

Consumption-Based Emissions Inventory (CBEI):

Modeling Emissions Embodied in Trade for U.S. States and Counties

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Consumer Responsibility in Emissions

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Comparing Inventory Methods

| | | Geographic | Hybrid | SEI-US' CBEI |
|-----------------------|-----------------------|---|-------------------------|----------------------------|
| Consumer End Use: | Fuels, Buildings | geographic responsibility = consumer responsibility | | |
| | Fuels, Transportation | geographic responsibility | consumer responsibility | |
| | Electricity | | | |
| | Waste Disposal | | | |
| Industrial/Commercial | | geographic responsibility (except for electricity) | | consumer responsibility |

Consumer Responsibility in Emissions

- “ Different way of viewing greenhouse gas emissions responsibility
- “ Post-consumer emissions the same as +hybrid+geographic inventories (although organized by consumer good)
- “ Pre-consumer emissions (industrial and commercial) modeled as the emissions embodied in goods and services

Emissions Embedded in Bread and Light Bulbs

| | | Consuming Sector | | | | | | | | | | |
|-----------------|--------------------------|------------------|-------------|-----------|-------|-------------|-------------|--------|----------|-------|-------|-------|
| | | Bread | Electricity | Filaments | Glass | Light bulbs | Natural gas | Silica | Tungsten | Water | Wheat | Yeast |
| Emitting Sector | Bread manufacturers | X | | | | | | | | | | |
| | Electric utilities | X | | | | X | | | | | | |
| | Filament manufacturers | | | | | X | | | | | | |
| | Glass manufacturers | | | | | X | | | | | | |
| | Light bulb manufacturers | X | | | | X | | | | | | |
| | Natural gas utilities | X | | | | | | | | | | |
| | Silica mining | | | | | X | | | | | | |
| | Tungsten mining | | | | | X | | | | | | |
| | Water utilities | X | | | | X | | | | | | |
| | Wheat farmers | X | | | | | | | | | | |
| | Yeast manufacturers | X | | | | | | | | | | |

Embodied Emissions Literature

- “ Peters and Hertwich 2008, 2009; Peters 2008; Peters et al. 2011
- “ Wilting and Vringer 2009; Davis and Caldeira 2010
- “ Numerous country comparison studies
- “ EIO-LCA; Hendrickson et al. 2006; Weber and Matthews 2007

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- “ For regions that export more embedded emissions (such as areas with a lot of industrial production or petroleum extraction), consumption-based emissions will be lower than in a geographic inventory.

CBEI Calculation Summary

| | | | | |
|--|----------|--|----------|---|
| Study Area Consumption (in dollars) | x | Emissions Coefficients (tons CO₂-e/\$) | = | Study Area Embedded Emissions (tons CO₂-e) |
| of Study-Area-made goods and services | x | Study Area | = | from Study Area |
| of U.S. (outside of Study Area) made goods and services | x | United States | = | from rest of the United States |
| of foreign goods and services | x | Imports to the U.S. | = | from other countries |
| | | SUB-TOTAL | | Study Area Embedded Emissions (tons CO₂-e) |
| | | | + | Study Area End-Use Emissions (tons CO ₂ -e) |
| | | TOTAL | | Total Study Area Consumption-Based Emissions (tons CO₂-e) |

Five Phases of the CBEI Model

| Emission Type | Life-Cycle Phase | Inventory Sources |
|---------------------------|-----------------------------|--|
| Embedded Emissions | Production | From CBEI Embedded Pre-Purchase model minus deleted emissions from electricity and waste disposal and minus transferred indirect emissions for fuel and electricity (to use phase) and waste disposal (to post-consumer disposal phase) |
| | Pre-Purchase Transportation | |
| | Retail/Wholesale | |
| End-Use Emissions | Use | From Geographic or Hybrid inventory end-use fuel and electricity plus transferred indirect emissions for fuel and electricity |
| | Post-Consumer Disposal | From Geographic or Hybrid inventory end-use waste disposal plus transferred indirect emissions for waste disposal |

Upstream (Indirect) Emissions

| Final production locale: | Study Area (SA) | Inside-US-Outside-SA (UX) | Foreign (FR) |
|--|--|---------------------------|--|
| Stage of production by locale: | | | |
| Final Production | $\text{SA direct+indirect demand} * \text{SA direct coefficient} + \text{UX direct+indirect demand} * \text{US coefficient}$ | | $\text{FR1} = \text{FR direct demand} * \text{"Import" direct+indirect coefficient}$ |
| Intermediate production: SA (used in final production by column) | | | |
| Intermediate production: UX (used in final production by column) | | | |
| Intermediate production: FR (used in final production by column) | $\text{FR2} = \text{US direct demand} * \text{"Global - US" direct+indirect coefficient}$ | | |

CBEI Emissions Disaggregated

- “ Life-Cycle Phase: production, pre-purchase transportation, wholesale/retail, use, post-consumer disposal
- “ Location of Emission: study area, inside-US-outside-SA, foreign

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- “ Type of Consumer: households, government, business investment
- “ Commodity Type: 440 commodity sectors, 62 subcategories, 16 categories

CBEI Categories and Subcategories

| | | |
|--|--|---|
| Appliances, HVAC | Forest products | Transportation services |
| Appliances, other Lighting fixtures and bulbs Ranges and microwaves Refrigerators and freezers Washers and dryers Other appliances | Paper and cardboard Other processed forest products Unprocessed forest products | Car rental, repair and wash Transportation services, air Transportation services, mass transit Transportation services, rail Transportation services, truck Transportation services, water Transportation services, other |
| Clothing | Fuel, utilities, waste Gasoline, heating fuels, other petroleum products Natural gas distribution Oil and gas extraction Power generation and supply Waste management Water- sewage and other systems | Vehicles and vehicle parts Aircraft Cars and light trucks Heavy duty trucks Other road vehicles Railroad rolling stock Ships and boats Vehicle parts |
| Concrete, cement and lime | Healthcare Healthcare services Medicines and other healthcare supplies | Other |
| Construction Non-residential construction Prefabricated buildings Residential construction and remodeling | Home, yard, office Home furnishings Household supplies Lawn and garden Media and office supplies (except paper) | |
| Electronics Computer service and equipment Other electronics | Retailer and wholesale Retailers Wholesale | |
| Food and beverages Beverages Condiments, oils and sweeteners Dairy Fresh fruit, nuts and vegetables Frozen food Grains, baked goods, cereals, roasted nuts, nut butters Poultry and eggs Processed fruit, nuts and vegetables Red meat Restaurants Seafood Other food and agriculture | Services Banks, financial, legal, real estate, insurance Building services Education and day care Hotels, motels, entertainment, media Other services | |

CBEI Projects To Date:

- ” State of Oregon (v.1.0)
- ” King County, Washington (v.2.1)
- ” City of San Francisco (v.2.1):
 - . San Francisco
 - . State of California

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