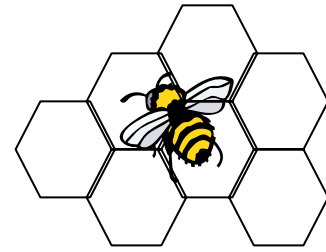
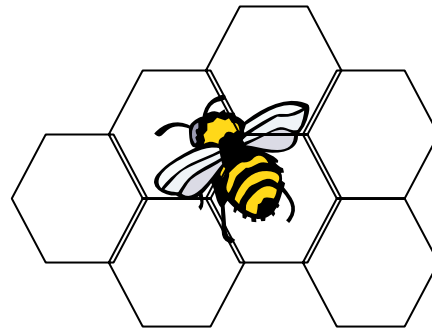


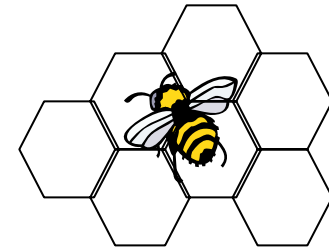
What Makes a Product Sustainable?



NIST Sustainability Performance Metrics and Tools



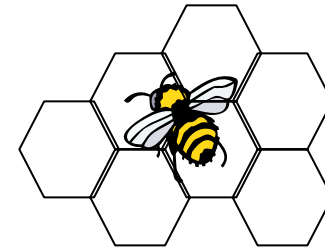
Barbara C. Lippiatt
U.S. Department of Commerce
National Institute of Standards and Technology



BEEES Sponsors

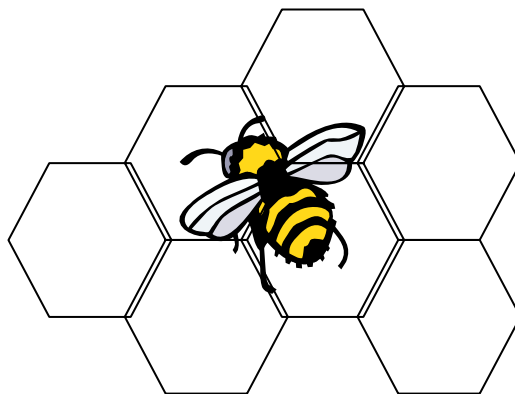
- U.S. Department of Agriculture
- U.S. Department of Energy
- U.S. Environmental Protection Agency
- National Institute of Standards and Technology (NIST)

BEEES

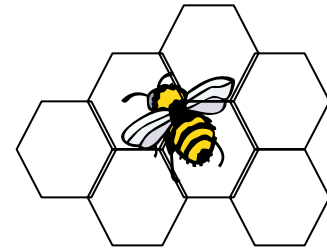


- Model
- Applications
- What's the Buzz?

BEES Model



What is Sustainability?



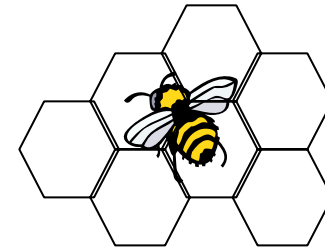
■ Definition

- *Meeting the needs of the current generation without compromising the ability of future generations to meet their own needs*

■ Life-Cycle Performance

- Social
- Environmental
- Economic

Sustainable Social Performance

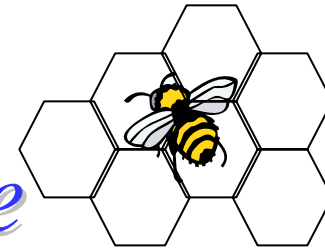


Agricultural Production

- Creates new jobs in rural communities
- Provides new markets for farm commodities



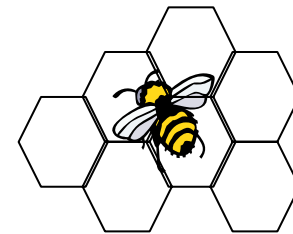
Sustainable Environmental Performance



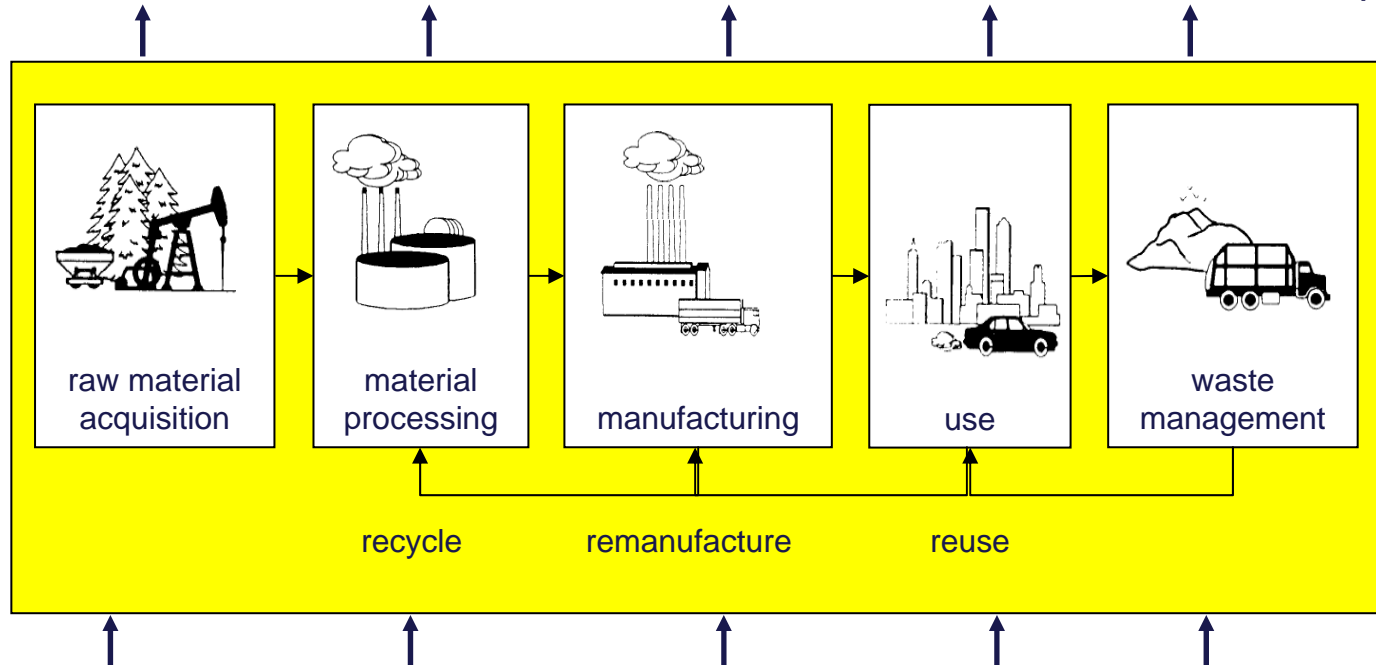
Industry Scale

- Take Life-Cycle Assessment Approach
- Follow Consensus Standards
 - Environmental Life-Cycle Assessment (ISO 14040)
 - Evaluating and Reporting Environmental Performance of Biobased Products (ASTM D7075)
 - Multiattribute Decision Analysis (ASTM E1765)
- Produce Consistent, Comparable Metrics

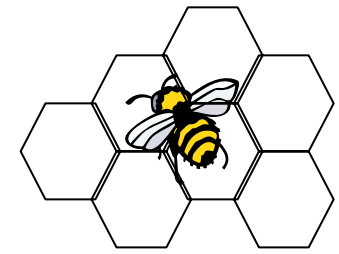
Life Cycle Assessment



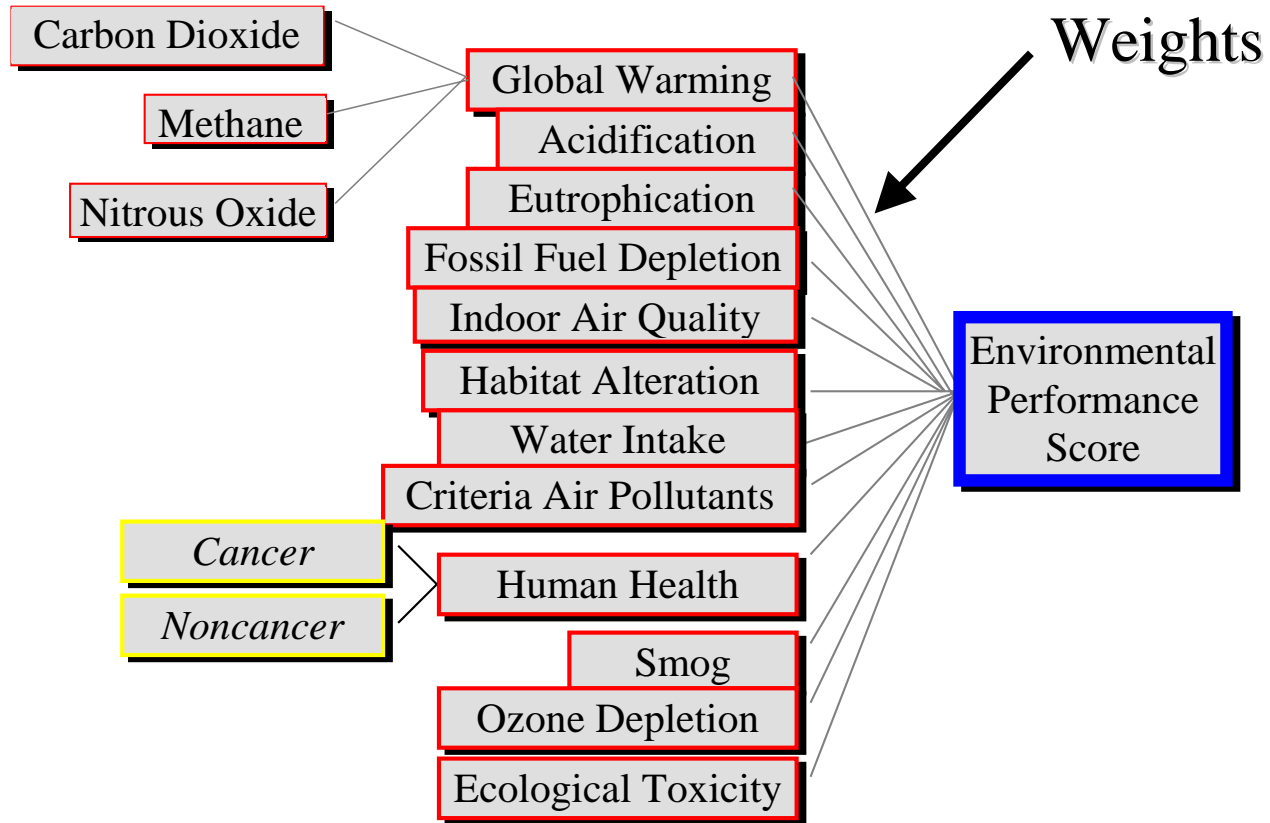
OUTPUTS: Products, Water Effluents, Air Emissions, Waste, Other Outputs



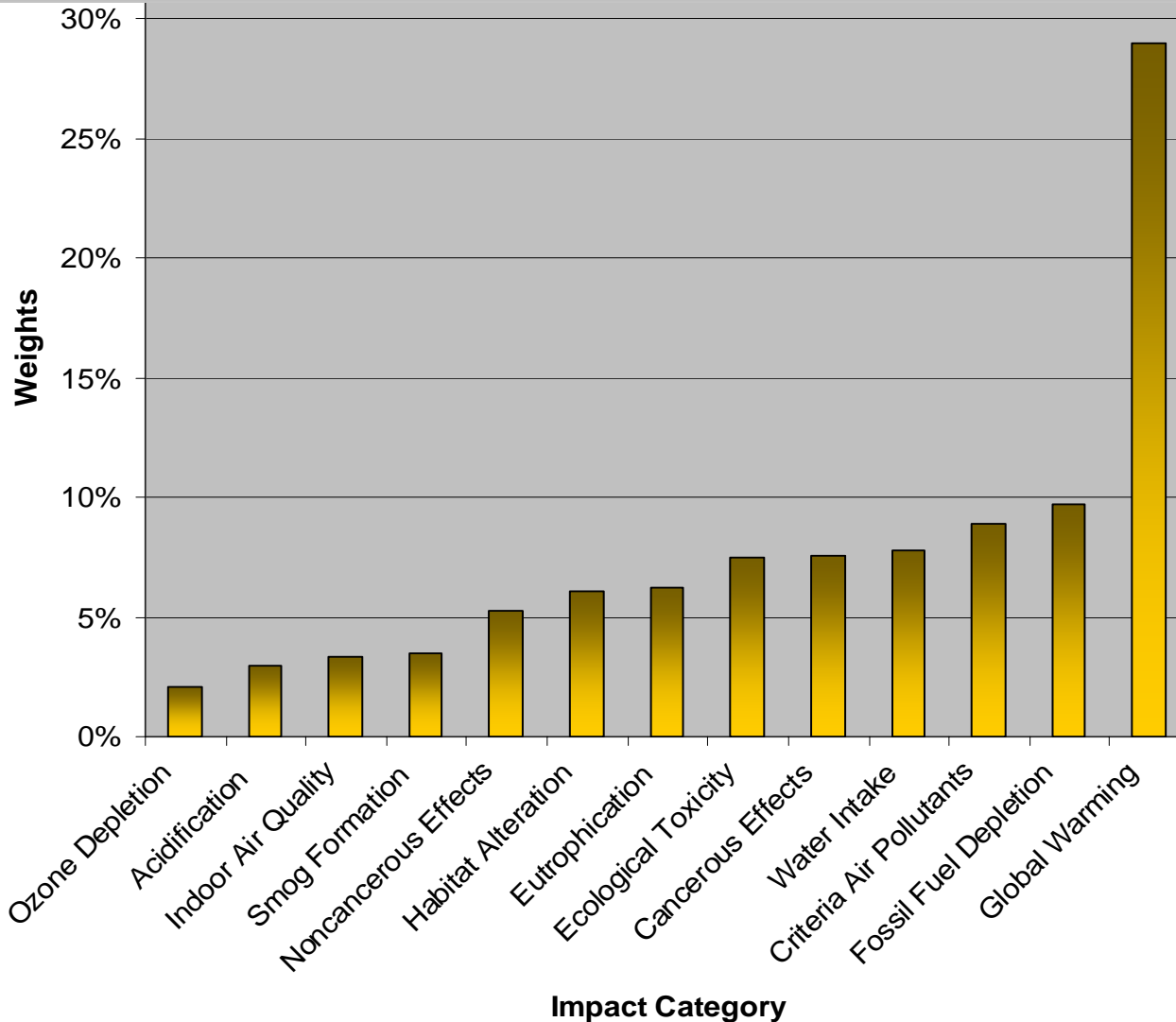
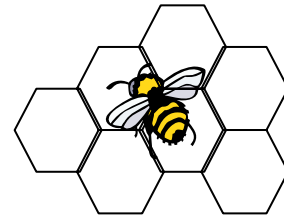
INPUTS: Materials, fuel, water, other inputs

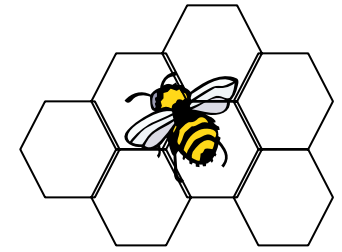


BEES 4.0 Model



Environmental Weights: BEES Stakeholder Panel



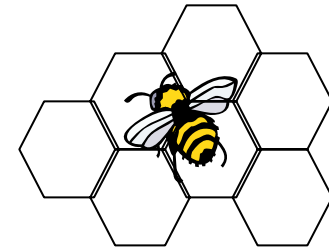


BEES Products

- **230+ Building Products**

- **100+ Biobased Products**
 - Gasoline Fuel Additives
 - Diesel Fuel Additives
 - 2-Cycle Engine Oils
 - Hydraulic Fluids
 - Transformer Fluids
 - Lubricants
 - and more...

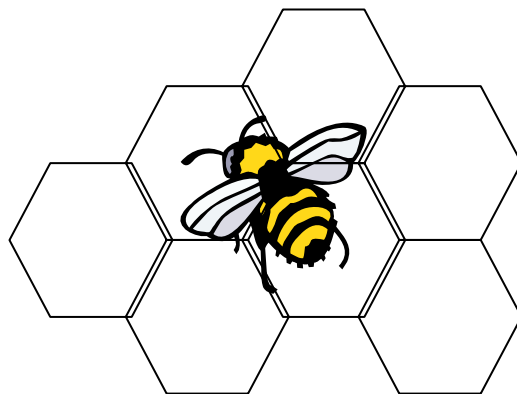
Sustainable Economic Performance



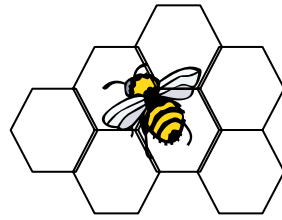
Industry Scale

- Take Life-Cycle Approach
- Follow Consensus Standards
 - Life-Cycle Costing (ASTM E917)

BEES Applications



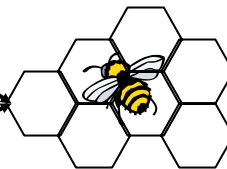
Federal BioPreferred Program



biobased content
functional
performance

cost performance
environmental
performance

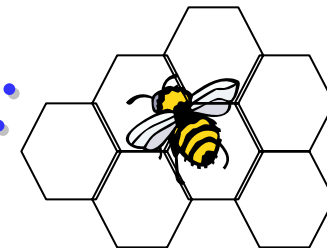
availability



BEES

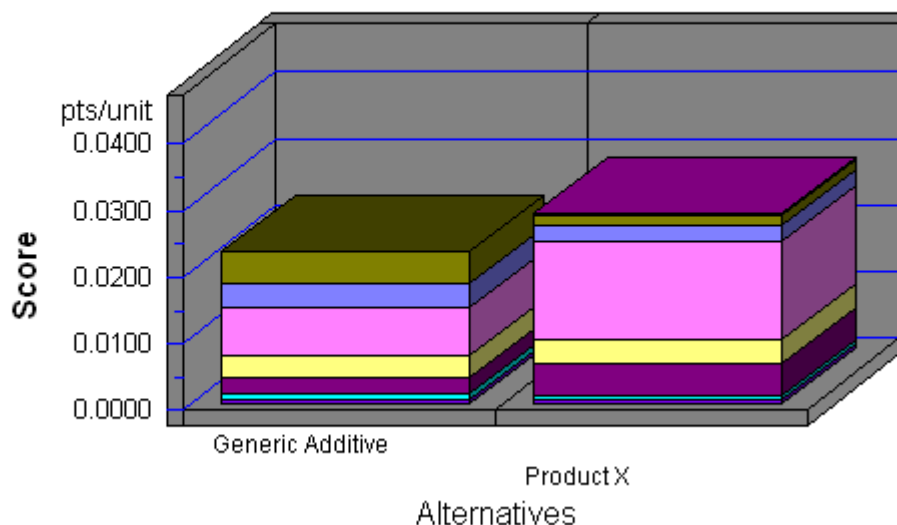
Item
Designation

BioPreferred BEES Results: Diesel Fuel Additives

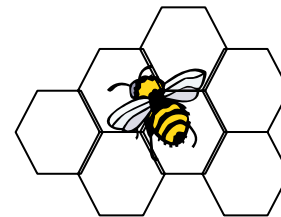


Environmental Performance

Acidification
Crit. Air Pollutants
Ecological Toxicity
Eutrophication
Fossil Fuel Depletion
Global Warming
Habitat Alteration
Human Health
Indoor Air
Ozone Depletion
Smog
Water Intake

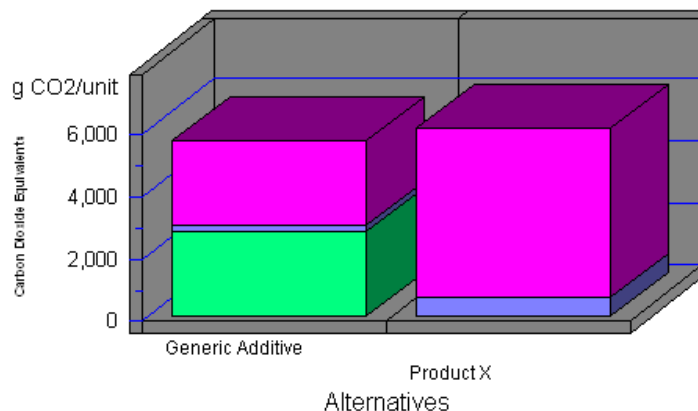


BioPreferred BEES Results: Diesel Fuel Additives



Global Warming by Flow

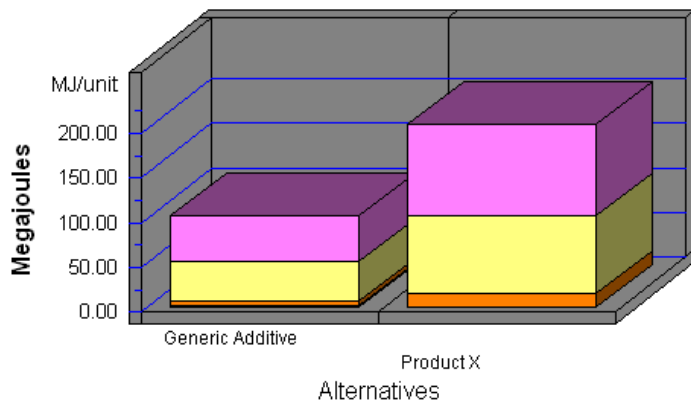
Carbon Dioxide
Carbon Tetrachloride
Carbon Tetrafluoride
CFC 12
Chloroform
Halon 1301
HCFC 22
Methane
Methyl Bromide
Methyl Chloride
Methylene Chloride
Nitrous Oxide
Trichloroethane



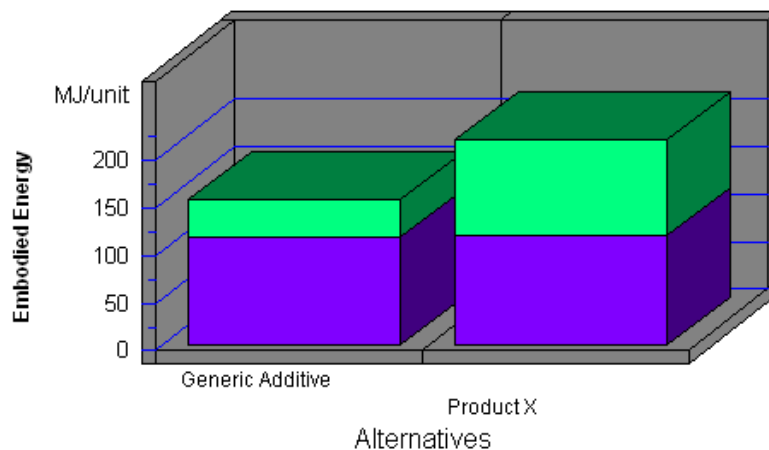
Nonrenewable Energy
Renewable Energy

Fossil Fuel Depletion by Life-Cycle Stage

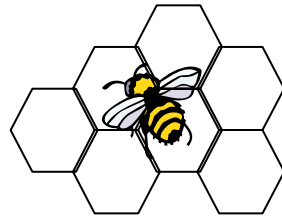
Raw Materials Acquisition
Manufacturing
Transportation
Use
End of Life



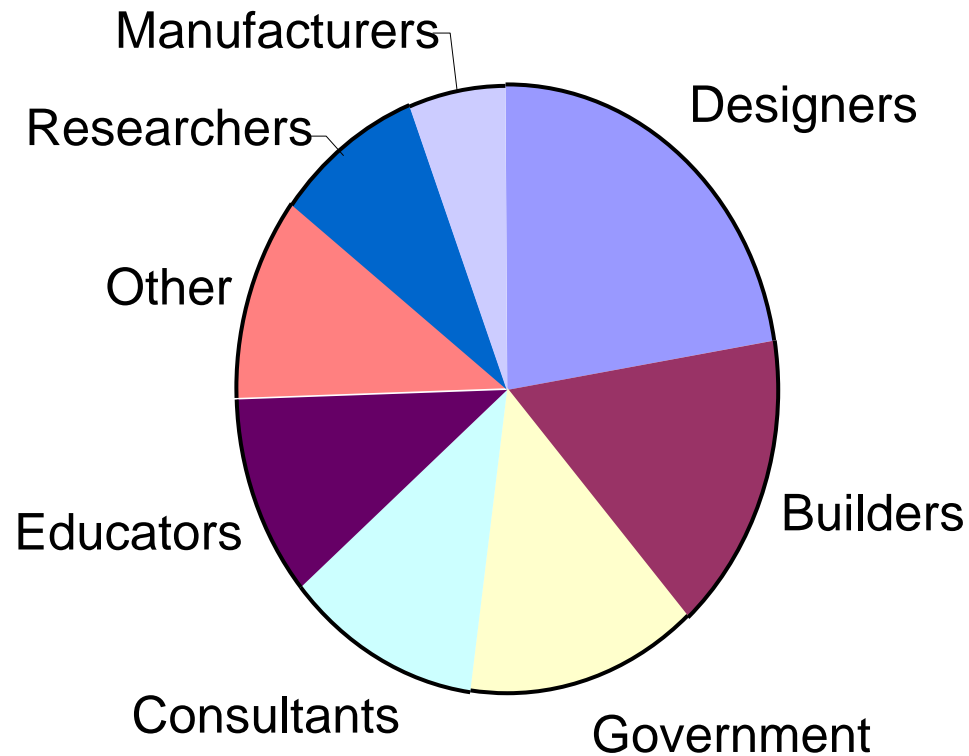
Embodied Energy by Fuel Renewability



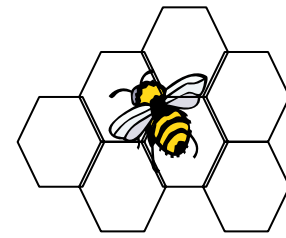
BEES 4.0 Application



24,000+ users from 80 countries

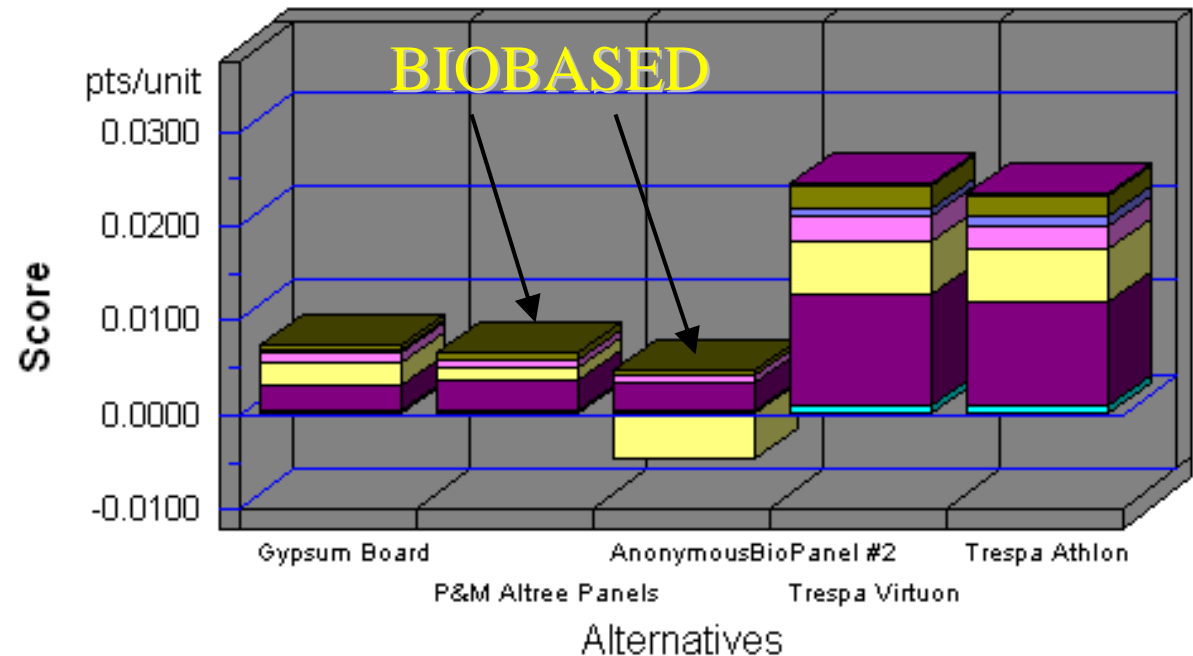


BEES 4.0 Results: Interior Wall Partitions

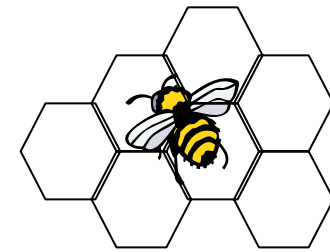


Environmental Performance

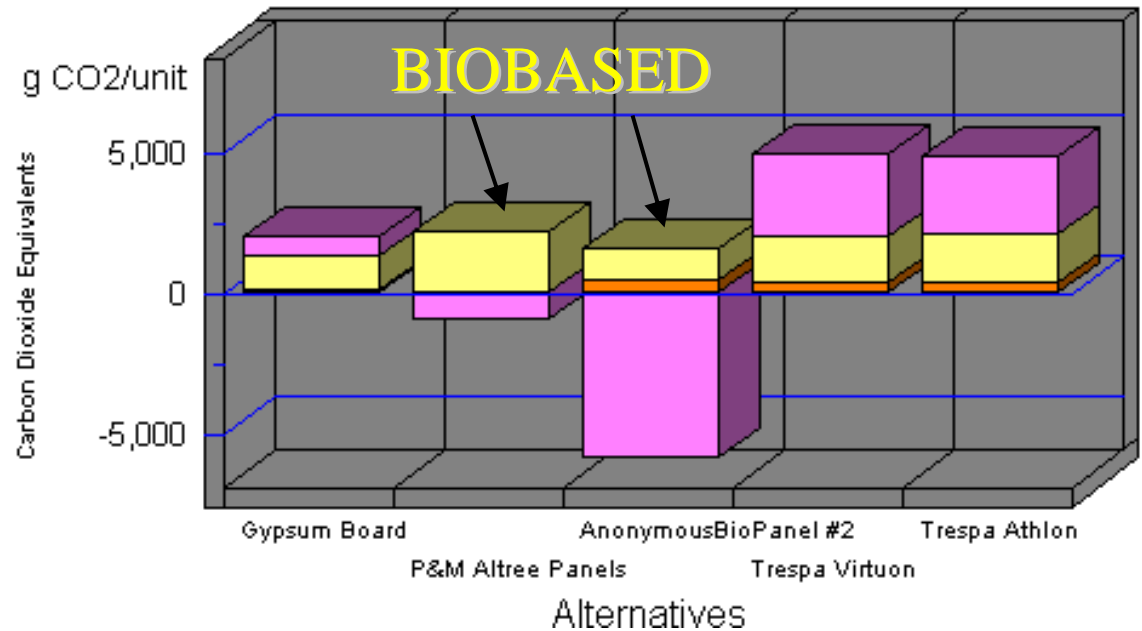
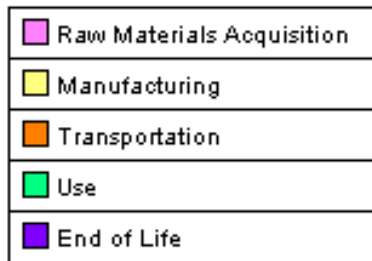
	Acidification
	Crit. Air Pollutants
	Ecological Toxicity
	Eutrophication
	Fossil Fuel Depletion
	Global Warming
	Habitat Alteration
	Human Health
	Indoor Air
	Ozone Depletion
	Smog
	Water Intake



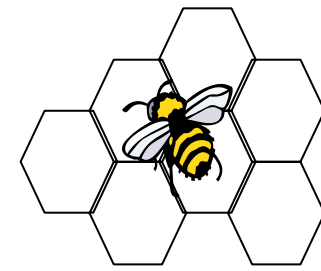
BEES 4.0 Results: Interior Wall Partitions



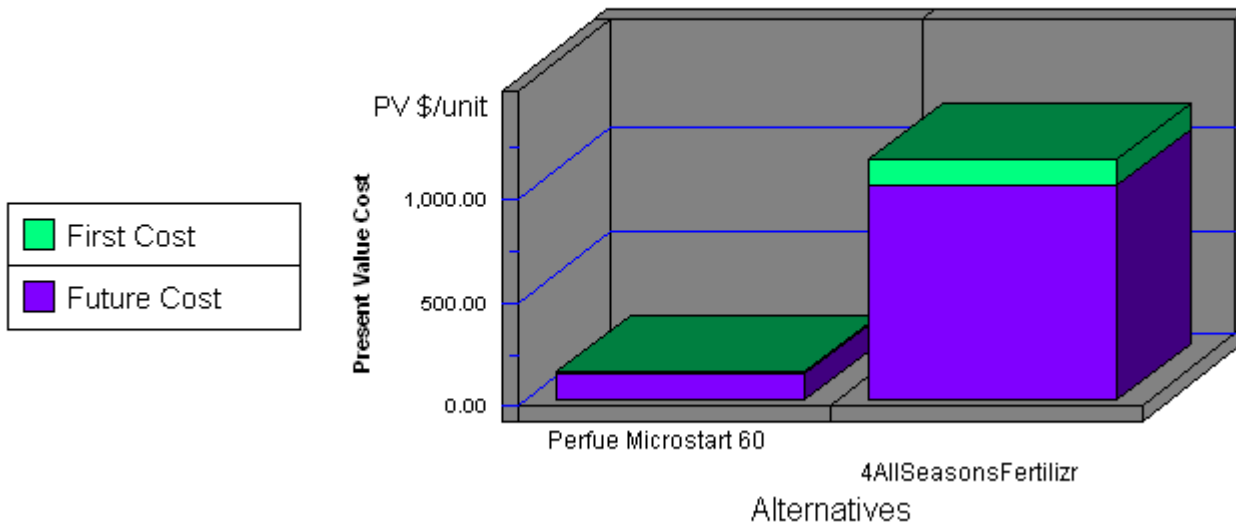
Global Warming by Life-Cycle Stage



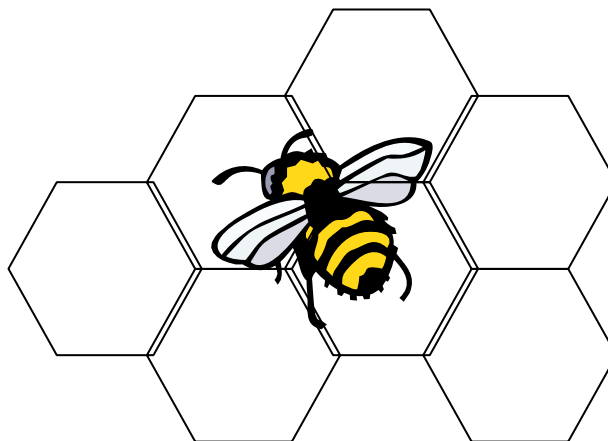
BEES 4.0 Results: Biobased Fertilizers



Economic Performance

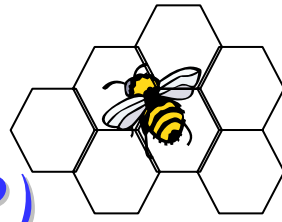


What's the Buzz?



Harmonizing Metrics:

Global Bioenergy Partnership (GBEP)



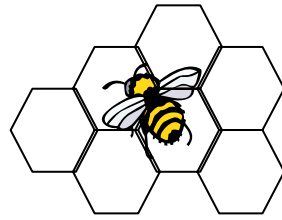
GBEP Task Force on Greenhouse Gas Methodologies for Transport Biofuels

- Convened by U.S. State Department
 - G8 +5 (Brazil, China, India, Mexico and South Africa) participating

- Goal: comparable life-cycle results

- Action: harmonize life-cycle greenhouse gas metrics

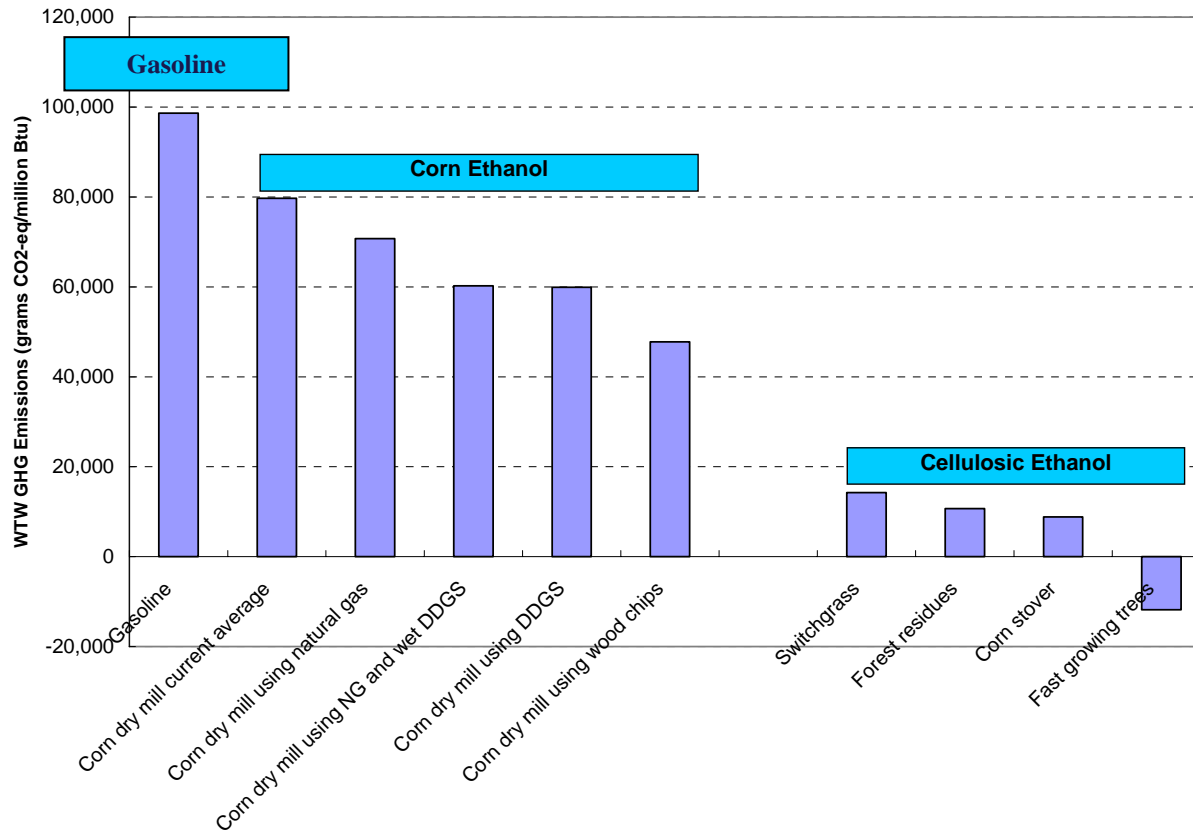
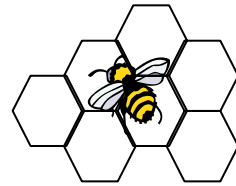
Integrating Metrics: Micro and Macro Scales



- **GREET**
 - transportation fuels
 - 3 environmental impacts
 - detailed analysis

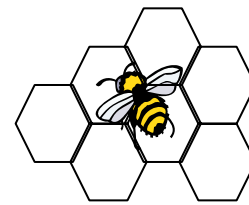
- **BusiBEES**
 - any industrial product
 - 13 environmental and economic impacts
 - summary metrics

GREET Greenhouse Gas Emissions: Gasoline vs. Ethanol



Source: M. Q. Wang, "Well-to-Wheels Energy and Greenhouse Gas Emissions Results and Issues of Fuel Ethanol," 2008.

BusiBEES Carbon Footprint Metrics: Energy Conservation Investments



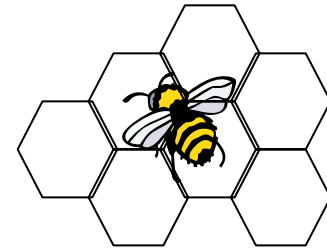
Study Period	Energy Savings	Cost Premium	Life-Cycle Cost Savings (\$PV)	Carbon Savings (t)	Carbon Efficiency Ratio (= \$PV/t)
50 years	30%	20%	\$6,990,000	\$117,500	\$60
	50%	50%	\$3,220,000	78,300	\$40
	100%	200%	\$1,550,000	195,800	\$10

Most cost-effective alternative

1 year	30%	-\$590
	50%	-\$600
	100%	-\$1,580
25 years	30%	\$70
	50%	\$30
	100%	-\$30

Only cost-effective alternatives?

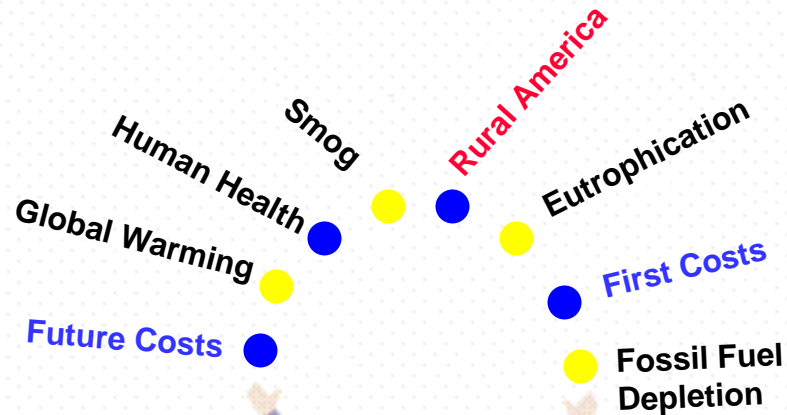
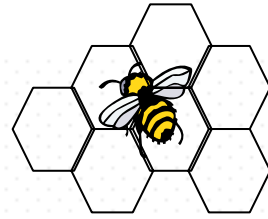
Sustainable Metrics for Sustainable Markets



- Provide Scientific Integrity
- Permit Comparability
- Promote Innovation



What Makes a Product Sustainable? The Answers Lie in the Tradeoffs

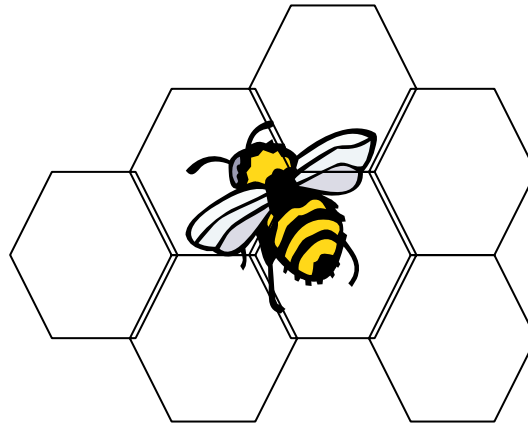


✓ Social

✓ Environmental

✓ Economic

For More Information...



www.bfrl.nist.gov/oea/software/bees