

ENVIRONMENTAL IMPACTS OF E-BOOKS

INTRODUCTION

With the growth in the number of e-readers and sales of E-books, many have begun to question the environmental impacts of E-readers and E-books. Currently E-books make up a relatively small portion of the overall book market and about 9% of the trade book market. However as discussed in more detail in the following section, sales of E-books are rapidly increasing, as are the number of devices capable of displaying E-books. With the rapid adoption of E-books many have questioned what effects (either positive or negative) E-readers will have on the environmental impacts of the book industry. At the time of this was written, none of the major manufacturers of dedicated e-readers (Amazon, Barnes and Noble and Sony) have published information about the environmental impacts of their devices, however Apple has released an environmental report on its iPad, a tablet computer with a built in E-book application, and the ability to download applications to read E-books from other suppliers. Additionally others have estimated the environmental impacts of Amazon's Kindle, and other e-reader devices and attempted to compare them to the environmental impacts of paper books. This report will summarize some of the information found in these reports and compare the environmental impacts of E-books to those of paper books. While E-books can be read on personal computers and smart phones this report will focus primarily on dedicated e-readers and tablet computers.



E-BOOK SALES

Since Amazon launched its E-reader the Kindle in November of 2007, sales of E-books have grown rapidly and more companies have released devices capable reading E-books. The Amazon Kindle still leads the E-reader market, though a recent study indicates that the Kindle is rapidly losing market share to Apple's iPad₁. Together the Kindle and the iPad make up the vast majority of the E-reader market. A recent survey of E-reader owners showed that 47% owned a Kindle and 32% owned iPads. The Sony Reader and the Barnes and Noble Nook respectively accounted for 5% and 4% of the respondents E-readers.

The rate at which E-book sales have increased in recent years is impressive. In 2009 sales of E-books totaled over \$169.5 million and E-books accounted for about 9% of all trade book sales from January through August of 2010₂. As can be see from the graph below, it appears that the shift towards E-books is only picking up steam. In January to August of 2010 E-book sales were 193% greater than they were for that same period in 2009₃.

The Book Industry Study Group's "Survey of Consumer Attitudes Toward E-Book Reading" suggests that we may just be seeing the beginning of the shift in how people choose to read books. According to the study, which was released in January of 2010, 37% of E-book buyers had purchased their first E-book in the past 6 months₄. Furthermore, the data from the BISG survey suggests that consumers of E-books will purchase fewer printed books. 25% of E-book owners surveyed said they would buy fewer printed books, 15% said they buy no printed books and 9% said they would not buy a printed book even if the book they wanted was not available as an E-book₅.

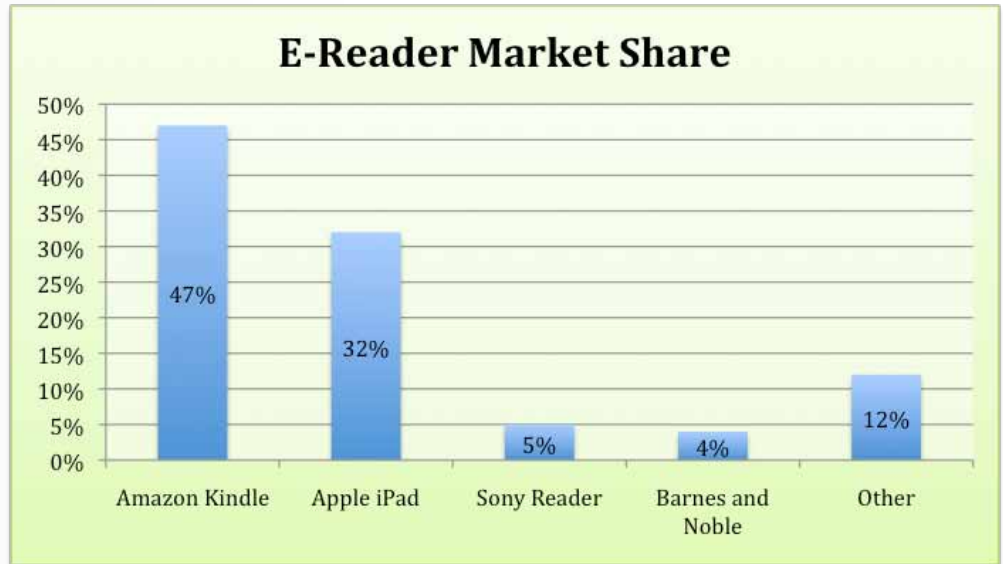


Fig 1. Market Share of E-readers as reported by ChangeWave
Data from <http://www.investorplace.com/24258/apple-ipad-vs-amazon-kindle-e-reader-market/>

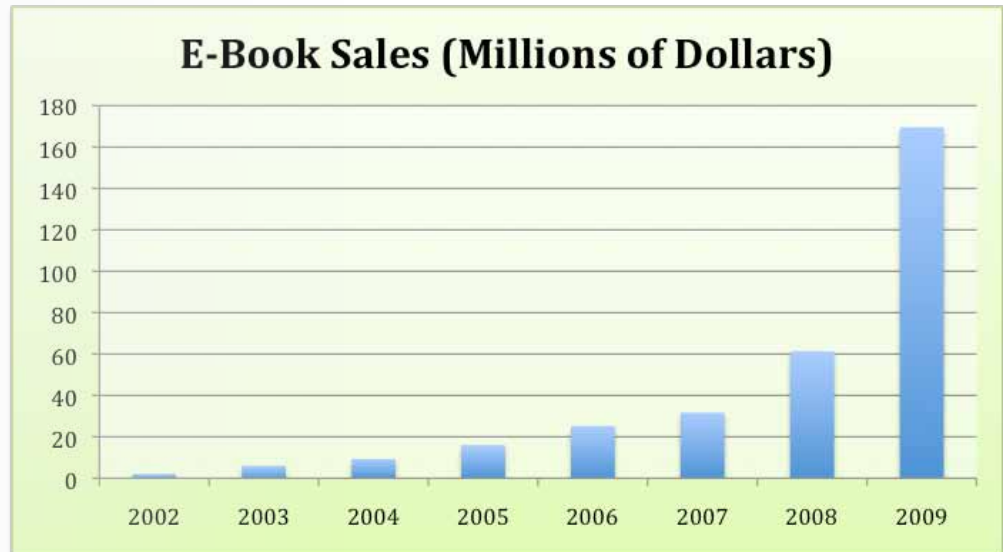


Fig 2. E-book sales by year
http://www.publishers.org/main/PressCenter/Archives/2010_Oct/AugustStatsPressRelease.htm

E-READER LIFECYCLE

Since the data suggests that sales of E-books are likely to increase while sales of printed books are likely to decrease, it is logical to question the environmental implications of this transition. In 2008 Green Press Initiative and the Book Industry Study Group commissioned a report on the environmental impacts of the U.S. book industry which included a lifecycle analysis of printed books₆. That report concluded that in 2006 the U.S. book industry consumed approximately 30 million trees and had a carbon footprint equivalent to 12.4 million metric tons of carbon dioxide, or 8.85 pounds per book sold.

Determining the environmental impacts of an E-book presents a challenge that does not exist in estimating the impacts of a paper book. That challenge is the fact that user behavior will significantly influence the impact of an e-book. This is due to the fact that the manufacturing of the E-reader device accounts for the vast majority of an E-books environmental impact. Because of this, on a per book basis, a reader who reads 100 books on an e-reader will have almost 1/100th of the impact of someone who reads only one book on the same device. Additionally, two readers who each read the same number of books per year, can have a very different per-book environmental impact if one buys a new E-reader every year while the other keeps his for four years before replacing it. Because of the impact that user behavior can have on the environmental impact of E-books, any analysis will either have to make assumptions about the behavior of a “typical” reader of E-books, or else identify a break-even point in terms of the number of books that must be read on an E-reader to offset the environmental impacts of a corresponding number of paper books. However even this can be confused by the fact that it is not clear that reading one E-book offsets one paper book. For example, the ability to instantly download any book at any time may encourage E-reader owners to read more books in which case each e-book read would not necessarily correspond to a printed book that would have been read. Additionally someone who buys a printed book and later lends it to a friend to read would in effect halve the environmental impact of reading that book. As such any analysis should strive to account for this and determine a break-even point in terms of “printed books offset” rather than E-books read. Additional complexity is added by the fact that most E-readers can be used for a variety of tasks other than reading books. For example, most can read newspapers and magazines in addition to books and some E-readers can also read blogs and surf the internet. Tablet computers can allow a user to check e-mail, play games, view photos and videos, listen to music and surf the internet in addition to other things. Thus for the owner of a Tablet computer, who only spends 10% of his time using the tablet to read books, it would seem reasonable to assume that only 10% of the manufacturing impact of the tablet should be counted towards the impact of that users E-books.

USER BEHAVIOR WILL SIGNIFICANTLY INFLUENCE THE IMPACT OF AN E-BOOK.



APPLE IPAD

as mentioned previously Apple is the only manufacturer that has completed an environmental report for its E-reader device. According to Apple's report, over its lifecycle, the iPad will be responsible for 130 kg of carbon equivalent greenhouse gas emissions⁷. 130 kg is equal to about 287 pounds. Using the carbon footprint of the book industry in the Environmental Trends Report, the average printed book is responsible 8.85 pounds of greenhouse gas emissions. This means an iPad owner would need to offset 32.4 printed books during the iPad's lifetime to break even in terms of the carbon footprint of reading those books. If you are also offsetting printed magazines and printed newspapers with the iPad then the number of books you would need to offset to break even could be much lower.

Daniel Goleman and Gregory Norris conducted their own lifecycle comparison of the iPad with printed books in an article printed in the New York Times titled "How Green is My iPad" Their analysis concluded that it would be necessary to offset 100 printed books to make up for the carbon footprint of the iPad⁸, however it is not clear if their analysis included the books impacts on forest carbon loss or not.

Of course greenhouse gas emissions are not the only environmental impacts of producing E-readers or printed books. Printed books require wood fiber which needs to be harvested from forests (or plantations that replaced natural forests) while e-readers require plastic (derived from oil) metal and glass as well as other mineral resources to make up the various electronic components and battery. Norris and Goleman mention that some materials that are in E-readers, such as columbite and tantalite, are often mined in war-torn regions of Africa and sourcing these minerals can have negative social impacts. In its environmental report, Apple makes a point of stating that the iPad has a mercury free LED display, that the glass is free of arsenic and that the iPad is free from Brominated Flame Retardants (BFRs) and Polyvinyl chloride (PVC)⁹. Norris and Goleman conclude that "With respect to fossil fuels, water use and mineral consumption, the impact of one e-reader payback equals roughly 40 to 50 books"¹⁰. In terms of health Impacts Norris and Goleman conclude that in terms of impacts on human health, 1 E-book has 70 times impact of 1 printed book, with the primary impact being particulate matter from energy use and production.

AMAZON KINDLE AND OTHER DEDICATED E-READERS

A report by Cleantech estimated that the lifetime carbon footprint of Amazon's kindle is approximately 168 kg of carbon dioxide equivalent emissions. This is equal to 370 lbs. or the emissions of about 42 paper books, which is very much in line with the greenhouse gas estimates for the iPad, however it should be noted that the estimates used in this report have been criticized by some.

As with the case of the iPad there are other impacts associated with E-readers besides the carbon emissions. A recent study by Asa Moberg et al. compared the impact of a daily newspaper to that of an E-reader and concluded that for a wide variety of environmental issues the impact of the e-reader is lower. This study is of limited importance because it is comparing newspapers, and using Swedish and European figures for electricity consumption, but it does support the idea that when an E-reader offsets a large amount of printed material (as is the case with a printed newspaper) there can be significant environmental savings. This study also suggested that more information is needed with respect to toxic materials that could potentially be in E-readers.



OTHER FACTORS TO CONSIDER AND ADDITIONAL RESEARCH NEEDS

ENERGY CONSUMPTION- Unlike a printed book, an E-reader requires energy consumption during the “use” stage of its lifecycle. In most of the estimates discussed above, this energy consumption used while the reader is reading is baked into the final estimates. Additionally, this number is likely to be relatively small compared to the energy used in manufacturing the device. For the iPad consumer energy use is equivalent to 30% of the tablet’s total carbon footprint¹¹. This number is likely to be much lower for dedicated e-readers that use e-ink technology which only requires energy to change the words on the page and does not use power while the user is actually reading. Even the iPad uses very little energy (about 3 watts) when someone is just reading on it¹². And Norris and Goleman point out that reading at night with a light on can use more electricity than charging an E-reader.

What is not clear is the degree to which the studies discussed above address the impact of the servers, modems and infrastructure that makes the delivery of E-books possible. To be certain energy demand for storing and transmitting data over the internet is increasing rapidly and poses a very serious environmental challenge. However the total portion of data storage that is associated with E-books, while unknown, is at this point assumed to be quite minimal compared to the total content of the internet. Additional research should be conducted to determine the environmental impacts associated with data storage/transmission for E-books.

E-WASTE AND RECYCLING Paper books can be recycled, though at this point not much data is available regarding the percentage of books that are recycled at the end of their useful life. Electronic equipment can also be recycled, however consumers should make sure they understand exactly what a manufacturer means when they say they will recycle a product. In some cases this simply means the item will be shipped to a developing country where in some cases children will dismantle the product removing only the most valuable components under unsafe working conditions. The rest of the “recycled” product is then landfilled or incinerated sometimes exposing workers and the community to toxic materials. It should also be noted that not all E-book manufacturers have recycling programs.

CALCULATING BOOKS OFFSET

The image to the right is a good way to visualize the environmental impacts of an E-reader. As the number of printed books that the E-reader offsets increases, so do the benefits of that E-reader. At some point these gains offset the impact of manufacturing and using the E-reader. This “breakeven point” will be different for different metrics of environmental performance but for most it is likely somewhere between 30 and 70 printed books that are offset over the lifetime of the E-reader. For greenhouse gas emissions this number is probably between 20 and 35 books while for measures of human health impacts the number is probably closer to 70 books.

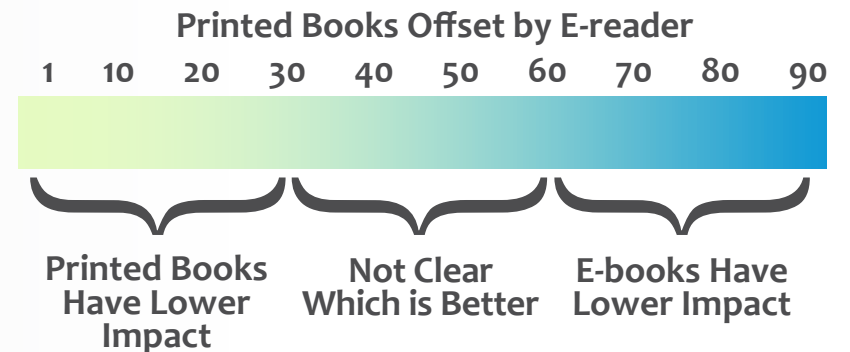


Fig. 3 Environmental Benefits of an E-reader by Printed Books Offset

In assessing the impact of an E-reader the idea of printed books offset must be carefully considered. As mentioned above, if the owner of an E-reader reads more books because of the ease and convenience of downloading a new title, then every book read on the device does not necessarily correspond to a printed book that is offset. Additionally the numbers in the figure above are based on a very simple comparison that is not likely to be replicated in the real world. The assumption is that the reader would either purchase a new printed book once and not share it with anyone else or that the reader would read the books on an E-reader and only use the E-reader for reading books. If a person would normally share a printed book with others, buy some used printed books, or borrow many of the printed books from the library then the numbers would need to be adjusted to account for that. Additionally, if the E-reader is used for other activities such as watching video, browsing the internet, checking email, or reading magazines and newspapers, it is unfair to assign the full impacts of producing the E-reader to E-books. More research is needed on typical user behavior in terms of time spent reading E-books verses other activities on E-readers and Tablet computers in order to make a more accurate comparison. If the trend of the iPad stealing market share from the Kindle continues, it seems likely that users will spend more time on the other activates that tablets like the iPad are optimized for. Additionally, if someone already owns a tablet computer or an E-reader, the marginal impact of downloading and reading an additional book is quite small. Thus for someone who already owns a device capable of reading E-books, the best choice from an environmental perspective would likely be to read a new book on that device.

CONCLUSION

While it is clear that the portion of books read in electronic format will continue to increase rapidly in the near future, it is not clear what percentage of books will ultimately be delivered electronically in the future. It seems reasonable to assume that moving forward a significant number of books will be delivered in electronic format, but a significant portion will also continue to be produced in print. As such, publishers and other book industry stakeholders should work with suppliers retailers and other partners to reduce the social and environmental impacts of books in all formats. For printed books the will involve the continued push to increase the amount of recycled fiber and FSC certified papers in the books while also reducing the overproduction of books and reducing the quantity of paper needed to make each printed book. For E-books this will involve putting pressure on the manufacturers of E-readers and tablet computers to eliminate the use of toxic components, improve recycling of electronic devices, ensure suitable working conditions where the devices are manufactured and recycled and strive to make the devices even more energy efficient. Additionally with E-books there is a clear need for more transparency from device manufacturers. Without full transparency a fully accurate comparison of paper books and E-books is not possible. Publishers, NGOs and consumers concerned about the environmental impacts of E-books should call on the major manufacturers of E-readers to release more information about the materials used in the devices and their lifecycle impacts.



(Endnotes)

- 1 <http://www.investorplace.com/24258/apple-ipad-vs-amazon-kindle-e-reader-market/>
- 2 http://www.publishers.org/main/PressCenter/Archives/2010_Oct/AugustStatsPressRelease.htm
- 3 http://www.publishers.org/main/PressCenter/Archives/2010_Oct/AugustStatsPressRelease.htm
- 4 <http://publishingperspectives.com/2010/05/e-book-sales-statistics-from-bisg-survey/>
- 5 <http://publishingperspectives.com/2010/05/e-book-sales-statistics-from-bisg-survey/>
- 6 Environmental Trends and Climate Impacts: Findings from the U.S. Book Industry
- 7 http://images.apple.com/environment/reports/docs/iPad_Environmental_Report.pdf
- 8 <http://www.nytimes.com/interactive/2010/04/04/opinion/04opchart.html>
- 9 http://images.apple.com/environment/reports/docs/iPad_Environmental_Report.pdf
- 10 <http://www.nytimes.com/interactive/2010/04/04/opinion/04opchart.html>
- 11 http://images.apple.com/environment/reports/docs/iPad_Environmental_Report.pdf
- 12 http://images.apple.com/environment/reports/docs/iPad_Environmental_Report.pdf