Insights Engine

IMPACT CALCULATOR METHODOLOGY

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This Technical Appendix describes the methodology used to quantify the greenhouse gas emissions reduction, water savings, and donated meal recovery potential of different food surplus management scenarios in the U.S. by sector and food type. This methodology is used to quantify results in the Impact Calculator, as well as the Food Waste Monitor and Solutions Database tools in the ReFED Insights Engine online platform.

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Acknowledgements

JUNIATA ANALYTICS

Juniata Analytics is a tech start-up working at the intersection of business, sustainability, and software to help organizations calculate, analyze, and share sustainability information across internal operations and supply chains. Juniata was responsible for crafting the initial vision for the ReFED Insights Engine, managing the project and coordinating contractors, developing the methodologies, collecting and processing data, and developing a web application to automate the data modeling.

QUANTIS

Quantis is a sustainability consulting group that guides top organizations to define, shape and implement intelligent environmental sustainability solutions. They employ internationally renowned experts in life cycle assessment and sustainability quantification. Quantis was commissioned in 2021 to support the development of Greenhouse Gas emissions factors of food loss and waste specific to supply chain stage, product type, and end destination. Quantis was commissioned again in 2024 to provide updated emissions factors that differentiate methane emissions from other greenhouse gases, as part of a grant to ReFED from the Global Methane Hub.

KOR Consulting

Kai Robertson is an independent Senior Corporate Sustainability Advisor who actively researches, writes, and provides advice about sustainability issues that affect the food industry. Kai is a globally-recognized expert on addressing food loss and waste in particular, and provided fundamental advisory on the development and implementation of the Quantis methodology.

Overview

In 2016, ReFED launched its landmark *Roadmap to Reduce U.S. Food Waste by 20%*. That initial report became a touchstone for those in the food waste space, but there was a growing need for more – and more granular — data about the issue to fill in knowledge gaps and move the food system from awareness about the issue to insight-driven action. The ReFED Insights Engine was launched in 2021 as the next generation of data, insights, and guidance on U.S. food waste. This online data and solutions hub for food loss and waste is designed to provide the information and insights needed to take meaningful action. Informed decision making is needed to achieve national and international goals of reducing food waste by 50 percent by 2030. With that in mind, ReFED is committed to keeping the platform updated and actionable through continuous improvement, maintaining sources and models that draw on the latest data available and providing novel views and insights.

Impact Calculator

The Impact Calculator quantifies greenhouse gas emissions reduction, water savings, and donated meal recovery potential of different food surplus management scenarios in the U.S. by sector and food type. The ReFED team designed the tool to fill key needs and data gaps not covered by existing tools in the market, based on input from our network of industry professionals (from businesses, capital providers, government, nonprofits, and academia). The 2021 launch featured the following thematic advantages provided by this tool and its features:

New and More Granular Information

- More destinations: The Impact Calculator was designed to analyze twelve destinations of surplus food including the EPA WARM[1] destinations as well as donations, animal feed, industrial uses, not harvested, land application, incineration, sewer, and dumping.
- Sector-specific GHG data: Impact factors vary greatly depending on where in the supply chain the surplus happens because greenhouse gas emissions accrue from stage to stage. The Impact Calculator uses sector-specific GHG factors developed by Quantis.
- More food types: The Impact Calculator was designed to cover all food types and includes nine comprehensive categories: Breads & Bakery, Dairy & Eggs, Dry Goods, Fresh Meat & Seafood, Frozen, Prepared Foods, Produce, Ready-to-drink Beverages, and “Standard Mix”. The “Standard Mix” option was created for cases when the exact food type makeup is unknown by the user - factors represent the typical food type makeup of surplus food in each sector using the waste characterization output of ReFED’s Food Waste Monitor[2].

Interactivity and Automation

- User-friendly online format: Rather than requiring users to download Excel-based tools or more technical Life Cycle Assessment (LCA) software formats, the Impact Calculator allows users to easily input information via web application and view results in seconds.

Transparency

- Open source data: Raw data and documentation is now made publicly available as much as legally possible. Confidential data is only used in cases where it yielded significant advantages over publicly available data.

Methodology

Greenhouse Gas (GHG) Footprint

Quantis developed emissions factors at the food item-level, for a suite of food items intended to represent the mix of food consumed in the U.S. The methodology used to develop those factors is described in a separate document.

From those factors, the ReFED team assigned category-level proxies (e.g., Quantis GHG factors for Strawberries were assigned as a proxy for Blueberries, Raspberries, etc., and GHG factors for Apples were assigned as a proxy for Apples, Pears, etc.) and those proxy assignments were then used to develop a weighted average emissions factor for the food department based on all items within a department. This results in an emissions factor for each sector-food type and each food type-destination, since GHG emissions are separated into two parts:

1. **Upstream GHG emissions** include emissions accrued throughout the supply chain to produce, store, and transport food up until the point of reference (e.g., Upstream emissions for grocery Retail include emissions for storage at the grocery store as well as emissions from upstream sectors including Farm, Manufacturing, etc., but they do not include Residential emissions).
2. **Downstream GHG emissions** include emissions associated with food disposal or redistribution to any destination in which the food is not ultimately eaten by people. For some destinations this number may be negative, indicating an emissions offset or reduction in emissions.

Department-level emissions factors are available for download from the Impact Calculator page of the Insights Engine. In addition to the weighted-averaging described above, users should be aware of the following modeling decisions:

- For simplicity, Quantis modeled “fresh” products such as apples, tomatoes, eggs, and seafood without any supply chain activities related to “processing” or manufacturing. However, ReFED believes most of these products still require packing, packaging, and transportation to the point of sale, so we have added emissions associated with those activities to the factors for those items.

- Prevention was not a destination included in the Quantis modeling. There is limited data on the upstream or system-wide effects of preventing food from going to waste, so prevention is modeled simply as a complete (100%) offset of production and supply chain activities. The idea is that keeping food in the human supply chain ultimately reduces demand for additional production of that food. Users will see that the emissions factors for Prevention are coded for simplicity as 0 upstream and 0 downstream.

- Somewhat similarly, food donation is modeled as leading to some production offsets - although we intuitively know that the food provided by rescue organizations is largely additional to the supply of food provided to those in need (i.e. would not otherwise be purchased) . Also, while donation operations vary significantly by organization size, scope,

and geography, a quick survey of food rescue organizations in ReFED's network indicated an average of 6.5% of food handled by rescue organizations still ending up as waste. The "upstream" component of emissions from donation there includes the standard upstream component that is specific to the sector generating the food surplus, then subtracts 6.5% of that upstream factor and an additional 20% of the upstream factor to account for inelastic demand for donated food. In addition, the survey indicated average transport distances for collection and distribution, which are included as the "downstream" impacts of donation.

- Two pathways for rendering were provided by Quantis, one for pet food and one for biodiesel production. Since the biodiesel pathway is only relevant for fats, oils, and grease (FOG), a single "rendering"/Industrial Uses destination is modeled by ReFED, where the emissions factors for olive oil and other FOG are pulled from the biodiesel model, but all other food items pull emissions factors from the pet food model.

- Two archetypes for landfill were also provided by Quantis, one following the "EPA Typical" gas collection schedule and one following the "NSPS minimum" gas collection schedule - in which gas collection begins several years later. Based on increasing evidence that landfill methane emissions are being underreported, ReFED's landfill emissions factors pull from the NSPS Minimum scenario and therefore represent a more conservative (less optimistic) view of how much landfill gas is being captured. That being said, some partners argue that even the gas collection efficiencies used in the NSPS Minimum scenario are overly optimistic.

- Sewer/wastewater treatment is an area of active ongoing research, although recent reports indicate that methane emissions from these systems are greatly underestimated. Quantis modeling draws from a single study that did not distinguish between food waste and other organic inputs to sewer as sources of methane, so further work in this area may reveal more specific attributions of the overall methane produced from each type of organic matter.

- For many of the destinations modeled, the emissions offsets (or benefits) from avoided conventional production of energy, fertilizer, etc are included. Users should be aware that actual realization of these benefits is highly dependent on whether implementation on the ground aligns with practices included in the model (i.e. digestate from anaerobic digestion is applied to soil and offsets the need for synthetic fertilizer to be produced and applied).

Inclusion of Methane

The main purpose of updating the emissions factors in 2024 was to highlight the emissions attributable to methane. This emphasis was driven and supported by a grant from the Global Methane Hub, whose work focuses on catalyzing rapid systemic reductions in methane emissions in the energy, agriculture, and waste sectors. Food loss and waste is a significant contributor to methane emissions and touches all 3 source sectors, so the goal of this project was to highlight the waste hotspots and key solutions that can help reduce U.S. methane.

Previously, GHG footprint values were reported in carbon dioxide equivalents, or CO_2e. This is a way of reporting that standardizes the warming potential of carbon dioxide, methane, and nitrous oxide into a single measure, using carbon dioxide as the reference gas. ReFED emissions factors have therefore always included methane emissions, but we now provide a separate methane emissions

factor that enables users to focus on methane reduction. Throughout the model, methane is calculated in metric tons of methane, and users of the Impact Calculator can select whether to convert to CO_2e on a 100-year or 20-year time horizon. Since methane only persists in the atmosphere for about 12 years, the 20-year conversion more accurately portrays the warming effect that can be expected from an emission of methane. The 20-year Global Warming Potential (GWP) for methane is ~80, whereas on a 100-year time horizon the GWP is ~28, which conveys the urgency of addressing methane emissions in the near-term.

Water Footprint

ReFED developed water footprint factors for each ReFED food department. These food department factors are weighted averages of water factors developed by the Water Footprint Network (WFN)[3,4,5] that were assigned as category-level proxies (e.g., The water footprint for wheat bread from WFN was assigned as a proxy for Bagels and then used to develop a sales weighted average for the Breads & Bakery food type). In cases where there was no suitable WFN proxy available for a particular food category, the category was excluded from the weighted average. USDA crop production data[6] was used to create the weighted averages for the Farm sector and retail sales data from Nielsen IQ[7] was used to create the weighted averages for all other sectors. A "Standard Mix" water factor, representing all food types, was also calculated for each sector. These factors are useful for businesses in cases where their waste data may not be broken down into multiple food types.

The WFN factors used are specific to the United States. ReFED chose to use WFN's blue water footprint factors, which only include water withdrawals from ground and surface reservoirs. With additional research, future iterations of this work could take a more robust approach similar to the previous section on Greenhouse Gas Emissions so that the total water factor numbers are broken down by sector and destination.

Understanding the Tool

The Impact Calculator is a scenario planner. It helps users calculate the emissions associated with their current or status quo food surplus management system, and by adding an "alternative scenario", the emissions associated with implementing solutions. Then, by calculating the difference between the two scenarios, the user is provided with the "net benefit" or impact savings from implementing the solutions that lead to an alternative scenario.

Users should select the sector from which the food surplus is generated, the food department the surplus belongs to, and the appropriate units of measurement. Then input the volume of food being sent to each destination - the Impact Results will automatically populate.

Total Greenhouse Gas Footprint Definition:
The amount of greenhouse gas emissions that ReFED estimates would result from a given food surplus management scenario. Reported in CO_2e, so this includes methane emissions.

Methane Footprint Definition:
The amount of methane emissions that ReFED estimates would result from a given food surplus management scenario. Reported in metric tons of methane and converted to CO_2e using the time horizon selected by the user.

Water Footprint Definition:
The amount of water required to produce the amount of food entered by the user in each scenario.

Meals Recovered Definition:
The estimated amount of donated meals that would result from a given food surplus donations scenario, where 1 meal = 1.2 lbs[8].

Footprint Equations:
Total GHG Footprint = Sum of Tons Surplus Sent to Each Destination * (Upstream MTCO2e per ton + Downstream MTCO2e per ton for Each Destination)
Methane Footprint = Sum of Tons Surplus Sent to Each Destination * (Upstream $MTCH_4$ per ton + Downstream $MTCH_4$ per ton for Each Destination)
Water Footprint = Sum of Tons Surplus Sent to any Destination other than Donations * (Upstream Gallons Water Use per Ton)

Equation for Net Benefit of Alternative Scenario:
Net Benefit = Current Scenario - Alternative Scenario

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