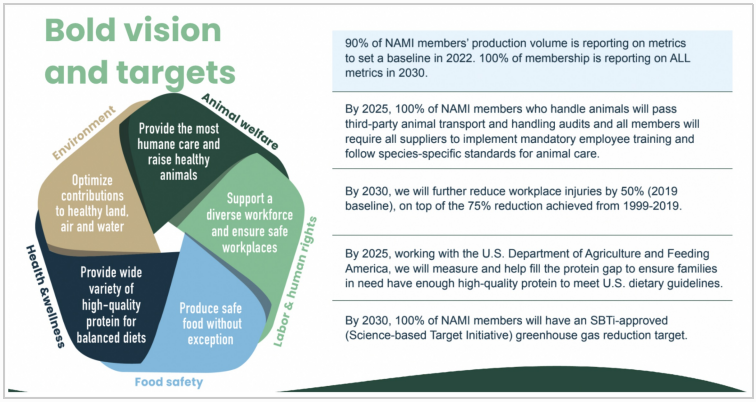
Greenhouse gas emissions surveys in the meat sector - A detailed case study

A practical guide to support development of science-based GHG reduction targets

Executive summary

Bold goals

The North American Meat Institute (Meat Institute) has set a target for 100% of its members to deliver greenhouse gas (GHG) reduction targets approved by the Science-Based Targets (SBT) Initiative by 2030, among the Meat Institute's comprehensive goals for continuous improvement across five focus areas aligned with global goals.



As of June 2023, 12 Meat Institute members have set or publicly committed to set SBTs. As these companies have conducted GHG inventories, many have noted a dearth of technical resources to help provide baseline instructions and answer common questions.

Resource and information gaps

To help address this gap and facilitate adoption of science-based GHG measurement and reduction practices throughout the meat sector, the North American Meat Institute and the United Nations Global Compact Network USA (UNGC USA) partnered to develop this detailed case study on conducting GHG emission surveys, authored by experts with direct experience in companies of varying sizes.

Practical tools

The first step in setting or committing to set an SBT is to conduct a thorough and accurate inventory of Scope 1, 2, and 3 emissions.

The GHG emission survey guide provides tangible support to help companies that have the desire but not the time or resources to apply SBT methodologies and develop GHG inventories without additional guidance.

The tool defines terms, provides direct citations of GHG Protocol and other relevant international standards, details data collection and calculation methodologies, provides alternative calculation methods, makes note of explanations and exceptions, and shares other resources that might be of assistance to companies conducting GHG inventories. The tool uses real-life data, methodologies, and structural details, with data randomized and company details anonymized to protect proprietary information.

Beyond the elements discussed above, the tool provides a concrete, real-life example that takes readers from defining a company's operational and organizational boundaries to understanding and measuring its direct, indirect, and value chain emissions. This tool is meant to be an industry-specific, practical complement to the foundational training provided by the UNGC USA's Climate Ambition Accelerator program.

The Climate Ambition Accelerator is a six-month program designed to equip companies with the knowledge and skills to accelerate progress towards setting science-based emissions reduction targets aligned with the 1.5°C pathway, putting them on a path towards net-zero emissions by 2050. In this program, participants will gain access to peer-to-peer learning opportunities, capacity-building sessions with industry experts, and on-demand training. At the end of the program participants will have a comprehensive understanding of the Science Based Targets Initiative (SBTi) and the net-zero concept. Additionally, they will have developed communication skills to motivate investors, corporate leadership, employees, and shareholders to set and meet Science Based Targets.

CLIMATE AMBITION ACCELERATOR

Please contact Mallory Cannon, Program Associate, Environment and Climate at the UN Global Compact Network USA for more information.

Introduction, motivation, and purpose

The following detailed case study provides a step-by-step, practical guide to help meat companies conduct a detailed inventory of Scope 1, 2, and 3 greenhouse gas emissions.

This case study is directly adapted from actual emissions inventory work conducted by the authors, one at a large processor with integrated slaughter operations, and one at a smaller regional processor. In order to integrate data taken from different sources, we (the authors) refer here to a fictional company called Longmont Sausage. Steps have been taken to ensure that no competitively-valuable information is contained within the case study: activity measurements (such as energy consumed) have been changed in ways not even known to us; company locations and organizational structures have also been changed.

The formulas and methodologies applied to these randomized numbers, however, are true to life, and the resources contained in this document are real-life resources available to companies wishing to conduct their own inventories.

The motivation for preparing this case study was simple: despite more and more companies in the sector becoming aware of the need to set science-based GHG reduction targets, there remains a dearth of technical resources to help answer common questions. To fill this gap and facilitate adoption of science-based GHG measurement and reduction practices throughout the meat sector, the authors, the Meat Institute, and the UNGC USA partnered to develop and disseminate this work.

The intended audience for this case study includes operational and sustainability experts within meat companies of all sizes, as well as partners throughout the value chain. Beyond the case study's direct applicability in aiding completion of GHG surveys, we hope the tool will also engage the broader sustainability community and generate additional resources for driving sustainability solutions in the meat sector. The case study is too technical for general audiences, but the executive summary, above, illustrates the general importance of GHG surveys in the meat sector and provides an overview of the approach detailed herein.

This case study is meant to be a living document. We expect it to prove *useful*, yet we acknowledge that methods and calculations used for emissions surveys will continuously evolve. To this end, we invite every reader to view this document critically and to share different or additional ways to tackle the complex nuances involved in conducting such detailed GHG emissions surveys. Any suggested improvements can be sent to Eric Mittenthal, Chief Strategy Officer at the North American Meat Institute.

Contributors to this effort

The Meat Institute is a founding partner of the Protein PACT for the People, Animals & Climate of Tomorrow, which unites organizations across the animal agriculture supply chain committed to a common vision for sustaining nutrient-dense animal-source foods for generations to come. Through the Protein PACT, the Meat Institute has set ambitious targets, including for 100% of its members to deliver science-based GHG reduction targets, and has pioneered sector-wide data collection and reporting.

As a special initiative of the United Nations Secretary-General, the UN Global Compact is a call to companies worldwide to align their operations and strategies with Ten Principles in the areas of human rights, labour, environment and anti-corruption. Our ambition is to accelerate and scale the global collective impact of business by upholding the Ten Principles and delivering the Sustainable Development Goals through accountable companies and ecosystems that enable change. With more than 18,000 companies and 3,800 non-business signatories based in over 160 countries, and 62 Local Networks, the UN Global Compact is the world's largest corporate sustainability initiative — one Global Compact uniting business for a better world.

The UN Global Compact Network USA is the Local Network chapter of the United Nations Global Compact.

Nectar's mission is to make climate data accessible to every business on the planet. The company spun out of MIT's Sandbox program—which provides seed funding, mentorship, and tailored entrepreneurship education for MIT students—and builds tools for sustainability teams to avoid manual data tasks and focus instead on higher impact initiatives. They've worked with small businesses to Fortune 500 companies. After piloting with NAMI members to inform development, Nectar's Scope 1 and 2 tool (nectarclimate.com) allows unlimited integrations for a single site and $1000 per site beyond the first (some members can record all data under their HQ site). Nectar's Scope 3 tool (estimator.nectarclimate.com) allows up to 1000 financial transactions for free and up to 10,000 transactions for $2500. Visit nectarclimate.com to learn more, or contact nami@nectarclimate.com or emittenthal@meatinstitute.org with questions.

Downloadable references:

- SBTi How-To Guide
- SBTi Getting Started Guide for FLAG
- SBTi Corporate Manual
- Forest, Land and Agriculture Science Based Target-Setting Guidance
- GHG Protocol: A Corporate Accounting and Reporting Standard
- GHG Protocol: Scope 3 Accounting and Reporting Standard
- GHG Protocol: Scope 2 Calculation Guidance
- GHG Protocol: Scope 3 Calculation Guidance
- GHG Protocol: Agricultural Guidance
- GHG Protocol: Land Sector Guidance Pt 1
- GHG Protocol: Land Sector Guidance Pt 2
- EPA Emission Factors Hub
- EPA eGRID Dataset
- Supply Chain Greenhouse Gas Emission Factors for US Industries and Commodities
- EPA Center for Corporate Climate Leadership

The Meat Institute cybersecurity committee has reviewed and approved Nectar's data security protocols as sufficiently safe for use, though users should refer to their own company policies regarding third-party technology platforms.

How to navigate this document

Our basic goal for this document is to show how GHG Protocol guidance is put into practice for meat companies that are developing, or already have committed to setting, a Science-Based Target. While Longmont Sausage's structure is unique, it is not necessarily unusual, and our operations are likely similar enough to most meat companies that our example can be useful.

Each section or sub-section will follow the same steps as suggested by the GHG Protocol for calculating total emissions for whatever organizational and operational boundaries are appropriate: 1) Identify sources, 2) Select calculation approach, 3) Collect data and choose emission factors, 4) Apply calculation tools, and 5) Roll-up data to corporate level.

Certain shaded boxes will always contain the same type of information:

> GHG Protocol Guidance
>
> Where appropriate and helpful, we'll include direct excerpts from guidance documents, contained in a box that looks like this.

> Alternative Calculation Methods, Notes, and Exceptions
>
> We did things a certain way—according to the tools and information available—but recognize that in certain cases this way of doing things won't be best or available to all. In these sections, we will note when this is probably the case and suggest alternatives.
>
> Longmont Sausage has around 2000 employees and therefore isn't defined as a Small- or Medium Enterprise (SME), but this document is written in large part with SME's in mind. So, where appropriate and helpful, we'll also include SME-specific notes and exceptions in boxes that look like this.

> Tools Available through Nectar Climate
>
> Throughout this process we worked with the team at Nectar Climate to help them develop tools that complement the approaches discussed in this case study. The narrative here provides the logic and calculations behind every step in the process for meat companies to understand their carbon emissions; Nectar builds tools to safely and accurately automate the process and ease calculations, helping companies move on to interpreting and implementing findings.
>
> Where Nectar has, or is developing, a tool that can be applied towards a certain set of calculations, we'll mention it in boxes that look like this.

Finally, each section and sub-section in which we actually calculate emissions will include a table, as such

Scope	Category	Activity	Location	Amount	Unit	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 1	Stationary combustion	Diesel Fuel - Generators	Company Manufacturing	400	GAL	10.21	0.41	0.08	4	0.000	0.000	4
Scope 1	Stationary combustion	Diesel Fuel - Generators	Global Headquarters	200	GAL	10.21	0.41	0.08	2	0.000	0.000	2
Scope 1	Stationary combustion	Diesel Fuel - Generators										6

The three main gases of interest for emissions surveys are cabon dioxide (CO_2), methane (CH_4, also referred to as natural gas), and nitrous oxide (N_2O). In order to get to "CO_2 equivalents", or CO_2e, we need to take into account the fact that CH_4 and N_2O are more potent greenhouse gases than CO_2. So we multiply each by their "Global Warming Potential" value before we add them up to get CO_2e.

The GWP for CO_2 is (naturally) 1, for CH_4 it is 25, and for N_2O it is 298. In order to recreate the exact calculations shown in the tables that follow, multiply the amount of emissions for each gas by these GWP values. The total will be equal to the value shown for CO_2e.

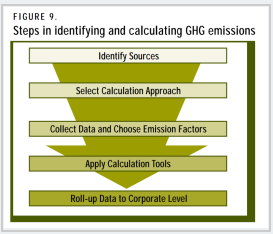
Except as otherwise noted, emission factors in these tables will have the units $\frac{kg\ CO_2}{Unit\ Activity}$, $\frac{g\ N_2O}{Unit\ Activity}$, and $\frac{g\ CH_4}{Unit\ Activity}$, to follow the convention used in the U.S. Environmental Protection Agency (EPA) emission factors database. To get metric tonnes of emissions, divide CO_2 by 10^3 and N_2O and CH_4 by 10^6.

This document is presented in what we imagine to be a logical order, starting with determining organizational boundaries, progressing through Scopes 1 & 2, developing a screening tool to determine which sub-categories of Scope 3 are material, and then calculating Scope 3 emissions. The necessary work that precedes and follows these steps—getting organizational buy-in, committing to a Science-Based emissions reduction target, and delivering on these commitments, is beyond the scope of this case study. The Table of Contents at the upper-left can be used to jump between sections and sub-sections.

A note about printing

The html version of this document will not print well; it was produced specifically to be viewed in a browser. We understand that some people work best when reading from an actual sheet of paper, however, so pdf versions are available on request if you send an email to Eric or Ben.

Parenthetical asides will be shown in the margins. Here is the actual image from the GHG Protocol document that shows the steps in identifying emissions:

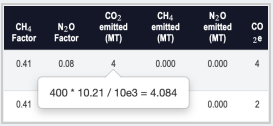


If you want to see the full-sized version of any image in the document, just click on it.

… and while the main source materials are all linked above, we will also endeavor to point out the specific sources we used whenever an emission factors is used, with formatting as below:

> *EPA Emission Factor Hub Table 1: Stationary Combustion (Distillate Fuel Oil No.2)*

For the calculated columns—MT of specific gas emissions and total CO_2e—you can hover over the numbers in the first row to see the actual formula used to get each value. It looks like this:



For this sample table only, the second row also shows the formula in words.

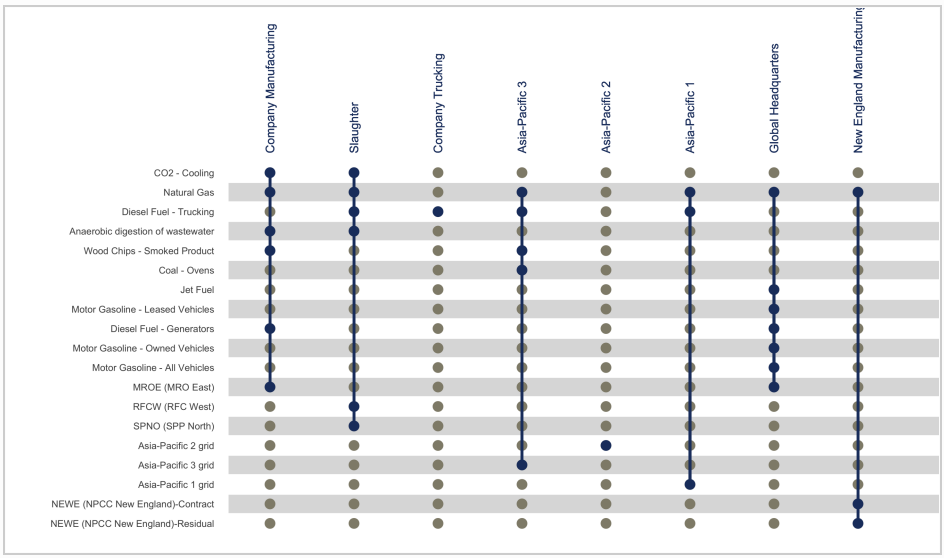
Determining organizational and operational boundaries

> GHG Protocol Guidance: Organizational and Operational Boundaries
>
> Companies shall account for and report their consolidated GHG data according to either the equity share or control approach…If the reporting company wholly owns all its operations, its organizational boundary will be the same whichever approach is used.
>
> **Equity share approach**
>
> Under the equity share approach, a company accounts for GHG emissions from operations according to its share of equity in the operation. The equity share reflects economic interest, which is the extent of rights a company has to the risks and rewards flowing from an operation.
>
> **Control approach**
>
> Under the control approach, a company accounts for 100 percent of the GHG emissions from operations over which it has control. It does not account for GHG emissions from operations in which it owns an interest but has no control. Control can be defined in either financial or operational terms. When using the control approach to consolidate GHG emissions, companies shall choose between either the operational control or financial control criteria.

Longmont Sausage owns and operates nine USDA-inspected production facilities in four states, plus three separate production facilities in Asia. Its business offices are concentrated on one campus in Longmont, Colorado, spread over three buildings. In addition to these business units, Longmont Sausage owns its own trucking fleet which handles some, but not all, of (mostly outbound) goods transport.

For the purposes of this exercise, however, we group operations according to each of the unique sets of different carbon-emitting activities taking place in different locations. Since all the slaughter facilities have the same set of carbon-emitting activities, we group them together; all manufacturing located in Boulder County, adjacent to Global Headquarters, is grouped together as well. Our New England manufacturing facility purchases some low-carbon electricity through a contractual agreement, so they pose a slightly different set of problems for creating an emissions inventory, and are in a separate group. Because each of our overseas business units performs a different set of carbon-emitting activities—one of which uses coal to heat their ovens, for example, the only location that does so—we will report on each separately.

Below is a summary of the different operational entities we'll consider here, along with the set of carbon-emitting activities that we attribute to each:



The matrix to the left is part of what's called an 'upset chart'; the full upset chart, shown later with total Scope 1 and 2 emissions, includes marginal bar plots for each *location* and each *activity*. We've created the chart ourselves and don't know of any publicly-available tools to take generic data and produce one. But it's easy enough to create a functionally-equivalent version on a spreadsheet, and we suggest you do so. When we first produced this chart—which allowed us to systematically *first* ask whether a certain location performed a certain activity, and *then* whether we had collected the relevant data—we noticed two gaps in our emissions inventory, which we were then able to correct.

> GHG Protocol Guidance: Accounting and Reporting Principles
>
> GHG accounting and reporting shall be based on the following principles:
>
> **RELEVANCE** Ensure the GHG inventory appropriately reflects the GHG emissions of the company and serves the decision-making needs of users – both internal and external to the company.
>
> **COMPLETENESS** Account for and report on all GHG emission sources and activities within the chosen inventory boundary. Disclose and justify any specific exclusions.
>
> **CONSISTENCY** Use consistent methodologies to allow for meaningful comparisons of emissions over time. Transparently document any changes to the data, inventory boundary, methods, or any other relevant factors in the time series.
>
> **TRANSPARENCY** Address all relevant issues in a factual and coherent manner, based on a clear audit trail. Disclose any relevant assumptions and make appropriate references to the accounting and calculation methodologies and data sources used.
>
> **ACCURACY** Ensure that the quantification of GHG emissions is systematically neither over nor under actual

> emissions, as far as can be judged, and that uncertainties are reduced as far as practicable. Achieve sufficient accuracy to enable users to make decisions with reasonable assurance as to the integrity of the reported information

Scope 1: Direct emissions

Put simply, Scope 1 emissions are those that result from the organization actually burning fuel or directly releasing greenhouse gases.

> GHG Protocol Guidance: Scope 1: Direct GHG emissions
>
> Direct GHG emissions are emissions from sources that are owned or controlled by the company.

Mobile combustion

Longmont Sausage's purchases of fuel for the purposes of mobile combustion consist entirely of diesel fuel and gasoline. Emissions from mobile combustion are calculated in a two-step process:

1. CO_2 emissions are a function of the *amount of fuel burned*, while
2. CH_4 and N_2O emissions are a function of *miles driven*, with emission factors varying by the year the vehicles were manufactured.

Activity data for both of these measures—gallons and miles—were available. In each case, we multiplied the number of gallons of fuel by the appropriate CO_2 emission factors, and then multiplied the number of miles driven by the appropriate CH_4 and N_2O emission factors, to get the total CO_2e emissions in this category.

> Alternative Calculation Methods, Notes, and Exceptions: Mobile vs Stationary Combustion
>
> Diesel fuel purchases for refrigerated trucks are (often) broken out by whether the fuel is used in the refrigeration unit or in the tractor's engine, as such:
>
> Diesel dispensed on campus at fuel pumps
>
Quantity	Receipt	Department
3.77	300529893	TLGR Reefer
48.36	300529894	TLGR Tractor
>
> While we chose to categorize both of these uses as 'Mobile combustion', it isn't clear that the available guidance has a real opinion on whether fuel used for refrigeration units is actually mobile or stationary.

> Alternative Calculation Methods, Notes, and Exceptions: Data availability for mobile combustion
>
> If only either fuel consumption or mileage information is available, it is easy enough to provide an estimate of the mileage—the EPA has official estimates available—and proceed as outlined here.

Scope	Category	Activity	Location	Amount	Unit	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 1	Mobile combustion	Diesel Fuel - Trucking	Slaughter	34,700		10.21			354			354
Scope 1	Mobile combustion	Diesel Fuel - Trucking	Company Trucking	859,200	GAL	10.21			8,772			8,772
Scope 1	Mobile combustion	Diesel Fuel - Trucking	Asia-Pacific 1	174,400	GAL	10.21			1,781			1,781
Scope 1	Mobile combustion	Diesel Fuel - Trucking	Asia-Pacific 2	25,200	GAL	10.21			257			257
Scope 1	Mobile combustion	Diesel Fuel - Trucking	Company Trucking	1,515,800	Miles		0.01	0.043		0.015	0.065	20
Scope 1	Mobile combustion	Diesel Fuel - Trucking										11,184

> *EPA Emission Factor Hub Table 2: Mobile Combustion CO_2 (Diesel Fuel, Motor Gasoline)*

> *EPA Emission Factor Hub Table 3: Mobile Combustion CH_4 and N_2O for On-Road Gasoline Vehicles*

> *EPA Emission Factor Hub Table 4: Mobile Combustion CH_4 and N_2O for On-Road Diesel and Alternative Fuel Vehicles*

Scope	Category	Activity	Location	Amount	Unit	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 1	Mobile combustion	Motor Gasoline - Leased Vehicles	Global Headquarters	23,500	GAL	8.78			206			206
Scope 1	Mobile combustion	Motor Gasoline - Owned Vehicles	Global Headquarters	100	GAL	8.78			1			1
Scope 1	Mobile combustion	Motor Gasoline - All Vehicles	Global Headquarters	493,700	Miles		0.008	0.001		0.004	0.000	0
Scope 1	Mobile combustion	Motor Gasoline - All Vehicles										0
Scope 1	Mobile combustion	Motor Gasoline - Leased Vehicles										206
Scope 1	Mobile combustion	Motor Gasoline - Owned Vehicles										1

Stationary Combustion

Longmont Sausage burns four types of fuels in activities that fall under *Stationary combustion*: diesel fuel for backup power generation, natural gas and (in one plant) coal for heating or cooking, and wood chips to make smoked sausage. Invoices for purchases of each of these fuels contain quantity information in the appropriate units—and vendors are happy to provide summaries of quantities on request—so calculating emissions from stationary combustion is straightforward.

Scope	Category	Activity	Location	Amount	Unit	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 1	Stationary combustion	Diesel Fuel - Generators	Company Manufacturing	400	GAL	10.21	0.41	0.08	4	0.000	0.000	4
Scope 1	Stationary combustion	Diesel Fuel - Generators	Global Headquarters	200	GAL	10.21	0.41	0.08	2	0.000	0.000	2
Scope 1	Stationary combustion	Diesel Fuel - Generators										6

EPA Emission Factor Hub Table 1: Stationary Combustion (Distillate Fuel Oil No. 2)

Scope	Category	Activity	Location	Amount	Unit	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 1	Stationary combustion	Wood Chips - Smoked Product	Company Manufacturing	900	Tons	1640	126	63	1,476	0.113	0.057	1,496
Scope 1	Stationary combustion	Wood Chips - Smoked Product	Asia-Pacific 2	100	Tons	1640	126	63	164	0.013	0.006	166
Scope 1	Stationary combustion	Wood Chips - Smoked Product										1,662

EPA Emission Factor Hub Table 1: Stationary Combustion (Biomass Fuels - Solid: Wood and Wood Residuals)

Scope	Category	Activity	Location	Amount	Unit	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 1	Stationary combustion	Natural Gas	Company Manufacturing	338,500	mmBTU	53.06	1	0.1	17,961	0.339	0.034	17,979
Scope 1	Stationary combustion	Natural Gas	Slaughter	129,300	mmBTU	53.06	1	0.1	6,861	0.129	0.013	6,868
Scope 1	Stationary combustion	Natural Gas	Global Headquarters	7,800	mmBTU	53.06	1	0.1	414	0.008	0.001	414
Scope 1	Stationary combustion	Natural Gas	New England Manufacturing	6,900	mmBTU	53.06	1	0.1	366	0.007	0.001	366
Scope 1	Stationary combustion	Natural Gas	Asia-Pacific 1	700	mmBTU	53.06	1	0.1	37	0.001	0.000	37
Scope 1	Stationary combustion	Natural Gas	Asia-Pacific 2	400	mmBTU	53.06	1	0.1	21	0.000	0.000	21
Scope 1	Stationary combustion	Coal - Ovens	Asia-Pacific 2	500	Tons	2116	246	36	1,058	0.123	0.018	1,066
Scope 1	Stationary combustion	Coal - Ovens										1,066
Scope 1	Stationary combustion	Natural Gas										25,686

EPA Emission Factor Hub Table 1: Stationary Combustion (Natural Gas)

EPA Emission Factor Hub Table 1: Stationary Combustion (Coal and Coke: Mixed (Industrial Sector))

Fugitive Emissions

The term *fugitive emissions* can be somewhat misleading, because in most other emissions contexts, *fugitive* means something like accidental or un-measured, and is used to refer to gases escaping from valves or pipe fittings. The GHG Protocol definition is broader:

> GHG Protocol Guidance: Scope 1: Fugitive emissions
>
> Fugitive emissions: intentional and unintentional releases such as equipment leaks from joints, seals, packing, gaskets, as well as fugitive emissions from coal piles, wastewater treatment, pits, cooling towers, gas processing facilities, etc.

Never mind the use of the term *fugitive emissions* within the definition of *fugitive emissions*. This category covers all gases released within the operational boundary that are not the result of actually burning some fuel.

Fugitive emissions from direct release of CO_2

The meat industry uses—and releases—CO_2 rather intensively, both as a way to cool meat and in CO_2 stunning of poultry and swine. Activity data, usually in (short) tons of CO_2 purchased, are available on invoices.

Scope	Category	Activity	Location	Amount	Unit	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 1	Fugitive emissions	CO2 - Cooling	Company Manufacturing	2,100	Tons	907.185	0	0	1,905	0.000	0.000	1,905
Scope 1	Fugitive emissions	CO2 - Cooling	Slaughter	53,200	Tons	907.185	0	0	48,262	0.000	0.000	48,262
Scope 1	Fugitive emissions	CO2 - Cooling										50,167

A *short ton* is 2,000 pounds, while a metric ton (or MT, or sometimes just *tonne*) is 1,000 kilograms. There are about 2204.62 pounds in a metric ton.

> *To preserve the convention of stating factors in units kg CO2 per unit activity, we show the emission factor as 907.185 which is just the conversion between short tons and kilograms.*

Fugitive emissions from release of coolant gases

Longmont Sausage's heating, ventilation, and cooling (HVAC) vendors neither itemize nor record the amount of gas used to recharge cooling systems during periodic maintenance visits. We have asked our contractors to start keeping these records and may include these activities in our annual reporting in future years. Because our industrial cooling system uses NH_4—not a greenhouse gas—and because our conversations with our vendors indicate the severity of fugitive emissions from this source is probably small, we have not included estimates in our inventories to this point.

> Alternative Calculation Methods, Notes, and Exceptions: Fugitive emissions from cooling systems
>
> The EPA has produced a comprehensive document to help guide practitioners through this step, available here: Greenhouse Gas Inventory Guidance: Direct Fugitive Emissions from Refrigeration, Air Conditioning, Fire Suppression, and Industrial Gases For most readers of this document, the "Simplified Mass Balance Method" will be appropriate. Refrigeration and air conditioning contractors should be able to provide the necessary inputs for these calculations, namely "refrigerant a) used to fill new equipment during installation, b) used to service equipment, and c) recovered from retiring equipment, as well as the total refrigerant capacities of new and retiring equipment."

Fugitive emissions from anaerobic digestion in wastewater treatment

Fugitive emissions from wastewater treatment can be significant, mostly occurring as CH_4 emissions during an anaerobic digestion phase.

> Alternative Calculation Methods, Notes, and Exceptions
>
> Small and Medium Businesses are very unlikely to have to account for emissions from wastewater treatment in Scope 1. Those SMB's choosing to build a Scope 3 emissions inventory will account for downstream emissions of its wastewater in Scope 3.5: Waste Generated in Operations.
>
> Those businesses that operate their own wastewater treatment plants will most likely have someone on staff who can make sense of the rather esoteric calculations that follow in this section.

The basic equation for estimating CH_4 emissions from industrial wastewater treatment is:

CH_4 Emissions = $(COD_{in} - COD_{out}) \cdot EF$

where

COD = Chemical Organic Demand, a standard measure of organic content of a wastewater stream

COD_{in} refers to COD of input to anaerobic step of wastewater treatment process

COD_{out} refers to COD of output from anaerobic step of wastewater treatment

EF = Emission Factor as $\frac{g\ CH_4}{g\ COD}$

> Alternative Calculation Methods, Notes, and Exceptions: Wastewater Treatment
>
> The two common measures for the organic content of wastewater treatment streams are COD (Chemical Organic Demand) and BOD (Biological Oxygen Demand). While we use COD in the calculations above, the references contain equivalent emission factors if it is more convenient to use BOD as the measure of 'activity' taking place here. (For red meat the EF for BOD is 0.384, and for COD it is 0.18.)

Scope	Category	Activity	Location	Amount	Unit	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 1	Fugitive emissions	Anaerobic digestion of wastewater	Company Manufacturing	400	Tons COD	0	0.18	0	0	72.000	0.000	1,800
Scope 1	Fugitive emissions	Anaerobic digestion of wastewater	Slaughter	200	Tons COD	0	0.18	0	0	36.000	0.000	900
Scope 1	Fugitive emissions	Anaerobic digestion of wastewater										2,700

The IPCC guidance for national GHG inventories has meat-industry-specific estimates for converting COD and BOD to CH_4 emissions (Table 6.8)

Emission factors for wastewater are $\frac{weight\ CH_4}{weight\ COD}$ so no conversion from kg to MT is necessary.

Scope 1 Totals

Scope	Category	CO_2e
Scope 1	Fugitive emissions	52,867
Scope 1	Mobile combustion	12,458
Scope 1	Stationary combustion	28,421
Scope 1		93,746

Scope 2: Indirect emissions

While Scope 1 emissions are those from direct combustion of fuels or release of gases, Scope 2 emissions are those emissions that result from the production of purchased energy.

Note that energy production within the organization falls under Scope 1, as in the case of diesel purchases for backup generators, above.

> GHG Protocol Guidance: Scope 2: Indirect GHG emissions
>
> Companies with any operations in markets providing product or supplier-specific data in the form of contractual instruments shall report Scope 2 emissions in two ways and label each result according to the method: one based on the location-based method, and one based on the market-based method.

The main difference between *market-based* and *location-based* calculations for emissions from purchased electricity is that *market-based* calculations try to take into account specific, directed energy purchases from a given (usually low-emissions) resource. This isn't how it works in real life, of course—electricity isn't traceable in this way—but purchasing energy from a low-emissions source does encourage more construction of renewable energy, and this is how that is accounted for.

An aside about the uncertain future of market-based accounting methods

The essential fungibility of electric power—once power enters the grid, we can't tell where it came from—can produce some uncertainty when accounting for purchased clean power. How can anyone be sure whether the amount of clean power produced is equal to the amount of clean power claimed by companies in their emissions inventories? It gets even more complicated with instruments designed as carbon *offsets* or *insets*, so much so that the latest Land Sector and Removals Guidance document from the GHG protocol says this (in Annex B):

> GHG Protocol Guidance: Note on Market-Based Accounting
>
> The GHG Protocol is undertaking a process to determine the need and scope for additional guidance building on the existing set of corporate GHG accounting and reporting standards for Scope 1, Scope 2, and Scope 3 emissions. As part of this process, the GHG Protocol plans to holistically examine the appropriateness for market-based accounting across sectors, end-uses, and scopes. This process would seek to explore both whether market-based accounting is appropriate within Scope 1 and/or Scope 3 and also whether the accounting approach for Scope 2 (e.g., dual reporting using location-based and market-based methods, market instrument quality criteria, etc.) would need to be applied, amended, or expanded if applied outside of Scope 2.

It isn't clear whether the GHG protocol will continue to *require* market- and location-based reporting for Scope 2 emissions or *allow* market-based instruments in other Scopes. For now, we proceed as required.

Simplified example contrasting market- and location-based methods

A simplified example may help. Suppose a region produces 10 units of electricity and in doing so produces 15 units of emissions. Under the location-based approach, each unit of electricity purchased would account for $\frac{15}{10} = 1.5$ units of emissions.

Suppose further that 2 of these 10 total units of electricity generation require zero emissions to produce, and are sold through contractual instruments. Each unit of electricity purchased through these contracts would account for $\frac{0}{2} = 0$ units of emissions, naturally, in the market-based approach. What's left over—called the "residual"—is 8 units of electricity and all 15 units of emissions; in the market-based approach, each unit of electricity *not* purchased according to a specific agreement is allocated $\frac{15}{8} = 1.875$ units of emissions.

More generally, in order to properly allocate all emissions from energy generation within a given region, we need three different emission factors:

1. The *average* emission factor: The average emissions per unit of energy purchased over the entire grid or sub-grid (renewable and non-renewable sources). ($\frac{15}{10} = 1.5$ in the example above)
2. The *resource-specific* emission factor: The emissions per unit of energy purchased from a specific resource and then purchased via a contractual arrangement. ($\frac{0}{2} = 0$ in the example above)
3. The *residual mix* factor: The average emissions per unit of energy *not purchased from a specific resource*. ($\frac{15}{8} = 1.875$ in the example above)

Average and residual mix factors exist for each grid and subgrid, while resource-specific emission factors are particular to a given energy production source.

Location-based calculations

Scope	Category	Activity	Location	Amount	Unit	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 2	Purchased electricity - Location based	MROE (MRO East)	Company Manufacturing	76,701,600	kWh	0.6924	0.063	0.0091	53,108	4.832	0.698	53,437
Scope 2	Purchased electricity - Location based	MROE (MRO East)	Global Headquarters	54,300	kWh	0.6924	0.063	0.0091	38	0.003	0.000	38
Scope 2	Purchased electricity - Location based	RFCW (RFC West)	Slaughter	11,241,200	kWh	0.4468	0.039	0.0054	5,023	0.438	0.061	5,052
Scope 2	Purchased electricity - Location based	SPNO (SPP North)	Slaughter	8,675,500	kWh	0.4327	0.0454	0.0064	3,754	0.394	0.056	3,780
Scope 2	Purchased electricity - Location based	Asia-Pacific Grid 1	Asia-Pacific 1	2,052,100	kWh	0.41	0	0	841	0.000	0.000	841
Scope 2	Purchased electricity - Location based	Asia-Pacific Grid 2	Asia-Pacific 2	6,576,400	kWh	0.51	0	0	3,354	0.000	0.000	3,354
Scope 2	Purchased electricity - Location based	Asia-Pacific Grid 3	Asia-Pacific 3	5,115,400	kWh	0.67	0	0	3,427	0.000	0.000	3,427
Scope 2	Purchased electricity - Location based	NEWE (NPCC New England)-Average	New England Manufacturing	1,134,400	kWh	0.2396	0.0336	0.0045	272	0.038	0.005	274
Scope 2	Purchased electricity - Location based											70,204

EPA eGRID dataset (SRL20 tab, columns S through Y)

Singapore grid emission factors

Philippines grid emission factors

Emission factors are lbs/MWh in this section, not kg/unit activity.

Market-based calculations

GHG Protocol Guidance: Scope 2: When to calculate market-based totals

If a multi-regional company has any operations within the corporate inventory where the market-based method applies, then a market-based method total shall be calculated for the entire corporate inventory to ensure completeness and consistency.

Companies using the market-based method shall ensure that any contractual instrument from which an emission factor is derived meets the Scope 2 Quality Criteria listed in Chapter 7.

Alternative Calculation Methods, Notes, and Exceptions: How to account for excess renewable energy sold back to the grid

Local ordinances and contractual obligations with different utilities will always prevail over what we write below—and bear in mind these can obligations and agreements can be arcane and confusing—but many companies that own their own solar panels (or other renewable energy sources) may end up selling some energy back to "the grid" and may want to account for it. Provided the amount of energy sold back to the grid exceeds 1 MWh, the company selling the energy has two assets to consider (1 MWh is the minimum size of an REC):

1. The energy itself, and
2. The Renewable Energy Certificate (REC), which is the market instrument associated with production of

Renewable Energy Certificates (RECs) explained at epa.gov

that energy.

The company may sell the REC to another company looking to decrease its Scope 2 emissions, or may just keep the REC itself. Either way, the company that ends up with the REC includes that purchase in its market-based Scope 2 calculations just like any other purchase of renewable energy.

(Buying REC's from entities other than power companies is not uncontroversial and can, according to some, be a sign of greenwashing.)

Residual mix emission factors at green-e.org

Scope	Category	Activity	Location	Amount	Unit	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 2	Purchased electricity - Market based	MROE (MRO East)	Company Manufacturing	76,701,600	kWh	0.6924	0.063	0.0091	53,108	4.832	0.698	53,437
Scope 2	Purchased electricity - Market based	MROE (MRO East)	Global Headquarters	54,300	kWh	0.6924	0.063	0.0091	38	0.003	0.000	38
Scope 2	Purchased electricity - Market based	RFCW (RFC West)	Slaughter	11,241,200	kWh	0.4468	0.039	0.0054	5,023	0.438	0.061	5,052
Scope 2	Purchased electricity - Market based	SPNO (SPP North)	Slaughter	8,675,500	kWh	0.4327	0.0454	0.0064	3,754	0.394	0.056	3,780
Scope 2	Purchased electricity - Market based	NEWE (NPCC New England)-Residual	New England Manufacturing	294,900	kWh	0.2397	0.0336	0.0045	71	0.010	0.001	71
Scope 2	Purchased electricity - Market based	NEWE (NPCC New England)-Contract	New England Manufacturing	839,500	kWh	0	0	0	0	0.000	0.000	0
Scope 2	Purchased electricity - Market based	Asia-Pacific Grid 1	Asia-Pacific 1	2,052,100	kWh	0.41	0	0	841	0.000	0.000	841
Scope 2	Purchased electricity - Market based	Asia-Pacific Grid 2	Asia-Pacific 2	6,576,400	kWh	0.51	0	0	3,354	0.000	0.000	3,354
Scope 2	Purchased electricity - Market based	Asia-Pacific Grid 3	Asia-Pacific 3	5,115,400	kWh	0.67	0	0	3,427	0.000	0.000	3,427
Scope 2	Purchased electricity - Market based											70,001

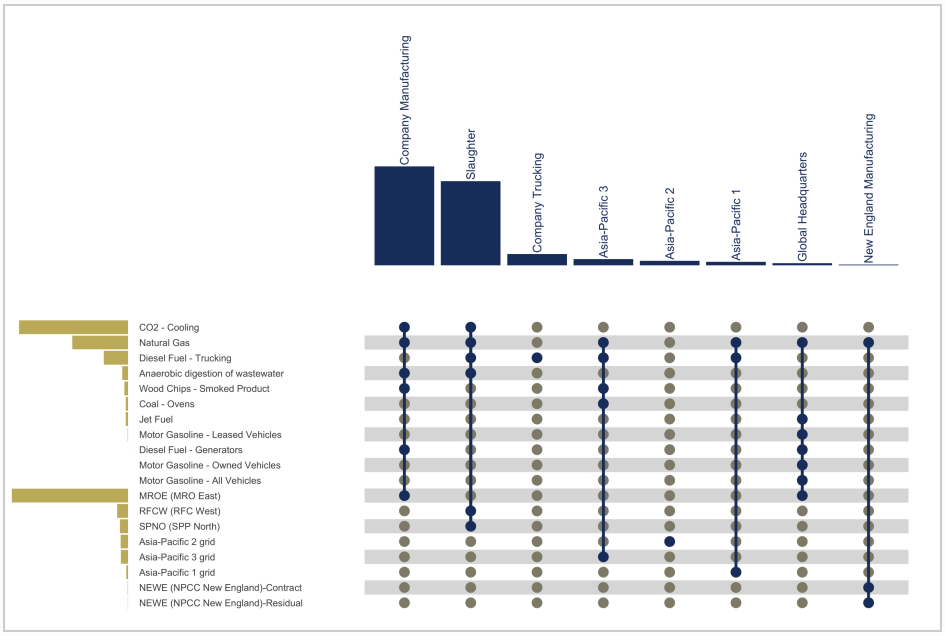
Scope 2 Totals

Tools Available through Nectar Climate

One of Nectar's offerings is a tool available at nectarclimate.com that allows users to avoid the tedious task of tabulating total kWH of usage from multiple sources, either by uploading pdf versions of energy bills or connecting directly to their utility accounts. The logic used within this tool has since been used more broadly for Nectar's Scope 1 & 2 tool (see below).

Scope	Category	CO_2e
Scope 2	Purchased electricity - Location based	70,204
Scope 2	Purchased electricity - Market based	70,001
Scope 2	Both values are reported	

Scope 1 and 2 Totals



> Tools Available through Nectar Climate
>
> Nectar has built tools to automatically aggregate energy/waste/water/fuel data, and are piloting a Scope 1 & 2 dashboarding tool with NAMI members at a discounted rate. The tool automatically collects utility data and displays Scope 1 & 2 calculations in dashboards, and is available at estimator.nectarclimate.com.

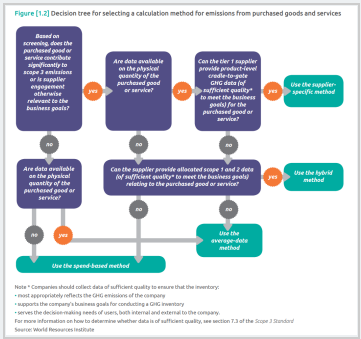
Scope 3 Screening

Scope 3: Upstream value chain (Scopes 3.1-3.9)

> GHG Protocol Guidance: Description and boundaries for **Purchased goods and services**
>
> The Scope 3 Standard recommends that companies identify which Scope 3 activities are expected to have the most significant GHG emissions, offer the most significant GHG reduction opportunities, and are most relevant to the company's business goals. Companies should begin by conducting a screening process, using less specific data, to determine the size of GHG emissions in each of the 15 categories. Then each category can be examined to determine whether to further refine its emission estimates.

> *GHG Protocol Scope 3 Calculation Guidance*

The reference materials produced by the GHG Protocol are, in our opinion, excellent. In almost every case, the advice contained within is unlikely to lead practitioners down the wrong path.



The advice around getting started with Scope 3 calculations is—again, in our opinion only—an exception. Figure 1.2 in the GHG Protocol's "Scope 3 Calculation Guidance" document (see margin) suggests companies *start* with a screening exercise and *then* employ spend-based methods only as a last resort: that is, only in the case where emissions are likely to be small **and** only total expense data is available. We propose there is a more efficient way to get the work done.

It is highly unlikely that Longmont Sausage—or any company, really—would be able to gather high-quality activity data from all primary and secondary suppliers. Therefore, at least part of Scope 3.1 and 3.2 calculations will have to employ lower-quality spend-based emissions assumptions. Given the way spend-based calculations are done, doing those calculations for *all* expenditures in the base year requires scarcely more work than doing them for only *some* expenditures. So rather than conduct a separate screening exercise and then a spend-based model, we took the following course:

1. For all expenses in base year, assign a North American Industrical Classification System (NAICS) industry code and a Scope 3 category, including differentiating Forest, Land, and Agriculture (FLAG) from non-FLAG activities
2. Using the EPA's supply chain emission factors for US Industries database (and estimates of inflation since this database was calculated), estimate emissions for all base-year expenditures
3. Using these results as the screening exercise,

    - Remove those expenditures (either by Scope 3 category or by NAICS code, as appropriate) that warrant more accurate (that is, activity-based) emissions estimates
    - What remains can be split into Scopes 3.1 and 3.2 *without any changes*.

This is still a lot of work. Even for moderately-sized organizations without industry codes and hierarchies built into their vendor records system, it would be surprising if any one person (or even small group of people) knows what each vendor actually provides. But it provides the best screening tool available at a very small (marginal) cost, so we recommend it.

Detailed small-scale example: spend-based model

Imagine that Longmont Sausage's base year payments to vendors looks like this:

Purchase type	Total spend mil
employee insurance	19.58
meat purchases	5.10
cheese	11.62
payroll processing	21.26
electric utility	26.59
sausage casings	2.54
contract manufacturing	24.11
plumbing contractor	29.37
corrugated cardboard	24.88
refrigerated warehousing and storage	5.37
polystyrene trays	20.74
media buying agency	12.19
multi-layer film	18.52
spices	19.28
waste management	27.60
construction and contracting	6.42
printed labels	24.58
employee 401k	15.30
poultry purchases	11.52
animal purchases	26.28
contract employees	19.59

The first task is to assign a NAICS code to each vendor (or vendor type), as such:

Purchase type	Total spend mil	NAICS group	NAICS code
employee insurance	19.58	Direct Health and Medical Insurance Carriers	524114
meat purchases	5.10	Animal (except Poultry) Slaughtering	311611
cheese	11.62	Cheese Manufacturing	311513
payroll processing	21.26	Computing Infrastructure Providers, Data Processing, Web Hosting, and Related Services	518210
electric utility	26.59	Other Electric Power Generation	221118
sausage casings	2.54	Rendering and Meat Byproduct Processing	311613
contract manufacturing	24.11	Animal Slaughtering and Processing	311612
plumbing contractor	29.37	Plumbing, Heating, and Air-Conditioning Contractors	238220
corrugated cardboard	24.88	Paper Mills	322120
refrigerated warehousing and storage	5.37	Refrigerated Warehousing and Storage	493120
polystyrene trays	20.74	Polystyrene Foam Product Manufacturing	326140
media buying agency	12.19	Media Buying Agencies	541830
multi-layer film	18.52	Plastics Packaging Film and Sheet (including Laminated) Manufacturing	326112
spices	19.28	Spice and Extract Manufacturing	311942
waste management	27.60	All Other Support Services	561990
construction and contracting	6.42	Commercial and Institutional Building Construction	236220
printed labels	24.58	Commercial Printing (except Screen and Books)	323111
employee 401k	15.30	Open-End Investment Funds	525910
poultry purchases	11.52	Poultry Processing	311615
animal purchases	26.28	Support Activities for Animal Production	115210
contract employees	19.59	Professional Employer Organizations	561330

Unfortunately, the emission factor database available from the EPA doesn't have emission factors for every NAICS code. They've chosen to 'simplify' things and only report emission factors for a subset of NAICS codes. Because NAICS codes are strictly hierarchical, this doesn't lead to errors, only extra work.

For example, the information in the table above that corresponds to the expense Longmont Sausage incurs for employee health insurance...

Purchase type	Total spend mil	NAICS group	NAICS code
employee insurance	19.58	Direct Health and Medical Insurance Carriers	524114

... shows the NAICS code and description that precisely corresponds to that activity: Code 524114, Direct Health and Medical Insurance Carriers. The first two values of the code, 52, contain everything within the Finance and Insurance industry. There are five sub-groups within this one group: Monetary Authorities-Central Bank; Credit Intermediation and Related Activities; Securities, Commodity Contracts, and Other Financial Investments and Related Activities; Insurance Carriers and Related Activities; and Funds, Trusts, and Other Financial Vehicles. Within the group that starts with 524, we see every type of business that has to do with Insurance, from Direct Life Insurance Carriers (524113) to Reinsurance Carriers (524130), Title Insurance Carriers (524127), and Pharmacy Benefit Management (524292).

We shouldn't necessarily believe that a dollar spent on title insurance corresponds to a different amount of emissions than a dollar spent on property insurance, and the EPA emission factor database reflects this. For the 17 different codes that start with 524, the EPA database gives us three choices: Direct life insurance carriers (524113); Insurance carriers, except direct life (5241XX); and Insurance agencies, brokerages, and related activities (524200). So instead of the precise NAICS code, we use the emission factor that corresponds to all codes that start with 5241, which is denoted as 5241XX in the EPA database. A good portion of NAICS codes must be approximated in this way, as below:

Here is an excerpt from the 2022 NAICS Manual, which is every bit as enthralling as it sounds:

> NAICS uses a six-digit coding system to identify industries and their placement in this hierarchical structure of the classification system. The first two digits of the code designate the sector, the third digit designates the subsector, the fourth digit designates the industry group, the fifth digit designates the NAICS industry, and the sixth digit designates the national industry. A zero as the sixth digit generally indicates that the NAICS industry and the U.S. industry are the same. The subsectors, industry groups, and NAICS industries, in accord with the conceptual principle of NAICS, are production-oriented combinations of establishments. However, the production distinctions become more narrowly defined as one moves down the hierarchy.

Detailed databases of NAICS codes, along with extensive supplementary documentation, can be found at census.gov/naics.

The EPA database referred to in this section is officially called Supply Chain Greenhouse Gas Emission Factors for US Industries and Commodities. Here is the description taken directly from that link:

> Many organizations quantify greenhouse emissions in their value chain. Emissions from purchased goods and services and capital goods, referred to as Scope 3 emissions in the Greenhouse Gas Protocol Scope 3 Accounting and Reporting Standard, represent a significant emissions source for many organizations. To assist in quantifying these emissions, we have developed a comprehensive set of supply chain emission factors covering all categories of goods and services in the US economy. The final factors are available in the Supply Chain Emission Factors for US Industries and Commodities dataset. These factors are intended for quantifying emissions from purchased goods and services using the spend-based method

Purchase type	NAICS code	NAICS description	Emission factor db code	Emission factor db description
employee insurance	524114	Direct Health and Medical Insurance Carriers	5241XX	Insurance carriers, except direct life
meat purchases	311611	Animal (except Poultry) Slaughtering	31161A	Animal (except poultry) slaughtering, rendering, and processing
cheese	311513	Cheese Manufacturing	311513	Cheese manufacturing
payroll processing	518210	Computing Infrastructure Providers, Data Processing, Web Hosting, and Related Services	518200	Data processing, hosting, and related services
electric utility	221118	Other Electric Power Generation	221100	Electric power generation, transmission, and distribution
sausage casings	311613	Rendering and Meat Byproduct Processing	31161A	Animal (except poultry) slaughtering, rendering, and processing
contract manufacturing	311612	Animal Slaughtering and Processing	31161A	Animal (except poultry) slaughtering, rendering, and processing
plumbing contractor	238220	Plumbing, Heating, and Air-Conditioning Contractors	2332A0	Office and commercial structures
corrugated cardboard	322120	Paper Mills	322120	Paper mills
refrigerated warehousing and storage	493120	Refrigerated Warehousing and Storage	493000	Warehousing and storage
polystyrene trays	326140	Polystyrene Foam Product Manufacturing	326140	Polystyrene foam product manufacturing
media buying agency	541830	Media Buying Agencies	541800	Advertising, public relations, and related services
multi-layer film	326112	Plastics Packaging Film and Sheet (including Laminated) Manufacturing	326110	Plastics packaging materials and unlaminated film and sheet manufacturing
spices	311942	Spice and Extract Manufacturing	311940	Seasoning and dressing manufacturing
waste management	561990	All Other Support Services	561900	Other support services
construction and contracting	236220	Commercial and Institutional Building Construction	233230	Manufacturing structures
printed labels	323111	Commercial Printing (except Screen and Books)	323110	Printing
employee 401k	525910	Open-End Investment Funds	525000	Funds, trusts, and other financial vehicles
poultry purchases	311615	Poultry Processing	311615	Poultry processing
animal purchases	115210	Support Activities for Animal Production	115000	Support activities for agriculture and forestry
contract employees	561330	Professional Employer Organizations	561300	Employment services

So while it would be nice if the EPA database contained every industry code within the NAICS structure, it doesn't, so this step is somewhat unavoidable.

One task remains before we can start multiplying our spend by the associated emission factor and estimate emissions, which is to assign a Scope to each category of purchase, as such:

Purchase type	Emission factor db description	Scope
employee insurance	Insurance carriers, except direct life	Scope 3.1 - Purchased goods and services
meat purchases	Animal (except poultry) slaughtering, rendering, and processing	Scope 3.1 - Purchased goods and services - FLAG
cheese	Cheese manufacturing	Scope 3.1 - Purchased goods and services - FLAG
payroll processing	Data processing, hosting, and related services	Other (Remove)
electric utility	Electric power generation, transmission, and distribution	Scope 2
sausage casings	Animal (except poultry) slaughtering, rendering, and processing	Scope 3.1 - Purchased goods and services - FLAG
contract manufacturing	Animal (except poultry) slaughtering, rendering, and processing	Scope 3.1 - Purchased goods and services - FLAG
plumbing contractor	Office and commercial structures	Scope 3.1 - Purchased goods and services
corrugated cardboard	Paper mills	Scope 3.5 - Waste generated in operations
refrigerated warehousing and storage	Warehousing and storage	Scope 3.9 - Downstream transportation and distribution
polystyrene trays	Polystyrene foam product manufacturing	Scope 3.5 - Waste generated in operations
media buying agency	Advertising, public relations, and related services	Scope 3.1 - Purchased goods and services
multi-layer film	Plastics packaging materials and unlaminated film and sheet manufacturing	Scope 3.5 - Waste generated in operations
spices	Seasoning and dressing manufacturing	Scope 3.1 - Purchased goods and services - FLAG
waste management	Other support services	Scope 3.5 - Waste generated in operations
construction and contracting	Manufacturing structures	Scope 3.1 - Purchased goods and services
printed labels	Printing	Scope 3.5 - Waste generated in operations
employee 401k	Funds, trusts, and other financial vehicles	Other (Remove)
poultry purchases	Poultry processing	Scope 3.1 - Purchased goods and services - FLAG
animal purchases	Support activities for agriculture and forestry	Scope 3.1 - Purchased goods and services - FLAG
contract employees	Employment services	Scope 3.1 - Purchased goods and services

Some categories of spend—like payments for electricity purchases—should be removed from the calculations entirely because they are accounted for elsewhere. Others—payments to 401(k) and payroll processing—aren't actually purchases (rather, they are funds transfers) and should also be removed; the fees associated with these services should be included instead. For all upstream Scope 3 categories except 3.4: Employee Commuting, these calculations will provide *both* a screening model and, in those cases where a spend-based model is appropriate, the actual emissions for that category. We proceed by converting our 2021 spend into 2018 equivalents, and finding the emission factor associated with this spend from the EPA database, keeping only those expenses that can be associated with Scope 3.1-3.9 emissions:

defined in the Greenhouse Gas Protocol Technical Guidance for Calculating Scope 3 Emissions.

Emission factor db description	Total spend mil	'18 Equivalent total spend	CO_2 Factor	CH_4 Factor	N_2O Factor	Other Factor	MT CO_2	MT CH_4	MT N_2O	MT Other	MT CO_2e
Insurance carriers, except direct life	19.58	18.01	0.033	0.000	0.000	0.001	594	0	0	18	612
Animal (except poultry) slaughtering, rendering, and processing	5.10	4.69	0.398	0.039	0.002	0.003	1,867	183	9	14	9,138
Cheese manufacturing	11.62	10.69	0.412	0.034	0.001	0.005	4,404	363	11	53	16,810
Animal (except poultry) slaughtering, rendering, and processing	2.54	2.34	0.398	0.039	0.002	0.003	931	91	5	7	4,703
Animal (except poultry) slaughtering, rendering, and processing	24.11	22.18	0.398	0.039	0.002	0.003	8,828	865	44	67	43,632
Office and commercial structures	29.37	27.02	0.211	0.001	0.000	0.034	5,701	27	0	919	7,295
Paper mills	24.88	22.89	0.712	0.002	0.000	0.004	16,298	46	0	92	17,540
Warehousing and storage	5.37	4.94	0.607	0.002	0.000	0.004	2,999	10	0	20	3,269
Polystyrene foam product manufacturing	20.74	19.08	0.514	0.002	0.000	0.005	9,807	38	0	95	10,852
Advertising, public relations, and related services	12.19	11.21	0.093	0.000	0.000	0.003	1,043	0	0	34	1,077
Plastics packaging materials and unlaminated film and sheet manufacturing	18.52	17.04	0.657	0.002	0.000	0.006	11,195	34	0	102	12,147
Seasoning and dressing manufacturing	19.28	17.74	0.263	0.002	0.000	0.003	4,666	35	0	53	5,594
Other support services	27.60	25.39	0.109	0.001	0.000	0.004	2,768	25	0	102	3,495
Manufacturing structures	6.42	5.91	0.216	0.001	0.000	0.017	1,277	6	0	100	1,527
Printing	24.58	22.61	0.373	0.001	0.000	0.004	8,434	23	0	90	9,099
Poultry processing	11.52	10.60	0.473	0.005	0.001	0.004	5,014	53	11	42	9,659
Support activities for agriculture and forestry	26.28	24.18	0.249	0.001	0.000	0.001	6,021	24	0	24	6,645
Employment services	19.59	18.02	0.033	0.000	0.000	0.001	595	0	0	18	613

So that the reader can actually follow along with the calculations, here is a repeat of the first table shown in this section, with the industry description from the EPA database and our assigned emissions category, plus total emissions:

Purchase type	Total spend mil	Emission factor db description	Scope	MT CO_2 e
employee insurance	19.58	Insurance carriers, except direct life	Scope 3.1 - Purchased goods and services	612
meat purchases	5.10	Animal (except poultry) slaughtering, rendering, and processing	Scope 3.1 - Purchased goods and services - FLAG	9,138
cheese	11.62	Cheese manufacturing	Scope 3.1 - Purchased goods and services - FLAG	16,810
payroll processing	21.26	Data processing, hosting, and related services	Other (Remove)	3,551
electric utility	26.59	Electric power generation, transmission, and distribution	Scope 2	97,453
sausage casings	2.54	Animal (except poultry) slaughtering, rendering, and processing	Scope 3.1 - Purchased goods and services - FLAG	4,703
contract manufacturing	24.11	Animal (except poultry) slaughtering, rendering, and processing	Scope 3.1 - Purchased goods and services - FLAG	43,632
plumbing contractor	29.37	Office and commercial structures	Scope 3.1 - Purchased goods and services	7,295
corrugated cardboard	24.88	Paper mills	Scope 3.5 - Waste generated in operations	17,540
refrigerated warehousing and storage	5.37	Warehousing and storage	Scope 3.9 - Downstream transportation and distribution	3,269
polystyrene trays	20.74	Polystyrene foam product manufacturing	Scope 3.5 - Waste generated in operations	10,852
media buying agency	12.19	Advertising, public relations, and related services	Scope 3.1 - Purchased goods and services	1,077
multi-layer film	18.52	Plastics packaging materials and unlaminated film and sheet manufacturing	Scope 3.5 - Waste generated in operations	12,147
spices	19.28	Seasoning and dressing manufacturing	Scope 3.1 - Purchased goods and services - FLAG	5,594
waste management	27.60	Other support services	Scope 3.5 - Waste generated in operations	3,495
construction and contracting	6.42	Manufacturing structures	Scope 3.1 - Purchased goods and services	1,527
printed labels	24.58	Printing	Scope 3.5 - Waste generated in operations	9,099
employee 401k	15.30	Funds, trusts, and other financial vehicles	Other (Remove)	2,110
poultry purchases	11.52	Poultry processing	Scope 3.1 - Purchased goods and services - FLAG	9,659
animal purchases	26.28	Support activities for agriculture and forestry	Scope 3.1 - Purchased goods and services - FLAG	6,645
contract employees	19.59	Employment services	Scope 3.1 - Purchased goods and services	613

Certain of these line items are actually purchases of capital goods rather than expenses. Using the exact same calculations, but substituting 'Capital spend' in place of 'Total spend' in the table above, we can generate a similar capital-only spend-based model:

Purchase type	Capital spend mil	Emission factor db description	Scope	MT CO_2e
plumbing contractor	25.55	Office and commercial structures	Scope 3.2 - Capital goods	6,360
construction and contracting	6.42	Manufacturing structures	Scope 3.2 - Capital goods	1,527

Keep in mind that these numbers are deeply fake. We will show more representative values below that *will not match* these numbers, even though we say we're taking the results directly from this analysis.

Finally, we can aggregate each of these emissions items according to Scope 3 category:

Emissions Category	MT CO_2e
Scope 3.1 - Purchased goods and services	11,124
Scope 3.1 - Purchased goods and services - FLAG	96,181
Scope 3.5 - Waste generated in operations	53,133
Scope 3.9 - Downstream transportation and distribution	3,269

What we have here is *both* the screening exercise and the spend-based model for Scopes 3.1-3.9 (except 3.3 and 3.7). Calculations for any material Scope 3 category can be further refined as long as activity-based data is available. Further refined or not, the values here are calculated in a way that meets GHG Protocol requirements for quality, and they can be used as such.

> Tools Available through Nectar Climate
>
> This, without doubt, seems like a lot. It is a lot. But it is a relatively efficient way to accurately get the job done

> and is simpler than it seems.
>
> Even better: Nectar has produced a tool that automates this process, available at estimator.nectarclimate.com. The tool reads a spreadsheet of transactions from ERP/financial systems and automatically matches each transaction with an EPA factor and corresponding scope.

Scope 3: Downstream value chain (Scopes 3.10-3.15)

For downstream Scope 3 categories, the screening process was much simpler:

- 3.10 (Processing of sold products) and 3.12 (End of life treatment of sold products) were deemed material due simply to volume—rendering, hides, and packaging are all significant—but no simple spend-based estimates were possible, so activity-based calculations were required.
- 3.11 (Use of sold products) The emissions required to cook our products are material, but no simple spend-based estimates were available, so activity-based calculations were required.
- 3.13-15 (Downstream leased assets, Franchises, and Investments) were all out of scope because Longmont Sausage doesn't have any activities that fall into these categories.

Scope 3: Value chain emissions

Scope 3.2: Capital goods

> GHG Protocol Guidance: Description and boundaries for **Capital goods**
>
> **Category description**
> Extraction, production, and transportation of capital goods purchased or acquired by the reporting company in the reporting year
>
> **Minimum boundary**
> All upstream (cradle-to-gate) emissions of purchased capital goods

Like any other manufacturing company, Longmont Sausage keeps track of capital spend for many reasons, the most obvious of which is for depreciation and tax calculations. Therefore, 3.2 (Capital goods) was fairly straightforward to calculate.

Using the results obtained directly from the spend-based screening exercise detailed above—we simply subtract capital spend from Scope 3.1 calculations and move them to Scope 3.2—we get the following (here aggregated by NAICS group):

NAICS cat	NAICS cat description	Capital Spend	MT CO_2e capital
23	Construction	21,681,220	49,455
32	Manufacturing - Plastics, Chemicals, and Wood Products	701,644	361
33	Manufacturing - Metals, Machinery, and Equipment	14,857,172	8,450
42	Wholesale Trade	1,312,502	221
44	Retail Trade - Household Goods and Food	621	0
45	Retail Trade - Personal Goods	15,584	2
51	Information	441,386	24
54	Professional, Scientific, and Technical Services	1,797,917	175
56	Administrative and Support and Waste Management and Remediation Services	227,761	22
81	Other Services (except Public Administration)	19,503	3
			58,713

The GHG Protocol Scope 3 guidance provides several other methods to calculate emissions related to capital goods, though the spend based method is likely the most straightforward.

Scope 3.1: Purchased goods and services

> GHG Protocol Guidance: Description and boundaries for **Purchased goods and services**
>
> **Category description**
> Extraction, production, and transportation of goods and services purchased or acquired by the reporting company in the reporting year, not otherwise included in Categories 2 - 8
>
> **Minimum boundary**
> All upstream (cradle-to-gate) emissions of purchased goods and services

Here are the results of the spend-based model for non-meat and -animal expenses:

We're presenting these items out of order because this is the order in which the calculations actually occurred. The narrative makes more sense this way.

NAICS cat	NAICS cat description	Total spend	MT CO_2e expense
11	Agriculture, Forestry, Fishing and Hunting	86,056	94
21	Mining, Quarrying, and Oil and Gas Extraction	260	0
23	Construction	3,416,278	7,793
31	Manufacturing - Food, Beverage, and Textiles	4,204,292	1,430
32	Manufacturing - Plastics, Chemicals, and Wood Products	19,310,005	9,945
33	Manufacturing - Metals, Machinery, and Equipment	10,424,522	5,929
42	Wholesale Trade	21,886,912	3,683
44	Retail Trade - Household Goods and Food	466,244	101
45	Retail Trade - Personal Goods	473,008	47
48	Transportation and Warehousing - Transportation	76,678	36
49	Transportation and Warehousing - Handling and Warehousing	58,947	26
51	Information	5,815,537	319
52	Finance and Insurance	44,347,611	1,158
53	Real Estate and Rental and Leasing	5,651,714	796
54	Professional, Scientific, and Technical Services	58,103,770	5,651
55	Management of Companies and Enterprises	603,206	72
56	Administrative and Support and Waste Management and Remediation Services	30,331,585	2,945
62	Health Care and Social Assistance	169,038	22
71	Arts, Entertainment, and Recreation	2,329,763	164
72	Accommodation and Food Services	129,522	23
81	Other Services (except Public Administration)	7,410,962	1,066
			41,298

We could have directly taken the results of the screening exercise detailed above—taking care to remove those items that are accounted for elsewhere—as our answer for *all* Purchased Goods and Services. Meat and animal purchases, however, warrant a detailed, activity-based treatment. For several reasons, a spend-based approach is sub-optimal:

- The price of meat varies according to a relatively volatile market, which has little to do with carbon emissions. If the price of pork (or beef or poultry) doubles, but nothing else changes, our emissions estimates shouldn't change either. Using a spend-based approach built from data from any year other than the base year would therefore introduce significant error.
- Longmont Sausage buys and slaughters culled sows for use in our fresh sausage product. Because culled sows are a byproduct of a larger supply chain—pork production—lifetime emissions for these animals *starts* when the sow is culled (that is, taken out of production) and *ends* when the animal arrives at our plants. Not accounting for sow-related emissions this way would result in double-counting.
- Due to having to report FLAG emissions separately, we decided that an activity-based approach for these materials would be prudent anyway, irrespective of accuracy concerns noted above.

Activity-based calculations for meat purchases

Because our meat purchases are denominated in pounds of delivered (boneless) meat, some quick conversions were required to be able to use the published emissions intensities from the sources in the margins.

Species	Published Emission Factor		Yield Ratio		Mass Units Conversion		Reporting Emission Factor
	$\frac{kg\ CO_2e}{kg\ CW}$	÷	$\frac{kg\ meat}{kg\ CW}$	÷	$\frac{lb}{kg}$	=	$\frac{kgCO_2e}{lb\ meat}$
Pork	4.5		0.59		2.2		3.47
Beef	48.4		0.695		2.2		31.65
Poultry	4.4		0.77		2.2		2.6

Scope	Category	Activity	Location	Amount	Unit	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2e Factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 3.1	Purchased meat	Pork	All manufacturing	112,815,337	pounds				3.47				316,968
Scope 3.1	Purchased meat	Beef	All manufacturing	3,536,109	pounds				31.65				129,483
Scope 3.1	Purchased meat	Poultry	All manufacturing	7,381,311	pounds				2.6				31,174
Scope 3.1	Purchased meat												477,625

> GHG Protocol Guidance: Description and boundaries for **Use of sold products**
>
> **Category definition**
> End use of goods and services sold by the reporting company in the reporting year
>
> **Minimum boundary**
> The direct use-phase emissions of sold products over their expected lifetime (*i.e.*, the Scope 1 and Scope 2 emissions of end users that occur from the use of: products that directly consume energy (fuels or electricity) during use; fuels and feedstocks; and GHGs and products that contain or form GHGs that are emitted during use)

> Alternative Calculation Methods, Notes, and Exceptions: FLAG emissions from purchased agricultural commodities
>
> This case study is meant to show how to conduct a detailed GHG emissions inventory, so we included the above calculations all the way through to total emissions due to purchased agricultural commodities. But the

Thoma et al, A Life Cycle Analysis of Land Use in U.S. Pork Production: Comprehensive Report

Thoma et al, Broiler Production System Life Cycle Assessment: 2020 Update

Asem-Hiablie, S., Battagliese, T., Stackhouse-Lawson, K.R. et al. A life cycle assessment of the environmental impacts of a beef system in the USA. Int J Life Cycle Assess 24, 441–455 (2019).

Clune S, Crossin E, Verghese K, Systematic review of greenhouse gas emissions for different fresh food categories, Journal of Cleaner Production (2016), doi: 10.1016/j.jclepro.2016.04.082.

MacLeod, M., Gerber, P., Mottet, A., Tempio, G., Falcucci, A., Opio, C., Vellinga, T., Henderson, B. & Steinfeld, H. 2013. Greenhouse gas emissions from pig and chicken supply chains – A global life cycle assessment. Food and Agriculture Organization of the United Nations (FAO), Rome.

SBTi Flag Tool

SBTi target-setting process for FLAG emissions does not actually require companies to go this far with their preliminary calculations.

The SBTi FLAG Tool includes emission factors for major agricultural commodities by region, which are automatically calculated once a user enters total carcass weight for a given commodity. It would be acceptable for a company to skip this section of their inventory and use the default values for Land Use Change (LUC) and non-LUC emission factors, and the calculated total emissions, given by the tool.

In our case, the total value shown above—478k MT CO_2e—is within 10% of the default values calculated by SBTi's tool, so we should feel comfortable using either value.

Emissions from purchased goods that belong under FLAG but are not from the list of major agricultural commodities—spice purchases, in our case—must be calculated using emission factors obtained elsewhere.

Scope 3.3: Fuel- and energy-related activities (not included in Scope 1 or 2)

GHG Protocol Guidance: Description and boundaries for **Fuel- and energy-related activities (not included in Scope 1 or 2)**

Category description

Extraction, production, and transportation of fuels and energy purchased or acquired by the reporting company in the reporting year, not already accounted for in Scope 1 or Scope 2, including: a. Upstream emissions of purchased fuels (extraction, production, and transportation of fuels consumed by the reporting company) b. Upstream emissions of purchased electricity (extraction, production, and transportation of fuels consumed in the generation of electricity, steam, heating, and cooling consumed by the reporting company) c. Transmission and distribution (T&D) losses (generation of electricity, steam, heating and cooling that is consumed (i.e., lost) in a T&D system) – reported by end user d. Generation of purchased electricity that is sold to end users (generation of electricity, steam, heating, and cooling that is purchased by the reporting company and sold to end users) – reported by utility company or energy retailer only

Minimum boundary

For upstream emissions of purchased fuels: All upstream (cradle-to-gate) emissions of purchased fuels (from raw material extraction up to the point of, but excluding combustion) b. For upstream emissions of purchased electricity: All upstream (cradle-to-gate) emissions of purchased fuels (from raw material extraction up to the point of, but excluding, combustion by a power generator) c. For T&D losses: All upstream (cradle-to-gate) emissions of energy consumed in a T&D system, including emissions from combustion d. For generation of purchased electricity that is sold to end users: Emissions from the generation of purchased energy

The calculations for Scope 3.3: Fuel- and energy-related activities are simple, provided one can find the proper emission factors. The activity information—gallons of diesel fuel burned, *etc*—can be taken directly from Scope 1 and 2 calculations. Finding the correct emission factor isn't always easy, but …

1. Transmission and Distribution losses—to be applied to electricity purchases—are available on a national-average basis from the World Bank.
2. Well-To-Tank (WTT) emission factors—applied to all purchased fuels—are available on an extensive worksheet produced by the United Nations Framework Convention on Climate Change (UNFCC). This source contains mostly information from the UK, but it was the best source we could find.
3. Emissions from *production* of electricity—applied to all electricity purchases, on a grid-specific basis—are available from the EPA's eGRID dataset, under the heading "eGRID subregion annual CO2 equivalent input emission rate (lb/MMBtu)"
4. Because emissions from our live animal purchases are almost entirely made up of fuel use during transportation, we chose to account for the WTT emissions from those fuel purchases here. The US Energy Information Administration publishes average miles per gallon for livestock trucks, which we converted to total gallons and used the same emission factors from #2, above.

Electric power transmission and distribution losses (% of output) from the World Bank

GHG Emissions Calculator from UNFCCC (downloads .xls file)

eGRID dataset from US EPA

US EIA fuel economy database for heavy trucks

Scope	Category	Activity	Location	Amount	Unit	CO_2e factor	CO_2e
Scope 3.3	Upstream emissions of purchased fuels	Diesel Fuel - stationary combustion	All manufacturing	379	GAL	2.310	1
Scope 3.3	Upstream emissions of purchased fuels	Natural Gas	All manufacturing	380,857	mmBTU	7.433	4,270
Scope 3.3	Upstream emissions of purchased fuels	Wood	All manufacturing	41,463	2021 dollars	0.192	15
Scope 3.3	Upstream emissions of purchased fuels	Diesel Fuel - mobile combustion	All manufacturing	611,222	GAL	2.310	2,799
Scope 3.3	Upstream emissions of purchased fuels	Motor Gasoline	All manufacturing	33,483	GAL	2.246	29
Scope 3.3	Upstream emissions of purchased fuels	Jet Fuel	All manufacturing	125,134	USG	1.993	248
Scope 3.3	Upstream emissions of purchased fuels	Diesel Fuel - inbound sow transp.	All manufacturing	856,906	USG	2.310	1,752
Scope 3.3	Transmission & distribution losses	Purchased electricity	All manufacturing	74,776	MT CO_2e Scope 2	53.000	3,127
Scope 3.3	Upstream emissions of purchased electricity	Purchased electricity	Longmont Manufacturing	23,741,403	kWh	0.276	9,972
Scope 3.3	Upstream emissions of purchased electricity	Purchased electricity	Longmont Manufacturing	26,910,004	kWh	0.276	4,885
Scope 3.3	Upstream emissions of purchased electricity	Purchased electricity	Longmont Manufacturing	4,135,132	kWh	0.276	1,849
Scope 3.3	Upstream emissions of purchased electricity	Purchased electricity	Global Headquarters	117,151	kWh	0.276	31
Scope 3.3	Upstream emissions of purchased electricity	Purchased electricity	Slaughter	4,717,980	kWh	0.273	2,762
Scope 3.3	Upstream emissions of purchased electricity	Purchased electricity	Slaughter	11,185,891	kWh	0.273	1,468
Scope 3.3	Upstream emissions of purchased electricity	Purchased electricity	Slaughter	10,134,726	kWh	0.299	2,528
Scope 3.3	Upstream emissions of purchased electricity	Purchased electricity	Longmont Manufacturing	1,355,059	kWh	0.276	269
Scope 3.3	Upstream emissions of purchased electricity	Purchased electricity	New England Manufacturing	604,967	kWh	0.165	65
Scope 3.3	Upstream emissions of purchased electricity	Purchased electricity	New England Manufacturing	717,501	kWh	0.165	84
Scope 3.3	Upstream emissions of purchased electricity	Purchased electricity	Asia-Pacific 1	3,440,782	kWh	0.276	1,232
Scope 3.3	Upstream emissions of purchased electricity	Purchased electricity	Asia-Pacific 2	5,076,588	kWh	0.276	2,016
Scope 3.3	Upstream emissions of purchased electricity	Purchased electricity	Asia-Pacific 3	5,749,917	kWh	0.276	2,053
Scope 3.3	Transmission & distribution losses						3,127
Scope 3.3	Upstream emissions of purchased electricity						29,213
Scope 3.3	Upstream emissions of purchased fuels						9,114

Scope 3.4: Upstream transportation and distribution

> GHG Protocol Guidance: Description and boundaries for **Upstream transportation and distribution**
>
> **Category definition:**
>
> Transportation and distribution of products purchased by the reporting company in the reporting year between a company's tier 1 suppliers and its own operations (in vehicles and facilities not owned or controlled by the reporting company)
>
> Transportation and distribution services purchased by the reporting company in the reporting year, including inbound logistics, outbound logistics (*e.g.*, of sold products), and transportation and distribution between a company's own facilities (in vehicles and facilities not owned or controlled by the reporting company)
>
> **Minimum boundary:**
>
> The Scope 1 and Scope 2 emissions of transportation and distribution providers that occur during use of vehicles and facilities (*e.g.*, from energy use)

Longmont Sausage has three primary activities that fall within Upstream Transportation and Distribution: freight on purchased raw materials, intracompany transportation between Longmont Sausage-owned facilities (in vehicles not owned by Longmont Sausage), and inbound freight on purchased live animals and trim meat materials.

Activity data for the first two categories, freight on purchased raw materials and inter-company freight, was not available so

we deferred to the spend based approach to estimate our emissions. Many vendors include 'freight' or 'delivery' as a separate line item on their invoices and our Accounts Payable department isolates this specific spend in a general ledger account designated for inbound freight. Calculating emissions from these two upstream transportation categories was, as a result, straightforward: we multiply dollars spent by the corresponding emission factors from the Environmentally-Extended Input-Output (EEIO) database.

For inbound freight on purchased live animals, we calculated the distance from our live animal suppliers to our facilities and multiplied this value by the number of truckloads of meat received during the base year. We then multiplied this total truck miles value by the emission factors for Medium and Heavy Duty Trucks from the EPA Emission Factors Hub.

Emissions from outbound transport of render and hides (see 3.10 for more information related to emissions estimation from these activities) were calculated in the same way. We first find distance from our facilities to the destination for these materials, calculated the total number of truckloads based on base-year volumes, and applied these total miles to corresponding emission factors from the EPA Emission Factor Hub.

Scope	Category	Activity	Location	Amount	Unit	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 3.4	Mobile combustion	Inbound materials	Longmont Manufacturing	1,110,264	2018 USD	1.246	0.003	0	1,246	0.003	0.000	1,246
Scope 3.4	Mobile combustion	Inbound meat	Longmont Manufacturing	1,049,871	miles	1.45	0.013	0.034	1,837	0.017	0.043	1,850
Scope 3.4	Mobile combustion	Inbound live animals	Slaughter	4,338,994	miles	1.45	0.013	0.034	5,506	0.049	0.129	5,546
Scope 3.4	Mobile combustion	Inbound meat	Slaughter	184,491	miles	1.45	0.013	0.034	325	0.003	0.008	328
Scope 3.4	Mobile combustion	Inbound live animals										5,546
Scope 3.4	Mobile combustion	Inbound materials										1,246
Scope 3.4	Mobile combustion	Inbound meat										2,178

Scope 3.5 and Scope 3.12: Operational and consumer waste

According to the GHG Protocol standards, emissions resulting from the use of the sorts of packaging common in meat companies—anything that includes wasted packaging at the manufacturing plant, basically—should be accounted for in two separate places within Scope 3. Any backing films or trimmed packaging, which would be accumulated within a plant and then disposed of some way, belongs in **3.5: Waste generated in operations**. Packaging that makes it to the consumer, however, belongs under **3.12: End of life treatment of sold products**.

The distinction between *who* disposes of packaging materials is probably more salient in other industries, but it made sense for us to consider it all together: for example, all PVC film that Longmont Sausage purchases for its fresh sausage product ends up in the landfill—the EPA says 0% of PVC film actually gets recycled in the United States—whether Longmont Sausage or a consumer sends it there. Accounting for these streams separately would have required knowing the waste percentage for this material (and all other packaging materials), which isn't information we collect. More importantly, doing so would miss the point. The same argument, making allowances for recycling rates that vary according to material, holds for all packaging materials.

For these reasons, below we break out three separate waste streams: Waste generated in operations *except packaging* (3.5), End of life treatment of sold products *except packaging* (3.12), and *all packaging materials* regardless of proximate source (3.5 + 3.12).

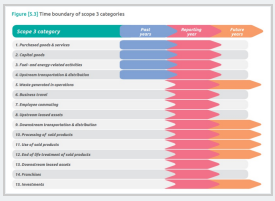
Scope 3.5: Waste generated in operations (except packaging)

> GHG Protocol Guidance: Description and boundaries for **Waste generated in operations**
>
> **Category definition:**
> Disposal and treatment of waste generated in the reporting company's operations in the reporting year (in facilities not owned or controlled by the reporting company)
>
> **Minimum boundary:**
> The Scope 1 and Scope 2 emissions of waste management suppliers that occur during disposal or treatment

Using our spend based model from Scope 3 Category 1 (Purchased Goods and Services) we isolated the spend related to waste management—primarily sludge hauling from our wastewater treatment plants—and applied the corresponding emission factors from the Environmentally-Extended Input-Output (EEIO) database.

Scope	Category	Activity	Location	Amount	Unit	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 3.5	Waste management and remediation services	Waste management and remediation services	All manufacturing	3,103,309	2021 USD	0.255	37	0	593	87	0	2,789
Scope 3.5	Waste management and remediation services	Waste management and remediation services										2,789

In Chapter 5.4 of the **Corporate Value Chain (Scope 3) Accounting and Reporting Standard**, the GHG protocol defines the time boundaries that are within scope for each sub-category of Scope 3 emissions:



Both 3.5 and 3.12 show "Future Years" as within scope. All packaging waste is Scope 3, and calculated in the exact same way. Spending time or effort measuring within-operations waste percentages for packaging materials would not help us better achieve any of the guiding principles behind the process—relevance, completeness, consistency, transparency, and accuracy—so treating all packaging materials as one category is appropriate.

Scope 3.12: End of life treatment of sold products (except packaging)

> GHG Protocol Guidance: Description and boundaries for **End of life treatment of sold products**
>
> **Category definition:**
> Waste disposal and treatment of products sold by the reporting company (in the reporting year) at the end of their life
>
> **Minimum boundary:**
> The Scope 1 and Scope 2 emissions of waste management companies that occur during disposal or treatment of sold products

Our products are either consumed or discarded, and can be discarded by either the retailer or the consumer; according to the EPA, 100% of discarded meat products end up in the landfill. To calculate the amount of landfilled meat, we begin with total finished good pounds sold and multiply first by a retailer-shrink value and then by a consumer-discard value. The corresponding emission factors for landfilled food waste, from the EPA Emissions Hub, was then applied to calculate the emissions output from this waste stream.

These emissions shown in the first two rows of the next table, below.

Scope 3.5 + 3.12: All packaging materials

The calculations behind emissions from packaging and food waste were slightly more complex. It is important to note that our calculation of packaging waste includes all packaging purchases and does not differentiate whether packaging waste generated during internal production versus downstream by the end consumer.

- **Total weight of packaging, by material type:** We multiplied total *units* of each packaging material purchased in the base year (from an internal spend report) by the per-unit weight of these same materials to get the total weight of packaging materials purchased in the base year.
- **Disposition of packaging materials, by material type:** The EPA provides recycling rates by material (reference #3 at right). Using these values, we calculate total pounds of waste, by material and disposition, in the base year.
- **Emissions by packaging material and disposition:** Each different *activity*—for these purposes defined as type of material and disposition of that material—has its own emission factor in the EPA Emission Factor Hub (Table 9), from which could finally estimate emissions from packaging, summarized below:

Scope	Category	Activity	Location	Amount	Unit	CO_2e Factor	CO_2e
Scope 3.12	End of life treatment of sold products - meat	Meat waste (shrink)	All manufacturing	3,743	Short tons	0.58	2,937
Scope 3.12	End of life treatment of sold products - meat	Meat waste (consumer discard)	All manufacturing	16,254	Short tons	0.58	13,826
Scope 3.12	End of life treatment of sold products - packaging	Polystyrene (Landfill)	All manufacturing	1,639	Short tons	0.02	46
Scope 3.12	End of life treatment of sold products - packaging	PVC (Landfill)	All manufacturing	1,577	Short tons	0.02	30
Scope 3.12	End of life treatment of sold products - packaging	HDPE (Landfill)	All manufacturing	1,322	Short tons	0.02	19
Scope 3.12	End of life treatment of sold products - packaging	Mixed paper (Landfill)	All manufacturing	1,725	Short tons	0.75	1,170
Scope 3.12	End of life treatment of sold products - packaging	Mixed paper (Recycled)	All manufacturing	972	Short tons	0.03	17
Scope 3.12	End of life treatment of sold products - packaging	Mixed paper (Combusted)	All manufacturing	63	Short tons	0.05	4
Scope 3.12	End of life treatment of sold products - packaging	Corrugated containers (Landfill)	All manufacturing	177	Short tons	0.9	148
Scope 3.12	End of life treatment of sold products - packaging	Corrugated containers (Recycled)	All manufacturing	11,129	Short tons	0.11	732
Scope 3.12	End of life treatment of sold products - meat						16,763
Scope 3.12	End of life treatment of sold products - packaging						2,168

1. *Customer shrink data available from either customers or paid services. Meat case shrink values range from <0.5% for cooked products to <5% for fresh sausage; our weighted-average value used here is ~2%.*
2. *Consumer waste data taken from 'in-home use' tests conducted by Longmont Sausage; latest estimates show 15% average waste by consumers.*
3. *Recycling rates by material from EPA*
4. *EPA Emission Factor Hub Table 9 (Scope 3 Category 5: Waste Generated in Operations and Category 12: End-of-Life Treatment of Sold Products)*

Scope 3.6: Business travel

> GHG Protocol Guidance: Description and boundaries for **Business travel**
>
> **Category description**
> Transportation of employees for business-related activities during the reporting year (in vehicles not owned or operated by the reporting company)
>
> **Minimum boundary**
> The Scope 1 and Scope 2 emissions of transportation carriers that occur during use of vehicles (*e.g.*, from energy use)

Longmont Sausage's business travel spend falls within two main categories: air travel and car rental. Our expense management software tracks this spend and other travel-related details: we used activity data (miles of air travel) and spend data (dollars of car rental spend) where appropriate to apply against the corresponding emission factors.

The air travel emission factors from the EPA Emission Factor Hub are categorized by the length of the flight: a short haul being less than 300 miles, a medium haul being between 300 and 2,300 miles, and a long haul being greater than 2,300 miles. Because our expense management system retains the departure and arrival cities for each flight purchased, including the route distance, we were able to easily categorize each flight as short, medium, or long haul and total the miles of each. The last step is to simply multiply the corresponding emission factors by the total number of miles.

Scope	Category	Activity	Location	Amount	Unit	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 3.6	Mobile combustion	Car rental	Global Headquarters	206,616	2018 USD	0.107	1e-06	0	12	0.000	0.000	12
Scope 3.6	Mobile combustion	Air Miles - Medium Haul	Global Headquarters	0	miles	0.129	6e-04	0.0041	0	0.000	0.000	0
Scope 3.6	Mobile combustion	Air Miles - Long Haul	Global Headquarters	199,929	miles	0.163	6e-04	0.0052	45	0.000	0.001	45
Scope 3.6	Mobile combustion	Air Miles - Short Haul	Global Headquarters	1,233,095	miles	0.207	0.0064	0.0066	253	0.008	0.008	256
Scope 3.6	Mobile combustion											313

> Alternative Calculation Methods, Notes, and Exceptions
>
> Not every company will have total miles available. Emissions from air travel can also be estimated using the spend-based method. Multiply the total dollars of air travel spend by the 'air transportation' emission factors from the Environmentally-Extended Input-Output (EEIO) database.

Longmont Sausage does not require staff members to record mileage when using a rental vehicle; therefore, the only data we had available for this activity was the total dollars spent. To estimate the emissions output, we multiplied the total dollars spent by the emission factors related to 'transit and ground passenger transportation' from the Environmentally-Extended Input-Output (EEIO) database.

> Alternative Calculation Methods, Notes, and Exceptions
>
> If your company has total rental vehicle miles available, the activity-based emission factors from the EPA Emission Factors Hub can be used.

Scope 3.7: Employee commuting

> GHG Protocol Guidance: Description and boundaries for **Employee commuting**
>
> **Category definition**
>
> Transportation of employees between their homes and their worksites during the reporting year (in vehicles not owned or operated by the reporting company)
>
> **Minimum boundary**
>
> The Scope 1 and Scope 2 emissions of employees and transportation providers that occur during use of vehicles (*e.g.*, from energy use)

Starting with a list of employee addresses and work location, we used Google Maps to calculate the exact commute distance for each employee. We then applied assumptions related to annual working days and salaried members who might work from home for part of the week. These total miles were then applied to the corresponding emission factors found in the EPA Emission Factor Hub.

We used the Google Maps API to do these calculations in bulk, which made it reasonable to do so. See the next "Alternative calculation methods" box for a less-demanding but acceptable alternative.

Scope	Category	Activity	Location	Amount	Unit	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 3.7	Mobile combustion	Employee commuting	Global Headquarters	1,175,548	miles	0.332	0.007	0.007	261	0.005	0.005	262
Scope 3.7	Mobile combustion	Employee commuting	Longmont Manufacturing	4,063,135	miles	0.332	0.007	0.007	1,029	0.022	0.022	1,036
Scope 3.7	Mobile combustion	Employee commuting	New England Manufacturing	0	miles	0.332	0.007	0.007	0	0.000	0.000	0
Scope 3.7	Mobile combustion	Employee commuting	Slaughter	2,420,276	miles	0.332	0.007	0.007	923	0.019	0.019	929
Scope 3.7	Mobile combustion	Employee commuting										2,227

> Alternative Calculation Methods, Notes, and Exceptions
>
> Not every company will have the ability to easily determine the exact commute length for each employee. The GHG Protocol does allow companies to calculate emissions from their employee commuting using the average-data method. According to the Scope 3 guidance, this involves 'estimating emissions from employee commuting based on average (i.e. national) data on commuting patterns'. The United States Census Bureau provides national estimates related to commuting.

Scope 3.8: Upstream leased assets

> GHG Protocol Guidance: Description and boundaries for **Upstream leased assets**

Category definition

Operation of assets leased by the reporting company (lessee) in the reporting year and not included in Scope 1 and Scope 2 – reported by lessee

Minimum boundary

The Scope 1 and Scope 2 emissions of lessors that occur during the reporting company's operation of leased assets (e.g., from energy use)

Longmont Sausage has no leased assets that fall in this category in the base year.

Scope 3.9: Downstream transportation and distribution

GHG Protocol Guidance: Description and boundaries for **Downstream transportation and distribution**

Category definition

Transportation and distribution of products sold by the reporting company in the reporting year between the reporting company's operations and the end consumer (if not paid for by the reporting company), including retail and storage (in vehicles and facilities not owned or controlled by the reporting company)

Minimum boundary

The Scope 1 and Scope 2 emissions of transportation providers, distributors, and retailers that occur during use of vehicles and facilities (*e.g.*, from energy use)

Longmont Sausage primarily uses over-the-road trucking and rail transport as a means of distributing finished goods to consumers. Our Distribution & Supply Chain team was able to provide the total number of distribution miles by transportation mode. Two complications bear mention:

- Intermodal transport involves moving freight by using two or more modes of transportation. At Longmont Sausage, this was largely a combination of road and rail transport but could include ocean, air, etc. It is important to know which modes are used as this will determine the correct emission factors to use.
- Approximately 30% of the road miles used to distribute Longmont Sausage product are considered 'less-than truckload' miles (i.e. the truck contained less than 100% of Longmont Sausage product). In these instances, we apportioned the total miles driven by the share of product on the truck. For example, if a truck that contained 40% of Longmont Sausage product drove 100 miles, we would only include 40 miles in our emissions calculation.

GHG Protocol Guidance: Operational boundaries covering transportation and distribution

Reminder: Any distribution with vehicles owned by the company, including direct shipping to distribution centers or retailers, falls within Scope 1, not Scope 3, and any distribution *paid for by the company* should fall within Scope 3.4: Upstream Transportation and Distribution.

Either miles or spend data can be used to calculate emissions from downstream transportation. At Longmont Sausage, we were able to use the miles obtained from our Supply Chain team and apply the corresponding emission factors from the EPA Emission Factor Hub. As stated above, it was important to differentiate between road and rail miles so the correct emission factors could be used.

For emissions associated with distribution—that is, warehousing and storage activities—we used the corresponding item from our Scope 3 Spend-Based model.

Scope	Category	Activity	Location	Amount	Unit	CO_2 factor	CH_4 factor	N_2O factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 3.9	Mobile combustion	On the road miles	All manufacturing	3,961,154	miles	1.45	0.013	0.034	4,895	0.04	0.11	4,899
Scope 3.9	Mobile combustion	Intermodal distribution	All manufacturing	845,869	miles	0.022	0.0017	6e-04	20	0.00	0.00	20
Scope 3.9	Warehousing and storage	Warehousing and storage	All manufacturing	24,530,741	2021 USD	0.575	1.84	0	14,427	46.17	0.00	15,581
Scope 3.9												20,500

Scope 3.10: Processing of sold products

GHG Protocol Guidance: Description and boundaries for **Processing of sold products**

Category definition

Processing of intermediate products sold in the reporting year by downstream companies (e.g., manufacturers)

Minimum boundary

The Scope 1 and Scope 2 emissions of downstream companies that occur during processing (e.g., from energy use)

The GHG Protocol defines intermediate products as 'products that require further processing, transformation, or inclusion in another product before use'. Longmont Sausage has two intermediate products that fall within this categories: materials sent for rendering, and hides sent for processing into leather goods.

These are the sorts of activities that are common for the meat industry but uncommon everywhere else, so finding reliable

1. *Laurenti et al, Measuring the*

emission factors took some work.

1. For hide processing, we found a study in the Journal of Industrial Ecology that provides an estimate of emissions from that process.
2. For rendering, we were able to use a life-cycle analysis performed by our primary rendering customer to estimate emissions for all rendered materials.
3. We also repeated some earlier analysis to estimate the emissions resulting from transport of these materials from our plants to the 'gate' of the next process.

Longmont Sausage sells two sizes of sow hides, and tracks the total amount of sales for each in pounds. The emission factor for hide processing is denominated in square meters. So we need to convert from pounds to square meters as such…

$$m^2 = (Total\ pounds\ hides) \times \frac{m^2}{hide}$$

… before applying the emission factor referenced above.

Scope	Category	Activity	Location	Amount	Unit	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2e Factor	CO_2 emitted (MT)	CH_4 emitted (MT)	N_2O emitted (MT)	CO_2e
Scope 3.10	Processing of sold products	Hides	All manufacturing	1,877,579	square meters				9.7				23,149
Scope 3.10	Processing of sold products	Render	All manufacturing	143,628,686	pounds				0.07183				4,532
Scope 3.10	Mobile combustion	Outbound hides and render	All manufacturing	3,532,698	ton-miles	0.052632				462			462
Scope 3.10	Mobile combustion	Outbound hides and render	All manufacturing	407,811	truck-miles		0.01	0.043			0.004	0.019	6
Scope 3.10													28,149

Alternative Calculation Methods, Notes, and Exceptions: Categorizing Render and Hide Processing as FLAG

It is not clear to us whether these specific activities fall under the umbrella of FLAG. This is too small a question to be addressed in any of the general guidance documents, so it's a situation where our judgment must suffice: we believe these activities belong under our FLAG emissions totals, and have categorized them as such.

Scope 3.11: Use of sold products

GHG Protocol Guidance: Description and boundaries for **Use of sold products**

Category definition

End use of goods and services sold by the reporting company in the reporting year

Minimum boundary

The direct use-phase emissions of sold products over their expected lifetime (*i.e.*, the Scope 1 and Scope 2 emissions of end users that occur from the use of: products that directly consume energy (fuels or electricity) during use; fuels and feedstocks; and GHGs and products that contain or form GHGs that are emitted during use)

It can be tempting to dismiss emissions resulting from the end use of products; *cooking* meat at home may seem like an insignificant activity when considered in the context of all the other activities detailed above. But given Longmont's roughly 50-50 split between fresh and fully-cooked sausage, and the fact that natural gas purchases contribute ~25k MT of CO_2e Scope 1 emissions through their use in relatively efficient industrial ovens, one should be wary of this temptation.

There is no authoritative resource that gives us an emission factor for cooking sausage (or any kind of meat) at home. We know that cooking at home must be less efficient, so the value reported above (equivalent to about 0.5 kg CO_2e / kg pork) will serve as a lower bound for our estimate.

1. Frankowska et al suggest that the cooking phase makes up 25% of all emissions associated with eating pork, or 3.45 kg CO_2e / kg pork. Their study did not consider emissions from cooking food on a grill, rather, provides a weighted-average emission factor for pork cooked indoors.

2. Johnson did a study that concentrated specifically on cooking meat on a grill. He found that charcoal grills emit 2.16 kg CO_2e / kg meat, while LP grills emit 1.03 kg CO_2e / kg meat

3. In a follow-up study with different methods, Johnson switches the order of efficiency for charcoal (1.4 kg CO_2e / kg meat) and LP (1.95 kg CO_2e / kg meat) grills.

All together, the best estimate currently available to us for the emissions associated with the Use of Sold Products is as follows:

Environmental Footprint of Leather Processing Technologies, Journal of Industrial Ecology, 2016; https://doi.org/10.1111/jiec.12504
2. *Personal communication*
3. *EPA Emission Factor Hub Table 2: Mobile Combustion CO_2 (Diesel Fuel)*

22-24 square feet per hide, proprietary communication

Frankowska et al, Impacts of home cooking methods and appliances on the GHG emissions of food

Johnson, Charcoal versus LPG grilling: A carbon-footprint comparison

USA carbon footprints of grills, by fuel & grill type, 2022-27

Here we assume that 2/3 of products are cooked indoors, with the remainder being grilled, with grill type split evenly betweeen charcoal and LP (source: proprietary in-home use study).

Scope	Category	Activity	Location	Amount	Unit	CO_2e Factor	CO_2e
Scope 3.11	Use of sold products	Cooking (indoors)	All manufacturing	27,860	Tonnes	3.45	96,119
Scope 3.11	Use of sold products	Cooking (charcoal grill)	All manufacturing	6,320	Tonnes	1.78	11,250
Scope 3.11	Use of sold products	Cooking (LP grill)	All manufacturing	6,320	Tonnes	1.49	9,417
Scope 3.11	Use of sold products						116,786

This implies that our industrial ovens are ~4.6 times more efficient, from a strict emissions perspective, than the weighted-average home cooking method. This seems within the range of what we might expect, so we'll proceed with these estimates.

> Alternative Calculation Methods, Notes, and Exceptions: Estimating emissions from cooking meat
>
> First a caveat; then a suggestion.
>
> **The caveat:** We proceed with these estimates because they are the best available, though they lack the sort of rigor and broad applicability one would hope for. Importantly, however imprecise the estimates are, the year-over-year changes that come from changes in total product sold will be an actionable reflection of how emissions are evolving.
>
> **The suggestion:** The SBTi has planned for this eventuality. Emissions inventories are always subject to refinements and improvements, but that shouldn't stop us from going forward with *best available estimates*, so long as they conform to GHG Protocol guidelines.
>
> In this case, once better estimates for Scope 3.11 are available, if the impact of better estimates comes to 5% of total Scope 3 emissions, we can go back and restate our base year emissions and recalculate our emissions reductions commitment. We will keep on the lookout for more directly-applicable emission factors and restate our emissions estimates, as necessary, in future years.

Scope 3.13-15: Downstream leased assets, Franchises, and Investments

Longmont Sausage has no activities that fall within these categories in the base year.

Scope 3 Totals

Scope	CO2e
Scope 3.1	3,289
Scope 3.1 - FLAG (commodity)	477,625
Scope 3.1 - FLAG (non-commodity)	119,824
Scope 3.2	58,713
Scope 3.3	41,454
Scope 3.4	8,970
Scope 3.5	2,789
Scope 3.6	313
Scope 3.7	2,227
Scope 3.9	20,500
Scope 3.10 - FLAG (non-commodity)	28,149
Scope 3.11	116,786
Scope 3.12	18,931
Scope 3 - non-FLAG	273,972
Scope 3 - FLAG (commodity)	477,625
Scope 3 - FLAG (non-commodity)	147,973

Next Steps in Setting Science Based Targets

A detailed discussion of the target-setting and submission process is beyond the scope of this case study. Specific choices regarding base year, target year, level and timing of commitment, and calculation approach are *policy decisions* rather than technical puzzles to solve, and such policy decisions will include consideration of company-specific factors. However, an overview of the target-setting and submission process follows.

Non-FLAG target setting

The target-setting tools provided by SBTi are quite simple and intuitive. Only the Scope 1 and Scope 2 totals, and Scope 3 non-FLAG totals, are required for the near-term target setting tool. These values are highlighted in green, below:

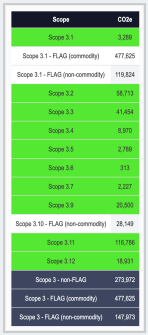
SBTi target setting tool

Scope	Category	CO2e
Scope 1	Fugitive emissions	52,867
Scope 1	Mobile combustion	12,458
Scope 1	Stationary combustion	28,421
Scope 1		93,746

Scope	Category	CO2e
Scope 2	Purchased electricity - Location based	70,204
Scope 2	Purchased electricity - Market based	70,001
Scope 2	Both values are reported	

Scope	CO2e
Scope 3.1	3,289
Scope 3.1 - FLAG (commodity)	477,625
Scope 3.1 - FLAG (non-commodity)	119,824
Scope 3.2	58,713
Scope 3.3	41,454
Scope 3.4	8,970
Scope 3.5	2,789
Scope 3.6	313
Scope 3.7	2,227
Scope 3.9	20,500
Scope 3.10 - FLAG (non-commodity)	28,149
Scope 3.11	116,786
Scope 3.12	18,931
Scope 3 - non-FLAG	273,972
Scope 3 - FLAG (commodity)	477,625
Scope 3 - FLAG (non-commodity)	147,973

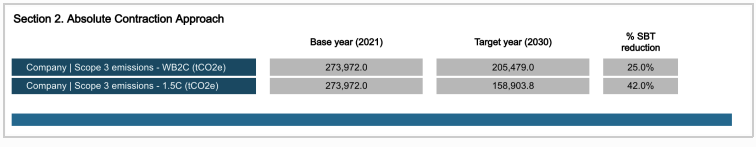
Companies may make commitments for any combination of Scope 3 sub-categories (provided they can justify the choice upon submission). In this case, rather than needing just the non-FLAG Scope 3 total, a company may input results from specific sub-category calculations, again highlighted in green below:



The trajectory of emissions from these sources that make up the actual SBTi commitment will depend on choices about base year, commitment length, and contraction approach. For Longmont Sausage, with a base year of 2021, target year of 2030, and using the Absolute Contraction approach, Scope 1 and 2 emissions will need to match this trajectory and will achieve a 42% reduction in absolute emissions:

SBTi FLAG target setting tool

With the timing and calculation approach assumptions, the non-FLAG Scope 3 calculation output looks like this (no charts are produced for the Absolute Contraction approach):



FLAG target setting

The FLAG tool is somewhat more complicated than the legacy 'SBTi Target Setting Tool' but still intuitive and quite helpful. For those activities that are in one of the nine named commodities for which we can use the tool's default emission factors, all we need is total weight of purchase. For meat, total weight must be expressed in carcass weight (that is, bone-in) equivalents.

These values are highlighted in orange:

Scope	Category	Activity	Location	Amount	Unit
Scope 3.1	Purchased meat	Pork	All manufacturing	86,757	MT Carcass equiv.
Scope 3.1	Purchased meat	Beef	All manufacturing	2,308	MT Carcass equiv.
Scope 3.1	Purchased meat	Poultry	All manufacturing	4,349	MT Carcass equiv.
Scope 3.1	Purchased meat				

The FLAG tool also has non-commodity FLAG emissions as a required input.

Scope	CO2e
Scope 3.1	3,289
Scope 3.1 - FLAG (commodity)	477,625
Scope 3.1 - FLAG (non-commodity)	119,824
Scope 3.2	58,713
Scope 3.3	41,454
Scope 3.4	8,970
Scope 3.5	2,789
Scope 3.6	313
Scope 3.7	2,227
Scope 3.9	20,500
Scope 3.10 - FLAG (non-commodity)	28,149
Scope 3.11	116,786
Scope 3.12	18,931
Scope 3 - non-FLAG	273,972
Scope 3 - FLAG (commodity)	477,625
Scope 3 - FLAG (non-commodity)	147,973

The output of the FLAG target tool looks something like this (again, subject to certain decisions and parameters beyond the scope of this discussion):

TOTAL FLAG SBT SUMMARY

	FLAG Base Year	FLAG Target Year	FLAG Base Year Absolute Emissions (t CO2e)	FLAG Target Year Absolute Emissions (t CO2e)	Absolute Abatement (t CO2e)	Total Abatement %	Emissions Reduction %	Removals %
Commodities	2021	2030	529,050	370,522	158,528	30%	23%	7%
Rest of Sector	2021	2030	147,000	102,449	44,551	30%	19%	11%
All	**2021**	**2030**	**676,050**	**472,972**	**203,078**	**30%**	**22%**	**8%**

Target submission form(s)

Once these tools have been used and targets have been calculated, we can move on to actual submission of our targets. As noted above, a detailed discussion of this process is outside the scope of this document. We can, however, outline the kinds of information required to complete the submission forms.

The SBTi Near-Term Target Submission Form and Guidance requires information in four general categories:

1. **General Information:** Identify the company, describe the business, declare any potential conflicts of interest (such as payments to SBTi for technical assistance)
2. **GHG Inventory:**
   - General questions: Verify that GHG Protocol guidance was followed, and describe emissions-producing activities, calculation approach, and exclusions (if any)
   - GHG inventory: Scope 1, 2 (market- and location-based), and 3 emissions, with Scope 3 emissions broken out by sub-category, for Base Year and Most recent year.
3. **Target Information:** Required emissions reduction targets taken from the target-setting tools, any other types of targets the applicant wants to include, as well as descriptions about how these targets are expected to be achieved.
4. **Progress Reporting:** Confirmation that the company will annually report progress towards these commitments.

The Forest, Land, and Agriculture annex requires the same sort of information, but restricted to FLAG-only activities:

1. **General Information:** Policy and calculation approach questions, and confirmation of No Deforestation commitment where applicable
2. **FLAG GHG Additional Inventory Data:** Output from target-setting tool, plus volumes (for intensity calculations) and references.

Particularly while using the FLAG target-setting tool, the first version of which was released in 2023, we caution the reader to exercise their own judgment and to stay alert for guidance changes and tool updates. The tool is well-constructed but we should expect any first generation tool to be updated for some reason or another.

SBTi target submission form

SBTi FLAG target submission form

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