

The Energy Nightmare of Web Server Farms

by Jane Anne Morris

One distracted click during my Internet research for this article gave me instant access to 936 photos of Brad Pitt. According to people who know, that click activated some 7000 computers in the search, and perhaps twice as many more trying to induce me to buy something or type in my personal data. [1] And because I recycle, adjust my thermostat to save energy, and scrawl grocery lists on the backs of envelopes, I had to wonder what ecological footprint my peek at Brad had left behind. After considerable clicking and flipping (I still do hardcopy), I stared into the Internet and saw the car of the twenty-first century.

Let me back up and ask a question: Where do you think all your stored emails are? They're not in the hands of tiny file clerks inside your computer — exactly. Nor in the library computer, where you can access them. Where are all those Bible-length attachments that nobody read but you're saving anyway? The hot web sites and blogs? Where do we imagine all this stuff is?

It's in the Cloud — the everything-seemingly-everywhere there-ness of the Internet. The Internet Cloud is generated and maintained by facilities called data centers or web server farms. These rustic-sounding server farms (think of a geek with a hayfork?), like Concentrated Animal Feeding Operations (CAFOs), are tucked — if something that covers dozens or even hundreds of acres can be said to be “tucked” — here and there across the country, downplayed if not concealed in generic buildings.

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 Colombia, a cancer cluster in New Jersey, or the current address of your high school sweetheart. Considerable server effort is devoted to articulating Brad's dimples.

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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. [2] 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.

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Given access to the right cable or wireless network, you tap into the resulting buzzing Cloud by means of a desktop computer or even a handheld. Gadgets so teensy, you could hide one in a coffee mug. Server farms so huge that one warehouse might be the size of several football fields. [3] And so needy that their electricity demand is measured in double- or triple-digit megawatts. A single megawatt (MW) can support about a thousand homes, on average. [4]

Server farm operators order up their electricity before they finalize their construction plans. In Sacramento, over 50 MW of capacity was requested. A server farm in New Jersey asked for 100 MW. In San Jose, 180 MW. [5] An Austin Energy utility spokesperson told the Wall Street Journal that 200 MW (8.5% of its customer load) went to server farms. [6] A “farm” near Seattle asked for 445 MW. A California utility was asked for 340 MW now, to be expanded by a thousand megawatts in the near future. [7] At least three utilities have reportedly received requests for over 1000 MW of capacity, as reported by Susan Mandel back in 2001. [8]

Google Corporation alone reputedly already uses over 20 server farms, housing some half a million servers. [9] It is supposedly already the largest electricity user in one state. [10] The 2006 electricity demand of major search engine facilities (just a small portion of the Cloud) uses an estimated 5000 megawatts. [11] Converted to residences, that’s about five million homes’ worth of electric capacity. [12] Converted to electricity generation, that’s ten 500 MW coal plants. (Want one in your back yard? Wanna work in the mine?) A modest server farm that draws only 20 to 30 megawatts uses enough electricity to power 20 to 30 thousand homes.

The search for cheap land prices and low electricity rates has led server farm operators to site them in rural areas, towns and smallish cities, or near large hydroelectric plants that provide cheap kilowatts. Backup (and unregulated) diesel generators stand ready to power up during blackouts so customers don’t get irritated at having to wait 10 seconds for a download.

Server farms get cut-rate electricity: per-kilowatt-hour rates cited in recent articles range from 1.8 to 3.4¢. [13] You did read that right. If I divide my monthly electric bill by the number of kwh I use, it always comes to over 20¢ per kwh. But I don’t pay industrial rates, which average out nationally just over 5¢ per kwh, and I don’t get other special deals often offered to large users. [14]

A server farm might sport a nice corporate goose pond with a fountain. Or, it might squat in generic buildings in an old industrial district. The advantages of being inconspicuous have not been lost on server farm entrepreneurs: one company brags that its “low profile, non-descript building does not attract attention.” [15] But as Barry Commoner reminded us, there’s no such thing as a free lunch: everything has to go somewhere.

The ecological footprint of a server farm isn’t any prettier than that of a power plant, a toxic waste dump, a gigantic feedlot, or a freeway. The Cloud is floating on a cradle-to-grave network of wrecked aquifers, oily cormorants, radioactive tumbleweed, and melting icecaps. According to one analyst, ordering a book online burns a half-pound of coal. [16] The Internet seems clean because its ecological footprint is elsewhere.

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The Internet Cloud’s supporting infrastructure is well nigh invisible to most of its users. Its costs — to earth, air, water, health, species diversity and future generations, among others — are externalized onto people “over there”: those who host the strip mines and nuclear power plants, whose soccer fields are brownfields if not

Superfund sites, and whose children go to schools nestled next to high-voltage power lines. Many of them live in low-income communities, or low-income countries. This is what the so-called “Environmental Justice” movement was about: privileged people stow the unpleasant, unhealthful, and ecologically devastating consequences of their comfortable lifestyles on the usual suspects, the lower classes, wherever they may be.

Meanwhile, on the bright side of the tracks, we are in the process of uploading our whole society onto the Internet. With our encouragement, those geeks with hayforks at the server farms are working overtime pitching ragged clumps of cultural data into this great content provider in the sky. In electronic form it stores fluff from all of our cultural pockets: baby pictures, thoughts about the election, yard sale items, songs of rage and joy, video games, pornographic videos, environmental impact statements, recipes, home movies, bank records, herbal remedies, and come-ons to purchase any tchotchka ever imagined. Often, once is not enough: online backup services are proliferating. If there’s an ecological footprint — and of course, there is — it is not going to Pop Up on our computer screens.

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With almost uncanny prescience, the story of the automobile offers a preview of where we are heading with the Internet Cloud. The Model T was introduced a century ago. It was a wonder, it was affordable, it got 25 miles per gallon of gas, it opened up hitherto unknown possibilities to the masses. [17] It would change the world, democratize transportation, and grant even those of moderate income unlimited horizons to explore. The cost? Apparently, just some cranking and a little fuel. If you had argued then that within a few generations the nation’s populace would rarely venture more than a quarter mile from their cars’ coveted parking spots, that world politics would be dominated by struggles to control petroleum deposits, and that chunks of the planet’s icecaps would be plopping into the oceans like so many frogs off their lily pads, people would have questioned your sanity.

James Howard Kunstler wrote a witty, melancholy, sadly fond memoir of the automobile’s stealth takeover of US culture (with infrastructure to match) that dropped us off in *The Geography of Nowhere*. Today, people say, “I’d like to stop using my car,” then add that unfortunately they can’t get to work, play, school, sports, yoga class, or the grocery store without it. And why is that? Because we’ve built our whole culture around it.

The car didn’t just penetrate our culture, it reconfigured its DNA. Like a retrovirus at its most efficient, it rewired our culture to serve its ends. Now, we’re up to our chins in smog and pavement and can’t quite figure out what to do next. Among other effects of our car addiction is cross-training in the art of externalization.

On the street, countless people sit in their idling cars, windows closed, with the heater or AC on, while passing pedestrians choke on fumes. That’s as good a model of externalization as any I know. Inside vehicular capsules, we can ignore not only our own immediate exhaust but also all the mining, smelting, refining, casting, and manufacturing, that make possible our automobile adventures.

Imagine if when you drove your car, you experienced the total consequences of your driving. The pollution from your tailpipe would be connected by a hose directly to your lungs. The waste from the manufacture of your car would be stirred into your coffee. The oil waste — all those -enes, -anes, -ones and -ines from the drilling, production, and refining of your gasoline — would be intravenously injected into your body. You would drink water contaminated with all of the wastes poured into waters around the country and the world so that you could

fill up with gas. If we did this every time we started 'er up and drove two blocks to the convenience store, we would certainly get around differently and drastically reduce driving time.

The consequences of dependence on the Internet Cloud are geographically, temporally, and socially displaced from users. The disconnect is almost absolute, leaving us leaning toward glowing, translucent screens emitting wind-chime notices that we need to save a document or check our mail. The terroir of a click is so faint at the screen end, and so diffuse at the footprint end, that we feel free to pretend that it is nonexistent.

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Like a single car's exhaust that seems too insubstantial to matter, a single click's contribution to any planetary ills seems to evaporate before it can be pinned down. Yet the impact remains.

I can hear the epithets. Luddite. Anti-Technology. Afraid of Change. Anti-Progress. Did I miss any? Oh, yeah, Stuck in the Past. I hear how much "we" need the Cloud and our computers. Activists offer horrifying online descriptions of clearcutting, five-legged androgynous frogs, and radioactive tumbleweeds pinned by prevailing westerlies against barbed-wire fences. We email each other about how bad the big corporations are: the stripminers of coal, the refiners of oil, the producers of chemicals, the manufacturers of land mines. The Internet Cloud, the argument goes, makes us more effective activists and provides unprecedented access to a wide range of information. Is this like saying we have to destroy a village in order to save it?

The automobile is the alpha and the omega of our daily fare. We will be locked in its embrace for some time to come if we do not first succumb to its strangulation. Shall we now do the same with the Internet Cloud?

Those 936 photos really are at the crux of the issue. Could I survive on fewer photos, say, half of them? Maybe if the consequences of my clicking for Pitt pics were dumped onto my kitchen table, I would settle for a tabloid stuffed under the mattress. Should the Pitt stuff be available on the same terms as the telephone numbers of my representatives, or my neighbor's homemade mittens web site? That is to say, cheap or free to the users, thanks to government subsidies and the sloughing off of externalities onto the usual suspects: the distant, the poor, and the future.

I would like to help decide what my government subsidizes. Which raises the Censorship Bogeyman. With a past as a teacher, activist, and writer, I can hardly imagine any task force that I would want to determine the limits of my exploration. But some collection of task forces already does that. Why don't we have a real public debate about it?

Like most technological innovations whose promoters promise social benefits along with profits, the Cloud has nearly everyone gushing about its democratizing effects and promises of greater freedom for all. Isn't it about time for a Virtual Reality Check, as Stephanie Mills famously asked in her 1986 book, *What Ever Happened to Ecology?* Last century our society adopted the automobile as its soul mate and re-ordered everything from our eating habits and courtship customs to the landscape itself. Dare we apply to computers and the Cloud today the same critiques that we applied to the car culture only in retrospect? Why should computer use be off-limits?

When I hear a mouse click I hear a coal train, see a "reclaimed" wasteland, smell an oily rotting otter corpse, and think of what it's costing us, and future generations for those 936 photographs. While screwing in that ultra-

efficient light bulb, we might think twice about doing all of our shopping, courtship, research, communication, and “organizing” online.

Disclosure: Corporate anthropologist Jane Anne Morris typed this article on a new laptop, purchased because it has become nearly impossible to get a publisher to accept a manuscript in “hardcopy.” In the 1980s, she fought against lignite strip mining and power plants in Texas, wrote a dissertation on the quasi-public utility company involved, and served on the Austin, Texas, Resource Management Commission.

She is the author of Not In My Back Yard: The Handbook (Silvercat Publications, 1994). Her forthcoming book, Gaveling Down the Rabble: How “Free Trade” Is Stealing Our Democracy, will be published by Apex Press. She bikes year-round in Madison, Wisconsin and her last electricity bill was for 78 kwh.

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Notes

1. Stephanie N. Mehta, Behold the server farm! Glorious temple of the information age, *Fortune Magazine*, August 1, 2006. The 7000 number is also cited by Ron Starner in Energizing the Internet, *Site Selection*, September 2006.
2. Kevin Fogarty, "The greening of the data center," in *Building: Design + Construction* (2006), cites Jon Koomey, a consulting professor at Stanford University, to the effect that every kilowatt used by a server requires another 1–1.5 kilowatts for cooling. Mehta concurs.
3. Wendy Kaufman, NPR, July 10, 2006, Morning Edition, stated that a single building on a server farm might be the size of eight football fields.
4. Kristina Shevory, Cultivating server farms, *New York Times*, October 25, 2006, uses the one megawatt per 1000 homes figure, as does Fogarty, above, and David Kathan & Thomas J. Grahame, Internet data centers: Demands for electricity proceed unabated, *Broadband Wireless Online*, June-July 2001. People describing the electricity demand of subdivisions of large single-family dwellings sometimes use figures as low as 300 homes per megawatt of capacity.
5. Numbers for Sacramento, New Jersey, and San Jose from William H. Dresher, Copper in the new economy: The transition from an industrial to an information-based economy could increase our reliance on copper, *Innovations*(The Online Magazine from the Copper Development Association), January 2002.
6. Austin numbers from Kevin J. Delaney and Rebecca Smith, Surge in internet use, energy costs has big tech firms seeking power, *Wall St. Journal*, June 13, 2006.
7. Seattle and California numbers from Dresher.
8. Susan Mandel, Rooms that consume, *Electric Perspectives*, May/June 2001.
9. George Gilder, The information factories, *Wired Magazine*, October 2006.
10. David Kirkpatrick, Microsoft’s new brain, *Fortune Magazine*, April 18, 2006.

11. Gilder.

12. If each megawatt of electric capacity supports 1000 homes, then 5000 MW times 1000 homes is 5 million homes.

13. Delaney and Smith.

14. Delaney and Smith.

15. AIS Network Corp. advertising online in November 2006.

16. Dresher, paraphrase of a report by Mark Mills, cofounder of the Digital Power Group, a Washington D.C.-based technology assessment and forecasting organization, in May 1999 *Forbes*.

17. Car Mileage: 1908 Ford Model T: 25 mpg; 2004 EPA Average All Cars: 21 mpg, in "WantToKnow.Info" The reference is from *Detroit News*, June 4, 2003.