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The Carbon Footprint of Email Spam Report

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Key Findings

- An estimated worldwide total of *62 trillion spam emails* were sent in 2008
- Globally, annual spam energy use totals 33 billion kilowatt-hours (KWh), or 33 terawatt hours (TWh). That's equivalent to the electricity used in *2.4 million homes in the United States,* with the same GHG emissions as 3.1 million passenger cars using two billion United States gallons of gasoline
- Spam filtering saves 135 TWh of electricity per year. That's like taking *13 million cars* off the road
- If every inbox were protected by a state-of-the-art spam filter, organizations and individuals could reduce today's spam energy by approximately 75 percent or 25 TWh per year. That's equivalent to taking *2.3 million cars* off the road
- The average GHG emission associated with a single spam message is 0.3 grams of CO_2. That's like driving three feet (one meter) in equivalent emissions, but when multiplied by the annual volume of spam, it's like *driving around the Earth 1.6 million times*
- A year's email at a typical medium-size business uses 50,000 KWh; more than *one fifth of that annual use can be associated with spam*
- Filtering spam is beneficial, but fighting spam at the source is even better. When McColo, a major source of online spam, was taken offline in late 2008, the energy saved in the ensuing lull—before spammers rebuilt their sending capacity—equated to taking *2.2 million cars* off the road
- Much of the energy consumption associated with spam (80 percent) comes from end-users deleting spam and searching for legitimate email (false positives). *Spam filtering accounts for just 16 percent of spam-related energy use*

Abstract

All email users throughout the world, including consumers and businesses, struggle with the scourge of spam email. The costs and risks associated with spam have been well documented and have led to attempts by both government and private industry to curtail spam, notably the United States legislature's CAN-SPAM Act of 2003 and proposals ranging from large email providers banding together to implement sender authentication systems to pay-to-send models.

Until McAfee® commissioned ICF International to study the global environmental impact of spam email, the focus has been on the financial fallout from spam. ICF's study determined that taking measures to discourage spam—which accounts for 80 percent of all emails—not only saves organizations and individual email users time and money but can lead to meaningful reductions in energy use and resulting greenhouse gas (GHG) emissions.

By taking an environmental approach to the cost of spam, McAfee hopes to aid the decision makers who are working to stem the tide of spam email and open a timely conversation on the costs of email spam to the planet. This white paper starts that conversation by discussing key findings from the ICF report.

Summary

Email spam is a significant problem for both individual users and businesses. Its financial impact and, in the case of some phishing schemes, the personal pain and loss has been the subject of many research studies. But until McAfee commissioned climate-change consultant ICF International and spam expert Richi Jennings to calculate the environmental impact of spam, spam's contribution to GHG emissions had been largely ignored.

This report looks at global energy expended to create, store, view and filter spam. ICF calculated the GHG emissions associated with this energy use, resulting primarily from the burning of fossil fuels for electricity generation.

This white paper uses the ICF analysis to make a compelling argument for stopping spam at its source as well investing in state-of-the-art spam filtering technology, which not only saves time and money but can pay off in big dividends to the planet by reducing the carbon footprint of email spam.

A Day without Spam

On November 11, 2008, McColo Inc., a United States-based web hosting provider notorious for its prolific contribution to email spam, was taken offline by its upstream Internet Service Provider (ISP). Overnight, global spam volume dropped by 70 percent. The most obvious benefit of the shutdown for practically anyone with an email address was an immediate reduction in unsolicited junk messages. At the same time, the planet experienced a less obvious environmental benefit. For every spam email not sent, an associated reduction in electricity use, and therefore carbon emissions, took place.

The substantial, though temporary, drop in total spam traffic that accompanied the disconnection was a decided relief for individual email users and organizations worldwide. It also spelled relief for the planet, according to ICF, who equated this reduced spam traffic to taking 2.2 million passenger vehicles off the road. While distributing spam does not require shipping physical goods, it does require innumerable pieces of computer hardware—for sending spam, moving it across the Internet, processing it, storing it, viewing it and filtering it out.

As the world struggles with everything from climate change to increased industrialization in developing countries, McAfee believes the time is ripe for looking at the global impact of an annual 62 trillion spam emails and asking the question, "What is the environmental benefit of blocking email spam?"

The Carbon Footprint of Spam

The ICF report associates 0.3 grams of CO_2 emissions with the average spam message. Granted, ICF associates the average legitimate email with almost four grams of CO_2. However, spam email accounts for just over one-third of the total emissions related to business and personal email globally because about 80 percent of all email messages are spam messages.

The average business email user is responsible for 131 kg of CO_2 per year in email-related emissions and 22 percent of that figure is spam-related. The ICF report equates this spam energy to the emissions that would result if every business email user burned an extra 3.3 gallons of gasoline annually.

The energy required annually to create, send, receive, store, and view spam adds up to more than 33 billion KWh, approximately equivalent to 4 gigawatts of baseload power generation or the power provided by four large new coal power plants. ICF estimates spam-related emissions for all email users at an annual total of 17 million metric tons of CO_2 or 0.2 percent of the total global CO_2 emissions—a number equivalent to emissions from approximately 1.5 million in the United States homes.

Emissions sources that are key contributors to spam's carbon footprint are:

- Harvesting addresses
- Creating spam campaigns
- Sending spam from zombies and mail servers
- Transmitting spam from sender to receiver via the Internet
- Processing of spam by incoming mail servers
- Storing messages
- Viewing and deleting spam
- Filtering spam and searching for false positives

The Life Cycle of Spam

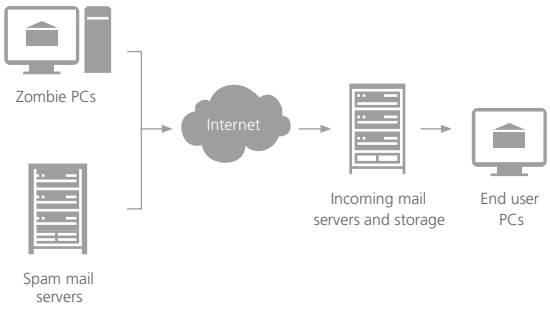


Figure 4-1. Each of the steps in the life cycle of spam.

Percentage of GHG Emissions per Spam Message

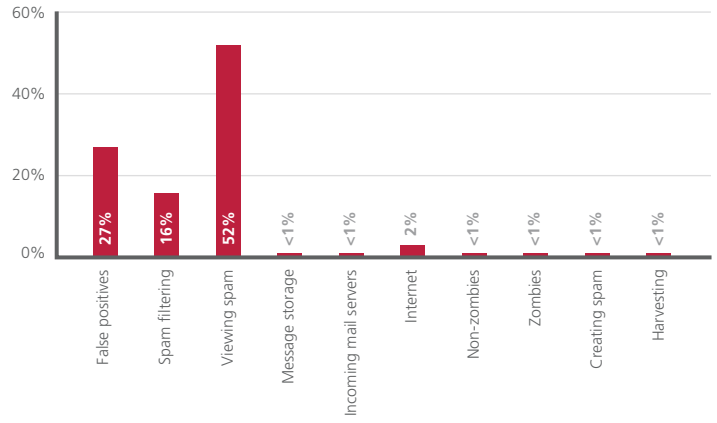


Figure 4-2. This chart describes the percentage of GHG emissions associated with each component of spam energy use.

Annual global spam footprint is equivalent to 3 million passenger vehicles on the road annually.

Analyzing the data

To determine the carbon footprint of spam, ICF, with the assistance of McAfee, calculated the energy use associated with each stage in spam's life cycle, then applied the appropriate emissions intensity to the total energy associated with spam and spam filtering. The results demonstrate that the average GHG emissions per spam message total 0.3 grams of CO_2-equivalent (CO_2-e).

The report attributes an overwhelming majority of spam's GHG emissions—nearly 80 percent—to energy used in the process of viewing and deleting spam or searching for legitimate email erroneously trapped in spam filters (false positives).

For further detail on the methodology ICF followed, see the McAfee/ICF International report, *Carbon Footprint of Spam Email.*

Annual global impact

The McAfee/ICF study examines spam in 11 countries and, since emissions cannot be isolated to one country, averages its findings to arrive at global impact. According to the study, the level of spam-related emissions generated in any country is usually proportionate to the number of email users in each country and the percentage of a country's email that is spam. Countries with greater Internet connectivity tend to have more email users, and countries where a greater percentage of incoming email is spam have proportionally higher emissions per email user.

Total Emissions for Spam by Country (Billion kg CO_2-e/yr)

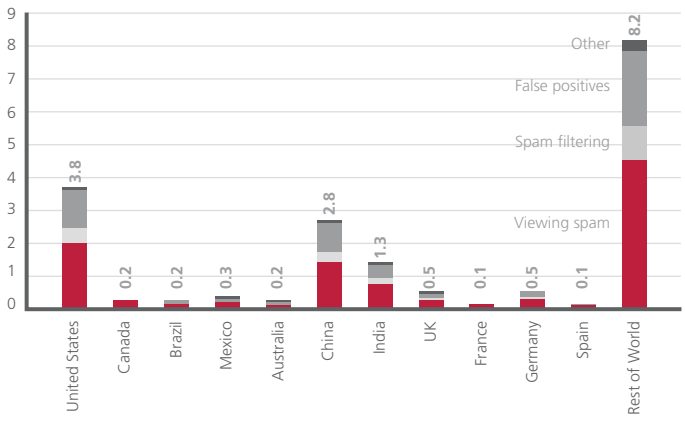
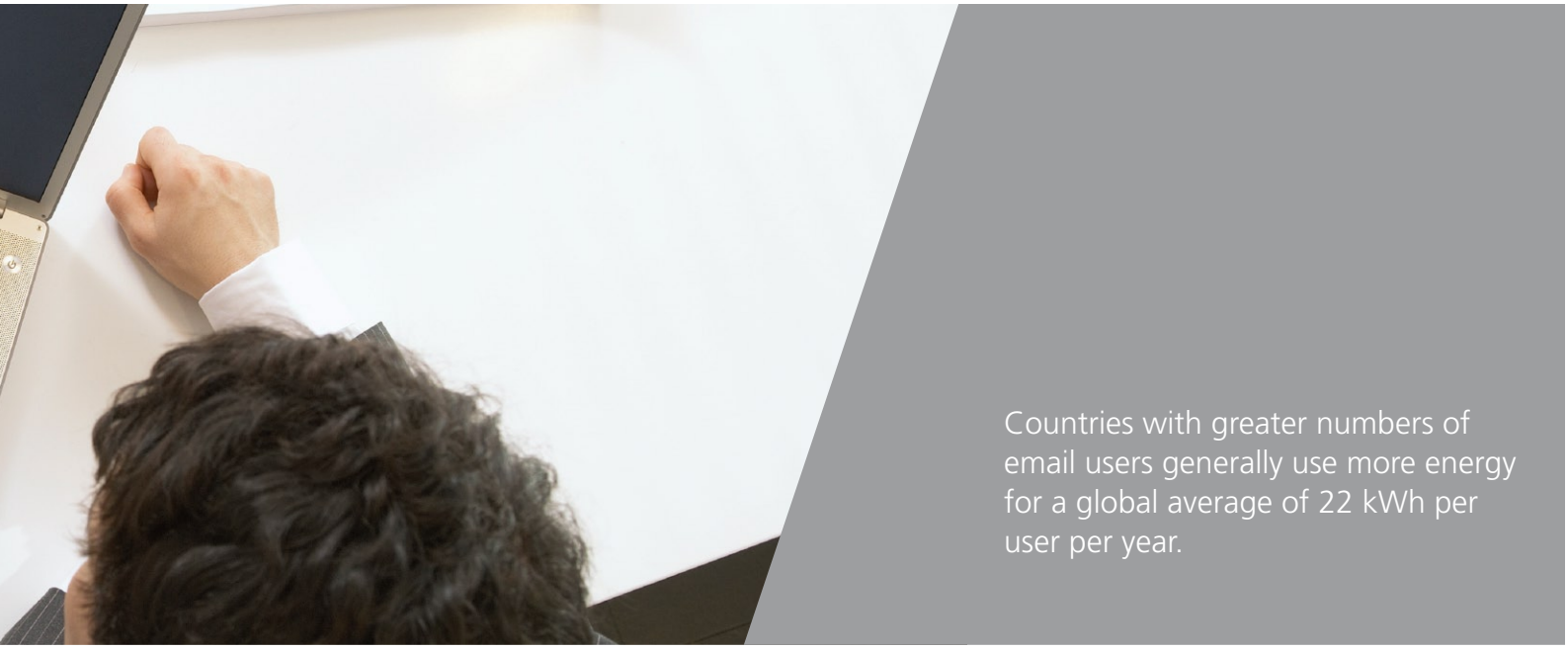


Figure 4-3. Emissions associated with spam for the 11 countries examined in the study



Countries with greater numbers of email users generally use more energy for a global average of 22 kWh per user per year.

Countries with more email users generally use more energy for a global average of 22 kWh per user per year. Variations among countries are due in large part to the differences in the percentage of spam emails received in each country. Not surprisingly, countries where spam makes up a higher percentage of all email expend more energy per user than those countries with lower spam rates.

While the spam that arrives in any individual's inbox may create just a small puff of CO_2, the puff multiplied by millions of users worldwide adds up. Taking careful measures to discourage spammers worldwide can lead to meaningful reductions in energy use and GHG emissions and save the world's email users time and money.

Energy Use for Spam by Country

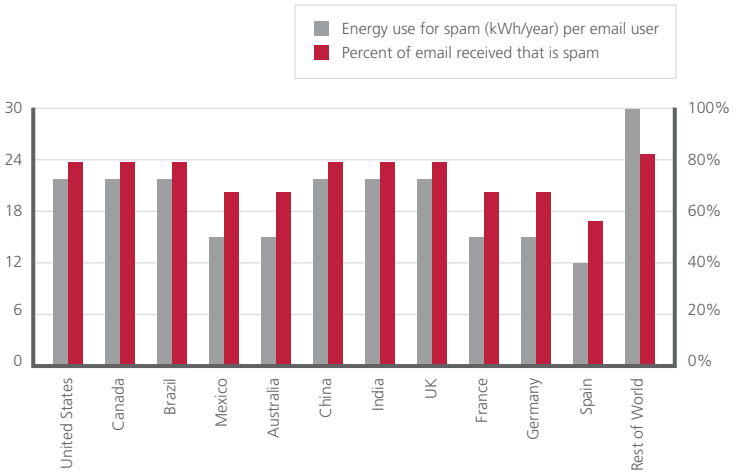


Figure 4-4.

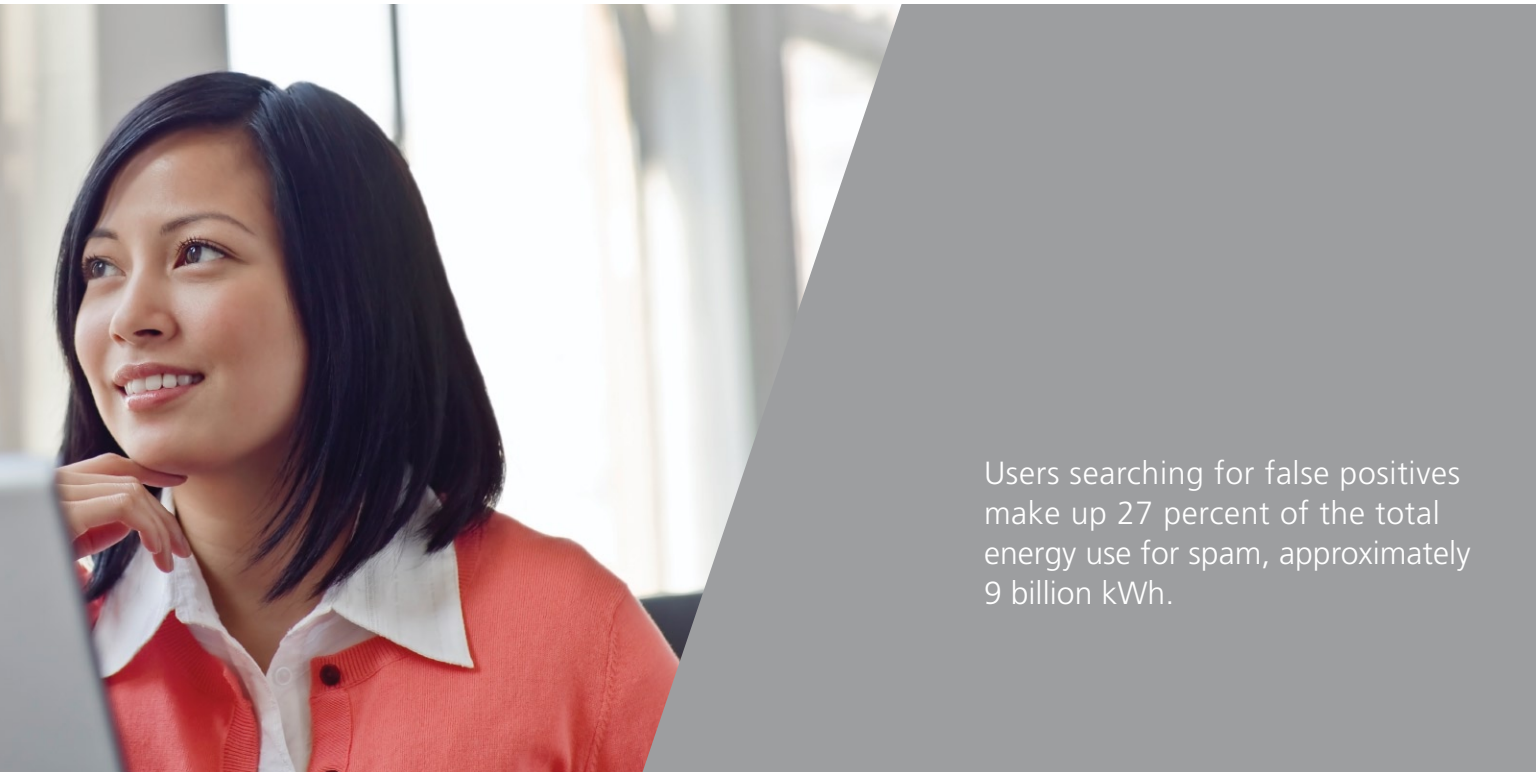
The average business email user is responsible for 131 kg of CO_2 per year in email-related emissions and 22 percent of that figure is spam-related.

Users viewing and deleting spam is the largest energy drain associated with spam, almost 18 billion kWh or 52 percent of total spam energy.

Energy Use For Spam (million kWh / year)

	HARVESTING	CREATING SPAM	BOTS	NON-BOTS	INTERNET	INCOMING MAIL SERVERS	MESSAGE STORAGE	VIEWING SPAM	SPAM FILTERING	FALSE POSITIVES	TOTAL
GLOBAL TOTAL	63/0%	0.2/0%	114/0%	9/0%	747/2%	181/1%	148/0%	17707/52%	5542/16%	9222/27%	33733/100%
UNITED STATES	12/0%	0/0%	24/0%	9/0%	151/2%	36/1%	30/0%	3571/52%	1120/16%	1860/27%	6805/100%
CANADA	2/0%	0/0%	3/0%	0.2/0%	19/2%	5/1%	4/0%	457/52%	143/16%	238/27%	872/100%
BRAZIL	1/0%	0/0%	5/0%	0.4/0%	33/2%	8/1%	7/0%	784/53%	246/16%	408/27%	1493/100%
MEXICO	1/0%	0/0%	3/1%	0.1/0%	9/2%	2/0%	2/0%	224/45%	120/24%	133/27%	495/100%
AUSTRALIA	0.5/0%	0/0%	1/1%	0.1/0%	4/2%	1/0%	1/0%	106/45%	57/24%	63/27%	234/100%
CHINA	8/0%	0/0%	23/0%	2/0%	145/2%	35/1%	29/0%	3444/52%	1080/16%	1794/27%	6560/100%
INDIA	0.5/0%	0/0%	22/0%	2/0%	140/2%	34/1%	28/0%	3317/53%	1040/16%	1727/27%	6310/100%
UK	3/0%	0/0%	4/0%	0.3/0%	28/2%	7/1%	5/0%	656/52%	206/16%	342/27%	1251/100%
FRANCE	2/0%	0/0%	3/1%	0.1/0%	12/2%	3/0%	2/0%	288/45%	155/24%	172/27%	639/100%
GERMANY	3/0%	0/0%	5/1%	0.2/0%	17/2%	4/0%	3/0%	407/45%	219/24%	242/27%	900/100%
SPAIN	6/2%	0/0%	2/1%	0.1/0%	5/2%	1/0%	1/0%	122/38%	102/31%	84/26%	323/100%
REST OF WORLD	25/0%	0.1/0%	18/0%	2/0%	183/2%	44/1%	36/0%	4331/55%	1054/13%	2158/27%	7851/100%

Figure 4-5.



Users searching for false positives make up 27 percent of the total energy use for spam, approximately 9 billion kWh.

Phases of spam energy use

ICF divides spam energy use into several phases. First, spammers harvest email addresses, typically by "scraping" websites, a process that uses automated software to download a website's entire content and search it for email addresses.

The spammer then creates the spam campaign by writing the code and creating the copy for the spam messages. Next, a combination of zombie PCs (called botnets when they occur in large numbers) and conventional mail servers send the spam. The spam messages travel over the Internet hardware owned by ISPs and other network providers, which acts as a bridge between sender and receiver. After reaching the receiver's network, mail servers process spam and place it into disk storage. Finally, energy is also used by spam filtering devices at several points along and by recipients who must view and delete spam that has evaded the filters (false negatives). The recipients also expend energy searching for legitimate mail caught in spam filters (false positives).

A year's email at a typical medium-sized business uses 50,000 KWh; more than one fifth of that annual use can be associated with spam.

Users manually sorting, viewing, and deleting spam

The ICF study found that the largest single source of spam-related energy consumption and emissions comes from end-users viewing and deleting spam. Manually sorting, viewing and deleting spam, as well as searching for legitimate email (false positives), uses almost 18 billion KWh or 52 percent of total spam-related energy use.

It takes an average of three seconds for a user to view and delete a spam message. Although spam filters block approximately 80 percent of spam before it reaches the user, the massive quantities of email spam and the increasing ingenuity of spammers leave a large number of spam messages in end-user inboxes. Approximately 104 billion user hours per year go to reading and manually deleting spam (Jennings, 2008).

An estimated worldwide total of 62 trillion spam emails were sent in 2008.

Energy use for spam filtering

Spam filtering also makes up a significant portion of PC energy use—approximately 5.5 billion KWh annually or about 16 percent of overall spam energy use. But compared to the energy users consume searching for false positives and viewing and deleting spam messages, the energy expenditure of spam filtering seems like a small price to pay. Spam filtering helps to reduce the overall number of spam messages, thus decreasing the time spent manually sorting through the messages and associated energy use and GHG emissions.

A day without spam filtering would have significant environmental consequences. If all spam were allowed to reach inboxes, the time end users would need to spend clearing spam out of their inboxes would increase dramatically. Not only would this circumstance exact a heavy price in lost employee productivity, but GHG emissions associated with spam would increase by about five times, because of the increased computing time required to view and delete these spam messages.

Conclusion

Spam email takes a toll on the finances and productivity of private and business email users all over the world. It also is a significant drain on the global environment. Because this impact is largely a result of the amount of time end users spend searching for and deleting spam, investments in next-generation spam filtering technology can pay big dividends—in economic terms and in a positive impact on the carbon footprint of spam.

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About ICF

For more than 20 years, ICF International has supported public and private clients on issues related to global climate change. Over that time, ICF has amassed significant expertise in analyzing policies and developing strategies to manage GHG emissions in the public and private sectors. ICF offers a wide range of energy analysis and services related to climate change.

For more information, visit:
http://www.icfi.com/sites/green-business/

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