

HOW DO YOU MEASURE SUSTAINABILITY?

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Introduction

The word “sustainable” is often used to describe building products, but seldom is the sustainability of these products quantified in a comprehensive, easy-to-compare manner. To truly understand whether a product is sustainable, you must consider all environmental and economic impacts and trade-offs from all stages of a product’s life. Considering a single factor misses many of the costs, both environmental and economic, associated with the product. For example, tightening a building envelope will reduce energy use, but it may also lead to indoor air quality issues.

A scientifically-based approach that implements a collective view of a product is necessary to determine a product’s sustainability. The Building for Environmental and Economic Sustainability (BEES) framework [1], developed by NIST over the past 16 years, allows a product to be analyzed for its sustainability, including life-cycle cost-effectiveness and cradle-to-grave environmental assessment.

Initial Assumptions

There are two assumptions that must be made for sustainability analysis. First, the study period length must be chosen. The study period length may vary depending on the investment time horizon, but the same study period length must be used for both environmental and economic estimates for consistency in the results. Second, the discount rate must be selected based on the relative value of future costs to the first costs of the investment. The discount rate will vary depending on alternative investment returns.

Environmental Performance

Environmental performance of a product is estimated using the environmental life-cycle assessment approach specified in International Organization for Standardization (ISO) 14040 standards [2]. The analysis includes 324 flows mapped to one or more of the 12 environmental categories shown in Figure 1: global warming, acidification, eutrophication, fossil fuel consumption, indoor air quality, habitat alteration, water intake, criteria air pollutants, human health, smog, ozone depletion, and ecological toxicity. These flows cover every aspect of the product’s life span: raw material acquisition, manufacturing, transportation, installation, use, and waste management.

Of the 324 pollutants, 180 have an impact on multiple categories resulting in a total of 504 environmental flows. For example, nitrous oxide impacts both global warming potential and eutrophication, which means nitrous oxide has two environmental flows.

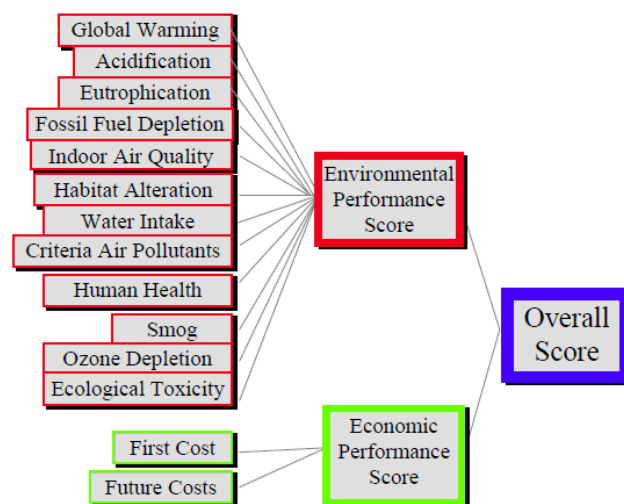


Figure 1. BEES Sustainability Framework.

The environmental flows are measured in many different units. Each flow is normalized as a percentage of the total U.S. flows, which allows the flows to be compared and totaled into an overall environmental score.

Economic Performance

Economic performance is estimated using the life-cycle cost approach defined by the ASTM, International life-cycle costing method [3]. Life-cycle costing includes all costs associated with a product, including the purchase and installation costs, maintenance, repair, and replacement costs, disposal costs, and residual value at the end of the study period length. All costs are discounted to present value dollars based on the discount rate, and summed to estimate the total life-cycle costs.

Performance Score

The environmental performance score is a weighted sum of the normalized environmental flows. The weighting approach used in BEES is based on the ASTM standard for Multi-attribute Decision Analysis [4]. Greater

weight is put towards the attributes that are deemed the most important, which may vary depending on the context of the decision. Note that LEED Version 3 even uses one of the BEES weight sets to allocate LEED credits.

The performance score for the economic costs is based on the total life-cycle cost of the product, and is normalized to the cost per unit of the product where units are common across comparable products.

The environmental and economic performance scores are combined to make an “eco-efficiency” score in which the two factors are weighted according to their importance in the decision at hand. These eco-efficiency scores internalize the trade-offs across products, which allows for direct product comparisons.

Summary

In summary, determining the sustainability of a product requires the determination of its cradle-to-grave performance across a comprehensive range of environmental and economic impacts and trade-offs. Performance relies on many factors that may vary depending on the context of the analysis, including the study period length and weighting scale chosen.

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References

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