

USEEIO National Models and Applications

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Disclaimer

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SHC 7 - LCIM

7.1. USEEIO Models

7.2. Data and Methods to Advance Facts & Figures

7.3. USEEIO Applications

7.4. Food Waste

Outline

1. Overview
2. Uses
3. Tools to build USEEIO and components
4. Accessing USEEIO
5. Applications
 - Supply Chain GHG Factors
 - SMM Tools
 - Sustainable Communities Web Challenge
6. Vision in Support of EPA SMM Program
7. Work in Progress
8. Collaborators and Team

USEEIO Models

A family of environmentally-extended input-output (EEIO) models of the US

- Depict environmental and economic performance of all commodities and industries in the US in 400+ or 70+ categories
- Track >2000 unique releases or resource types
- Report 20+ environmental, resource and socio-economic impact indicator scores
- Built on >10 million data points
- Include formal data quality characterization of results
- [Open source data and modeling framework](#)
- Most recent version (v2.0)
- [Technical article for USEEIOv1](#) and [slide overview](#)

USEEIO Versions

Name	Model Form*	# of Sectors	Input-Output Data Year	USD Year	Indicators §	Availability
USEEIOv2.0	Commodity	411	2012	2012	ACID, CCDD, CMSW, CRHW, ENRG, ETOX, EUTR, GHG, HAPS, HCAN, HNCN, HRSP, HTOX, JOBS, LAND, MNRL, NNRG, OZON, PEST, RNRG, SMOG, VADD, WATR	full matrices
USEEIOv1.2	Commodity	386	2007	2013	ACID, CCDD, CMSW, CRHW, ENRG, ETOX, EUTR, GHG, HAPS, HCAN, HNCN, HRSP, HTOX, JOBS, LAND, METL, MNRL, NNRG, OZON, PEST, RNRG, SMOG, VADD, WATR	waste satellite tables API
USEEIOv1.1	Commodity	385	2007	2013	see indicators in elementary flows and indicators	full matrices elementary flows and indicators satellite tables openLCA
USEEIOv1	Commodity	385	2007	2013	see indicators in elementary flows and indicators	Not available

Full details on [USEEIO Technical contents page](#)

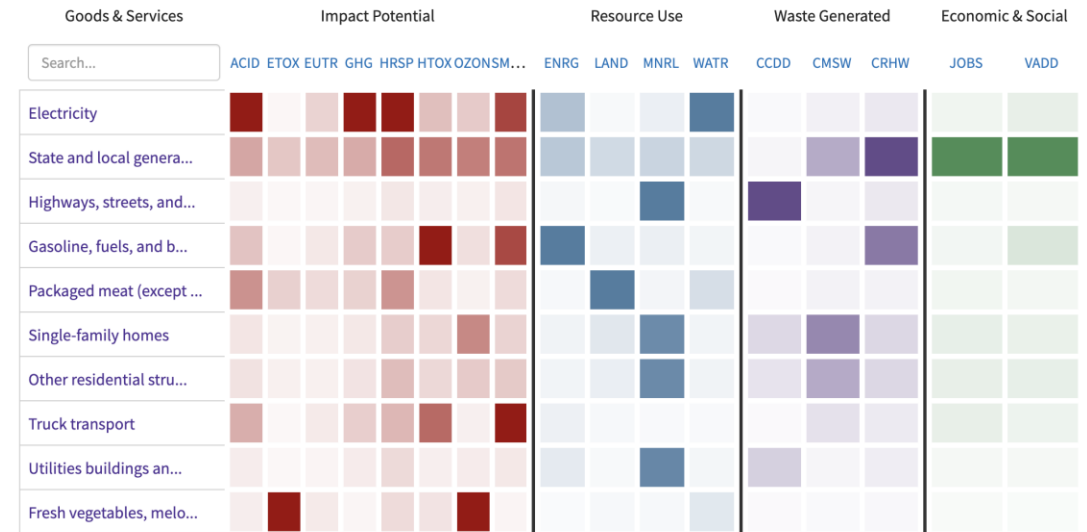
USEEIO Uses at EPA

Existing

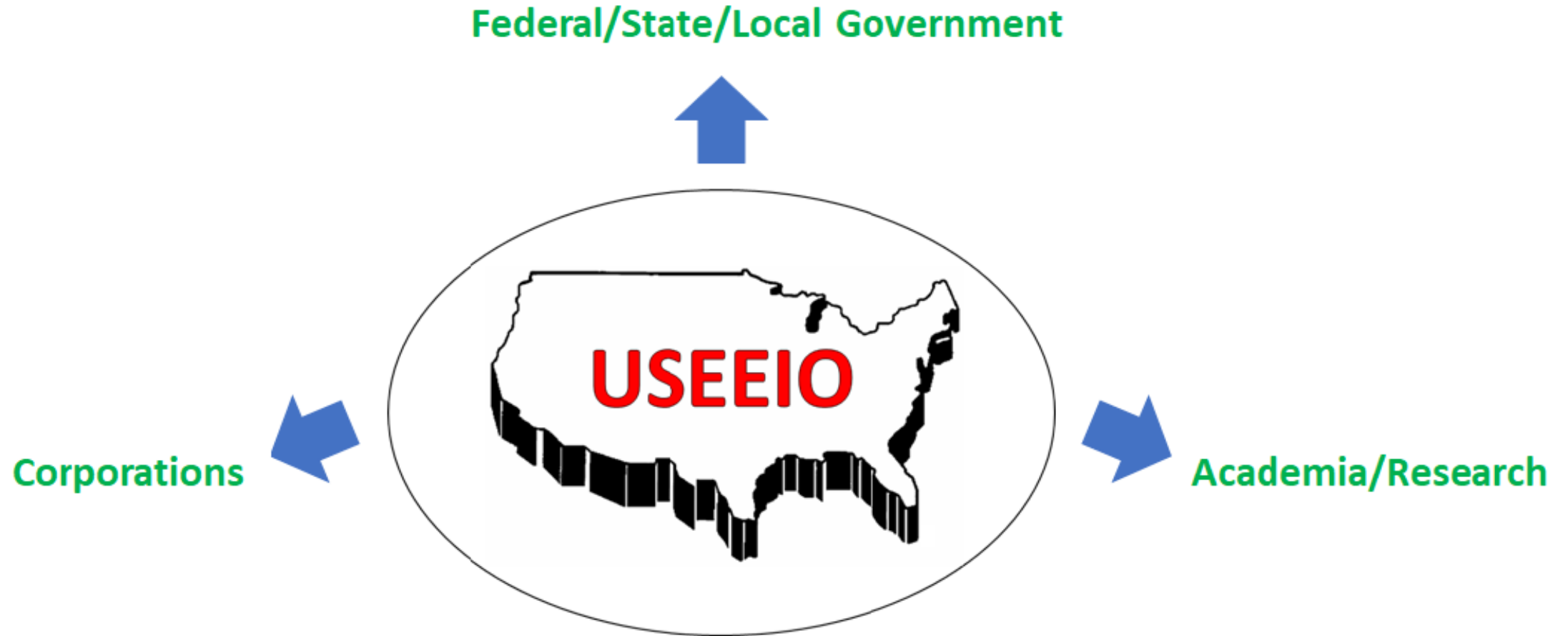
- [Sustainable Materials Management Prioritization Tools](#)

In Development

- [GHG Emission Factors Hub](#)
- [Recycling Economic Information Report](#)
- [WARM](#)
- [GHG Reductions Through Materials and Land Management](#)
- [Smart Sectors Program](#)



Growing Uses of USEEIO

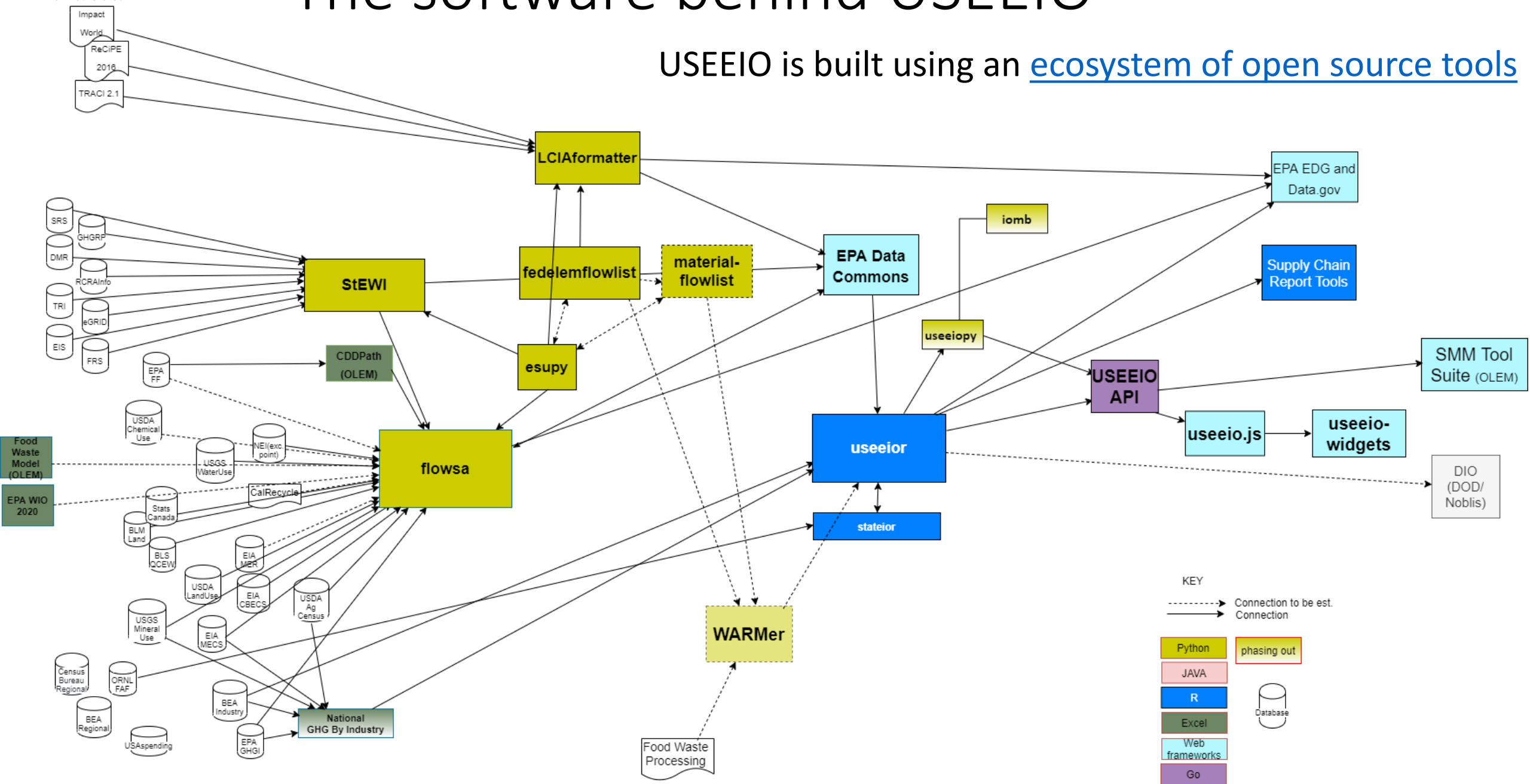


Common Uses of USEEIO

Use Type	Examples
Organizational GHG Scope 3 reporting	General Motors 2021 Carbon Disclosure Report , World Resources Institute GHG Inventory
Sustainable purchasing	Jora app , Alameda County Supply Chain Sustainability Report
Industry hotspot analysis	Health Care Pollution And Public Health Damage In The United States
Food and other subsystem life cycle modeling	Integrating Social and Biophysical Models for Exploration of Urban Food, Energy, and Water Systems , Potential Socioeconomic and Environmental Effects of an Expanding US Bioeconomy
Background LCI data for LCA studies and teaching	UMich EAS 573
Footprinting (individual, org, community or region)	Amazon Carbon Footprint

The software behind USEEIO

USEEIO is built using an ecosystem of open source tools



Principal Tools for National Model

1. [useeior](#) - Model specification, import of econ data, assembly, calculation
2. [flowsa](#) - Environmental/employment data preparation
3. [LCIAformatter](#) - Indicator data preparation

Model Formats

1. useeior and supporting ecosystem tools
2. USEEIO API
3. USEEIO widgets
4. Excel
5. openLCA version

USEEIO Excel - Outlet



DATA TOPICS ▾ RESOURCES STRATEGY DEVELOPERS CONTACT

DATA CATALOG

Home / Datasets Organizations ?

Home / U.S. Environmental... / U.S. EPA Office of...

Submit Data Story


Report Data Issue



USEEIOv2.0

Metadata Updated: June 25, 2021

This dataset provides the waste sector disaggregation data, model component matrices, model result matrices, model price adjustment matrices, and associated metadata for the USEEIOv2.0 model. This model was generated using useeiorv0.4 (<https://github.com/USEPA/useeior/tree/v0.4/>) by calling the `buildModel()` function and passing "USEEIOv2.0" as the model. This uses the model configuration file, which can be found @ <https://github.com/USEPA/useeior/blob/v0.4/inst/extdata/modelspecs/USEEIOv2.0.yml>. The resulting model was exported using the `writeModeltoXLSX()` function to create this dataset. The waste disaggregation data are required for model building and also embedded in the useeiorv0.4. The `generateModelIdentifier()` function was used on the same model create the model identifier. The US dollar (USD) year for the model data, where USD is used, is 2012. See any additional notes in Contents on specific components. A complete description can be found in the associated manuscript.

 Publisher

U.S. EPA Office of Research and
Development (ORD)

USEEIO Excel - A matrix

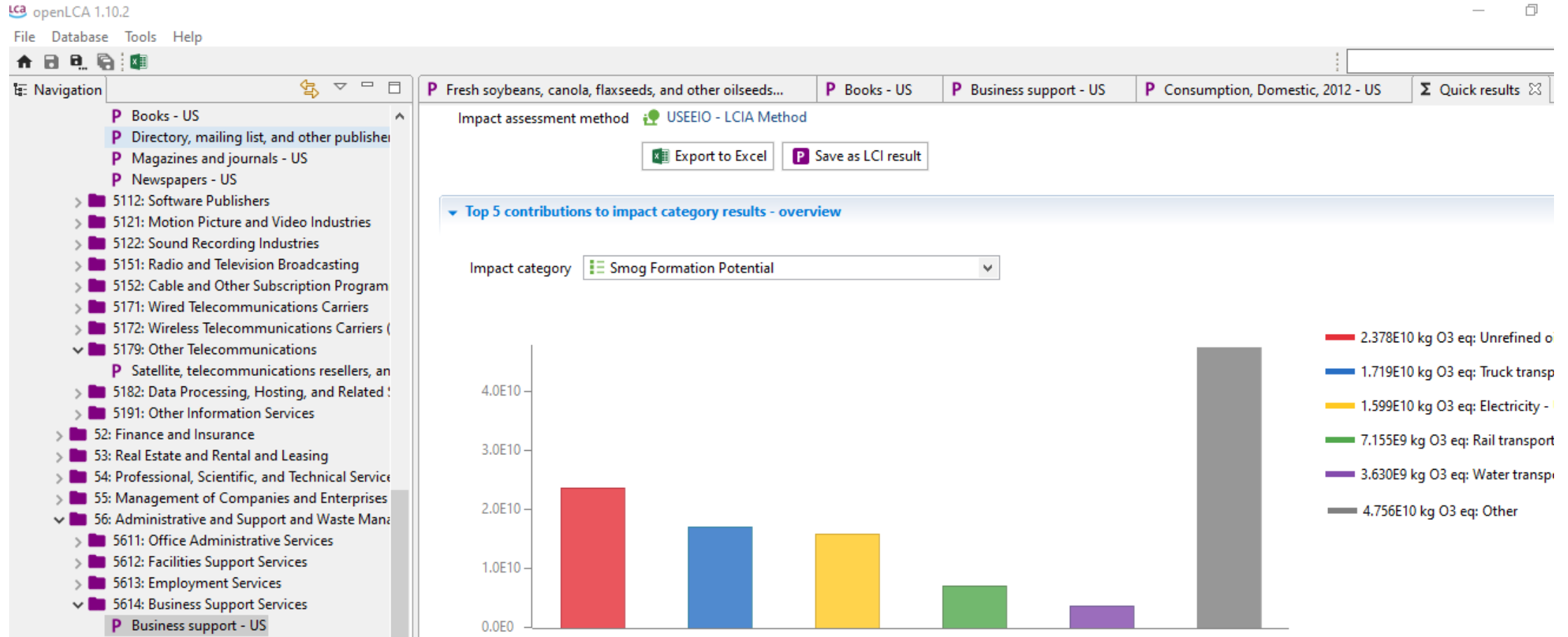
AutoSave Off USEEIOv2.0.xlsx - Last Modified: June 24 Search

File Home Insert Draw Page Layout Formulas Data Review View Help Acrobat

Clipboard: Paste, Cut, Copy, Format Painter
 Font: Calibri, 11, Bold, Italic, Underline, Color, Background Color
 Alignment: Wrap Text, Merge & Center
 Number: General, Currency, Percentage, Decimals
 Styles: Normal 2 2, Bad

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1		1111A0/US	1111B0/US	111200/US	111300/US	111400/US	111900/US	112120/US	1121A0/US	112300/US	112A00/US	113000/US	114000/US	115000/US	211000/US	212100/US
2	1111A0/US	0.052092	0.001397	0.000203	0	0	0	0	0	0	0	-3.3E-06	0	0.000474	0	0
3	1111B0/US	0	0.073033	0	0	2.4E-08	0.009443	0.051184	0.079851	0.04653	0.007668	0.000656	3.63E-06	0.004115	0	0
4	111200/US	0	0	0.04384	0.000194	3.03E-08	0	0	0	0	6.33E-07	3.61E-06	1.7E-06	0.00029	0	0
5	111300/US	0	0	0	0.005744	2.91E-09	0	0	0	0	2.3E-07	1.31E-06	6.18E-07	3.89E-05	0	0
6	111400/US	0	0	0	0	0.159081	0	0	0	0	2.99E-05	0.00017	8.03E-05	0.011122	0	0
7	111900/US	0.009096	0.00144	0	0	1.21E-09	0.026621	0.004705	0.003813	0	0.000524	0.001685	3.56E-06	0.000373	2.09E-08	5.51E-05
8	112120/US	0	0	0	0	3.15E-09	0	0	0	0	7.47E-05	5.38E-07	0	5.43E-07	0	0
9	1121A0/US	0.000774	0.002122	0.000203	0.000815	0.00053	0.00048	0.047318	0.288066	0	0.008214	8.94E-05	0	0.007464	0	0
10	112300/US	0.000211	0	0	0	4.36E-09	5.33E-05	0	0	0.101708	2.96E-06	2.02E-05	7.96E-06	0.001211	0	0
11	112A00/US	0.000492	0.001267	6.78E-05	0.000388	0.000266	0.001014	0.00338	0.006402	0	0.126052	0.001303	2.71E-06	0.014046	0	0

USEEIO in openLCA



Accessible via [Federal LCA Commons](#)

USEEIO API

USEEIO-API

Base URL: /api, **Version:** 1.0.2, [The USEEIO API Wiki on github provides more information on using the API.](#)

A RESTful API that provides access to versions of the USEEIO models. Results are returned as JSON objects.

Schemes: http

Summary

Path	Operation	Description
/models	GET	Get the available models from the server.
/{model}/calculate	POST	Calculate the result for a given demand and perspective.
/{model}/demands	GET	Returns a list with all available demand vectors from a model
/{model}/demands/{demandID}	GET	Returns a demand vector from the model
/{model}/indicators	GET	Get all indicators of the model.
/{model}/indicators/{indicatorID}	GET	Get indicator information by ID.
/{model}/matrix/A	GET	Get the direct requirements matrix of the IO model.
/{model}/matrix/B	GET	Get the satellite matrix of the IO model.

USEEIO Widgets

Upstream

Search

- Primary iron, steel, and ferroalloy
\$0.050 input per \$1 spent
- Other secondary nonferrous met
\$0.034 input per \$1 spent
- Vehicle engines and engine parts
\$0.033 input per \$1 spent
- Transmission and power train pa
\$0.025 input per \$1 spent
- Vehicle metal stamping
\$0.021 input per \$1 spent
- Lids, jars, bottle caps, other meta
\$0.021 input per \$1 spent
- Other vehicle parts
\$0.021 input per \$1 spent
- Motor vehicle and motor vehicle i
\$0.021 input per \$1 spent
- Vehicle seating and interior trim (i
\$0.021 input per \$1 spent
- Company and enterprise manage
\$0.018 input per \$1 spent

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Commodities

Search

- Primary batteries
Value Added: \$0.501 per \$1 spent
- Mechanical power transmission equipr
Value Added: \$0.467 per \$1 spent
- Automobiles
Value Added: \$0.282 per \$1 spent
- Customs duties
Value Added: \$1.000 per \$1 spent
- Household employees
Value Added: \$1.000 per \$1 spent
- Tenant-occupied housing
Value Added: \$0.266 per \$1 spent
- Independent artists, writers, and perfor
Value Added: \$0.277 per \$1 spent
- Owner-occupied housing
Value Added: \$0.870 per \$1 spent
- Wholesale electronic markets and ager
Value Added: \$0.335 per \$1 spent
- Sound recording
Value Added: \$0.825 per \$1 spent

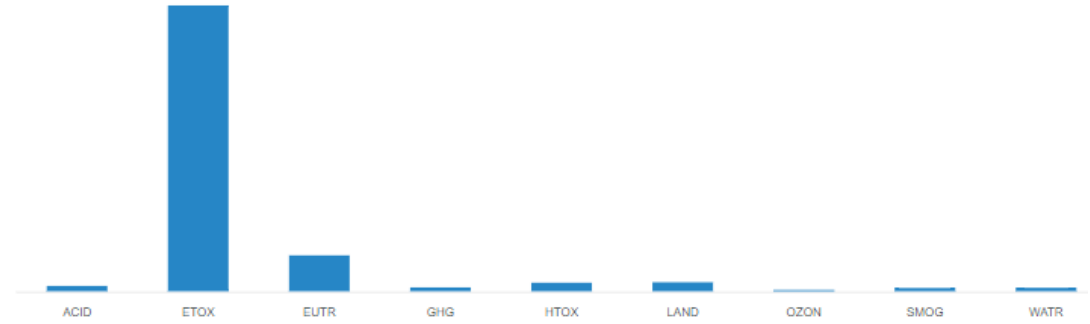
Rows per page: 10 1-10 of 411

Downstream

Search

- Speed changers, industrial high-s
\$0.258 output per \$1 spent
- Mechanical power transmission e
\$0.145 output per \$1 spent
- Heavy duty trucks
\$0.097 output per \$1 spent
- Other engine equipment
\$0.077 output per \$1 spent
- Ships and ship repair
\$0.059 output per \$1 spent
- Material handling equipment
\$0.041 output per \$1 spent
- Remediation services
\$0.023 output per \$1 spent
- Veneer, plywood, and engineered
\$0.022 output per \$1 spent
- Primary batteries
\$0.021 output per \$1 spent
- Hydraulic pumps, motors, cylinde
\$0.019 output per \$1 spent

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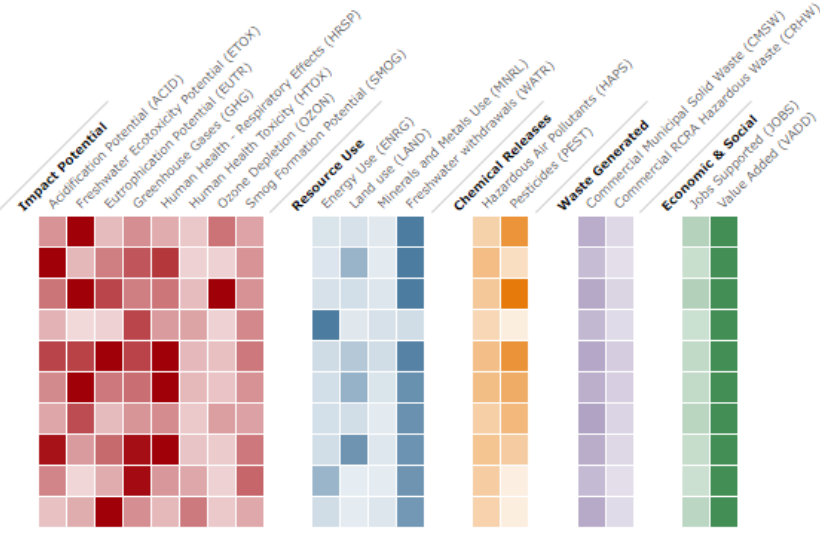


Goods & Services

Search

ID	Name
<input type="checkbox"/> 111300	Fresh fruits and tree nuts
<input type="checkbox"/> 112A00	Animal farms and aquaculture ponds (except cattle and poultry)
<input type="checkbox"/> 111200	Fresh vegetables, melons, and potatoes
<input type="checkbox"/> 212100	Coal
<input type="checkbox"/> 1111B0	Fresh wheat, corn, rice, and other grains
<input type="checkbox"/> 111900	Tobacco, cotton, sugarcane, peanuts, sugar beets, herbs and spices, and other...
<input type="checkbox"/> 311920	Coffee and tea
<input type="checkbox"/> 1121A0	Cattle ranches and feedlots
<input type="checkbox"/> 221100	Electricity
<input type="checkbox"/> 221300	Drinking water and wastewater treatment

Rows per page: 10 1-10 of 411



Impact chart with configuration

The settings box, sector list and indicator results are linked via a hash configuration on this page.

Model version: USEEIOv1.2 | Perspective: Supply chain | Year: 2007 | Location: US

Sectors

Search

- Computers
- Telephones
- Wireless communications
- Abrasive products
- Accounting, tax preparation, bookkeeping, and
- Adhesives
- Advertising and public relations
- Agriculture and forestry support
- Air and gas compressors
- Air conditioning, refrigeration, and warm air heating
- Air purification and ventilation equipment
- Air transport
- Aircraft
- Aircraft engines and parts
- All other converted paper products
- All other food and drinking places

Indicator results

Acid Rain	Freshwater Aquatic Ecotoxicity
Eutrophication	Greenhouse Gases
Human Health - Respiratory Effects	Human Health Toxicity
Ozone Depletion	Smog Formation
Energy Use	Land Use
Minerals and Metals Use	Water Use
Commercial Municipal Solid Waste	Commercial RCRA Hazardous Waste
Hazardous Air Pollutants	Metals
Pesticides	Jobs Supported
Value Added	

USEEIO Widgets - About

- Drop-in components for displaying USEEIO model data for web pages open to anyone
- Created for web developers without the model/domain expertise to use USEEIO directly
- Simplify process of integrating model results
- Configurable to work with any USEEIO family model available on the USEEIO API

Widgets Links

- [List of widgets with standalone implementation](#)
- Example [integration with local data](#)

Widgets summarized in webinars

- [Industry Comparison Tools for Sustainable Communities](#)
- [SMM Prioritization and Web-Enabled Tools Session](#)

Applications

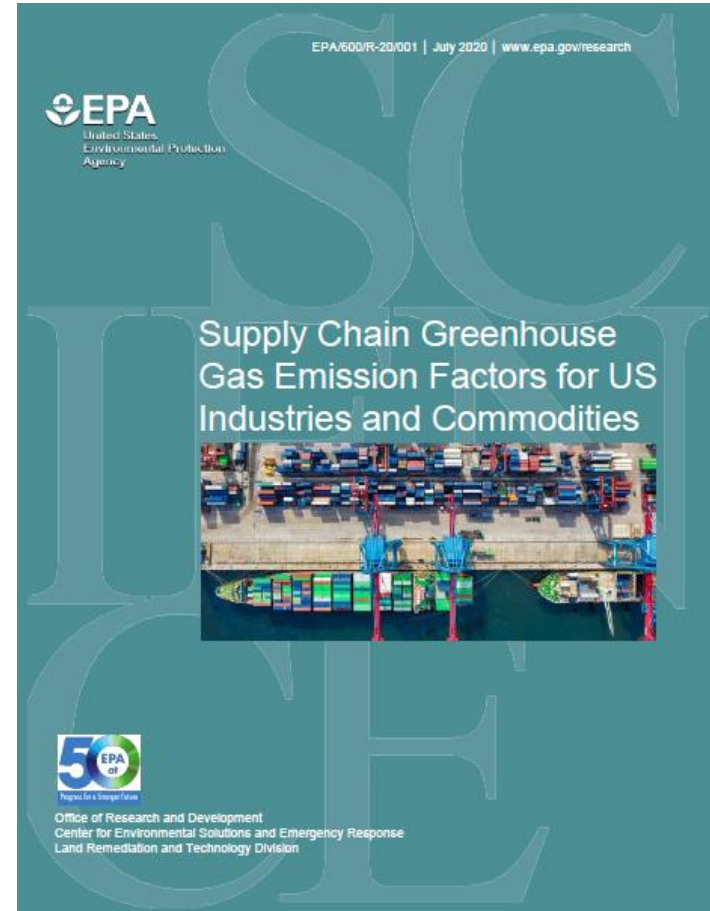


Supply Chain Factors (SEFs)

[Report](#)

[Factors Dataset](#)

[National GHG Industry Attribution Model](#)



Supply Chain Factors (SEFs) Details

GHGs Included

- CO₂
- CH₄
- N₂O
- Other GHGs (SF₆, NF₃, CFCs/HFCs)

Form of the Factors

kg of GHG per **\$** purchased of a commodity or from an industry

where \$ are in 2018 USD in purchaser price

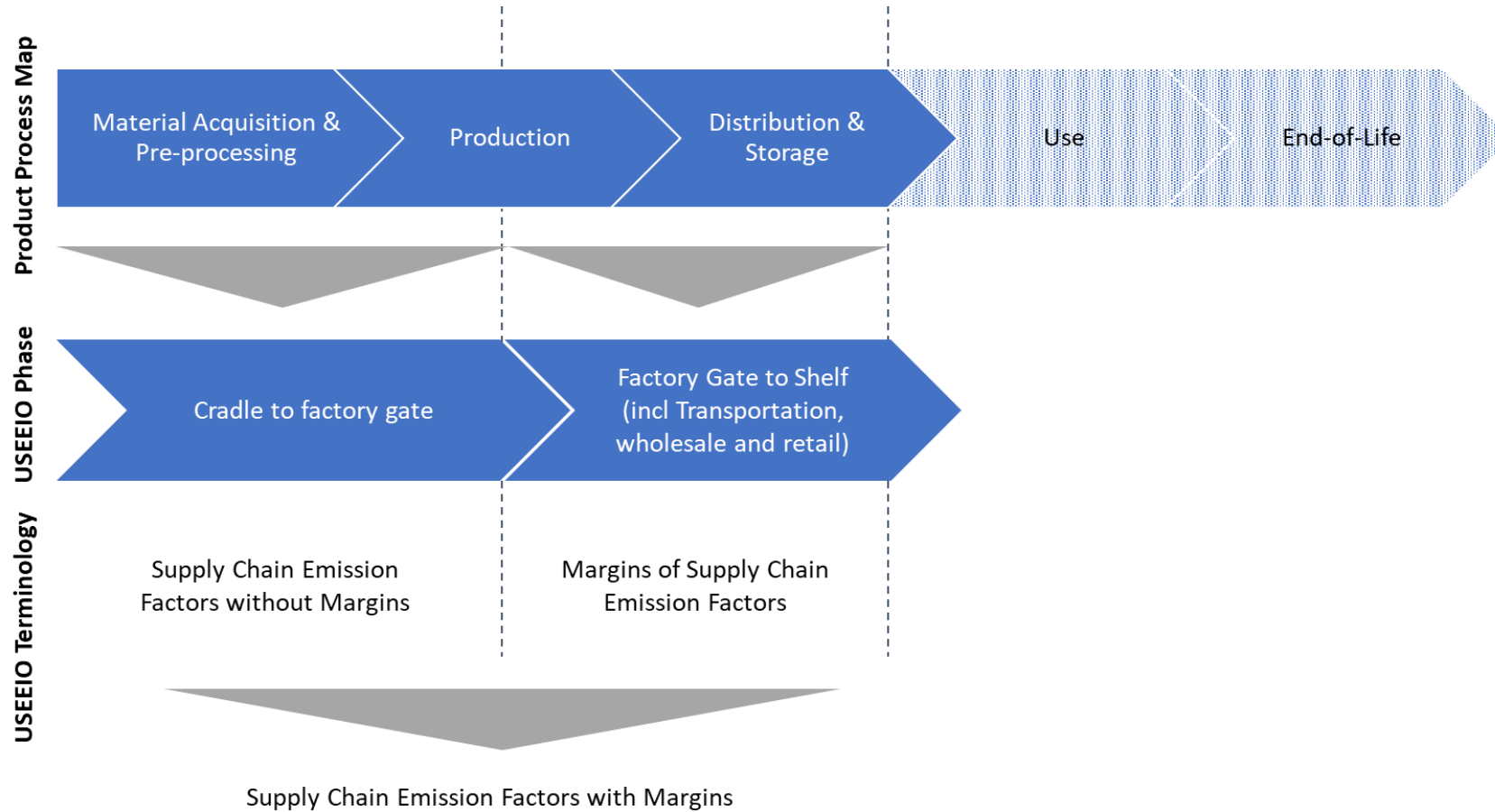
Examples

0.467 kg CO₂/\$ of farm commodities

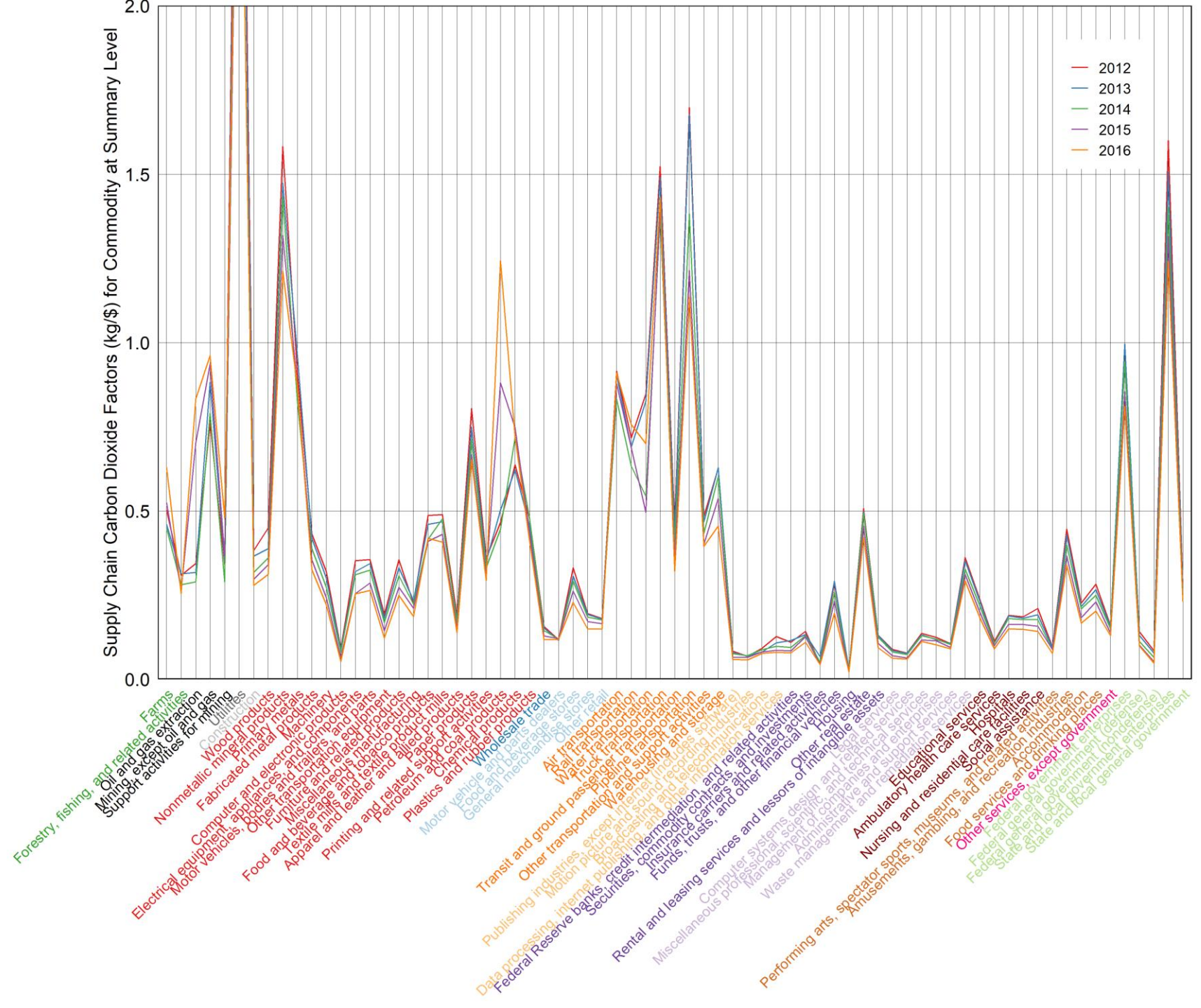
0.008 kg CH₄/\$ of fresh wheat, corn, rice and other grains

0.21 kg CO₂/\$ from the ship building industry

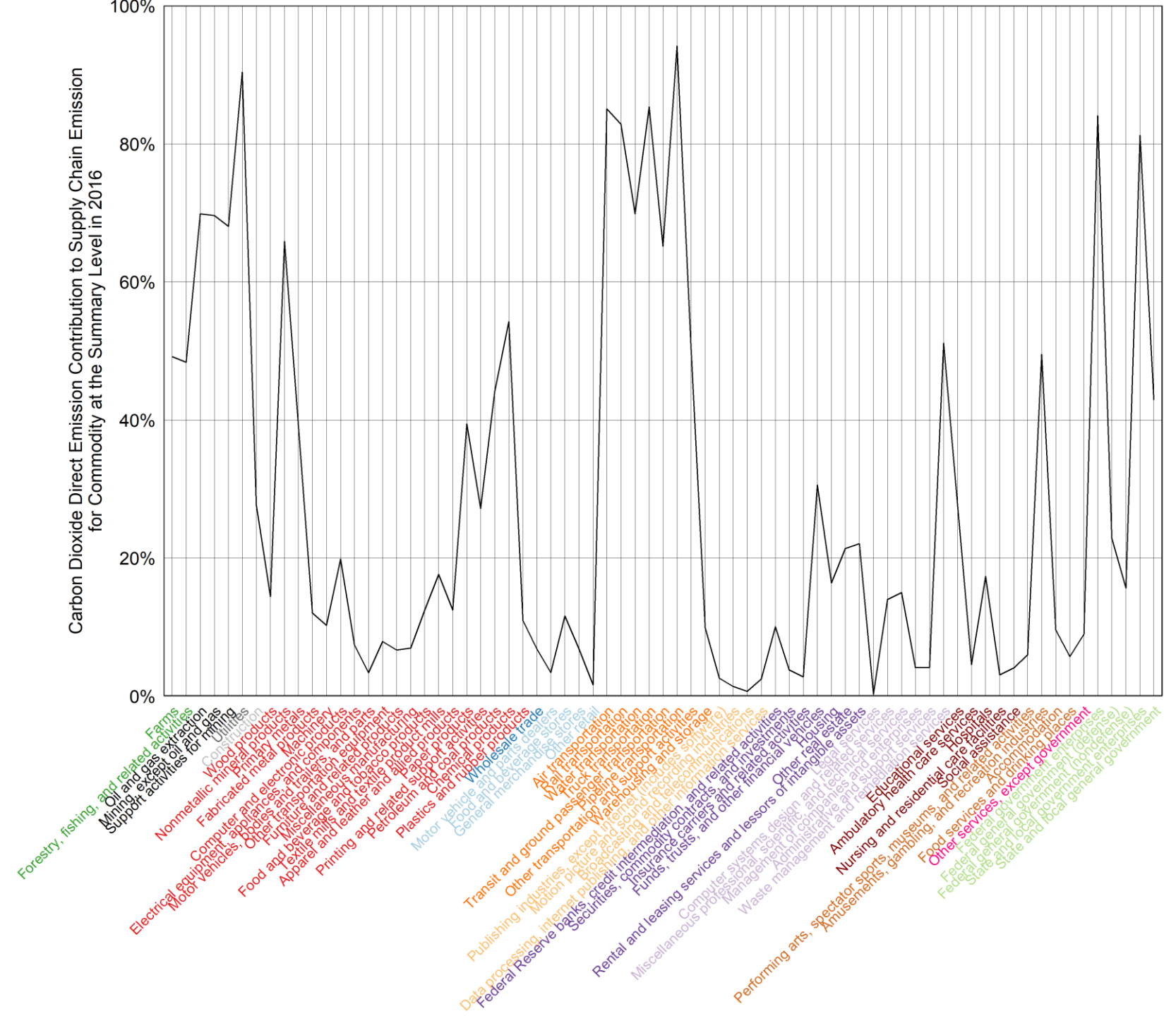
The Coverage of the Factors in the Product Life Cycle



SEFs for CO₂ 2010-2016



SEFs for CO₂ 2016 Direct vs Indirect



Sustainable Communities Web Challenge 2021

A virtual [Federal Challenge](#) event that culminated on 10/2/2021 for web developers, designers and students to build off the [model.earth community](#) platform, awarding \$9,000 in prizes

Objective: To develop, customize and improve the look-and-feel of community-specific web resources on model.earth that integrate the USEEIO widgets with other data sources useful to inform assessment of community sustainability.

Background

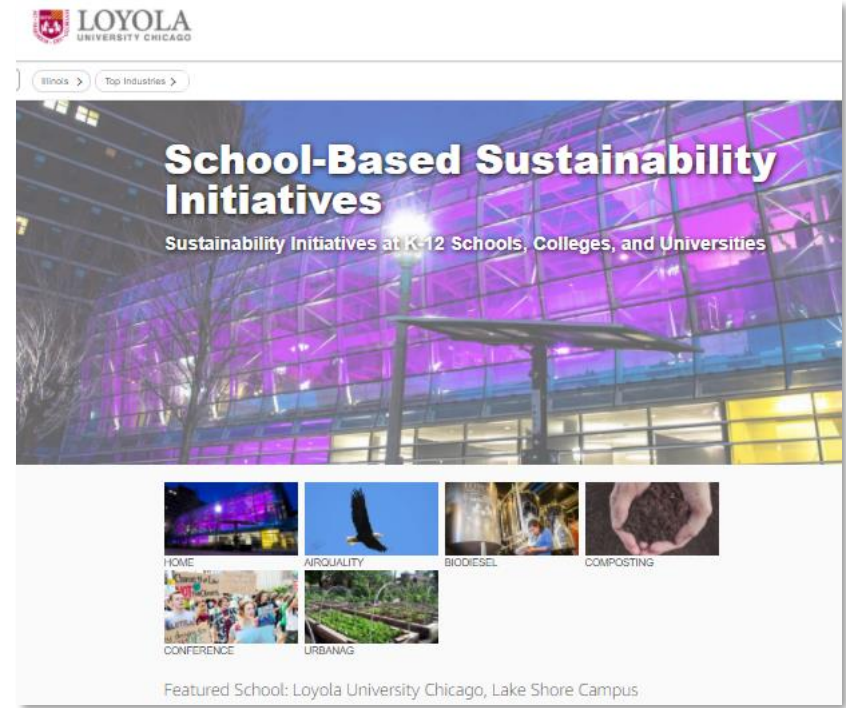
[EPA Science Matters July 2020](#); [SMARTer Together Industry Comparison Tools webinar](#)

Challenge Partners

- EPA ORD and Region 4
- GA Economic Development Center for Innovation
- GDIT and [Code for America](#)

Challenge Winners

- [School-based sustainability initiatives, Loyola Chicago](#)
- [Āinaviz Data Viewer, Code for Hawaii](#)
- [Impact Profiles for Communities, Abrie Badenhorst](#)
- [Get Involved Within Your Community, Ryan Marohn](#)
- [Nature's Lifecycle: Parks and Recreation, Don Adams and Julie Bender](#)



A Sustainable Future

Āina Vis is a public dataset of a historical index of 'aina organizations from 1906-2021 in Hawaii, which are organizations dedicated to the concept of Āina (land, that which feeds) in Hawaii. This community page is an example of how the dataset can be utilized once downloaded from our public site, which is in progress.

The dataset referenced here was compiled by KIA, Consuelo Foundation, and DOFAW.

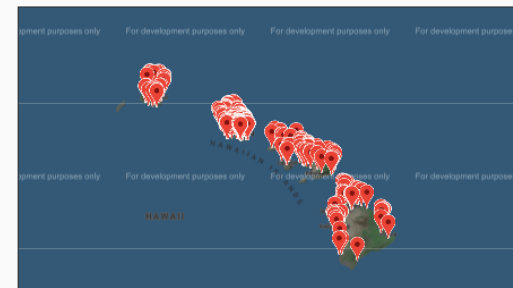
Excerpted from the work-in-progress public site:

PROJECT INTRO: ĀINA translated from Ōlelo Hawaiʻi (Hawaiian language) into English means land, or that which feeds. "VIS" is short for vision, and also means power, in relation to as compiled with, face-to-face with, together. This dataset named Āina Vision is about 'aina power, 'aina face-to-face, and 'aina together.

This humble webpage is a start to a full website in the works, which currently serves as a preliminary public dataset of 'aina organizations across Pae Āina (Hawaiian Islands) in a format that can be easily combined with other datasets to facilitate further research and inquiry pertaining to 'aina work.

While in the future, a living directory of organizations working on 'aina may emerge, for now our intent is to simply encourage the representation of 'aina work as important contributors to public health and economy in Hawaii. As a tool, the dataset may assist in recognizing the existing network of 'aina organizations to facilitate partnerships with on-the-ground, place-based efforts that can increase local capacity for climate resilience and culture resurgence rooted for Pae Āina Hawaiʻi by Pae Āina Hawaiʻi.

A Community Effort



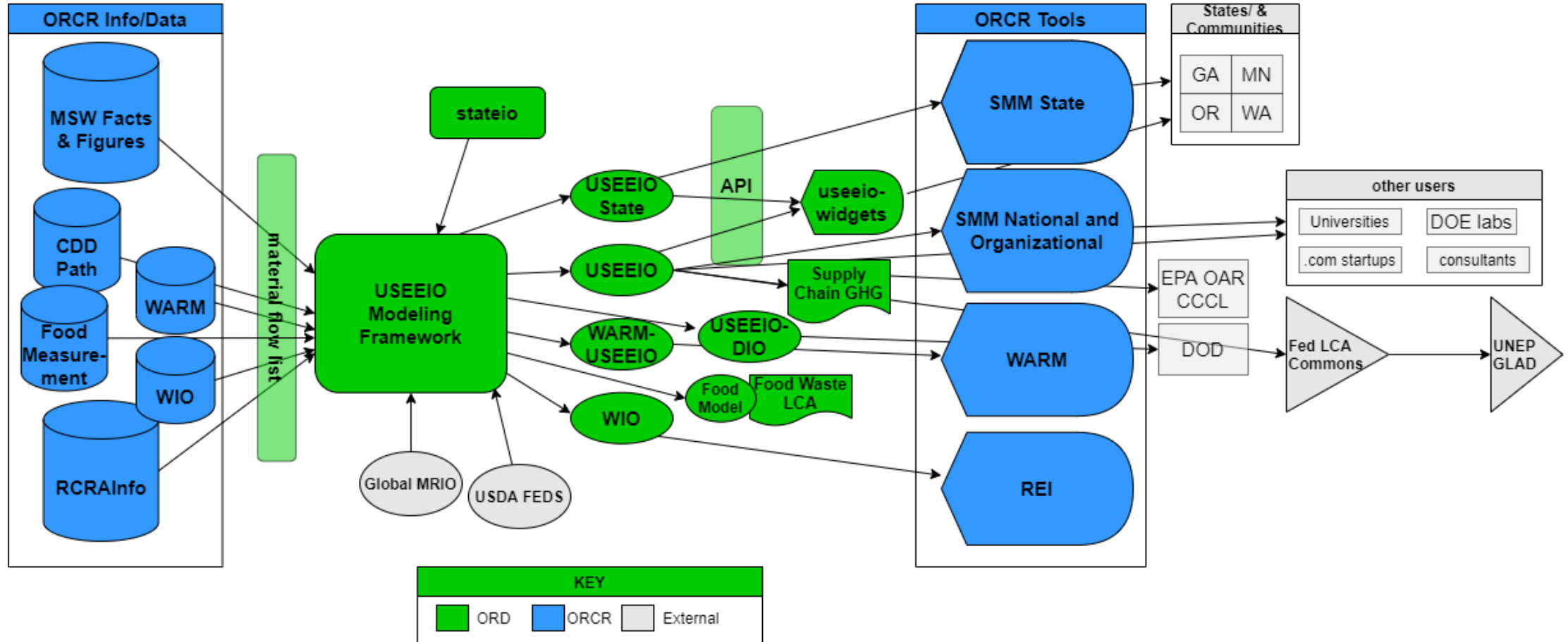
The map shows the state of Hawaii with several red flower icons scattered across the islands, representing community effort locations. The text 'HAWAII' is written at the bottom of the map.

Community Footprints

See <https://zclaimpacts.abrie.dev> for a live demonstration.

Community/Region Profile	
New York	
Entire State	
Acidification Potential (kg SO2 eq)	6.8895962657620465
Commercial Construction and Demolition Debris (kg)	7004.082167387476
Commercial Municipal Solid Waste (kg)	857.7983179787074
Commercial RCRA Hazardous Waste (kg)	3.6794818186634084
Energy Use (MJ)	6726.183734059896
Eutrophication Potential (kg N eq)	0.7776218768983102
Freshwater Ecotoxicity Potential (CTUw)	94.34107839398356
Freshwater withdrawals (kg)	220160.22810426046
Greenhouse Gases (kg CO2 eq)	3334.319128412912
Hazardous Air Pollutants (kg)	0.6398883840363889
Human Health - Cancer (CTUh)	0.00009273823184721436
Human Health - Noncancer (CTUh)	0.00029574639113378614
Human Health - Respiratory Effects (kg PM2.5 eq)	8.294740833369276
Human Health Toxicity (CTUh)	0.00030986625030861772
Jobs Supported (jobs)	0.2316726542510336
Land Use (m ² /yr)	3281.8793849938644
Minerals and Metals Use (kg)	29940.76405280348
Nonrenewable Energy Use (MJ)	309265.637102527
Ozone Depletion (kg CFC-11 eq)	0.00006760183929283867
Pesticides (kg)	0.00027768910641488906
Renewable Energy Use (MJ)	192.408121283821
Smog Formation Potential (kg O3 eq)	163.7832367054907
Value Added (\$)	28831.129462708616

USEEIO Supporting OLEM SMM Program - Building to Future



Work in progress with near-term delivery

- v1 release with peer-review documentation for supporting software:
 - useeior
 - FLOWSA
 - StEWI
- New technology addition to economy
- Electricity sector disaggregation
- Add model hybridization capability to useeior
- Update of [EPA's Systems-Based GHG Inventory](#)

Work in progress with medium-to-long term delivery

- Update national flow by industry models for:
 - GHGs
 - Nutrient releases
 - Pesticide releases
 - Mineral and materials use
 - Criteria and hazardous air pollutants
- Foreign import GHG coefficients for USEEIO commodities
- WARM-USEEIO
- Waste Input-Output (WIO) Model
- US food system model (see '*Food waste management applications...*' presentation)
- Add final consumer (households, government) satellite tables

USEEIO Team



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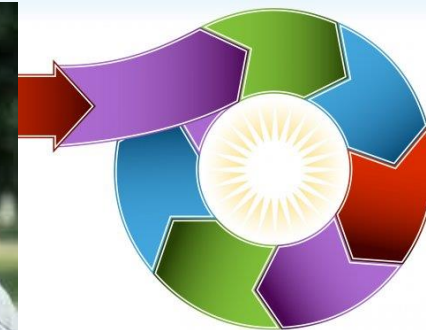
David Meyer, EPA



Loren Heyns,
GA Center for
Innovation



Michael Srocka,
GreenDelta



Wes Ingwersen, EPA

External Collaborators and Friends

[Amazon Sustainability](#), [ANL GREET team](#), [BONSAI](#), [Brightway LCA software](#), [Cornell Food Environmental Data System Project](#), [DataFEWSVision team](#), [DOE Advanced Manufacturing Office Strategic Energy Analysis Center](#), [Georgia Center of Innovation](#), [Federal LCA Commons Working Group](#), [NETL Energy Analysis Group](#), [NREL BEIOM Team](#), [National Capital Accounting Working Group](#), [National Socio-Environmental Synthesis Center \(SESYNC\)](#), [Office of the Assistant Secretary of Defense for Sustainment](#), [openLCA software](#), [Sustainable Industrial-Natural Coupled Systems \(SINCS\) lab](#), [USGS Materials Flow Analysis Section](#), [USDA ERS Food Dollar Team](#), [Thomas Group @ Georgia Tech](#), [Yale Center for Industrial Ecology](#)

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Additional Slides



v2.0 Basic Specs

- 2012 IO data, ~2012-2017 physical flows
- 411 commodities
- 2668 physical flow types
- 23 environmental and economic indicators
- Total US Consumption, Production and Household Consumption vectors (2012)

v2.0 New Features

- Disaggregation of Waste and Remediation sector
- Domestic vs. foreign input and result distinction
- Price adjustment matrices
- Production and consumption demand vectors
- Validation proofs

v2.0 Improved Data Description & More Data Distribution

- National Totals by Sector by NAICS-6 datasets in lieu of separate satellite tables
- Harmonization with [Federal LCA Commons Elementary Flow List](#)
- Additional data provision
 - Make and Use tables
 - Industry and commodity output
 - USEEIO<->BEA<->NAICS crosswalk
 - Domestic versions of matrices
 - More metadata

Updated Environmental Data Inputs

Dataset

[National Water Withdrawal Totals By Industry 2015](#)

[National Criteria and Hazardous Air Pollutant Totals By Industry 2017](#)

[National Point Source Releases to Ground By Industry 2017](#)

[National Point Source Releases to Water By Industry 2017](#)

[National Commercial Hazardous Waste Totals by Industry 2017](#)

[National Land Occupation Totals By Industry 2012](#)

[National Employment Totals By Industry 2017](#)