SCHOOL of SUSTAINABILITY
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Master of Science

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Will defend her thesis

Hybrid Life Cycle Assessment and Dynamic Trend Measurement of Personal Computers: Energy and Carbon Dioxide Intensity

Abstract

With the rapidly increasing number of personal computers in use, environmental impacts such as energy consumption become important in computer design, use, and management. However, there are two major challenges concerning the assessment of environmental impacts of PCs. First, the supply chain of PCs is extremely complex, and the robustness and accuracy of traditional environmental assessment methodologies could be problematic when studies encounter the complexity of supply chain structure of manufacturing, delivering consuming and recycling electronics. Second, driven by technology progress and consumers' increasing demand for more and more advanced devices, the processes and products of PCs manufacturing sector are evolving rapidly over time. Facing those two challenges, this study first conducts a hybrid life cycle assessment to examine energy use and carbon dioxide emissions of manufacturing and use of a laptop computer. Results are that manufacturing a laptop computer requires 3,009-4,339 MJ of primary energy, 52-67% less than the energy to make a desktop computer, and emits 227-270 kg CO_2. The manufacturing phase represents 63-71% of total primary energy of manufacturing and operation. This indicates, as for desktop computers, that mitigating manufacturing energy use, for example through extending lifespan, can be an important strategy to manage the life cycle energy of laptop computers. Results also indicate that truncation error from excluded processes in the bottom-up process model is significant, perhaps particularly due to complex supply chains of IT products. Thus, this study suggests that some form of hybrid analysis is needed to reasonably estimate life cycle impacts of computers. Second, this study explores the methodology on how to measure trends of environmental impacts in a manufacturing sector whose products and processes evolves rapidly over time. As a start point, the trend of energy intensity of microprocessor manufacturing is measured in this study through functionality

normalization and “typical product” normalization. The functionality results show that electricity use per transistor, displays rapid and sustained reductions over time. In addition, the qualitative nature of the trend is insensitive to the measure of functionality. The results of “typical product” normalization, electricity use per representative CPU, show that the substantial variations from year to year but no clear pattern of either increasing or decreasing over time. Based on the implications of this case study, a dynamic LCA for PCs is proposed for future work.

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Faculty, students, and the general public are invited.

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