Consumption-related greenhouse gas emissions

Minnesotans' consumption of goods and services generates emissions at home and abroad

From gasoline to food and clothing to healthcare, consuming products and services results in greenhouse gas emissions. We already know that making, growing, and transporting goods and services releases emissions all over the world. But, how much of those emissions are Minnesotans responsible for based on the goods and services they consume? Understanding the full picture of these emissions can help people make informed decisions to address climate change and sustainably manage materials. This report summarizes Minnesota's contribution to global greenhouse gas (GHG) emissions, compares the different types of GHG inventories, and highlights how consumption-based emissions inventories can be used to reduce Minnesotans' GHG emissions, wherever in the world they occur.

Different ways to measure greenhouse gas emissions

Consumption-based inventory

This is a global approach for emissions anywhere in the world in service of things consumed in Minnesota.



In-boundary inventory

This is a geographic approach for emissions released in Minnesota, regardless of where things are consumed.



Consumption-based emissions inventory

The Minnesota consumption-based emissions inventory (CBEI) is a tool used to estimate the greenhouse gas (GHG) emissions associated with the goods and services Minnesotans buy and consume every day. This approach accounts for emissions released throughout a product or service's entire life cycle. For products, this includes all emissions from the time raw materials are mined until end-of-life disposal, and for services it includes all emissions from the material and energy inputs used to provide the service.

Many are already familiar with Minnesota's state Greenhouse Gas Inventory, which calculates the emissions released within state borders from sources like vehicle tailpipes, home furnaces, and coal-fired power plants. This "production-based" or "in-boundary" approach to GHG accounting follows international guidelines and is designed to allow direct comparisons between nations or states. However, that data doesn't include the "upstream" life cycle emissions from Minnesotans' purchases of goods and services produced out of state. A CBEI uses a different analytical approach to offer a more complete picture of Minnesota's emissions than the in-boundary GHG inventory alone can provide. A CBEI includes everything that households and governments consume, as well as life cycle GHG emissions resulting from any goods that businesses have not yet sold or from

capital equipment. The model breaks down emissions by five life cycle phases: production, pre-purchase transportation, wholesale and retail, use, and post-consumer disposal.

To get a clearer picture of Minnesotans' total GHG emissions, the MPCA used an environmentally-extended input-output model developed by the U.S. Environmental Protection Agency (EPA) to create a new Minnesota CBEI that estimates emissions from broad categories of goods and services consumed in Minnesota. See section "Methodology for the Minnesota CBEI" at the end of this document for further details.

Consumption and in-boundary: two complementary inventories

The CBEI complements the "in-boundary" GHG emissions inventory that Minnesota's Next Generation Energy Act requires the state to conduct every two years. The in-boundary inventory measures GHGs emitted within the state's geographical boundaries regardless of where the goods or services are ultimately consumed. For example, the in-boundary inventory counts emissions from a turkey raised in Minnesota that is exported and eaten in New York. The in-boundary inventory is particularly useful for developing priorities and programs to reduce GHG emissions generated by in-state activity.

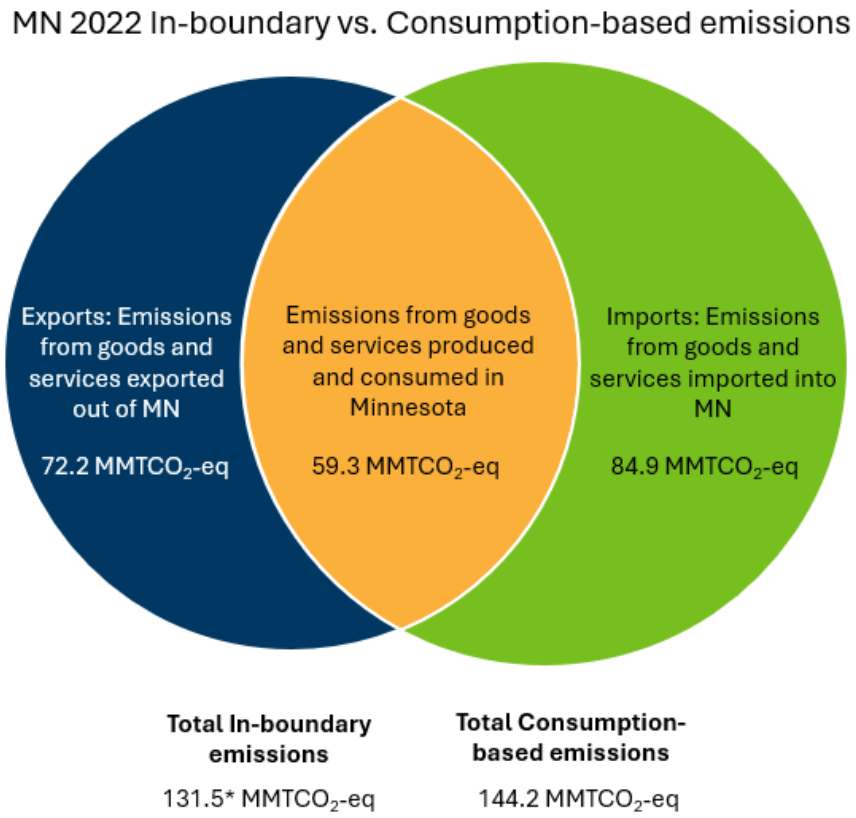
The CBEI, however, estimates emissions of goods and services consumed in Minnesota regardless of where they came from. For example, the life cycle emissions from the turkey that went to New York aren't counted in the CBEI, but the life cycle emissions from a coat made in China and bought in Minnesota are included.

Because the in-boundary GHG inventory and CBEI are developed using different methodologies, they group emissions into different categories. For example, the in-boundary inventory estimates emissions for broad economic sectors, like agriculture, transportation, electricity generation, and the waste sector. But because the CBEI uses economic data on consumption within industries to estimate emissions, it reports emissions caused by these individual industries, such as construction, food/beverages, health care, and clothing/textiles. Dividing emissions into these consumption-focused categories helps identify the potential of specific actions that households, citizens, and governments can take to reduce emissions.

Comparing results of the two inventories

The two inventories provide different perspectives on Minnesota's GHG emissions which complement each other when viewed together. Figure 1 illustrates the distinct roles that in-boundary inventories and CBEIs play in illuminating where emissions come from as well as the overlap between the two. In short, both the in-boundary inventory and CBEI are able to quantify a large portion of Minnesota's total emissions, but each inventory type quantifies some additional emissions that the other does not.

Figure 1: MN 2022 In-boundary vs. Consumption-based emissions



**The official MN in-boundary GHG emissions inventory represents "net" emissions and includes negative emissions due to emissions sinks, and also includes emissions from land use and land use change. Because the activities which generate these emissions are not readily attributable to the consumption of goods and services, the CBEI does not include them, and they are omitted from the in-boundary total used here to enable a more accurate comparison and to allow for an estimate of emissions from exports. The official MN in-boundary inventory also includes emissions from imported electricity, but these are excluded here as they overlap with the imports that are already accounted for by the CBEI. The official 2022 MN statewide in-boundary net GHG emissions total was 120.1 MMT CO_2-eq at the time this document was published.*

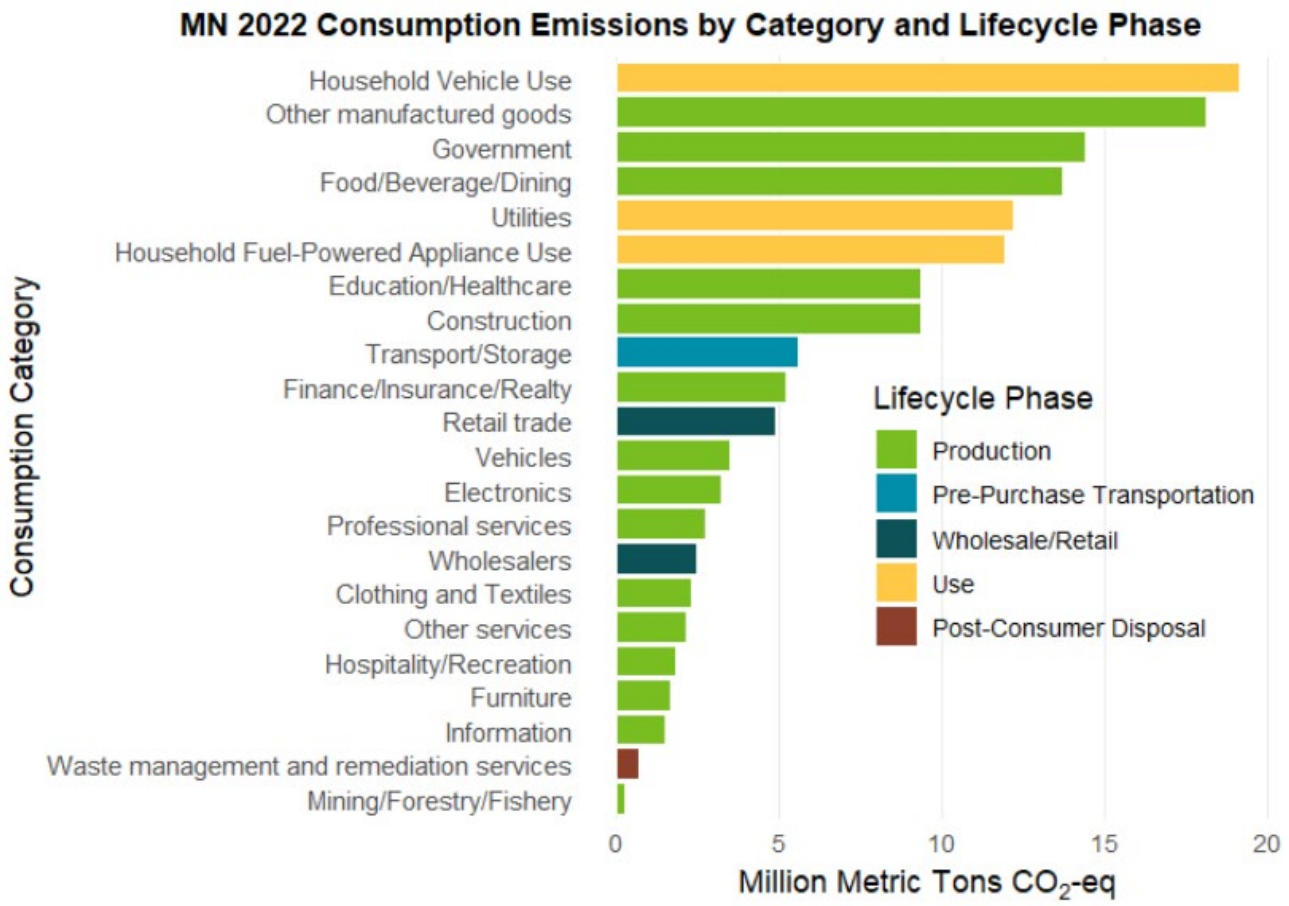
Together, Minnesota's GHG Inventory and CBEI show that:

- The largest share of Minnesota's GHG emissions originate from goods and services that are imported from other states and countries, totaling 84.9 million metric tons CO2-eq of GHGs that have not been previously estimated in state GHG inventories.
- Minnesota is a net importer of GHG emissions. Emissions from goods and services Minnesota produces and exports (e.g., agriculture, mining, forestry, health care) are lower than emissions from goods and services Minnesota imports from other states and countries.
- Goods and services produced in Minnesota that are exported are responsible for 72.2 million metric tons CO2-eq of GHGs.

Minnesota's consumption emissions

The following figures present the Minnesota Consumption Based Emissions Inventory for the year 2022.

Figure 2: MN 2022 Consumption Emissions by Category and Lifecycle Phase[1]



Household Vehicle Use includes emissions from automobiles and other fuel-powered vehicles. **Household Fuel-Powered Appliance Use** includes natural gas/oil powered home appliances like heating systems, water heaters, and gas-heated clothes dryers**. Utilities** includes emissions associated with the generation, transmission and distribution of electricity to power household commodities like televisions, refrigerators, and mobile phones**,** as well as emissions from the production and distribution of natural gas consumed by households, drinking water consumed by households, and treatment of household wastewater. **Government** includes emissions from the production of goods and services provided by all federal, state, and local government entities.

[1] An adjustment of -1.22 million metric tons CO_2-eq for used goods due to the transfer, or "selling off" of secondhand assets and scrap between industries has been omitted from this figure, and in addition an adjustment of -0.47 million metric tons CO_2-eq for non-comparable imports and rest-of-world adjustment has also been omitted. For more information on these categories see the Bureau of Economic Analysis' Primer on BEA's Industry Accounts.

Figure 3: MN 2022 Consumption Emissions by Region of Origin

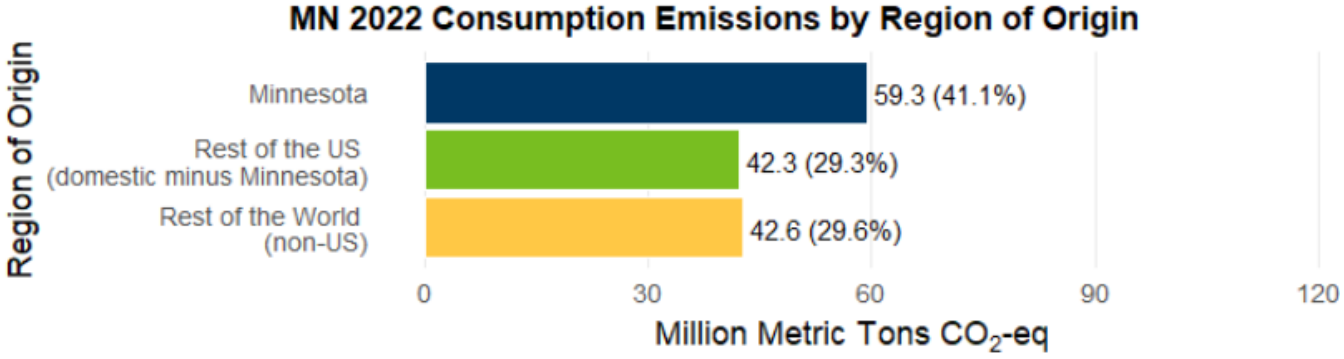
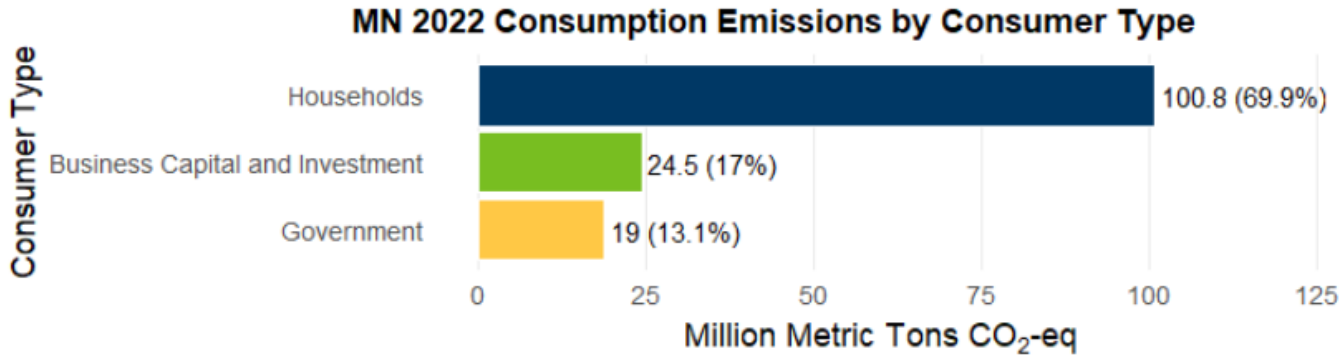


Figure 4: MN 2022 Consumption Emissions by Consumer Type



The Minnesota CBEI shows that:

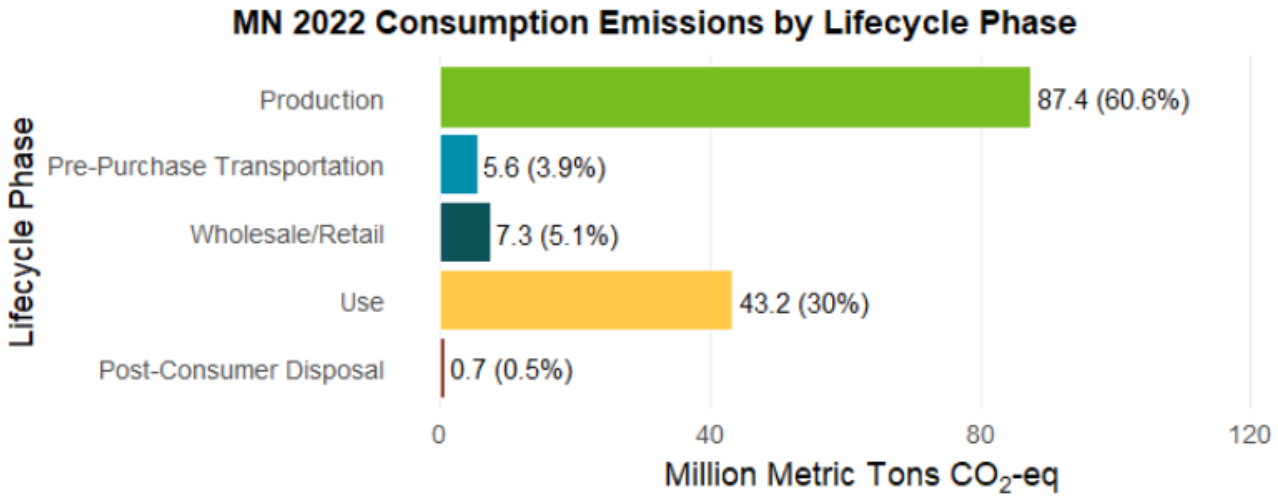
- Categories like manufactured goods, food/beverage/dining, and construction make up a large portion of Minnesotans' consumption emissions based on the CBEI, whereas the in-boundary inventory perspective focuses less on the impact of these goods and services (Figure 2).
- 60% of Minnesota's consumption emissions are from goods or services Minnesota imports from other U.S. states or other countries. The other 40% of consumption emissions are from goods or services produced and consumed in Minnesota. Figure 3 illustrates the relative contribution of emissions from in-state products and services compared to those imported across state or national borders.
- Emissions from household consumption make up 70% of Minnesotans' total consumption emissions, whereas business capital, business investment, and government contribute 30% (Figure 4).

Informing climate and materials policy and action

The CBEI estimates not only the amount of GHGs emitted from each of Minnesota's consumption categories, but also how much each life cycle phase contributes to those emissions. Figure 5 illustrates that the majority of Minnesota's consumption emissions can be attributed to the production and use phases, not from waste disposal at end-of-life[2].

[2] In addition to the GHG emissions associated with waste services, the impacts of recycling on GHG emissions are included in the CBEI in the form of both (1) the reduced use of virgin materials and (2) the use of recycled feedstock within manufacturing processes.

Figure 5: MN 2022 Consumption Emissions by Lifecycle Phase



These estimates can help identify opportunities to minimize the climate impacts of materials, products, and services. By focusing on the most emissions-heavy consumption categories and life cycle stages, we can prioritize the materials management policies and practices that maximize emissions reductions. For example, if CBEI data reveal that many appliances have the greatest GHG impact during the use phase, we can reduce emissions the most by focusing on designing appliances to be more energy efficient.

Similarly, for goods like household furnishings and clothing that have the highest GHG emissions during production, we can prioritize reducing demand and extending the life of existing items through repair and reuse to maximize environmental benefits. In fact, the CBEI indicates that doubling the useful life of Minnesotans' clothing and household furnishings this way would be equivalent to increasing statewide vehicle efficiency by 10%, reducing GHG emissions by about 2 million metric tons of CO_2-eq (carbon-dioxide equivalent) annually.

How the CBEI can help Minnesotans

While the in-boundary GHG inventory and the CBEI both offer important insights into Minnesota's emissions, one particular benefit of the CBEI is how relatable its findings are for Minnesotans. Compared to the in-boundary GHG inventory's broad sector-based categories (agriculture, industrial, electricity generation, etc.), the CBEI uses more specific categories that reflect typical household consumption (furnishings, clothing, electronics, food, etc.). This structure supports individuals' understanding of how their individual consumption choices can meaningfully reduce climate pollution, empowering Minnesotans to take specific and direct actions within their sphere of influence to lower environmental impacts.

Methodology for the Minnesota CBEI

The Minnesota CBEI was developed using a set of tools published by the U.S. Environmental Protection Agency (EPA) that derives CBEIs for all 50 US states from the EPA's United States Environmentally-Extended Input-Output (USEEIO) State Models. The MPCA performed additional analysis beyond the EPA's published CBEI results for Minnesota by altering the grouping and labeling of consumption categories, deriving the direct emissions occurring outside of Minnesota's borders that are attributed to Minnesota's consumption, and performing the comparison between the Minnesota in-boundary GHG Inventory and the Minnesota CBEI.

EPA CBEIs for US states: Ingwersen, Wesley W. AND B. Young. Consumption-Based Greenhouse Gas Inventories for Northeastern States. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-23/319, 2024
EPA USEEIO State Models: Ingwersen, Wesley W., C. Birney, B. Young, AND J. Vendries. USEEIO State Models v1.0 Environmentally-Extended Input-Output Models for U.S. States. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-23/228, 2024