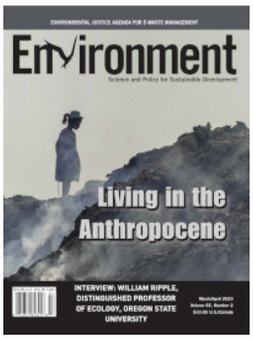

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The Environmental Justice Agenda for E-Waste Management

by Oladele A. Ogunseitan

The management challenge of mixed e-waste is apparent.

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Environmental Context of the Electronics Revolution

The exact number and quantity of chemicals present in a typical consumer electronic product such as a mobile phone or computer are difficult to pinpoint, but each device is estimated to contain myriad components that are manufactured with several chemical elements, compounds, composites, and alloys. Some elements are precious metals such as gold, whereas other elements and compounds are unambiguously toxic, among which lead, mercury, cadmium, chromium, nickel, brominated flame retardants, phthalates, and perfluorooctanoic acids (PFOA) are notorious.[1] The detrimental environmental impacts associated with electronic products begin at the stage of mining natural mineral resources to produce many of the material constituents, for example, cobalt for which nearly half of the world's supply is mined in the Democratic Republic of Congo.[2] Perhaps the most serious environmental impact is at the end of the useful life of electronic products, when they are discarded as hazardous electronic waste (e-waste) with domestic waste or managed under conditions that generate environmental pollutants.[3] The World Health Organization (WHO) recently concluded that nearly 13 million women and 18 million children work in the informal labor sector to manage e-waste, hoping to recover small amounts of copper or gold from discarded products through dangerous procedures that lead to exposure to toxic chemicals and to adverse impacts on human health and environmental quality. In the preface to the WHO report, Director Tedros warned of the mounting "tsunami of e-waste" and called for urgent action.

Globally, we recover and recycle less than 20% of used electronic products, thereby wasting valuable natural resources such as cobalt, nickel, lithium, and rare earth elements that could be used to manufacture new electronic devices.[4] Various studies have documented the adverse impacts of exposure to e-waste particularly in resource-poor countries where regulations for occupational safety and environmental protection are either absent or difficult to enforce.[5] Concern for the health risks associated with informal e-waste management has emerged as a rallying topic for labor- and environmental-rights activists, who point to the inequity of the electronics revolution where benefits are disproportionately allocated to people in affluent countries and the harm of e-waste is disproportionately allocated to people in countries where labor is cheap, environmental regulations are lax, and health care is not affordable. However, in some affluent countries, including the United States, employment of prisoners in e-waste management has also raised similar concerns. The range of issues that have drawn the attention of the environmental justice movement to e-waste spans the life cycle of electronic product manufacturing, beginning with the acquisition of minerals and ending with e-waste disposal. There is a lack of coherence in the agenda for environmental justice, a situation that has the effect of diluting the potential impact of initiatives to identify sustainable solutions through established principles of fair treatment of workers and meaningful engagement of communities.[6]

The purpose of this article is to identify cross-cutting themes in the international context of transactions in the life cycle of electronic products and waste generation,[7] and to examine case studies within the themes to derive a consistent agenda for environmental justice regarding e-waste management.

Intersectional Transactions in E-Waste: Labor, Health, and Environment

The Environmental Justice Context of E-Waste Management

In 2019, nearly 54 million metric tons of e-waste was generated globally. The fate of 83% of hazardous e-waste generated is unknown, likely traded through unpoliced international channels and ending up in the environment as toxic pollution.[8] International policies to regulate the importation and exportation of hazardous waste, including the United Nations Basel Convention on the Transboundary Movement of Hazardous Materials and Their Disposal, have been largely ineffective regarding e-waste management, in part because of loopholes that hinge on international humanitarian donation of used electronic products. Another reason is the economic incentives associated with the international market for used electronic product components and refurbished devices such as mobile phones, the use of which has transformed under-resourced communities worldwide in terms of social networking, communications, education, and bank transactions. Regulatory policies on e-waste exportation are also not well coordinated with strategies to eliminate or reduce the concentrations of toxic chemicals present in electronic products. These gaps have led to the proliferation of activist nongovernmental agencies seeking improvements in the protection of the health of those who labor in e-waste management, prevention of toxic environmental pollution, and remediation of ecosystems contaminated by e-waste.

To address the emergent environmental justice concerns about e-waste management, some activists have called for the outright ban on international trade in used electronics.[9] However, the intention of initiatives to ban the exportation of e-waste or to promote the domestic recycling of used electronic products is not always about protecting global health and the environment in the context of international trade in hazardous materials. For example, the 111th Congress of the United States (2021–2022) introduced "H.R.3036—Secure E-Waste Export and Recycling Act," which aims to "control the export of electronic waste in order to ensure that such waste does not become the source of counterfeit goods that may reenter military and civilian electronics supply chains in the United States, and for other purposes."[10] This view emphasizes the quality assurance of electronic equipment and intellectual property issues over environmental pollution and human health issues.

Citing a different approach to economic and labor justice, some activists

Incineration of plastic parts produces toxic fumes including volatilized dioxins which are highly carcinogenic.

have argued that the long-term benefits of employment and sustainable development in under-resourced countries importing e-waste outweigh the current risks of environmental pollution and health impacts. In 2019, the International Labor Organization (ILO) hosted its first meeting dedicated to this topic and argued that e-waste is a resource in the emerging circular electronic economy and that improvements are needed in e-waste management practices to advance its universal vision of decent work. The ILO Forum eventually adopted 17 points of consensus, including a call on governments to strengthen laws, regulation, and policies, while considering international labor standards to advance decent work in e-waste management. ILO's consensus document does not mention electronics manufacturers and industries or the concept of extended product responsibility, which could contribute to the efforts of making electronic products safer for resource recovery and recycling.[11] The omission of corporate responsibility from ILO's consensus points to a major gap in the international agenda for environmental justice because electronic manufacturers have the technological and financial resources to support national governments' investments in infrastructure for e-waste collection, resource recovery, and personal protective equipment for e-waste processors in the informal economic sector, and for remediating contaminated environments.

The Agenda of Fair Treatment

The principle of fair treatment is well established in the framework for environmental justice as a commitment to implement continuous monitoring and corrective measures that ensure that no group of people, domestic or international, bears a disproportionate burden of the negative environmental consequences resulting from industrial, governmental, and commercial operations or policies. During the past two decades, continuous monitoring by independent researchers, nongovernmental organizations, and international agencies has produced evidence that some people do bear a disproportionate burden of the negative impacts of the electronics industry across the materials life cycle of their products. The agenda of fair treatment in the e-waste management sector is to remove the disproportionate burden without shifting that burden to another population, while also not replacing the burden of toxicity and environmental pollution with the potentially equally burdensome impacts of unemployment and poverty. All credible projections of the magnitude of the e-waste problem conclude that without corrective action, the generation of e-waste will likely double the current amount to more than 110 million metric tons by 2050. The global pause in in-person interactions during the COVID-19 pandemic reinforced the benefits of having up-to-date electronic devices widely accessible for all people in all countries; sales of electronic products increased accordingly, and the relatively brief useful life span of electronic products means that e-waste generation following the pandemic period will also increase considerably.

Therefore, the agenda for fair treatment of e-waste management acknowledges the

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A pile of mixed electronic waste and other materials.

responsibilities of electronics manufacturers and regulatory policies harmonized at the national and international levels, including cooperation among United Nations (UN) agencies that currently host relatively independent agendas on the topic, namely, the International Labor Organization, the UN Environment Program, the World Health Organization, and the United Nations Industrial Development Organization. Extending the useful life of electronic products can reduce the pace at which e-waste is generated, but manufacturers and their investors fear that this approach will reduce profit margins.[12] The solution to this concern is for the manufacturers to invest more vigorously to support the right-to-repair movement, and to share profits with third-party repairers. This means that a reduction in e-waste generation does not necessarily have to mean less work for e-waste management laborers and defunct product repairers, or reduced profit for manufacturers. The U.S. Supreme Court paved part of the way for this action in its landmark opinion issued in 2016 to overturn a federal appeals court ruling in the case of *Impression Products, Inc. vs. Lexmark International, Inc*, which was deemed important for third-party or consumer right to repair or refurbish electronic products, which could serve to reduce the volume of e-waste being generated and exported. However, differences in the Supreme Court opinion may pose problems for application of this case to international contexts and the transboundary movement of e-waste.[13] In November 2021, Apple, Inc., previously opposed to accessible product repair, relented and agreed to allow individual consumers to repair some of its consumer electronic products by making spare parts, tools, and manuals for iPhone 12 and iPhone 13 available to individual consumers. This program extended the company's Independent Repair Provider program, which was launched in the United States in 2019 and now covers independent repair shops in more than 200 countries where access to training, parts, and tools is provided at the same level as for Apple's Authorized Service Providers.[14] Some activists have argued that Apple's relaxation of product repair was a strategy to avoid legislation that could have required stricter policies. For example, the California legislature introduced Senate Bill 983 in the 2021–2022 session to require every manufacturer of electronic products to make available to service and repair facilities sufficient service literature and functional parts to repair such products for at least 7 years after the date a product model or type was manufactured.[15]

Tightening national and international regulatory policies at the beginning and at the end of the materials life cycle of electronic products not only will be in harmony with ILO's guidelines for a just transition toward environmentally sustainable economies and societies for everyone, but also will reduce the unfair treatment associated with the disproportionate international risks associated with toxic environmental pollution and human health impacts due to e-waste.[16]

The Agenda of Meaningful Engagement

The principle of meaningful engagement is intrinsic to the environmental justice framework in its emphasis on

participatory decision making about activities from any source or agency that may affect their environment and their health. The literature on strategies for community engagement and participatory decision making is extensive, particularly with respect to formal programs initiated by government agencies.[17] However, the best practices and recommendations for meaningful engagement derived from such experiences are not easy to apply to informal labor sectors, where some activities may flout international regulations and are possibly illegal in local contexts. The management of e-waste occurs through both formal and informal practices, and, although transboundary movement of e-waste is prohibited internationally through the United Nations Basel Convention, not all countries (including the United States) have ratified the Basel Convention, and instead they rely on voluntary national or regional trade agreements that may be difficult to monitor in terms of their effectiveness in preventing risk disparities and in terms of their consistency with global international standards of equity and the agenda for environmental justice. The case of e-waste is further complicated by the categories of products that may involve counterfeits and uncertainties regarding authority to repair and refurbish products for resale that is not sanctioned by manufacturers. Therefore, many stakeholders in the e-waste management sector may not participate willingly in formal community engagement initiatives. The uncertainty in the results of epidemiological studies linking e-waste exposure to specific health outcomes has also proved challenging in attempts to communicate the risks to the public.[18] In this regard, the literature on the post-normal science (PNS) paradigm can inform an aspect of the emerging environmental justice agenda, particularly with respect to the core principles of PNS: (1) managing scientific uncertainty beyond references to quantitative epidemiological data such as relative risks and odds ratios, (2) managing plural perspectives about e-waste, particularly from the technological sector represented by electronics manufacturers, environmental health scientists, and those in government agencies responsible for formulating and enforcing regulatory policies, and (3) managing community stakeholders through an inclusive approach that is nonthreatening toward workers and activists.[19]

Meaningful engagement in local jurisdictions can be monitored through the influence of public contributions gathered by voting or focus-group discussions of decisions made by regulatory agencies, and evidence that community concerns are considered in the decision-making process, documented by decision makers requesting input through public notices and engagement of populations most likely to be affected. At the international level, meaningful engagement is not easy to implement or document, particularly regarding broad contentious issues such as transboundary movement of hazardous waste and commodities that have implications for national or regional economic interests. Typically, international policies give much leeway to national priorities. For example, ILO's guidelines for a just transition toward environmentally sustainable economies and societies for all provides nonbinding orientation to national governments and activists by

E-waste incineration leaves toxic residues in the soil and water.

A cocktail of toxic compounds is found next to e-waste incineration sites.

delineating options on the formulation, implementation, and monitoring of policy frameworks according to national circumstances and priorities. However, the inclusion of social dialogue and social protection of rights at work in ILO's "Decent Work Agenda" aligns with the principle of meaningful engagement in the environmental justice agenda for e-waste laborers.[20] Social dialogue includes effective exercise of the right of workers to organize and bargain collectively through unionization. This is clearly not an easy process for the informal sector of miners and e-waste laborers, where international nongovernmental organizations have assumed the responsibility of advocating for the rights of workers.

Some investigators adopted an anthropological perspective to describe a situational model of environmental justice regarding informal e-waste management. This approach engages e-waste as a problem of intervention that can augment environmental justice by aligning e-waste technical interventions such as described in the ILO's consensus points (e.g., provision of furnaces, personal protective equipment, and other techno-solutionist management options) with grassroots forms of community engagement. The goal is to leverage livelihoods of e-waste management to deepen our understandings of the local complexities and the situatedness of e-waste struggles in general, and areas of local community justice struggle and concern in particular. When e-waste management is hyperfocused on the circular economy, material conversion, and life cycles, this can dwarf the actual complexities of the livelihoods at stake. E-waste anthropology helps to humanize these complexities and exposes the varieties of experiences of e-waste. Advancing e-waste anthropology and environmental justice in community contexts calls for deeper social, political, and cultural contextualization, especially if building a more just and grassroots e-waste approach is the focus of sustainable partnerships and interventions. Since sites of e-waste labor are more often than not also spaces of repair and reuse, a reparative environmental justice perspective might provide a more effective conceptual foundation for designing new forms of environmental justice experimentation and action in locations of e-waste labor and livelihoods.[21] This approach reflects the ultimate goal of the Decent Work Agenda and initiatives on the greening of economies toward sustainable development and poverty eradication.

Progressing From Agenda to Action on E-Waste

An Inclusive Agenda for Environmental Justice for E-Waste Management

Establishing an actionable agenda for the environmental justice movement to reform e-waste management is urgent because of the upward trend in hazardous e-waste generation, the accumulation of health impacts on an increasingly vulnerable community of workers, the heavy burden imposed on polluted ecosystems, and the insatiable demand for minerals needed to manufacture new electronic devices. This article focused on the tail end of the material life cycle of electronic products, but the root of the problem is at the mining of natural resources to feed the spiraling production of new electronic devices. An inclusive agenda for environmental justice must be engaged with initiatives to fully circularize the economy of electronic products without compromising gainful employment and safe labor. Some proposed solutions to reduce the generation of e-waste, including extending the useful life of electronic products, can also have the co-benefit of reducing carbon emissions associated with the production of new devices from newly mined minerals.[22] An inclusive agenda for environmental justice of e-waste must also embed fair treatment of workers of all kinds, with particular attention to prisoners and women because evidence shows a disproportionate burden of disease associated with e-waste, including adverse impacts on pregnancy outcomes and child development.[23,24] Meaningful engagement of e-waste workers would require organizing labor in a way that assures human rights in addition to the technical solutions for better options regarding e-waste management. Harmonization of regulatory policies at the national and international levels, including all pertinent branches of the United Nations that have distinct agendas for solving the problems of e-waste management, will be necessary to support and advance the work of grassroots organizations working with communities

to pursue justice for clean environments and healthy bodies among e-waste workers. Two case studies serve as examples of the challenges associated with navigating the intersectoral issues involved in e-waste management, as follows.

In August 2015, I visited Agbogbloshie district in Accra, Ghana, noted in the international media for informal management of e-waste recycling, and according to New York-based Pure Earth (Blacksmith Institute) and Green Cross, it was identified as the world's most polluted site due to extensive contamination by toxic lead, affecting more than 40,000 people, including children.[25] I witnessed incineration of e-waste releasing thick smoke into the air, and the contamination of the soil and stream with ash from the residues. I observed the co-mingling of food in the same environment as ongoing e-waste dismantling, burning, and disposal (Figure 1). It had been documented that soil samples taken around the perimeter of the e-waste management site contained lead levels as high as 18,125 ppm.[26] I was also convinced that the residents have grown wary of visitors, including international journalists and scientists who they accused of causing and perpetuating the threat by government agencies to evict them, thereby deepening uncertainties around employment, access to food, and shelter. Moreover, attempts by nongovernmental activist agencies to intervene by introducing safer e-waste management procedures, including Blacksmith Institute (Pure Earth) and Green Advocacy Ghana's attempt to pilot alternatives to the e-waste burning process with hand wire-stripping tools, were not very successful. The painstaking process of inclusive strategies for improving fair treatment and meaningful engagement was eventually derailed on Thursday, July 1, 2021, when government forces invaded the e-waste market and violently evacuated the approximately 8,000 workers and residents. As of March 2022, the entire zone was razed of all informal e-waste management activities, leaving only a technical training facility operated by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and Pure Earth's recycling containers. Residual informal e-waste management has been displaced and decentralized, with uncertain impacts on population health and environmental quality. The recent eviction occurred without public warning, and the destabilization of people including migrant workers meant the loss of progress made over many years by grassroots-level advocates of labor and environmental justice to improve the condition of workers and prevent rampant environmental pollution.[27]

The second case study focuses on the employment of prisoners in e-waste management facilities and presents special opportunities to explore challenges faced by strategies for inclusive integration of environmental justice principles, including fair treatment and meaningful engagement. Since its inception in the United States in 1997, the use of prison labor for e-waste management has provoked concerns about human rights and environmental justice. In November 2022, a U.S. federal judge ruled that UNICOR (Federal Prison Industries, Inc.)[28] must pay nearly $995,000 in fines regarding the careless abandonment of 14 million pounds of e-waste, in violation of regulatory policies against dumping (Figure 2).[29] This recent litigation with a penalty imposed on UNICOR about e-waste is surprising because of the company's history of violations of occupational and environmental health statutes, and the progressive reforms that were supposed to have been implemented and publicly advertised.[30] For more than two decades, UNICOR's operations on behalf of the U.S. government to employ prisoners in e-waste management have been highly controversial.[31] In response to whistleblower allegations, the U.S. Office of the Inspector General conducted a lengthy investigation in collaboration with the Occupational Safety and Health Administration (OSHA), the Centers for Disease Control and Prevention (CDC), the National Institute for Occupational Safety and Health (NIOSH), the Federal Occupational Health Service (FOH), and the Environmental Protection Agency (EPA). The report of the investigation, released in 2010, concluded that UNICOR violated several health and safety regulations through its management of e-waste in the Bureau of Prisons.[32] The investigation included 200 interviews with stakeholders and resulted in more than 150 recommendations for reform, focusing primarily on technical and operational procedures. Although many prisoners felt lucky, initially, to be assigned to e-waste management duties, some have expressed regret after leaving prison and blame current health problems on hazardous exposures that occurred while they were working in UNICOR e-waste management facilities. There is currently no institutional framework to address ex-inmate concerns in a manner similar to how the recent e-waste dumping and environmental pollution problems associated with UNICOR's e-waste management operation were addressed through litigation.[33] Some states, including California, have established similar programs for using prison labor for e-waste management.[34] The incentive is both the profitability of the business model and the growing stream of e-waste from governmental agencies. A deeper understanding of the intersection of labor, human rights, and environmental concerns can inform the development of a robust agenda whereby initiatives and reforms to improve fair treatment of workers and meaningful engagement take into account the uncertainties associated with the experiences of people who are temporarily incarcerated, the time lapse between occurrence of activity and discovery or remediation of environmental pollution, and the geographic distance between origin of e-waste and eventual disposal.

Tempering Antagonistic Agendas to Engage Manufacturers in E-Waste Justice

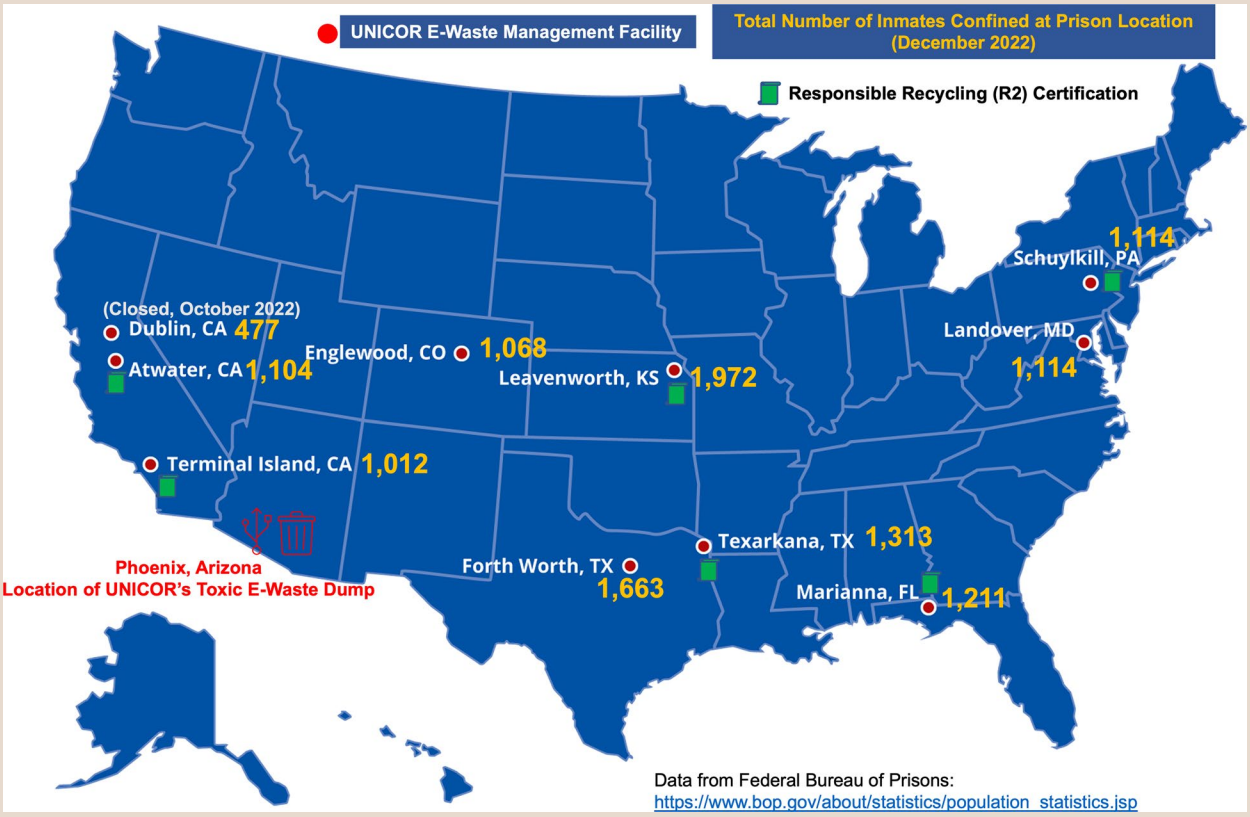
Frequently, the relationship between the environmental justice movement and corporate manufacturers is defined by antagonistic litigation. For example, in 2019, the International Rights Advocates (IRA) filed an injunctive relief and damages class-action lawsuit against electronics manufacturers, including Apple, Dell, Google, and Tesla, on behalf of 14 families and injured children in the Democratic Republic of Congo, seeking damages for forced labor, unjust enrichment, negligent supervision, and intentional

Figure 1. Electronic waste management in many parts of the world is dangerous labor that exposes people and the environment to toxic chemicals. (A, B) In the market depicted in these images, defunct electronic and electrical equipment are manually disassembled. The arrow in panel A points to a natural creek abutting the e-waste dump. (C, D) E-waste is typically burned to recover small amounts of precious metals or to reduce the volume of solid waste, including printed circuit boards likely made with tin–lead solder, leading to contamination of water systems, air, and soil.

Photographs from the author.

infliction of emotional distress associated with informal cobalt mining.[35] At the tail end of the materials life cycle of electronics, some have called for an international tribunal for e-waste to establish forums for claims that serve as a temporary monetary solution to human rights violations caused by illicit international transactions.[36] Retailers are not immune from litigation about e-waste dumping. In December 2021, the California Attorney General filed a lawsuit against Walmart based on the allegation that the company has transported hazardous e-waste collected at store locations across California to municipal landfills.[37] Prosecuting large corporations by government agencies on behalf of the people they represent in domestic courts may be routine in litigious societies, but it is more challenging to litigate international cases on behalf of communities of loosely organized informal workers. It is necessary to take appropriate legal actions against environmental injustice, and the lawsuits about e-waste transactions that violate international conventions and domestic regulatory policies must continue. A complementary

Figure 2. As of 2022, UNICOR operated e-waste management facilities at 10 locations for the Federal Bureau of Prisons. In 2010, a report of the Department of Justice's investigation faulted UNICOR for violations of health and environmental regulations that endangered prisoners' health. In 2022, UNICOR was found liable for a contaminated warehouse site located in Phoenix, Arizona, a finding that demonstrates that environmental justice reforms to improve fair treatment of workers and meaningful engagement are fraught with uncertainties across people who are temporarily incarcerated, the time lapse between an occurrence of activity and discovery or remediation of environmental pollution, and the geographic distance between origin of e-waste and eventual dumping.



strategy should also be nurtured to engage multinational corporations that benefit tremendously from global sales of electronic products to be proactive in the environmental justice movement regarding e-waste. Investments in childhood education and training of laborers managing e-waste could be a way to move beyond antagonistic relationships between industrial manufacturers, environmental nongovernmental organizations, and communities of workers who need e-waste management jobs to be available, protected, and harmless to people and the planet.

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NOTES

1. Citing proprietary considerations, manufacturers are secretive about the bill of materials in most electronic products, particularly the latest models. Several research projects have attempted to back-engineer electronic products by analyzing the chemicals that leach out of products or conducting a composite chemical analysis. For examples, see J. D. Lincoln, O. A. Ogunseitan, J.-D. Saphores, and A. A. Shapiro, "Leaching Assessments of Hazardous Materials in Cellular Telephones," *Environmental Science and Technology* 41, no. 7 (2007), 2572–78; D. Kang, M.

Chen, and O. A. Ogunseitan, "Potential Environmental and Human Health Impacts of Rechargeable Lithium Batteries in Electronic Waste," *Environmental Science & Technology* 21, no. 47 (2013), 5495–503, doi:10.1021/es400614y; K. Hibbert and O. A. Ogunseitan, "Risks of Toxic Ash from Artisanal Mining of Discarded Cellphones," *Journal of Hazardous Materials* 278 (2014), 1–7; N. Nimpuno and C. Scruggs, "Information on Chemicals in Electronic Products: A Study of Needs, Gaps, Obstacles and Solutions to Provide and Access Information on Chemicals in Electronic Products," TemaNord 2011:524 (Nordic Council of Ministers, Copenhagen, 2013), ISBN 978-92-893-2218-8, https://www.diva-portal.org/smash/get/diva2:702629/FULLTEXT01.pdf.

2. There is an active lawsuit against major electronics manufacturing corporations regarding child labor and unsafe conditions for cobalt mining. See V. Aalto, "The Development of Social Supply Chain Actions as a Result of Stakeholder Pressure: Focus on Companies Using Cobalt Mined From DRC" (2022); A. Kelly, "Apple and Google Named in US Lawsuit Over Congolese Child Cobalt Mining Deaths," *The Guardian* (2019), 16; C. Brown, A. Daniels, D. S. Boyd, A. Sowter, G. Foody, and S. Kara, "Investigating the Potential of Radar Interferometry for Monitoring Rural Artisanal Cobalt Mines in the Democratic Republic of the Congo," *Sustainability* 12, no. 23 (2020), 9834.
3. Most cities have no infrastructure for the public to properly dispose or manage hazardous e-waste. In the United States, most households store up to four small defunct electronic devices that are eventually discarded in general waste. The trend in e-waste toxicity has changed as devices are miniaturized, Some notorious toxic metals have been phased out (e.g., lead), but new toxic materials or poorly characterized chemicals are introduced with innovation in functional features. See J.-D. M. Saphores, H. Nixon, O. A. Ogunseitan, and A. A. Andrew, "How Much E-Waste Is There in US Basements and Attics? Results From a National Survey," *Journal of Environmental Management* 90, no. 11 (2009), 3322–31; M. Chen, O. A. Ogunseitan, J. Wang, H. Chen, B. Wang, and S. Chen, "Evolution of Electronic Waste Toxicity: Trends in Innovation and Regulation," *Environment International* 89 (2016): 147–54; V. Murthy and S. Ramakrishna, "A Review on Global E-Waste Management: Urban Mining Towards a Sustainable Future and Circular Economy," *Sustainability* 14, no. 2 (2022), 647.
4. World Health Organization, "Children and Digital Dumpsites: E-Waste Exposure and Child Health" (2021), https://apps.who.int/iris/bitstream/handle/10665/341718/9789240023901-eng.pdf. For specific case study of complex issues surrounding e-waste impacts on people and the environment, see P. C. Little, *Burning Matters: Life, Labor, and E-Waste Pyropolitics in Ghana* (Oxford University Press, 2021); P. C. Little and G. A. Akese, "Centering the Korle Lagoon: Exploring Blue Political Ecologies of E-Waste in Ghana," *Journal of Political Ecology* 26, no. 1 (2019), 448–65.
5. Numerous toxic chemicals found in e-waste have been independently and collectively linked to a variety of health effects, including cancers, reproductive harm, respiratory diseases, and cognitive challenges. For examples, see N. Singh, O. A. Ogunseitan, and Y. Tang, "Systematic Review of Pregnancy and Neonatal Health Outcomes Associated With Exposure to E-Waste Disposal," *Critical Reviews in Environmental Science and Technology* (2020), doi:10.1080/10643389.2020.1788913; S. M. Parvez, F. Jahan, M. N. Brune, J. F. Gorman, M. J. Rahman, D. Carpenter, Z. Islam, M. Rahman, N. Aich, L. D. Knibbs, and P. D. Sly, "Health Consequences of Exposure to E-Waste: An Updated Systematic Review," *Lancet Planetary Health* 5, no. 12 (2021), e905–920; S. Lin, M. U. Ali, C. Zheng, Z. Cai, and M. H. Wong, "Toxic Chemicals From Uncontrolled E-Waste Recycling: Exposure, Body Burden, Health Impact," *Journal of Hazardous Materials* 426 (2022), 127792.
6. The literature on environmental justice is extensive, and various definitions and case studies have been published. In this article I adopt the definition offered by the U.S. Environmental Protection Agency, noting that environmental justice is "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies. Additionally, fair treatment means no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental and commercial operations or policies; and meaningful involvement means that people have an opportunity to participate in decisions about activities that may affect their environment and/or health; The public's contribution can influence the regulatory agency's decision; Community concerns will be considered in the decision-making process; and Decision makers will seek out and facilitate the involvement of those potentially affected." Also, see U.S. Environmental Protection Agency, "Learn About Environmental Justice," https://www.epa.gov/environmentaljustice/learn-about-environmental-justice, accessed 17 September 2022; K. Wang, J. Qian, and S. He, "Contested Worldings of E-Waste Environmental Justice: Nonhuman Agency and E-Waste Scalvaging in Guiyu, China," *Annals of the American Association of Geographers* 111, no. 7 (2021), 2165–84; G. A. Akese and P. C. Little, "Electronic Waste and the Environmental Justice Challenge in Agbogbloshie," *Environmental Justice* 11, no. 2 (2018), 77–83; A. Iles, "Mapping Environmental Justice in Technology Flows: Computer Waste Impacts in Asia," *Global Environmental Politics* 4, no. 4 (2004), 76–107; P. C. Little and C. Lucier, "Global Electronic Waste, Third Party Certification Standards, and Resisting the Undoing of Environmental Justice Politics," *Human Organization* 76, no. 3 (2017), 204–14; B. Bakhiyi, S. Gravel, D. Ceballos, M. A. Flynn, and J. Zayed, "Has the Question of E-Waste Opened a Pandora's Box? An Overview of Unpredictable Issues and Challenges," *Environment International* 110 (2018), 173–92; T. De Loughry, "Incendiary Devices: Imagining E-Waste Frontiers and Africa's Digital Futures," *CLCWeb: Comparative Literature and Culture* 24, no. 1 (2022), 17; Basel Action Network, "Exporting Harm: The High-Tech Trashing of Asia" (2002), http://www.ban.org/Ewaste/technotrashfinal-comp.pdf.
7. In a recent publication, I argued that sustainability challenges of the electronics industry include mitigating and preventing environmental pollution and the mining of raw minerals using child labor. These challenges are opportunities to revise the electronics revolution into a circular economy in which e-waste can be recycled into materials to produce new, less toxic devices. See O. A. Ogunseitan, "Bending the Curve of the Electronics Revolution Toward a Circular Economy of E-Waste," *One Earth* (2022), https://doi.org/10.1016/j.oneear.2022.10.016.
8. At least 5.1 Mt of e-waste was moved in 2019 across international borders and about 70% of this amount was not controlled or monitored through international regulations. See C. P. Baldé, E. D'Angelo, V. Luda, O. Deubzer, and R. Kuehr, "Global Transboundary E-Waste Flows Monitor," United Nations Institute for Training and Research (UNITAR) Bonn, Germany (cited October 26, 2022), https://api.globalewaste.org/publications/file/286/Global-Transboundary-E-waste-Flows-Monitor-2022.pdf.
9. The Basel Action Network (BAN), a nongovernmental organization, is among the most prolific champions of the concern about international trade in e-waste. BAN's E-Trash Transparency project uses embedded geographic positioning system (GPS) monitors to track the location and transportation of e-waste. See https://www.ban.org/trash-transparency (accessed 17 September 2022). The United States is not a signatory to the United Nations Basel Convention on the Transboundary Movement of Hazardous Waste and Its Disposal, which covers e-waste. Parties to the Basel Convention have debated the topic of banning, restricting, or at least identifying with public notification, any international transactions in e-waste. At their 15th Conference of Parties to the Basel Convention, consensus was reached on the "Swiss–Ghana Amendments," which established new definitions of electronic waste hazard categories and affirmed that international movements of e-waste either be banned or require notification by the exporting country and consent by the importing country before exportation.
10. See U.S. Congress, 117th Congress (2021–2022), H.R.3036—Secure E-Waste Export and Recycling Act, https://www.congress.gov/bill/117th-congress/house-bill/3036/text?r=11&s=7 (accessed 17 September 2022).
11. The United Nations International Labor Organization (ILO) hosted the "Global Dialogue Forum on Decent Work in the Management of Electrical and Electronic Waste (E-Waste)" in April 2019 with participants from governments, employers' and workers' organizations, and intergovernmental and nongovernmental organizations. At the ILO Centenary, the Forum adopted 17 points of consensus, including point number 3:

    > While recognizing that e-waste represents challenges and opportunities in all countries, most work on the management of e-waste in some developing countries takes place in the informal economy in poor conditions, with limited opportunities for workers to organize and improve their livelihoods. While there is a lack of hard statistics, there are reports that in some countries a higher proportion of women than men work in particularly vulnerable situations, and that the work is sometimes carried out by children in contravention of the ILO's Worst Forms of Child Labour Convention, 1999 (No. 182).

    Point number 6 addressed the context of policies and regulations:

    > Coherent and effective laws, regulation and policies, as appropriate, that take into account international labour standards, where relevant, are key to advancing decent work in the management of e-waste. Social dialogue in all its forms is essential to engaging governments and employers' and workers' organizations in the formulation of such laws, regulations and policies, and to ensuring that they are effectively coordinated and implemented in practice. This in turn requires that freedom of association and the effective recognition of the right to bargain collectively are guaranteed in law and practice.

    See International Labor Organization, "Global Dialogue Forum on Decent Work in the Management of Electrical and Electronic Waste (E-Waste) (2019), https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/meetingdocument/wcms_685681.pdf (accessed 17 September 2022).
12. N. Singh and O. A. Ogunseitan, "Disentangling the Worldwide Web of E-Waste and Climate Change Co-Benefits," *Circular Economy* 1, no. 2 (2022), 100011, https://doi.org/10.1016/j.cec.2022.100011.
13. Supreme Court of the United States, *Impression Products, Inc. v. Lexmark International, Inc., certiorari to the United States Court of Appeals for the Federal Circuit No. 15–1189*. Argued March 21, 2017—decided May 30, 2017, https://www.supremecourt.gov/opinions/16pdf/15-1189_ebfj.pdf (accessed 17 September 2022).
14. Apple, Inc., 2021. "Apple Announces Self Service Repair," (2021), https://www.apple.com/newsroom/2021/11/apple-announces-self-service-repair (accessed 17 September 2022).
15. California Legislative Information, SB-983, Consumer Warranty Protection: Express Warranties (2021–2022), https://leginfo.legislature.ca.gov/faces/

billNavClient.xhtml?bill_id=202120220SB983 (accessed 17 September 2022).

16. International Labor Organization, "Guidelines for a Just Transition Towards Environmentally Sustainable Economies and Societies for All" (2015), https://www.ilo.org/wcmsp5/groups/public/@ed_emp/@emp_ent/documents/publication/wcms_432859.pdf (accessed 17 September 2022).
17. A recent assessment of the impact of community engagement studies showed a wide range of approaches, many with little or no impact in terms of environmental outcomes or legislative policy-related outcomes. See D. H. Williamson, "Using the Community Engagement Framework to Understand and Assess EJ-Related Research Efforts," *Sustainability* 14, no. 5 (2022), 2809; K. Larsen, U. Gunnarsson-Östling, and E. Westholm, "Environmental Scenarios and Local-Global Level of Community Engagement: Environmental Justice, Jams, Institutions and Innovation," *Futures* 43, no. 4 (2011), 413–23; R. Holifield, M. Porter, and G. Walker, "Spaces of Environmental Justice: Frameworks for Critical Engagement," *Antipode* 41, no. 4 (2009), 591–612.
18. O. A. Ogunseitan, "The Basel Convention and E-Waste: Translation of Scientific Uncertainty to Protective Policy," *Lancet Global Health* 1, no. 6 (2013), e313–14, doi:10.1016/S2214-109X(13)70110-4.
19. According to its key theoreticians, post-normal science was developed to "address practical problems in which facts are uncertain, values in dispute, stakes high and decisions urgent. It challenged traditional assumptions about scientific knowledge when employed in the policy process." See S. Funtowicz and J. Ravetz, "Post-Normal Science," in *Companion to Environmental Studies* (Routledge, 2018), 443–47, ebook ISBN 9781315640051; S. O. Funtowicz and J. R. Ravetz, "Uncertainty, Complexity and Post-Normal Science," *Environmental Toxicology and Chemistry: An International Journal* 13, no. 12 (1994), 1881–85, https://doi.org/10.1002/etc.5620131203; J. Turnpenny, M. Jones, and I. Lorenzoni, "Where Now for Post-Normal Science? A critical review of Its Development, Definitions, and Uses," *Science, Technology, & Human Values* 36, no. 3 (2011), 287–306, https://doi.org/10.1177/0162243910385789; A. Carlsson-Kanyama, K. H. Dreborg, H. C. Moll, and D. Padovan, "Participative Backcasting: A Tool for Involving Stakeholders in Local Sustainability Planning," *Futures* 40 (2008), 34–46.
20. The International Labor Organization (ILO) oversees the United Nations' Decent Work Agenda and its four pillars: employment creation, social protection, rights at work, and social dialogue. Work in the e-waste sector in many poor countries only satisfies the requirements of the first of these pillars. There is no guaranteed social protection, rights, or dialogue with government authorities. The principle of decent work intersects the environmental justice framework. On the 2014 World Day of Social Justice, the UN Secretary-General stated that "Experience shows that economic growth, on its own, is not sufficient. We must do more to empower individuals through decent work, support people through social protection, and ensure the voices of the poor and marginalized are heard." See International Labor Organization, "Decent Work," https://www.ilo.org/global/topics/decent-work/lang–en/index.htm (accessed 17 September 2022).
21. My understanding of the anthropological perspectives of e-waste and the need to situate interventions in local contexts owe much to my discussion with Peter Little, who has worked extensively with informal e-waste processors in Ghana. He is the author of a book on the subject: P. C. Little, *Burning Matters: Life, Labor, and E-Waste Pyropolitics in Ghana* (Oxford University Press, 2021).
22. N. Singh and O. A. Ogunseitan, "Disentangling the Worldwide Web of E-Waste and Climate Change Co-Benefits," *Circular Economy* (2022), https://doi.org/10.1016/j.cec.2022.100011.
23. N. Singh, O. A. Ogunseitan, and Y. Tang, "Systematic Review of Pregnancy and Neonatal Health Outcomes Associated With Exposure to E-Waste Disposal," *Critical Reviews in Environmental Science and Technology* (2020), doi:10.1080/10643389.2020.1788913.
24. S. Cousins, "WHO Calls for Action on E-Waste," *Lancet* 397, no. 10293 (2021), 2453, https://doi.org/10.1016/S0140-6736(21)01435-5.
25. Top Ten Toxic Threats: Agbogbloshie, Ghana: The site is reputed to be the second largest e-waste processing area in western Africa with approximately 215,000 tons of used electronics imported annually, and about 129,000 tons of e-waste generated locally. See https://www.worstpolluted.org/projects_reports/display/107 (accessed 12 December 2022).
26. In comparison, the U.S. EPA standard for lead in soil is 400 ppm. See J. Caravanos, E. Clark, R. Fuller, and C. Lambertson, "Assessing Worker and Environmental Chemical Exposure Risks at an E-Waste Recycling and Disposal Site in Accra, Ghana," *Journal of Health and Pollution* 1, no. 1 (2011), 16–25, https://doi.org/10.5696/jhp.v1i1.22; T. Feldt, J. N. Fobil, J. Wittsiepe, M. Wilhelm, H. Till, A. Zoufaly, G. Burchard, and T. Göen, "High Levels of PAH-Metabolites in Urine of E-Waste Recycling Workers From Agbogbloshie, Ghana," *Science of the Total Environment* 466 (2014), 369–76, https://doi.org/10.1016/j.scitotenv.2013.06.097; S. A. Takyi, N. Basu, J. Arko-Mensah, D. Dwomoh, K. G. Houessionon, and J. N. Fobil, "Biomonitoring of Metals in Blood and Urine of Electronic Waste (E-Waste) Recyclers at Agbogbloshie, Ghana," *Chemosphere* 280 (2021), 130677, https://doi.org/10.1016/j.chemosphere.2021.130677.
27. G. Akese, U. Beisel, and M. Chasant, "Agbogbloshie: A Year After the Violent Demolition," *African Arguments* (2022), https://africanarguments.org/2022/07/agbogbloshie-a-year-after-the-violent-demolition.
28. UNICOR is the trade name of the Federal Prison Industries program that was established in 1934 by President Franklin D. Roosevelt. It is a wholly owned corporation of the U.S. government and expected to be self-supporting without taxpayer funds. The profitable business model is based in part on the low wages earned by prison inmates, while the products are sold on the open market at competitive prices. This model has provoked criticism about labor justice, while UNICOR responds that its program trains prisoners on a career path and creates safer prisons and reduced recidivism.
29. S. Hawkins, "UNICOR to Pay $1 Million to Clean Up Electronic Recycling Waste," *Bloomberg Law* (2022), https://news.bloomberglaw.com/environment-and-energy/unicor-to-pay-1-million-to-clean-up-electronic-recycling-waste (accessed 11 December 2022); J. Paben, "Suit Targets Closed Loop E-Scrap Suppliers in Arizona," *Resources Recycling* (2022), https://resource-recycling.com/recycling/2022/12/05/suit-targets-closed-loop-e-scrap-suppliers-in-arizona (accessed 11 December 2022).
30. UNICOR published an approximately 5-minute video of reforms and practices regarding e-waste management associated with correctional facilities, with the note that its factories are regulated and operate in accordance with all applicable federal, state, and local EPA regulations, with full-time safety managers, third-party inspections by OSHA (state, federal, and the EPA), state permitting, annual complete environmental compliance testing, and monthly safety training and instructions. See https://www.unicor.gov/RecyclingProcessVideo.aspx (accessed 12 December 2022).
31. D. Bernstein, "Prison-Based e-Waste Processing—The Consequences to Business, Health and Safety" (2013), https://iaitam.org/prison-based-e-waste-processing-the-consequences-to-business-health-and-safety (accessed 11 December 2022).
32. The Department of Justice Office of the Inspector General concluded that "prior to 2009 UNICOR's management of the e-waste recycling program resulted in numerous violations of health, safety, and environmental laws, regulations, and BOP policies. We concluded that UNICOR's Headquarters staff poorly managed UNICOR's e-waste program prior to 2009. UNICOR staff members often failed to perform hazard assessments on new e-waste operations or did so incorrectly, and important health and safety information was not shared with BOP executives and safety staff that could have prevented the violations from occurring." Also see U.S. Department of Justice, "A Review of Federal Prison Industries' Electronic-Waste Recycling Program" (2010), https://oig.justice.gov/reports/BOP/o1010.pdf (accessed 12 December 2022); S. M. Conrad, "A Restorative Environmental Justice for Prison E-Waste Recycling," *Peace Review* 23, no. 3 (2011), 348–55, https://doi.org/10.1080/10402659.2011.596071; G. Dayaneni and A. Shuman, "Toxic Sentence: Captive Labor and Electronic Waste," *Race, Poverty & the Environment* 14, no. 1 (2007), 45–46, https://www.urbanhabitat.org/files/RPE14-1_Dayaneni-Shuman-s.pdf.
33. S. Conrad, "Mothers, Toxicity, and the School-to-Prison Pipeline," in A. Nocella II, K. Ducre, and J. Lupinacci, eds., *Addressing Environmental and Food Justice Toward Dismantling the School-to-Prison Pipeline* (New York: Palgrave Macmillan, 2017), https://doi.org/10.1057/978-1-137-50822-5_9.
34. The California Prison Industry Authority (CALPIA) E-Waste Program was established in part to meet the legislature's goal of 75% recycling, composting, or source reduction of solid waste by 2020, and in retrospect, it is clear that this goal has was not met for e-waste. See https://catalog.calpia.ca.gov/services/e-waste (accessed 12 December 2022).
35. The International Rights Advocates (IRA) brought the lawsuit under the Trafficking Victims Protection Reauthorization Act ("TVPRA"), 18 U.S.C. § 1595 et. seq. The companies each denied responsibility; for example, the statement from Microsoft was "We hold our suppliers to the high standards prescribed in our supplier code of conduct, including upholding human rights, labour, health and safety, environmental and business ethics. While we continue to work with non-governmental organisations to help bring an end to child labour in the DRC and beyond, we have filed a motion to dismiss this suit. The claims are without merit and we believe that the court will agree." The court did dismiss the case on 2 November 2021. However, IRA filed a notice of appeal, and on 8 August 2022 filed the Appellants' Opening Brief. See International Rights Advocates, "Multinational Companies Are Liable for Human Rights Abuses Within Their Supply Chains," https://www.internationalrightsadvocates.org/cases/cobalt (accessed 18 September 2022).
36. E. McIntire, "The International Tribunal for E-Waste: Ending the Race Towards Lethal Fallout," *Seattle Journal of Environmental Law* 5, no. 1 (2015), article 4, https://digitalcommons.law.seattleu.edu/sjel/vol5/iss1/4.
37. R. Bonta, *The People of the State of California, Plaintiff, v. Walmart Inc., a Delaware Corporation; and DOES 1-100, Inclusive. Complaint for Injunctive Relief, Civil Penalties, and Other Relief. Superior Court of the State of California, County of Alameda* (2021), https://oag.ca.gov/system/files/attachments/press-docs/E-filed%20Complaint%20-%20Peo.%20v.%20Walmart.pdf (accessed 18 September 2022).