

BALANCING THE ENVIRONMENTAL AND ECONOMIC PERFORMANCE OF PRODUCTS

by

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Balancing the Environmental and Economic Performance of Products

The newest version of the BEES life-cycle assessment software can help you choose green building products based on both environmental and economic performance data.

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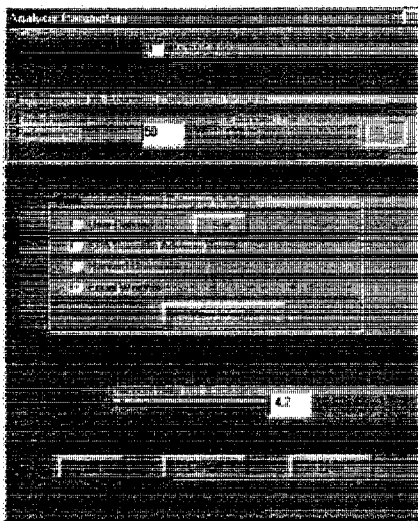


Figure 1. Setting BEES Analysis Parameters

How do you select environmentally preferable products? Is a product environmentally preferable if it has recycled content? Is it not preferable if it offgasses during use? Are mainstream products always less preferable than products marketed and perceived as "environmentally friendly"? Do environmentally preferable products always cost more? The BEES software says, "not necessarily."

BEES (Building for Environmental and Economic Sustainability) provides a powerful technique for selecting cost-effective, "green" building products. Developed by the NIST (National Institute of Standards and Technology) Build-

1. BEES 2.0 Technical Manual and User Guide is also downloadable from the listed web site. If you prefer a free BEES 2.0 compact disc and printed manual, place your order through the EPA Pollution Prevention Information Clearinghouse by calling (202) 260-1023 or e-mailing ppic@epamail.epa.gov.

ing and Fire Research Laboratory with support from the US EPA Environmentally Preferable Purchasing Program and the White House-sponsored Partnership for Advancing Technology in Housing (PATH), the tool is based on consensus standards and is designed to be practical, flexible and transparent. Version 2.0 of the Windows-based decision support software, aimed at designers, builders and product manufacturers, is now available for downloading at no charge (www.bfrl.nist.gov/oe/bees.html).¹ This new version includes actual environmental and economic performance data for over 65 generic building products.

What Does BEES Measure?

BEES measures the environmental performance of building products using the science-based life-cycle assessment approach that has been standardized inter-

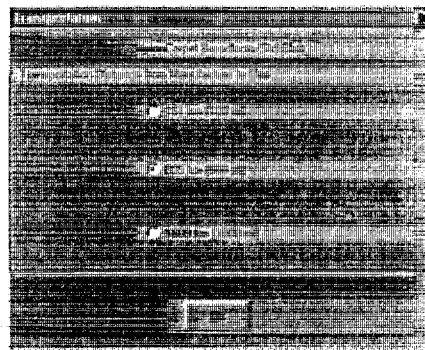


Figure 2. Setting Transportation Parameters

nationally. All stages in the life of a product are analyzed, including raw material acquisition, manufacture, transportation, installation, use, and recycling and waste management. Up to 10 environmental impacts are measured across the following life-cycle stages: global warming, acid rain,

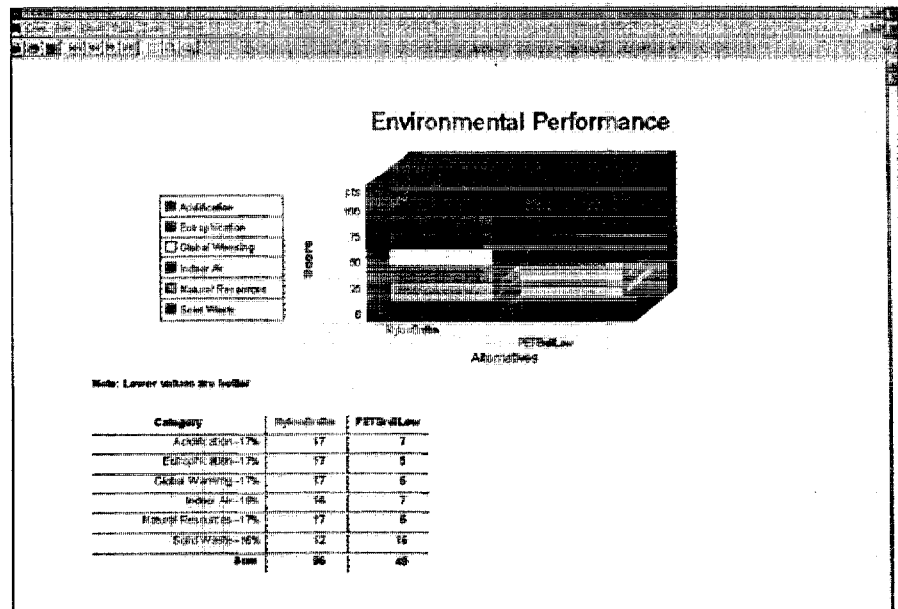


Figure 3. Viewing BEES Environmental Performance Results

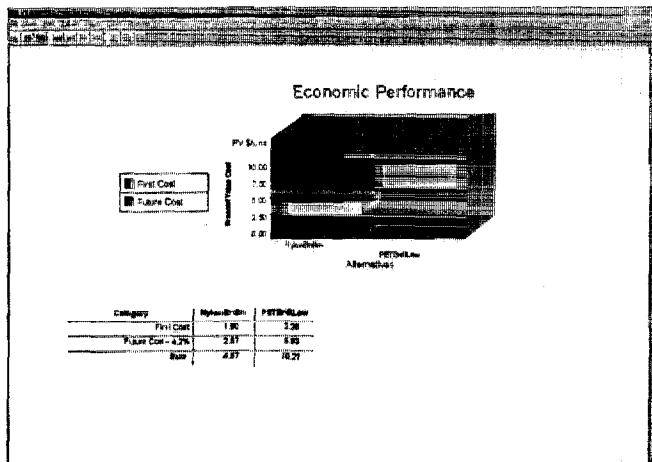


Figure 4. Viewing BEES Economic Performance Results

resource depletion, indoor air quality, solid waste, eutrophication (the unwanted addition of mineral nutrients to the soil and water), ecological toxicity, human toxicity, ozone depletion, and smog. Due to its comprehensive, multi-dimensional scope, life-cycle assessment accounts for shifts of environmental problems from one life-cycle stage to another, or one environmental medium (land, air, or water) to another. The approach highlights the tradeoffs that must be made to genuinely reduce overall environmental impacts.

BEES measures economic performance using similar life-cycle thinking in the form of the standard life-cycle cost method, which covers the costs of initial investment, replacement, operation, maintenance and repair, and disposal. The life-cycle cost method sums these costs over a fixed period of time, known as the study period. Alternative products for the same function, say floor covering, can then be compared on the basis of their life-cycle costs to determine which is the least cost means of covering the floor over the study period.

To combine environmental and economic performance into an overall performance measure, BEES uses the standard for Multi-Attribute Decision Analysis. The BEES user specifies the relative importance weights used to combine environmental and economic performance scores and may test the sensitivity of the overall scores to different set of relative importance weights. Supporting data and computations are documented.

Using BEES to Compare Products

So how can you use BEES to compare the environmental and economic performance of competing products? Let's run through an example. Suppose we're considering two floor coverings: 1) a broadloom nylon carpet installed using a standard glue, a mainstream alternative, and 2) a broadloom carpet made from PET (recycled soft drink bottles) and installed using a low-VOC glue (a glue emitting relatively low levels of volatile organic compounds), a product promoted as an environmentally friendly alternative.

The first step is to set our analysis parameters using the BEES window shown in Figure 1. If we do not wish to combine environmental and economic performance measures into a single score, we can select the "no weighting" option and still compute disaggregated BEES results. Otherwise, we need to set importance weights. For this example, environmental performance and economic performance are of equal importance, so both are set to 50%. Next, we need to set relative importance weights for the

BEES

environmental impact categories included in the BEES environmental performance score. We select a built-in weight set derived from an EPA Scientific Advisory Board Study. Our last parameter is the real discount rate used to convert future building product costs to their equivalent present value. Here, we accept the default rate of 4.2%, the rate mandated by the U.S. Office of Management and Budget for most Federal projects.²

Next, we need to set one last parameter for each of your floor covering alternatives: the transportation distance from the manufacturing facility to the building in which the product will be installed. This parameter lets BEES compute an environmental performance score accounting for the significance of using locally produced products. As illustrated in Figure 2 (p. 24), we have selected a transportation distance of 805 km (500 mi) for our nylon carpet alternative.

Now we are ready to compute and view BEES results. Figure 3 (p. 24) shows the BEES Environmental Performance Results displaying the weighted environmental performance scores for our example. Lower values are better; if a product performs worse with respect to all environmental impacts, it receives the worst possible score of 100. In our example, the nylon broadloom carpet received a score of 96, and the PET broadloom carpet a score of 49. The graph breaks down the weighted environmental score by its six contributing impact scores: Global Warming Potential, Acidification Potential, Eutrophication Potential, Natural Resource Depletion, Indoor Air Quality, and Solid Waste. As shown, PET carpet performs better on all impact categories except solid waste.

Figure 4 (p. 25) shows the BEES Economic Performance Results for our example, which gives first costs, discounted future costs and their sum, the life-cycle cost. The graph shows that PET broadloom carpet has a higher life-cycle cost, with both a higher first cost and higher future costs (due to its higher and more frequently-occurring replacement cost). Thus, based

Continued on page 110.

2. Office of Management and Budget (OMB) Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, Washington, DC, October 27, 1992 and OMB Circular A-94, Appendix C, February 2000.

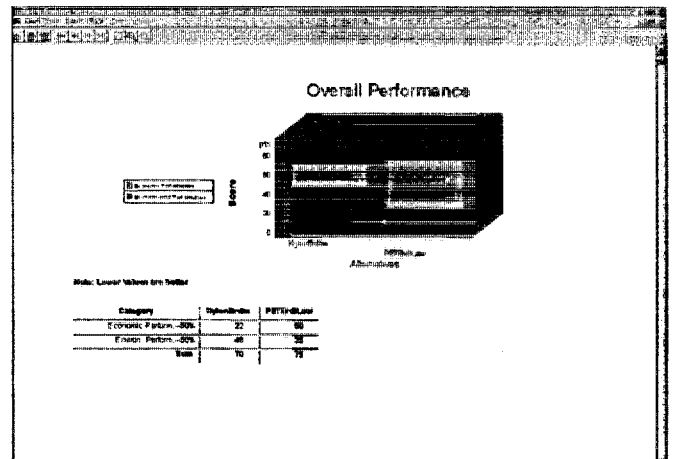


Figure 5. Viewing BEES Overall Performance Results

on our parameters, PET broadloom carpet scores better environmentally, while nylon broadloom carpet scores better economically.

The overall performance score gives us a way to combine and balance the environmental and economic performance scores. Figure 5 shows the BEES Overall Performance Results based on our equal weighting of environmental and economic performance. It displays the overall performance score for each product alternative, which is the sum of the weighted environmental and economic performance scores. We can see from this graph that

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nylon broadloom carpet receives a score of 70 and PET broadloom carpet a score of 75. Thus, based on our analysis parameters, nylon broadloom carpet installed with a standard glue is slightly preferable overall to PET broadloom carpet installed with a low-VOC glue. Note that besides the summary graphs shown here, BEES also offers detailed graphs for each environmental impact (e.g., reporting grams of carbon dioxide each product contributes to the global warming impact), which help pinpoint the "weak links" in a product's environmental life cycle.

Evaluating the Tradeoffs

Applying the BEES approach to the dozens of other products included in BEES 2.0 (including framing, exterior and interior wall finishes, wall and roof sheathing, ceiling and wall insulation, roof and floor coverings, slabs, basement walls, beams, columns, parking lot paving and driveways) leads to several general conclusions. First, environmental claims based on single impacts, such as indoor air quality alone, should be viewed with skepticism. These claims do not account for the fact that other impacts may indeed cause equal or greater damage. Second, assessments must always be quantified on a functional unit basis as they are in

BEES, such that the products being compared are true substitutes for one another. One roof covering product may be environmentally superior to another on a kilogram-for-kilogram basis, but if that product requires twice the mass as the other to cover one square meter of roof, the results may reverse. Third, a product may contain a high-impact constituent, but if that constituent is a small portion of an otherwise relatively benign product, its significance decreases dramatically. Finally, a short-lived, low first-cost product is often not the cost-effective alternative. A higher first cost may be justified many times over for a durable, maintenance-free product. In sum, the answers lie in the tradeoffs.

BEES will be expanded and refined over the next several years. First, many more products will be added to the system so that entire building components and systems can be compared. To that end, manufacturers are encouraged to submit brand-specific performance data through the new BEES Please program

(contact: blippiatt@nist.gov). Second, more environmental impacts, such as habitat alteration, are under development for incorporation into future versions of BEES. Finally, US region specificity and greater flexibility in product specifications (e.g., useful lives) are being incorporated. The intended result is a cost-effective reduction in building-related contributions to environmental problems. **EDC**

About the Author: Barbara C. Lippiatt is an economist at the Office of Applied Economics, Building and Fire Research Laboratory, National Institute of Standards and Technology. She develops economic decision methods and tools for efficiently designing and managing buildings. Two of her software publications have been on the National Technical Information Service's Bestseller list; one is being distributed by the EPA, US Department of Energy and US Green Building Council, and another by the National Fire Protection Association. She can be reached at blippiatt@nist.gov.