2021 Energy Use & Greenhouse Gas Emissions Inventory for Juneau, Alaska

Public Review DRAFT

May 16, 2023

Produced by

Constellation.

for

CITY AND BOROUGH OF JUNEAU
ALASKA'S CAPITAL CITY

Acknowledgements

CBJ Assembly

Juneau Commission on Sustainability

Energy Chair: Steve Behnke

Consultant Team

Sunny Sanwar, Ph.D., Constellation Energy
Alex Calder, Constellation Energy

Municipal Staff Contributors

Denise Koch, Deputy Director, Engineering & Public Works
Nate Abbott, Building Maintenance Supervisor, Parks and Recreation

Others who provided information and assistance
Lori Sowa, AEL&P
Mike Satre, Hecla Mining
Michael Spencer, Alaska Housing Finance Corporation
Rochelle Lindley, Kensington Mine

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

The City and Borough of Juneau (CBJ) previously completed greenhouse gas (GHG) emissions inventories for the years 2007[1] and 2010.[2] Those inventories quantified energy use by and emissions from both CBJ government facilities and sources in the community at large.

CBJ recently contracted with Constellation Energy to update the 2010 baseline information with 2021 energy use and GHG emissions data.[3] The purpose of the study was to get an updated analysis of energy usage and GHG emissions for the community. While the study is not designed to update CBJ climate or energy policy, the findings may guide future policy or actions.

In 2021, transportation and buildings caused the most GHG emissions, 47% and 25% respectively. It is important to note that, as in the 2010 report, and consistent with the standards of the Global Protocol for Cities, this study is limited to Juneau's community boundary and the energy consumed within it (its internal energy economy). As such, it excludes external energy consumption related to activities essential to the economy such as fuel purchased outside of Juneau for cruise ships, barge and air transport, etc.

The population of CBJ increased by 1.8% from 31,387 in 2010 to 31,973 in 2021.

This study also found that despite this slight growth in population, Juneau consumed 18% less energy which created 28% fewer emissions in 2021 compared with 2010.

Energy Consumption in 2007 (MMBtu)	MT CO2e in 2007	Energy Consumption in 2010 (MMBtu)	MT CO2e in 2010	Energy Consumption in 2021 (MMBtu)	MTCO2e in 2021
7.2 million	440,000	6.3 million	416,716	5.3 million	299,965
% Change from 2007				-29%	-31%
% Change from 2010				-18%	-28%

In 2010, the "Juneau Climate Action and Implementation Plan" set an emission reduction target of 25% from the 2007 base year to be reached by 2032.[4] The 2021 data shows that this milestone was already achieved by the end of 2021. In 2018, CBJ adopted a new target in the "Juneau Renewable Energy Strategy" (JRES) of increasing renewable energy usage to 80% of the total community energy use by 2045.[5] The 2021 data also indicates progress toward Juneau achieving its JRES target, with renewable energy (hydroelectricity) providing about 29% of total community energy use in 2021, compared with 20% in 2010.

[1] "City and Borough of Juneau Greenhouse Gas Emissions Inventory for 2007," March 2009. https://juneau.org/wp-content/uploads/2017/03/Juneau_GHG_Inventory_for_2007_FINAL.pdf

[2] "2010 Greenhouse Gas Emissions Inventory: City and Borough of Juneau," November 2011, https://juneau.org/wp-content/uploads/2018/04/GHGinventory11_16.pdf

[3] In this inventory, Global Protocol for Community-Scale Greenhouse Gas Inventories (GHG) is used to determine energy consumption (e.g., fuel use, electricity use) and appropriate emission factors.

[4] Juneau Climate Action & Implementation Plan. Available at https://juneau.org/wp-content/uploads/2018/04/CAP_Final_Nov_14.pdf

[5] CBJ Renewable Strategy https://juneau.org/engineering-public-works/jcos/renewable-energy-strategy

The reduction in community GHG emissions are very encouraging, but caution should be used when trying to detect a trend from only three points in time with an 11-year gap between the two most recent years studied.

II. COMMUNITY GHG EMISSIONS - 2021

Community energy and emissions analyses for Juneau are divided into the following sectors:

1. Buildings and the built environment (both stationary combustion and purchased electricity)
2. Equipment
3. Transportation (both on-road, water borne and air transport)
4. Industrial processes
5. Solid waste treatment

The methodology used in the 2021 inventory involved the collection or modeling of energy, fuel, and vehicle data, and the calculation of GHG emissions based on fuel types and uses. The inventory used the standard international protocols and methodology to determine metric tons of carbon dioxide equivalent ($MTCO_2e$) for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). A detailed description of the methodology can be found in Appendix A.

Emissions are generally broken down into Scope 1, 2, and 3. Scope 1 emissions refer to in boundary emissions, such as combustion of fuels for use within the community like heating a home or workplace and driving. Scope 2 emissions typically refers to grid supplied energy, such as electricity. Since AEL&P's electricity is generated and sold within Juneau, Scope 2 is already counted as Scope 1 generation.[6]

Table 1 below provides data on total emissions from Juneau by sector and source (fuel type) as well as details about each sector and source. This table and the following notes provide the information used to generate the 2021 community energy use inventory. The energy use information, combined with the emission factor (metric tons of CO2 equivalent per unit of energy use) was used to generate the GHG emissions figures found here and used in the updated 2021 Juneau Greenhouse Gas Emissions.

The population of CBJ increased by 1.8% from 31,387 in 2010 to 31,973 in 2021. On a relative basis, we can use the population-adjusted metric of per-capita emissions and energy uses across the three inventory years. Per capita emissions reduced over 29% in 2021 (9.38 MT per capita) from the 2010 inventory (13.28 MT per capita), and 34.5% since 2007 (14.32 MT per capita). Additionally, there was a per capita energy reduction of over 17% in 2021 (166 MMBtu per capita) from the 2010 inventory (201 MMBtu per capita), and 29% since 2007 (234 MMBtu per capita). As a frame of reference, various other U.S. cities have wide ranging per capita emissions, for instance - Farmington, NM at 69 metric tons per capita, to Seattle at 2.2 metric tons per capita[7].

---

[6] See the Appendix for more detailed discussion of the inventory scope.
[7] Source: Bloomberg CityLab: Which Cities Tend to Be the Greenest? The Answer May Surprise You

Table 1. 2021 Community-wide Energy Use and GHG emissions[8]

Sector	Fuel Type	Quantity	Units	MMBtu	%	$MTCO_{2}e$	% MT CO2e in 2007	% MT CO2e in 2010	% $MTCO_{2}e$ in 2021
	Heating Oil	6,572,542	gallons	6,572,542	18%	67,464	28%	22%	22.5%
	Propane	620,051	gallons	620,051	1%	3,498	1%	2%	1.2%
	Wood	1,175	cords	1,175	0%	2,510	2%	4%	0.8%
	Electricity	332,574	MWh	332,574	22%	2	1%	0%	0.0%
Built environment	**TOTAL**			**2,126,199**	**42%**	**73,475**	**32%**	**28%**	**24.5%**
Equipment	Diesel fuel	1,853,165	gallons	**266,011**	**5%**	**19,061**	**4%**	**5%**	**6.4%**
	Propane	4,003	gallons	364	0%	23	0%	0%	0%
Greens Creek	Diesel Fuel	604,300	gallons	83,394	2%	6,218	14%	5%	2.1%
	Electricity	71,099	MWh	242,661	5%	0	0%	0%	0%
	TOTAL			**83,758**	**6%**	**6,241**	**14%**	**5%**	**2.1%**
	Propane	204,785	gallons	18,637	0%	1,152	0%	0%	0.3%
Kensington[9]	Diesel Fuel	4,467,010	gallons	616,448	13%	45,749	0%	5%	15.3%
	TOTAL	**4,671,795**		**635,085**	**13%**	**46,901**	**0%**	**5%**	**15.6%**
Highway Transportation	Gasoline & Diesel	5,940,515	gallons	753,015	15%	55,039	25%	29%	18.3%
Air Transport	Ave Gas & Jet Fuel	3,909,528	gallons	522,259	10%	37,365	10%	9%	12.5%
Marine Transportation*	Gasoline & Diesel	4,800,000	gallons	464,960	9%	48,877	16%	17%	16.3%
	Electricity	764	MWh	2,606	0%	0	0%	0%	0%
Transportation	**TOTAL**			**1,742,840**	**34%**	**141,282**	**51%**	**55%**	**47.1%**
Waste	Waste		Metric			12,904		2%	**4.3%**
Total				**5,097,935**	100%	**299,965**			**100%**
Change from 2007				7,212,181 (-29%)		440,545 (-31%)			
Change from 2010				6,249,372 (-18%)		416,716 (-28%)			

[8] Totals may not be 100% due to rounding.
[9] AEL&P transmission and distribution system ends several miles from Coeur-Kensington Mine. The mine is not located within AEL&P's utility service area.

Figure 1
2021 Community-wide Energy Consumption (Source)

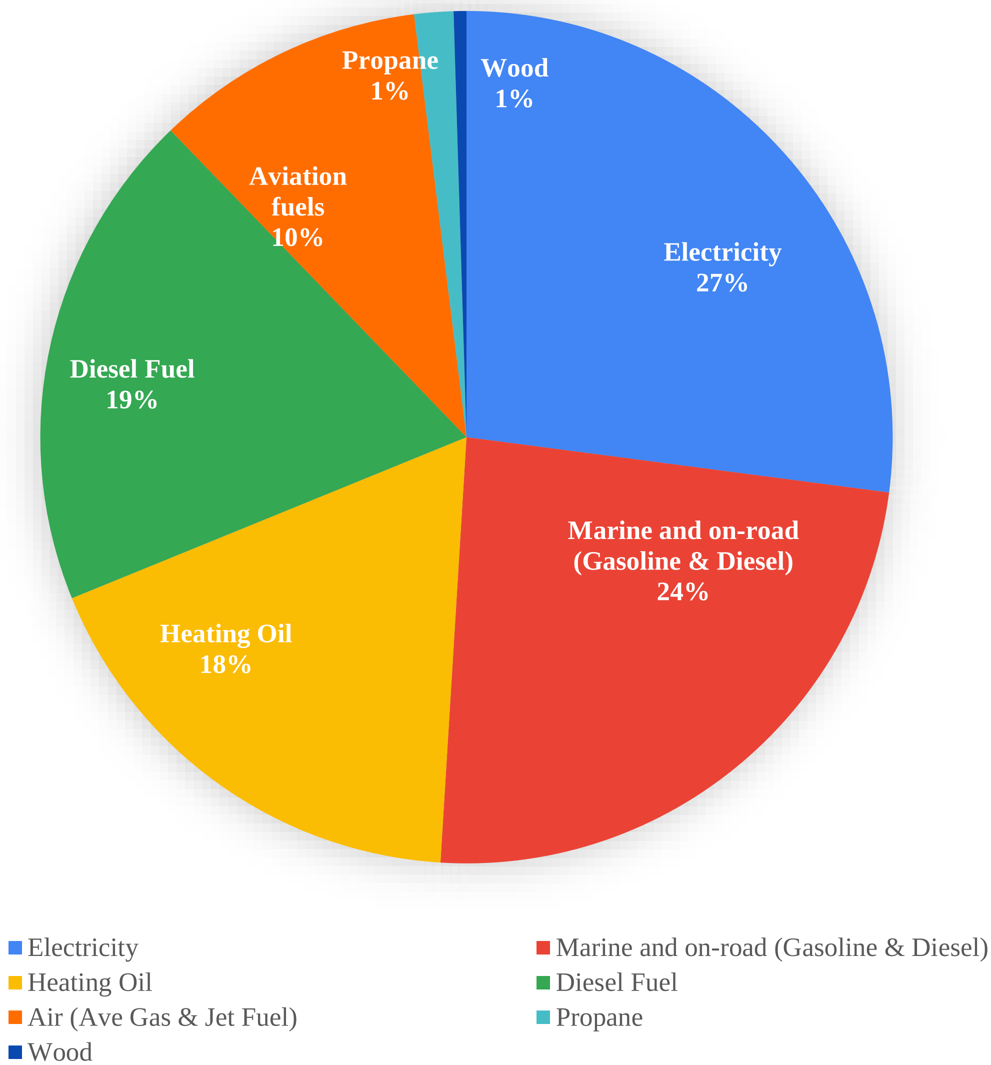
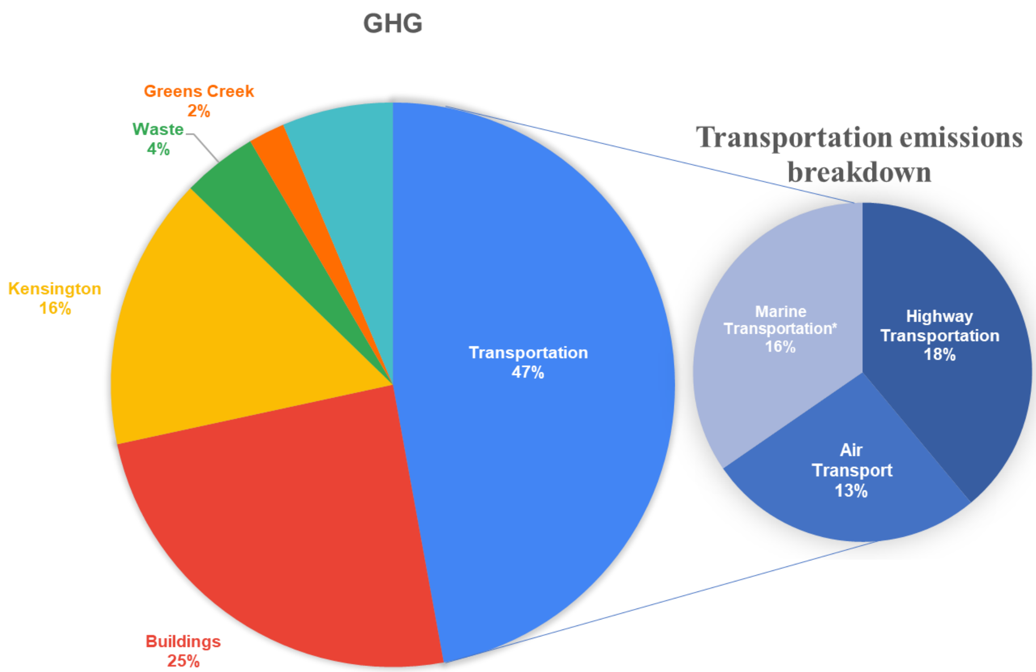


Figure 1 shows the total energy used by source, including petroleum, wood, propane, and electricity. Figure 2 shows the emissions produced by each sector.[10] Energy use correlates to GHG emissions in most sectors, with the highest fuel consuming sectors, transportation and buildings, providing the greatest opportunity for future reductions in GHG emissions. In 2021, transportation contributed more than 47% of GHG emissions, with almost half (18%) coming from highway transport. Buildings produced almost 25% of community GHG, primarily from petroleum-based sources used for ventilation, space heating, and hot water.

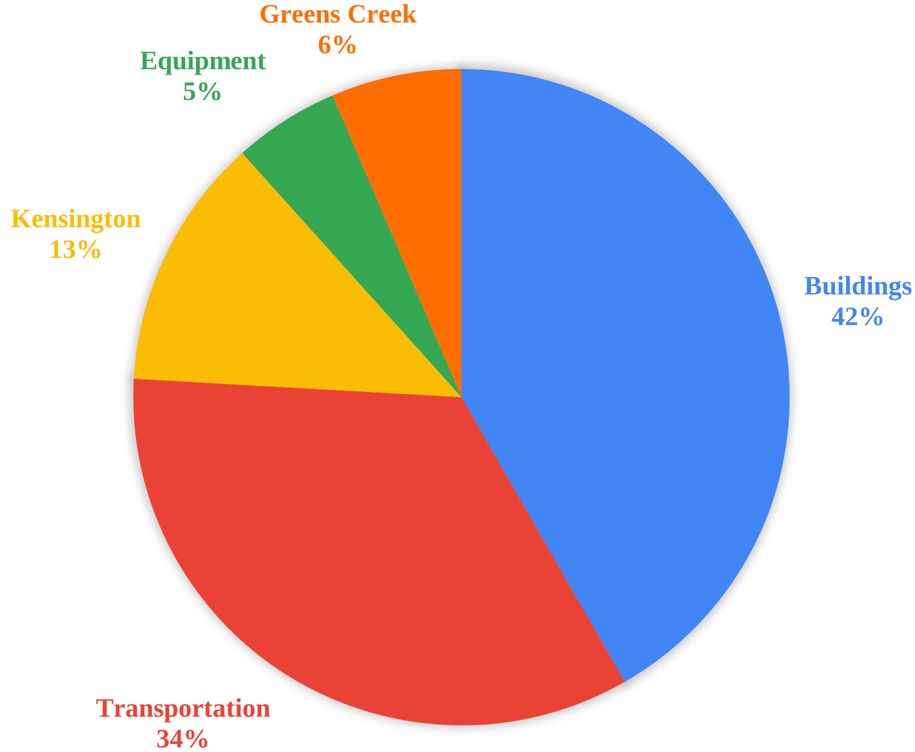
[10] NOTE: Diesel fuel for industrial usage is shown in green, where heating fuel for stationary heating in buildings is shown in yellow. Diesel fuel for transportation is shown in combination (air and marine uses) in red, along with gasoline.

Figure 2
Community-wide GHG Emissions (Sector)



As the highest energy consumers, the transportation and building sectors will provide the greatest future opportunities to reduce energy use in Juneau. Buildings represent the greatest single energy consuming sector, accounting for 42% of total energy use, as shown in Figure 3. However, when highway, air, and marine transportation are aggregated, that combined transportation sector uses 34% of the community's energy. The borough's two large mines consume 24% of total energy- 19% in stationary energy and 5% equipment-related fuels.

Figure 3
2021 Community-wide Energy Consumption



1. Buildings

Building and the built environment includes energy types like electricity and fuels (diesel, propane, wood, etc.) which are in turn used in residential, commercial, and industrial buildings located within the community. Most emissions are from fuel used to heat buildings and provide hot water. Street and marina and airport lighting was included in the built environment category, similar to building lighting, in terms of electricity usage. In 2021, liquid fuels consumption data was not provided by the respective fuel providers, as was the case in 2010. Thus, 2010 fuel actuals were obtained direct from primary data, whereas in 2021, fuel consumption was modeled based on activity data obtained from several government sources.

For stationary use, unlike 2010 inventory where fuel data was directly available, a model was used that estimated energy use in BTU for the 2021 year. See Table 2.

Table 2. 2020 ACS (US Census) Survey Estimates of CBJ Heating Fuel Distributions.

Total occupied housing units	**12,922**	**100%**
Heating oil (Fuel oil, kerosene, etc.)	6,838	53%
Electricity	4,164	32%
Other	698	6%
Propane (Bottled, tank, or LP gas)	643	5%
Wood	242	3%

Heating oil refers to liquid fuels sold by suppliers and was estimated given fuel data was not available. A model was created that first evaluated the total heating-fuel based households in the CBJ boundary, from the American Community Survey (ACS) of the U.S. Census 2020. A similar approach was used for propane and wood. **Propane** also had historically included all propane sold by local distributors, Amerigas and Arrowhead in 2010, and did not include propane delivered from outside Juneau to either mining operation. However, in 2021, due to the unavailability of this data, the same model was used as heating oil and fuel.

Wood energy data in 2010[11] and emissions calculations was based on the Alaska Department of Environmental Conservation Mendenhall Valley 2007 wood use survey extrapolated to the rest of the community. We applied a similar model[12] for both wood, propane and heating oil for the 2021 update – which included data for every building in the CBJ area, year-built, principal use of building, square footage and orientation, to estimate energy-use-intensity by fuel type.

Electricity includes all electricity sold by AEL&P in 2021, including electricity sold to cruise ships while docked in Juneau (538 MWh). In 2021, most electricity was produced by hydroelectric power with less than 0.2% provided by diesel fuel.

AEL&P provided data on consumption of electricity in 2021 within the CBJ boundary in MWh, broken down by major uses, such as residential, commercial, governmental and industrial customers, and transportation. According to supplier specific emission factors provided by AEL&P, the market-based Scope 2 methodology resulted in 628.32 MT CO2e of emissions[13] which is a 6% decrease in electricity emissions, despite a 9% increase in total electricity consumption between 2010 and 2021.

Please note, the location-based emission factors from the U.S. EPA for the ASCC Miscellaneous (AKMS) EGRID subregion, which includes CBJ, are 486 lbs./MWh or 0.24 MT CO2e/MWh. This EPA subregion is a compilation of several different islanded electrical utilities throughout the state of Alaska that are not interconnected, and so these emission factors do not accurately represent electricity production for the CBJ and therefore are not used in this analysis. [14]

[11] By calculating the total number of households likely using wood from the 2020 ACS survey. The total number of households were used to understand the cords of wood used. Previously, a similar model was used in 2010 using survey data of households to estimate number of cords and pellets per household by the number of households, to determine total energy from wood used in MMBtu.
[12] https://www.energy.gov/eere/buildings/articles/energyplus
[13] Assuming the diesel emissions of 2.24 lbs. per kWh, or 0.00102 MT CO2e per kWh at 616,000,000 kWh of diesel generation reporting in CY2021.
[14] Source: Communication with Lori Sowa at AEL&P

Table 3. AEL&P 2021 Downstream Delivered Electricity in CBJ Sectors.

Sectors	kWh usage in 2021
Commercial	168,762,235
Residential	159,844,781
Government	74,842,124
Transportation	763,621

Table 4. AEL&P 2021 Upstream Generation of Electricity in CBJ

Electricity generation CY 2021	
Diesel generation (MWh)	616
Hydro Generation (MWh)	431,652
Total Generation	432,268
% Diesel	0.14%
% Hydro	99.86%
Gallons of diesel combusted	51,408

2. Equipment

Equipment includes gallons of fuel used by industrial equipment and machinery, like mobile combustion in mining or waste treatment facilities. Diesel equipment level emissions were already accounted for by generators operated by AEL&P, and discussions regarding industrial facilities and mining operations in the two mines are discussed in the industrial processes sections and provided by landfill and mining company personnel.

3. Transportation

Highway Transportation: This on-road transportation emissions included emissions from burning gallons of gasoline and diesel combusted by vehicles. While past GHG emissions from highway transportation are based on actual gallons provided by fuel distributors, given the lack of such data in 2021, a novel method to estimate vehicle miles traveled (VMT) was used, which was a recommendation in 2010.

Using the 2021 Average Annual Daily Traffic Count from the Alaska Department of Transportation & Public Facilities, the 2021 update estimated 152,063,352 miles of travel by passenger, light-duty and heavy-duty vehicles. In order to get 2021 vehicles by class codes, the inventory made use of the State of Alaska Division of Motor Vehicles' list of vehicles. To determine the number of passenger cars and light and heavy trucks, this analysis identified vehicles registered in the zip codes within City and Borough of Juneau as of December 2021, across Vehicle Class Codes. CBJ has a special attribute given its location, such that the lack of roads in or out of Juneau means that most fuels purchased in Juneau are used within borough boundaries. Since the assumptions regarding fuel usage across registered vehicles did not include electric vehicles, transportation emissions may be slightly skewed to gasoline and diesel. Electric vehicle charging was included as a separate component shown in Table 1 with 538 MWh to cruise ships and 224 MWh for residential EV and 2 MWh for commercial EVs.

Air Transportation: Emissions from air travel includes gallons of aviation gasoline and jet fuel provided by local distributors within CBJ. Generally, the fuel flowage records from the Juneau International Airport (JIA) based on reporting for the CBJ fuel flowage fee charged on all fuel sold at the airport is less than the combined amount from distributors, primarily due to less aviation gas being pumped at the airport than sold by distributors. However, in 2021, distributors' data on sold fuels were not available – so JIA personnel provided data across all airlines and fuel types.

We also collected data on total enplanements from the Federal Aviation Administration (FAA) (306,512 enplaned passengers in 2021) with small carriers reporting directly to FAA, and not to JIA – which is why the 2021 data on enplanements was 253,170 passengers. Additionally, 1,594,283 tons of mail and 4,264,882 tons of freight being carried via the airplanes going out from CBJ. As a result, the total gallons of liquid fuels for 2021 was 3,909,529 – 170,530 gallons of aviation gasoline and 3,738,999 gallons of jet fuel[15], which overall was a 0.4% reduction from 2010 numbers. The 2021 sales of fuels were considered high given data over the past 7 years, with consumption has typically ranged between 2.5-3 million gallons. For example, 1.56 million gallons were consumed in 2019. The variability is generally affected by economic conditions, as well as varying purchasing policies of different airline companies that change year to year.

Marine Transportation: Scope 1 energy use and emissions for marine transportation totaled 4.8 million gallons of fuels and 48,877 metric tonnes of CO2e. Scope 1 emissions refer to emissions from direct combustion of fossil fuels for all riverine trips, by marine ferries and boats traveling between seaports that originate and terminate within the CBJ boundary (GPC, pg 80-81[16]). In the 2007 and 2010 inventories marine transportation emissions included all marine gasoline and diesel sold by the fuel distributors in Juneau. These figures included fuel for the Alaska Marine Highway and other marine fuel pumped in Juneau but did not include the fuel used to ship goods to Juneau or fuel used by cruise ships, which would be Scope 3 emissions. In the 2021 update, due to no data provided by fuel distributors, an alternative process was used and explained in the Appendix.

4. Industrial Processes

Any energy used for businesses for non-process purposes such as energy for heat and lighting for buildings is included in the "Buildings and built environment" section. This section includes energy used specifically for industrial processes.

Greens Creek Mine: The Hecla Greens Creek Mining Company operates on Admiralty Island near Juneau. This report uses information from EPA for Greens Creek consumption information for electricity, propane, and diesel fuel used for equipment and non-highway vehicles, heating,

[15] It is to be noted, that only fuel consumed within Juneau for air transportation is being counted as the in-boundary scope 1 - as a result, flights that have fueled elsewhere before arriving at the airport, are not being counted above, which would represent its scope 3 emission instead. See cruise ship emissions for broader discussion around in-boundary fuel usage classification for Scope 1 and 3 calculations according to GPC.

[16] GHG Community Protocol, pp. 80 - 81. Global Protocol for Community-Scale Greenhouse Gas Emission Inventories, available at https://www.ghgprotocol.org/sites/default/files/ghgp/standards/GHGP_GPC_0.pdf

and hot water.[17] In 2021, Greens Creek Mine used 0.604 million gallons of Distillate Fuel oil (#2), 4,003 gallons of propane, as well as 38,000 gallons of used oil, emitting the 6,603 metric tons of total emissions. Between 2007 and 2010 Greens Creek GHG emissions were reduced by 67% by shifting from self-generating electricity with diesel to using hydropower from the new Lake Dorothy hydropower project. Greens Creek's data on actual fuels purchased and used each year for stationary combustion was used and includes power and heat generation facilities, as opposed to the partial data reporting conducted under the Toxics Release Inventory (TRI) Program. The EPA data does not include fuels consumed or combusted in mobile surface and underground equipment. All of the mines annual fuel used on-site is purchased from Petro Marine and delivered via fuel barge from outside of Juneau. The mine didn't differentiate which portion of the fuels were from within Juneau (Scope 1) and which portion originated outside (Scope 3).

Kensington Mine: The Coeur Alaska Kensington Gold Mine operates at the northern end of the City and Borough of Juneau in the vicinity of Berners Bay. The mine started production in June 2010. Kensington supplied information on diesel fuel and propane for stationary use (as reported to the U.S. Environmental Protection Agency) in 2021. Kensington's reported diesel fuel includes stationary fuel used for generators, non-highway vehicles, heating, and incinerators. Kensington Gold Mine used 4.47 million gallons of Distillate Fuel oil (#2) as well as 204,785 gallons of Liquified Petroleum Gas (LPG) and emitted 46,917 metric tons of CO_2e, which increased drastically (2.5x) from 2010 – at 18,285 metric tons. It is to be noted, that this significant difference in 2010 was due to the fact Kensington had just opened, and the energy use reflected only one-half year of regular operational activities.

Also of note, Coeur Alaska invested in a new powerhouse, with construction of the plant completed in 2019. According to Coeur Alaska, the new plant reduced fuel consumption by 25% and particulate matter by 85% thereby reducing overall emissions. Even with these efficiencies, Coeur Alaska has been seeking sustainable power solutions to reduce or eliminate reliance on diesel power generation, and to reduce greenhouse gas emissions. Coeur Alaska is in the process of exploring alternative options to reduce diesel usage and GHG emissions, such as an onsite battery bank, heat capture system, and in-pipe hydro generation.

5. Solid Waste Treatment

Juneau's privately-owned solid waste landfill is located in the Lemon Creek area and includes municipal solid waste and construction/demolition debris deposited in the Capital Disposal landfill. As a point of note, Capital Disposal landfill provided total waste tons for 2007 and 2010, divided into types of waste (paper products, food waste, plant debris, wood or textiles, and all other waste). The metric ton equivalent was determined using the following standard formula, assuming 1 short ton is 0.90 metric tons with the methane coefficients applied for each type of

[17] A full GHG annual report is available for the company at https://www.hecla.com/wp-content/uploads/2021-Hecla-Sustainability-Report.pdf listing overall mobile fuel use at just over 1 million gallons of diesel and 12,000 gallons of gasoline.

waste. Finally, the EPA national default value for the efficiency of methane collection (75%) was applied, with an assumed 1% of methane collected escaping during the flaring process.

In 2021, Capitol Disposal Landfill emitted lower emissions of 12,904 mt CO2e[18] compared to the 2010 amounts of which was 26,893 mt CO2e and a 6,925 mt CO2e w/flare. This was due to 1,539 MMBtu of diesel use, as well as 3066 MMBtu of used oil use, contributing to 341 metric tons of CO2e in 2021 for stationary combustion. Additionally, 12,562 metric tons of CH4 were emitted from the landfill decomposition and processing of both organic and inorganic materials, from municipal solid waste and construction or demolition debris, into the atmosphere, accounting for a combined 12,904 metric tons of CO2e. The normalized comparison is between 12,904 mt CO2e in 2021 which is 48% of the 26,893 mt CO2e in 2010 (an eleven-year period), was already on a reduction trajectory over a three-year period from 18% in 2007. Capitol landfill additionally purchased approximately 15,325 gallons of offroad diesel for use in their non-stationary equipment. This contributed to a further 150 metric tons of emissions is significantly lower than GHG emissions from fuels community residents use in traveling back and forth from the landfill for both dropping off recycling and their residential waste.

In 2010, amounting to 25,310 metric tons of waste (28,121.6 short tons) resulting in 26,892 metric tons of CO2e, which included 75% capture of methane through the passive flare system (with 1% of the 75% escaping) – a methodology that had changed such that waste emissions are no longer factored as net zero. This adjustment resulted in 6,925 metric tons of emissions with flaring. In 2007, total annual waste added to the landfill was 33,277 short tons, equal to 29,949 metric tons, resulting in 31,823 MT CO2e of emissions which were 8,194 metric tons with flaring – resulting in an 18% reduction.

III. OPERATIONAL GHG EMISSIONS FOR CBJ 2021

Overall, local government accounted for 4.5% of community -wide energy consumption and produced a little over 3% of area-wide GHG emissions in 2010, compared to 6.6% and 4.96% in 2021 – being slightly higher as a portion of community emissions attributable to government operations. The CBJ government purchased about 1.25 million gallons of fuel in 2010 and almost 37.4 million kilowatt hours of electricity, compared to 1.38 million gallons of fuel and 37.4% in 2021 – given an approximately 5% increase in CBJ full time equivalents from 463 in 2010 to 486 in 2021. Table 5 also summarizes the portions of emissions attributable to specific departments[19] within CBJ.

[18] According to the U.S. EPA Facility data

[19] General government included Centennial Hall, City Hall, libraries, and miscellaneous other city facilities. Lighting under the 2010 and 2007 category included street lighting, traffic signals, and all docks and harbors meters– both dock/marina lighting and private boat electricity use, which were not broken down by AEL&P in 2021.

Table 5: CBJ Operational emissions summary 2021

	FUEL			ELECTRICITY			Total			
Sector	**Gallons**	**MMBtu**	**MT CO2 e**	**kWh**	**MMBtu**	**MT CO2e**	**Total MMBtu**	**Total MTCO2e**	**% MTCO2e**	**% in 2010**
School Facilities	393,668	54,326	3,993	7,289,021	24,877	7	79,203	4,000	29%	21%
OTHER FACILITIES										
Hospital	250,358	34,549	2,547	6,021,139	20,550	6	55,099	2,553	18%	18%
Airport	19,173	2,646	193	3,174,334	10,834	3	13,480	196	1%	6%
Parks & Recreation	108,219	14,934	1,016	4,073,743	13,904	4	28,838	1,020	7%	6%
Public Works	50,937	7,029	497	2,239,370	7,643	2	14,672	499	4%	2%
General Government	24,499	3,381	247	3,344,780	11,416	3	14,797	251	2%	2%
Fire	69,291	9,562	691	634,976	2,167	1	11,729	691	5%	3%
Police	47,914	6,612	449	536,435	1,831	1	8,443	450	3%	1%
Harbors	15,602	2,153	152	1,473,797	5,030	2	7,183	154	1%	0%
Total	***979,661***	***135,193***	***9,784***	***28,787,595***	***98,251***	***29***	***233,444***	***9,814***	***71%***	***59%***
EQUIPMENT NON-FACILITY										
Wastewater	264,199	36,459	2,675	6,484,462	22,131	7	58,591	2,681	19%	13%
Water	12,759	1,761	118	1,750,513	5,974	2	7,735	119	1%	0%
Lighting	-	-	-	-	-	-	-	-	0%	0%
Total	***276,958***	***38,220***	***2,792***	***8,234,975***	***28,106***	***8***	***66,326***	***2,801***	***20%***	***13%***
FLEET[20]										
Capital Transit	127,572	17,605	1,297	230,000	785	0	18,390	1,297	9%	11%
Vehicle Fleet	463	64	4	105,305	359	0	423	4	0.03%	16%
Total	***128,036***	***17,669***	***1,301***	***335,305***	***1,144***	***0***	***18,813***	***1,301***	***9%***	***27%***
TOTAL	**1,384,654**	**191,082**	**13,878**	**37,357,875**	**127,501**	**38**	**318,584**	**13,916**	**100%**	**100%**
Change since 2010	11.08%	11.08%	10.67%	-0.21%	-0.21%	-43.13%	15.70%	10.49%		

Note: In 2010, the total operational emissions were calculated to be 12,594 MT CO_2e. For 2021, the total operational emissions increased to 13,916 MT CO_2e using the market-based scope 2 accounting, representing a 10.5% increase. Additionally, Scope 3 items such as business travel (70.89 MT CO_2e) and employee commute (1,411.35 MT CO_2e), which were not included in the past inventory of 2010, were estimated using departmental finance and imputed HR data – 1,482 MT CO_2e in 2021.

[20] Fleet vehicles and equipment, and their operational ownership or use attribution by various CBJ departments may have been different than past inventories.

Table 5 provides data on total emissions from CBJ by sector and source (fuel or electric). This table and the following notes provide additional information used to generate the 2021 operational government energy use findings. The energy use information, combined with emission factor determinations under the GHG local government protocol was used as the basis for the methodology used to generate GHG emissions findings for this report based on 2021 data. Local government energy consumption and emissions analyses were divided into the following sectors, keeping in line with 2007 and 2010 inventories:

1. Facilities;
2. School facilities;
3. Wastewater treatment and drinking water;
4. Capital transit; and
5. CBJ vehicle fleet.

Government consumption and emissions data have been included in the Section II community-wide calculations. However, the unique ability of local government to gather building, fleet, and department-specific data, as well as the government's enhanced ability to abate emissions through direct agency action, warrants the following separate analysis. The 2010 community GHG report also included a separate analysis of local government. Government facilities, including schools, accounted for 62% of all local government energy consumption in 2010 and accounted for 73% in 2021. Facilities, schools, and wastewater treatment plants produced 72% of government GHG emissions in 2010, vs 91% in 2021. In 2010, the transportation sector produced 27%, while the CBJ wastewater treatment plant alone produced 13% of local government GHG emissions – however in 2021, the transportation sector produced 9% and wastewater 19% respectively.

The 2021 GHG increases, compared with 2010, are driven mostly by schools and the biosolids dryer used at the wastewater utility. The Mendenhall Wastewater Treatment Plant prior to 2019 averaged about 80,000 gallons of fuel per year. Usage increased in 2019 when biosolids dryer came online. As production increased, fuel usage increased with an estimated attribution of 128,000 gallons annually. Similarly, energy usage in schools increasing after COVID could be attributed to increased amount of outside air being brought into facilities, correlating with increased fuel usage. In terms of electricity specifically, there are several electric-only facilities that have come online, as well as certain facilities converted to heat pumps since the 2010 GHG report. For instance, Dimond Park Aquatic Center and Mendenhall Valley Library accounts for a high proportion of the electricity increase.

Fleet energy and emissions included all fuel use (diesel and gasoline), provided by CBJ from an internal database tracking gallons of diesel and gasoline used by department. An alternative data source for vehicle fleet was gallons purchased (CBJ Purchasing Division); however, because CBJ indicated that the fleet database (Consumption Statistics) is a more accurate accounting of vehicle fleet fuel usage, the fleet database was used. The emissions factors for calculating metric tons of carbon dioxide equivalent (MTCO2e) for all CBJ vehicles (fleet and Capital Transit) use of gasoline and diesel included carbon dioxide (CO2) figures from local government emission factor databases. This list includes both on-road and off-road vehicles such as automobiles, trucks, Capital Transit buses, and miles driven, as well construction equipment for operational hours. In 2021 however, each vehicle had a departmental code that could be linked to other non-fleet departments, versus lumping all fuel consumption by vehicles to fleet.

This was due to data availability for vehicles, at the wastewater level (and other facilities) which were ascribed generically to fleet in 2010. As a result, direct comparison between departmental boundaries from 2010 to 2021 could be difficult, despite being more accurate representation of departmental emissions breakdown using 2021 categories. Items like government-operated lighting and water pumping, which ran on electricity in 2010, contributed essentially nothing to the government's share of area-wide GHG emissions. For 2021, lighting electricity usage was not broken down by AEL&P and were added to facilities overall power consumption.

These data trends highlight that an emphasis on increasing energy efficiency and changes in fuel consumption related to buildings, transportation, and wastewater treatment will be key to reducing both annual government operating expenditures and area wide GHG emissions in the coming years.

Energy use and data collection

Electricity and petroleum fuel (mostly diesel, fuel oil and gasoline) use in facilities, schools, wastewater and drinking water treatment, Capital Transit, and the vehicle fleet were analyzed from data sources by department. Data for CBJ electric meters was obtained from AEL&P as well as Portfolio Manager software system maintained within CBJ, whereas data for CBJ fuel tanks was obtained from CBJ reports. Facility and department name were added to the meter specific information from AEL&P. The detailed list of CBJ tanks (provided by tank number by CBJ) was paired with the fuel provider information, using tank numbers, provided usage by facility, department, and fuel type. Each tank was associated with a source (vehicle fleet, facilities, or wastewater treatment) and with a department. Similar emission factors assumptions are made for operational footprint, as were the community estimations.

All energy data were provided by CBJ, except for Scope 3 data around employee commute – which, in addition to emissions related to business travel conducted in 2021, were not items that were tracked in previous inventory years, 2007 and 2010. In the 2010 report, recommendations were made in terms of how to accommodate a more accurate picture of GHG emissions from both the CBJ fleet and community fleet. First, in 2021, the annual mileage for each CBJ vehicle and equipment were tracked, in addition to the consumption in terms of miles driven or hours operated. The exact type of fuel each vehicle and equipment use were also recorded. For community emissions, the State of Alaska Division of Motor Vehicles registration data by zip code and type (see community section for more details) were used.

IV. CONCLUSION AND RECOMMENDATIONS

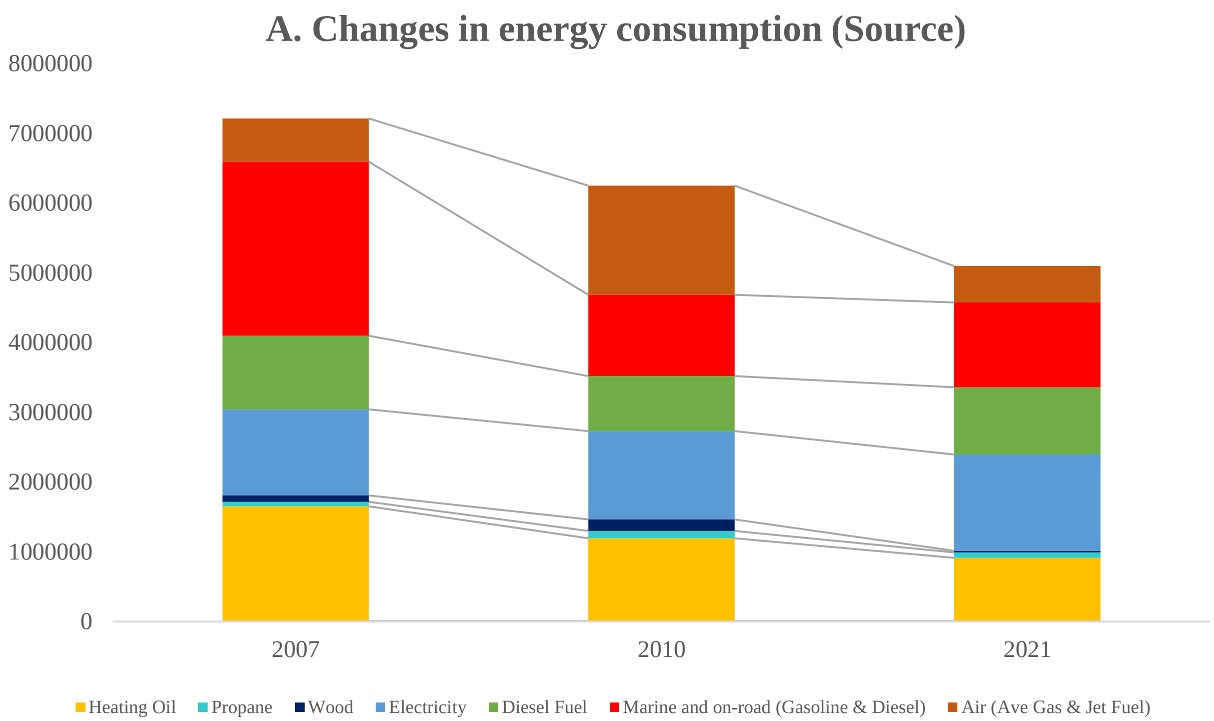
The 2021 GHG emissions inventory reveals that both energy use and GHG emissions for the overall community decreased from the 2010 and 2007 inventories. Figures 3a. to 3d. show the changes in energy consumption and GHG emissions, by upstream energy source, as well as downstream economic sectors, across the three years.

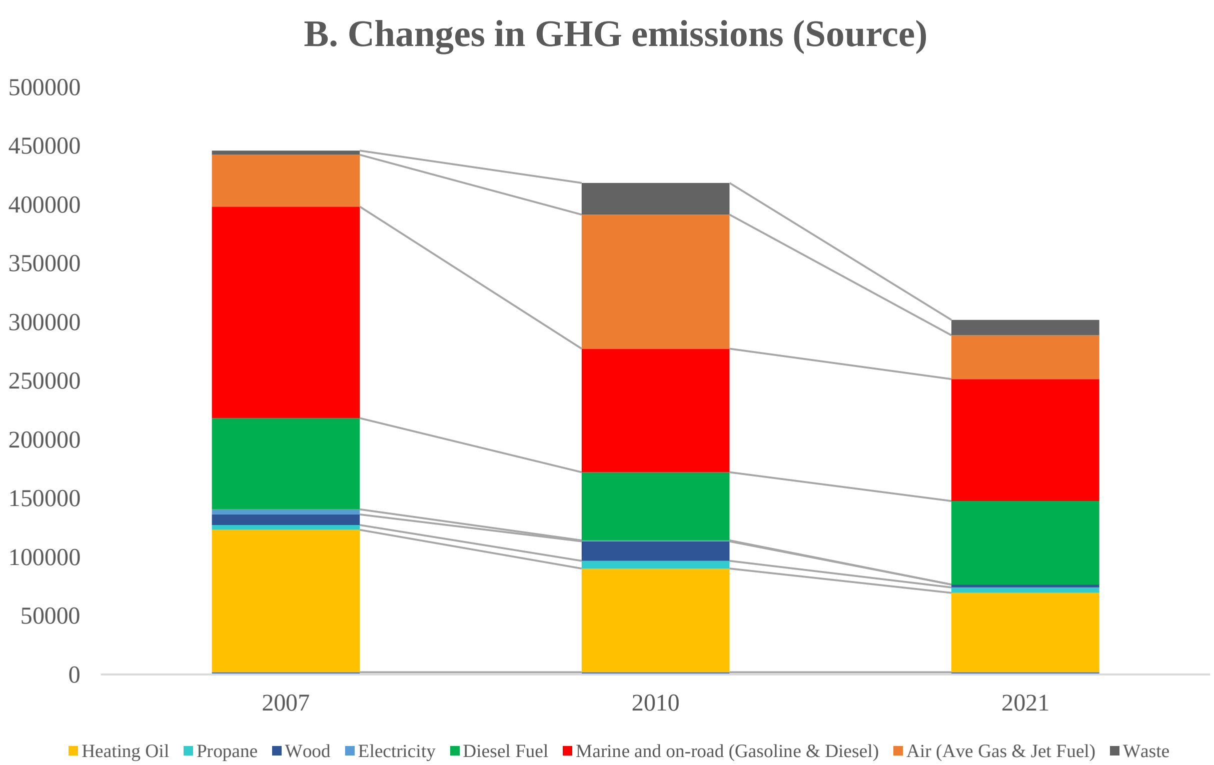
While comparing the three non-consecutive years of information over a range of 11 to 14-year provides data reference points, it does not enable us to define a trend. When comparing snapshots of energy use and GHG emissions from nonconsecutive years, it is important to identify variables that may have influenced energy use and GHG emissions in each year. These include factors like relative discrepancies in the availability, accuracy, and reliability of collected data; revisions in the emission measurement framework; variations in economic productivity; differing heating degree days;[21] and the construction or demolition of buildings.

Obtaining additional reference points over the coming years would enable CBJ to identify areas of lasting improvement more readily than we can in this report, given the gaps in the years and only three data sets. To accurately identify trends in area-wide energy use and the production of GHG emissions, it is recommended that annual community-wide energy use and GHG emissions inventories be conducted for five consecutive years. After usage and emissions patterns are established, and the effectiveness of abatement efforts has been determined, it can be determined whether inventories will continue to need to be conducted annually or biennially.

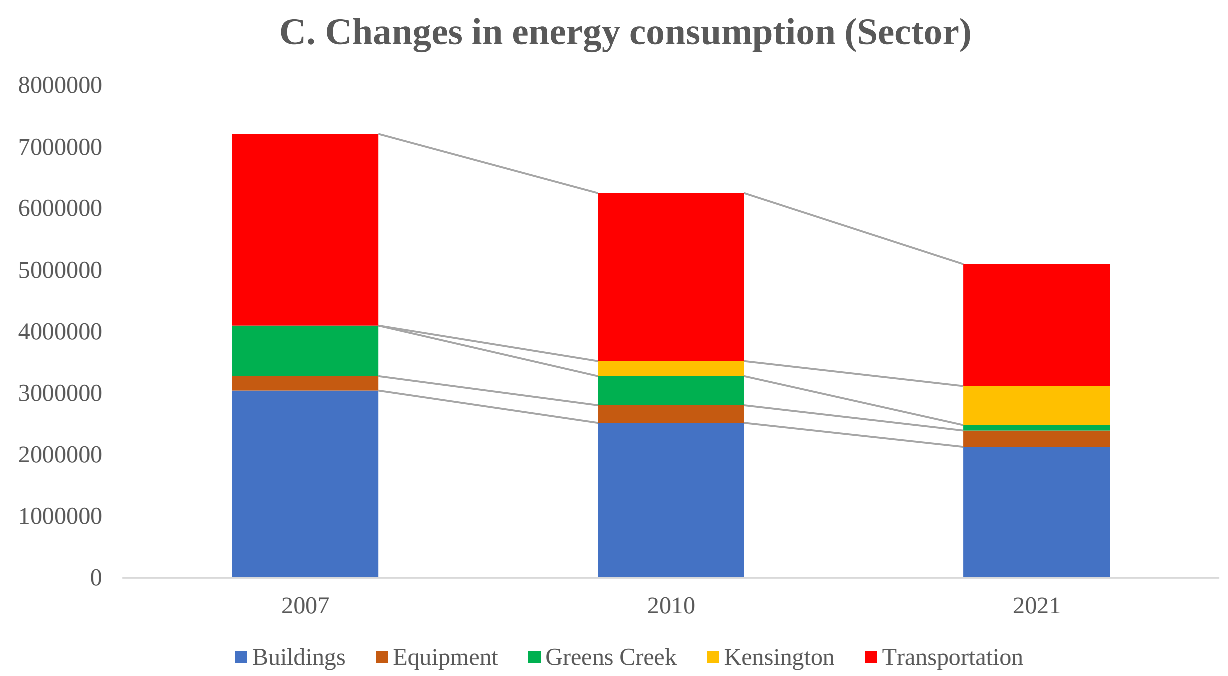
As the local, state, and federal governments continue to move forward with energy efficiency and conservation measures, consideration should be given to breaking out energy use and GHG emissions from the building sector into three separate categories— Residential Buildings, Government Buildings and Commercial Buildings. This would help to better identify and address energy-related dynamics in each of these areas. Energy use analyses of specific buildings will help determine which buildings would produce the greatest energy savings from weatherization, energy system upgrades, and other retrofitting. CBJ should continue to track and keep records of energy use and costs and operational GHG emissions, by department and, where building or system energy audits are completed, by building and/or system. In addition, obtaining an accurate accounting of square footage for these types of buildings will help determine energy use per square foot and allows for comparisons among buildings in Juneau. The charts on the following pages summarize the (a) energy and (b) emissions trend across the three inventory years, in terms of **energy source.** Energy consumption is in MMBTU units.

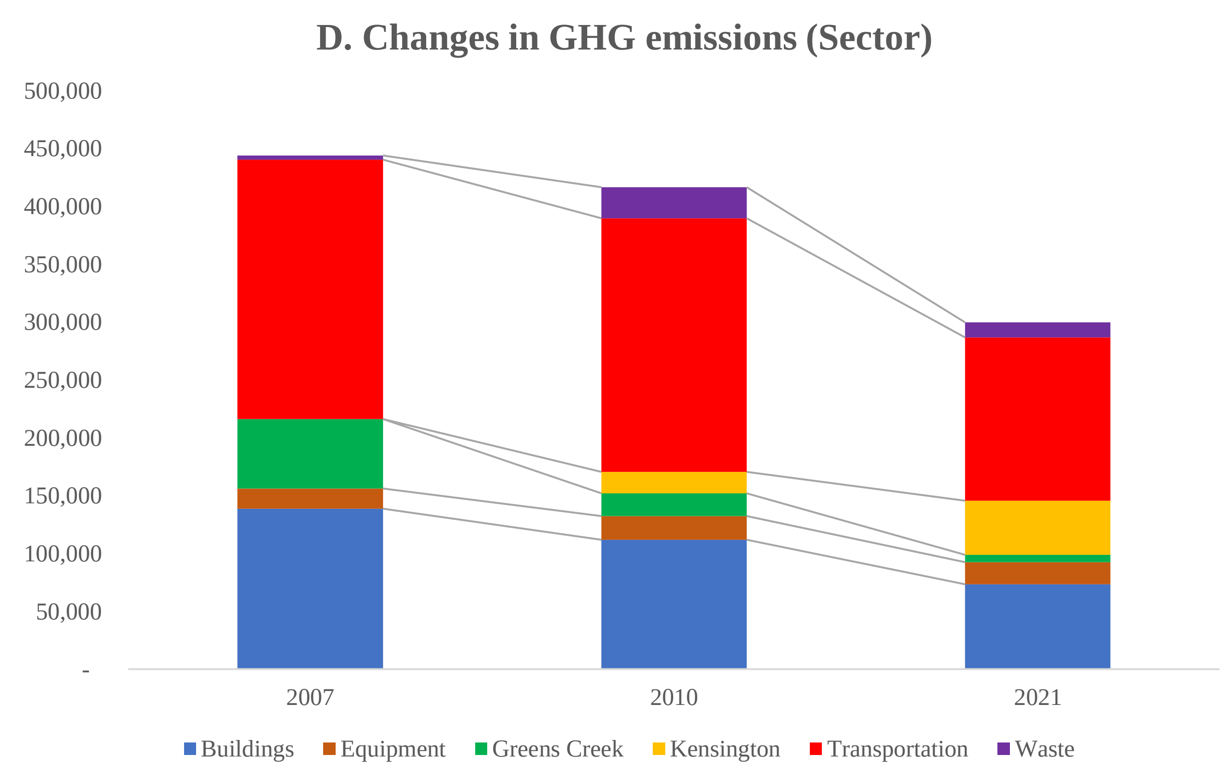
[21] The heating degree days (HDD) for 2021 were 8659, compared to 8074 for 2010 and 8656 for 2007. Year-to-year variations in average daily temperature affect energy use and thus GHG emissions associated with meeting heating demands. Less energy is needed for heat in a warmer winter, and more is needed a colder winter. More information on heating degree days and how they are calculated is found here: https://www.weather.gov/key/climate_heat_cool

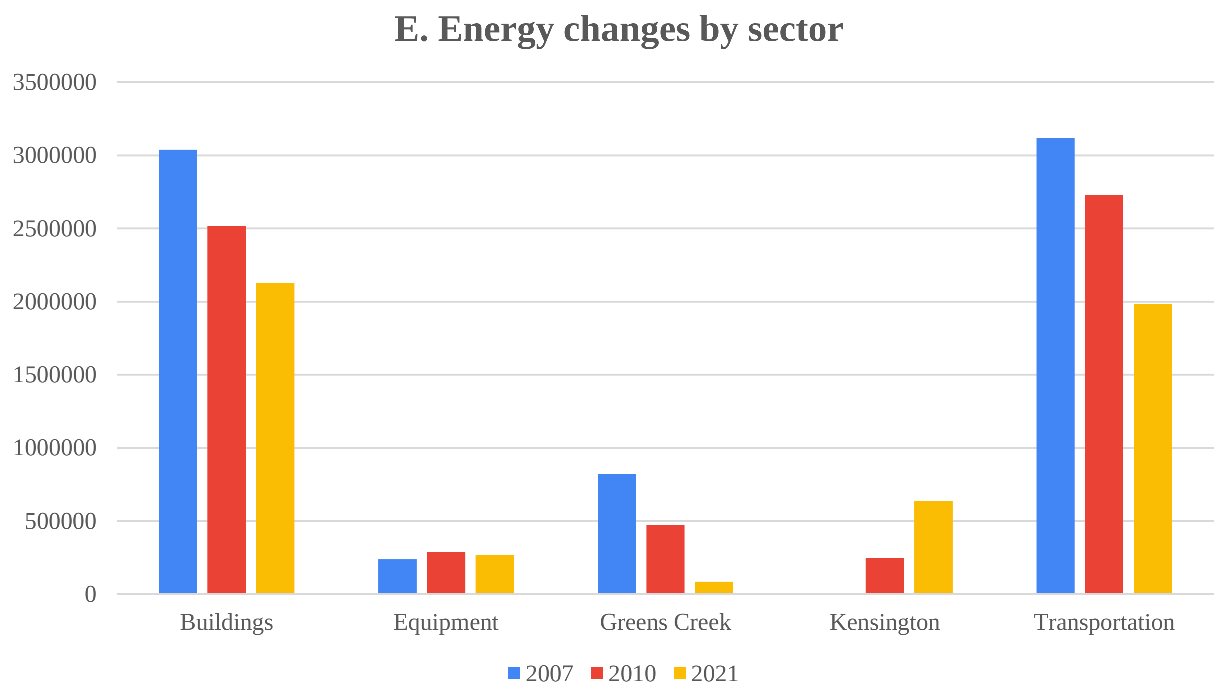

A. Changes in energy consumption (Source)
8000000
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
2007
2010
2021
Heating Oil
Propane
Wood
Electricity
Diesel Fuel
Marine and on-road (Gasoline & Diesel)
Air (Ave Gas & Jet Fuel)

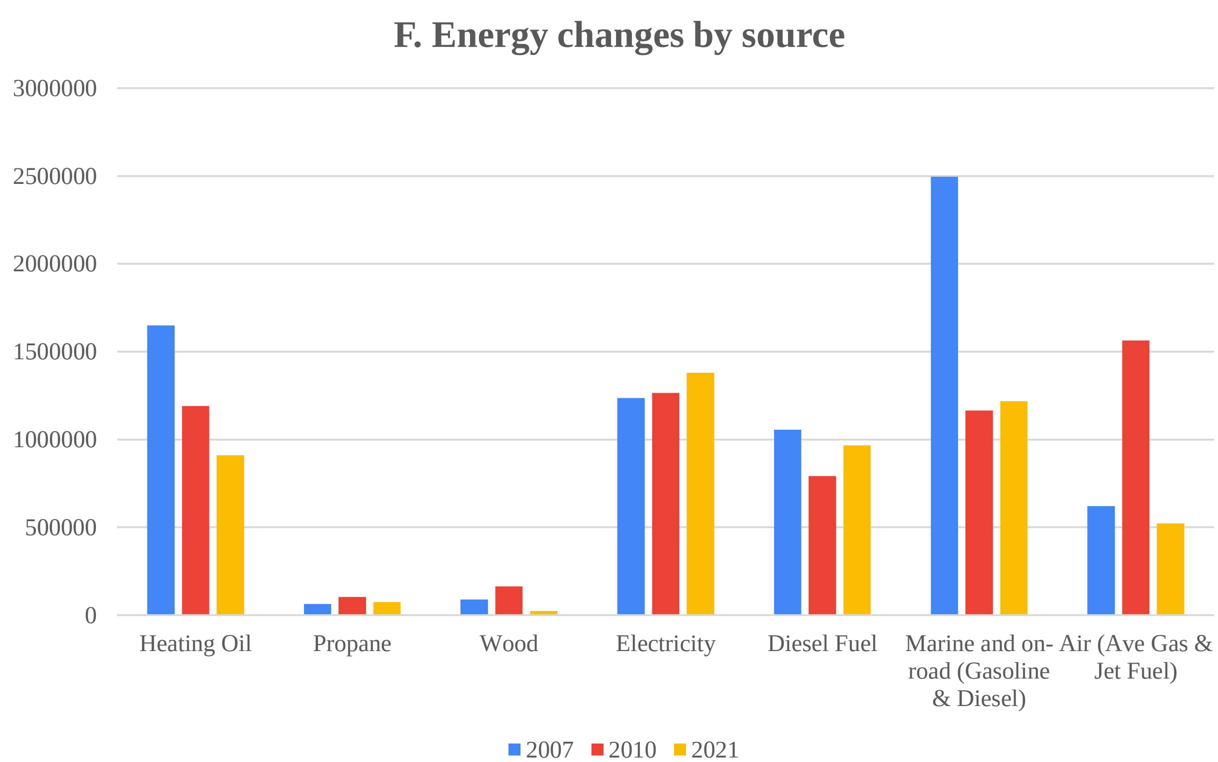

B. Changes in GHG emissions (Source)
500000
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
2007
2010
2021
Heating Oil
Propane
Wood
Electricity
Diesel Fuel
Marine and on-road (Gasoline & Diesel)
Air (Ave Gas & Jet Fuel)
Waste

The charts below summarize the (c) energy and (d) emissions trend across the three years, in terms of **economic sectors.** Total GHG emissions is shown in MT CO_2e units.

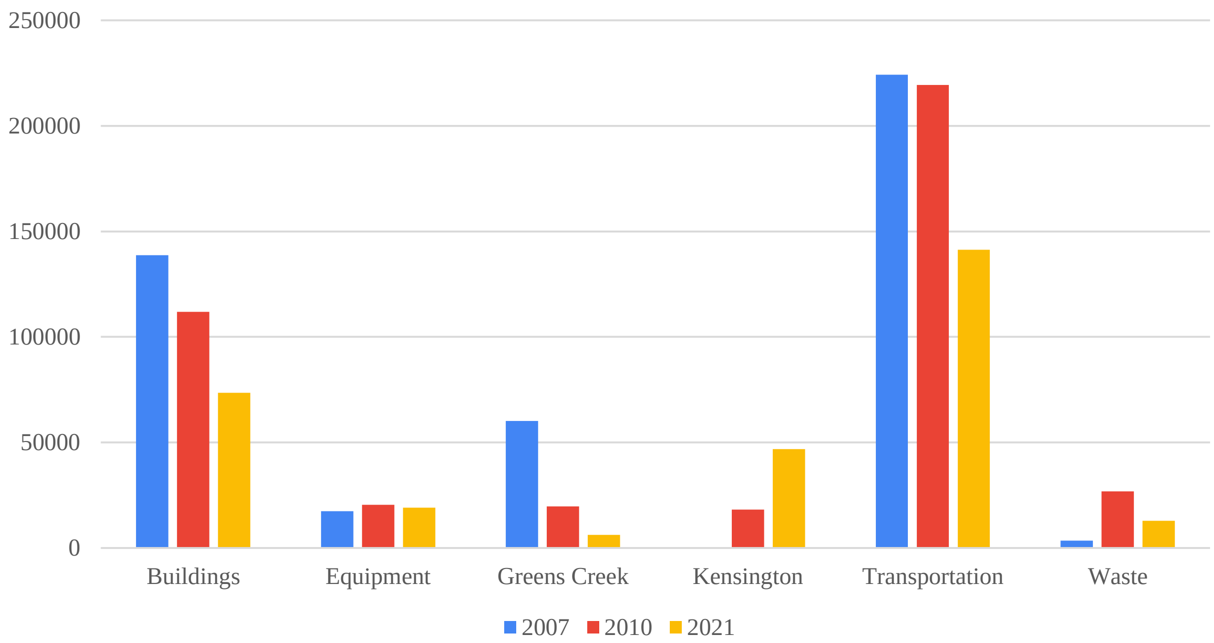




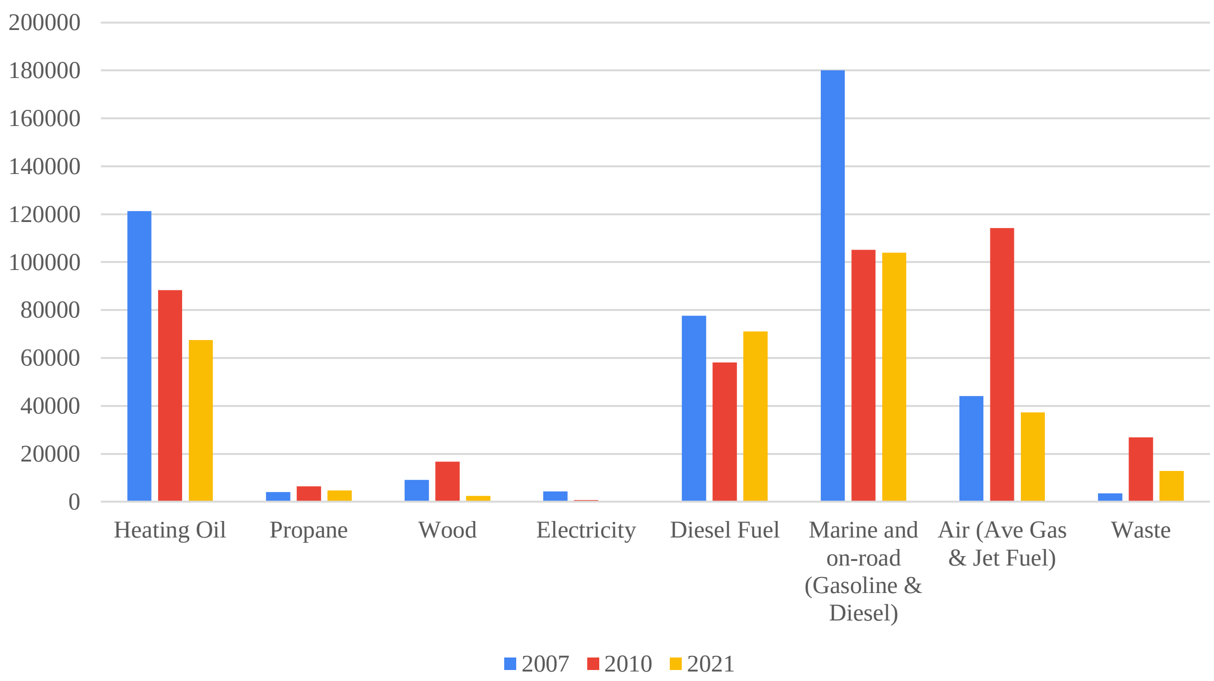

E. Energy changes by sector
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
Buildings
Equipment
Greens Creek
Kensington
Transportation
2007
2010
2021


F. Energy changes by source
3000000
2500000
2000000
1500000
1000000
500000
0
Heating Oil
Propane
Wood
Electricity
Diesel Fuel
Marine and on-road (Gasoline & Diesel)
Air (Ave Gas & Jet Fuel)
2007
2010
2021

G. Emission changes by sector



H. Emission changes by source



APPENDIX A

Methodology

Timescale: A standardized emissions inventory report comprises all GHG emissions occurring during a calendar year. Among others, the United Nations Framework Convention on Climate Change, the Kyoto Protocol, the European Union, The Climate Registry, and the California Climate Action Registry all require GHG inventories to be tracked and reported on a calendar year basis. Additionally to conducting a base year inventory of emissions, a comprehensive inventory of emissions should be completed at regular intervals following the base year (2007). This report used the 2021 calendar year for the reporting year.

Boundary: The local government organization boundaries for GHG accounting were established in 2007 and are the boundaries of the City and Borough of Juneau. The Juneau GHG emissions calculation is an internal estimate of GHGs and does not include fuel for cruise ship, barge, or air travel within CBJ limits where the fuel used came from outside Juneau. It does include energy (fuel and electric) use where the energy was obtained locally (e.g., electricity supplied at Juneau's docks and cruise ship and airplane refueling that occurs in Juneau). The 2007 report established, and 2010 followed that approach for defining the departments, activities, and operations that constitute Juneau's community and local government for the purpose of reporting GHG emissions. The 2007 and 2010 inventory approach was duplicated to the extent feasible in the current report. Wherever changes in data reliability, calculation methods, or data display were encountered, they are noted in the text.

Activity calculation: In 2021, the calculation-based methodologies were used to quantify both the community and government-sourced GHG emissions. This methodology involves the calculation of emissions based on "activity data" and "emission factors." *Activity data* represent the relevant measurement of energy use, such as fuel consumption by fuel type (propane, heating oil, diesel, gasoline, jet fuel, etc.) and metered electricity use (mostly from AEL&P). These activity data were used in conjunction with an emission factor per unit of fuel, to determine emissions, using the following generalized equation, such that *Emissions (CO2) = Activity Data (MMBTU*[22]*) x Emission Factor (CO2 per MMBTU).*

Emission factors: Emission factors are calculated ratios relating GHG emissions to a proxy measure of activity at an emissions source. We used the emission factors provided in the GHG Accounting Protocol to convert activity data, such as energy usage, into the associated GHG emissions. Whenever emissions values were directly provided, we consulted the source U.S. EPA or the emitters directly to understand data quality. These emission factors are approved by regulatory and research bodies, and were determined by means of direct measurement, laboratory analyses, or calculations based on representative heat content and carbon content. No site-

[22] Here MMBtu represents one million British thermal units and is a unit of energy used to compare across different fuel quantities, like diesel vs. electricity - all units of fuels, electricity, and wood have been converted to MMBtu for purposes of comparison.

specific emission factors representative of the technology employed at specific consuming facilities were used.

For example, in calculating emissions from stationary combustion using fuel use activity data and default emission factors by fuel type involves the following steps. First, the inventory process determined the total annual consumption of each fuel combusted at community-level sectors, as well as facilities and assets for CBJ operational footprint. Then, determine the appropriate CO2, CH4 and N2O emission factors for each fuel. Finally, calculate each fuel’s CO2, CH4 and N2O emission contributions, and lastly convert CH4 and N2O emissions to MTCO2 equivalent to determine total emissions. These are reported in the tables for both 2021 community emissions, as well as the operational emissions of the local government.

Converting emissions of non-CO2 gases to units of CO2e allows greenhouse gases (GHGs) to be compared on a common basis: the ability of each GHG to trap heat in the atmosphere. In this report, non-CO2 gases have been converted to CO2e using internationally recognized Global Warming Potential (GWP) factors. CO2e is an abbreviation for carbon dioxide equivalent, the internationally recognized measure of greenhouse gas emissions.

The Intergovernmental Panel on Climate Change developed GWPs to represent the heat-trapping ability of each GHG relative to that of CO2. For example, the GWP of methane is 21 because one metric ton of methane has 21 times more ability to trap heat in the atmosphere than one metric ton of carbon dioxide. The GWP of nitrous oxide is 310. The CO2e measure is used worldwide to report the equivalent weight of carbon dioxide in metric tons (MTCO2e) (1,000 kilograms or 2,205 pounds). The global warming potential from each greenhouse gas is based on the amount of carbon dioxide that would have the same global warming potential measured over a specified time period.

Inventory Scopes

Emissions are generally broken down into Scope 1, 2 and 3 to show differences in control and boundaries. Scope 1 emissions refer to in-boundary emissions, such as combustion of fuels for stationary use, such as heating offices and buildings, as well as mobile use, such as in-boundary transportation, both driving, flying and marine transportation with fuels extracted within the boundary. Industrial processes, such as mining as well as waste and wastewater, are also Scope 1 emission. Scope 2 emissions refers to grid supplied energy, such as power consumption. Since power is generated and sold within Juneau, the Scope 2 purchased electricity, is already counted as Scope 1 generation from hydroelectric and diesel. Scope 3 would include out-of-boundary emissions, like biosolids hauled to Oregon for disposal, transmission and distribution losses outside of boundary, any transportation outside of Juneau, or fueling of transportation vehicles outside of Juneau, as well as other indirect emissions, such as imported goods and services produced outside of Juneau. Scope 3, similar to previous studies, have been left out for the 2021 study update as well. Below are further details on scope.

Scope 1: All direct GHG emissions were recorded. Scope 1 emissions from stationary combustion cover seven sectors for CBJ and the community. For the community inventory, Scope 1 includes stationary combustion, such as fuel use in buildings and facilities located within Juneau, as well as in boundary transportation, like the movement of different classes of vehicles within the community boundary, including air, on-road as well as marine transportation.

For the operational footprint, this includes: Water delivery facilities and Wastewater facilities owned and operated by CBJ; power generation facilities owned and operated by AEL&P for the generation of electricity that is then consumed by CBJ and the broader community; solid waste facilities; port facilities owned by CBJ, and reported as Harbors; the Airport facilities (JIA); and finally all other buildings and facilities.

Scope 2: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling are irrelevant for Juneau's community-wide emissions, since Juneau's electricity supply is produced within the borough's geopolitical boundaries, there are no Scope 2 emissions. In this analysis, most emissions are considered Scope 1, with minor Scope 2 for CBJ facilities - since AEL&P power is purchased by CBJ, electricity does form the basis of their scope 2 emissions, which this report estimates on both market-based and location-based emissions. This would include electricity consumed by the facilities and transportation sources identified above in the Scope 1 paragraph, namely the residential, commercial, transportation and industrial power consumption.

Scope 3: Emissions resulting from the extraction and production of purchased materials and upstream fuels, transport-related activities in vehicles not owned or controlled by the reporting entity (e.g., employee commuting and business travel for CBJ's operational), air travel, and marine travel. The Scope 3 emissions analyzed herein include those from the following sources: wood use, waste disposal, marine transportation, and air transportation. Emissions from cruise ships, barges and some air travel, are considered Scope 3, but for these modes of transportation this inventory only includes estimated emissions from fuel obtained within in Juneau, AK, in line with previous inventory studies. The distinction between scopes is relevant for reporting emissions at different levels; however, for this inventory, all scopes are embedded in total Juneau emissions for community-wide inventory.

APPENDIX B

Cruise Ship Emissions:

Below is an explanation of the methodology, given the GPC standards around waterborne emissions across boundaries, with the related discussions around implications for comparisons to the previous inventories in 2007 and 2010. Local fuel purchases and local marine activity differ on its impact on cruise ship emissions - in that, only a minority of the fuels for cruise ships is purchased locally within the community. As various data sources across the years show, certain smaller vessels, such as tour vessels, purchase fuels within Juneau, whereas barges, tugboats and ferries highly likely purchase their fuels from outside of Juneau.

First, the GPC methodology was consulted in operational boundaries and recommendations on the collection of activity data (GPC, pg 80-81). According to the community protocols, marine transportation includes ships, ferries, and other boats operating within the city boundary, as well as marine-vessels whose journeys originate or end at ports within the city's boundary but travel to destinations outside of the city. While water transportation can be a significant source of emissions globally, most emissions occur during oceanic journeys outside of the boundaries of a port city, and thus not included in the calculations. IPCC Guidelines allow for exclusion of international waterborne navigation, although these journeys and their associated emissions can be useful for a city to understand the full impact of the transit connecting through the city. In this report, keeping with past two inventories for Juneau, we have only accounted for Scopes 1 and 2 emissions for marine transportation, while following recommendations to estimate Scope 3 emissions, particularly for meaningful contributors, which in the case of Juneau, is cruise ships.

Scope 1 includes emissions from direct combustion of fossil fuels for all trips that originate and terminate within the city boundary - which includes all riverine trips within the city boundary as well as marine ferries and boats that travel between seaports within the city boundary (including sightseeing ferries that depart from and return to the same seaport within the city boundary). To calculate Scope 1 emissions, cities usually:

1. Obtain total real fuel sales estimates of fuel loaded onto marine vessels by inquiring with shipping companies, fuel suppliers (e.g., quantity of fuels delivered to port facilities), or individual port and marine authorities, separated by geographic scale of activity. This was not available for Juneau, so alternative methodologies below were used. For example, the 2021 inventory first collected data at the Port of Juneau that had partial data for the major locations of activity for in-boundary CBJ marine fuel usage.

Table 6: Port-provided estimation for 2021

Location	Type	2021 data (gallons)
Rock dump	Petro Marine Fuel Dock	None
Bridge	Petro Marine Fuel Dock	Approx. 1.15 million
Harbor	Petro Marine Fuel Dock	885,000
Gitkof dock	Delta Western Fuel Dock	Approx. 1.15 million
Auke Bay Loading Facility	Fuel Truck Delivery	55,000
Seadrome Dock	Fuel Truck Delivery	240,000
Total		**3.45 million gallons**

Table: Port of Juneau, AK estimates of 2021 fuel gallons for marine transportation

Since it was not possible to obtain complete total real fuel sales estimates of fuel loaded onto marine vessels by inquiring with shipping companies or fuel suppliers, data was partially collected from some of the individual port and marine authorities within CBJ.

2. A representative sampling survey can be used, to identify the driver of activity at the sample site (e.g., tonnes of freight or number of people), and use driver information to scale-up the activity data to the city-scale. We used the Marinetraffic.com data for this purpose. We further estimated the distances traveled and resulting fuel usage. The main source of vessel traffic information for the vessel types, is the AIS SHIPTYPE number broadcast through AIS, which is sometimes updated with reliable third-party information – mostly for IMO registered vessels. The classification is reliable, except for small vessels, without IMO numbers, the informational integrity is a function of the crew's inputs to the AIS transponders. Records of port calls included a list of arrivals to and departures from Juneau in 2021, with deadweight (the maximum weight of cargo in metric tonnes) of cargo and passenger vessels, and with the previous and next port information, as well as nautical miles traveled. Cargo vessels include containers, dry bulk, etc., and during the 2021 calendar year there were only four calls belonging to 'Cargo' type. Tankers were not included in this category, as there were no port calls for tankers in the 2021 period. Passenger vessels include larger tourist cruise ships as well as smaller passenger vessels. Based on the tons and nautical miles of all the vessels leaving Juneau, in 2021 – for an estimated 4.8 million gallons equivalent of fuel consumption. 538 MWh of electricity was consumed by cruise ships in 2021, which was reduced significantly from 6,304 MWh in 2019, likely due to the global pandemic that began in 2020.

3. Total city activity may be determined through local, state, or national statistics or transportation agencies for the city. Particularly, a 2017 study using scaled national level data was consulted, which included Juneau level estimates using appropriate scaling factors. This used national marine navigation data through administration agencies. 2017 was the latest year available from the state, was also requested and accessed, across the various vessel types:

Table 7: State-provided data for the last year of record

Category	**Total gallons in 2017**
Bulk Carrier	956
Cruise Ships – Diesel	4,149,642
Cruise Ships – Gas Turbine	244,203
Ferries	557,548
Fishing – Diesel	232,173
Fishing – Gasoline	29,171
Tugs	8,742
Total	**5,222,435**

Table: State of Alaska estimates of 2017 fuel gallons for marine transportation[23]

4. Additionally, private data was also acquired to identify the main drivers of marine activity at CBJ boundary, particularly, tonnes of freight and number of people across specific vessel types, such as cruise ships. Finally, data on movement schedules to calculate distances traveled and using the distance traveled estimate to calculate fuel usage by utilizing fuel economy figures for boats: A fuel consumption estimation project was developed for the summer season of 2022. These were not actual inputs from the cruise ships, but rather based on the ships across cruise companies, vessel size given their passenger and crew capacity, taking into consideration the length of the cruises and total seasonal days in operations that range from propulsion (85%) to hoteling when docked (30%). Gallons per day per vessel type was collected from third-party sources and literature articles - as well as energy content of various marine hydrocarbon fuels, like gasoline, diesel, marine gasoline oils, Ethanol - 85 and bunker fuels. Assumptions made on percentage of energy used given hours at dock and shore power. Docking in Seattle,

[23] U.S. EPA (2020). Technical Support Document (TSD) - Preparation of Emissions Inventories for 2016v1 North American Emissions Modeling Platform - September 2020, page 60. For in CBJ (FIPS code 02110) in-boundary fuel-based emissions.

WA and Vancouver, BC where the majority of the vessels are assumed to fuel, were ignored - given they would be accounted as scope 3 emissions.

Scope 2 emissions refers to grid-supplied energy that marine-vessels purchase and consume, typically at docks, ports or harbors - this was included in the data provided by AEL&P.

Scope 3 covers emissions from departing transboundary trips powered by direct fuel combustion, apportioned to cover those departing trips that are attributable to the city. Cities can estimate the proportion of passengers and cargo traveling from the city, using official records, manifests, or surveys to determine the apportionment. Emissions from transboundary trips can be calculated based on distance traveled from the seaport within the city to the next destination or from fuel combustion, by quantifying the combustion of fuel loaded at the stations within the city boundary - regardless, transparently documenting the methods used in the inventory reports is crucial, which was done here.

According to the 2022 Juneau Cruise Ship Dock Electrification Study[24] (pg. 40-41), Cruise ships are in the Port of Juneau about 6,800 hours annually, where on average, they collectively burn about 352 gallons/hour. This results in about 24,354 metric tons of CO2e annually based on 2.4 million gallons of liquid fuels[25] in generators in onboard power plants, more than 8% of 2021 total scope 1 emissions.

[24] "Cruise Ship Dock Electrification Study," 2002 by PND Engineers, McKinley Research Group, and Haight & Associates for CBJ Docks and Harbors. See page 40 – 41 https://juneau.org/index.php?gf-download=2022%2F08%2FJuneau-Cruise-Ship-Dock-Electrification-Study-FINAL1.pdf&form-id=113&field-id=32&hash=e49db54725700fd6d01b4193ea7d26673d70ed02f79ccfe32788148a5bab511d

[25] Emission factor for diesel used in the calculation