Modeling Increased Product Lifetime in WARM

In EPA's efforts to conserve resources, we usually focus on a well-known trio of actions: reduce, reuse, recycle. Between reducing the amount of trash generated and reusing products comes the concept of **increasing the lifetime of products**. Increased product lifetime is one type of source reduction, which refers to any change in the design, manufacture, purchase, or use of materials or products that reduces or delays the amount or toxicity of material entering waste collection and disposal.

EPA's Waste Reduction Model (WARM) allows users to compare the greenhouse gas (GHG) impacts of source reduction with four other materials management options: recycling, composting, combustion, and landfilling. Product lifetime extension can be modeled using the "source reduction" pathway in WARM. Increased product lifetime reduces the need for new materials and delays or prevents the product from entering the waste stream.

The concept is simple: use an existing product for longer than the typical lifespan. The products in WARM this concept applies to best are personal computers (PC), carpet, asphalt shingles, drywall, vinyl flooring, and wood flooring. Note that in some cases, in order to extend product lifetime, the product owner may need to engage in maintenance and improvement activities that could have GHG and other environmental impacts that are not accounted for in the simplified analysis presented here. This paper presents a few example applications to quantify the GHG benefits from increasing product lifetimes.

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Extend the Life of U.S. Desktop PCs by 50 Percent

We estimate the GHG benefits of extending the life of desktop PCs in the United States as one example of the benefits available from extending product lifetimes. We assume that extending the life of PCs is equivalent to reducing the production of PCs that would otherwise replace those computers, because an increase in the lifetime of a computer would lead to a reduction of replacement computer purchases. Estimates of PC sales are described in Table 1.[1]

Table 1: U.S. Total Computer Sales by Type in 2006

Computer Type	Number of Computers (units)	Unit Weight (pounds)	Weight of Computers (short tons)
Desktops (CPU + CRT Display)[2]	26,311,806	22.0 (CPU); 50.5 (CRT Display)	953,803
Portables	46,439,055	6.4	148,605

We calculated the GHG benefits using WARM. In the baseline scenario, we assumed that 33.5 percent of the materials from desktop computers are recycled into secondary materials, 65 percent are landfilled, and 1.5 percent are combusted with energy recovery, based on EPA estimates (see Table 2, Baseline row).[3] In the alternative scenario, we estimate a 50-percent increase in the average lifetime of a PC in

[1] EPA. (2010). *Electronics Waste Management in the United States through 2010*. Forthcoming. Washington, DC: U.S. Environmental Protection Agency.

[2] We model only *desktop* PCs in this analysis because the WARM PC emission factor is for a desktop central processing unit (CPU) and a cathode ray tube (CRT) monitor. Most PCs sold today have flat panel monitors, which have a very different composition than CRT monitors. Although the number of displays sold is slightly higher (27,205,433) than the number of CPUs, here we assume it is the same, and assume that all displays are CRTs.

[3] Assumptions based on an average of the recycling rates for computers of 38 percent and computer displays of 29 percent, as cited in EPA (2010) with the remainder being disposed of. About 10 percent of municipal solid waste is

the United States. This increase is equivalent to a reduction in the manufacture of 33 percent of PC sales volume in 2009.[4] The assumption that the manufacture of 33 percent of PC sales are reduced comes from assuming that for every 100 computers retired under current conditions, only 67 computers would be retired in the alternative scenario, where the lifetime of PCs has been extended.[5] This translates roughly to increasing the average life of a PC to 10.5 years, from the current seven year average before storage or disposal.[6] As shown in Table 2, when we calculated the alternative scenario, we entered 33 percent (317,934 tons) of the total generated PCs (953,803 tons) in the Source Reduction column, to represent the increased lifetime. The remaining 67 percent of the generated amount was distributed among recycling, landfilling, and combustion in the same relative percentages as in the baseline scenario (33.5, 65, and 1.5 percent, respectively).

Table 2: Baseline and Alternative Scenarios for Lifetime increase of Desktop PCs in the U.S. Sold in 2009

Scenario	PC Generation (Short Tons)	Source Reduction (Short Tons)	Recycled (Short Tons)	Landfilled (Short Tons)	Combusted (Short Tons)
Baseline (current)	953,803	NA	319,524	619,972	14,307
Alternate (50% lifetime increase)	953,803	317,934	213,016	413,315	9,538

The benefits of improving today's computers would only accrue starting several years in the future, but this estimate equals the total benefit over time. The resulting GHG benefits amount to roughly **17.5 million metric tons carbon dioxide equivalent** ($MMTCO_2E$) from the PCs sold in 2009.

Extend the Life of Vinyl Flooring by 25 Percent

The average lifespan of vinyl flooring in a home is about 50 years, according to industry sources.[7] Increasing this lifetime by 25 percent to 62.5 years results in GHG savings from avoided manufacture of virgin vinyl flooring. Assuming a current installation of 50 tons of vinyl flooring (all of which is landfilled in the baseline scenario), this increase in lifetime is equivalent to a reduction in vinyl flooring manufacture of 20 percent, or 10 tons (see Table 3), as calculated by the ratio of the original lifetime to the current lifetime (1/1.25 = 0.80, or a 20 percent reduction in flooring manufacture). WARM estimates this lifetime increase as resulting in **GHG benefits of about 7 $MMTCO_2E$**.

Table 3: Baseline and Alternative Scenarios for Vinyl Flooring Lifetime Increase

Scenario	Vinyl Flooring Generation (Short Tons)	Source Reduction (Short Tons)	Recycled (Short Tons)	Landfilled (Short Tons)	Combusted (Short Tons)
Baseline (current)	50	NA	NA	50	0
Alternate (25% lifetime increase)	50	10	NA	40	0

Caveats

For older PCs to remain useful for an additional 3.5 years, upgrades may be necessary to keep up with software and technology advances. This will reduce the source reduction GHG benefits shown here, since the upgrades may have high energy and GHG impacts. In addition, delaying the purchase of newer,

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combusted (according to Simmons, et al. (2006) The State of Garbage in America. *BioCycle*, 47(4):26), but we assume this proportion is smaller for PCs, which are likely to be picked out by hand before entering the incinerator.

[4] This scenario assumes that all sales of PCs are replacing PCs that were retired.

[5] Based on a simple ratio of current lifetime to increased lifetime of 1/1.5 = 0.67.

[6] EPA (2010).

[7] National Association of Homebuilders/Bank of America Home Equity. (2007). *Study of Life Expectancy of Home Components*. Available at http://www.nahb.org/fileupload_details.aspx/?contentTypeID=3&contentID=51&subContentID=262451.

more energy efficient PCs, may reduce the GHG benefits associated with source reduction due the extended lifetime of the more energy intensive PCs. However, if new PCs are less efficient than previous models, there may be additional GHG benefits associated with the increased lifetime of older PCs.

Increasing the lifetime of vinyl flooring could involve more frequent cleaning and maintenance activities, which could use energy and emit GHGs, thus reducing the benefits shown in this analysis.