OPERATIONAL SUSTAINABILITY - BASELINE GREENHOUSE GAS INVENTORY

COLLEGE OF BUSINESS

Prepared by: Natalie Wiley
Graduate Student
Department of Ecosystem Science and Sustainability

AUGUST 18, 2022

Executive Summary

The ramifications associated with greenhouse gas emissions pose a substantial risk to community health and further climate change. Therefore, the College of Business at Colorado State University has a goal of being the first college on campus to reach carbon neutrality, in association with the university's climate goal of carbon neutrality by 2040. The College of Business has committed to advancing operational sustainability and reducing emissions across eight source categories.

This report provides estimates of greenhouse gas emissions to assess a baseline inventory for the fiscal years 2019 and 2021. This report includes two baseline years to reflect a non-pandemic versus pandemic year. The baseline includes a pandemic year to show the previous year's emissions while the non-pandemic year shows a more accurate distribution of emissions moving forward post-pandemic.

Key findings in this report show that natural gas and electricity consumption for energy are the highest emitters within the College of Business. Natural gas accounted for 13% of emissions in FY21 and 15% in FY19. Purchased electricity accounted for 54% in FY21 and 37% in FY19. The total greenhouse gas emissions in FY21 were 1,500 metric tons of CO2 equivalents (MT CO_2e), whereas FY19 produced 2,150 MT CO_2e.

Drivers of emissions within the College of Business come from faculty, staff, and student operations. Recommendations for mitigation encompass eight emission source categories along with whole-scale recommendations that reduce emissions across the board. These recommendations reflect top priorities such as installing sensor lighting, servicing the HVAC system, and replacing mini fridges with community fridges. Whole-scale recommendations such as purchasing carbon offsets, creating a green space, and staff training on these initiatives will kickstart a culture centered around sustainability within the College of Business.

Introduction

The College of Business (COB) at Colorado State University (CSU) has set forth to implement sustainable practices in accordance with the University's Climate Action Plan (CAP). The CSU CAP has outlined a clear goal to achieve carbon neutrality by 2040[1]. The COB aims to help achieve this goal by setting its own sustainability goal. The COB's goal is to be the first college to reach carbon neutrality on campus. A baseline greenhouse gas (GHG) inventory for FY21 and FY19 has been conducted to assess the COB's operational sustainability and develop a plan to improve their efforts in emissions reduction. The global pandemic impacted the COB's desire for an assessment of operational sustainability during 2020 and 2021. The baseline inventory for the COB has been conducted in 2022 to encompass a covid and non-year, FY21 and FY19. These two years represent a year with normal operations and a year with limited operations due to people being absent on campus during the pandemic.

This baseline tier 2 inventory uses the approach and methods provided by the Greenhouse Gas Protocol and SIMAP methodologies to quantify the trends in greenhouse gas emissions of CO_2, N_2O, and CH_4 from an operational perspective[3,4]. This is coupled with providing a matrix of recommendations for improved sustainability.

This document begins with a discussion of the GHG emission sources and provides context for strategies and recommendations to prioritize the COB's goal of carbon neutrality. The GHG inventory provides context to help prioritize efforts to achieve the COB's and the University's goals.

The COB has three buildings on campus. Rockwell Hall, Rockwell West, and Rockwell North. Of these three buildings, CSU owns two of them, Rockwell Hall and Rockwell West. Rockwell North is owned by a third-party company, called CSURF. These three buildings all contribute to campus emissions, but Rockwell North is not owned by CSU. Their emissions are not reported in the annual CSU GHG Inventory. However, their emissions are a result of the COB's operations. This means emissions from Rockwell North will be reported in the COB's GHG Inventory.

Methods

Baseline Inventory Boundaries

The College of Business has prepared a baseline inventory for fiscal years FY19 and FY21. FY21 shows us where we are at with our current emissions, however; these emissions were impacted by the pandemic due to lower emissions in the categories of air travel and commuting. This baseline inventory provides data to track progress in the COB's emission reductions. Inventories will continue to be done at the end of each fiscal year.

The GHG inventory is a complete account of utility data, source data collected from staff, and back calculations based on the university's GHG inventory. Emission estimates are detailed in this report as metric tons of carbon dioxide equivalents (CO_2e) to account for the global warming potential of significant greenhouse gases including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and chemical refrigerants.

This baseline GHG Inventory includes eight emission source categories across various scopes. These scopes represent different areas of emission outputs such as:

- **Scope 1 Emissions**: natural gas, travel (fleet vehicles), refrigerants (fugitive emissions)
- **Scope 2 Emissions**: purchased electricity
- **Scope 3 Emissions:** air travel, waste disposal, commuting (student and employee), paper

Scope 1 emissions cover sources that an organization directly controls. Scope 2 is an indirect source of emissions that come from purchased items. These purchased items produce emissions offsite from the organization. Scope 3 categorizes emissions that are not produced directly from the organization but are emissions from areas or people the organization is directly responsible for.

This inventory is categorized as Tier 2. Tier 2 GHG inventories consist of local emission factors with standard equations built into both GHG Protocol and SIMAP. Emission factors for the eight source categories were collected from the university wide GHG inventory conducted by Carol Dollard[2]. A tier 2 inventory improves the accuracy of the baseline inventory.

Methods – SIMAP, GHG Protocol, and Back Calculations

For the baseline inventory, GHG emissions were quantified using calculation methodologies provided by the Greenhouse Gas Protocol Institute. This tool allowed for the input of custom emission factors and

activity data. This tool has equations built in to calculate emission summaries. Results of this inventory are reported in metric tons of CO_2 equivalents.

Activity data were collected for natural gas, electricity, air travel, and paper usage. These were collected by sourcing data from staff by using monthly utility bills, flight purchase logs, paper purchase receipts, and monthly kWh and natural gas usage.

Back calculations were done for three of the eight source categories. These back calculations were based on the percentage of employees and students that represent the COB within the university. In 2019, the COB represented 6% of the CSU population and 7% for 2021. The number of people on campus significantly decreased in FY21 due to the pandemic, back calculation numbers were fixed to represent a percentage of people that were on campus. These back calculations provided emission totals for student and employee commuting, waste disposal, and refrigerants.

For natural gas usage between the three buildings the COB uses on campus, Rockwell Hall and Rockwell West use steam for energy generation, whereas Rockwell North uses natural gas. To make the activity data for natural gas the same, a conversion was used to convert monthly steam use (klbs) into natural gas (BTUs). This conversion was done by taking the total usage of steam, dividing the total by 0.85, and then converting it into BTUs to represent the efficiency of natural gas.

Once the GHG emission results were finalized using the GHG Protocol tool, a test for quality control was done using SIMAP. SIMAP is another tool for estimating GHGs emissions provided by the University of New Hampshire (UNH). SIMAP is a platform that analyzes and tracks campus sustainability through GHG inventories. The same emission factors and activity data used in the GHG Protocol tool were used on SIMAP.

Inventory Findings (Results)

The trends in emissions between FY19 and FY21 showed similarities. The three largest emission contributors for both years were electricity, natural gas, and student commuting (Figure 3). In 2021, the COB produced 1,500 MT CO_2e. The distribution of the source categories shows that natural gas and electricity consumption represents the majority of emission outputs. The other source categories do represent a smaller number of emissions, but they are also important to reduce when accounting for whole-scale sustainability (Figure 1).

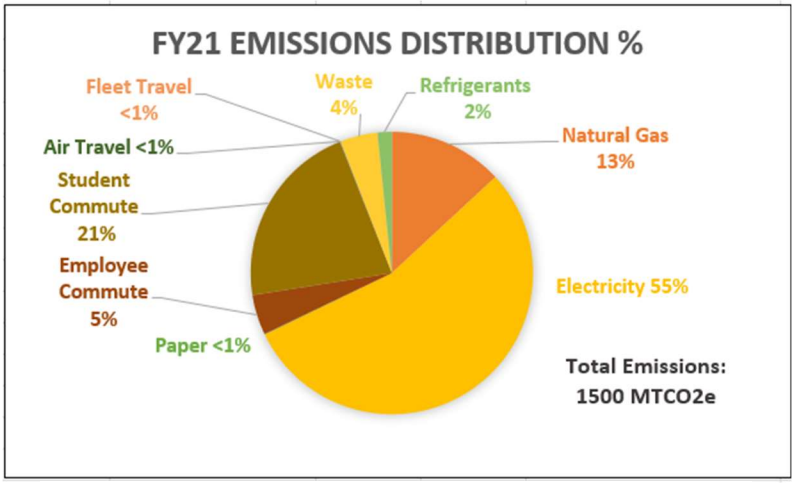

Figure 1. FY21 Distribution of the eight emission source categories

In 2019, the COB produced 2,150 MT CO_2e. The distribution of the source categories shows that electricity, student commuting, and natural gas are the three largest emission sources (Figure 2). FY19 is more representative of the emission distribution going forward since this was a non-pandemic year.

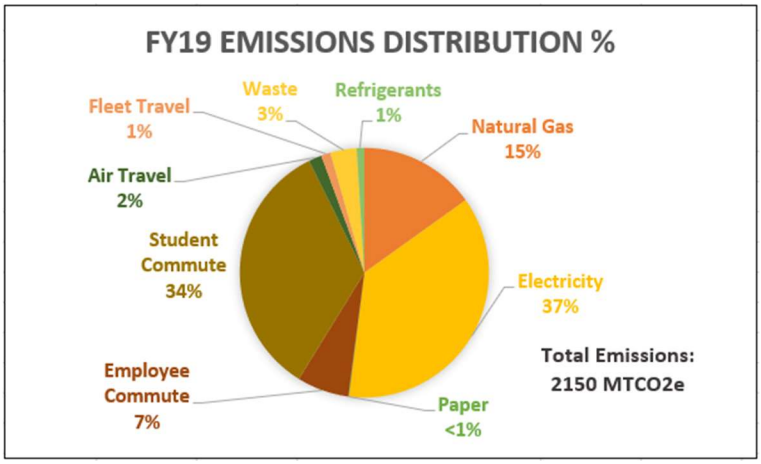

Figure 2. FY19 Distribution of the eight emission source categories

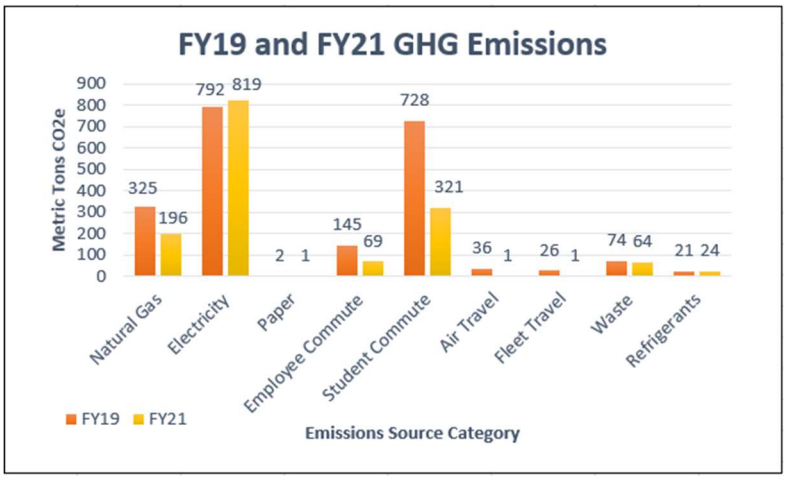

Figure 3. Emission trends and amounts (MT CO_2e) for FY19 and FY21

Sustainability Implementation Strategies

To help CSU achieve the goal of carbon neutrality by 2040, the COB must eliminate or offset its current and future emissions. This can be done by reducing emissions through achieving higher levels of sustainability within the COB's operations. A matrix was created to show mitigation actions along with associated costs and time for implementation. This mitigation matrix covers the eight emission sources along with whole-scale recommendations that reduce emissions across the board.

The following sections identify GHG reduction and mitigation strategies among the 8 emission sources:

1. **Natural Gas**

2. **Electricity**
3. **Commuting (Employee and Student)**
4. **Air Travel**
5. **Fleet Vehicles**
6. **Refrigeration**
7. **Waste**
8. **Paper**

Natural Gas

Year	Use	Units	MT CO_2e	% Emissions
2019	6,122	MMBtu	325.01	15%
2021	3,696	MMBtu	196.20	13%

In FY19, natural gas usage for energy accounted for 15% of the COB's GHG emissions. In FY21, it accounted for 13%. Rockwell Hall and Rockwell West use steam for their energy production while Rockwell North used natural gas. The data for steam use was converted to reflect natural gas. The burning of natural gas is used to provide heat and hot water to buildings. These mitigation actions will reduce energy consumption and allow for better heating and cooling of the three buildings.

The following portion of the mitigation matrix shows actions that can be taken to reduce GHG emissions from natural gas consumption.

Energy	GHG Impact	Cost	Time
HVAC Servicing	High	Low	Low
Better thermostats	Moderate	Low	Moderate
Community Fridges (high energy rating)	High	High	Low
Phase out mini fridges	High	Low	Low
Service window sealings	Moderate	Low	Low
Employee Data Dumps	Moderate	Low	Low
Enable energy save on employee computers	Moderate	Low	Low

Electricity

Year	Use	Units	MT CO_2e	% Emissions
2019	1,732,261	kWh	792	37%
2021	1,556,763	kWh	819	55%

In FY19, purchased electricity accounted for 37% of the COB's GHG emissions. In FY21, it accounted for 55%. This source category has the largest number of emissions being produced annually. This can be sourced from lights never being turned off, old light fixtures, excess use of electricity, etc. These mitigation actions will allow for optimal use of electricity along with reducing kWh and monthly utility costs.

The following portion of the mitigation matrix shows actions that can be taken to reduce electricity consumption.

Electricity	GHG Impact	Cost	Time
Sensor lighting	High	High	Moderate
Solar Panels	High	High	High
Electric Car Charging Stations	Moderate	High	High
RWN LED Lights	Low	Low	Low
Retime Classroom Lighting	Low	Low	Low

Commuting – Student

Year	Units	MT CO_2e	% Emissions
2019	Miles	728	34%
2021*	Miles	321	21%

*Emissions from commuting were reduced by the pandemic in FY21

Emissions from student commuting make up a large portion of the COB's GHG emissions. In FY19, student commuting accounted for 34% of emissions whereas FY21 accounted for 21%. Emissions in FY21 were affected by the pandemic due to fewer students commuting to campus. Student commuting is a greater portion of emissions because there is a larger portion of students than employees that represent the COB. The goal of this category is to reduce single occupancy vehicle (SOV) commuting to classes at the COB.

Reducing emissions from student commuting will require a survey to be conducted to determine the ways COB students are coming to campus which will be followed by incentives to either bike, walk, carpool, or take public transportation.

The COB took part in the Positive Impact Rating for Business Schools (PIR) where the students voiced what they would like to see from the COB. One of these focus points was operational sustainability. This means that the COB students want to see a reduction in emissions. These results will provide an incentive for the students to find alternative forms of commuting to classes.

Commuting – Employees*

Year	Units	MT CO_2e	% Emissions
2019	Miles	145	7%
2021*	Miles	69	5%

*Emissions from commuting were reduced by the pandemic in FY21

*COB Employees encompass both faculty and staff

In FY19, emissions from employee commuting accounted for 7% whereas, in FY21, emissions were 5%. The pandemic reduced the number of employees commuting to the office for work. This has created a cultural shift of employees working from home. The goal for this source category is to reduce the number of commuting trips done in SOV's.

The following portion of the mitigation matrix shows actions that can be taken to reduce emissions from SOV Commuting.

Commuting	GHG Impact	Cost	Time
Electric Car Charging Stations	Moderate	High	High
Commuting Survey	Moderate	Low	Low

Air Travel

Year	Units	MT CO_2e	% Emissions
2019	miles	36	2%
2021	miles	1.11	<1%

*Emissions from air travel were reduced by the pandemic in FY21

In FY19, air travel reflected 2% of the COB's GHG emissions. Whereas FY21 reflected <1% of emissions. The pandemic significantly affected air travel. Pre-pandemic, air travel was much higher and will reflect this in future GHG inventories as flights are happening again for the COB. The goal is to reduce the number of flights purchased for travel within the COB.

The following portion of the mitigation matrix shows actions that can be taken to reduce emissions from air travel.

Travel	GHG Impact	Cost	Time
More mosaic classrooms	High	High	High

More mosaic classrooms will allow for larger meetings and conferences to be held virtually. Virtual gatherings mean fewer flights will be purchased for the COB. This will create a jump in energy usage but will reduce emissions from fuel use on air crafts (Figure 4).

Figure 4. Mosaic classroom in Rockwell Hall Room 118

Fleet Travel

Year	Units	MT CO_2e	% Emissions
2019	Gallons	26	1%
2021*	Gallons	0.88	<1%

*Emissions from fleet travel were reduced by the pandemic in FY21

Fleet travel emissions stem from ground travel by both employees and students. Ground travel can be categorized as either mileage reimbursement from personal vehicles or using a university fleet vehicle. The employees and students of the COB mainly used personal vehicles for ground travel in both FY19 and FY21. These accounted for 1% and <1% of GHG emissions. The goal is to reduce the number of trips in personal SOV's taken for ground travel or incentivize alternative forms of transportation.

The following portion of the mitigation matrix shows actions that can be taken to reduce emissions from fleet travel.

Travel	GHG Impact	Cost	Time
More mosaic classrooms	High	High	High

Refrigerants

Year	MT CO_2e	% Emissions
2019	21	<1%
2021	24	1%

Refrigerants are gases that provide air conditioning and sources of cooling in buildings. They contribute a small number of emissions within the COB, but they are still important to measure as they have a high global warming potential. Managing leaks and having a reliant HVAC system help stop the release of refrigerants.

CSU uses five refrigerant types across campus including:

- R-404
- MP39-30
- R-134A (phasing out)
- R-410A (phasing out)
- R-22 (phasing out)

Three of the five refrigerants are currently being phased out at CSU due to regulatory compliance. This is an emission source that has an ozone depletion potential and global warming potential. These emissions can be offset in other ways by reducing emissions in other areas or purchasing carbon offsets.

Waste

Year	MT CO_2e	% Emissions
2019	74	3%
2021	64	4%

In FY19, emissions from solid waste accounted for 3% of total emissions whereas FY21 accounted for 4%. Emissions from solid waste are the result of materials sent to the landfill from the COB buildings. While this is a smaller percentage of emissions compared to our larger sources, promoting waste reduction initiatives are a visible component of sustainability. The goal is to reduce the amount of waste produced within the COB. While the emissions reduction from recycling and composting is low, reducing the volume of waste sent to landfills is important to impart a culture of sustainability within the COB.

Waste emissions were representative of the percentage of COB employees and students compared to university totals. The COB cannot account for their individual waste production, so a back calculation from the CSU inventory is the most accurate estimate.

The following portion of the mitigation matrix shows actions that can be taken to reduce emissions from solid waste.

Waste	GHG Impact	Cost	Time
Reuse all received packaging	Low	Low	Low
Green Cleaning Supplies	Low	Low	Low
Compost Bins	Moderate	Low	Low
Coffee shop use recycled plastic	Low	Low	Low

Paper

Year	Use	Units	MT CO_2e	% Emissions
2019	400	pounds	1.62	<1%
2021*	210	pounds	0.85	<1%

*Emissions from paper use were reduced by the pandemic in FY21

In both FY19 and FY21, emissions from paper use were less than 1%. While this is the lowest source of emissions for the COB, it is important to reduce drivers of printing within the college to promote a culture of sustainability and reduce outside sources of emissions from paper production.

The goal is to reduce drivers of printing by both students and employees. This can be done by adding a printing allotment with a carbon fee or by making all uses for paper virtual. Current paper activity data was only representative of purchases made by the HR department. Future inventories for the COB should encompass paper purchases from all departments.

Whole-Scale Recommendations

Recommendations were made that do not focus on a single source category of emissions. These recommendations focus on improving areas within the three COB buildings and ensuring they are implementing strategies that further the sustainable culture.

The following portion of the mitigation matrix shows actions that enact sustainable sourcing and reduce emissions.

Whole Scale Recs	GHG Impact	Cost	Time
Patch Carpeting	Low	Low	Moderate
More water bottle filling stations	Moderate	Low	Moderate
Green messaging on computers/TVs	Low	Low	Low
Coffee Shop Sustainable Fixes	High	Moderat	Moderate
Ecosia web browser	Moderate	Low	Low
Carbon Offset Credits	High	High	Low
COB Green Space	Moderate	Low	Moderate
New Employee Training	Low	Low	Low
Peep Sessions	Low	Low	Low
Replace turf grass with ground cover	Low	Low	Moderate

Patch carpeting is a non-toxic and sustainably sourced material that allows for easy cleaning and is replaced less frequently. More water bottle filling stations incentivize students and employees to bring reusable bottles to campus and reduce plastic use.

Figure 5. Patch carpeting placed in Rockwell Hall next to non-patch carpeting

Many of these whole-scale recommendations have low GHG impact potential, but they instill positive habits among the employees and students that represent the COB. Peep sessions conduct training on sustainable practices for employees currently working at the COB. Having new employee training sessions will engage incoming staff and faculty on the importance of keeping the workspace green.

There are also actions that the IT department can take to reduce emissions. These actions entail green messaging on computer screens, enabling power save mode on all computers, and having employees do 'data dumps' to delete unused files that use up energy.

Top Priority Recommendations and Visibility Potential

All the recommendations made in the mitigation matrix have some form of GHG reduction potential. There are three that stand out as the biggest drivers in reduction, however. These priority recommendations are focused on reducing energy consumption within natural gas and electricity usage.

The following portion of the mitigation matrix shows actions that have the highest emission reduction potential.

Electricity	GHG Impact	Cost	Time
Sensor lighting	High	High	Moderate
Energy	**GHG Impact**	**Cost**	**Time**
HVAC Servicing	High	Low	Low
Community Fridges (high energy rating)	High	High	Low
Phase out mini fridges	High	Low	Low

The COB currently has no sensor lighting in their three buildings. Installing sensors would allow for better usage of lighting and electricity within the COB. Having the HVAC system serviced would allow it to run optimally for better heating and cooling of the buildings. The COB currently has a high use of mini fridges among the faculty and staff. Mini fridges use up excess energy and do not allow the HVAC system to run optimally. Phasing out mini fridges and replacing them with community fridges that have a high energy rating will reduce energy consumption.

Some recommendations also serve as a potential for national visibility. These recommendations will have a reduction in GHG emissions, but they also show a sense of creativity and instill the sustainable culture the COB is creating.

The following portion of the mitigation matrix shows actions that have national visibility potential.

Travel	GHG Impact	Cost	Time
More mosaic classrooms	High	High	High
Whole scale recs	**GHG Impact**	**Cost**	**Time**
Carbon Offset Credits	High	High	Low
COB Green Space	Moderate	Low	Moderate

These recommendations will reduce emissions across all source categories and are highly visible components of sustainability efforts. This not only enacts operational sustainability, but it also shows that the COB is striving toward its goal of carbon neutrality.

Purchasing carbon offset credits will allow the COB to offset any emissions that remain after reduction methods are met. This is a great way to reach carbon neutrality while still implementing new strategies that decrease emissions from the eight source categories. A green space within the COB will also be a visible impact of sustainability. This green space can be created in the front entrance of one of the three buildings, or within the courtyard at Rockwell Hall. This green space will create a pollinator garden along with areas of vegetation that also act as a carbon offset.

Appendix

Quality control was conducted by Carol Dollard and Stacey Baumgarn at CSU Facilities. This quality control check was to ensure activity data and SIMAP results were fully covered and accurate. Errors were found while deriving activity data and during the SIMAP calculations and were fixed accordingly. As a baseline inventory, there is the challenge of missing utility data in FY19 that was accounted for using extrapolation/interpolation analysis using the program R Studio.

The following list depicts areas of improvement for future GHG inventories to further implement operational sustainability:

1. Obtain full air travel and ground travel data for fleet emissions. The data provided for the baseline inventory was not organized properly and led to possibly missed mileage for the activity data.
2. Obtain full paper usage data. The activity data provided by the COB did not encompass paper usage for the entire college. Activity data provided only covered the HR department. Tracking paper usage for future inventories will allow for a more well-defined scope of paper use.
3. A survey for students commuting to campus would allow the COB to have their own commuting data rather than conducting back calculations from the CSU GHG inventory.
4. Secure SIMAP account in advance of future GHG inventories

Sources

1. *CAP 2022 Update*. Facilities Management. (n.d.). Retrieved August 15, 2022, from https://www.fm.colostate.edu/sites/default/files/sustain/downloads/CAP_2022_Update.pdf
2. *GHG Inventory FY21*. Facilities Management. (n.d.). Retrieved August 15, 2022, from https://www.fm.colostate.edu/sites/default/files/sustain/downloads/ghg_inventory_fy21.pdf
3. *The Greenhouse Gas Protocol*. (n.d.). Retrieved August 15, 2022, from https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf
4. *User's guide - simap*. (n.d.). Retrieved August 15, 2022, from https://unhsimap.org/sites/default/files/user-uploads/SIMAP%20User%20Guide_DRAFT6.2_2.21.2018.pdf