2017

Standard	Status	Last Update
NSF 426 (Servers)	Merged with IEEE 1680.4; required repair language only reflects current legal requirements and the optional requirements do not include information sharing, or availability of software/testing tools. Three balloting rounds have been conducted and all have passed. NSF plans to publish the standard in late 2017.	05.31.2017
IEEE 1680.6 (Complex Set-top boxes)	Repair language provided and initial review by the working group has been completed. Standard approved to move to IEEE balloting.	Ongoing work
UL 110 (Mobile Phones)	The standard was approved in early 2017 and has been accepted for use in the EPEAT registry system. The registry went live on July 31. Contains some repair criteria and optional requirements for battery removability without tools.	03.24.2017

History of standards development

In order to assess the current state of standards for electronics, it's important to first understand their history. In the early 2000s, environmental requirements for institutional purchasers, led by the US government, increasingly became part of procurement contracts for IT equipment. However, individual contracts outlined different approaches for assessing "green" electronics. This presented challenges to the IT industry in designing and marketing their products. Manufacturers also found it challenging to integrate a standard set of environmental features—for example, ENERGY STAR designations or ISO 14001 environmental management certifications—based on various purchasers' desires. Purchasers and manufacturers needed a consistent set of environmental criteria.

In 2004, a more holistic green procurement standard for electronics began as an Environmental Protection Agency-funded project. The development committee included members of the personal computer industry, key suppliers, purchasers, academics, non-governmental organizations, environmental advocacy organizations, and users. Their work became the basis

How products are assessed in IEEE 1680

The Institute of Electrical and Electronics Engineers (IEEE) 1680 standard sets out achievement levels of judged product via a combination of required and optional criteria. In addition to the baseline required criteria, manufacturers can earn optional points for specific improvements that require additional costs, design impact, or information disclosure. Manufacturers submit individual products to independent certification groups for assessment against the standard. If the product meets the baseline criteria, it can earn either **a Gold, Silver, or Bronze assessment.** To meet the minimum Bronze level, all required criteria must be met. Silver demands that at least 50% of the optional criteria, along with all required criteria, are met. Gold demands 75% of optional and all required criteria are met. This tiering system allows manufacturers to be recognized for environmental leadership—and the registry gives purchasers the opportunity to identify environmentally preferable products. **If the majority of products achieve "Gold" ratings, then it is failing to set forth criteria that is actually environmentally progressive.**

of the IEEE 1680 standard for computers and monitors, which was implemented in 2006. The process of developing the IEEE 1680 standard and implementing the initial registry took stakeholders roughly two-and-a-half years.

IEEE 1680 identified eight key environmental areas to target: **Restricted Materials**, **Materials Selection**, **Design for End-of-Life**, **Product Longevity**, **Energy Efficiency**, **Corporate Performance**, **End-of-Life**, and **Packaging**. The group that authored the standard developed criteria over a two-year period in a consensus-based approach that was taken through IEEE's standards accreditation process, resulting in an American National Standards Institute (ANSI) accredited standard. The standard was implemented via the Green Electronics Council, which currently manages a product registry—the Electronic Product Environmental Assessment Tool or EPEAT. The EPEAT registry tracks products that meet the relevant IEEE 1680 standard. The registry helps purchasers identify environmentally preferable products and gives manufacturers a comparative sustainability assessment tool for their products.

From 2008-2012, new standards committees developed and released the IEEE 1680.2 (Imaging Devices) and .3 (Televisions) standards.

Since the completion of the original standards, new standards for additional product categories have begun development (refer to Table 1, pgs. 8-9). UL 110 is the standard for mobile phones. NSF 426 and IEEE 1680.4 are separately developed standards that both focus on servers (these two groups have since merged their work and have worked together to jointly develop a standard).[5] IEEE 1680.6, the newest electronics standard to start development, is focused on complex set-top boxes. Each standard covers at least the same eight key environmental areas

[5] The joint standard was separately balloted by each institution. It failed to achieve approval in IEEE but was approved by NSF. NSF will publish the standard in late 2017.

as previous standards—though some additional topics are also considered, depending on the product category.

In addition to new standards, the original IEEE 1680.1 personal computer standard (finished in 2006) underwent minor updates in 2009. The computer standard has since undergone a full revision but has yet to pass balloting approval. The 1680.2 and 1680.3 standards completed minor updates in 2017 for End-of-Life management criteria and were approved through balloting.

IEEE 1680: A study of successful standards criteria

In 2006, the IEEE 1680 standard provided an easy way for purchasers to know they were choosing environmentally-preferable products. The standard also fundamentally changed how environmental standards were perceived by directly tying environmental performance to product purchasing. When the US government—the country's largest equipment purchaser—adopted IEEE 1680 as part of its buying requirements, large manufacturers were essentially *required* to implement environmentally preferable designs or lose one of their biggest customers: government institutions. Because of IEEE 1680, it was no longer optional to be green; EPEAT registration was essential to widespread market success. The Bronze, Silver, and Gold ranking system implemented by EPEAT also introduced an element of market competition, allowing manufacturers to capitalize on their environmental leadership (to learn more about EPEAT's tiered ranking system, see the "How products are assessed in IEEE 1680" sidebar, pg. 10).

The 1680 family of standards introduced a number of industry-leading criteria. Here are some of the biggest successes of the initial 1680 family of standards:

Recycled plastic content

One of the first requirements of the 1680 standards was a required declaration that the product uses post-consumer recycled plastic. Manufacturers were given an optional credit for meeting minimum threshold levels of 10% and 25%. Prior to the requirement, manufacturers encountered a challenging catch-22. Many companies *wanted* to use post-consumer recycled plastic in their products, but there wasn't enough material available on the market due to lack of aggregate demand.

"As of late 2016, there were 365 products claiming to have at least 10% post-consumer recycled plastic."

When developing criteria for 1680, the task force determined that the supply chain for recycled plastic was not large enough to justify mandating a minimum threshold of recycled plastic content use. But the mere inclusion of post-consumer recycled plastics in the standard was enough to stimulate and expand the market for recycled plastics.

By 2012, the supply of recycled plastics was high enough that the next standard (1680.2) was able to include a mandatory recycled content amount. The standard shaped the market: the drive for higher EPEAT ratings provided "a significant boost to the plastics recycling industry from the electronics industry," Wayne Rifer, then of the GEC, wrote in 2014.[6]

The standards have continued to shape the market for recycled plastics. As of late 2016, some 365 products that are covered by the 1680.1 standard (computers, monitors, tablets) claimed to have at least 10% post-consumer recycled plastic content.[7] Some examples of products registered have included the Lenovo ThinkPad E475 (a notebook), Dell XPS 7760 (an integrated desktop), and HP Elite E230t 23-inch display (a monitor).

End-of-life management and takeback

The 1680 standard mandated that manufacturers provide takeback services for products. The .2 and .3 standards added responsible recycling requirements—either through R2 or e-Stewards recycling certified programs—and included an expanded set of products for takeback. The addition of a manufacturer-funded takeback requirement provided both leadership and established e-waste recycling as an important issue for the electronics industry.

It is difficult for GEC to estimate how much e-waste has been diverted from landfills due to takeback criteria, but the inclusion of a set of standards for end-of-life (EoL) processors raised the bar for environmental stewardship in the recycling industry. As an unanticipated downside, though, manufacturers often point to these EoL criteria during the development phase as a justification for not encouraging more repair and reuse in standards.

Reduction of hazardous materials

Prior to 2006, the electronics industry had not established a consistent restriction on potentially hazardous materials used in devices. Even today, California and a few other

[6] Rifer, Wayne. "Overcoming barriers: EPEAT's impact on the use of PCR plastics in electronics manufacturing." *Recycling Today.* 29 Sept, 2014. http://www.recyclingtoday.com/article/rt1014-pcr-plastics-epeat/

[7] The EPEAT database changes daily and some of these product could be removed, for whatever reason, at any time.

Hazardous materials in electronics

Since its inception, EPEAT has worked in concert with Europe's Reduction of Hazardous Substances (RoHS) Directive to minimize or eliminate the use of certain environmentally sensitive materials in electronics, including:

Cadmium: Used in rechargeable batteries, CRT screens, printer toners, and printer drums, cadmium can cause kidney and liver damage in humans.

Hexavalent Chromium: Used in metal housings, hexavalent chromium is a known carcinogen.

Lead: Once widely used in CRT monitors, batteries, and solder, lead is toxic to humans and long term exposure has been linked to blood, nervous system, and brain disorders in children.

Mercury: Used in the manufacturing of LCDs and batteries, mercury is a toxic heavy metal that can cause brain and liver damage.

Other environmentally sensitive materials targeted by EPEAT include: **Polybrominate biphenyls (PBB), polybrominated diphenyl ethers (PBDE), and Polyvinyl chloride (PVC).**

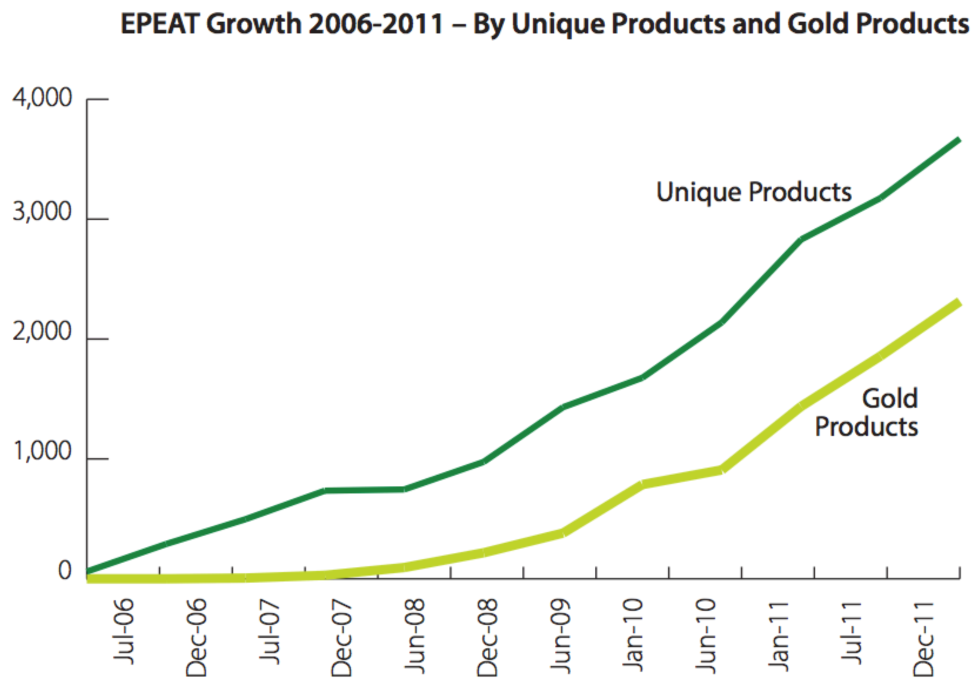
individual states have laws for material restrictions on electronics, but the United States has no national-level material restriction on electronics. The 1680 standard required that products meet the European Union's Reduction of Hazardous Substances (RoHS) requirements. This effectively globalized the RoHS standard, making it a purchasing requirement in all regions.

Due to the global nature of supply chains, it is likely that the US would have eventually reached EU RoHS compliance—but IEEE 1680's endorsement accelerated its adoption. EPEAT and RoHS have been so effective that many products now claim lower-than-RoHS thresholds—further reducing the amount of hazardous materials used in electronic products. (See "Hazardous material in electronics" sidebar, pg. 13 for more information on hazardous materials in electronics.)

These successful mandates show how leadership standards can shape the marketplace. Impelled by the standard, manufacturers met and in some cases even exceeded the expectations put forth under the standard's criteria. Along the way, manufacturers made better products.

The declining strength of standards

Green procurement standards should require commitment to environmental leadership: a common rule of thumb used by other U.S. leadership standards is that only the top one-third of products on the market should be able to meet the minimum level of the standard. The IEEE standards follow the same baseline, according to guidelines for its computer standard: "This is an environmental leadership standard, defined with the intention that that only leading products, i.e., approximately 25 - 35% of the market, would be able to qualify to the standard at the base or Bronze level, at the date of publication of this standard. As the environmental



The Green Electronics Council's 2011 Environmental Report details the growth of the unique products listed in the EPEAT registry of products between the years of 2006 and 2011.

performance of products that are available in the marketplace improves, the standard will be updated and revised to set a higher performance standard for leadership products."[8]

"Effective green standards should drive device design in a more sustainable direction. Any standard that substantially reflects the current market is neither rigorous nor effective."

Effective green standards should drive device design in a more sustainable direction. Any standard that substantially reflects the current market is neither rigorous nor effective. When the first EPEAT standard for computers (1680.1) was released in 2006, only 60 products[9] on the market were able meet the "silver" and "bronze" levels (see "EPEAT Growth" graph, published by the Green Electronics Council, pg. 14).[10] Initially, no product was good enough to meet the highest "gold" level achievement when the standard first launched. The development team—of which the author was a member—intentionally crafted this topography of product scores. In June of 2007—a year

[8] See https://standards.ieee.org/develop/project/1680.1.html

[9] "History." EPEAT, Green Electronics Council, http://www.epeat.net/about-epeat/history/

[10] "EPEAT Growth 2006-2011." *Environmental Benefits of 2011 EPEAT Purchasing*, Green Electronics Council, 2012, http://www.epeat.net/wp-content/uploads/2012/11/Report2012_R6_Full.pdf

after EPEAT's registry went live—the first products were registered to the highest level of the standard. In fact, manufacturers competed amongst each other to be the first to achieve the highest level on the registry. The same year, the U.S. government mandated that 95% of computers and displays purchased by all federal agencies must be EPEAT-registered. By 2008, 1,000 products were listed on the registry.[11] By 2011, there was a "significant growth in EPEAT product registrations, with particularly rapid growth in Gold level registrations," according to EPEAT's own environmental report.[12] As of mid-July 2017, 1140 of the 1779 (or 64%) registered to the 1680.1 standard in the US were registered as gold. With of the addition of the 595 products registered as EPEAT silver, 1735 of the 1779 products (or 97%) were registered to the two highest tiers of the 1680.1 standard in the US.[13] In the imaging registry, which covers devices like printers, copiers, and fax machines—81% of the devices on the registry achieved silver or gold designations, making them preferred for government purchasing. The multifunction printer category, which contains the most products (1186 as of July 18, 2017) within the imaging registry—40% of the products (476 products) were registered as gold and 44% (525 products) were registered as silver.[14]

"Manufacturers can easily vote against policies they deem too challenging."

The success of the 1680 standard family as a de-facto purchasing requirement presents a challenge for manufacturers and purchasers alike. As new standards are released, manufacturers and purchasers need to ensure that existing products met *at least* the minimum requirements from the first day new standards are enacted. Without products that achieved either a "gold" or "silver" rating from day one, manufacturers would be unable to sell their newest products to large purchasers bound to the standard. These concerns have made manufacturers reluctant to seriously strengthen the criteria.

Standards development processes are consensus-based, so manufacturers and purchasers can vote against the strongest environmental incentives—including effective repair and reuse criteria. Reaching consensus in the standard discussion is very challenging and time consuming. One-hundred percent agreement is not necessary for consensus—though it is desired. For critical decisions, especially where criteria are to be added or removed from the standard, approval between 66% and 75% is required (consensus varies by standard organization and the phase of voting or balloting). As manufacturers often make up such a

---

[11] "History." EPEAT, Green Electronics Council, http://www.epeat.net/about-epeat/history/

[12] "EPEAT Growth 2006-2011." *Environmental Benefits of 2011 EPEAT Purchasing*, Green Electronics Council, 2012, http://www.epeat.net/wp-content/uploads/2012/11/Report2012_R6_Full.pdf

[13] Search of EPEAT's US registry for computers & displays conducted on July 18, 2017 at https://ww2.epeat.net/searchoptions.aspx (registered products shift and change over time).

[14] Search of EPEAT's US registry for imaging equipment conducted on July 18, 2017 at https://ww2.epeat.net/searchoptions.aspx (registered products shift and change over time).

New Criteria Under Consideration

While standards under development fall short in many areas, some criteria under consideration are rigorous. They include:

1. *New criteria incentivizing recycling of rare earths.*
2. *Development of substance inventories for products.*
3. *More supply chain transparency due to corporate reporting and supplier responsibility options.*
4. *Conducting Life Cycle Assessments on products.*

If passed, these criteria would help to push standards—and consequently, electronics—in a greener direction. Still, these policies are not guaranteed to make it through the ongoing development and approval process.

large portion of standards committees, they can easily vote against policies they deem too challenging and approve more lax requirements.

In late July of 2017, the first batch of phones were registered to EPEAT for the new UL 110 mobile phone standard. Of the 8 devices registered, 7 claimed EPEAT gold. LG claimed one silver product, while Samsung claimed a gold rating for Galaxy S8 line and Apple claimed gold ratings for the iPhone 7, 7 Plus, 6s, 6s Plus and SE.[15] The gold-dense scoring line-up is troubling in a standard so new. A properly-developed leadership standard should start off with devices just barely able to achieve the bronze level—as the initial computer standard did in 2006. The fact that two of the largest producers of mobile phones were immediately able to achieve gold designations for their existing products indicates that the leadership standard substantially reflects the status quo. It doesn't lead—and the new criteria isn't driving device design in a more sustainable direction.

Other non-US standards have faced similar challenges. In 2015, Europe to had to restructure its energy label rating valuations for household appliances. Previously, the energy label rated products on a scale from A+++ to D. Products disproportionately ranked in the A-range—an effect that devalued the entire standard and confused consumers. "[S]uch a positive result now makes it difficult for consumers to distinguish the best performing products: they might think that in buying an A+ class product they are buying one of the most efficient on the market, while in fact they are sometimes buying one of the least efficient ones," the European Commission reasoned.[16] As such, the commission moved to an A through G rating label to more accurately reflect which products were actually energy efficient.

In the US, efforts to strengthen standards must be approved by standards participants—and manufacturers occupy a large bloc of votes on these committees. Consistent opposition has prevented the inclusion of many criteria that are more rigorous than existing US legal requirements. Further, these standards take several years to develop and revise. The 1680

---

[15] Search of EPEAT's US registry for mobile phones conducted on August 1, 2017 at http://ww2.epeat.net/publicsearchresults.aspx?stdid=4&return=searchoptions&epeatcountryid=1 (Registered products shift and change over time.)

[16] "Making Energy Efficiency Clearer: Commission Proposes a Single 'A to G' Energy Label and a Digital Database for Products." European Commission, 15 July 2015, http://europa.eu/rapid/press-release_MEMO-15-5350_en.htm

computer standard revision is, as of 2017, in its fourth year of development. When finished, it will replace a standard that is over a decade old. No leadership standard can maintain leadership in the electronic space with that infrequent an update cycle.

Consequently, some stakeholders are concerned that a consensus-based development process can no longer produce a leadership standard. Unless the process changes, environmental standards going forward might only be able to raise the floor for product sustainability by small, incremental degrees, instead of implementing a higher bar of environmental leadership that the proliferating electronics industry so desperately needs.

The process favors industry voices

The process by which standards are developed makes it particularly difficult to craft strong, industry-shaping standards for sustainability in the electronics market. The environmental standards are "multi-stakeholder" efforts, meaning individuals representing a range of perspectives write and develop them. Ideally, a well-balanced working group would boast members with a range of viewpoints on environmental leadership in the areas of product use, design, and impact.

Each standard considered in this paper has slightly different category names for "types" of stakeholders—but they fit roughly into the following categories and will be classified as such in this report:

Manufacturers/Producers

Manufacturers of IT products covered by current and future standards used in the EPEAT program and their trade associations. Examples of standards development members that have participated in the development in standards from this category might include manufacturing companies like Apple, Lenovo, HP, Dell, Oracle, and Samsung.

Other Industry Members

Other businesses commercially engaged with the product during its lifecycle—including suppliers, recyclers, retailers and their trade associations, and others. Examples of standards development members in this category might include Intel, AT&T, SABIC (a chemical company), and The Vinyl Institute (a vinyl industry trade group).

Public Agencies/Organizations

A member representing a public agency—whether local, regional, state, federal, or international. The member may also represent professional environmental, health, or safety organizations, not-for-profit environmental organizations, or model code organizations. Examples of members in this category might include the International Campaign for Responsible Technology, Northeast Recycling Council, US Department of Energy, and the US Environmental Protection Agency.

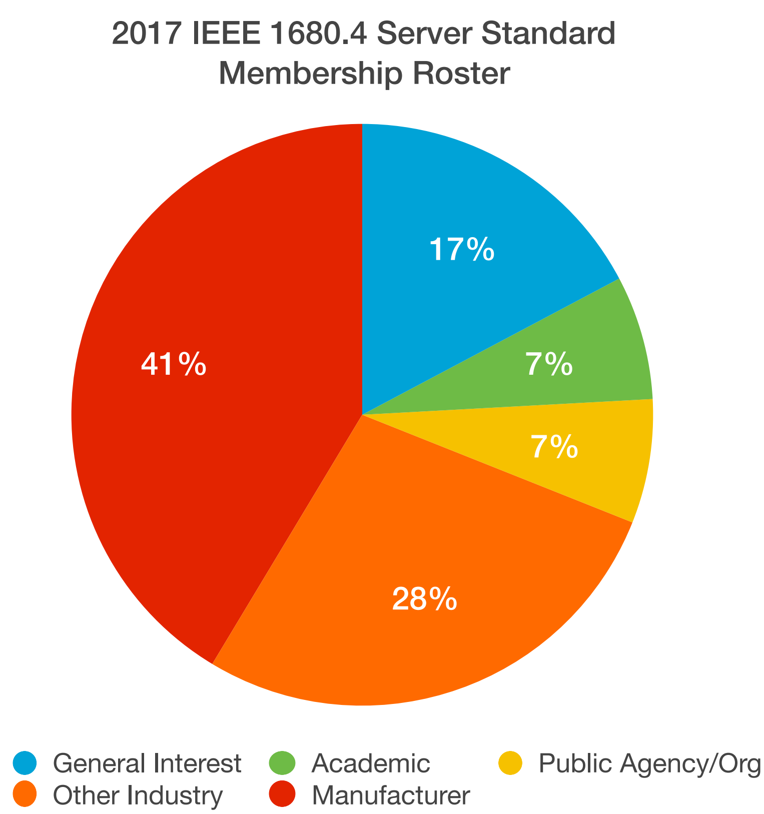
Academia

A member in this category is associated with a university, college or similar academic organization and typically has some level of expertise in electronics and/or the environment.

General Interest/Consumer/Purchaser

A member who purchases, uses, or specifies materials, products, systems, or services covered in the scope of the standard. Consumers and their trade association representatives, third-party product certifiers and testing laboratories, retailers, purchasers and standards developers are also included in this membership classification. Examples of members in this category might include the Green Electronics Council (which administers EPEAT), Green House Data, and testing lab Intertek.

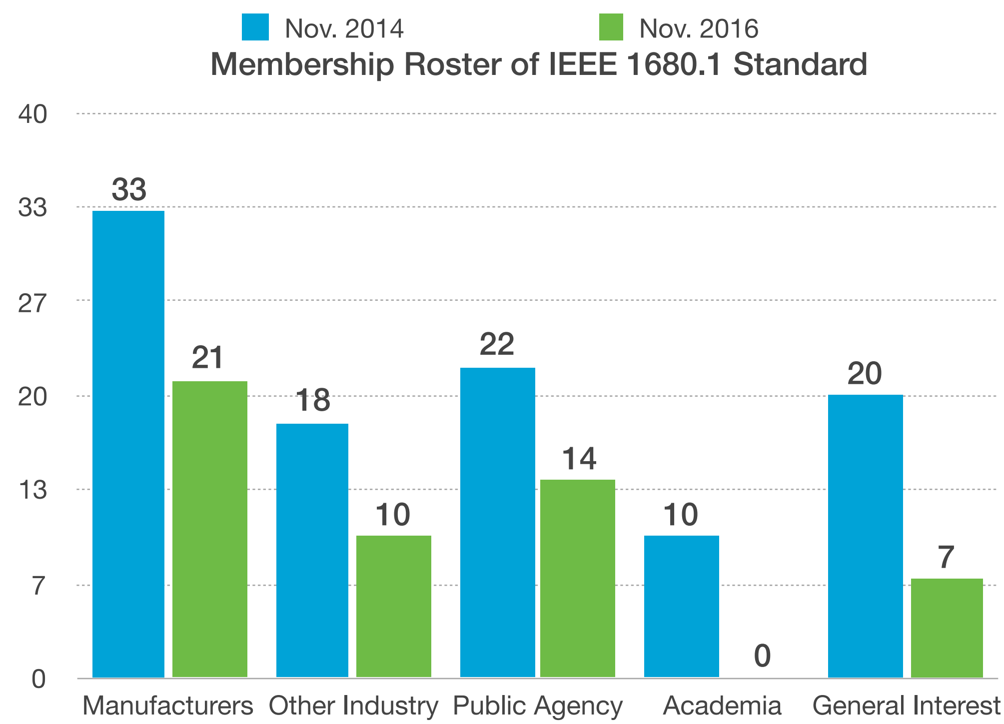
Standards groups benefit especially from vocal members representing academia, public agencies, and general interest/consumer groups—as they have little financial stake in bringing a product to market. At the moment, IEEE doesn't have any written rules governing the membership balance of these working groups, but there is a general guidance that no single category should make up more than 50% of the working group. Still, these guidelines can be skirted. Members select their own category assignments. As a result, manufacturers often list representatives in the general interest category, as well as in the manufacturer category. Unable to achieve balance, the joint NSF-IEEE server standard moved to a weighted voting system within the working group so each membership category had a fixed and equal percentage, regardless of the number of participants in each category. Unfortunately, this measure is only helpful as the standard is being crafted. The formal balloting conducted by IEEE to adopt the draft standard is non-weighted; industry members can outweigh other constituents. In order to re-balance the scales, it takes sustained, coordinated



effort from another group or groups of stakeholders.[17]

The working group for the 1680.4 server standard, for example, was heavily weighted towards manufacturers and other IT industry affiliates. Of the 29-member working group as of 2017, 12 manufacture servers and 8 are related industry representatives—including a trade group for chemical companies.[18] On the other hand, public agencies and academia numbered just 2 representatives apiece, while general interest groups had just 5 members.[19] (See "2017 IEEE 1680.4 Server Standard Membership Roster" chart, pg 18.)

The nature of the standards process also makes it very difficult to maintain a well-rounded working group. Developing standards typically takes anywhere from three to five years. That's a tremendous investment of time and energy for members that are not paid by their organization to sit at the table. Indeed, in many cases, members of the working group have to pay to participate in the form of membership or balloting fees. The cost is not significant but—in combination with the time requirements—it is enough to winnow many of the academic and NGO members away from working groups. For example, the Electronics Takeback



[17] In 2017, IEEE members banded together to voice concerns that repair and reuse criteria were not being well represented in the 1680.4 server standard. They joined the open balloting committee, and blocked the weak standard from being approved.

[18] "1680.4 Working Group." IEEE Standards Association, https://ieee-sa.imeetcentral.com/16804public/doc/WzIsMjcyNTQzMjVd/w-MemberList

[19] See Table 3 in the Additional Materials section at the end of this report for a more detailed breakdown of membership affiliation and the categories I've sorted them into.

Coalition[20]—an organization that promotes green design and responsible recycling in the electronics industry—was active in standards developments for years, but lost funding and has since stopped participating in standards.

Even working groups like NSF and UL that tried to start with balanced participation from various member categories usually end the years-long process with groups weighted towards manufacturers. A few non-governmental organizations and other general interest representatives usually see the work all the way through—but it's not enough. For example, nearly all of the electronics standards have lacked consistent representatives with expertise in reuse and repair (the UL 110 standard for mobile phones is exception to this rule). Without a supporting bloc of members to defend forward-looking criteria against the opposition of manufacturers, strong criteria tends to disappear or is weakened to the point of uselessness.

The roster of the 1680.1 standard for computers, for example, shows heavy attrition rates of academic and general interest groups over time (see "Membership Roster of the IEEE 1680.1 Standard" chart, pg 19.) At the beginning of the process, industry and "non-industry" voices (public agencies, academia, and general interest groups) were equally represented in the group, at 51 to 52 members respectively.[21] Manufacturers made up the largest single bloc with 33 participating members and 32% of the 103 total participants. By 2016, they represented 40% of the 52 participants.

Over the course of two years, the participating membership of each interest category shrunk across the board; however, the "non-industry" categories (public agencies, academia, and general interest groups) declined most significantly—from 52 to 21. Industry categories also shrunk, but less significantly—from 51 to 31. By 2016, industry groups had one-third more members influencing the results of the standard. Academic points of view—including members who perform research on how products impact society and the environment—were completely lost. This is crippling to the process, as academic voices often provide forward-looking data on where environmental leadership is most needed. Without counterpoints, manufacturers are free to develop standards that fit their needs with little guidance on the future of environmental design.

Updating standards to include repair

Given process constraints, it can be difficult to update standards to include any forward-looking criteria—but current standards have fallen especially short in the area of reuse and repair. During the development of the initial 1680 standard, repair was not included, though

[20] See http://www.electronicstakeback.com/ for more information about the Electronics Takeback Coalition.

[21] For a more extensive look at the affiliation of working group members, as well as a breakdown of the categories I've sorted them into, see Tables 4 and 5 in the Additional Materials section at the end of this report. IEEE's 2014 1680.1 working group roster can be found at https://ieee-sa.imeetcentral.com/16801public/doc/WzIsMjE2NzI0Mzdd/?rev=2

Retina MacBook Pro passes, EPEAT fails

In 2012, Apple released the MacBook Pro with Retina Display. Historically, the MacBook Pro line had been modular, repairable, and upgradeable. The 2012 Retina MacBook Pro, however, shipped with a proprietary SSD, non-upgradeable RAM, and a glued-down lithium-ion battery—choices that limit the lifespan of the laptop and make it more difficult to recycle. Yet, the laptop was still able to garner an EPEAT "Gold" rating, despite the standard's stipulation that devices be "upgradeable with commonly available tools" and that batteries should be easy and safe to remove. When criticized for the Retina's inclusion on the registry, EPEAT said that its product verification committee had determined that products were upgradeable if they had an externally accessible port—which all laptops have. The committee also declined to define what "easy and safe" meant for component removal. **The move effectively gutted the modularity criteria in the standard**—and the language re-interpretation made it much easier for products to achieve a "Gold" rating.

disassembly-by-hand and disassembly-by-shredding were addressed in the context of recycling. IEEE 1680.2 (Imaging Devices) and .3 (Televisions) followed the same course: Repair was not seriously considered by the standards development group, though it was brought up as something to consider in future work near the end of the development process.

Part of the reason that development groups did not seriously incorporate repair in early standards was because the design of electronics, at the time, did not demand it. For the most part, products were *already* repairable because they were upgradeable and modular. Repair of expensive electronics was popular practice—especially at the institutional level. The 1680.1 standard, for example, included modularity and upgradeability criteria that reflected consumer expectations in 2005.

Over time, modern designs have shifted towards less modularity and less upgradeability. Yet, many emerging products have still been judged to meet the 1680.1 modularity standards[22]—a fact that has garnered EPEAT criticism in recent years.[23] (See sidebar on the Retina MacBook Pro, pg. 21, for a more detailed explanation.)

There is a growing awareness that increasing reuse is critical to developing a more sustainable electronics industry. In 2012, a study by the German government environmental agency, UBA, determined that product lifespans for electronics are getting shorter. Their analysis found this worrying trend in a wide spectrum of products, from TV sets and large electrical appliances to small mobile phones. The environmental agency asked Öko-Institut researchers to examine why consumers were replacing electrical and electronic appliances. Researchers found that the proportion of all units

[22] "EPEAT Announces Findings in Ultrathin Notebook Investigations ." EPEAT, 12 Oct. 2012, http://www.epeat.net/ultrathin-investigation-findings/

[23] Clancy, Heather. "EPEAT Keeps Ultra-Thin Notebooks in Green Registry, despite Concerns over Recycling." ZDNet, 15 Oct. 2012, http://www.zdnet.com/article/epeat-keeps-ultra-thin-notebooks-in-green-registry-despite-concerns-over-recycling/

sold to replace defective appliances grew from 3.5% in 2004 to 8.3% in 2012, in what researchers deemed a “remarkable” increase.[24] In the United Kingdom, a study by WRAP found that nearly 25% of electronics and electrical equipment disposed of at recycling centers could have been reused with “just a small amount of repair.”[25]

Guidelines on electronics reuse by respected German engineering association VDI found that it was “absolutely necessary” to adopt policies to support the reuse of electronics.[26] Optimizing devices for reuse reduces the impact those devices have on the environment, including a tremendous potential to decrease carbon emissions. A report by McKinsey & Company and the Ellen MacArthur Foundation found that increasing the reuse and refurbishment of mobile phones to 95% could reduce the production of mobile phone by 3 million tons of CO2.[27] It is clear that reuse, repair, and refurbishment are critical to improving the overall sustainability of electronic devices.

At the same time, modern electronic designs—especially of mobile devices—increasingly eschew the possibility of repair. Most new designs include strong adhesive, non-replaceable batteries, non-upgradeable components, proprietary screws, and hard-to-open outer cases. Moreover, owners, recyclers, and refurbishers don’t have access to manufacturers’ repair and disassembly manuals for these devices—reducing the economic viability of reuse. Including reuse criteria—even as optional criteria in green standards—would reward manufacturers who are already incorporating these features into their products and incentivize other manufacturers to optimize for repair. **Just as the original IEEE 1680 standard stimulated the market for recycled plastics, new reuse/repair criteria could foster the creation of more upgradeable, repairable, and reusable products.**

"Easy-to-open outer cases and modular components make it easy for consumers and repair professionals to fix or upgrade the device."

In recent years, many advocates for reuse and repair have joined the ongoing development of green standards for additional electronic products. Through their efforts, those standards groups are actively discussing device longevity, reuse, and repair strategies.

---

[24] Prakash, Siddharth et al. *Einfluss Der Nutzungsdauer Von Produkten Auf Ihre Umweltwirkung: Schaffung Einer Informationsgrundlage Und Entwicklung Von Strategien Gegen Obsoleszenz*. Umweltbundesamt, https://www.umweltbundesamt.de/en/publikationen/einfluss-der-nutzungsdauer-von-produkten-auf-ihre-1

[25] “The Value of Re-Using Household Waste Electrical and Electronic Equipment.” WRAP, http://www.wrap.org.uk/content/value-re-using-household-waste-electrical-and-electronic-equipment

[26] Brüning, R. “The VDI 2343 Guideline Gives Recommendations For The Concerned Parties – Part ReUse.” Verein Deutscher Ingenieure, http://www.iswa.org/uploads/tx_iswaknowledgebase/Bruening.pdf

[27] *Towards the Circular Economy.* Ellen MacArthur Foundation, 2013, https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf

Recycling, reuse, and repair experts on standards boards have identified and advocated for four critical criteria—**design for recycling/repair**, **battery removability**, **public availability of disassembly information**, and **use of common tools**—to increase and enable the reuse and repair of electronics:

Design for Recycling and Repair

Devices should be designed with reuse, repair, and recycling in mind. At the very least, devices should be designed in such a way that they don't actively discourage the possibility of reuse. Easy-to-open outer cases and modular components make it easy for consumers and repair professionals to fix or upgrade the device, adding years to its lifespan. In the mobile device category, screens and batteries are two very common failure points. Making it easier to repair those two components in particular would help consumers keep the device for longer periods of time.

Devices that are designed to be taken apart are also more easily and more efficiently recycled. In order to reward these design choices, advocates have suggested that green standards include incentives for ease of disassembly.

Proposed solution in the standard: Devices should be rewarded for the use of screws, snaps, and latches in the outer case, instead of adhesives or epoxies. The screen, primary circuit board, and battery should be easily removable by a qualified service technician—without causing damage that would preclude reuse or refurbishment. Finally, the heavy use of adhesives should not prevent removal of the display assembly, outer case, glass, battery, or primary circuit board.

Battery Removability

Manufacturers typically rate the batteries of most consumer products at between 300 to 1,000 discharge and charge cycles. Electronics have the potential to last much longer than this initial limitation. Take the example of a flagship smartphone that ships with a 400-cycle rated battery. If the owner charges and discharges it 200 times (cycles) per year, then the phone will need three battery replacements to last seven years (at years two, four, and six).

Batteries that are soldered to the circuit board, sealed in, or glued down with excessive adhesive shorten the lifespan of a device to the life of the consumable battery. Device hardware has the potential to last years longer than the battery itself. Batteries that can be removed and replaced easily—either directly by the consumer or through a repair service—extend the lifespan of the device, as well as optimizing it for safe recycling.

Note7: A Case for Removable Batteries

In late 2016, Samsung faced a crisis of unprecedented scale: dozens of consumers reported that the battery of their new Galaxy Note7 was overheating or catching fire. As reports kept climbing, the company issued a recall of 2.5 million phones—ordering owners to return affected models for a phone replacement.

Unfortunately, replacement phones suffered from battery concerns of their own, and several also burst into flame. Samsung issued a complete recall of both original and replacement models of the Note7, discontinuing the line. The incident damaged their reputation as an electronics maker, violated the public's trust in the product, and cost the company billions of dollars. Had the Note7 featured an easily-replaceable battery, Samsung might have been able to avoid such staggering losses. The company could have directed consumers to remove and replace batteries.

Lithium-ion batteries also have to be removed from a device before they can be processed for recycling. Glued-in batteries make the process more difficult, ultimately compromising the overall recyclability of the device.

Integrated, glued-in batteries can also be dangerous for recyclers. Technicians run the risk of puncturing volatile batteries during removal. Batteries left inside devices can make their way into shredders and ignite.[28]

Proposed solution in the standard:
Standards language should reward products with batteries that are able to be safely and readily removed without the use of proprietary tools and without damage to the device that would preclude reuse or refurbishment. Optional points would be awarded for making removal instructions available to consumers and repair services.

Disassembly Information

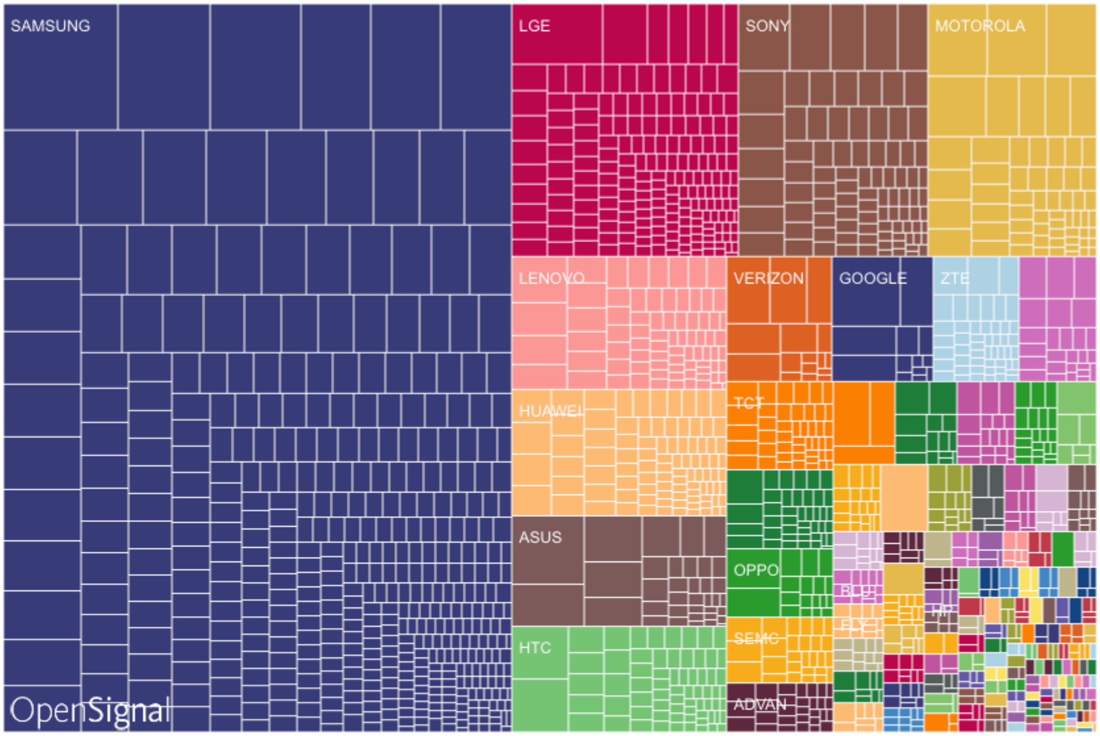
Lack of information about repair and disassembly is a major barrier to reuse for consumers, independent repair technicians, and recyclers. As OpenSignal's chart (pg. 25)[29] on Android fragmentation helps demonstrates, there are thousands of different cell phones, laptops, televisions, and other electronics on the market. Each one has a different opening process, a different internal design, and different procedures for disassembly and repair.

Most manufacturers already have disassembly information documented for their own internal warranty, repair, and refurbishment programs. Some electronics makers, like Dell, put that information online for free—so customers and repair technicians will be able to repair products (See sidebar, pg. 26, for a breakdown of which manufacturers release repair information). Other manufacturers keep repair information guarded,

[28] Anderson, Mark. "Potential Hazards at Both Ends of the Lithium-Ion Life Cycle." IEEE Spectrum, 1 Mar. 2013, http://spectrum.ieee.org/green-tech/fuel-cells/potential-hazards-at-both-ends-of-the-lithiumion-life-cycle

[29] "Android Fragmentation Visualized." OpenSignal, Aug. 2015, https://opensignal.com/reports/2015/08/android-fragmentation/

much to the detriment of both consumers and end-of-life organizations. Recyclers, for example, need access to disassembly information to safely remove components like batteries or to enable refurbishment of devices.



This chart from OpenSignal demonstrates the immense fragmentation amongst just Android-branded devices. As of 2015, OpenSignal found that the Android market had extended to over 24,000 kinds of distinct Android devices.

Proposed solution in standards: Manufacturers should be required to provide repair and disassembly information for use by service repair technicians, including step-by-step disassembly instructions with required tools, product specifications, maintenance procedures, and troubleshooting information. This documentation shall be available, at a minimum, both in HTML and IEEE 1874 “oManual” format, and licensed under the Creative Commons.

Common Tools

Standardizing disassembly tools across devices would simplify the downstream disassembly and repair process. The use of common fasteners in products—fasteners that can be removed with tools that most refurbishers, recyclers, and consumers already have at their disposal—means more products can be reused non-destructively. On the other hand, many manufacturers use proprietary or security screws, designed to keep consumers and third-party repair technicians out of devices. These non-

Public repair information available?	
amazon	N
Apple	N
ASUS	N
DELL	Y
FAIRPHONE	Y
Google	N
hp	Y
LG	N
Lenovo	Y
SAMSUNG	N
SONY	N

standard fasteners require the use of non-common tools. Apple, for example, uses a security screw known as the pentalobe screw to keep people from easily opening up devices like iPhones. Such tactics make it more difficult to repair or reuse a product.

Proposed solution in standards: Manufacturers receive optional points for the use of common fastener types and common tools for disassembly.

Manufacturers oppose leadership standards

The most vocal opposition to creating leadership environmental standards around repair/reuse has come from product manufacturers. Device-makers have consistently refused to support any design improvements that would make products easier to repair or recycle, often claiming that such mandates would “stifle innovation” or that reuse mandates would compromise "design for durability." However, when asked for supporting data—especially for device durability—they are unable or unwilling to provide it. Even moderate reuse proposals using optional points—the technique that was so successful at incentivizing post-consumer recycled materials—have been met with strident opposition.

After prolonged and contentious negotiations, members were able to include some repair/reuse-related criteria in the UL 110 standard for cell phones. The standard includes a section on End-of-Life management that includes criteria for the responsible recycling of products—as well as criteria on battery removability/replacement, ease of disassembly, repair and refurbishment, replacement parts, safe handling and erasure of user data.[30] These criteria were intended to support the enablement of phone repair; however, the language has been so heavily watered down that they, at best, reflect existing regulation (such as WEEE) or incentivize the current practices of the large OEMs.

[30] EPEAT. “UL 110 Standard for Sustainability for Mobile Phones Verification Requirements.” Green Electronics Council. http://epeat.net/documents/verification-round/UL%20110%20Verification%20Requirements%20-%20FINAL.pdf

For example, the standard includes a requirement for ease-of-disassembly. But the criterion was written in such a way that Samsung is claiming its Galaxy S8—a phone that is heavily glued together—meets the requirements set forth in the criterion.[31] Indeed, the Samsung 8 is included as a gold-level device in the EPEAT registry.[32]

The only effective, repair-focused language in UL 110 is an optional criterion that awards manufacturers extra points for batteries that can be removed without the use of tools. It is the only repair-related criterion in the UL 110 standard that incentivizes a different design. Still, one manufacturer steadfastly opposed this proposal and refused to vote for its inclusion in the standard: Apple. Ultimately, this was one of the few instances in which manufacturers broke ranks. Enough device-makers voted to have the optional criterion included in the recently published version of the standard (UL 110.03.24.17).

By and large, though, manufacturers have been able to either neuter language regarding repair or resist criteria that would lead to more repairable design for electronic products. Manufacturers have also largely declined to share their own internal repair documentation with the public, a policy that would enable more device repair in general.

Manufacturers point to several reasons for their refusal to support reuse and repair criteria for repair. The common arguments against repair are listed here:

"Providing a canonical source of best practices would increase safety while disassembling and repairing products."

Safety

“Consumers may be harmed in the process of performing a repair.”

Manufacturers often cite the possibility that making repair information public could increase the likelihood of consumer harm. Owners might injure themselves in the course of a repair, manufacturers claim, opening up the company to liability concerns. Still, the lack of available repair documentation could make it more difficult for owners and novice repairers to assess the difficulty of the repair service and more apt to injure themselves (or break their device) during a repair.

Device-makers already have and use these documents internally in their warranty repair centers. They have vetted the procedures in-house, ensuring that the instructions they provide are indeed safe. Providing a canonical source of best practices to owners would increase

---

[31] See EPEAT’s US cell phone registry for Samsung Galaxy S8 criteria display: http://ww2.epeat.net/criteriadisplay.aspx?productid=17682&epeatcountryid=1&category=11

[32] Underwriters Laboratories. “Samsung Galaxy S8 / Galaxy S8+ Become First Mobile Phones Certified to ANSI/UL 110, Standard for Sustainability for Mobile Phones,” *PR Newswire*. Jun 07, 2017. http://www.prnewswire.com/news-releases/samsung-galaxy-s8--galaxy-s8-become-first-mobile-phones-certified-to-ansiul-110-standard-for-sustainability-for-mobile-phones-300470355.html

safety while disassembling and repairing products. Moreover, this information could be used by other reuse and recycling professionals, increasing a consumer's access to repair services. Also important, information about what techniques manufacturers use to remove lithium-ion batteries safely would aid recyclers, who need to remove such components at the end of the device's life. In the absence of public information about the location and removal of integrated batteries, recyclers face increased hazards during disassembly and shredding—and fires do break out at recycling centers when batteries make their way into the shredder.

Authorized repair centers

"Our existing authorized service network provides the best customer experience."

Manufacturers have used the existence of their current service network (which they are required to operate by California law[33]) as a means of discouraging repair criteria in environmental standards—even if it is optional in the standard.

"Independent repair shops fill the gaps in service availability."

While it is true that manufacturers sometimes have repair centers, such centers are usually only located in well-populated regions. The need for repair is worldwide. Electronics, especially cell phones, are used and repaired in developing countries. Particularly in countries with high mobile technology adoption but low PC availability, mobile phones can serve as users' sole means of communication and connection to the Internet. "Indeed," reports the BBC's Rachel Nuwer, "many developing countries, especially in Africa, rely predominantly on mobile connections for accessing the internet."[34] Quick, local repair is a requirement for many people around the world.

Even in countries where authorized repair centers are located, rural populations rarely have easy access to official services. There's only one Apple Store in Alaska, for example. And the entire state of Oregon has three Apple Store locations split between just two cities.[35] Google Pixel contracts with UBreakiFix for the repair of Pixel phones—and repair services are also limited in less populated areas. There are just two official repair locations in Oregon and no locations in Alaska.[36] Independent repair shops fill the gaps in service availability, allowing consumers to fix their electronics quickly and easily.

Moreover, while factory repair service offer many repairs—they often don't offer all the services that consumers need. In 2016, Apple's iPhone 6 and 6 Plus models suffered widely from a flaw dubbed Touch Disease, where chips governing touch functionality malfunctioned. For months,

---

[33] See Ca. Civ. Code § 1793.03

[34] Nuwer, Racehl. "The Last Places on Earth without Internet." *BBC*. Feb. 14, 2014. http://www.bbc.com/future/story/20140214-the-last-places-without-internet

[35] "Apple Retail Store - Store List." Apple, https://www.apple.com/retail/storelist/

[36] Locations noted as of July 2017. For more complete list of locations, see https://www.ubreakifix.com/locations

Apple did not repair the problem, as it required specialized repairs that they couldn't do in-store. Skilled independent board-level repair specialists, however, could make repairs to the motherboard and return an owner's original phone back to working condition.

Making repair and disassembly information available to those independent repair technicians would assist them as they continue to develop innovative techniques towards reusing, repairing, and refurbishing electronics—so those devices can go onto longer, more sustainable lives. Of course, enabling independent service centers to repair more devices does mean that manufacturers would have to compete with other repair options. Still, it is the job of green standards to protect the environment, not to protect a manufacturer's profit channel. The more options consumers have to repair, the more likely these devices won't end up as e-waste.

Independent technicians lack certifications

"Only our trained technicians are competent to repair our products, and no certifications exist to verify the training of independent technicians."

Manufacturers have asserted that there is no standard certification for independent electronics repair. Encouraging third-party repair in a standard would spur on the proliferation of unqualified repair shops, they claim. This is not true; various repair "certifications" have been developed by independent organizations—such as CompTIA's A+ certification for computer maintenance, iFixit's MasterTech certification for cell phone repair, and CompTIA's Server+ certification for server maintenance.

Some independent certifications go above and beyond the level of technical depth provided by the manufacturer certification. For example, the National Service Institute for Automotive Service Excellence (ASE) has an auto repair certification for automotive techs and service technicians. To qualify for certification, techs must have years of training and experience in automotive repair.[37]

Even without a certification, independent repair businesses hire skilled technicians and train them extensively. Repair businesses themselves are continually vetted by consumers through review services such as Yelp. And Consumer Reports has found that people who use independent repair services have higher satisfaction rates than consumers who use factory repair services, which is why independently-owned auto repair shops thrive, even side-by-side with dealer repair shops.[38]

Intellectual property of service and repair information

---

[37] "About ASE." ASE, http://www.ase.com/About-ASE.aspx

[38] "Should You Repair or Replace That Product?" *Consumer Reports,* Jan. 2014, https://www.consumerreports.org/cro/magazine/2014/02/repair-or-replace/index.htm

"We invest heavily in research and development, and disclosing proprietary service documentation would enable theft of our product designs."

Manufacturers often claim that a repair requirement would require disclosure of intellectual property that would put them at a competitive disadvantage and encourage reverse engineering. Still, no service manual could ever take the place of the actual device for the purpose of reverse engineering.

Car manufacturers have been releasing service information and wiring schematics to the public for decades. Many appliance makers also regularly post service documentation, parts lists, exploded diagrams, and wiring schematics for their products. Those documents are widely used to help owners repair their devices, and not by competitors to reverse engineer washing machines. Limiting the availability of repair information does more harm to owners and recyclers than it does good to manufacturers.

"The repair information being sought is for devices that are in need of minor or cosmetic repairs. Otherwise they would end up as e-waste," says Craig Boswell, president of HOBI International, an electronics remanufacturing and recycling operation. "Recyclers understand the OEM position, but there needs to […] be recognition of the greater good created by the exchange of information, or at least contributing to the conversation in a productive manner. […] Legitimate Responsible Recycling-certified (R2) processors are not seeking information to destroy business opportunities for the OEMs. They are seeking the repair and [data] erasure information to not destroy the planet. The ultimate goal is protecting the planet, and if that is a shared goal, then it should be a common endeavor."[39]

Global consensus for repair strategies

"From [an] ecological perspective, long-life products perform better in all environmental impact categories than short-life products." - The UBA, Germany Environment Agency

Over the last two decades, many environmental experts have concluded that extended device lifespan is critical to the sustainability of electronic products.

Electronics, especially, are incredibly resource intensive to manufacture. Making a 0.07-ounce microchip uses 66 pounds of materials, including toxic chemicals such as flame retardants and chlorinated solvents.[40] Fueled by the demand for gadgets, iron ore production has increased

[39] Boswell, Craig. "HOBI International Calls For Team Effort to Extending the Life of Mobile Devices." PRWeb, HOBI International, 7 June 2016, http://www.prweb.com/releases/2016/06/prweb13467210.htm

[40] Gilson, Dave. "The Scary Truth About Your iPhone." *Mother Jones,* Mar. 2010, http://www.motherjones.com/environment/2010/03/scary-truth-about-your-iphone/

by 180%, cobalt by 165%, and lithium by 125% in roughly 10 years.[41] The longer we can use and reuse products—in their entirety—the lower their environmental impact becomes. That's especially true for electronics.

In a 2016 report on planned obsolescence, the German environmental agency Umweltbundesamt (UBA) wrote, "From [an] ecological perspective, long-life products perform better in all environmental impact categories than short-life products. The economic performance of long-life products depends largely on the difference in the purchase prices of long-life and short-life products as well as on costs for repair and upgrades required to achieve a longer usage time […] Furthermore, innovative service models of manufacturers, minimum requirements for the software, improvement of consumer information, extending the obligation to inform by manufacturers and improved reparability of the products need to be implemented at the same time."[42]

"Despite the evidence that strong environmental criteria should include reuse and repair measures, manufacturers have consistently blocked such efforts."

The European Commission has also pointed to the powerful potential of reuse incentives, especially as it relates to job creation: "Moving away from a wasteful economy towards one based on durability and reparability of products is likely to create job opportunities throughout the product lifecycle in terms of maintenance, repair, upgrade, and reuse."[43] Instead of these devices winding up in landfills, repairable devices can be cycled back into the market. Which is why increased repair and reuse are supported as "closed loop" strategies by the Ellen MacArthur Foundation and the European Union.

"The focus should be on design to reduce embodied materials; on using goods more intensively (e.g. car-pooling); on extending service lives and *repairing or upgrading used products*; and on designing products to be dismantled and the components re-used or, failing re-use, so that the materials can be separated and recycled," say environmental experts Roland Clift and Julian Allwood (emphasis added).[44]

---

[41] Sibaud, Phiippe. *Opening Pandora's Box: The New Wave of Land Grabbing by the Extractive Industries and The Devastating Impact on Earth.* Gaia Foundation, 2012, http://www.gci.org.uk/Documents/Pandora_.pdf

[42] Prakash, Siddharth et al. *Einfluss Der Nutzungsdauer Von Produkten Auf Ihre Umweltwirkung: Schaffung Einer Informationsgrundlage Und Entwicklung Von Strategien Gegen Obsoleszenz*. Umweltbundesamt, https://www.umweltbundesamt.de/en/publikationen/einfluss-der-nutzungsdauer-von-produkten-auf-ihre-1

[43] European Commission staff. "Exploiting the Employment Potential of Green Growth." 2012, http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52012SC0092

[44] Clift, Roland, and Julian Allwood. "Rethinking the Economy." Ellen MacArthur Foundation, 18 Mar. 2011, https://www.ellenmacarthurfoundation.org/news/rethinking-the-economy

Greenpeace International also agrees that increased focused on enabling reuse in the IT sector would have strong environmental benefits—and the organization is now taking a device's repairability into account for its consumer guide to buying greener electronics. In a recent report on device repairability, Greenpeace explained, "Making devices that can be repaired and made to last longer is the most significant step that brands can take to reduce the various environmental impacts associated with electronics manufacturing—from the extraction of virgin raw materials, through to the hazardous chemicals and the large amounts of energy used in manufacturing. Devices that can be easily disassembled for repair are also easier to disassemble for re-use and recycling—the next stage of a product's life—once it is no longer possible to use the whole product anymore. Components can be used again and, if not, recycled to recover the valuable raw materials."[45]

Various recycling organizations in the United States support increased focused on non-destructive reuse and repair. In 2016, the Institute of Scrap Recycling Industries (ISRI)—a trade group representing recycling organizations—asserted the need for greater reuse protections. "Reuse provides an excellent environmental and economic benefit. Despite these benefits, product manufacturers limit the ability of recyclers to legitimately reuse products; for example, by limiting parts and parts information, manuals, and utilizing digital locks that impede a product's reuse. These practices inhibit every recyclers' right to return products and goods back into the marketplace for legitimate reuse."[46]

Boswell (of recycling organization HOBI International agrees), calling the lack of available repair parts for repairable devices "a huge challenge." "OEMs limit the spare parts pipeline by imposing restrictions and limits to who can and can't buy spare parts such as glass and housings," he explained. "This creates a logjam for refurbishers trying to put devices back into the market. In some instances, the delay and lack of availability of spare parts forces the devices to be scrapped rather than be refurbished."[47]

Across the world, governmental organizations are stepping in to increase rates of repair and reuse in the name of the environment. Indeed, the European Parliament is actually working towards enshrining the tenets of reuse and repairability into public policy. Their recommendations include many of the same maxims that US advocates have recommended in environmental standards for electronics. In a 662-32 vote, the EU Parliament voted in July of

---

[45] Cobbing, Madeleine, et all. *How Repairable Is Your Mobile Device? A Product Guide to Best-Selling Smartphones, Tablets, and Laptops.* Greenpeace East Asia. June 2017. http://www.greenpeace.org/eastasia/Global/eastasia/publications/reports/toxics/2017/howrepairableisyourmobiledevice.pdf

[46] "Institute of Scrap Recycling Industries Passes Right to Reuse Policy." ISRI, 29 Jan. 2016, http://www.isri.org/news-publications/article/2016/01/29/institute-of-scrap-recycling-industries-passes-right-to-reuse-policy#.WYLZtdPyvkK

[47] Boswell, Craig. "HOBI International Calls For Team Effort to Extending the Life of Mobile Devices." PRWeb, HOBI International, 7 June 2016, http://www.prweb.com/releases/2016/06/prweb13467210.htm

2017 to promote a "longer product lifespan" for tangible goods and software.[48] EU Parliament recommendations include:

- "robust, easily repairable and good quality products"
- "member states should give incentives to produce durable and repairable products, boosting repairs and second-hand sales"
- "consumers should have the option of going to an independent repairer"
- "essential components, such as batteries and LEDs, should not be fixed into products"
- "spare parts which are indispensable for the proper and safe functioning of the goods should be made available"

The EU Commission also suggests a voluntary labeling scheme that would educate consumers as to the expected durability of their products—and would function as a purchasing guide for consumers. These principles belong in US electronics standards, as well.

Despite the evidence that strong environmental criteria should include reuse and repair measures, manufacturers have consistently blocked such efforts. This has been particularly true where the criteria would challenge current design trends.

"We need strong green electronics standards that encourage long-lasting products; the future of our planet depends on it."
– Kyle Wiens, iFixit

"Technology undoubtedly makes our lives better. But the social and environmental price of manufacturing electronics is high. If we're going to pay that price, it's critical that products last as long as possible," wrote Kyle Wiens, co-founder of iFixit and standards participant. "We need strong green electronics standards that encourage long-lasting products; the future of our planet depends on it."[49]

New activity in standard development

There have been a number of proposals to improve product lifespan in many of the standards in developed today. Below are the specific standards under development, and how repair criteria has been incorporated into those standards:

---

[48] European Parliament. *Making Consumer Products More Durable and Easier to Repair*. 4 July 2017, http://www.europarl.europa.eu/news/en/press-room/20170629IPR78633/making-consumer-products-more-durable-and-easier-to-repair

[49] Wiens, Kyle. "Greenwashing the Retina MacBook Pro." *Wired*, Conde Nast, 3 June 2017, https://www.wired.com/2012/10/apple-and-epeat-greenwashing/

Table 2: Current status of standards in development

IEEE 1680.1: Computers	The board seeking to update to 1680.1 discussed product longevity and design for End-of-Life. Proposed language included specific service information for repair and durability criteria. All durability criteria have been rejected due to lack of an agreed-upon durability standard to reference; repair enablement criteria are either optional or neutered with substantial exemptions. A list of upgradeable parts to support product longevity has been developed as an optional criterion. The standard was approved by the working group to go back through IEEE balloting.
NSF 426 / IEEE 1680.4: Servers	NSF's innovative balanced joint committee allowed reuse experts to push for criteria that enables third-party repair and information sharing. While manufacturers were still reticent to share information, reasonable compromises were reached. Since two standards were developed independently, there was an effort to merge the two. Unfortunately, during the merger with IEEE 1680.4, the task group sided with the manufacturers and criteria were put forward with very limited reuse and repairing enablement. However, during balloting, the IEEE standard failed to achieve approval—in part due to negative votes by members supporting repair and reuse. NSF 426, in a separate ballot, was approved—which will result in the publication of the standard as an NSF-only standard in August or September 2017.

UL 110: Mobile phones	Stakeholders negotiated multi-option criteria to enable repair and repairable design. Multiple manufacturers argued against the approach, maintaining that UL 110 should not impose a design-limiting factor on their products. They also argued against enabling independent repair services, pointing to their own authorized repair services as sufficient. After prolonged negotiations, a criterion requiring batteries to be replaceable by authorized service centers and an optional criterion for the information on how the public can replace batteries was included. An optional criterion for user-replaceable batteries without the use of tools was also included. Over manufacturer objections, a revised standard with essentially no changes to the repair criteria was balloted and approved in early 2017. The finalized standard was published in March 2017 and is listed as a standard for use in the EPEAT registry as of July 2017.
IEEE 1680.6: Set-top boxes	Service information for enabling repair and recycling has been approved by the working group. Standard approved by the working group and is going through mandatory IEEE editing prior to being balloted.

Conclusion

After half a decade of extensive engagement from the reuse community and environmental experts, green standards have demonstrated an inability to substantially evolve. These standards need to incorporate more requirements and optional requirements for reuse: for removable batteries, for modular design, for common tools, for information sharing.

Unweighted standards developments organizations will always bias heavily in favor of manufacturing groups. Such biased groups are fundamentally incapable of pushing green standards forward. Manufacturers tend to vote in favor of their corporate interests, which are often at odds with environmental interests. Moreover, because these standards groups require a heavy investment of time, manufacturers are often the only players in the room with enough resources to dedicate representatives to the process in its entirety—giving them yet another advantage in the development process. While promising attempts at balanced standards have been made at NSF, manufacturers have substantially throttled the green electronics standards process.

With manufacturers standing in the way, it takes years to pass even weak standards. There is little room for negotiation and scant opportunity for progress. It's time for oversight groups or regulatory bodies to step in and re-craft the development process. No single group should be able to control voting and water down the standards. Academics, environmental experts, NGOs, and other advocacy groups unconnected to manufacturers need to have a stronger, consistent, coordinated voice in crafting environmental standards for electronic devices—even if that means abandoning the current unweighted consensus-based model. Because without rigorous criteria, green electronics standards aren't standards at all. They don't lead and they don't drive environmental progress.

Instead, they have become a complicated way for manufacturers to greenwash products that have a devastating environmental impact and pat themselves on the back for business as usual.

Problem	Proposed solution
Electronics standards aren't driving environmental progress anymore.	Use an **expedited development** process to create **challenging, inspiring, research-backed criteria**—such as design for repair and disassembly.
Standards boards have become bloated with manufacturers' representatives.	Regulatory bodies should **balance the representation** of standards boards (similar to NSF's approach), to avoid a process that can be commandeered by manufacturers' representatives.

Problem	Proposed solution
Manufacturers resist repair criteria because of misconceptions about the dangers of electronics repair and the global reach of authorized service centers.	Members of standards boards should know that consumer repair and unauthorized repair centers are **far less dangerous** than they assume, and that many populations around the world have little or no access to manufacturer-authorized service centers.
There is not enough engagement—both in time and in numbers—by the community of recyclers, remanufacturers, and refurbishers during the development of the standards.	The standards boards need to have more **diverse representation**, in numbers, by recyclers and refurbishers—so that those points of view and concerns are included during the development of the standard. Substantial and consistent commitment of time and knowledge is needed to offset manufacturers' input. An NSF-style approach guarantees balanced participation.
The recycling/repair/refurbisher (3R) community is not unified enough to push back against manufacturers on the standards boards.	The 3R community needs to **get organized** by developing working groups within their key associations (Repair.org, ISRI) that identify the concerns of the community and develop potential solutions. **Developing a set of both short and long-term strategies, principles and goals** before engaging with standards is necessary for success.

Additional Materials

Table 3: 1680.4 Membership Roster - 2017

Member Affiliation	Manufacturer	Other Industry	Public Agency	Academia	General Interest
AMD		✓			
American Chemistry Council		✓			
Apple		✓			
bit-com					✓
Chemtura		✓			
Cisco	✓				
Cisco Systems	✓				
Dell	✓				
ECD Compliance					✓
Fujitsu	✓				
Hitachi	✓				
HPE	✓				
IBM	✓				
ICF International			✓		
Intel		✓			
ITIC	✓				
Lenovo	✓				
Lenovo	✓				
Lenovo	✓				
Microsoft		✓			
MRIGlobal					✓
NYAS / IEEE					✓
Oracle	✓				
Rochester Institute of Technology				✓	
SABIC		✓			

Member Affiliation	Manufacturer	Other Industry	Public Agency	Academia	General Interest
Schaffer Environmental LLC					✓
Strategy Advisory on behalf of DOE			✓		
The Vinyl Institute		✓			
Universidad Autonoma de Nuevo Leon				✓	
Total	**12**	**8**	**2**	**2**	**5**

* Member affiliations listed multiple times indicate that the same organization has more than one member on the working group.

Table 4: IEEE 1680.1 Roster - 2014

Member Affiliation	Manufacturer	Other Industry	Public Agency	Academia	General Interest
Aarhus University, Denmark				✓	
AMD		✓			
American Chemistry Council (ACC)		✓			
American Chemistry Council (ACC)		✓			
Apple	✓				
Apple	✓				
Apple, Inc	✓				
Apple, Inc.	✓				
Argonne National Laboratory					✓
Bait al qayyum national school, Saudi Arabia				✓	
Barnes and Noble					✓
Blackberry		✓			
Blackberry		✓			
California CalRecycle			✓		
Carnegie Mellon University				✓	
Chemtura		✓			
Cisco		✓			

Member Affiliation	Manufacturer	Other Industry	Public Agency	Academia	General Interest
CS SAB					√
CSR			√		
DEFRA			√		
Dell	√				
Dell	√				
Dell, Inc.	√				
Dell, Inc.	√				
Dell, Inc.	√				
Dept of Computer Science, Georgia State Univ.				√	
DOE			√		
ECD Compliance					√
Ecospan					√
Egyptian Space Program National Authority for Remote Sensing and Space Sciences					√
Electronic Recyclers International		√			
Environmental Defense Fund (EDF)			√		
EPA			√		
EPA			√		
EPA			√		
EPA			√		
EPA Pollution Control DC			√		
EPA Region 9 Pollution Control SF			√		
Fujitsu	√				
Fujitsu	√				
Fujitsu	√				
Fujitsu	√				
Fujitsu	√				

Member Affiliation	Manufacturer	Other Industry	Public Agency	Academia	General Interest
Ghana Technology University College				✓	
Green Electronics Council					✓
HP	✓				
HP	✓				
HP	✓				
HP	✓				
IEEE					✓
IEEE					✓
IEEE CS					✓
IEEE-SA					✓
IEEE/CA/SAP					✓
Instituto Costarricense de Electricidad (ICE) / Government TELCO & Energy Company			✓		
Intel		✓			
Intel		✓			
Intel		✓			
IPC - Association connecting electronics industries		✓			
ITIC	✓				
Lenovo	✓				
Lenovo	✓				
Lenovo	✓				
Lexmark		✓			
LG Electronics	✓				
LG Electronics	✓				
Lockheed Martin					✓
Lockheed Martin Technical Operations, Systems Administrator					✓
Microsoft Corporation	✓				

Member Affiliation	Manufacturer	Other Industry	Public Agency	Academia	General Interest
Microsoft Corporation	✓				
NIST			✓		
Northeast Recycling Council			✓		
Oracle America, Inc.		✓			
Panasonic - PSCNA	✓				
Panasonic Corporation of North America	✓				
PhD student at the Faculty of Engineering, University of Porto, Portugal				✓	
Purdue University				✓	
QD Vision					✓
SABIC - Global Agency Relations		✓			
Samsung	✓				
Schaffer Environmental LLC					✓
Sony Electronics	✓				
Sony Electronics	✓				
The City of Santa Maria					✓
The Nature Conservancy			✓		
The University of Manchester				✓	
The Vinyl Institute, Inc		✓			
Toshiba	✓				
Toshiba America	✓				
UL LLC, Environment					✓
Unaffiliated					✓
University of California, Irvine				✓	
University of Maryland University College				✓	
Upward Arrow DBA EraseMyLaptop		✓			
US Air Force					✓

Member Affiliation	Manufacturer	Other Industry	Public Agency	Academia	General Interest
US Department of Energy			✓		
US Department of Energy			✓		
US Department of Energy			✓		
US Department of Energy			✓		
US EPA			✓		
US EPA			✓		
US Government GSA			✓		
Wistron Greentech (subsidiary of Wistron Corp		✓			
Total	**33**	**18**	**22**	**10**	**20**

* Member affiliations listed multiple times indicate that the same organization has more than one member on the working group.

Table 5: IEEE 1680.1 Roster - 2016

Member Affiliation	Manufacturer	Other Industry	Public Agency	Academia	General Interest
Acer America	✓				
AMD		✓			
American Chemistry Council (ACC)		✓			
Apple	✓				
Apple, Inc.	✓				
California CalRecycle			✓		
Chemtura		✓			
Dell	✓				
Dell, Inc.	✓				
Department of Labor					✓
DOE			✓		
ECD Compliance					✓

Member Affiliation	Manufacturer	Other Industry	Public Agency	Academia	General Interest
EPA			✓		
EPA			✓		
EPA			✓		
EPA			✓		
EPA Region 9 Pollution Control SF			✓		
Fujitsu	✓				
Green Electronics Council					✓
Green Electronics Council					✓
HP	✓				
HP	✓				
HP	✓				
HP	✓				
Intel		✓			
Internatinoal campaign for responsible technology		✓			
ITIC	✓				
Lenovo	✓				
Lenovo	✓				
Lexmark		✓			
LG Electronics	✓				
Materion		✓			
Microsoft Corporation	✓				
Microsoft Corporation	✓				
NIST			✓		
Northeast Recycling Council			✓		
Panasonic - PSCNA	✓				
Panasonic Corporation of North America	✓				
SABIC - Global Agency Relations		✓			

Member Affiliation	Manufacturer	Other Industry	Public Agency	Academia	General Interest
Samsung	✓				
Samsung	✓				
Schaffer Environmental					✓
Schaffer Environmental LLC					✓
Sony Electronics	✓				
The Vinyl Institute		✓			
The Vinyl Institute, Inc		✓			
UL LLC, Environment					✓
US Department of Energy			✓		
US Department of Energy			✓		
US Department of Energy			✓		
US EPA			✓		
US Government GSA			✓		
Total	**21**	**10**	**14**	**0**	**7**

* Member affiliations listed multiple times indicate that the same organization has more than one member on the working group.