The Digital Cloud and the Micropolitics of Energy

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What strikes you immediately is the scale of things. The room is so huge you can almost see the curvature of Earth in the end. And it's wall to wall, . . . racks and racks and racks of servers with blinking blue lights and each one is many, many times more powerful and with more capacity than my laptop. And you're in the throbbing heart of the Internet. And you really feel it. . . . Here was the ephemeral made real.
—Steven Levy at a Google data center, quoted in Steve Inskeep, "The Brain of the Beast"

The images and stories that translate the technical structure of networks into lay terms lean heavily on ecological metaphors: we have server farms and the hive mind, mountains of data and streaming content. Within this array of high-tech metaphors, the most ubiquitous of all is *the cloud*. Reporting on a recent unprecedented visit to a Google server farm (or data center), journalist Steven Levy disturbs the light and airy image of a digital cloud by taking readers into "the throbbing heart of the Internet" (see figs. 1–2). There he encounters the walls of concrete warehouses, endless racks of servers, a morass of electrical circuitry, and water-hungry cooling systems, all of which, in his terms, make "the ephemeral real." Yet even so, the pull of metaphor directs one's attention away from the materiality of information. As Levy imagines the Internet in not ecological but biological terms—with the data center as its "throbbing heart"

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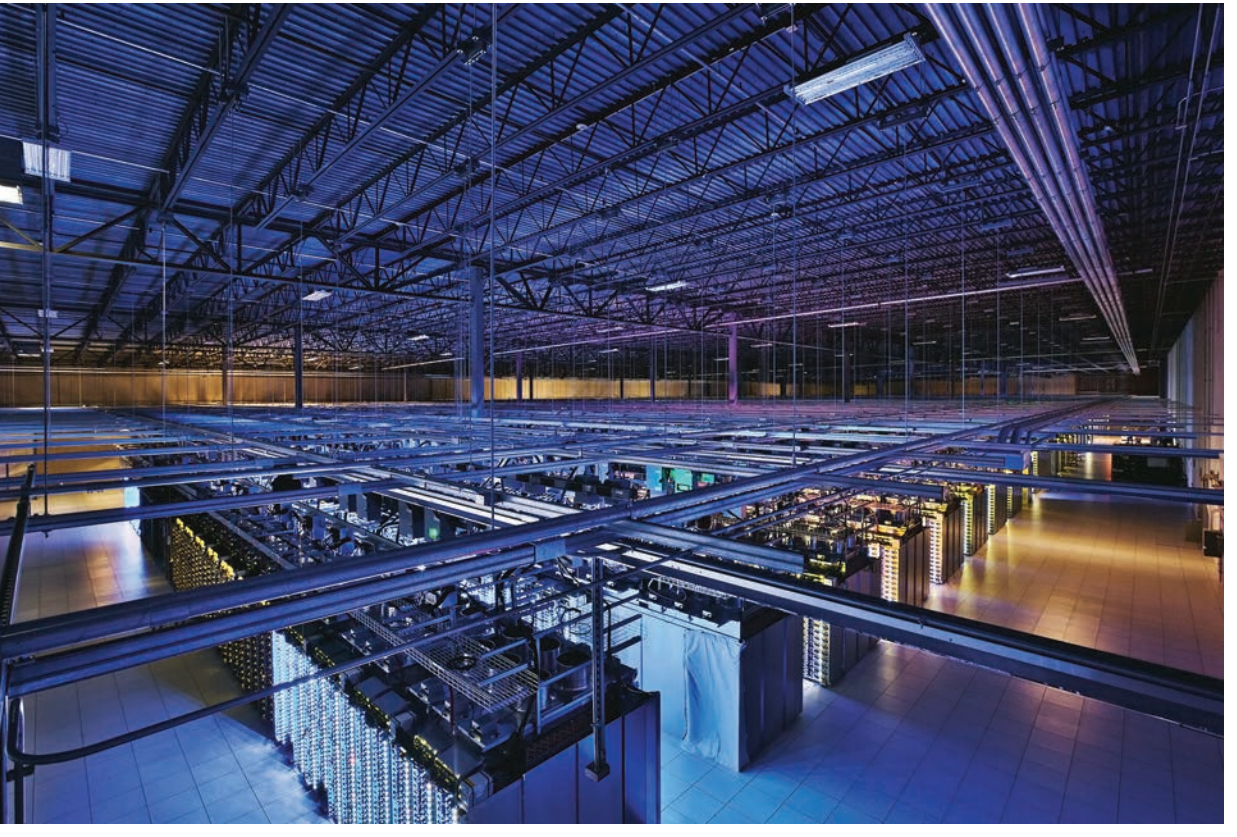


Figure 1 Server room at Google data center in Council Bluffs, Iowa. © 2013 Connie Zhou / Google. Reprinted by permission

and the "blinking blue lights" of servers as its nervous system—the real fades back into the ephemeral.

From technology news to corporate infographics, the vision of the Internet as a green space at once everywhere and nowhere in particular is pervasive. Consider an infographic titled "Accelerating Cloud in Asia Pacific," which depicts the cloud as a verdant, volcanic island suspended in the air.[1] Commissioned by Microsoft and published on a tech blog (evidently without permission), this graphic renders a cell phone as a rectangular mountain meadow and displays bar charts variously as rays of sunshine, hot air balloons, alpine skis, and rainbows. This floating island image also envisions the cloud as "green" by suggesting that cloud comput-

1. The infographic can be viewed here: farm6.static.flickr.com/5107/5692321314_5886bed37e_z.jpg.

Figure 2 A central cooling plant at a Google data center in Douglas County, Georgia. © 2013 Connie Zhou / Google. Reprinted by permission

ing offers a harmonious marriage between cost savings and energy savings for the companies that move their ostensibly less energy-efficient networks off-site. With the Microsoft infographic in view, it bears mention at the outset that everyday parlance blurs the distinctions between individual and organizational uses of the cloud—or between consumer platforms such as iCloud, Dropbox, Facebook, and Google Drive and fee-based cloud computing services such as outsourced data storage and so-called virtual applications. If the cloud has become synonymous with all Internet-based platforms that store and deliver content from remote servers, cloud computing refers only to "subscription-based or pay-per-use services that, in real time over the Internet, extend existing IT [information technology] capabilities" for firms and institutions (Greenpeace 2011: 5). Whether business-to-business (B2B) or consumer-centered, however, the metaphor of the cloud obliterates not just the Internet's physical structure but also sedimented mean-

ings of the word *cloud*.[2] Those meanings include the haunting images and disastrous consequences of mushroom clouds since the United States detonated the first atomic bombs during World War II (a history that Elizabeth DeLoughrey's essay [in this issue] shows persists into the present and with particular force in the Pacific Islands). They also include long-standing idiomatic uses that invoke storm clouds to convey experiences of fragility, impermanence, haziness, concealment, darkness, danger, gloom, and anxiety—connotations that take on profound weight in the era of climate change, with its attendant increase in volatile weather and severe storms. It was only in 1989 that this word, which originated in English before the Norman Conquest, took on the sense of "a network operated by a telecommunications service provider, used in routing data" (*OED Online* 2013a). That multinational corporations like Microsoft and Google represent the digital cloud as an ethereal system for communication and connection, itself without a footprint, seems all the more striking when one takes note of the first and now obscure meaning of *cloud*: "a mass of rock, earth, or clay" (ibid.).

The preponderance of ecological metaphors in how we speak about digital technology and networked computing masks, willfully in some cases, what is an energy-intensive and massively industrial infrastructure. Nicole Starosielski (2011a; 2011b: 2), in her research on the undersea fiber-optic cables that surface at coastal sites such as San Luis Obispo, Fiji, and Oahu's west shore, has been the first media scholar to document at length this infrastructure to discern the "fundamental materiality of our media systems." Her project focuses on conflicts between "global cable systems and local cultural practice" over these so-called critical infrastructures, a term that a US report published on WikiLeaks coined to signal the importance of undersea cables to US national security interests—a militarized paradigm that the National Security Agency (NSA) PRISM data monitoring program no doubt embodies (Starosielski 2012: 38, 53–54). In dialogue with Starosielski's important work, I seek here to excavate the Internet's data centers and energy demands from the ethereal images of the cloud. Those images mold how individual users think about platforms like Facebook, Twitter, and Instagram and, in turn, conceal from public consciousness underlying network infrastructures: the servers, wires, undersea cables, microwave towers, satellites, data centers, and water and energy resources that constitute networks, along with the programs and applications by which devices access those networks. It is the very allure of virtual reality—the desire to escape what cyberpunk novelist William Gibson (1986)

2. My thanks to Claire Bowen for helping me think through this dimension of the digital cloud's rhetoric and iconography.

famously termed "the meat" of bodies, machines, and materials—that inspires the cloud metaphor. That desire allows the data centers connecting computers around the globe largely to escape attention as matters for environmentalist concern. Two reasons for this blind spot merit comment. First, the cloud's apparent ubiquity makes it difficult to assume an outside, critical perspective on its infrastructure. In *The Laws of Cool*, Alan Liu (2004: 144) observes that the rise of " 'total environment' computing" since the 2000s means that "information systems now appear to communicate with each other in such a 'worldwide' web of pervasive networking that what is 'inside' is also inevitably 'outside' and vice versa." Put differently, the web is so ubiquitous for those cultures and communities that are "plugged in" that its infrastructure becomes imperceptible. Second, visualizations of the cloud often depict it as socially transformative, appealing to long-held utopian ideals about online networks. Fred Turner (2006: 148) has shown how Cold War–era countercultural movements that rejected hierarchical structures of work and promoted collaboration and communalism influenced early online communities like the WELL (Whole Earth 'Lectronic Link) as well as the broader formation of cyberculture. Today the corporations that own and market the cloud monetize the ideal of open, connected networks by touting principles of hosting, sharing, and, in some cases, open-source development.

My aim here is to put pressure on the dominant rhetoric of the cloud by investigating counternarratives and alternative images that flesh out the all-too-real infrastructure supporting every stroke of the keyboard and swipe of the touch screen. My primary materials include journalism, fiction, corporate white papers, advertisements, and infographics. These diverse cultural artifacts all powerfully affect how the Internet has been imagined and how it might be reimagined. The visual has been the coin of the realm in shaping what computing and communicating mean in a digital era and hence in shaping popular understandings of the cloud. I thus turn in the essay from visual culture to a work of contemporary fiction that interweaves verbal narrative and word pictures (with a chapter written in PowerPoint slides): Jennifer Egan's 2011 *A Visit from the Goon Squad*. Egan's novel draws a provocative correlation between climate crisis and the everyday habits of those privileged communities that spend the most time online, accessing vast global networks via ever-smaller mobile devices. With her experimental novel as fodder, the essay takes up what I term the *micropolitics of energy*[3]—defined as the planetary ramifications of minute individual practices that are fueled by

3. I wish to acknowledge Fred Turner for his feedback on this project in its nascent stage, which helped in coining the phrase "micropolitics of energy."

cultural values of connectivity and speed and that rely, above all, on the infrastructure of server farms.

Branding the Cloud

Two advertisements that recently ran in *Wired* magazine demonstrate that the metaphor of the digital cloud is rich in aesthetic and emotional appeals. The first, part of a campaign for Brocade (2012, 2013a) (a "network solutions" company valued at nearly $3 billion), opens with the question "Where on earth is your data center now?" suspended over a satellite image of outer space and the *Blue Planet*. The viewer turns the page to encounter a two-page spread with the answer, "HERE," recurring six times over photographs of, respectively, a bank vault, a nighttime cityscape, a container port, a woman standing in her office window, a research ship in the Arctic, and an international airport terminal. The ad's visual exhortation to migrate devices and data to the cloud is echoed by its small-print text, which announces the omnipresence of "cloud-optimized networks" across the earth. While Brocade's (2013b) wider brand identity interweaves "the physical and virtual," this marketing campaign encourages a fuzzy sense of the processes and resources that run networks. Such visual rhetoric traffics in the technological sublime, to adapt a term from David Nye (1996) and others (Marx 1964; Miller 1970). That is, the marketing of the cloud works to cultivate awe at its enormous scale and complexity but also, in line with how Immanuel Kant defined sublime aesthetic experiences of natural phenomena, to underscore the marvels of human ingenuity and engineering.

By comparison, everyday experiences of the cloud often move online users out of the realm of the sublime and into the realm of the magical; their devices seem to open up conduits into impossible-to-apprehend yet wondrous worlds. Paralleling an image of the cloud as magical is an image of its virtuality. The second *Wired* advertisement, directed at consumers, entreats viewers to subscribe to NeatCloud's data storage service by promising the end of cumbersome analog filing systems: "Imagine all of your important files, always in your pocket. Whether you scanned it at home, emailed it in, or snapped it with your phone. NeatCloud keeps it all together, always in sync, and always available" (Neat 2012). This appeal to *imagine* one's life uploaded to the cloud, and hence always at one's fingertips, pops up again and again in IT marketing campaigns. With advertisements that zero in on a single hand holding a tablet or a pair of eyes reflected in a screen, calls to imagine the cloud persistently visualize individuals and their portable devices rather than infrastructures. When those infrastructures do appear,

as in an AT&T campaign "The Network of Possibilities," they are often rendered abstract in the form of connected dots or an iconic "wired Earth" image that signals a utopian and online global village.[4]

Virtual Infrastructure

Virtual reality inventor Jaron Lanier, in his best-selling manifesto *You Are Not a Gadget* (2010: 45–47), laments the individualistic terms in which IT companies present the network, arguing that they turn "ourselves, the planet, our species, everything, into [discrete] computer peripherals attached to the great computing clouds." Such laments are now familiar thanks to nonfiction works like Nicholas Carr's *The Shallows* (2010) and media coverage of online gossip, gawking, addiction, and bullying. Even as writers have sounded the alarm about the interpersonal and cognitive fallout of the digital age, however, their outcries have left underexamined the environmental consequences of network infrastructure. This lacuna stems from the fundamental design of the World Wide Web (WWW). Dating back to the first hyperlinks and graphical browsers of the early 1990s, the web has functioned precisely to hide and make "user-friendly" the Internet, which grew out of state-funded, military engineering programs during the Cold War (see Edwards 1997: 353; Nakamura 2007: 87; Sardar 1996: 21; Turner 2006: 24–28).[5]

A 2009 essay on online habits published in the nature and culture magazine *Orion* demonstrates the invisibility of the web's infrastructure not only in IT marketing but also in environmental discourse. The essay siphons off physical encounters with the outdoors, which afford an escape into "unconnected, unwired time," from the virtual information stream, an ecological metaphor that does not alert the author (Anthony Doerr [2009]) to contemplate the cloud as itself an environment with ecological import. Doerr classifies his own habits of searching, posting, streaming, and surfing as an addiction. He pins his own online cravings on a digital alter ego, "Z," whom Doerr (ibid.) envisions as a junkie and a weed: "He's a sun-starved, ropy bastard [who] lives somewhere north of my heart. Every day he gets a little stronger. He's a weed, he's a creeper; he's a series of thickening wires inside my skull." An environmentalist and outdoor enthusiast, Doerr writes of a recent vacation without Internet access and how this state of bliss comes to

4. An example of the campaign can be viewed at www.att.com/rethinkpossible/#fbid=Vj0szqD-dTu.

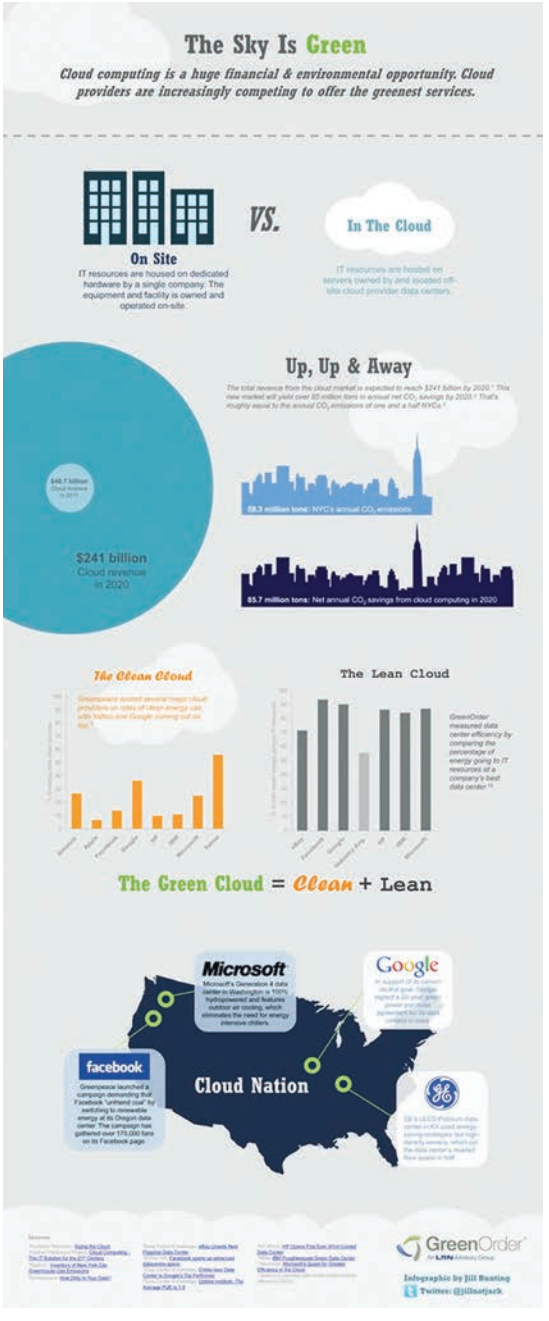
5. The WWW is in technical terms a system of virtual addresses, hyperlinks, and web pages that first took shape between 1991, when Tim Berners-Lee and others developed the WWW framework and HTTP (hypertext transfer protocol) for connecting computers to servers, and 1993, when the Mosaic PC browser was released (O'Malley and Rosenzweig 1997: 133).

an abrupt end on his return because of Z's obsessions with "surfing the web," "reading news feeds," and chasing down information about everything from climate change to health insurance premiums. For Doerr as for Lanier, the problems of life on the net are the social anomie and habits of mind that digital culture engenders. Dwelling on those effects, environmental writers often overlook the coal-fired power plants and energy-intensive cooling systems that translate kinetic actions (all those keyboard strokes and touch-screen swipes) into data.

While both the psychosocial effects of "plugging in" and the mounting "e-waste" that each phone, tablet, and laptop perpetuates have garnered public attention, the cloud's infrastructure and the energy that runs it, as Doerr's essay suggests, remain in the shadows. Media historians Richard Maxwell and Toby Miller (2012: 29) contend that "cloud computing might as well result from invisible magic"—to return to my earlier point—"for all that we can see of it." They go on to observe that while "the existence and impact [of data centers] are largely immaterial to consumers," the infrastructure for prior communication technologies, from telephone lines to TV broadcast stations, has been far more visible, a visibility that has galvanized political action such as environmental justice opposition to the siting of high-tension power lines in low-income neighborhoods (ibid.). Book-length studies like Maxwell and Miller's *Greening the Media* and Elizabeth Grossman's *High Tech Trash* have challenged the cloud's perceived immateriality, then, by applying the frameworks of toxicity and pollution to IT manufacturing. Since the 1960s, silicon mining operations and semiconductor plants have been disastrous for the people and places located near them. As Grossman (2007: 78) details, the county in which Silicon Valley is centered "has the greatest concentration of Superfund sites of any county in the country."[6] This statistical fact finds a visual echo in an information-rich map that appears in Rebecca Solnit's (2010) unconventional atlas of San Francisco, *Infinite City* (see fig. 3). The map overlays famous culinary destinations in the Bay Area with toxic Silicon Valley sites and hence works to visualize the social epicenter of information technology against the grain. In Solnit's and her collaborators' hands, Silicon Valley shape-shifts from a mecca of entrepreneurship and innovation to the industrial underbelly of cyberculture. Liu suggests that such efforts to map or otherwise make visible this underbelly are integral to apprehending the "politics of information." As he

6. "Over 80 percent of this toxic pollution comes from the high-tech industry, primarily from leaks and spills of volatile organic compounds" such as copper, Freon, lead, and chlorinated solvents (E. Grossman 2007: 78).

Figure 3 "Poison/Palate" map showing Silicon Valley Superfund sites along with Bay Area food and agriculture landmarks. Rebecca Solnit, *Infinite City: A San Francisco Atlas*, 2010. Reprinted with permission of the University of California Press



observes, "IT only looks green . . . when one's gaze extends no farther than a manicured Silicon Valley . . . research 'park' " (Liu 2004: 267) or, we might add, a minimal and slick MacBook Air.

Clearly, the pollution associated with information technology calls out for sustained analyses and provocative visualizations. But so too do the voracious energy demands of the cloud. The resource-intensive, industrialized structure of the data center haunts images of the cloud that celebrate its virtuality. Over the past two years, technology reporters have begun to cover this topic, albeit in most cases to marvel at innovations in data center energy efficiency. Two notable exceptions to this pattern provided the occasion for this essay. In a series of articles for the *New York Times*, James Glanz (2011, 2012) investigated the unsustainability of the cloud from an energy perspective, while Levy (2012), writing for *Wired*, has covered rising energy costs within the data center industry. Yet even when reporters like Glanz and Levy tackle the cloud's footprint, they tend to underscore green initiatives on the part of behemoths like Google, which according to a kind of metonymic substitution stands in for the cloud as a whole. Google's investments in renewable energy in turn propel stories about the green cloud as an environmentally conscientious alternative to privately owned networks, on the one hand, and off-line processes, from driving to the library for books to printing documents on paper, on the other.

Industry-sponsored infographics and white papers show that the green cloud image often serves

Figure 4 "The Sky Is Green" Infographic, designed by and reprinted with permission of Jill Bunting, Green Order, published in *Green Biz*, 2011

to greenwash both network infrastructure and corporate America. Consider a recent infographic titled "The Sky Is Green" (2011). Published in *Green Biz*, the infographic devotes half its visual real estate to a definition of *cloud computing* and a representation of the rapid economic growth projected for data center operators (see fig. 4). As the viewer scrolls down a characteristically long, vertical page, "The Sky Is Green" goes on to present anecdotes about the cloud's eco-friendly promise. It pictorially compares, for example, New York City's annual carbon footprint to the net carbon dioxide (CO_2) emissions *savings* that cloud computing is estimated to provide by 2020, and it provides a bare-bones map showing iconic IT companies' renewable energy projects around the United States. Examining data visualization in the context of environmental art and activism, Heather Houser (in this issue: 321) identifies the infographic as a medium that functions to digest "data sets that are too large, complicated, inaccessible, or . . . tedious for [viewers] to comprehend." In infographics about the cloud, whether lauded as a silver bullet for corporate sustainability or exposed as much dirtier than we think, the medium works, in addition, to simplify the "large, complicated, [and] inaccessible" infrastructure that moves data around the world.[7]

A report titled *SMART 2020*, sponsored by The Climate Group, has become a touchstone for this green cloud imaginary. The report projects that a cloud-fueled "shift to energy saving . . . technologies could produce global [greenhouse gas emissions] reductions of up to 15% by 2020" (quoted in Greenpeace International 2011: 9). This line of reasoning has merit. Data center operators have an economic incentive to reduce energy costs, and cloud-based innovations related to residential, commercial, and municipal energy use are aiming to automate and improve upon manual energy-saving practices. Google gets singled out, once again, as a model company in this arena. Responding to reports that the majority of data center energy use derives from coal, Google released first in 2007 and then again in 2012 its own energy consumption statistics to the media in tandem with a public relations campaign about the deals it has structured with solar- and wind-power companies (Stone 2007; Reuters 2011; Greenpeace International 2012; Inskeep 2012; Levy 2012; McMillan 2012b). Spokespeople for the company between these years promoted the idea that "the world is a greener place because people

7. "The Sky Is Green," for example, bases its CO_2 emissions claims on a single analysis by the nonprofit Carbon Disclosure Project's analysis of American companies with annual revenue over $1 billion and the projected energy efficiency gains that cloud computing, by "streamlining information-crunching into single facilities on speedy machines," might bring (Gilmer 2011).

use less energy as a result of the billions of operations carried out in Google data centers" (Glanz 2011).

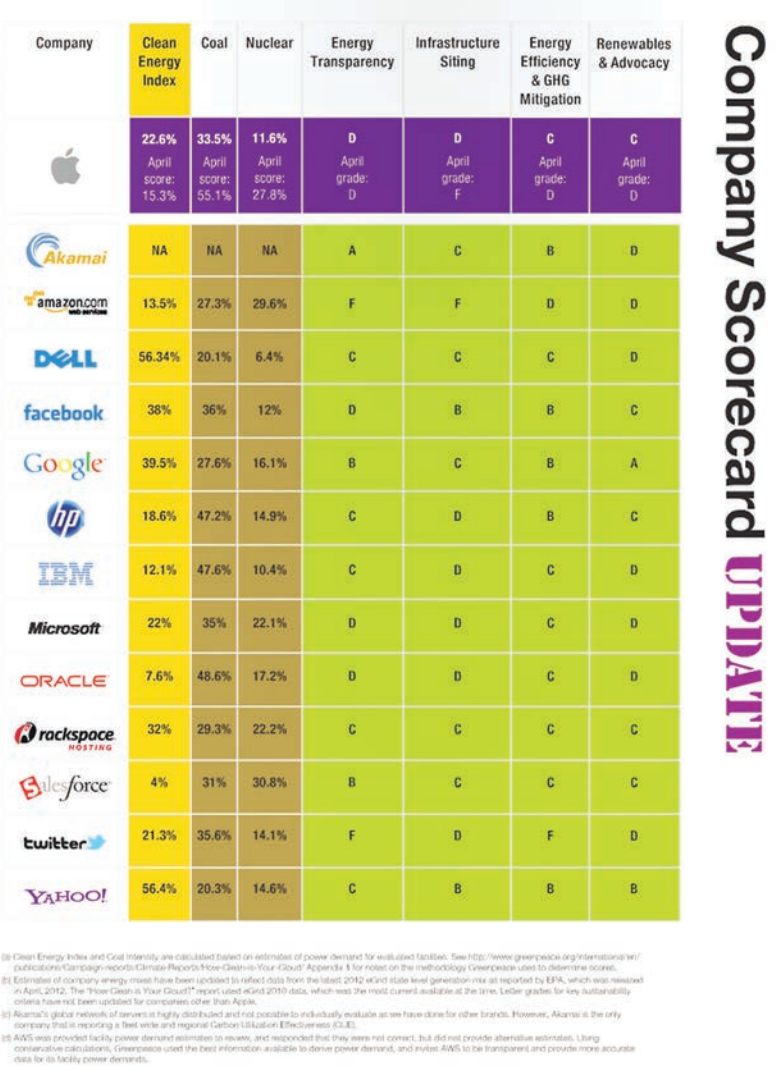
However, there are countervailing stories to tell of the cloud's energy track record and trajectory. Consider, for example, that Google's data center operations require 260 million watts of energy continuously, the equivalent of the annual energy consumption of two hundred thousand US homes. Those figures are just the tip of an iceberg, moreover. There are, by last count, over 3 million data centers and over 10 billion network connections globally (Cisco 2012; Howell 2012).[8] While massive, the carbon footprint of the cloud proves nearly impossible to pin down, in part because of exponential growth and in part because data center operators closely guard energy-saving innovations as a matter of competitive advantage. As we might expect, IT companies treat sustainability as one more brand asset. Nonetheless, data on data centers has been made more public of late. In October 2012, *Wired* published a short article on the "dirty little secret" that many data centers—due to redundant and underutilized servers—are energy *inefficient* (McMillan 2012a). We also now know that many large data center operators, including Amazon and Apple, prioritize cheap power in expanding their operations. Of Facebook's first three data centers, to this point, two were located in regions where over 60 percent of electricity comes from coal (Greenpeace International 2012: 26).[9]

In stark contrast to visualizations of the cloud as ethereal, magical, and organic (as with Microsoft's floating island), a new image taking shape reveals the cloud to be akin to heavy manufacturing industries like the automotive sector. Several recent Greenpeace International reports deploy infographics, designed in the same slick style as industry-commissioned ones, to advance this alternative and oppositional image. One titled "Company Scorecard" rates IT companies in terms of their energy portfolios (see fig. 5); another projects the global expansion of data centers using nonrenewable energy sources by 2020. These graphics cast a shadow over the cloud's favorable representation in "The Sky Is Green" by showing that, even with energy savings for some corporate users of more efficient third-party data centers, skyrocketing individual uses of the cloud mean that the Internet's overall energy requirements are on the rise. These Greenpeace Interna-

8. Data centers now use 1.5 to 2.0 percent of global electricity and as much as 3 percent of the US power supply (Greenpeace International 2011: 5, 12; Inskeep 2012).

9. The first two centers are in Oregon and North Carolina, respectively, while the third is in Sweden, where only 20 percent of the national grid is based on fossil fuels.

tional exposés accordingly conclude that data centers are "the information factories of the twenty-first century" (2011: 14). The aptness of this *industrial* metaphor is apparent in aerial photographs of data center compounds that show—as with an Apple site in Maiden, North Carolina, and a Google facility in the Dalles region of Oregon—warehouses and power generators stretching for miles (McMillan 2012c). Even as some IT companies invest in renewable energy sources, then, data centers remain massive industrial complexes. The interior shots of Google server rooms show precisely that reality. Writing about his firsthand observation of this gigantic built environment, Levy (2012) reflects, "This is what makes Google Google: its physical network, its thousands of fiber miles, and those many thousands of servers that, in aggregate, add up to the mother of all clouds."



Company Scorecard UPDATE

Company	Clean Energy Index	Coal	Nuclear	Energy Transparency	Infrastructure Siting	Energy Efficiency & GHG Mitigation	Renewables & Advocacy
Apple	22.6% April score: 15.3%	33.5% April score: 55.1%	11.6% April score: 27.8%	D April grade: D	D April grade: F	C April grade: D	C April grade: D
Akamai	NA	NA	NA	A	C	B	D
amazon.com web services	13.5%	27.3%	29.6%	F	F	D	D
DELL	56.34%	20.1%	6.4%	C	C	C	D
facebook	38%	36%	12%	D	B	B	C
Google	39.5%	27.6%	16.1%	B	C	B	A
hp	18.6%	47.2%	14.9%	C	D	B	C
IBM	12.1%	47.6%	10.4%	C	D	C	D
Microsoft	22%	35%	22.1%	D	D	C	D
ORACLE	7.6%	48.6%	17.2%	D	D	C	D
rackspace HOSTING	32%	29.3%	22.2%	C	C	C	C
salesforce	4%	31%	30.8%	B	C	C	C
twitter	21.3%	35.6%	14.1%	F	D	F	D
YAHOO!	56.4%	20.3%	14.6%	C	B	B	B

(a) Clean Energy Index and Coal Intensity are calculated based on estimates of power demand for evaluated facilities. See http://www.greenpeace.org/international/en/publications/Campaign-reports/Climate-Reports/How-Clean-is-Your-Cloud/ Appendix 1 for notes on the methodology Greenpeace used to determine scores.

(b) Estimates of company energy mixes have been updated to reflect data from the latest 2012 eGrid state level generation mix as reported by EPA, which was released in April, 2012. The "How Clean is Your Cloud?" report used eGrid 2010 data, which was the most current available at the time. Letter grades for key sustainability criteria have not been updated for companies other than Apple.

(c) Akamai's global network of servers is highly distributed and not possible to individually evaluate as we have done for other brands. However, Akamai is the only company that is reporting a fleet wide and regional Carbon Utilization Effectiveness (CUE).

(d) AWS was provided facility power demand estimates to review, and responded that they were not correct, but did not provide alternative estimates. Using conservative calculations, Greenpeace used the best information available to derive power demand, and invites AWS to be transparent and provide more accurate data for its facility power demands.

Figure 5 "Company Scorecard," in *How Clean Is Your Cloud* (Greenpeace International 2012). Reprinted with permission of Greenpeace International

Data centers are thus significant to the contemporary politics of energy and climate change, and that significance hinges on the sheer amount of data that governments, corporations, institutions, and, crucially for my argument, individuals store on the cloud. While both promoters and critics of the cloud concentrate on corporations, the environmental implications of individual, interpersonal cloud use have been underexamined. The case for attending to these practices is strong in light of the approximately 3 billion daily search queries on Google alone and the free, or nearly free, cost of storing online the now zettabytes of data generated by our collective tweets, updates, e-mails, media streams, image and video captures, and file transfers (Farber 2013; IDC 2011; Savitz 2012).[10] In 1993 the total amount of information on the Internet could be measured in gigabytes. Today an affluent household in the United States is likely to have upward of one terabyte of data stored on the cloud.

The inattention among environmentalists to this Web 2.0 habitus arguably stems from a larger inattention to how intersections of class, education, race, gender, and nationality have governed who has the Internet access and savvy to convert routine digital acts into social opportunity and economic wealth. To the earlier statistic of 10 billion network connections, only one-third of the world's 7 billion people were estimated to be online as of January 2012, suggesting that the exponential growth of Internet access and cloud storage has been highly concentrated among communities and nations in which an individual owns many devices (from a laptop and smartphone to a Blu-ray player and onboard navigation system). Turner, Liu, Lisa Nakamura, and other media scholars have led the way in accounting for how social power and social inequality have shaped cyberculture globally and in the United States particularly.[11] As Cotton Seiler (2012) shows about car ownership, online use increases with affluence.[12] This correlation underscores the tight linkage, moreover, between the cultural and ecological

10. One zettabyte is 10^{21} bytes.

11. Like Maxwell and Miller, Turner (2006: 260–61) documents not only the "millions of plastic keyboards, silicon wafers, glass-faced monitors, and endless miles of cable" but also the "extraordinarily dangerous" work that disenfranchised communities perform in the manufacturing of network technologies and IT devices.

12. Pew Research Center (2011) has found that of social media users on major social networking sites, between 54 percent (MySpace) and 78 percent (Twitter) of users have some college education (Hampton 2011: 12). An infographic that went viral (Online MBA 2012) shows that 81 percent of Facebook users have either some college education or a higher education degree, while 58 percent of Facebook users earn over $50,000 per year.

politics of information. Environmental scholars and activists thus have a role to play in developing an ecological ethic for storing, accessing, and sharing data that takes into account forms of digital power and disempowerment. Such a project might begin with an interrogation of the online practices of activists and academics (myself included), who tend to make heavy use of IT devices, social media, and cloud services.

To connect routinized online acts with their environmental consequences, we also need to rethink the ecological metaphors that permeate not just the IT industry but also the field of media studies. From its beginnings, the field has taken as an organizing concept the metaphor of media ecology, a term Neil Postman and Marshall McLuhan coined in the late 1960s. In *The Medium Is the Massage*, McLuhan memorably articulated this metaphor in writing that information technologies were becoming "so pervasive" that any "understanding of social and cultural change is impossible without a knowledge of the way media work *as environments*" (McLuhan and Fiore 1967: 26). Ursula K. Heise (2002: 152, 161) observes that such metaphors of "ecology" and "environment" have served two opposing tendencies in media theory: on the one hand, to envision the Internet as a "unifying" system spanning the globe and, on the other, to stake out ground for a multiplicity of digital subcultures. She concludes that the digital world consequently eclipses "natural environments" (ibid.: 164, 165). Postman (2000: 11) himself suggested that the media ecology metaphor, in emphasizing the "interaction between media and human beings," has been an unabashedly anthropocentric lens within media studies that has short-circuited investigations of the "interaction" between media technologies and ecosystems.

However, we can find the kernels of cyberenvironmentalism in the early days of Silicon Valley itself. Silicon Valley's culture of bootstrapping has roots in the 1970s New Left and, more specifically, the back-to-the-land movement and *Whole Earth Catalog*, which brought together the values of life science research, do-it-yourself (DIY) engineering, and "hippie homesteading" (Turner 2006: 5). That said, Silicon Valley pioneers, such as *Whole Earth Catalog* founder Stewart Brand and *Wired* executive editor Kevin Kelly, drew their linked investments in environmentalism and innovation from deep ecology rather than environmental justice. Thus does Kelly, in his 1994 *Out of Control*, claim that the Internet will "lead humanity back toward a reintegration with nature" (Turner 2006: 202) by producing a hive-like system of "distributed, decentralized, collaborative, and adaptive" people and technologies (quoted in Turner 2006: 202–3). In other words, to the extent that today's cloud grew out of an ecological consciousness, it did so via a

utopian vision of nature that did not provide the imaginative terms through which to recognize the *negative* ecological consequences and environmental injustices of the Internet itself.

Visualizing the Cloud's Footprint: Egan's Speculative Fiction

Fiction has played an influential role in this decades-long process of decoupling digital networks from ecological impacts. The paradigmatic instance is William Gibson's *Sprawl* trilogy and its first installment, *Neuromancer* (1986). In *How We Became Posthuman*, N. Katherine Hayles (1999: 36) contends that Gibson's futuristic novels sowed the image of cyberspace as a "nonmaterial space of computer simulation" populated with users who interface with one another via the network and as virtual patterns rather than embodied presences. However, these dystopian stories also bring into the reader's line of vision the machines, wires, circuits, routers, and bodies that form the stuff of the net, even as they privilege characters who can directly access "the matrix" of data. For Gibson, virtual interfaces are inescapably in situ, as evident in *Neuromancer*'s thick descriptions of Chiba City and Istanbul as well as in a *Wired* essay about Tokyo, where Gibson (2001) observes that the city's "electric kitsch" and "overlapped media" are fundamentally imbricated in a physical "streetscape." Even as writers like Gibson deploy the metaphors of media ecology, virtual reality, distributed cognition, and the digital cloud, they, too, help us imagine a cyberenvironmental ethic that addresses how technology networks "relate to other types of environments" (Heise 2002: 165).

One work of fiction that offers a particularly provocative narrative sequence through which to get beyond the ethereal imagery of the cloud and to move toward what I am calling cyberenvironmentalism is Egan's *A Visit from the Goon Squad* (2011). Published shortly before Greenpeace International released its first "dirty data" report (2011), Egan's Pulitzer Prize–winning novel proves timely in drawing attention to what a *Time* op-ed calls "the continuous flow of electronic attention" (L. Grossman 2007). The novel's structure brings people, places, and events in and out of focus in a manner akin to social media feeds while calling into question the cult of personality within Web 2.0 culture. Reaching back to 1970s San Francisco and orbiting around 1990s New York, the novel culminates in a speculative vision of 2020s US society, whose distinguishing features are a post-9/11 surveillance state, massive investments in renewable energy and geoengineering as bulwarks against climate change, and, finally, an omnipresent culture of touch screens, text messages, and digital avatars.

The novel's penultimate chapter takes the unconventional form of seventy-six PowerPoint slides, a feature for which the novel has garnered much press. Designed by a tech-savvy adolescent character, Alison Blake, the slides call to mind not the colorful multimedia aesthetic of Web 2.0, as we would expect of the character, but rather the grayscale, text-heavy style of nineties-era management consulting presentations and web browsers. PowerPoint, put simply, has become "retro" in this near future. In terms of their content, Egan's slides tell a multifaceted story of the Blake family and the desert landscape surrounding them. The story centers on Alison's brother, Lincoln, a music lover with Asperger's syndrome who uses digital recording and looping technologies to catalog the silent pauses in iconic rock songs, but it also invokes the many characters and plots that populate Egan's tale of the music industry before and after digitization. The chapter is structured as so many hyperlinks, radiating out from the desert landscape and nuclear family to a much wider world (or worldwide web). In this, the PowerPoint chapter mirrors the novel as a whole, which Egan (2009: 459–60) thinks of as a "tentacled" narrative whose multiple storylines mimic the "lateral curiosity" that web surfing promotes (Churchwell 2011; Herman 2012).

PowerPoint, as a visual medium, offers the novel an opportunity to concretize these interests in the web's hyperlinked structure and the cognitive and social behaviors it cultivates. Rather than the logic of chronology or thematic connection, PowerPoint provides Egan a structure of loose associations. It is through this structure that *A Visit from the Goon Squad* not only mimics the web but also visualizes "the throbbing heart of the Internet," by portraying part of its energy infrastructure and ecological footprint. Just outside the Blake family's door is an enormous solar array sited at the edge of a desert community. One evening, the PowerPoint slides relate, Alison and her father walk out to the array together. "After a Long Time, We Reach the Solar Panels," the headline reads, leading into three stacked flowcharts that depict the solar field as "a city on another planet" (Egan 2010: 291). The graphic ultimately counters current notions of renewable energy by painting an ominous picture of the solar panels as "oily black things."

How might we explain this image? In short, the desert energy grid Egan describes through the medium of a graphical software program operates to power the surveillance technologies, corporate networks, and mobile devices that the reader encounters in the novel's final chapter (set in New York, also in the near future). One reviewer glosses this speculative conclusion as follows: "Several interlocking developments . . . together lead to a state of mass depoliticisation where even the obsession with personal identity that had previously overlaid the

reality of class conflict turns into competition between consumer status groups" organized around IT brands (Mishra 2011).

The huge solar array that readers encounter in the PowerPoint slides stands as a material trace of, and effort to visualize, the escalating energy requirements of this culture in which nearly every experience, exchange, and thought finds its way onto IT networks—onto, that is, the cloud. Egan's novel here reckons, in a way few contemporary cultural artifacts do, with both the ecological and social horizons of the Web 2.0 habitus. More pointedly, the final two chapters draw a line from a North American desert and its renewable energy resources to the digital lives of elite, highly connected Americans. The novel ends with a concert marketed via social media and viral tactics that draws thousands of New Yorkers to hear an unknown musician and takes place in an outdoor Lower Manhattan venue called "The Footprint." The scene invites consideration of this now commonplace term, whose linguistic origins in English date to the sixteenth century when the word took on its first meaning of the "print or impression left by the foot," especially in fossilized form (*OED Online* 2013b).[13] The contemporary use of *footprint*—that impression of one body left on the ground—to visualize human environmental impacts has functioned to eclipse the collective yet incredibly uneven responsibilities for environmental degradation. Investigating the linguistic roots of the word uncovers the two meanings that *footprint* gained in the 1970s: that of one's ecological "mark or impact" (of which *carbon footprint* is a subset) and, less well known, that of "the area . . . occupied by a microcomputer or other piece of hardware" (ibid.). This coincidence links the planetary footprint of individuals, corporations, and states to the ever-expanding physical space "occupied by" computers and all that runs them. To think deeply about the carbon footprint of digital acts, as Egan's final chapters prompt, is thus to interrogate the individualism that informs current rubrics of carbon footprint calculation, particularly in the context of US energy and environmental policy making. It is also to see the fundamentally ecological—or geological—roots of this metaphor for greenhouse gas emissions: a mental leap that takes us from *fossilized footprints* to *fossil fuels*.

Egan's "Footprint" interweaves all three senses of the term: the archaeological, ecological, and technological. In the final chapter, the crowd gathers for the concert under a panopticon of "visual scanning devices affixed to cornices, lampposts, and trees" (Egan 2010: 331). Alex, the person hired to generate buzz for the

13. My thanks, again, to Claire Bowen for drawing my attention to these complex and generally taken-for-granted meanings of *footprint*.

event, hears in this morass of people and technology a primal, geological sound: "just out of earshot, the vibration of an old disturbance . . . a low, deep thrum that felt primally familiar, as if it had been *whirring* inside all the sounds that [he] had made and collected over the years" (ibid.; my emphasis). With this keyword, the description recalls the solar array of the PowerPoint chapter, whose continuous white noise Egan describes as "whirring" (293). The sound seems to derive simultaneously from the crush of bodies and from the many "handsets" recording and posting about the event. With the repetition of this keyword, *A Visit from the Goon Squad* correlates the renewable energy facility to the handheld machines that the solar array works ceaselessly — Egan asks us to see — to connect to the Internet. Her near future is also marked by "warming-related 'adjustments' " to the planet that stem from a postindustrial society's ever-rising energy demands (322). These consequences of climate change inspire new desires for nature in the story as Egan's New Yorkers congregate every evening in large numbers along the East River to watch the sunset, a ritual that calls to mind the sunsets made more beautiful by a "toxic airborne event" in Don DeLillo's *White Noise* (2009 [1985]). The correlations between PowerPoint and power and between cyberculture and climate change in *A Visit from the Goon Squad* thus reveal a pressing, if contested, environmental issue of the early twenty-first century: the amount of energy that will be required over the coming decades to power billions of individual devices and millions of data centers around the world. In tackling this issue, Egan's concluding chapters speak powerfully to the micropolitics of energy.

Conclusions and Speculations

The question I would then pose is how cultural critics might credit and also elaborate on narratives like Egan's by fleshing out an environmental ethic for the cloud that encompasses not just the pollution of semiconductor plants and the exporting of e-waste to China or just the worst offenders of coal-fired data centers but also the micropolitics of so many individuated acts of uploading and accessing data online. In a talk at the 2011 Modern Language Association annual convention, Robert P. Marzec clarified why it is so difficult to envision exactly how much energy individual use of the cloud consumes. In contrast to print culture, he argues, cyberculture does not yet have a "critical" history of its environmental record (Marzec 2011). As a result, he goes on to suggest, individuals are hard-pressed to translate a smattering of statistics into a coherent picture about the energy required for the cloud services they enjoy:

> Imagine, for instance, a series of Google searches performed by the average user, on an average morning. . . . Millions of people surf the web every hour, and we can mark that carbon footprint concretely at 2% of international emissions each year. Viewing a simple webpage generates approximately .02 grams of CO_2 per second; ten times this is required to view a complex website with multiple images; a running PC generates 40 to 80 grams of CO_2 per hour; a fifteen-minute Google search, 7–10 grams. All of this activity adds up. (Ibid.)[14]

"All of this activity adds up" in the aggregate material effects of discrete acts that seem, to the online user, utterly virtual. These effects are ecological as well as social, and they invite a reflexive ethical stance on how often, how much, and to what ends different individuals connect to and make use of the cloud. At the same time, Marzec's formulation acknowledges the practical difficulties in tallying precisely and mitigating ethically the carbon footprint of everyday online activities. Describing the digital world as one where the imperative for "speed transforms knowledge into information," Marzec argues that "faster computers, faster targeting programs and apparatuses (both military and civilian), faster transportation devices (both physical and virtual), have as their goal the erasure of not only time, but space, in terms of geographical distances" (ibid.). This erasure of distances is both metaphoric and all too real when it comes to the digital cloud. It is metaphoric in that the "global village" trope translates complex computing processes and network infrastructures into a quaint picture of people around the world communicating and connecting instantaneously. It is real in that the rapid development of lightning-fast networks and the exponential growth of cloud services constitute a feedback loop—a closed system in which environmental risks and energy demands recede from view.

The rush to expand the capacity and speed of the cloud should be, we have seen, central to twenty-first-century environmental research, activism, and policy. And the neglected question of how *personal and individual* uses drive the cloud's expansion, and hence energy requirements, is of particular concern. One example offers an occasion to think through this question by showing the inextricable ties between the growth in network infrastructure and the individual's desire to access huge amounts of data from any device, at any time. That example is the cur-

14. Marzec develops the argument that print publishing is moving toward more ecologically responsible methods of production and distribution relative to digital publishing. For instance, while "paper remainders" are recycled, 54 percent of e-waste "ends up in toxic dumps" outside the West (Marzec 2011).

rent race to provide ever-faster network connections between the world's stock exchanges; such connections support what is known as high-frequency trading, whose practitioners are "a subset of quants, investors who make money the newfangled way: a fraction of a cent at a time, multiplied by hundreds of shares, tens of thousands of times a day" (Adler 2012). This profit model would be impossible without computer algorithms and superfast Internet connections, on which these so-called algo traders depend to make enormous profits, "a fraction of a cent at a time." Their business model is driving the construction of competing—and hence redundant—high-speed networks that aim to shave just milliseconds off the round-trip data transfer times from the New York Stock Exchange to the Chicago Board of Trade and the London Stock Exchange. Companies unknown to the public are building these networks in a manner akin to how the oil and gas industry is going after hard-to-reach fossil fuels: by tunneling deep under land and sea. To achieve the goal of accelerated data, for example, network providers are literally arming undersea cables against sharks, which are drawn to the electromagnetic fields copper wires generate. With billions of dollars on the line, some high-frequency trading firms are also willing to pay a premium for "dark fiber" services, or connections that belong solely to them (Adler 2012). At a recent conference in New York titled "Battle of the Quants," the CEO of one firm went so far as to suggest that the next stage for the *global finance cloud* would be a "fleet of unmanned, solar-powered drones carrying microwave relay stations" that would "hover at intervals across the Atlantic" (ibid.). The lead-in of the *Wired* article that broke this story is telling: "Wall Street used to bet on companies that build things. Now it just bets on technologies that make faster and faster trades" (ibid.).

Unlike deepwater drilling and fracking, however, the infrastructure being built to support high-frequency trading has proceeded relatively undisturbed by environmental resistance. It is tempting simply to interpret the high-speed network construction boom as evidence that the profit motives of global finance specifically and multinational corporations more generally are the chief problems with the cloud from an ecological and environmental justice perspective. However, the high-frequency trading firms that benefit from faster networks are also benefactors of our daily acts of plugging in to the cloud. They are, to be precise, mining data aggregated from smartphones and social media platforms—that is, from the digital content individuals upload to the cloud that reveals preferences, anxieties, and habits—in order to anticipate market changes and tweak their investment

algorithms accordingly (Adler 2012).[15] Such tactics depend for their efficacy on a network in which connection speed matters far more than energy efficiency, but they also depend on high adoption rates among individuals of cloud-based applications like Google+, iCloud, and Facebook. The micropolitics of digital energy use—and of digital information—are thus not just a matter of how much power (and from what source) each stroke of the keyboard and swipe of the touch screen uses. They are also a matter of how one's desires to share experiences online and to access data from anywhere provide the foundation on which industries profit, including those industries like high-frequency trading that are nearly invisible and so all the more difficult to hold to account for their ecological footprint. These, in the final analysis, are the micropolitics of energy in the information age.

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