CITY OF HOMER
CLIMATE ACTION PLAN:
PROGRESS REPORT

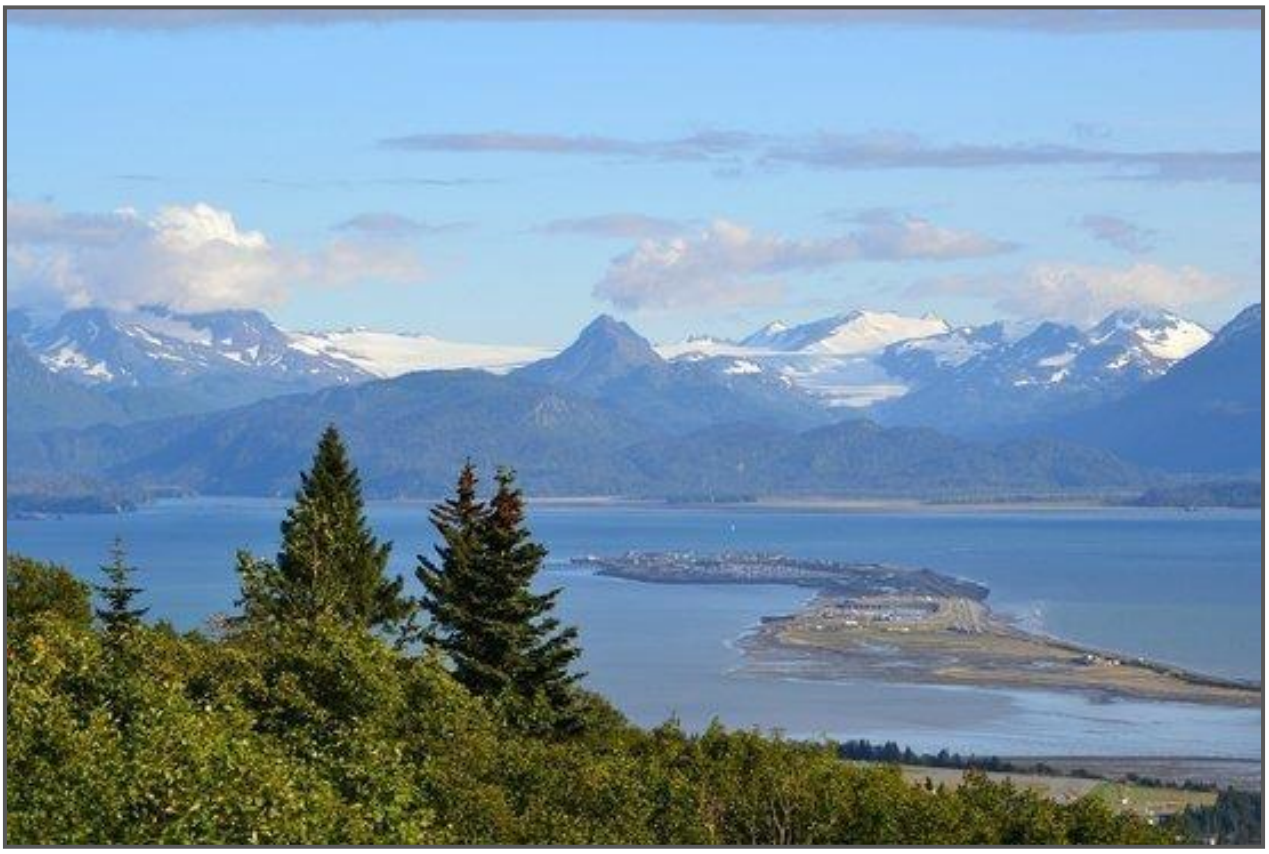

Photo Credit: Homer Chamber of Commerce

Prepared by the City of Homer

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Executive Summary

In 2009 The City of Homer adopted a Climate Action Plan (CAP) to battle the deleterious effects of climate change. The plan established a blueprint to analyze and improve the ways in which the City utilizes energy in its operations. The greenhouse gas (GHG) reduction strategy outlined in the plan has been implemented in phases over the past decade. This report - organized in scientific format - provides a summary of methods, results and recommendations related to Homer's CAP based on a comparison of data from 2010 and 2019.

Homer is a small Alaskan community situated on Kenai Peninsula's Kachemak Bay. With a relatively remote location and small population of 5,709[1], this unlikely yet ambitious community became the first Alaskan municipality to develop a CAP. Since then, City Government (and therefore City priorities) have changed, but implementation of the plan has persisted.

To determine progress relative to the plan's goal of reducing GHG emissions by 20%, the City maintained a comprehensive energy use inventory for 15 years. The inventory covers all energy consuming sectors of City operations. Acquiring, organizing, and quantifying these data comprises the bulk of work to produce greenhouse gas emission quantities. A comparison of values with the baseline year reveals whether positive gains were achieved since implementation of the CAP.

Results show that reductions in total City GHG emissions were achieved between years 2010 and 2019. With the exception of the vehicle fleet, all sectors experienced reductions in GHG output. More reductions were made in the electricity energy source than the City's stationary fuels sources (i.e. heating oil, propane and natural gas).

For context, results were examined in relation to increases in building square footage, warming winter temperatures, and differences in electricity emission factor sets. GHG reductions in stationary fuel use seemed very promising considering the increase in square footage and, correspondingly, heating demands. Yet, comparing these data to recent spikes in winter temperatures indicate that demand for heating decreased during the same period of square footage increases, thus moderating the difference in stationary fuel GHG comparisons.

For electricity, a moderating variable on reduction achievements is the fact that the electricity source in 2010 was more energy intensive than in 2019. In effect, a more energy intensive electricity source makes that emission factor set more CO2 rich and the GHG output higher. In conclusion, GHG reductions were made since CAP implementation, but external variables suggest positive gains may be more limited than inventory results indicate.

This report concludes with recommendations for future CAP efforts. These include community outreach and messaging to restart the climate action discussion, investigating new and improved energy saving measures, and improving energy use tracking and reporting. CAP advancement will likely be based on the level of community response and its willingness to commit to climate action.

[1] US Census Bureau: *2019 American Community Survey 5-year Estimates*

Background & Purpose

In 2006, then Mayor Jim Hornaday attended a national climate change conference in Girdwood, Alaska. Inspired by the event, he tasked the City of Homer to take a proactive position regarding the current and foreseeable impacts of human induced climate change. As there were a number of concerned community members willing to champion this cause, the Homer City Council passed Resolution 06-141(A) establishing a Global Warming Task Force in January 2007. The purpose of the Task Force was to solicit ideas and information from the public and other sources and prepare recommendations to forward to the Mayor and Council for a CAP. In March the City became a member of the International Council on Local Environmental Initiatives (ICLEI) - an organization that assists local governments in establishing a framework for measuring energy use and emissions, producing climate/societal related forecasts, and planning mitigation strategies. In December of that year City Council approved the City of Homer CAP, effectively completing the Task Force's mission. After the CAP was adopted, City Council authorized funds for a Climate Action Plan Implementation Report, which was completed by Deerstone Consulting between July 2008 and December 2009.

Local governments have been developing and implementing CAPs independent of larger state and federal governments for many years now. For example, ICLEI has provided assistance to international cities concerned with climate change since 1990. Due to the failure of larger government organizations to take meaningful action, CAPs are being produced by local government or community organizations who realize the importance of sustained climate action to protect their communities from the most severe environmental, social and economic effects of global warming.

The City of Homer's CAP provides mitigation strategies to improve and develop energy management practices which would decrease emissions of greenhouse gases (GHG) in all sectors of City operations. The CAP also provides ideas for public outreach and engagement, recommendations to ensure GHG reduction goals are met, and expectations that momentum to carry out CAP implementation goals is sustained. Additionally, the CAP establishes a sustainability fund, whereby loans used for CAP implementation are repaid based on savings accrued by energy conservation measures.

Specifically, the CAP sought to accomplish 12 tasks:

- Maintain a comprehensive compilation of energy use data in all city sectors
- Outsource energy audits for all facilities
- Investigate alternative energy sources
- Reduce vehicle fleet emissions
- Incentivize GHG reduction efforts among employees
- Incorporate GHG reduction strategies in City Planning/Land Use
- Produce an Employee Sustainability Handbook for GHG reduction in everyday operations
- Act as liaison in all scales of government and organizations to champion GHG reduction efforts
- Sponsor community events/campaigns associated with global warming awareness/mitigation
- Draft any and all forms of communication for public relation purposes relating to CAP implementation
- Maintain up to date climate change information on City website
- Prepare/submit grant applications for CAP funding, and provide oversight of grant-funded projects

CAP implementation has been in effect since 2009, with the most recent improvements being conversion to LED lighting for most major municipal facilities. While many of these tasks have been partially or fully accomplished, some haven't been realized, or require improvement. Limited staff and time devoted to CAP implementation contributes to these shortcomings. Be that as it may, recommendations not implemented were at least evaluated regarding their efficacy and practicality.

The City's zeal for dealing with climate change has fluctuated over the years. The Global Warming Task Force disbanded after the CAP was approved in 2007, and membership to ICLEI was allowed to lapse after Deerstone Consulting completed its report in 2010. While attention to climate change has waned in the intervening years, the momentum for completing the more conservative mitigation goals has been sustained. The quiet persistence of this effort may be best exemplified by the fact that City-wide energy consumption data has been maintained on a monthly basis from 2006 to the present. This comprehensive record of energy use is the critical foundation for making climate mitigation policy decisions.

Over the past two years inquiries by City Council members about the efficacy of CAP implementation has revitalized interest in The City's role in climate change action. Specifically, in 2019, Council sought a narrative report on quantifiable GHG reduction achievements, failures, and insights. The report was accompanied by an inventory quantifying energy use and associated GHG emissions from the original baseline year of 2006 through the end of 2018. Results from this analysis, however, fell short of accurately telling Homer's climate action story. Questions arose regarding the relationship between GHG outputs and it didn't account for City facility growth and recent temperature trends. These shortcomings led to the production of a second inventory in early 2020.

This inventory evaluated the same range of years with the addition of year 2019. The graphs and charts were consolidated into broader categories to more easily convey information. Increases in building square footage and warmer winter temperatures were included to add more context to the results. Unfortunately, (or fortunately) a city staff member noticed a discrepancy between GHG outputs from Deerstone Consulting's report and this latest effort. As the 2020 analysis is mostly based on an iterative process of the 2010 analysis, GHG outputs for years prior to 2010 were expected to be the same in both reports, yet his was not the case. The fact that different results were occurring for the same categories in the same year indicated discrepancies in methodology.

The GHG evaluation methods within the 2019 and 2020 reports were roughly modeled after the practices used by Deerstone Consulting in 2010. Unfortunately, the ICLEI protocol used to produce the 2010 report was abandoned in favor of a method that used emission factor sets from an unknown source to calculate emission totals within an excel spreadsheet. The most error prone aspect of this approach is that the annual fluctuation associated with electricity emission factors was not accounted for. Instead, a static emission factor value was used for every electricity inventory year. Given these problems, the 2019 and 2020 reports are only useful for displaying approximate trends and total energy usage. Following these disappointing attempts, City Council decided a more rigorous and defendable methodology was needed to ascertain whether or not the City achieved reductions in GHG emissions since the implementation of the CAP. This report is an accounting of that process.

Description of Homer

The City of Homer is located on the northern shore of Kachemak Bay - a 40-mile long arm of Cook Inlet that extends east into the southwestern tip of the Kenai Peninsula (**Figure 1**). This area's amenities include valuable fisheries, natural beauty, and marine-centric recreational opportunities. Being situated between two large bodies of water, Homer has a mild (relative to Alaska) maritime climate. The average low temperature is 32 degrees Fahrenheit, the average high is 45 degrees Fahrenheit. The Homer side of the Kenai Peninsula is just outside the temperate rainforest climate regime present in the coastal regions to the east and southeast. Therefore, annual average rainfall is a relatively moderate 24.34 inches, while the average snowfall is 48 inches.

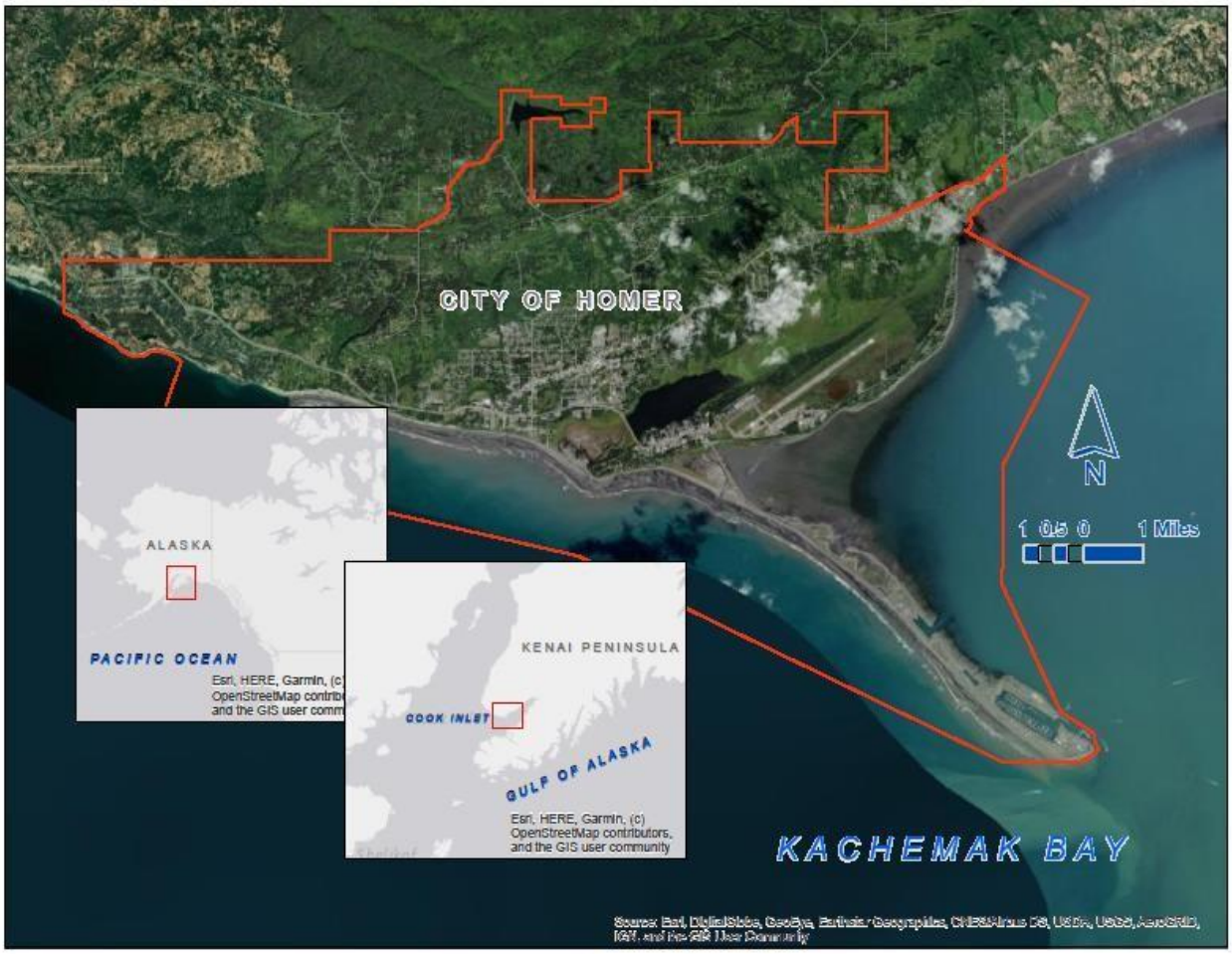

Figure 1. *City of Homer Location*

Excluding the portion extending into the Kachemak Bay, City limits encompass an area of approximately 15 square miles. As of 2019, Homer's population numbered 5,709. However, the larger Homer service area (the communities and residents relying on Homer as the commercial core) stretches from the confluence of the Kachemak Bay and Cook Inlet east to the head of the Bay. These periphery residents live in communities such as Kachemak City, Fritz Creek, Anchor Point, and others. The number of people relying on Homer's amenities is approximately 12,500.

Homer's municipal government currently employs over 100 full time employees across six departments:

- Administration
- Finance
- Police
- Fire
- Public Works
- Port & Harbor

The City maintains approximately 214,076 square feet of facility space, of which Public Works and Port & Harbor make up the most energy intensive portion. Electricity, provided by Homer Electric Association (HEA), and natural gas, provided by ENSTAR, comprise the two primary sources of energy consumption. The City maintains a fleet of 89 light vehicles, most of which are gasoline-powered, and 16 pieces of heavy equipment as well as a fleet of fire trucks, ambulances, and other special purpose rolling stock. Public Works and Port & Harbor regularly utilize diesel-powered heavy equipment to perform road maintenance, water and sewer repair, and snow removal.

Methods

Methodology

GHG inventories were created to evaluate the City of Homer's emission outputs for years 2010 and 2019. The years 2010 and 2019 were chosen for emission output comparison, as 2010 was the earliest year that reliable emission factors for electricity can be obtained, and 2019 is the latest year with a full record of City energy use. The 2010 and 2019 inventories examined all credibly sourced City GHG producing activities. The methodology for producing these GHG inventories involved four major steps:

- Acquiring data from energy providers
- Creating and organizing relational tables of energy data in excel
- Acquiring/producing emission factor sets
- Processing relational table results in ICLEI Clear Path Software

Raw Data Sources

All City buildings rely on both electricity and stationary fuels in daily operations. HEA has provided electricity consumption data since the beginning of CAP implementation. HEA delivers data in an Excel relational table format on a monthly basis. Table information includes dates, energy consumption, facilities, and energy costs. A minor amount of processing is required to achieve consistency with previous data.

Stationary fuel use for the City is sourced through invoices from fuel and natural gas providers: Petro Marine and Enstar, respectively. These invoices contain information about how much fuel of what type is delivered to which facility. As fewer facilities use stationary fuel than electricity, these tables are not maintained on a monthly basis, but as time allows.

Relational Tables

Excel tables have been maintained for over a decade and reflect the City's changing energy use patterns. The energy use tables are extensive and can be sorted by a variety of organization schemes, but for the purpose of monitoring GHG emissions, and to reduce table information into manageable format, two organizing iterations are required. The first iteration sorts information by three criteria:

1. Type of energy consumed
2. Two energy consuming sectors: Facilities and vehicle fleet
3. Energy use by each facility and vehicle fleet

This organization allows calculations of total energy use for each facility by energy type. Electricity, natural gas, and heating oil consumption are all summarized separately by month, then aggregated to produce an annual total for each facility. Because measures of energy units vary by energy source - i.e., electricity is KWh, natural gas is ccf, fuel is gallons - it is important that the type of energy consumed be the first level in organization.

The second iteration groups facilities into the following City sectors:

- Airport
- Buildings & Facilities[2]
- Port Facilities
- Streetlights and Traffic Signals
- Wastewater Facilities
- Water Delivery Facilities

This generalized grouping follows the organizational precedent established in the 2010 GHG report and provides an orderly way to evaluate total annual energy use by major energy consuming sectors. Additionally, this organization aligns with ICLEI's Clear Path inventory management system providing a comprehensive and clear overview of energy use and GHG emission status among these sectors. Energy totals from these tables are used in the Clear Path calculators to determine GHG emissions.

Table 1 *Monthly KWH by City sector*

Sector	KWH												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
Airport	14840	13880	11920	11000	13040	11000	10760	10560	11000	11480	11800	10680	**141960**
Buildings & Facilities	83856	74944	64557	59073	55954	49009	43554	43400	45402	49215	52760	62487	**684844**
Port Facilities	219687	200407	213151	200364	191680	207760	186103	258680	235357	195368	230883	210003	**2549054**
Streetlights & Traffic Facilities	16576	12788	11194	9548	6980	5222	4926	5638	8943	10786	15961	15099	**125311**
Wastewater Facilities	105372	99083	94543	99643	94324	97958	100863	102087	119584	103920	105445	105372	**1229172**
Water Delivery Facilities	58710	61246	56369	55821	53993	57501	56142	53799	54111	52474	50546	54211	**671214**

Emission Factor Sets

Emission factors are ratios necessary to calculate the amount of GHG produced by unit of energy used; expressed as lbs. of CO2/KWh, for example. To account for all GHG types, factors are needed for CO2, CH4, and N2O. Alaska's electric utilities monitor GHG outputs and are therefore able to provide emission factors associated with electricity consumption. For Homer, these factors vary from year to year because the community's electricity source is a fluctuating combination of hydro-power and natural gas. These varying values are averaged to produce a singular emission factor for a given year. Conversely, emission factors associated with stationary fuel consumption are static and are already built into the Clear Path calculators. Vehicle fleet emission factors are a product of fuel type, vehicle type, manufacture year, and model fuel economy.

Clear Path Software

Clear Path software provides a means for organizing complex energy and emissions inventories and for calculating GHG outputs from a wide variety of energy sources. Inventories for 2010 and 2019 were

[2] This category refers to all energy consuming structures not operating under Water/Wastewater, Port & Harbor, or Airport

created with this software. The inventories default to general categories that helped model the organizational scheme of the Excel relational tables:

- Buildings & Facilities
- Street Lights & Traffic Signals
- Vehicle Fleet
- Water &Wastewater Treatment

Within these categories are emission calculators for grid electricity, stationary fuel consumption, vehicle emissions, and ancillary emissions related to wastewater treatment. Each calculator is populated with the appropriate emission factor and amount of energy consumed. Clear Path creates detailed reports for each inventory year based on emission calculations for the above categories. The information from these reports is used to evaluate and generate tables and charts.

Inventory Specifics – 2010

Category – Buildings and Facilities**:**

This category covers electricity and stationary fuel consumption for all City buildings and facilities. Sub-categories include the Airport and Port and Harbor.

Electricity

As HEA was an all-requirements customer of Chugach Electric Association (CEA) in 2010, meaning that Chugach Electric provided HEA with most of its energy, factor sets for electricity were obtained from CEA. They are as follows:

- CO2 lbs/KWh: 1.19
- CH4 lbs/KWh: 0.00002
- N20 lbs/KWh: 0.000002

As Clear Path factors have to be in lbs /MWh for CO2, and kg/GWh for CH4 and N2O, the factors are converted accordingly, producing:

- CO2 lbs/MWh: 1190
- CH4 kg/GWh: 20
- N2O kg/GWh: 2

Factors and Kwh totals are then entered into the Clear Path electric grid calculator. Additional information such as daily operating hours and total square footage of all facilities was included to report detailed energy use. Figure **2** shows an example of the results of electric grid calculations City sector.

Inputs

	Value	Units
Is This a Direct Entry Record?	No	
Electricity Used	1089190	kWh
Daily Occupancy (optional)		People
Daily Operating Hours (optional)	8	Hours per Day
Building Square Footage (optional)	107578	Square Feet
Is this a Scope 3 Record?		

Outputs

Name	Value
Electricity Energy Equivalent (MMBtu)	3717.4
CO2 (MT)	587.92
CH4 (MT)	0.0098810
N2O (MT)	9.8810×10^{-4}
CO2e (MT)	588.46
Energy per Square Foot (MMBtu)	0.034555
CO2e per Square Foot (MT)	0.0054700
Energy per Occupant (MMBtu)	Infinity
CO2e per Occupant (MT)	Infinity
Energy per Operating Hour (MMBtu)	464.67
Scope	Scope 2
CO2 Emissions Factor	0.15815
CO2 Emissions Factor Units	MT/MMBtu
CH4 Emissions Factor	2.6581×10^{-6}
CH4 Emissions Factor Units	MT/MMBtu
N2O Emissions Factor	2.6581×10^{-7}
N2O Emissions Factor Units	MT/MMBtu

***Figure 2**. ICLEI Clear Path calculator for grid electricity*

Stationary Fuels

In 2010, the two stationary fuels consumed were heating oil and propane. Calculations for stationary fuel require two values – amount of fuel consumed and type of fuel. Supplemental information includes facility square footage and facility hours of operation. Emission factors for stationary fuels are built into Clear Path calculators.

The subcategories of Airport and Port & Harbor followed the same process for calculating electricity and stationary fuel emissions. All emission totals for electricity and stationary fuel consumption are combined to produce a GHG grand total for the Building & Facility category.

Category – Streetlights and Traffic Signals

This is an electricity-based category that utilizes the same emission factors of Buildings and Facilities. Included with Streetlights and Traffic Signals are the tsunami warning system sirens. Total KWh per unit are used to calculate GHG totals.

Category – Vehicle Fleet

The 2010 vehicle mileage and equipment hours were obtained from a fleet vehicle report produced in that year. A relational table organized by vehicle type (i.e., light truck, heavy diesel, passenger car, etc.) and miles traveled, or hours metered, depending on equipment type, was created to produce required values for use in the Clear Path calculator. Emission factors for vehicles are a function of vehicle fuel economy by vehicle type and year. Fuel economy values were obtained through U.S. Energy Information Administration and U.S. Department of Transportation open data sources. Fuel consumption is based on deliveries to the Public Work's fuel island with the assumption that fuel delivered is fuel consumed.

The Clear Path calculator was set up to evaluate vehicle fleet emissions based on three variables related to fuel type:

- Total volume of gasoline or diesel purchased
- Total Fleet miles traveled by fuel type
- Percentage vehicle miles traveled (VMT) by vehicle type

VMT percentage is a ratio of the sum of total miles traveled by vehicle type - passenger car, light truck, etc. - over total fleet miles traveled by fuel type. A gasoline example is as follows:

- Total miles traveled by light truck: 266,498
- Total fleet miles traveled for gasoline vehicles: 330,282
- Light Truck VMT %: 226,498/330,282 *100 = **80.68 %**

This process was repeated for all gasoline and diesel consuming vehicles with values computed in GHG calculator to produce emission totals.

Category – Water & Wastewater Treatment Facilities**.**

As with the previous categories, the primary energy sources for Water & Wastewater Treatment Facilities are electricity and heating oil. The wastewater treatment facility also consumed 2,000 gallons of propane. These records were calculated for GHG using the same methods and emission factors as the previous electricity and stationary fuel consuming categories.

In addition to electricity and stationary fuels, N2O emissions from aerobic processing of waste, and N2O from effluent discharge are measured. The calculation for N2O emissions from waste treatment is based on community population for the given year, which in 2010 was 5,049 people. N2O for effluent discharge is based on daily Nitrogen load in kilograms released to the environment. The daily nitrogen load was

derived from a ratio of average wastewater treatment plant flows and monthly average NH3 readings for 2010.

All electricity and stationary fuel use for water and wastewater facilities was combined with N2O emissions from waste treatment to produce a GHG emissions grand total for this category.

Inventory Specifics – 2019

Category – Buildings and Facilities

As in 2010, energy sources for this category are electricity and stationary fuels. Unlike 2010, the primary stationary fuel consumed is natural gas rather than heating oil. City infrastructure growth in the intervening period necessitated creation of additional records for evaluation in relational tables. All subcategories within Buildings and Facilities remain the same.

Electricity

HEA provided the city with a relational table containing formulas to convert annual KWh into emission factors for CO2, NH4, and N2O. Monthly KWh totals were organized by City sector, then input into HEA's table to obtain emission factors (Table 2). As with the 2010 factors, additional conversions were required to get values into the appropriate units for use in the clear path calculators.

A singular Emission factor per GHG type is required to calculate inventory records. To obtain this value, emission grand totals are divided by the grand total of City electricity use, as illustrated in Table 3.
This method was repeated to produce the following GHG emission factors for 2019 electricity consumption

- CO2 lbs/MWh: 876.67
- CH4 lbs/GWh: 16.52
- N2O lbs/GWh: 1.652

Stationary Fuels

The majority of City facilities converted from heating oil to natural gas use prior to 2019, yet some facilities still partially rely on heating oil for their operations. One of the Homer Recreation and Education Complex (HERC) buildings is in low use status requiring relatively little oil for its square footage. Furthermore, the Public Works headquarters building, the sewer treatment plant, and the old Homer Police Station all used some amount of heating oil in 2019. A negligible amount of propane was used by Public Works. Stationary fuel emission factors are static, so GHG emission totals are a function of the quantity of fuel used by fuel type. A stationary fuel grand total was produced by combing GHG emissions from all fuel sources.

Table 3 *HEA monthly KWh GHG calcualtion sheet for 2019*

FACTOR VALUES BY MONTH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
System CO2 Production Tons/MWh	0.4242	0.5085	0.5299	0.4525	0.3884	0.4438	0.4207	0.3549	0.2698	0.2699	0.2961	0.3336	**0.3910**
System CH4 Production Tons/MWh	0.000007994	0.000009583	0.000009987	0.000008528	0.000007320	0.000008365	0.000007929	0.000006688	0.000005085	0.000005086	0.000005581	0.000006287	**0.000011875**
System NOx Production Tons/MWh	0.000000799	0.000000958	0.000000999	0.000000853	0.000000732	0.000000836	0.000000793	0.000000669	0.000000509	0.000000509	0.000000558	0.000000629	**0.000001936**
kW Used	61246	56369	55821	53993	57501	56142	53799	54111	52474	50546	54211	105372	711585.00
CO2 Produced (lbs)	57273.32	63192.40	65213.19	53862.12	49235.98	54935.71	49897.76	42336.45	31215.73	30074.30	35391.53	77490.56	610119.05
CH4 Produced (lbs)	1.07940667	1.19096123	1.22904618	1.01511720	0.92793025	1.03535080	0.94040259	0.79789765	0.58830999	0.56679789	0.66700965	1.46043269	11.49866279
NOx Produced (lbs)	0.10794067	0.11909612	0.12290462	0.10151172	0.09279302	0.10353508	0.09404026	0.07978976	0.05883100	0.05667979	0.06670096	0.14604327	1.14986628
GW Used	0.061246	0.056369	0.055821	0.053993	0.057501	0.056142	0.053799	0.054111	0.052474	0.050546	0.054211	0.105372	0.711585
MW Used	61.246	56.369	55.821	53.993	57.501	56.142	53.799	54.111	52.474	50.546	54.211	105.372	711.585

Table 2 *Emission factor Calculation sheet for grid electricity 2019*

Emission Totals in lbs	Airport	Buildings & Facilities	Port Facilities	Streetlights & Traffic	Wastewater Facilities	Water Delivery	Totals
CO2	188,863.19	606,733.55	2,103,902.59	225,288.90	1,050,808.45	610,119.05	4,785,715.73
CH4	3.56	11.43	39.65	4.25	19.80	11.50	90.19
NO2	0.36	1.14	3.97	0.42	1.98	1.15	9.02

Energy Totals	
KW	5,458,909.00
MW	5,458.91
GW	5.458909

Factors in MW		
CO2 FACTOR	CH4 FACTOR	Nox FACTOR
876.6798875	16.52242532	1.65

Emission totals for electricity and stationary fuel consumption are combined to produce a GHG grand total for the Building & Facility category

Category – Streetlights & Traffic Signals.

GHG emissions for this category were calculated in the same way as in 2010.

Category – Vehicle Fleet.

Fleet reports for 2019 were not as comprehensive as 2010. Even so, the methods used for calculating GHG emissions are the same as in 2010.

Category – Water & Wastewater Treatment Facilities.

Methods for calculating GHG emissions relating to electricity and stationary fuel are the same as in 2010. Updates for community population and water treatment flows were required before running the Water and Wastewater Treatment calculators.

Results

The Clear Path software calculates emissions for CO2, NH4, and N2O concurrently, but for the purpose of evaluating totals by City sector, the CO2 equivalent (CO2e) output is most useful. CO2e is a universal measurement that equates the global warming potential (GWP) of greenhouse gases into one unit of carbon-dioxide. For example CO2 itself has a GWP of 1, while CH4 has a GWP of 28-36, meaning that 1 unit of CH4 has 28-36 times the global warming potential of CO2. GWP of N2O is significantly higher at 265-298. As CO2e provides a useful summation of GHG emission totals, all results displayed in the following charts and tables use CO2e as the GHG unit of measure.

CO2e totals for 2019 are 951.22 metric tons less than totals for 2010 – a 21.78% decrease. The most significant decrease belongs to Buildings & Facilities followed by Water and Wastewater.

With the exception of the Vehicle Fleet, all clear path categories experienced decreased emissions.

Table 4 *Total CO2e output comparison by City sector*

Category	2010 CO2e (MT)	2019 CO2e (MT)
Buildings & Facilities	2533.39	1919.32
Water & Wastewater	1320.69	983.98
Street Lights & Signals	85.82	49.88
Vehicle Fleet	429.22	464.72
TOTAL	4369.12	3417.90

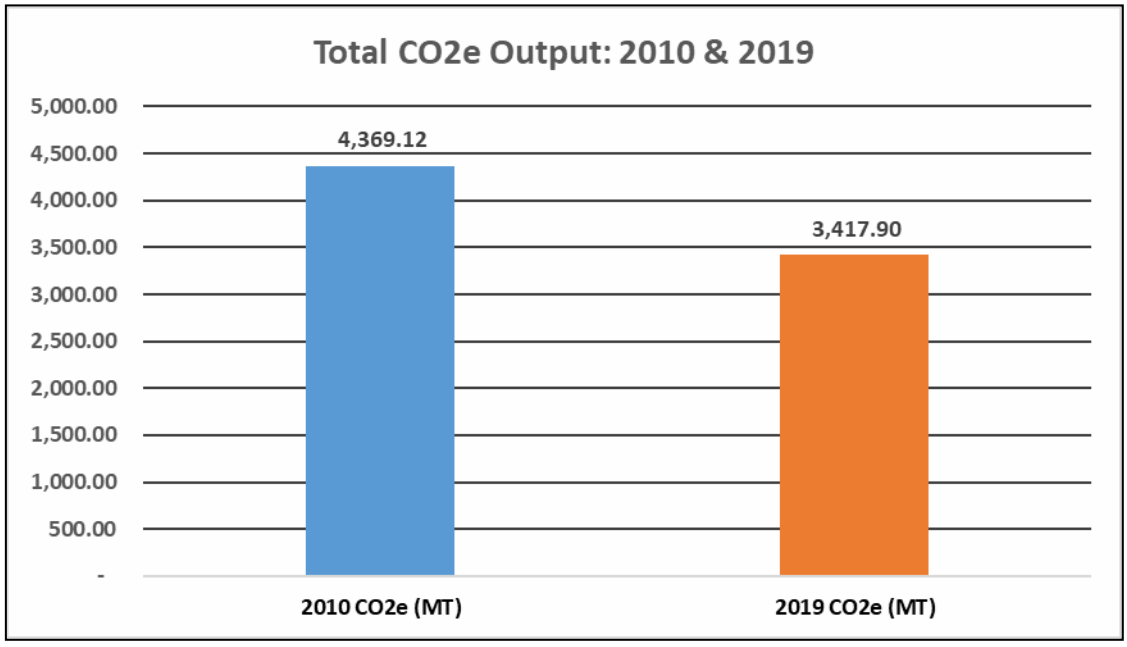

Chart 1 *Total City CO2e output comparison*

The proportion of total City emissions by Clear Path category remained relatively constant between 2010 and 2019. The greatest shift occurred in the Vehicle Fleet category, which assumed a 4% increase of total city emissions.

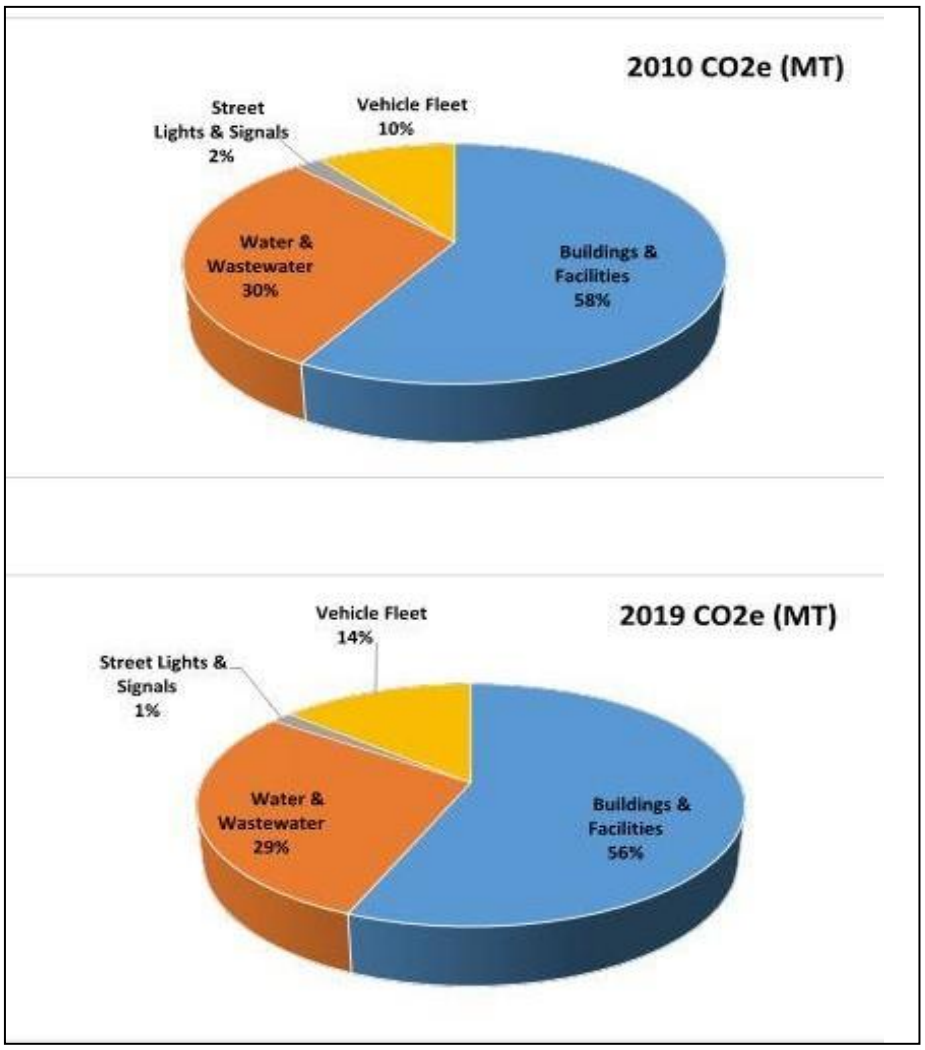

Chart 2 *Comparison of CO2e output % by City sector*

Two important questions in the analysis of GHG reduction progress are:

1. In what City sector did emissions reduce?

2. What was the energy type of any such emissions reductions?

The following tables and charts provide a more detailed look at emission outputs by examining specific inventory records contained within the broader Clear Path categories for both electricity and stationary fuel use. These records include:

- City Facilities
- Port & Harbor
- Airport
- Water Treatment
- Wastewater Treatment
- Streetlights & Traffic Signals

The Vehicle Fleet inventory was omitted from this list as little to no emission mitigation efforts were initiated.

A comparison of electricity use reveals a CO2e reduction of 987 CO2e (MT) between years 2010 and 2019. The largest reductions were achieved in the Water and Wastewater Treatment Facilities.

Table 5 *CO2e output comparisons for electricity use*

Inventory Record	2010	2019
City Facilities	588.46	489.29
Port & Harbor	1,268.91	1,014.69
Airport	149.16	272.61
Water Teatment	393.69	56.51
Waste Water Treatment	651.84	267.19
Streetlights & Signals	85.82	49.88
TOTAL	3,137.87	2,150.17

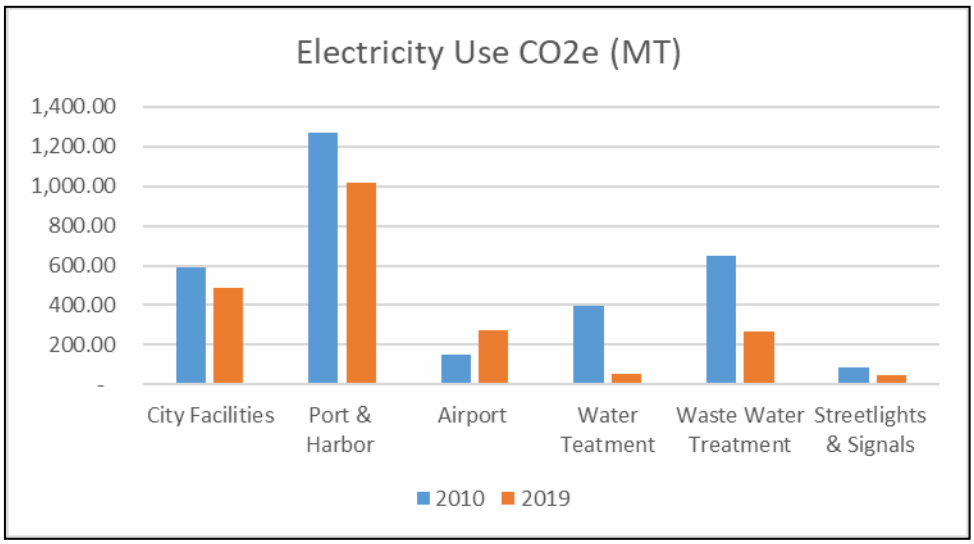

Chart 3 *CO2e output comparisons for electricity use*

Stationary fuel use in 2010 was exclusively heating oil. By 2019, all facilities had converted to natural gas. The 2019 CO2e totals for the Public Works Headquarters Building, the Wastewater Treatment Plant, and Port & Harbor was a combination of both natural gas and heating oil use. Even so, natural gas use far outweighed heating oil consumption for these facilities

CO2e reductions associated with stationary fuel use were less than reductions associated with electricity. Indeed, total emissions for all facilities combined increased by 19.2 metric tons. Four out of five sectors experienced small decreases, with the greatest reduction realized by the water treatment facility at 21 metric tons. Yet, these improvements were offset by an increase of 72.58 metric tons from the City Facilities sector.

Table 6 *Stationary fuel CO2e output comparison. Asterisk denote facilities that use both heating oil and natural gas*

Inventory Record	2010	2019
City Facilities	372.36	444.94*
Port & Harbor	68.56	63.07*
Airport	84.50	66.43
Water Treatment	80.23	59.68
Wastewater Treatment	128.23	118.94*
TOTAL	733.88	753.06

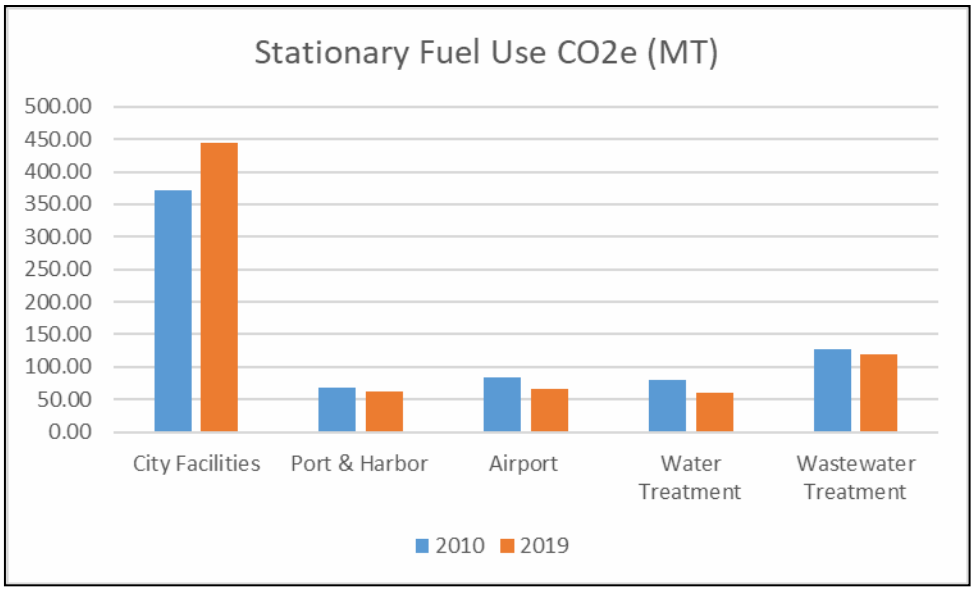

Chart 4 *Stationary fuel CO2e output by City Category*

To help explain how these reductions were achieved, **Table 7** presents a general timeline of the City's efforts in implementing emission mitigation strategies outlined in the CAP. The timeline begins in 2009 with the Deerstone Consulting report recommendations and carries through to 2019. In the rightmost column, all completed projects are marked with an "X", incomplete or unmitigated issues are left blank.

Table 7 *History of CAP implementation*

CAP Implementation Recommendations Based on Deerstone Consulting Report of 2009			
CATEGORY	FACILITY	PROJECT DETAILS	COMPLETED
Airport	Terminal	Separate switches on baggage area lighting fixtures to separately control high use lights & low use lights	
	Terminal	Variable frequency drives for main air handling unit to conserve electricity and fuel	**X**
Port & Harbor	Fish Dock	Remove 8 high energy consuming transformers	**X**
	Ice Plant	Install digital controls for ice machine boost system	
	Main Shop	Transition to manual operation of air compressor to save energy when not in use	**X**
Buildings and Facilities	Harbor Restrooms	Insulate hot water pipes and improve cold air return furnace system	**X**
	Harbor Restrooms	Add grid tied wind generator at good wind area with estimated 12 mph average	
Water & Wastewater Treatment	Pressure Reducing Stations	Turn off 3 KW heaters when temperatures are above 50 Deg. F.	**X**
	Pressure Reducing Stations	Use hydro turbines at some pressure reducing stations to heat the maintenance and water plant buildings	
Energy Consumption Evaluation by Bill Smith & EDC, LLC 2009-2010			
CATEGORY	FACILITY	PROJECT DETAILS	COMPLETED
Buildings and Facilities	Homer Public Library	Adjustments made to ventilation system & staff operating procedures	**X**
Siemens Industry, Inc. Energy Audit Recommendations: 2011 - 2018			
CATEGORY	FACILITY	PROJECT DETAILS	COMPLETED
Water & Wastewater Treatment	Sewer Treatment Plant	Replace existing pump motors with high efficiency motors	**X**
	Raw Water Pump Station	Replace existing motors with higher efficiency motors & install VFDs	**X**
	Sewer Treatment Plant	Solar Aeration System	**X**

Water & Wastewater Treatment	Sewer Treatment Plant	Interior & exterior lighting upgrade	**X**
	Sewer Treatment Plant	Natural Gas Conversion	**X**
	Water Treatment Plant	Natural Gas Conversion	**X**
Airport	Terminal	HVAC Improvements	**X**
	Terminal	Interior & Exterior lighting upgrade	**X**
	Terminal	Natural gas conversion	**X**
Buildings & Facilities	Public Works Dept.	Insulate various pipes	**X**
	Public Works Dept.	Natural gas conversion	**X**
	Police Station	installed LED to replace indoor T-12's and all outdoor lights	**X**
	Fire Station	Natural gas conversion	**X**
	Homer Public Library	Natural gas conversion	**X**
	Animal Shelter	Natural gas conversion	**X**
Port & Harbor	Harbor Maintenance Building	Conversion to 100% LED lighting	**X**
	Harbor Master Office	Natural gas conversion	**X**
	Ice Plant	Conversion to 100% LED lighting	**X**
	High Mast Lights	LED upgrade with digital controller	**X**
CITY FUNDED LIGHTING AUDIT AND LED CONVERSION WORKPLAN: 2018-2020			
CATEGORY	FACILITY	PROJECT DETAILS	COMPLETED
Buildings & Facilities	City Hall	LED lighting conversion	**X**
	Animal Shelter	LED lighting conversion	**X**
	Homer Public Library	LED lighting conversion	**X**
	Public Works Dept.	LED lighting conversion	**X**
Airport	Terminal	LED lighting conversion	**X**

Discussion

The results demonstrate the City reduced its GHG emissions in all inventories for electricity consumption and in four out of six inventories for stationary fuel use. Conversion to natural gas and implementing electricity conservation strategies have had a measurable positive effect in meeting CAP goals. In fact, if the CAP goal of decreasing community wide emissions by 20% by 2020 were applied to this municipal accounting, the City has exceeded that mark. Using the CO2e total of 5,369 tons emitted in 2006, the City achieved a 29.44% decrease in emissions by 2019.

This is a positive outcome, yet the discussion needs to consider two external variables, that undoubtedly impacted total emissions – building square footage and recent winter temperatures. The following discussion addresses these variables against the backdrop of the City's reduced emissions.

As Table 8 indicates, through expansions, additions and replacements, total building area increased by 10,986 sq. ft. from 2010 to 2019. With the exception of the HERC buildings and the old police station, City facilities converted to natural gas for heating purposes over the last decade. As natural gas produces 30% less CO2 than heating oil, more substantial CO2e reductions are assumed for 2019, yet the Clear Path calculators don't show this. In fact, stationary fuel emissions increased in 2019, which is likely due to the increased square footage heating requirement. Apparently, the increase in City building area after 2010 diminished potential GHG emission reductions. Some facilities use a combination of natural gas and heating oil in their operations (albeit, the amount of heating oil is significantly less than natural gas). Even so, stationary fuel emissions could be brought closer to 2010 levels if all City facilities stopped using heating oil.

The other variable that may belie stationary fuel GHG reductions is that in this time period, average annual temperatures increased. Obviously, the fewer freezing days in the year, the less heat is required to warm a building. Therefore, warmer temperatures may partially explain some of the GHG reductions in relation to increased building area for stationary fuel use. The CAP report the City produced in 2020 contains information which may help illustrate the interplay among these variables. Even though results from this inventory do not accurately represent fluctuating emission factors for electricity over this time period the stationary fuel emission quantities were based on the amount of energy consumed and are, therefore, useful in displaying trends. Chart 5 displays this relationship by overlaying CO2e output over changes in facility square footage and annual average temperatures.

Chart 5 and Table 8 indicate temperature increases roughly coincide with facility expansion while emissions remain relatively stable throughout this intersection. Therefore, temperature increases over this time period may play a large role in emission reductions. If this is the case, natural gas conversion during the period of facility expansion did help to keep emissions stable, but cannot entirely account for positive gains in reducing stationary fuel GHG emissions.

Table 8 *Temperature fluctuations and City square footage increases from 2006 to 2019*

Year	Avg Annual Temperature Fahrenheit	Bld Sq Footage	Facility Added
2006	36.58	150,948.00	New Library
2007	37.08	150,948.00	No Additions
2008	37.00	150,948.00	No Additions
2009	37.25	150,948.00	No Additions
2010	37.35	150,948.00	No Additions
2011	37.25	153,738.00	City Hall Remodel
2012	37.00	153,738.00	No Additions
2013	37.47	154,890.00	WKFl RR; Bartlett RR
2014	44.05	154,890.00	No Additions
2015	43.42	175,444.00	Skyline Fire Station; Harbormaster Office; PW Equip Shed; Ramp 5 RR
2016	43.48	175,524.00	Mariner Park Camp Fee Building
2017	42.75	178,204.00	Fire Station Pole Shed; 4 Conexes
2018	42.55	179,296.00	No Additions
2019	34.58	179,296.00	No Additions

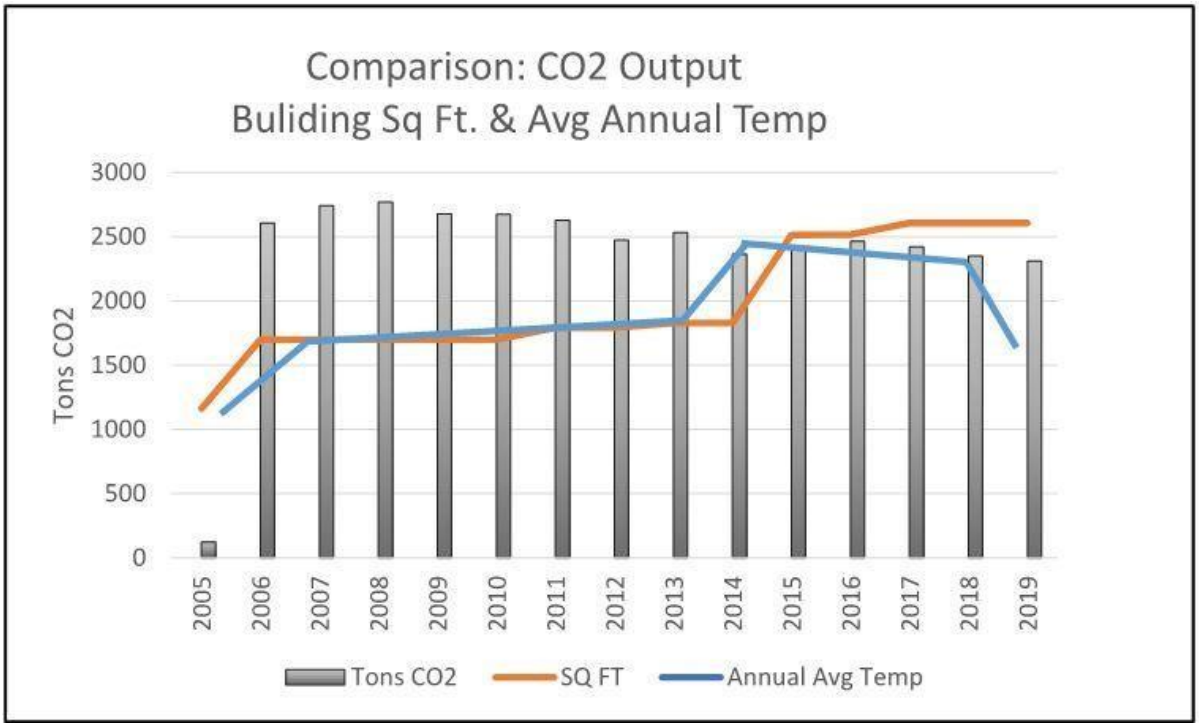

Chart 5 *Temperature, sq. footage and CO2e output comparison from 2005 to 2019*

Less equivocal are the positive results from electricity conservation measures. Even with greater electricity demands from increases in building area, every inventory experienced a reduction in emission output. Lighting conversions in City facilities have been effective in reducing electricity related GHG emissions; however, these reductions require another consideration – specifically that HEA provided a less GHG intensive energy source in 2019 than CEA did in 2010. For example, Table 8 shows that a comparison of MMBTU and CO2e outputs for electricity consumption reveals that Port & Harbor actually used more electricity in 2019 than in 2010, yet the CO2e for 2019 was less than 2010. Revisiting emission factors for electricity bolster this result, as the 2010 emission factor of 1190 lbs. CO2/MWh, is considerably larger than the 2019 factor of 876 lbs. CO2/MWh.

Table 9 *MMBtu comparison by City sector*

Inventory Record	**2010** (MMBtu)	**2019** (MMBtu)	Inventory Record	**2010** CO2e	**2019** CO2e
Port & Harbor	8,015.91	8,699.84	Port & Harbor	1,268.91	1,014.69
Buildings and Facilities	3,717.37	2,337.35	Buildings and Facilities	588.46	272.61
Airport	942.25	484.51	Airport	149.16	56.51
Water Teatment	2,487.01	2,290.83	Water Teatment	393.69	267.19
Waste Water Treatment	4,117.75	4,195.13	Waste Water Treatme	651.84	489.29
Lights and Signals	542.12	427.68	Lights and Signals	85.82	49.88
	19,822.43	18,435.34		3,137.87	2,100.28

Regardless of the disparity in emission factors, the electricity MMBtu in Table 9 illustrate that, with the exception of Port and Harbor, proactive measures taken by the City helped reduce energy consumption across the remaining electricity-dependent inventories.

The City failed to make any gains in the vehicle fleet category. Of the four Clear Path categories, this was the only one where total emissions increased. A contributing factor is that the City – particularly Parks Dept. - operate many older vehicles. In fact, some vehicles were in use before the CAP was initiated. Considering that the standard for vehicle replacement at the time of the first CAP report was approximately 10 years of use or 65,000 miles, these older vehicles have exceeded their useful life in terms of GHG emissions potential. Another issue is the lack of consistent record keeping for vehicle mileage and equipment meters. More accurate (and potentially more positive results) may be achieved with concise and up-to-date vehicle reports.

Another shortcoming of this inventory is the dearth of data regarding City solid waste disposal and the associated methane emissions. The Deerstone Consulting CAP Implementation Report of 2009 accounted for that activity, but at some point since then solid waste disposal tracking ceased. ICLEI provides emission calculators to quantify methane produced from waste disposed in landfills. Adding this activity as an emission category will make future inventories more comprehensive.

Recommendations

Public Engagement

Moving forward, the City must reengage the community about climate change mitigation and the status of the City's CAP. Outreach and messaging could be conducted via several formats to solicit maximum participation. For instance, the venues can include open meetings, city web pages devoted to the topic, in-person workshops, interactive media, etc. Unfortunately, due to pandemic restrictions, some of these options may not be available. CAP history and report results will drive discussion in these meetings, and should generate meaningful input about community concerns, hopes, and motivations regarding climate change and its potential impacts to Homer. Ideally, by showcasing the City's successful climate mitigation efforts, enough support for climate action will be generated to carry on with future energy use improvements. Potentially, if enough momentum is gained, these efforts may extend beyond the local Government sphere and into the greater community.

Partnerships and collaborations with local climate change motivated entities should be pursued. An active exchange of information and ideas between stakeholders with various expertise on this issue will produce synergetic relationships with positive outcomes for climate action advancement. Some of these groups should include the Kenai Peninsula Resilience Commission, the Kachemak Bay National Estuarine Research Reserve, and the University of Alaska. Collaboration with these groups may prove invaluable to develop and implement community and region wide climate mitigation strategies.

Energy Use

Any energy related recommendations are contingent on the level of support from the community and City Council for advancing an updated climate action agenda. As energy saving technology, and alternative energy systems continue to advance, there may be opportunities beyond the City's current CAP implementation achievements for reducing energy consumption. The following recommendations reiterate many found in the Deerstone Consulting report of 2010, yet may be more viable today. They include:

- Reexamine unaccomplished recommendations in the Deerstone Consulting Implementation report for alternative energy production
    - Wind/Solar/Hydro energy production
- Investigate whether or not additional facility energy savings are feasible by conducting up-to-date energy audits
- Eliminate remaining heating oil use in City facilities
- Make improvements to vehicle fleet and operations
    - Hybrid/Electric vehicle introduction
    - Reduce vehicle Idling
    - Reduce unnecessary travel

Inventory & Reporting

It is recommended that inventories be maintained for all energy consuming and GHG producing City sectors to ensure that the compilation of energy data always be up to date and viable regardless of the motivation or disinclination to act on data information at any given time. Maintaining these records isn't over-burdensome to the City, as data gathering relationships with energy providers are well established and only one city staff member is required to organize the data on a monthly basis. That being said, there is room for improvement with inventory maintenance and reporting. It is also recommended that this report be supplemented with a cost analysis associated with reduced energy consumption between baseline year 2010 and comparison year 2019.

The following recommendations will help the City better understand its level of energy consumption and associated costs in terms of climate change exacerbation and monetary expense:

- Maintain annual membership with ICLEI
- Continue to use ICLEI protocol for organizing and calculating energy use
- Improve vehicle fleet inventory
    - Maintain more detailed records for vehicle age, mileage/hours, maintenance history
- Develop inventory for disposal of landfill waste
- Produce basic inventory reports on an annual basis for year to year comparison
    - Reports should include summaries of energy consumption, GHG, and energy outputs and energy costs
    - In addition to City sector totals, reporting should account for all facilities individually for detailed evaluation