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Research paper

Energy costs of digital publication vs printed matter

Take NY Times as an example. Its billing information is that you will be automatically charged $8.00 every 4 weeks for one year, then $15.00 every 4 weeks thereafter. You may cancel at any time. Enjoy unlimited article access on NYTimes.com and in The NYTimes app. In compare, get The New York Times paper delivered plus the full digital experience are as low as $5.00 a week the first 12 weeks. You can GET PRINT + ALL ACCESS (Price varies according to location and frequency, subscribers receive free All Access Digital with a Home Delivery subscription.)

From the example we saw before, printed publications are always costs more money than zines. It will spend more energy on setting up pages and spreads, printing out, making a book, then send it to the company and finally deliver to your home. Those took money during the process. Printed publications not only spend energy of the earth, but also energy of people.

“Late last year, I came across a video of Jay Walker’s TED talk in which he pointed out that transferring 1 MB of data requires the amount of energy contained in a common charcoal briquette. It’s a memorable and surprising image of power consumption, and points to the fact that the Internet is a physical reality, not something in the ether — it consumes energy, has been inserted into physical spaces all around us, and lives on our belts, desks, and walls.

But the notion that transferring 1 MB of data consumes a small square of charcoal made me feel guilty about all the downloads, streaming, emailing, blogging, and social networking I’m doing.

It also led to a professionally interesting question — Does delivering an online journal use more or less energy than delivering a print journal?

Our findings are that print takes about 65 times as much energy as online, given the boundaries and limitations outlined above.

From what I could find, a charcoal briquette produces about 21,000 joules of energy. Printing a month’s worth of journals for about 35,000 copies and two issues per month consumes about 42 million briquettes, from paper harvesting through to getting it ready to mail. By comparison, a month’s worth of online traffic, with arguably more visitors than print has subscribers, requires about 650,000 briquettes worth of energy.

Stating that in joules, printing one 35,000 circulation journal with a 96-page page budget consumes about **450 trillion joules of energy**, with about 83% of this energy consumed making the paper that goes through the press. Of the 450 trillion joules, about 50 trillion joules are needed to print, cut, collate, and bind. For our two issues per month, we need about 900 trillion joules of energy to complete a print job.

Producing a full run for one print edition of this journal consumes the equivalent of 4.7 households' energy needs for a year.

Taking an article-by-article approach, only focusing on the editorial well of print and comparing it to article-level access online, we'll assume an article averages 5 pages in length. To print each article for each subscriber requires more than 2 charcoal briquettes of energy (about 48,000 joules), while distributing the same article online (via a PDF download) requires about 1 charcoal briquette of energy.

Imagine what it would look like if you delivered energy instead of pages. Each month, we'd deliver the energy equivalent of a bag of Kingston charcoal to our subscribers.

Interestingly, our PDFs and our Web pages each average about 1 MB in size, so serving a page or a PDF has equivalent energy requirements.

Printing requires big, complex technology. It's a manufacturing process, and it requires a lot of electricity, propane (for dryers and other heated processes), and oil (to heat the facilities to room temperature or something similar), in addition to raw materials (paper, ink, adhesives, coatings). It's not surprising it takes a lot more energy to do. It is amazing how energy-intensive paper making is, however.

This study doesn't present any value judgment about either medium, but some interesting aspects emerged during discussions. For instance, in thinking about the user's computer that accesses and displays the online version, it became clear that the computer, if factored in, would be completely different than the paper of the print edition — that is, the computer is a non-dedicated device that can access journals, check emails, surf other sites, and provide desktop applications, while printed pages are dedicated to that one use, after which they are usually discarded (or archived or shared before being discarded). There are loads of differences like this — articles online are only displayed when requested, pages have to load separately for abstracts, full-text, and PDFs, leading to more data transmission, etc. As one person I worked with on this said, there are tendrils hanging off this, many of which would be interesting to pursue.

This casual little study also shows that even if you were to eliminate editors, reviewers, programmers, designers, copy editors, management, or business people, there are costs to running an online venture, purely from an energy standpoint. Online is not free or energy neutral. It consumes power, and the more heavily utilized it is, the more power it will consume. Google, for example, continuously uses enough electricity to power 200,000 homes.

I couldn't help asking the natural next question, even though it's a little dangerous to go down this road. I'm worried I'll see these figures taken out of this very particular context, as in "this is the cost of delivering a PDF" or some other sloppy interpretation. But I'll risk it, with that caution. The natural next question is: How much does the energy involved with a single PDF download cost? For a 1 MB PDF download, the energy involved in delivering it — based on an average cost of $0.10 per KwH in the US — costs about $0.001, or 1/10th of one cent. While this may seem a small price on a per-download basis, in aggregate, it can get quite large. For our site, the energy costs alone to deliver content would run about $385 per month, or $4,600 per year. For Elsevier, which claims 240 million downloads per year, energy costs for serving these downloads would run about $141,000 annually. For PLoS ONE, which had 4.725 million downloads in 2010, energy costs for just providing these downloads amount to about $28,000 annually. If PLoS ONE stopped receiving author fees tomorrow, it would still face a stiff electric bill if it kept serving documents at that rate.

We all know energy costs are a fraction of the expense of running a Web site on a monthly basis, but even if you took out all those costs for office space, hardware, programmers, designers, servers, infrastructure, licenses, and maintenance, just delivering content online for a medium-large journal takes a few hundred dollars each month in pure energy costs — and much more for larger, busier sites. Using these estimates, Google must have an energy bill of about $535 million per year. Data centers like Google's now account for about 2% of US annual electricity consumption.

Of course, if Google had to continuously print all that information, these findings suggest it would be using enough electricity to power 13 million homes to do so." By Kent Anderson.

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