BEES Online 2.0 Summary

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BEES (Building for Environmental and Economic Sustainability) is a software tool that implements a powerful technique for selecting cost-effective, environmentally-preferable building products. Developed by the NIST (National Institute of Standards and Technology) Engineering Laboratory's Applied Economics Office, BEES is based on consensus standards and designed to be practical, flexible, and transparent. The most recent version, BEES Online (2011), is a web application aimed at designers, builders, and product manufacturers, includes actual environmental and economic performance data for over 230 building products.

BEES Online measures the environmental performance of building products by using the life-cycle assessment (LCA) approach specified in the ISO 14040 series of standards. All stages in the life of a product are analyzed: raw material acquisition, manufacture, transportation, installation, use, and end-of-life. Economic performance is measured using the ASTM standard life-cycle cost method, which covers the costs of initial investment, replacement, operation, maintenance and repair, and disposal. Environmental performance and economic performance can be combined into an overall performance measure using the ASTM standard for Multi-Attribute Decision Analysis. For the entire BEES Online analysis, building products are defined and classified according to the ASTM standard classification for building elements known as UNIFORMAT II.

NIST recognizes that the current version of BEES should be updated, both in terms of the software interface and the underlying impact methods and data. Given new requirements for LCA in green certification programs, such as MRc2 – Building Product Disclosure and Optimization: Environmental Product Declaration in USGBC's LEED v4, it is apparent that the use of Environmental Product Declarations (EPDs) based on industry-defined Product Category Rules (PCRs) is a strong trend in the industry that will continue to grow in the future. Therefore, NIST will be developing a new version of BEES Online (BEES 2.0) – which will be specifically designed to address the needs of a broad range of stakeholders (architects, designers, government agencies, certified LCA practitioners, green certification organizations, and consumers). Users will be able to compare product LCAs, including LCAs that correspond with industry PCRs.

Discussions regarding new proposed changes to BEES have already taken place with officials from a number of stakeholders, including USGBC, American Chemistry Council (ACC), DOE Federal Energy Management Program, General Services Administration, Federal government

interagency environmental and sustainability groups/committees, as well as a number of informal conversations with industry and manufacturers. Based on stakeholder feedback to date, the software design for the initial version of BEES 2.0 is projected to include the following features:

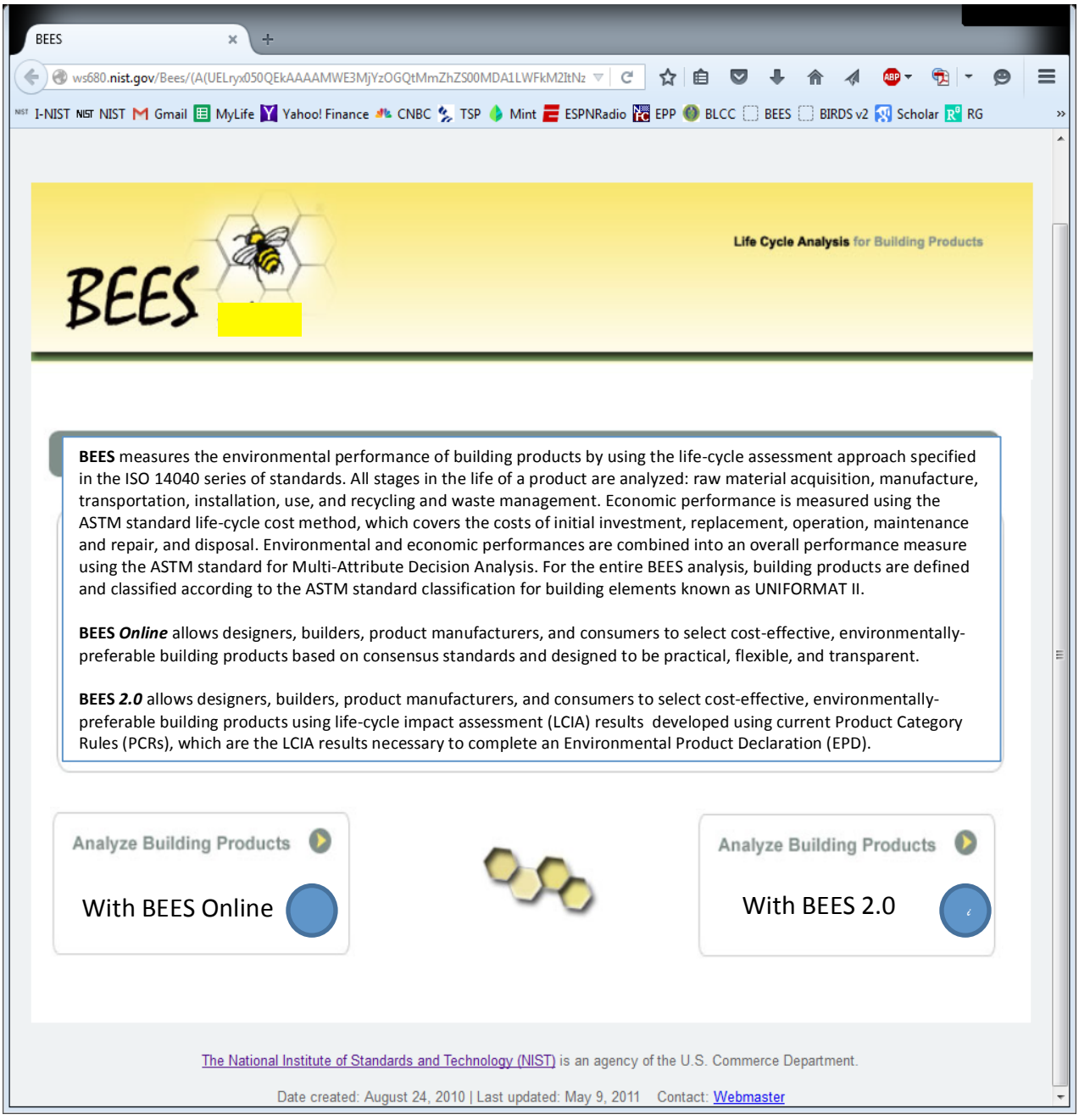
(1) Modern looking, user friendly graphical interface.
(2) Auto-populating of parameter selections based on the desired "Analysis Type" (e.g. "get products for green building certifications"; "federal agency green acquisitions requirements")
(3) Products to be filterable based on different characteristics like recycled content, bio-based content, or product certification. The ability to filter will be important for selections that are made based on acquisition requirements not necessarily based on the LCA.
(4) A variety of results options, including the results categories required by the PCR, the traditional BEES environmental and cost categories, and the social cost of carbon.[1]
(5) Downloadable results to allow users to analyze the results in ways not currently allowed within BEES Online.
(6) Updated flooring products using the most current LCIA Methods (TRACI 2 and CML), most recent LCI databases, and appropriate ASTM (economic) and ISO (LCA) Standards. Accordingly, results can be limited to the categories required by the PCR (i.e., subset of TRACI 2 or CML).
(7) Future integration of current BEES Online product categories, based on the appropriate PCR, for seamless expansion.

[1] Offering so many variations of results allows for inclusion of other categories should PCR requirements change in the future. Social cost of carbon will be included if time allows.

BEES 2.0 Visual Representations and Commentary

Main Page

The existing BEES Online main page will be the starting point for BEES 2.0. A link to the new BEES 2.0 will direct the user to the new web application.



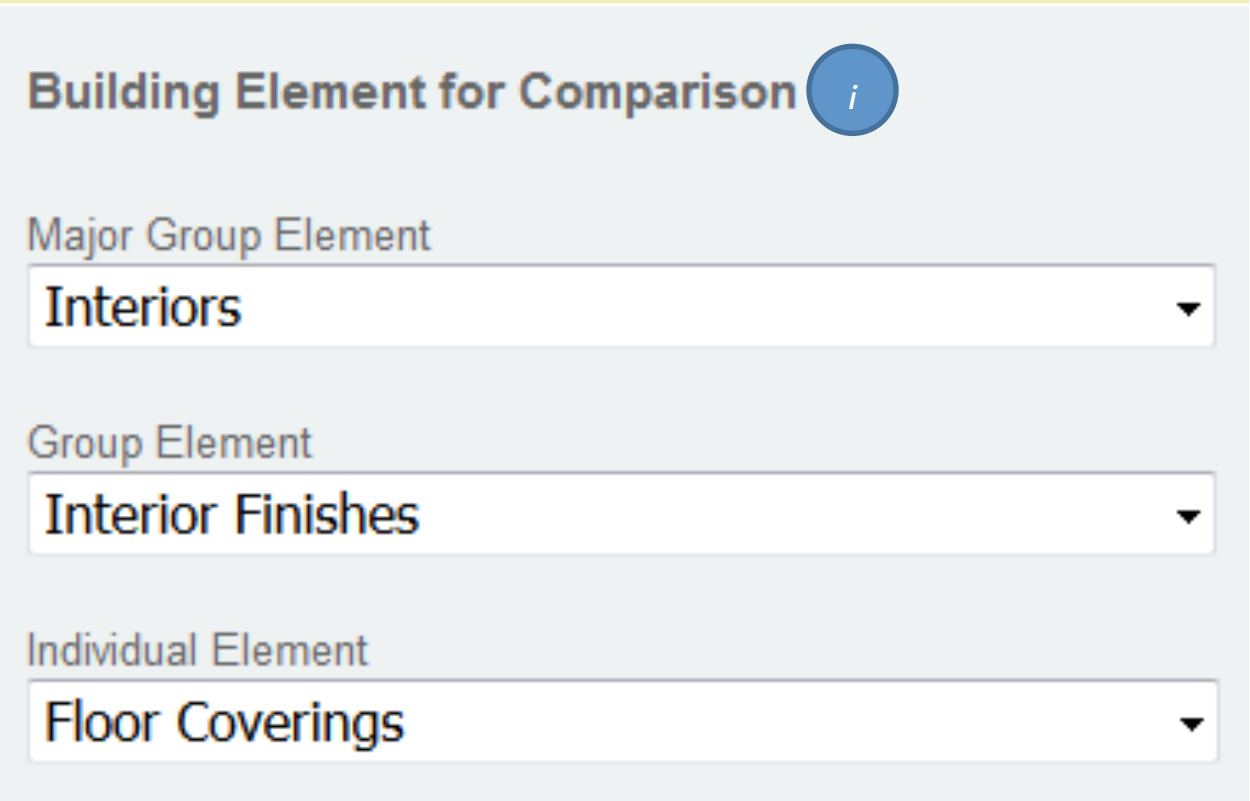
Once the user clicks on the “BEES 2.0” button, the user is taken to the BEES 2.0 main page, which is similar to the BEES main page. The user can either go through the tutorial or begin to analyze products.

Throughout this document tabs in the excel spreadsheet and columns identifying specific data will be in the format [tab name].[column name].

Step 1: Select Product Category

Below is the information that will be required to select for Step 1 in BEES 2.0.

What building product category would you like to analyze?



The Building Element dropdown boxes should function as a group. The Major Group Element is populated from column [Product Categories – UNIFORMAT].LEVEL1 unique records. Group Element is populated from column [Product Categories – UNIFORMAT].LEVEL2 based on the user selection of Major Group Element. Individual Element is populated from column [Product Categories – UNIFORMAT].LEVEL3 based on the user selection of Major Group Element and Group Element.

Display Item	Table	Column	Detail
Major Group Element dropdown	ProductCategories-UNIFORMAT	Level1	Unique Level1
Group Element dropdown	ProductCategories-UNIFORMAT	Level2	Based on selected Major Group
Individual Element dropdown	ProductCategories-UNIFORMAT	LEVEL3	Based on selected Group Element and selected Major group Element

Step 2: Filtering

[Check box]Do you want to select products based on Detail 1?

If yes then provide additional selection check boxes that are unique values from column [Product Information].Detail 1 for selected product category. For flooring the list should include: Wood, Carpet, Tile, Vinyl, Bamboo, Cork, Terrazzo

[Check box]Do you want to filter based on a characteristic or certification?

If yes then provide additional selection radio buttons that are unique values from column [Product Categories - UNIFORMAT].CategoryCertificationIDArray for selected product category.

Step 3: Select Analysis Type and Impact Method

The third step is to select the type of analysis you want to do. We will include an option for each specific program/certification/purchasing for which BEES 2.0 is approved. In this example, we have included one for "green building certification." In cases where there may be multiple options under a type of analysis (e.g. recycled or bio-based content requirements for green acquisitions), there will be a nested list whereby selecting the analysis type, the sub-list will appear. If the user selects products towards "green building certification," the economic performance will not be included because the PCR does not include any such information. The user will also have the option to make a custom analysis, which will allow for the implementation of the traditional BEES economic and environmental metrics.

By selecting a specific type of analysis, the LCIA Impact Method will be auto-populated. If the user selects a custom analysis, the user will see two follow up questions. The first is for selection of the LCIA Impact Method while the second is for the discount rate to be implemented in the economic analysis:

What LCIA Impact Methodology would you like to implement in your analysis?

- PCR Impact Categories
- TRACI 2
- CML
- BEES (TRACI 2 + 3 Others)

What Discount Rate would you like to use? 

X %

Allow user to input numeric value only.

Step 4: Review Analysis Selections

The user will see a table of all the assumptions to be used for the analysis. The user can determine whether to continue with the analysis or change an input. The "additional restriction" would only apply if the user desires to only look at products with a specific characteristic (e.g. certification or a specific material content).

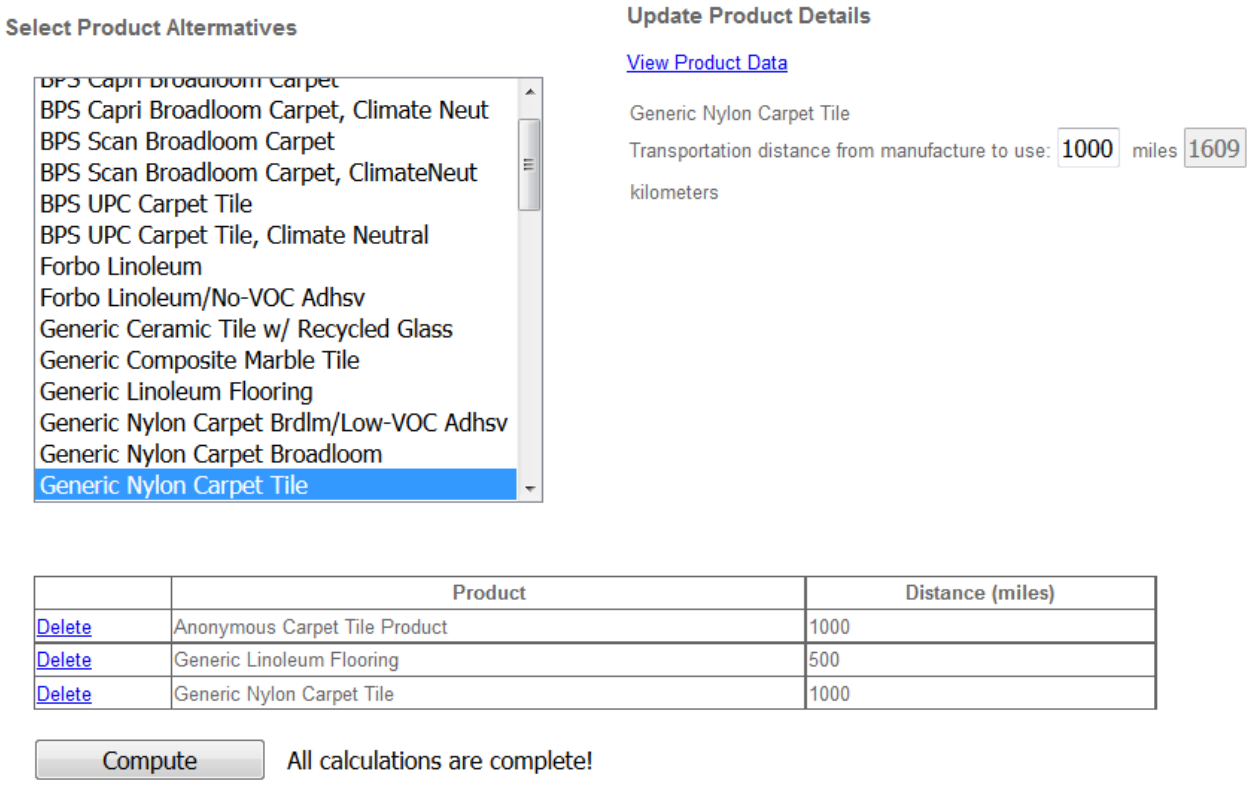
This data will come from user selections.

Selections	**Summary**
Parameter	Selection Value
Product Category	Flooring
Discount Rate	3.0 %
Analysis Type	Select Product for Green Certification
Additional Restriction	None
Impact Method	PCR Categories

Step 5: Select Products for Comparison

The user then selects which products they want to compare, which could include generic products and/or specific product lines from manufacturers. The product list will be improved to be more user friendly by developing a clear format (product type – manufacturer – product line – product line detail). The data to be displayed here is in the table Product Information. The products in the list will be filtered based on the "additional restrictions" offered in Step 3. Transportation distance to installation for a selected product will be displayed to assist the user in selecting products. The column [Product Information].Distance to install (mi) contains this information. Current plans for the tool allow the user to change the transportation distance, although this value may be fixed if the PCR specifies the distance. Detailed product data can also be retrieved by way of the View Product Data link. The selected products will be displayed at the bottom as shown below.

The compute button will query data and calculate the LCC and LCIA results based on the user's selected parameters.



Step 6: Calculations

Life-Cycle Costs:

Use the [Product Information] table for the LCC calculation.

$/unit: [Product Information].Cost/ft2

Discount rate: d from user input

Replacement years: [Product Information].Lifetime

Study Period: T = 60 for all products

$$\text{LCC} = \sum_{i=1}^{I} \left[\frac{\$/unit}{(1+d)^{Lifetime*(i-1)}} \right] - \frac{\$/unit * \frac{[Lifetime-(T-Lifetime*I)]}{l}}{(1+d)^{T}}$$

Environmental Impacts

Based on the Impact Methodology selected in the user inputs, the LCIA results will be obtained from [Product LCIA Results].

If the user selects…

TRACI 2, then select data from Columns [Product LCIA Results].A1-[Product LCIA Results].A9 for each product ([Impact Categories].TRACI2)

BEES (TRACI 2 + 3 Others), then select data from Columns [Product LCIA Results].A1-[Product LCIA Results].A12 for each product ([Impact Categories].BEES)

CML, then select data from Columns [Product LCIA Results].B1-[Product LCIA Results].B13 for each product ([Impact Categories].CML)

PCR Impact Categories, then select the impact categories from [Impact Categories].PCR for the UNIFORMAT product category.

Make the following calculations, where…

Study Period T= 60

l represents the value for a single lifetime of the product

$\boldsymbol{t}$ represents the value for a single year of the product's use

$\boldsymbol{I}$ represents the number of installations from [Product LCIA Results].# installs-60 yrs

$\boldsymbol{m}$ represents the number of miles the product travels for each installation from [Product LCIA Results].Distance to install (mi)

RM represents raw materials

MANUF represents manufacturing

TRANS represents transportation

INSTALL represents installation

$$RM_T = RM_l * I$$

$$MANUF_T = MANUF_l * I$$

$$TRANS_T = TRANS_l * m * I$$

$$INSTALL_T = INSTALL_l * I$$

$$EOL_T = EOL_l * I$$

$$PROD_T = RM_T + MANUF_T + TRANS_T + INSTALL_T + EOL_T$$

$$USE_T = USE_t * T$$

$$F_T = PROD_T + USE_T$$

For each product, this calculation is completed for each of the 12 environmental impact categories for the specific impact methodology selected.

Step 7: Analysis Results

The results should be available for download as well as display in tables within the interface.

Download

From a link or a button, the user should be able to download the calculated data in csv format. The data to include is shown in the table below:

Product Category
Product ID
Product Line
Lifetime
Installs
Distance
RM_T (Value for each Impact Category)
$MANUF_T$ (Value for each Impact Category)
$TRANS_T$ (Value for each Impact Category)
$INSTALL_T$ (Value for each Impact Category)
EOL_T (Value for each Impact Category)
$PROD_T$ (Value for each Impact Category)
USE_T (Value for each Impact Category)
FT_T (Value for each Impact Category)
Life-Cycle Costs

Summary Reports:

A summary report should be generated, which will include results tables as shown below. The LCC for all products compared can be displayed in a single graph while the environmental results will require a table for each product compared.

Economics Table

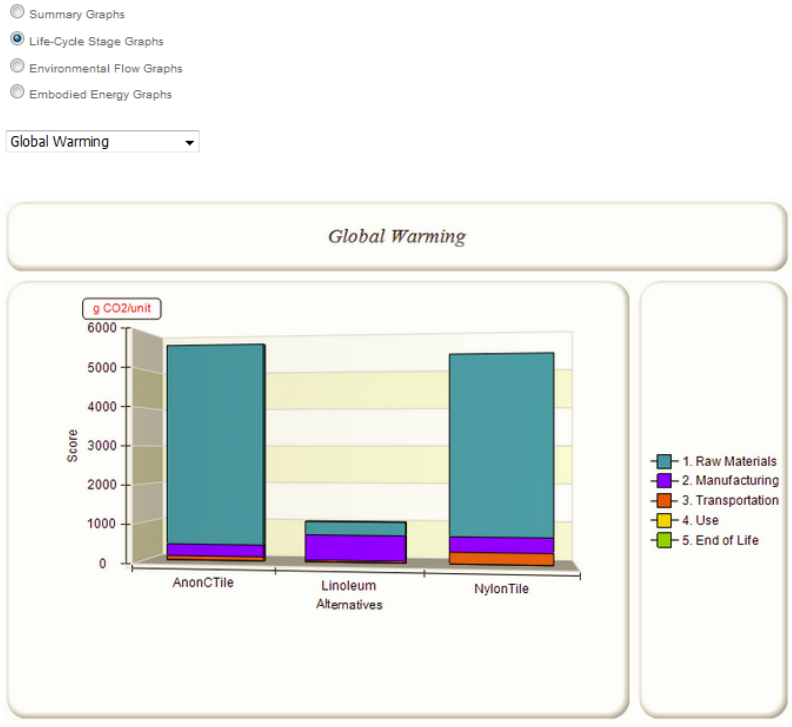
Results	**Product**		
Metric	X	Y	Z
LCC ($/unit)	LCC_X	LCC_Y	LCC_Z

Environmental Table – Single Table for Each Product

Product X	Life-Cycle Stages							Product Life	Total for Bldg. Service Life (60Yr)
	(Over 60 Yr Building Service Life)						Use (60-Yr)		
Metric	Raw Mat.	Manuf.	Transp.	Installation	EOL	Total			
Impact Category (Units)	RM_T	$MANUF_T$	$TRANS_T$	$INSTALL_T$	EOL_T	$PROD_T$	USE_T	l	F_T
…	…	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…	…
IC_N	…	…	…	…	…	…	…	…	…

Extra Challenge

Graphical representations of the results would be beneficial as well, and could include stacked bar graphs by environmental impact. The user will be able to select specific data for which to see graphical representations, which helps to easily compare products. Below is an example from BEES Online of the types of environmental comparisons that may be included in BEES 2.0. The data for this graph is located in [Product LCIA Results]. You can see the functionality desired by looking at BEES Online at http://ws680.nist.gov/Bees/.



Note: Lower values are better

Category	AnonCTile	Linoleum	NylonTile
1. Raw Materials	5234.7272	343.8419	4632.4248
2. Manufacturing	306.2365	653.8358	391.8796
3. Transportation	107.7307	44.2780	300.3960