SITKA COMMUNITY RENEWABLE ENERGY STRATEGY
A City and Borough of Sitka Project

GREENHOUSE GAS EMISSIONS INVENTORY

DRAFT

Public comment is open until January 25th, 2026

Email comments to sustainability@cityofsitka.org

For questions or assistance, please call (907) 747-1856

2023
ENERGY BASELINE

Greenhouse Gas Emissions Inventory Guiding Questions:

If you want to leave public comment but don't know where to start, here are some prompting questions to help get you thinking:

Is the document clear and easy to understand?

Are there areas you want more information or clarity?

Are the assumptions used to calculate emissions easy to understand?

Are there any categories/sources of emissions that are missing?

What is the most useful piece of information in the GHG emissions inventory to you?

What would make this document more useful for you?

Public Comment on Sitka's Greenhouse Gas Emissions Inventory is open until January 25th, 2026.

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SCRES

SITKA COMMUNITY RENEWABLE ENERGY STRATEGY

A City and Borough of Sitka Project

City and Borough of Sitka

Sheet'ka

December 2, 1971

CITY AND BOROUGH OF SITKA

Mission: *To provide public services for Sitka that support a livable community for all.*

ACKNOWLEDGEMENTS

Andrea Mott, Ali Trueworthy, and Molly Grear, of the Pacific Northwest National Laboratory (PNNL), provided research and methodology to support Sitka's requests

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Thank you, previous members

THANK YOU TO ALL COMMUNITY MEMBERS WHO CONTRIBUTED INFORMATION & FEEDBACK

A special thank you to those who contributed detailed information for specific emission sources

Sitka Tribe of Alaska
Public Transportation

Sitka Dock Company, LLC.
Tourism-Related Ground Transportation

Sitka Rocky Gutierrez Airport
Air Travel

Alaska Longline Fishermen's Association
Kempy Energetics
Alaska Department of Fish and Game: Sitka Area Management Division of Sport Fish
Marine Activity

PHOTO CREDITS

Josh Houston, Lee House, Brittany Falch

RECOMMENDED CITATION

2023 Sitka Greenhouse Gas Emissions Inventory. City and Borough of Sitka, 2026.

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FIGURES, GRAPHS, AND VISUALIZATIONS

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TABLES

ACRONYMS AND ABBREVIATIONS

AIS	Automatic identification system
AK	Alaska
AR6	6th assessment report by the IPCC
ATV	All-terrain vehicle
Avg	Average
BEV	Battery electric vehicle
CBS	City and Borough of Sitka
CFC	Chlorofluorocarbon
CH_4	Methane
CO_2	Carbon dioxide
DHW	Domestic hot water
DMV	Department of Motor Vehicles
DOT	U.S. Department of Transportation
EIA	Energy Information Administration
ETIPP	Energy Technology Innovation Partnership Project
EV	Electric vehicle (BEV and PHEV)
FAA	Federal Aviation Administration
FHA	Federal Highway Administration
GHG	Greenhouse gas
GVWR	Gross vehicle weight rating
GWP	Global warming potential
HCFC	Hydrochlorofluorocarbon
IPCC	Intergovernmental Panel on Climate Change
HCH	Harrigan Centennial Hall
MSW	Municipal solid waste
NHTSA	National Highway Traffic Safety Administration
N_2O	Nitrous oxide
PFC	Perfluorocarbon
PHEV	Plug-in hybrid electric vehicle
PNNL	Pacific Northwest National Laboratory
STA	Sitka Tribe of Alaska
SUV	Sport utility vehicle
USACE	U.S. Army Corps of Engineers
VEAT	Vessel Energy Analysis Tool
VIN	Vehicle identification number
vPIC	NHTSA's VIN decoder program
WA	Washington State

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UNITS OF MEASUREMENT AND SYMBOLS

Numerical Abbreviations

k	1,000, one thousand
M	1,000,000, one million
~	Approximately
> #	Greater than
< #	Less than
≥ #	Greater than or equal to
≤ #	Less than or equal to

Emissions

$MTCO_2e$	Metric ton of Carbon dioxide equivalent
GWP	Global warming potential

These units use CO_2 to compare other gases. See details on page 4.

Building Heating

Btu	British thermal unit, measures energy used for heat
MMBtu	1,000,000 Btu*
sf	Square-foot, measures floor space
° F	Degrees in Fahrenheit, measures temperature

*unlike other units, Btu use different abbreviation prefixes; Mbtu = 1,000 Btu

Ground Transportation

AADT	Annual average daily traffic, measures traffic volume. Represents the number of vehicles that cross a certain point in either direction each day, over the course of one year.

Cruise Ships

MCR	Maximum continuous rating, measures how much a cruise ship engine is running and is reported as a percentage.

Weight, Volume and Distance

g	Gram
kg	Kilogram, 1,000 g | 2.2 lb
MT	Metric ton, 1,000 kg
lb	U.S. pound | 0.45 kg
ton	U.S. short ton | 2,000 lb | 0.9 MT
gal	U.S. gallon
mi	U.S. mile

Electricity

kW	kilowatt
MW	Megawatt, 1,000 kW
GW	Gigawatt, 1,000 MW
-Wh	Watt-hour, kWh, MWh, GWh

Watts measure electrical power while watt-hours measure electricity that was used. Think of it as the diameter of a water pipe (W), vs how much water ends up in a bucket (Wh).

Air Travel

RPM	Revenue passenger miles, measures air traffic volume. Represents the number *occupied* seats and the miles they travel. For example, a plane with 100 passengers that travels 500 miles generates 50,000 RPM. RPM are reported in thousands. 1 RPM = 1,000 mi
ASM	Available seat miles, measures the *total number of seats* available and the miles they travel, like RPM. Dividing the RPM by the ASM tells you how full a route was. For example, if a plane with 100 seats with only 60 passengers travels 500 miles, it produces 50,000 ASM and 30,000 RPM. That means the flight was 60% full.

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The Blue Lake dam

IN 2023, SITKA PRODUCED

128,675 $MTCO_2e$

Metric Tons of Carbon Dioxide Equivalent

ELECTRICITY

0.1%

Scope 1

27%

33,275 $MTCO_2e$

EMITTED DIRECTLY

Scope 3

73%

95,399 $MTCO_2e$

EMITTED INDIRECTLY

HYDROELECTRICITY REDUCED SITKA'S EMISSIONS BY ↓46%

~110,000 $MTCO_2e$ from ~11M gallons of diesel

TRANSPORTATION

51%

Air Freight/ Mail	**34%**
Barge	1%
Air Travel	**9%**
Vehicles	4%
Rec & Charter Boats	3%

BUILDINGS

8%

Residential	**7%**
Commercial	1%

INDUSTRY

38%

Cruise Ships	**26%**
Commercial Fishing	12%

WASTE

3%

Municipal Solid Waste	3%
Wastewater	0.01%

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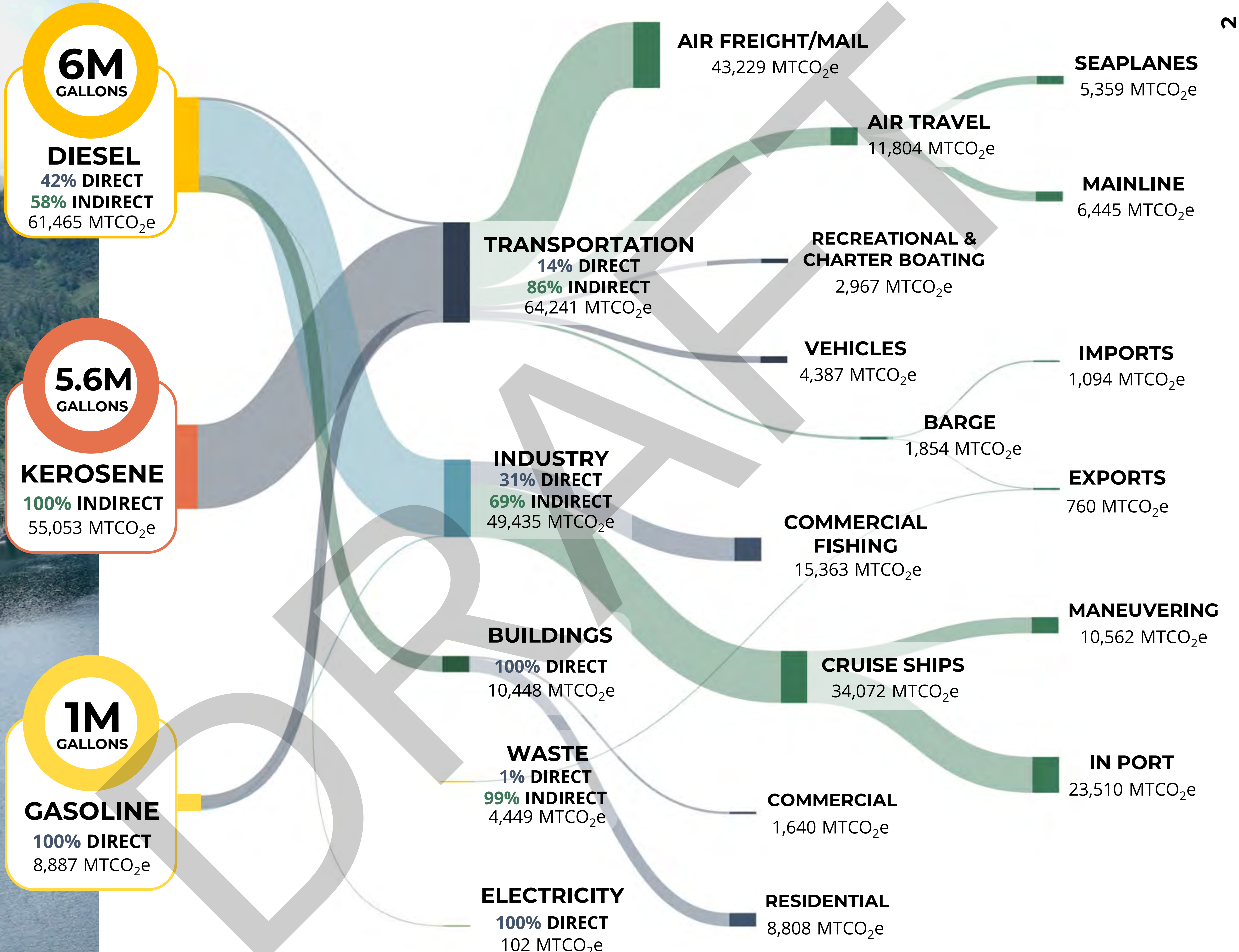
EXECUTIVE SUMMARY

EMISSION SOURCE END USES



Numbers are rounded and may not add up exactly.

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The backside of the Blue Lake dam

SECTION 1

INTRODUCTION TO GREENHOUSE GAS EMISSION INVENTORIES

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INTRODUCTION TO GHG EMISSION INVENTORIES

What are Greenhouse Gases?

Solar radiation from the sun warms the Earth's surface, which in turn releases heat back into the atmosphere. Some of that heat leaves the atmosphere and dissipates into space, but some is absorbed and re-emitted by certain gases in the atmosphere, trapping the heat in the atmosphere. This is known as the *greenhouse effect*[1] *(Figure 1)*.

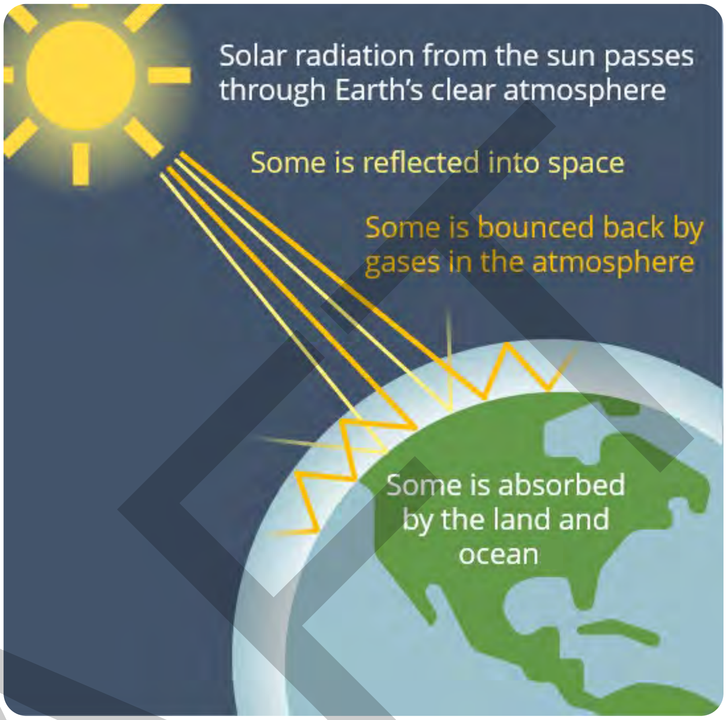
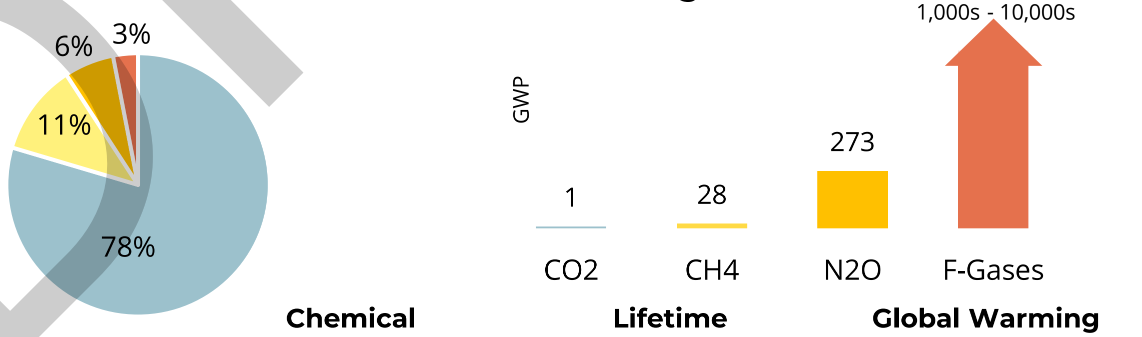


Figure 1: The Greenhouse Gas Effect. Increased GHGs means less heat from the sun escapes the atmosphere.

Greenhouse gases (GHG) are gases that contribute to this heat trapping effect. Many of these gases occur naturally in the atmosphere; however human activities that emit GHGs are responsible for increases in concentrations. This phenomenon is known as *global warming,* which plays a significant role in broader climate changes caused by human activities that rely on fossil fuels.

Not all GHGs are the same. Some GHGs are more effective at trapping heat. GHGs can remain in the atmosphere for different lengths of time, from just a few years to thousands of years. Global Warming Potential (GWP) is used to compare GHGs heat trapping capabilities compared to one ton of CO_2 over 100 years[2].

Global Emissions and Global Warming Potential



GHG	Chemical Abbreviations	Lifetime in the Atmosphere	Global Warming Potential (GWP)
Carbon dioxide	CO_2	1,000s of years	1
Methane	CH_4	10 years	28
Nitrous Oxide	N_2O	~300 years	273
Fluorinated Gases (F-Gases)	CFCs, HCFCs, PFCs	1,000-10,000 years	1,000- 10,000+

Figure 2 and Table 1: How Greenhouse Gases Warm Our Planet. AR6 values, IPCC Sixth Assessment[2].

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What is a Greenhouse Gas Emissions Inventory?

Figure 3: Common sources of GHG emissions.

GHG emissions inventories consider human activities associated with GHG emissions and estimate the quantity of those emissions from those activities [3] (*Figure 3*). They are a tool to help communities understand where their energy comes from and where it goes. Greenhouse gas inventories can measure the amount of emissions released at any scale, like from a single home, operations of a business, an entire industry, or whole areas based on local, state, or national boundaries.

The amount of energy used and what it is used for is also known as an **energy baseline.** Since most human actives use energy from fossil fuel sources, a common way to estimate energy baselines is by measuring the amount of GHG emitted by human sources within a defined boundary over the course of a year. An example can be found below (*Figure 4*).

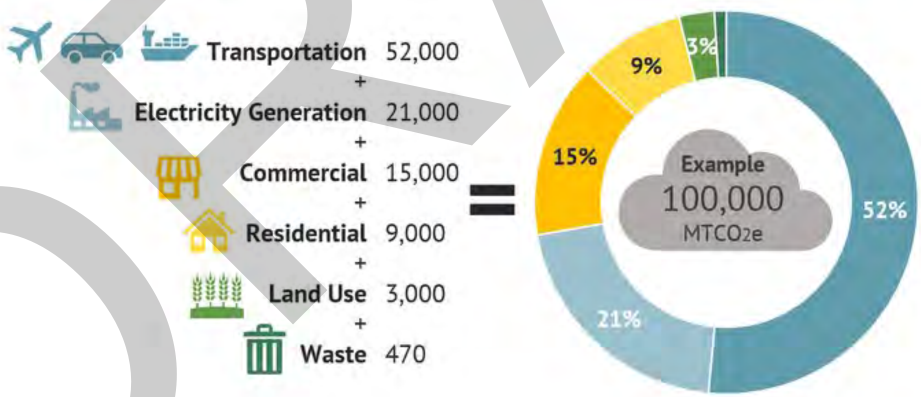

Figure 4: An example of a GHG emissions inventory.

Why do you Inventory Greenhouse Gas Emissions?

Currently, fossil fuels are necessary in our society. While non-fossil fuel sources of energy are becoming more available every day, everyone directly or indirectly requires fossil fuels for daily life. It is important to remember that GHG emission inventories are a snapshot in time and reflect the level of technology available and should inform strategies that enhance energy independence and reduce harm to people and the environment — keeping the focus on solutions, not fault-finding.

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GHG inventories serve as an energy baseline for a community and are essential for energy planning. They provide a comprehensive snapshot of local emissions, energy needs, and other information that can help individuals, organizations, and local government leaders prioritize actions and make informed decisions about their energy use. These inventories can be used to identify reduction targets and effective strategies for reducing emissions, they can also track increases and decreases in future emissions (*Figure 5*).

With a Greenhouse Gas Emissions Inventory, goals can be set and accomplished strategically.

Example Target Goal:

A community that emits 100,000 MTCO$_2$e every year wants to reduce their overall emissions by 50% by 2050.

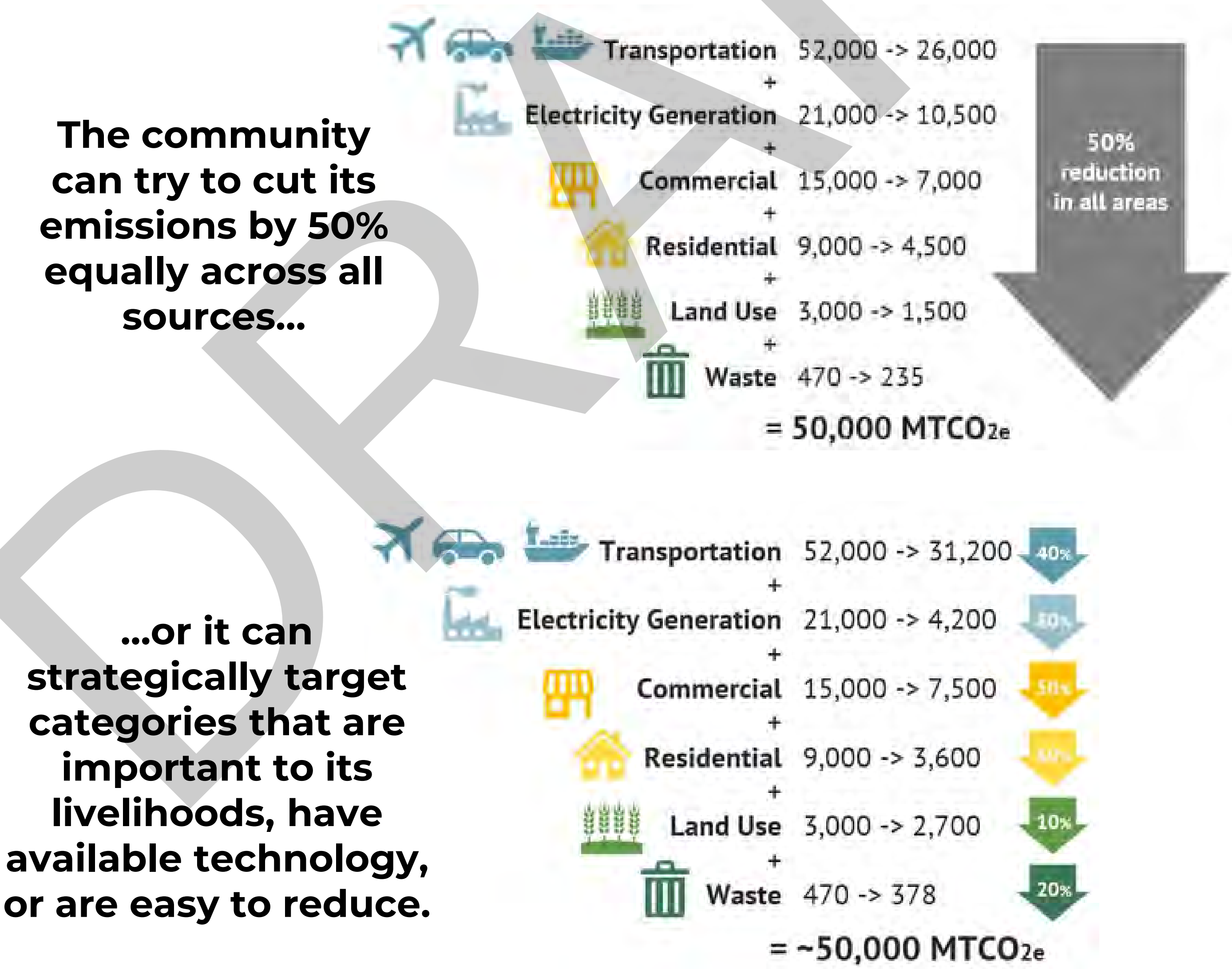

Figure 5: An example of how GHG emission inventories can be used to set strategic goals.

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THE GHG EMISSIONS INVENTORY PROCESS

Since GHG emission inventories are useful for all sorts of purposes. Standards exist to help inventories remain consistent and comparable. Generally, the process to create a GHG emissions inventory is conducted in the following phases and steps:

GHG EMISSION INVENTORY DEVELOPMENT PHASES

SCOPE AND PLAN

1. Define the purpose, boundaries, and timeframe
2. Choose methods and standards best suited for the purpose
3. Decide the Scope of what is and isn't included

COLLECT DATA AND QUANTIFY EMISSIONS

4. Collect information for emission Scopes
5. Create informed assumptions to fill data gaps
6. Calculate emissions using emission factors from chosen methods and standards
7. Validate estimates when possible.

REPORT, UPDATE, AND TRACK PROGRESS

8. Report emission findings
9. Use the inventory to set goals based on community wants and needs
10. Update with new information to improve assumptions and estimates
    - ➡ Track progress on community goals

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SCOPE AND PLAN

1. Define the Purpose, Boundaries, and Timeframe

The purpose of an inventory varies depending on the kind of organization requesting the inventory. Similarly, the boundary of an inventory can range from a single business or industry to a larger community, covering the emissions released by all human activities that occur within the boundaries of a city, town, or county. The team conducting the inventory selects a timeframe, typically a year. Since information necessary for the inventory might take time to be published, the chosen year is often a few years prior to when the inventory is conducted.

2. Choose Methods and Standards

The methodologies used and standards followed should be based on the purpose or specific activities in an inventory, availability of data, and consistency with a country's national inventory and/or other measurement and reporting programs. **The Greenhouse Gas Protocol for Cities** is the most widely used standard and guidance for governments, cities, and corporations for tracking emissions in their jurisdictions[3]. The protocol includes methodologies and formulas necessary calculate the total emissions of selected Scopes.

3. Decide the Scope

GHG emissions are commonly classified into three scopes, which are used to help categorize and track emissions *(Table 2).* **The GHG Protocol for Cities defines those Scopes as:**

Scope	DEFINITION	DIRECT/ INDIRECT
Scope 1 *BURN*	GHG emissions from sources located within the city boundary.	Direct
Scope 2 *BUY*	GHG emissions occurring due to the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary.	Indirect
Scope 3 *BEYOND*	All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary.	Indirect

Table 2: Definitions of Scopes for cities' GHG emissions, as defined by GHG Protocol for Cities with descriptions from the World Resource Institute[3].

Most community-wide inventories include Scopes 1 and 2, and may include some Scope 3 emissions, depending on the purpose of the inventory and data availability. Frequently, Scope 3 is omitted because there is not enough high-quality data that is readily available. Fortunately, the GHG Protocol allows reporting of GHG emissions in a variety of formats depending on the purpose and audience (*Figure 6*).

CATEGORIES OF GHG EMISSIONS

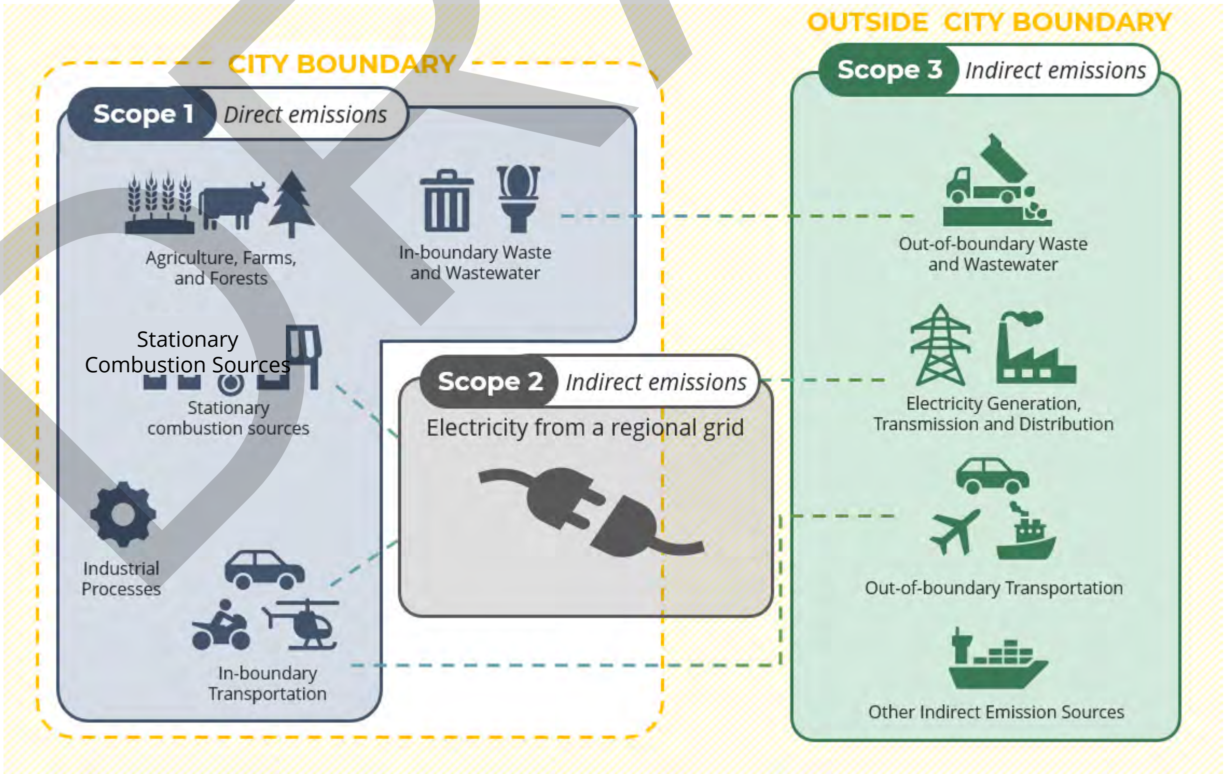

Figure 6: Visualization of the three Scopes of GHG emissions, based on Scope and whether they are emitted directly or indirectly. Adapted from the GHG for Cities Protocol[3].

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Scope 1 *BURN*

Also known as *direct* emissions, Scope 1 emissions include all GHG emissions from the heating and cooling of residential and non-residential building as well as transport of people and freight occurring within a city's boundaries. A shorthand for Scope 1 emissions is *burn*, because it includes things a community burns. **Scope 1 emissions can be broken down further into:**

Stationary combustion: Fuel, like oil and gas, burned in buildings or equipment in the community. Think boilers and other fuel-powered machinery that does not move and is used for industrial processes.

Mobile combustion: Fuel used for vehicles and mobile equipment like cars, trucks, and other gas-powered tools within a geographic boundary.

Fugitive emissions: Refrigeration chemicals released from air conditioning and fire suppression chemicals used in building fire suppression systems or equipment like fire extinguishers.

Scope 2 *BUY*

The shorthand to remember Scope 2 is *buy* because this scope includes emissions from the energy purchased to run things like heating, cooling, and home appliances. These are considered *indirect* emissions because in many communities, electricity is generated from fossil fuel sources, often outside the boundaries of a city and delivered via transmission powerlines. Scope 2 emissions are often one of the biggest emission sources for communities, which is why many strategies emphasize saving electricity or installing renewable generation sources.

Scope 3 *BEYOND/BENEFIT*

Scope 3 emissions are *indirect* emissions from activities that support a community but are not necessarily within a community's boundaries. That is why they are emissions *beyond* the control of a community but still *benefit* the community. Scope 3 emissions are the most challenging to find good data for calculations, are challenging to regulate, and are therefore often excluded in GHG emissions inventories. However, understanding Scope 3 emissions help community members make informed decisions about their daily lives. The extent of inclusion of Scope 3 emissions depends on the purpose of the inventory.

Scope 3 emissions can be further categorized into:

Upstream emissions come from moving a good or person to a place, or the emissions in creating a product.

Downstream emissions come from disposing of a product or moving people from a place.

COLLECT DATA AND QUANTIFY EMISSIONS

4. Collect Information

Information on energy use in the residential, commercial, and industrial sectors, as well as solid waste, water use and treatment, as well as transportation occurring within the defined boundary are collected from a variety of sources. However, in some cases, data is not available for all sectors. Depending on the scale and Scope needed, government agencies, researchers or other organizations work with a variety of local partners. Such partners may include local utilities, regional transit authorities, and local businesses to collect data to create estimates.

5. Create Informed Assumptions to Fill Data Gaps

Data gaps frequently occur in GHG emissions inventories, especially for larger-region inventories and Scope 3 emissions where data availability is less consistent or boundaries are less clear. In these cases, **assumptions**, or numbers derived from available information and research, are used to fill data gaps. Assumptions in GHG reports are common, especially for harder-to-track sectors, such as marine and air travel. Fortunately, GHG inventories are a living document and can be updated as new information or more accurate data becomes available. This inventory should be updated accordingly.

6. Calculate Emissions Using Emission Factors

Once all the information is gathered, the total emissions can be calculated based on either the quantity of fuel used in an area, estimated amount of activity, or a combination of both. Since not all fuels produce the same amount or kind of emissions and the fuel efficiency can vary from activity to activity, emission factors are used. **Emission factors,** or emissions per activity unit, are numbers published by the U.S. Environmental Protection Agency's (EPA) and can be found on the EPA GHG Factor Hub. These emissions factors may be occasionally updated as more scientific research is done.

7. Validate Estimations

Since almost all data sources and activity data have limitations, comparing multiple forms of data helps improve the accuracy of the inventory. By cross-referencing estimations with multiple sources, areas of improvement can be identified, further researched, and updated to better reflect reality. In many cases, data validation includes a combination of research and community input and requires back and forth collaboration to determine a reasonable level of accuracy. The accuracy of an estimate is indicated by a level of confidence (see page 24). Estimates with high confidence are considered very accurate while estimates with lower confidence may benefit from some updates which may or may not significantly change the estimate.

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REPORT, UPDATE, AND TRACK PROGRESS

8. Report Emissions Findings

Emissions are reported in *metric tons of carbon dioxide equivalent* ($MTCO_2e$), which is the standard unit for GHG emission reports. Since some GHGs are more effective at trapping heat and remain in the atmosphere for longer periods of time, the Intergovernmental Panel on Climate Change (IPCC), publishes conversions of all GHGs to the global warming potential of one metric ton of carbon dioxide (CO_2) over 100 years[2]. By converting all GHG to $MTCO_2e$, other GHGs like methane (CH_4), and nitrous oxide (N_2O) can be compared side-by-side (Figure 7). This also has the benefit of enabling comparison between emissions categories that emit different kinds gases either within the inventory or with other GHG emission inventories.

ONE METRIC TON OF CARBON DIOXIDE ($MTCO_2e$)
has the same global warming potential as:

1,000 kg of carbon dioxide[4]
about 113 gallons of gasoline

37 kg of methane[4]
about 9.5 residential trash cans (~1,600 lb.) of food waste

3.8 kg of nitrous oxide[5]
about 1 dairy cow over a year

Figure 7: Examples of one Metric Ton of Carbon dioxide equivalent.

9. Use the GHG Inventory to Set Goals

GHG emission inventories are a tool that provides a comprehensive snapshot where energy comes from and where it goes. Since a GHG emission inventory is a tool, it does not include recommendations for action. However, the information in the inventory can help individuals, organizations, and local government leaders prioritize actions and make informed decisions about their energy use. It can be used to identify reduction targets and effective strategies for reducing emissions and track increases and decreases in future emissions.

10. Update and Track Progress on Goals

GHG inventories are a living document and can be updated as new information or more accurate data becomes available. this inventory should be updated accordingly. Additionally, once goals are set, updating the inventory helps track progress on meeting those goals. The frequency of the updates typically ranges between every five to ten years and should be determined based on the kinds of goals set and when a community hopes to accomplish them.

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Backside of the Blue Lake Dam

Panorama of the Blue Lake Hydroelectric Project

SECTION 2

ABOUT SITKA'S GREENHOUSE GAS EMISSION INVENTORY

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SITKA COMMUNITY RENEWABLE ENERGY STRATEGY
A City and Borough of Sitka Project

ABOUT SITKA'S GHG INVENTORY

The purpose of this inventory is to **quantify GHG emissions for the entire community and serve as an energy baseline for Sitka.** It can be used for future energy planning efforts, goal identification, and progress tracking for emission reduction, improving energy independence, or simply better understanding how Sitka uses energy. As an energy baseline, this document does not make any policy recommendations.

Based on available data, the chosen **baseline year for Sitka's inventory is 2023**, though some data sources are from 2021 or 2022. While the best available information was used at the time of this report, amounts, figures, and statistics can be updated as new data become available.

Who Prepared Sitka's Greenhouse Gas Emissions Inventory?

Sitka's GHG emissions inventory was prepared as part of the City and Borough of Sitka's (CBS) Sitka Community Renewable Energy Strategy (SCRES) project, supported by the 2023 cohort of the Department of Energy's Energy Technology Innovation Partnership Project (ETIPP), focused on aiding remote and islanded communities that are interested in creating a more reliable, affordable, and efficient energy system. Through ETIPP, CBS partnered with the Pacific Northwest National Laboratory (PNNL). Throughout the process, PNNL was guided and advised by the CBS Sustainability Commission to ensure the inventory accurately reflected the unique needs of Sitka and that assumptions were based on local data that was as accurate as possible.

In this report, the term "Sitka" indicates the community at large, "CBS" indicates the local municipality which includes the municipally owned electric utility, and "Sitka Sustainability Commission" indicates the group of local community members appointed to a city board to advise CBS on matters of sustainability.

How Was Sitka's GHG Emissions Inventory Conducted?

Sitka's GHG emissions inventory was conducted iteratively over two years following the Greenhouse Gas Protocol for Cities with modifications to better capture the nuances of an islanded community like Sitka. Throughout the process, PNNL was guided and advised by the CBS Sustainability Commission and public comment to ensure the inventory accurately reflected the unique needs of Sitka and that assumptions were based on local data that was as accurate as possible (*Figure 8 and Table 3*).

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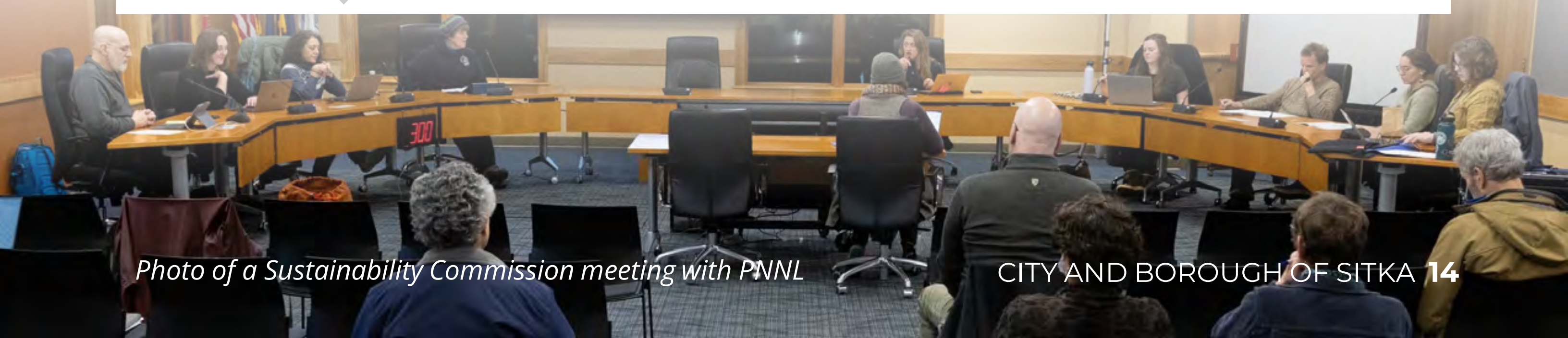

Photo of a Sustainability Commission meeting with PNNL

Sitka's GHG Inventory was Built Iteratively and Collaboratively

Pacific Northwest National Lab

- Provided guidance on standard practices for GHG emissions inventories
- Gathered information to determine timeframes and boundaries for requested emission sources
- Conducted research to draft assumptions for emissions with data gaps

Sustainability Commission

- Identified important emission sources to include
- Provided recommendations for local information sources to fill data gaps and improve assumptions
- Gave feedback on methods for calculating emission sources and assumptions
- Approved timeframes, boundaries, methods, and assumptions

Public

- Provided additional sources of information to improve assumptions
- Identified emission source assumptions for further refinement

Figure 8: The working relationship between PNNL, the Sustainability Commission, and the public.

Key Actions and Approvals

2023	Oct	Presented GHG emission inventory standard practices and methods to the Commission
	Nov	Reviewed draft inventory Scope Provided feedback on emission sources of importance to Sitka
	Dec	Approved SCRES Scope with Sitka-specific GHG emission sources
2024	Jan	Collected information and drafted methods
	May	Approved timeframe and Scope 1 emission methods
	Jun	Review and advised on draft Scope 3 emission methods
	Aug	Approved Scope 3 emission methods
	Nov	Draft GHG emission inventory released
	Dec	Gave feedback on draft GHG emissions inventory
		First round of public comment
2025	Jan	Commissioner and public comment integrated into updated inventory
	Dec	Updated draft released
		Second round of public comment
2026	**Jan**	Final recommendations on GHG emissions inventory **Final GHG emissions inventory released**

Table 3: Timeline of actions and steps to prepare this inventory.

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THE SCOPE OF SITKA'S INVENTORY

EMISSION SOURCES INCLUDED IN STIKA'S GHG INVENTORY

Scope 1	GHG emissions from sources located within the **city boundary**
	Electricity Generation – *Backup Diesel Generation*
	Building Heating – *Residential and Commercial*
	Ground Transportation – *Cars, Trucks, Buses, Motorcycles, etc.*
	Marine Activity – *Commercial Fishing; Recreational and Charter Boats*
	Wastewater Treatment – *Year-Round Residents and Visitors*
Scope 2 *NOT APPLICABLE*	GHG emissions occurring due to the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary.
Scope 3	All other GHG emissions that occur outside the city boundary as a result of activities taking place within the **city boundary**
	Shipping – *Tons of Material to/from Sitka via Barge and Aircraft*
	Soild Waste Disposal – *Tons of Waste and Recycling Decomposing in a Landfill*
	Air Travel – *Commercial Travel, Seaplanes, Helicopters, Small Personal Planes*
	Cruise Ships – *Ship Maneuvering while in Sitka and in port*

Figure 9 & Table 4: Map approximating sources and boundaries of Sitka's GHG inventory and table with descriptions.

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SITKA'S GHG INVENTORY CHALLENGES

Sitka does not have clear boundaries for some emission sources

As a remote, islanded community, Sitka does not have clear boundaries that are typically used in GHG emission inventory methods (*Figure 10*). While land-based emissions are much easier to calculate as the sources have clear boundaries, many Scope 3 sources are minimally included or excluded in community-wide inventories, but for islanded communities, the role of Scope 3 emissions sources are critical and important to understand and include. Sitka's emissions sources are not necessarily confined to its land and Sitka is generally more reliant on indirect, Scope 3 sources.

Indirect, Scope 3 emissions presented a set of challenges for creating an inventory that is representative of Sitka's unique lifestyle while remaining helpful, accurate, and not overly broad. To address this, many boundaries used for Sitka were created based on the emission source, available information, and community context provided by the Sustainability Commission and by the public.

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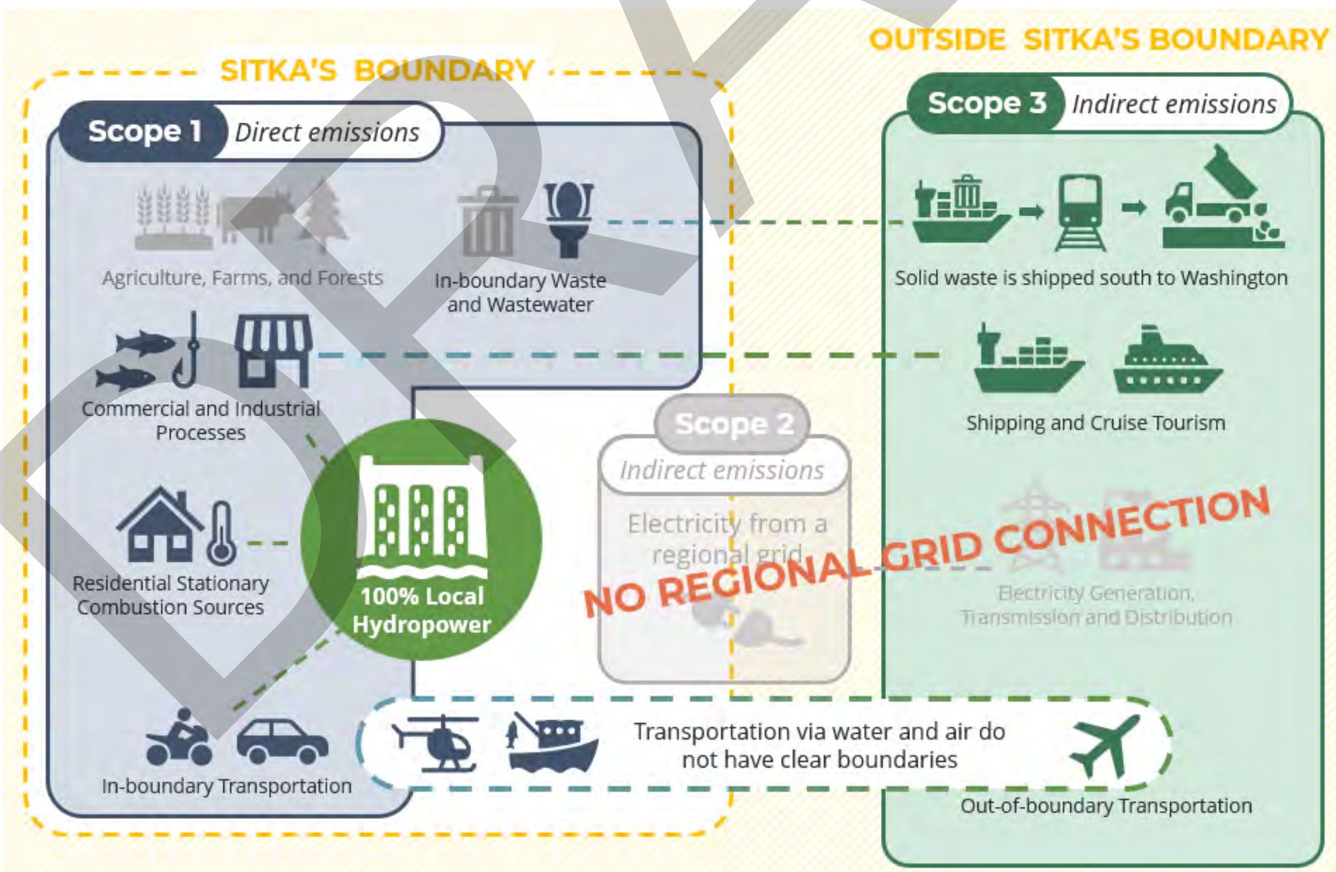

Figure 10: Sitka's categories of GHG emissions differ from standard methodologies.

SITKA'S GHG INVENTORY CHALLENGES, CONTINUED

Sitka is only accessible by plane or boat.

As an islanded community, residents and visitors can only arrive by plane or boat. As Scope 3 sources, these emissions are difficult to calculate as they are often linked to information that is considered proprietary and not publicly available.

Sitka relies on shipping for goods and waste disposal.

Since all goods arrive in Sitka via barge, these emissions are important to include in the inventory. However, there is no standard way to calculate this.

Similarly, Sitka does not have a landfill that accepts most municipal solid waste. Instead, waste is shipped south to Seattle, where it is then taken to the Roosevelt landfill in Southeastern Washington.

Sitka is not connected to a regional electric grid.

All electricity used in Sitka is generated locally by the Blue Lake and Green Lake Hydroelectric Projects, which means electricity generation falls in Scope 1, not Scope 2. There is no connection to a larger regional grid, so Scope 2 does not apply to Sitka. Nearly 100% of electricity in Sitka is renewable and does not emit greenhouse gases. That is good for the total emissions in Scope 1 and means Scope 2 does not apply. In many community GHG emissions inventories, Scope 2 is the largest contribution to the total emissions, depending on the available renewable energy resources.

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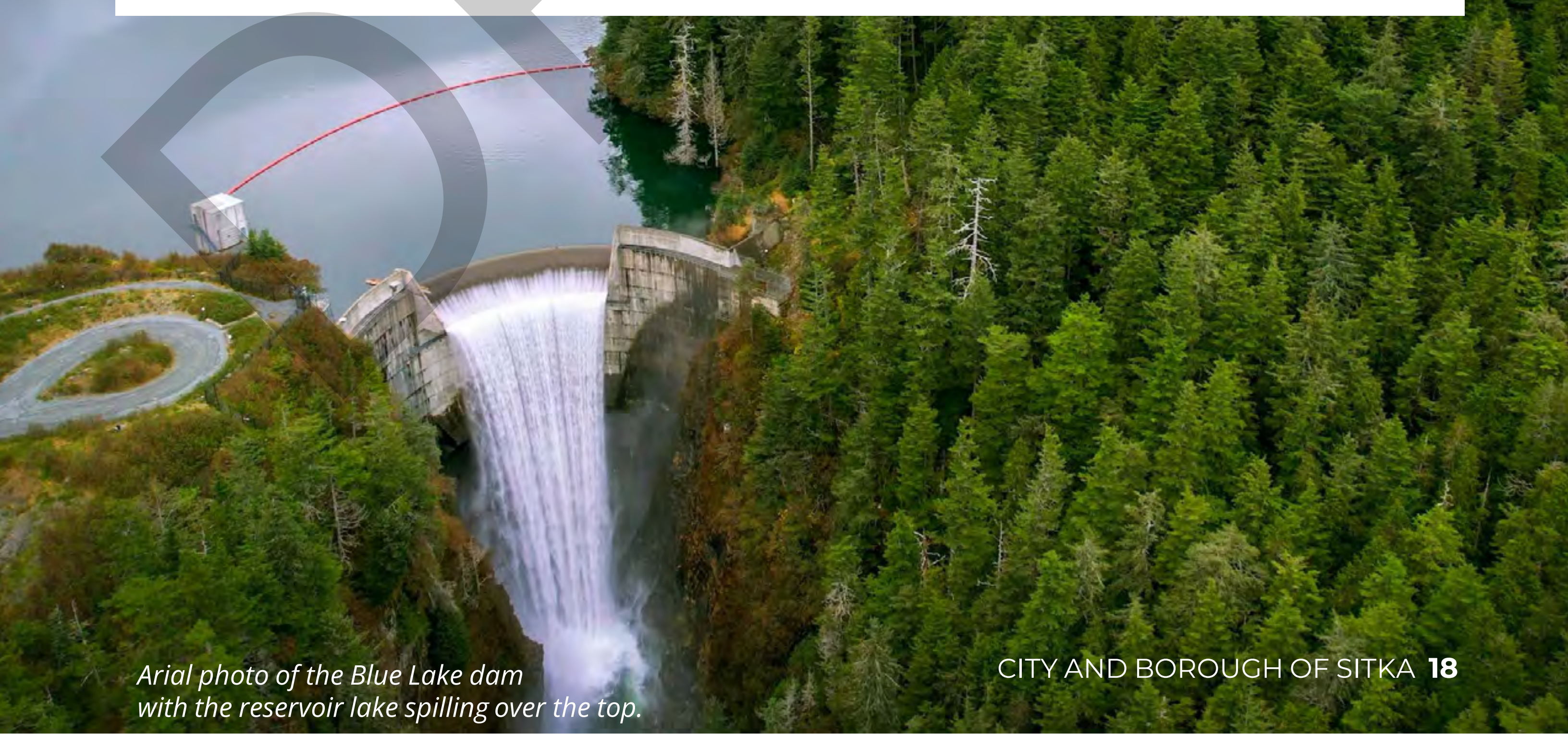

Arial photo of the Blue Lake dam with the reservoir lake spilling over the top.

What does Sitka's GHG Emissions Inventory NOT Include?

Natural Process that Emit or Absorb Greenhouse Gases

GHG emission inventories are designed to capture emissions from unintentional human behavior. As such, this inventory does not include natural processes like trees removing CO_2 from the atmosphere (carbon sequestration) or other non-human emission sources such as decomposition of materials or other natural processes. The Tongass National Forest stores the most carbon of any U.S. National Forest[6] (*Figure 11*).

While various policies and practices have established ways of quantifying and crediting individuals or organizations for reforestation or forest protection, these methods of crediting are not standard in greenhouse gas inventories. This is especially true when the land in question is not managed or designed intentionally for carbon sequestration. In short, we do not credit Sitka for what the trees do, but that's okay!

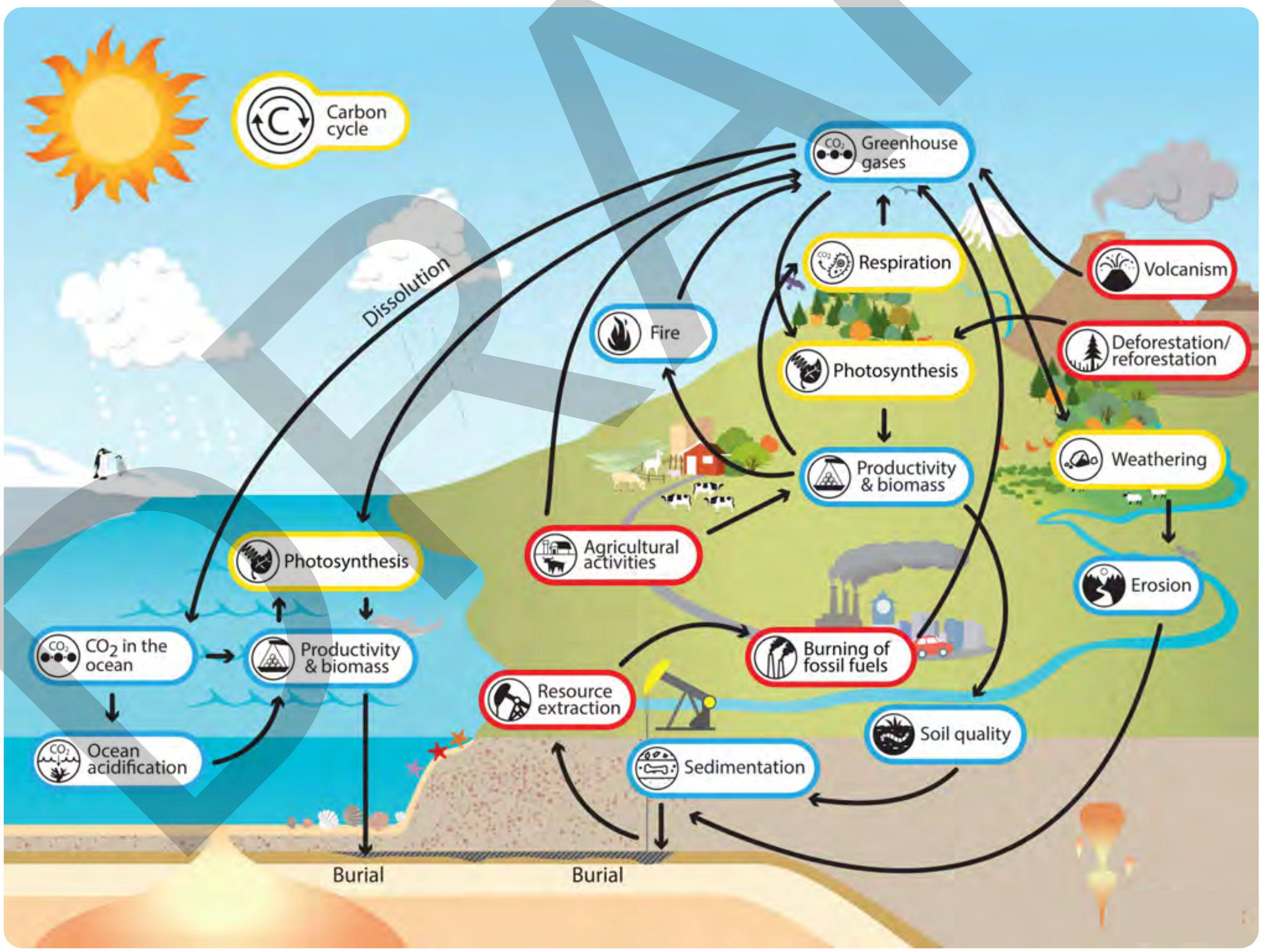

Figure 11: The carbon cycle (yellow) is a naturally occurring process that influences the climate. Human activity is currently adding more carbon than the cycle can handle, increasing the amount of carbon in the atmosphere which warms the planet. Graphic by University of California Berkley Museum of Paleontology.

Fugitive Refrigerant Emissions

Refrigerants are fluorinated gases (F-gases) that, for the most part, are created by humans and do not occur in nature. Many residential and industrial technologies use refrigerants in refrigerators, air conditioners, industrial ice production facilities, and data centers. Due to the high warming potential (GWP) of refrigerants and the length of time they remain in the atmosphere, the small volume of direct emissions that are released accounts for approximately 1% of U.S. emissions[7] (*Table 1 and Figure 2*). In theory, refrigerants can be collected from machinery and reused, however this does not often happen because the costs of recovering refrigerants currently outweigh the potential revenue from resale.

Global Warming Potential of GHGs

GHG	Lifetime in the Atmosphere	Global Warming Potential (GWP)
Carbon dioxide	1,000s of years	1
Methane	10 years	28
Nitrous oxide	~300 years	273
Fluorinated Gases (F-Gases)	**1,000-10,000 years**	**1,000- 10,000+**

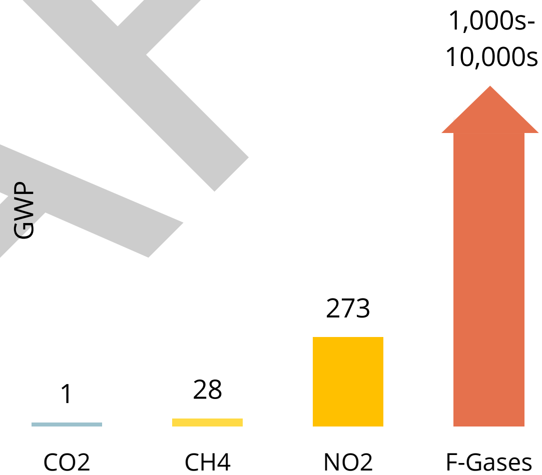

Table 1 & Figure 2: How Greenhouse Gases Warm Our Planet. AR6 values, IPCC Sixth Assessment[2].

Refrigerant emissions are not included in this inventory, primarily due to the difficulty and uncertainty of quantifying those emissions. Ideally, a refrigerant is contained within the technology where it exists. However, technologies using refrigerants are prone to leakage or improper disposal, which leads to the refrigerants being released into the atmosphere. This leakage is the main source of direct emissions and therefore is extremely difficult to quantify and track.

That said, refrigerants are still abundant in Sitka, especially in the technologies used by the seafood processing industry. Any steps taken to make seafood processing more efficient or to prevent refrigerant leakage in the industry could lead to decreased emissions. Similarly, the shipping of goods that require refrigeration is another major source of refrigerant emissions. After fishing vessels, refrigerated bulk carriers are responsible for the highest amount of refrigerant emissions for refrigeration (but not for air conditioning) compared to other ships globally[8]. In 2018, refrigerated containers accounted for 18.2 million $MTCO_2e$ worldwide.

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HOW SITKA'S EMISSIONS WERE CALCULATED

Throughout the process of conducting this inventory, the technical experts worked to find the best available data to create estimates for each emission source. In addition to guidance from the Greenhouse Gas Protocol for Cities[3], calculations were shaped by feedback from the Sustainability Commission and public input. Assumptions were iterated upon to improve the estimates as new information became available, and they were validated as much as possible through comparison with available data.

In General, Two Kinds of Data Were Used to Create Estimates

Fuel imports were used to calculate the quantity of emissions from different fuel types that arrive in Sitka and **activity data** was used to break down how that fuel was used in Sitka by sectors and sub-sectors. Breaking fuel and emissions down into finer resolution categories helps determine which policy mechanisms or community actions could have the highest impact to achieve goals.

FUEL IMPORTS		ACTIVITY DATA	
PROS	• Quantifies different types of fuels • Works well for land-based emission sources	**PROS**	• Uses well researched emission factors for each fuel type • Activities like wastewater treatment have standardized calculations • Customizable for specific sources
CONS	• Doesn't specify what the fuel types are used for • Can be inconsistent year-to-year • Doesn't account for fuels brought in from other locations ex. a boat refueled in Juneau and traveling to Sitka	**CONS**	• Requires additional information to determine accurate activity levels, especially for small communities • Some necessary information is not publicly available, especially if it is related to a business's operations

Table 5: Pros and cons of using fuel import data vs activity data.

FUEL IMPORTS

U.S. Army Corps of Engineers' (USACE) 2022 5-Year Cargo Report for Sitka Harbor[9] is a record of all shipments in and out of the city, including fuels, which are broken into categories of gasoline, kerosene, distillate fuel oil, residual fuel oil, hydrocarbons and petrol gases, and "petro products" not elsewhere counted (NEC). If we were to assume the amount of fuel burned is the same as the amount of fuel imported, emission estimates from burning fossil fuels using the Cargo Report would be simple. However, due to both fluctuations in the Cargo Report data from year to year and some issues with data quality (discussed in detail in Appendix A), this is not the only data source relied upon. Instead, a combination of Cargo Report data and activity data is used *(Table 5).*

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ACTIVITY DATA

Activity data is data that allows us to estimate how often certain emissions-related activities take place in Sitka. Using activity data, emissions are calculated from the ground up by estimating how often certain activities take place and what levels of emissions are caused by those activities. Each emission source's activity data comes from a variety of sources with a variety of uncertainties, which are outlined in each section.

Breaking fuel and emissions down into specific categories helps determine which policy mechanisms or community actions can have the highest impact in reducing emissions. Policy mechanisms can include incentivizing building energy efficiency measures and electrifying vehicles, buildings, or boats. For example, understanding the emissions tied to heating residential housing can determine the emissions impact of incentivizing home electrification measures.

In 2022, Sitka imported an estimated...

~5,200,000 gallons of fossil fuels[9]

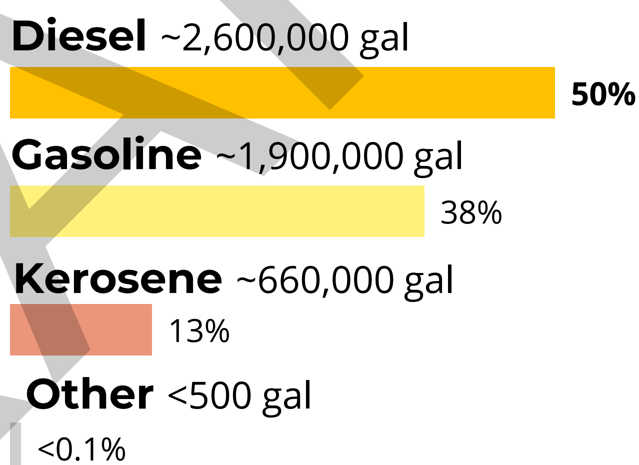

Figure 12: For simplification, this report uses the term diesel in place of "Distillate Fuel Oil", which includes diesel used for transportation and heating (Diesel #1 and #2). Most of the fossil fuel imported to Sitka is diesel.

DATA VALIDATION

Throughout the process of conducting this inventory, the best available data was used, and assumptions were updated iteratively with help from knowledge members of the Sitka community. Once emissions were calculated from both the fuel import and activity data, they were compared. Since both fuel import data and activity data have limitations, comparing the two forms of data helped improve estimates. Each time assumptions were updated, estimates were verified by checking that activity data fell within reasonable estimates as compared with fuel import data. In addition, we compared the total amount of fossil fuels using sales tax information. The total sales were consistent with the USACE Cargo Report. For recreational fishing vessels, seaplanes, small planes, helicopter trips, and for other activities for which there was limited activity data, the estimates relied more on Cargo Report data.

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LIMITATIONS

How Accurate is Sitka's Greenhouse Gas Emissions Inventory?

GHG inventories are a strategic tool and are not 100% accurate, nor do they have to be. While some information necessary for developing GHG emissions inventories is readily available, other information is not as easy to obtain. While doing additional research may improve some estimates, the improvements are often small compared to the resources needed to create the most accurate inventory possible.

Sitka's GHG emissions inventory uses a combination of commonly used data sources and community sources, such as data from CBS departments and surveys, or local organizations with expertise. Where data gaps remained, **assumptions** were created based on CBS Sustainability Commission feedback and public comment. Throughout this report, the confidence of an emission estimate is clearly stated.

What are Assumptions?

Gaps in data are a challenge in conducting a GHG emissions inventory, especially for larger-region inventories where data availability is less consistent. Assumptions, or numbers derived from available information and research, are used to fill data gaps. Assumptions in GHG reports are common, especially for harder-to-track sectors, such as marine and air travel. Fortunately, GHG inventories are a living document and can be updated as new information or more accurate data becomes available. This inventory should be updated accordingly.

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Photo of Molly Grear, PNNL, presenting information about Sitka's GHG inventory to the Sustainability Commission

CONFIDENCE LEVELS

How do you know how accurate a GHG emission estimate is?

For this inventory, each estimate includes the inputs used to create the assumptions that were used to calculate the emissions and the data sources. These data sources were ranked based how detailed they were, and the kind of information provided. Once all the sources were ranked, the overall emissions category was also ranked based on the quality of the inputs. If they fell between levels, the score was rounded down to the lower confidence level.

Confidence Level	Rationale
Great	Values with this ranking use values that are unlikely to need to be adjusted in the future, except in response to major community changes or changes to scientific understanding. Datasets used were specific to Sitka and contained detailed information or were not dependent on Sitka-specific data. EPA emission factors are an example
Good	Values used may be specific to Sitka but may have been aggregated and some detail obscured, or the inputs are research-based and adapted to Sitka based on additional information and community input if provided. While more information would improve the estimate, the overall impact would likely be small, and these inputs are still justifiable with a general understanding.
OK	Values used was not specific to Sitka. Additional, better, or more local data could improve the estimate, but the overall impact would likely be small unless additional inputs were also changed. These inputs are still justifiable with a general understanding.
Poor	Information was likely unavailable or too obscure to be useful for creating the input. More or better data could improve the estimate, and the overall impact could be meaningful to the category.

Table 6: Categories of the confidence level and descriptions

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Arial photo of the back of the Blue Lake dam

SUMMARY OF ASSUMPTIONS AND CONFIDENCE

The following tables provide a summary of the confidence levels of each input for each emission source. Details about each input can be found in the methodology section for that source.

Scope 1

Emission Source	Assumption Inputs					
Electricity Generation - Great						
Hydroelectricity	123,035 MWh from hydroelectricity					
Diesel Backup	9,975 gallons of diesel used in generators	86.9 gallons of diesel needed to generate 1 MWh				
Building Heating - Good						
Residential	3,513 occupied houses	1,689 sf average	76MMBtu/sf of heating energy	41% of houses use fuel oil		
Commercial	2.3 million sf of building space	75% of the space requires heating	25 kBtu/sf of heating energy	51% of buildings use fuel oil		
Ground Transportation - Good						
All Vehicles	8,132 conventional vehicles	70% of vehicles are actively driven	Avg 4 miles are driven daily	Avg fuel efficiency by vehicle type	Vehicles are active 350 days	
Public Transportation	13,945 gallons of gas used by The RIDE					
Cruise-related Transportation	140,000 miles driven by buses	100 vehicles permitted at HCH	25% of tourists take a tour	Each tour is ~20 miles		
Marine Activity - Good						
Commercial Fishing	510 vessels participate	95% are active	Vessel Fuel efficiency (varies)			
Recreational Fishing	~1,500 vessels registered	66% are active	540 miles traveled per year	Fuel efficiency of 3 mpg		
Charter Boats	7,920 trips	25 miles per trip	Fuel efficiency of 2.5 mpg			
Wastewater Treatment - Great						
Residents	8,380 residents	0.009g/ N2O per day				
Seasonal Visitors	694 equivalent year-round residents					

Table 7: Summary of confidence levels for all emission sources included in Scope 1.

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Scope 2

Scope 2 Emissions are not applicable to Sitka. See page 48 for details.

Scope 3

Emission Source	Assumption Inputs			
Solid Waste Disposal - Great				
Municipal Solid Waste (MSW)	7,618 tons of waste	240 tons of recycling	Mixed MSW emissions factor	Recycling emission factor
Shipping - Great				
Marine/Barge Transport	117,658 tons of materials shipped and received	1,000 miles on a barge to/from Seattle	1 gallon of diesel moves 1 ton 650 miles	
MSW/Recycling Disposal	7,858 tons of material to Seattle			
Air Transport	3,963 tons of materials to/from Sitka	850 miles from Seattle to Sitka	t0.00109 $MTCO_2e$ per Ton-mile emission factor	
Air Travel – Good				
Mainline Flights	40,586 revenue passenger miles (RPM)	67% of flights are medium-haul 32% are short-haul	Weighted average emission factor 0.159 MTCO2e/ RPM	
Seaplanes, Small Planes, Helicopters	657,784 gallons of kerosene imported	Aviation fuel emission factor 0.84kg $MTCO_2e$/gal	80% of imported fuel is used for this sector	
Cruise Ship Emissions – Good				
Cruise Ship Hotel	9 hours average time in port	29% Hotel MCR	Installed power (kW) and generator efficiency varies	
Cruise Ship Maneuvering	4 hours average approaching/leaving Sitka	54% Propulsion MCR		
Number/Types of Cruise Ships	333 scheduled trips	39 ships		

Table 8: Summary of confidence levels for all emission sources included in Scope 3.

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HOW TO READ THIS INVENTORY

This inventory is structured and written to be easily understandable and not require extensive knowledge on GHG emission inventories or the science behind it. As such, the following sections are highly visual and are presented in a way that is intended to be easily digestible.

Before beginning, please keep in mind two things:

The numbers and percentages are rounded and may not add up perfectly. For ease of reading, each section utilizes only whole numbers, there may be instances where percentages add to 99% or 101%. Similarly, $MTCO_2e$ are also rounded, and may not add up exactly.

The amount of fossil fuels used will not perfectly match the estimated total of imported fuels. In 2022, it was estimated that Sitka imported 5.2 million gallons of fossil fuels[9]. Each section converts emissions into total gallons of fuel, and, if possible, fuel type. Since the 5-year cargo report is reported in short tons and not gallons, there is some room for conversion differences depending on the density of the fuel. Similarly, the same amount of fuel is not imported each year and the fuel used may carry over in some years (See Appendix A for more details). Lastly, some emission sources use data from both fuel imports and activity data, which accounts for emissions from fuel from other places used in Sitka.

Each emission source will have a one-page summary followed by a methodology section that details how inputs were created and more information about the sources used *(Figure 13)***.**

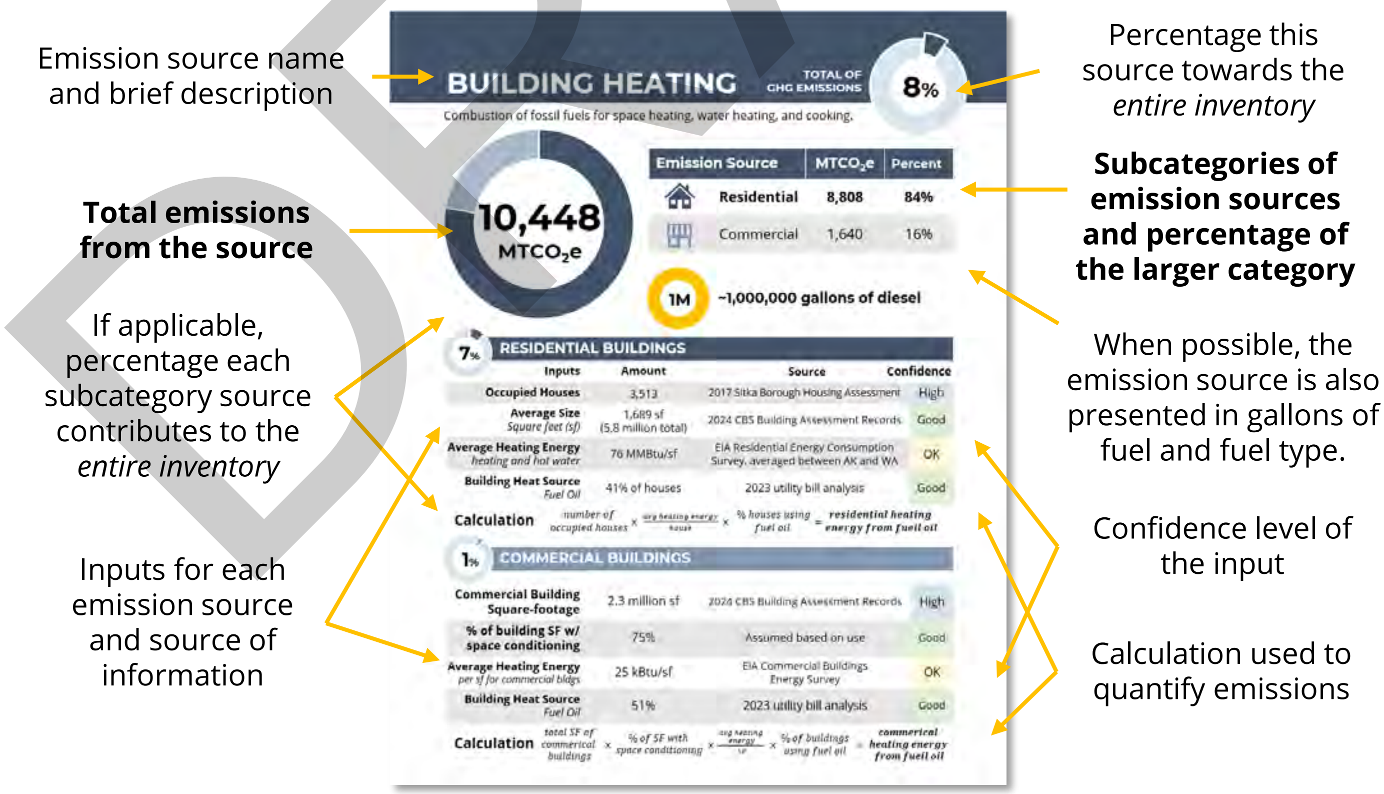

Figure 13: Example inventory page with notes on what different sections mean.

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The backside of the Green Lake dam

SECTION 3

SCOPE 1: DIRECT EMISSIONS

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SITKA COMMUNITY RENEWABLE ENERGY STRATEGY
A City and Borough of Sitka Project

Scope 1 SUMMARY

TOTAL OF GHG EMISSIONS **27%**

Direct emissions that occur within Sitka's boundaries. These include emissions from electricity generation, buildings, vehicles, marine activity such as commercial recreational, and charter transportation fishing, and wastewater treatment.

33,275 $MTCO_2e$

46% **Industry**
Commercial Fishing 46%

34% **Buildings**
Residential 26%
Commercial 5%

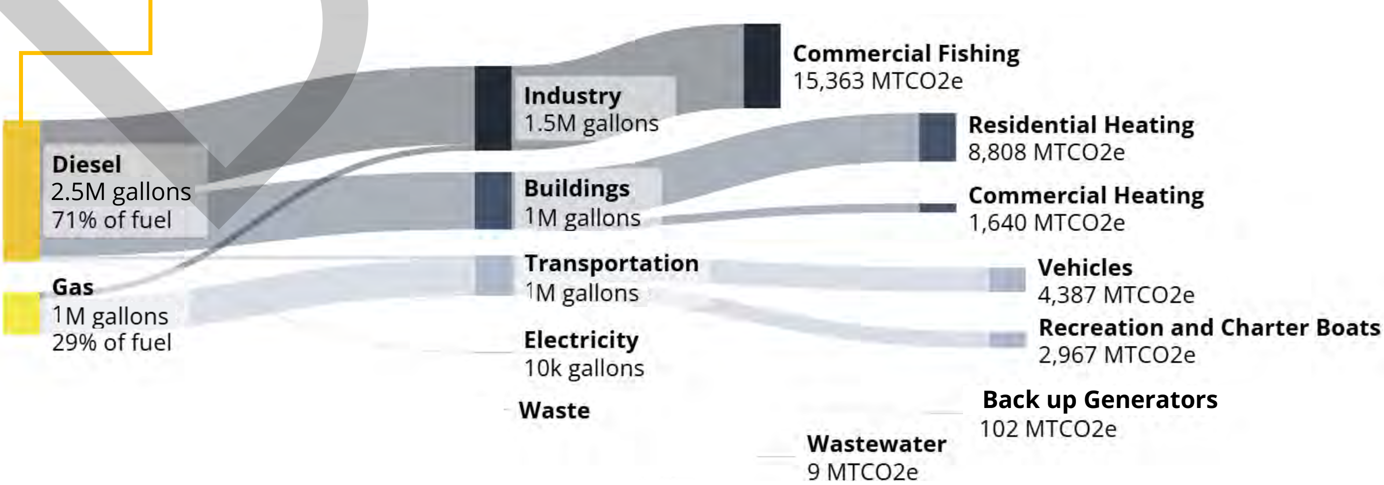
20% **Transportation**
Vehicles 13%
Rec & Charter Boats 9%

<1%
Electricity 0.3%
Wastewater 0.03%

TOTAL FUEL
3.5M gal

HYDROELECTRICITY REDUCED SITKA'S Scope 1 EMISSIONS BY 77%
~110,000 $MTCO_2e$ from ~11M gallons of diesel

ENERGY FLOW



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Scope 1 SUMMARY

CONFIDENCE LEVELS OF ESTIMATIONS

DRAFT

Emission Source	Assumption Inputs					
Electricity Generation - Great						
Hydroelectricity	123,035 MWh from hydroelectricity					
Diesel Backup	9,975 gallons of diesel used in generators	86.9 gallons of diesel needed to generate 1 MWh				
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Ground Transportation - Good						
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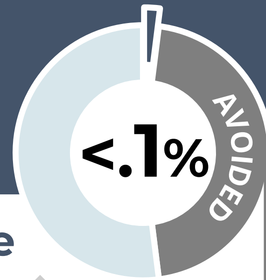
Cruise-related transportation	140,000 miles driven by buses	100 vehicles permitted at HCH	25% of tourists take a tour	Each tour is ~20 miles		
Marine Activity - Good						
Commercial Fishing	510 vessels participate	95% are active	Vessel Fuel efficiency (varies)			
Recreational Fishing	~1,500 vessels registered	66% are active	540 miles traveled per year	Fuel efficiency of 3 mpg		
Charter Boats	7,920 trips	25 miles per trip	Fuel efficiency of 2.5 mpg			
Wastewater Treatment - Great						
Residents	8,380 residents	0.009g/ N_2O per day				
Seasonal Visitors	694 equivalent year-round residents					

Table 7: Summary of confidence levels for all emission sources included in Scope 1.

ELECTRICITY GENERATION

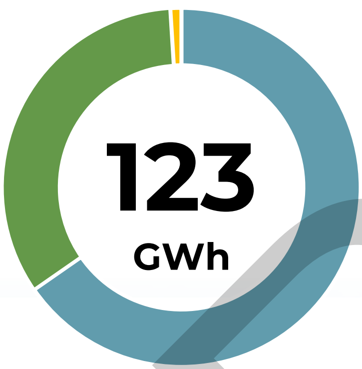


Sitka's Electricity Generation is 99.9% Renewable

Emission Source	$MTCO_2e$	Percent
Hydroelectricity Emissions Avoided	109,443	0%
Diesel Generators	**102**	**100%**

9,975 gallons of Diesel

11M **~11,000,000 gallons of diesel avoided**



Generation Source	MWh	Percent
Blue Lake	80,992	65.8%
Green Lake	42,043	34.1%
Diesel Generators	111	0.09%

46% HYDROELECTRICITY

Inputs	Amount	Calculation	Confidence
Generation	123,035 MWh	$\frac{\sim 86.9\ gallons}{MWh\ generated}$	Great
Diesel Avoided	10,686,820 gal		

<0.1% BACKUP DIESEL GENERATOR

Inputs	Amount	Calculation	Confidence
Diesel Used	9,975 gal	$\frac{10{,}240\ g\ CO_2e\ *}{gallon}$	Great

Avoided emissions were calculated by multiplying the amount of diesel needed to generate electricity using generator efficiencies reported by the Electric Department by the *EPA diesel emission factor[4]. The calculation does not include marginal emission factors.

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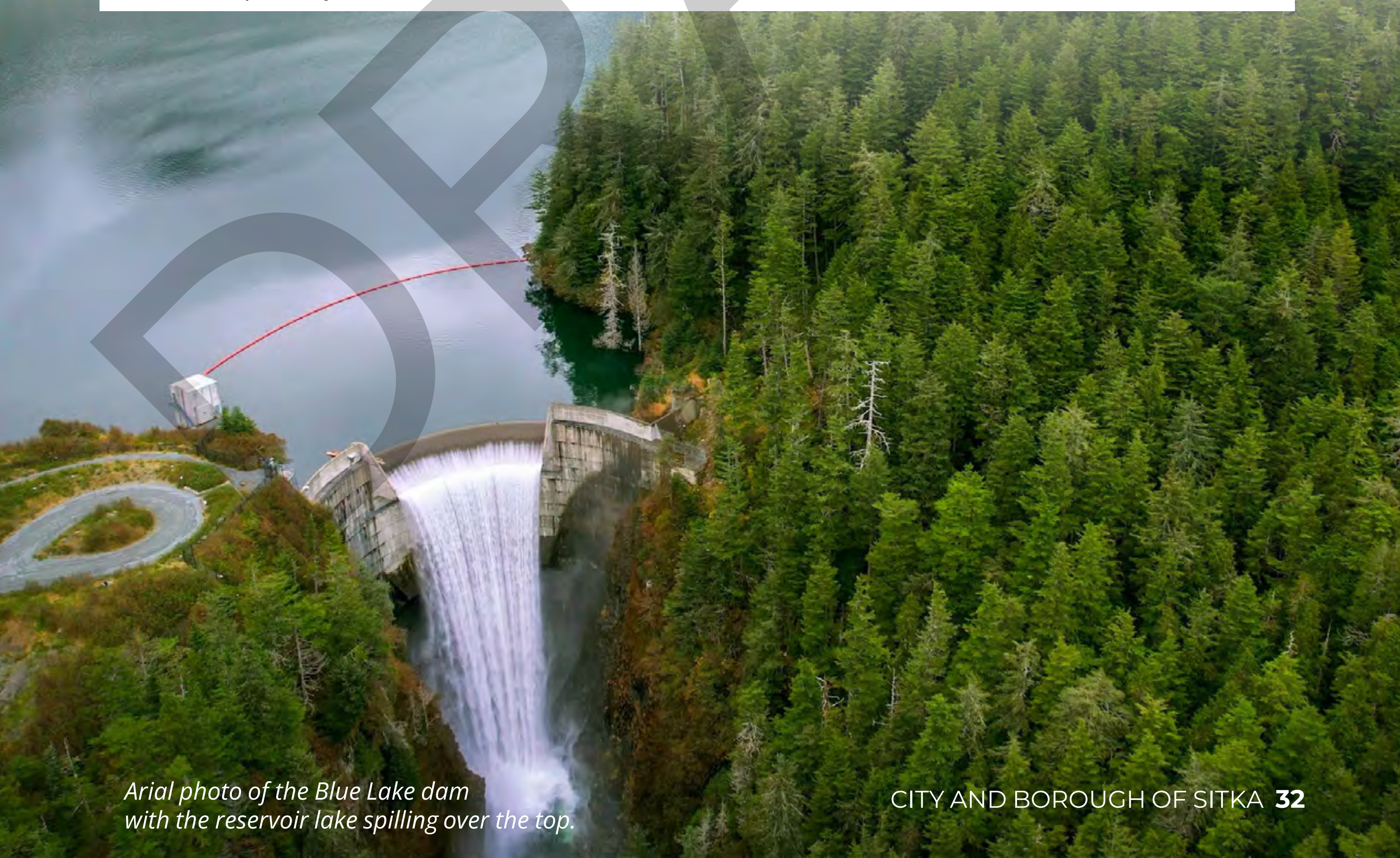
ABOUT SITKA'S ELECTRICITY GENERATION

Sitka's electricity is generated by hydropower, which does not have emissions associated with its primary electricity generation. Backup diesel generators are available in case of long failures or outages. Any longer failures or outages of the dams resulting in diesel being burned for electricity lead to increased emissions from this source. Since the Blue Lake Expansion Project, no significant amount of diesel has been used to meet Sitka's electricity needs.

HYDROELECTRIC GENERATION

CBS runs two hydroelectric projects, which together produce 99.9% of Sitka's electricity. Power generation is split between the two projects, with the Blue Lake Project generating about two-thirds of the power.

The Blue Lake Hydroelectric Project has three vertical 8.5 MW turbines and can produce 15.9 MW of electricity. In 2014, the Blue Lake Expansion Project was completed, which raised the dam 83 ft to its maximum height of 425 ft. This increased the amount of water stored in the reservoir. The expansion also upgraded the turbines, penstock, and powerhouse. Blue Lake is also the primary source of Sitka's water.



Arial photo of the Blue Lake dam with the reservoir lake spilling over the top.

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The Green Lake Hydroelectric Project has two horizontal 9 MW turbines and can produce 18 MW of electricity. The Green Lake Project was originally built in 1982 as the Blue Lake Project neared its generation capacity. It has been running nearly continuously since.

Arial photo of the Green Lake Powerhouse.

BACKUP DIESEL GENERATION

CBS has 27 MW of diesel generators to act as backup to the hydroelectric projects. These generators are exercised periodically throughout the year to ensure they are available if needed. The amount of fuel fluctuates slightly year to year but does not significantly change the amount of emissions from the generators when compared to the total electricity produced by the hydroelectric projects. The five-year average of emissions from diesel generators is 159 $MTCO_2e$ *(Figure 14).*

159 $MTCO_2e$

5-year average

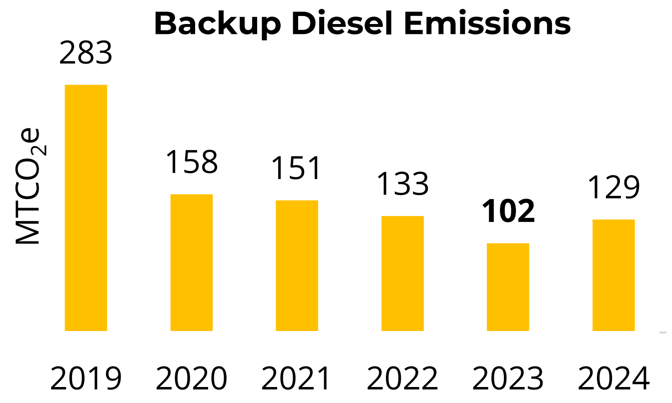
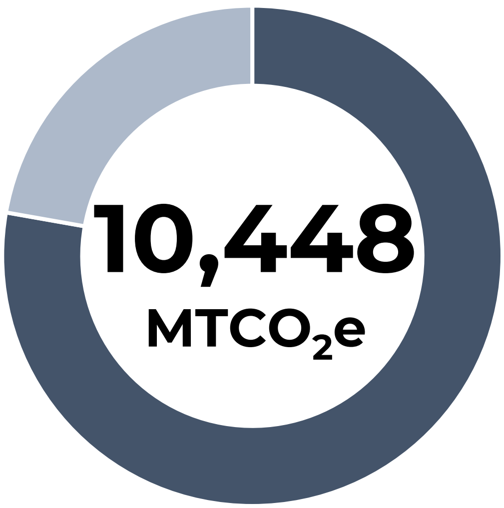


Figure 14: Sitka's back-up diesel emissions over 5 years

BUILDING HEATING

TOTAL OF GHG EMISSIONS **8%**

Combustion of fossil fuels for space heating, water heating, and cooking.



Emission Source	$MTCO_2e$	Percent
Residential	**8,808**	**84%**
Commercial	1,640	16%

1M **~1,000,000 gallons of diesel**

7% RESIDENTIAL BUILDINGS

Inputs	Amount	Source	Confidence
Occupied Houses	3,513	Alaska Housing Finance Corporation[10]	Great
Average Size *Square feet (sf)*	1,689 sf (5.8 million total)	2024 CBS Assessing Department Records	Good
Average Heating Energy *heating and hot water*	76 MMBtu/sf	EIA Residential Energy Consumption Survey, averaged between AK and WA[12]	OK
Building Heat Source *Fuel Oil*	41% of houses	2023 utility bill analysis	Good

Calculation

$$\text{number of occupied houses} \times \frac{\text{avg heating energy}}{\text{house}} \times \text{\% houses using fuel oil} = \textbf{residential heating energy from fueil oil}$$

1% COMMERCIAL BUILDINGS

Inputs	Amount	Source	Confidence
Commercial Building Square-footage	2.3 million sf	2024 CBS Building Assessment Records	Great
% of Building sf w/ Space Conditioning	75%	Assumed based on typical commercial buildings	Good
Average Heating Energy *per sf for commercial bldgs*	25 kBtu/sf	EIA Commercial Buildings Energy Survey[11]	OK
Building Heat Source *Fuel oil*	51%	2023 utility bill analysis	Good

Calculation

$$\text{total sf of commerical buildings} \times \text{\% of SF with space conditioning} \times \frac{\text{avg heating energy}}{\text{sf}} \times \text{\% of buildings using fuel oil} = \textbf{commerical heating energy from fueil oil}$$

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METHODOLOGY

Buildings have emissions associated with their electricity and fuel oil consumption. Since Sitka's electricity generation is supplied from hydropower, which has no emissions associated with its generation, the building emissions are solely from combustion that occurs onsite for the purposes of space heating, domestic hot water (DHW), and cooking. Since energy data for every building's space heating, DHW, and cooking is unavailable, we estimated their associated emissions based on square footage (sf), electricity utility bills, fuel source, and energy intensity estimates for homes and commercial spaces from the Energy Information Administration (EIA) [11].

AVERAGE HEATING ENERGY

RESIDENTIAL BUILDINGS

Sitka is more temperate than the majority of Alaska. To avoid overestimating Sitka's residential heating requirements, metrics for space heating and hot water were averaged between Alaska and Washington's energy consumption profiles from the EIA Residential Energy Consumption Survey (RECS)[12] *(Table 9).* **The total amount of energy used by residential buildings is estimated to be 266,988 MMBtu/yr.**

ENERGY USE	AK	WA	Avg	SITKA
Heating MMBtu	81	30	56	Avg AK and WA
Hot Water MMBtu	25	15	20	
TOTAL MMBtu	**106**	**45**	**76**	
TEMPERATURE				
Winter Avg °F	21°	43°	32°	39°
Summer Avg °F	54°	65°	60°	56°

Table 9. MMBtu for major energy needs in Alaska and Washington and their average, which is used for Sitka. When compared to the average seasonal temperatures of each location, the energy average between AK and WA is close to Sitka's seasonal averages.

COMMERCIAL BUILDINGS

Since Sitka does not have a large industrial foodprint, commercial and industrial buildings were combined. City Assessing Department data shows a footprint of 2.3 million square feet for Sitka's commercial and industrial buildings. To account for spaces that are either unoccupied (especially seasonally) or are used as warehouses or storage space and not space conditioned (heating or cooled), we assume that 75% of commercial buildings' square footage is actively used year-round and conditioned. The EIA estimates that commercial buildings in mixed-to-cold climates use, on average, 25 kBtu/SF for space heating[11]. **This results in the total amount of energy used by commercial building estimated to be 42,418 MMBtu/yr.**

CONFIDENCE LEVEL: OK

Metrics related to humans and generalized for the entire state of Alaska are often skewed towards Southcentral as it is the most populated region. While this is somewhat fixed with the average, it is not based on local data, however, it is still justifiable with general understanding. More research into energy use in Sitka would improve the estimate but would likely have a small impact on the results.

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BUILDING HEAT SOURCE

To calculate how much of this energy is from fuel oil, which diesel is a type of, and produces emissions, the fuel source of the building must be determined. In U.S. homes, space heating and water heating combined account for more than 28% of household electricity use[12]. Since air conditioning is not common in Sitka , and space heating is seasonal due to the mild climate, it can be assumed the heating accounts for an even higher percentage of electricity use in the winter. Homes that heat with electricity will have a significant difference between summer and winter electrical consumption. While some houses' monthly electricity data may be influenced by changes in occupancy (e.g. decrease of energy one month from traveling out of town), these fluctuations even out across the large number of households. Similarly, houses that have multiple heating sources (heat pumps and baseboards), or that use primarily fuel oil for heat and use supplemental heaters, also likely evens out.

UTILITY BILL ANALYSIS

To estimate how many buildings use electricity as their primary heat source, utility bills from 2023 were analyzed with the following logic: if the average electricity consumption over the summer months (June, July, August) was 50% lower than the winter months (November, December, January), the building was determined to have an electric heat source *(Figure 15).* If houses were not heated by electricity, they were assumed to be heated by fuel oil and, in the case of residential buildings, a small percentage by wood. In all cases, it is assumed that if a building has electric heat, it also has electric hot water.

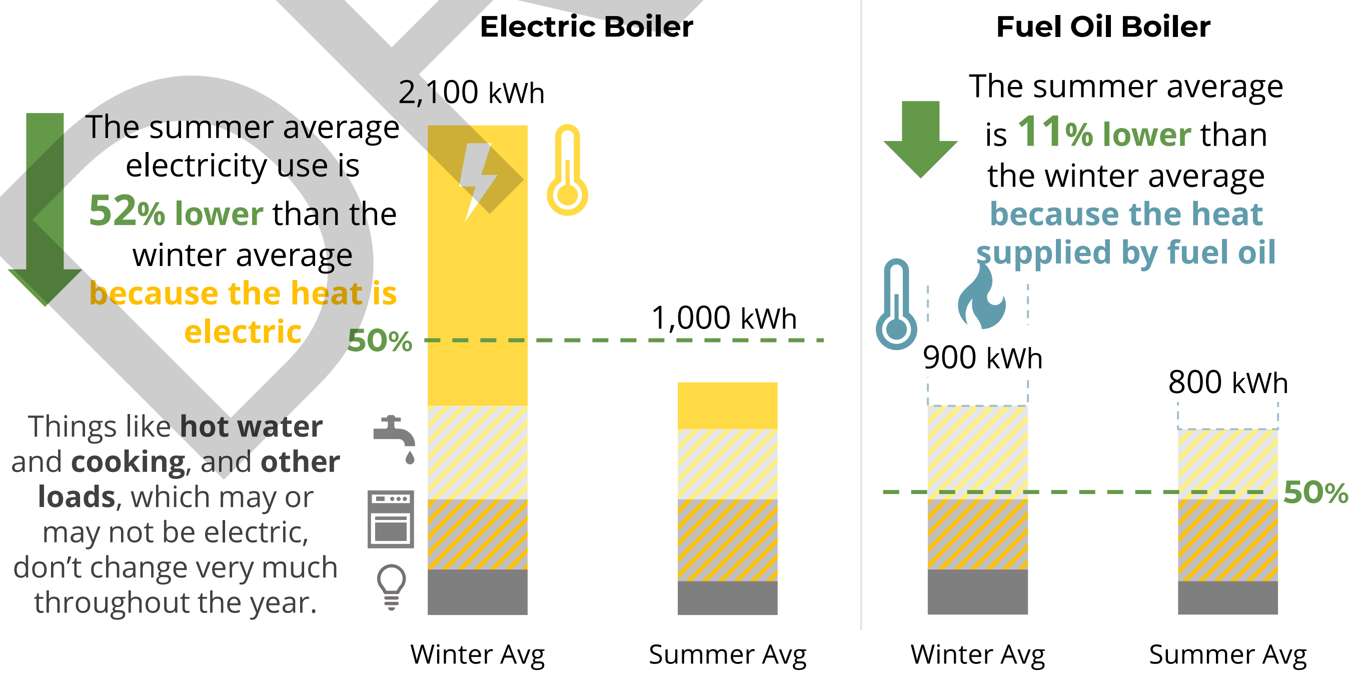

Figure 15. Utility bill analysis can be used to determine which homes use electricity and fuel oil heat for heating.

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UTILITY BILL ANALYSIS RESULTS

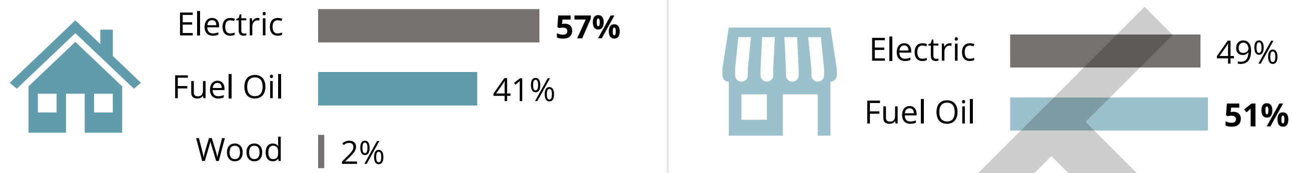


Figure 16. Most homes in Sitka use electric heat while most commercial buildings use fuel oil.

LIMITATIONS

RESIDENTIAL BUILDINGS: The 50% seasonal change works best to capture homes heated with less efficient electric heat sources, like resistive heaters and boilers. Heat pumps, which are becoming increasingly common and are far more efficient than other electric heat sources, may not always cross the 50% threshold and may be incorrectly categorized as a fuel oil home. While the number of heat pumps and their exact impact on electrical consumption in Sitka is not known, they can use up to two-thirds less energy than other electric systems *(Figure 17).* Because of this, 41% is likely an overestimate of homes that are heated by fuel oil.

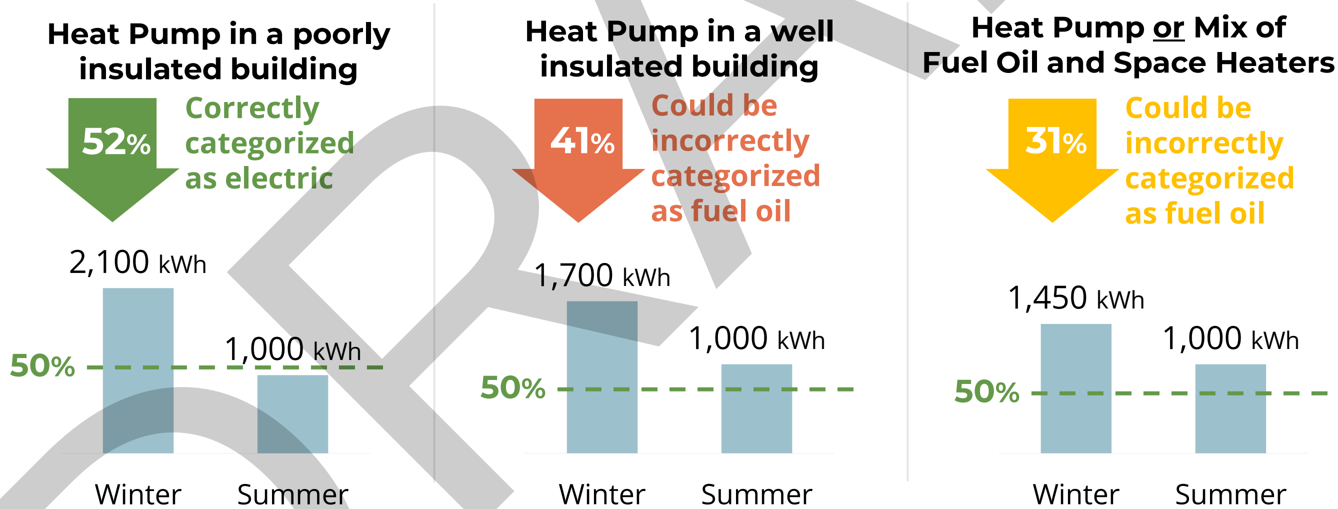


Figure 17. Example of how heat pumps may be incorrectly categorized as fuel oil due to their efficiency.

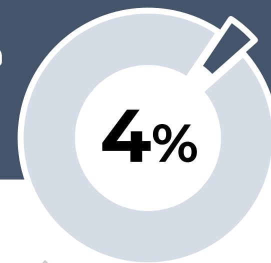
COMMERCIAL BUILDINGS: The limitations on commercial buildings are similar to residential buildings. While this approach works best for stores that are open year-round, some of Sitka's largest commercial consumers are seafood processing plants, whose consumption is greatest in late summer.

CONFIDENCE LEVEL: GOOD

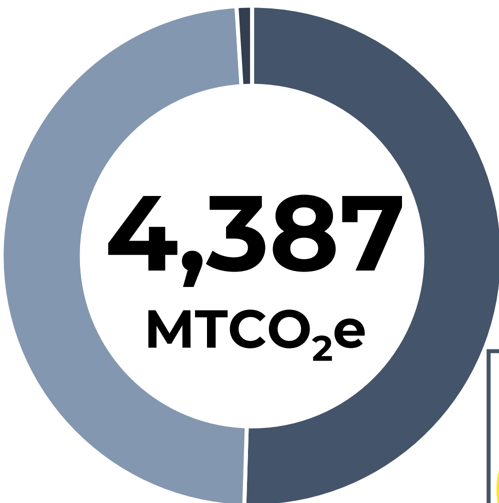
Additional analyses on local residential and commercial building heating systems could improve assumptions. This could also have other benefits for CBS and residents and businesses.

GROUND TRANSPORTATION

TOTAL OF GHG EMISSIONS



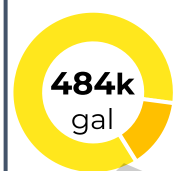
Combustion of fossil fuels for vehicles.



138 $MTCO_2e$ **avoided by EVs**

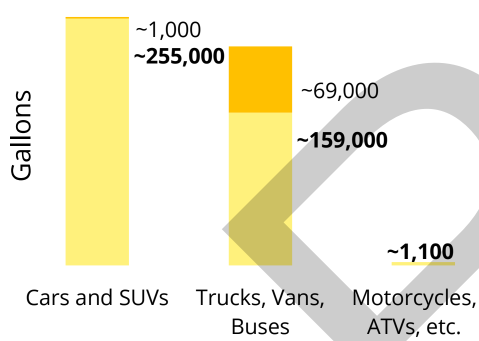
Emission Source	$MTCO_2e$	Percent
Cars and SUVs	**2,280**	**52%**
Trucks, Vans, Buses	2,097	48%
Motorcycles, ATVs, etc.	10	<1%

Fuel Types



Gas	**~414,000**	**3,767**	**86%**
Diesel	~70,000	747	14%

Fuel Use by Vehicle Types



Vehicle Type	Fuel: Gas	Fuel: Diesel	Fuel: Electric	Total
Cars and SUVs	5,222		221	**5,443**
Trucks, Vans, Buses	2,423	339	0	**2,762**
Light Duty	2,309	202	0	**2,511**
Medium Duty	251		0	**232**
Heavy Duty			0	**19**
Motorcycles, ATVs, etc	148	0	0	**148**
Total	**7,765**	**367**	**221**	**8,353**

VEHICLE EMISSIONS

Inputs	Amount	Source	Confidence
Conventional Vehicles	8,132	2024 AK DMV	Great
Actively Driven Vehicles	70%	Assumption based on AK DOT Traffic AADT[14]	Good
Avg Daily Miles Driven	4 mi/day	CBS Short-term Tourism Plan End of Season Survey[13]	Great
Avg Fuel Efficiency	20 mpg (Cars) 15 mpg (Trucks) 6 mpg (Heavy-Duty) 30 mpg (ATV)	Adjusted from U.S. avg efficiency report[15]	OK
Active Days per Year	350 days (Vehicles) 80 days (ATV)	Assumption	Good

Calculation

$$\textit{number of active vehicles} \times \frac{\textit{total miles driven}}{\textit{year}} \times \frac{\textit{miles}}{\textit{gallon}} = \textbf{gallons of fuel used by vehicles}$$

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A list of every vehicle identification number (VIN) registered in Sitka was provided by the Alaska Department of Motor Vehicles (DMV) and was decoded using the National Highway Traffic Safety Administration's (NHTSA) Vehicle Product Information Catalog and Vehicle Listing (vPIC) tool. **8,353 vehicles** had valid VINs and were decoded to find the following information:

VEHICLE TYPES AND CLASSIFICATIONS

The NHTSA classifies all vehicles into six categories, while the Federal Highway Administration and (FHA) categorizes all vehicles by weight (GVWR) as either light, medium, or heavy-duty. Neither completely translate to how the public use these terms. For example, the NHTSA defines anything that can carry more than ten people as a bus, and anything designed to carry cargo as a truck. While all passenger cars and SUVs are considered light-duty, a "pickup" truck is considered a body style and can be considered either light or medium-duty depending on weight. To learn more about how these classifications vary between agencies, see Appendix B.

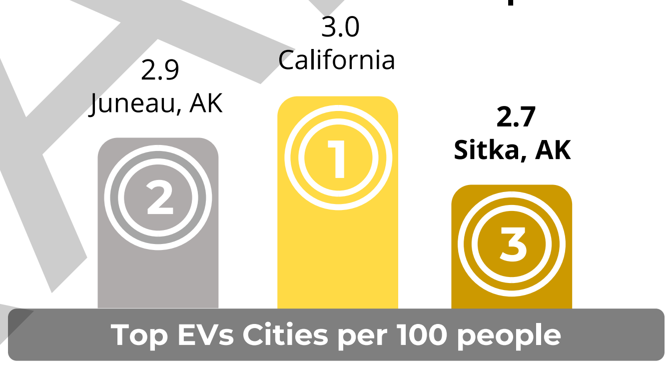
FUEL TYPES

Vehicles were categorized as powered by either gasoline, diesel, or electricity. Plug-in hybrid electric vehicles (PHEV) were considered all electric as many PHEVs have batteries capable of driving 20-30 miles. With limited roads, these vehicles were assumed to primarily run on electricity.

Similarly, while 145 vehicles in Sitka are "fuel-flexible" they were categorized given that gasoline as is it generally cheaper and given high-ethanol gasoline is not widely available.

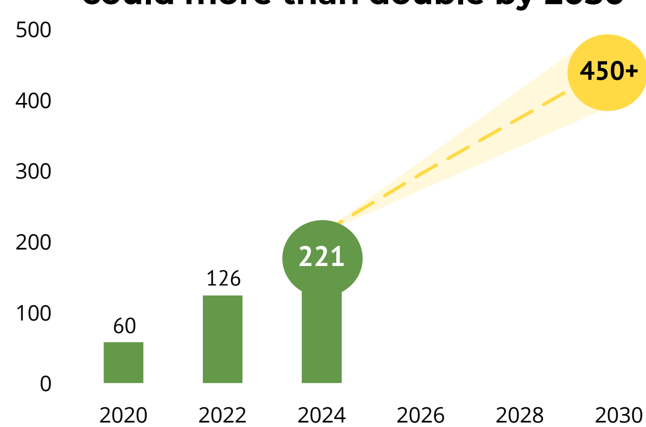
2.6% of all vehicles in Sitka are electric, with 201 battery electric vehicles (BEV) and 20 PHEVs. When compared to population, that puts Sitka as a top adopter of EVs in the country. The number of EVs is also rising. Since 2022, the number of EVs in Sitka has increased by 75% and could reach over 450 EVs in 2030.

Sitka is a leader in EV adoption



Runner Ups: Washington (1.8), Hawai'i (1.7), Oregon (1.4), Alaska (0.5, 40th place)

The number of EVs in Sitka could more than double by 2030



Figs 18 & 19. Sitka is one of the highest EV adopting communities and is only expected to grow.

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DAILY MILES TRAVELED

The 2022 Short-term Tourism Plan End-of-Season Survey asked respondents to estimate where they lived and worked. The distance between each point was estimated, and based on the 466 valid responses, the average Sitkan traveled 4 ± 2.5 miles per day or ~ 1,400 miles a year[13]. (*Figure 20*).

For heavy-duty vehicles, 4 miles per day was used and supplemented with additional information provided information from local operators with heavy-duty vehicles.

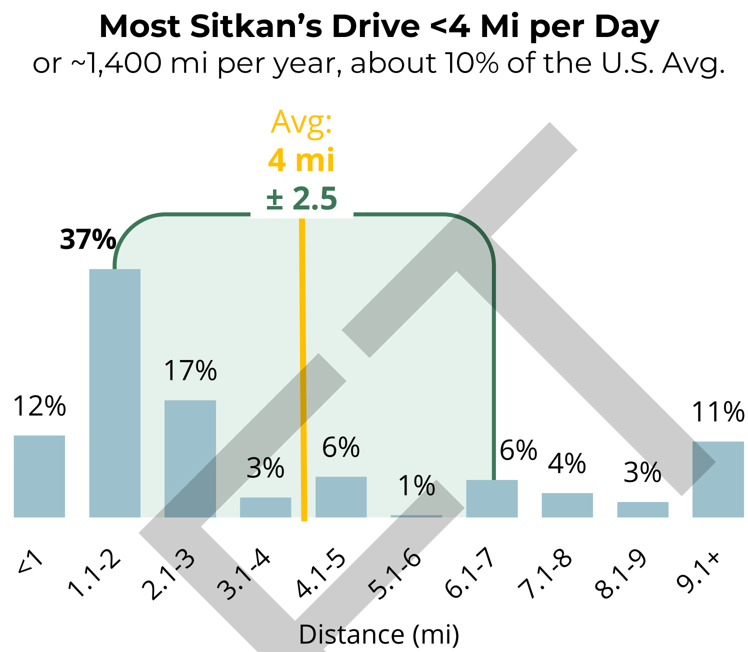

Figure 20. Estimated annul miles traveled per Sitkan is between 1.5 and 6.5 miles per day[10].

CONFIDENCE LEVEL: Great

Information was provided directly from the DMV in September 2024. While some errors existed in the VINs, the overall numbers remained close to annually reported numbers from the DMV. In combination with the 2022 Short Term Tourism Plan End-of-Season survey, these inputs are built with local information.

ACTIVE VEHICLES

The Alaska Department of Transportation (DOT) monitors annual average daily traffic (AADT) on major roads year-round at three sites in Sitka[14] *(Figure 21)*. Based on the average volume of 7,310 AADT, and to adjust for vehicles passing through multiple points or for vehicles used multiple times a day, **it is estimated that about ~6,000 (70%) vehicles are used consistently throughout the year.**

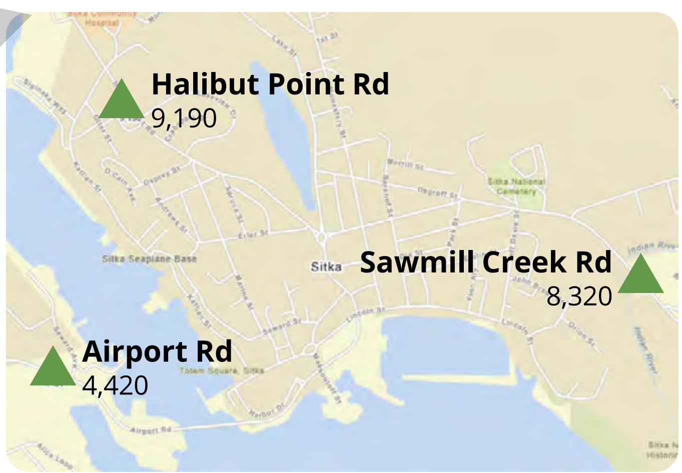

Figure 21. Annual Average Daily Traffic (AADT) stations in Sitka.

CONFIDENCE LEVEL: GOOD

Not all vehicles that are registered are frequently driven. AADT is a measurement of volume and does not directly convert to vehicles driven. Additional local information could improve these estimates but given the large sample size and low overall emissions from vehicles, the impact would be small.

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ACTIVE DAYS PER YEAR

Most vehicles are not driven every day of the year. Active days per year was set at 350 days out of 365 days, or about 95%. This is about 2 weeks of inactivity, which could include weekends vehicles were not driven or longer vacations. Motorcycles and ATVs were adjusted to 80 days, or about 2.5 months, to account for weather and seasonal usage. While extended out of town travel is common for many Sitka residents, this likely evens out due to the large data set used.

Vehicles in Sitka are ~33% more active in the summer than in the winter

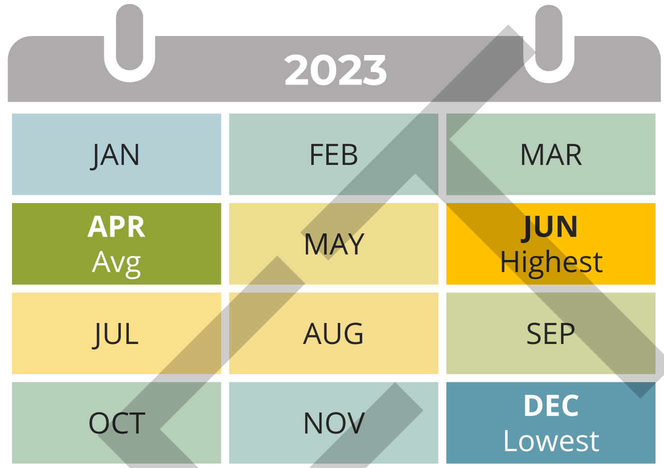


Figure 22. Graphic showing seasonal traffic volume changes in Sitka. Volumes are highest in June and lowest in December[14].

CONFIDENCE LEVEL: GOOD

While this data isn't locally sourced, it is a reasonable assumption to account for inactivity. While local data would improve the estimate, changes to overall emissions would be minimal.

FUEL EFFICIENCY

The average fuel efficiency for cars in the United States is 24 miles per gallon (mpg), which is combined between low-speed driving and frequent stops (city) and high-speed driving with few stops (freeway)[15]. Because of the lack of long-distance driving in Sitka, the overall mpg was lowered to reflect the driving conditions of Sitka.

Avg Fuel Efficiency of Vehicles in the U.S.
(Miles per Gallon)

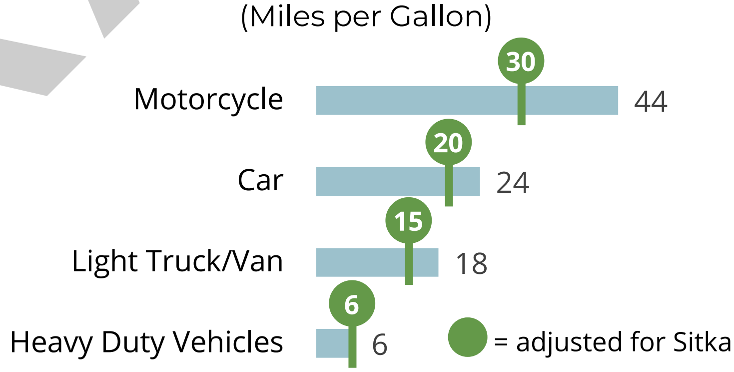


Figure 23. Fuel efficiencies for different vehicle types used in Sitka's GHG emission inventory (green circles) vs national avg[12].

CONFIDENCE LEVEL: OK

These numbers are based on national averages and not local data. More local data would improve the method of calculation which would better account for efficiency differences or other changes, but such changes would have minimal impacts on overall emissions. This estimate is still justifiable with general understanding.

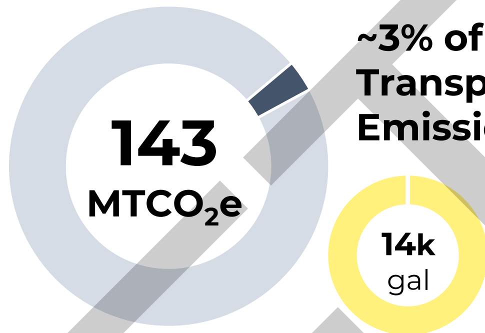
DRAFT

ADDITIONAL TRANSPORTATION ANALYSES

Emissions from these analyses are not an *addition* to the previously counted ground transportation emissions but rather a *portion* of those emissions.

PUBLIC TRANSPORTATION

Public transportation in Sitka is offered through The RIDE, which is operated by the Sitka Tribe of Alaska (STA). Information provided by STA stated that in **2023, 13,945 gallons of gasoline was used for buses, resulting in 143 MTCO$_2$e.**



~3% of Ground Transportation Emissions

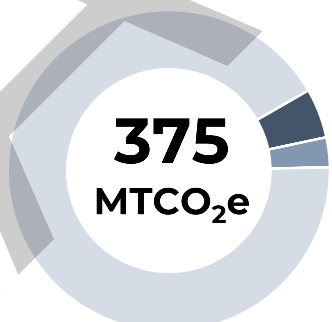
CONFIDENCE LEVEL: Great

Quantity and type of fuel used is the most preferred and accurate level of data possible.

TOURISM-RELATED GROUND TRANSPORTATION EMISSIONS

TRANSPORTATION TO DOWNTOWN

Information provided by Sitka Dock Company LLC stated that in 2023, the bus fleet drove 140,000 miles. Large motorcoach-style buses are heavy-duty (6 mpg). This results in **~23,300 gallons of diesel and 238 MTCO$_2$e.**



~8% of Ground Transportation Emissions

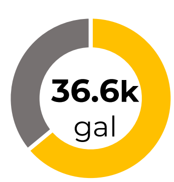
CONFIDENCE LEVEL: GOOD

Data provided for transportation to downtown was reported in miles traveled, not gallons of fuel.

Destination	MTCO$_2$e	Percent
To Downtown	**238**	**5%**
Tours	137	3%

TOUR TRANSPORTATION

According to Harrigan Centennial Hall, there are 100 permits for small passenger vans or buses to load/unload tourists. Most of these are medium-duty (15 mpg). Assuming one in four tourists (~25%) takes a tour of ~20 miles, this results in **~13,300 gallons of fuel, or 137 MTCO$_2$e.**



Fuel Types (gal)		%
Diesel	**~23,300**	**64%**
Unknown	~13,300	36%

CONFIDENCE LEVEL: OK

Data for tour transportation was based on estimated capacity of tour vehicles operating on cruise ship days and may be slightly overestimated. While additional data would improve this estimate, the impact would likely be small.

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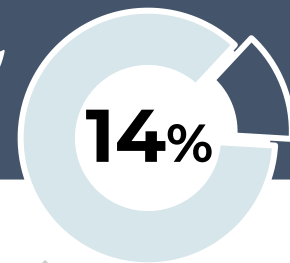
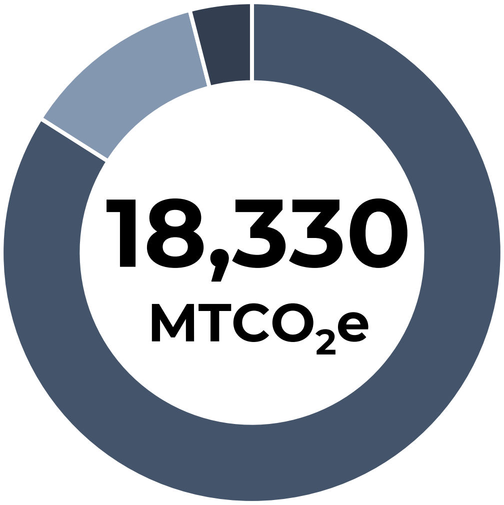
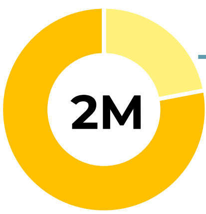
MARINE ACTIVITY



Commercial fishing, recreational fishing and boating, and charter boats.

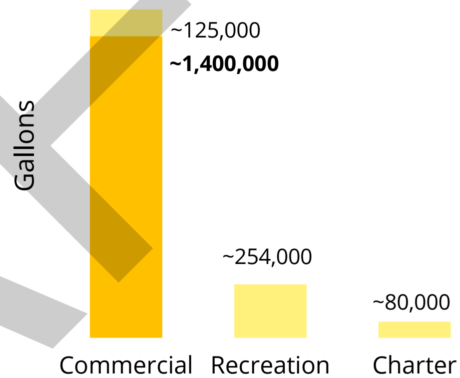


Emission Source	$MTCO_2e$	Percent
Commercial Fishing	**15,363**	**84%**
Recreational Boats	2,256	12%
Charter Boats	711	4%



Fuel Types		$MTCO_2e$	%
Gas	~459,000 gal	4,078	22%
Diesel	**~1,400,000 gal**	**14,252**	**78%**

Fuel Use by Vessel Types



12% COMMERCIAL FISHING

Inputs	Amount	Source	Confidence
Vessels	510	State of AK Commercial Fishing Database[16]	Great
Active Vessels	95%	Assumption	Good
Fuel Efficiency	Variable	See Appendix C for details	OK

2% RECREATIONAL BOATS

Inputs	Amount	Source	Confidence
Vessels	~1,500	2024 AK DMV Boating Registrations	OK
Active Vessels	66%	Assumptions	OK
Miles Traveled	540/miles/year/boat	Assumptions	Good
Fuel Efficiency	3 miles/gallon	Assumptions	OK

1% CHARTER BOATS

Inputs	Amount	Source	Confidence
Number of Trips	7,920 trips	2023 Charter Boat Logbook, Sitka Area Management, Division of Sport Fish	Great
Miles per Trip	25 miles	Assumption	Good
Fuel Efficiency	2.5 miles/gallon	Assumption	OK

Calculation

$$\textit{number of active vessels or trips} \times \frac{\textit{total miles driven}}{\textit{year}} \times \frac{\textit{miles}}{\textit{gallon}} = \textbf{gallons of fuel used by vessels}$$

DRAFT

METHODOLOGY

Fishing is a large portion of Sitka's economic activity and boating is a significant aspect of Sitka's lifestyle. However, marine activity is challenging to quantify as vessels come into Sitka Sound or other from elsewhere, and some of Sitka's vessels leave the nearby area. For Scope 1 emissions, only activity from Sitka's registered vessels is included. Shipping is included in Scope 3 section.

VESSEL CLASSIFICATIONS

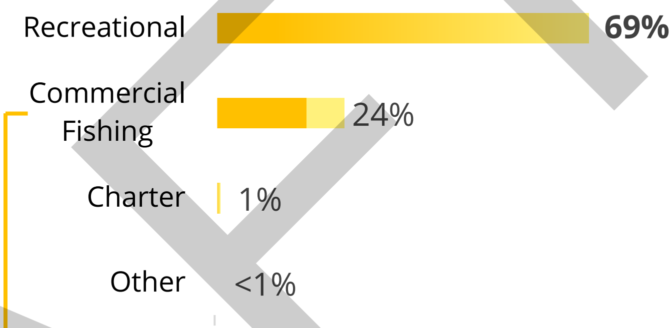
In 2023, the Alaska DMV **reported that 2,167 motorized boats were registered in Sitka.**

510 of those vessels were related to commercial fishing[16]. Of the registered vessels, 71% were diesel engines, 28% gas, and 1% left no answer. Given the importance of commercial fishing in Sitka, a detailed breakdown is provided in Appendix C.

142 vessels were used for fishing charters. According to feedback from the community, most of these are gas-powered. Some diesel charter boats do exist but how many is unknown.

The remaining ~1,500 vessels were assumed to be for recreational boating and fishing, with a small number of "unclassified" vessels. Information on these vessels, like the U.S. Coast Guard Cutter, was unavailable and not included in this inventory.

Most Vessels in Sitka are Used for Recreation



Most Commercial Fishing Vessels in Sitka Have Diesel Engines

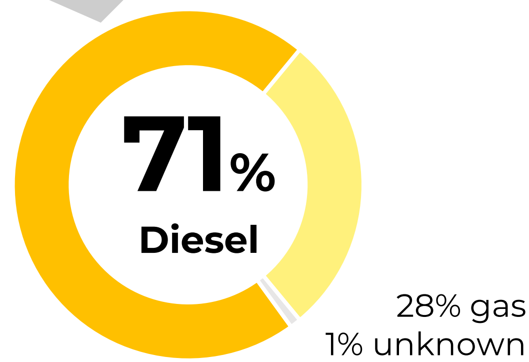


Figure 24. Most vessels in Sitka are for recreational use, but the fuel type is unknown. Most commercial vessels in Sitka use diesel.

OVERALL CONFIDENCE: GOOD

Commercial and Charter: Great The number of commercial fishing vessels and charter boats were provided by the State's Commercial Fishing Database and the Department of Fish and Game (AKDFG), Sitka Area Management Division of Sport Fish's charter boat logbook.

Recreational: OK More detailed, local data would improve the number of recreational boats and their fuel efficiencies and would better distinguish recreational and other vessels, such as search and rescue and larger tour vessels that operate in Sitka. Depending on the level of data available, this could change overall emissions in this category or create new categories, but the extent is unknown. This estimate is still justifiable with general understanding.

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ACTIVE VESSELS

Similar to vehicles, not all boats were assumed to be used. Fortunately, the number of active charter vessels was provided by the AKDFG Sitka Area Management Division. For commercial fishing, 5% of vessels were assumed inactive and 66% assumed inactive for recreational boats.

CONFIDENCE LEVEL: GOOD

While this data isn't locally sourced, it is a reasonable assumption to account for inactivity. While local data would improve the estimate, changes to overall emissions would be minimal.

MILES TRAVELED & FUEL EFFICIENCY

To determine emissions of marine activity in Sitka, information about the miles traveled and fuel efficiency of vessels must be determined, however, this information is not readily available. For the purposes of this inventory, the following assumptions were used:

Charter boats: 25 miles per trip, 2.5 mpg. 25 miles is a reasonable distance for day trips around Sitka Sound. 2.5 mpg is a conservative estimate. With 7,920 reported trips, this results in 79,200 gallons of fuel. Based on community input, charter boats primarily run on gasoline, although some diesel charter boats exist.

Recreational boats: 540 miles per year, 5 mpg. In this assumption, we assume that most boats take an average of 20-mile trips, 4 times per month, 6 months per year. This equals about 540 miles per boat. The fuel efficiency for recreational boats is 5 mpg, or approximately the fuel efficiency of a 20-ft aluminum Hewescraft. This results in about 254,000 gallons of fuel which is assumed to be primarily gasoline.

Commercial Fishing: In addition to the challenges that affect all boats, commercial vessels' fuel efficiency can also drastically differ depending on the kind of gear used and the vessel activity depends on the kind of fisheries that are opened, which can vary drastically from year to year. Data from the Vessel Energy Analysis Tool (VEAT) by Kempy Energetics[17] was used to estimate the fuel efficiency of a variety of fishing boats that take into account gear type and other factors with a full breakdown available in Appendix C. This resulted in 1,393,760 gallons of diesel and 124,619 gallons of gasoline.

CONFIDENCE LEVEL: OK

This data was based on research and not actualized local information, which was unavailable. More detailed, local data would improve the miles traveled and fuel efficiencies, however the impact on emissions is unknown. Given the complexity and lack of physical boundary for marine activity, this estimate is still justifiable with general understanding.

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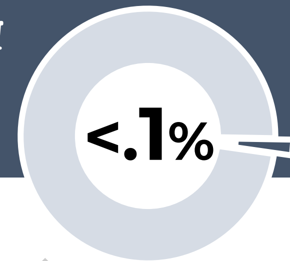
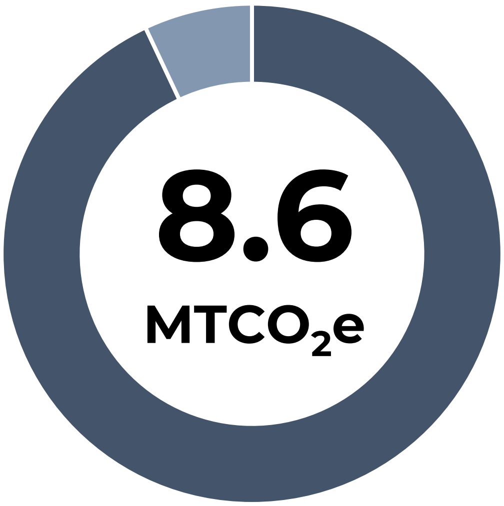
WASTEWATER TREATMENT

TOTAL OF GHG EMISSIONS



Nitrous oxide (N2O) from the biological treatment process of wastewater.



Emission Source	$MTCO_2e$	Percent
Residents	**8**	**93%**
Seasonal Visitors	0.6	7%

METHODOLOGY

Sitka's Wastewater treatment does not have nitrification or denitrification processes. Wastewater treatment emissions are calculated based on the total population served and type of treatment, using the federal GHG wastewater reporting methodology and corresponding emission factor[18]. Although the emissions from wastewater is small, it is included for completeness.

WASTEWATER EMISSIONS

Inputs	Amount	Source	Confidence
Residential Population	8,380	2023 U.S. Census Bureau	Great
Seasonal Visitors	694*	*Assuming 607,000 tourists spend ten hours in Sitka equates to this many people year-round residents	Good
Emission Factor	0.009 g N_2O /person/day	Federal GHG Accounting and Reporting Guidance	Great

Calculation $Number\ of\ People \times \frac{0.009g}{person} \times 365\ days = \boldsymbol{g\ of\ N_2O}$

CONFIDENCE LEVEL: Great

Scientific understanding of emissions associated with wastewater treatment plants is evolving. Using this emission factor is still considered best practice under current guidelines.

CONFIDENCE LEVEL: GOOD

This metric assumes every visitor to Sitka uses a facility connected to Sitka's sewer system. This is likely overestimated, however, given the small amount of emissions from this source, additional refinement to this section would not change emissions significantly.

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High-voltage transmission lines (not in Sitka)

SECTION 4

SCOPE 2: INDIRECT EMISSIONS | ELECTRICITY

NOT APPLICABLE

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SITKA COMMUNITY RENEWABLE ENERGY STRATEGY
A City and Borough of Sitka Project

Scope 2 SUMMARY

TOTAL OF GHG EMISSIONS **N/A**

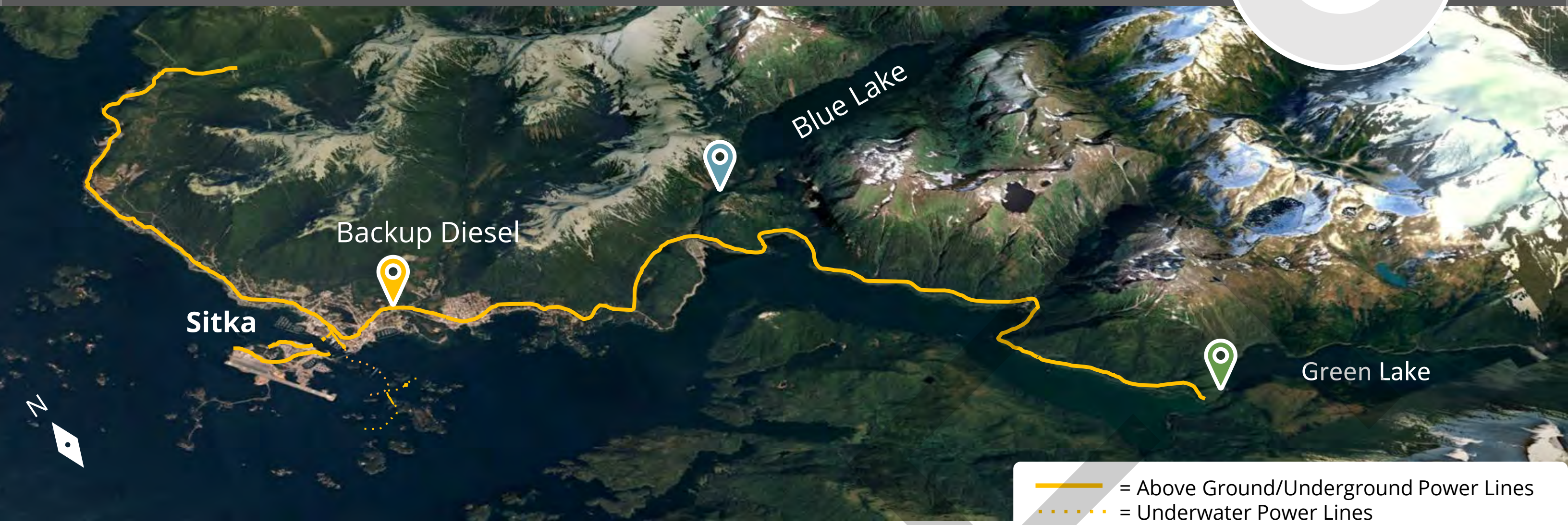

Figure 25 : Sitka's electric grid (orange line) is not connected to any other community

SITKA DOES NOT HAVE ANY Scope 2 EMISSIONS

Scope 2 emissions are indirect emissions associated with energy that is generated outside of Sitka's boundaries but consumed within Sitka's boundaries. Most commonly, Scope 2 emissions are from GHGs that are burned in power plants outside the boundaries of an area, but supply electricity via the grid connection *(Figure 25 and 10).* Because Sitka generates all electricity locally, there are no Scope 2 emissions.

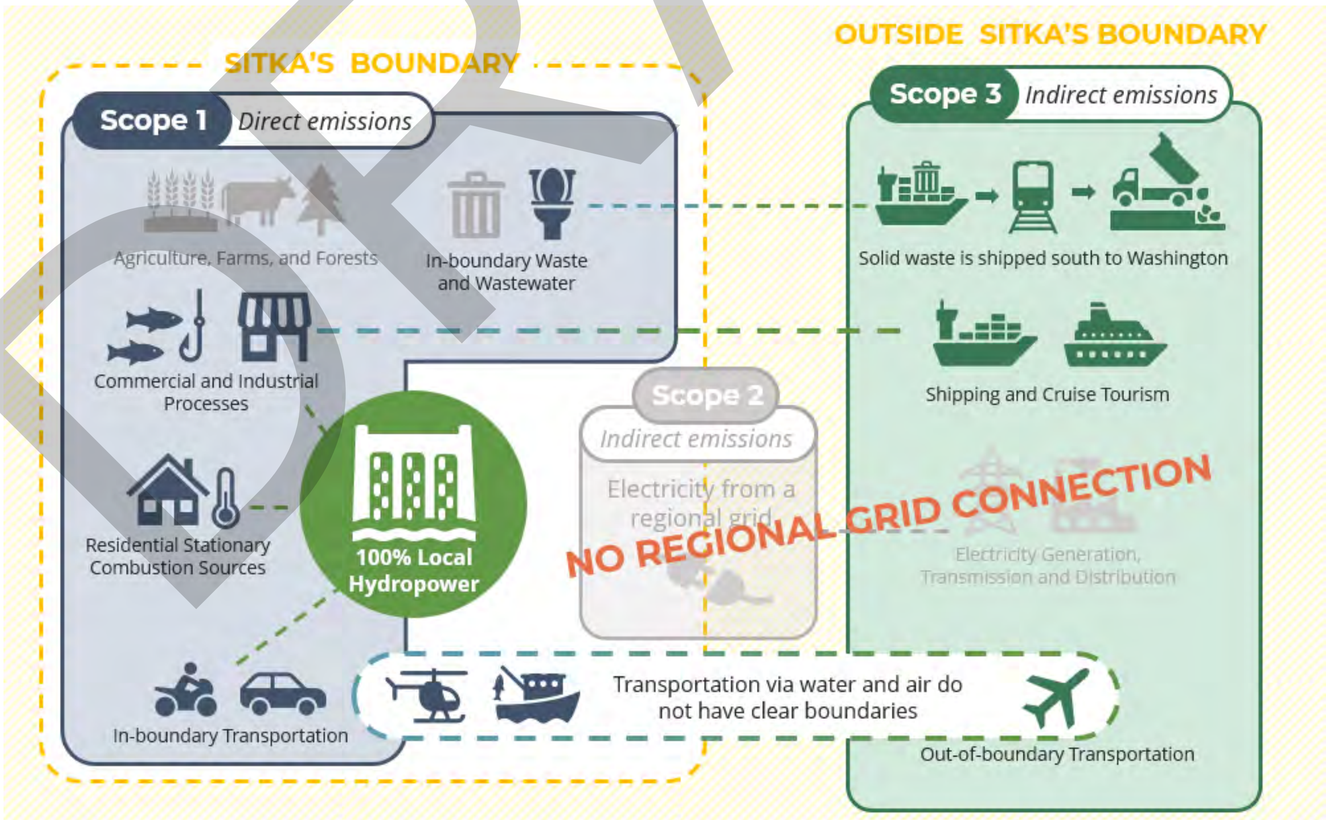

Figure 10: Sitka's categories of GHG emissions differ from standard methodologies.


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The Blue Lake dam

The Green Lake powerhouse on Silver Bay

SECTION 5

SCOPE 3: INDIRECT EMISSIONS

SITKA COMMUNITY RENEWABLE ENERGY STRATEGY
A City and Borough of Sitka Project

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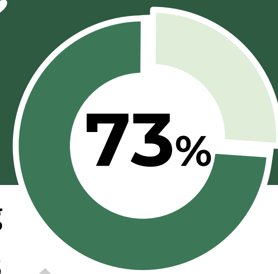
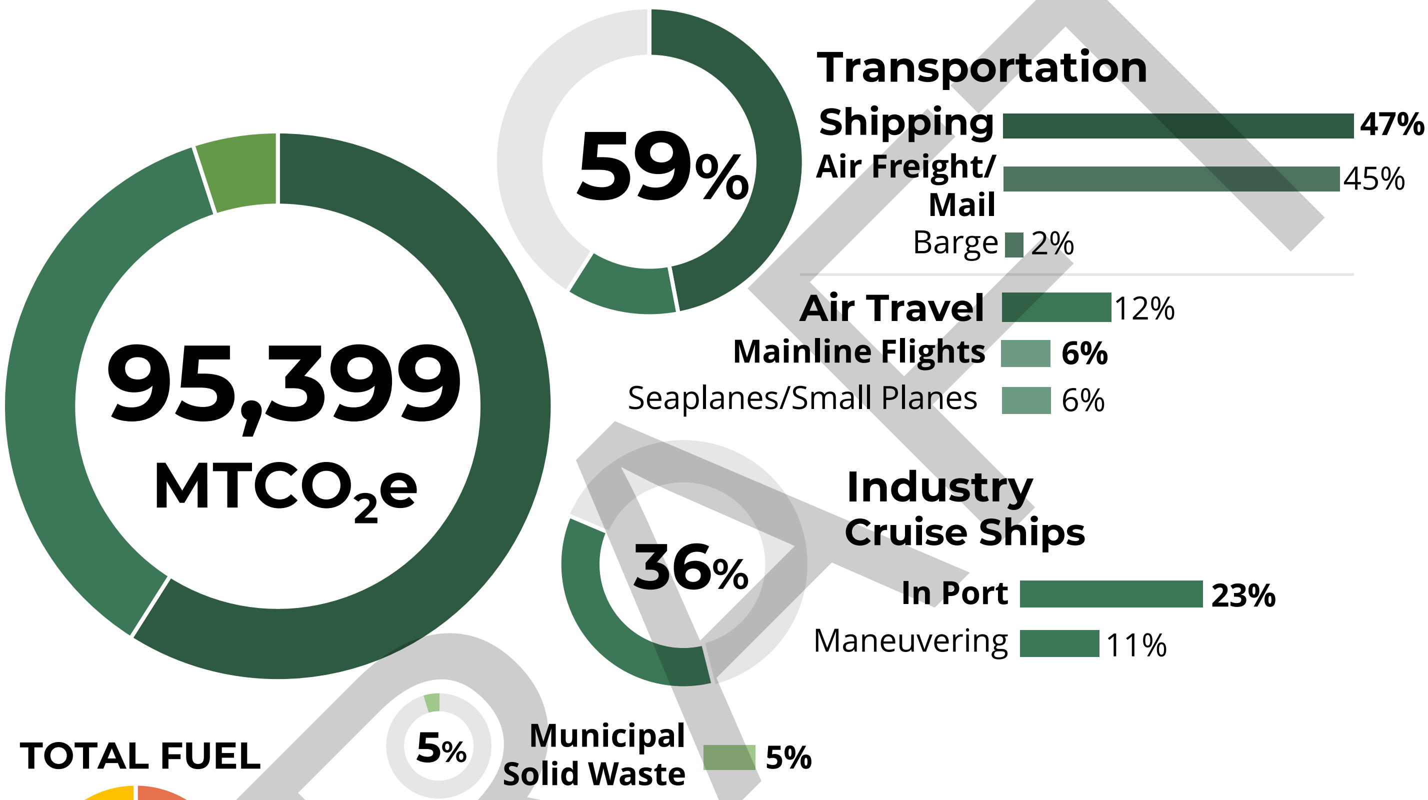
Scope 3 SUMMARY

TOTAL OF GHG EMISSIONS

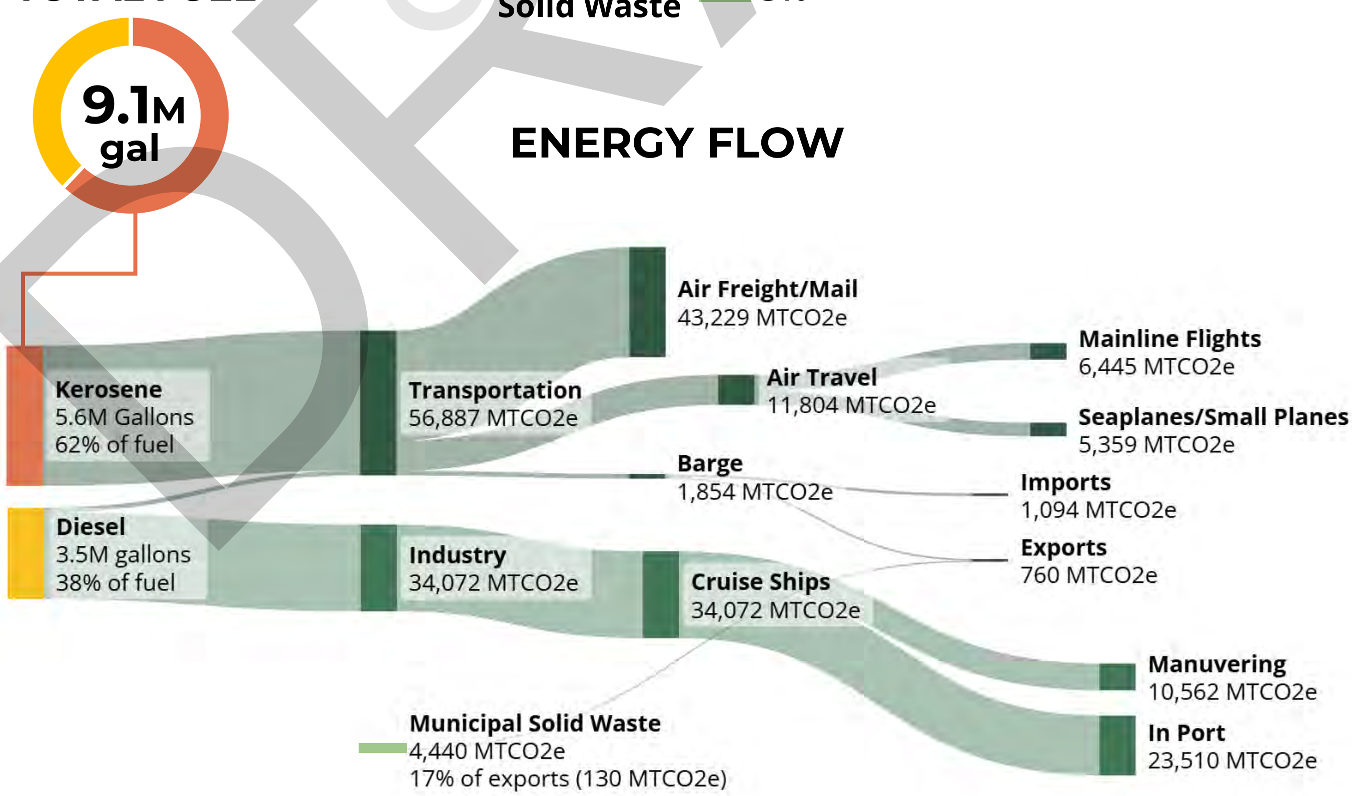


Indirect emissions that occur outside of Sitka as a result of activities taking place within the boundary. Because Sitka is an island, certain Scope 3 emissions were included to more accurately reflect the community. These include solid waste, shipping via barge and air, air travel, and cruise ships.



TOTAL FUEL

ENERGY FLOW



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Scope 3 SUMMARY

CONFIDENCE LEVELS OF ESTIMATIONS

Emission Source	Assumption Inputs			
Solid Waste Disposal - Great				
Municipal Solid Waste (MSW)	7,618 tons of waste	240 tons of recycling	Mixed MSW emissions factor	Recycling emission factor
Shipping - Great				
Marine/Barge Transport	117,658 tons of materials shipped and received	1,000 miles on a barge to/from Seattle	1 gallon of diesel moves 1 ton 650 miles	
MSW/Recycling Disposal	7,858 tons of material to Seattle			
Air Transport	3,963 tons of materials to/from Sitka	850 miles from Seattle to Sitka	0.00109 $MTCO_2e$ per ton-mile emission factor	
Air Travel – Good				
Mainline Flights	40,586 revenue passenger miles (RPM)	67% of flights are medium-haul 32% are short-haul	Weighted average emission factor 0.159 $MTCO_2e$/ RPM	
Seaplanes, Small Planes, Helicopters	657,784 gallons of kerosene imported	Aviation fuel emission factor 0.84kg $MTCO_2e$/gal	80% of imported fuel is used for this sector	
Cruise Ship Emissions – Good				
Cruise Ship Hotel	9 hours average time in port	29% Hotel MCR	Installed power (kW) and generator efficiency varies	
Cruise Ship Maneuvering	4 hours average approaching/leaving Sitka	54% Propulsion MCR		
Number/Types of Cruise Ships	333 scheduled trips	39 ships		

Table 8: Summary of confidence levels for all emission sources included in Scope 3.

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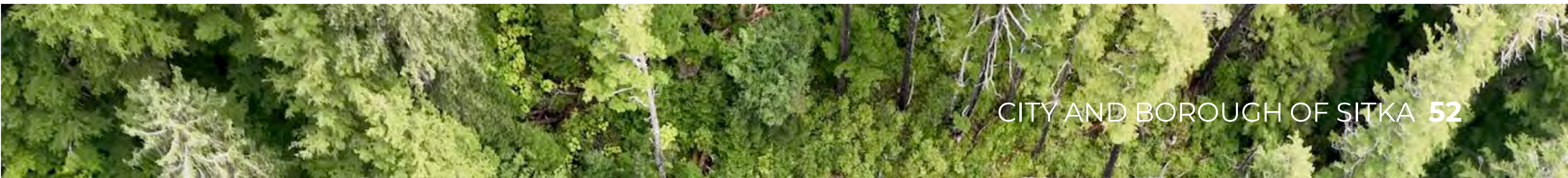
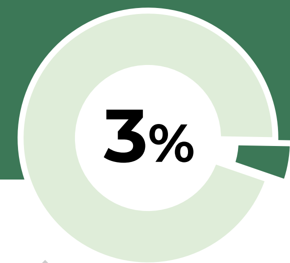
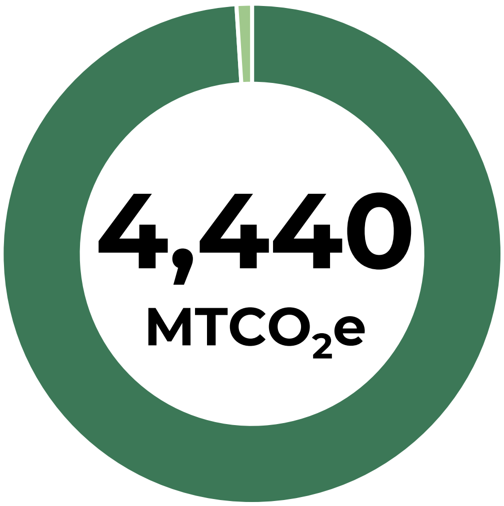


MUNICIPAL SOLID WASTE

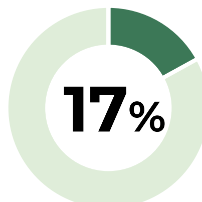
TOTAL OF GHG EMISSIONS



Decomposition of organic matter in landfills



Emission Source	$MTCO_2e$	Percent
Municipal Solid Waste	**4,418**	**99%**
Recycling	22	<1%
Shipping		
Barge Shipping	130	*



Barge Export Shipping Emissions

**this is not included in the total emissions for solid waste but is accounted for under shipping on page 54.*

MUNICIPAL SOLID WASTE (MSW) EMISSIONS

Inputs	Amount	Source	Confidence
MSW Shipped	7,618 tons	Republic Services 2023 Summary	Great
Recycling Shipped	240 tons	Republic Services 2023 Summary	Great
Mixed MSW Emission Factor	0.58 $MTCO_2e/ton$	EPA Emissions Factor[4]	Great
Recycling Emission Factor	$\frac{0.09\ MTCO_3e}{ton}$	EPA Emissions Factor[4]	Great

Calculation $\left(\frac{tons}{of\ MSW} \times \frac{0.58\ MTCO_2}{ton}\right) \times \left(\frac{tons}{of\ recycling}\ \frac{0.09\ MTCO_2}{ton}\right) = \boldsymbol{Emissions\ from\ Solid\ Waste}$

SHIPPING

Inputs	Amount	Source	Confidence
Distance Traveled	1,000 miles	Assumption of approximate one-way distance from Sitka to Seattle	Good
Miles one gallon can move one ton	650 miles	Texas A & M Transportation[20]	Good
Diesel Consumed to Transport to/from Sitka to/from Seattle	$\frac{1.54\ gallons}{ton}$	Texas A & M Transportation[20]	Great

Calculation $Tons\ of\ Waste\ Transported \times \frac{1.54\ gallons}{ton} = \boldsymbol{gallons\ of\ diesel\ to\ transport\ waste\ to\ seattle}$

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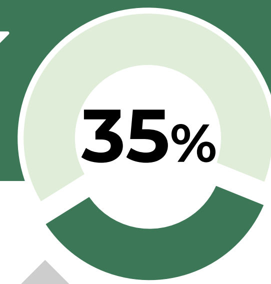
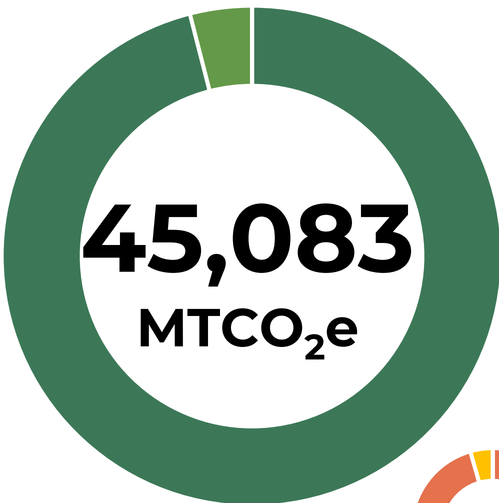
TRANSPORTATION
SHIPPING

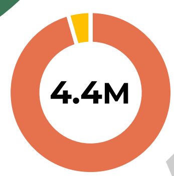
TOTAL OF GHG EMISSIONS



Emissions from transporting goods to and from Sitka via plane and barge.



Emission Source	$MTCO_2e$	Percent
Air Cargo	**43,229**	**96%**
Barge	1,854	4%
Received Goods *(Imports)*	1,094	2.5%
Shipped Goods *(Exports)*	760	1.5%
Solid Waste and Recycling	130	0.3%



Fuel Types			
Kerosene	**~4,200,000**	**43,229**	**96%**
Diesel	~180,000	1,854	4%

34% AIR CARGO

Inputs	Amount	Source	Confidence
Freight/Mail	46,658 tons	Bureau of Transportation Statistics	Great
Distance	850 mi	Estimated Distance from Seattle to Sitka	
Emission Factor	0.00109 $MTCO_2e$/ Ton-mile	EPA Emission Factor	

Calculation

$$\frac{Tons\ of}{Freight/Mail} \times \frac{Distance}{Traveled} \times \frac{Emission}{Factor} = \frac{\textbf{emissions from}}{\textbf{air shipping}}$$

1% BARGE

Inputs	Amount	Source	Confidence
Tons of Materials Shipped and Received	117,658 tons	USACE Cargo Report[9]	Great
Distance Traveled	1,000 miles	Assumption of approximate one-way distance from Sitka to Seattle	Good
Miles one gallon can move one ton	650 miles	Texas A & M Transportation[20]	
Diesel Consumed to Transport to/from Sitka to/from Seattle	$\frac{1.54\ gallons}{ton}$		Great

Calculation

$$\frac{tons\ of\ material}{transported} \times \frac{1.54\ gallons}{ton} = \frac{\textbf{gallons of diesel to transport}}{\textbf{to/from Sitka}}$$

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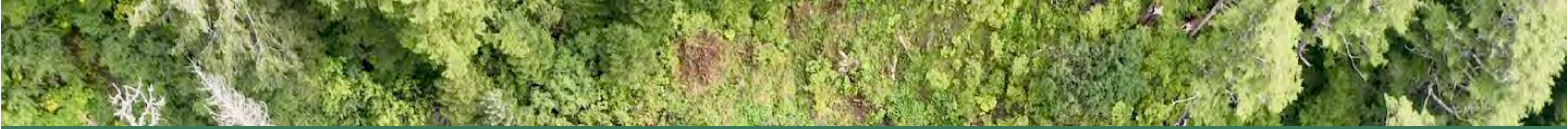

METHODOLOGY

Sitka is dependent on shipping for nearly all goods. Emissions from shipping are considered Scope 3 and are not always included in GHG inventories because of the difficulties estimating and lack of available information. It should be noted that although expensive, barge shipping is highly efficient when compared to other transportation. This is because more material can be loaded on ships compared to other forms of shipping, like trains, trucks, or planes. Similarly, air shipment is both expensive and extremely emission intense *(Figure 26).*

SHIPPING TO SITKA VIA AIR EMITS 42 TIMES MORE EMISSIONS THAN BY BARGE

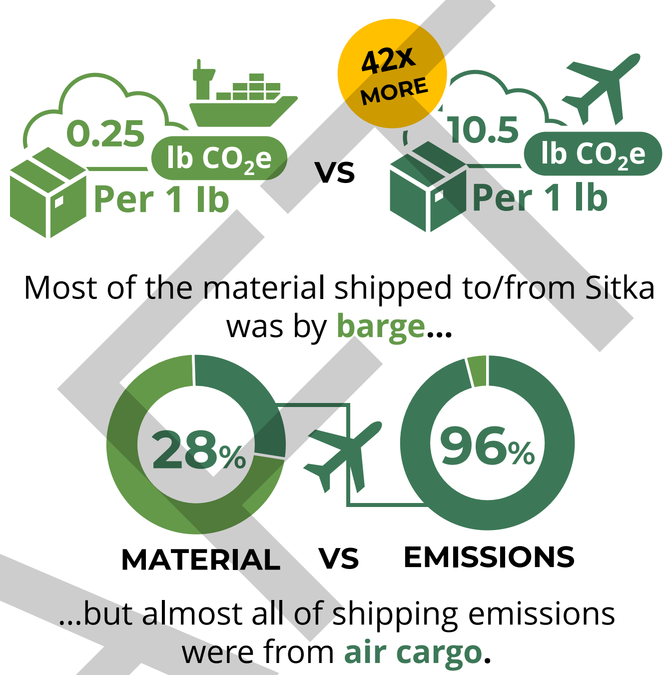

Figure 26: Comparison of emissions between shipping methods to Sitka.

AIR CARGO

The amount of freight and mail that arrives, and departs, from Sitka via mainline carriers (see page 60 for definition) is reported to the Bureau of Transportation Statistics[19] but is not divided into import and exports like with barge shipments. **In 2023, Sitka shipped and received 46,658 tons of freight and mail by air[19]** *(Figure 27)*.

TONS OF AIR CARGO IN 2023

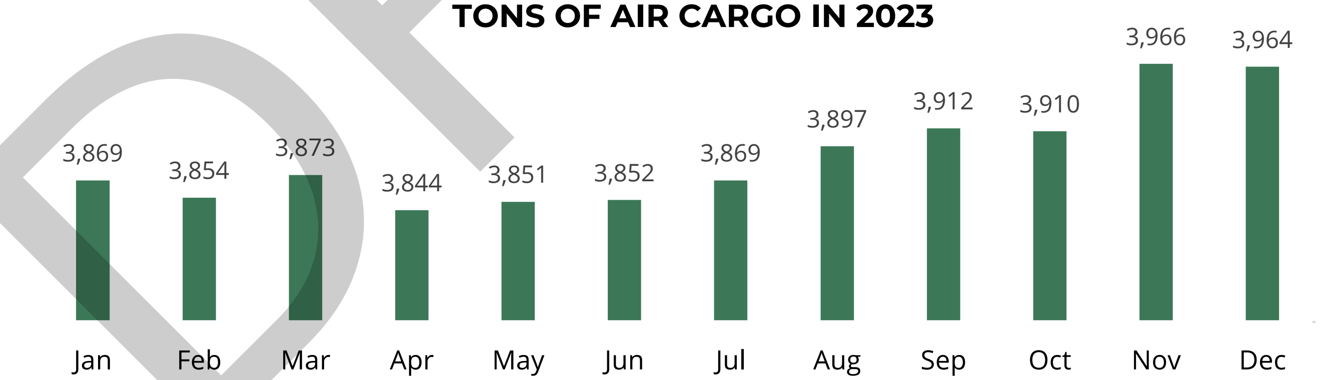

Figure 27: Sitka gets more air cargo in the winter months. This is consistent with the rest of the country when holidays increase the amount shipped.

OVERALL CONFIDENCE: Great

This estimate uses data reported from the Bureau of Transportation Statistics that is specific to Sitka. While the kinds of goods shipped and received would be insightful, they do not impact the estimate of emissions.

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BARGE SHIPMENTS

According to the 2022 Cargo Report, **Sitka shipped and received 118,000 tons of material via barges**[9]**.** Materials moved on waterways are categorized with **commodity codes** as described by the Waterborne Commerce of the United States[21]. These four-digit numbers include information about broad categories of goods but contain some details about the cargo *(Figure 28 and Table 10).*

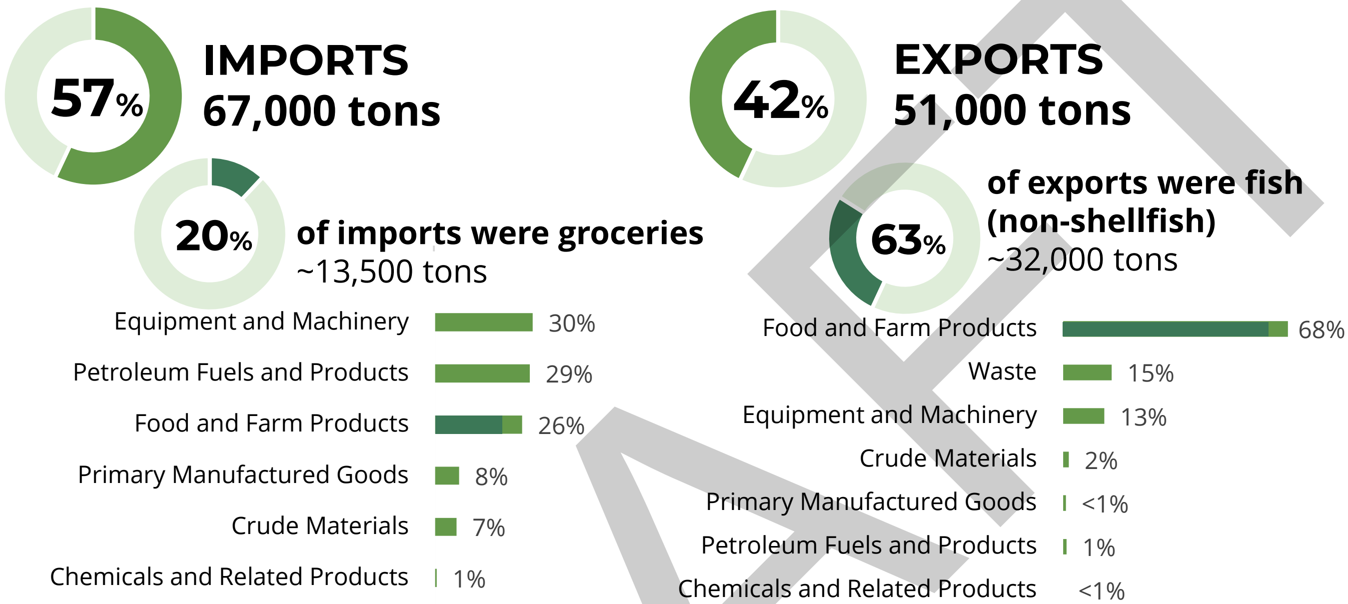

Figure 28: Groceries were the single biggest import to Sitka while fish was the biggest export.

Commodity Category	Examples
Petroleum Fuels and Products	Gasoline, diesel, kerosene, asphalt, tar, pitch
Chemicals and Related Products	Alcohols, some plastics, paints, chemical additives
Crude Materials	Inedible items, excludes petroleum Includes lumber, iron, salt, sand, gravel
Primary Manufactured Goods	Paper products, pipes, glass, metal sheets
Foods and Farm Products	Animal-sourced proteins, fruits, vegetables and other edible grocery items, alcoholic beverages, animal feed
Equipment, Machinery and Other Manufactured Goods	Electronics, vehicles, boats, aircrafts, parts, other machinery, clothes, plastic products
Waste Material	Garbage and landfill-destined items

Table 10: Definitions of commodity categories used in the Cargo Report[9, 21]*.*

OVERALL CONFIDENCE: GOOD

Though the shipping distance may vary based on agencies or material, it is a reasonable assumption to account for stops in other communities. While using distances of specific routes would improve the estimate, changes to overall emissions would be minimal. Although the emissions factor is not specific to Southeast barges, it is based on a large dataset over a long period of time. More specific would improve the estimate, but changes to overall emissions would be minimal.

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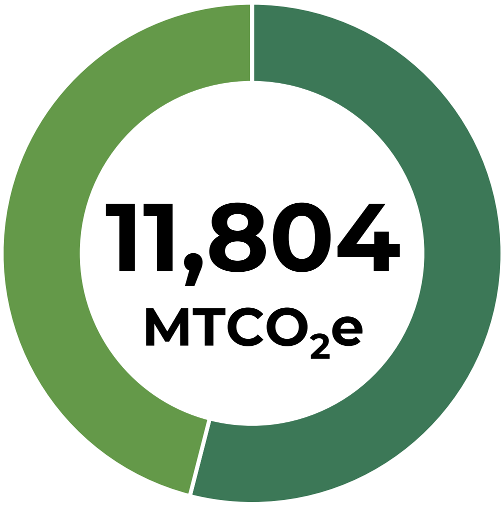
TRANSPORTATION

AIR TRAVEL

TOTAL OF GHG EMISSIONS **9%**

Emissions from commercial, personal, cargo, and general aviation.



Emission Source	$MTCO_2e$	Percent
Mainline Flights	**6,445**	**54%**
Seaplanes, Small Planes, Helicopters	5,359	46%

1.2M ~1,200,000 gallons of kerosene

5% MAINLINE FLIGHTS

Inputs	Amount	Source	Confidence
Revenue Passenger Miles (RPM)	40,586	Rocky Gutierrez Airport T-100 Segment Data, Bureau of Transportation Statics[22]	Great
Flight Distance	67% Medium-haul 32% Short-haul	Rocky Gutierrez Airport T-100 Segment Data, Bureau of Transportation Statics[19]	Great
Flight Emission Factor	0.159 $MTCO_2e$/ RPM	EPA Emission Factor, weighted avg been short and medium-haul flights[4]	Great

Calculation

$$\textit{number of RPM} \times \textit{flight emission factor} = \textbf{emissions from commercial air travel}$$

4% SEAPLANES, SMALL PLANES, HELICOPTERS

Inputs	Amount	Source	Confidence
Total Imported Kerosene	657,784 gallons	USACE 2022 Cargo Report[9]	OK
Aviation Fuel Emission Factor	0.84kg MTCO2e/gal	EPA Emission Factor[4]	Great
% of Imported Kerosene Used	80%	No supporting data	Poor

Calculation

$$\textit{gallons of kerosene used} \times \textit{aviation fuel emission factor} = \textbf{emissions from sea planes, small planes helicopters}$$

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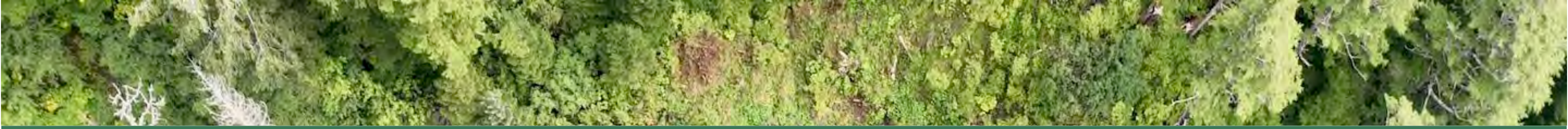

METHODOLOGY

Because Sitka is on an island, air travel is the primary mode of transportation to anywhere outside the city. This inventory includes emissions from aviation fuel combustion occurring within the city boundary and from portions of one-way transboundary journeys outside the city boundary (e.g., a flight to New York that has a layover in Seattle).

MAINLINE FLIGHTS

Ideally, this estimate would be calculated based on the amount of fuel used on flights destined for or originating from Sitka; however, that data is not reported to entities like the Federal Aviation Administration (FAA). Instead, this estimate uses available metrics reported by airlines with a method known as passenger-miles and associated emission factors. This section only includes mainline airlines that report to the Bureau of Transportation Statics[12]. In 2023, that included Alaska Airlines and Delta Air Lines. Commercial travel for small planes/seaplanes is not reported and therefore not included in section. Instead, commercial travel by seaplanes is included in seaplanes, small plane, and helicopter category, which generally lacks specific information.

REFUELING IN SITKA

The 5-Year Cargo Report shows Sitka imported 658,000 gallons of kerosene in 2022, which, in its highly refined form, is a type of jet fuel. This jet fuel is used for smaller, more local air travel such as seaplanes, small personal planes, and helicopters used for Coast Guard or medical evacuation. Emissions from burning this jet fuel are 5,359 $MTCO_2e$. However, according to community feedback, the Sitka Rocky Guiterrez Airport does some portion of refueling on-site, meaning some portion of this fuel imported goes toward refueling mainline air carriers at the airport. However, requests to obtain on-site refueling information from Alaska Airlines were unsuccessful. For this report, it is estimated that 20% of fuel in Sitka is used by mainline carriers, as it is assumed most of the fuel is used locally.

REVENUE PASSENGER MILES

Revenue passenger miles (RPM) is a metric reported by airlines that combines air traffic volume and distance traveled. For example, a plane with 100 passengers that travels 500 miles generates 50,000 RPM. For simplicity, RPM is reported in thousands. That means Sitka’s 40,586 RPM represents 40,586,000 miles and includes flight segments arriving to and departing from Sitka. This metric should not be confused with Available Seat Miles (ASM), which measures total carrying capacity.

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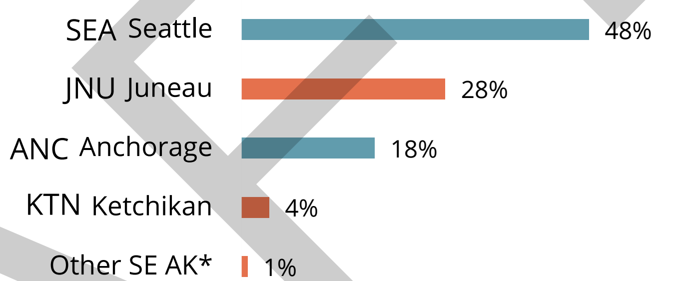
AIR TRAVEL HAUL EMISSION FACTORS

The distance a plane travels impacts its fuel efficiency. EPA emission factors are divided into three categories based on distance *(Table 11).* Flights to/from Sitka can be categorized as either short-haul (SIT-JNU, ~100 mi) or medium-haul (SIT-SEA, ~850 mi). For this inventory, the factor used is a weighted average of 67% medium-haul and 32% short-haul flights. Reporting for air taxi/seaplanes is optional and makes up ~1% of reported flights[22] *(Figures 28 and 29).*

Haul	Distance (mi)	MTCO2e per RPM
Short	<300	0.22
Medium	≥300 - <2,300	0.13
Long	≥2,300	0.17

Table 11: Seattle was the most common destination from Sitka and is considered a medium-haul flight.

Top Destination Airports and Haul-Distance



Most of Sitka's Flights are Considered Medium-Haul

**Other reported Southeast communities include Klawock, Kake, Wrangell, Petersburg, Port Alexander and Port Armstrong. Graphic does not reflect actual flightpaths.*

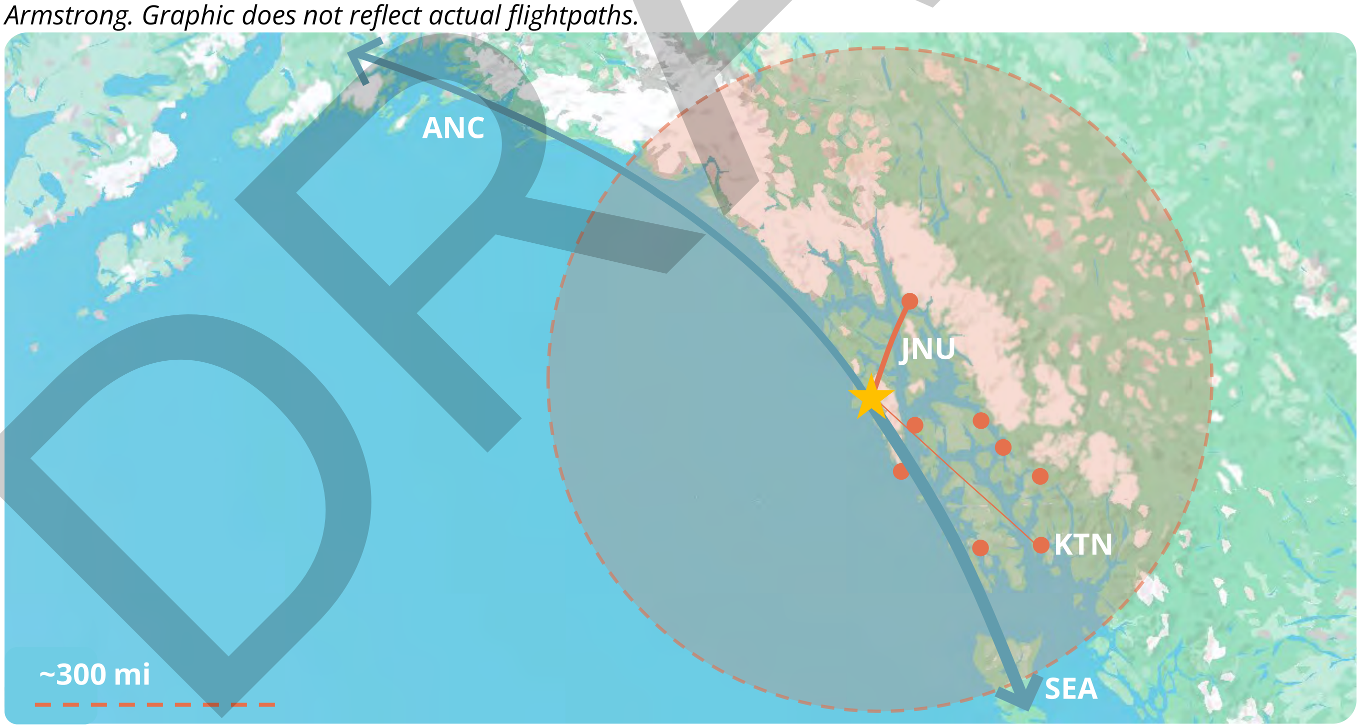


Figure 29 & 30: Destinations from the Sitka Rocky Gutierrez Airport and haul-category.

OVERALL CONFIDENCE: Great

This estimate uses Sitka-specific data. While the emission factor for aviation is considered accurate, this estimate is likely slightly underestimated, as the emissions factor and reporting is specific to mainline carriers. Even so, it is justifiable with general understanding.

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SEAPLANES, SMALL PLANES, HELICOPTERS

This section includes seaplane flights, including commercial passenger flights with fewer than 60 passengers and any associated cargo, as well as A29 Seaplane Base (float planes, which are Alaska Seaplanes and float planes for hire). The estimate assumes that 80% of jet fuel shipped to Sitka is used for these aircrafts.

OVERALL CONFIDENCE: NEEDS WORK

This estimate assumes that 80% of the jet fuel in Sitka goes to this sector with no additional supporting data. Details about flights, passengers, cargo, etc. could be impactful to this section and could be significant. It is unknown how additional data would affect the estimate.

FUTURE AIR TRAVEL WORK

This data is included in case additional information becomes available regarding refueling and local air travel in Sitka. The Sitka Rocky Gutierrez Airport tracks and report flights to the FAA. However, the FAA categories do not separate passenger flights, cargo flights, or track distances. As such, flight data provided by the Sitka Rocky Gutierrez Airport did not contain required information to quantify emissions from specific types of aviation but did provide some insight into the kinds of flights that take place. The following category descriptions are interpreted from official definitions provided by the FAA and contextualized for Sitka *(Figure 30 and Table 12).*

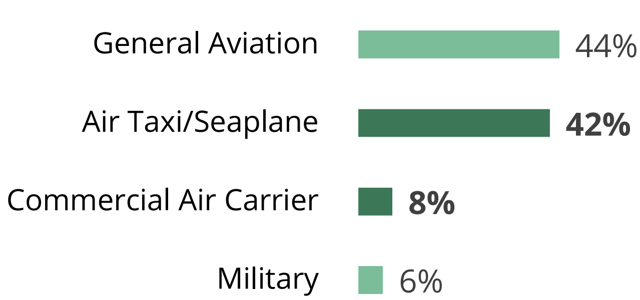
Commercial Air Carriers: Aircraft with a seating capacity of more than 60 passengers or a payload of >18,000 lbs that carry passengers and/or cargo. This includes mainline passenger jets and large cargo planes.

Commercial Air Taxis/ Seaplanes: Aircraft with a seating capacity of fewer than 60 or a payload of <18,000 lbs that carry passengers and/or cargo. This includes seaplanes and other small planes.

Military: Operations performed by military aircraft. The size and type of aircraft can vary widely depending on what operation is performed.

General Aviation: Private or rented civil aircraft used for recreation, training, or other private uses. These are generally smaller aircraft but may include small personal jets.

Half of flights in Sitka are commercial flights for passengers and/or cargo



Type	Number of Flights
Commercial Air Carrier	**1,812**
Air Taxi/Seaplane	**9,860**
Military	1,325
General aviation	10,342
Total in 2023	**23,339**

Figure 31 & Table 12: Types of flights to/from Sitka.

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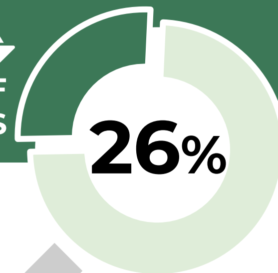
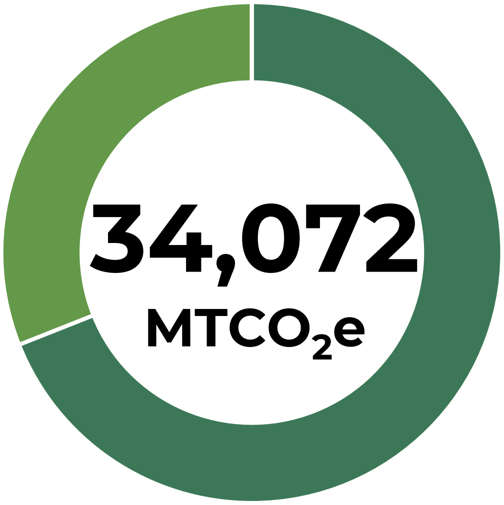
INDUSTRY

CRUISE SHIPS

TOTAL OF GHG EMISSIONS



Emissions from cruise ships entering, docking, and leaving Sitka.



Emission Source	$MTCO_2e$	Percent
Cruise Ship in Port	**23,510**	**69%**
Cruise Ship Maneuvering	10,562	31%

3.3M **~3,300,000 gallons of diesel**

Inputs	Amount	Source	Confidence
Avg Maneuver Time	4 hours	Historical Automatic Identification System (AIS)	Good
Avg Hours in Port (Hotel)	9 hours avg	2024 cruise ship schedule	Great
Propulsion MCR	25%	Input from cruise captain	Good
Hotel MCR	29%	Input from cruise captain	
Installed Power (kW) of Ship	Varies	Models from Alaska Cruise Schedule and additional research	Great
Generator Efficiency	Varies (grams of diesel/kWh)		

Calculation $\frac{\text{Hours in}}{\text{Sitka}} \times MCR\,\% \times \frac{\text{Installed}}{\text{power}} \times \frac{\text{Generator}}{\text{efficiecy}} = \frac{\textbf{Gallons of diesel}}{\textbf{used by a cruise ship}}$

DRAFT

METHODOLOGY

The cruise industry accounts for a large portion of Sitka's economic activity. Cruise ships do not draw power from Sitka's port, and they do not refuel in Sitka; however, they burn fuels while in port in Sitka. Although this combustion happens within Sitka's boundaries, it is standard practice in GHG reporting to count emissions from intercity or international trips as Scope 3 emissions. Only GHG emissions for cruise ships are reported. Additional pollutants such as nitrogen oxides (NO_x), sulfur oxides (SO_x), and fine particulate matter emissions (PM 2.5) are not included[23].

The schedule of cruise ships that visit Sitka each year includes specifics on dates, times, and names of ships. **In 2024, there were 333 scheduled trips to Sitka from 39 ships carrying ~600,000 passengers.**

TIME SPENT IN SITKA

BOUNDARY: To better understand the emissions produced within Sitka, a line connecting Cape Edgecumbe and Biorka Island served as Sitka's "boundary" *(Figure 31).*

MANEUVERING TIME: The time necessary for a cruise ship to approach Sitka, dock, and leave Sitka. Historical data from the Automatic Identification System (AIS), a system used to track ships, indicated that the average maneuver time for a cruise ship was four hours.

HOURS IN PORT: The 2024 cruise calendar times were analyzed and found that the average time spent in Sitka was nine hours.

On average, cruise ships spent 13 hours in Sitka.

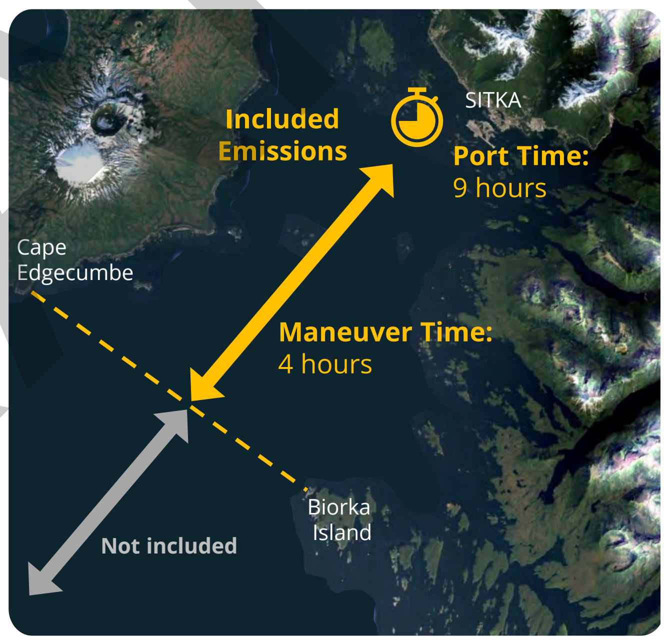


Figure 32. Map of cruise ship emission boundary and included parameters (orange).

CRUISE SHIPS ENGINES - MCR

Cruise ships use diesel engines to generate electricity, which is then used to power all aspects of the ship. Similar to generators, these operate at different loads depending on what the ship is doing. **How much an engine runs is reported as the maximum continuous rating (MCR) in the form of a percentage.** To estimate emissions, two MCRs are used, one while the ship moves and one while the ship is docked. The MCR estimates were provided by cruise ship captains and were noted to be slightly conservative.

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PROPULSION: The power that is needed to run the diesel-electric motors that spin the propellers that move the ship. This was reported to be **25% MCR** *(Figure 32).*

HOTEL: The power that is needed to run lighting, air conditioning, and other amenities on cruise ships while stationary. This was reported to be **29% MCR** *(Figure 32).*

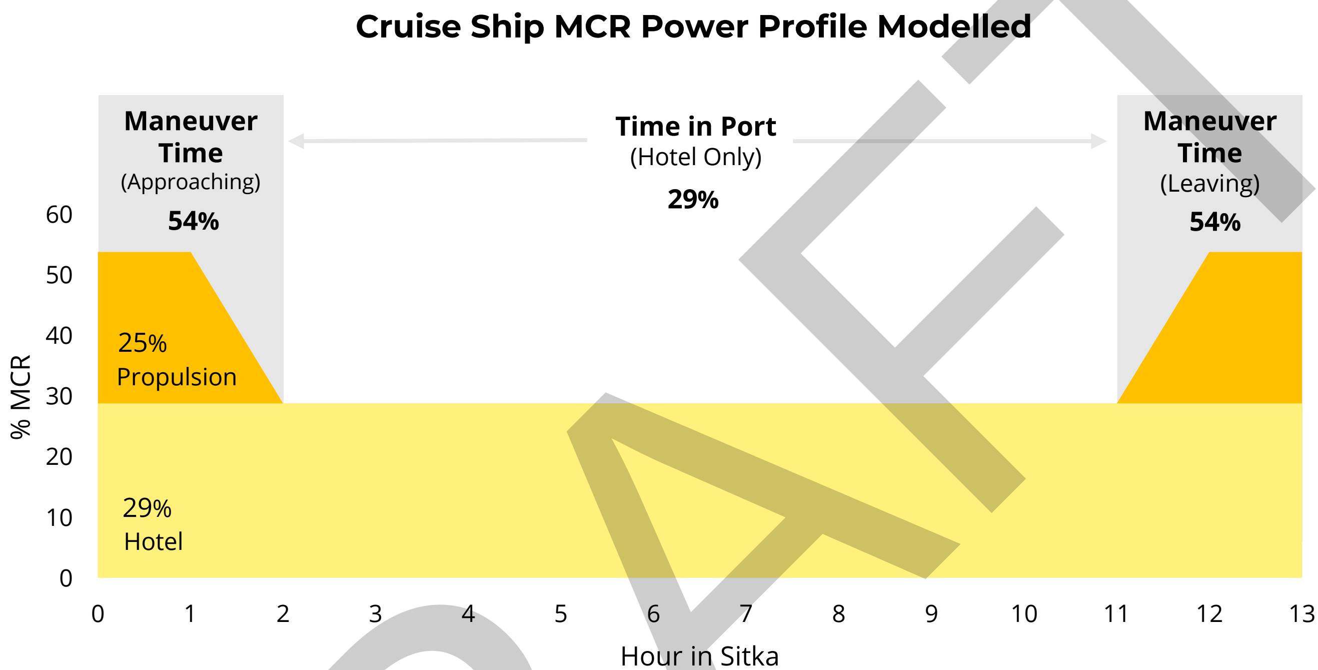

Figure 33: Cruise ships spend most of their time at the Hotel level of MCR.

OVERALL CONFIDENCE: GOOD

This estimate uses time-based information, researched data, and input from operators of cruise ships; however, each cruise ship operates differently, and information on propulsion is generalized. Improved data on fuel usage would improve the estimate, but the impact would likely be small.

CRUISE SHIP-RELATED GROUND TRANSPORTATION EMISSIONS

This is a subset of the emissions already considered from trucks and buses in the ground transportation section of Scope 1. This means emissions from tourism-related ground transportation are not an *addition* to the previously counted ground transportation emissions but rather a *portion* of these emissions. **This specific section of transportation resulted in ~36,600 gallons of gasoline/diesel and 375 MTCO$_2$e per year, or ~8% of ground transportation emissions.** Details of the methodology used can be found on page 42).

The Blue Lake reservoir

SECTION 6

REFERENCES AND APPENDICES

Appendices A and C are currently under final review and are not yet approved for public release. This document will be updated when final approval is made by PNNL.

SITKA COMMUNITY RENEWABLE ENERGY STRATEGY
A City and Borough of Sitka Project

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APPENDIX B

Vehicle Weight Classes & Categories

Gross Vehicle Weight Rating (GVWR) (lbs)	Federal Highway Administration		US Census Bureau
	Vehicle Class	**GVWR Category**	**VIUS Classes**
> 6,000	Class 1: < 6,000 lbs	Light Duty < 10,000 lbs	Light Duty < 10,000 lbs
10,000	Class 2: 6,001 – 10,000 lbs		
14,000	Class 3: 10,001 – 14,000 lbs	Medium Duty 10,001 – 26,000 lbs	Medium Duty 10,001 – 19,500 lbs
16,000	Class 4: 14,001 – 16,000 lbs		
19,500	Class 5: 16,001 – 19,500 lbs		
26,000	Class 6: 19,501 – 26,000 lbs		Light Heavy Duty 19,001 – 26,000 lbs
33,000	Class 7: 26,001 – 33,000 lbs	Heavy Duty > 26,001 lbs	Heavy Duty > 26,001 lbs
> 33,000	Class 8: > 33,001 lbs		

Gross Vehicle Weight Rating (GVWR) (lbs)	EPA Emissions Classification			
	Heavy Duty Vehicle and Engines			**Light Duty Vehicles**
	H.D. Trucks	**H.D. Engines**	**General Trucks**	**Passenger Vehicles**
< 6,000	Light Duty Truck 1 & 2 < 6,000 lbs	Light Light Duty Trucks < 6,000 lbs	Light Duty Trucks < 8,500 lbs	Light Duty Vehicle < 8,500 lbs
8,500	Light Duty Truck 3 & 4 6,001 – 8,500 lbs	Heavy Light Duty Trucks 6,001 – 8,500 lbs		
10,000	Heavy Duty Vehicle 2b 8,501 – 10,000 lbs	Light Heavy Duty Engines 8,501 – 19,500 lbs	Heavy Duty Vehicle Heavy Duty Engine > 8,500 lbs	Medium Duty Passenger Vehicle 8,501 – 10,000 lbs
14,000	Heavy Duty Vehicle 3 10,001 – 14,000 lbs			
16,000	Heavy Duty Vehicle 4 14,001 – 16,000 lbs			
19,500	Heavy Duty Vehicle 5 16,001 – 19,500 lbs			
26,000	Heavy Duty Vehicle 6 19,501 – 26,000 lbs			

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Gross Vehicle Weight Rating (GVWR) (lbs)	EPA Emissions Classification			
	Heavy Duty Vehicle and Engines			Light Duty Vehicles
	H.D. Trucks	**H.D. Engines**	**General Trucks**	**Passenger Vehicles**
33,000	Heavy Duty Vehicle 7 26,001 – 33,000 lbs	Medium Heavy Duty Engines 19,501 – 33,000 lbs		
60,000	Heavy Duty Vehicle 8a 33,001 – 60,000 lbs	Heavy Heavy Duty Engines Urban Bus > 33,001 lbs		
> 60,000	Heavy Duty Vehicle 8b > 60,001 lbs			

These charts illustrate the vehicle weight classes and categories used by the Federal Highway Administration (FHWA), the U.S. Census Bureau, and the U.S. Environmental Protection Agency (EPA). The vehicle weight classes are defined by FHWA and are used consistently throughout the industry. These classes, 1-8, are based on gross vehicle weight rating (GVWR), the maximum weight of the vehicle, as specified by the manufacturer. GVWR includes total vehicle weight plus fluids, passengers, and cargo. FHWA categorizes vehicles as Light Duty (Class 1-2), Medium Duty (Class 3-6), and Heavy Duty (Class 7-8). EPA defines vehicle categories, also by GVWR, for the purposes of emissions and fuel economy certification. EPA classifies vehicles as Light Duty (GVWR < 8,500 lb) or Heavy Duty (GVWR > 8,501 lb). Within the Heavy-Duty class, there is a Medium Heavy Duty Diesel Engine class for engine-only certification, but no Medium-Duty Vehicle class. The September 2011 U.S. Department of Transportation (DOT)/EPA rulemaking on Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles uses categories and weights for Heavy-Duty Vehicle Classes 2b through 8, similar to the FHWA weight classes.

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CITY AND BOROUGH OF SITKA

Mission: *To provide public services for Sitka that support a livable community for all.*