Eat, Sleep, Click

BY JANE ANNE MORRIS

Save a tree, bank online. Subscribe Online, reduce your carbon footprint. Listen to music online, watch movies online, read books online. No mess, no fuss. Google Inc. has photovoltaic (PV) solar panels on its headquarters. With all that footprint-lightening, you may soon be down to no ecological footprint at all, right?

Since everyone wants the Internet to have a gentle footprint and not be "evil," we should power it with green electricity. Start with a bicycle generator and a server. Here are some back-of-the-envelope figures.

All the stuff on the Internet, or in the "cloud," is kept aloft by computers called servers (plus routers and so on). An average server draws 400 watts/hour, half of that for cooling (fairly typical), and 3500 kilowatt-hours (kwh) per year, because it never shuts down.

A healthy biker can produce a constant 100 watts/hour on a bicycle generator, a generous estimate. Four generator bikes at 100 watts/hour apiece would power a server. Alas, that single server can't accomplish much by itself. Various techies have estimated that a single online search activates between 1000 and 20,000 servers, often located all over the world.

File Size Matters

A text-only file of the Bible is approximately 1.5 MB. With pictures, depending on how elaborate, it is closer to 100 MB. A 2-hour video about the greatest story ever told would use up more like 1-1.5 GB. Comparing music and video, a 4-minute video would use about 24 MB, while 4 minutes of music would use only about 4 MB.

MEGAWHAT?

Terms like megawatt, kilowatt, and watt express power or capacity, while megawatt-hour, kilowatt-hour, and watt-hour measure energy. A solar panel rated at one kilowatt of capacity will produce one kilowatt-hour of energy if the sun shines on it steadily for an hour. A kilowatt is a thousand watts; a megawatt is a million watts or a thousand kilowatts.

Numerous servers are housed together in places called server farms or data centers. To power a modest-sized data center (50,000 servers) by bicycle power would require almost a million pedalers and an area equivalent to 347 football fields. Data centers can be as small as closets at the back of a business, or as large as several football fields and use as much electricity as small cities. They run 24/7/365, and tend to have multiply redundant backup systems, so no one has to wait ten seconds to learn from a web site if it's raining outside.

If you live in a city or a large town, you probably pass by one or more data centers each day. But they don't advertise themselves with signs saying, "Corporate Data Center Containing Highly Sensitive Personally Identifiable Information," so you might not notice. And you won't see 347 football fields of bike generators surrounding them because they're powered by the coal and nuclear power plants that supply most electricity in the US.

What finally matters is not this or that server or data center, but the overall Internet electricity use. How much bicycle-power would it take to run the Internet? Later we can figure out how to landscape the facility, and decide where to put the snack bars and port-a-potties.

The EPA's conservative and dated number for 2006

The Whole World Wide, Internet Powered By Solar! – 200 billion kwh / year = 2081 square miles of panels (the area of Houston, Phoenix, L.A. and

The Whole World Wide Internet Powered By Solar! = 200 billion kwh / year = 2081 square miles of panels (the area of Houston, Phoenix, L.A., and Nashville combined) + 133,200 MW + Batteries + Power Lines + Cooling Equipment + Maintence

Internet electricity use within the US alone is 60 billion kwh. Getting that much electricity from the setup described above would require 600 million bike generators. Assuming 6-hour pedaling shifts, that would take 2.4 billion pedalers. Think of the stimulus to the global economy: pedaling jobs for the entire populations of the US (305 million), Canada (33 million), Mexico (110 million), South America (382 million), India (1.5 billion), and Japan (127 million).

Five years later, that number has doubled (at least). It is widely claimed that in 2010 the Internet used 3% of US electricity (3884 billion kwh), which is 117 billion kwh. So, we're now talking about 1.2 billion bike generators and 4.8 billion pedalers.

In 2007, an independent outsider who is not on the dole of the IT industry calculated that US Internet energy use was around 350 billion kwh annually, approximately six times the EPA's 2006 estimate, and three times the conservative 2010 estimate used above. I will use the lower numbers, but actual Internet electricity use may be much higher.

What about worldwide Internet electricity use? Available 2010 estimates—200 billion kwh—are probably conservative, as they were calculated by an analyst who works for the likes of the EPA, the New York Times, and various IT industry corporations. Extrapolation from the number of servers worldwide results in about the same number: the reported 60 million servers would use 210 billion kwh annually. What's that in bicycles?

Using the same assumptions as before, the worldwide Internet could be powered by a mere two billion bike generators, with 8 billion people pedaling. (Current world [over]population is 7 billion.) If you placed that many bicycles end-to-end, they would reach far enough for three round trips to the moon, and then a trip back up. Maybe we should terraform the moon and put the generator system up there?

Who would want to design a bicycle-generator system to power the Internet? Someone who wanted to imagine a human-scale equivalent for how much energy the Internet already sucks up. What about other "renewable" energy sources?

Solar And Wind-Powered Internet

At the biggest, most successful photovoltaic projects in the world, the rule of thumb is that ten acres of panels produce a megawatt of capacity (as would 10,000 bicycle generators). A square mile (640 acres) could provide 64 MW. Each megawatt might yield 1.5 million kwh/year, so the annual kwh from a square mile of good solar would be 96 million.

Generating an annual 117 billion kwh (2010 US Internet use) with solar would require at least 1220 square miles of PV panels, and 78,000 MW. For 200 billion kwh for world Internet use, it would take 2081 square

Bicycle power at Occupy Wall Street, Three Google Searches for 500 Calories miles (that's Delaware) and 133,200 MW.

What about a wind-powered Internet? Experience in the wind turbine industry (and again in the choicest spots), has shown that it's good to get 20 MW of capacity per square mile. Three million kwh a year from each megawatt of capacity is also optimistic.

Using wind turbines to get that 117 billion kwh for 2010 US Internet electricity use would require 1950 square miles. The 200 billion kwh for 2010 world Internet use would require 3300 square miles. Most wind power sites are less productive than the sites from which these numbers were derived.

It's not appropriate to compare solar and wind directly to conventional power plants. Except for maintenance and accidents, coal and nuke plants operate 24/7, though demand drops at night. In contrast, solar is always down at night, and wind is variable, exactly what data centers can't be.

With solar, more than half the electricity would have to be stored for use when little or no power is generated. The huge batteries necessary for storing this much power look like a cross between upturned railroad freight cars and electric substations. They require space, maintenance, and cooling. Every time energy is converted from one form to another (like rotating energy to electrical energy to heat energy, or electricity into batteries and then out again) energy is lost. That slippage increases the initial kwh necessary, but I have not factored that in.

Also omitted in calculations here are the power lines, substations, maintenance roads, other support facilities, and buckets of ammonia water to clean PV panels. Not to mention the fact that most areas don't get nearly as much sun as the prize spots already selected for large solar arrays. I'm also not considering the resources needed to manufacture, transport, and maintain the PV panels. Similar considerations apply to wind power.

Solar and wind have different advantages. Fewer acres of solar than wind are required for each MW of capacity (10 versus 32), but for each MW capacity of wind, you get more kwh/year (3 million as compared to 1.5 million). That is because you are never, ever, going to average more than 12 hours daily of solar. However, you might average more than that for wind, depending on location and circumstances.

At the scale necessary to power data centers, solar, wind, and even bicycle power involve considerable habitat loss. Bicycle space to power the 2010 U.S. Internet would be about 4304 square miles (about the size of the Everglades). For the 2010 world Internet, about the combined area of Delaware and Connecticut. When chunks of ecosystem are shoveled into industrialism's mill, Gaia is diminished. Acres sacrificed to solar arrays, wind farms, power line rights of way, or thousands of bicycle generator pads destroy habitat no less than those given over to GMO crops, cooling ponds, interstate highways, and parking lots.

I'll leave it to curious readers to do their own math on powering the Internet with switchgrass, corn cobs, or cow patties.

Energy-Intensive, Thy Name Is Internet

How can the Internet use so much electricity? Suppose you have an awesome video of your cat at a laptop using her little cat feet to scroll through online celebrity cats in fetching poses. (Click for full screen.) It’s stored in your email account, and you have a copy on your laptop and/or handheld. Your email is backed up by the company that offers it, and you have backup service for your laptop, so that’s more Internet storage space on servers somewhere; then the back-up companies back up their back-ups. You send the cat video to fifty people. Some store it in their emails; some download it and have it backed up on their own online backup systems; some send it out to a few other people; and some do all three. How many places can we find the cat? It's a hall of mirrors, a grain of wheat doubling on each square of a chessboard. All of it eats kilowatt-hours. How much fracking is that cat porn worth to you?

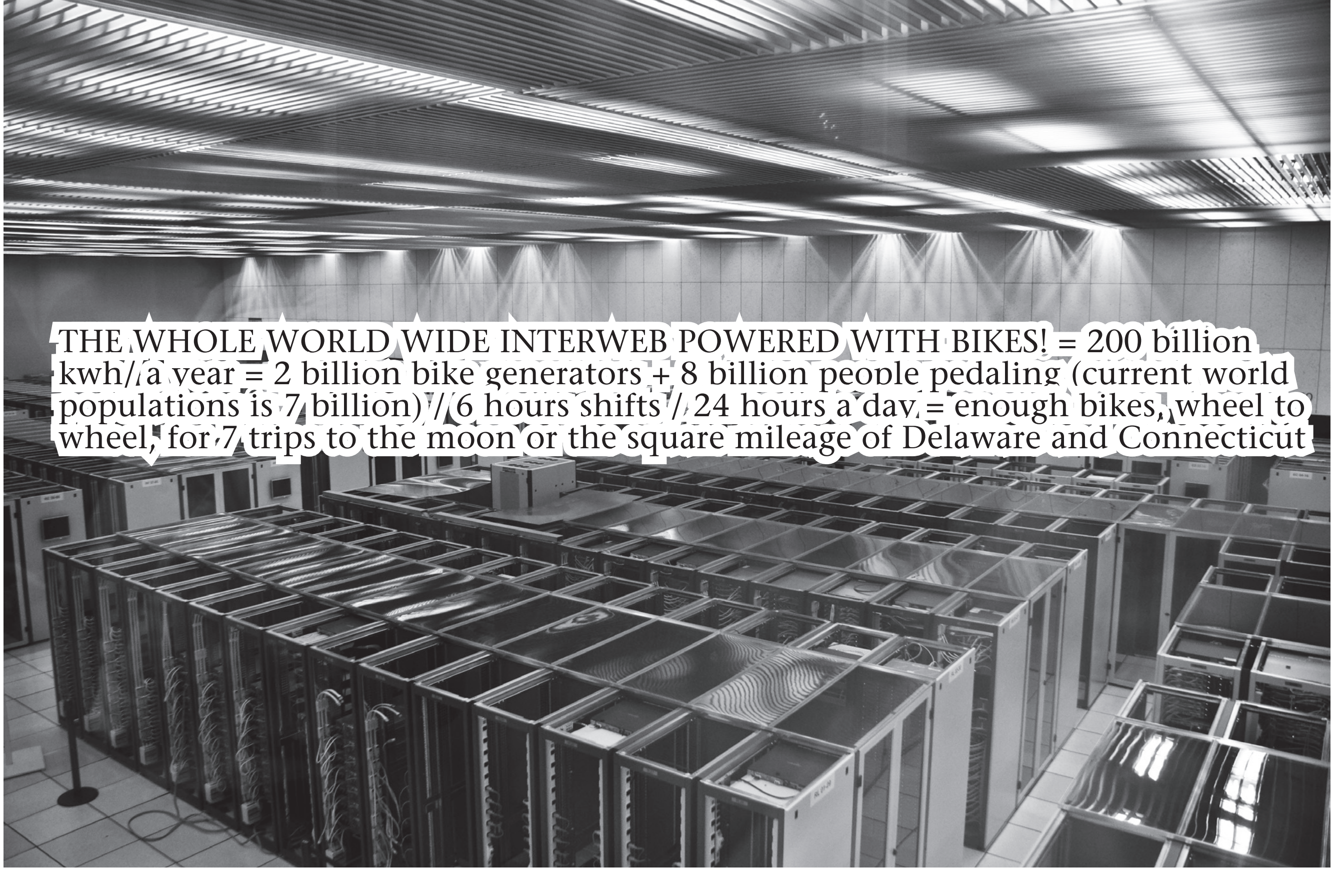
All online content is not born equal. It takes very little electricity to support text, even italics. Graphics such as photos and drawings are much more energy-intensive. Music exceeds even graphics, and video (bouncing bunnies, or time-lapse wrinkle cream results) is the greediest of all.

Online action is hosted and processed in massive data centers that use up to 100 or even 200 MW of demand; data center operators are not often eager to release this information. Chicago's Lakeside Technology Center (a data center, on 350 East Cermack, Chicago IL) reportedly draws 100 MW, a higher electric demand than any other Commonwealth Edison customer except O'Hare airport. A quick check reveals what a "renewable" electricity supply would look like for a facility like this. With bike generators: over a million generators, over four million pedalers, and almost half a million acres, which is 757 square miles (almost three times the size of Chicago). Probably not available anywhere near the Loop. Using solar panels: 2917 acres (2210 football fields), not counting battery space, which is also probably not in the Chicago zoning plan. Using wind in the "windy city": 9347 acres (or 7081 football fields), again not counting battery space.

As Alex Roslin of the Montreal Gazette put it, if the Internet were a country, it would be the fifth biggest power consumer, ahead of India & Germany.

Who Is Paying For This?

Tax breaks and other subsidies are common for data centers. Even modest-sized ones often reap government subsidies for drawing huge amounts of electrici-



ty and providing fewer jobs per buck, or per kwh, than almost any other kind of facility.

For instance, in 2007 a Google Inc. data center got tax breaks on utility bills, plus a property tax exemption. Iowa's own web site describes the tax exemption as including "cooling systems, cooling towers, and other temperature control infrastructure...also exempt from property tax are all power infrastructure for transformation, distribution, or management of electricity used for the maintenance and operation of the web search portal, including but not limited to exterior dedicated business owned substations, back-up power generation systems, battery systems, and related infrastructure; and racking systems, cabling, and trays, which are necessary for the maintenance and operation of the web search portal."

Iowa even calculated its expected tax losses: $3.6 million in 2009, $12.7 million in 2010, $22 million in 2011, and $32.7 million in 2012. The corporation got a similar deal in North Carolina, where estimates of tax losses to the state were approximately $97 million over 30 years.

Lack of enforcement of environmental and occupational safety laws across the board is an often-overlooked form of subsidy available to large corporations, including data centers. This includes the cradle-to-grave production, processing, transport, and use of nuclear and fossil fuels, as well as the toxic waste and byproducts of the same. Companies burn through energy and resources far more cheaply than would be possible if laws "on the books" were enforced.

Finally, there are those bargain-basement electricity bills. Data center electricity rates are as low as 3-4¢/kwh, while residential customers pay much higher rates: easily 15, 20, 25¢/kwh, and even steeper when charges for distribution and other fees are included.

The public is massively subsidizing data centers, the Internet, and the profits of IT corporations. Yet, many corporations with huge data centers are not eager to advertise their locations, and use third parties to negotiate their deals. Some go to great lengths to hide their electricity use. In 2007, for example, at Google Inc.'s urging, Oklahoma rewrote its open records law to allow data center owners to conceal from the public the amount of electricity used.

If Inefficiency Is Not The Problem, Efficiency Is Not The Solution

When I raise the issue of the massive electricity use of all things Internet, everyone tells me how efficient IT is becoming.

The idea that efficiency reduces consumption is at best debatable, and at worst a public relations scam. As Don Fitz wrote in "Why Energy Efficiency Isn't Reducing Consumption" (Synthesis/Regeneration, 2009), over a century and a half of research on the relationship between efficiency and consumption of a resource has marshaled considerable evidence that the opposite is true. Since Stanley Jevons documented that coal consumption increased ten-fold after smelters tripled their efficiency (The Coal Question, 1865), the phenomenon has been called the Jevons Paradox. Historically, in capitalist systems, increased efficiency has led to more consumption, not less.

Being efficient is good, but it does not mean sustainable, it does not mean green, and it does not reduce consumption. Data center efficiency is improving, and Google Inc.'s are reputed to be among the best. But when Gaia is diminished by the ripping out of coal, and the dumping of sludge, her suffering is in no way reduced if the resulting electricity is used "efficiently." Earth's problem is not the inefficiency of resource use, but the quantity. Ask Gaia.

Food, Internet, Spam

Why do we figure out the ecological implications of eating a hamburger but not clicking a search? When it comes to food, the green or even greenish band of the political spectrum is all over it. Local food. Organic food. Slow food. Urban agriculture. Permaculture. Rooftop gardens. Alice Waters, Will Allen, Michael Pollan. "Eat food. Not too much. Mostly plants." Fast food nation. Eat low on the food chain.

But when it comes to the Internet, people spout shallow unexamined cliches as they tap at sleek, shiny gadgets. The PV panels at Google Inc.'s headquarters and other cheap stunts deflect attention from the enormity of Internet energy use. Engineering Professor Mohamed Cheriet, at Montreal's Ecole de Technologie Superieure, who works on "green" IT innovation, gushes, “We’ve found the key to the problem: Follow the wind, follow the sun.” The Internet is the fast food triple bacon cheeseburger of communications, yet people are convinced it's green.

Are the brains who figured out it takes 150 or 630 or 1300 gallons of water to produce a hamburger just out to lunch when it comes to the Internet? Why is the Internet—a global system if there ever was one—immune from the same analysis? Spending two hours on the porch showing your neighbor your family photo album is not especially energy-intensive. Doing so online, and sending it around to everyone on your email list, carries vastly higher ecological costs.

What's the actual content that billions of publicly subsidized kwh go to support? Nicholas Carr (The Big Switch, 2008) estimated in 1996 that 94% of all emails are spam, and that there may be 85 billion spams a day. This year, John Markoff in the New York Times claimed that about 90% of all email is still spam, and that one single spam campaign generated three emails for each person on the planet, some 21 billion messages. Ken Auletta (Google, 2009) suggested that as many as a quarter of all searches are for porn. According to Alex Roslin at the Montreal Gazette, 250 billion emails are sent daily. The study Markoff referenced suggested that over 12 million messages were needed to sell $100 of Viagra. Dennis Walsh from *Green@Work Magazine*, among others, states that over 200 million Internet searches happen daily in the US alone; 100 million photos are uploaded daily. Google Inc. reported that it carries out about a billion searches per day, according to James Glanz in the New York Times.

One person estimated that fantasy football aficionados spent 2.4 billion hours online per season. Online games, role-playing, social networking, gambling, and an almost unbelievable amount of advertising is up there in the "cloud" at tremendous energy cost. Much of it is not the relatively energy-cheap text, but the photos, music, video, bouncing cartoons, and interactive click-fests that are hundreds or thousands of times more energy-intensive. Subsidizing the entire current Internet system because an activist can upload photos of stripmining and clearcutting is like subsidizing an industrial-sized WalMart because six feet of shelf space holds organic spinach.

The Internet is not, and will not be, powered by so-called renewable energy, magical energy that is somehow without consequences. Sleek, glowing screens may hide the truth from people who don't want to hear about it, but the consequences remain. The real costs of Internet electricity use are being cast over state boundaries and national borders, across class, ethnic, and species lines, and onto future generations.

In hindsight, most wish that we had used a little more foresight about the automobile. And, we are a species with a decidedly mixed record on learning from history. Today is a good time to look up from our screens and take advantage of the fact that we are still in the Model T era of the Internet.

If we keep pretending that the Internet is innocuous, neutral, democratic, clean, and green, we can look forward to more iPipelines, iFracking, iMountaintop Removal, iCoal Plants, iNukes, iStripmining, iSpecies Extinction, iHabitat Loss, iClimate Change, iTar Sands, iSludge, iOil spills, iFloods, and continued iResource Wars.

Or, we can begin to give it the attention we give a burger.

*Corporate anthropologist Jane Anne Morris (*DEMOCRACYTHEMEPARK.ORG*), whose most recent book is* Gaveling Down the Rabble: How "Free Trade" is Stealing Our Democracy *(Apex/Rowman & Littlefield, 2008), first wrote about Internet energy use in "The Energy Nightmare of Web Server Farms: Feet in the Cloud, Head in the Sand," Synthesis/Regeneration: A Magazine of Green Social Thought, Winter 2008.*

“Want to check my facts? Contact jam at: MORNINGDEWBERRYJAM@HOTMAIL.COM.*”*