Environmental Impact of Personal Computers: Need for Precise Assessment

The fast-growing trend in use of consumer electronic goods around the world is causing significant environmental concerns. Use of personal computers has steadily increased in developed countries and has been rapidly growing in emerging markets such as China, India, as well as Asian and South American economies since the Internet revolution. According to a recent Gartner study, 305.8 million computers were sold worldwide in 2009, out of which 96 million were sold in the United States (Gartner, 2010).

With an average lifespan of 2-4 years, desktop and notebook computers are continuously entering the waste stream (de Saillan, 2007; Dunn, 2005). It is estimated that 30 million units of desktop computers and 12 million units of portable computers were discarded in the United States in 2007 (EPA, 2008). The increasing popularity of electronics and rapid advancements in technology raises serious concerns about the environmental impact of this ever-increasing waste-stream. There is, therefore, a critical need to develop models to estimate the environmental impact of the production and disposal of electronics. The U.S. Environmental Protection Agency estimates that about 18% of personal computers disposed of each year are recycled, the rest are disposed of in landfills (EPA, 2008).

In keeping with the mounting concern about environmental impact, an increasing number of products from paper towels to computers are being marketed as 'eco-friendly,' 'sustainable,' or 'green.' Individuals and businesses are urged to cut their carbon footprint and reduce their greenhouse gas emissions (Brown et al., 2002; Hu, 2005; McWhinney et al., 2005; Wackernagel and Rees, 1996). Consumers who are concerned about environmental issues may compare labels that declare a product's carbon footprint or energy efficiency, or examine a company's environmental policy via their website. A recent study discusses the carbon footprints of six common products, including a pair of hiking boots and a half gallon of milk (see Table 1) (Ball, 2008).

Table 1: Greenhouse gas emissions (lbs CO_2 equivalents) as reported in terms of life cycle stages rather than specific processes (Ball, 2008)

	Car	Hiking Boots	Laundry Detergent	Fleece Jacket	Six-Pack of Beer	½ Gallon of Milk
Raw Materials, %	12.9	93			20.9	31
Production, %	21.5	7	18	100	64.3	66
Use, %	57.3		73		8.2	
Disposal, %	8.3		9			
Other, %					6.6	2
Total Footprint (lbs. CO_2 equivalent)	97,000	121	31	66	7	7.2

Estimating carbon footprints in the life cycle of personal computers is therefore critical to assess the environmental impact of computers. The term 'carbon footprint' refers to the quantity of greenhouse gas emissions released by a process or set of processes (Fiala, 2008; Wackernagel and Rees, 1996). Greenhouse gases (GHGs) are defined as compounds that are released into the atmosphere from human activities and contribute to global warming. The list of GHGs includes carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and halocarbons (IPCC, 2009). For simplicity, emissions are expressed in terms

of CO_2 equivalents, or the amount of CO_2 that would cause the same amount of global warming as the specific GHGs emitted.

Computer manufacturers such as Dell, HP, and Apple have begun to estimate the carbon emissions of their products. In 2009 Dell reported a total of 471,000 tons of carbon emissions and HP reported 8.4 million tons of carbon emissions and Apple reported a total of 10.2 million metric tons of carbon emissions (Arya, 2009). Apple provides a break-down of carbon emissions during the life cycle of their products. Apple reports 38% of their total emissions comes from manufacturing, 53% from product use, 5% from transportation, 1% from recycling, and 3% from its own facilities (Apple, 2010).

Developing models that enable accurate estimation of carbon emissions during the life cycle of computers is vital to ensure computer companies adopt more environmentally friendly manufacturing practices. Life cycle analytical tools provide companies with the capability to analyze alternate materials that would reduce eco-toxicity and also develop manufacturing processes that would lower environmental impact.

LCAT from LCAnalytics for Environmental Impact Assessment of Computers

LCAnalytics, LLC is a company specializing in the development of advanced analytical models of environmental impact of computers. The team at LCAnalytics consists of experts from academia and industry, with a passion for the environment.

LCAnalytics tool, LCAT™, provides:

- Accurate assessment of a computer's impact on global warming, human health, and nature.
- High precision estimates based on component-level analysis.
- Estimates based on more accurate assumptions than existing models, which only use industry-wide averages.

The development of LCAT was based on:

- Professional disassembly, material and process analysis of computers and components.
- Review of recent literature and documentation.
- Correlation of product manufacturer specifications with environmental impact.
- Industry-standard LCA software, including the Ecoinvent database.
- ISO 14000 series requirements.

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