MAKING AND UNMAKING E-WASTE: TRACING THE GLOBAL AFTERLIFE OF DISCARDED DIGITAL TECHNOLOGIES IN BERLIN

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This dissertation examines the politics and practices of contemporary management of waste from electrical and electronic equipment (e-waste or WEEE) in Germany. Contrary to predictions that the digital revolution would lead to less resource-intensive and thus more sustainable societies, this study documents the opposite. Global consumption of digital technologies such as personal computers, cell phones and iPods is exacting significant environmental and health costs. Through ethnographic and archival research this project reconstructs how social actors, including policymakers, multi-national firms and informal recyclers, transform discarded technologies once they are placed on the curb. The resulting analysis shows how the environmental and social impact of a technological artifact extends over its entire lifecycle.

Germany's reputation for exemplary waste management and, more generally, environmentalism, coupled with its status as Europe's largest e-waste producer and exporter, makes it a powerful site to examine the tensions and contradictions between national attempts to address e-waste and the existence of globalized licit and illicit e-waste networks that unequally distribute the associated pollution and wealth across the globe.

This project integrates, builds on and extends scholarship from the fields of Science and Technology Studies and Development Sociology. Such an integration is necessary to analyze how the afterlife of electrical and electronic equipment is shaped

by and reinforces uneven global political, economic and ecological relationships in a postcolonial context. Equally important, this work engages with recent debates in the social sciences on the boundaries between technology, society and ecology, the co-production of the social and the material, as well as the relationship between globalization and the environment. It reworks and extends key concepts in the social studies such as fetishization, the black box, technological systems and regimes of perceptibility while proposing new concepts including the notion of "unmaking" and "the green box." As countries across the globe are struggling to manage their e-waste, this study of Germany offers important clues to the challenges associated with developing efficient and responsible e-waste management systems. Furthermore, this project provides a concrete ethnographic and archival study of the effects and limitations of national formulations of environmental policies in an uneven globalized economy.

BIOGRAPHICAL SKETCH

Djahane Banoo Salehabadi was born on November 12, 1978, in Munich, Germany. She grew up in Canada and spent her high school years in Switzerland. In 2002, she graduated with a BA in Earth and Atmospheric Sciences from Dartmouth College. She currently lives in Switzerland with her husband, Martin Gutmann, and her two sons, Espen and Emil.

To Espen, Emil, and Martin, my “bestest”

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CHAPTER 1: INTRODUCTION: MAKING, UNMAKING AND REMAKING

About This Mac

I wrote this dissertation on a white MacBook that I bought in June of 2008, right before I went to Ghana to conduct preliminary research on the informal recycling of electrical and electronic equipment. My laptop is the most important tool I own. I use it to write and research, calculate and communicate. I also use it to keep in touch with my family and friends, watch movies, listen to music, shop, and document my life through pictures and videos. I use it all day, every day.

My computer has a 32.5 cm screen. It is white, sleek and weighs roughly 2.25 kg. I click on the "About This Mac" tab under the Apple icon and learn that my computer is a Mac OS X Version 10.5.8 with a 2.1 GHz Intel Core 2 Duo Processor. I have 1GB of memory and 667 MHz DDR2 SDRAM. The "More Info" tab reveals that my Mac is a 4,1 model with dual Cores, an L2 Cache of 3MB, and a Bus Speed of 8000 MHz. On the left side of the window are countless tabs for retrieving more technical information about my computer's hardware and software. This information is largely indecipherable to me.

There seems to be an endless supply of technical information at my fingertips. Yet there is no tab that tells me about the Foxconn and Inventec factories in Shenzhen, Chengdu or Chongqing where my computer was probably manufactured.[1] I cannot click on a button to find out about the tantaline mine in the northern Katanga district of the Democratic Republic of the Congo where workers extract coltan–a key component in my computer's capacitor. No "More Info" button discloses the origins

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[1] A number of recent news reports have focused on the social costs of ICT equipment manufacturing. For instance, see the New York Times' "iEconomy" series ("The iEconomy," 2013). See also the Daily Telegraph's exposé (M. Moore, 2012).

and composition of the flame-retardant white plastic cover stained by years of eating while working. Nor does it allow me to taste the acrid smoke in Agbogbloshie market in Ghana where children burn computer casings. That governments, the recycling industry, environmental organizations and informal waste handlers are presently engaged in an intense struggle over the toxic and valuable innards of my computer is far from a mouse click away.

This Dissertation

Things—be they commodities, technological artifacts or everyday objects—are more than their physical form; they are crystallizations of socio-environmental relations and processes. These relations often extend across the globe, making and remaking particular places, relationships and institutions. Marxist political economists and scholars in the field of science and technology studies (STS) have written extensively on the social and environmental dimensions of production and use. In the pages that follow, I extend their work by reconnecting *discarded* ICT equipment with the social and environmental relations in and through which they are constituted.

I conducted ethnographic and archival research on discarded ICT equipment in Berlin between 2008 and 2011. In the pages below I describe and analyze what happens to discarded cell phones, computers and MP3 players once they are placed on the curb in Berlin, Germany. I reconstruct the everyday practices that make up ICT recycling on the ground—describing the actors involved, their relationships, the places they work, and the various ways in which they physically and discursively transform discarded digital equipment. I also analyze how these actors relate to each other and how existing local, national, regional and international infrastructures shape and are, in turn, shaped by the disposal process.

The Problem

Waste from electrical and electronic equipment (WEEE or e-waste) is a shorthand term that refers to a wide range of discarded technologies, such as washing machines, microwaves, hair dryers, light bulbs and vacuum cleaners. Items such as computers, cell phones, iPods and televisions fall under the rubric of electronic equipment. The European Union, the Organization for Economic Cooperation and Development (OECD) and the United Nations Environment Programme (UNEP) have all declared e-waste a priority waste stream. As a result, concern over e-waste over the past twenty years has grown among governments, NGOs, scholars and the media in Germany as well as the rest of the world.

The discourse on e-waste hinges on four points: abundance, toxicity, the uneven distribution of the environmental and health costs of disposal, and most recently, e-waste's potential value. According to the United Nations, global annual generation of WEEE runs anywhere between twenty and fifty million metric tons (Schwarzer, De Bono, Guiliani, & Kluser, 2005). Globally, e-waste represents the fastest growing waste stream.

A combination of rapid technological development, planned obsolescence—that is, the fact that technologies are "made to break" (Slade, 2006)—coupled with perceived obsolescence, drive the exponential growth in e-waste production. As an executive of a large computing firm described during an interview,

> . . . people's consumption habits also change. My parents, I think, bought in their entire life, maybe two TV's and two radios. I'm not sure how many I've bought in my life. You might think about how many you bought. So that's also happened. I think that my father had to pay two months' salary for his first TV. And if you have to pay two months' salary, you don't discard it after two years. But now, I think, there are some people who can buy a TV from one hour's salary. . . . No, but you can get them for 60 Euros. If you then move, you think, "Should I really keep it? No, come on." Then again, it goes back to habit. If you take mobile phones, that's the perfect example—the average life of a mobile phone is less than one year. Average usage time, not lifetime. We

> need to be very clear on the wording. (personal communication, March 9, 2010)

This ICT industry executive makes a critical distinction here between a product's lifetime and its usage time. He draws attention to perceived obsolescence's growing role in driving e-waste production.

The use of electrical and electronic equipment has grown exponentially in Germany since the 1960s. Recent studies estimate that Germany alone produces somewhere between 1.1 and 1.8 million metric tons of e-waste each year (Deutsche Umwelthilfe, 2006; Huisman, Magalini, Kuehr, & Maurer, 2007).[2] This translates to approximately 13 kg per resident, per year. Add business e-waste and the amount generated per resident jumps to 20 kg per annum.

Emerging markets in the developing world are not exempt from this trend. A report by UNEP and the United Nations University (UNU) estimates that, in certain emerging economies, e-waste production could grow by up to 500% over the next 10 years (Schluep, 2009).

E-waste's toxicity is also cause for great concern. Electronic goods contain noxious compounds such as polyvinyl chloride (PVC plastics), plastics rich in brominated flame-retardant, lead, mercury, cadmium, manganese and cobalt (Puckett et al., 2002). Older equipment can be tainted with arsenic. These substances can be, and often are, released during disposal and recycling. NGOs have published numerous reports characterizing the e-waste issue as an impending environmental crisis of epic proportions (Cobbing, 2008; Leonhardt, 2007; Puckett et al., 2002). The German media as well as numerous English-language newspapers and magazines followed suit, stressing this waste stream's potential hazardousness (Bitala, 2008; Denkler,

[2] See Deutsche Umwelthilfe 2006 report for a breakdown of estimated quantities of e-waste arising annually by category.

2006; Engelhardt, 2008; Granatstein, 2008, 2008; Höges, 2009; Pelley, 2008; Walsh, 2008, 2009; Wray, 2008).

Besides concerns over e-waste's sheer volume and potential danger, the uneven distribution of health and environmental costs associated with disposal are routinely the subject of NGO and media indignation. Their reports evoke powerful images of electronic dumps in China, Bangladesh, Pakistan and Ghana, which they assert represent some of the most toxic places in the world. They suggest that e-waste is the latest form of toxic waste dumping and that it displaces the environmental and social costs of the developed world's high-tech lifestyle to some of the most disadvantaged and vulnerable places.

Yet discarded equipment is also valuable. Over the past five years, scavengers, exporters, municipal waste authorities, waste handling firms and mining companies have become increasingly interested in e-waste as a potential source of revenue. E-waste has multiple values. Functional equipment is reusable, and thus holds value in second-hand markets. In addition, technologies can be mined for spare parts and base metals such as copper or aluminum. They are also a source of precious metals and rare earth elements. In fact, e-waste's potential value has led to a recent shift in popular discourse. In the early to mid 2000s, the talk was of toxicity, dumping and danger. Phrases such as "*vergiftete Flammen*," (poisoned flames) (Reinbold, 2008) and "*Höllenfeuer der Hightech-Welt*" (hellfire of the high tech world) (Bitala, 2008) were commonplace in media accounts. Around 2008–2009, right around the time of the world economic crisis, phrases such as "*Gold-Berge auf Müllhalden*" (Gold in the trash heap) (Bojanowski, 2010) and of "*Gold in der Tonne*" (gold in the bin) (V. P. Chancerel, 2009) and *"Schätze im Elektroschrott"* (treasures in e-scrap) (Entdecken, 2011) became popular.

The Place

The specific point of departure for this study is Berlin. The capital is Germany's largest city with a population of over three and a half million. It also hosts the country's oldest municipal waste management authority, the *Berlin Stadt Reinigung* (BSR). Moreover, Berlin is home to the country's largest immigrant scavenger population.

Formal and informal networks of disposal and trade link the city to the rest of the world. Disposal of end of life equipment is organized along a complex and interconnected global division of labor and environment. Discarded electrical and electronic equipment, in the form of reusable goods, spare parts, scrap, metal-rich components and toxic waste does not remain in Germany. It circulates and crisscrosses the globe. Thus, although the point of departure for this study is Berlin, I conceptualize the city as a node in a complex of social, economic, cultural and environmental relationships that are global in scale (Hart, 2002; Hopkins, 1978; McMichael, 1990; Tomich, 1994). In thinking of Berlin as a node constituted by its relationships to other places and, in turn, constitutive of other places, I seek to unsettle the tendency to reify the tidy boundary of the city or the country in my study.

Furthermore, Germany embodies a paradox. As a supposedly model country, Germany has a long-standing reputation as a global leader in solid waste management and, more recently, e-waste handling (Schreurs, 2002). This reputation is well deserved. Germany recognized and addressed the e-waste issue in the mid 1990s, through its first electronic waste policy called the *IT-Altgeräte-Verordnung* (ITV). The country also played a pivotal role in the development of European-wide guidelines, specifically the European Waste Electrical and Electronic Equipment Directive (WEEE Directive) and the Restriction of Hazardous Substances Directive (RoHS Directive), the two most comprehensive and forward-looking e-waste policies the world.[3] In 2005, Germany transposed these EU directives into national law through the Electrical and Electronic Equipment Act (ElektroG).[4] Member states have substantial leeway in how they interpret the European directives into national policy. Germany's national e-waste policy stands out as stringent and comprehensive.

However, despite the country's forward-thinking e-waste policies and extensive waste handling infrastructure, Germany is not only Europe's biggest e-waste producer, but also most likely its biggest exporter. Germany can only account for twenty to at best fifty percent of its electronic and electrical waste each year (Huisman et al., 2007). While some of this refuse goes to landfills, many suspect that the majority is exported. A recent report by Ökopol—a German environmental policy think tank—estimated that up to 216 000 metric tons of e-waste flows out of Germany to the developing world each year (Sander & Schilling, 2010). It is these staggering export rates that prompt environmental groups such as Deutsche Umwelthilfe (DUH—German Environmental Relief) to provocatively dub Germany the "waste export world champion" and argue that the country's supposedly model environmental laws are actually causing more harm than good by incentivizing export (Leonhardt, 2007).

Thus, e-waste, and its exportation, is of enormous practical relevance in Berlin, Germany and beyond. Relatively little is known about this modern detritus, how it is handled, regulated, represented and where it ends up. In a time when countries around the world are struggling to manage their e-waste, this study of Germany offers important clues to the many legal, policy, ethical and environmental challenges

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[3] The WEEE Directive regulates collection and recycling of EEE. Its objective is to minimize the quantity of electric and electronic equipment (EEE) in the waste stream and to harmonize the disposal of waste from electrical and electronic equipment (WEEE or e-waste) across European nations. The RoHS directive restricts the use of certain hazardous substances in electrical and electronic equipment, specifically, lead, mercury, cadmium, chromium, VI Polybrominated biphenyl (PBB) and Polybrominated diphenylether (PBDE).

[4] Gesetz über das Inverkehrbringen, die Rücknahme und die umweltverträgliche Entsorgung von Elektro- und Elektronikgeräten.

associated with developing efficient and responsible e-waste management systems. Moreover, this study of e-waste in Berlin offers a concrete ethnographic and archival study of the limits and effects of national formulations of environmental policies in an uneven and globalized economy. As the recently failed climate negotiations in Copenhagen make evident, such insights are critical, perhaps now more than ever.

The Theories

Beyond its immediate policy relevance, this study makes a number of theoretical contributions. Located at the intersection of development studies and the socio-historical studies of technology, my analysis builds on, reworks and extends scholarship in these interlinked fields. In recent years, scholars in development studies have shifted their attention to the interplay between uneven global political-economic relationships and the environment (J Martinez-Alier, 2005; McMichael, 2009; Peet & Watts, 2004). Building on the field of political ecology, development sociologists have analyzed how access to environmental goods such as minerals, lumber and water, on the one hand, and the burdens of environmental bads such as toxic waste and pollution on the other hand, are mitigated by and reinforce patterns of poverty, wealth and power (Bryant & Bailey, 1997; J Martinez-Alier, 1995; Ribot, 1998; Robbins, 2004). By analyzing how Northern environmental policies and consumption patterns both rely on and affect the developing world, this dissertation adds to this literature. My study of ICT waste also contributes to the field of development sociology by explicitly engaging with waste and technology, two topics that often remain marginal to the field.

At the same time, recent scholarship in the STS subfield of envirotech has made important inroads for understanding the intersection between technology and the environment (Pritchard, 2011; Stine & Tarr, 1998). Drawing on this work, I explore how a focus on waste refines our understanding of key analytic tools from the field.

Specifically, I examine how analyzing the global afterlife of digital technologies extends three central STS concepts: the black box, materiality and technological systems. I address the first two concepts below. My discussion of technological systems follows in Chapter 2.

The Black Box

The conceptual separation of things—be they artifacts or commodities—from the social, cultural, economic and environmental relationships in and through which they are constituted is a key theme in both Science and Technology Studies (STS) and Marxist political economy. Social scientists and historians of technology use the concept of the "black box" to describe, analyze and, to some extent, undo the reification of technologies.

Engineers originally used the concept of the black box to refer to technologies that are widely used with little or no knowledge on the part of the user about how they function (Sismondo, 2003, p. 97). In this sense, a washing machine, toaster or a computer is a black box; very few of us know or deem it necessary to know how they work; yet we use them on a day-to-day basis. During the 1980s, STS scholars borrowed the concept to highlight how various actors render invisible the historicity and thus contingency of a scientific fact or a technological item. Where for STS scholars opening the black box of science involves recognizing that scientific truths are products of political struggle and compromise, taking a technology out of the black box means appreciating that there is no external, inherent standard towards which technological change inherently strives. That is, to take a technology out of the black box is to appreciate how racial and gender ideologies, cultural norms and political and economic relationships shape the development, design, production, adoption, and use of technologies as well as the meanings they take on (Pinch & Bijker, 1984; Scharff, 1992).

Marxist political economists do similar work, though they focus on the broad category of commodities and replace the image of "taking something out of the black box" with the notion of defetishization. Marx introduced the concept of "commodity fetishism" in *Das Kapital* (Marx, 1996). The notion of the fetish refers to how commodities take the form of "extremely obvious, trivial thing[s]" in capitalist societies. The tendency to portray commodities as essential and immutable entities severed from social relations is deceptive and dangerous, warned Marx, it makes partial and incomplete representations of things seem real. Marx saw the commodity as a microcosm or "economic cell" of capitalism. Consequently, commodity defetishization was a powerful way to unlock the mysteries of capitalist societies (Marx, 1996).

Not only do the black box and fetishization give the analyst the tools to peer behind the veil of the phenomenal, but they also bring in time and space. As long as actors and analysts focus on the relationship between reified things, their understanding of artifacts and commodities—as well as institutions, structures, or concepts, for that matter—remain ahistorical and aspatial (Watts, 2009). However, the moment the connection between the process of making and the object of analysis—be it sugar (Mintz, 1986) or the bicycle (Pinch & Bijker, 1984)— is made, spatial and temporal contingency becomes apparent. In this way, the act of connecting production with the commodity or artifact has political implications. If humans located in particular places and times make things a certain way then they can also, at least to some extent, remake them.

Invisibility, Waste and Wasting

Both STS and Marxist political economy—in particular the subfields of the Social Construction of Technologies (SCOT) (Bijker, Hughes, & Pinch, 1987; Pinch & Bijker, 1984) and commodity chain analysis (Collins, 2005; Koponen, 2004; Leslie &

Reimer, 1999; Ribot, 1998) help illuminate the connections between production and the commodity or artifact. They also provide the tools to analyze why and how certain actors conceptually and physically separate these two things.

Scholars in the emerging field of discard studies frequently complain that their particular discipline—be it sociology, political-economy, geography, anthropology, philosophy or history—overlooks waste. For instance, sociologist Martin O'Brien laments,

> It is as if, for the discipline of sociology in general, and for sociological theory in particular, nobody ever throws anything away or ever carries out the bin-bags for a "waste management authority" to deal with. It is as if, when you go to a shop, restaurant, club or place of work, you work, consume, or take your leisure without ever producing rubbish or detritus of any kind. Sociology treats "waste" as if it were literally immaterial, as if it existed in a world apart from the one we inhabit in our daily, routine lives. (O'Brien, 1999a, p. 62)

This provocative statement highlights a serious limitation. It is also a bit of an exaggeration. Things are not as dire as O'Brien suggests. Social scientists, including sociologists, have written quite a bit about waste, and for quite some time.[5] In particular, the past twenty years have witnessed a dramatic growth in scholarly engagement with garbage and the creation of a new multidisciplinary field called "discard studies" is proof of this.[6] This new wave of scholarship centered on waste contradict claims about waste's invisibility in social scientific literature (Åkesson, 2006, p. 42; G. M. Hawkins, 2003, p. xiv; S. Moore, 2008, p. 602).

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[5] Anthropologists have engaged with waste. Margaret Douglas dealt with the issue in her seminal book *Purity and Danger* (1966). Michael Thompson wrote *Rubbish Theory* (1979). Later Rathjee and Murphy published *Rubbish!* (1992) and started the Garbage Project at the University of Arizona. Historians have also written extensively about waste, in particular in the past 15 years (Barles, 2005; Clark, 2005; Melosi, 1981; Stine & Tarr, 1998; Strasser, 1999; Zimring, 2005). Geographers have also published on the subject (Gregson, Crewe, & Metcalfe, 2005; Gregson, Metcalfe, & Crewe, 2007; S. Moore, 2008) as have sociologists (Gille, 2007; Weinberg, Pellow, & Schnaiberg, 2000).

[6] See http://discardstudies.wordpress.com.

In *Rubbish Values: Reflections on the Political Economy of Waste* (1999b) O'Brien directs his criticism at what he claims is political economy's almost exclusive focus on production and consumption and their neglect of waste. Yet, as for sociologists in general, political economists cannot be accused of entirely ignoring refuse. Marx and Engels, for instance, engaged with waste in multiple instances, most notably through their theory of the metabolic rift. The theory of the metabolic rift describes and explains the rupture in town-country relations that go hand in hand with capitalist production. Whereas prior to capitalism organic "wastes" were returned to the soil, urbanization and industrialization rendered what had been a relatively circular production system linear—large amounts of resources where extracted from rural areas and transported to urban centers where they were consumed and eventually became garbage. The result was an accumulation of waste in urban centers and resource depletion in the countryside (Foster, 1999). The theory of the metabolic rift captures what Sabine Barles calls "the invention of waste" during the nineteenth century (Barles, 2005). It historicizes the concept of waste as a modern invention.

As sociologist of waste Zsuzsa Gille (Gille, 2007, p. 25) points out, waste was also an important topic for Marxist political economists of the 1960s and 1970s such as Paul Baran and Paul Sweezy (1966). Baran and Swezy wrote about what they believed was the tendency of capitalism to be wasteful. More recently, the field of environmental justice has engaged with waste as an environmental issue. The politics and economics of landfill and waste incinerator sitings are key objects of study in this field. This literature provides important insights for how and why the poor often carry the health and environmental burdens of waste processing (Bullard, 1990; Di Chiro, 1996; Pellow, 2004; Szasz, 1994). While much of this scholarship engages with domestic US waste, environmental justice scholars have also written on transnational waste flows (Clapp, 2001, 2002; Okereke, 2006; Pellow, 2007, 2008).

There is less engagement with waste in STS. The majority of biographies of technologies or studies of a technology's lifecycle end with consumption. Still, waste is not entirely absent. For instance, historians of technology such as Martin Melosi (Melosi, 1981, 1994) and Joel Tarr (Tarr, 1996, 2002) document the development and implementation of waste water and solid waste treatment systems in the US, as do the more recent studies by Sabine Barles (2005) and Carl Zimring (2005). Historian of technology, David Edgerton (2007), in turn, writes about the persistence and revival of "old" technologies. Christina Dunbar-Hester centers her work on the repair and reuse of obsolete computers and FM radios (Dunbar-Hester, 2008). Allison MacFarlane, among others, has worked on nuclear waste (MacFarlane, 2003). More recently, Finn-Arne Jørgenson (2011) published a study on recycling systems in Scandinavia. The key here, however, is that the focus in STS is often less on technologies *as* waste than on the technologies of waste management.

Thus, the problem is not that waste is entirely absent. This realization is likely what led O'Brien to amend his initial position. In a subsequent essay to *Rubbish Values*, O'Brien clarifies his complaint that sociologists assume that "nobody ever throws anything away" (1999a, p. 62). He explains that his critique is actually not so much that waste is entirely absent, but that the focus tends to be on the *object* of waste instead of the act of making, circulating and using waste, as well as the social construction of the category of waste. In other words, O'Brien takes issue with how these scholars represent garbage as a solid, given, unchanging thing. In light of this, he urges sociologists to engage with the "social process by which things become 'waste' and the social relationships that sustain and organize wastes as wastes" (O'Brien, 1999b, p. 269).

More recent studies echo this emphasis on the process of making and using waste. For instance, Gille calls for "a shift from waste to wasting" in social scientific analysis (2007, p. 18). Similarly, Gregson et al. (2007) stress the importance of focusing on "practices of divestment" rather than on the wasted object (p. 2). Hence, as these waste scholars underscore, the problem is not so much the invisibility of waste as the conceptual and empirical disconnect between waste and the social process of wasting.

Unmaking

Another way to frame the issue is to argue that more work needs to be done to connect the process of *unmaking* with the made. Like wasting, *unmaking* draws attention to the social and material processes that transform technologies once they are initially discarded. Both unmaking and wasting highlight that the "afterlife" of an object is a process that involves people, things, relationships, environments and structures all situated in particular places and times. However, I privilege unmaking over wasting to avoid what Kevin Hetherington refers to as "the conceptual slippage that equates disposal with waste" (2004). Wasting can suggest finality whereas unmaking captures the true complexity of an artifact's afterlives.[7]

Gregson et al. have put forth the concept of "divestment" as an alternative to disposal in order to underline that objects can and often do retain and regain value after they are thrown away. While I see the concept of divestment as a step in the right direction, I am not entirely satisfied with the term because it subtly suggests passivity. Unmaking, in contrast, immediately brings to mind the people who unmake objects, the places in which they work, and accentuates the process of change.

[7] Though I stress that discarded objects can regain value and thus challenge the finality implicit in the term wasting, I want to acknowledge that some things *do* become waste. Not all wastes are social constructions (Gille, 2007).

Moreover, though I may be splitting hairs, divestment still retains an air of unidirectionality. It also reinforces the conception of a total separation between systems of production and disposal. What I want to stress is that making and unmaking are simultaneous, overlapping and mutually constitutive processes and categories. Not only is the line between a technology's production, use and unmaking phase fluid, but the lifecycle of a commodity is anything but linear.[8] Artifacts, materials, people and knowledges travel back and forth between networks of ICT making and unmaking. For instance e-waste handlers extract copper, plastic, glass, platinum, and tantalum during the process of unmaking. These recovered materials are raw materials for new production. Not only are valuable materials transformed into new products, but toxic elements such as brominated flame-retardants or mercury also seep into production systems through contaminated landscapes, waterways or materials. At the same time, the process of physical transformation creates its own forms of refuse. For instance, the harvesting of platinum from circuit boards often creates toxic materials that have no value in today's economy.

In brief, a single artifact fractures into multiple entities as it is unmade. Importantly, the materiality of production, use and unmaking stages of an artifact or commodity's lifecycle overlap. For instance, the depletion of rare earth elements necessary for production of ICT equipment results in e-waste taking on new meanings. This also leads to new transportation practices and routes, new patterns of energy use and pollution, the development of new technologies and trade relations as well as new waste products, to name a few things.

As Douglas and Lawson (2000) explain,

[8] In this case, we can apply Hughes' concept of seamlessness to think in terms of seamless lifecycles.

> Declining resource quality [. . .] means that, behind the surging direct resource flows [. . .] there is a shadow material economy of energy and waste flows which also has expanded in volume and spatial extent. These hidden material flows surrounding the production of a given unit of energy or metal can be many times larger than the direct flows: for example, around 18 billion tons of material are dug up and displaced to produce the roughly four billion tons of coal mined each year; and for every ton of copper produced, nearly 200 tons of earth must be moved, sorted and processed.

Thus, unmaking makes it possible to challenge discrete, linear representations and understandings of the various stages of a technology's lifecycle.[9] The term facilitates the transcendence of the conceptual boundary that in conventional parlance separates the systems of production and disposal.

In a 2008 call for papers for the Annual Meeting of the American Association of Geographers, Jennifer Bair and Marion Werner invited scholars to examine the ways in which "hidden circuits of waste and pollution make global orderings of production possible" (Bair & Werner, 2011).[10] As Bair, Werner and other scholars working on networks of disarticulation show, taking the permeability between systems of making and unmaking into account opens up new areas of research for political economy in general and for commodity chain analysis in particular. How are systems of unmaking and making connected? How have these relationships changed over time? Why and by whom has the connection between these systems been concealed or, to put it slightly differently, what orderings has the dichotomy between making and unmaking reinforced? Thinking in terms of unmaking opens up space to consider these critical questions.

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[9] Importantly, while this dissertation works to reconnect making and unmaking at the conceptual level, I recognize that systems of making and unmaking are often as distinct in practice as they are in theory. The rupture between relations of making and unmaking are historically specific, and I engage with this separation in Chapter 3 titled *The Circular Economy.*

[10] As I discuss in Chapter 3, the German notion of *Abfallwirtschaft* (waste economy) attempts to capture this complexity.

Materialities

Theories of materiality from STS help draw attention to how discarded technologies are not mere social constructions. They have distinct material properties that shape the cultural meanings they take on, who handles them and how and where they end up (Callon, 1985; Crosby, 1988; G. Hecht, 1998; Igler, 2004; Latour, 2004; Law, 1987; Mitchell, 2002). For many years, the specter of technological determinism haunted the fields of STS and the history of technology. Technological determinism stands for the idea that technological development is driven by an independent inherent logic and that technology determines social change. The fear of determinism led STS scholars to emphasize technologies as social constructions. While the constructivist perspective furthered understandings of how social relationships shape technological development in many complex ways they failed to pay adequate attention to how the material characteristics of technologies can also influence social processes.

Critical of this theoretical gap, a handful of scholars, most notably Actor Network Theorists such as Callon (1985), Law (1987) and Latour (1987) called for a re-engagement with the material. They argued, as Trevor Pinch later aptly summarized, that "the social world is a world built of things, social action is through and through mediated by materiality, and social theory will remain impoverished unless it addresses this materiality" (c.f. Mitchell, 2002, p. 479; Pinch, 2008, p. 479).

This new materialism distinguishes itself from determinism, because rather than focus on the material in isolation it highlights the interactions between the social and material as co-constitutive dynamic categories (Allen & Hecht, 2001; Bakker & Bridge, 2006; Callon, 1985; Castree & Braun, 2001; Latour, 2000; Pritchard, 2011; Thrift, 1996; Whatmore, 2006).

The field of discard studies has also experienced a material turn. In her book on postsocialist Hungary, Zsuzsa Gille critiques the social scientific literature on waste for overlooking the materiality of refuse. She also takes issue with how waste scholars of the past have conceived of waste's material composition "as a backdrop or spur to social action" (Casper 2003 in Gille, 2007, p. 26). Gille argues that it is precisely because policymakers and analysts overlook waste's material composition that waste management policies are often ineffective. Her notion of the "hybridity of waste," (*idem*) which alludes to waste's simultaneous social and material dimensions, makes it possible for me to conceive of discarded technologies as at once cultural and physical products.

Like Gille, I maintain that e-waste's distinct materiality shapes and constrains its afterlives. For instance in Chapter 4, I show how the material composition of e-waste is an important actor in the struggle over who can glean value out of discarded technologies and who is responsible for the toxic components of this waste stream. E-waste's complex materiality also plays an important role in the character of transnational shipments of e-waste, as I illustrate in Chapter 5. It is precisely because e-waste contains certain materials that it flows to certain places and not others. In Chapters 3 and 5, I also explain how and why e-waste's rapidly changing materiality is a serious obstacle for regulators, and has played a significant role in the failing of German and European e-waste policies.

In turn, my focus on discarded technologies extends the concept of materiality in three ways. First, examining discarded digital equipment makes evident that a technology's materiality is unstable. The social actors who unmake e-waste continually alter technologies physically. They break them apart or add new parts to repair them. In addition, they discursively or representationally transform them. The same discarded computer or cell phone can mean different things in different places for different people. Thus, in both physical and discursive regards, materiality is always temporally and spatially specific.

Second, a focus on discarded ICT equipment invites us to probe the analytical implications of relying on such a broad notion of the material. A careful look at e-waste shows that at any given time and in any given place objects can have multiple, and at times contradictory, materialities (Bakker & Bridge, 2006). Particular historical actors bring to light or conceal the heterogeneity of the materiality of discarded technologies. For instance, until recently, environmental groups and German lawmakers have tended to almost exclusively focus on the hazardous materiality of discarded technologies whereas others such as development organizations and the Solving the E-waste Problem (StEP)[11]—a global network of industry, government and academic representatives—have for some time underscored the potential value of the materials in used and end-of-life digital equipment, particularly as market value for certain components and materials in e-waste has increased (see Chapters 3 and 5). In other words, representations of e-waste's materiality are always multiple, selective and strategic.

Just as in her book on the *Confluence: The Nature of Technology and the Remaking of the Rhône*, Sara Pritchard questions whether it is important to distinguish between biophysical and technological materialities (2011), my work examines what is lost when analysts rely on the broad category of the material to refer to all that is not social. Since any object can have multiple, potentially contradictory and shifting materialities, it becomes imperative to understand why historical actors and analysts choose to highlight particular material characteristics and not others. In other words, is not enough to assert that the material is important but to interrogate which material characteristics of any technology, if any, actors and analysts draw attention to. It is also critical that analysts examine when and why they do so (Pinch, 2008). The case of

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[11] For more information on the StEP Initiative see, http://www.step-initiative.org.

e-waste shows that we need to think in terms of strategic social constructions of materialites.[12] The material is not self-evident or singular just as representations and meanings are not.

Conclusion

Attention to the processes of e-wasting creates new possibilities for social scientific inquiry. It creates space to think about how actors, places, institutions, materialities, (infra)structures and relationships shape various acts of unmaking. It also opens up the space to analyze how these processes of unmaking, in turn, create, maintain and reinforce particular relationships and arrangements.

Scholars who readily use phrases such as "disposal society" or "throwaway culture" assume that in today's modern consumer society, an object simply vanishes or dematerializes once it's original user no longer wants it. As Gregson et al. (2007) explain, however, the throwaway society thesis, popularized in the 1950s "refuses to acknowledge that discarding (the act) is a spatially, socially and economically differentiated process, one that can be anticipated to connect in myriad ways to the making of social relations, identities, and distinction" (p. 683). In other words, the moralizing narrative of disposability hides a complex world. A key argument of this dissertation, thus, is that this hidden world of wasting is just as complex as the world of production and consumption, and very much worthy of social scientific analysis.

Throughout the course of my research, I often met incredulous gazes when I explained my dissertation project. "You are a sociologist, right? Is there enough material for an entire dissertation on discarded ICT equipment? Is that not more of topic for engineers?" Despite these individuals' disbelief that the afterlives of

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[12] The idea of strategic social construction stems out of a conversation with Sara B. Pritchard on the February 28, 2013.

technologies is a worthy topic for a sociologist, despite their firm conviction that wasting is a clear-cut, boring and worthy *technical* matter, I propose that disposal of ICT is anything but straightforward and clear cut. What follows below is a story in which the things we throw away do not merely disappear. Instead the digital technologies we attempt to get rid of keep on living, transforming in form and meaning by the people who handle them, shaping the lives and environments they encounter as they move through space and time.

CHAPTER 2: SEAMLESS GEOGRAPHIES

Overview

In this chapter, I argue that the STS concept of technological systems is useful for analyzing e-waste originating in Berlin. Conceptualizing a discarded technology as a technological system, rather than a discrete artifact, makes it possible to take it out of the black box. My focus on e-waste, enriched by insights from the field of development studies, in turn, extends understandings of technological systems. At the same time it outlines a fundamental problem with the current literature on the "global" e-waste problem. In their studies of e-waste, scholars invoke "local" and "global" perspectives to avoid reifying the city or nation-state as a unit of analysis. Historians and social scientists of technology often do the same in their analysis of technological systems. Yet both these literatures often continue to work with a rigid and binary understanding of these geographic categories. Philip McMichael's notion of incorporated comparison offers a way out of this dualistic thinking. Building on McMichael's relational understanding of space, I make a case for "seamless geographies" in technological systems in general and studies of e-waste in particular. The notion of geographic seamlessness reframes a place such as Berlin—the point of departure of my study—as a node within a larger social, political, economic, and environmental complex of relations rather than a place that can be understood in isolation.

Science and Technology Studies and Development Studies

Though I am a development sociologist by training, this methodological chapter focuses primarily on the interplay between STS and development studies. I bring these two literatures in conversation with one another as a way to promote critical engagement with science and technology in my field. Development sociologists make several important contributions for the sociohistorical study of technologies. For instance, they challenge the modernist tendency to reduce development to a question of access to technologies. Countless case studies show that development is a multifaceted and contested cultural, social, political, economic, environmental process in which technologies certainly play an important, though not determinant, role.

Despite these important insights, however, development sociologists often fail to directly engage with the social construction of science and technology. This oversight leads to discussions in which scientific "facts" and technological artifacts are taken at face value. For instance, recent studies on development and climate change rarely acknowledge the social construction of the scientific information they cite (Martinez-Alier, 2005; McMichael, 2008). Others in the field perpetuate Marx's determinist understanding of technological development. Such limited understandings of technologies permeate otherwise critical analyses of North-South relations and inequality.

Naturally, there are important exceptions to this rule, such as Timothy Mitchell's *Rule of Experts* (2002) and Michael Goldman's *Imperial Nature* (2006). These development scholars show how expertise and scientific knowledge are outcomes of social and historical relations. I seek to build on these important works by exploring the ways in which STS perspectives—in particular the idea of technological systems—can enrich my analysis of the global networks of unmaking originating in Berlin. At the same time, I strive to maintain a critical perspective on the relationship between development and technology as promoted by development sociologists.

Technological Systems and the Seamless Web

In *Networks of Power* (1983), Hughes describes and compares the development of electric supply systems in Germany, England and the United States. What made Hughes' study unique was that rather than focus on a singular technology as was common practice among historians of technology, he thought of larger technological systems.

Hughes also stressed the co-productiveness of the social and technological through his notion of the "seamless web" (Allen & Hecht, 2001; Hughes, 1983, p. 2). In his book, Hughes explains that the making of a technological system is simultaneously political, economic, cultural and social. For instance, Thomas Edison's invention was successfully adopted because he was at once an inventor and a system builder. The system Edison built consisted of individuals, institutions and technological artifacts (Law, 1987, p. 112; Sismondo, 2003, p. 77).

Several scholars have reworked and extended Hughes' notion of technological systems and seamlessness. Most notably, Gabrielle Hecht points to the mutual conditioning of technologies, culture and politics. She explains that technological systems are material and social *as well as* cultural and political (Hecht, 1998, p. 5). Historians of technology often give lip service to the mutual conditioning of these categories, claims Hecht. However, in practice, most studies concentrate on how culture and politics shape the production and use of technological systems. Often great pains are taken to avoid talking about how technologies influence cultures for fear of slipping into technological determinism (G. Hecht, 1998, p. 9). In response, Hecht stresses the importance of "opening the black box of culture and technology simultaneously" and with equal weight (G. Hecht, 1998, p. 10).

Sara Pritchard adds that, because they seek to avoid environmental determinism, STS scholars rarely analyze the mutual articulation of technologies and the environment (Pritchard, 2012a, p. 224).[13] They treat the environment "as an

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[13] According to Pritchard, Hughes recognizes, at least to some extend, how the environment influences the development and working of technological systems. However, Hughes does not develop this point. Further, he repeatedly slips into talking about technologies and the environment as distinct categories (Gille, 2007).

unproblematic, ahistorical backdrop to studies of technological change, inferring that nature and technology are distinct, and that the environmental factors and ecological processes play no role in technological development" (Pritchard, 2011, p. 12). An antidote to this problem is Pritchard's "envirotechnical system." This concept highlights the "historically and culturally specific configurations of intertwined 'ecological' and 'technological' systems, which may be composed of artifacts, practices, people, institutions and ecologies" (Pritchard, 2011, p. 19).

Following Hughes, Hecht and Pritchard, my 2008 MacBook is a technological system. Its designers used a computer to create it. It was manufactured with the help of a circuit board printer and a soldering iron, to name but two examples. Further, I could not use my computer for its intended purpose without wireless networks and electrical supply systems. My computer is also a crystallization of knowledges, people, environments and institutions. By knowledges I refer to, among other things, the information on how to assemble a semi-conductor and how to design my computer's shell so that it appeals to me. The people included in the system range from coltan miners in Rwanda to workers at the Foxconn manufacturing plant in China to designers in Silicon Valley. The environments in which these individuals work and from which the raw materials and energy necessary for the production and use are extracted are also part of the system, as are institutions ranging from governing bodies such as the WTO and national governments to multinational corporations and environmental and social justice NGOs.

Technological System of Unmaking

Though the concept is often used for technologies that are in use, I apply the notion of technological systems to underscore how a *discarded* digital artifact is part of a network of interrelated and interactive human and non-human components. Specifically, I include the following elements in the technological system that forms the basis of my analysis: designers and manufacturers of ICT equipment, their knowledge about how these technologies work, regulatory bodies ranging from the Berlin municipal government to the Secretary of the International Basel Convention, waste management companies, recycling facility workers and their knowledge about the recycling process, entrepreneurs who collect, reuse, recycle and export e-waste and their expertise, environmental and development NGOs as well as discarded computers and the technologies, such as acid baths and integrated smelters, used to dismantle them.

Hughes' notion of seamlessness informs my analysis of the process of unmaking. I engage with the political and technological dimensions of unmaking as coproductive. The STS idiom of coproduction highlights the mutually articulating relationship between two seemingly distinct categories (Jasanoff, 2004). In the case of e-waste this means that various interests and ideological commitments shape how ICT equipment is designed, which impacts how, by whom and with what consequences these artifacts can be unmade (see Chapter 3). For instance, manufacturers strive to maximize profit. The ideology of profit maximization leads producers to incorporate planned obsolescence into their designs. In fact, efforts to render ICT equipment more environmentally sustainable almost entirely focus on the use-phase. This approach to greening ICT does not challenge the profit imperative because it does not confront the role consumption plays in waste production. On the contrary, it encourages consumers to perpetually purchase newer, more efficient and greener technologies as they come on the market. Individuals can continue to purchase new "green" devices. Greening technologies by making them last longer would be less compatible with capitalist social relations as it would result in reduced consumption. Consequently this approach is rarely, if ever, brought up in discussions of how to green the IT industry.

Moreover, specific interests and cultural norms shape the structure and workings of networks of unmaking (see Chapters 4 and 5). The established networks, in turn, reinforce social and cultural norms. For instance, technologies are manufactured so that it is difficult to extract valuable materials out of them once they become waste. The only options are to use techniques such as acid baths and fire—which are environmentally catastrophic—or expensive integrated smelters to which only a handful of wealthy countries have access. The dominant narrative on unmaking represents informal e-waste recyclers as irresponsible, ignorant, polluting criminals. In contrast, formalized high tech e-waste recovery and recycling firms are represented as responsible and green. What results is a technological system of unmaking that is shaped by and reinforces North-South inequalities.

Pritchard's insight pertaining to the mutually conditioning and inextricable relationship between environmental and technological systems provides me with the conceptual tools to engage with the materials and energy embedded in discarded ICT equipment. This involves addressing the environmental impact of formal and informal disposal practices—that is, the fact that unmaking equipment can and often does release toxic components into the air, soil and water. It also means analyzing competing representations of the environmental impact of unmaking practices as I do in Chapters 4 and 5.

Moreover, it makes it possible to draw attention to the often imperceptible "naturalness" of ICT equipment. In taking discarded ICT equipment out of the "black box" of dematerialization as I do in the conclusion, I problematize, as Pritchard does, the static binary conception of technology and nature that runs through much STS scholarship (Pritchard, 2011, p. 21). Finally, highlighting how people, artifacts, knowledges, institutions and the environment interact to shape the unmaking of ICT equipment brings politics and power back in. The physical artifacts and environments in which they are produced and used are embedded in and reinforce cultural norms, ideologies and uneven relationships.[14]

E-Waste: A Global Problem

There remains a tendency among STS scholars to equate the boundaries of technological systems with that of the city of the nation-state. For instance, Thomas Hughes compares Germany, France and the United States. Underlying his analysis is the subtle notion these three national systems are discrete units.[15] It is true that such national or comparative studies make important contributions for understandings of how "distinctive approaches to system building emerged in response to particular political, geographical, and institutional conditions" (Hecht, 2009, p. 8). However, such an approach also runs the risk of black boxing the relationships and networks between these seemingly separate places.

However, a focus on e-waste pushes against common assumptions about the geographic boundaries of technological systems. I draw on the field of development

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[14] Alone, the concept of technological systems runs the risk of remaining primarily descriptive. Hecht and Pritchard counteract this by underscoring how systems are embedded in and reinforce political systems, power arrangements and particular ideologies. Specifically, Hecht's "technopolitical regime" draws attention to how "people, engineering and industrial practices, technological artifacts, political programs, and institutional ideologies, which act together to govern technological development and pursue technopolitics" (G. Hecht, 1998, p. 16). Pritchard's "envirotechnical regime" stands for "the institutions, people, ideologies, technologies, and landscapes that together define, justify, build, and maintain a particular envirotechnical system as normative" (Pritchard, 2011, p. 23). By adding the term regime, both scholars stress that specific people or institutions, with particular interests create and make use of technological systems for particular purposes (*idem*). In other words, existing uneven power relations shape and are reinforced by technological systems.

[15] More recently, Hecht and Pritchard have begun to recognize the limitations of stopping at a country's borders in their analysis of technological systems. For instance, since the publication of her seminal book *The Radiance of France* (1998) increasingly extended her analysis of nuclear technological systems. Her most recent book, *Being Nuclear,* explores uranium production in Africa and traces the flows of this radioactive mineral across the globe (G. Hecht, 2012). She has also recently published an edited volume entitled *Entangled Geographies (2011)* that addresses the global dimensions of the history of technology. Pritchard's work is shifting towards analyzing at France's relationships to its colonies (Pritchard, 2012b).

sociology to challenge this problematic methodological assumption. As the same time I seek to unsettle the assumption among scholars writing about e-waste, in particular those writing about transnational flows, that the categories “developing” and “developed,” “import” and “export,” and “local” and “global” are separate and discrete.

The realization that discarded electrical and electronic equipment rarely stays in one place has inspired policymakers and analysts to increasingly commit to taking a global perspective on e-waste (Kahhat et al., 2008; Widmer, Oswald-Krapf, Sinha-Khetriwal, Schnellmann, & Böni, 2005). More often than not, however, these “global” studies are limited to formal comparisons of e-waste management policies and strategies between countries.

For instance, in their essay entitled “A comparison of electronic waste recycling in Switzerland and in India” (2005), Sinha-Khetriwal et al. begin by justifying their selection of Switzerland and India as case studies. Switzerland is chosen for its oldest and most extensive industry-wide e-waste disposal system. According to the authors, the country represents “the best opportunity to study the evolution of an e-waste management system” (p. 493). In contrast, India houses the fastest growing markets for electronics consumptions and has an extensive informal recycling industry. It also functions as important market for obsolete computers. The first section of the text, devoted to describing the conditions in each country, reads more like a tribute to Switzerland and an indictment of India. The authors elaborate on the virtues of the highly organized, efficient and effective Swiss system. India’s recycling system, on the other hand, is “abysmal” (p. 492). We are reminded that India has a weak government that is unable to effectively restrict illegal import of e-waste. The e-waste recycling industry, which has evolved “organically” in India, is informal, indiscriminate, disorganized and highly polluting (pp. 499–500).

Fundamentally descriptive, the article only briefly questions why the two countries manage their waste in such disparate ways. According to the authors, the big difference between India and Switzerland is the cost of labor. There is no incentive to mechanize and develop a more efficient recycling system in India because labor is so cheap. The authors, however, do not explore why labor is so much cheaper in India than in Switzerland. They leave out any mention of uneven contemporary trade agreements. Cheap labor in India appears as natural as Switzerland's ranking as number 7 on the Environmental Sustainability Index. Because Sinha-Khetriwal et al. operate with an ahistorical and spatially-bound epistemological stance they are unable to see how the rapid rate of e-waste generation, the uneven labor costs they describe, the export and import of toxic e-waste, as well as the discursive and material construction of Switzerland as a clean and green, rationalized and modern place and India as a dirty, polluted, 'organic' and backward space are products of historically specific social relations. The authors fail to acknowledge that there is nothing essential about Switzerland that makes it inherently capable of managing e-waste in a more socially and environmentally sound manner. Nor is it 'natural' that India has a more informal, polluting e-waste management system.

While they have made vital contributions to understandings of how local customs, socio-economic structures and existing infrastructure shape the ways in which e-waste is handled in particular places, these studies remain state-centric. They have not, as of yet, taken a truly transnational perspective and engaged with places as points a larger complex or system (Burawoy, 2000; Hart, 2002; McMichael, 1990; Tomich, 1994).[16] The absence of a relational perspective that emphasizes the

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[16] The Swiss Federal Laboratories for Materials Science and Technology (EMPA), which is at the forefront of research on e-waste, almost exclusively produces e-waste country assessments. These assessments focus on how e-waste is handled in various countries without much acknowledgement of

seamlessness between these apparently distinct places has sometimes even led to rather problematic, developmentalist studies that seek to understand how, for instance, a country such as India can "learn" from a country like Switzerland (Sinha-Khetriwal, 2005) without taking the countries' historical positions within a stratified global political-economic complex into consideration.[17] In fact, the idea that e-waste should be handled on a country-by-country case is popular among many scholars, policymakers and NGOs. The danger of such approaches is that they perpetuate the idea that the e-waste problems faced by particular places, be they Berlin, Dehli or Acrra, are spatially bound, the outcome of factors endogenous to particular societies.

A Relational Perspective

A world historical perspective helps address some of the limitations listed above. Specifically, Philip McMichael's incorporated comparison is a useful antidote to bounded studies and comparative approaches that reify geographic and temporal boundaries of the objects of study (1990). Formal comparison takes two cases and attempts to isolate their commonalities and their differences as a means to extract general lessons. In contrast, an incorporated comparative approach highlights the relationship between "cases." In other words, instead of asking how Switzerland and India are similar and different in their management of e-waste, as Sinha-Khetriwal et al. (2005) do, an incorporated comparison perspective investigates in what ways

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how these countries relate to each other. More more on EMPA's country assessments, see http://ewasteguide.info/ewaste/case-studies.

[17] A relational approach represents a commitment to a particular way of seeing or interpreting the world. To think relationally is to see people, institutions, societies, cultures, events, places, concepts, knowledge, and so forth as outcomes or products of interactions rather than as self-contained, unchanging, static, or 'natural' things. Thinking relationally also involves seeing the interaction or relationship itself as a product or outcome. That is, a relational approach acknowledges the ways in which core and periphery, for example, far from discrete entities that 'interact' to produce particular outcomes, are themselves products of interactions as are the relationships between them. In brief, a relational approach invites us to see the world as a continually changing outcome of infinitely interconnected layers of interaction.

Switzerland is Switzerland because India is India (Tomich, 1994). This approach underscores the seamless connection between the various places that make up a technological system. Such a relational perspective helps me underscore how Germany's ability to be a "model" "green" country when it comes to e-waste is directly related to the "inability" of other places such as Ghana to resist the import of toxic substances. Likewise, it helps me underscore that places such as the Congo that exports coltan and China that manufacturers motherboards, monitors and keyboards are intimately linked to Germany, though this connection often remains imperceptible.

I do not specifically compare two places in this dissertation, as is usually the case among those who use the methodological tool of incorporated comparison. Instead, I build on and draw from the nuanced understanding of space and time that underlies incorporated comparison. Human geographer Doreen Massey explains that many social scientists tend to operate with a rigid and fixed idea of the spatial boundaries of their objects of study. Such an approach is problematic, explains Massey. She writes,

> The particular mix of social relations which are thus part of what defines the uniqueness of any place is by no means all included within that place itself. Importantly, it includes relations which stretch beyond—the global as part of what constitutes the local, the outside as part of the inside. Such a view of place challenges any possibility of claims to internal histories or to timeless identities. The identities of place are always unfixed, contested, and multiple. And the particularity of any place is, in these terms, constructed not by placing boundaries around it and defining its identity through counter position to the other which lies beyond, but precisely (in part) viewed this way are open and porous (Massey, 1994, p. 5).

In other words, places such Berlin do not have solid boundaries. Relationships and processes within and across particular locations shape these places, be they cultural, political, economic, physical or environmental. Particular locations are not created *in opposition* to other places as much as they are constituted by *relationships* *to* these other places (Massey, 1994, p. 121). Such a relational understanding of space—where space and social relationships continually co-produce each other—makes it possible for me to avoid the trap of reifying the boundaries of Berlin in my study.

Importantly, a relational perspective makes it possible to avoid thinking in terms of a separate, discrete "global" that determines the "local." A common critique of world-systems approaches—which the idea of incorporated comparison builds on—is that they presuppose the global. On the one hand, incorporated comparison aligns with what McMichael calls the Wallerstein/Tilly Path in that it challenges the ways in which formal comparison unproblematically uses analytical categories such as the nation-state as an ahistorical given. Both the Wallerstein/Tilly form of comparison and incorporated comparison seek to shed light on the larger whole that produces particular places. However, while the former methodology presupposes a whole—that is, the world system—incorporated comparison, because it is interested in historically specific social relationships, advances an understanding of the whole as a spatio-temporal conjuncture or formative moment in world history. Put differently, the whole is the product of the relationships between the geographic locations or social entities. Therefore, it is never given. Instead, the whole is always emerging.

By the same token, McMichael calls the part—be it the nation-state, the city, an institution or specific place—a "moment" or "outcome" to emphasize that the part is also a product of continually changing historically specific social relationships, which are themselves continually in flux (McMichael, 1990, p. 392). This is how I conceive of Berlin and the places to which it is connected through e-waste. The particular places of my study are constitutive of and constituted by the whole—a whole or system that is continually being constituted by its parts.

Such a perspective also acknowledges the heterogeneity within places. Places are internally different, complex and contested. Hence, each place is always changing, shifting, and, at times, paradoxical (Massey, 1994, p. 121). As such, Berlin is a site of multiplicity where power is unevenly distributed along gender, racial, ethnic and economic lines and where identities, meanings and subjectivities can simultaneously align, crosscut and conflict in each place, if not within the same individuals. Thinking of the various "places" in my study as heterogeneous sites full of unequal relationships and contested meanings adds a richness to my analysis that could not be attained through a traditional, macro world-systemic approach alone. Thus, by emphasizing the heterogeneity within places McMichael's conceptualization of geography makes it possible for me to engage with how meaning, identity and so forth can help shape the process of unmaking of ICT starting in Berlin.

The technological system that forms the object of my study clearly extends beyond Berlin or even Germany. Despite policymakers, industry representatives and municipal governments' efforts to keep Berlin's e-waste local, discarded technologies flow out of the city and across the globe through formal and informal channels of unmaking. Berlin is connected to the rest of the world through flows of materials, money and toxins as well as through its unique location in the global division of labor and environment.

Given the globalized nature of the technological system I analyze, this study invites questions pertaining to how, when and why national borders and the borders of technological systems align or do not align as the case may be. It is not only critical to engage with how technological systems transcend national boundaries, but also how a globalized technological system maps onto an uneven political-economic topography.

By applying the technological system to discarded technological artifacts my study extends the concept in yet another way. Generally studies of technological systems tend to look at technologies in their commodity form and overlook the fact that technologies eventually become waste. Taking discarded technologies as my object of study makes it possible to investigate why studies of technological systems frequently leave waste out. Furthermore, because discarded ICT equipment goes back and forth between being a commodity and waste, we see that the line between a technological system based on an object in the commodity form and one based on an object in the waste form is far from solid. Another way to think about it is that the line between the commodity form of a technology and its waste form are seamless—mutually articulating and inextricably bound. I suggest that this insight has implications that extend beyond the line between the commodity and waste phases. It opens up questions for historians and social scientists of technologies to explore the relationships and fluidity between production use and design.

In Sum

The STS concepts of technological system and seamless web are central to my study of the unmaking of ICT technologies placed on the curb in Berlin. Specifically, the technological system allows me to underscore that the technological artifacts that form the object of my study are not just given, singular, discrete entities. Instead they are part of a system that consists of many other technologies, as well as a host of social, political, cultural, physical and environmental relationships and processes. The notion of the seamless, in turn, helps me avoid reproducing binary representations of the categories listed above. Instead it allows me to emphasize the mutually articulating and co-productive characteristics of the components that make up the technological system I study.

Instead of focusing on the design, making and use of technologies, however, I study the process of unmaking. Though, to my knowledge, the concept of technological system has not been used to talk about unmaking, it easily lends itself to discussions of this process.

The Specifics

Below I will briefly elaborate on my research process and the methods I used. I conducted research Germany as well as in Belgium, Holland, Switzerland and Ghana. I carried out the German portion of my research from July 2009 to January 2011. The archival portion of my research consisted of analyzing the legal and discursive framework in which the e-waste networks I study are embedded. My ethnographic research reconstructed and analyzed the formation and operation of the licit and illicit e-waste recycling networks in Berlin and beyond through over sixty semi-structured interviews with key actors and non-participatory observation at formal and informal e-waste processing sites. Specifically, I reconstructed how various actors discursively and materially transformed discarded technologies after they had been placed on the curb in Berlin. I paid particular attention to the organization of export and how various actors along the formal and informal networks perceived of the e-waste problem and, in particular, the issue of e-waste export. My research in Belgium, Holland and Switzerland, which took place from February 2011 until June 2011, was devoted to situating Germany within its regional and global context.

My decision to conduct ethnographic and archival research beyond Germany was inspired by my methodological commitments as described in detail above. That places such as Berlin cannot be understood in isolation rings particularly true with regards to e-waste given the globalized nature of e-waste recycling and reuse systems: legislation governing e-waste management and export in Germany is formulated in response to EU directives and international conventions. Furthermore, once disassembled, multinational firms in Belgium and Holland process a significant portion of the plastic, glass and metals in e-waste—even e-waste that is disassembled in the developing world. Finally, German e-waste is not only exported through the Hamburg port but also finds its way to the Rotterdam and Antwerp ports. Hence to fully understand German laws and to reconstruct licit and illicit e-waste recycling networks in Germany, I had to conduct archival and ethnographic research in the countries mentioned above. The e-waste networks I studied are global and I did conduct primary ethnographic research at Agbogbloshie market in Ghana in the summer of 2008. However, given the constraints of time and resources, I choose to focus primarily on the European segments of the networks as they have been largely understudied in relation to the developing world; most emerging research on e-waste flows concentrates on importing developing countries or conceives of Europe as a closed system.

Archival Research

I conducted the archival component of my research at the Scientific Library for Environmental Protection of the Federal Environment Agency in Berlin.[18] It primarily involved tracing the history and politics of German e-waste management. Specifically, I focused on the German laws that govern e-waste management and export—the Electrical and Electronic Equipment Act (ElektroG) and the Waste Shipment Act (AbfVerbrG).[19] Because of Germany's cooperation principle—which stipulates that environmental policies should be developed in close cooperation among all relevant parties (Hucke 1985)—stakeholder meetings were held prior to the implementation of both acts. The minutes of these meetings are publicly available as are the technical studies that were conducted in preparation for the acts. Moreover, opponents and

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[18] The Fachbibliothek Umwelt des Umweltbundesamtes is the largest environmental library in the German-speaking world.

[19] Abfallverbringungsgesetz (AbfVerbrG).

proponents of the acts produced a spate of publications, speeches and advertisements. Minutes of the debates in the *Bundestag* were also available. These minutes provided an important window on the reaction of various parties and regional representatives. In addition, I reviewed and analyzed journalistic and popular accounts of the disputes over the acts.

In Belgium and Switzerland I studied the three policies that are crucial for understanding the international dimensions of Germany's e-waste management: the Waste Electrical and Electronic Equipment Directive (WEEE Directive), the Restriction of Hazardous Substances Directive (RoHS Directive) and the Basel Convention on the Control of Transnational Movements of Hazardous Wastes and Their Disposal (Basel Convention). The former two directives set the standards for e-waste management in Europe and for the use of certain hazardous substances in electrical and electronic equipment respectively, while the latter convention regulates the international flow of discarded electrical and electronic equipment. I visited the European Commission in Brussels and the Secretariat of the Basel Convention in Geneva, where the documents pertaining to the implementation of the Directive and Convention are respectively housed, to collect written material pertaining to e-waste management and interview key informants.

My archival research was guided by the following questions: Under what circumstances do these actors and the public at large become interested in e-waste? How are discarded technologies defined? How are debates regarding the definition of waste characterized? What policy initiatives are favored and why? I used the archival sources outlined above to reconstruct the politics of e-waste management and export and to analyze how debates over e-waste enters into wider national and regional debates regarding the reconciliation of environmental sustainability, technological development and economic pursuits.

Ethnographic Research

The ethnographic portion of my research consisted of a qualitative material flow analysis.[20] To date engineers have conducted the majority of research on e-waste flows in the form of lifecycle or material flow studies. I had the opportunity to interact with engineers at the forefront of e-waste studies at the 2009 StEP e-waste summer school organized by the United Nations University, the 2009 World Resource Forum in Davos as well as during various e-waste conferences and presentations at the Technical University in Berlin and through conversations with scholars at the Wuppertal Institute for Climate, Environment and Energy. These engineers repeatedly expressed the need for research that focuses on how politics and meanings shape the material flows they study. My qualitative material flow analysis—which simultaneously engages with e-waste flows as physical and social constructs—addresses this need in e-waste studies and provides important insights for policymakers into the loopholes and limitations of existing national e-waste policies. This methodological approach bridges the divide between the social sciences and engineering.

Specifically, the ethnographic portion of my research consists of semi-structured interviews with officials at the German Federal Ministry of Environment, the Federal Environment Agency, the Berlin municipal recycling organization (BSR), Hamburg Authority for Urban Development and Environment (BSU), and the European Commission and the European Parliament. I met with Hewlett Packard, Dell, Sony, Ericsson, Elektrolux Gillette and Philips executives. I also interviewed representatives of industry lobby groups such as the WEEE Forum, the European Committee of Domestic Equipment Manufacturers, Digital Europe, The European

[20] Perrine Chancerel, an environmental engineer at the Technical University in Berlin, introduced this term to me during an informal conversation in September 2009.

Electronics Recyclers Association and The European Engineering Industries Association. I had intended to interview representatives of plastic and CRT glass recycling firms, but they did not answer my numerous requests to meet. Representatives of the following NGOs: GermanWatch, Greenpeace Germany, Oekopol, the European Environmental Bureau, WASTE based in the Netherlands, and Greenpeace Netherlands were willing to speak with me. Furthermore, I established links with informal e-waste recyclers and exporters in Berlin and Hamburg. I conducted follow-up interviews with most of the respondents listed above.

Importantly, the European WEEE and RoHS directives, which form the basis of the ElektroG, were recast at the European Parliament and Commission. Hence, 2010 and 2011 was an ideal time for me to interview and observe key stakeholders, as they were in the process of explicitly voicing their concerns and critiques of the existing legislation to lawmakers. I found that industry, government and NGO stakeholders were particularly eager to discuss existing and proposed e-waste policies with me at this point in time.

I extended my understanding of the formation and operation of the illicit networks through interviews with the European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL), reports by the Hamburg, Antwerp and Rotterdam Harbor Patrols, and NGOs that actively monitor transnational movements of e-waste. The most active of these groups are the Swiss Federal Laboratories for Materials Testing and Research (EMPA) in St. Gallen, Switzerland, Greenpeace International in Amsterdam, The Netherlands and DanWatch in Copenhagen, Denmark. The Basel Action Network and the Silicon Valley Toxic Links Coalition—two US NGOs—are also important players. I monitored these organizations' websites and publications and had, albeit limited, contact with their representatives. I had intended to interview customs officials and analyze customs files and closed court cases that deal with illegal export of e-waste at the EU level, but I was not granted access to these individuals and files. Finally, I spent significant time interviewing and observing informal recyclers who gather outside Berlin's fifteen recycling centers and used equipment exporters, the majority of whom have businesses on Billstrasse in Hamburg. I also interviewed and rode along with a number of informal scrap dealers in Berlin.

My interview questions covered six broad issues aimed at understanding the characteristics of e-waste networks. These six areas were 1) organization or firm characteristics: number of employees, the history of firm or organization's engagement with e-waste and organization of work; 2) the transformative processes: how organizations handle and transform e-waste; 3) flows of value or money: annual revenue, growth sectors, cost breakdown; 4) material streams: what materials are processed, origin and final destination of materials; 5) perceptions of emerging and existing legislation: specifically the ElektroG, WEEE and RoHS directives and their revisions as well as the Basel Convention and Amendment; 6) and finally, perceptions of strengths and weaknesses of current e-waste recycling and reuse practices.

During my interviews I paid particular attention to how respondents defined the discarded technologies they handled and how they addressed e-waste export. I also focused on how respondents discussed issues pertaining to the reconciliation of technological development, economic growth and environmental sustainability. Through non-participant observation I was also able to gain insight into how my respondents' narratives of e-waste transformations compared to the practices I witnessed.

In August 2009 I obtained approval from the Cornell Institutional Review Board for this research. I continued to follow Human Subjects protocols and adhere to accepted standards of ethical research to secure the safety of my respondents, particularly those who engage in illicit activities throughout the course of my research (Emerson, 2001).

CHAPTER 3: THE CIRCULAR ECONOMY

Overview

In this chapter, I analyze the ElektroG, Germany's most recent Extender Producer Responsibility-based policy [EPR], which went into force in 2005. I argue that, in theory, EPR policies represent an improvement over end-of-pipe waste solutions such as land filling, incineration and recycling in that they recognize a fundamental problem with the linearity of capitalism. By the linearity of capitalism, I refer to the propensity of capitalist social relations to sever the connection between making and unmaking, thereby creating unidirectional, rather than circular, commodity lifecycles through disposability, planned obsolescence and the devaluation of refuse.

I explain why EPR applied to e-waste does not work in practice. Despite the praise Germany's forward-thinking and extensive approach to solid waste management in general and e-waste in particular has received, the ElektroG does not meet its stated objectives because it fails to acknowledge the complex relational system in which the problem it attempts to fix is embedded. Specifically, EPR does not work because competitive pressures force firms to outsource the very externalities the ElektroG seeks to force companies to internalize. Specifically, two loopholes in the German e-waste law make it possible for companies to continue evading responsibility for their products once they become waste: methodological state-centrism and methodological formalism. By methodological state-centrism I refer to the tendency—as outlined in Chapter 2—to reify the nation-state as the unit of analysis and thus obscure how Germany is connected to and constituted by its social, economic, technological and environmental relations to other places. By methodological formalism, in turn, I mean that the policy does not acknowledge the informal dimensions of the technological system in which Germany and the rest of the world are embedded.

This chapter is organized as follows. The first section traces the history of waste management in Germany in order to situate the problem of e-waste historically. I begin with a discussion of how the rise of modern capitalism in the late nineteenth century in Germany resulted in a shift from more circular systems of production to linear ones. Following this shift, Germany struggled to manage its growing and increasingly complex waste stream by implementing high-tech municipal waste management systems. The country's efforts to manage its waste over the last hundred years has been punctuated by a number of waste crisis, which I describe and analyze. Having contextualized Germany's e-waste problem historically, the main section of this chapter focuses on the ElektroG. I outline how the law came about, what it stipulates and finally, building on my archival and ethnographic research on e-waste in Berlin, explain how and why this law fails to meet its stated objectives.

The Rupture

The ElektroG represents an attempt to reverse the negative environmental and health implications associated with capitalism's linearity. The problems with capitalism's linearity became evident as early as the second half of the nineteenth century. This was a period of tremendous social, political and economic upheaval in Europe. The radical restructuring of relations and processes of production that accompanied the rise of modern-day capitalism was a key driver of these changes. Rapid industrialization in the cities and the mass exodus from the rural areas, often called the *Landflucht* in Germany, resulted in an increase in urban populations across the entire country. Urban population growth was particularly pronounced in Berlin, which had become the German empire's capital upon its founding in 1871. The capital's population rose from 172,000 to more than 2.7 million between 1800 and 1900 (Curter, 1996, p. 19). This dramatic demographic shift resulted in a significant rise in waste production. Traditional waste handling systems were no longer able to cope. In other words, even if reuse, frugality and other “circular” techniques were compatible with capitalism, they would have probably still not been able to accommodate the dramatic increase in waste production.

Changes in consumer habits also contributed to the waste explosion. For instance, the industrialization of food production and the changes in working conditions meant that less time could be spent cooking food (Curter, 1996, p. 23). Instead, many factory workers began to eat preserved goods. As a result, disposable glass and tin containers flooded the municipal waste stream. At the same time, traditional uses for household and workplace “outputs” were rapidly becoming obsolete. Up until industrialization, women and scavengers actively sought out household and commercial leftovers such as rags, food scraps, ashes and scrap metal. They transformed these “wastes” into new products. However, new mass production techniques necessitated a consistent supply of homogenous materials; modern industry had very little use for the mixed scraps supplied by scavengers (Strasser, 1999). Moreover, women started working in factories and thus spent less time reusing waste products. Likewise farms could not make use of urban waste as a soil amendment.

The turn of the nineteenth century witnessed a dramatic change not just in the quantity of waste being produced in Berlin, but also in its quality—or material composition. Until industrialization, waste was primarily comprised of ceramic shards, stone, rags or organic matter. The creation of Berlin’s sewage system in 1878 meant that fecal matter, the most valuable waste for famers, was whisked away. Additionally, as new materials such as plastic were introduced, the waste became correspondingly complex and difficult, if not hazardous, for traditional reusers and recyclers to handle, let alone reintegrate into production (Curter, 1996, p. 28).

These changes, which are closely related to the rise of modern-day capitalism and industrialization, resulted in a radical restructuring in the relation between production and consumption. Whereas systems of production had been relatively circular in the past—making and unmaking inextricable interconnected—production suddenly became linear during this historical period. Outputs of household and workplace activities were no longer raw materials for new production. Instead, they were now hazardous bads that threatened local environments and public safety. It was during this period that the idea of waste was born (Barles, 2005; Melosi, 1981; Strasser, 1999; Windmüller, 2004).

The Responses

Like many of its neighboring cities, Berlin responded to the waste crisis of the nineteenth century by creating various dumps in and around the city (Curter, 1996, p. 19).[21] Until then, residents had simply dumped their waste in nearby fields (Grant, 2003). First the city required residents to collect their waste in pits located in their courtyards. These pits were to be emptied on a monthly basis. However, this system did not work for various reasons, and so the city established its first municipal waste collection points in 1887 (*idem*). These collection points were distributed throughout the city. The growing mountain of waste quickly overwhelmed the collection points. Thus, in 1894 the city built a larger landfill approximately 40 km outside the city. The creation of the dump followed one year after the passing of the Prussian

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[21] It is not quite accurate to say that Berlin had a municipal waste authority during this period. In 1887 Kaiser Wilhelm I called for an independent branch of the government to handle street cleaning. The city then initially contracted out the task to 60 independent enterprises. Ten years later, a number of Berlin's most prominent landowners banded together and formed the *Berliner Grundbesitzer GmbH.* This organization handled approximately 90% of city's trash until WWI. The labor shortage of WWI drove the cost of waste handling up to the point that the *Berliner Grundbesitzer GmbH* went under. After WWI the *Berliner Müllabfuhr-Akiengesellschaft (BEMAG)* was founded. The city purchased 25% of company shares as a means to ensure that public interests were kept in mind. In addition, the major began to monitor the waste company's activities during this period. Four years later, the city had taken over 85.8% of the company. Only after WWII, however, did the city host a truly municipal waste management authority. After the city was divided into two, each side had its own waste authority: the Berlin Stadtreinigung in West Germany and the Grossberliner Stadtreinigung und Muellabfuhr in East Germany.

Kommunalabgabengesetz (local tax law)—the first waste law that explicitly made the city responsible for street cleaning and waste disposal (Curter, 1996).

Over time, Berlin's waste authority became more efficient at whisking away the growing urban refuse, effectively keeping the consequences of the new relations of production "out of sight and out of mind."[22] Landfills were the preferred approach across the country. By the early 1970s, over 50,000 dumps dotted the Federal Republic of Germany (Schnurer, 2002). However Germany's success in waste management proved to be relatively short-lived. Landfills were unable to accommodate the vast quantities of waste generated by German consumers and industry.

The average West Berlin resident produced approximately 0.5 kg of waste daily around the end of the 1950s. In the ten years between 1960 and 1970 Berlin's waste increased 126% (Grant, 2003). By the 1980s that number had increased fivefold to 2.5 kg (Curter, 1996, p. 36).[23] Especially as the culture of disposability took over in the 1960s and packaging waste grew, it became apparent that the city's landfills were

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[22] Though most of Berlin's waste was landfilled until the 1970s, various groups and individuals experimented with alternative channels of disposal well before the second waste crisis of the 1970s and 1980s. Obviously, resource scarcity during WWI and WWII incentivized higher rates of reuse and recycling (Curter, 1996; Grant, 2003). For instance, during WWI a program was set up in which residents exchanged organic wastes for firewood. In addition, during the 1920s many openly criticized landfills for taking up too much space and resulting in a loss of valuable raw materials. In light of these criticisms, the city of Charlottenburg, adjacent to Berlin, started a recycling program. In 1919 Berlin also experimented with incinerator technology (Grant, 2003). Another "alternative" waste channel consisted of private ovens in homes. Until the 1960s, many Germans burned a substantial quantity of their own waste in their home heating ovens. As centralized heating and oil burning furnaces replaced wood burning stoves in the 1960s, this form of waste disposal subsided.

[23] East Berlin also saw an increase in garbage production during this time. However, East Berliners created significantly less waste than their Western counterparts. Annual per capita production of waste in West Berlin was 450 kg whereas it was only 270kg in East Berlin. The majority of West German waste was landfilled or incinerated (after 1967). East Germany stressed reuse and recycling more. For more information on East German recycling see SERO-System (Curter, 1996, p. 36).

unable to accommodate its waste.[24] The problem was particularly acute in West Berlin because of the wall surrounding the city meant limited space for landfills, yet it extended over the entire country.

To complicate matters, Germans were voicing concern over the safety of landfills. By the 1970s, the country had about 50,000 small and mostly unregulated dumps. Most of these dumps were located close to residential areas. Residents complained that contaminants were leaking into the groundwater. Public concern over dwindling natural resources also grew. These factors resulted in a second waste crisis in Germany.

The German government addressed the second waste crisis through a combination of institutional, legal and technological interventions. Waste incinerator technology experienced a revival (Curter, 1996; Grant, 2003). In 1961 Berlin constructed a high-tech incinerator in the Ruhleben district. The incinerator, however, put only a small dent in the growing mountain of Berlin waste. Less admirably, the practice of exporting garbage to less affluent areas took hold (for more on this see Chapters 4 and 5). In particular, the West Berlin government began to export its waste to the DDR. This option was costly, both because of the export fees and because the city had to purchase a compressor to handle waste before it was transported to the East. All around the country officials looked into measures to increase recycling.

What made Germany stand out, however, was its policymakers' willingness to openly acknowledge the limitations of end-of-pipe tactics such as landfills, incinerators and recycling programs during the 1970s and 1980s. While many other

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[24] Importantly, not just changes in consumption patterns, but also infrastructural changes resulted in the increase in waste production. For instances, as noted in the previous footnote, the shift from household ovens to central heating, gas and oil meant that Germans were no longer burning their waste. This infrastructural change resulted in a significant growth in the quantity of waste produced in the postwar period.

countries focused almost entirely on downstream solutions, many German policymakers and the general public were open to treating the waste problem (as well as the larger problem of pollution) as a market failure.[25] According to the popular discourse, the waste problem made evident the existing system's inability to connect making and unmaking and this resulted in significant inefficiencies. In order the remedy these shortcomings, German officials introduced a new general waste policy based on the idea of the *Kreislaufprinzip* or the principle of the circular economy. This principle promised to reintegrate making and unmaking and thus usher in a more efficient and environmentally sustainable form of capitalism.

Industrial Ecology

Though the idea of a circular economy has a long history, the field of industrial ecology formalized it. In their foundational article titled "Strategies for Manufacturing" (1989), industrial ecologists Robert Frosh and Nicholas E. Gallopoulos maintained that conventional linear production practices were unsustainable in the long run, given the finiteness of natural resources—including waste sinks. Instead, these two thinkers, along with other industrial ecologists from a host of disciplines—including economics, engineering and environmental sciences—argued that economies needed to be modeled after natural systems in which waste is continually reused as raw material for new production. It was imperative that societies shifted from open-looped to closed-loop production systems, argued industrial ecologists, in order to promote a more efficient, sustainable and ultimately zero-waste and zero-emissions economies.

[25] By market failure I refer to an instance in which the invisible hand of the economy, for whatever reason, does not work. The solution, in such cases, is for the government to step in, though as minimally as possible, to correct the glitch in the system.

Key for the success of a circular economy is *Produktverantwortung,* or product responsibility. Broadly speaking, the term *Produktverantwortung* stands for the idea that goods should be produced and used in such a way as to minimize waste generation. Concretely this term has come to stand as a shorthand for the principle of EPR.[26] EPR, to recall, dictates that producers should be responsible for the environmental costs of the products they produce (Lindhqvist & Lifset, 2003, p. 144). It is basically an extension of the producer pays principle (PPP) (Neyland & Simakova, 2012).[27] The polluter pays principle is a market-based mechanism to counteract the tendency among profit-seeking firms to externalize the environmental costs of their activities. The idea behind this approach is that the act of "internalizing externalities" (Lifset, 1993, p. 163) will incentivize sustainable development. This is accomplished by "changing the behavior of producers by tightening the link between product design and marketing decisions and waste management-related concerns" (*idem*).

Ideally, not only does EPR lead to product redesign, but also to a total reconfiguration of how disposal is organized (Walls, 2003, p. 5). Most existing disposal systems consist of publically funded, end-of-pipe diversion programs. Once an object is discarded, local governments become owners of the waste and responsible for its disposal. This approach enables the privatization of profit and the socialization

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[26] EPR is also sometimes also referred to as manufacturer take-back or product stewardship (Khetriwal, Kraeuchi, & Widmer, 2009, p. 154). EPR is a variation of the polluter pays principle (PPP). While PPP has traditionally been applied to production/manufacturing, EPR extends the idea to waste. Many policy instruments actualize EPR such as product take-back mandates, advance disposal fees, deposit-refunds, recycled content standards, and so forth (Walls, 2003, p. 1). In Germany, EPR takes the form of product take-back.

[27] Lifset (1993) offers a useful and succinct explanation of EPR and market failures. He writes, "Economists have long argued that by incorporating the impact of pollution and other environmental insults into prices—internalizing externalities—we can resolve our environmental difficulties. A negative externality arises when an economic activity imposes costs on a third party and that cost is not reflected in the price paid in the relevant commercial transaction" (Lifset, 1993, p. 165).

of the environmental and social costs of production, consumption and disposal (Lifset, 1993, pp. 170–171). Instead of public disposal and private production, EPR policies make private producers own and operate the entire production-disposal chain—which ultimately is transformed into what William McDonough and Michael Braungart (2002) call “cradle-to-cradle” systems in which making and unmaking are reintegrated.

EPR in Germany

In 1991, a year after the Swedish economist Thomas Lindhqvist introduced the concept of EPR, the German government passed the Ordinance on the Avoidance of Packaging Waste (VerpackV), the most recognizable result of which is the green dot system.[28] The packaging ordinance makes producers responsible for the end-of-life of the packaging they use. Though the VerpackV has been criticized on many fronts, the ordinance was generally successful.[29] After Germany introduced the ordinance, collection and recycling rates improved (Clean Production Action, 2003). The

[28] *Verpackungsverordnung; Der Grüne Punkt*

[29] Some complain that the DSD suppressed market competitions and thus produced inefficiencies (Tojo, 2001, pp. iii, 41). Still, according to a report by the Clean Production Action, “Between 1992 and 1993, the volume of packaging material in circulation was reduced by half a million metric tons. Since the passage of the Ordinance, total packaging has been reduced by 1 million metric tons, a per capita reduction of 15 kg. The reduction reflects the elimination of some types of unnecessary packaging, such as shrink or blister packaging and the increased use of concentrates and refillable packaging. Significant design changes were made to reduce the amount of material used in packaging. For comparison, between 1991 and1995, Green Dot packaging decreased 14% from, while total packaging in Germany decreased 7%; during the same period in USA, packaging grew by 13%. The proportion of beverages sold in refillable containers has increased. The transport packaging sector, which has seen the greatest drop in packaging, has developed reusable shipping containers. Furthermore, the Ordinance has raised awareness among packaging producers of the need to radically rethink material use in packaging. [. . .] This drop reflects avoidance and minimisation of plastic packaging, in favor of paper/carton and tinplate. Also seen within the plastic packaging sector were shifts away from PVC to PE and PP. [. . .] The Ordinance has spurred the development of new sorting and recycling technologies, especially for mixed plastics.” (Clean Production Action, 2003)

ordinance also successfully stimulated product redesign, which in turn resulted in a reduction in the amount of packaging waste produced each year (Tojo, 2001, p. 12).

Figure 1. Germany's official waste hierarchy clearly places waste avoidance at the top. Recycling, recovery and landfilling are all secondary and tertiary goals. Reprinted from Federal Environment Ministry, http://www.bmu.de/english/waste_management/doc/3432.php.

Subsequently, in 1996, the German government passed The Act for Promoting Closed Substance Cycle Waste Management and Ensuring Environmentally Compatible Waste Disposal (KrW-/AbfG).[30] The Act represented a relatively radical rethinking and restructuring of German *Abfallwirtschaft,* or waste economy. For one, the law explicitly, and for the first time, distinguished between reclaimable waste and

[30] *Gesetz zur Förderung der Kreislaufwirtschaft und Sicherung der umweltverträglichen Beseitigung von Abfällen* also referred to as *Kreislaufwirtschafts- und Abfallgesetz* (KrW-/AbfG).

waste for disposal.[31] Further, it set up a clear hierarchy of waste management objectives: the first priority being waste avoidance, followed by waste recovery or recycling and finally environmentally responsible disposal (see Figure 1). Perhaps most significantly, the law cemented Germany's commitment to the principles of the circular economy and extended producer responsibility. The Act remains the cornerstone of Germany's waste law and forms the basis of the ElektroG.

There are a number of reasons why the ideas of the circular economy and of EPR gained such a strong foothold among German environmentalists, industry representatives and policymakers. First, EPR policies echoed a larger trend in environmental policy during the 1990s in which end-of-pipe solutions were no longer satisfactory on their own (Khetriwal, Kraeuchi, & Widmer, 2009, p. 155, Castell, Clift, & Francae, 2004, p. 4). EPR policies promised to get at the root of the problem by broadening notions of responsibility. They made "upstream entities responsible for downstream impact" and thus corrected a glitch in capitalism's feedback system (Lifset, 1993, p. 165).

Secondly, EPR policies represented a way to reconcile two seemingly diverging goals: Germany's long-time commitment to environmental sustainability and the country's desire to remain one of the world's economic powerhouses. Up until then German law had favored "green social welfare" policies, in which the government, rather than the market, was expected to promote environmental sustainability (Schreurs, 2002). However, as of the 1970s, industry, trade unions and the labor movement accused the country's green policies of leading to job losses and impeding Germany's economic competitiveness and technological innovation (Schreurs, 2002). They saw market-based environmental strategies, such as EPR, as

[31] *Abfälle zur Verwertung* and *Abfälle zur Beseitigung*.

the ideal solution to this problem as these policies promised to use market feedback to "shift the world's economies towards more circular patterns of resource use and recycling" without the burden of what was increasingly perceived as heavy-handed, "command-and-control" environmental regulations (Castell et al., 2004, p. 5; Lifset & Lindhqvist, 2008, p. 144; Mayers, 2005).[32] These policies, resonating with the neoliberal political ethos, promised to correct market failure while remaining flexible and economically efficient because they gave "producers freedom to innovate and to choose the most inexpensive approach to regulatory compliance" (Lifset, 1993, p. 166).[33]

Importantly, social-welfare environmentalism remained strong in Germany until at least the 1980s when the Christian Democratic Union (CDU) reemerged as the ruling party. The CDU, under the leadership of Helmut Kohl, evoked the rhetoric of Thatcher and Reagan, did not however push neoliberal cuts in government to the same extent as the British and Americans. In fact, Kohl merely continued with moderate tax reduction policies instituted during the final years of his predecessor's rule. Nonetheless, compared to the 1970s, the 1980s were a period of financial constraints

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[32] Key here is the word "less." EPR policies differ from pure laissez-faire economic approaches in that they stresses the importance of government involvement (Tojo, 2001, pp. iii, 41). According to orthodox economic theory the market corrects itself at each stage of making and unmaking (Lifset, 1993). For instance, orthodox liberal economists argue that customer demand for more sustainable products would ultimately lead to product redesign. However in practice, the market, left to its own devices, often fails to give the appropriate feedback to stimulate less resource intensive and environmentally friendly production. In the case of consumer pressure for environmental design, it is commonly accepted that the market signal is simply too weak to trigger any changes (Tojo, 2001, p. 39). Voluntary programs, which would be more in line with orthodox economic theory, often also do not work in practice. Consumer awareness campaigns rarely impact economic behavior (OPEC 200, p. 40). The same applies to voluntary recycling programs, which only tend to work for waste that has a net market value. In fact, such voluntary approaches often make matters worse as they often create a situation in which publically funded programs are left with the cost of recycling unprofitable wastes without the income they would otherwise glean from handling the valuable waste. It is for these reasons that promoters of EPR policies argue that the government needs to get involved to "level the playing field" and "get the prices right."

[33] The underlying belief is that industry is a more creative and efficient problem solver than the government (Lifset & Lindhqvist, 2008, p. 144).

for municipalities in Germany (Prasad, 2006, pp. 168–171) and a shift away from top down environmentalism.

Finally, and perhaps more mundanely, EPR policies represented a way to raise money for municipal waste programs. Berlin's municipal waste authority was under pressure to cut costs as it had been accused of overcharging residents. Residents wanted a reduction in their tax bills (Walls, 2003, p. 1). Germany's EPR policies were governed by the principle of shared responsibility: municipal governments continued to collect and sort discarded items and manufacturers paid for these services. Consequently, EPR policies meant more income for municipal waste authorities that were struggling to survive.

EPR policies appeared to offer the perfect balance between market efficiency, technological innovation and government regulation for Germany in the late twentieth century. However, while the theory behind EPR underscores the importance of taking a more holistic, upstream approach to addressing the problem of waste, in practice, many EPR policies, including Germany's ElektroG, are ultimately reduced to end-of-pipe activities. In the following section, I explain how and why the ElektroG, Germany's most recent EPR policy, fails to meet its stated objectives.

The Drive to E-Waste Flows

In March of 2005 the German government passed the Law on the Use, Return and Environmentally-Compatible Disposal of Electrical and Electronic Equipment (ElektroG).[34] This law governs the production, registration, management and disposal of discarded electrical and electronic equipment in Germany. The ElektroG is the national transposition of the European Union's Waste Electrical and Electronic

[34] *Gesetz über das Inverkehrbringen, die Rücknahme und die umweltverträgliche Entsorgung von Elektro- und Elektronikgeräten.*

Equipment Directive (WEEE directive) and the Restriction of Hazardous Substances Directive (RoHS directive), which went into force in January 2003.[35] As noted earlier, the WEEE directive regulates collection and recycling of electrical and electronic equipment (EEE). Its objective is to minimize the quantity of EEE in the waste stream and to harmonize the disposal of waste from electrical and electronic equipment across European nations. The RoHS directive restricts the use of certain hazardous substances in EEE, specifically, lead, mercury, cadmium, chromium, VI Polybrominated biphenyl (PBB) and Polybrominated diphenylether (PBDE).[36]

By the time the ElektroG passed in early 2005, Germany had been searching for ways to regulate its e-waste stream for nearly a decade. Already in the early 1990s, long before other European nations had given much serious thought to the afterlife of discarded electrical and electronic equipment, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)[37] and the Federal Environment Agency (UBA)[38] had begun formulating a general e-waste ordinance.[39] Later, in 1998, a series of stakeholders drafted an information technology waste management ordinance[40] (Deutscher Bundestag, 2011, p. 7). However, unlike countries such as Sweden and the Netherlands, which implemented national e-waste

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[35] At the time of writing this dissertation, the European parliament and council were recasting the WEEE and RoHS directives. As a result, all involved parties, from industry representatives to member-state environmental offices to NGOs are currently in the process of articulating their complaints and criticisms of the existing laws. As a result, this was a particularly exciting time to be looking into this issue.

[36] European directives are only enforceable once member states have transposed them into national law. Importantly, each member states has considerable leeway in terms of how they transpose directives. In other words, Germany's transposition of the WEEE and RoHS directives varies quite a bit from Italy's or France's for example.

[37] Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit.

[38] Umweltbundesamt.

[39] Elektronikschrott-Verordnung.

[40] The IT-Altgeräte-Verordnung (ITV).

policies prior to the finanalization of the WEEE directive, Germany became heavily involved in articulating a European-wide strategy. Consequently, the country postponed efforts to draft a national e-waste law until it could transpose the EU legislation into federal law.

Though Germany only passed its e-waste law in 2005, it already had an e-waste handling infrastructure. Over 400 German companies were involved in e-waste handling and treatment (Deutsche Umwelthilfe, 2006). These included about 300 disassembly plants ranging from small to medium enterprises, "social projects" that work with handicapped and otherwise socially marginalized individuals, non-government and governmental charitable organizations as well as larger corporations.[41] In addition, about 120 companies specialized in the manual and mechanical processing of discarded electrical and electronic equipment. These 120 possessors—half of which were small to medium enterprises and half of which were larger, multinational firms—manually and mechanically processed the country's e-waste. Many of these firms were equipped to handle the removal of potentially hazardous CRT tubes and cooling elements. Together, these enterprises handled somewhere between 1,000 to 500,000 metric tons of e-waste per year (Deutsche Umwelthilfe, 2006).

However, prior to the ElektroG, the quantity and quality of collection and processing varied significantly according to product type. For instance, the collection and handling of large household appliances by municipalities functioned quite well, whereas other forms of waste often ended up in the municipal waste bin. While

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[41] According to the report by the German federal government, there are currently about 50 such social projects in Germany today. These projects are not financially viable due to the high labor costs and thus their futures are precarious. For more *see das Bericht der Bundesregierung zu den abfallwirtschaftlichen Auswirkungen der §§ 9 bis 13 des Elektro- und Elektronikgerätegesetzes* (Deutscher Bundestag, 2011, p. 19).

measures were taken to handle toxic components in cooling devices, there were no unified collection targets or handling protocols. As a result, handling of these potentially hazardous components was inconsistent. Moreover, the quality and quantity of collection and handling varied considerably from state to state (Deutsche Umwelthilfe, 2006). Further, prior to the ElektroG, Germany's e-waste sector was largely financed through municipal waste taxes and dumping fees (Deutscher Bundestag, 2011, p. 7). This funding schema not only meant limited financial resources for collection and processing, but the depot fees also created a disincentive for residents to properly dispose of their unwanted technologies. Finally, monitoring and data collection was inconsistent at best and non-existent at worst. Given these limits, the country desperately needed an e-waste policy that would harmonize collection and handling across the country, increase recovery rates, standardize the treatment of toxic components, improve monitoring and data collection and raise funds for municipal collection and handling of the growing mountains of German e-waste.

Outline of the ElektroG

After years of negotiations and debates, the German government adopted the ElektroG in 2005. The ElektroG has three main objectives: waste avoidance, improved recycling and recovery and the minimization of hazardous substances in electrical and electronic equipment (Deutscher Bundestag, 2011; Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2010). Waste avoidance is promoted through reuse and redesign.[42] The ElektroG sets clear recycling and recovery targets for each

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[42] The EletroG states clearly in § 9 Abstatz 9 that reuse is a priority and that collection should take place in such a way that reuse and maximal recycling is possible. In order to optimize reuse and recycling, collection needs to be organized in such a way as to ensure minimal damage. Importantly, the law qualifies its prioritization of reuse by stating "as long as it is technically and economically feasible."

category of e-waste. Clear restrictions on what chemicals can be used to manufacture products placed on the German market minimize the hazardous chemical content of electric and electronic equipment.[43] According to the German government, the three goals listed above will reduce the overall environmental impact of electrical and electronic equipment by reducing extraction of virgin resources and minimizing the environmental impact of production and disposal. Furthermore, improved e-waste recycling and recovery will secure Germany's access to critical raw materials (see Chapter 4) (Deutscher Bundestag, 2011, p. 5).[44] Importantly, in accordance with the country's overall waste policy the *Kreislaufwirtschaft und Abfallgesetz*, the ElektroG places its two primary goals in a hierarchy: reuse and redesign supersede recovery and recycling (ElektroG, § 1, ¶ 1).[45]

In addition to setting clear goals, Germany's e-waste law defines e-waste, which is no small task[46] It also identifies all stakeholders and outlines their roles and

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This qualification makes it easy to justify non-compliance with the reuse rule (see also ElektroG, § 11, ¶ 1 ElektroG).

[43] Specifically, the ElektroG restricts levels higher than 0.1 percent weight of lead, mercury, hexavalent chromium, polybrominated biphenyls (PBBs) or polybrominated diphnyl ethers (PBDEs) for products placed on the market after July 1st 2006 (See ElektroG, § 5).

[44] The ElektroG also lists a series of secondary objectives: better monitoring and data collection as well as the harmonization of e-waste collection and handling across Germany.

[45] The German Kreislaufwirtschaftsgesetzt—the country's overall waste policy—depicts a five level waste management hierarchy (See KrW-/AbfG, § 6, ¶ 1). At the top of the pyramid stands Vermeidung, or avoidance. Next comes Vorbereitung zur Wiederverwendung, or preparation for reuse. Recycling is third. Fourth and fifth are Sonstige Verwertung z. B. energetische Verwertung, or other forms of recovery such as thermal processing and Beseitigung, or disposal respectively. For more information on Germany's approach to waste management, see the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) webpage "General Information Waste Management in Germany" ("BMU - Waste Management," n.d.).

[46] Annex I of the ElektroG provides an extensive list of items that fall under the purview of the ElektroG (Deutscher Bundestag, 2005). As I discuss in Chapter 5, classificatory systems vary from place to place. This is because e-waste is a broad category that includes objects ranging from toasters to washing machines to MP3 players. Furthermore, the category of e-waste is constantly expanding as new products are introduced and more and more objects become 'digitized.' Consequently, there is often considerable confusion and conflict over what should be labeled as e-waste. Section 9 of the ElektroG categorizes e-waste into five subsections: 1. Large household appliances and automatic dispensers 2. Refrigerators and freezers 3. IT and telecommunications equipment and consumer equipment 4. Gas

responsibilities (Curter, 1996). The ElektroG places the most demands on the producer.[47] According to the ElektroG, producers must organize and pay for the responsible handling—be it reuse, recycling or disposal—of e-waste.[48] The ElektroG sets explicit guidelines for responsible handling, and requires producers to provide documentation of compliance with these guidelines on a regular basis.[49] Furthermore, the law makes producers responsible for meeting relatively high recovery and recycling quotas (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2010, p. 2). All producers who place items on the German market must not only register with the federal government, but must regularly report on their activities as well as provide a substantial financial guarantee in the case of insolvency. Finally, the law compels manufacturers to disclose information on product composition to waste processors within one year of putting a product on the market as a means of rendering e-waste recycling safer and more efficient. Though in practice manufacturers circumvent this requirement by citing trade secret laws.

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discharge lamps 5. Small household appliances, lighting equipment, electric and electronic tools, toys, sports and leisure equipment, medical products, monitoring and control instruments. In contrast, the WEEE directive lists 10 categories of e-waste. The German law simplifies the classification scheme and uses 5 categories in order to make collection and handling more logistically possible. As municipal waste workers in Berlin explained to me, few collection points have enough space to accommodate ten separate collection containers.

[47] The category of producer includes manufacturers, importers as well as retailers that place their brand name on the products they sell. There has been some controversy over how the ElektroG should define the category of producer. For instance, it is unclear how big an enterprise has to be to be considered a producer.

[48] The task of organizing the end-of-life of discarded items in Germany includes mundane tasks such as supplying municipal waste management authorities across Germany with collection containers for each category of e-waste and picking these up in a timely fashion. It also involves running a national clearinghouse, the EAR. The EAR monitors and coordinates e-waste pickup from municipal collection depots across Germany.

[49] The guidelines set by the ElektroG are remarkably detailed and specific. See section 11 of the ElektroG for more.

The ElektroG applies the principles of shared responsibility.[50] This means that whereas producers are responsible for e-waste recycling, recovery and disposal, the collection of household e-waste falls under the purview of the municipal waste management authorities.[51] These public agencies are required to collect municipal e-waste free of charge. They must then sort the collected items and make them available to producers (Deutsche Umwelthilfe, 2006).[52] It is also the responsibility of public waste management authorities to make residents aware of the resources available to them, educate residents about proper disposal protocols and sensitize them about the environmental and health implications of improper handling.[53] Consumers, in turn, are obligated to dispose of their unwanted technologies in a responsible manner; the ElektroG makes it illegal for consumers to place items in the trash (ElektroG, § 9, ¶ 1). The symbol shown below—which must be placed on all electrical and electronic equipment placed on the German market after July 1 2006—reminds consumers of their civic waste duties (see Figure 2).

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[50] My translation. The original term is *geteilte Produktverantwortung*.

[51] A caveat, municipal waste management authorities may take over ownership of one or more categories of e-waste (see the ElektroG, § 9 ¶ 6). This option is called *Optieren.* If a municipal waste authority chooses to *optieren* a category of e-waste, they must notify the EAR of their intensions three months prior to taking over that particular waste stream. The waste authority must then take over responsibility for that waste stream for a minimum of one year. A waste management authority might select to *optieren* a category of waste if it is valuable and thus represents a source of income. Of course, if the waste management authority takes over the waste is must also provide documentation that the waste was handled according to the environmental provisions set out by the ElektroG (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2010). In section 9 paragraph 7 & 8 it states that distributors and producers that wish to collect equipment and thus bypass the municipal collection scheme, may do so as long as they meet the requirements for environmentally sound handling of e-waste as described in the ElektroG.

[52] The only exception is if they provide a pick up service. In such cases the fee should cover transportation costs (Deutscher Bundestag, 2011, p. 10).

[53] Section 9, paragraph 2 of the ElektroG states "Public waste management authorities obligated under state law to dispose of WEEE must notify private households of their obligation [to separate e-waste from domestic waste]."

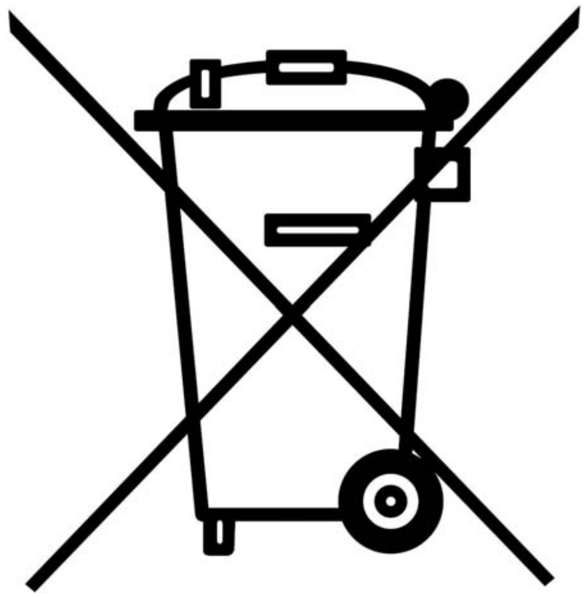

Figure 2. This symbol reminds German consumers that unwanted electrical and electronic devices do not belong in the trash. Still, a significant portion of discarded equipment, especially small devices such as cell phones, is thrown away annually. Reprinted from http://www.fuer-mensch-und-umwelt.de.

The ElektroG also explicitly describes the duties and obligations of the *Stiftung Elektro-Altgeräte Register* (EAR—The National Register for Waste Electric Equipment).[54]

The EAR is a non-governmental organization that operationalizes aspects of the ElektroG on behalf of the federal government. The EAR registers all producers in the Federal Republic of Germany. It also collects, processes and regularly reports data on e-waste to the Federal Environment Agency (UBA). In addition, the EAR must calculate, based on annual market share, the quantity of e-waste each producer is responsible for. The EAR coordinates pickups from municipal collection points across the country.[55] As stipulated by the ElektroG, the Federal Environment Agency

[54] For more on the EAR see http://www.stiftung-ear.de/.

[55] For a detailed list of the clearing house's responsibilities see section 14 of the ElektroG. Chapter four of this dissertation also provides a description of the EAR.

(UBA)[56] oversees the EAR and determines whether producers may be registered in Germany.[57]

In addition to identifying all stakeholders and outlining their roles and responsibilities, the ElektroG sets specific collection, recycling and recovery quotas for each category of e-waste. Recovery quotes range between 70–80% and recycling quotas between 50–80%. As noted above, and in accordance with the principles of extended producer responsibility, the responsibility for meeting these quotas rests on producers (Deutsche Umwelthilfe, 2006).[58] The ElektroG also provides clear protocols for monitoring, data collection and reporting.[59] Municipalities, waste processing firms and manufacturers are obligated to regularly report their activities to the national clearing house (EAR), which, in turn, reports to the Federal Environment Agency (UBA) (Deutscher Bundestag, 2011, p. 22).[60]

The ElektroG classifies e-waste as a waste that "necessitates careful monitoring" (Deutsche Umwelthilfe, 2006, p. 4).[61] Consequently, only specific waste handling firms are permitted to treat this waste stream. The ElektroG also gives very

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[56] For detailed explanation of the Federal Environment Agency's roles and responsibilities, see section 16 of the ElektroG.

[57] Importantly, this marked-based law gives the government a relatively conscribed role. Besides having municipal governments collect discarded items, the government's role is restricted to "keeping competition alive." The importance of keeping "competition alive" in the ElektroG is a direct response to problems with the 1990s packaging waste ordinance. The packaging EPR law made it easy for one company, the DSD, to monopolize the packaging waste management sector and drive the price of waste handling up considerably. (Deutscher Bundestag, 2011, p. 8).

[58] See section 12, paragraph 1 of the ElektroG.

[59] According to a recent report evaluating the ElektroG for the German parliament (Deutscher Bundestag, 2011), Germany has exceeded the 4kg quota set by the ElektroG considerably. In fact, along with Sweden, Denmark and Norway, Germany exceeded 8KG collection in 2006. Germany has also met the recycling and recovery quotas set by the ElektroG.

[60] Specifically, producers have to report once per month to the national clearing house for private e-waste and once a year for business-to-business waste. See § 13 of the ElektroG for more on reporting requirements.

[61] *Besonders überwachungsbeduerftiger Abfall.*

specific and elaborate guidelines for treatment and recovery procedures (Deutscher Bundestag, 2011, p. 10).[62] Moreover, the law calls for the annual auditing and recertification of processing firms (Deutscher Bundestag, 2011, p. 19).[63]

Not only has the ElektroG successfully improved collection and recycling rates in Germany, but the market-based approach to e-waste has also made the ElektroG politically and economically palatable to a wide range of actors.[64] Advocates of the ElektroG say that the law places Germany's e-waste system in the hands of private firms thus maintaining competition. This is turn results in an "eco-efficient" system in which the costs of disposal are relatively low in relation to other European countries (Deutscher Bundestag, 2011, p. 23).

Despite the praise for the ElektroG, many of its key provisions fall short in practice. I describe and analyze the shortcomings of the ElektroG below.

Limitations of the ElektroG: Reuse

To recall, the ElektroG states, like Germany's overall waste policy, that reuse of electrical and electronic equipment represents the most effective way to minimize resource use and waste generation (Deutscher Bundestag, 2011, p. 18). Various initiatives have been put in place to promote reuse. For instance, the Federal Environment Ministry (UBA) and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) are collaborating with the environmental NGO Deutsche Umwelthilfe (DUH) on a project called "Second Life." This project

[62] See sections 10 and 11 and Annex III of the ElektroG.

[63] See section 11, paragraph 3 of the ElektroG.

[64] The ElektroG appears to be successful. It is estimated that Germany is one of Europe's, if not the world's top e-waste collectors (Deutscher Bundestag, 2011, p. 11). Though there is still considerable room for improvement in terms of collection, recycling and precious metal recovery, German recycling and recovery rates are comparatively high. Furthermore, the law has reduced the level of toxic compounds in e-waste (Deutscher Bundestag, 2011, pp. 21–23).

explores the feasibility of a quality label for second hand items as means to promote reuse.[65]

In addition, the government supports "social projects" such as the Werkstatt Frankfurt e.V., which employs marginalized individuals to repair and sell discarded electrical and electronic equipment.[66] More locally, Berlin's BSR actively promotes reuse as well. Originally, the institution ran a store that sold functional discarded items. This store has since been replaced by an online market on the BSR website.[67] Despite these initiatives, however, only a small quantity of discarded electrical and electronic items have a second life as used equipment in Germany. In fact, an extensive report on reuse conducted by the Technical University of Braunschweig shows that reuse has *declined* from 10% to 3% since the ElektroG was introduced in 2005 (TU Braunschweig, 2009).

There are a number of reasons why reuse does not work in practice. Perhaps the most straightforward challenge is the fact that many items break during the collection phase and thereby become dysfunctional. Berliners are required to drop off their equipment at one of the city's municipal waste depots. Each of the city's depots has five separate containers, each designated for a separate category of e-waste. Residents often drop or toss their unwanted equipment into the containers without much care often damaging still-functional objects. Furthermore, many items are broken during the transportation process from the municipal waste depots to the initial waste processing facility (Deutscher Bundestag, 2011, p. 13). Waste processors complain that not only are many of the items they receive damaged, but valuable objects and components are often also removed between when they are collected and

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[65] For more information, see http://www.duh.de/wiederverwendung.html.

[66] For more information, see http://www.werkstatt-frankfurt.de.

[67] http://www.bsr.de/verschenkmarkt/list.asp.

when they are delivered to waste processors. The waste processers I spoke to suspected the collection depots or transport companies of removing and selling the valuable objects, parts or materials from the waste stream.

The report on reuse by the Technical University of Braunschweig concluded that reuse rates could be improved considerably if more effort and care was put into improving e-waste collection and transportation practices (TU Braunschweig, 2009). Despite the report's recommendations, however, collection and transportation practices remain unchanged. The problem lies in the wording of the ElektroG. The law states, "Where technically and financially feasible, a check must be made prior to treatment as to whether the waste equipment or individual components thereof can be sent for reuse" (ElektroG, Section 11, paragraph 1). The caveat "where technically and financially feasibly" makes it challenging to justify the extra cost of reuse friendly collection and transportation.

Even if items were collected and transported in a reuse friendly way, there remains the problem that the domestic market for used goods is rather limited in Germany (Deutscher Bundestag, 2011, p. 18). There are a number of second-hand cell phone and appliance stores in Berlin. However, most of their clientele consists of recent immigrants. Mane of these customers prefer higher quality used equipment to what they perceived as less well-built cheap new technologies. Other clients purchased goods in bulk from these second-hand stores in order to export them to their home country. Traders in second-hand equipment explained that the market for these goods was flooded. One interviewee explained that business had gotten significantly worse in the past few years (personal communication, August 27, 2010). They explained to me that they struggled to make a living (personal communication, August 26, 2010). One man whose store specialized in the repair of electronic equipment explained that, in most instances, repair cost more than buying something new. This is because of the relatively high cost of labor in Germany and because items were increasingly being manufactured in such a way to make repair difficult. He confided in me that the only reason he was still in business was because recent immigrants who, he explained, “don’t know that repair will cost them more than buying something new” (personal communication, August 27, 2010).

While the possibilities for domestic reuse are quite limited, there exists a substantial market for reusable and refurbished German equipment in the developing world. However, export for reuse poses another set of problems. Perhaps most importantly, as I discuss in greater depth in Chapter 5, export for reuse is often a ruse for illegal export. In other words, the controversy surrounding export for reuse explains the considerable confusion among waste handlers in Berlin regarding the legality of reuse. While conducting ethnographic research at the official recycling centers in Berlin, I was repeatedly told by recycling center workers, as well as by a representative of BRAL, the semi-private company that handles e-waste recycling for the city, that reuse was prohibited (personal communications, November 27, 2009–December 9, 2009). This, of course, is technically inaccurate, but the belief that reuse is undesirable if not illegal is firmly held among the people with whom I spoke. I was repeatedly told that once a product crosses the recycling center property line it becomes waste. Many of the workers found this policy highly disturbing, given their rough estimation that 80 percent of the electrical and electronic goods they collect are still perfectly functional when they are dropped off. One recycling center worker in a rather affluent part of Berlin told me that seeing what people threw away made him want to cry, especially since he knew so many people who were struggling to make ends meet (personal communication, December 9, 2009).

Finally, and perhaps most importantly, there are number of powerful actors with an incentive to curtail repair and reuse. The primary goal of manufacturers such as Dell, HP and Apple is to sell as many new products as possible. They embed this intention into the physical structure of their products by designing and manufacturing them to become obsolete as soon as possible (Slade, 2006).[68] At the same they promote perceived obsolescence through advertising. Recycling and recovery firms also have a vested interest in minimizing reuse. Waste handling firms, from the BSR to processors to recovery firms need constant supply of waste to earn a profit. Extending a product's life would lead to decreased consumption, which means decreased waste generation. Less waste translates into fewer profits for producers and recyclers respectively. I discuss in Chapter 4, these actors invest substantial capital in lobbying efforts and directly influence European and German policies regarding e-waste handling.

A representative of the Federal Environment Agency aptly summed up the problem of reuse. She explained,

> Reuse is the best way for us to achieve our goals of waste minimization and of lessening the environmental impact of electrical and electronic equipment, but there is very little reuse going on. It's not that hard to figure out why this is the case. No one besides us has any interest in making reuse an attractive option. Producers want to sell new technologies, consumers, influenced by million-dollar ad campaigns, want the latest models, and recyclers—ranging from collectors to processors to metals recovery firms—want to handle as much waste as possible. Reuse feels like a lost cause. In fact, since the ElektroG was implemented in 2005, our numbers indicate a steady decline in reuse. (personal communication, December 23, 2009)

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[68] Importantly, the ElektroG addresses the tendency for companies to sabotage reuse. The law states: "electrical and electronic equipment should, whenever possible, be designed to provide for and facilitate its disassembly, recycling and recovery, and particularly the reuse and recycling of WEEE and its components and substances. Producers should not prevent its reuse through specific design features or manufacturing processes, unless such specific design features or manufacturing processes present overriding advantages, for example with regard to the protection of human health and the environment or safety requirements" (ElektroG, § 4, §1). The caveat "whenever possible" makes it possible to bypass this requirement, however. Manufacturers easily argue that their design is necessary. Furthermore, they can refuse to share information on design by citing trade secret protection laws.

In sum extending the life of digital equipment through reuse is a priority of the ElektroG. However, in practice, powerful actors actively marginalize reuse.

EcoDesign

Since the idea of extended producer responsibility was first introduced, there has been considerable debate over what EPR stands for and its goals should be.[69] Despite the lack of consensus, scholars in the field of industrial ecology generally agree that stimulating design for the environment was the original impetus for EPR (Clift & France, 2006; Lifset, 1993). As Lifset and Lindhqvist, two leading scholars in the field of industrial ecology, explain, "At the heart of the original version for extended producer responsibility was the desire for a policy strategy that could provide ongoing incentives for the incorporation of environmental concerns into the design of products. If producers were made responsible for end-of-life management (i.e. reuse, recycling, energy recovery, treatment and/or final disposal) of products, they would find it in their self-interest to anticipate end-of-life costs and obligations and design their products to minimize those costs" (Lifset & Lindhqvist, 2008).

The ElektroG also stresses redesign. As the Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) explains in their summary of the ElektroG, "The obligation to take on responsibility for disposal management, in other words treatment, recovery or disposal of WEEE, aims to compel producers to

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[69] There is considerable debate over what EPR is and what its goals are or should be (Lifset & Lindhqvist, 2008, p. 3; Walls, 2003, p. 1). Some argue that EPR is only about waste, whereas others claim that it refers to the entire lifecycle of a product. Some governments see EPR primarily as a means to raise funds for recycling programs, whereas others see it as a means to stimulate redesign. What some call "downstream EPR" concentrates on minimizing how much waste is landfilled and incinerated. Others include design for diposal under the label of downstream EPR. Promoters of "upstream EPR," in turn, "argue that EPR should be aimed at optimizing the environmental performace of a product throughout the life (Lindhqvist, 1998) Castell et al. (2004) argue that the lack of agreement over the meaning of EPR watered down the effectiveness of the WEEE directive and the ElektroG. See also (Khetriwal et al., 2009) for more on the various objectives of EPR.

incorporate the entire life cycle of their products into their calculations" (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2010). In a section on the environmental goals of the ElektroG, Deutsche Umwelthilfe, a prominent environmental NGO, writes: "A significant aspect of the ElektroG is producer responsibility, that is, producers cover the cost of disposing and recycling equipment. The goal of this intervention is to encourage producers to take the entire lifecycle of their products into consideration, and not just until the point of purchase. This is intended to create incentives for producers to design high quality, easily manually disassembled and long-lasting productions. Recycling alone does not make products 'green'"("Deutsche Umwelthilfe e.V.," n.d.).

However, much like reuse, the ElektroG does not meet this goal for a number of reasons. The literature analyzing existing EPR policies and programs underscores the challenges with actually incentivizing design for the environment through EPR policies. For instance, a report by the United Nations University on EPR states, "there is no evidence that the WEEE Directive has led to design for the environment" (J Huisman et al., 2008; Lifset & Lindhqvist, 2008). Analogously, in an essay evaluating the Swiss e-waste handling system, which is purportedly the most effective e-waste system in the world, the authors admit in the conclusion that the Swiss system excels in collection and recycling but has considerable room to improve in terms of redesign. The authors write, despite the fact that the Swiss e-waste system is based on the idea of EPR, in practice "it provides little incentive to producers to design more environmentally friendly products or to consumers to influence buying habits" (Khetriwal et al., 2009, p. 164). The problem is that in practice the disposal-design feedback chain contains a number of loopholes. These problems with EPR are perhaps most pronounced in the case of e-waste (Castell et al., 2004; Clift & France, 2006).

A number of the challenges to the success of Germany's EPR-based e-waste law are directly linked to e-waste's unique properties. Unlike packaging, which has a relatively short lifespan, electrical and electronic equipment are kept for comparatively longer period (Tojo, 2001, p. 36). At the same time, innovation and change is very rapid in the electronic and electrical equipment industry. Thus, by the time products become waste and give "feedback" to manufacturers, manufacturers have moved on to making entirely different products (Tojo, 2001, p. 22). An engineer working at a large manufacturing firm explained why design for the environment through EPR does not work in practice: "There's not much benefit of working on an end-of-life benefit in a TV, which comes back after 15 years [. . .]. We stopped selling CRT TVs probably almost ten years ago now, but we're only getting CRT TVs back as waste (personal communication, January 21, 2010)." Thus, by the time the CRT televisions were returned, the 'feedback' they gave was entirely irrelevant to the design and manufacture of new products.

Moreover, the material composition of a product has a significant impact on the success of EPR policies (Tojo, 2001). The more complicated a product, the more challenging it becomes for EPR policies to incentivize design changes (Tojo, 2001, p. 41). E-waste is one of the most complex waste streams in the world. For instance, a printer contains over 34 different types of plastic. A television is made up of over 4,300 different chemicals. To complicate matters further, most products are loaded with various toxic compounds (Deutscher Bundestag, 2011, p. 5). For this reason, e-waste is challenging and often very expensive to handle and attempts at redesign are correspondingly difficult (Walls, 2003, p. 17). In other words, e-waste's unique materiality makes it challenging to reconnect processes of making and unmaking.

To complicate matters, manufacturers are not really manufacturers anymore. This means that making them responsible for the end-of-life of their products has virtually no impact on their design choices. The engineer I quoted above highlighted this problem repeatedly during our interview. He explained:

> For us, as [manufacturers] we don't make the panels [for flat screen televisions]. For us, it's –commodity is maybe not the right word, but it's a module we buy in from another country. [. . .]. Things changed because of different business models. [. . .]. Where traditionally we were a company that would develop and make everything ourselves, now we're also shifting more to original equipment manufacturers (OEMs), buying other products is from other companies, buying complete modules and then putting them together. [. . .] But that stopped, because we didn't have so much in-house development, and it's not happening in [city where company is headquartered]—it's happening in China and other countries. [. . .] We got approached by [a recycling firm] to sit in a discussion group on how to deal with [the LCD TVs we produce] and we said "OK, I'll join." But there's one problem—we don't make those modules, so yes, we can contribute, we can share facts and information with you [. . .]. We can't come up with the solutions because we don't make them ourselves anymore, (personal communication, January 21, 2010)

Another executive concurred,

> . . . our challenge from a supply chain perspective, is much more control. We don't make screws—I'll just take an example—we buy screws from the market, from wholesalers, who buy them from different vendors around the world. It's very, very difficult for us to go down and really check that a really small factory somewhere applies the environmental protections to make screws. So the challenge for manufacturers like [name of company] is very much controlling the supply chain of the environmental process. And here there is a big gap in local enforcement of environmental legislation. The EU legislation in many countries is too lax. (March 9, 2010)

Indeed, more often than not, companies such as Philips or Dell outsource production to a number of firms connected across the globe via commodity chains, and only add their name brand to the goods that they buy. As such these firms have little knowledge, and thus impact, on the ways in which the products they sell are produced. Further, because of the ways in which production has been restructured in the past twenty years, there is no longer a single manufacturer that can be held accountable for its products. As another high-ranking executive of a large computer manufacturing firm explained to me, production practices had changed considerably in the last two decades. Whereas in the early 1990s, when Germany's packaging waste ordinance passed, many manufacturers were located in Germany, today there is nearly no production in the country. The executive claimed,

> Well, the producers of course already at [the time of the packaging waste ordinance] were not only in Germany, but there were still many producers in Germany, yes, there was more production available at that time in Germany, there was also in Germany more research and development departments of companies to develop appliances. So I remember that in that preamble, I involved our R&D department, and remember for instance, in [names four specific manufacturing firms], they all had their R&D and production people involved in this process. Nowadays there's very little production left, and indeed very little research left in Germany, unfortunately, so you would not have today access to all these people. So I think that is a big difference between now and let's say, 15 years ago. It is a significant change, and if you would have to do that today again in the same very early learning curve, we would need much more time. Because here we could talk across the street with production and R&D people, and nowadays I would have to talk to somebody in probably the US or in India or in China. So that is a big, big, big difference. (personal communication, March 09, 2010)

In addition, manufacturers complained that they had very little control of their products once they were discarded. As one high-ranking executive explained during our discussion of the actors involved in unmaking,

> It's not so informal. It's really brokers, these companies at least who buy from Deutsche Bank are in the meantime bigger companies who are making several hundred—several million dollars a year. It's not just the informal unemployed person who comes and collects waste. It's really companies who do some refurbishment, mainly in completing the product. Because if they buy from Deutsche Bank a printer, this printer most likely doesn't have a driver with it, maybe nor a manual, maybe not the right power cord. So those guys who are taking it, they may not repair a printer because it's not broken, but they just complete it so they can resell it. But the point is the stuff is out of our hands completely. And we cannot tell the customer, the Deutsche Bank, what they have to do with it. So that's what I see as a development—more and more, we as manufacturers don't have control over the e-waste. (personal communication, March 9, 2010)

Important here is the fact that manufacturers are not simply competing with a wily informal sector, but also with large powerful and well organized brokers that trade in end-of-life products. These products carry the manufacturer's name, and it is the manufacturer who suffers the consequences of bad publicity when images of their products in e-wastelands surface in the global media.

In brief, they key issue is that we live in a time in which there is a radical separation between making and unmaking. The project of reintegrating making and unmaking is challenging because the legislative framework remains state-centric and focused on formal processes and actors. It cannot address the fact that Germany is a place that is constituted by economic, social, environmental relations—both formal and informal—that extended beyond its borders.

Not only state-centrism, but also the ability to diffuse responsibility, undermines EPR policies. In order for EPR to work, manufacturers must "feel" the consequence of their design choices. However, because the ElektroG defines responsibility rather loosely, manufacturers can, and mostly do, contract out disposal to third parties, called end-of-life service providers (Lifset & Lindhqvist, 2008, p. 144). As such, besides writing a check, companies end up taking on very little responsibility for the end of their products' lives. The ability to outsource their responsibilities renders the feedback mechanism imbedded in the ElektroG virtually impotent.

Furthermore, in current formulations of the ElektroG, responsibility for e-waste can be shared among all producers and divided according to current market share. Because manufacturers share responsibility there is little incentive for individual companies to take on the costs of designing more eco-friendly products. To use the company Apple as an example: Apple has to share the costs of recycling all e-waste in Germany. Since Apple is not merely accountable for the actual products it produces, that is, it is not *individually* responsible, investing in designing green products at a higher cost places them at a market disadvantage over competitors who design difficult to recycle yet cheaper goods. An engineer at a large manufacturing firm explained,

> Whatever type of investment you make, and also looking at the recycling processes themselves, it's much more or less focused on shredding. Sometimes you have to do some de-pollution, so you have to take out, for example a TV, the CR tube has to be treated separately. For years, that's what's been happening. So there's some manual labor involved, people who dismantle the TV, take out the tube. The latest recycling treatment processes, you don't even have to do that anymore. You just put it together in the shredder, and you still separate the waste streams afterwards, because of all the various improved filtering techniques and technology.
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> So you can invest in a product today, but you have no idea how it's going to be treated when it comes back. And what else is in that same stream when it comes back. So unless you do it all separately, individually, you're unlikely to get any payback on that investment. And if there is a payback, the chances are unlikely that another party has already gotten hold of that product and taken it out for you. [Here is a] famous example: a few years ago, we had a nice presentation from [a computer manufacturer] at a conference in Berlin, and they were painting a nice picture about their products. They were investing in their products so that when they came back they could retail more value from those products [. . .] And a very simple question from the audience was, or remark from the audience was to say, "OK, that's good to know, because in a few years, I'll start collecting [your] products because I know there's a value in there. And there is nothing you can do to stop me." At which point the presenter got very upset, and he got upset because it was exactly the weak point. And that is what we are faced with, with the informal and non-registered systems, if a product retains representative value, it will never reach you. Whatever investment you make into a product, the chances that you will actually get a benefit from that investment is very small. (personal communication, January 21, 2010)

A 2007 report by the German environmental consulting firm, Ökopol (Sander et al., 2007), explained that the WEEE directive (and consequently the ElektroG) as it is formulated now, "makes it nearly impossible for producers to benefit from investments in product design that minimize the cost or improve the environmental performance of their products at the end of life" (Lifset & Lindhqvist, 2008, p. 145).

The idea of the individual producer responsibility versus collective responsibility was introduced as a means to overcome the problems with collective schemes (Lifset & Lindhqvist, 2008, p. 3). Individual Producer Responsibility (IPR) distinguishes itself from general extended producer responsibly in that it makes manufacturers directly responsible for the specific physical items they sell. The idea is that if manufacturers were forced to take back their own products they would have a greater incentive to redesign. In addition, they would be less likely to be outcompeted by their cost-cutting competitors. A number of manufacturers such as Electrolux, IBM and Sony are in favor of IPR and have joined forces with environmental groups and scholars to form an advocacy group called IPR Works.[70] Advocates of IPR stress that without individual responsibility "the core objectives of EPR will be lost" (Lifset & Lindhqvist, 2008, p. 145).

To clarify: technically, according to the WEEE directive and the ElektroG, all non-historical waste—that is waste that was produced after national laws went into effect—should in fact be handled according to an individual responsibility scheme. In other words, in the case of Germany, HP would only technically have to handle discarded HP products that were placed on the market after 2005. German policymakers foresaw that an individual responsibility scheme would be more likely to realize the original goal of the ElektroG, and this is why the WEEE directive and the ElektroG favored individual responsibility.

However, few European member states actually transposed individual responsibility into national law and of those that did, none have been able to effectively run a system in which e-waste is separated and returned to individual producers. According to the 2007 Ökopol study on EPR (Sander et al., 2007), only 9

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[70] For more information, see http://www.iprworks.org/contact.asp.

out of the EU 27 member states formulated their national e-waste laws in such a way that clearly privileges individual responsibility. The other states either passed legislation with vague language or entirely excluded any mention of IPR (Sander et al., 2007). Though the ElektroG has adopted IPR, in practice collective responsibility takes precedence as industry representatives as well as government officials believe IPR is too costly and logistically impossible to implement.

The challenge with implementing an individual responsibility program is that tracking and coordinating a system in which every company receives its own, and only its own, discarded technologies would be, as one official at the *Bundesumweltministerium* (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, BMU) plainly stated, "a logistical nightmare" (personal communication, December 23, 2009). Other interviewees stressed that IPR was "unreasonably costly." To complicate matters, individual physical responsibility creates a disincentive for collection, since the more is collected the more manufacturers have to pay (Tojo, 2001, p. 211). As such, IPR could further incentivize illegal export.

Not only is it difficult to create and uphold a feedback mechanism that makes producers "feel" or internalize the costs of disposal, but, much as in the case of reuse, many of the actors involved in the process of unmaking have a vested interested in keeping things the way they are. In 2009, during the course of my field research, I heard an executive for one of the world's largest e-waste processing firms, Sims Recycling Solutions, blatantly tell a group of engineers and social scientists interested in green ICT design: "To all of you interested in design for recycling, give it up right now. You're wasting your time. We're not interested. Design for recycling does not add value. We can recycle the e-waste with the machines we have. Focus on something else" (personal communication, September 9, 2009).

Ironically, the executive made this statement during a presentation at the "Solving the E-waste Problem Conference." The conference, which was organized by the United Nations University, was intended to bring together PhD students in engineering and the social sciences who were conducting promising research on e-waste, and who would, it was believed, eventually help find ways to solve the global e-waste problem. One of the problems with the conference, however, was that, according to Sims, a powerful, well-connected and politically active multi-national corporation, and incidentally also one of the primary hosts of the conference, there was no real e-waste problem to speak of. Or, to be more accurate, for this company that had invested significant amount of capital in high-tech recycling technologies, the problem of e-waste was a question of improved collection and recycling. The problem was not consumption or design. This way of framing the problem makes it possible to maintain capitalism's linearity—where production, use and disposal are discrete, successive stages of a commodity's lifecycle—intact. It leaves no room to question the premise that capitalism and unbridled consumption represent the inevitable pinnacle of social organization.

Notably, not only high-powered firms but also informal waste handlers are dependent on growing waste production and thus have an interest in sabotaging waste avoidance initiatives, though the latter actors have little recourse to formally further their interests. The scavengers and exporters I interviewed in Berlin and Hamburg were clear that their livelihood relied in large part on German's consumption patterns. Analogously, during the course of my fieldwork in Ghana in 2009, it quickly became apparent that the children that informally recycled e-waste in Agbogbloshie market needed rich Europeans to keep discarding their electronics and exporting them to Ghana. However disturbing the situation in Agbogloshie market is, in the end, the more waste was brought there, the more these children are able to sustain themselves.

Recovery and Recycling

The ElektroG also seeks to improve domestic recycling and recovery rates. The law sets a collection target of 4 kg per resident per year. As noted earlier, Germany has not only successfully met its goals but it has also exceeded it in some years by more than 100% (Deutscher Bundestag, 2011). A target of 4 kg per person per year is relatively low for a country like Germany, given how much waste is produced each year. The target was set this low to make it possible for other European member states with less sophisticated collection infrastructure or less production of e-waste to meet it.

Still, Germany continues to export a significant portion of its waste. Part of why so much e-waste escapes is that ElektroG systematically ignores scavengers, informal recyclers and used EEE brokers, who play a central, yet largely unseen, role in Germany's e-waste management system. This informal sector is a significant hindrance to Germany's ability to improve its recycling and recovery rates (Deutscher Bundestag, 2011, p. 6; Tojo, 2001, p. 23).

German officials have a hard time accepting that such an informal sector exists in Germany. As a German government official working at the Hamburg port explained, "The problem in Germany is that we can't imagine, let alone accept, that we have an informal sector. We can see informality in developing countries. We can even accept that there is informality in France, but not Germany" (personal communication, March 04, 2010). Regardless of German administrators' wishful thinking, however, the country's informal e-waste sector is not only alive but well. It is also remarkably complex and diverse (see Chapter 4 for more on Germany's informal sector).

In the draft proposal for the revised WEEE directive, the European government proposes to shift the recycling target from 4 kilograms of WEEE per capita, per year to 65% of the weight of EEE placed on the market in the two preceding years. Shifting the target from a weight to a percentage, claims the EU government, will even out the playing field between member countries. Increasing the overall collection mandate is obviously intended to increase recycling and thus minimize waste generation. Producers, however, argue that increasing the target without taking the existence of informal recyclers and used EEE brokers into account, forces producers to either find a way to shut down the informal market in EEE, or gives them no choice but to purchase used goods from informal handlers in order to meet the high collection goals set by the government. In effect, producers claim that by increasing the collection target without cracking down on informal brokers who "hoard" up to 80 percent of Germany's e-waste, the government makes producers responsible for stopping the informal market, something they adamantly assert goes well beyond their responsibilities as private companies.

Not only does the ElektroG's failure to recognize the informal sector place unrealistic expectations on industry, but because Germany's e-waste law does not take the informal globalized e-waste economy into account—that is, because of its methodological formalism—it enables the displacement of the health and environmental costs of e-waste disposal onto the developing world. As informality is not acknowledged, export through informal channels continues. Not only informality but also the globalization of unmaking eludes the ElektroG. The past twenty years have seen a rapid reorganization of the global recycling industry. Formerly recycling firms were generally small and medium-sized, often family-run, local operations. Today, a handful of multi-national corporations dominate the global recycling sector.[71]

[71] For a fascinating account of the recent reorganization and globalization of the American scrap metal industry see "American Scrap" in *The New Yorker*, January 18th, 2008.

Conclusion

Since the rise of modern capitalism during the nineteenth century, Germany has struggled to handle its waste. The struggle has been punctuated by two major waste crises. In response to the first waste crisis the federal republic built landfills and later incinerators. However, these tactics of displacement were only temporary. Germany faced a second waste crisis during the 1970s and 1980s. This time, policymakers, NGOs and the general public recognized mass consumption as key to the waste problem. However, liberal economic theory dominated at the time. Thus, German lawmakers introduced market-based environmental policies based on the idea of extended producer responsibility. Germany's EPR-based waste policies promised to reconcile social and environmental objectives with the goals of increasing profit and economic growth. Consequently, they became very popular and palatable among many actors in and outside of Germany.

Though EPR policies certainly represent an improvement from end-of-pipe solutions in that they acknowledge capitalism's role in creating the waste problem, such incentive-based policies often fail to meet their stated objectives. In this chapter I have argued, using the example of Germany's most recent EPR policy—the ElektroG, that while the law tries to internalize that which the market usually externalizes, it obscures other things. Specifically, because of the fact that given the way the law is formulated responsibility remains at odds with market survival of firms. Profit seeking manufacturers, recycling and recovery firms and even the informal sector have a vested interest in stopping waste avoidance as their income is contingent on as much consumption as possible. Thus, their incentive to elevate profit stands in direct opposition to the ElektroG's goals of waste avoidance through reuse and redesign. Furthermore, the ElektroG's mechanism to stimulate redesign through holding manufacturers responsible is watered down because the market-based law allows manufacturers to hire end of life services providers to work on their behalf. Individual responsibility policies, though more likely to successfully stimulate green design and though mandated by the WEEE directive, are rarely applied because they are deemed too costly and thus "unrealistic."

The pervasiveness of neoliberal economic thought heavily circumscribes what "solutions" to the problem of e-waste policymakers and even environmental NGO employees consider. Keeping costs down and increasing profit shapes the parameters of what is deemed a "realistic" or "possible" solution to the problem of e-waste. The profound importance of economic efficiency is clearly evident in the ElektroG's caveat that efforts to improve reuse and redesign are only to be pursued if they are "economically realistic" (ElektroG, 11, 1). In fact, according to Castell et al. (2004, p. 6), economic considerations superseded health and environmental protection objectives during negotiations over the WEEE directive, which in turn had direct impacts on the ElektroG. Policymakers were very concerned that environmental policy would not violate trade agreements and WTO rules. Such caveats make it easy to abandon interventions that would threaten profits.

The extent to which the discourse of economic feasibly has permeated the discourse on e-waste is quite striking. Nearly all the stakeholders I spoke to throughout the course of my research refused to seriously consider solutions to the problem of values that supersede the market. A representative of a large European environmental group explained during an interview that NGOs were forced to speak in the language of economic feasibility if they wanted to be taken seriously:

> We've got to—not to speak in the language of profitability, but to integrate that into a constraint to make things practical. I don't say I fully agree with this, I don't say that we should always consider the environment with what kind of business we can make out of it. It's rather unfortunate, I repeat, I think from an NGO point of view, that at the end of the day, if you want to make

> things happen, you've got to be realistic about this issue. (personal communication, November 19, 2009)

Other NGO workers were less critical of the pressures to speak economics. Many of my interviewees began to laugh when I asked why they did not focus on campaigns that would address mass consumption. One respondent openly stated, "Trying to get people to consume less? That's simply ridiculous. Even if it were possible, we don't want that. That would be mean going backwards in time" (personal communication, July 9, 2008).

Of the many NGO representatives I spoke to only one was openly critical of the economistic logic that dominated the discourse on e-waste in Europe. In the quote below, the NGO employee is responding to a question on the Best of Two Worlds project. This project proposes to create a global division of labor in which electrical and electronic equipment is manually disassembled in the developing world and the valuable circuit boards containing precious and rare earth elements are shipped to Europe for high tech recovery (for more on the Best of Two Worlds Project see Chapter 5).
He stated,

> Okay, but for me, I can understand that as an economical justification, but as long as we send our waste to other countries, even if it's done properly so that they can in a way take charge of disassembling, recycling, treating them, and sending them back to us, I think it's not a strong appeal for us to start changing our consumption patterns. So to be honest, for me it's not a problem even if it's more costly here. I can understand that it's difficult, and that we've got to deal with social fairness and social acceptability, accessibility to consumption, but for me, if we had to treat our waste here at a bit more expense—well, then let's have it treated here and be more expensive. Then maybe if the product is more expensive, people would pay more attention to it. The whole idea is how can we create patterns so that people can access the modern technology and things like this, so it's all about how we can create another item of ideas—I'm not an expert on that, but how we can create the structure to give access to people, but paying the right price in terms of what it costs. So as long as you say, "Okay, it's cheaper to have it dismantled there, then what's the incentive for us to

> behave differently? That's my question. (personal communication, November 19, 2009)

In the course of my research I rarely came across discussion of other values that supersede the value of making more money; no one took seriously the idea of asking people to "pay more" as the man I cite above suggests.

The challenges of implementing a policy that actually stimulates redesign led a number of stakeholders, including the United Nations University, to claim that efforts to create circular systems should be abandoned. However, advocates of EPR policies, stress that an "EPR justified solely in terms of landfill diversion is an impoverished policy strategy." They explain that, "the special value of EPR is not realized unless there are incentives for (re)design of products, distribution and logistical networks, and a host of other environmentally related innovations" (Lindhqvist, 1998, p. 7). Nonetheless, in a 2008 review of the WEEE directive, the United Nations University argued for the abandonment of the original goals of WEEE directive—namely waste avoidance and the stimulation of a circular economy (Lindhqvist, 1998, p. 7). The authors argued that the WEEE directive's goals should be to increase recycling and recovery and raise funds for waste collection schemes. Stimulating green design and a circular economy is simply not possible because it is not cost effective, they maintained. Thus, as the case of the ElektroG suggests, as long as policies aimed at creating a circular, more green economy allow for competitive pressure between firms to prevail and do not address the methodological state-centrism and formality, there is little hope for EPR policies to usher in a circular economy. In fact, as other scholars working on market-based environmental policies have shown, incentive-based "solutions" to environmental problems, though very palatable to a range of actors, often fail to meet their objects because of what they obscure and ignore (Lohmann, 2006; Neyland & Simakova, 2012, p. 37). Consequently, in practice, they often make matters worse by “recycling the problem as the solution” (McMichael, personal communication, August 23, 2013).

CHAPTER 4: DER KAMPF UM DEN ABFALLSTROM: THE STRUGGLE OVER THE WASTE STREAM

Overview

In the summer of 2009, as part of my year conducting dissertation field research, I visited, along with a number of other researchers, the impressive sprawling headquarters of a Belgian mining company at the forefront of global e-waste recycling. Before they allowed us to enter the premises, our guides asked us to sign comprehensive confidentiality forms and hand over our cameras and cell phones for the duration of the visit. In addition, each visitor obtained a personalized security badge. We needed the badge to enter and exit the main building, as well as to pass through security checkpoints during the tour. They warned us to keep close to our tour guides and avoid deviating from the path. The tour culminated in randomized searches of our persons and bags—apparently a daily occurrence for visitors and employees. Having made it through the final checkout, my colleague turned to me and whispered "All this trouble for trash?"

Indeed what my trip to the e-waste recycling facility made plainly visible was that e-waste can be an extremely valuable resource—a resource worth investing in, protecting, and fighting over. Over the past decade, the Belgian mining company, which has been in the mining business for well over two hundred years, has invested upwards of 250 million Euros in developing the world's most state-of-the-art metals recycling facility. While the facility has the capacity to handle multiple metal-rich waste streams, e-waste holds a particularly high rank among the detritus handled at the plant. The representatives I interviewed routinely referred to e-waste as "urban ore" and stressed that the handling of discarded electrical and electronic goods represented the new frontier in precious metals mining. "As global consumption of high-tech goods increases and the combination of political instability and dwindling natural reserves restricts access to metals needed for the production of high-tech goods, e-waste will grow into a strategic and immensely profitable material stream" predicted the company engineers (personal communication, Sep. 11 2009).[72] Indeed, according to the company's website, their Belgian facility should be thought of as "our very own Fort Knox" (accessed 28 May 2012).

E-waste is a hot commodity. Various actors, such as the Belgian mining company I visited, struggle to control this strategic material stream. I use the term struggle consciously, since, far from straightforward and unproblematic, the disposal process is characterized by conflict and contestation. In this chapter, I outline and analyze what one German government official dubbed as "der Kampf um den Abfallstrom," or the struggle over the waste stream. I begin by taking a closer look at how Germany's e-waste policies translate into practice. I describe e-waste's path once it has been discarded, introduce the various actors involved in Germany's e-waste networks and describe how they handle and, where applicable, transform discarded electrical and electronic technologies. Following waste engineers, I separate the e-waste chain into three phases: 1) collection; 2) pre-processing; and 3) recovery (Chancerel et al., 2009; Deubzer, 2011). Importantly, though I separate the formal and informal networks here for the sake of clarity, I wish to stress that in practice the boundary between these two chains is porous. Actors and objects move fluidly between these two networks. Further, the phases of processing sometimes overlap, particularly in the informal processing chain.

Specifically, I argue that disposal is a complex social process worthy of social scientific analysis (Gregson et al., 2005; Gregson et al., 2007). In other words, an object's story does not end when an object is labeled as trash. Rather, another equally

[72] In fact, rising prices have motivated some companies to re-mine previously abandoned mine-tailings. See for example, "Remining in 10 historic tailings dames probed" (Kolver, 2007).

compelling social, political, economic and cultural tale of unmaking begins once something is discarded. Moreover, e-waste's physical characteristics influence the recycling process and play a role in determining who can legitimately—in terms of meeting environmental and efficiency standards—extract value out of e-waste. In other words, the struggle over e-waste cannot be reduced to politics and power alone. As we will see again, materiality—in the sense of values and relationships crystallized into material properties—matters.

Collection Phase

According to the ElektroG, the responsibility for collecting e-waste lies with municipal waste management authorities, which in Berlin is the *Berlin Stadt Reinigung* (BSR). Producers, also referred to as original equipment manufacturers (OEMs), in turn, are responsible for the environmentally sound recycling of discarded equipment. This division of labor and responsibility between public and private entities is referred to as *geteilte Produktverantwortung* or shared product responsibility.[73] As noted in Chapter 3, an independent clearinghouse, the Elektro-Altgerätregister (EAR), supervises and coordinates Germany's dual e-waste system.[74] Technically, the legal responsibility for collection and disposal lies with the municipal waste authorities and OEMs respectively.[75] However, as mentioned in Chapter 3, both parties can contract out their obligations to private third parties. In Germany, nearly all

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[73] For a detailed discussion of "geteilte Produktverantwortung" and an extensive explanation of why collection remains in the hands of the municipal government in Germany, see: *Das Bericht der Bundesregierung zu den abfallwirtschaftlichen Auswirkungen der §§ 9 bis 13 des Elektro- und ElektronikgerätegesetzesBericht* (Deutscher Bundestag, 2011, pp. 6–10).

[74] *Das Bericht der Bundesregierung zu den abfallwirtschaftlichen Auswirkungen der §§ 9 bis 13 des Elektro- und ElektronikgerätegesetzesBericht (Deutscher Bundestag, 2011, p. 5)*, provides a clear description of EAR's function and the institution's relationship to the UBA. Importantly, the report explains that there has been quite bit of conflict over the EAR algorhythm. This conflict even resulted in a court case (Deutscher Bundestag, 2011, pp. 9, 17).

[75] According to the ElektroG retailers are also permitted to collect electrical and electronic equipment.

producers take advantage of this option and hire end-of-life full-service providers (ESP). ESPs are private firms that handle anything from registering and reporting duties, to pick-up, storage, recycling, recovery and disposal of e-waste. Importantly, it is technically illegal for private third parties to collect municipal e-waste unless they have been contracted to do so by the BSR. As we will see below, however, this law is challenging to enforce.

According to formal collection schemes, unwanted electrical and electronic equipment should be dropped off at one of Berlin's 15 Recyclinghöfe, the city's recycling stations scattered around the city.[76] In addition, as of 2011, Berlin has introduced the "Orange Box," which according to the city's advertisement, campaign represents "*den* Recyclinghof *vor Ihre Haustür*" or the recycling center at your doorstep. Orange boxes collect all "*Wertstoffe"* or valuable materials, including metal-rich items ranging from pots to plastic toys to untreated wood to textiles as well as e-waste. These boxes are located in the courtyards of apartment buildings or anywhere else the city's assortment of recycling containers can be found. The boxes are meant to address the problem that many Berliners did not, or could not, transport their items—particularly small gadgets—to official collections depots. Though, as noted above, private actors are technically forbidden from collecting waste in Germany, for various historical reasons, the recycling firm ALBA also collects a portion of the city's e-waste in its *Gelbe Tonne Plus* or Yellow Bin Plus collection bins. Finally, the BSR also provides a pick-up service for items that are too big to fit into the orange box. Few residents take advantage of this option, however, as it is costly and inconvenient.

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[76] Other cities have regular collection days during which residents place their unwanted items on the curb. However, this practice makes it easier for what the German government refers to as "thieves" to collect discarded materials. These informal collectors note official pick up days and do collection rounds before he municipal waste management authority (Deutscher Bundestag, 2011, p. 12).

The city's recycling stations collect a wide range of recyclables including paper, plastics, textiles and unwanted electrical and electronic goods. Upon arrival at the recycling stations, Berliners are asked to sort their e-waste into separate containers provided by the manufacturers. In theory, once a container is full, the BSR notifies the clearing house (EAR). The EAR then contacts the next manufacturers in line to pick up the e-waste. The ElektroG stipulates that the turnaround time between notification and pickup should take no longer than a few days. In reality, however, the process can take four to six days, and sometimes even longer. Because of limited space, Berlin's waste authority collaborates with a third-party BRAL Reststoff-Bearbeitungs GmbH. BRAL collects e-waste from the recycling depots and transports it to a larger facility outside the city center. BRAL notifies the EAR and submits relevant data pertaining to types and quantities of e-waste collected on behalf of the city.

Though the BSR mainly handles municipal e-waste, the city will also accept up to five items from small firms as well as up to twenty items from small companies. Private firms, businesses, larger institutions such as hospitals, schools and retailers do not go through the BSR. These firms and institutions are required to pay for environmentally sound and socially responsible collection and disposal through private channels. In contrast to the public disposal process, private networks of unmaking is not easily monitored or regulated.[77]

[77] The responsibility to for the waste stream is not shared with municipal waste authorities as is the case for municipal waste. The language used in the ElektroG on business-to-business (B2B) e-waste remains rather vague. The law stipulates that producers must give businesses reasonable opportunities to return their devices (zumutbare Möglichkeiten zur Rückgabe) (Deutscher Bundestag, 2011, p. 5). The law also allows for businesses and producers to come to alternative arrangements. (Deutscher Bundestag, 2011, p. 10). The vagueness of this statement helps explain why there is relatively little data on B2B e-waste.

Pre-processing

The municipal waste authority hands over collected items to pre-processors. First, pre-processors break equipment into their constitutive parts: plastic casings, glass and metal-containing components. At this point, the firms extract hazardous components and substances such as the mercury-containing backlights of LCD monitors or batteries. They also take out valuable components such a printed circuit boards, processors or components that can be used as spare parts.[78] This breaking apart can be done manually or, if the cost of labor is too high, mechanically. Some facilities specialized in e-waste pre-processing claim to have the technological capacities to break equipment apart while keeping components intact.

Technically, the municipal waste management authority's role in the recycling chain is restricted to collecting and sorting unwanted electrical and electronic equipment. Private so-called end-of-life service providers take over pre-processing and recovery for the manufacturers. However, according to the ElektroG, all municipal waste authorities have *das Recht zu Eigenvermarktung*, or the right to assume ownership of any category of e-waste for at least one year.[79] Selling e-waste components and fractions represents an important source of revenue for the municipality, and thus the waste authority frequently takes advantage of this option. In Berlin, the waste authority extends the right to a private firm called BRAL. BRAL

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[78] Obviously, the terms toxic, hazardous and valuable are anything but static. As I argue throughout this dissertation, these definitions fluctuate over time and space. For instance, presently there is a heated debate among stakeholders over whether one should use the term "toxic" or "hazardous" in relation to e-waste.

[79] As mentioned earlier, the term "*optieren*" is also used to describe when municipalities take over a waste category. E-waste categories 1 and 5 are most often *optiert* as are the most valuable sections of the e-waste stream. For more information on municipal waste management authorities or "öffentlich-rechtlichen Entsorgungsträger(örE)" as they are called in German, see *Bericht der Bundesregierung zu den abfallwirtschaftlichen Auswirkungen der §§ 9 bis 13 des Elektro- und Elektronikgerätegesetzes* (2011, pp. 10–12).

thus not only stores and sorts Berlin's e-waste, but also handles valuable subcategories of this waste stream.

At BRAL facilities sixteen workers manually and mechanically disassemble e-waste into parts or materials. While manual manipulation is a more effective method for recovery of precious metals—whole components, as opposed to mechanically shredded fractions can often be more easily harvested for valuable metals later—mechanical pre-processing dominates in Germany due to high labor costs. However, because BRAL also employs socially marginalized populations such as the long-term unemployed and handicapped—a common practice among e-waste handling firms—it can also afford manual disassembly in certain instances.

After the processor manually or mechanically breaks the equipment apart into glass, plastic and metal segments, he extracts the larger hazardous and valuable components. He comminitizes the rest. Comminution is the process whereby solid objects are transformed into smaller parts. For e-waste this usually means shredding. Large machines break the equipment into small pieces. Mechanical separation follows comminution, which is comprised of multiple steps. Mechanical separation sorts the shredded materials into multiple fractions: aluminum, copper, iron, plastics and glass. BRAL, or another end of life service provider, then sells these fractions to traders or directly to firms specialized in recovery and recycling.

Recovery

The next step in the e-waste recycling chain is recovery, whereby valuable materials are extracted and processed into raw materials for production. Pre-processing firms either sell the fractions or components to traders or they directly send them over to companies specialized in recovery and re-processing. If the pre-processing firm is small, for instance as with BRAL, the company then sells to traders who collect larger quantities, as recovery firms prefer to deal in large volumes. Traders collect e-scrap, components or fractions from all over the world before shipping them to recovery and re-processing firms.

Glass from CRT monitors can be rich in lead or other contaminants. Some firms such as the UK-based NuLifeGlass specialize in e-glass recycling.[80] They transform e-glass into pellets, which can be used to manufacture new products. However, since glass recycling is minimally lucrative, Germany incinerates most of its glass.

Plastic fractions are heterogeneous. This makes them difficult to recycle. Consequently, in Germany, the plastic fractions from e-waste are, like glass, mostly incinerated. Cement kilns frequently use plastic fractions as an alternative source of fuel. E-plastic, especially the plastic produced before the RoHS directive was passed, contains brominated flame-retardants. The process of incinerating plastics often releases furans and dioxins, which are toxic. Flue gas cleaning technology captures these compounds and prevents them from being released into the air. Some plastic fragments are sold to traders who then export this plastic to processing firms specialized in the manual and mechanical separation and recovery of plastics. Most plastic pre-processing occurs in China. A recent market study by BCC Research predicts that e-plastics will be valued at $1.6 billion by 2014 (BCC Research, 2010). However, it is generally accepted that metal, and in particular the copper fractions, are the most valuable segment of e-waste.

Only a handful of smelters are specialized e-scrap recycling: Arubis in Germany, Boliden in Sweden, Umicore in Belgium, Xstrate in Canada, Dowa in Japan and Singapore-based TES-AMN. Of these recovery firms, some are specialized in iron and aluminum fractions. These fractions are treated to remove contaminants such as

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[80] See http://www.nulifeglass.com.

lead, tin and copper. However, because of the physical and chemical properties of iron and aluminum, the elimination of contaminants out of this waste stream is challenging. Further, it is nearly impossible to extract traces of precious metals out of aluminum and iron mixtures. Given these constrains, aluminum and iron fractions generally have lower returns.

The copper fraction is rich in rare earth elements. Copper's physical and chemical properties makes extracting contaminants and valuable metals much easier. Of the recovery firms that can handle e-scrap, only a few specialize in precious metals and rare earth elements recovery. These companies have invested heavily in their e-waste processing infrastructure. To use one unnamed company as an example, though the facility has the capacity to handle multiple metal-rich waste streams, e-waste holds a high rank among the detritus handled at the plant despite only representing ten percent of the feed (personal communication, November 18, 2009). Similarly, Boliden's board recently approved an investment of SEK 1.3 billion growth in its e-scrap recycling capabilities (Boliden Group, accessed on 12 April 2011 at http://www.boliden.com/Sustainability/Presidents-statement/).

A Note on Disposal

The recycling process is never 100% efficient, even in state-of-the-art recycling facilities in the global North. Every phase in the e-waste processing chain produces effluent. For instance, during pre-processing hazardous components such as batteries and mercury-containing backlights of LCD monitors are removed. Some of these toxic components or materials are sent to facilities specialized in the recycling of mercury and batteries. These specialized firms also produce hazardous leftovers, which they deposit in specialized landfills. Further, pre-processing and recovery produce dust. This dust is often noxious, but can also contain valuable metals. Depending on the quality of the captured dust as well as the market price of metals at any given time, these filters are sent to facilities to be recycled or they are landfilled.

In addition, the recovery process and incineration produce slag. Some of this slag is used in road construction and for backfilling mines. The slag that is too toxic is deposited in a classified landfill. Other leftovers from the recovery stage are captured in a concentrated cake, which as one interviewee explained, is then deposited in waste "safety deposit boxes." While private firms dominate pre-processing and recovery, public facilities often handle the hazardous leftovers.

The Formal Recycling Chain

Three observations about the formal recycling chain need to be made before continuing with the informal network. E-waste handlers repeatedly denied me entrance to their processing sites. When I finally managed to gain access I always had to hand over my phone and sign waivers that I was not carrying any audio and visual recording devices. After many negotiations and much paperwork I gained permission to take a limited number of pictures at the Berlin recycling stations. Likewise, my contact at BRAL—the private end-of-life service provider for the city of Berlin—rushed me through the processing facility and forbid me from speaking with the workers or taking any pictures. I had similar experiences at most of the other sites of unmaking that I visited—be they formal or informal.

What struck me in particular was how otherwise my engaged and friendly industry contacts became suddenly vague and reluctant to speak when I asked about the leftovers from the recovery process. For instance, no one would tell me where the safe-deposit boxes or classified landfills that captured the toxic slag or cakes were located. One respondent vaguely mentioned something about a mine in Germany where these materials were deposited. My questions about the less valuable plastic and glass fractions were largely met with blank stares. The secrecy surrounding waste in general and particularly the waste left over from the “green” recycling process, though worthy of analysis in and of itself, renders any step-by-step description of the formal recycling chain limited.

The second structure of the formal network of unmaking changes as the availability of technology, the materiality of the waste or fragment, labor costs and the market demand for e-waste fluctuate. For instance, according to manager at BRAL, disassembly is tailored towards market demand. If interest in circuit boards is high, BRAL disassembles the goods in such a way to make whole circuit boards available. However, if there is a market for processors, then BRAL provides processors. Further, some metals are more easily extracted from whole components versus shredded fragments. If the cost of labor is low in relation to the value of the boards, then processors will try to remove entire components manually. For these reasons, my description of the recycling chain should be thought of as a snapshot in time, as the whole chain or steps within the process of unmaking are constantly in flux.

Third, the e-waste recycling chain is global and highly mobile. E-waste exporters and dealers in e-scrap operate in the shadows and are difficult to find. Nonetheless, I spoke to an executive who frequently interacts with e-waste traders. He attested to the international and mobile character of the e-waste market. As we walked around his facility, the man pointed to a pile of shredded circuit boards and explained,

> This e-waste here has an incredible story—a story that is not too uncommon these days. I do not know where the equipment came from, but I know the circuit boards originated somewhere on the East Coast of North America. A Taiwanese trader bought them and shipped them to Hong-Kong. Someone in Mainland China then bought them and had the components manually removed. The circuit boards minus the components were then sold to another trader in California who sold the goods to yet another trader. This guy trucked the boards to the Midwest and had them shredded there. The man in the Midwest then sold it to our customer, who then shipped the shredded material to us in Belgium, so we could recover the precious metals. (personal communication, September 11, 2009)

As my contact stressed, this arrangement is common. What exactly happens to the used and end-of-life electronic equipment once it leaves countries such as Germany is difficult to quantify with any certainty. Still, it is clear that e-waste does not follow a simple North-South trajectory (Lepawsky & McNabb, 2010). In fact, the flows of e-waste out of Germany are anything but linear. Used and end-of-life electronic equipment rarely stays in one country or region. Instead, e-waste traders and recyclers move the once-obsolete items from place to place. Along the way, informal and formal recyclers and re-users repeatedly transform these items, with varying economic, health, environmental and social repercussions.

In contrast to certain forms of mechanical disassembly, such as the manual extraction of copper wires in Bangladesh, other types of informal e-waste recycling can be catastrophic for human health and the environment. For instance, in Ghana, children break apart equipment imported from Europe and North America and set the wires on fire to get at the copper. They then bury, burn or sell the rest to brokers. At each stop along the formal and informal circuits traveled by used and end-of-life electronics, handlers focus on particular parts and use different techniques. In some places, e-waste processing causes significant environmental and health damage; in other locations, it causes nearly none at all. Some make a significant profit from handling e-waste, while others, such as the children at Agbogbloshie Market in Ghana make barely enough to survive.

Finally, as noted in Chapter 3, the waste processing and recovery sector has become increasingly consolidated in the past decade. Whereas pre-processing firms were small and medium-sized, often family-run, operations, today, a handful of large multinational companies, mostly based in the global North, including SIMS, Remondis, Elektrocycling, Alba and Veolia dominate the global recycling sector. Small firms such as BRAL thus face increasing competition. The e-waste recovery sector is particularly consolidated; recovery firms specialize in a particular fraction or process. For instance, Arubis focuses on copper, Boliden on lead, and Umicore on precious metals. Such specialization lessens competition or even eliminates it in certain instances. In fact, one industry representative revealed that collaboration is not uncommon in this specialized sector, "The metallurgy world works like that—you have for certain materials competition and then again you contract your competitor for other metals" (personal communication, November 19, 2009). Thus, just like networks of production, trade liberalization has led to the consolidation of small firms into larger, powerful multinationals that dominate networks of unmaking.

Informal Network: Collection

Despite Germany's sophisticated e-waste management infrastructure, up to half the country's e-waste remains unaccounted for every year. Some of the missing e-waste ends up in the trash or in storage. Gifting represents another channel of divestment. Many hand down their used equipment to friends and relatives or to strangers via forums such as the BSRs "*Tausch- und Verschenkmarkt,*" or exchange and gifting market, and Craigslist's "*Kostenlos zu Abgeben,*" or to give away for free section. So-called digital-divide development organizations such as ReCellular, World Computer Exchange and ComputerAid are also popular ways to get rid of unwanted items. These development agencies collect used and end-of-life equipment and ship them to countries in the global South in an effort to bridge the digital divide.

Export through development agencies represents only a fraction of used and end-of-life electronics that leaves Germany. A much larger amount of e-waste exists the country through individuals who are either settled immigrants or persons who have come to Germany for the intended purpose of collecting and exporting discarded technologies. The group that I refer to as informal waste collectors or scavengers consists of an amalgamation of multiple players. These actors have different backgrounds and overlapping, yet distinct interests. First there are individuals from Albania, Romania and Russia who collect second-hand goods for resale or as spare parts in their home countries. These actors access the waste stream through flyers, newspaper advertisements, on the street, as well as by standing outside the BSR recycling stations and asking for donations of goods intended for the depot. More recently, these actors have taken to raiding the city's Orange Boxes. Many Berliners choose to give their unwanted technologies to informal collectors as a means to assuage their guilt over getting rid of functional equipment. Informal collectors also scour listservs and online forums such as those listed above. They also periodically purchase e-waste at second-hand stores—many of which are located in the neighborhood of Neukölln in Berlin (the borough with the largest immigrant population).

Of primary interest for these collectors are televisions, refrigerators, washing machines, cell phones, laptops and desktop computers. Circuit boards and metal parts are of little value to these waste handlers. These scavengers were hesitant to speak to outsiders for fear of retribution. The men who agreed to be interviewed explained that they make very little money selling second-hand goods. Most claimed that they had once had well-paying factory jobs in Germany or in their home countries. However, because of deindustrialization and the ensuing layoffs, they now had little or no other means of eking out a living. The Eastern European e-waste collection system appeared to be highly organized. Individual collectors had a defined territory and reported to a boss. Any attempt to trespass on another's turf such as standing outside a BSR depot resulted in conflict and potentially violence. One BSR worker told me that I should be careful as he had heard that a collector outside his station had stabbed another man who wanted to collect on his turf in the eye (personal communication, November 17, 2009).

Afghanis, Palestinians, Nigerians, Senegalese and Ghanaians, among others, make up the second group of informal e-waste collectors. This group specializes in large-scale export of goods to developing countries, in particular African states. They access equipment through advertisements, pick-up services, websites, and second-hand stores as well as through larger institutions such as businesses, government offices and schools that upgrade their equipment. An additional source is merchants that deal in returned and slightly damaged equipment—known in Germany as *A, B and C Ware* (A, B and C goods). A goods are the least damaged, whereas C goods require considerable repair, and are thus sold at a much lower price. Before export, the goods are stored in depots along Billstrasse in Hamburg or similar streets in harbor cities. Afghanis run most of the depots on Billstrasse. Like their Eastern European counterparts, e-waste exporters focus on items for resale or as spare parts. However, they also export equipment that is damaged beyond repair. This suggests that another source of revenue for these waste handlers consists of exporting goods for end-of-life service providers (ESPs) as a means to defray the cost of domestic recycling. Those who export broken equipment as a means to defray domestic disposal costs often declare their exports as used goods re-use. Some also pack their containers so that a row of functional equipment conceals the waste cargo. Others paste money on the inside of container doors as a way to bribe customs inspectors to let their shipments through. Moreover, this group of exporters, in contrast to their Eastern European counterparts, often has substantial capital at its disposal and thus often purchases rather than collects equipment.

International brokers purchase discarded equipment from individuals, businesses and e-waste collection sites. Larger brokerage firms generally purchase EEE from companies that wish to upgrade their IT equipment. In the absence of official reports or relevant academic research, international brokers and their activities remain poorly understood. I had a hard time identifying and contacting brokers. Furthermore, while some brokerage firms are large and well established, the line between "individuals" and smaller or unregistered "businesses" can be gray, making it challenging to discern the difference between these latter two categories.

The third and final cluster consists of a diverse group of Turks, Bulgarians, Poles, Roma as well as individuals from various Arab and African countries who specialize in scrap metal. As one scrap dealer explained, the scrap-collecting sector in Berlin consists of "small fish, medium fish and big fish" (personal communication, May 7, 2010). The "small fish" are mostly foreigners who work alone collecting scraps with an old vehicle. Some smaller fish focus on manually extracting scrap metal, specifically copper, from equipment such as television sets placed on the streets. They sell the accumulated metals to the numerous local scrap metal firms in Berlin such as TSR and ALBA. These small scrap dealers make anywhere from thirty to two hundred Euros a day depending on the market price for metals and what they could find. The "big fish," some of whom have been in the business for upwards of 30 years, have multiple vans and employees (though mostly family members). These actors have established close ties to scrap producing companies and industry and, as one scrap dealer described, "have huge homes and drive Mercedes" (personal communication, May 14, 2010). Medium fish have been in the business for some time and make enough to live comfortably. Scrap dealers collect pieces of iron, steel, copper, and brass: anything that can be dismantled manually. They especially covet washing machines, gas stoves, metal bed frames, bicycles, electronics, DVDs, heating elements, some auto parts, wires and pipes, as they are largely comprised of metals. The collectors stay away from televisions and refrigerators because, as one person explained, "they have poison gas" (personal communication, May 14, 2010). Again here, the line between a scavenger and a legitimate businessperson is blurry as many scrap dealers have tax numbers and report their earnings—a requirement from the scrap purchasing firms. However, many scrap collectors admitted that they had found ways to go around the requirements and only pay taxes for a fraction of what they earned.

Pre-processing

Like the formal network, some scavengers manually disassemble items and extract valuable components such as copper wires, copper yolks or spare parts. One often sees the effects of this process on Berlin streets as unwanted TVs left on the curbside are slowly cannibalized over the course of a few days. As with the formal recycling chain, that which waste handlers deem value-less is handed over to the public facilities for final disposal. For the informal waste handlers this means either bringing the unwanted items to the BSR recycling stations or leaving unwanted items on the streets. While the “dumping” of leftover waste in the formal e-waste recycling chain is rarely, if ever mentioned, the informal “dumping” is a frequent topic in German news reports (Schmolinga & Bottin, 2010). As with the formal e-waste processing chain, informal pre-processing extends beyond the city. Informal collectors frequently send collected items to be processed abroad.

Recovery

Most informal recovery occurs in the developing world. Informal recyclers focus on copper and some precious metals. For instance, at Agbogbloshie market, the largest e-waste processing site in Accra, Ghana where I conducted field research during the summer of 2008, children—mostly from the impoverished northern part of Ghana—break apart and then burn discarded electrical and electronic equipment to extract copper wires. The children sell the copper to scrap dealers who then export the metals to India, China and sometimes even the United States and Europe. In other areas, such as Guiyu, China, recyclers use acid baths to extract gold, platinum and other precious metals from circuit boards. In turn in Bangladesh women strip copper wires by hand. Plastics are manually and sometimes mechanically broken apart and then sold to international traders or local manufacturers, depending on available technology, need and infrastructure. Other times handlers burn the plastic casings or just leave them in piles. They manually break the glass apart and sell it for re-processing, landfill it or leave it out in the open. Such informal recycling occurs all over the globe. However, different countries receive different equipment, use different techniques to recycle goods, and focus on different materials or components.

Der Kampf

As the price of metals and the cost of domestic recycling have risen in recent years, and the market for digital technologies in the developing world has grown, the e-waste management sector has developed substantially (Cobbing, 2008; Hicks, 2005).

The higher potential profits, the more pronounced the conflict over parts of e-waste. Global companies and governments have begun to target scavengers. In Berlin two sets of actors challenge scavengers for control over the waste stream: municipalities and a conglomeration of manufacturers, scrap dealers and multinational mining companies.

The BSR has a vested interest in controlling the e-waste stream. As noted above, e-waste is an important source of revenue for the city's municipal waste authority. Many of the BSR workers I interviewed ranged from being mildly annoyed by, to outright hostile towards informal e-waste collectors, especially those that milled outside the collection depots. The workers I interviewed repeatedly described the Eastern European e-waste collectors standing outside the BSR recycling stations as "*<u>un</u>erwünscht*" (unwanted) (personal communication, December 2, 2009). Scavengers were often referred to as "*Ausländer*" (foreigner) in a tone that hinted at racial and ethnic tensions (personal communication, December 8, 2009). One respondent confided, “we don’t want them here, but there is nothing we can do” (personal communication, December 8, 2009). Some workers referred to e-waste collectors as “environmental criminals” (personal communication, August 2009 - April 2010), citing local news reports to substantiate their claim that the exporters had no regard for Germany’s environment. “If they don’t dump the stuff in our forests then they take it to their home countries where it eventually lands in a pit or in the woods. These people don’t care for the environment” (idem). Others characterized the scavengers as dangerous and unpredictable. Some BSR workers admitted that they sometimes called the police or used other tactics to dissuade scavengers. However, they complained that their efforts were often futile, since as long as the collectors remained off BSR property they could do as they pleased.

While many BSR employees resented the informal recyclers, a select few tolerated them. One man explained, “it’s best if we just live and let live” (personal communication, December 9, 2009). Another worker spoke warmly about the man standing outside his station. “He’s been here for about 3–4 years. He doesn’t cause any problems and never leaves a mess. He’s tidy and doesn’t make any trouble” (personal communication, November 11, 2009). I once even witnessed a BSR worker waving at a scavenger in a friendly manner as he pulled into the station.

The scavenger is also a threat to the municipal waste authority. The administrators I spoke to described scavengers as petty criminals who steal the city’s property and thereby deprive the municipality of a much-needed source of income.

As one interviewee explained,

> Now, again, to give you a personal experience, my dishwasher broke down last year, and the guy who replaced it said, “Can I keep the old one?” I said, “OK, yes, but tell me what you’re doing with it?” And he said, “We the employees of this dealership, we collect them, and as soon as we have a truckload, we bring it to the nearest shredder, and they pay 100, 150 Euro and out of that

> we'll have a beer fest." Some dealers like Media Markt do this on a much more professional basis—it's not the employees, it's the company itself. They're collecting it and selling it. And the municipalities lose out. My municipality here, they have the workers on this collection place, they have a lot of—a lot to pull on the salary, because everybody is bringing their waste and stuff there. But throughout the week, you know I sometimes saw them dismantling washing machines, throwing the iron and the steel into their steel container which they get paid for. So if you see the study you will see the details- I think it's 2 kilos which are sold—it's all average per day there—are sold from the municipality directly to the recyclers. Another 3 kilos are going to retail, and then they have the scrap dealers and all those guys. (personal communication, March 9, 2010)

Scrap processing firms such as BRAL, SIMS, and Remondis, mining companies and manufacturers, such as Umicore and Boliden have been the most active and adamant critics of the informal sector. These multinational firms see scavengers as serious competitors. In fact, in a PowerPoint presentation on expanding their e-waste processing facilities, Sweden's Boliden listed its major competitors as Umicore, Arubis, Xstrata, Dowa and "e-waste exporters" (Boliden, accessed on 12 January 2011 at http://www.boliden.com/Documents/Press/Presentations/100503_e-skrot_ronnskar_eng.pdf). The burden of meeting the collection targets stipulated by European and German e-waste laws falls on manufacturers. Manufacturers predict that they will have to buy e-waste from informal waste handlers to meet increasing collection quotas. In addition, the bad publicity associated with illegal export is a key motivating factor for OEMs. As a representative of a major ICT manufacturing firm told me, "no manufacturer wants pictures of their name on a product being burned in Ghana being plastered all over the place. That's a public image disaster" (personal communication, February 3, 2010).

Like the BSR administration, the convergence of pre-processors, mining companies and OEMs represent scavengers and backyard recyclers as environmental criminals who seek to make a quick buck at the expense of the environment and human health. Engineers who study e-waste flows, many with industry ties, use the pejorative “Beraubung” (plundering) to describe informal recycling (Ebert, 2011; R. Lucas & Wilts, 2011; Michalski, 2013; Thome-Kozmiensky, Versteyl, & Beckmann, 2007).

In other words, these companies attempt to delegitimize informal recycling by emphasizing the environmental, health and efficiency problems with backyard approaches and by, in turn, representing their recovery techniques as clean and green alternatives. In a recent study, Christian Hagelücken and Christina Meskers, engineers as well as employees of a large mining company, argue that backyard recycling is inefficient (Hagelücken and Meskers 2009). They cite a study conducted in Bangalore that found “that only 25% of the gold contained in circuit boards is recovered, compared to over 95% at integrated smelters (Rochat, Keller, & Widmer, 2007).” They choose to selectively represent e-waste and types of unmaking to promote their interests and ideology, at times co-opting images from Greenpeace and the Basel Action Network that draw attention to the environmental harm caused by e-waste to secure control over the potentially lucrative waste stream and delegitimize competing networks of unmaking. That in 2007 alone Umicore earned $2,600 million through precious metals recovery and $400 million through other recycling is rarely revealed in presentations and reports decrying the inefficiency and dangers of the informal e-waste sector.

Though both parties stress the importance of stopping scavengers, the BSR and the recycling-manufacturing industry are also in conflict with each other. The tension between these two groups hinges on three issues: 1) collection; 2) the extraction of value; and 3) environmental responsibility. According to the current ElektroG, German municipalities cover the costs of collection. Because the public sector has a monopoly on collection, the collection is more costly and less efficient than it could be, argues the lobby for the privatization of collection. They add that market competition in collection will eventually lead to more environmentally sound e-waste recycling.

The same executive predicted that municipal waste management authorities would soon become a thing of the past,

> Again, today, everybody here at least in our part of the world—US, Europe—are relying on waste removal services, of the municipalities. In ten years from now, we will not depend on it. I can imagine that by then, you know, you will have waste collection companies offering you a minimum of free service if not paying you so that they can pick up your waste. And then the question is what role will the municipalities have? Now in that scenario, we will always have ups and downs of raw material prices. So what if we have another financial crisis like in 2008 in the year 2021, where raw materials within three months drop from 100 to 20 or even less? So this is what we need to discuss is, what safety net are we putting below a structure, an infrastructure, which is not based on municipalities. (personal communication, March 9, 2010)

The sentiment, that public waste management authorities were a thing of the past was widespread among the industry representatives I interviewed. My respondent stressed that in the next decade, public waste handling would be a thing of the past. He continued,

> This is what I usually call the Waste 2020 scenario—I think almost all waste will by then carry enough value that people are going after it, which will then lead into a complete paradigm change. So until today, and maybe even tomorrow—means next year, next two years—the main intention when people talk about waste is, "Get rid of it in a cheap and safe way." In 2020, we will be in a situation that people say, "Can I get your waste?" And again, I think the expression you used earlier in our conversation about, how this is now considered an ore, is exactly hitting the point. Now why do I expect raw material prices to go up? It's a very, very simple equation. In the early 1950's, there were about 2.5 billion people on this planet. By then, maybe 200 million of those 2.5 billion, so less than ten percent, had enough wealth to buy electronic products: TV's and radios, and disc players at that time. Today, there are 6.7 billion on this planet. People say there are about 2.5 to 3 billion people who have enough money to buy electronic products. And again, it's more than a TV, and a radio and a disc player. Today it's PC's, it's videos, cell phones, whatever. Now in the year 2040, people expect the world population to be around 9 billion. And people also expect that by then more than 4.5 to 5.5 billion people will have the purchasing power to buy electronics. That means

> doubling of the demand. Now again, even if we design our products to be lighter, to use less materials, we will see a much stronger demand for raw materials. So that's one side. On the other side, all the rich mines and a rich mine is one that has a high metal content in the ore, are empty. When you go back to the turn of the 19th into the 20th century, so around 1900, a mine in average required—or profitable mining required a metal content of between 7 and 10 percent in the ore. When I finished my studies in the 80's, mid 80's, it was about 2 percent. And today it's going down to 0.6. So what does that mean? It means that you have to process up to 15 times more ore to gain the same metal. So for one kilo of copper, you need to process 10–15 times more ore. The processing ore requires energy. So the energy costs for many of the ore, many of the mining activities, are already very important. So with increased fuel prices, we will see also the manufacturing costs of metals going up. So I think all indications show that there will be higher metal prices, therefore people are going much more aggressively after scrap. Then again, people means private enterprises, people sometimes call them the informal sector, and then we need to understand what is the role of the municipalities in the future, and we also need to understand what type of environmental legislation or waste legislation do we need. (personal communication, March 9, 2010)

According to this high-ranking executive, and many others I spoke to, the future of municipalities was basically nonexistent. Privatization of waste handling is inevitable given the resource crunch.

The BSR counters that e-waste brings in a much-needed source of income for the city of Berlin, a city struggling under ever-increasing budget-cuts. The profits gleaned from e-waste recycling keeps the city's waste taxes low and subsidizes the costs of treating unprofitable waste streams. In addition, one BSR representative I interviewed questioned the ultimate result of privatization. "Private firms are out to increase their profits," he explained. He continued,

> They have an incentive to "recycle" as quickly and cheaply as possible. This will probably lead to less environmentally and socially responsible e-waste handling in the end. If we privatize e-waste recycling, we'll end up with a system in which valuable parts are extracted and the toxic parts are dumped here or abroad. These private companies assume that because e-waste has valuable components we don't need to pay for recycling but this logic is wrong, because our goal is 100% recycling, not just the recycling of the

> valuable parts, and for this you need long-term investment in infrastructure. (personal communication, December 9, 2009)

Another official who lamented the privatization and globalization of the waste industry stressed that, "Abfall ist keine Handelsware!" (garbage is not a commodity), a notion that in many ways runs counter to Germany's notion of *Abfallwirtschaft* or Waste Economy. He argued that e-waste needed to be handled and treated locally (personal communication, December 16, 2009). Another respondent remarked pessimistically that, "ultimately, the BSR will have to clean up the mess anyway" (personal communication, April 7, 2010). He used the example of paper recycling in Germany to illustrate his point. A few years back, the paper recycling industry had boomed. In response private companies had set up collection bins everywhere. Once the price of paper fell, however, the firms abandoned their bins. Municipalities were left to deal with the mess. The BSR official predicted that the same thing would happen with e-waste as ultimately municipal governments remained the ultimate safety net.

The Response

Scavengers, ranging from exporters to scrap metal collectors to informal recyclers, in turn, rarely have the means or venue to respond to their attackers. The Eastern European collectors who stood outside the BSR stations were aware of their negative public image. In fact, many were hesitant to speak with me, as the police and local residents regularly harassed them. One man I interviewed said that the police had harassed him three times in the past week (personal communication, December 16, 2009). He and others stated that harassment was severe on days after news reports on e-waste had aired on television or published in newspapers (personal communication, December 9, 2009). Interestingly, several interviewees said that they did not merely dump what they collected in the forest—a sign that they were all too aware of popular lore. “They think we take the stuff and bring it to the forest, but we don’t. We take it to Poland and from there is goes to Russia,” said one man (personal communication, December 16, 2009). Some even pointed out that they were doing important environmental work by repairing and reusing functional equipment discarded by affluent Germans. “Isn’t reuse the most environmentally friendly thing to do?” asked one scavenger rhetorically (personal communication, November 20, 2009).

Whereas waste collectors were frequently confronted with their bad reputations, exporters and scrap collectors seemed to be largely unaware or unconcerned with the campaign to stop them. In fact, exporters often insisted that what they did was not illegal. It is difficult, of course, to determine if they were saying this because they were not aware of Germany’s laws or if they were just trying to hide the illegality of their work from me. Nonetheless, when I asked them about their work, nearly all scrap dealers stressed that recycling represented their sole means of making a living. Of course, they understood that what they did could potentially be detrimental to their health, but they had no choice.

Conclusion: Matter Matters

In Berlin, three sets of actors—the municipal waste authority (BSR), the recycling and manufacturing industry, and scavengers—vie for control over the city’s e-waste stream. These actors mobilize the language of responsibility, environmentalism, and technological sophistication to selectively socially construct e-waste and unmaking to gain control over digital detritus. As a representative of the Berlin municipal waste management authority explained, we must see the conflict over e-waste as “ein Kampf um den Abfallstrom,” or a struggle over the waste stream (personal communication, February 19, 2010).

Der Kampf um den Abfallstrom—where waste should be treated, who is responsible for it and who can benefit from it—is a theme that runs through social scientific and historical engagements with waste (Pellow, 2004). E-waste's materiality plays an important role in the struggle. In fact, e-waste's materiality could be considered a fourth actor in the story of e-waste's afterlives.

As noted in the introduction, e-waste contains both toxic and valuable components. These elements are almost inextricably mixed in electrical and electronic goods. Furthermore, as manufacturing becomes more resource efficient, fewer precious metals in smaller quantities are present in new equipment. This renders extraction of valuable parts such as precious metals in any meaningful quantities challenging. In addition, the physical characteristics of electrical and electronic equipment make it such that recycling can and often does cause significant environmental and human health damage. Thus, increasingly expensive and sophisticated technology is required to extract value out of e-waste if one is to avoid toxic exposure.

Waste engineers with close ties to industry, recycling and recovery firms, are quick to stress e-waste materiality to the exclusion of all other factors. They construct a certain notion of e-waste and cite these seemingly immutable physical properties of electrical and electronic equipment as proof that only the most modern and efficient waste recycling companies in the North are capable of and thus should be the only ones permitted to handle e-waste. Such technologically determinist claims render imperceptible a host of factors such as the underlying causes of uneven labor and environmental relations or the politics of technological design. For instance, given the way circuit boards are manufactured, extraction of precious and rare earth elements is challenging. These valuable metals can only be recovered through capital-intensive integrated smelters or environmentally destructive and poisonous techniques such as acid baths and wire burning. This leads many informal recyclers to focus on less valuable, yet easily extractable metals such as copper and aluminum. Alternately, they engage in recycling methods that pose a grave threat to their health and environment.

Mining companies with integrated smelter technology do, in fact, provide what appears at first glance to be the best and only environmentally friendly option for e-waste recycling. However, an examination of what is left out in their green narrative of modern high-tech recycling helps us see why it is worth probing these assertions. The mining company representatives I interviewed stressed that the way in which electrical and electronic goods are designed and built makes it such that the ideal approach to recycling discarded equipment would be a system in which technologies are manually disassembled, preferably in the developing world where labor costs are low, and then processed at their facilities, where state of the art integrated smelter technologies result in clean and green recovery (see Chapter 5 for more on this). These unmakers strategically socially construct e-waste—bringing some characteristics to the fore while concealing others—as a means to particular ends.

Importantly, the materiality of e-waste is “real” in that it has physical properties that cannot be reduced to the social. Yet this materiality is not separate from the social. Electrical and electronic equipment does not necessarily have to be made of flame-retardant plastic, lead glass, and cadmium. Furthermore, that computers, cell phones and other ICT equipment are constructed in such a way as to make repair nearly impossible and environmentally friendly recycling challenging is not solely determined by physical limitations. As green designers point out, electrical and electronic equipment could be manufactured using different materials and in decidedly different ways. Thus the materiality of these technologies is, at least in part, an outcome of social and economic forces. Lobby and special interest groups, ideological commitments, fashion trends and cultural norms influence how technologies are designed, which are taken up and how they are used (Bijker et al., 1987). For instance, Europe's e-waste policies are indented to alter the materiality of e-waste to make disposal more environmentally responsible, efficient and less of a health risk. However, as noted above, interest groups, such as waste processing firms, fight these changes. A political battle ensues, one that is certainly shaped by technical limitations but not reducible to them.

As Gille's (2007) work makes evident, measures of efficiency and wastefulness are subjective. It is difficult to know for sure whether CO2 emissions from formal recycling practices, for instance, are less environmentally damaging than the toxins released through informal recycling practices. Comparing the impacts of formal and informal recycling is complicated by the fact that most of the research on this issue is primarily conducted by mining company employees or scholars with close ties to industry. In brief, the question of what is the "best" way to handle e-waste and who should be authorized to handle it is a complex one, one that is strife with conflict and struggle. What remains clear, however, is that matter matters in this *Kampf um den Abfallstrom.*

CHAPTER 5: TRANSNATIONAL FLOWS

Overview

In a July 2007 press release, *Deutsche Umwelthilfe* (DUH), a non-profit environmental organization, accused Germany of being the "waste export world champion" (DUH, 2007). The press release referred to Germany's status as Europe's biggest e-waste producer and exporter.[81] DUH openly questions Germany's status as a global leader in environmentally sustainable solid waste management. In fact, the environmental organization argued that Germany's progressive e-waste policy has caused more harm than good. Rather than reduce e-waste production, the ElektroG has merely created an incentive to export e-waste to developing countries because, while the law raises the

[81] The past decade has seen a rapid growth in the overall generation and export of waste in Europe—be it non-hazardous, hazardous or illegal waste shipments (Wang et al., 2012, p. 47). European trade in waste in general is far from negligible. According to an extensive study on the transnational shipments of waste conducted by the European Topic Center on Resource and Waste Management in 2008, the export of waste out of the EU-25 represents a major segment of the European trade in secondary materials, in particular paper, plastic and metal (Fischer et al., 2008, p. 9). The majority of this waste is exported to China and the Far East (Fischer et al., 2008, p. 49). In terms of hazardous waste, Estonia, the United Kingdom and Germany represent the top three European producers and exporters (Fischer et al., 2008, pp. 23–25). Here, Germany, Europe's largest economy and most populated country, stands out. It is estimated that the country is responsible for half of the total hazardous waste generated in Europe each year. It is important to note that these high numbers are at least partially explained by Germany's stringent waste classification system; according to German law, the burden of proof lies with the producer. In other words, the manufacturer must explicitly prove that his or her waste is non-hazardous, otherwise the refuse is automatically classified as hazardous garbage. Nonetheless, even when one takes Germany's stringent waste classificatory system into account, the country still stands out as Europe's largest producer and exporter of toxic waste.

E-waste represents a critical fraction of European waste. It is estimated that Europe generates anywhere between 4–7 million tons of e-waste each year. Given that e-waste is the world's fastest growing waste stream, this number is expected to grow exponentially in the coming years (Fischer et al., 2008, p. 10; Juan, 2009, p. 69). Not only production, but also export is on the rise. According to the European Topics Center, approximately 250,000 metric tons of e-waste are 'officially' exported within and out of Europe annually (Fischer et al. 2008, p. 10). In addition, a large portion of e-waste exists Europe through unofficial and illegal channels. These shipments are difficult to quantify and trace, yet it is clear that the official number of 250,000 tons of legally exported e-waste is merely a fraction of total European exports (Fischer et al., 2008, P. 82 for detailed estimates). Again, Germany leads the way in terms of legal and illegal export of e-waste. According to a recent report by the German environmental research institute Ökopol, illegal e-waste shipments go to Ghana, Nigeria, South Africa, Vietnam, India and the Philippines (Sander & Schilling, 2010, p. 19) cost of domestic recycling, the government inadequately enforces measures to prohibit export of toxic waste (Leonhardt 2007). The report concludes that Germany's environmental e-waste law is actually compounding and intensifying the negative social and environmental consequences of toxic waste disposal. Drawing parallels to the toxic waste export crises of the 1980s, the report points out that in both instances the environmental and social consequences of Germans' high-tech and affluent lifestyles are not felt domestically.[82] Instead, hazardous waste flows to countries in the global South that lack the technical, political, and economic capacity to safely handle and dispose of hazardous materials.

The narrative of toxic waste colonialism promulgated by the DUH is widespread, particularly among environmental NGOs and, until recently, the media. However, two competing understandings of transnational e-waste flows have started to gain acceptance in recent years. One perspective sees export as a leakage of valuable strategic metals. Another interpretation posits that export represents a natural manifestation of comparative advantage—a manifestation that must merely be tweaked to correct glitches in the system pertaining to social and environmental justice. All three representations of e-waste export—the "dumping," "leakage" and "comparative advantage" narrative—are selective representations of transnational e-waste flows; they bring some things to light, while obscuring others. In all three cases,

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[82] Analogously, during the 1990s, Greenpeace Germany criticized the Avoidance and Recovery of Packaging Waste Ordinance, Germany's packaging waste policy. Greenpeace claimed that the ordinance, which was intended to minimize packaging waste in Germany, merely increased Germany's export of packaging waste to countries like Indonesia (Bokerman, 1993). A recent article in the New York Times offers yet another example of the paradoxical effects of Germany's green environmental policies. The article explains that Germany's remarkable recent cut in carbon emissions is in part explained by the fact that the country's steel industry has moved to China. This move has resulted in an rise in net global carbon emissions, because steel production in China emits more carbon into the atmosphere than production of steel in Germany would have. See New York Times Report "China Grabs West's Smoke-Spewing Factories," December 21, 2007.

actors represent e-waste and the problem of export in such a way as to support their interests and uphold their paradigms.

The Toxic Precursor

The international toxic waste scandals of the 1980s have played a significant role in shaping conceptions of transnational movements of e-waste. Policymakers, NGOs and the media frequently reference the 1980s in discussions of e-waste export. Furthermore, the laws that regulate the transnational movements of e-waste today were formulated in response to these events. Thus, to understand the narrative of dumping more fully, we must briefly revisit the toxic waste scandals of the previous decades.

On December 12th, 1991, Lawrence Summers, then the chief economist and vice president of the World Bank, sent out what would become an infamous memo. The memo took the theory of trade liberalization to its logical end. It argued that the export of toxic waste from the developing world to least developed countries (LDC) made perfect economic sense. Summers reasoned that because the cost of labor was lower in developing countries and because "under-populated countries in Africa are vastly UNDER-polluted," the morbidity and mortality associated with toxic waste handling and the associated economic losses would be comparatively lower in the developing world (Summers, 1991). Summers concluded, "I think the economic logic behind dumping a load of toxic waste in the lowest wage country is impeccable and we should face up to that'' (Summers, 1991). Indeed, for Summers, the export of toxic waste represented a win-win solution, a perfect example of comparative advantage in a globalized economy.[83]

That the export of toxic waste became an issue precisely when countries around the world were implementing domestic environmental policies is no coincidence. One outcome of the environmental movement of the 1960s, 1970s and 1980s was that many countries in the global North began implementing stringent waste disposal regulations. These policies, in turn, significantly raised the cost of domestic waste handling. In contrast, low labor costs, minimal environmental regulations, and limited enforcement capabilities kept the cost of waste handling in the developing world relatively low. In the 1980s, the cost of disposing waste in industrialized countries was as high as US$3000/ton. In contrast, exporters could pay as little as US$5/per ton for disposal in certain impoverished African countries. Today the costs are roughly US$2000/ton in Europe versus US$40 in Africa (Kone, 2010).

The abundance of waste, the prevalence of free-trade policies and the uneven social, economic and environmental global topography not only facilitated toxic waste export, but also rendered it highly lucrative. Entrepreneurs who would later be dubbed "toxic commodity traders" took advantage of these circumstances and made fortunes exporting wastes.

A series of waste export scandals during this period catapulted the issue of toxic waste trade onto the international stage. Three incidents between 1986 and 1988 were particularly important for sensitizing the world to the issue. These incidents were the Khian Sea in Haiti, Koko beach in Nigeria, and the Rhadhost in Lebanon. In each

[83] Once the memo was leaked, Summers clarified that his aid, Lant Pritchett had actually written the text. Summers insisted that he had signed the memo without having read it carefully. He also claimed that the memo was a joke.

case, toxic waste was exported from affluent, industrialized countries to impoverished ones.[84]

The international media obsessed over these cases and the general toxic waste trade (Brooke, 1988; Cody, 1989; Financial Times, 1988; Henwood, 1992). Ultimately indignation translated into new policies. Groups such as Greenpeace International, the Natural Resources Defense Council, the Environment Liaison Centre International, among others, formed an alliance called International Toxic Waste Action Network (ITWAN). This group worked closely with 77 developing countries (subsequently referred to as the G-77) to raise awareness of toxic waste export. ITWAN argued that toxic waste was not a commodity and was thus not subject to free trade laws. The alliance pushed for domestic and international laws that would ban the export of hazardous waste (Clapp, 1994; Russell, 1989). These efforts ultimately resulted in the implementation of a number of international, regional and national policies that restricted the transnational movements of toxic waste, most notably the Basel Convention on the Control of Transnational Movements of Hazardous Wastes and Their Disposal (The Basel Convention).[85]

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[84] The Khian Sea, a cargo barge loaded with toxic ash from Philadelphia, set sail for the Bahamas in August 1986. The cargo was refused by the Bahamian government, however, due concerns about human and environmental health. Rejected at every port it subsequently attempted to doc at, the ship sailed the seas for months searching for a place to unload. The itinerant vessel became the object of widespread public attention, if not obsession. Newspapers, magazines and television programs closely followed the plight of the Khian Sea. The ship eventually secretly dumped the unwanted freight in Haiti and in the Indian Ocean. A year later, NGOs and the media picked up on yet another toxic waste scandal. In this case, highly caustic industrial waste from Italy was discovered on Koko Beach in Nigeria. It was revealed that Italian businessmen had brokered a deal with a local Nigerian man to store 18000 barrels of chemical waste on his land for $100 a month. The waste leaked out of the barrels and poisoned local residents, which led to the eventual discovery of the deal. One month after the Koko Beach scandal, another toxic waste scandal hit the headlines in September 1987. This time a ship named the Radhost was caught exporting 15, 000 barrels of toxic chemical waste to Lebanon.

[85] Significantly, though attention to toxic waste export peaked in the 1980s, the practice of exporting hazardous toxic waste to the developing world dates back to the post World War II period. The post-war economic boom led to changes in production practices and patterns of consumption that ultimately resulted in the production of vast quantities of waste, as discussed in Chapter 3. The annual global generation of waste rose from 5 million metric tons in 1947 to 300 million tons in 1988 (Bomani,

One possible explanation for why toxic waste export received so much attention is that the practice of sending hazardous waste to poor nations raised important questions about globalization and the environment. The scandals captured a key dilemma faced by the environmental movement during the 1980s: the tightening of environmental regulations in affluent countries such as the United States, Italy or Germany frequently resulted in the displacement of the problem to a poorer region of the globe. In other words, the so-called accomplishments of the environmental movement in the developed world appeared to be making matters worse by facilitating the export of pollutants to developing countries that lacked the resources to resist the export of these toxic materials let alone to handle them effectively (Pellow, 2007, p. 8). These scandals unearthed the obstacles to formulating effective domestic environmental policies in an increasingly interconnected and globalized capitalist economy.

Moreover, the issue of dumping hazardous waste raised important questions about the definition of a commodity and the ethical limits to trade liberalization. Even though export made perfect economic sense according to the logic of neo-liberal economics, the practice transgressed an ethical boundary for many activists, lawmakers and members of the general public. It hit a nerve. Something about the poor of the world literally being dumped on by rich countries was simply too outrageous—a sign that free trade had gone too far.

1996). This "modern" waste was not only abundant, but it was also qualitatively different than earlier forms of refuse. It contained complex materials and toxic compounds, which made it challenging and costly to handle. Complex connections, means of communication and social structures compound the problem (Gille, 2007, p. 27; Melosi, 1981; Tarr, 1996)

The Dumping Narrative

Today, more than two decades since the toxic waste crises of the 1980s, the issue of waste export has resurfaced.[86] This time the focus is on e-waste rather than industrial waste. NGOs and environmental consulting groups—including Deutsche Umwelthilfe, Germanwatch and Ökopol, as well as their international counterparts such Greenpeace International, the Basel Action Network (BAN) and The Silicon Valley Toxics Coalition (SVTC)—have released reports on e-waste in the past ten years (Cobbing, 2008; Leonhardt, 2007; Puckett et al., 2002; Sander & Schilling, 2010). The German-speaking media has also enthusiastically taken up the issue of e-waste during this time (Bitala 2008; Denkler 2006; Engelhardt 2008; Höges 2009; NZZ 2010; Reinbold 2008) as has the English-speaking media (Black, 2004; Granatstein, 2008, 2009; Mayfield, 2003; Mooallem, 2008; Pelley, 2008; Walsh, 2008, 2009; Wray, 2008).[87]

In addition to concerns over e-waste's sheer volume and potential danger to human health and the environment, a popular theme, if not the most frequently mentioned one, has been the export of the health and environmental costs associated with e-waste disposal. Media and NGO reports repeatedly characterize the international movements of e-waste as toxic waste dumping. Provocative images of smoldering e-wastelands in China, India and West Africa, and titles such as "Exporting Harm" (Puckett et al., 2002), suggest that once again the poor and marginalized and their environments are paying the price for the affluent, high-tech

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[86] Critics of the German Landfill Ordinance (which is the national transposition of the European landfill directive, Council Directive 1999/31/EC of 26 April 2000), make a similar argument. They maintain that tightening of domestic waste regulations incentivises export.

[87] Media and NGO attention to e-waste export has pressured manufacturers to take a stand on the issue. Manufacturers such as HP, Dell, Philips, Sony, Samsung, Panasonic and distributers such as Best Buy all have openly addressed the e-waste issue on their websites and through diverse publications (Electronics TakeBack Coalition 2011). In 2009, for instance, Dell publically condemned e-waste export. Steve Jobs released an extensive statement pertaining to Apple's stance towards e-waste (Jobs 2007). HP, a company that has been directly dealing with e-waste for some time, continually releases public statements on e-waste (HP 2010, 2005, 2007).

lifestyles in the North (Bitala 2008; Denkler 2006; Högens 2009; Mayfield 2003; Reinbold 2008).

While some reports implicitly reference the 1980s by reviving phrases such as "toxic traders" and "toxic waste colonialism," others explicitly refer back to the toxic waste crises of the 1980s in discussions of e-waste export. This construction of continuity between the 1980s and today is emphasized again and again in popular and scholarly discussions of e-waste trade (Ekine, 2009; Pellow, 2007).[88] For instance, the Basel Action Network (BAN), an environmental and human rights organization specializing in toxic waste trade, represents e-waste export as the latest manifestation in a long line of toxic waste export scandals dating back to the 1980s. According to BAN's website, the key events in the history of toxic waste trade are the Khian Sea, Koko Beach, and Rhadhost scandals of the 1980s and, most recently, the e-waste export scandal ("Basel Action Network (BAN)," n.d.). As in the 1980s, these texts call attention to the link between environmentalism in the North and pollution in the South (Bitala, 2008; Leonhardt, 2007; Reinbold, 2008).

Narrative of Leakage

Though it is far from dominant, a second interpretation of export has been gaining traction among policymakers, industry representatives and the media in the last five years. This perspective narrows in on e-waste as an "urban ore." Of particular significance is e-waste's relatively rich concentration precious metals and rare earth elements. The platinum, tantalum, indium and rare earth elements found in e-waste are critical for economic growth, technological innovation and national security. They are

[88] In this article, Ekine equates e-waste export with the recent dumping of toxic waste by Dutch Abidjan in 2006 and placed both events in a long line of toxic waste scandals dating back to the 1980s. Pellow (2007), in turn, includes a chapter on e-waste in his book on toxic waste trade, often slipping into equating toxic waste and e-waste streams.

essential for the production of touch screens, wind turbines, electric cars, catalytic converters, printed circuit boards, and superconductors (European Commission, 2011).

Stores of these minerals are rapidly dwindling while demand is increasing. According to a report by European commissioner for industry and entrepreneurship, Antonio Tajani, the market for certain precious metals and rare earth elements will grow twenty times by 2030 (2011-03-08 Securing Europe's supply of rare earth elements, 2011a, "The Scramble for rare earth metals in frontier Africa, including Somalia," n.d.; Dempsey, 2011). To further complicate matters, extraction of these materials is concentrated in a handful of countries.[89] Political instability in source countries coupled with geo-political tensions between importing and exporting nations further restricts access.[90] In light of these threats to future access, countries such as

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[89] For instance, most of the world's supply of antimony, fluorspar, gallium, germanium, graphite, indium, magnesium, rare earths and tungsten is located in China. Russia hosts a significant quantity of platinum and group metal (ruthenium, rhodium, palladium, osmium, iridium, and platinum) ores. Tantalum and cobalt are found in The Democratic Republic of Congo, whereas Brazil has a significant portion of the world's niobium and tantalum stock. For more on the geographic distribution of these resources and the uses of individual materials, see ("Rare Earth Element Mines, Deposits, and Occurrences," n.d., "Rare Earth Elements - Pictures, More From National Geographic Magazine," n.d.). For instance, the Democratic Republic of Congo houses 80% of the world's stock of coltan, the ore from which tantalum is extracted. Tantalum, a rare metal, is essential for the production of cell phones, DVD players, computers and other electronics. The price of coltan has skyrocketed in the past decade due to the digital boom. At the same time that demand for this rare metal has increased exponentially, coltan mining has become the subject of controversy. This is because coltan mining directly finances the civil war in the Congo. In addition, Coltan mining, which occurs primarily in the Kahuzi Biega National Park, is causing significant environmental destruction. In particular mining is endangering the Mountain Gorilla. The political instability of the Congo, coupled with international outcry over the social and environmental impacts of coltan mining, have made industry and government representatives in the rest of the world nervous about their future access to this important mineral (*Coltan*, 2012; Mantz, 2008).

[90] Rare earth elements represent one of the biggest concerns. They are particularly vital for high-tech and clean energy industries. According to a report released by the United States Congressional Research Service, demand for rare earth elements rests at approximately 136,000 short tons annually and is rising rapidly. However, only about 133,600 tons are currently being produced each year. While production will certainly grow as new mining projects are developed, the research institution predicts that it will take 10 years for new projects to produce enough to meet demand (Humphries, 2012; Messenger, 2013, p. 2). China dominates the global market in rare earth elements. In the same report, it is estimated that 97% of the world's supply of rare earths in 2009 came from China (2012, p. 12). China has a monopoly on these essential materials, and as a European report stated, "Europe is completely dependent" on China (Perkowski, 2012). Yet in the past three to four years, China has dramatically cut its export of

Germany, the United States and Japan have recently begun developing multi-faceted "critical raw materials" strategies.[91]

These strategies encompass efforts to improve diplomatic relations with exporting countries, challenge export bans through the World Trade Organization and identify alternative foreign sources of critical materials. In addition, they mandate identification and securing of domestic sources of these materials as well as appropriate alternatives (2011-03-08 Securing Europe's supply of rare earth elements, 2011b; European Commission, 2011). Increasing domestic sources involves improving, when possible, national or regional mining capacity. Given the growing concern over the social and environmental impacts of mining, the positive connotations of recycling, and the relatively high concentration of critical raw materials in e-waste, recycling of digital detritus has taken on a new meaning as part

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rare earth elements. In 2010 alone, China cut its export of rare earths by 40% and further cuts are anticipated (Burgess, 2010). China claims that it has reduced exports on the grounds that the mining of rare earths causes significant environmental damage. Another explanation for the cuts is the recognition that domestic demand for these materials is likely to grow rapidly. In fact, recent reports predict that China will soon become a net importer of rare earths. This has prompted the country to begin stockpiling these elements and cutting exports.

Not only future scarcity, but also potential diplomatic tensions represent a threat to consistent supplies of rare earth elements. China banned the export of rare earth elements to Japan in 2010 because of a diplomatic quarrel over fishing rights. The ban on export to Japan, a country whose high-tech industry is entirely dependent on Chinese rare earth exports, caused panic among industry and governments not only in Japan, but around of the world.

[91] Growing awareness of dwindling stocks of rare earth elements coupled with the export ban of rare earth elements to Japan have underscored the world's vulnerability in terms of access to these important materials. As a result, there has been a rush among policymakers to develop domestic rare earth strategies. In September of 2010, the Japanese government declared that it would invest upwards of 1.2 Billion to improve its recycling capacities as part of its larger critical raw materials strategy (Burgess, 2010). See also "Strategy for Ensuring Stable Supplies of Rare Metals" (Japanese Ministry of Economy, Trade and Industry, 2009) In the same year, the United States government proposed three separate bills focused on securing domestic sources of minerals including rare earth metals. See also ("Commentary—Recycling a key part of mineral policy," 2012) for more on US policy to secure rare earth metals. Similarly, the European Union held hearings on rare earth metals in 2010 (Dempsey, 2011). In addition, the European Commission revised and updated its strategy for securing access to what it calls critical raw materials. The Commission has also spent 17 million Euros ($23 million) on research that it hopes will improve the European Union's access to rare earths through multiple channels including new mining projects, substitutions and recycling (Dempsey, 2011). The report identifies discarded electrical and electronic goods as a significant potential source of rare earths (Dempsey, 2011).

of Germany's critical raw materials strategy.[92] Germany has been particularly active in drawing attention to the topic of critical raw materials. The state has initiated various stakeholder meetings on the topic and has pressed the issue in the European Parliament and at G20 meetings (Dempsey, 2010).

While the economic and technological viability of recycling for these strategic materials is still hotly debated, numerous experts with whom I spoke predicted that recycling of e-waste would become an important source of critical "raw materials" in the coming decades. One mining company representative stated that "[electronic devices] represent a considerable metal stock in society. Effective recycling will become more and more important for supply security" (personal communication, November 18, 2009).

The recognition of e-waste's potential value as an urban ore has had serious implications for understandings of and attitudes towards its export. In this case, powerful stakeholders such as governments and the mining industry construct an

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[92] However, it is important to note that not everyone sees domestic recycling as a realistic solution to the rare materials crisis. The European report clearly states that "no recycling or substitution processes for rare earths are currently commercially viable" (*Communication from the Commission to the European Parliament, the Council, The European Economic and Social Committee and the Committee of the regions tackling the challenges in commodity markets and on raw materials*, 2.22011, p. 12). The report explains, "recycling of rare earths has been thrown around as a partial solution. Japanese tech firms have discussed 'urban mining' as a way to get rare earths from discarded e-waste. However, in the recent UK hearing over strategic minerals the British Metals Recycling Association (BMRA) spoke about the complexities of recycling." (Montgomery, 2011). Similarly, the UK government warns that too much faith in e-waste recycling as a source of critical raw materials is dangerous. During a hearing in the UK on strategic metals, Ian Hetherington, the director general of the British Metals Recycling Association (BMRA), discussed the dangers of assuming that e-waste recycling represents a comprehensive solution to the imminent access problems. Hetherington explained, "Some are claiming the U.K. should protect its position strategically, recycling them within Europe and not exporting them . . . The widespread use of these metals is a relatively recent phenomenon, and so there is not a significant amount recovered through [Waste EEE] recycling. Currently, recovering these materials can be costly and only produces very small quantities, making it uneconomical," (Montgomery, 2011). Nonetheless, I predict that domestic recycling will become increasingly strategic in the years to come. As many have pointed out, once the "true" cost of mining is taken into consideration—that is, the environmental and social costs of extraction are internalized—e-waste recycling will become more economically viable (Dempsey, 2011). Rare earth element prices have been kept deceptively low as a result of China's relatively lax environmental policies. However, these prices are rising rapidly as China attempts to stymie the environmental damage caused by mining (Montgomery, 2011).

entirely different meaning for e-waste. This strategic social re-construction has revitalized efforts to restrict its export. Indeed, the past few years have seen a surge in government and industry reaffirmation for a ban on e-waste export. However, rather than a ban on the unethical dumping of toxic waste, this push to restrict transnational movements of e-waste can be understood as an attempt to secure continued access to strategic resources ("Commentary—Recycling a key part of mineral policy," 2012).[93] For instance, European Energy Resource Alliance claims that 3–4 million tons of European e-waste is "lost" each year. In an interview, Mr. Zonneveld of the Alliance, refers to exported e-waste as a loss of Euro 700–1,000 million (cited in Juan, 2009: 12).

The Narrative of Comparative Advantage

While there is growing movement in the North to plug export channels—whether because e-waste represents a toxic bad or a strategic good—a group of government

[93] It should be noted that the potential value of discarded equipment has also had the opposite effect. It has made it possible to openly promote export without running the risk of being dubbed a "socially ruthless and arrogant . . . conventional economist," as Lutzenburger called Summers back in the 1980s (Jensen, 2004). For instance, non-governmental development organizations specializing in technology transfer—commonly referred to as "digital divide NGOs"– encourage export of used ICT equipment as an important component of economic development. They contend that in today's digitized world, access to ICT equipment is imperative for development. In an advertisement published in *Computer Woche*, a German IT magazine, an NGO called Close the Gap Deutschland solicited used computer donations for African schools and universities. The advertisement claimed that "[a]ccess to ICT equipment is a significant factor for supporting education, growth and the fight against poverty in developing countries. Work in this area fulfills the UN 'Millennium Goals' for the economic development of poor countries" (Knoll, 2005). Export of used technologies is represented in this narrative as a win-win solution. This is because, "in the industrialized world, computers are replaced every three to four years, meaning that companies are increasingly looking for sustainable ways to replace their used devices. At the same time, millions of computers are needed in developing countries," (See http://www.closethegap.be/about/ for more on this organization). Similarly, World Computer Exchange, another digital divide organization, reasons that by exporting used ICT equipment to developing countries, it makes significant contributions to the improvement of children's education. This in turn, helps children to "be more equipped to fight poverty, disease, injustice and instability" ("What We Do | World Computer Exchange," n.d.). A third organization, Computer Aid, maintains that export of used ICT helps "reduce poverty through practical ICT solutions" ("Computer Aid International » Home," n.d.). See also the One Laptop Per Child Campaign (http://one.laptop.org) and Carmara Education (http://camara.ie/web/).

officials and industry representatives centered in Europe and closely aligned with the United Nations University's "Solving the E-waste Problem" (StEP) contend that a total ban on e-waste export is both impractical, disadvantageous and potentially environmentally disastrous ("3 Reasons Why a Ban on E-waste Exports is Wrong," n.d.). This group challenges the Basel Convention's insistence on localized toxic waste management, and thus the minimization of export of hazardous waste, on three grounds. First, they point out that most countries lack the technological sophistication to safely and efficiently handle materially complex waste streams. They also insist that developing state-of-the-art domestic recycling and recovery capacity is unrealistic in many countries given the high cost of the requisite technologies, such as integrated smelters used to handle discarded electrical and electronic goods. Second, the unique physical make-up of used and end-of-life electronics necessitates both manual and high-tech disassembly. Third, labor is significantly cheaper in the developing world than in the industrialized world, and established informal collection systems in the developing world are highly efficient.

Advocates of the comparative advantage perspective dismiss the prevalent narrative of e-waste dumping as a sensationalized exaggeration. They maintain that almost all German exports consist of re-usable equipment. In particular, the executives I interviewed were keen to stress this point. For instance, one respondent explained,

> And again, this is very important to distinguish—that this is not e-waste export. It's second hand products. Again, as in any second hand market, you have different qualities. You have a superior quality which usually, in IT, it's very much related to the age of a product—maybe 2–3 years from these returns from retired products of commercial customers, which—where almost everything you are getting here can be reused, and will be reused. It is my view that most of those products will either end up in Eastern Europe or in Northern Africa—Morocco, Tunisia. Then you have another category or quality category of used products which may end up—which are of lower quality, much lower quality, which also could lead into e-waste, right? It's no clear boundary of what is e-waste and what is a product for reuse or secondhand product. And they are sold to Africa. Basically, people are coming from Africa

> as tourists, they hire a couple of containers, and then they go to flea markets, they go to E-bay, and buy low-end secondhand products, fill the container, ship them down, and what the study found out is that about 30 percent of the products in these containers are not sold. And this doesn't mean that those products are not functioning anymore. No, who wants a Pentium III PC? I'm not sure if you know what a Pentium III is, this is 16 years old. Even if you get it for free, you will not take it. (Personal communication, 3 February 2010)

Interestingly, this interviewee distinguished between various types or qualities of used products and tied their trajectory to different geographic locations. Still, what he and other respondents wanted me to understand was that the majority of products leaving Germany were valuable goods, not waste.

The Swiss Federal Laboratories for Materials Testing and Research (EMPA), which is closely aligned with the StEP initiative of the United Nations University, insists that the majority of exports from Europe to West Africa consists of items intended for re-use (Ayodeji, 2011). EMPA reasons that only a small percentage of goods arrive in a non-working state and half of that is repaired locally and resold for re-use (Ayodeji, 2011, p. 78; Lubick, 2012; Secretariat of the Basel Convention, 2011).[94]

While I was in Ghana, I saw both types of containers. Some were filled to the brim with what one can only describe as junk, whereas others mostly contained re-usable equipment. Often, containers had both types of discarded technologies. In my experience the line between export for reuse and export as dumping was often blurry. Ghanaian exporters I spoke to described that they were brought to warehouses in Germany where they were told that they could buy equipment. However, the seller would not allow them to test the equipment for functionality. The Ghanaians exported

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[94] For more studies on this, see: http://www.ewasteguide.info/Where-are-WEEE-in-Africa.

the bulk of their purchases to their home countries—some of which was functional and could be resold. They sold the rest to scrap dealers at Agbogbloshie market.

Critics of the dumping narrative also point out that there is a large market for second-hand technologies in the developing world. A recent paper on business re-use asserts that many companies complain that they cannot access enough used EEE. In fact, they rare access to adequate second-hand technologies as their primary barrier to business expansion (Kissling et al., 2012). From this perspective the transnational movement of end of life technologies is central to establishing a reliable and consistent supply of suitable equipment.

Given the potential value in end-of-life equipment, advocates of the comparative advantage perspective promote controlled export of e-waste, instead of a total ban. Architects of such a global division of labor argue that the export of e-waste to the developing world will continue, given that e-waste holds value. Thus, formalized, regulated channels of export that adhere to strict environmental and health regulations are vastly superior to unregulated informal recycling networks that rely on "primitive" recycling techniques. From this vantage point informal processes of unmaking are harmful to both human health and the environment. They are also grossly inefficient (Juan, 2009, pp. 11–12). In a controlled global system of unmaking the South gains employment while high-tech firms in the North can more easily recover critical raw materials. In addition, such an arrangement protects the environment by circumventing both informal, backyard recycling and the expansion of mining.[95]

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[95] Such an arrangement, however, may perpetuate an unequal global division of recycling (Grossman, 2006). Others dispute this, proposing that as mechanized recovery technology grows more sophisticated in Europe and if producers are more mindful of designing for the environment, constructing products with mineral recovery in mind, the entire process of disassembly may shift to Europe. Whether the latter claim proves to be accurate is yet to be seen. Nonetheless, it remains the case that, given the global distribution of technology, uneven wages and the various potential values embedded in discarded

The Solving the E-Waste Problem (StEP) initiative of the United Nations University (UNU) is at the forefront of exploring the feasibility of green international e-waste export channels. Together with a host of academic and industry partners located in China and Europe, StEP launched a pilot project called "The Best of Two Worlds" (Bo2W) in 2004 which seeks to integrate recycling best practices from the developing and developed countries (Wang et al., 2012).[96] The project sets up an arrangement in which Chinese equipment is dismantled in regulated Chinese workshops that adhere to relatively high health and environmental standards, yet have low labor costs.[97] Such an arrangement makes "complete dismantling" economically viable. Complete dismantling is a term waste engineers use to refer to a combination of manual disassembly and high-tech recovery that enables maximum materials.[98] The Bo2W system promises to pave the way for a globalized recycling system that is both "economically profitable and environmentally sound," or, to use a more prevalent term, "eco-efficient" (Jaco Huisman et al., 2007).[99, 100]

EEE, a global system of processing seems inevitable to many policymakers and industry representatives.

[96] The following organizations are involved in this project: the United Nations University, Delft University of Technology in the Netherlands, the Swiss Federal Laboratories for Materials Testing and Research (EMPA), the Chinese Academy of Sciences, Taizhou Chiho Tiande Metal Co. Ltd., China's largest mixed-scrap recycling firm, Philips, AER Worldwide an electronics "de-manufacturing" firm based in the United States and the WEEE Forum, a European-based association for firms specialized in the collection and handling of electronic waste.

[97] For instance, Deubzer writes in reference to Bo2W project: "Lower labor cost in developing countries and countries with market economies in transition may enable better treatment" (Deubzer, 2011, p. 85).

[98] For more on why a combination of manual and mechanical processing is ideal for e-waste, see Chapter 4.

[99] The StEP initiative, together with the Swiss EMPA, is researching the viability of applying this model to a number of other countries including South Africa, Ghana, Morocco (Personal communication, November 30 2012).

[100] Though I do not have the space to address this issue in this dissertation, I would like to note that the term "eco-efficient" was quite popular among engineers and policymakers I spoke to. This warrants careful analysis.

In order to avoid dumping, advocates of a formalized global system of unmaking outline explicit provisions that characterize controlled green shipment. For one, formalized export channels must go hand-in-hand with sophisticated "monitoring frameworks" that trace discarded equipment throughout the globalized recycling and recovery process, and ensure that manual disassembly in the developing world must comply at all times with strict environmental standards (Wang et al., 2012).[101] Another stipulation is that exporters are held accountable for the waste they ship.

The Bo2W project as it is formulated now focuses on domestic Chinese e-waste. Supporters of Bo2W distance themselves—at least publicly—from the idea of exporting European and North-American e-waste to China for manual disassembly. In fact, they stress that the shipment of e-waste from developed to developing countries is technically illegal. Swiss material flows analyst Martin Streicher-Porte, explains, "The Bo2W project focuses explicitly on recycling of Chinese domestic e-waste, no illegal transboundary waste will be involved" (Streicher-Porte, 2009). Indeed, during official interviews with mining company representatives and individuals working at the Swiss Federal Laboratories for Materials Science and Technology (EMPA), two of the major stakeholders in the Bo2W project, I was repeatedly told that there was "absolutely no intention to ship waste to the developing world for manual disassembly" (personal communication, August 24, 2010).

However, "off the record" conversations with industry and government officials exposed a somewhat different attitude. For instance, a leading figure in the e-waste world remarked that were it not for the widespread "ideological" or "political" resistance to export—and these terms were clearly used as synonyms for irrational—he and many other more "scientifically inclined"—read rational—individuals would

[101] Of course, as I will discuss later in this chapter, it is nearly impossible to ensure that these provisions are actually followed in practice.

be openly promoting the shipment of discarded equipment to countries with low labor costs for manual disassembly (personal communications, December 17, 2009; January 25, 2012). Similarly, an industry representative admitted to me,

> I don't understand why we don't send our stuff to India or China, and have them dismantle it manually and then send certain components back—the important parts to us to process. We'd increase our profitability and they would have jobs. Why can't we take advantage of cheap labor, when this is a common practice in other sectors? (personal communication, September 11, 2009)

A manufacturing industry representative who was involved with the Bo2W project since its inception explained,

> Originally, the Best of Two Worlds was looking into both handling domestic Chinese waste as well as imported European waste. But politically, the option of treating European waste in China was very badly received in China. Here [in Europe] I don't think people made a big issue about it, as long as it's done responsibly and according to proper standards, but it was very badly received in China. (personal communication, January 21, 2010)

In fact, over the four years I have researched e-waste export, I have observed an increasing willingness to openly discuss export of e-waste from the North to the South for manual disassembly. When I began my field research in 2008, any mention of North-South export was—at least officially—vehemently rejected. Today, however, I encounter more and more actors who are willing to openly discuss the possibility with me. For instance, in his master's thesis conducted at the Technical University at Delft, the Netherlands—a key center for those working on e-waste issues in Europe and with close ties to the StEP initiative—Wang Juan writes, "thus, transnational shipment of e-waste does not necessarily mean a disaster to developing countries, if they are controlled under certain conditions, such as a monitoring system." For Juan, whose thesis focuses on transnational shipments of e-waste from Europe to China, an ideal future is one in which the Bo2W model in China and Europe is extended "to an international agreement where the transnational shipment could be performed in a global legal environment" (Juan, 2009, p. iv). Countless interviews and discussions confirm that Juan's thesis captures the sentiments of a majority of the StEP community. Thus, while it would not always be publicly admitted, one of the purposes of the Best of Two Worlds pilot project (as well as other projects) is to explore the viability of a global recycling system in which the world's e-waste is manually disassembled in less affluent countries with low labor costs and then sent to countries in the North in which high-tech recovery of valuable precious metals and rare earth elements can take place.

Conclusion: Selective and Strategic Representations

In sum, three narratives dominate debates over the transnational movements of e-waste: the dumping narrative, the leakage narrative, and the narrative of comparative advantage. According to the dumping narrative, e-waste export is yet another instance in which the "effluent of the world's affluent" is dumped on the poor (Grossman, 2006). However, e-waste's duality as toxic bad and valuable good ultimately weakens any attempts to make a direct comparison with historical cases of toxic waste dumping. Discarded digital equipment certainly contains toxic compounds, as the dumping narrative points out. However, it is also is a source of valuable materials.[102]

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[102] E-waste does not just exit Germany as a liability, but also as a valuable good. A lot of the literature that engages with the phenomenon of global environmental trends of pollution and waste flows tends to focus on how and why toxic bads—be it the environmental and social costs of manufacturing a computer or the cost of carbon sequestering are "dumped" on the poor. In other words, the narrative is often about how trade liberalization enables the displacement of the liabilities and costs that arise out of the production and destruction of commodities in a globalised capitalist system.

However, the export of e-waste from North to South is not simply a story of the affluent dumping on the poor. E-waste is also a source of value at multiple stages of its unmaking—in the sense that there is money to be made from it. E-waste value also drives its transnational movements from North to South. For waste management firms, e-waste is a source of revenue, not because it contains valuable materials, but because it is something that needs to be handled. And because waste treatment costs less in developing countries—due to lower labor costs and often less stringent or less enforced environmental regulations –than it does in exporting countries such as Germany, the profit margin is

Therefore the transnational movements of discarded electronics cannot be reduced to a tactic to defray the costs of recycling in countries with stringent environmental and human health regulations, as had been initially assumed (Espejo, 2010; Josh Lepawsky & McNabb, 2010).

In contrast, the leakage narrative acknowledges e-waste's value. According to this alternative construction, which consciously contrasts itself with the dominant narrative of dumping, "the enormous resource impact of EEE . . . is widely overlooked" (Schluep, 2009: 2). This effort to reframe e-waste underscores that e-waste is not a burden but a potential benefit for various actors. Alone, however, this perspective remains problematic as it ignores e-waste's toxicity and thus fails to deal with questions of ethics and responsibility that arise due to e-waste's potential hazardousness.

Finally, the narrative of comparative advantage acknowledges both e-waste's value as well as its toxicity. This framing of the issue, however, reifies the uneven

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larger in developing countries, thus incentivizing the export of e-waste. Furthermore, as discussed in detail in Chapter 4, e-waste also has value as a source of secondary materials, spare parts and reusable goods.

Interestingly, discarded items and scrap are more valuable in the global South not simply because the people who live there have less income. As Odeyingbo (2011) points out, a cell phone that is worth one Euro in Germany is worth five Euros in Nigeria. The difference in value of a Cathode Ray Tube (CRT) television monitor in Germany and Nigeria is even more striking. In Germany, there exists virtually no market for used CRT televisions. In addition, the environmentally responsible disposal of a television costs more than the revenue gleaned from recovering the materials through the recycling process. However, in Nigeria, the intact television is worth somewhere between 17–35 Euros as a second-hand technology or a source of spare parts. Thus, exporters of reusable technologies stand to make a lot of money. Odeyingbo calculates that an exporter can make upwards of several thousand Euros per container shipped to Nigeria (Deubzer 2011, p. 69).

The same trend applies to e-waste as scrap. Because EU and German regulations mandate higher recycling rates, the European market has been flooded with secondary materials. "For example, the amount of recycled packaging waste increased from 27 million tones in 1997 to 36 million tones in 2003" (Fischer 2008, p. 10). However, the value of these secondary materials is higher on the international market. In the case of e-scrap, trade out of Germany is directed toward Asia, rather than Africa. E-scarp flows to Asian countries because the demand for raw materials is high in this region due to the fact that the ICT manufacturing sector is centered there. In addition, transportation costs (specifically shipping) to Asian countries are low. This is because cargo ships that bring commodities from East Asia to Europe end up sailing back to Asia with empty containers (Fischer, 2008, p. 10).

labor costs and differences in environmental regulations on which a proposed global division of labor would rest. As noted above, once e-waste arrives in importing countries it becomes exceedingly challenging to monitor this waste stream, let alone ensure its sound environmental disposal. Given this, it seems unlikely that controlled networks of export would actually be able to meet their criteria of ensuring the responsible handling of imported e-waste—a stipulation fundamental to the case for controlled export. Thus, what would likely come out of a global division of labor is a system of unmaking that not only capitalizes on global inequality in terms of labor and the environment, but one that would entrench this inequality. By creating a system of unmaking in which the added value aspects of e-waste recycling take place in the North and the low-value and more potentially environmentally and socially costly forms of recycling and disposal are relegated to the global South, inequality is likely to be perpetuated.

In brief, how much and what kind of value e-waste holds is highly contingent on where the e-waste is located and by whom it is handled. In countries like Ghana, e-waste is valuable as second-hand equipment, whereas in Germany and other industrialized wealthy countries e-waste is deemed valuable as a source of precious and rare earth elements. Thus, e-waste's combination of toxicity *and* value helps explains how, when, to where and by whom e-waste is exported out of Germany through legal and illegal channels. Furthermore, the relations and geographies of global networks of unmaking are in flux; market fluctuations in the price of raw materials and the geographic and temporal location of discarded equipment continually shape and reshape its physical makeup and meanings. To complicate matters, channels of export in which discarded EEE traverses national boundaries as valuable goods co-exist and often overlap with channels through which e-waste is exported as a toxic bad. It follows then that the strategic construction of the social and physical characteristic of e-waste by various actors is central to the nuances of how, why, when, where and by whom it flows across national boundaries, what types of regulatory efforts are made to channel the flow and how various actors interpret the transnational movements of discarded technologies.

Furthermore, following the transnational network of unmaking makes evident that the North and South are more heterogeneous and the relationships between the two hemispheres more intricate than "rich" countries dumping on "poor" (Lepawsky & McNabb, 2009). Thus, the conceptual model underlying the dominant narrative of dumping—a model in which the world is cleanly divided into the wealthy, developed, high-tech global North that exports waste and the impoverished, technologically-primitive global South—is not only oversimplified, but may actually hinder a more productive understanding of the issue. Such a model overlooks too many important subtleties to capture the second-life of used and end-of-life electronics as well as the array of social, economic, political and material relationships they engender.

CHAPTER 6: TRANSNATIONAL REGULATIONS AND LOOPHOLES

Overview

In response to the exponential growth in global e-waste production and the international controversy over export, the last ten years have seen a burgeoning of regulations at the local, national, regional and international levels.[103] The policies and guidelines that apply to e-waste export out of Germany specifically are the Basel Convention on the Control of Transnational Movements of Hazardous Wastes and Their Disposal of 1992 (Basel Convention), the Organization for Economic Co-operation and Development Council Decision C (2001) 107/Final (OECD Council Decision), the European Waste Shipment Regulation (WSR), and the German Waste Shipment Law (AbfVerbrG).[104]

Though impressive in scope and number, these regulations are limited in their ability to stem the unwanted flow of e-waste out of Germany. E-waste exits Germany because of a series of loopholes in the existing legal infrastructure. These loopholes include: the difficulty in defining e-waste, the lack of harmonization in classification

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[103] E-waste has become a priority issue for policymakers across the globe (Yu, Williams, Ju, & Yang, 2010). Since the early 1990s, countries around the world have struggled to manage their e-waste. For information on US e-waste policies see, http://www.epa.gov/osw/conserve/materials/ecycling/pubs.htm. See also the US Congress Bill HR 2284, otherwise known as the Responsible Electronics Recycling Act and the Gov Accountability Office Report, especially appendix 3. For more on Chinese e-waste regulations see the State Council issued the *Waste Electronic and Electric Equipment Disposal Administrative Measures* (China WEEE) and the *Waste Electronic and Electric Equipment Disposal Catalogue* and the *Catalogue Drafting and Editing Rules*. See also, http://www.usito.org/dev/policy-work/environmental-protection/china-weee. In addition, the Asia e-waste Project is an initiative funded by the Ministry of the Environment of Japan and the Secretariat of the Basel Convention. The goal of the partnership is to establish a public-private partnership for dealing with e-waste in seven countries in the Asia and Pacific region (Cambodia, Malaysia, Sri Lanka, Mongolia, Thailand, Philippines China), see http://www.env.go.jp/en/recycle/asian_net/Project_N_Research/Asia_E-waste_Project.html. See also the following report by the Global Information Society Watch for more on e-waste policies and provisions in other laws that can apply to e-waste in African countries, http://www.giswatch.org/sites/default/files/gisw2010regionaleastafrica_en.pdf. Finally, Widmer et al. (2006) provide a good, though somewhat dated, overview of national e-waste regulations.

[104] *Gesetz über die Überwachung und Kontrolle der grenzüberschreitenden Verbringung von Abfällen*

systems, the logistical challenges of monitoring transnational movements of e-waste and the lack of resources to enforce export bans. The majority of stakeholders working on the problem of transnational e-waste flows favor a "technofix" interpretation of the problem; they see the issues listed above as individual glitches that can be repaired through technological and managerial interventions.

I argue that underlying these problems of regulation and enforcement, however, lies a more complex challenge. While regulations are enforceable at the nation-state level, networks of unmaking are global. The tensions between national formulations of environmental waste policies and an uneven global political-economic topography make it challenging to effectively regulate global networks of unmaking. Though the case of e-waste illustrates this point vividly, the tensions I analyze in this chapter are applicable to other environmental issues. This chapter is structured as follows: I begin by describing the national, regional and international regulations that govern unmaking. Next I analyze the loopholes that facilitate unwanted export. Finally, I explore the ways in which e-waste export draws attention to some of the fundamental contemporar challenges to effective environmental policies today.

The Basel Convention

The Basel Convention, which arose in direct response to the toxic waste scandals of the 1980s, is the international policy that has the most potential to effectively regulate transnational flows of unmaking. In 1989, 179 countries signed the Convention and it went into force in May, 1992. The subsequent Nairobi Declaration in 2006 and the Cartagena Decisions in 2011 revised the Convention.[105] Based on the principle of environmentally sound management (ESM), the Basel Convention has three stated

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[105] Note also that in 2012 the Basel Convention, in conjunction with a host of relevant partners, launched the Call for Action, a global survey on e-waste. For more on this, see (Hortoneda, 2012).

objectives: to minimize the production of hazardous waste, to encourage local hazardous waste handling, and to reduce hazardous waste export from developed to developing countries.[106]

It is important to note that the Basel Convention does not ban the export of hazardous waste altogether.[107] Instead, the Convention's objective is to reduce the social and environmental harm caused by the international trade in wastes. The Convention has put a number of provisions in place to meet this objective. First, it attempts to clearly define hazardous and non-hazardous waste. In establishing codified classifications of waste, the Convention seeks to counteract export justified by the notion of cultural, geographic or historical contingency of hazardousness.[108] In the case of the Basel Convention, hazardousness is defined by the chemical properties of the waste. In other words, waste that contains mercury above the official threshold is considered hazardous. The Convention does not have a specific rule for every category of waste. For instance, all televisions are not considered hazardous. Whether the

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[106] Importantly, the Basel Convention stipulates that in certain limited instances, when a country clearly lacks the technology to handle hazardous waste locally in an environmentally-sound manner, hazardous waste may exported to a country with the necessary technology/infrastructure for the purposes of disposal. For more about the history of the Basel Convention, see the UN Audiovisual Library of International Law at http://untreaty.un.org/cod/avl/ha/bcctmhwd/bcctmhwd.html.

[107] The Basel Ban Amendment was introduced in 1994 as a means to address some of the problems with the Basel Convention. According to some developing countries and environmental groups, the Basel Convention was not strict enough. Critics of the Convention point out that the Secretariat has nearly no power to enforce the Convention. Furthermore, with notification and consent, nearly anything could, at least theoretically, still be exported. Unlike the Basel Convention, the Basel Ban places a total ban on any export of hazardous waste for any purpose, including re-use, from Annex VII countries to non-Annex VII countries. The Basel Ban has yet to be ratified, however. This is because some developing countries that specialize in waste handling see a total ban as a loss of revenue. Other critics of the Basel Ban, including industry representatives, argue that stopping all flows of hazardous waste would unnecessarily restrict access to recyclables and raw material. For more on the Basel Ban, see: (Kellow, 1999; Josh Lepawsky & McNabb, 2010).

[108] See Annex I for a list of wastes that are considered hazardous. Annex III exempts certain wastes listed in Annex I. Annex II of the Convention gives the definition of "other wastes" covered by the Convention. Annex VIII and IX of the Convention, which were added later, expressly list what the Convention considers hazardous and non-hazardous.

export of televisions is restricted by the Basel Convention or not is contingent on the materials contained in that particular shipment.

Second, the international agreement created protocols for waste export that all signatory countries must adhere to when exporting waste. Exporters must obtain prior informed consent from the Basel Convention authorities of import and transit countries prior to any activities. Moreover, waste shipments must be closely monitored at all times. Any waste shipment from developed to developing country that does not meet this provision is classified as illegal, according to the Basel Convention (see Annex VII). Finally, according to the convention, export of waste for disposal (as opposed to export for the purposes of recycling and recovery) are restricted; only in instances in which it can be guaranteed that the exported waste will be handled in an environmentally-sound manner, can this type of waste transfer occur.

Currently, a number of public-private initiatives are attempting to address the unique challenges posed by the transnational networks of e-waste. The public-private Partnership for Action on Computing Equipment (PACE) and the Mobile Phone Partnership Initiative (MPPI) have created guidelines for the re-use, recycling, and transnational movement of used and end-of-life mobile phones and computing equipment.[109] PACE is also implementing pilot projects on used and end-of-life computing equipment and the informal sector in developing countries. Another group, the Basel Convention Open-Ended Working Group (OEWG), is creating technical guidelines to address the movement of used and end-of-life electronics. This initiative is largely based on the work done by PACE.[110] Finally, the Legal Clarity Workgroup

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[109] For more on MPPI, see: http://archive.basel.int/industry/mppi.html; For more on PACE, see: http://archive.basel.int/industry/compartnership/index.html

[110] For more on OEWG, see: http://www.basel.int/TheConvention/OpenendedWorkingGroup%28OEWG%29/Mandate/tabid/2295/Default.aspx

launched by the recent "Country-Led Initiative" (CLI) on the Ban Amendment is working on improving definitions of wastes in general and of reuse in particular.[111]

The OECD Council Decision

In 1992, the OECD passed the Council Decision C(2001)107/FINAL, with the aim of controlling waste shipments and facilitating the trade in recyclables and recoverable materials between OECD countries. The Council Decision does not conflict with the Basel Convention. The Basel Convention permits the development of other international agreements and treaties as long as they comply with the Convention's goal of environmentally sound and socially responsible waste management (see Article 11 of the Convention).[112] Like the Basel Convention, the OECD Council Decision defines hazardous and non-hazardous wastes. Furthermore, like the Convention, the OECD agreement classifies hazardous and nonhazardous wastes according to established thresholds of toxic chemicals. Finally, if wastes are exported for the purposes of disposal (not recovery and recycling) then export countries must obtain prior informed consent from importing countries before shipments can be legally made.

The OECD Council decision differs from the Basel Convention in a number of important ways, however. First, the Council Decision applies to a slightly different geographic area—countries such as Haiti and the USA, which did not sign the Basel

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[111] For more on CLI, see: http://www.basel.int/Implementation/LegalMatters/CountryLedInitiative/tabid/1339/Default.aspx

[112] Most of the basic terms and definitions used in the OECD Waste Agreement, such as the terms "waste" and "hazardous waste," were harmonized with those of the Basel Convention in the 2001 revised OECD Council Decision. However, for the sake of clarity, the terms "disposal" and "recovery" are distinct terms in the OECD Waste Agreement, whereas the term "disposal" covers both disposal and recovery operations in the Basel Convention. Furthermore, the OECD Waste Agreement retains certain procedural elements of the original OECD Decision C (92)39/FINAL that do not exist within the Basel Convention, such as time limits for approval process, tacit consent and pre-consent procedures.

Convention—can trade with other OECD countries. Furthermore, at the heart of the Basel Convention is the desire to minimize waste export regardless of the purpose of export. The Council decision, on the other hand, is much more tolerant of waste trade. The goal for the latter international agreement is to control the trade of potential resources secured from waste. Because of its slightly different focus, the OECD's regulation has more specific guidelines than the Basel Convention regarding waste destined for recovery.

Another important difference is how the OECD defines waste. After the passing of the Council Decision of November 2003, the OECD waste agreement recognizes two types of wastes: green wastes, which can be shipped like any other commodity, and amber wastes, which require informed consent because they pose a potential threat to human and environmental health (see Appendix III and IV for the lists of wastes).[113] Though the OECD Waste Agreement in 2001 (C(2001)107/Final) made improvements to harmonize with the Basel annexes (the green and amber waste lists were made to align with the lists in the Basel Convention Annexes) there remain significant differences in how these two agreements classify wastes and how they see the transboundary movements of wastes.

The European Waste Shipment Regulation

In 2006 the European Union transposed the Basel Convention and the OECD Council Decision into European regulation with the European Waste Shipment Regulation (WSR).[114] The WSR implements the international obligations of the two regulations

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[113] Appendix IV of the Council Decision contains a list of these wastes. Again, the OECD classification consists of two categories. The first category includes the wastes listed in Annexes II and VIII of the Basel Convention. The second category consists of additional wastes that OECD Member Countries have agreed to classify as Amber wastes.

[114] The current regulation is the revised version of the Council Regulation (EEC) No 259/93 of 1 February 1993 on the supervision and control of shipments of waste within, into and out of the

and includes the stipulation that wastes should be disposed of in an environmentally-sound manner. How and what types of waste can be exported under the WSR is contingent on a number of factors: the intended destination, the purpose of export (re-use, recovery or disposal) and the type of waste being exported. Much like the two multilateral agreements it builds on, the WSR divides wastes into three primary categories: "Prohibited Waste," "Notification Control" and "Green Listed Controls." Unlike the Basel Convention, however, it classifies waste by components, meaning that used and end-of-life electronics fall into one of the three categories mentioned above depending on what components they contain. The Regulation forbids the shipment of hazardous wastes in particular from EU to non-OECD countries.[115] It does, however, allow the shipment of non-hazardous waste to other countries, so long as that waste is exported for the purpose of recovery. Moreover, if items are taken apart in the country of origin, what remains is often categorized as green list waste. This classification exempts an exporter from having to notify the authorities (Fischer et al., 2008, p. 33). The export of functioning second-hand items is also permitted under this regulation, though the recent revision of the WEEE Directive lays more restrictions on the export of used equipment.[116] Like the Basel Convention and the OECD Council Decision, the WSR does not list many of the key components in used and end-of-life electronics. Importantly, Basel Convention, the OECD Council

European Community. The European Waste Shipment Regulation was revised in 2007. As Juan explains, "The revised law aims to develop a simplified but stronger regime for waste movement, ban certain types of waste exports, establish greater enforcement actions and streamline existing procedures. It also seeks to incorporate into Community legislation the amendments to the lists of waste annexed to the Basel Convention as well as the revision adopted by the OECD in 2001" (Juan, 2009). While the new law is clearer, the export process remains complicated and confusing.

[115] See Annex V of the Regulation.

[116] For more details, see: http://ec.europa.eu/environment/waste/shipments/pdf/correspondents_guidelines_en.pdf.

Decision and the European Waste Shipment Regulation are not enforceable in and of themselves. They must be transposed into national regulation to be effective.

Germany's Waste Shipment Regulation (AbfVerbrG)

In the case of Germany, the ElektroG and the federal Waste Shipment Act (AbfVerbrG)[117] set the guidelines for the production, collection and processing of e-waste in Germany. Whereas the ElektroG concentrates on domestic matters, the Waste Shipment Act regulates the export of waste, including e-waste, out of Germany.

The federal law goes beyond the multilateral and regional policies by clearly delegating responsibility for controlling waste shipments to specific government institutions. Importantly, according to the Waste Shipment Act, the main responsibility, including the right to conduct inspections, falls on the state in which the waste shipment begins its journey (Schilling & Sanders: 14).

The waste shipment act also gives clear protocols in case an illegal shipment is discovered. It gives port authorities the right to impound illegal shipments. It also outlines a clear chain of command and responsibility. In the case of Hamburg, for example, the city through which much of German end of life equipment leaves the country, the Regional Authority for the Environment (BSU),[118] the Hamburg Water Police[119] and the Customs Office are the agencies that inspect and deal with WEEE shipments.

Together, the Basel Convention, the OECD Council Decision, the European Waste Shipment Act and the German AbfVerbrG, create an impressive regulatory

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[117] *Gesetz über die Überwachung und Kontrolle der grenzüberschreitenden Verbringung von Abfällen,* also commonly referred to as the *Abfallverbringungsgesetz* or AbfVerbrG. .

[118] *Behörde für Stadtentwicklung und Umwelt*

[119] *Wasserschutzpolizei*

landscape, especially when compared to the United States, which has not signed the Basel Convention and does not have an e-waste regulation to speak of. As outlined above, these regulations strive to adapt to the complexities of contemporary networks of e-waste unmaking. They take measures to acknowledge e-waste's duality as both a commodity and waste, its constantly changing material makeup, as well as its spatial and temporal contingency. Moreover, rather than promote a total ban, these policies focus on regulating transnational flows by providing up-to-date and detailed definitions of goods for reuse, hazardous and non-hazardous waste, harmonizing their classifications, outlining proper protocols for each type of waste, requiring proper classification of waste streams, and by stipulating the need for consent and the proper dismantling of exported waste to developing countries. Yet despite these elaborate efforts, transnational networks of unmaking continue to evade regulators.

Slippery Status

The fluidity of the category of waste—indeed of waste itself—poses a serious challenge for lawmakers, as regulations require a stable definition of something in order to control it. One way legislators have attempted to deal with e-waste's ambiguity is to categorize e-waste by its various uses: re-use, recovery or disposal. To recall, all the regulations listed above permit the export of discarded EEE for the purpose of re-use (Espejo, 2010).[120] In addition, existing regulations permit the export of equipment for material recovery under particular conditions (Josh Lepawsky & McNabb, 2010). By distinguishing between end-of-life technologies that retain value

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[120] Annex 6 of the WEEE Recast states that it is incumbent on the exporter to prove that the items for export are functional. In the old formulation of the law it was the responsibility of the competent authority to test functionality. Placing the burden of proof on the exporter should improve the situation somewhat, though it is unclear how this will work in practice. Some products are easier to test for functionality than others. For more information, see (European Commission, 2007).

and those that are waste, the laws seek to acknowledge and adapt to e-waste's inherent hybridity.

Key for the success of these provisions, however, is the ability of authorities to differentiate between shipments that genuinely contain valuable goods and those that are waste. This is challenging for various reasons. For one, exporters adapt to new legislation by merely relabeling their activities instead of genuinely changing their practices. For instance, when the Basel Convention was first introduced, it banned the export of hazardous waste for disposal. However, the convention permitted export for recovery and re-use. As a result the export of waste intended for disposal from OECD countries to non-OECD countries decreased by 31 per cent between 1990 and 1995, whereas exports for the purposes of refurbishment and re-use increased by 32 per cent over the same time period (Espejo, 2010). In other words, export of wastes for disposal continued; only the exporters adapted to the new regulations by relabeling their shipments as reusable goods.[121]

As noted in the previous chapter, whether the containers are filled with items that could be reused or with junk cannot be objectively assessed. It is contingent on subjective understandings of what is reusable and what is not, market conditions and existing technological capacity and know-how. A container full of discarded "broken" equipment, it could be argued, is not waste because it may have value in the import country. Many Nigerians and Ghanaians, for example, have the know-how and the cheap labor to repair broken equipment. Thus, a Nigerian or Ghanaian immigrant to Germany can legitimately argue that his shipments do not constitute waste (Espejo,

[121] The Partnership for Action on Computing Equipment (PACE)—an initiative launched at the ninth meeting of the Conference of the Parties to the Basel Convention—introduced a recommended test for functionality to counter this problem. However, because the recommended test has not been adopted by the *Conference of Parties* (COP) it is not legally binding. Consequently, there is little guarantee that the test is routinely enforced by member states. For more information on the test for functionality, see http://archive.basel.int/industry/compartnership/index.html.

2010, p. 18). Harbor police and customs officials have a hard time disproving claims that equipment has value in import countries given the multiple factors that play a role in determining whether claims to value are accurate at any given time and for any given place.

Perhaps more than most other forms of discard, e-waste makes evident that there exists a continuum between waste and commodity. As Christian Fischer explains in a report for the European Topic Centre on Sustainable Consumption and Production, “The conditions under which a used electronic or electrical product is, or is not, regarded as ‘waste’ for regulatory purposes are a matter that appears repeatedly in any discussion about the trade in these products. In the case of electronic and electrical items, the potential for direct reuse of a discarded but functional product complicates matters rather more than is the case for, say, waste paper.” (Fischer et al., 2008, p. 54). Items can be non-functional, but given the right circumstances—be it the availability of knowledge on how to repair electronic items, relatively low labor costs, a market for used goods and so forth—individuals can repair, break apart, reconstitute or even just rename what had been waste and thus create a new commodity. As soon as there is any legitimate claim of reuse, the cargo immediate falls “outside of the waste regime” and thus can be freely traded as any other commodity (Willke, 2012).

Moreover, all exporters have to declare the goods—if, as is often the case, they are being shipped outside of the EU—using the Customs Office’s IT system ATLAS (Sander & Schilling, 2010, p. 19). However, as Sander & Schilling have pointed out in their report commissioned by the German Ministry of Environment (BMU) on e-waste export out of Germany, “in the case of EEE, the codes do not distinguish between used and new equipment “ (Sander & Schilling, 2010, p. 20). The lack of a shipment category for waste renders it invisible and thus very difficult to monitor and regulate.

Classificatory Disharmony

Definitions of e-waste vary not only from person to person but also from place to place (Huisman et al., 2012). Different countries emphasize the material composition of the product or try to define its status as functional or waste. For instance, whereas in Europe e-waste is classified according to its hazardousness, waste in China is classified according to the raw materials it contains. Thus, a form of e-waste that contains significant quantities of hazardous materials will be banned from being exported out of Europe, but if the waste is rich in raw materials the Chinese government will likely permit its import (Juan, 2009, p. 48). This means that it is very possible to have the same goods be legally imported to China but be illegally exported out of the EU.

Not only do definitions of waste differ between countries such as Germany and China, but they also vary significantly among European countries. Theoretically, the European Waste Shipment Regulation provides the template for how member states should define e-waste. However, in practice, member states interpret the EU waste codes quite differently. As a result, countries across Europe operate with different classifications (Grossman, 2007; Josh Lepawsky & McNabb, 2010; Pellow, 2007). Discrepancies in national annual reports illuminate this. For instance, in 2003, the Netherlands reported that they had exported 1.3 million tonnes of household waste (the exact category was Y46) to Germany. Germany, however, reported only receiving 21,000 tonnes of household waste from the Netherlands (Fischer et al., 2008, pp. 22–23). While the example of household waste is used to illustrate the point here, this phenomenon extends to shipments of used and end-of-life electronic equipment as well (Juan, 2009, p. iii).[122]

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[122] A similar issue exists between the United States and the EU with regards to end-of-life automobiles. The U.S. exempts them from hazardous waste regulation as they are considered scrap metal. The Basel

There are also inconsistencies and incompatibilities between multilateral agreements and national regulations, as well as between multilateral agreements, in regards to definitions of e-waste. For instance, the Basel Convention's classifications of e-waste contradict the classifications of many signatory countries (Josh Lepawsky & McNabb, 2010).[123] Moreover, multilateral agreements operate with different definitions of e-waste. Contrary to the stated desire to harmonize the Basel, Rotterdam and RoHS Conventions, these three continue to use distinct and sometimes contradictory codes. [124] In addition, despite efforts to harmonize definitions in the OECD Council Decision and the Basel Convention, they still conflict with each other in terms of their definitions of hazardous types of e-waste.[125]

What is perhaps most problematic is that there are inconsistencies and contradictions even within individuals policies. This is most clearly seen in the Basel Convention, which has mirror listings for certain wastes in both Annex VIII and Annex IX, depending on whether and to what extent they contain Annex I material and if this amount is sufficient to cause them to exhibit an Annex III characteristic. More specifically, Annex VIII of the Basel Convention encompasses a list of

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Convention and the EU regulate end-of-life autos as hazardous if the liquids have not been removed. The Port of Rotterdam frequently contacts the US competent authority to notify them of what they consider to be an illegal shipment. The US EPA has no legal authority, however, to compel an exporter to take back the shipment. Nevertheless, exporters often try to hasten their shipments' return as the ports charge large storage fees.

[123] Recall that the Basel Convention stipulates that its guidelines are applicable to all signatories. However, the Convention also gives member countries significant leeway in their definitions of hazardous waste.

[124] The Rotterdam Convention regulates the transnational movements of hazardous chemicals. For more information see: http://www.pic.int/TheConvention/Overview/tabid/1044/language/en-US/Default.aspx.

[125] The European Commission's Council Decision C(2001)107 contains codes explicitly distinct from Basel codes. The OECD Decision cancels out Basel's classification of WEEE as hazardous; it says, "Basel entries A1180 and A2060 do not apply and OECD entries GC010, GC020 and GG040 in Appendix 3 Part II apply instead when appropriate." Basel code A1180 is the WEEE item on the hazardous list. OECD replaced the WEEE deemed hazardous in Basel under codes (GC010, GC020 and GG040) that are listed as "green control," which means that they are treated more as commercial products than as hazardous waste as long as they remain within the OECD.

substances, including forms of e-waste that are considered to be hazardous. At the same time, Annex IX—which lists non-hazardous materials—exempts the very same forms of e-waste listed in Annex VIII, so long as these materials pass tests for hazards defined in Annex III. Annex III, however, states that there are no conclusive tests to measure flammability and toxicity (Lepawsky & McNabb, 2010, p. 5). Thus, as Lepawsky & McNabb aptly conclude, "the Convention remains highly ambiguous when it comes to common e-waste materials (and many others) and leaves a great deal of room for 'flexible' interpretation of its intentions to halt the transnational movement of them" (2010, p. 4)

Though a lot of e-waste is exported illegally and without record, making it administratively invisible and thus untraceable, the lack of harmonization in classifications makes legal shipments almost equally challenging to monitor (Ayodeji, 2011). Most reports on e-waste—be it about domestic generation or transnational flows—include the caveat that all data on used and end-of-life electronics is based on estimates.[126] This is beginning to change, however, as attempts to track flows have increased in recent years.[127] Still, the data is of poor quality. The lack of reliable data,

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[126] Reports on e-waste frequently attempt to quantify its existence. One commonly used method for quantification is using the number devices put on the market to estimate the amount of e-waste generated. Another common method involves looking at trade statistics for shipments of electrical and electronic devices and then using the price-to-weight ratio of containers to estimate whether the devices being shipped are new or used. Fischer et al. (2008) use the latter method, looking at the export value of shipped goods to determine whether they are new or used equipment, or even e-waste (Fischer et al., 2008, pp. 56–59).

[127] Previously, there were no mechanisms in place to track flows of discarded electronic items, although now various groups are working on establishing mechanisms for future tracking. For instance, Valerie Thomas of Georgia Tech University is working on developing a system in which Universal Product Codes (UPC) barcodes or RFID (radio frequency identification) are attached to every electronic item. Angie Leith of the US EPA is also working on this issue.

in turn, makes it difficult to monitor and evaluate the economic and environmental impacts of these shipments, key goals of existing e-waste regulations.[128]

Coordination and Enforcement

Coordinating and monitoring activities pertaining to international flows of e-waste also poses a great challenge. There is very little communication among responsible authorities in export, transit and importing countries. This lack of communication is explained by language barriers; the fact that the agencies responsible for implementing and enforcing the regulations often lack resources to do their own jobs effectively, let alone coordinate with other agencies; and resistance to working and exchanging information with agencies in other countries because doing so is often perceived as a threat to national sovereignty. Not only is communication between international agencies challenging, but cooperation and communication between and among local, regional and national agencies is often also wanting (Fischer et al., 2008; Grossman, 2007; Hieronymi, Kahhat, & Williams, 2012; Pellow, 2008; Secretariat of the Basel Convention, 2011; Wang et al., 2012).[129] For instance, there is often minimal coordination between police and customs within individual countries. As with

[128] Importantly, e-waste's complex materiality poses serious challenges for classificatory systems and definitions. E-waste is not a traditional waste stream. For instance, in the United States, regulations were developed to address more "traditional" materials such as sludge or slag. The Resource Conservation and Recovery Act (RCRA) places the burden on the generator to test the waste if it is not expressly listed in Subtitle C. To perform the Toxicity characteristic leaching procedure (TCLP) test, the generator must grind up the waste if it is solid and then test it for toxicity, corrosivity, leachability or pyoritic characteristics. However, if a laptop, for example, is ground it is already rendered waste before it can be tested. One solution would be to list laptops as hazardous, but depending on their design, they might not test as hazardous (and could thus be labelled as such by the manufacturer). Thus, these newer, non-traditional waste streams, such as ship recycling outputs, end-of-life electronics or construction and demolition debris pose a serious challenge to regulators.

[129] For more on this, see the European Electronics Recyclers Association website at: www.eera-recyclers.com.

transnational shipments, concerns about jurisdiction and lack of resources hamper coordination.

Port authorities also often lack the resources to monitor, let alone, test items. At the same time that awareness of the negative social and environmental effects of e-waste export has grown in Germany, the German government has cut funding for water police and customs. Officials at the port of Hamburg complain that they simply cannot check every container that passes through the port (personal communication, December 23, 2010; March 4, 2010). One respondent confided in me that customs uses sophisticated software to calculate the probability that any given container held waste. The budget for this software had recently been cut, claimed my contact (personal communication, March 4, 2010; February 2, 2013). Authorities in other major European ports face similar conditions (Espejo, 2010). The Rotterdam Harbor in the Netherlands, for instance, hosts one of the world's largest and most important container transport ports. Over seven million containers pass through the harbor every day, yet they employ under twenty inspectors to monitor this cargo (Juan, 2009). The low ratio of controllers to containers in Hamburg and other major European ports confirms that in practice governments devote very few resources to actually enforcing the regulations that prohibit unauthorized transnational shipments of e-waste (BCRC, 2005; IMPEL-TFS, 2006; Juan, 2009).

In cases where customs officials actually identify a waste shipment, exporters rarely face any consequences. Often illegal exporters only receive a small fine and are ordered to take back their cargo. Denied at one port, exporters simply try to ship the same materials from another harbor (Deubzer, 2011, p. 69; Espejo, 2010). Moreover, exporters rarely face legal action. The few court cases involving illegal shipments of e-waste out of Germany have all been dismissed on the grounds that existing regulations make it difficult, or even impossible, to legally define the difference between waste and commodity.

Even if port authorities had enough resources to enforce the laws, they face the challenge of identifying the perpetrator. Shipments go from harbor to harbor and repeatedly change hands, making it difficult to determine who "owns" a given shipment. This is particularly true if the materials pass through the Hong Kong port where shipments often vanish from administrative records without a trace. According to German law (and this holds true for most other European countries), if customs officials cannot identify and find the owner of any illegal shipment, then the municipality in which the harbor is located must cover the costs of disposal. In other words, if the water police or customs find an illegal shipment but cannot find its owner, the city of Hamburg has to pay for the proper disposal of the cargo. This creates a strong disincentive for local authorities, who are perpetually struggling under budget cuts, to enforce e-waste regulations as their city will ultimately carry the cost of detecting the infraction.

In addition, officials also struggle to enforce compliance with domestic provisions. It is difficult to ensure that domestic processors act according to e-waste regulations and handle e-waste locally and in the most environmentally sound way possible, as stipulated by German law. In a recent report evaluating Germany's e-waste handling system, engineer Otmar Deubzer explains, "the treatment operators are audited and certified annually by third party auditors in order to ensure that they have adequate technology, know-how and organization for a state-of-the-art treatment of e-waste. It is, however, difficult to prove whether treatment operators actually make use of their abilities in daily operations" (Deubzer, 2011). Economic factors play a large role in treatment operators' decisions to employ the most environmentally sound techniques, as it is often costly for operators to follow specified procedures and regulations. Deubzer (2011, p. 62) continues, “It would be difficult to prove if a treatment operator shreds entire LCD displays, for example, instead of removing the mercury-containing backlights before. Such incompliance would save cost for expensive manual disassembly of the LCD displays, and the small amounts of mercury would evaporate and be diluted in the waste stream.” During a telephone conversation, Deubzer expressed his concern that on non-inspection days, German recyclers cut corners and sometimes even sent entire containers of e-waste to the developing world in order to cut costs (personal communication, November 21, 2011). The inability to enforce existing regulations and to successfully sanction violators thus helps explain the high incidence of export of e-waste (Bodeen, 2007a, 2007b; Juan, 2009, p. 13).

Consistently monitoring and enforcing regulations in importing countries poses an even greater challenge. As I explained above the Basel Convention and the OECD Council Decision permit export of certain types of e-waste for disposal from one signatory country to another as long as exporting countries obtain prior informed consent (PIC). However, notions of consent become meaningless when a country racked with poverty has no real choice but to accept imported e-waste as a much-needed source of income.

Moreover, the policies require assurances that the waste will be treated in environmentally sound manner in the importing countries (see article 11, paragraph 1 of the Basel Convention). However, the regulations only vaguely define the criteria for “environmentally-sound management” (Josh Lepawsky & McNabb, 2010, p. 3) and rarely, if ever, does anyone actually control disposal practices in non-OECD importing countries. In fact, as a number of my interviewees explained, once items arrived in importing countries in the global South, they simply vanished administratively speaking. This makes it difficult to ensure that they are being handled according to the international agreements. As one interviewee explained,

> But there's also the environmental side. The environmental side is how we—and this is one of the biggest challenges—how can we ensure that the same standards of recycling—and again I'm just using China as an example—are used in China and in Germany? In Germany you have a very—well, I wouldn't say a very, but a solid enforcement strategy for recycling scrap metals. I'm not sure this is the case in Nigeria. The biggest challenge for people that are involved in recycling somehow is how we can ensure that recycling is done according to the same or similar standards across the globe. (personal communication, March 9, 2010)

My respondents blamed the disorganization, lack of motivation and rampant corruption in import countries for this problem. The same respondent quoted above, claimed that the biggest problem was . . .

> . . . . corruption and that people just don't know how to enforce; people do things because it's written in a law, but they are not behind it. From their gut feeling, they say, "Why the hell should I do it? I'll just dump it. Fine." [. . .] They are forced by international agreements. You know, governments—people in governments are usually well-educated. They have friends in western countries, who then tell them, "Hey, the environment"—and then they understand that a certain habit can then have a negative impact on the globe. A shop owner, somewhere in the middle of somewhere—in the middle of nowhere—doesn't see the consequences of what he's doing. And it's not only education, I think if you can help, you should do it. But it's the same here—I was raised on a farm, a long, long time ago, and do you know my father used to spill the oil from his tractor—just put it on the field. Because he didn't see an impact. The impact came that a little bit more—unfortunately he had people that came and enforced the regulation on him, and then he started to rethink. So it's a matter of—even people in Europe, and in Germany sometimes or many times are not behind an environmental regulation. They try to make a dollar fast, or a fast dollar, or whatever you call it, and then they go their way. They don't care about the environment. (personal communication, March 9, 2010)

Many of my interviewees argued that they could not overstep foreign sovereignty to ensure proper disposal in importing countries. As privileged Germans they were in a bind. They could not make sure that the critical provision in the policies allowing controlled export in other countries without being paternalistic. However, it is precisely these provisions that differentiate controlled export from dumping.

Materiality

Finally, e-waste's materiality plays an important role in determining to what extent legal provisions are successfully implemented. For one, it is easier to test the functionality of some products than others. A cell phone, for example, is easier to test than a base station, which can only function as part of a larger system and cannot simply be plugged in and run on its own. German authorities are aware of this problem and have attempted to address it, for instance, by giving customs officers clear protocols for various categories of equipment. In practice, however, despite these specifications and protocols, port authorities still have trouble testing certain items that require additional expertise and time to evaluate.

To complicate matters even further, as noted in chapter three, new technologies often contain different concentrations of key materials than were present in earlier models. For example, mercury was a key component in EEE when the Basel Convention was written, but it now represents a much less significant ingredient in newer models. This means that even if regulators put all their resources into classifying e-waste, the dynamic material composition of electronics makes it hard for laws to effectively regulate their export.

Conclusion: National Regulations, Global Unmaking

While I was researching for my dissertation, the StEP initiative commissioned me to write a white paper on transnational e-waste shipments. In my role as author, I participated in numerous conference calls with stakeholders from across the globe. The stakeholders I communicated with—ranging from academics, to industry representatives (manufacturers and waste processors), to government officials—agreed that the most effective and realistic approach to fixing the problem of unwanted export was to systematically address each loophole I outlined above.[130] My questions about underlying causes and drivers of export faced silence and, at times, exasperation. As one engineer from China, clearly frustrated by my repeated efforts to question the status quo, finally exclaimed: “I don’t understand what you mean by underlying problems. We just need to optimize protocols!”

This engineer and his colleagues wanted me to focus on “realistic” and “practical” solutions. Again, the implication here was that these terms were synonyms with rational. They asked that I concentrate on finding ways to develop a clear global definition of and classification system for e-waste. I should look into what it would take to create clear protocols and increase funding for enforcement agents, improve coordination among competent authorities and find mechanisms for regulations to keep up with the changing composition of equipment. Once the regulations addressed these hiccups, an ideal transnational system of unmaking would emerge—one that took e-waste hybridity as valuable good and toxic bad into account. This ideal system would also take advantage of each country or region’s strengths to create an efficient and productive global division of labor.

Despite the theoretical promises of such an idealized arrangement, however, in practice addressing the issues individually will likely only incrementally improve the status quo.[131] The problem is that on the one hand, national governments strive to

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[130] Projects such as the Partnership on Computing Equipment (PACE), the Open-ended Working Group of the Basel Convention (OEWG) and Country-Led Initiatives (CLI) of the Basel Convention also favor this approach.

[131] There exist alternative proposals such as the Best of Two Worlds Project that acknowledge the complex global system. Other proposals include setting up a system that incentivizes the re-export of secondary raw materials to the global North and putting in place a ‘buffer loan scheme’ in which individuals from the informal sector in the developing world are immediately financially compensated as a means to bridge the gap towards the payment of the integrated metal smelters in the global North. These possible solutions represent an important step in the right direction, yet they continue to run the risk of capitalizing on and thus reinforcing global inequalities rather than offering a socially- and environmentally-just solution.

implement policies that will render their countries more environmentally sustainable. However, these countries are integrated in a larger set of unequal global political, economic, cultural, and environmental relations. The cost of labor, regard for human health and the environment—or at least the technological and economic capacity to protect them—as well as the values of critical minerals, components and waste differ drastically from place to place. Given this, as Larry Summers observed two decades ago, in a liberalized economy, the 'natural' tendency is for the externalized costs of capitalism to flow from rich to poor countries as a means to maximize profit and reduce costs.

Multinational agreements such as the Basel Convention arose as a means to counter the tendency of rich nations to displace the social and environmental costs of their consumption onto the developing world through the channels of a liberalized global economic system. That is, these agreements represent an effort to keep the free market in check. However, multilateral agreements such as Basel Convention rarely, if ever, manage to make true on their promises. This is because these regulations are only enforceable at the level of the nation-state.

Political-economic unevenness means that different countries vary in their capacity to implement regulations that should, in theory, be uniform. For instance, European countries, at least in theory, follow streamlined export and import procedures. However, in practice the ability to implement such complex procedures varies considerably from country to country, depending on available resources, priorities and knowledge. This means that while the Basel Convention, the OECD Council Decision and the WSR provide guidelines for national regulations, each member state has considerable discretion in how they implement and enforce the regulations. Consequently, some countries like Germany have stricter regulations and are better able to enforce these regulations than others (Juan, 2009, p. 81; Widmer et al., 2006, p. 30).

Processing times also vary from country to country, despite the fact that they should, at least in theory, be the same across the globe in order for the regulations to be effective. Companies or individuals seeking permission to ship discarded equipment out of or into a given country can wait anywhere from weeks to years for the proper paperwork to be processed, in which time the re-use value of the equipment can be dramatically reduced or eliminated altogether.

As soon as a shipment of discarded equipment exits Germany, it is no longer regulated. Adaptable exporters—driven by the profit incentive—capitalize on this regulatory and bureaucratic no man's land. They look for countries and ports where regulations are less stringent or where authorities do not enforce the regulations completely. When regulations tighten in one port, they quickly shift operations to another. Exporters also go out of their way to ship items from countries that have faster processing times in terms of paperwork. In other words, the tightening of controls in a country like Germany is only marginally effective because exporters can easily evade them by shifting their shipments to ports in more lenient countries.

In practice, this means that transnational networks of unmaking are structured so that unwanted digital equipment flows to the developing world. Though some items are repaired and reused, they eventually also become waste, resulting in the net flow of e-waste to the global South. European mining companies fight to gain control of the valuable components and materials in e-waste such as circuit boards, whereas the less valuable materials such as cathode ray tube glass lined with lead or plastic drenched in brominated flame retardants amass in poor areas. Moreover, despite the stipulation that exports of hazardous waste must be responsibly handled in import countries, these provisions cannot be enforced. Thus, despite the promises of a global system of unmaking that builds on the strength of each individual country, in reality a form of consented dumping ensues.

In sum, a close look at Germany's efforts to regulate its networks of unmaking makes analytical contributions that extend beyond the specific case of e-waste and Germany. It touches on a key issue of our times: the tensions and implications of national formulations of environmental policies in a profoundly interconnected and uneven global topography. The world we live in today is not only interwoven through waterways, the atmosphere, flora and fauna, but also through globalized networks of production and unmaking as well as through flows of people, capital and information, which are interconnected themselves (Langston, 2011).

The tension between a Westphalian system and a world that is interconnected on so many levels poses both a regulatory and a methodological challenge.[132] Closely examining the everyday practices that make up the global unmaking of e-waste—where the materials being exported are simultaneously valuable and toxic—encourages those who write about global environmental relations to look more closely at the particular manifestations and mechanics of the unequal relations of production and unmaking they write about.

[132] For more on how I address the methodological and theoretical dimension of this quandary see Chapter 2.

CHAPTER 7: CONCLUSION: UNMAKING DEMATERIALIZATION

Overview

The belief that social and economic activity has "gone virtual" with the advent of ICT equipment such as cell phones, iPods and computers is widespread. According to this narrative of dematerialization, digital technologies have made it possible to live and work online, ushering in a wire-less, paper-less and resource-less world in which social and economic life has been effectively decoupled from the physical. Computers, smart phones and the Internet represent gateways to unlimited, un-tethered and more sustainable virtual existences.

Despite the promises of digitalization, global consumption of information and communication technologies such as personal computers, cell phones and iPods relies on a resource intensive and often environmentally destructive socioenvironmental infrastructure in which the costs of dematerialization are unevenly distributed across the globe. As material studies scholar Neil Maycroft explained over a decade ago, the virtual world is dependent on "the materiality of the computer technology which generates" it (Langston, 2011). Yet the physical infrastructures, the environments and people who make it possible to go wireless remain mostly imperceptible.[133] We remain, paradoxically, deeply ignorant about "the resources with which [we] are otherwise intimately familiar" (Bridge, 2009, p. 2).

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[133] The literature—both popular and scholarly—that draws out attention to the social and environmental costs of our seemingly virtual lives is abundant (Grossman, 2007; Josh Lepawsky & McNabb, 2010; Pellow, 2007; Williams, 2003). It unsettles "the claim that—by contrast to the old economic sectors of iron, steel and auto, for example—electronic production processes are clean and safe for ecosystems and workers" (Pellow, 2008, P. 225–226). The growing popular and scholarly attention to the negative social, economic and environmental impacts of the digital revolution makes important inroads to unsettling the regime of perceptibility that promotes the idea of a friction-free, resource efficient digital world. It also disputes the linear association between technological development and environmental sustainability underlying the dematerialization narrative (Hayes, 1989, Kuehr and Williams, 2003, Williams, 2003, Smith et al., 2006).

In this concluding chapter, I use Michelle Murphy's concept of "regimes of perceptibility" to analyze the invisibility of the material underpinnings of digitization. I also explore how the theme of hiding and concealment runs through my analysis of the unmaking in the previous chapters. I argue that the invisibility of the material underpinnings of digitization in general and of the process of unmaking specifically reinforce dominant narratives about modernity, North-South relations and capitalism. The invisibility of digital waste also reinforces a number of "tactical separations" at the conceptual level: namely that between nature and society, nature and technology, technology and society as well as waste and resource (Pritchard, 2011, p. 23). The visibility of e-waste in recent years, in turn, signals that we are living in a time in which fissures and gaps in the dominant narratives are becoming apparent. It is in these spaces that change can take place.

The Promise of Dematerialitzation

An article published in 2011 in Forbes magazine lauds the many environmental advantages of the digital revolution:

> As many businesses are now digital, and operate virtually versus physically, there's a potentially significant degree of resource consumption that no longer takes place, that hasn't been tracked. Perhaps, we'll realize, for every kWh computers and data centers consume, they give back x number of kWhs.
>
> Consider e-commerce, something that has been around in force for well over a decade now. How many physical retail stores have not been built, and do not operate, due to e-commerce? (For purposes of this argument, I'm using the term "online economy" fairly broadly, to cover all types of computing that invokes services from someone else' servers, including cloud computing, e-commerce, Internet computing, and social networking.)
>
> Or consider other potential hidden benefits of the online economy. How many automobile trips and additional office space is no longer necessary due to telecommuting and remote work? How much travel is no longer necessary because of online college courses? How many trees are no longer cut down because of electronic documents, PDFs, and collaborative solutions? (McKendrick, 2011)

The author draws attention to the environmental benefits of economic dematerialization through digitalization. Economic digitalization refers to what, at least at first glace, appears to be "less materially intensive" but equally productive (Hilty et al., 2006, p. 1618). Economic dematerialization occurs through greater efficiency, which is in turn attained through technological improvements; the quantity of energy and raw materials decreases as production speeds up. A shift from the production of commodities to the provision of services is also key for economic dematerialization. The shift to a more service oriented economy, or a tertiary economy is made possible by replacing an economy centered on the manufacturing of things with the provision of ethereal commodities such as information, consultation, experience and conversation. Concomitantly, financial, educational and health services take up a larger percentage of the overall economy.

Particularly noteworthy is the increasing importance of financial services or, to use a different term, the financialization of the economy. David Harvey (2006) explains that the financialization of the economy occurs when trade in stocks, bonds and shares as well as claims on non-circulating commodities or future property rights takes on more importance than the things they represent. What results is an economy largely based on "fictitious capital" which Harvey describes as "money that is thrown into circulation as capital without any material basis in commodities or productive activity" (Harvey, 2006).[134]

There is another sense in which the economy is seemingly dematerialized: trade is no longer constrained by geographic and temporal limits. The term "friction-free flow" is often used to describe this phenomenon. Alternately, one can speak of "space-time compression." According to Harvey, the drive for profit in capitalist

[134] The danger of economic dematerialization, explains Harvey, is that it leads to a very fragile economy that is susceptible to collapse, as evidence by the 2008 financial crisis.

systems leads to the (attempted) erasure of any barriers (be they spatial, temporal or biological/physical/chemical) to the creation of profit (Harvey, 1989, p. 240).

According to this narrative of dematerialization, digital technologies have not only launched social and economic life into the realm of the virtual, but in replacing physical things such as stores, books, letters, traveling time and commodities with their virtual counterparts, these technologies hold the key to humankind's environmental salvation. Environmental economists and green capitalists Paul Hawkins, Amory and Hunter Lovins (Hawken, Lovins, & Lovins, 1999), among others, argue that dematerialization through digitization are making societies more green because they reduce consumption resources and energy. As such dematerialization plays a central role in reconciling capitalist growth and environmental sustainability (Maycroft, 2000; Pellow, 2008).

A dematerialized society, they contend, is one in which economic growth is separated from excessive resource consumption, pollution and unbridled waste production. In this way dematerialization provides a substantial challenge to the dire predictions of the influential 1972 Club of Rome report *Limits to Growth* (1972), which assumed that economic growth would inevitably mean ever more consumption of non-renewable resources. Dematerialization is a key source of hope for proponents of green capitalism as it "gleefully suggests" the marriage of unbridled capitalist growth and environmental sustainability (Maycroft, 2000, p. 143)

Grounding the Cloud (or Taking Digitization Out of the Green Box)

Despite these promises of friction-free economic activity, the digital world is profoundly material. Digitization relies on a complex technological infrastructure. For instance, the experience of being un-tethered is contingent on a material infrastructure that actually constrains the seemingly limitless possibilities of wi-fi. The wi-fi infrastructure includes everything from the router and the computer's wireless adaptor (which are made up of plastic, metal and knowledge, among other things) to the Ethernet cable that connects the router to a system of cables and wires, to radio waves, to electricity, to the people who design, operate, repair and disassemble wi-fi systems.

Analogously, the dematerialization of the economy is only made possible through computing and communication capabilities (Gille, 2007). Increased efficiency, financialization and the rapid, apparently barrier free global market is made possible by often times invisible, yet important technological systems that are simultaneously comprised of knowledge, people, artifacts, environments, cultures and societies.

Moreover, as the growing body of literature on the environmental impact of digitization evidences, the technologies we use to access the apparently virtual, dematerialized world are highly resource-intensive and polluting throughout their entire lifecycles (Kuehr & Williams, 2003; Josh Lepawsky & McNabb, 2010; Pellow, 2007). For instance, environmental engineers estimate that the production of a single personal computer uses over 240 kg of fossil fuels, 1500 kg of water and releases significant amounts of CO2 into the atmosphere (Kuehr and Williams, 2003). Importantly, the resource intensiveness of production extends to labor. Manufacturing of ICT equipment relies on exploitative labor conditions (Moore, 2012; SACOM, 2011). Not only is labor cheap in countries in which resource extraction and production takes place but environmental standards are also often less stringent or not enforced. As a result, the export of production magnifies the social and environmental impacts of production.

ICT equipment is also resource intensive during the use phase. While ICT manufacturers design more energy efficient products every year, net energy consumption associated with ICT use has increased rather than decreased in the last decade as the technologies perform more functions and are more widely used.

Furthermore, while many believe that the Internet has ushered in an era of virtual limitlessness, the environmental dimensions of the web are rarely acknowledged. For instance, the web server farms that enable Internet searches use an exorbitant quantity of energy to run and cool the servers. According to one article recently published in the *New York Times*, worldwide server farms use the energy equivalent to what 30 nuclear power plants produce each year (Glanz, 2012). Anthropologist Jane Ann Morris vividly describes just how resource intensive seemingly friction-free Internet escapades are. She writes,

> At server farms, zillions of complexly linked computers constantly juggle electrons storing messages, texts, songs, web sites, advertisements, film clips, birthday cards and other cultural effluvia. The mission of each server is to prevent captive electrons from doing what all free electrons want to do: dissolve back into the electromagnetic ether to hook up randomly. All that data coded into electronic pluses and minuses enables you, at any moment, to get the latest information about a massacre in Colómbia, a cancer cluster in New Jersey, or the current address of your high school sweetheart. Considerable server effort is devoted to articulating Brad [Pitt]'s dimples. Server farms are double-dippers. There, colonies of warehouses packed with rows of racked, stacked computers draw electricity like black holes suck light. That's the first scoop. Because the heat generated by this conglomeration of circuitry, unless dispersed, will damage the equipment, server farms are air conditioned to a brisk temperature. That's the second scoop. A typical server farm uses at least half of its electricity for cooling. Imagine a refrigerator wrapped around an electric stove, and you have the essence of a server farm: a pig-in-a-blanket that consumes electricity in almost unimaginable quantities. (Morris, 2008)

The desire to underscore the underlying materiality of ICT use has led some researchers to speak of the carbon footprint of internet searches (Leake and Woods, 2009). The argument that Internet searches have environmental impacts is easily extended to capture the environmental impacts of digitalization. In this case, one can refer to the ecological footprint of digitization or, alternately, apply the notion of taking digitization out of the green box.

The concept of the green box builds on the idea of the black box. It draws attention to how environmental language is used to conceal the unmaking of digital technologies as well as the environmental implications that this concealment has. I apply the notion of the green box to discarded computers in Germany in three ways. First, it involves challenging the inevitability of a technology's design uncovering the decisions that have been made—whether explicit or implicit—about how to design computers in regards to their disposability and environmental impact. Exposing the historical and social contingency of ICT design is simultaneously an analytical and political act. It is political because by unsettling the notion of inevitability it makes space for considering alternatives; in other words, computers could potentially be designed in such a way that their disposal would be less environmentally damaging. In addition, taking a digital technology out of the green box involves interrogating why and how historical actors as well as analysts studying digital technologies (including me) become interested in taking the design of computers out of the green box at particular historical junctures.

Second, taking the computer out of the green box means bringing to light computers as imminent environmental hazards. It also involves investigating the everyday discursive and material practices that attempt to conceal the environmental risks associated with computers as waste products and understanding the motivations of the actors who transform obsolete computers in Germany in this way.

Finally, applying green boxing to the laws governing computer disposal and contemporary computer recycling practices, involves bringing to light how environmentalism in the North relies on pollution in the South. These three forms of green boxing are related and continually enable and reinforce each other. Drawing attention to the material underpinnings of digitization takes digital technologies out of the green box in all three senses of the term.

In brief, as the literature that takes digitization out of the green box evidences, the narrative of dematerialization through digitization—the idea that digital technologies facilitate untethered, resource-less and hence more environmentally sustainable societies, is "naïve and specious" (Maycroft, 2000, p. 143) at best and dangerous at worst (Bridge, 2009; Grossman, 2007; J. Lepawsky & Billah, 2011; J. Lepawsky & Mather, 2011). The supposedly virtual world is anchored in a complex and resource intensive system that is simultaneously social, cultural, political and material, in both an organic and an inorganic sense of the term (Pritchard, 2011). Importantly, scholarship on the socioenvironmental basis of digitization has, until recently, maintained a narrow focus on the production and use phases of ICT equipment. However, as I have argued throughout this dissertation, the resource-intensiveness of digital technologies is not limited to its functional lifetime but extend throughout a technology's lifecycle: production, use, and *unmaking,* which themselves form a seamless continuum.

Regimes of Perceptibility

Michelle Murphy's notion of regimes of perceptibility is a useful tool for analyzing the invisibility of the material basis of digitization and the other invisibilities I have written about in the previous chapters. In her book, Sick Building Syndrome and the *Problem of Uncertainty: Environmental Politics, Technoscience, and Women Workers* (2006), Murphy introduces the concept of "regimes of perceptibility."[135] She uses the

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[135] Other fields also engage with notions of regimes that are applicable to my discussion of e-waste. For instance, the food regime literature (Friedman & McMichael, 1989; McMichael, 2009) focuses on the ways in which food and agricultural systems reinforce and shape the world capitalist system. This perspective could be applied to waste in the sense of examining how waste and processes of unmaking maintain systems of capital accumulation. Though I do not directly engage with the food systems literature, I address this question in the section of this chapter. Perhaps more importantly, Zsuzsa Gille's (2007) concept of waste regimes is also relevant to my work. Gille's concept represents an attempt to move away from what she refers to as "a too-rigid, mode-of-production-type" approach to studying

concept to underscore the partial and incomplete character of scientific and lay interpretations of the phenomenal world. Murphy contends that actors and analysts work within regimes of perceptibility, and as such, some things are visible while others remain imperceptible (Murphy, 2006, p. 10, Hecht, 2009b, p. 899;).

What distinguishes Murphy's concept is her emphasis that regimes of perceptibility extend beyond the conceptual level. The regimes she writes about are "assemblages of social and technical things" (*idem*). In other words, the blind spots associated with a particular regime cannot merely be dispelled through additional information and increased awareness. Historical actors' and analysts' beliefs about what is real and what is imagined crystallizes into material structures and objects. Physical objects and structures, in turn, set the parameters of what kind of information actors can collect, thereby reinforcing common perceptions of what is real and what is not (Murphy, 2006, p. 24).

For instance, Murphy explains that in the case of sick building syndrome there were few tools or concepts to measure people's (often women's) experience of this condition.[136] Consequently, for a long time their complaints were dispelled as imagined and illegitimate because they could not be measured. Yet, at the same time,

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waste. Instead, the concept simultaneously underscores the "production, representation and politics of waste." Like Murphy's regimes of perceptibility, Gille's concept explicitly transcends the rigid binaries between meanings. It also allows for spatial and temporal comparisons of various waste regimes. I choose to use Murphy's concept, however, because I am interested in narrowing in on issues of visibility/invisibility. I plan to explore the ways in which my research on the unmaking of digital technologies builds on and reworks understandings of food regimes and waste regimes in future publications.

[136] The US Environmental Protection agency defines sick building syndrome as a condition in which "building occupants experience acute health and comfort effects that appear to be linked to time spent in a building, but no specific illness or cause can be identified. The complaints may be localized in a particular room or zone, or may be widespread throughout the building." These symptoms include "headache; eye, nose, or throat irritation; dry cough; dry or itchy skin; dizziness and nausea; difficulty in concentrating; fatigue; and sensitivity to odors" (Hanie, Aryan, MohammadReza, & Elham, 2010)

the tools to measure and study this illness remained unavailable as sick building syndrome was deemed the invention of hypochondriacs.

In her envirotechnical analysis of the Rhône, Pritchard develops Murphy's concept further by including technologies and landscapes in her discussion of technological regimes, thereby emphasizing additional dimensions of the materiality of regimes. She writes "The material manifestation of a regime helps to sustain—perhaps even naturalize, both literally and metaphorically—the authority and interests of that regime, thereby making it more difficult to challenge" (Pritchard, 2011, p. 23). Hence, regimes of perceptibility shape material constraints, and these material constrains, in turn, reinforce such regimes.

Importantly, regimes of perceptibility go beyond the descriptive. The word regime draws out the values, politics and ideologies in which dominant regimes are embedded and which they reflect and reinforce. Furthermore, there is always struggle over which regimes of perceptibility become dominant. Thus analysts can engage with and analyze uneven power relations and interrogate normative assumptions regarding the status quo. Put plainly, Murphy's regimes of perceptibility allows the analyst to interrogate *what, by whom, how and why* things are hidden.

Imperceptibility of E-waste

One way to think about the previous chapters is to see them as an analysis of numerous imperceptibilities—imperceptibilities at the epistemological, methodological and empirical level. From this standpoint, the conceptual and epistemic project of this study has been to explore the causes and consequences of the absences I write about. The theme of invisibility goes hand in hand with waste.

Popular texts on garbage often evoke the tropes of mystery, hiding and danger. From Heather Roger's *Gone Tomorrow: The Hidden Life of Garbage* (2005) to Elizabeth Royte's *Garbage Land: On the Secret Trail of Trash* (2005), popular texts emphasize that it is not only that objects, once they are transformed into waste, are whisked away with little knowledge on our part as to where they go, but also that gaining access to waste and sites of waste processing is often challenging, if not dangerous. Once we place our rejected objects on the curb they seem to vanish without any idea of who handles them, how they are processed or where they go.

Academic engagements with waste echo these popular observations. For instance, the first chapter of historian Martin Melosi's seminal book *Garbage in the Cities* is entitled "Out of sight, out of mind." This title foregrounds the imperceptibility of waste (Melosi, 1981). Moreover, sociologists and anthropologists explain that individuals and groups often go to great pains to hide their waste and prevent others from rummaging through it (Åkesson 2006: 42). Waste is associated with marginalized communities and criminality. It is something secret, private, dirty and hidden, a "public secret" (Hawkins, 2003 quoted in Moore, 2008) and a moral failing. As a result, refuse is largely imperceptible in our day-to-day lives (Åkesson, 2006, p. 42, Hawkins and Muecke, 2003, p. xiv, Moore 2008, p. 602).[137]

The association between waste and concealment extends to my analysis of e-waste in Germany. *What* is hidden? In addition to e-waste itself and the various sites of its unmaking, in Chapter 1, I argued that the concept of waste and the relationships between making, made and unmaking remain largely imperceptible. Reintroducing these themes opens up new frontiers for social scientific analysis. Specifically, reconnecting the making, made and unmaking extends and reworks concepts such as

[137] Journalist Heather Rogers writes, "Each garbage collection system, transfer station, recycling center, landfill and incinerator is an expensive, complex enterprise that uses the latest methods developed and perfected at laboratories, universities and corporate campuses across the globe. An examination of this accumulation of technological innovation, scientific inquiry and geological and atmospheric study, coupled with unrelenting, disciplined public relations, community outreach and education, reveals much about this society's priorities" (Rogers, 2005, p. 26). See also Dominique Laporte (2002) for more on the role technologies play in rendering waste invisible.

the black box, fetishization, materiality, technological lifecycles, and technological systems. Chapters 2 explains that the discourse around e-waste often ignores the global context in which the unmaking of digital technologies is embedded. In other words, the second chapter engages with methodological state centrism—that is, the tendency to use the state as a natural or given unit of analysis—as a form of camouflage.

In the third chapter, I addressed two additional concealments. This chapter focuses on how environmental economists have attempted to reverse the invisibility of the social and environmental costs of production, consumption and unmaking—or what they refer to as externalities—through market-based environmental e-waste policies. However, these strategies render other relationships and processes, specifically the thriving informal sector and the uneven global geography, imperceptible. This chapter also examines what actors and analysts leave out in their engagements with the e-waste problem. With the exception of a few supposedly "radical" individuals, the issue of e-waste is never talked about as a problem of consumption or of capitalism.[138] Instead, a lot of energy is invested in framing e-waste as a technological problem necessitating a simple technological fix. This techno-fix discourse suppresses the socio-political origins of the e-waste issue (Rogers, 2005, p. 96).

The process of creating value out of discarded digital technologies is far from straightforward and easy, as is often implicitly assumed in discussions of the throwaway society. In Chapter 4, I exposed the complex hidden social life of discarded technologies and analyzed the process of unmaking. I argued that the act of unmaking is riddled with conflict and contestation, and thus worthy of social scientific

[138] The individuals who point out the connection between the current waste problem and mass-consumption as viewed as 'radical' is itself a kind of elision.

analysis. Moreover, I criticized the tendency to elide how e-waste's materiality shapes the struggle over the e-waste stream.

In Chapters 5 and 6 I engaged with the issue of transnational movements of e-waste. Specifically, in Chapter 5 I contended that the three dominant interpretations of export—the dumping, leakage and comparative advantage narrative—represent strategic social constructions of e-waste and global networks of unmaking. These three dominant discourses emphasize and hide different dimensions of e-waste—a particularly malleable object—in order to further their interests.

Chapter 6 deals with the loopholes and leakages in existing local, national, regional and international regulatory systems that enable e-waste export despite efforts to the contrary. The majority of policymakers, academics and industry representatives who are working on solving the problem of e-waste export see the loopholes I outline in Chapter 6 as individual issues necessitating techno-bureaucratic solutions. I contended that addressing each loophole and leakage according to this view will yield limited results. As long as policymakers ignore the larger phenomenon—the outcome of the tension between national formulations of environmental policies in a deeply interconnected and uneven global system—there will unlikely be any meaningful and long lasting solution to the problem of transnational movements of e-waste. Finally, the first section of the conclusion drew attention to the hidden socio-material infrastructure that undergirds the seemingly ethereal cloud.

In sum, as a whole, my research challenges two key disappearing acts. The first consists of the concealment of the complex social, material, political, economic and environmental afterlives of digital technologies. The second is the tendency to overlook the uneven global division of labor and ecology that undergirds systems of ICT making and unmaking. Following Murphy, an analysis of regimes of imperceptibility is incomplete without addressing the questions of "who," "how" and "why" things are hidden.

Who is hiding e-waste? As I describe in the previous chapters, a wide range of actors are involved in creating competing regimes of perceptibility pertaining to e-waste. These include academics, journalists, policy makers, government officials, informal waste handlers, NGO workers, activists and industry representatives.

How do these actors render e-waste or dimensions of it imperceptible? By whisking e-waste away. By heavily guarding sites of e-waste transformation. By exporting the process of unmaking to the global South. By selectively socially constructing e-waste as a valuable good or toxic bad. By using vague and contradictory classification systems that make it nearly impossible to obtain reliable data on e-waste and its global flows. By framing of the problem of e-waste as a techno-bureaucratic issue necessitating a technocratic fix. And finally, by hiding server farms and perpetuating the idea that digitization's material basis is immaterial.

The Why

The invisibility of the material basis of digitization in general and of the process of unmaking in particular is significant. As this dissertation shows, particular actors construct the regime of perceptibility of e-waste for particular ends. For instance, as discussed in Chapter 3, environmental organizations like the Basel Action Network frame e-waste as a toxic bad—hiding its value—in order to stop its export. Alternately, advocates of the Best of Two Worlds problem, which promotes a regulated global division of labor in e-waste unmaking, normalizes and thus elides the causes of low labor costs in the global South as a means to ensure maximum profit for multinational recovery firms. Importantly, the invisibility of e-waste, its characteristics and the process of unmaking are not natural or given. As anthropologist Lynn Åkesson writes "Lots of cultural energy is used to keep the hidden and disgusting at distance"

(Åkesson, 2006, p. 44). Not only cultural energy but also "vast resources [are] channeled into getting rid of our dead commodities" (Rogers, 2005, p. 11, see also p. 26).

Analyzing patterns of visibility and invisibility as they pertain to digital technologies offers insights into the value systems and power arrangements dominant in the particular society and historical period under examination. Thus, the questions follow: What explains this active investment in keeping e-waste out of sight and out of mind? How are we to understand the lack of knowledge about the materiality and afterlife of the technologies we use? How and why do actors and analysts systematically black box or mystify the unmaking of technologies? What are the analytical and political consequences of this concealment? In what ways does the camouflaging of e-waste, its making and processing, the people who handle it, and the environmental and social effects of its disposal, mystify and thus uphold uneven power relationships? In brief, what explains this lack of "direct sensuous engagement with the material world" that is so pervasive today in regards to the digital revolution (Maycroft, 2000, p. 158)?

We must note, however, though regimes of perceptibility are dominant, they are not total. There are always competing narratives, forms of resistance, and critiques of the dominant vision of objects and social orderings. The same is true for e-waste. In the last few years, the processes of making and unmaking have increasingly become visible. The popularity of local food movements and "made in the USA" campaigns signal a growing awareness of and interest in the provenance of commodities. These movements reconnect the making with the made. Similarly, the growing media, NGO and policy attention to e-waste signal a move to reconnect the made with unmaking. While the people who write about e-waste talk about it as hidden, their collective works are in fact proof of waste's growing visibility. That e-waste is becoming increasingly perceptible is simultaneously a signal of a particular historical moment in which the dominant ideologies, values, power relations and infrastructures are being challenged and a window onto those changes. Specifically, the visibility of waste unsettles three narratives: the dominant narratives about modernity, North-South relations and capitalism.

Waste and Modernity

Waste represents the "abject of development" (Moore, 2008, p. 604). It is precisely because waste supposedly constitutes the antithesis of modernity that many cities introduced high-tech sanitation systems during the nineteenth century. The drive to create modern metropoles went hand in want with efforts to render waste invisible, as argued in Maria Curter's history of waste in Berlin, as well as other works on the waste crisis of the 1900s (Strasser, 1999, Barles, 2005). In 1871, Wilhelm II decreed that no waste should be visible in Berlin as the metropolis of the newly formed German Empire needed to be clean and modern. It is for this reason that in 1895 the police decreed that all wastes—including industrial and household garbage, ashes, slag, excavated materials, debris, sweepings, dirty snow, kitchen and meat wastes, bones, rags and so forth—would have to be transported in completely opaque containers (Curter, 1996, p. 25). Other cities did the same during this period.[139] To this

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[139] In *The Sanitary City*, Martin Melosi notes that there has long been a connection between cleanliness, beauty, and order and that the desire for these in urban areas has been a contributing factor in the development of urban infrastructure (Melosi, 2000). Similarly, in *The History of Shit,* Dominique Laporte argues that the articulation of such ideas goes back as far as Rome's sewer system, which was considered not only a technological achievement, but also the 'height of civilization" (Laporte, 2000 in Moore, 2008, p. 599). As Hawkins explains in reference to urban sanitation programs, **"**Here was a technology that would purify urban space, that would allow populations physical and moral escape from the unacceptable (Hawkins 2003:40, quotes in Moore 2008: 599). Importantly, though waste management systems did not eliminate waste altogether, they transformed waste into a technical problem, out of the sight and mind of ordinary citizens. At the same time they marginalized the scavenger and waste handler, if not rendered them obsolete. In this way, the establishment of formal waste management rendered refuse and civilization more compatible. As geographer Sarah Moore writes in her study on modern scavengers in Oxaco, not only is waste processed in marginal spaces but

day, the idea of a modern Germany is connected to the imperceptibility of waste. Germany prides itself on being clean and green, hosting one of the world's most efficient and effective waste management systems.

The invisibility of waste is thus part of a larger phenomenon in which being modern is associated with being disconnected from the material basis of life. As anthropologist Argyrou writes: "At the most general level, the vision of the world in which litter appears to have no place presupposes a certain relation with the world. It is a relation in which one does not need to grapple with the world physically because, given the division between mental and manual labor, the economic necessity to do so has been effectively neutralized" (Argyrou, 1997, p. 160). This, in turn, perpetuates the idea of mastery over nature as the pinnacle of civilization (Argyrou, 1997, p. 159). In brief, fundamental to the narrative of modernity and development is the assumption that we live in an era in which modern societies have transcended the material.[140] In fact, it is not just that people in their daily lives ignore the material, but that modern social theory is predicated on the idea that the social and environmental are separate (Latour, 2004).

"the people who formed the squatter settlements around the dump are seen not as speaking subjects in Kristeva's terms, but rather as abject others who pose a threat to the more civilized citizens of the central city" (S. Moore, 2008, p. 604). See also Donald Reid's *Paris Sewers and Sewermen: Realities and Representations* (1991)

[140] A derivative of this dichotomy is the assumption that the technological and the environmental are separate, discrete entities. Here the crisis of e-waste makes plain that we cannot separate the technological and natural. Attention to e-waste re-embeds technologies environmentally by challenging the notion that the digital revolution will lead to more virtual, de-materialized, and therefore, more sustainable societies. Instead, we focus on what journalists and activists refer to as the "dark side of the digital age" (Mayfield, 2003) which brings to light that high-tech lifestyles are not detached from the environmental (Kuehr and Williams 2003; Lepawsky and McNabb 2009; Pellow 2007). E-waste demonstrates that far from enabling the transcendence of the environment, technologies are environmental themselves (e.g. Pritchard, 2011). Computers, iPods are ultimately made of nature. Furthermore, their use and disposal are socio-environmental processes. They have environmental impacts. They shape the landscape.

The invisibility of digital waste in particular plays an important role in maintaining this conception of modernity. Understandings of modernity and the consumption of electronic technologies often go hand in hand. For instance, Pellow (2008, p. 227) writes that India's quest to modernize largely translated into increased consumption of ITC technology. Often technology is treated as a synonym for ICT equipment.[141] The reason that we conjure up images of high-tech digital technologies when we think of modern societies is partially because these technologies make it possible for us to dissembed, at least at first glace, from space and time. According to sociologist Anthony Giddens this dislocation is the defining characteristic of modernity (Giddens, 1981, 1984). Dematerialization in this sense is taken as proof that humankind is not only modern, but has developed to the point of becoming omnipresent and all knowing. Geography, temporality, biology—most, if not all, physical and material constraints to human existence—appear to have become irrelevant for social life. The visibility of e-waste, in turn, poses a particularly potent threat to modernity. Images of polluted e-wastelands littered with the innards of ICT equipment represent the dark side of the digital age. These images directly confront notions of friction-free, untethered digital technologies and draw attention to the environmental consequences of digitization.

Importantly, the idea of the social as separated from the environmental is historically specific. The rift between the social and the material is contingent on the economy—during economic downturns people become more aware of the material underpinnings of their lives. Geographer Gavin Bridge maintains that between the 1970s and the late 2000s the material basis of modern lives was largely invisible. This changed with the global financial crisis of 2008. Using the example of indium, which

[141] I am grateful to Sara Pritchard for pointing this out to me.

is vital for the manufacturing of LCD monitors, Bridge explains, "Rising raw material prices brought the material underpinnings of economic activity sharply into focus, exposed the economic and political geographies of resource flows, and drove a renewed debate about the relationship between economic growth and the availability of key resources" (Bridge, 2009, p. 2). Thus, following Bridge, we see that the visibility of e-waste signals that we are entering a particular historical juncture in modernity, where the longtime invisible material basis of social life is starting to come sharply into focus.

The Perceptibility of Waste and North-South Relations

The imperceptibility of waste and waste handlers, particularly informal ones, not only perpetuates the image of cities such as Berlin as clean, green and modern, but also reinforces the image of Northern metropoles as modern and sustainable *in opposition to* Southern cities. This is not merely an issue of representation and images. In fact the global political economic system makes it possible for Germany to export the most socioenvironmentally costly aspects digital technologies' lifecycles; the making and unmaking of German ICT equipment is mostly outsourced to countries in the global South.

The German government official I wrote about in Chapter 3 illustrates that the invisibility of waste and the people who handle it continues to be important for perpetuating Germany's identity in opposition to other places. To recall, the official stated, "The problem in Germany is that we can't imagine, let alone accept, that we have an informal sector. We can see informality in developing countries. We can even accept that there is informality in France, but not Germany" (personal communication, March 4, 2010). Here, the official underscores that any type of waste that is not sanitized through modern, high-tech handling systems and any form of informality—in this case the people who handle this unsanitized waste—is inconceivable because it challenges the idea of Germany as the apex of civilization in opposition to other places.

Much like the modernist severance of the social and the material, the tactic of displacing the problem of consumption spatially (through export) and temporally (through landfills) is beginning to come undone. Temporal displacement through landfills was the initial mechanism to handle waste. However, Germany, like many other countries, quickly ran out of space for landfills and so the act of temporal displacement was supplemented and sometimes even replaced with spatial displacement—that is, export. Export has become increasingly untenable because waste importing countries are running out of space. In addition, global awareness about the social and environmental harm caused by waste has risen, as the people in these countries are pushing back, thanks largely to the communication possibilities afforded to them by ICT equipment. As discard studies scholar Max Liboiron explains, we often say that rubbish is thrown "away." Yet these spaces of away—be they landfills, ocean floors or the atmosphere—are diminishing (Liboiron, 2013).

Not only that, but we are living in a moment in which the environment is "biting back" (Latour, 2000). The effects of years of pollution are becoming ever more apparent in the form of climate change and flows of toxins. As images of dumping grounds in the South circulate back North, so too are the toxins that were exported. For instance, pollution in an estuary in Ghana next to the informal e-waste dumping ground in Agbogbloshie market returns to Europe through fish. Plastics recycled from discarded computers in China are used to make water pipes and toys, which are then exported back to Europe. Disused electronics sent to Nigeria or Ghana to disappear are not lost; instead savvy locals collect hard drives and glean the sensitive data they contain to their advantage. During my research in Ghana, for example, I found hard drives from the US Army and the UK NHS with the sensitive information unencrypted and easily accessible.

By "erode[ing] some of the distinction between the civilized and the uncivilized that became the basis for modern urban citizenship. . . ." (Moore, 2008, p. 601), the perceptibility of e-waste threatens the dominant representation of the global topography in which countries in the North are modern, high-tech, clean and green, and Southern countries are backward, informal, dirty, polluted and virtually "off the map. " Rather than see these two hemispheres as discrete units, recent attention to waste flows unsettles narratives of separation. It makes visible the many ways in which the North and the South are profoundly intertwined and coproductive.

The Perceptibility of Waste and Capitalism

The imperceptibility of e-waste supports the idea that capitalism is an effective and just way of organizing the world's economic activities. Marxist environmental sociologists have for a long time drawn attention to the negative social and environmental consequences of capitalism. Unbridled consumption depletes resources, production causes pollution, and the mountains of waste created during production, use and unmaking are immense and often toxic. Many argue that direct confrontation with these socio-environmental consequences of capitalist relations could, at least in theory, work as feedback mechanisms to curb consumption and challenge the capitalist system (Liboiron, n.d.). This holds particularly true for garbage, as it represents the "visible interface between everyday life and the deep, often abstract horrors of the ecological crisis" (Rogers, 2005, p. 3). The logic is that if people saw, smelled, tasted and felt the garbage they produced and were aware of how their consumption patterns were based on the exploitation and ill health of vulnerable populations and environments, they would start to question their lifestyles and capitalist social relations. There would be a drive to consume less and a demand for the restructuring of relations of production so that the drive for profit would not supersede all other values. This is particularly true for digital technologies, as they are now so profoundly integrated into our daily lives. Thus, rather than see pollution as something "out there and disconnected from (people's) daily routines" a focus on e-waste helps us see that the environmental consequences of unbridled consumption of ICT is an everyday issue, one that is intimately connected to our mundane individual lives (Pellow, 2008, p. 225).

In addition to temporal and special displacement of the problem of e-waste, sanitization of unmaking has weakened the feedback mechanism between waste and capitalism. As historian Joel Tarr explains for the United States, only during the crises period of 1960s and 1970s did Americans link the waste problem to affluence and mass-consumption. However, even then they "were still trying to learn how to manage the solid waste problem, not solve it" (Tarr, 2005, p. 16). Tarr's distinction between managing and solving the waste problem is crucial here and applies to e-waste as well. The mountains of e-waste scattered around the world could be interpreted as a problem with consumption. Most often, however, policymakers and industry representatives quickly redefine the problem of e-waste as a logistical or technical matter necessitating a bureaucratic or technological "fix."

As I discuss in Chapters 6, the United Nations' Solving the e-waste problem (StEP) program concentrates much more on managing the problem of e-waste than on addressing the underlying issues that are causing it. The StEP members, German government officials and even NGOs representatives I interviewed, engaged very little with the option of reducing consumption, extending product lifetimes, reusing and repairing. Though these "solutions" could potentially make a significant impact, they remain imperceptible. Within this regime of perceptibility, the images of e-waste are translated to fit the dominant narrative in which consumption and environmentalism are compatible and any challenge to capitalism is not even considered or discussed. Instead powerful actors with interests in maintaining the capitalist status quo reconfigure the problem of waste in general and e-waste in particular as a technocratic, apolitical problem to which there are only technoscientific, market-based solutions.

While Germany's official waste policy places reduction and reuse at the top of its environmental waste policy, recycling—basically a management strategy—takes precedence in practice. [142] In fact, to recall, whenever I mentioned strategies for waste minimization such as decreased consumption, longer product lives and reuse, most of the individuals I interviewed, including representatives of environmental NGOs, dismissed these ideas as naïve impossibilities. In narrowing the parameters of the debate over e-waste in this way, these actors leave little room to question capitalism's role in creating the waste problem. As Rogers writes, "the social, political and financial power that drives ever-more sophisticated attempts to annihilate discarded commodities is staggering. The more efficient, the more 'environmentally responsible' the operation, the more the repressed question pushes to the surface: What if we didn't have so much trash to get rid of" (Rogers, 2005, p. 26)? In this case, we are again talking about a regime, in the sense that the terms of what is "realistic" are being defined very concretely by the state and individuals in positions of power for particular purposes.

Finally, e-waste's materiality is yet another dimension of the particular historical juncture in which we currently find ourselves. E-waste is not simply abundant, but is also materially complex. A product of late capitalism, this modern refuse is highly toxic. Unlike kitchen waste, for example, this waste cannot be easily cycled back into the environment. As Gille explains, modern waste is not merely

[142] Here recycling refers to the dismantling of equipment to retrieve raw materials whereas reuse refers to extending the life of still-functional technologies by promoting second-hand use.

characterized by its abundance, but also by its physical properties. She writes, "it is the complexity of linkages, both among different scales and among different materials in circulation, that renders today's waste problems so much more daunting than they were for the nineteenth-century sanitary movement (Melosi, 1981; Tarr, 1996). This complexity therefore is of a hybrid nature; it is the convergence of ever-more numerous and complex materials, today's means of communication and exchange, and the new social structures that facilitate today's unprecedented global connections" (Gille, 2007, p. 27). E-waste in many ways represents the apex of modern waste in that it is highly complex and highly toxic. This form of waste is an expression of the developing capitalist system, which, in its pursuit of newer frontiers of commodification, not only produces successively more quantities of waste in successive eras, but also more toxic waste.[143]

Conclusion

Dematerialization—the idea that we have detached from the physical world—is not only analytically inaccurate, but also socially, politically, economically and environmentally destructive. The notion of dematerialization is analytically problematic because it green boxes key socio-environmental relationships that are at the foundation of digitized and seemingly virtual modern existence. The concealment of the material basis of social life functions to make us blind to the social and environmental inequalities on which our social system is based (Martinez-Alier, 2009, p. 1100). Further, the assumption of dematerialization hides the fact that increasing global reliance on digital technologies, at least in the form they take now, is actually

[143] As world historical political economists, Jason Moore explains, "it is not only that every phase of capitalism is produced by a new bourgeoisies, but also that every phase of capitalism produces qualities and quantities of waste/codification that are historically specific and cumulatively mounting" (Personal communication, May 5, 2012).

counterproductive to environmental sustainability (Hilty et al., 2006, p. 1618). In contrast, taking the virtual out of the green box and analyzing the socioenvironmental process of unmaking brings politics back it; it exposes and challenges these inequalities.

Importantly, I am not suggesting that e-waste is at the center of the crisis of modernity, North-South relations and capitalism. Rather, it is one of many symptoms, a lens onto a larger process. This crisis in the narrative of separateness extends beyond the issue of waste. In fact, it would probably be more accurate to say that the issue of e-waste is a partial manifestation of a larger phenomenon in which modern capitalist society's bad checks are starting to bounce. Perhaps the biggest and most obvious bad checks are exposed through climate change, the economic crisis and the growing resistance of the world's poor.

Still, over the past two decades, there has been a slow, yet pervasive "penetration into our daily lives of almost invisible technological gadgets" (Trinova, 1996, p. 167 cited in Bakker & Bridge, 2006, p. 16). It follows that tracing the second-life of such intimate technologies is a powerful way to link the everyday with larger global trends and processes. Waste is not just about waste. It is a critical lens onto society's "larger values and priorities" (Tarr, 2002, p. 8). The act of wasting is a transformative and transforming process (Åkesson, 2006, p. 39). During this process priorities are set, social orders are re-created, values are articulated, identities—both individual and collective— and relationships are forged (Gregson et al., 2007, pp. 4, 19, 25). Waste also makes the historical changes in classification and their relationship to larger social transformations visible (Lucas, 2002, p. 10). In addition, waste represents a powerful way to think about the relationship between humans and nature. As Heather Rogers explains,

> Through waste we can read the logic of industrial society's relationship to nature and human labor. Here it is, all at once, all mixed together: work, nature, land, production, consumption, the past and the future. And in garbage we find material proof that there is no plan for stewarding the earth, that resources are not being conserved, that waste and destruction are the necessary analogues of consumer society. (Rogers, 2005, p. 3)

At the same time, e-waste, or rather computers, networks and cell-phones, enable the global poor to push back against the system and allow researchers such as myself to discover the interconnectedness of the global system.

This dissertation has sought to increase understandings of the afterlives of digital technologies. Beyond this, my goal has been to connect that which is continually conceptually disassociated. It underscores the co-productive interaction between technologies and environments, in terms of the resources needed to manufacture and use them, as well as in terms of the social and environmental impact of their afterlives. It also reconnects the made with the unmade, making and unmaking, people with things, green landscapes with toxic e-wastelands, and the affluent high-tech lifestyles in the global North with the impoverished, poisoned existence in certain parts of the South.

In reconnecting that which has been disconnected and thus making visible that which has been hidden, my goal has been to help unearth the sources of our current e-waste problem. It is my hope that exploring the fissures and cracks in the existing system of unmaking of discarded digital technologies will support efforts to create socially just and environmentally sustainable solutions to the growing problem of e-waste.

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