King County Housing Authority
2017 Greenhouse Gas Accounting Report

Updated February 2020

Note – this is an updated version of the original 2017 Greenhouse Gas Inventory Report, which reflects updated and refined carbon accounting practices. The original report was published in August 2018.

I. Project Introduction

King County Housing Authority (KCHA) hired an EDF Climate Corps Fellow[1] for a 12 week project in the summer of 2018 to support their sustainability work and development of KCHA's greenhouse gases (GHGs) inventory. KCHA's Resource Conservation team, which has been working on reducing energy and water consumption while trying to improve solid waste practices, has set goals for KCHA on water consumption, energy consumption and diversion of solid waste through 2021. With this project KCHA intends to introduce a dimension of greenhouse gases in their sustainability efforts which would then inform as well as become a common denominator for the next sustainability plan.

The project was approached with these broad objectives:

a. Quantify KCHA's GHG footprint
b. Develop a convenient and easy method for tracking and reporting relevant data
c. Help align to King County's Strategic Climate Action Plan
d. Make recommendations to reduce GHG footprint

II. Basics of GHG Inventory

Global warming and climate change have come to the fore as a key sustainable development issue. In fact, climate change is now increasingly being viewed as a "threat multiplier". Many governments across the world are taking steps to reduce GHG emissions through policies like emissions trading programs, carbon taxes, regulations and standards on energy efficiency and emissions. As a result, organizations must be able to understand and manage their GHG risks if they are to ensure long-term success and readiness for future national or regional climate policies.

A GHG emissions inventory estimates the quantity of GHG emissions associated with community sources and activities taking place during a chosen analysis year. Local government organizations typically choose to develop a community GHG emissions inventory report for the following reasons:

- Inform climate action planning
- Demonstrate accountability and leadership
- Track GHG emissions performance over time
- Motivate community action
- Recognize GHG emissions performance relative to similar communities
- Enable aggregation of GHG emissions data across regions, and

[1] Environmental Defense Fund (EDF) has been developing a Climate Change Corps since 2008, recruiting graduate students every year with past project management experiences in the energy and environment sectors.

- Demonstrate compliance with regulations, voluntary agreements, and market standards (where applicable)

Quantifying emissions

Accounting for GHG emissions can be tricky because of multiple reasons. For instance, there are many gases which are classified as GHGs which then calls for a need to standardize the unit of gas emissions. What is the right way to classify emissions when comparing, for example, direct emissions from a company's fleet to indirect emissions associated with manufacturing of cement that was used in constructing residential units? Organizations have varying levels of ownership and responsibility of these emissions which in turn calls for a method which segregates these emissions appropriately.

Organizational boundaries are determined using an equity share or control approach. Under the equity share approach, the reporting organization is only responsible for the emissions proportional to the amount of equity they have in the operation. Under the control approach, the organization accounts for 100% of the emissions from operations over which it has either financial or operational control. For KCHA it becomes important to consider this issue when considering certain sources of emission like electricity consumption, for example, as KCHA doesn't have control over residents' consumption and isn't responsible for their bills (however the common area bills at properties are paid by KCHA.) Interestingly, given that most big appliances like refrigerators, electric stoves, etc. are pre-fit in units by KCHA, it does provide some level of control in reducing emissions from residential units. Since data is not entirely available at this segregated level, this GHG inventory assumes KCHA has operational control over properties and thus all emission sources accounted for are assumed to be fully under KCHA control from this perspective.

Operational boundaries are based on the emissions generated as a direct or indirect result of the organization's operations. Due to the different types of emissions associated with different kinds of activities and varying control over these emissions, they can be classified into scopes for further consideration. According to the GHG Protocol, operational boundaries can be divided up into three scopes:

- Scope 1: Direct emissions owned or controlled sources. For example, emissions from company vehicles.
- Scope 2: Indirect emissions from generation of purchased energy. For example, emissions from purchased electricity.
- Scope 3: Upstream and downstream emission activities. Emissions associated before and after the creation of a product, such as transportation or capital goods.

Scope 1 and 2 are relatively easy to identify and estimate, since data for these emissions are often accessible. Organizations leading their industries in carbon accounting are now also accounting for Scope 3 emissions however, they are generally much more difficult to quantify. Figure 1 provides a visual representation of these scopes with additional examples.

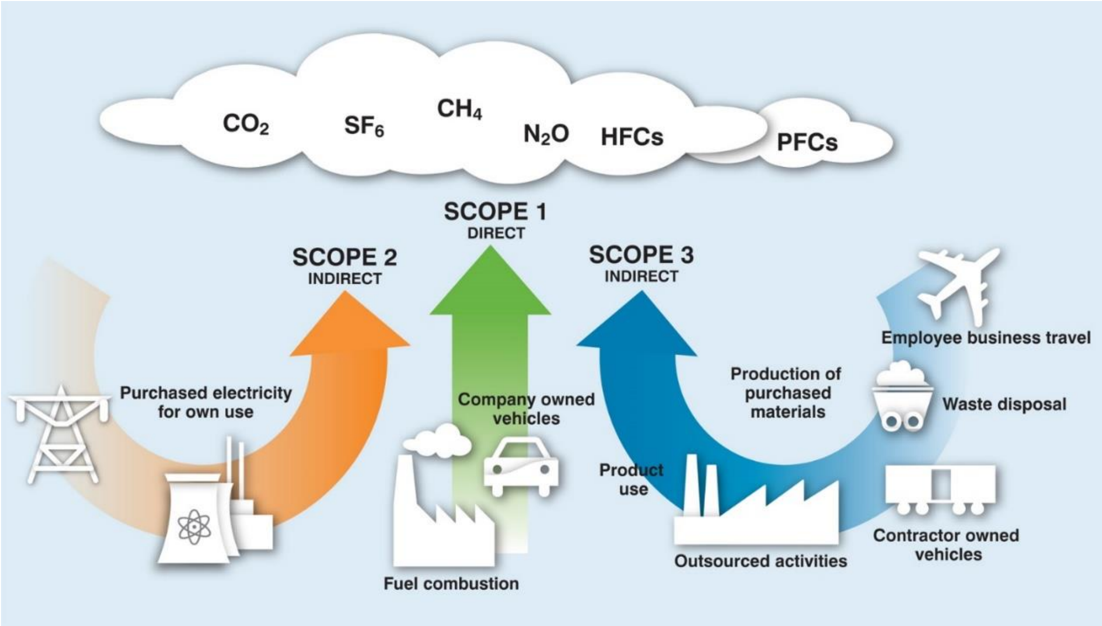


Figure 1 - Pictorial representation of Scope 1, 2, and 3 of GHG Emissions

Greenhouse Gases (GHGs)

Greenhouse gases are gases that trap heat in the atmosphere. They absorb and emit energy within the thermal infrared range which is the fundamental reason for the greenhouse effect. Carbon dioxide (CO_2) is the most abundant GHG in the atmosphere, followed by methane, nitrous oxide and fluorinated gases.

- Carbon dioxide (CO_2): Carbon dioxide primarily enters the atmosphere through burning fossil fuels (coal, natural gas, and oil), solid waste, trees and wood products, and also as a result of certain chemical reactions (e.g., manufacture of cement).
- Methane (CH_4): Methane emissions commonly result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills. Methane is emitted during the production and transport of coal, natural gas, and oil.
- Nitrous oxide (N_2O): Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.

From amongst the other GHGs, fluorinated gases are important. They are synthetic and powerful GHGs emitted from different industrial processes. They are used inside products like refrigerators, air-conditioners, foams and aerosol cans. These are typically emitted in smaller quantities but are very potent as GHGs. Their measurement, however, needs greater scientific attention and precision before reliable emission factors can be developed for wider use by organizations for updating their GHG inventory.

Global Warming Potential (GWP)

GHGs warm Earth by absorbing energy and decreasing the rate at which energy escapes to space, almost like an insulating blanket around the planet. Different gases have varying potential for this, depending on their ability to absorb energy (radiative efficiency) and the duration for which they stay in the atmosphere (lifetime)[2].

The concept of global warming potential (GWP) was developed to allow for comparisons and to help standardize impacts of these different gases. More specifically, it is a measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide (CO_2)[3]. The larger the GWP, the more that gas warms the Earth compared to CO_2 over that time period. The time period usually used for GWPs is 100 years. GWPs provide a common unit of measure, which allows for adding emissions' estimates of different gases.

EPA considers GWP estimates presented in the most recent IPCC scientific assessment to be true. The GWP assumptions (listed in Table 1 - Common GHGs and their global warming potential (GWP), below) this piece of work utilizes are from the IPCC's Fifth Assessment Report, published in 2014.

Greenhouse gas	Global warming potential (GWP)	Normalized equivalence
Carbon dioxide (CO_2)	1	1 metric ton (MT) of CO_2 = 1 MT of CO_2e
Methane (CH_4)	28	1 MT of CH_4 = 28 MT of CO_2e
Nitrous oxide (N_2O)	265	1 MT of N_2O = 265 MT of CO_2e

Table 1 - Common GHGs and their global warming potential (GWP)

[2] United States Environmental Protection Agency (EPA)
[3] United States Environmental Protection Agency (EPA)

III. Boundaries of KCHA inventory

Defining the boundaries of a GHG inventory study is the most critical and tricky task. Every object we use in our daily lives, directly or indirectly, has a greenhouse gas footprint. Every object is made using energy (created using a fuel) or is made up components which utilized energy in their own manufacturing processes or objects release GHGs when they decompose. For a housing authority, release of GHGs is associated with resident properties, corporate offices, employees and all supporting activities to provide affordable housing for low income communities. More specifically, this includes electricity and gas consumption at KCHA properties and central offices, consumption of fuel in employee commute, disposal of residents and employees' solid waste at Cedar Hills landfill, consumption of various construction materials, among others. Figure 3 below offers specifics of what is included in the 2017 analysis and what is not included.

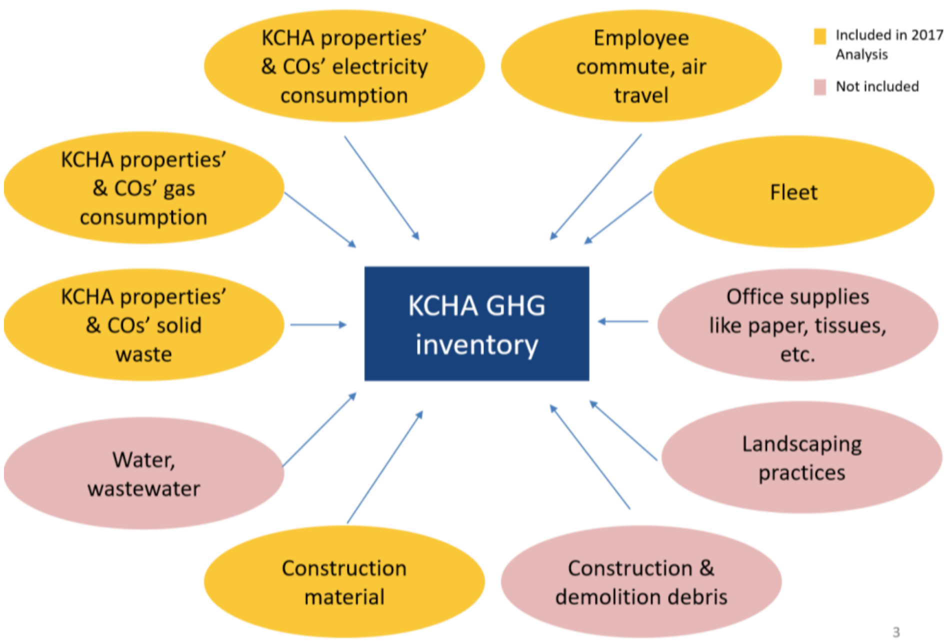


Figure 2 - Sources of GHG Emissions at KCHA

Based on internal KCHA interviews in the first two weeks of the study, the boundaries for this project were decided after consulting department heads and getting a sense of what information is available, what can be collated in a few weeks and what cannot be measured at all or without a certain degree of confidence given the prevailing data management mechanisms. 2017 was chosen as the baseline year as it's the most recent year for which KCHA has reliable information about its energy use among other categories. We engaged with Seattle Housing Authority (SHA) to understand the boundary of their GHG inventory study. King County's Senior Climate Change Specialist Matt Kuharic was consulted for finalizing our scope of work[4].

[4] KCHA 2017 GHG inventory excludes water and waste water related emissions as Matt Kuharic suggested that these emissions are almost insignificant

IV. Methodology & results

Quantifying emissions from each GHG source was done using a different methodology which was specific to each category of emissions and is covered alongside each category. For conceptual clarity and assumptions (where KCHA specific data wasn't available), this work relies on International Council for Local Environmental Initiatives (ICLEI) Community Protocol for Accounting and Reporting of GHGs.

This 12 weeks' effort was to assess and quantify KCHA's GHG emissions using 2017 as the baseline year. As accuracy of data reporting improves and as coverage of sources of GHG emissions increases, these results will also change.

KCHA's 2017 total GHG inventory stands at 38,066 metric tons of carbon dioxide equivalent (MT CO_2e). Not surprisingly, KCHA's largest source of GHG emissions is energy consumption at properties and offices, followed by employee commute.

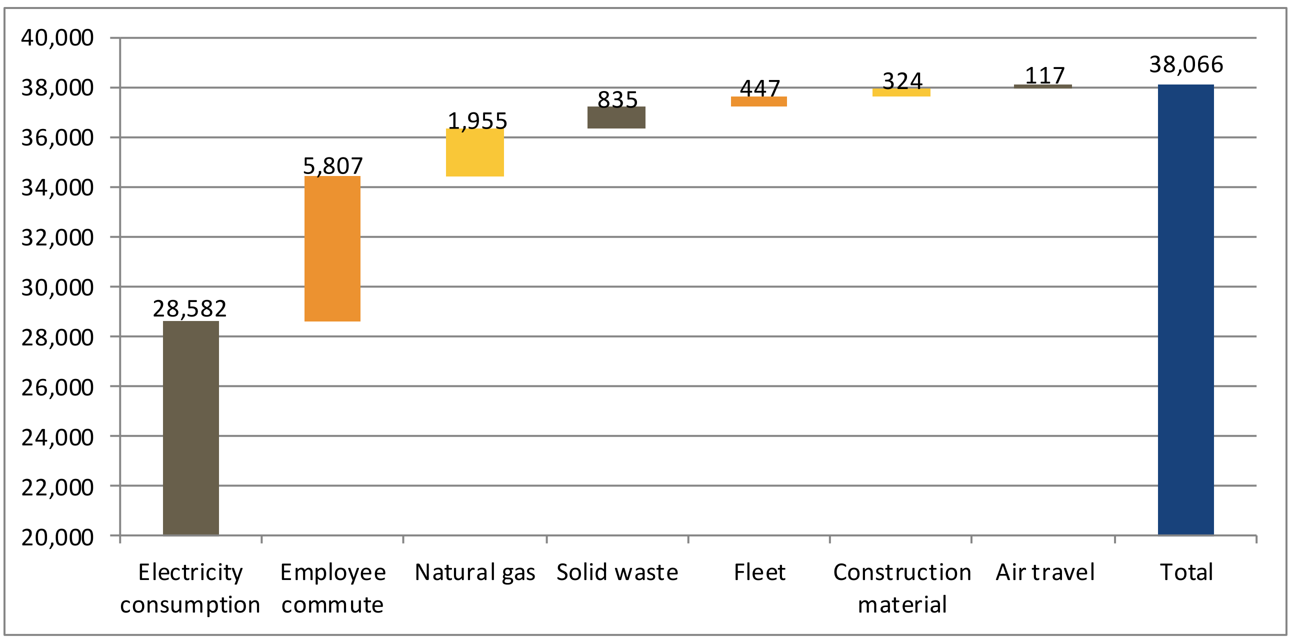


Figure 3 - KCHA GHG inventory, 2017 (MT CO_2e)

While the GHG analyses for these individual sources of emission are explained later in this section, it is important to consider these emissions from an operational boundary perspective so as to disaggregate these emissions into scope 1, 2, and 3 which then allows an organization to get a more wholesome sense of their emissions and how much control do they have over the various sources of emissions.

Sector	Scope 1	Scope 2	Scope 3
Electricity	-	28,582	-
Natural gas	1,955	-	-
Employee commute	-	-	5,807
Solid waste	-	-	835
Fleet	447	-	
Construction material	-	-	324
Air travel	-	-	117
Total	**2,402**	**28,582**	**7,082**

Table 2 - KCHA 2017 GHG Emissions, by Scope (MT CO_2e)

It's important to note that Scope 2 emissions are the largest for KCHA since electricity consumption is the biggest source of GHG emissions. While KCHA residents and employees do have some control over consumption, they do not control what fuel mix the concerned utilities use to produce that electricity which governs emissions associated with electricity. This is covered in detail in the buildings' energy section below.

A. Buildings Energy

Methodology

The GHG emissions associated with electric power and gas heating were calculated using KCHA property energy consumption data and carbon contents from utility fuel mix disclosure reports. Energy usage data was shared by the utilities with Energy Star Portfolio Manager, which collects energy consumption data on a whole building level.

Results

Energy consumption related to KCHA buildings' power and heating makes up the vast majority of its GHG emissions (30,537 MT CO_2e). These emissions are necessary to its operations. The two most impactful factors for building energy GHG emissions are the overall energy consumption and the utility's electricity production method. KCHA operates in two electric utility territories. Seattle City Light (SCL), a public utility providing electricity primarily in Seattle city limits, generates nearly all of its electricity through hydropower. Puget Sound Energy (PSE), a private electric and gas utility spanning the Puget Sound region, uses a variety of renewable and fossil fuel sources to produce its electricity. Since over 85% of its properties are located in PSE territory, KCHA's GHG emissions are very closely tied to PSE's electricity supply fuel mix.

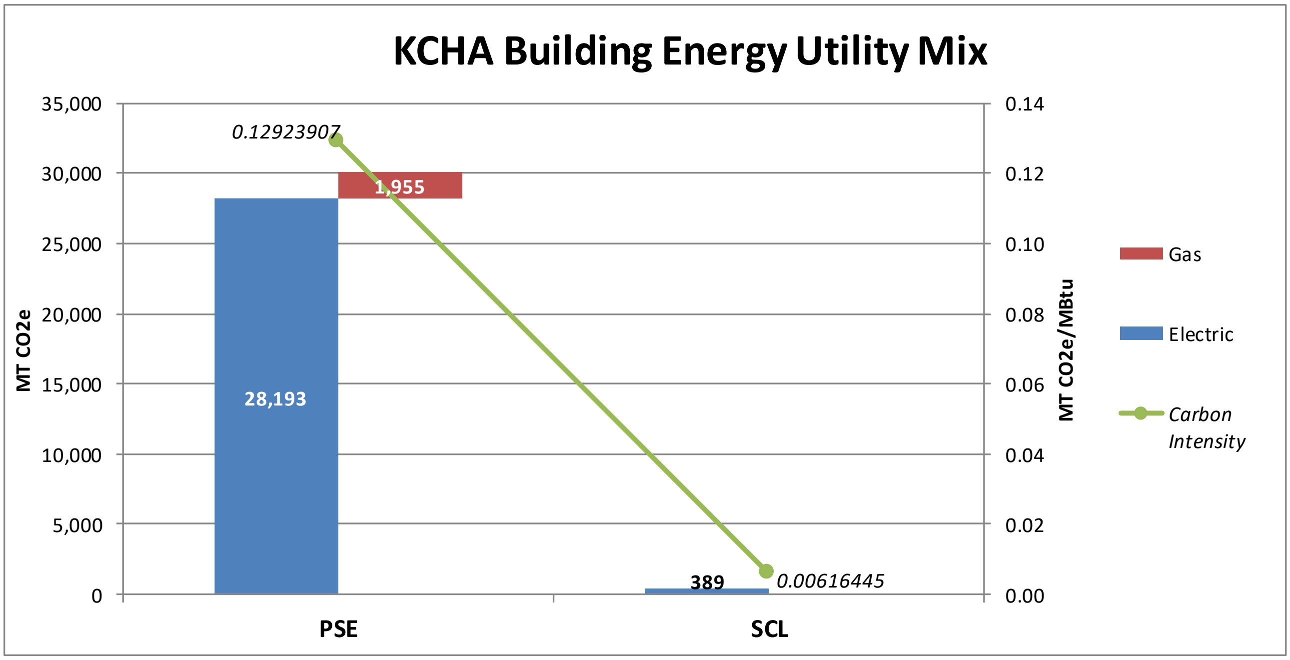


Figure 4 - KCHA Building Energy Utility Mix

We examined GHG emissions on a square foot and a per resident basis, across seven different building type designations. Our most efficient buildings per square foot and per resident respectively are apartments and semi-detached, while the least efficient per square foot and per resident building types are semi-detached and houses, respectively. However, apartment GHG efficiency can in part be attributed to a several apartment properties using SCL electricity, while all KCHA houses, manufactured housing, or semi-detached homes receive their electricity from PSE.

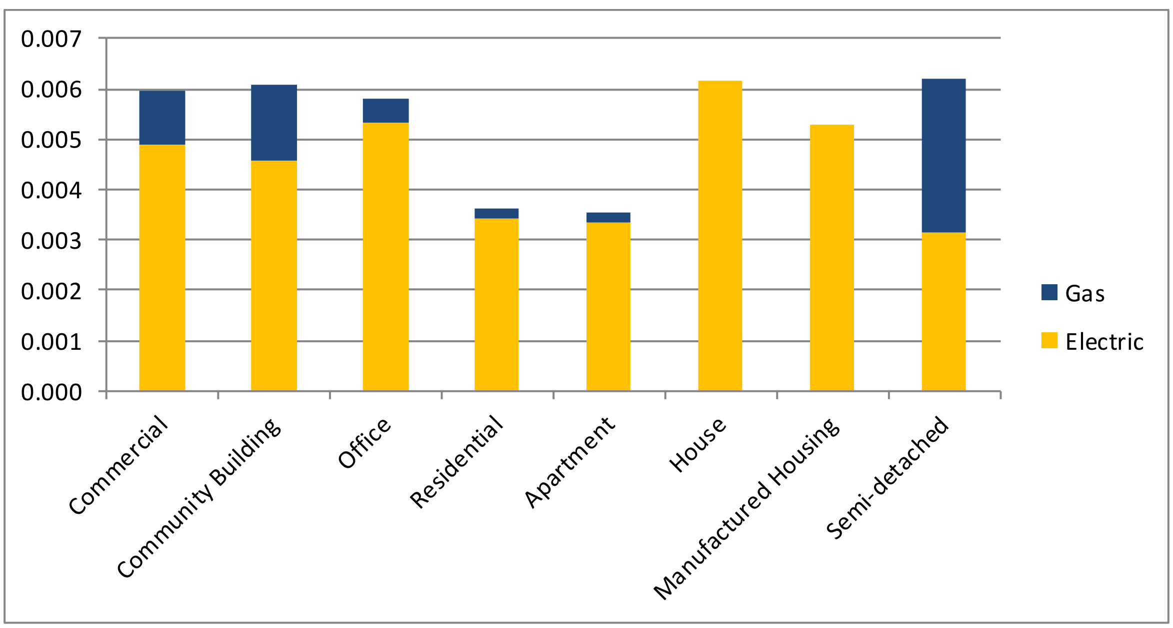


Figure 5 - Energy related GHG emissions per sq. ft. by building type

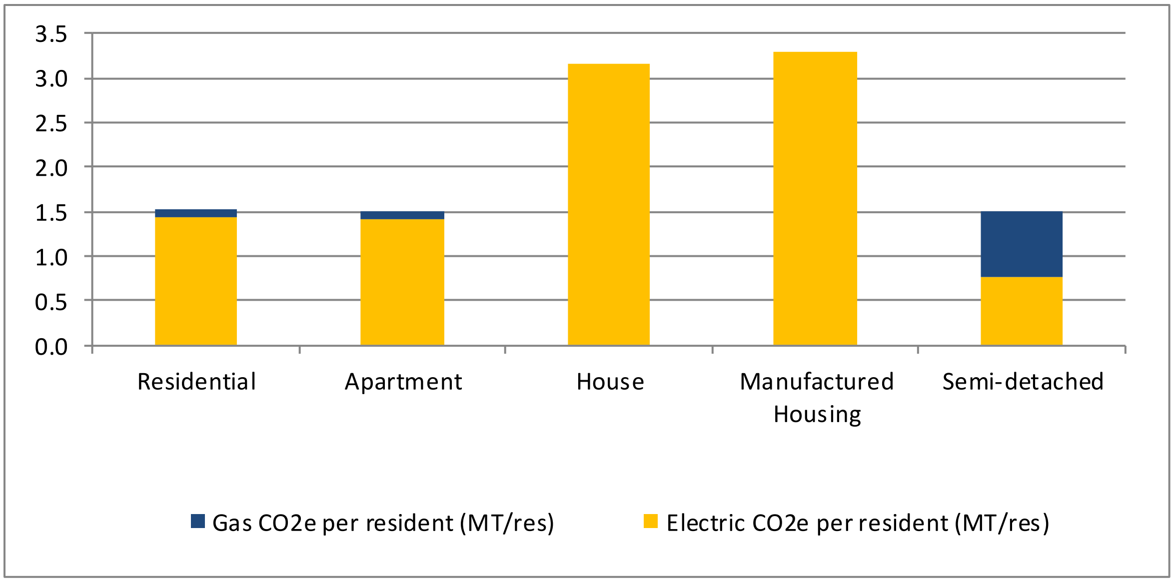


Figure 6 - GHG emissions per resident, by building type

B. Employee Commuting

Methodology

In order to better understand employee commuting characteristics, employees were asked to complete an online survey. The survey results revealed how far employees typically commute, and what modes of transportation they use.

Results

Employees overwhelmingly use their personal vehicles as their primary mode of commuting—likely due to KCHA office locations and ample parking provided at properties. However several use a combination of public transit services including buses, Link light rail, Sounder train, and Washington State Ferries. Additionally, some employees use carbon neutral options like cycling, walking, and telecommuting.

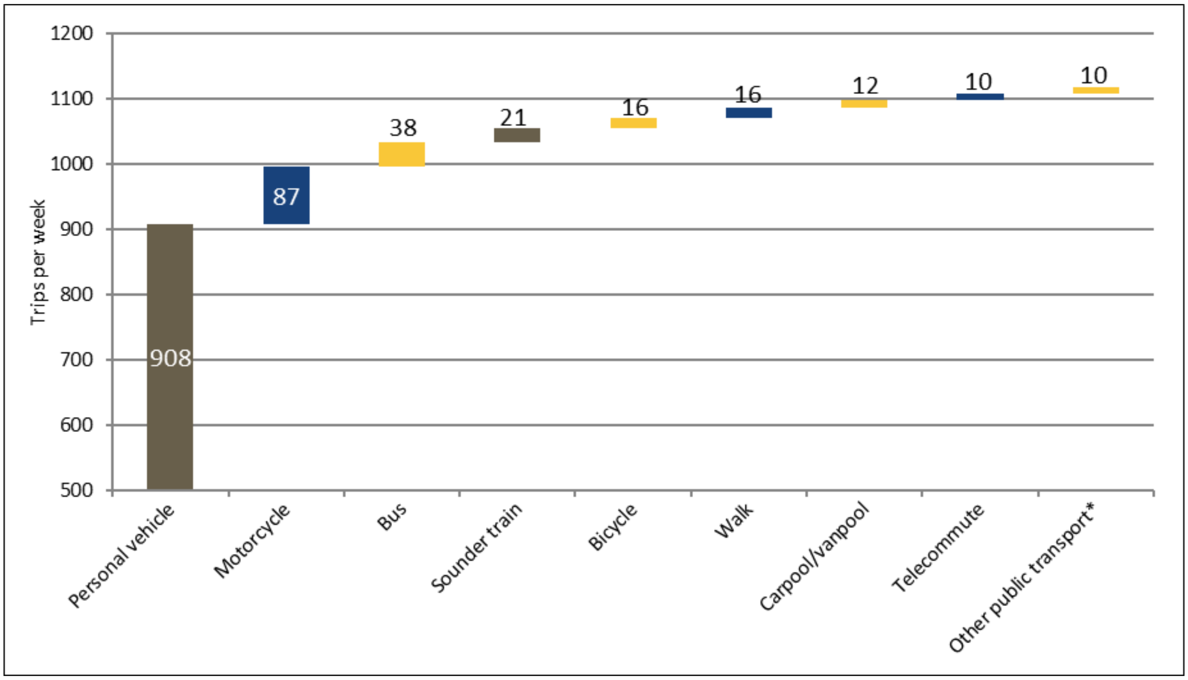


Figure 7 – KCHA employee trips per week by transportation mode, 2017

Over 5,800 MT of CO_2e annually is produced by KCHA employee commutes. Due to the low emissions fuel and energy efficiency of alternative transit options, the vast majority of those GHG emissions are from personal vehicle travel. Telecommuting, while rarely utilized by KCHA employees, prevents nearly 192 additional MT of CO_2e due replacing personal vehicle commutes.

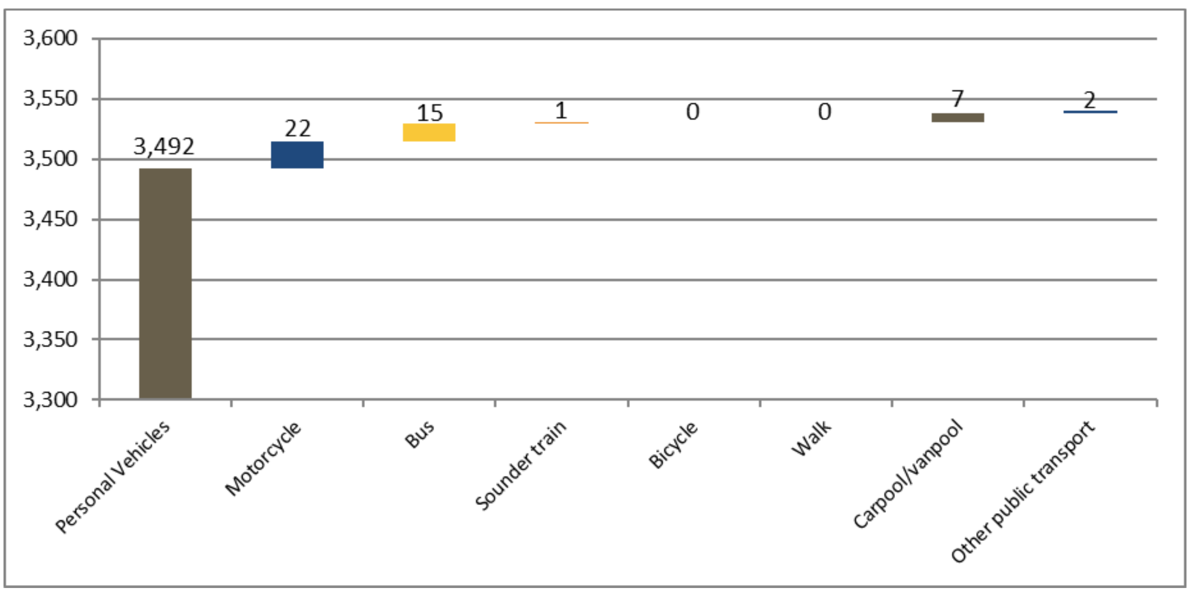


Figure 8 - Weekly GHG emissions from KCHA employee trips by transportation mode, 2017

C. Solid Waste

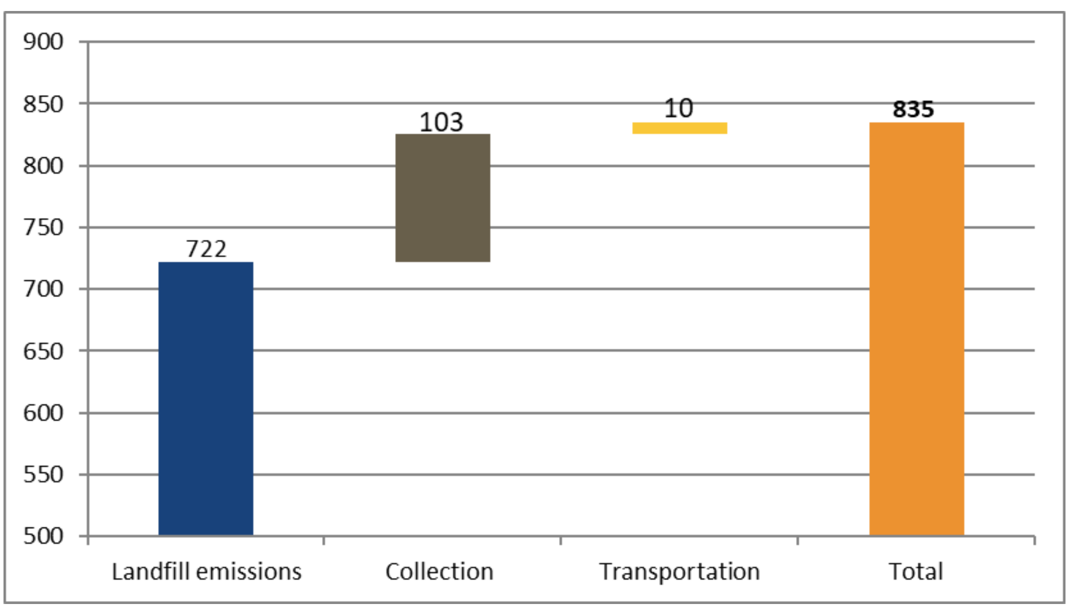
Methodology

The Resource Conservation team maintains records for collection of solid waste from properties and central offices. Ideally, we would collect receipts of actual tonnages of KCHA related waste from the various haulers who work with KCHA. While tonnage data can be collected for the compactors that several properties have, the vast majority of waste is collected in dumpsters for which we are charged by volume and not tonnage. This effort leveraged compactor tonnage and dumpster volume and service frequency to estimate the amount of solid waste collected, transported and processed to generate electricity at the Cedar Hills facility. In addition to some carbon dioxide, methane is the important GHG released when this solid waste decomposes and is captured for further electricity generation. Emission factor assumptions from International Council for Local Environmental Initiatives (ICLEI) were used.

Results

Solid waste from resident and employee activities is another significant source of GHG emissions, accounting for 835 MT CO_2e. These emissions are largely due to decomposition of solid waste that take place at the Cedar Hills landfill. Recall that methane is 28 times more potent for global warming than carbon dioxide, which is why even with 92% gas capture efficiency[5] at the Cedar Hills facility, 722 MT CO_2e emissions are still taking place.

As per calculations build off of Resource Conservation's solid waste analysis, a total of 4,996 metric tons of garbage was estimated from KCHA properties and Central Offices. This excludes the recyclable and yard waste that is diverted away from going to landfills. In fact, current diversion rate of ~45% is keeping at bay ~670 MT CO_2e of emissions. Interestingly, at current levels of solid waste every additional 1% annual diversion is equivalent to reduction of ~20,500 miles driven by a passenger car.



[5] ICLEI recommends using 75% as the gas collection efficiency in the absence of data from the requisite facility.

Figure 9 - Solid waste related GHG emissions, 2017 (MT CO_2e)

D. Fleet

Methodology

For calculating emissions associated with the KCHA fleet, information from ARI Fleet Manager was used. This portal, which KCHA subscribes to, successfully captures fuel consumption for all the different vehicles in the fleet. Suitable emission factors were used for different car segments and methane and nitrous oxide emissions were estimated using EDF-NAFA[6] Fleet GHG Emissions Calculator.

Results

The KCHA fleet, comprised of light duty trucks, vans, SUVs, passenger cars and non-road vehicles (like lawn mowers, etc.), accounts for ~447 MT CO_2e in 2017. ~77% of the fuel consumption was for light duty trucks, vans and SUVs - as a category.

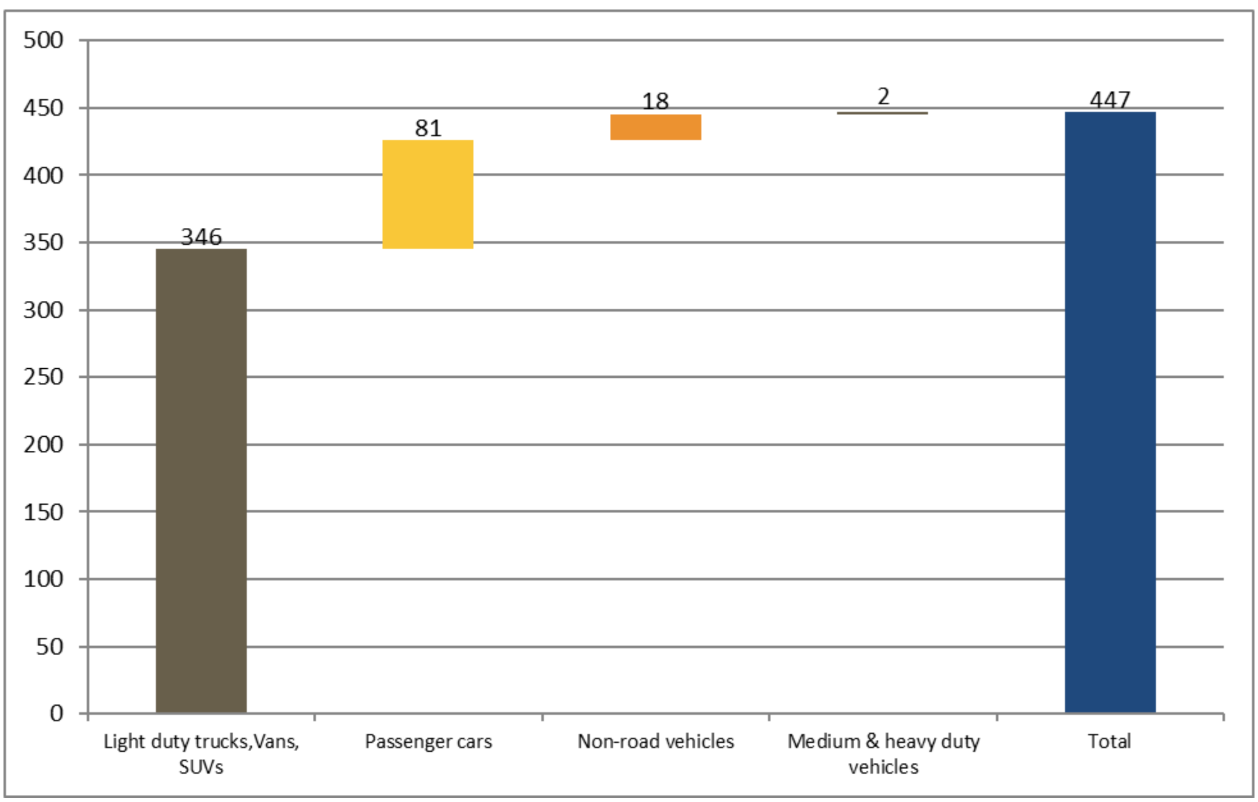


Figure 10 - Fleet related GHG emissions, 2017 (MT CO_2e)

[6] NAFA Fleet Management Association

E. Construction material

Methodology

Construction material was a fairly tough category for capturing emissions, given the way material is procured and the range of materials being used by Capital Construction and Asset Management teams. Large projects get awarded basis proposals which are naturally tied to value of the project and not the amount of material being used. This causes a fundamental problem in collecting information about the amount of cement, paint, doors, windows, siding tiles, asphalt, etc. that are used by KCHA contractors in building or renovating or refurbishing residential units.

After several discussions with the Capital Construction and Asset Management teams, it was decided that they would compile information from some of their larger projects in 2017 and estimate quantities used by contractors. To provide a sense of the share of the total construction material being covered through these selected projects, the teams calculated the share of these construction materials' cost in the total money spent on construction material – Capital Construction (~30%) and Asset Management (~27%).

Results

Construction materials, accounted for 324 $MTCO_2e$ emissions. This is based on incomplete data and is likely to be a much bigger emissions category as KCHA improves data reporting and management for this category. LP siding and concrete are leading contributors due to their cement content. Windows and paint came out to be the other key contributors.

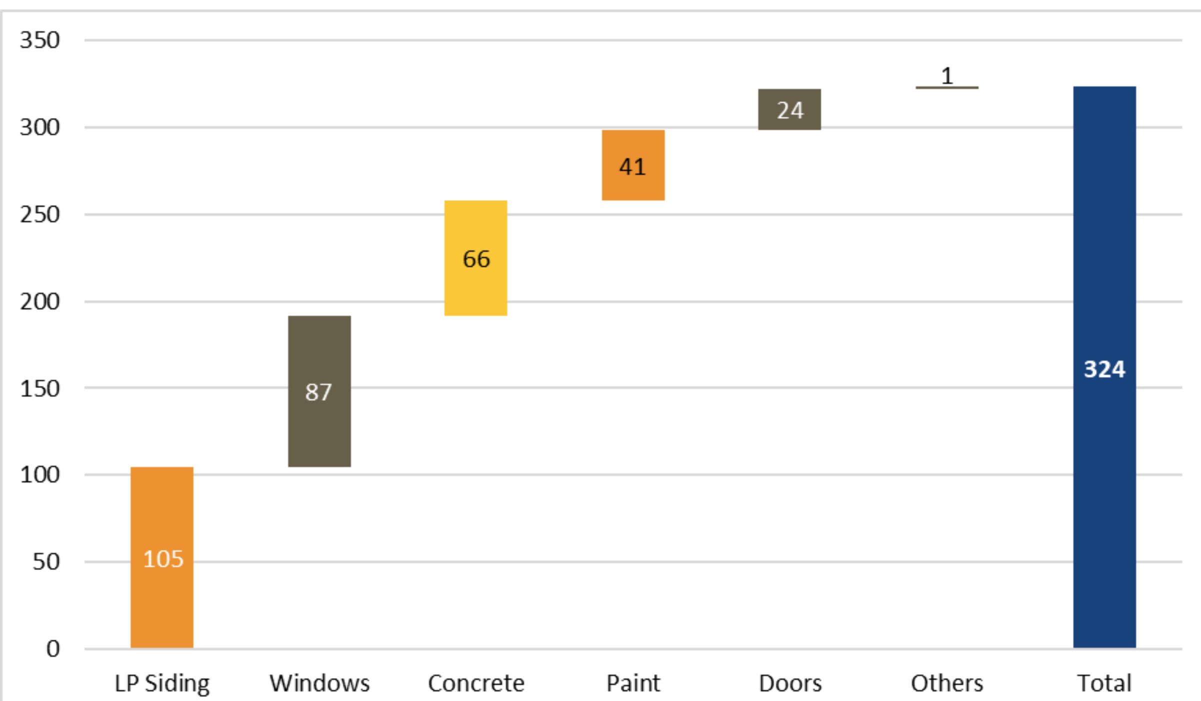


Figure 11 - Construction material related GHG emissions, 2017 (MT CO_2e)

Following are the quantities estimated for a few big projects for the most used 5-6 materials for each of the two departments.

Material	Quantity (tons)
LP Siding	759
Windows	75
Concrete	970
Paint	32
Doors	20
Others[7]	256

Table 3 - Construction materials included and quantity

Given that there isn't an exhaustive inventory of materials being consumed in construction, maintenance and weatherization of residential units, it is hard to ascertain whether the most polluting material per unit and/or the most polluting material at an aggregate level has been definitely covered or not. This is only likely to improve when more data is collected and reported.

F. Air Travel

Methodology

Emissions from flight travel were calculated using the Myclimate Flight Emission Calculator, available online for free. The website calculates GHG emissions on a per person basis using airport coordinates, distance traveled, fuel consumed and typical plane size. Full details behind Myclimate's methodology are available online.[8]

Results

Air travel makes up a small portion (108 MT CO_2e) of KCHA's GHG emissions. Air travel GHG emissions were assessed on a per seat-mile basis using an air travel GHG calculator, available online. Nearly 200 flights were taken by employees, with roughly 80% east of the Mississippi river. For more details on frequently traveled flight routes, see Table 4 - Most frequent flight routes of KCHA air travel, 2017 below.

[7] Includes roofing material (largely gravel) and asphalt (~95% reused material)
[8] https://www.myclimate.org/fileadmin/myc/files_myc_perf/12_flight_calculator_documentation_EN.pdf

Figure 12 - Flight routes of KCHA air travel, 2017

Destination	# of Flights	Round-trip Miles Traveled	MT CO_2e	MT CO_2e per Seat Mile
Washington, DC	26	121,168	33.8	0.00028
Orlando, FL	14	71,334	19.6	0.00028
Las Vegas, NV	11	26,657	7.76	0.00029
Lexington, KY	11	43,745	12.1	0.00028
Boston, MA	7	34,797	9.1	0.00026

Table 4 - Most frequent flight routes of KCHA air travel, 2017

V. Way Forward

2017 GHG inventory is supposed to serve as a baseline for methodology and results. Organizations and local governments compile their GHG inventory in phases, increasing coverage and improving methodologies with time. This 12 weeks' effort has helped KCHA (i) understand directionally what categories of emissions need to be targeted, (ii) understand how to approach compiling a GHG inventory, and (iii) internalize what needs to be done at departmental levels to improve the estimation precision within these categories. This section enlists what needs to be done to improve KCHA's understanding of emissions within each category and then some basic recommendations are discussed which are intended to offer some directional advice and need further analysis before implementation.

Next steps for GHG inventory development

- *Energy consumption* – KCHA is dedicated to improving the energy efficiency of its building stock. It is critical to parse energy consumption into residential units and common areas, as the latter offers a higher scope for emission control by KCHA. Additionally, further steps must be taken to ensure that full access to building-level energy consumption is collected.

- *Employee commute* – Response rate was 61% despite significant steps taken to get a higher rate. Anecdotally, survey fatigue was highlighted by KCHA employees as a major reason for this. Need to sharpen strategy for future surveys.
- *Solid waste* – KCHA needs to get actual solid waste tonnage from its waste haulers. There is a need to understand why this data is not being reported by haulers and what needs to be done to ensure this information is captured and shared with KCHA.
- *Construction Material* – KCHA's construction material associated GHG emissions are expected to be much higher than the 2017 analysis reflects. Asset Management and Capital Construction teams need to devise ways to report the consumption of various materials by their contractors.
- *Purchase of electronic appliances and office supplies* – KCHA controls the type and make of equipment like electric range, refrigerator, washer, etc. which are set up in residential units. While KCHA vendor provided a list of appliances bought and their quantity, they were unable to provide us with GHG emissions associated with these specific appliances. Additionally, some of the most commonly used office items like printing paper, tissue papers, plastic cutlery, etc. need to be factored in to this inventory but only after developing a simple reporting mechanism. Need to follow up on both these fronts.

While building on this piece of work and refining the GHG inventory further is expected to be a continuous task, KCHA should consider focusing on some specific sources of GHG emission and design specific approaches to reduce emissions.

Recommendations

- Continue the energy conservation upgrade projects (e.g. EPIC) to reduce GHG emissions associated with building operations. EPIC is estimated to reduce GHG emissions from building energy consumption by 40%, annually, at participating properties.
- Consider installation of on-site renewable energy, where appropriate.
- Conduct a telecommuting pilot program to evaluate its GHG emissions savings potential across different KCHA departments.
- Increase composting and recycling capacity and utilization across properties, where appropriate.
- Assess impact of any employee commute related initiatives being implemented by KCHA.

While it was not included in this study, land use change is a major driver of GHG emissions. KCHA should be cognizant of its decisions that directly and/or indirectly result in the removal of wooded areas and other (biodiverse) green spaces, as the removal of green spaces will intensify the impacts of the urban heat island effect, and decrease on-site carbon sequestration.