ENSURING SUSTAINABLE PRODUCTION RESOURCES AND REDUCING E-WASTE

Networked Solutions for the Electronics Industry

As technology advances, the consumer electronics industry struggles to manage ever-increasing volumes of electronic waste. Personal electronics have become integral to the daily lives of individuals around the world, and e-waste is now the most rapidly growing stream of waste globally.

At the same time, the industry faces supply-side challenges, including cost and availability of raw materials to produce personal electronic devices, and the hazards and toxicity of extraction techniques. Policy makers, civil society, and the industry itself have been working to address these increasingly onerous production issues.

Multi-stakeholder global solutions networks offer a new approach with the potential to overcome the persistent obstacles to managing hazardous production and toxic waste. Networked models could be key to solving these global problems, engaging multiple stakeholders to create the norms, policies, innovations, and governance needed to generate lasting change in the personal electronics industry.

GLOBAL SOLUTION NETWORKS

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Idea in Brief

The increasing demand for new electronic devices and discarding of outmoded devices has created serious consequences that threaten the environment and human health. The dual challenge of ensuring that the production of electronic devices is safe and cost-effective and also reducing the impact of discarded electronics (e-waste) has been on the agenda of policy makers and industry leaders for almost two decades yet persistent problems remain, including:

- Continued use of toxic materials in production.
- Prioritization of design over reparability and recyclability.
- Limited capacity to collect, repair, reuse, and recycle devices.
- Increasing volume of e-waste in the refuse stream.
- Illegal flow of e-waste from developed to developing countries.
- Hazardous methods for disassembly of discarded products.

Sustainability is defined as the ability to "meet the needs of the present without compromising the ability of future generations to meet their own needs."[1] This includes environmental, economic, and human needs. A sustainable industry must have respect for its labor force and for the environmental resources required for production. It looks for improvements to the social and environmental contexts of production, aims for the least possible impact on human health and the environment, and is circular in its ability to capture recycled resources for future production.

Some operators in the electronics industry are working effectively toward this ideal. The more advanced operators in the refurbishing category rely on both recyclers and manufacturers to optimize their output, and scrap material generated by recycling and repair operations are processed at highly specialized recovery centers. However many electronic devices, particularly smaller devices, frequently wind up at the end-of-life in regular trash or generic rather than an optimized recycling system where efforts are fragmented and there are poor connections between the functions. Carole Mars of The Sustainability Consortium explains:

> Each little area knows its business very well; it's that these areas are not talking to each other. Recyclers are not necessarily talking to the refurbishers, who are not talking to the manufacturers, who are not talking to the state. Each node is fairly isolated right now. So it's now a question of looking at how we start communicating across those nodes.[2]

A networked approach could be key to solving this problem, one that engages multiple stakeholders to create the norms, policies, innovation, and public awareness required to generate lasting change for small consumer electronic devices. The optimized economic value that refurbishers are able to realize by working with the manufacturers of larger devices could be extended throughout the electronics industry.

Effective examples of this type of problem solving have emerged in recent years in response to major global problems from climate change to inequality, human rights to urbanization. Dynamic, self-organized, and collaborative problem-solving initiatives—global solution networks (GSNs)—represent a new paradigm in global affairs. GSNs move beyond traditional state-based solutions and offer significant promise for strengthening global cooperation. In the context of ensuring that the electronics industry can safely sustain both raw material supplies and end-of-life disposal and material recycling, there are numerous groups engaged—including stakeholders from civil society, private sector, and state-based initiatives—but the problems persist.

Organizations such as The Sustainability Consortium are working to ensure resource sustainability by introducing positive practices in electronics production and consumer behavior. Groups such as Solving the e-Waste Problem (StEP), the e-Stewards certification body and the Basel Action Network are championing new policy approaches and innovative systems that better manage electronic waste. These initiatives, while not without challenges, represent some of the most promising approaches to resource sustainability and zero waste for the electronics industry and they demonstrate that although these issues are considerable, they are not insurmountable. To move forward and have greater impact, the GSN model of multi-stakeholder engagement in a self-organizing entity that leverages the power of the digital revolution may allow these organizations to amplify their efforts and address the problems that continue to obstruct progress.

Defining the Problems: Unsustainable Production and E-Waste

The modern digital era depends on widespread access to electronic devices. In 2014, it was estimated that 1.895 billion mobile phones were sold worldwide.[3] In 2013, it was reported by the Consumer Electronics Association (CEA) that the personal electronics industry posted record sales—even amidst a struggling global economy—with over 105 million tablets and 111 million smartphones sold in the US alone. Growth for the industry has been tremendous in developing countries and emerging markets as well: Gallup estimated in 2013 that 65% of households in 23 sub-Saharan African countries had at least one mobile phone. Gallup further reported a median

growth rate in phone ownership of 27% in the five years since 2008.[4] The Chinese spent over $87 billion on mobile phones in 2014, a 15% increase over the previous year.[5] Personal electronics have become integral to daily lives around the world, regardless of age, socio-economic status, or political or religious affiliation.

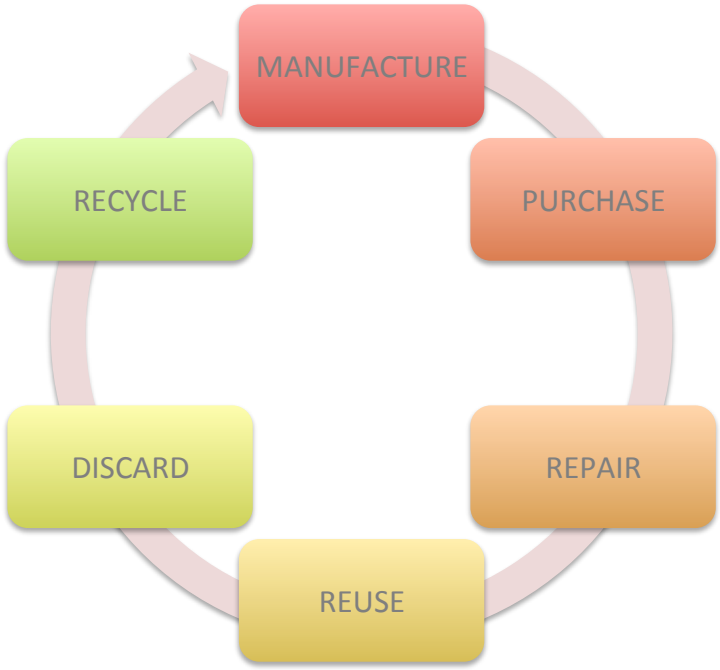
This rapid growth in adoption of electronic devices is putting significant strain on recycling capacity. E-waste is now the most rapidly growing stream of waste globally[6]—largely due to the increase in individual ownership of multiple personal electronics, combined with rapid obsolescence created by technological advancement. According to StEP, 48.9 million tons of e-waste were produced globally in 2013 and this number is expected to increase to 65.4 million tons by 2017 (equivalent to the weight of 200 Empire State Buildings or 11 Great Pyramids of Giza).[7]

Ineffective management of this waste stream has had a number of perverse outcomes including the exhaustion of valuable materials, human rights abuses, and environmental degradation. The United Nations Industrial Development Organization (UNIDO) website describes the current e-waste situation as a "ticking time-bomb."[8] Smail Alhilali, an Industrial Development Officer for UNIDO, states that this issue is "of increasing concern in developing countries due to the dramatic increase in e-waste, the lack of infrastructure and an overall lack of knowledge and awareness about the matter."[9] Successful resolutions of these issues will require the collaboration and cooperation of numerous stakeholders.

Coltan Mine in Rubaya

Electronics: From Conceptualization to E-Waste

In an ideal world, electronic devices would be designed with sustainability in mind. They would be both purchased and discarded conscientiously by their primary consumers, repaired and reused by consumers in the second-hand market, and finally proceed to recycling where their components would be broken down and prepared for reuse in production.



Global society is far from achieving this ideal. In fact even the producers of "green" devices are able to focus on only one or two of the points on the sustainability continuum. Design optimization could easily address toxin reduction, ease-of-repair, ease of materials recovery, reduced energy use, etc. But at the present time there is no holistic approach to these issues.

Production and Consumption

The way a product is designed and produced has significant implications for its safety, repairability, and recyclability down the line. It is important to ensure that electronic devices are conceptualized with both the use of sustainable resources and with end-of-life management in mind.

Two examples of legislation that curbed the use of toxic and unethical materials in consumer electronics are Europe's Restriction of Hazardous Substances Directive (RoHS) and the Registration, Evaluation, Authorization

and Restriction of Chemicals (REACH) legislation. RoHS banned the use of six[10] toxic substances from use in consumer goods and, according to Carole Mars of The Sustainability Consortium (TSC), "[RoHS… has really transformed how industry has had to work, because it was the first time that industry had to find out what was in their products."[11] REACH came into force in 2007 and maintains a growing list of 'Substances of Very High Concern' that are restricted in their use for consumer products and RoHS has instituted a 2019 ban on certain phthalates.[12]

Nevertheless, potentially carcinogenic compounds, such as brominated flame-retardants, are still found in many electronic devices, predominantly in the plastic casings of computers, keyboards, and mice.[13] Furthermore, although some manufacturers have been increasing the amount of recycled plastics in their devices, the percentage of use is still very low and there has been little experimentation with biodegradable or other alternative materials. The "green" electronics that have been introduced present consumers with a trade-off: sustainable and ethical materials being used in manufacturing, but delivered at a higher price and with reduced functionality. According to Allison Schumacher of CEA, while some manufacturers have found a niche group of customers for green devices, the majority of consumers have not embraced these products.

Price often trumps all other attributes and the definition of "green" remains unclear. In fact, a recent report by TerraChoice on the "Seven Sins of Greenwashing" shows that companies will misrepresent their products as "green" in order to sway customers who are motivated to purchase products that are more benign to humans and to the planet.[14] The pursuit of advanced design and powerful functionality continues without significant consideration of how these new devices might be repaired or recycled in the future. Continuous consumption is key to profitability for any consumer goods business, and the electronics industry is no exception as it employs a powerful marketing machine focused on convincing customers to buy new devices. The rapid pace of innovation renders technologies obsolete faster than ever before. It could be argued that sustainable electronics production will never be assured until a collective solution is found to meet consumer demand while also reducing the volume of new devices produced.[15]

Repair and Reuse Markets

Consensus on the value of repairing electronic devices and the creation of a second-hand market for reuse of electronic devices is a significant, yet often unexplored, opportunity for increasing resource sustainability in the industry. Enabling easy repair of electronic devices or creating an easy-to-use repair system through the manufacturer can greatly extend the lifecycle of a device.[16] Building longevity into the design and production of electronic devices—perhaps by giving consumers opportunities to upgrade software or to replace batteries as needed—allows the useful life of a device to be greatly extended. However, the current legal strictures surrounding intellectual property and manufacturer liability impede innovation in this area. In fact,

life cycle assessment methodologies currently do not account for reduced impacts associated with extended useful life. Indeed, for electronics where the use phase is often where the largest impacts are felt, increasing the useful life by current methodologies actually increases the overall product environmental impact.

Consumers who want to repair a device face an uphill battle. The ability of consumers or local technicians to repair devices is stymied by design and by legislation. Toshiba, concerned about the issues of corporate liability, forced the takedown of a website operated by a local laptop repairman that provided free repair manuals online. Although this action may protect the company from liability risks, Toshiba faced significant criticism.[17] Repairs often require returning a device to the manufacturer, leaving the consumer without connectivity. This makes upgrade to a new device very attractive. Policy reform aimed at limiting corporate liability for unauthorized and/or inexpert repairs would allow for greater sustainability in electronic products. In addition, repair routings used to optimize repair yields are the intellectual property of the third party repair vendors. This means that OEMs and brand owners don't always possess the best information about effective repairs for their products. Also, since the largest category of failure for electronics is typically "NTF" (no trouble found), diagnostics is key to longevity.

Reuse may be more straightforward to establish: consumers recognize that if their device is still functional it can be resold and some of its value recaptured. Alternatively, many NGOs call for old devices to be donated so that they can be transferred, refurbished and reused in developing countries—a major step toward reducing the global digital divide.[18] However, limited access to repair guides and knowledge about which components are interchangeable across brands means that there are many devices that cannot be refurbished or reused.[19] The emerging reality is that products are moving globally, but information on how to repair them isn't following,[20] making it extremely difficult to modify production while still meeting demand. Liability and intellectual property issues are significant barriers to innovative solutions for these problems, but barriers that could be surmounted using thoughtful and collaborative policy development.

Collection

Once options for repair and reuse are exhausted, a device enters the waste stream and optimally the recycling stream. The entire forward supply chain of personal electronics is dependent on the initial collection system and therefore it is imperative these services be socially acceptable and frictionless—as well as financially viable.[21]

In 1998, Switzerland was the first country to pass legislation aimed at establishing the electronics industry's responsibility for e-waste, creating a formal domestic e-waste management system.[22] E-waste legislation and management systems subsequently spread throughout Europe and culminated in 2002 with the European Union's Waste Electrical and

Electronic Equipment Directive (WEEE).[23] The directive mandates that electronics manufacturers design products in a way that facilitates ease of recycling, that they set up mechanisms for the recovery of their products, and that they finance collection and recycling systems. The directive has gone through a number of revisions and was recast in 2012 to include greater enforcement mechanisms and penalties for non-compliance.

The new directive sets specific targets for e-waste collection. Member states are expected to increase their capacity to collect e-waste to 45% of electronic equipment sold per year by 2016 and 65% by 2019.[24] Although Europe has been a leader in e-waste collection and recycling, in 2012 it was estimated by the European Commission that, out of 10 million tons of e-waste generated in the region each year, only 2 million tons were being collected.[25] The current version of the directive aims to scale up e-waste collection to recover 85% of the e-waste generated in Europe by 2020.

The situation is similar in North America where private-sector systems are predominant and where the development of e-waste regulation and systems has been on a state-by-state, or province-by-province, basis. The US Environmental Protection Agency estimated that in 2009 only 38% of computers, 17% of televisions, and 8% of cellphones discarded in the US were collected for recycling—the rest presumably being either reused, put in a drawer, or sent to regular landfills.[26] Those individuals who wish to take advantage of electronics collection and recycling are often put off by the cumbersome nature of delivering their electronics to collection sites. There is also the legitimate concern that discarding personal electronics puts the data they contain at risk.[27] For this reason, many private e-waste collectors must also offer data-erasing and/or physical destruction services that greatly add to the cost of recycling and limit the ability of the industry to recapture resources. Furthermore, the fractured nature of legislation that regulates the collection and management of e-waste across regions creates a significant compliance burden for those effective collection and recycling operations trying to increase their scale.[28] In developed countries, high wages and low demand for used electronics imply that electronics collection and recycling runs a net cost.[29] As a result, public and private e-waste collectors and recyclers find it very difficult to run a profitable system without cutting corners.

The US has no national legislation regarding producer responsibility for e-waste collection. As stated by the EPA, “there have been numerous attempts to develop a federal law. However, to date, there is no consensus on a federal approach.”[30] That being said, 26 states* have passed regulations on e-waste collection.[31] While this is certainly progress, the Consumer Electronic Association’s Allison Schumacher says that a national approach would still be preferred in order to reduce the now severe compliance burden in the US presented by having to deal with 26 different state laws, registrations, fees, reporting requirements and duplicative administrative bureaucracies. She states further that, overall, “a lot of money is just going to administrative

* Arkansas, California, Colorado, Connecticut, Georgia, Hawaii, Illinois, Indiana, Iowa, Kentucky, Louisiana, Massachusetts, Maine, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Oklahoma, Oregon, Pennsylvania, Rhode Island, Santa Clara, South Carolina, Texas, Utah, Vermont, Virginia, Washington, West Virginia, and Wisconsin.

overhead and to agencies that may or may not have adequate expertise to provide sufficient oversight. [CEA] would prefer to see this compliance burden reduced through harmonization and for the bulk of administrative overhead money to go towards actual recycling."[32]

A WEEE (Waste Electrical and Electronic Equipment) processing plant

Recycling

Electronic devices are composed of thousands of different substances and materials,[33] but there are only a few dozen that make up the major proportion of any device. These include common materials that are relatively easy to recycle such as plastic, steel, aluminum, and tin. They also include rare metals such as gold and silver. These materials can be recovered and recycled to serve as a source of secondary raw materials, reducing pressure on scarce natural resources, as well as minimizing the overall environmental footprint of the industry.[34]

Personal electronics also contain hazardous materials that should be kept out of landfills where they may leach into the ecosystem. Establishing the systems, including facilities that are able to break down personal electronics into separate streams of recyclables and also safely deal with toxins, is complicated.[35] The increasing volume of e-waste overwhelms existing capacity.

Limited and high cost domestic recycling systems have created incentives for the export of e-waste from developed countries to developing countries.[36] Nigeria, India, and China process billions of tons of e-waste every year.[37] Guiyu, China, a small collection of islands in the South China Sea, is the largest e-waste site in the world, with an estimated 150,000 workers processing more than one hundred truckloads each day.[38] In Delhi, India, it is estimated that more than 10,000 people, including children, work in

the informal e-waste recycling industry.[39] These centers of disassembly contribute to a multi-billion dollar global e-waste recovery and recycling industry, expected to be worth $20.25 billion by 2016.[40]

E-waste primarily flows from industrialized countries to developing countries.

The workers, however, receive little compensation and use dangerous methods of disassembly that expose them to hazardous toxins. In order to disassemble electronic devices, workers smash them and burn the wires and plastic casings in order to recover precious metals. The smoke is contaminated with flame-retardants and other chemicals.[41] They use cyanide and acid baths to extract copper and then dump those liquids, allowing them to leach into the water system.[42] Workers cook circuit boards on wood-fired skillets to loosen lead and tin soldering.[43] They are often unaware of the health and environmental risks of their work, and are not in a position to demand improved health and environmental safety measures.[44] NGOs and scientists have documented the health and environmental consequences of this system, and found that e-waste workers suffer from increased levels of brain damage, allergies, and cancer.[45]

Lax environmental and human protection mechanisms in developing countries allow electronics recycling to be run at a profit by those willing to turn a blind eye to social and environmental impacts of this practice.[46] Some have argued that, if the system could be legalized and formalized, e-waste would offer a valuable opportunity to stimulate economic development in these countries.[47] While the current informal systems of e-waste management in developing countries do generate some income, they do not maximize potential profit and they certainly do not contribute to tax or social welfare structures.[48] Jim Puckett of the Basel Action Network expressed his concern about the exploitative nature of the process, stating:

"The idea that people can use hazardous waste as a way to grow their economy is just, very insidious."[49]

A worker in Guiyu, China disassembles electronics. ©EPA/MICHAEL REYNOLDS

International Efforts Have Stalled

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was signed in 1989 and came into force in 1992.[50] Some of the common elements used in electronic devices are included in Annex VIII of the convention, which restricts the transboundary movement of substances such as lead, mercury, and arsenic.[51] One hundred eighty-one nation states have since become party to the Basel Convention.[52] The Convention was strengthened in 1995 when it was modified to include what is called the "Ban Amendment." The Ban Amendment explicitly prohibits the export of hazardous waste from 30 of the wealthiest OECD countries to non-OECD countries, even for the purpose of recycling.[53]

Implementation of the Ban has been stalled and it has been fiercely opposed by a number of industrial parties to the Convention including Canada and Australia.[54] It was decided in 2011 that the Ban Amendment would enter into force when 68 of the 90 countries that were party to the Convention in 1995 ratified the amendment. There are 13 more ratifications

required, and the best that can be expected is that the Ban Amendment would come into force in 2017.[55]

Although the US signed the initial convention in 1990, it has not ratified the Convention or the Ban. In 2013, US Representative Gene Green introduced the Responsible Electronics Recycling Act to the US Congress. The act was meant to bring the US into alignment with the Basel Ban by prohibiting the export of e-waste from the US to non-OECD countries.[56] The resulting domestic electronics recycling system was predicted to create 42,000 jobs in the US with over $1 billion in payroll earnings.[57] However, the bill was referred to committee and has not moved forward at the time of writing. While the spirit of the Basel Convention is admirable, lower labor costs overseas would help expedite recovery operations that have already proven the concept while offering recovered feedstock to regional manufacturing operations. Designing for sustainability is a much more difficult goal to achieve, and removing a few key impediments to facilitating material recovery would allow significant circularity to the supply chain.

With no limiting legislation, the US remains one of the world's largest producers and exporters of e-waste.[58] Studies have estimated that the amount of e-waste being shipped overseas from the US ranges from 8.5%[59] of collected e-waste to 50-80% of collected e-waste.[60] This enormous variance in estimated quantities points to a major lack of knowledge and data on the subject. The lower estimate of 8.5% was produced in 2013 by StEP. At the time, they cited significant difficulty in determining the quantity of e-waste exported due to "limited mechanisms for data collection, undifferentiated trade codes, lack of consistent definitions for categorizing and labeling used electronics as well as their components, minimal regulatory oversight, and limited agreement on definitions of end uses (i.e., reuse vs. recycling)." These issues point to a significant gap between ideals and implementation.[61]

Developing countries are beginning to work with international partners, including other governments, e-waste producers, importers, recyclers, and NGOs, to improve their domestic e-waste recycling industries.[62] Pressure is also mounting for a renegotiation of the Basel Ban due to the fact that it is ultimately the emerging markets, particularly China, that are the major manufacturers of electronic devices and therefore the most likely users of recycled materials.[63]

As global society is increasingly technology-based, significant action is required in order to ensure that the next generation is able to enjoy both improved technology and a sustainable environment. As new stakeholders engage in the problem, innovative design and business practices are evolving that offer the potential to ensure future products are able to meet market expectations, while protecting the environment and the industry workers.

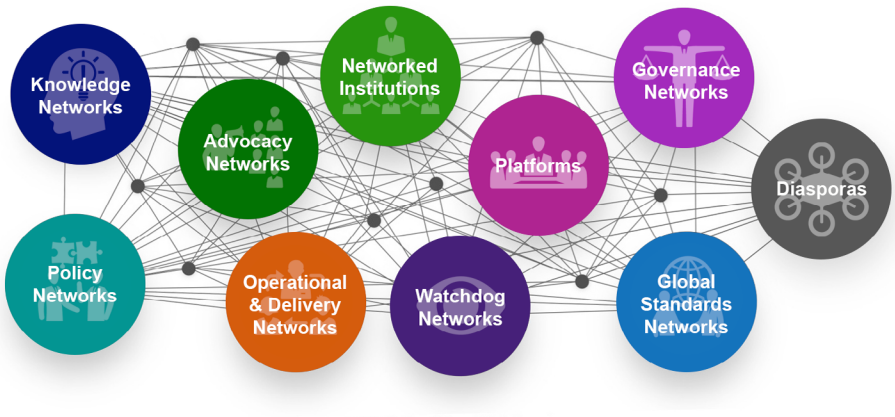
The Potential of Global Solution Networks

While daunting, these issues present a significant opportunity for global problem solving from a network perspective. It is a networked problem, where innovations at different scales and levels must be tied together to achieve maximum impact. A network-based approach, therefore, utilizing the resources and expertise of multiple stakeholders, offers great potential.

The Global Solution Networks program defines a GSN as having four characteristics:

1. Diverse stakeholders—participants from at least two of the four pillars of society: government, business, civil society (including NGOs and NPOs), and individuals.
2. Beyond One Nation State—addressing a global problem
3. Networked using the power of digital collaboration.
4. Self-organized and self-governing.

The investigations of the GSN program have identified ten different ways to solve global problems. The GSN taxonomy of ten network types looks like this:



- **Governance Networks** have achieved or been granted the right and responsibility of non-institutional global governance.
- **Policy Networks** create policy, even though they may consist of non-governmental players.

- **Global Standards Networks** are non-state based organizations that develop technical specifications and standards for virtually anything, including standards for the Internet itself.
- **Watchdog Networks** scrutinize institutions to ensure they behave appropriately.
- **Knowledge Networks** develop new thinking, research, ideas, and policies that can be helpful in solving global problems. Their emphasis is on the creation of new ideas, not their advocacy.
- **Operational and Delivery Networks** actually deliver the change they seek, supplementing or even bypassing the efforts of traditional institutions.
- **Advocacy Networks** seek to change the agenda or policies of governments, corporations or other institutions.
- **Networked Institutions** provide a wide range of capabilities, even similar to state-based institutions but with a very different *modus operandi.*
- **Diasporas** pursue problem solving through kinship and ethnicity connections.
- **Platforms** provide the infrastructure upon which other networks organize.

GSNs offer significant potential to overcome some of the world's most difficult and protracted problems—including sustainability and waste management issues for the electronics industry—through the use of collaboration, openness, and interdependence.

Knowledge Producers: Mobilizing Information for Sustainability

A significant gap in the landscape of sustainability and innovation for the electronics industry is a lack of information exchange between scientists, designers, and producers. As identified by the GSN program, knowledge producers can play an important role in global problem solving in the form of new thinking, research, ideas, and policies that can be helpful to other stakeholders and lead to innovative products, services, and systems.

Two such organizations, the Sustainability Consortium and the Sustainable Electronics Initiative, are providing industry with the tools and ideas it needs to innovate. These organizations facilitate collaboration on the production of sustainable ideas, are orchestrated by academic institutions and social entrepreneurs, and are changing the way companies think about electronic devices from their very inception. Industry groups are a significant part of this as well. Industry groups have been known to block environmental progress, but they also have contributed to the data gathering and sharing infrastructure required for progress, environmental compliance standards, auditing, and reporting protocols.

Network Examples

The Sustainability Consortium

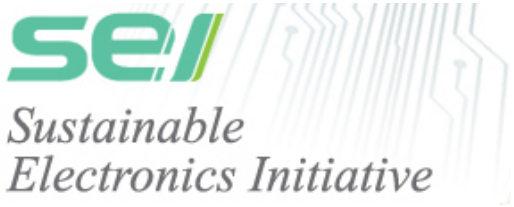
Established in 2009, The Sustainability Consortium (TSC) is jointly administered by four academic institutions (Arizona State University, the University of Arkansas, Wageningen University in the Netherlands, and Nanjing University in China[64]) and fosters a multi-stakeholder membership including over 100 suppliers, manufacturers, and retailers, as well as public and civil society actors.[65] Companies such as Coca-Cola and Wal-Mart and organizations such as the World Wildlife Fund work alongside other stakeholders within TSC to elucidate sustainability issues and opportunities for improvement across global industries. Susan Heaney, Director of Marketing, Communications and Development, describes the work of TSC as "translating the science of sustainability into action to drive sustainable consumer products, creating tools and services that are practical, pragmatic, applicable, and actionable."[66]

To this end, TSC has produced the Product Sustainability Toolkit that gives retailers and manufacturers the practical knowledge they need to make sustainable product development and purchasing decisions. The Category Sustainability Profile contains the "key performance indicators" and the supporting research that compiles available data on product life cycle impacts and supply chain management assessments into an easily-accessible format. Although TSC has been quite successful in producing valuable content from multi-stakeholder processes, Carole Mars explains that this was not easy. She states that getting representatives to "move beyond their scripts" was one of the most significant challenges to facilitating knowledge exchange and cooperation that TSC has faced.[67] However, as Chief Strategy Officer Euan Murray explains, the Consortium's "longer term intention must ultimately be to use this as the basis to drive real disruptive,

real radical, product transformation so that we're genuinely decoupling growth from impact."[68]

Specific participants from the electronics industry include Samsung, Cisco and chemical companies such as DuPont. TSC's Electronics Working Group is focused on determining the effectiveness of electronics take-back programs and assessing the impact of materials used in electronic devices. Through its work, TSC has also identified a number of key areas of concern moving forward, including both consumer awareness and the difficulty of continuing to engage and challenge large manufacturers such as Samsung, while also bringing the rest of the industry up to speed.[69]

Sustainable Electronics Initiative



The Sustainable Electronics Initiative (SEI) is dedicated to the development and implementation of a more sustainable system for designing, producing, using, and managing electronic devices.[70] Coordinated by the Illinois Sustainable Technology Center at the University of Illinois, the SEI supports ongoing research into electronics production and integrates sustainability issues into academic programing for engineering, design, and computer science students.[71]

Most interestingly, the SEI holds the annual International Sustainable Electronics Competition for college and university students, which aims to prompt dialogue about the environmental and social impacts of electronics and to contribute to the body of knowledge that advances the practice of environmentally responsible product design, manufacture, use, and disposal. The winners from 2013 presented ideas such as taking working components of broken devices and turning them into several different products including an inexpensive GPS collar for cattle,[72] a light for people in disadvantaged communities that is charged by attaching it to a bicycle,[73] and a tiled display screen for advertising.[74, 75] Ideas such as these inspire further innovation for electronics, for reducing the burden on recyclers that manage e-waste, and for meeting the growing demand for electronics.

Shared Knowledge is Power

Developing research and facilitating knowledge exchange require significant human and financial resources. Knowledge producers work with public and private partners to support their projects. However, many offer their

findings only to members who pay for access. While it is understandable that electronics manufacturers and knowledge producers in this space are seeking to protect their R&D investments, challenges could potentially be resolved more quickly if resulting data was made accessible to a broader community of researchers and innovators.

A further difficulty arises in the actualization of innovative ideas. Although ideas such as the recycled GPS cow collar may have potential, turning this idea into reality would require a business plan, sourcing workable GPS components, a manufacturer, and distribution. These are significant hurdles for an undergraduate student. While the ideas are innovative, they do little to address questions of sustainability as they are realized.

New Modes of Operation and Delivery: Realizing Innovation

While the knowledge producers are principally involved in pre-competitive knowledge sharing efforts, there are numerous organizations already developing “green devices” and testing their solutions in the marketplace. Not all of these product experiments will succeed, but the process of experimentation, and the successes and failures along the way, will better inform the future efforts of all stakeholders. They also create tangible alternatives for those consumers wanting to make sustainable purchasing decisions today, not someday. They promise innovations from the private sector that point to a sustainable future and are therefore a vital component to global problem solving on this issue.

Network Examples

Google’s Project Ara

In order to address the problems of planned obsolescence, increasing the longevity of electronic devices, and reducing the volume of electronics that are discarded because one component is broken or out-of-date, electronics

producers have begun to discuss the idea of modular devices. Google initiated Project Ara, a design challenge to create an effective endoskeleton for a modular smart phone upon which developers could build components.[76]

Development of modules for Project Ara is being facilitated by crowdsourcing and incentivized through prizes and conferences. If successful, it would drastically change the way the electronics industry functions because hardware manufacturers won't have to convince giant phone makers to include their parts in big name phones, they could just sell directly to consumers.[77]If development points to viability, Google plans to begin piloting the highly customizable phone in Puerto Rico during 2015.[78]

iFixit

Since 2003, iFixit, has been fostering a Wikipedia-style community that creates DIY repair guides and makes them free online. A central member of the Right to Repair Coalition, iFixit aims to empower consumers to repair their own devices and promote policy discussion on the liability risks that force electronics manufacturers to restrict unauthorized and/or inexpert repairs. At its most basic, iFixit provides a hub for over 4 million people per month[79] to create, post, and use repair guides for over 100,000 different electronic devices and appliances.[80] In some cases, iFixit has established fruitful relationships with electronics manufacturers such as Dell that provide spare parts, repair guides, and product teardowns directly to the project. Further, iFixit ranks devices based on their repairability and it advocates for repairability as a factor to consider in consumer purchasing decisions. In a recent survey of iFixit's members, 91% said that the information provided enabled them to repair a device that they otherwise would have taken back to the manufacturer—potentially saving their device from being discarded and preventing a new device from entering prematurely into use.

Bio and Organic Electronics

Although there is no single organization dedicated to testing and bringing environmentally focused product innovations to market, scientists, engineers, and companies have been working to create bio and organic materials for electronic devices. In 2008 and 2009, there was a spike in the discussion about the need for green electronic devices with much of the literature pointing toward growing demand. As a result, producers such as Samsung and LG began to produce eco-friendly mobile phones.

Innovators are pushing past the idea of a phone that is made from recycled components, or is simply easier to recycle, as the basis for being "green." The field of medical science is experimenting with fully organic, biodegradable electronics in order to improve the treatment of diseases such as diabetes.[81]

> *"This concept of 'transient technologies,' technology that is designed to completely disappear over time, has already been applied to creating batteries that have enough energy to power LEDs and radio transmitters."*

Recent studies have shown that paper, silk, gelatin, caramelized glucose, shellac, and inks can replace glass, metals, and plastics as component materials for electronic devices.[82] In one case, an ultrathin electronic sensor was fabricated on silk and then placed onto exposed brain tissue. The silk then safely dissolves and reabsorbs, resulting in conformal coating of folded brain tissue with the sensor array.[83]

Studies such as this indicate that organic materials may be uniquely suited to produce electronics that can not only be sustainable and biodegradable, but can also have functionalities inaccessible to standard crystalline semiconductors.[84] This concept of "transient technologies," designed to completely disappear over time, has already been applied to creating batteries that have enough energy to power LEDs and radio transmitters.[85]

Producing Results Together

The challenge of delivering sustainable and innovative electronic devices to consumers is daunting. Companies aiming to disrupt the current electronics industry with innovative products are faced with overhauling entire global production and supply chains.

There is an ongoing paradox presented by the efforts and perceived benefits of corporate social responsibility for corporations and translating those efforts into changed consumer behavior. Research by the Reputation Institute estimates that companies with reputations for corporate social responsibility are worth as much as 150% more than those without such reputations.[86] However, research out of the UK has shown that even self-identifying green consumers find it extremely difficult to make purchasing decisions based on sustainability due to the amount of time and effort required to make brand choices.[87]

Furthermore, innovative ideas such as transient technologies and modular devices also run the risk of increasing production and consumption in their own ways.[88] Google's Project Ara, for example, is only expected to increase the life-span of the endoskeleton phone to about six years, which doesn't address the consumption and discarding of the modular components. It is essential that the development of new technologies anticipates the life-cycle impacts of the ideas and considers whether they might cause more problems than they solve since often marketing focuses on one aspect of a product life cycle at the exclusion of other life phases which may adversely skew the sustainability characteristics of the product.

These issues point to the need for greater industry collaboration around innovative ideas and products that address environmental concerns.[89] The companies and initiatives currently leading experimentation have already demonstrated an openness to collaboration, which could set the stage for larger networks focused on advancing green innovation. Operational and delivery networks could be a lightning rod for industry participation, fostering excitement and support for sustainable products within the market.

Advocates: Voices that Influence Market Demands

If environmentally conscientious manufacturing of electronics is to be achieved, the industry message to consumers will have to shift, reversing years of marketing messages that push increased consumption and disregard the issues of toxicity, durability, repair, and reuse. Many manufacturers are now placing sustainability at the center of their operations and corporate strategy, but much more is needed to reverse consumer expectation that electronics are increasingly cheap, and increasingly disposable. Advocates and watchdogs will be needed to join the effort to educate consumers about the long term cost of cheap electronics.

Advocacy groups working in this space play an important role by raising consumer awareness of the sustainability challenges posed by electronic devices. iFixit and the Enough Project have established far-reaching coalitions of civil society actors and government and industry partners to change the perspective of consumers on electronic devices.

However, a sustained and dedicated advocacy network for comprehensively sustainable electronic devices has not yet been established and legal liability is a real concern. Advocacy networks are characterized by their ability to change the agenda or policies of governments, corporations, or other institutions. In the context of sustainable electronics, advocates understand that changing the agenda of governments and corporations must be driven from the bottom up—by influencing market demands.

Amplifying the Collective Voice

Public awareness and advocacy efforts have been working to empower consumers to make sustainable choices by educating them on the leading sustainability-focused companies and enabling them to repair their own devices (and thus increase life-spans). However, these efforts cannot overcome consumer desire to stay on trend, and own the latest technology. Kyle Wiens of iFixit points out that the iPad is one of the most ubiquitous items across the consumer market, yet it is absolutely one of the least recyclable devices in existence.[90] Were more consumers aware of the long term impact of their purchase choices, they might be influenced to change their purchasing behavior.

It has been difficult to sustain momentum behind public awareness and advocacy efforts. The literature on green electronics drops off after 2009 and there is an apparent lack of new participants in the Enough Project's Conflict-Free Cities network since their initial campaign in 2013.[91] Some organizations are turning their attention to conducting studies on what attributes consumers are looking for when purchasing devices and what

factors hinder or facilitate sustainable purchasing decisions. However, lack of consumer awareness regarding the tremendous efforts of industry, civil society, academia, and government institutions to ensure the sustainability of their devices remains one of the most persistent gaps. A primary benefit of a networked approach to global problem solving is the ability of network participants to pool their knowledge and resources towards creating greater impact. Advocacy networks could increase consumer awareness of sustainable electronics and unify and amplify the voice of these various groups and collective efforts.

New Institutions: Orchestrating Global Efforts on Electronic Waste

National and international institutions such as the US Environmental Protection Agency, the United Nations, and the World Bank have provided significant leadership regarding environmental, sustainability, and industry issues. However, these efforts have often suffered from corruption, misalignment, and institutional inertia. In response to the failure of global institutions to respond to new challenges, a specific type of GSN has evolved: Networked Institutions.

The participation of high-level stakeholders, the development of broad mandates, and the establishment of a multi-faceted approach to global problem solving are what characterize these non-state networks. Although partially funded by bodies of the United Nations, StEP and the GPWM, could be considered networked institutions. These organizations are orchestrating dynamic, multi-stakeholder cooperation on addressing e-waste and producing innovative solutions.

Network Examples

Solving the E-Waste Problem (StEP)

Based at the United Nations University, StEP is a multi-stakeholder initiative identifying new ideas on the social, environmental, and economic impacts of e-waste. StEP works with Industry, government, and civil society partners to build capacity and conduct pilot projects on proposed solutions, as well as advocating against harmful practices in the global trade and recycling of e-waste.[92] StEP has established five taskforces (policy, redesign, reuse, recycle, and capacity building) that are supported by myriad participants including the Global e-Sustainability Initiative, Hewlett Packard, and the US Environmental Protection Agency.

In June 2014, StEP published a white-paper, developed through a multi-stakeholder process, that recommends a comprehensive approach to responsible e-waste management to be included in a standard or set of standards aimed at the responsible collection, handling, treatment, and disposal of electrical and electronic equipment at the end of its life.[93] The paper outlines the components of an e-waste management standard, including theoretical foundations, legal and financial obligations for stakeholders, downstream due diligence, methods of handling of hazardous waste, and auditing. The hope is that this will provide a foundation for leaders and organizations that are working towards a standard for e-waste management.

Global Partnership on Waste Management (GPWM)

The United Nations Environmental Programme established the GPWM in order to achieve aspects of their Millennium Development Goals (MDGs) that were dependent on effective waste management, specifically those goals concerned with the promotion of sustainable development, access to safe drinking water, and the improvement of living conditions for slum dwellers.

In 2009 it became clear that the e-waste problem was undermining progress on these goals and that greater coordination of a holistic approach was needed. UNEP's governing council implored relevant stakeholders to become better integrated and more focused.[94] GPWM has since brought multiple stakeholders together in order to "enhance international cooperation, outreach, advocacy, knowledge management and sharing, and [to identify] and [fill] information gaps in waste management to protect human health and the environment, and to tackle adverse impacts of unsound management of waste."[95]

The GPWM focuses on six key areas of waste management and has designated lead international agencies for each of those areas—including one specifically for e-waste. By establishing focus and delegating responsibility, the GPWM provides leadership by creating operational and delivery networks that achieve the change sought by the MDGs. UNIDO, for example, has been working on behalf of the GPWM in developing countries such as Tanzania and Ethiopia to increase facility and societal capacity to manage e-waste, in addition to establishing partnerships between government, industry, and civil society partners.

Developing a Multi-Faceted Approach

As technology changes, the ongoing evolution of the e-waste problem requires constant engagement. Networked institutions can provide a centralized and sustained channel for achieving consensus on emerging issues among changing stakeholders. Although StEP and the GPWM provide two of the strongest examples of GSNs working in this space, it is unclear how much they cooperate with one another, how many common stakeholders they have, and where duplication of work may be occurring.

The risk of having multiple institutions dedicated to all facets of this problem is that efforts will remain inefficient, fractured, and uncoordinated. Institutions must capitalize on their strengths and take leadership where appropriate, while cooperating with other institutions that offer complementary strengths. In this way, networked, effective, and multi-faceted leadership could be achieved.

Policy Facilitators: Creating Consensus on Evolved Policy

Numerous policies have been enacted at the international, national, and local levels to address e-waste. Analysis of these policy developments reveals the central role that international policy forums and *ad hoc* policy networks

are playing in improving environmental and social performance within the electronics industry. Policy GSNs support policy development or create an alternative for policy, even though they consist of non-governmental players. They also exist to create and encourage discussions on policy issues.

Toward Policy Networks

Organizations such as the Organization for Economic Co-Operation and Development (OECD), the Digital Right to Repair Coalition, and the Silicon Valley Toxics Coalition have produced foundational policy approaches and have contributed vital perspectives to ongoing policy discussions.

At the international level, the OECD provides a neutral forum for policy dialogue between governments and other stakeholders in the industrialized world. It has worked to facilitate international consensus on how to compel companies to take responsibility for mitigating the environmental impacts of their products. One example is the principle of extended producer responsibility (EPR), which originated in Sweden in the 1990s.[96] EPR is defined as "an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle."[97] EPR has since been championed by the OECD and adopted by companies, NGOs, and national governments around the world. The principle prohibits producers from externalizing the costs and impacts of their products on to the public sector and to vulnerable populations, thus creating an incentive to innovate and reduce these costs. The concept has taken particular hold in relation to the electronics industry and the problem of designating responsibility for e-waste.[98]

Today, the OECD works with practitioners of EPR to determine best practices and standards, works with prospective governments to advocate for policy implementation, and produces materials such as "Extended Producer Responsibility: A Guidance Manual for Governments." The OECD's international network of stakeholders is working to create standard and harmonized legislation that limits loopholes without the need to negotiate a formal international treaty. The EU Waste Electrical and Electronic Equipment Directive (WEEE) set a collection and recovery target in 2002 for all electronics that has recently been updated to accomplish a new, higher level of per capita collection of waste materials. The aim is to reach an 85% recycling rate by 2016. Importantly, the cost burden for this rate of recycling is to be borne by the manufacturers.

In the US, the first discussion on introducing EPR legislation was taken up by the Product Stewardship Institute, an organization that, in 2000, assembled a policy network called the National Electronics Product Stewardship Initiative (NEPSI). Although NEPSI ultimately disbanded without achieving a national law on EPR for the electronics industry in the US, it laid the groundwork for policy groups such as the Silicon Valley Toxics Coalition and the Electronics Take-Back Coalition to pursue a state-by-state approach. More recently in the US, the Consumer Choice and Wireless Competition Act was created

"...the Consumer Choice and Wireless Competition Act was created by a concerted campaign of policy groups and activists who utilized the White House's "We the People" platform to generate a petition for the law with over 114,000 signatures."

by a concerted campaign of policy groups and activists who utilized the White House's "We the People" platform to generate a petition for the law that carried over 114,000 signatures.[99] This law temporarily remedies the conflict posed by the 1998 Digital Millennium Copyright Act, which penalizes individuals who unlock their phones with up to five years imprisonment. It is common practice for cell phones to be locked to specific network providers making it necessary to purchase new phones to change networks or travel overseas. By allowing the option to retain a phone while changing networks, the life-span of these devices is increased and the demand for production of new devices is lessened. The stakeholders in this effort achieved a significant victory for consumer rights and for sustainability.

Civil society has also been active around the recent introduction of "kill-switch" laws in the US that are meant to deter the theft of electronic devices. In 2013, 3.1 million phones were reported stolen in the US. A kill-switch would allow the phone's rightful owner to disable the device and wipe data remotely, effectively rendering the device useless.[100] California and Minnesota have recently mandated that all cell phones come with a kill-switch, and Nevada and New Jersey are considering implementing similar legislation. Advocacy groups such as the Electronic Frontier Foundation can also influence policy. These groups have worked to raise collective concern about this type of legislation. One issue is the fear on behalf of industry that this legislation will "lock in" a particular method of achieving this mandate and limit future technological innovation.[101] Another is that this legislation potentially limits reuse, increases consumption and burdens recycling systems if phones are bricked accidentally or prematurely and a phone cannot be unlocked by its owner. Wiens of iFixit likens this to losing your car keys and having to throw your car away and buy a new one as a result.[102] These existing and potential policy conflicts point to the need for greater systemic perspective, consultation, and collaboration in policy making.

Introducing Dynamic and Flexible Policy Solutions

Emerging issues with the foundational norms, knowledge, and systems produced by these organizations and coalitions require renewed energy to develop innovative, networked solutions. While somewhat successful within industrialized countries, the implementation of the EPR policy approach has become problematic in developing contexts due to continued influx of e-waste from abroad, lack of capacity building on behalf of local governments, and an overall desire to keep the economy informal in order to keep costs low.[103]

Furthermore, while EPR policies have made the electronics industry responsible for collection and recycling of discarded electronic devices in developed countries, they have also ceded control on how to accomplish these tasks to industry itself. The result is that industry is willing to pay only minimal prices for recycling. According to Jim Puckett of the Basel Action

> *"...international norms, principles and policies evolve in response to emerging issues and the changing nature and capabilities of the e-waste solutions ecosystem."*

Network, in North America, "Industry has squashed the prices down so far that responsible recyclers are having a tougher and tougher time doing their work."[104] In June 2014, Sims Recycling Solutions announced that they were closing their facility in Ontario, Canada because they were unable to compete with cheaper and less environmentally concerned recyclers.[105] When environmental standards for recycling were very high, Sims invested significantly in the technology required. Subsequent dilution of these standards resulted in cheaper and less ethical recyclers taking control of the market. Electronics producers can still claim to be meeting their EPR responsibilities by using these companies, but pure market forces are ultimately reducing the quality of the recycling process.

Overall, the development of state-by-state policy related to e-waste management has left large loopholes, created a severe compliance burden, and suffered from implementation problems. A networked approach that utilizes the advocacy and policy dialogue capacity of other groups could overcome partisanship and effect change.

While the official drafting and implementation of policy remains within the power of states and state-based institutions, policy development and policy discussions have become increasingly open to wide participation. As documented by the GSN program's research on policy networks, the rules for engagement on policy development have broadened dramatically and new digital technologies are allowing average citizens, industry, and civil society to participate in policy development and implementation. GSNs provide a vehicle for ensuring that international norms, principles and policies evolve in response to emerging issues and the changing nature and capabilities of the e-waste solutions ecosystem.

Standards Bodies or Networks

A key component of managing e-waste is ensuring compliance with evolving norms and policy through proper implementation and enforcement. Typically, industry non-compliance is for one of three reasons:

- They do not believe that the emerging paradigm is legitimate or the costs of non-compliance are not sufficient to change behavior.
- They do not have the infrastructure capacity to comply.
- The efforts they have taken have not been sufficient due to specific contextual challenges, and misunderstanding of expectations.

Global standards networks establish the common language by which compliance can be achieved and judged. Subsequent certification schemes provide rigorous criteria to which stakeholders can aspire and

also provide green-labeling systems that make it easy for a consumer to buy sustainable products.

Certification based on a set of specific standards has been used to encourage industry compliance with an emerging international norm and provide confidence to consumers who want to support a movement with their purchasing power. Global standards networks are an essential component to global problem solving as it is these organizations that create the frameworks for common operations and transparency, organize collective best practices that elevate an overall sector or industry, and find the balance between theoretical ideals and practical needs to meet market demand. One of the best-known examples of this kind of effort is the Kimberley Process, which was designed to certify diamonds as conflict free. The Forest Stewardship Council (FSC) logo is similarly familiar as it appears on many paper and wood products, indicating that the item has been produced from sustainable sources.

On electronic devices, there are numerous certification marques that indicate compliance with national and regional laws regarding health, safety, and environmental protection. In Europe, the CE marque indicates that a product is compliant with various European directives including RoHS. Similar markings exist for products sold in Canada, the US, China, and numerous other countries. Carole Mars of The Sustainability Consortium estimates that there are over 400 green or sustainable badges in existence around the world.[106] However, the details of each marque vary considerably and there is still no overarching symbol to indicate that an electronic device is environmentally sustainable in the same way that other products and processes are clearly certified “organic” or “fair trade.” A global standards network for sustainable electronic devices would establish clear expectations from beginning to end of a product’s life-cycle and would provide consumers with the ability to make informed purchasing decisions. That being said, the following standards bodies have carved out a piece of the sustainability problem for the electronics industry and are attempting to establish widely recognized certification schemes for producers and recyclers.

Network Examples

EPEAT Registry

Managed by the Green Electronics Council (GEC), a sub-group of the International Sustainable Development Foundation, the EPEAT Registry aims to improve the sustainable production of electronic devices. EPEAT assesses electronic devices according to a set of environmental criteria

including reduction of environmentally sensitive materials, design for end-of-life, product longevity, packaging and energy consumption.[107] These criteria were developed by a multi-stakeholder group including representatives from the electronics industry, civil society, government, and academia. According to the GEC's CEO Robert Frisbee, "[EPEAT] is not government regulation, it is market incentives through consensus based standards, delivering high performance electronics that have a significantly lower impact on the environment."[108] Even so, EPEAT is quasi-regulatory, since it's a requirement for US government purchases and for some municipal, county, and state government purchases, and for some educational institutions. It's a very good foundation, and it gets a lot of traction via Federal government purchasing requirements. Ideally, as consumers purchase their electronics based on environmentally informed decision making, electronics manufacturers will compete to provide greener products.

R2 Standard and the e-Stewards Certification

As the problem of mismanaged e-waste has gained greater exposure, companies that collect and manage e-waste are under increasing pressure to verify their business practices. The Responsible Recycling Standard for Electronic Recyclers (R2), currently maintained by Sustainable Electronics Recycling International, was originally initiated by the US EPA in 2005. A multi-stakeholder process, it took three years to produce R2:2008, which was envisioned as a voluntary, market-based mechanism for ensuring best practices that would also provide essential information/assurances to prospective customers.[109] R2 is targeted at recycling facilities that process e-waste and sets expectations for the drafting of internal policies that comply with environmental, labor, and health legislation. The standard also establishes an obligation for recycling facilities to send working devices for repair and reuse and establishes standards for how to handle and treat hazardous components.[110] Updated in 2013, the R2 standard has since been used to certify over 500 facilities in 17 countries.

Although an early participant in the development of the R2 standard, the Basel Action Network (BAN), a leading NGO in this space, ultimately decided the end result was insufficient to ensure the compliance of electronics recyclers with international environmental policies and norms. Of primary issue, the R2 standard does not require recyclers to comply with the Basel Convention. As such, BAN and a number of supporting recyclers launched the e-Stewards Certification program in 2008. Certification under this scheme is based on adherence to the e-Stewards Standard for Responsible

Recycling and Reuse of Electronic Equipment and was written using a collaborative process involving industry, environmental, and non-profit leaders. The standard sets rigorous expectations for recyclers of e-waste regarding criteria for data security, ethical labor practices and compliance with international law, including the Basel Convention. Companies are certified following an assessment by an e-Stewards certification body, all of which are accredited by the ANSI-ASQ National Accreditation Board.

Watchdog Organizations

Watchdog networks investigate emerging issues and call attention to the ways in which other stakeholders undermine or subvert existing norms and policies and are thereby often instrumental in re-launching the norm and policy process to address these new problems.

In order to adhere to international standards or domestic policy, manufacturers and recyclers must build significant capacity and bear the subsequent costs. There is incentive for some to cheat on or ignore environmental standards in order to ensure profits. An essential element to reducing the environmental impact of any global industry is those organizations and networks that monitor the activities of relevant operators and identify those that are sidestepping the system. These watchdog networks undertake investigative journalism and public outreach in order to reveal problems and issue calls to action.

In the context of e-waste, there are two categories of potential contributors to a watchdog network—both on the front-line of this problem and essential to identifying those that continue to flout international policy and exploit loopholes: law enforcement and civil society organizations. These entities investigate electronics manufacturers and recyclers, name and shame non-compliers, and ensure prosecution for those that violate emerging norms—even in cases where environmental laws have not been established.

Watchdog Examples

Law Enforcement

While law enforcement capabilities are inherently intertwined with the legal apparatus of states, in the face of global problems there is a clear need for greater networking between law enforcement agencies and other stakeholders. International institutions such as INTERPOL and the World Customs Organization (WCO) are adopting a GSN-like approach by connecting with national agencies around the world to orchestrate a global network that prevents e-waste from being imported or exported across borders. As these organizations increasingly connect to knowledge

producers, policy groups, and other institutions working in this space, INTERPOL and the WCO make a unique contribution. They are at the forefront of leveraging global connections to improve their capacity to combat environmental crimes such as the illegal transfer and dumping of e-waste.

Countering Waste Electrical and Electronic Equipment (WEEE) Illegal Trade (CWIT)

With 190 member countries, INTERPOL is the world's largest international police organization and is responsible for coordinating international cooperation between national police agencies and combating transborder crime such as illicit trade. In 2013 INTERPOL launched a two-year project, the Countering WEEE Illegal Trade (CWIT) project, which is focused on generating data regarding the illegal trade of e-waste. CWIT is coordinated by a multi-stakeholder consortium of research-focused partners including public institutions (United Nations University and the United Nations Interregional Crime and Justice Research Institute), private think tanks (Zanasi & Partners and Compliance & Risks Ltd) and non-profits (Cross-Border Research Association).

The European Commission funds the project, and the ultimate goal is to create a set of recommendations for countering the illegal trade of e-waste.[111] The project has three central objectives that have characteristics of the GSN network types identified in our program research.

1. Acting like a knowledge network, CWIT will estimate the volume of e-waste generated in Europe, assess the types of companies involved in exporting e-waste, analyze the involvement of organized crime, and develop a detailed understanding of the destinations and routes used for illegal e-waste shipments.[112]

2. Acting like a policy network, the project will identify policy gaps that are exploited by illegal traders of 3-waste and develop recommendations.

3. And CWIT will establish a platform for information exchange among the various actors involved in combating e-waste trade. Platforms and platform networks are essential to the development of other GSNs and networks of GSNs as they create the capability for other networks to organize.

By leveraging their position on the frontline of the global fight against e-waste, CWIT and INTERPOL can sound the alarm on violations of policy, produce knowledge on the quantity and direction of e-waste, provide evidence based policy recommendations, and build the infrastructure that catalyzes other stakeholders to act on the information provided.

> *"From March to May 2009, 65 national customs agencies at more than 300 seaports participated in Operation Demeter, resulting in 142 seizures of illegal shipments and 181 million pounds of waste shipments confiscated, the majority of which involved e-waste."*

World Customs Organization

Similarly, the World Customs Organization (WCO) utilizes its position as the gatekeeper at global borders to develop knowledge and facilitate action against violators of e-waste norms and policies. Now representing 179 national customs administrations, the WCO was established in 1952 as an independent intergovernmental body to enhance the effectiveness and efficiency of customs agencies around the world.[113]

The WCO is committed to combatting environmental crime and illicit trade and has taken on the responsibility of enforcing multilateral environmental agreements with trade-related provisions, including the Basel Convention and Ban.[114] In 2009, the WCO decided to dedicate its operations to environmental issues and launched the "Customs and the Environment: Protecting our Natural Heritage" campaign. During 2009, the WCO coordinated the first ever joint global operation focusing on the illegal waste trade: Operation Demeter.[115] From March to May 2009, 65 national customs agencies at more than 300 seaports participated in Operation Demeter, resulting in 142 seizures of illegal shipments and 181 million pounds of waste shipments confiscated, the majority of which involved e-waste.[116]

Operation Demeter has since been repeated twice—in 2012 and in 2014.[117] These operations have been conducted in cooperation with national environmental agencies, the Secretariat of the Basel Convention, and UNEP.[118] The seizure of these contraband materials is certainly a success with this first global venture being characterized by the participation of 65 countries, a large scale of engagement and an unprecedented volume of information exchanged.[119] This effort remains primarily state-based, but the WCO continues to set the stage for greater GSN engagement by working with external stakeholders to support its efforts and connect its findings to larger research and policy-oriented networks.

A World Customs Organization official inspects a shipment of waste during Operation Demeter III.

Toxics Link

In India, the GSN Toxics Link has been central to raising the issue of e-waste, advocating for policy and ensuring that companies follow through with increasing environmental sensitivity in their operations. Based on the EPR principle that was making significant impact in Europe, India passed legislation in 2011 that placed responsibility for take-back and recycling systems for electronic products on the manufacturers.[120] Three years later, in 2014, Toxics Link published a national ranking of electronics companies operating in India that was based on each company's take-back mechanisms. The report revealed that many companies are not yet in compliance.

> *"Although the US has not ratified the Basel Convention and has no national equivalent, the Denver company was charged with fraud as they were said to have "deceived their customers by stating their electronics were being recycled responsibly and domestically within the United States" when, in reality, Executive had shipped 300 containers of e-waste overseas between 2005 and 2008."*

The take-back systems of electronics manufacturers were rated based on five criteria:

1. Sufficiency of information about the take-back system on the company's website
2. Ease of accessibility of information
3. Take-back system
4. Number of collection points
5. Information via customer care or helpline.

Of the 50 brands evaluated, an astonishing 34% had taken absolutely no steps to establish a take-back system by 2014.[121] Those companies that earned zero points in the assessment included Blackberry and HTC.[122] Only seven companies, including Nokia and Lenovo, made it into the "good" category.[123]

Basel Action Network

The Basel Action Network (BAN) keeps an eye on e-waste recyclers and activities that contravene the Basel Convention. In 2013, an investigation by BAN resulted in two jail sentences and a $4.5 million dollar fine for a Denver based recycling company called Executive. Although the US has not ratified the Basel Convention and has no national equivalent, the Denver company was charged with fraud as they were said to have "deceived their customers by stating their electronics were being recycled responsibly and domestically within the United States" when, in reality, Executive had shipped 300 containers of e-waste overseas between 2005 and 2008.[124] This is an important example of the strength of emerging norms in this area, even where policy gaps exist.

BAN also makes public internal documents from electronics companies and public sector entities that outline efforts to subvert or undermine environmental progress within the electronics industry.[125] Furthermore, BAN tracks new manifestations of the e-waste problem as standards and policies are enacted. For example, California is home to the strictest e-waste laws in the US and an unfortunate consequence has been the dumping of California's e-waste in the desert of neighboring Arizona.[126] Continuing to identify gaps in enforcement and the evolution of the e-waste problem ensures that policy makers stay abreast of the issue and can make course corrections as necessary.

Weaving Networked Compliance

Standards and watchdog networks are a vital part of ensuring compliance with efforts to curb the negative impact of e-waste. However, as many solutions as these organizations and methods provide, they also reveal numerous further challenges. For example, although the World Custom Organization's "Operation Demeter" was a success, it also exposed gaps in the adoption of and compliance with the Basel Convention.[127] Those states that have signed and ratified the Ban, including many in Europe and importing countries such as China and India, are clearly struggling to develop the necessary capacity and enforcement mechanisms to reduce the generation and international transport of e-waste. Sole responsibility for tackling these problems has fallen to global law enforcement and customs agencies that are unable to address the root causes.

Certification methods and standards have also proven problematic. Even if consumers are aware of the issues related to e-waste in developing countries and are dedicated enough to seek out an ethical recycling service, they might be unaware that being certified by the R2 standard does not prevent the recycler from shipping that e-waste overseas. Furthermore, the consensus-based and multi-stakeholder nature of the EPEAT registry has delayed updates to the ranking criteria due to "horrible politicking among manufacturers."[128] The system is now believed to be almost 8 years out-of-date and subject to increasing pressure to further dilute the criteria.[129]

An example of pressure on EPEAT criteria became public in 2012 when a conflict occurred between Apple and EPEAT. At the time, the CEO of EPEAT, Robert Frisbee, stated that Apple had decided "their design direction was no longer consistent with the EPEAT requirements," but the company did not elaborate.[130] Within days, Apple rejoined EPEAT due to outcry from consumers and procurement officers in government and business.[131] With this decision, Apple stated that the company has been an industry leader on sustainability issues and that the EPEAT standard needs improvement.[132] The ongoing challenge is to develop a green certification that is strict enough to have legitimacy but flexible enough to allow for innovation in design and compliance with the standard.[134]

The importance of watchdog organizations cannot be understated. Kyle Wiens of iFixit argues that the shaming of electronics manufactures is the "only thing that's been effective" in forcing change to production and recycling systems. For civil society watchdogs, it has been especially difficult to maintain momentum over the long term. For example, where the Greenpeace "Guide to Greener Electronics" was once updated multiple times per year, it has not been updated since 2012.

Change makers inside companies often need external impetus in order to make something happen. When you talk to environmental managers at a company, they tell you, "I'd like to do things, but I don't have the power internally to get it done. But when Greenpeace comes and shames us, it's a way that I can actually get something changed inside the company."[135]

Public pressure is less necessary when corporations see the market advantages of sustainability. It has been well documented that corporate sustainability initiatives create greater market resiliency and public goodwill. However, watchdogs are still essential to ensure that what corporations say they are doing is actually happening.

Collaborative Networks

Despite significant effort on the part of industry, state, and civil society, success in ensuring the sustainable production of electronic devices and effective management of global e-waste continue to elude global problem solvers. A new approach could help to reach those goals. The Global Solution Networks research contains numerous insights into collaborative, dynamic, and multi-stakeholder initiatives that are having significant impact on some of the world's most daunting issues—from climate change to youth unemployment. Applying the GSN model to the issues challenging the electronics industry could be impactful, beginning with mitigation of two significant hurdles.

> Hurdle #1: A lack of political will at the national level has left the management of collection and recycling programs to industry and, although many industry partners are clearly concerned about e-waste, the basing of action and planning on competition and market forces by many e-waste management systems has reduced program legitimacy and quality.
>
> Hurdle #2: A lack of leadership persists at the global level resulting in an overlapping, contradictory, and ultimately inadequate patchwork of solutions. Although numerous organizations are tackling parts of the puzzle, there is either a lack of capacity or a lack of determination to establish central arbitration of a global green standard for electronic devices and e-waste management. As a result, various networks are duplicating effort. As a result, stakeholder participation in the design of a global approach is fragmented.

Organizations such as StEP and the GPWM show potential to become full-fledged networked institutions and could provide the leadership, coordination, and convening power to have impact on the issues. Regrettably, international policy aimed at curbing the illegal trade of e-waste suffers from the absence of participation by the world's greatest producer of e-waste, the United States.

The potential for networks to coalesce around the issues and amplify their effectiveness is underscored in the GSN model. Policy coalitions can facilitate policy discussion on issues ranging from the right-to-repair to national alignment with the Basel Convention in order to gain momentum and present a unified voice to policy makers and Industry stakeholders. Global standards

networks and watchdog networks can bring legitimacy and influence to current industry and state-based initiatives.

Many organizations are harnessing multi-stakeholder models to develop understanding of problems, devise appropriate policy responses, and orchestrate solutions. A commitment to a networked approach by all groups can go a long way in overcoming defensiveness, territoriality, and entrenchment by any one stakeholder. Greater collaboration among and between these groups of institutional, policy, standards, and watchdog leaders will help to close remaining loopholes more effectively.

Implications for Network Leaders

In the context of sustainable production for the electronics industry, GSNs in the form of knowledge, operational and delivery, advocacy, policy, standards, and watchdog networks show a potential path forward for actors trying to achieve change in this space.

Leadership vacuums undermine the ability to achieve progress on complex, transnational issues like e-waste, despite the presence of significant problem solving activity. Existing actors have significantly reduced the use of toxic and unethical materials in electronic devices, the flow of e-waste to developing countries, and the opportunities for subversion of this new system. However, a lack of ecosystem-wide leadership perpetuates fragmentation and duplication of effort, resulting in a proliferation of policy responses, standards, and metrics, and a failure to communicate the importance of making thoughtful choices to consumers. A networked approach to e-waste would foster greater policy coherence, reduce the compliance burden on industry, establish clear indicators for consumers, and accelerate the design and development of green devices that will be accepted by the market.

GSN orchestrators rooted in existing vehicles of international cooperation may have the greatest potential to facilitate networked e-waste solutions. International organizations such as the United Nations have the ability to act as arms-length orchestrators for GSNs. In fact, UNEP, an actor already identified as having established the GPWM, has been identified by the GSN program as one of a handful of super-orchestrators—organizations that have been especially active in brokering and supporting multi-stakeholder solutions to global problems.

UNEP has been central to the creation of the Global Reporting Initiative and the Principles for Responsible Investment—both GSNs dedicated to mainstreaming sustainability issues within industry and financial systems.

Orchestrators such as the UNEP provide the legitimacy and resources to foster collaboration and innovative thinking among diverse stakeholders.[130] In most instances of network orchestration an intermediary organization—a GSN—is set up through which stakeholders can achieve their goals using a cooperative process, rather than a top-down, command-and-control, process.[131] From the pool of organizations studied in the e-waste space, organizations such as StEP and the GPWM already have the backing of orchestrators based in the United Nations system and as potential intermediary organizations they could provide the kind of focus, leadership, and systemic perspective necessary for establishing networked solutions for the e-waste problem.

Knowledge networks can support effective e-waste solutions in diverse ways, from helping define the scope of the problem to assisting electronics manufacturers in actualizing emerging knowledge on how to design sustainable products. There is an important place for statistics and data on the problem of e-waste. Clear consensus on what the problem is and clarity around definitions and expected behaviors are necessary before any significant progress can be made. However, the development of this knowledge must be widely available in order to have innovative impact. Sheila Davis of the SVTC points out the importance of mutual support through the sharing of knowledge and research about this problem: "Some companies don't have the will, some don't have the resources, and some just don't know what to do. That's a role we can step into to actually provide that information to companies."[136] Knowledge networks are crucial to ensuring that all stakeholders, even those currently outside of the ecosystem, have all the necessary information to continue moving forward.

Operational and delivery networks could provide hubs for developing greener products and entirely new models of product ownership that move the industry towards a circular economy. However, this can only be achieved if the electronics industry both establishes manufacturing systems that embed sustainability into their operations and produces products that are economic and convenient for consumers. Networking among those that produce research and innovative ideas is central to fueling green design and to solving the more complex issue of overconsumption. Operational and delivery networks could support broader solution efforts by developing and testing alternative products, services, and even entirely new models of ownership and economics that would move the industry towards more circular systems.[137] While companies such as Google have the clout and resources to push these efforts forward, electronics companies and start-ups across the board also have a significant role to play and a responsibility for supporting the development of these networks.

Advocacy networks are shining a light on the problem, but consumers need more information and greener product choices. Companies such as Fairphone and organizations such as the Enough Project have worked in conjunction with watchdogs such as the Basel Action Network to increase public awareness issues on the sustainability challenges presented by electronic devices. Jim Puckett of the Basel Action Network points out that consumers are still limited in their ability to have an impact on this issue.

"A lot of people say that the consumer world is the ultimate democracy, but it doesn't really work that way," says Puckett. "Consumers don't really have a lot of choice; we're not an educated voting populous because we don't know what's in the product and we don't know what the alternatives are."[138] Advocacy networks are central to translating the efforts of industry, government, and civil society into changed consumer behavior.

Policy networks could facilitate effective governance by connecting the work of advocacy, watchdog, and knowledge networks to global decision makers within governments, institutions, and industry. The creation of national and/or international policy frameworks requires extensive negotiations and consultation between key decision makers and impacted stakeholders. Policy networks can work between different groups of stakeholders, gathering perspectives, facilitating behind-the-scenes confidence building and ensuring that all stakeholders are well informed on the issues at. Improved integration and communication between a wide variety of groups including the Enough Project, the Right to Repair Coalition, and The Sustainability Consortium would allow decision makers to devise evidence-based policy more rapidly. With the support of multiple stakeholders, collaborative policy processes facilitate policy solutions that are viewed as legitimate, have greater buy-in, and are ultimately more effective, reducing the burden on watchdog organizations to force compliance.

Coordination and communication between global standards networks and watchdog networks weave greater compliance mechanisms. This is essential to providing clear communication to consumers, manufacturers, and waste management stakeholders, creating clear consequences for those who ignore or undermine global efforts to address the e-waste problem. On one hand, the creation of clear standards for environmentally and socially sustainable electronics, as well as reputable e-waste managers, provides the consumers with clear and assured choices, making it easy for them to participate in and support sustainability efforts. One the other hand, the reputational damage caused by shaming non-complying companies strengthens the incentives for industry to innovate and lends credibility to the efforts of those companies that choose to reduce the environmental impact of their products.

Global solution networks present a significant opportunity for achieving unprecedented impact on the issue of sustainability for the electronics industry. Establishing collaborative, multi-stakeholder networks could fill in the remaining gaps and address many of the persistent challenges that stymie progress on supplying green alternatives. The utilization of a digitally enabled and networked approach would provide all stakeholders with the ability to amplify their individual efforts, ensuring that the electronics industry approaches a sustainable, zero waste economy in the near future.

Interviewees

Smail Alhilali, United Nations Industrial Development Organization, Vienna, Austria

Sheila Davis, Silicon Valley Toxics Coalition, California, USA

Susan Heaney, The Sustainability Consortium, Arizona, USA

Elisabeth Herbeck, United Nations Industrial Development Organization, Vienna, Austria

Carole Mars, The Sustainability Consortium, Arizona, USA

Jim Puckett, Basel Action Network, California, USA

Allison Schumacher, Consumer Electronics Association, Virginia, USA

Kyle Wiens, iFixit and the Right to Repair Coalition, California, USA

Saskia Widenhorn, Fairphone, Amsterdam, Netherlands

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About Global Solution Networks

The Global Solution Networks (GSN) program was launched in 2013 to understand the emergence and impact of multi-stakeholder networks in solving global problems. Our three-part mission:

- To fill the knowledge gap surrounding multi-stakeholder networks for global problem solving.
- To put GSN tools in the hands of people working to solve global problems.
- To connect the people and networks working to address common global issues.

This research project is a deliverable of the GSN program, offered through the Martin Prosperity Institute at the Rotman School of Management, University of Toronto.

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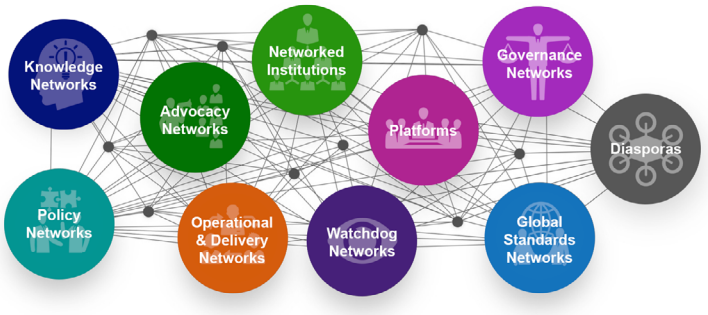

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