User Manual for the Sustainable Materials Management Prioritization Tools

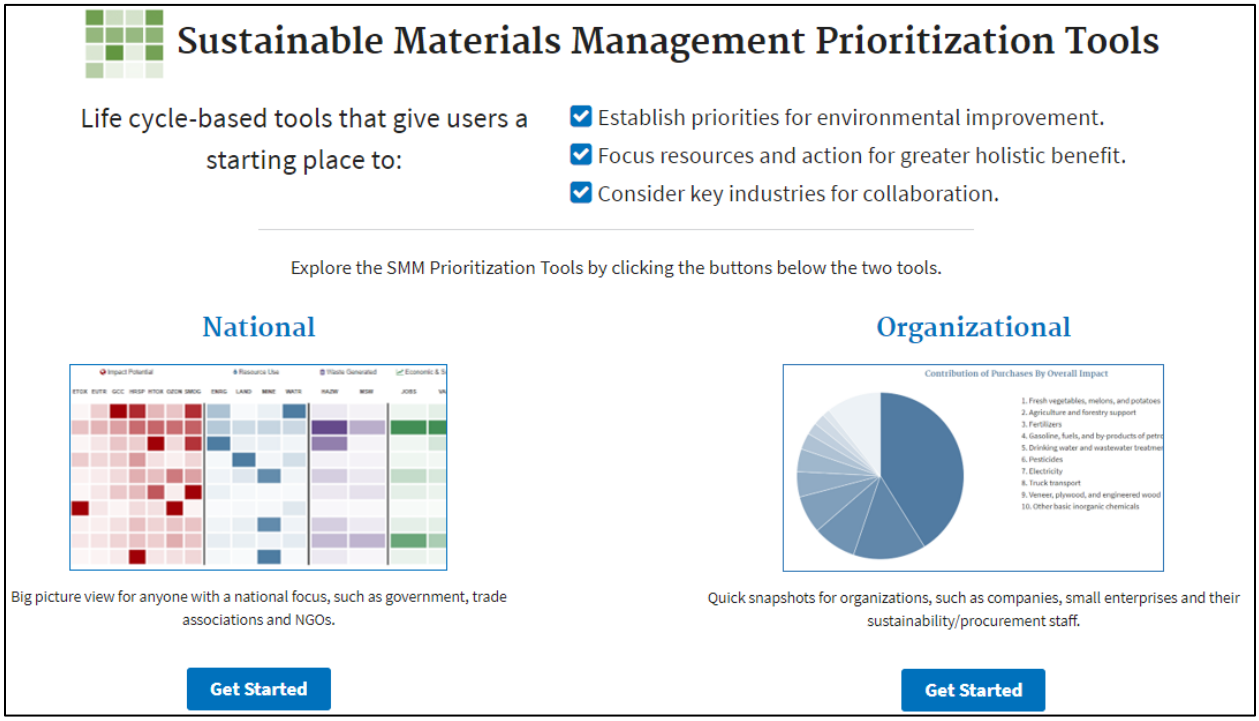


Image on cover: Landing page of the Sustainable Materials Management Prioritization Tools.

Table of Contents

Table of Figures

Introduction

The life cycle-based Sustainable Materials Management Prioritization Tools (SMM Prioritization Tools) can serve as a starting place to help consider potential opportunities for environmental improvement in the production and consumption of goods and services. These tools are designed to help highlight potentially significant environmental issues and hotspots. This knowledge can be helpful when prioritizing actions, focusing limited human and financial resources to achieve greater overall environmental benefit and considering key industries for collaboration. The SMM Prioritization Tools should be supplemented with more detailed information for greater accuracy and prior to considering specific actions.

The SMM Prioritization Tools include:

- National Tool: The National Tool provides a life cycle perspective of environmental issues, resource use and socioeconomic information potentially associated with goods and services produced and/or consumed in the United States. This information could of interest to government, non-governmental organizations, academic institutions and others looking for environmental improvement opportunities at a national level.

- Organizational Tool: The Organizational Tool guides a company or organization through a life cycle view of the potential environmental issues and resource use that may be typical for their sector. Socioeconomic information is not included in this tool. The Organizational Tool provides an environmental issues profile, supply chain hotspots and purchasing categories with potentially significant "embodied" issues. This information could be of interest to CEOs, procurement and sustainability professionals, small- and medium-sized organizations and others looking for environmental improvement opportunities at an organizational level.

Who should use these tools?

These tools are for individuals interested in an overview of environmental issues and resource use across the life cycle of goods and services to find opportunities to minimize negative human health and environmental impacts, to promote economic growth and to conserve natural capital in a way that cuts across more traditional organizational, decision and policy "silos".

How do these tools work?

Each tool serves as a non-expert user interface to EPA's United States Environmentally-Extended Input-Output (USEEIO) model. The Tools pull complex information from the model and display it in an understandable format.

The USEEIO model takes advantage of the U.S. Bureau of Economic Analysis (BEA) having mapped the network of relationships among businesses throughout the United States. (from those engaged in the extraction of raw materials and resources to businesses that sell goods or services to the consumer). This network of relationships is then overlaid with environmental, resource use and socioeconomic data. Associations are then drawn between goods and services and those data.

Explanation of input-output calculation

Assume that Industry A creates 100 widgets and, in the course of doing so, generates 100 kg of a pollutant of concern. If Industry B purchases 25% of Industry A's output (25 widgets), then 25 kg of the pollutant is associated with the demand created by Industry B. These 25 kg are "embedded" in the output (i.e., goods and services) produced by Industry B. When Industry C consumes goods and services produced by Industry B, the 25 kg are "passed on" to the products of Industry C. In this way, impacts that occur throughout the U.S. are allocated to goods and services.

The USEEIO model calculates environmental impacts, resource use and socioeconomic data at a national scale using publicly-available data. However, this capability comes with limitations. The most important is that the data are somewhat aggregated (e.g., small electrical appliances vs. coffee grinder or coffee grinder from a certain manufacturer). Thus, the level of resolution is limited to national averages for a good or service classification. In most cases, information provided will need to be supplemented with more detailed information prior to considering specific actions.

The Organizational Tool uses the USEEIO model to focus on individual goods or services of interest.

Where can you find more information?

The general EEIO approach underlying these tools was used by EPA to conduct the Relative Ranking Analysis found in EPA's report Sustainable Materials Management: The Road Ahead (2009). The user is encouraged to read the Road Ahead and its Appendix, including its supplemental information, for context in using these tools. The USEEIO national model developed by EPA in 2016 is an important step in making EEIO methodologies transparent, reproducible, open, free and up-to-date, as well as improving upon existing models. Users are encouraged to read up on EEIO, in general.

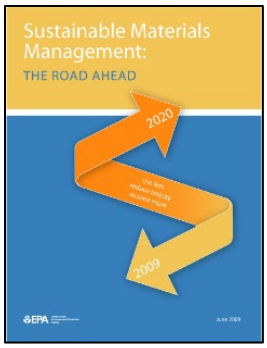


Figure 1 - Sustainable Materials Management: The Road Ahead report.

Links for more information:
SMM: The Road Ahead
USEEIO datasets
USEEIO documentation

Building Blocks of the SMM Prioritization Tools

Environmental and Socioeconomic Indicators

The following environmental and socioeconomic indicators are used in the SMM Prioritization Tools to evaluate the potential environmental, social and economic impacts that may arise throughout the life cycles of goods and services provided to society. The indicators are calculated by multiplying the total amount of each resource, waste or pollutant associated with a good or service by "characterization factors," which relate these to an environmental impact of interest, or aggregate these by more generic material, waste or release types. The full list of resources and pollutants tracked in the model and the characterization factors for these indicators are available here. Full definitions for these indicators are available in Appendix A. Definitions of the indicators can also be found by hovering over their abbreviations in the tools.

Impact Potential

- Acid Rain (ACID) (kg SO_2-eq) [1]
- Freshwater Aquatic Ecotoxicity (ETOX) (CTUe) [1]
- Eutrophication (EUTR) (kg N-eq) [1]
- Greenhouse Gases (GHG) (kg CO_2-eq) [1]
- Human Health – Cancer (HCAN) (CTUh) [2,3]
- Human Health – Noncancer (HNCN) (CTUh) [2,3]
- Human Health – Respiratory Effects (HRSP) (kg PM2.5-eq) [1]
- Human Health – Toxicity (HTOX) (CTUh) [1,3]
- Ozone Depletion (OZON) (kg CFC-11-eq) [1]
- Smog Formation (SMOG) (kg O_3-eq) [1]

Resource Use

- Energy Use (ENRG) (MJ) [1,4]
- Land Use (LAND) (m^2*yr) [1]
- Minerals and Metals Use (MNRL) (kg) [1]
- Nonrenewable Energy Use (NNRG) (MJ) [2,4]
- Renewable Energy Use (RNRG) (MJ) [2,4]
- Water Use (WATR) (m^3) [1]

Chemical Releases

- Hazardous Air Pollutants (HAPS) (kg) [2]
- Metals (METL) (kg) [2]
- Pesticides (PEST) (kg) [2]

Waste Generated

- Commercial Construction and Demolition Debris (CCDD) (kg) [1]
- Commercial Municipal Solid Waste (CMSW) (kg) [1]
- Commercial RCRA Hazardous Waste (CRHW) (kg) [1]

Economic & Social

- Jobs Supported (JOBS) (# of jobs) [2]
- Value Added (VADD) ($) [2]

[1] Indicator is included in the default analysis for all three tools.
[2] Indicator is not included in the Organizational Tool.
[3] The HCAN and HNCN indicators are subsets of the HTOX indicator. HTOX will be deselected automatically if HCAN and/or HNCN are included in the analysis to avoid double-counting.
[4] The RNRG and NNRG indicators are subsets of the ENRG indicator. ENRG will be deselected automatically if RNRG and/or NNRG are included in the analysis to avoid double-counting.

Goods and Services

The SMM Prioritization Tools categorize goods and services based on the list of 389 commodities included in the 2007 Input-Output tables from the U.S. Bureau of Economic Analysis (BEA), often referred to as the BEA IO accounts. The BEA IO accounts provide the framework for preparing the national and other economic accounts that are used for policy analysis, business planning and other purposes. The tables serve as both the data source and the framework used to estimate gross domestic product (GDP), which is used by the Federal Reserve to formulate monetary policy and the by the U.S. government to formulate fiscal policy. In business, macroeconomic and microeconomic forecasting models are built using the data from the IO accounts.

The BEA commodities can be roughly correlated to the industries described by the North America Industry Classification System (NAICS). The USEEIO model contains a crosswalk between the BEA categories of goods and services and NAICS. Detailed descriptions of the NAICS industry categories can be found on the U.S. Census NAICS website. Descriptions of goods and services in the National Tool can be found by hovering over their names. The Organizational Tool provides these descriptions when a good or service of interest is selected in the first tab.

Heatmap

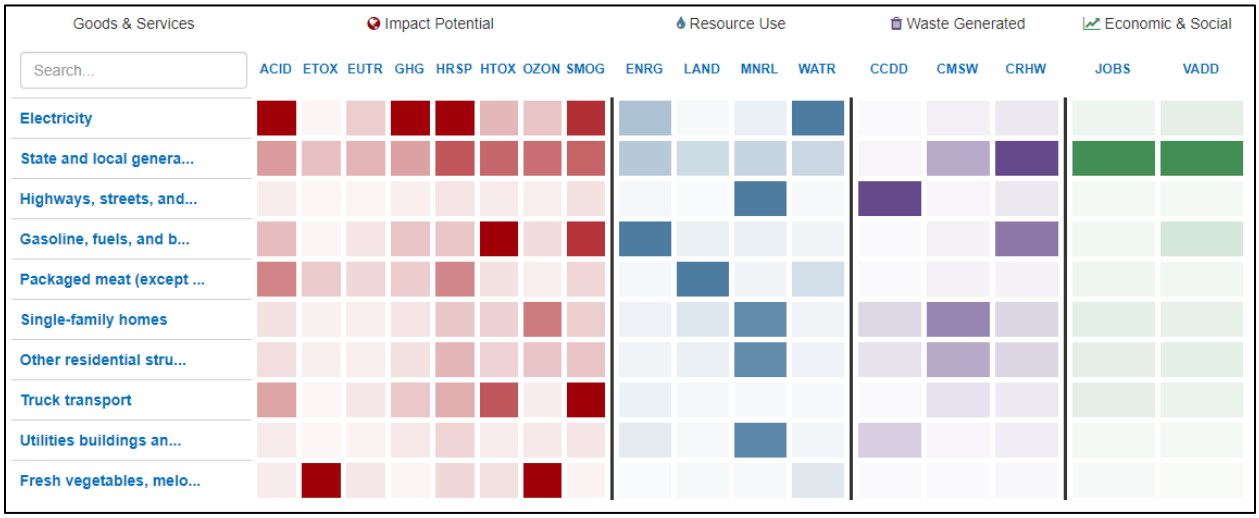


Figure 2 - Heatmap from National SMM Prioritization Tool.

The first set of results the user will see in the National Tool are displayed in the form of a heatmap. The heatmap shows a systems-view of how the production or consumption of goods and services may contribute to environmental impacts, resource use, waste generation and socioeconomic outcomes for the U.S.

Initially, the heatmap shows a list of ten goods and services in the leftmost column. Each good or service shown here has a corresponding relative significance "score" for each indicator. The darker the shading of the boxes to the right of each good or service the higher the relative contribution is for that good or service to that indicator.

The list of goods and services in the heatmap is shown in a ranked order with potentially highly impactful goods and services shown first. Each good or service contributes a certain percentage of the U.S. total of each indicator. Each good or service's percent contributions to the indicators in the Impact Potential, Resource Use and Waste Generated categories are summed. The goods and services are then shown in descending order of those summed percent contributions.

Explanation of ranking of goods and services

Assume Good or Service A contributes 3% to the U.S. total for Indicator 1, 5% for Indicator 2, 1% for Indicator 3, and 8% for Indicator 4. Good or Service A's percent contributions are then summed and compared to the sums of percent contributions for all other goods and services. The goods and services are then displayed in descending order of those sums. This ranking procedure is referred to as "normalization." Each indicator is weighted equally.

Note: Indicators in the Economic & Social category are not used for ranking. These indicators are interpreted in the opposite way of the indicators in the other categories. For example, a relatively high contribution of "Jobs Supported" is interpreted as a positive impact, whereas a relatively high contribution to "Hazardous Waste Generation" is interpreted as a negative impact. The indicators in the Chemical Releases category are not used for ranking since their data are used for indicators in the Impact Potential category.

Users can see the list of goods and services in a ranked order according to their potential impacts for a single indicator by clicking on the title of an indicator along the top of the heatmap. This list of goods and services in the heatmap will now be in descending order according to their potential impacts solely for that indicator. Clicking the title of the indicator a second time will return the heatmap to the default ranking. Users can expand the list of goods and services from ten up to 50 goods and services, in increments of ten, using the "Display" drop-down list below the heatmap.

Analysis Settings

The results and ranked list of goods and services shown in the heatmap are determined by the data and information provided by the USEEIO model. The specific data and information provided depend on the analysis settings selected in the tool. The currently selected analysis settings are listed directly above the heatmap. When users first open the SMM Prioritization Tools, the default settings are selected. Users can change the analysis settings in the National Tool by clicking the "Analysis Settings" button above

the heatmap. Clicking the "refresh" button next to the "Analysis Settings" button will return the analysis to default settings. The Organizational Tool uses the same default settings, but users cannot change the settings in the Organizational Tool.

There are three settings that users can change in the National Tool.

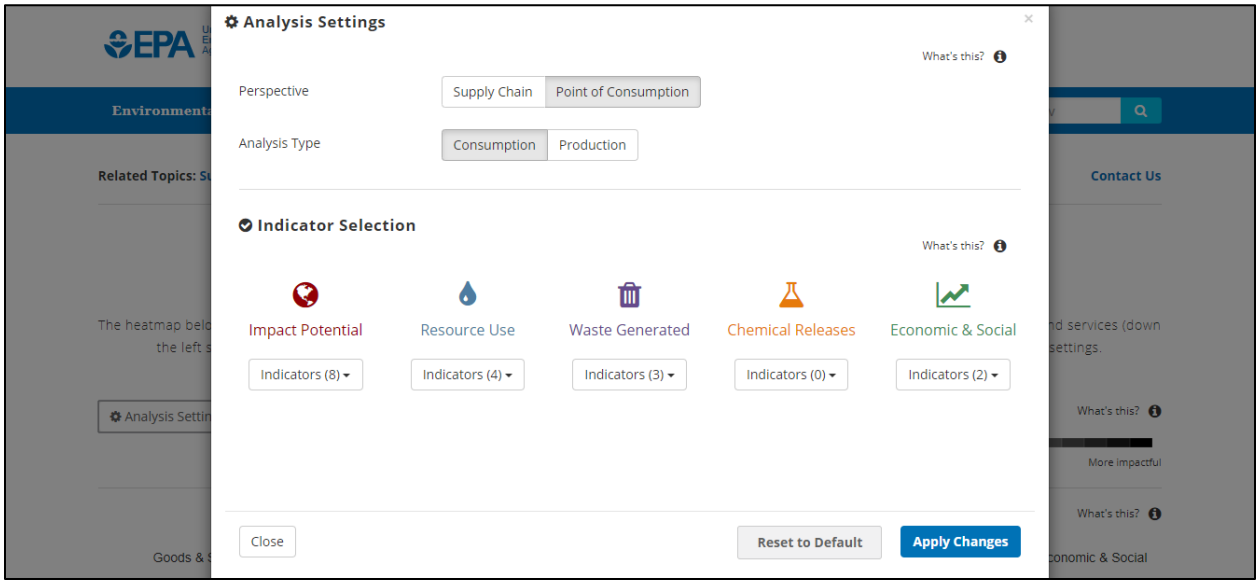


Figure 3 - Analysis Settings menu in National SMM Prioritization Tool.

Perspective

Changing the Perspective setting changes the way the USEEIO model allocates potential impacts of goods and services. This can help conceptualize the flow and accumulation of potential environmental issues along the production of goods and services. These perspectives enable users to see how potential issues can be "passed on" and "embodied" in the final good or service (Figure 2). The two Perspective options are Point of Consumption and Supply Chain. We recommend users explore both perspectives to obtain broad insights about the potential impacts of a range of goods and services.

- Point of Consumption[5] shows potential impacts associated with the operations and supply chain for a good or service PLUS the potential impacts that may be associated with processes in the supply chain of that good or service[6]. When this option is selected, the heatmap can be interpreted as showing "cradle-to-gate" potential impacts of the goods and services.

[5] Default perspective setting in all three tools.
[6] Supply Chain refers to the entire network of activities required to produce a good or service, while Operations refers to the potential issues arising from releases, resource use and waste generated at the facilities producing or providing a good or service.

- Supply Chain shows only potential impacts associated with the industries that emit the pollutants, use the resources, or create the jobs/add the value that are directly linked to the given impact. When this option is selected, the heatmap can be interpreted as showing potential hotspots or origins of impacts in the U.S.

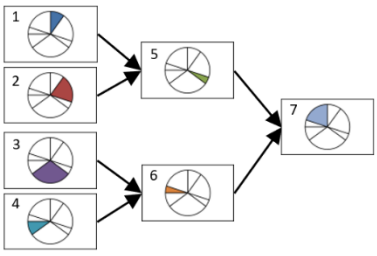
Figure 4 - Explaining the different perspectives.

The diagrams below depict how a single impact category is measured from the different perspectives included in the National Tool using the EEIO approach. The two diagrams depict the same supply chain used to produce a good or service. Each box represents a good or service category that produces output used as an input for a "downstream" good or service category (where material flow is depicted by the arrows). The box at the right-hand side of the diagrams (Good/Service #7) represents the final good or service as it is consumed by the end user.

The fully colored pie chart represents the total amount of the impact incurred to produce the good or service. The individual slices of the pie chart represent the portion of the impact associated with each of the goods or services in the supply chain. For example, the red slice represents the amount of impact associated with the production of Good/Service #2.

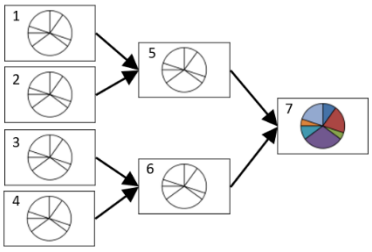
Supply Chain Perspective

The total impact associated with producing Good/Service #7 is broken down and allocated to the original sources (goods and services) in the supply chain.



Point of Consumption Perspective

The total impact associated with producing Good/Service #7 is measured in terms of "embodied" impact at the point of consumption.



Analysis Type

The National SMM Prioritization Tool allows users to see the results of analyzing the U.S. economy from two different analyses: Consumption and Production.

- Consumption[7] shows what potential environmental issues may be associated with final consumption of goods and services by households and governments (i.e., final output including any that is imported and excluding any that is exported). This type of analysis helps users see potential environmental issues

[7] Default Analysis Type setting in National Tool.

associated with goods and services consumed within the political boundaries of interest.

- Production[8] shows what potential environmental issues may be associated with domestic production of good and services within the region of interest (i.e., final output including any that is exported and excluding any that is imported). This type of analysis helps users see potential environmental issues across the production of goods and services whether or not they are consumed within the political boundaries of interest.

Indicator Selection

Users can choose which indicators are included in the analysis using the drop-down lists associated with each indicator category (i.e., Impact Potential, Resource Use, Waste Generated, Chemical Releases and Economic & Social). The indicators included in the analysis by default are noted above in the section "Environmental and Socioeconomic Indicators."

Examine Individual Goods and Services

The heatmap of the National Tool is designed to give users big picture, directional insights into where the major potential issues are occurring in the U.S. economy. Users can get more specific information about the potential impacts of individual goods and services by clicking on the name of a good or service of interest in the heatmap.

Clicking the name of a good or service while using the Point of Consumption perspective will open a module with several tabs of information on potential impacts that may be associated with that good or service, whether those impacts are mainly occurring in the supply chain and, if so, what parts of the supply chain could be significant contributors[9].

The information is organized into the following tabs, which can be seen above the chart area.

The Organizational Tool is built entirely around these tabs. Rather than beginning at the heatmap as in the National Tool, the Organizational Tool begins in the Select Good/Service tab, which prompts users to select a good or service of interest from the full list of 389 goods and services contained in the USEEIO model.

[8] Default Analysis Type setting in Organizational Tool to highlight the issues associated with goods and services produced in the United States. Note: Settings cannot be changed in the Organizational Tool.
[9] Note: Clicking the name of a good or service while using the Supply Chain perspective will open a module containing only the Environmental Profile tab for that good or service.

Environmental Profile

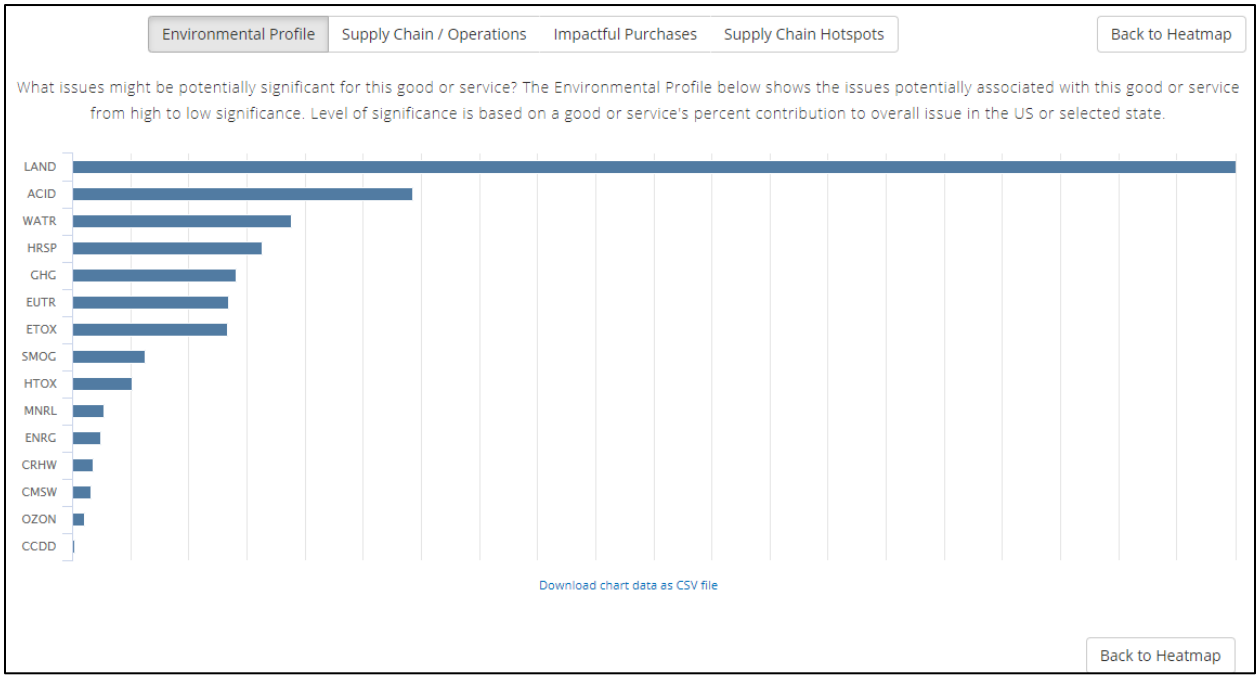


Figure 5 - Environmental Profile of an individual good or service.

The Environmental Profile tab provides a bar chart showing how the potential impacts, resource use and waste generation (e.g., Energy Use, Eutrophication, etc.) associated with the selected good or service compare to each other. Results are in decreasing order of significance, with the most potentially significant impact set to 100% and the other impacts made relative to it. Users can quickly identify issues that might be significant for this good or service.

Supply Chain/Operations

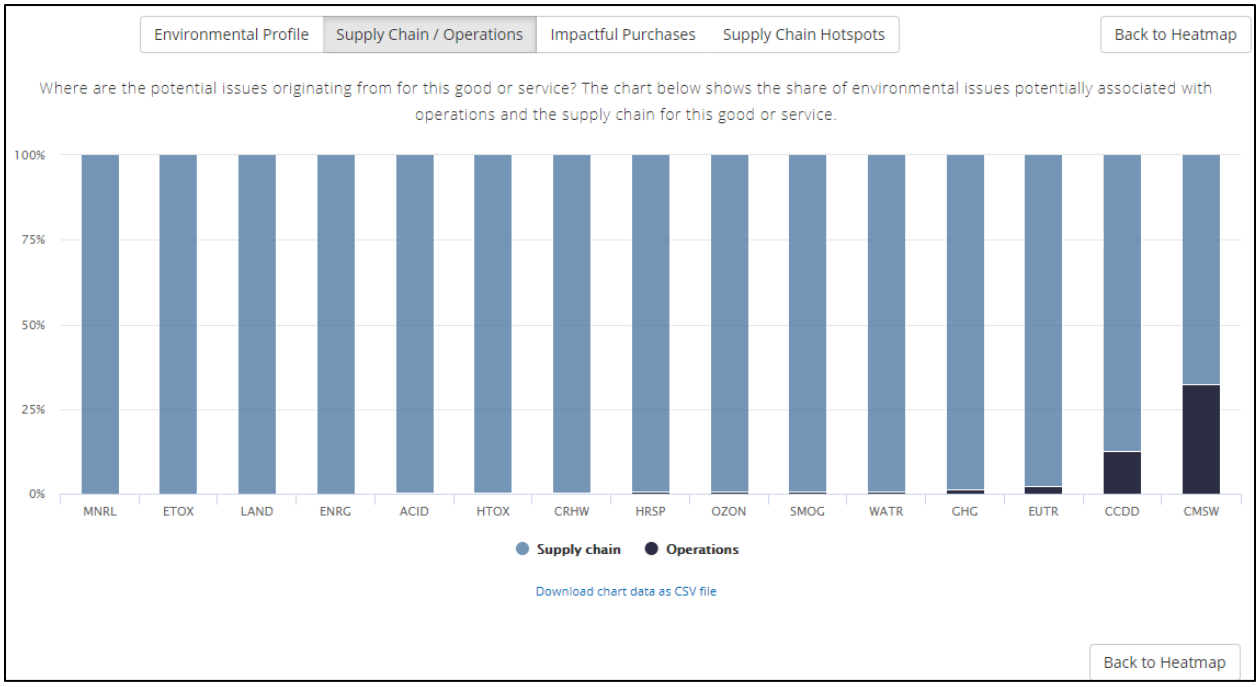


Figure 6 - Supply Chain/Operations tab for an individual good or service.

The Supply Chain/Operations tab provides a stacked bar chart showing what potential proportion of each environmental issue may be associated with the supply chain or operations of the entities producing and/or delivering the good or service. Supply chain refers to the entire network of activities required to produce and deliver a good or service purchased by an organization. This includes Tier 1 suppliers, as well as those that support them (e.g., Tier 2, 3, and so on). Operations refers to the activities of an organization to produce or provide a good or service. This gives users a sense of where they might want to focus their attention to address potential issues.

Supply Chain vs. Operations

Supply Chain refers to the entire network of activities required to produce a good or service, while Operations refers to the potential issues arising from releases, resource use and waste generated at the facilities producing or providing a good or service. For example, air emissions and wastewater generated during the production of paper at a paper mill would be included in the operations of the paper mill, along with any potential issues associated with electricity generated on-site at paper mills (a common practice in that industry). However, the supply chain portion of the potential issues would include those associated with logging operations, the off-site generation of electricity that is purchased by the mill and the manufacturing of capital equipment purchased by the mill.

Impactful Purchases

The Impactful Purchases tab displays which direct purchases made by an organization potentially embody ("contain") a significant proportion of the supply chain impacts. Two pie charts are displayed with wedge size reflecting proportion of contribution. The first pie chart shows purchases that potentially embody a significant proportion when considering all impact categories (i.e., all the indicators included in the current analysis). The second chart shows purchases that potentially embody a significant proportion when considering a single indicator. Users can select the indicator of interest using the drop-down list above the chart. This information helps users identify purchasing categories that may offer greater opportunities for improvement.

Clicking on a wedge in either pie chart on the Impactful Purchases tab will provide more information about that specific purchasing category. Clicking a wedge in the first pie chart (i.e., impactful purchases according to total combined impacts) will provide a list of five potentially significant impacts embodied in that purchase, as well as a list of five potentially significant upstream origins of the embedded impacts. Clicking a wedge in the second pie chart (i.e., impactful purchases according to a single indicator) will provide a list of five potentially significant upstream origins of that embodied impact in that purchase.

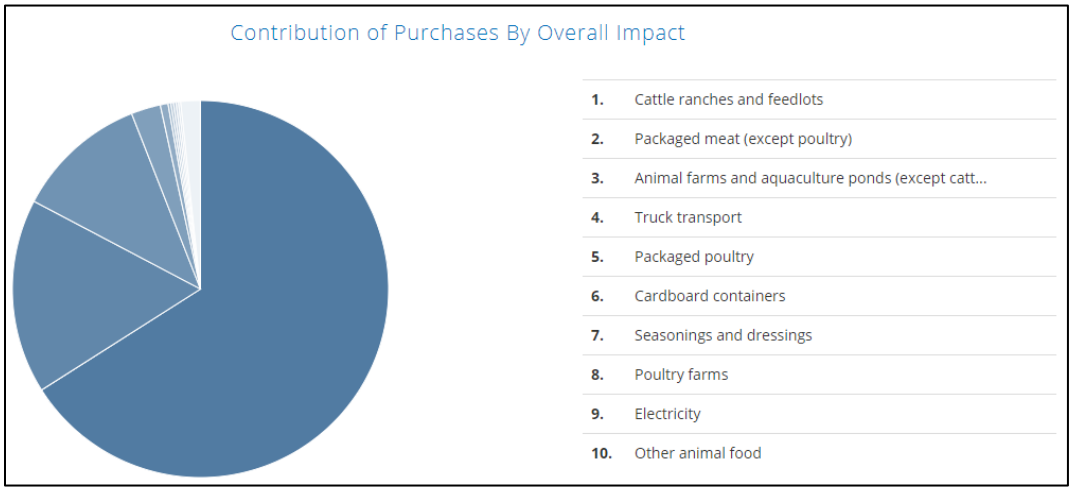


Figure 7 - Impactful Purchases for an individual good or service according to total potential impact. Click a wedge in the pie chart to reveal more information.

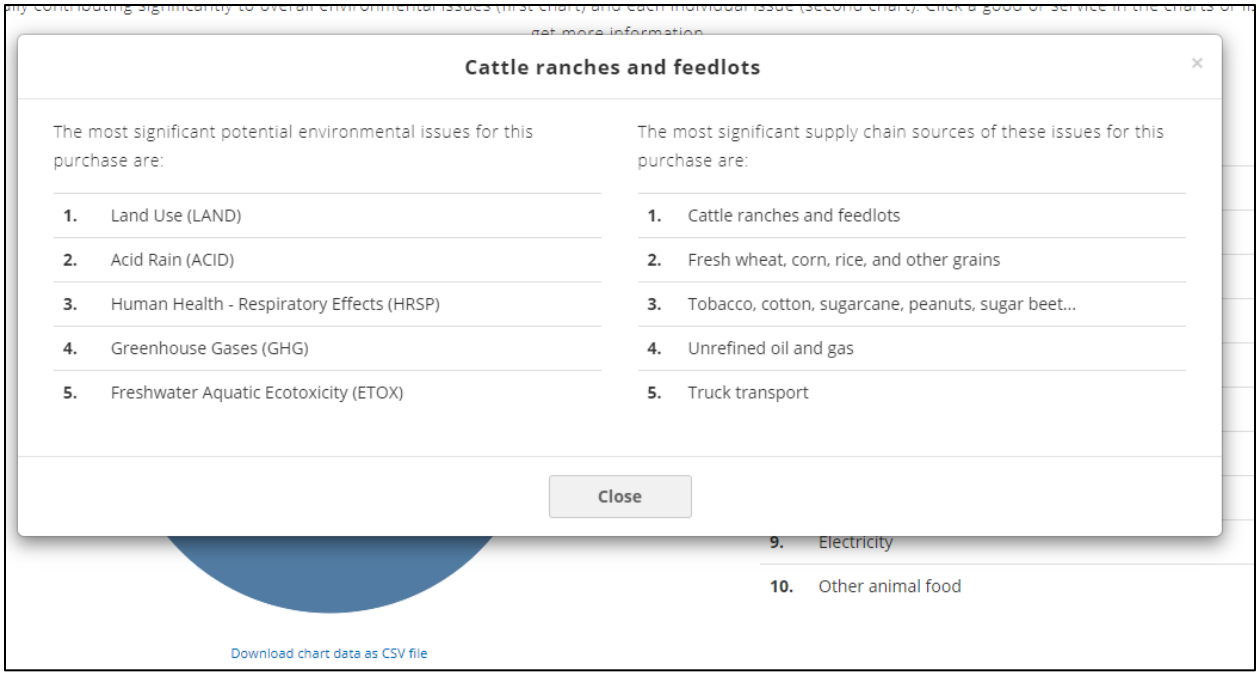


Figure 8 - Lists of potential issues and supply chain sources of issues for a single wedge in the first pie chart.

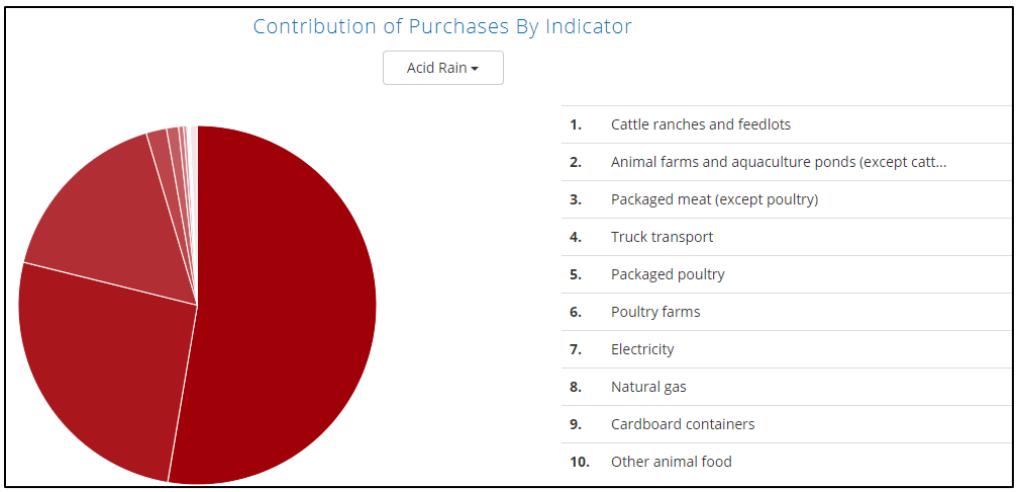


Figure 9 - Impactful Purchases for an individual good or service according to potential Acid Rain impacts. Click a wedge in the pie chart to reveal more information.

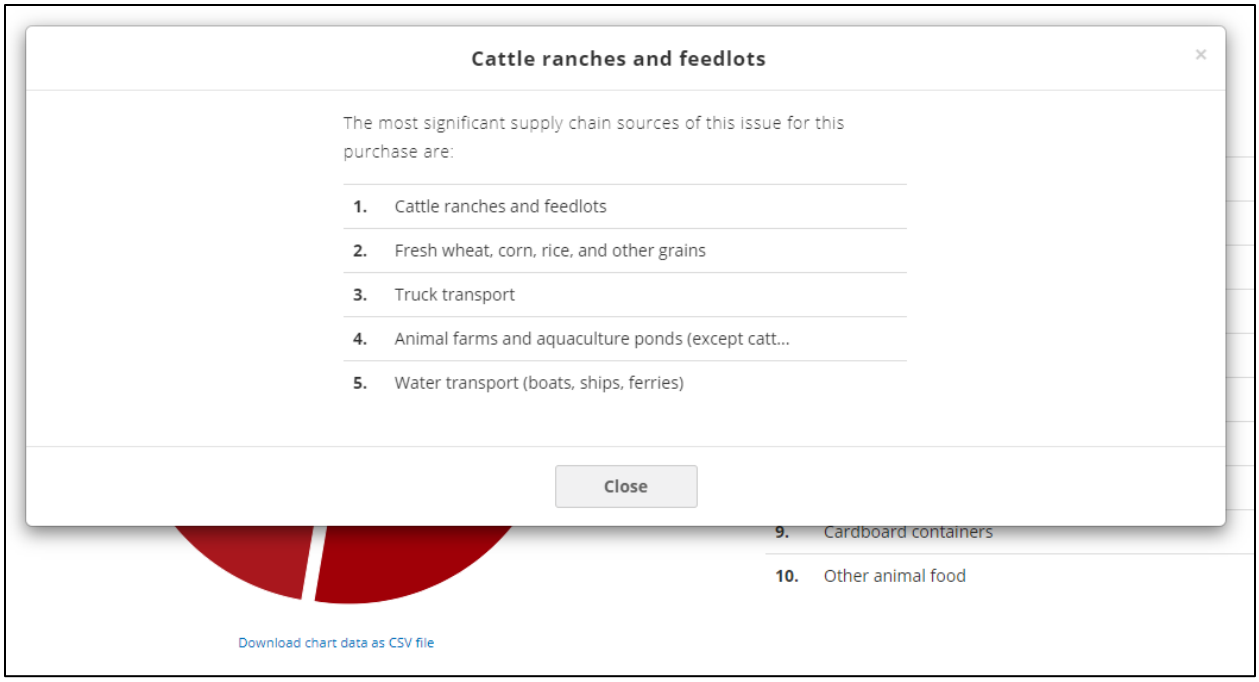


Figure 10 - List of supply chain sources of issues for a single wedge in the second pie chart.

Supply Chain Hotspots

The Supply Chain Hotspots tab provides the relative contribution of the potential sources of issues in the supply chain of the selected good or service. This can help further target limited resources to address potentially significant sources of issues in the supply chain. The potential issues associated with hotspots are then "passed along" the supply chain and embodied in the direct purchases analyzed in the Impactful Purchases tab. Two pie charts are displayed with wedge size reflecting proportion of contribution. The first pie chart shows hotspots that potentially contribute significantly to embodied supply chain issues across all impact categories (i.e., all the indicators included in the current analysis). The second chart shows the hotspots that potentially contribute significantly to a single embodied issue in the supply chain. Users can select the indicator of interest using the drop-down list above the chart.

Clicking on a wedge in the first pie chart on the Supply Chain Hotspots tab (i.e., significant supply chain hotspots according to total combined impacts) will provide a list of five potentially significant impacts originating from that hotspot. There is no further information available when clicking a wedge in the second pie chart (i.e., significant supply chain hotspots of a single indicator).

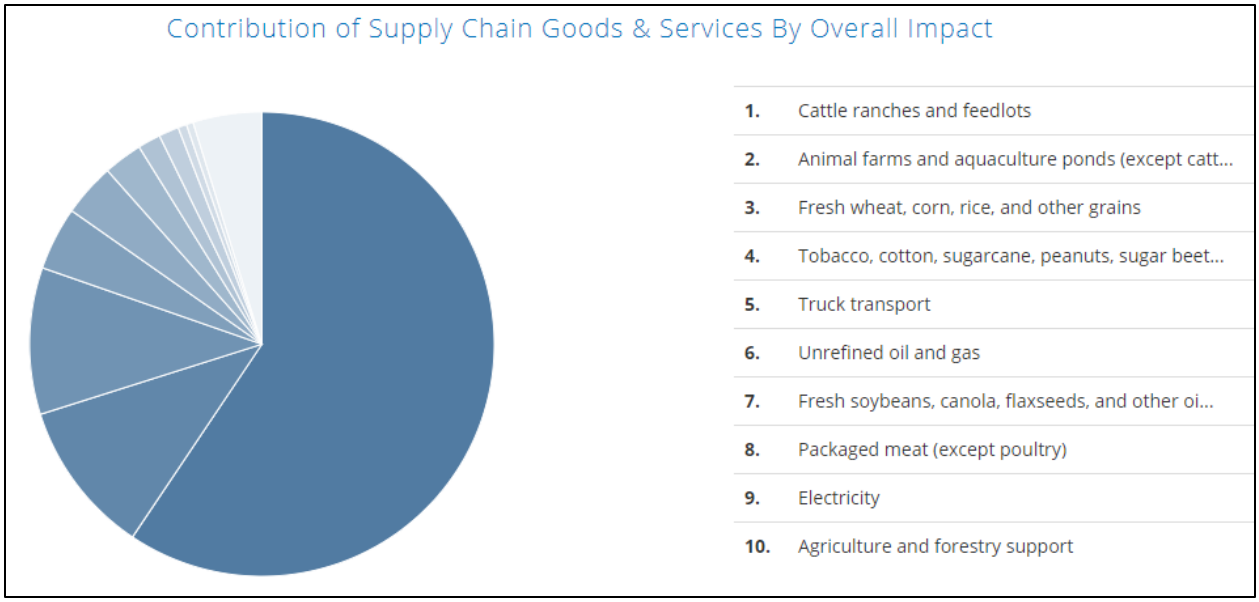


Figure 11 - Supply Chain Hotspots for an individual good or service according to total potential impacts. Click a wedge in the pie chart to reveal more information.

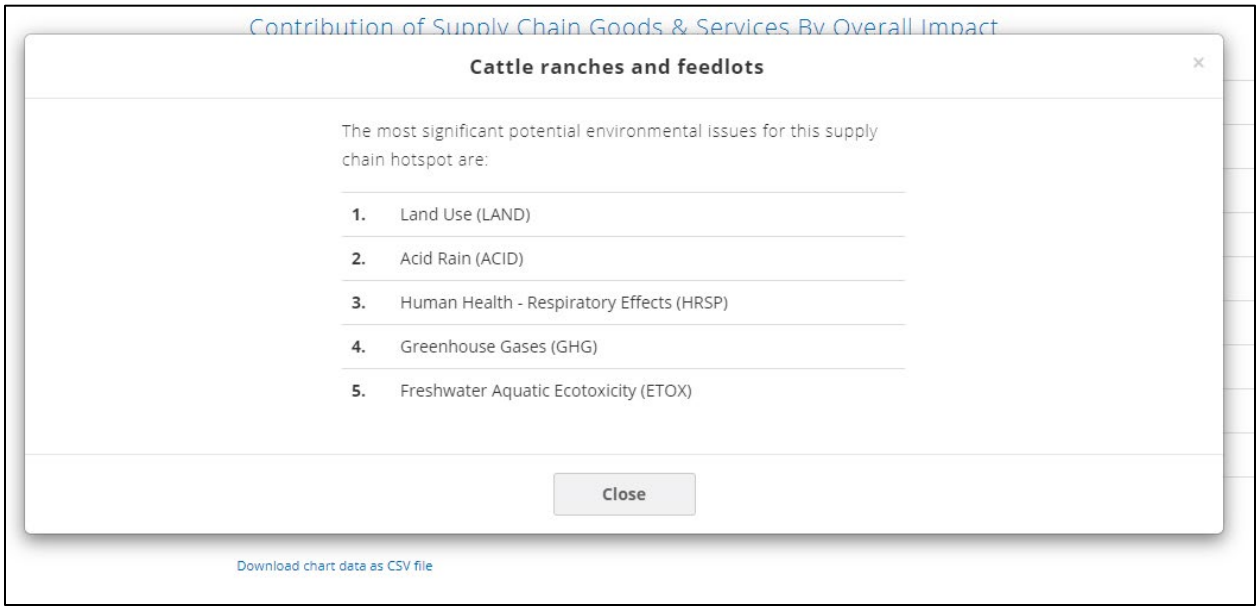


Figure 12 - List of potential issues for a single wedge in the first pie chart.

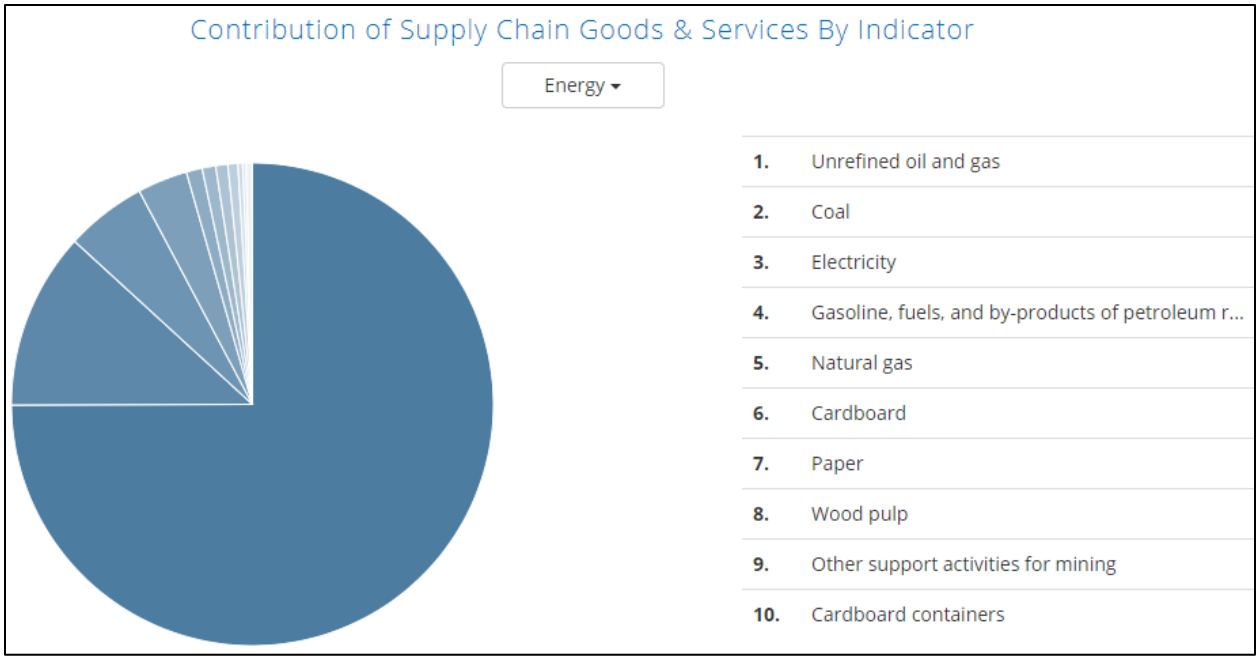


Figure 13 - Supply Chain Hotspots for an individual good or service according to potential Energy Use impacts.

Summary

The Summary tab (only available in the Organizational Tool) brings the charts and basic insights from the previous tabs into one location for users to review. Use the "Print this Summary" button at the bottom of the tab to print the information in the tab.

Comparison Analyses

The National SMM Prioritization Tool provides users the capability to perform several basic comparison analyses that can be accessed from the Comparison Analysis drop-down list below the heatmap.

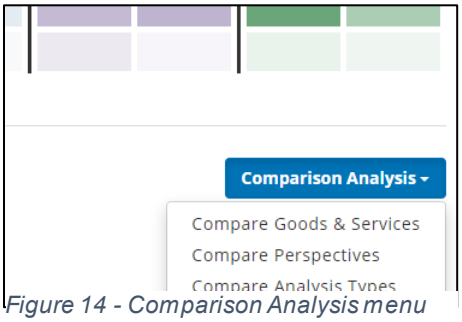


Figure 14 - Comparison Analysis menu below the heatmap.

Compare Goods and Services

Choosing this analysis allows users to compare goods and services by selecting goods and services of interest from the list that appears on the left-hand side of the screen. The list is in the same ranked order as the list in the heatmap. Data associated with the selected goods and services will be used to populate two charts, which can be accessed by clicking either the "Environmental Profiles" tab or "Supply Chain/Operations" tab above the chart area.

Environmental Profiles

The “Environmental Profiles” bar chart shows a side-by-side comparison of the potential issues for these goods & services. The good or service with the highest value in each indicator is set to 100% and the other values are normalized to it.

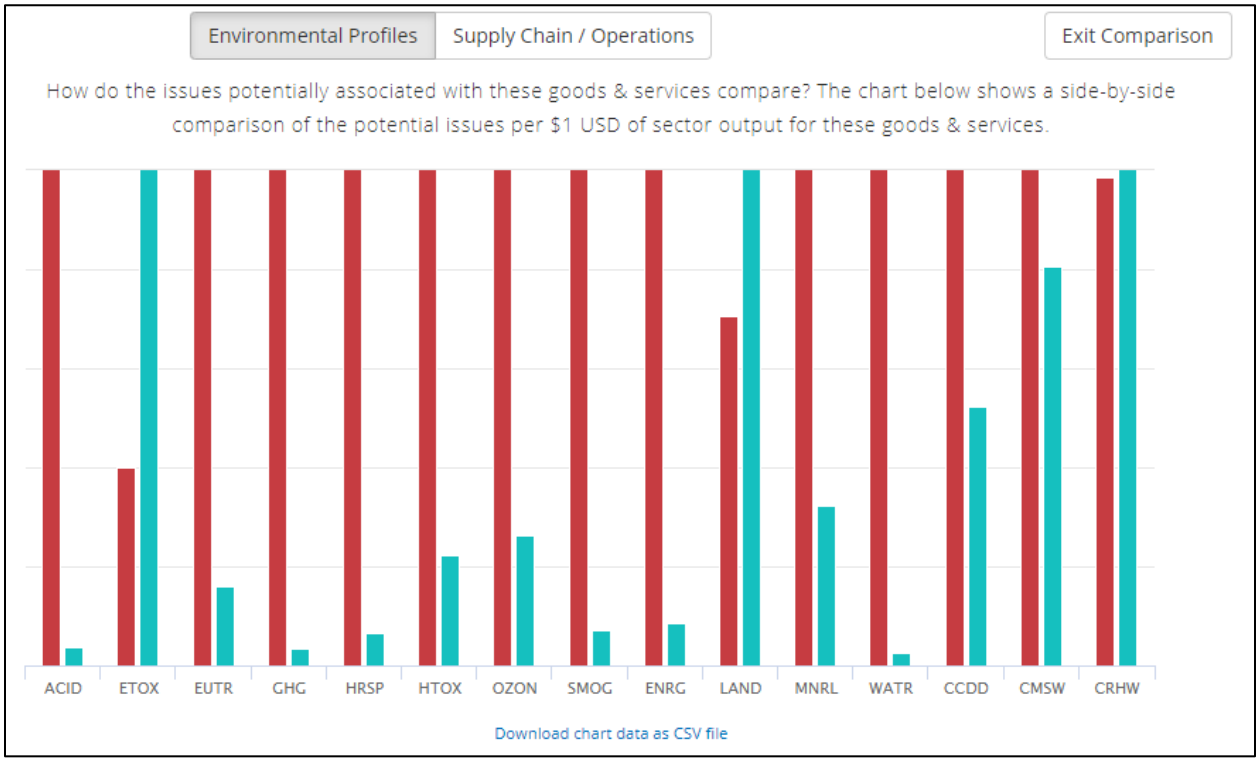


Figure 15 - Comparing Environmental Profiles of two goods and services side-by-side.

Supply Chain/Operations

The “Supply Chain/Operations” stacked bar chart shows the percentage of each indicator that is associated with the supply chain and operations for each good or service being compared. Supply chain refers to the entire network of activities required to produce and deliver a good or service purchased by an organization. This includes Tier 1 suppliers, as well as those that support them (e.g., Tier 2, 3, and so on). Operations refers to the activities of an organization to produce a good or service. All stacked bars are normalized to 100% to make it easier to compare differences in percentages represented by each bar. The solid-colored portion of each bar represents the contribution from operations, while the translucent portion represents the contribution from the supply chain.

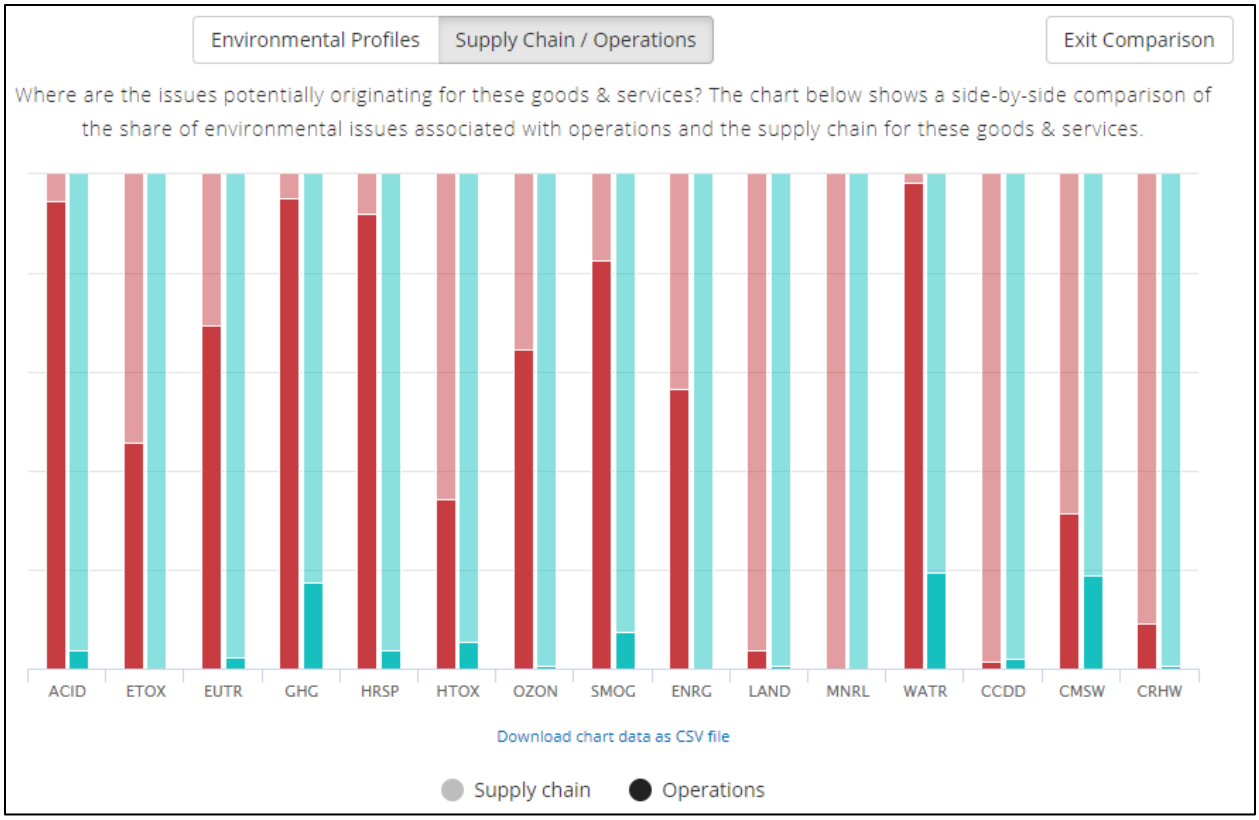


Figure 16 - Comparing potential impacts associated with Supply Chain and Operations of two goods and services side-by-side.

Compare Perspectives and Compare Analysis Types

These comparison analyses show users two lists of ranked goods and services. The lists will be ranked according to the same analysis settings, except for the variable being compared. For example, when comparing Perspectives, the only difference between the two lists will be the Perspective used to rank the goods and services. When comparing Analysis Types, the only difference will be the Analysis Type used to rank the goods and services. In either of these analyses, the "View Heatmap" buttons below the lists can be selected to view the heatmap associated with the top 10 ranked goods and services with those settings.

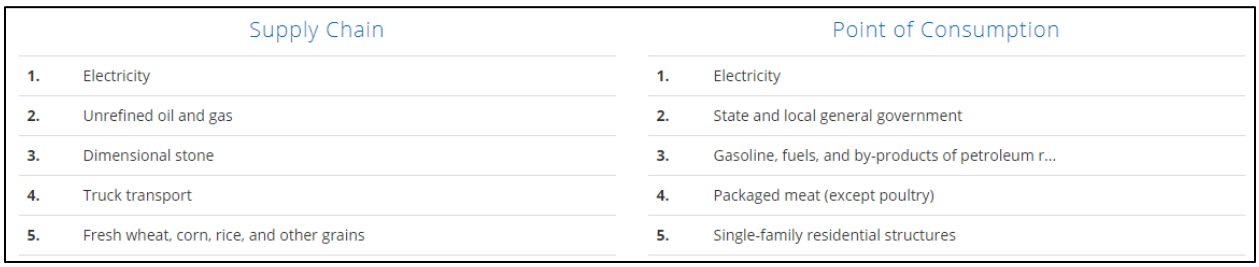


Figure 17 – Comparing ranking results when using Supply Chain and Point of Consumption perspectives.

	Consumption		Production
1.	Electricity	1.	Electricity
2.	State and local general government	2.	State and local general government
3.	Gasoline, fuels, and by-products of petroleum r...	3.	Fresh wheat, corn, rice, and other grains
4.	Packaged meat (except poultry)	4.	Gasoline, fuels, and by-products of petroleum r...
5.	Single-family residential structures	5.	Packaged meat (except poultry)

Figure 18 - Comparing ranking results when using Consumption and Production analysis types.

Appendix A: Indicator Definitions

Impact Potential

The Impact Potential category is composed of indicators of potential environmental and human health impacts that arise from emissions associated with processes that provide goods & services to society.

Acid Rain (ACID) (kg SO_2-eq)

Acid rain occurs when acid-precursors are absorbed from the atmosphere by clouds and dissolved in falling rain. Acid rain, while not directly dangerous to people, causes millions of dollars in damage to infrastructure by very slowly dissolving the exposed surfaces of roads, buildings, drains, and even statues. Acid rain is also detrimental to natural life: acidic soils make it difficult or impossible for plants to survive and grow and acidic runoff can disrupt the delicate chemical balance in natural bodies of water. In this indicator, emissions are expressed in sulfur dioxide (SO2) equivalents. The source of the factors for this indicator is TRACI 2.1 (Bare 2012).

Freshwater Aquatic Ecotoxicity (ETOX) (CTUe)

Like humans, wildlife can be harmed by exposure to toxic chemicals and substances. An ever-expanding list of common chemicals have been assessed for their tendency to cause ecological damage when released in to the air, water, or soil. In this indicator, emissions are expressed in terms of their contribution to ecological damage in the water column of freshwater bodies. A standardized Comparative Toxicity Unit is used. The source of the factors for this indicator is TRACI 2.1 (Bare 2012) which uses USETox 1.0 (Rosenbaum et al. 2008).

Eutrophication (EUTR) (kg N-eq)

Aquatic life is frequently limited by access to mineral nutrients, but the most common limiting nutrients are in both agricultural fertilizers and sewage. When these nutrients are carried in to natural water bodies, usually by rain or pipe, they can cause massive blooms of algae. These algae can choke out other life in the water by rapidly taking up oxygen, blocking sunlight, or even releasing toxic chemicals. After the bloom, the algae die and leave behind a devastated ecosystem. In this indicator, emissions are expressed as their equivalent in kilograms of bioavailable nitrogen, based on the emission in question's potential to reach a body of water and its resultant impacts on algal growth. The source of the factors for this indicator is TRACI 2.1 (Bare 2012).

Greenhouse Gases (GHG) (kg CO_2-eq)

Greenhouse gases are the primary driver of climate change. These gases absorb infrared radiation emitted by the sun at a higher rate than standard atmospheric gases. The result is that, when these gases are emitted, the atmosphere absorbs and stores more heat, causing it to warm up. Carbon dioxide is the most commonly known greenhouse gas, but other gases such as methane, nitrous oxide, and even water vapor are all major contributors to the warming of the atmosphere. In this indicator, emissions are expressed as their equivalent in carbon dioxide (CO2), based on the amount of heat they can absorb and their average life span in the atmosphere. The source of the factors for this indicator is TRACI 2.1 (Bare 2012).

Human Health – Cancer (HCAN) (CTUh)

Exposure to certain chemicals, called carcinogens, can increase the likelihood of cancer in humans by damaging DNA, facilitating the damage of DNA, or otherwise causing human cells to behave abnormally. Cancer is a costly disease, both in its burden on human life and on the economy. Many carcinogens can be avoided, but others are present in our air, water, and food. In this category, emissions are expressed in terms of their contribution to the incidence of cancer in humans. A standardized Comparative Toxicity Unit (CTU) is used. The source the factors for this impact category is TRACI 2.1 (Bare 2012) which uses USETox 1.0 (Rosenbaum et al. 2008).

Human Health – Noncancer (HNCN) (CTUh)

Cardiopulmonary distress and cancer are not the only ways a chemical can be harmful, but they are perhaps the most prevalent and easily categorized. Yet, there exist millions of harmful chemicals that a human can be exposed to with detrimental effect. This Human Health category serves as a way to track illness not captured by Criteria Pollutants or Cancer Effects. In this category, emissions are expressed in terms of their contribution to the incidence of illness in humans. A standardized Comparative Toxicity Unit (CTU) is used. The source the factors for this impact category is TRACI 2.1 (Bare 2012) which uses USETox 1.0 (Rosenbaum et al. 2008).

Human Health – Respiratory Effects (HRSP) (kg PM2.5-eq)

Particulates can be nearly any ingestible material ground down to a fine enough size. Even otherwise harmless substances, when suspended as a dust and inhaled in to the lungs, can clog airways and irritate the sensitive tissues of the lungs. Over time, exposure to these particulates can lead to a variety of harmful

respiratory and cardiac diseases and a general loss of cardiopulmonary function that significantly lowers both lifespan and productive years. In this indicator, emissions are expressed in terms of their effect on human respiratory health in PM2.5 equivalents. The source of the factors for this indicator is TRACI 2.1 (Bare 2012).

Human Health – Toxicity (HTOX) (CTUh)

Millions of tons of chemicals are used in commerce that a human can be exposed to with potential detrimental effect. Exposure to certain chemicals can increase the likelihood of cancer or other illness in humans. In this indicator, emissions are expressed in terms of their contribution to the incidence of cancer and illness in humans. A standardized Comparative Toxicity Unit (CTU) is used. This indicator is a combination of the HCAN and HNCN indicators. The source of the factors for this indicator is TRACI 2.1 (Bare 2012) which uses USETox 1.0 (Rosenbaum et al. 2008).

Ozone Depletion (OZON) (kg CFC-11-eq)

The earth is surrounded by a protective layer of atmospheric ozone that filters out harmful radiation from the sun. Certain chemicals, when released in to the air, have the ability to react with and destroy large quantities of the ozone layer, allowing more harmful radiation to reach us. Some chemicals are more long lasting or more likely to interact with ozone than others, so they have different destructive potentials. In this indicator, emissions are expressed as their equivalent in kilograms of CFC-11, an extremely harmful gas formerly used as a common refrigerant capable of destroying thousands of times its mass in ozone. The source of the factors for this indicator is TRACI 2.1 (Bare 2012).

Smog Formation (SMOG) (kg O_3-eq)

Smog formation is a complex process by which a group of inorganic gases, typically released by the burning of fossil fuels, react with another group of organic substances, typically released by plant-life, to create ozone at the ground-level. Ozone created at the ground level can cause respiratory disease in humans and stresses plant life, making them more susceptible to disease. Ground-level ozone is also generally broken down and destroyed before it can rise up to join the protective atmospheric ozone layer. In this indicator, emissions are expressed in terms of how much they will contribute to the creation of ground-level ozone (O3), units are kg O3 -equivalents. The source of the factors for this indicator is TRACI 2.1 (Bare 2012).

Resource Use

The Resource Use category is composed of indicators that measure the resource demands of processes throughout the life cycles of goods & services provided to society.

Energy Use (ENRG) (MJ)

Energy Use is an indicator of the life cycle total amount of primary energy used as defined by heat value in a combusted resource or the available energy in a renewable resource to a converting device such as a wind turbine or water turbine. This indicator is a combination of the NNRG and RNRG indicators. This indicator is expressed in megajoules (MJ).

Land Use (LAND) (m^2*yr)

Nearly every process requires some amount of land for factories, offices, or roads. This land is often converted from existing natural habitats for wildlife. Habitat loss is the leading cause of wildlife extinctions worldwide and additional habitat conversion could lead to further loss of species. This indicator tracks the total area of usable land occupied to allow for the process. This indicator is expressed in square meters for a year (m2*yr).

Minerals and Metals Use (MNRL) (kg)

Minerals and Metals Use is an indicator of the life cycle total mass of nonmetallic and metallic minerals extracted for use measured in kilograms (kg).

Nonrenewable Energy Use (NNRG) (MJ)

Nonrenewable Energy Use is an indicator of the life cycle amount of primary energy that is nonrenewable as defined by heat value in a combusted resource. This indicator is expressed in megajoules (MJ).

Renewable Energy Use (RNRG) (MJ)

Renewable Energy Use is the amount of primary energy that is renewable as defined by the available energy in a renewable resource to a converting device such as a wind turbine or water turbine. This indicator is expressed in megajoules (MJ).

Water Use (WATR) (m^3)

Water Use is an indicator of the life cycle total amount (m3) of freshwater withdrawn from surface and groundwater sources in order to provide a given good or service to society.

Chemical Releases

The Chemical Releases category is composed of indicators that estimate the amount of certain chemical releases throughout the life cycle of goods and services provided to society.

Hazardous Air Pollutants (HAPS) (kg)

Hazardous Air Pollutants is an indicator of the life cycle total EPA-defined hazardous air pollutants emitted (kg).

Metals (METL) (kg)

Metals is an indicator of the life cycle total mass (kg) of metals released to the air, water and soil.

Pesticides (PEST) (kg)

Pesticides in an indicator of the life cycle total mass (kg) of pesticides escaping from agricultural fields.

Waste Generated

The Waste Generated category is composed of indicators that estimate the amount of waste generated by processes associated with providing goods & services to society.

Commercial Construction and Demolition Debris (CCDD) (kg)

The CCDD indicator represents the annual generation amount of construction and demolition (C&D) materials during the construction, renovation and demolition of buildings (including homes), roads, bridges and other structures. C&D materials include steel, wood products, drywall and plaster, brick and clay tile, asphalt shingles, concrete and asphalt concrete. The CCDD indicator does not include C&D debris from DIY renovations or natural disasters. This indicator is expressed in kilograms (kg).

Commercial Municipal Solid Waste (CMSW) (kg)

EPA refers to trash, or municipal solid waste (MSW), as various items consumers throw away after they are used. These items include bottles and corrugated boxes, food, grass clippings, sofa, computers, tires and refrigerators. However, MSW does not include everything that is landfilled in MSW, or nonhazardous, landfills, such as construction and demolition debris, municipal wastewater sludge, and other non-hazardous industrial wastes. These wastes come from: our homes; institutions such as schools and hospitals; and commercial sources such as restaurants and businesses. The CMSW indicator includes MSW found in the dumpsters of commercial and institutional entities. It does not include MSW from homes. Data for CMSW comes from this CalRecycle report (2014). This indicator is expressed in kilograms (kg).

Commercial RCRA Hazardous Waste (CRHW) (kg)

Hazardous wastes are wastes with properties that make them dangerous or capable of having a harmful effect on human health or the environment. Hazardous waste is generated from many sources, ranging from industrial manufacturing process wastes to batteries and may come in many forms, including liquids, solids, gases and sludges. EPA identifies hazardous waste and collects information on quantities generated through its Biennial Hazardous Waste Report. Individual states can identify hazardous waste beyond what EPA identifies. Unless otherwise specified, quantities reflected in this indicator come from EPA's Biennial Report. This indicator is expressed in kilograms (kg).

Economic & Social

The Economic & Social category is composed of indicators that measure the socioeconomic effects associated with the processes that provide goods & services to society. These indicators do not factor into the ranking of goods and services.

Jobs Supported (JOBS) (# of jobs)

Jobs Supported is an indicator of the total number of employees supported by the processes that provide a given good or service to society.

Value Added (VADD) ($)

Value Added is an indicator of the total value added to the economy by providing a given good or service to society. It is defined as the sum of employee compensation, taxes minus subsidies, and gross operating surplus.