



How Old Technologies Became Sustainable

An Introduction

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Why bring the story of cycling and recycling together in one frame to understand and analyze how history can help us move toward more sustainable societies? Do the histories of commuting by city bikes and recycling of used bottles have anything to do with each other in the transition to sustainability?

On the surface, the idea of combining the history of waste treatment and recycling with the history of cycling and mobility seems like a bold undertaking. Today's discussions about sustainable technologies tend to focus on finding new solutions to pressing environmental challenges. The belief and hope that technological innovations will offer an escape route from impending ecological collapse is as pervasive as it is appealing. The belief in "green tech," for example, promises to avoid back-to-nature traditions, which some environmental activists have embraced as sound and sustainable, but is ridiculed by their opponents as sentimental and untenable. In this volume, however, we examine alternative debates. Our *Re/cycling* concentrates on the notion of transitioning to a more sustainable future by resurrecting older technologies for a new purpose. We explore the intriguing histories of two technologies that were advanced almost fifty years ago as important tools for a more sustainable future: cycling and recycling. As we argue, the two technologies have more than merely etymological similarities.

From the traditional viewpoint of the history of technology, waste treatment and bicycle production seem to have little in common. When approaching the same subjects from the perspective of consumers of goods and users of technology, however, we find that they are interrelated—certainly in practice, if not in theory. In the late 1960s and early 1970s, environmental activists mobilized older rather than newer technologies as political tools to save the planet. At the time, the revival represented a deliberate act of resistance to the politics of economic growth. Consumer activists demanded that glass bottles be returned to manufacturers. Cargo bikes were appropriated as an alternative to automobiles. Windmills were invested with the hope that they would one day replace nuclear power plants. Once ridiculed as hopelessly outdated, old technologies

were deliberately embraced: they were revived through repurposing them into new uses and having new meanings reassigned to them.

In resurrecting older technologies for a new purpose, the rebelling consumers and users of the 1970s were pivotal in a movement that quickly became transatlantic and transnational. Many environmentalists in Europe and beyond found inspiration in their counterparts in the United States.¹ The influential San Francisco Bay Area entrepreneur Stewart Brand and his Whole Earth network, for example, placed the greatest hope for the environment on technology users. Brand advocated a do-it-yourself culture and believed in the transformative power of relevant technology. *The Whole Earth Catalogue: Access to Tools*, the first edition of which was issued in 1968, was a kind of shopping catalogue for the environmental movement: from educational instruments such as books, maps, and courses to well-designed, special-purpose utensils such as garden tools, welding equipment, and hiking gear. It listed tools for a just and sustainable society available on the market and offered people access to these instruments.² The reader could “find his own inspiration, shape his own environment, and share his adventure with whoever is interested.”³ The catalogue’s mission was based on the ethic of do-it-yourself crafting, tinkering, and self-reliance; low-tech and high-tech tools as well as old and new implements were all part of the same universe.⁴

The do-it-yourself practice was also part of a new theory of appropriate technology. Originally defined by economist Ernst Friedrich Schumacher in his book *Small is Beautiful: A Study of Economics As If People Mattered* (1973), appropriate technology is an ideological movement believing that technological choices and their applications should be small-scale, decentralized, labor intensive, energy efficient, environmentally sound, and locally controlled. In the same spirit, the nascent British environmental movement published do-it-yourself books like the *Consumers’ Guide to the Protection of the Environment*, which teaches consumers how to organize recycling clubs. Another publication, the *Environmental Handbook*, suggested that consumers should mobilize the law and rely on “maintenance and repair of existing products” instead of buying into the consumer-society logic of “planned obsolescence.”⁵

The belief in low-tech and repair practices has endured and recently revived. In California’s Bay Area, the Maker Faire movement, founded by *Make* magazine in 2006, promotes environmental resilience through a low-tech, do-it-yourself culture. In Africa, events were organized in cities like Accra (Ghana), Nairobi (Kenya), and Cairo (Egypt) to embrace “arts, crafts, engineering, science projects, and the do-it-yourself mindset.” We find similar ideas in the Repair Café Foundation, initiated in 2009 by the Dutch former journalist Martine Postma, who inspired like-minded activists to create their own Repair Cafés in many European and American cities. Other grassroots movements provide open access to technological platforms, like fab labs (fab-

rication laboratory) and the Open Source Ecology network. These green tech initiatives all utilize old and new methods to generate low-tech and low-carbon technologies that users can apply in order to serve their communities and the planet. They are also a testimony to the long-lasting effect of the 1970s movement. It begs the question, however: to what extent does the 1970s represent a break with the past?

Historicizing Sustainability

Contemporaries—and others since then—experienced the 1970s as ground zero for the planet, as a sudden and seismic rupture in history, as if everything that had happened before was merely relegated to history in the face of the awful future threatening mankind. The 1970s were culturally reframed as radically different from earlier decades. At the same time, the period witnessed the celebration and resurrection of older practices and technologies, suggesting continuities to rather than a radical break from the past. Indeed, recently there has been an interest in recovering older notions of sustainability.

In 2013, nearly every town in Germany staged a day, if not a week, of sustainability (*Nachhaltigkeit*) in celebration of the “Year of Sustainability,” commemorating the three-hundredth anniversary of the publication of Hans Carl von Carlowitz’s *Sylvicultura oeconomica or the Instructions for Wild Tree Cultivation (Sylvicultura oeconomica oder Hausßwirthliche Nachricht und Naturmäßige Anweisung zur Wilden Baum-Zucht Anweisung zur wilden Baum-Zucht)*. For example, in the small town of Püttlingen, in the country’s western state of Saarland, events such as the designing of apiary-friendly gardens to fight the devastation of the dying bee colonies were held. German communities embraced the mining officer Carlowitz as the true inventor of the term *sustainability*—as Germany’s gift to the current global debate⁶—although he may seem like an unlikely hero for today’s environmental challenges. Before *Sylvicultura oeconomica* was published in 1713, he had been managing mines on behalf of the Saxon court in Freiberg for decades, when he observed the dire impact of timber shortages on the metallurgy industries. For him, “sustainable use” of a forest can only be achieved if one refrained from extracting more wood than can be regrown through reforestation management and without destroying the precious resource in the long run. Current public debates on energy transition and climate change have claimed a straightforward causal link to Carlowitz’s work and his term *Nachhaltigkeit*—coined at a time when enlightenment was still in its infancy and mercantilism rather than modern capitalism ruled economic affairs. Yet, there has never been a direct link from Freiberg in 1713 to Rio in 2012, from *Sylvicultura oeconomica* to the recent *Report to the Club of Rome 2052*.⁷

Moreover, as historian Richard Hölzl explains, the emergence of sustainability in German scientific forestry has been a contested story from the start: “Focusing on timber production and financial revenue for the state treasury, scientific forestry simplified the biological composition of forests, re-organized their internal structure along the lines of legibility and accountability, and restricted access for users other than scientifically trained personnel.”⁸ For one, the scientific mode of forest management met local resistance and clashed with the vested interests of other groups in society. It turned out that “sustainable” forest management increased the vulnerability of forest environments to droughts, storms, and forest pests. In the tradition of Carlowitz, sustainability transformed nature into a commodity that could be measured, registered, accounted, and taxed.

Sustainability in the sense of turning nature into a commodity promoted ideas of rationalizing and standardizing the natural world, as James C. Scott observed in his seminal study on the emergence of modern statecraft.⁹ Furthermore, such a high-modernist viewpoint that sees the world through the eyes of state power clashes with the widely accepted definition of sustainability as “meeting the needs of the present without compromising the ability of future generations to meet their own needs”—a formulation we owe to the United Nations’ 1987 Brundtland Commission. Neither Gro Harlem Brundtland nor Dennis L. Meadows and his coauthors of the *Limits to Growth* report for the Club of Rome of 1972 knew anything about Carlowitz. In forestry science, Carlowitz’s concept of a sustained yield continued to be highly esteemed internationally: the 1951 UN Food and Agriculture Organization (FAO) report, entitled *Principles of Forest Policy*, states that it would take another two decades before the internationally accepted term of the forestry profession “was to serve as the blueprint for the universal concept of ‘sustainable development,’” as historian Ulrich Grober pointed out.¹⁰

The claim for a straightforward history of the term *ecology* is equally problematic. As Robert Friedel’s essay reminds us in this volume, the term experienced a similarly long, nonlinear history of creation and transformation. When, in 1866, German naturalist Ernst Haeckel coined the term *ecology* (*Ökologie*), he linked the maintaining of order in human households and communities to that of the Earth’s environment: Planet Earth needs care like a home does. It took more than a century before ecology—fully stripped of its post-Darwinism roots—could develop into a more rigorous scholarship that links evolutionary biology and environmental sciences together to analyze the interaction between living things and their environment.

The concept of ecology was first embraced by UNESCO’s Man and the Biosphere Program in 1970. Two years later, the UN Conference on the Human Environment in Stockholm established a set of principles aimed at strengthening Earth’s capacity to produce renewable resources. The late 1960s and early

1970s saw not only intergovernmental top-down ambitions for safeguarding the planet, but also a rich palette of bottom-up movements, many of which—including Steward Brand’s Whole Earth network and Greenpeace, founded in 1972 by a group of Californian hippies—emerged from a remarkable fusion of countercultural movements and technoscientific expert communities.¹¹ The rise of these new environmental movements marked an important turning point in environmental history. The movements were also a response to the transition from a slow-moving to a rapid loss of global sustainability that had begun already in the 1950s.¹²

In short, despite efforts to establish lineages to earlier times, the 1970s still seem important as a turning point.

Toward a Nonlinear, Cyclical History of Sustainability

How should we interpret a movement that explicitly sought to resurrect older practices for new environmental purposes? The issue of what constitutes a turning point in history—indeed how change occurs—has been subject to debate. Two scholarships are of importance in our discussion of how we need to understand the story of cycling and recycling in a larger historical time-frame. One has resulted from innovation studies, the other from environmental history.

Recent innovation studies have come to appreciate so-called enduring technologies—those used daily and almost casually discovered rather than the capital-intensive ones invented in research and development labs. It helps us to understand the key actors of the 1970s—rebellious consumers—who viewed cycling and recycling as acts of green citizenship. They revived cycling as a mode of sustainable transportation and advanced these relatively low-tech and low-carbon technologies as innovative tools for sustainable mobility and resource management. Their impact has been profound: today, many urban policy makers have come to embrace bicycles as their favorite mobility policy instrument for more livable and sustainable cities. In the same manner, policy makers have focused on waste recycling as a cornerstone in dealing with the planet’s limited resources. Given the enormous negative associations of these technologies as old-fashioned and antimodern, the grassroots and policy success has been a remarkable turn of events. More importantly, these practices challenge easy narratives of innovation as a series of progressive steps.

The strand of innovation scholarship argues that stories of use, rather than invention and innovation, demonstrate the enormous significance of these relatively low-tech technologies in people’s daily lives; therefore, they also should be central to understanding innovations. Historians of technology such as David Edgerton first issued a call to decenter innovations as the premier site of

technological progress.¹³ This insight has now also reached innovation studies, which theorize how policy makers can best introduce environmentally beneficial innovations, in situations where stakeholders have a vested interest in keeping old and unsustainable systems intact. Traditionally, these theorists have concentrated on transitions and tipping points, exploring how entrenched systems like our dependence on unsustainable fossil-fuel economies can move to more sustainable economies most effectively.¹⁴ Given that change is a complex issue, these theorists of sustainability have sought to learn from historical scholarship to advance their own inquiries.

The British sociologist of technology Elisabeth Shove, in particular, has turned to the historical scholarship of cycling to explain why examining older technologies is theoretically important for environmental studies. Innovation studies and transition theory successfully explain when and how innovations have come into existence and gelled into systems, but they pay less attention to how old innovations were maintained or revitalized because, she suggests, focusing on older technologies is detrimental to the dominant narrative of progress. Scholars tend to concentrate on “processes of emergence and stabilization” rather than on “those of disappearance, partial continuity, and resurrection.” When analyzing innovations, we should focus instead on understanding how they have been shaped by persistence, continuity, and the revival of old technologies: “How dormant remains of past regimes come back to life and how innovation journeys start over again.” Using the historical case study of cycling to make her theoretical point, Shove suggests to “set the terminology of replacement and substitution aside and concentrate instead on how cycling and driving are positioned [in relation to one another], as their trajectories develop and decline.” She concludes that the successful resurrection of old technologies is based on “pockets of persistence,” rooted in (still) existing materiality, know-how (expertise), user routines, and an active new cultural framing that fits new contexts.¹⁵

Indeed, historians—specialists in examining the dynamics of change—are particularly well equipped to focus on such pockets of persistence. In the analysis of how developments come about, historians have a useful toolbox at their disposal to examine issues of continuity and discontinuity, of developments that endure and those that have been ruptured. In this volume, Georg Stöger refers to the long tradition of secondhand trading, dating way back to the early modern period, which he interprets as practices of recycling. Roman Köster stresses the ruptures in organizational structures and technological cultures of recycling in West Germany after the Second World War. Technology users are often the carriers of pockets of persistence, as Djahane Salehabadi points out in her case study on the battle over the waste stream and urban mining, again in West Germany. Users are also in the business of launching protests and resistance to system builders who lobby for new systems. Technology users

have played an important role in the survival and reappearance of the “old” cycling and recycling technology in the environmental movement. Indeed, in the West, such pockets of persistence turned into movements of resistance in the 1970s.

Political scientists suggest that movements need social organizations to achieve their well-defined goals. In terms of power relations, political opportunities also need to be conducive for activism to blossom into movements; it includes greater access to political decision-making power and to elite allies as well as the growing instability of ruling elites and the state’s declining capacity to repress dissent. In cultural terms, political scientists now recognize that the act of framing an issue is important in helping activists to mobilize potential recruits and audiences like the media, elites, and sympathetic allies.¹⁶ What we have learned from this scholarship is that, by the same token, in order for older technologies to become viable again, they need a movement’s social organization, political leverage, and cultural framing. What made the 1970s particularly successful and different was the combination of these three important elements: its broad-based social movement, its transnational political coalition building, and its fundamental cultural reframing. These insights may help us understand the seemingly simple question of why older technologies such as bicycles and recycling became popular and legitimate again during the 1970s. During this era, everywhere in the Western world, environmental activists began to recycle as a political act in a broad-based social movement.¹⁷ Similarly, bicycle activists in the 1970s sought to build a large social movement—a critical mass—to change mobility policies.¹⁸

In the cases of both cycling and recycling, the cultural (re)framing in the pivotal decade of the 1970s proved essential in making change possible at all. In both cases, this cultural reframing was quite a tour de force. For decades, bicycles had been negatively associated with working class rebellion, chaotic cities, and undisciplined behavior.¹⁹ War also generated a negative discursive place for bicycles, as Catherine Bertho Lavenier shows in her contribution. Yet, in their roles as environmental activists, urban-based consumers came to reframe the bicycle as the ideal vehicle to meet the new social challenges for sustainable, silent, clean, safe, cheap, and efficient urban transport. Only by bringing bicycles into the discourse of modernity and speed was the Human-Powered Vehicle movement able to recast bicycles as a site of innovation, as Manuel Stoffers explains in his chapter. By changing the image of bicycles from a working-class vehicle to a desirable tool for green citizenship, cycling gained a fighting chance for equal treatment among motorized traffic, when funds for infrastructures and urban planning were allocated, as Ruth Oldenziel and Adri Albert de la Bruhèze argue in their essay on the history of bicycle taxes.

At the same time, it also became increasingly evident that while social organizations like the environmental moments are crucial for social change,

technological systems endure and create path dependencies that are hard to break—they become the true “monuments of unsustainability,” as Martin Emanuel makes clear in his essay on urban planning and cycling in Stockholm.²⁰ Social organization, cultural reframing, and political leverage may not be enough for old technologies to be successful again. The practices of recycling and cycling are up against large entrenched technical systems that carry weight and momentum that are hard to change. Indeed, we need to recognize that cultural reframing and political leverage may not be enough to undo the kind of path dependency that is institutionalized in large technical systems and have become the monuments of unsustainability. These contributions caution us to understand the story of innovation as a simple linear process of progress.

Well-intentioned policy may have unwanted and even disastrous outcomes. As Zsuzsa Gille reminds us, in East Europe the political transformation from socialist to postsocialist societies within the European Union policy framework established conditions leading to environmental disasters rather than preventing them; and as Bill Steele points out, creative attempts in Japan to recycle abandoned bicycles have ended up aggravating environmental problems rather than solving them. Even more importantly, Hans Peter Hahn’s contribution on bicycles in Africa reminds us that Western narratives of change are limited in tracing a sustainability discourse and practice outside the Western beliefs in material progress on the one hand, and the industrial development as an inevitable march forward into resource exhaustion on the other.

The second strand of scholarship that has questioned the unilinear progression of change comes from environmental history. Recent scholarship in environmental history has mobilized a far larger timeframe that goes beyond the discussion of whether we need to see the 1970s as a pivotal turning point along the path of historical time, or whether the Western narrative is limited in capturing the stories from Africa. Environmental history has, moreover, embarked on questioning the linearity of change in nature-culture-relations that often have been told as stories of decline, decay, and degradation.

Today, most observers agree that humanity has become a global factor that affects the overall Earth system in sectors such as water circulation, climate, biodiversity, sedimentation patterns, and use of lands and seas. To pay tribute to the deep impact we as humans have on the environment, a conceptual framework has been proposed that would transcend the sustainability paradigm: the term *Anthropocene*, which was popularized by biologist Eugene F. Stoermer and Nobel Prize-winning atmospheric chemist Paul J. Crutzen around the year 2000. The core thesis is that humanity has affected nature in such a way that a new, human-made stratum has emerged in the geological record. Only a few years after Crutzen and Stoermer popularized the Anthropocene as the new geological “age of mankind,” the International Subcommission on Quaternary Stratigraphy established a working group to determine

whether there is enough scientific evidence to define a new Earth era. This new era, the Anthropocene, would succeed the Holocene. The Greek word *holocene* literally means “entirely recent,” which indicates there is not much room for moving to something novel in a discipline that usually counts in hundreds of thousands and millions of years.

While earth scientists discuss the hard facts of geological strata, historians have started a lively debate about periodizing the Anthropocene.²¹ Three periodization schemes have been proposed. The first is the Neolithic Revolution, which began about 11,000 years ago when humans started to use agriculture in addition to hunting and gathering. Second is the Industrial Revolution that started in Great Britain in the late eighteenth century. The final periodization scheme is the Great Acceleration at the beginning of the second half of the twentieth century, when almost all parameters of human intervention in nature changed from linear to exponential growth. In all three schemes, technology plays a prominent role. Novel technical solutions spurred the transition from societies based on hunting and gathering to agriculture and settlement; mechanization and the transition from renewable energy resources to fossil fuels spurred industrialization; and the Great Acceleration was driven by consumers’ mass use of technologies.

Environmental history not only has broadened issues of periodization beyond narrations of industrial development and economic progress. It has also fundamentally questioned the unilinear notions of history to reassess older notions of cyclical interpretations of history. In that context, we have come to appreciate that the very notion of the future as an undetermined space that is open to human creativity is a recent invention. Only around the long transition to the nineteenth century, when the enlightenment finally gained ground in Western societies, were cyclical ideas of futures that were bound to Christian eschatology dismissed. In its stead, the “discovery of the future”—the singular is crucial—became an integral part of the Western project of modernity. At the time, the belief in the future helped transform history from a cyclical into a linear endeavor.²² Henceforth, in the professional domain and the public realm, “history” came to be seen as a linear mode of succession of change. Periodization became the noble and central task of the historians’ profession; graphical tools such as timelines and chronologies fostered a linear understanding of history.²³

The Western idea of future as a linear project has become increasingly contested—a trend that has been reinforced by the success of postmodernism, postcolonialism, and globalization scholarship. The field of technology, where the idea of endless progress and a linear concept of innovation was particularly deeply embedded, has at last been affected by these trends as well, as indicated by the scholarship of Shove and others. Historians and sociologist of technology have struggled against linearity and the hegemony of modern forms of

one-dimensional futures. From such a perspective, history of technology has been understood as an open source of knowledge that provides orientation in current debates about the present and the future by uncovering creative ideas buried in the past.

In its appreciation of cyclical forms of historic progression over linear models, this volume is taking the idea of the openness of both the past and the future seriously. In doing so, the individual chapters emphasize the fact that *recycling* often means repurposing and reimagining. This also holds true for cycling. The widely debated concepts of “cradle to cradle” and “upcycling,” which Michael Braungart and William McDonough have developed to rethink recycling as a sustainable mode of reusing things and stuff, may still fall short in stressing the cyclical dimensions of material flows in societies.²⁴ Yet they both point to the potential of a nonlinear understanding of sustainability—and they stress the need to pay tribute to economic factors. As Donald Worster reminds us in his essay, the quest for sustainable technologies will fail altogether if it neglects to question its very foundation and belief in economic growth as the underlying model for sustainability, no matter how many bottles we recycle or how many bicycles we ride. In this debate, the insights from historical scholarship on cycling and recycling may serve to better contextualize our current debates on the transition to a more sustainable society.²⁵

Notes

1. Ruth Oldenziel and Mikael Hård, *Consumers, Users, Rebels: The People Who Shaped Europe* (London, 2013), 235–271. We thank Adri A. de la Bruhèze, Mikael Hård, and Gijs Mom for their suggestions and comments. Special thanks goes to Katie Ritson, Marielle Dado, and Brenda Black for their invaluable editorial support.
2. Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago, 2006).
3. Portola Institute, “Purpose,” in *Whole Earth Catalog: Access to Tools* (1969).
4. Turner, *From Counterculture to Cyberculture*.
5. Garrett De Bell, “Recycling,” in *Environmental Handbook*, ed. J. Barr (London, 1970), 217, as quoted in Timothy Cooper, “War on Waste: The Politics of Waste and Recycling in Post-war Britain, 1950–1975,” *Capitalism, Nature, Socialism* 20, no. 4 (2009): 53–72, here 62. *Consumers’ Guide* was published in 1971. Andrew Jamison, *The Making of Green Knowledge: Environmental Politics and Cultural Transformation* (Cambridge, 2001), chapter 4.
6. Carl von Carlowitz, *Sylvicultura oeconomica oder Haußwirthliche Nachricht und Naturmäßige Anweisung zur Wilden Baum-Zucht*, ed. Joachim Hamberger (Munich, 2013 [1713]).
7. Ulrich Grober, “Von Freiberg nach Rio–Carlowitz und die Bildung des Begriffs Nachhaltigkeit,” in *Die Erfindung der Nachhaltigkeit. Leben, Werk und Wirkung des Hans Carl von Carlowitz*, ed. Sächsische Carlowitz-Gesellschaft (Munich 2013), 13–30; and Franz Josef Radermacher, “Die Ressourcen der Erde setzen uns Grenzen—vom säch-

- sischen Bergmann Hans Carl von Carlowitz 1713 bis zum neuen Report an den Club of Rome 2052,” in *ibid.*, 141–156.
8. Richard Hölzl, “Historicizing Sustainability: German Scientific Forestry in the Eighteenth and Nineteenth Centuries,” *Science as Culture* 19, no. 4 (2010): 431–460, here 431.
 9. James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven, CT, 1998), 2–4.
 10. Grober, “Von Freiberg”; see also Ulrich Grober, *Sustainability: A Cultural History* (Totnes, 2012).
 11. Frank Zelko, “*Make it a Green Peace*”: *The Rise of Countercultural Environmentalism* (New York, 2013).
 12. Christian Pfister, “The ‘1950s Syndrome’ and the Transition from a Slow-Going to a Rapid Loss of Global Sustainability,” in *The Turning Points in Environmental History*, ed. Frank Uekötter (Pittsburgh, PA, 2010), 90–118.
 13. David Edgerton, *The Shock of the Old: Technology and Global History since 1900* (London, 2006). Oldenziel and Hård, *Consumers, Users, Rebels*. See also Nelly Oudshoorn and Trevor J. Pinch, eds., *How Users Matter: The Co-Construction of Users and Technology* (Cambridge, MA, 2003).
 14. Frank Geels and Johan W. Schot, “Typology of Sociotechnical Transition Pathways,” *Research Policy* 36 (2007): 399–417.
 15. Elizabeth Shove, “The Shadowy Side of Innovation: Unmaking and Sustainability,” *Technology Analysis & Strategic Management: Innovation, Consumption, and Environmental Sustainability* 24, no. 4 (2012): 363, 367, 372–373.
 16. On the social movement debate, see for example Marco Giugni, Doug McAdam, and Charles Tilly, *How Social Movements Matter: Social Movements, Protest, and Contention* (Minneapolis, MN, 1999); Jeff Goodwin and James M. Jasper, *Rethinking Social Movements: Structure, Meaning, and Emotion, People, Passions, and Power* (Oxford, 2004).
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20. See Martin Emanuel in this volume; Langdon Winner, *The Whale and the Reactor: A Search for Limits in an Age of High Technology* (Chicago, IL, 1986); Ruth Oldenziel and Adri A. de la Bruhèze, "Contested Spaces: Bicycle Lanes in Urban Europe, 1900-1995," *Transfers* 1, no. 2 (2011): 31-49.
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22. Reinhard Koselleck, *Futures Past: On the Semantics of Historical Time* (New York, 2004), and Lucian Hölscher, *Die Entdeckung der Zukunft* (Frankfurt, 1999); see also Niklas Olsen, *History in the Plural: An Introduction to the Work of Reinhart Koselleck* (New York, 2012). Peter Burke has emphasized that the late middle ages and particularly the seventeenth century saw multiple "future-oriented practices," but he also has admitted that the idea of a more distant future as a space open to human creation is a project of modernity; Peter Burke, "Foreword: The History of the Future, 1350-2000," in *The Uses of the Future in Early Modern Europe*, ed. Andrea Brady and Emily Butterworth (New York, 2010), ix.
23. Daniel Rosenberg and Susan Harding, eds., *Histories of the Future* (Durham, 2005); Daniel Rosenberg and Anthony Grafton, *Cartographies of Time: A History of the Timeline* (Princeton, NJ, 2010).
24. William McDonough and Michael Braungart, *Cradle to Cradle: Remaking the Way We Make Things* (New York, 2002), and McDonough and Braungart, *The Upcycle* (New York, 2013).
25. See also Christof Mauch and Helmuth Trischler, *International Environmental History: Nature as a Cultural Challenge* (Munich, 2010); Bernd Hermann and Christof Mauch, eds., *From Exploitation to Sustainability? Global Perspectives on the History and Future of Resource Depletion* (Stuttgart, 2013).