Future of Middlebury College's Greenhouse Gas Inventory

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Middlebury College
Department of Environmental Affairs
Sustainability Solutions Lab

Emily Hogan '24
Oscar DeFrancis '24.5

With support from Jack Byrne, Environmental Affairs; Jonathan Kemp, Sciences Technical Support Services; Ryan Clement, Library; and Wendy Shook, Library

Updates to GHGI Protocol

Gathering data from internal and external entities

Along with reporting actual annual values for data, internal and external entities should make note of specific anomalies, trends, changes in reporting, etc.
To be reported:

- Data values
- Description of data, what it refers to, and how it is used at Middlebury
- From where and how the entity who reported the data got the data
- Any significant trends or anomalies in data with notes as to why these trends happened
- Notes on any significant changes to reporting or company/institutional changes (for external parties)

Analyzing data internally

It is important for those receiving the data to analyze it for any trends, errors in reporting, and accuracy. After all data have been reported, a small group of people dedicated to the inventory should place all documents and information received ("backup data") in an institutional folder where all GHGI information is held. When analyzing the data, this group must:

- Make sure the information is accurate. That is, make sure data do not include drastically different values from other years or unreasonable values.
- Compare data with other years and note any trends. For all trends and anomalies, there must be an explanation in the notes as to why it occurred.
- Write down all questions that weren't answered about the data and note gaps in knowledge. Make sure these questions are answered and the answers are noted.
- Note where data have changed from past years (i.e. different sources).

Entering data into GHGI

When entering data into GHGI, it is important to keep an edit log in a separate tab. These edits can include changes to the existing data and first-time inputs of new data. New edits should have the following form:

Date
Editor:
Description of edit:

Also important when entering data is to make sure the correct source is entered, and all variables in the GHGI have sources. The inventory should be updated to include multiple spaces for inputting new sources and the date of inputting. This will allow for tracking past provenance of data and how these sources change over time, and allow for easier tracking of past data.

Producing an Annual GHG Emissions Report

Information can be consolidated and organized in an annual emissions report, which would allow the public to more easily understand the current trajectory of Middlebury College's emissions goals, as well as learn about plans for the future. A report may include the following:

- A brief overview of the GHGI, including what it is, what it covers, how it was developed
- Visuals of trends in carbon emissions for different scopes
- Overview of current and developing projects around campus (i.e. building construction) that may affect energy efficiency
- Future plans for construction/innovation
- Normalization factors used to indicate growth and trends on a student or employee basis
- Explanation of significant trends
- Links to GHGI, codebook, guidebook

By producing an annual report, the college can succinctly convey its sustainability goals and progress to students, employees, alumni, and the general public. This report may live as a page on Middlebury's website (FECH). An example of an emissions report/update from Bowdoin College can be found here: https://www.bowdoin.edu/sustainability/pdf/2017-ghg-enissions-update-9-20-17.pdf. Another option might be to produce an infographic with information on updates, as seen here: https://www.bowdoin.edu/sustainability/pdf/bowdoin_sustainability_infographics_2016-1.pdf.

More Notes

The school should dedicate a yearly student internship position to maintaining the GHGI for that year. This should include receiving and organizing all new data reported, inputting those data into the GHGI, and analyzing trends. The students should then work on updating conversion factors and constants as necessary and noting these updates in the inventory. Finally, these students should publish an annual report for the public to better understand these trends and changes in the GHGI for that year.

Specific Protocols

Travel Accounting

Given the 2019 change in accounting from Banner to Oracle, it is important to develop a clear protocol for calculating travel emissions. As of July 2022, Oracle has not been adapted to provide the travel costs data for inventory travel carbon, though this is a project that may prove useful in the future. By looking at past breakdowns of travel emissions, we can develop an accurate protocol for travel accounting. From FY 06/07 to FY 18/19, taxi emissions were on average 1% of total travel emissions. Similarly, buses were on average 4% of the total, and trains were on average 1.1% of total travel emissions. Thus, when inputting values into the inventory, consider these values and calculate taxi, bus, and train emissions using these percentages. Another method for calculating travel emissions that may take time and effort to develop is to work through receipts from travel purchases, taken from the Middlebury College Budget Office. Since

these receipts often include specific details on travel (i.e. flight from BTV to LGA), one can use miles (air, train, etc.) to calculate emissions instead of only reimbursement dollars, which allows for more specificity in travel emissions.

Employee and Student Commute

Middlebury College does not currently track the emissions from employee and student commutes. However, the college received points off on its past STARS (Sustainability Tracking Assessment and Rating System) reports for not tracking this data. Furthermore, it would be useful for students and faculty to know the scope of commuting emissions. Therefore, it is crucial that Middlebury keep annual reports of employee and student emission from commutes. For the LEED certification of buildings on campus, it is also important to know which specific buildings employees and students are commuting to. In the past, commuting data have been found by surveying employees and using the data from the survey to estimate emissions for all employees. Another way to estimate emissions from commuting is through calculating total parking spaces on campus. Sending out a survey may be the best option, because it allows for more detailed data on how long of a commute employees have, how often and far students travel to and from their home, and other information necessary for calculating commuting emissions. While the college is not required to include employee or student commute in its emissions total, it is important to note that similar institutions, such as Bowdoin College and Bates College, include employee commute in their estimate of emissions. Including employee commute in this total should be considered and evaluated, and at the very least employee and student commute should be tracked.

Normalization Factors

Normalization factors have been used in the past to measure institutional emissions growth throughout the inventory's existence. These should be maintained in order to provide students, faculty, and staff at the college with information about their own carbon footprint as it relates to the college. The following normalization factors should be tracked and maintained:

- MTCDE per Full Time Equivalent (FTE) student
- MTCDE per FTE employee
- MTCDE per FTE students and employees
- MTCDE per degree-day
- MTCDE per gross building square footage

In the past, normalization factors have been further broken down into MTCDE for heating and cooling (stationary and electric emissions) and MTCDE from other sources. Normalization factors can be further broken down into MTCDE for electricity specifically, which could allow students and employees to see a breakdown of carbon emissions from electricity usage. Furthermore, emissions can be broken down into MTCDE per employee for travel, which can give employees and incentive to choose lower-emissions travel options.

Middlebury College reports the total number of students annually to the Department of Education's Integrated Postsecondary Education Data System, though this does not include Language School students. Data on Language Schools can be gathered from Sunderland Language Center. Employee data can be gathered from Human Resources. Building square footage can be gathered from Middlebury Facilities

Services. Degree-day values are gathered from data reported for Burlington International Airport at http://www.degreedays.net using 65°F as a base temperature.

Carbon Offsets

Currently, Middlebury's GHGI does not actively track where all of its carbon offsets come from. Initially, multiple departments bought carbon offsets in order to help the college reach its 2016 Carbon Neutrality goals. In the past, the college tracked its avoided carbon impact fromc composting food waste instead of sending it to a landfill (in the form of MTCDE sequestered/ton composted). By gathering data from dining services, this information can continue to be recorded in the GHGI (in the category of internal offsets). External offsets include offsets bought as part of the Breadloaf Carbon Credit Program. The offsets section should be reorganized to reflect offsets bought from the Breadloaf Program as well as offsets from composting, and should be updated annually.

Updating conversion factors and constants

The Comprehensive Guide to the GHGI, published in 2007, details the frequency of updates necessary for the inventory. In the first few years of the inventory, most of the following values were updated repeatedly. However, updates lagged as the inventory became more dense. Thus, it is important to have a few dedicated students, interns, or employees working on updating these factors and inputting variables. In this protocol, these notes carry over, along with suggestions for other updates of conversion factors, constants, and equations.

An important note when updating conversion factors is that future years' emissions totals after the updates will be less comparable to emissions totals in years before the update. Thus, it is important to note when these updates happened, so that large changes in emissions can be attributed, at least somewhat, to these changes.

To be updated annually:

- Renewable energy projects: As of July 2022, projects in which Middlebury College will receive power from in the future, such as the Goodrich Farms Anaerobic Digester and the South Ridge Solar Project, will need to be inputted into the GHGI. Future projects will need to be inputted as well.
- EPA Emissions Factors and Coefficients: The EPA publishes updates to its Emissions Factors Hub periodically. Emissions Factors in the GHGI should be updated as needed every 5 years.
    - These include: HC (MMBTU/bbl), CCC (kg C/ MMBTU), Fraction Oxidized, MW ratio (kg CO2/kg C), CH4 EF (g gas/MMBTU), CH4 GWP, N2O EF (g gas/MMBTU), CH4 EF (g gas/MMBTU), N2O GWP
- Net growth of Vermont forests: Middlebury's GHGI assumes the net growth of Vermont forests in order to claim carbon offsets. This should be reevaluated to reduce error when making this assumption.
- EPA Climate Leaders equations for estimating CO2, N2O, and CH4 emissions

    - Climate Leaders Program was created under the Bush Administration and was often used for greenwashing in companies. Equations should be reevaluated in new version of GHGI .
- Specific variables and factors:
    - Burlington to NYC RT price (air travel)
        - Given that the price of plane tickets fluctuates significantly from year to year, prices should be updated annually. Update prices on https://www.kayak.com/flights, inputting current location and destination, selecting 1 passenger and round trip flight, setting flight date to 4 weeks in future, and taking average of first 4-5 results.
    - Burl. to Phoenix via DC RT price (air travel)
        - See above for details on how to update.
    - Burl. to London via DC RT price (air travel)
        - See above for details on how to update.
    - Average cost of a gallon of gasoline in cents. "Annual ave cents/gal"
        - Values calculated according to the Energy Information Association (EIA) at https://www.eia.gov/petroleum/gasdiesel/. Values calculated by adding "US change from a year ago" to previous year's average.
        - Note: In the inventory, values are inputted as dollars. This should be changed so as not to confuse cent values with dollar values.
    - Putative Vehicle Mi/Gal (for multiple scopes)
        - Vehicle gas mileage should be updated to the make and model of a car built 5 years prior to the year of updating.
    - % of $ spent on dom travel (air travel)
        - Value obtained through Middlebury College Budget Office
    - Dom BTU jet fuel/pass. Mi.
        - The Bureau of Transportation Statistics publishes new values for the energy intensity of passenger modes yearly (https://www.bts.gov/content/energy-intensity-passenger-modes).
    - Int BTU jet fuel/pass. Mi.
        - The Bureau of Transportation Statistics publishes new values for the energy intensity of passenger modes yearly (https://www.bts.gov/content/energy-intensity-passenger-modes).
    - Amtrak BTU/pass. Mi.
        - The Bureau of Transportation Statistics publishes new values for the energy intensity of passenger modes yearly (https://www.bts.gov/content/energy-intensity-passenger-modes).
    - Mode Bus Size (by capacity)
        - Value obtained through Premier Travel.
    - Base hourly fee ($/hr) (bus)
        - Value obtained through Premier Travel.
    - Live Mile charge/mile ($/mi) (bus)
        - Value obtained through Premier Travel.
    - Dead Mile charge/mile ($/mi) (bus)
        - Value obtained through Premier Travel.

Necessary changes to GHGI

1. **Refrigeration**

GHG Protocol requires science and research facilities with refrigeration to calculate the amount of refrigerant that leaks into the atmosphere, given that refrigerants contain Hydrochlorofluorocarbons (HCFCs) and other greenhouse gasses. When Middlebury College's GHGI was originally created, the college considered including refrigeration in the inventory, as refrigeration occurs in Bicentennial Hall for labs and science classes. However, the college estimated that the amount of leaked refrigerant was less than 5%, and therefore, according to GHG Protocol, they are not required to include leaked refrigeration in the GHGI. Middlebury has not reconsidered including these emissions in the inventory since 2007, though the amount of refrigerants has changed in this time period. Thus, it is important, when reevaluating the GHGI, to inquire about the quantities of refrigerants we buy and replenish each year, and to periodically ensure our estimates of leaked refrigerants continue to meet the requirement of 5% or less.

2. **Variable Names**

Many variables within the GHGI, as well as conversion factors and constants, should be renamed to more accurately describe the value to which they refer and how they are used. These include the following:
Scope 1B:

1. Putative vehicle mi/gal
    a. Change to: Gas putative vehicle mi/gal and Diesel putative vehicle mi/gal
2. Gas vehicle activity miles (2 variables for gas vehicles and diesel vehicles)
    a. Change to: Gas vehicle activity miles and diesel vehicle activity miles

Scope 3A:

Mileage:

1. Total Reimbursement $
    a. Change to: Mileage Reimbursement $
2. Total Reimbursement Gas
    a. Change to: Mileage Reimbursement gas
3. Putative vehicle mi/gal
    a. Change to: School-owned putative vehicle mi/gal
4. Gas vehicle activity miles
    a. Change to: School-owned gas vehicle activity miles

Bus Emissions:

5. Base hourly fee ($/hr)
    a. Change to: Base bus hourly fee ($/hr)
6. Live mile charge/mile ($/mi)
    a. Change to: Bus live mile charge/mile ($/mi)
7. Dead mile charge/mile ($/mi)
    a. Change to: Bus dead mile charge/mile ($/mi)
8. Live Speed

    a. Change to: Live bus speed
9. Dead Speed
    a. Change to: Dead bus speed
10. Total Cost
    a. Change to: Total cost for bus trip
11. Total Gal Diesel Combusted
    a. Change to: Total Gal Diesel Combusted (bus)
12. Gal/$ Given the High Em. Scenario
    a. Change to: Gal/$ Given Bus High Em. Scenario
13. Total diesel (gal)
    a. Change to: Total diesel (gal) for bus trip
14. Gas Vehicle Activity miles
    a. Change to: Bus vehicle activity miles

3. **Variable Values and Units**

a. Scope 3A Air Travel Mileage: In the GHGI, mileage for air travel emissions scenarios (short, medium, and long haul) is one-way, and is also reported as on-ground miles, not air miles. This mileage should be round-trip air miles, and needs to be updated as follows:

i. Burlington to NYC RT mileage: Mileage is currently listed as 304. This number should be changed to 516 miles (https://www.airmilescalculator.com/distance/btv-to-lga/).

ii. Burl. to Phoenix via DC RT mileage: Mileage is currently listed as 2870. This number should be changed to 4832 miles (https://www.airmilescalculator.com/distance/btv-to-dca/ and https://www.airmilescalculator.com/distance/phx-to-dca/).

iii. Burl. to London via DC RT mileage: Mileage is currently listed as 4180. This number should be changed to 8202 miles (https://www.airmilescalculator.com/distance/btv-to-dca/ and https://www.airmilescalculator.com/distance/dca-to-lhr/).

b. Scope 3B Landfill Methane Units: In the 'Scope3 Travel Sources' tab, it seems there is an error in the units of CH4 EF numbers that have sources. Operating under the assumption that these units are wrong, the following changes should be made:

i. CH4 EF w/out Recovery (tonne gas/ton)
    Change to: CH4 EF w/out Recovery (MTCE/ton)

ii. CH4 EF w/ Recovery (tonne gas/ton)
    Change to: CH4 EF w/ Recovery (MTCE/ton)

iii. CH4 EF w/ LFGE (tonne gas/ton)
    Change to: CH4 EF w/ LFGE (MTCE/ton)

4. **Taxi Emissions**

When the inventory was created in 2006, ride sharing services like Uber or Lyft had not yet been created, and employees often used taxi services on business trips and to commute to and from Burlington International Airport (BTV). Given that Uber has taken on more popularity for transportation and taxis aren't as commonly used, it is important that this is reflected in the inventory. Currently, hired ride purchases such as Uber or Lyft are included in taxi emissions. In Scope 3 Travel, taxi emissions are calculated using a case study from Middlebury to Burlington through Middlebury Transit, a company that has since gone out of business. In reworking the GHGI, this case study should be redeveloped. The case study currently has 4 variables in need of updating:

1. Average $/person

2. Average people/trip
3. Average $/trip
4. Van mi/gal

Updating these variables requires working with the Middlebury College Budget Office and looking at receipts from trips through Uber and other rideshare and taxi services to determine the cost of an average pre-Covid trip, how many people were in a group using that service, the total cost of an average trip, and what kind of car employees usually took. When looking at Uber, gas mileage can be determined by looking at what type of Uber service employees often took when commuting to or from BTV or on a business trip.

5. **Notes in Margins**

There are several notes in the margins of the inventory which refer to the data in the GHGI. These notes should be consolidated and uniformly placed in a separate notes tab. To the extent possible, these notes should be labeled in the following format:

> **Date:**
> Name of note-taker:
> Note:

6. **Unnecessary Information**

Some information in the current GHGI is remnant from original inventory work and has not since been deleted, even though it is not used in the GHGI. This information clutters the GHGI and causes confusion, and therefore should be deleted. This includes the following Scope 1B variables:

- Car tank size (gal)
- Car ave miles/gal
- 15/11-pass. van tank size (gal)
- 15/11-pass. van ave miles/gal
- Mini-van tank size (gal)
- Mini-van ave miles/gal

Roadmap for New GHGI

Prior to Summer 2023 (Fall 2022, Spring 2023)

Major Goal: Complete update and reboot of GHGI

Steps:

1. Make necessary adjustments to the organization of the GHGI.

2. Go through conversion factors and constants and update as necessary.

3. Contact the Budget Office to change numbers for Taxi/Rideshare Emissions Case Study.

4. Rework previously disregarded GHGI tabs

a. Employee/Student Commute: Create and send out survey to employees and students about their commute.

b. Normalization Factors: Come up with a new formula or look into past formulas for calculations of MTCDE per student.

* Send out a survey to students and employees asking about plant-based diet, electric cars, etc. Develop a new formula that calculates MTCDE per students with these considerations in mind (i.e. MTCDE per student with plant-based diet). This might be a separate project.

c. Offsets

5. Research biomass emissions, where they come from, and what the college currently reports as biomass emissions.

6. Collect data for new tabs.

a. Refrigeration: To collect data on refrigeration, it is important to know what quantities of refrigerants the college buys and replenishes each year. To get this information, one can get in touch with faculty and staff working in Bicentennial Hall, such as Tim Wickland (twicklan@middlebury.edu) and Caitlin Carr (cacarr@middlebury.edu).

7. Work with the Budget Office to look into gathering more data about travel, such as looking at plane ticket receipts, so that emissions are more accurate. Perhaps there is a way to adapt Oracle to reflect these receipts and this information instead of just reimbursement dollars.

8. Work on the transparency of the GHGI (and accompanying documents). To increase transparency and knowledge about the inventory, it could possibly have its own page on the Office of Sustainability Integration website, or could be linked on the Energy 2028 or Carbon Neutrality pages. Furthermore, it would be interesting to send out a survey to students and employees to inquire about their questions on Middlebury's GHG emissions, and work on ways the inventory and a page on Middlebury's website could be presented to answer these questions. Publishing an annual report or update detailing trends and significant changes in the inventory for a particular year would be one such way of increasing transparency.

Summer 2023 and Future Years

Major Goals: Receive and input data into GHGI, analyze trends, report errors (following the new GHGI protocol listed at the top of this document), create an annual GHG report

1. Receive data from internal and external entities and place it in an institutional folder

2. Input data to GHGI in correct format, noting correct sources and adding to the edits log.

3. Analyze data for trends and answer questions about anomalies in data.

4. Update online public version of GHGI to reflect 2023 changes.

5. Create a GHG Report detailing annual GHG emissions and trends