Greenhouse Gas Emissions Inventory Management Plan

New Mexico State University

Fiscal Year 2019 Inventory

lotus engineering & sustainability

2019 GHG Inventory Contact Information

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INTRODUCTION

Lotus Engineering and Sustainability, LLC (Lotus) was hired by New Mexico State University (NMSU) to create a 2019 fiscal year greenhouse gas (GHG) emissions inventory to create a clear picture of current GHG emission sources on NMSU's main campus in Las Cruces and establish a baseline for future emission inventories that will guide climate action planning. Additionally, data was used to backcast emissions to estimate the 2005 emissions level for the university.

To support this work, Lotus completed the following tasks:

- Developed a 2019 fiscal year GHG inventory and incorporated GHG accounting best practices, including data collection and methodology that are consistent with accepted national and international standards. Lotus created a customized inventory workbook to keep a record of data, emission factors, contacts, and assumptions.
- Created an Inventory Management Plan (IMP) for the inventory workbook which provides guidance to NMSU staff so that they can continue to track emissions in the future. The IMP is contained herein and provides university information, inventory boundary and scope, GHG emission factors, emission quantification methods (including assumptions made about data), data management methods, and an overview of the inventory tool.
- Created an additional workbook that used available data on population and other metrics to estimate the 2005 emissions level for NMSU.

GHG INVENTORY BOUNDARIES

REPORTING PROTOCOL

Lotus recommended that NMSU report their emissions using The Climate Registry (TCR) General Reporting Protocol (GRP) Version 3.0. The GRP provides the basic framework for businesses, government agencies, and non-profit organizations to report their GHG emissions to TCR's voluntary program. The GRP draws on existing standards and protocols. Since this IMP is drawing directly on the GRP, some language in this IMP has been taken directly from the protocols. When this happens, we have *italicized* the font.

REPORTING PRINCIPLES

There are five GRP accounting principles, and this IMP will help outline the process needed to ensure that these principles are adhered to:

- *Relevance: Ensure that the GHG inventory appropriately reflects an organization's GHG emissions and serves the decision-making needs of users—both internal and external to the organization.*
- *Completeness: Account for and report all relevant GHG emissions and activities within the defined inventory boundary.*
- *Consistency: Use consistent methods to allow for meaningful comparisons of emissions over time. Clearly document any changes to the data, inventory boundary, methods, or any other relevant factors.*
- *Transparency: Address all relevant issues in a factual and coherent manner, based on a clear audit trail. Disclose any relevant assumptions and make appropriate references to the quantification methods and data sources used to allow intended users to make decisions with reasonable confidence.*

- *Accuracy: Ensure that the quantification of GHG emissions is neither systematically overstating nor understating true emissions, and that uncertainties are reduced as much as practicable. Achieve sufficient accuracy to enable users of the data to make decisions with reasonable assurance of the integrity of the reported information.* [1]

Organizational Boundaries

An organization's boundary must be well defined and defensible. Inventories can be constructed to reflect three different types of organizational boundaries: operational control, financial control, or equity share.

- *Operational Control: Reflects the activities where the organization or its subsidiaries has the full authority to introduce and implement operating policies. The organization that holds the operating license for an activity typically has operational control.*
- *Financial Control: Reflects activities where the organization has the ability to direct the financial policies of the activity with an interest in gaining economic benefits from the activity. An organization has financial control over an activity if the activity is fully consolidated in the organization's financial accounts.*
- *Equity Share: Reflects activities that are wholly owned and partially owned according to the organization's equity share in each.* [2]

NMSU has decided to follow an "operational control" approach since they have full ability to influence items over which they have operational authority.

Reporting Boundaries

Per the GRP, organizations are able to define their own reporting boundaries to fit their operational and sustainability goals. These boundaries include:

- Reported GHGs.
- GHG scopes and sources.
- Reporting period.
- Geography/business units.

Reported Greenhouse Gases

The following GHGs will be included in NMSU's inventory (if applicable):

- Carbon dioxide (CO_2).
- Methane (CH_4).
- Nitrous oxide (N_2O).
- Hydrofluorocarbons
- Biogenic CO_2.[3]

All GHGs have different, defined global warming potentials (GWP). This allows for easy comparison of the absolute effects of different gases. The GWP of a GHG defines its contribution to global warming (i.e., the

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[1] The Climate Registry's General Reporting Protocol Version 3.0, May 2019 https://www.theclimateregistry.org/

[2] The Climate Registry's General Reporting Protocol Version 3.0, May 2019 https://www.theclimateregistry.org/

[3] Biogenic CO_2 emissions are generated during the combustion or decomposition of biologically based material. Organizations must track and report biogenic CO_2 emissions separately from other emissions because the carbon in biomass was recently contained in living organic matter.

ability of each gas to trap heat in the atmosphere), where a GWP of one is equal to the impacts of one unit of CO_2. Per GRP, all non-CO_2 will be expressed as CO_2e, or carbon dioxide equivalent.

GWP values will be sourced from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5).[4] Table 1 shows the GHGs to be included in the inventory and their GWPs. CH_4, N_2O, and HFCs are converted to CO_2e by multiplying their value by the 100-year GWP coefficient. In future years, NMSU will want to use the most recent IPCC report to source 100-year GWP values.

TABLE 1. GLOBAL WARMING POTENTIALS

Common Name	Formula	GWP
Carbon Dioxide	CO_2	1
Methane	CH_4	28
Nitrous Oxide	N_2O	265
Hydrofluorocarbons	HFCs	Varies

Several sources may also release biogenic carbon, which is the emissions related to the natural carbon cycle, as well as those resulting from the combustion, harvest, digestion, fermentation, decomposition, or processing of biologically based materials. Biogenic carbon is not included in overall carbon emissions.

GHG Scopes and Sources

Per the GRP, direct and indirect emissions are categorized as follows:

- *Scope 1: Direct anthropogenic* (i.e., caused by human activity) *GHG emissions.*
- *Scope 2: Indirect anthropogenic GHG emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling (collectively referred to as consumed energy).*
- *Scope 3: All other (non-Scope 2) indirect anthropogenic GHG emissions that occur in the value chain.*
- *Additional GHGs: Biogenic GHG emissions are excluded from the scope categories and are reported separately. Non-Kyoto GHG emissions are also outside of the scopes.* [5]

For additional information see Figure 1.

[4] For more information see: https://www.ipcc.ch/report/ar5/index.shtml.
[5] The Climate Registry's General Reporting Protocol Version 3.0, May 2019 https://www.theclimateregistry.org/

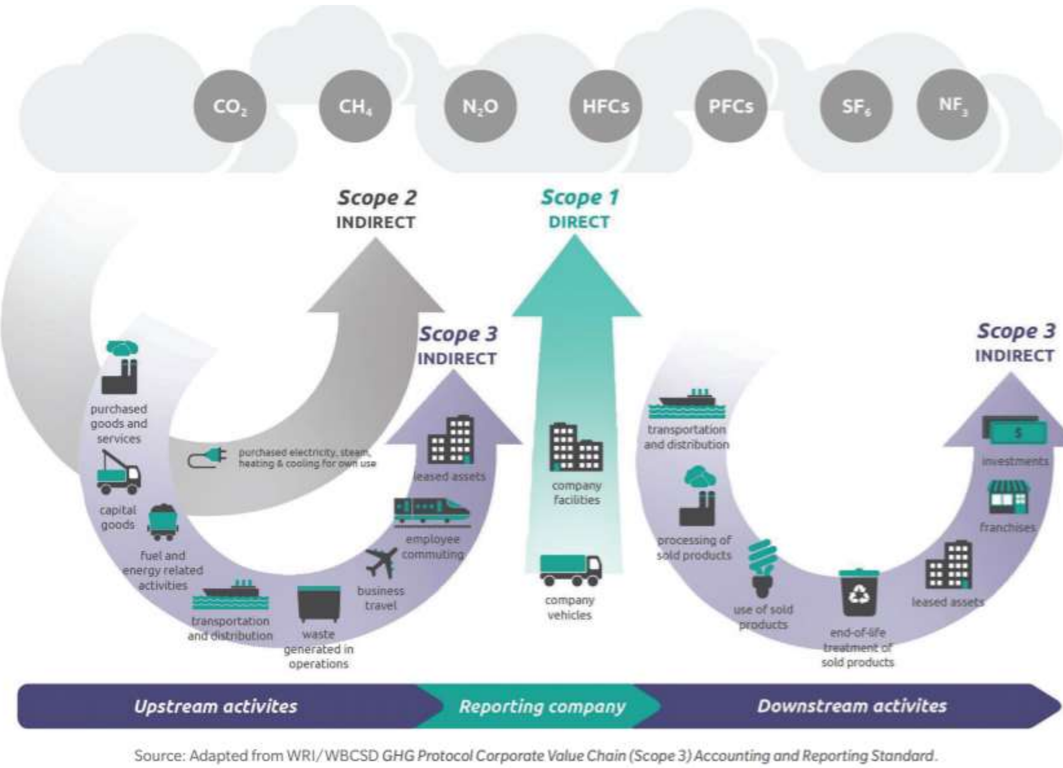

FIGURE 1. OVERVIEW OF SCOPES AND EMISSIONS THROUGHOUT AN ORGANIZATION'S OPERATIONS[6]

The items listed in ***italics and bold*** are applicable to NMSU in the 2019 inventory. The only Scope 3 emissions sources included in the inventory were waste, transmission and distribution losses from electricity, and employee and student commuting activities; other Scope 3 categories were excluded because they were either not applicable to NMSU, considered *de minimis,* or there were no reliable sources for data at this time.

- Scope 1: GHG emissions from sources located within the organizational boundary, including:
  - ***Stationary combustion of fuels in any stationary equipment (including boilers, furnaces, burners, turbines, heaters, incinerators, engines, flares, etc.).***
  - ***Mobile combustion of fuels in transportation source sources (i.e., cars, trucks, marine vessels, and planes) and emissions from non-road equipment.***
  - ***Physical and chemical process other than fuel combustion (i.e., refrigerant use).***
  - ***Fugitive sources (i.e., intentional or unintentional releases from the production, processing, transmission, storage, and use of fuels and other substances).***
- Scope 2: ***GHG emissions occurring as a result of the use of grid-supplied electricity, heat, steam, and/or cooling.*** The location-based method was used for calculating Scope 2 emissions.
- Scope 3: indirect GHG emissions that occur outside of the organization boundary other than those associated with consumed energy:[7]
  - Purchased goods and services.
  - Capital goods.
  - ***Fuel and energy-related activities (e.g., transmission and distribution losses).***

[6] The Climate Registry's General Reporting Protocol Version 3.0, May 2019 https://www.theclimateregistry.org/

[7] For more information please see the Scope 3 Account and Reporting Standard at https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf.

- Upstream transportation and distribution.
- ***Waste generated in operations.***
- Business travel.
- ***Employee commuting.***
- Upstream leased assets.
- ***Downstream transportation and distribution (i.e., student commuting).***
- Processing of sold products.
- Use of sold products.
- End-of-life treatment of sold products.
- Downstream leased assets.
- Franchises.
- Investments.

De Minimis Sources

De minimis sources are very small sources of emissions that represent a high reporting burden, such as hand-held fire extinguishers, refrigerants in office water coolers, or carbon dioxide (CO_2) from soda fountains. These sources are not required to be reported; however, their omission should not:

- Compromise the relevance of the reported inventory.
- Significantly reduce the combined quantity of Scope 1, Scope 2, and biogenic emissions reported.
- Impact the ability to identify the viable opportunities for emissions reduction projects.
- Impact the ability to ascertain whether the organization has achieved a reduction (of five percent or greater) in total entity emissions from one year to the next.
- Impact the ability to assess the organization's climate change-related risk exposure; or,
- Impact the decision-making needs of users (i.e., is not deemed critical by key stakeholders). [8]

Unless the absence of a source will violate one of the above tenants, Lotus suggested not including de minimis sources in the GHG inventory.

Note on Information-Only Items

The GRP does not allow for the subtraction of emissions avoided through the purchase of renewable energy credits (RECs), local installation of renewable energy systems, or recycling. However, the GRP does encourage entities to report these avoided emissions as information-only items in their inventories. For NMSU, these items are calculated as "information-only" and include avoided emissions from:

- Recycling.
- Renewable generation through on-site solar.
- Electricity generated through the campus cogeneration system.

Per conversations with El Paso Electric Association (EPE), the electricity provider to NMSU, EPE owns the RECs associated with rooftop solar within their service territory.

Reporting Period

The 2019 inventory is based on the 2019 fiscal year (July 1, 2018 through June 30, 2019). If data specific to the 2019 fiscal year (FY 2019) was not available, the most recent year was included and noted in the workbook and this IMP.

[8] The Climate Registry's General Reporting Protocol Version 3.0, May 2019 https://www.theclimateregistry.org/

Geography/Business Units Boundary

The physical boundary for the NMSU main campus inventory is the area known as the "triangle" on the main campus; this is the area of land bound by Interstate 25, Interstate 10, and University Avenue. This inventory does not include land and buildings owned and operated by NMSU outside of the main campus "triangle".

The emissions inventory boundary used by NMSU for this inventory is an operational control approach; this means that all potential emissions sources where NMSU has full operational control and decision-making authority were included in the analysis. All emissions occur within the United States.

The Process To Update Inventories

Lotus recommends updating the GHG inventory at regular intervals to track trends. The total time dedicated to data collection is estimated at between 30 and 50 hours. Data collection typically takes up to three to four months, allowing time for the frequent follow-up to each data contact. As data contacts become more familiar with the data collection process and tracking the information that is being collected, data collection in subsequent years may become more efficient.

For consistency purposes, it is good practice to request that data is provided in the same format it was provided for this inventory. In the zipped folder of data provided by Lotus, portable document format (pdf) copies of email communication with each data contact are included (where applicable). The text in the emails/pdfs can be used to save time when sending out new emails to collect data.

In addition, the spreadsheet is set up to ensure that it is clear which cells need to be updated on a regular basis. See Table 2 for an overview and example of how color-coding was used to help the user identify which data should be updated regularly versus less often.

Table 2. Cell Color Guide.

Cell Color	Meaning	Notes
	Do not edit	Do not edit since it is a formula.
	May need to be updated	These cells may need to be updated depending on if a protocol releases new emission factors, large infrastructure changes, etc. These cells are not updated regularly.
	Needs to be updated each inventory	Blue cells require manual entry each year since data updates on an annual basis.

Changes to an NMSU's operations may call for a re-calculation of the base year. The following events may trigger a recalculation:

- Merger, acquisition, and divestments of assets.
- Outsourcing and in-sourcing of emitting activities.
- Changes in calculation methodology.
- Improvements in the accuracy of emission factors.
- Discovery of significant errors.

NMSU WORKBOOK OVERVIEW

The NMSU inventory workbook includes different colored tabs, as described below:

- **Summary Tabs:** The dark gray tabs provide an overview of the spreadsheet including a 1) Workbook Intro and 2) Emission and Visual Summaries.
- **Conversion Factors and GWPs** and **University Indicators Tabs:** These two dark blue tabs provide data used throughout the workbook. University indicators are those that are unique to NMSU in the inventory year, such as student, faculty, and staff population numbers. The university indicators also allow for the ability to identify trends over time (e.g., population increase or decline).
- **Source Data Tabs:** The various lighter blue tabs store the raw data for each source and calculate the resulting GHG emissions. All data in light blue cells within these tabs will need to be updated annually or as often as a new inventory is completed. Data in green cells should be verified to ensure they are still correct and updated if needed.

SUMMARY TABS

Workbook Introduction

The workbook introduction provides an overview of each tab within the workbook and is intended to guide the user. This does not need to be updated with each new inventory unless changes are made to the spreadsheet by adding or subtracting tabs.

Emission and Visual Summary

This tab provides visual and emission summaries from the workbook and aggregates the data in tables, charts, and graphs. No changes will need to be made annually unless new or additional visuals are desired.

CONVERSION FACTORS AND GWPS AND UNIVERSITY INDICATORS TABS

Conversion Factors and GWPs

This dark blue tab provides conversion factors that will not change over time. The GWPs will need to be updated when the most recent IPCC 100-year values are made available. See the Reported Greenhouse Gases subsection for more information.

University Indicators Tab

The University Indicators tab provides key information about NMSU that is useful for normalizing emissions and understanding trends and drivers behind changes in the campus' total emissions over time. This tab will need to be updated with each new inventory.

University Indicators Assumptions

The following assumptions were made in the University Indicators tab:

- Costs for domestic water and sewer were not included in the utility budget data.
- FTEs for faculty, staff, and students were calculated and provided by Calixto Melero. Per Calixto, student FTEs were calculated using student credit hours, where 15 student credit hours equals one undergraduate FTE and 12 credit hours equals one graduate student FTE.

Source Tabs

The source data tabs are in various shades of blue. Within each tab, there are four sections:

- Emissions Summary: The emission summary summarizes all emissions from the tab by scope.
- Data Sources and Assumptions: Explains each data source and assumptions.
- Emission Factors: Provides a list of all emission factors used in calculations. Appendix A: Emission Factors provides all the emissions factors.
- Data Calculations: Provides an overview of the data calculations.

Some tabs additionally have a Raw Data section that includes raw data provided by NMSU data contacts that are included in the calculations.

Stationary Energy Data Tab

NMSU uses natural gas, electricity, and a small amount of propane to power, heat, and cool campus buildings. Additionally, NMSU operates a combined heat and power cogeneration facility on campus that uses high-pressure natural gas to generate steam electricity and heat for use in buildings. NMSU also has several chillers on campus that provide space cooling. Figure 2 provides an overview of the NMSU campus energy system.

Natural gas and propane use on campus generate Scope 1 emissions. The use of grid-supplied electricity on campus generates Scope 2 emissions.

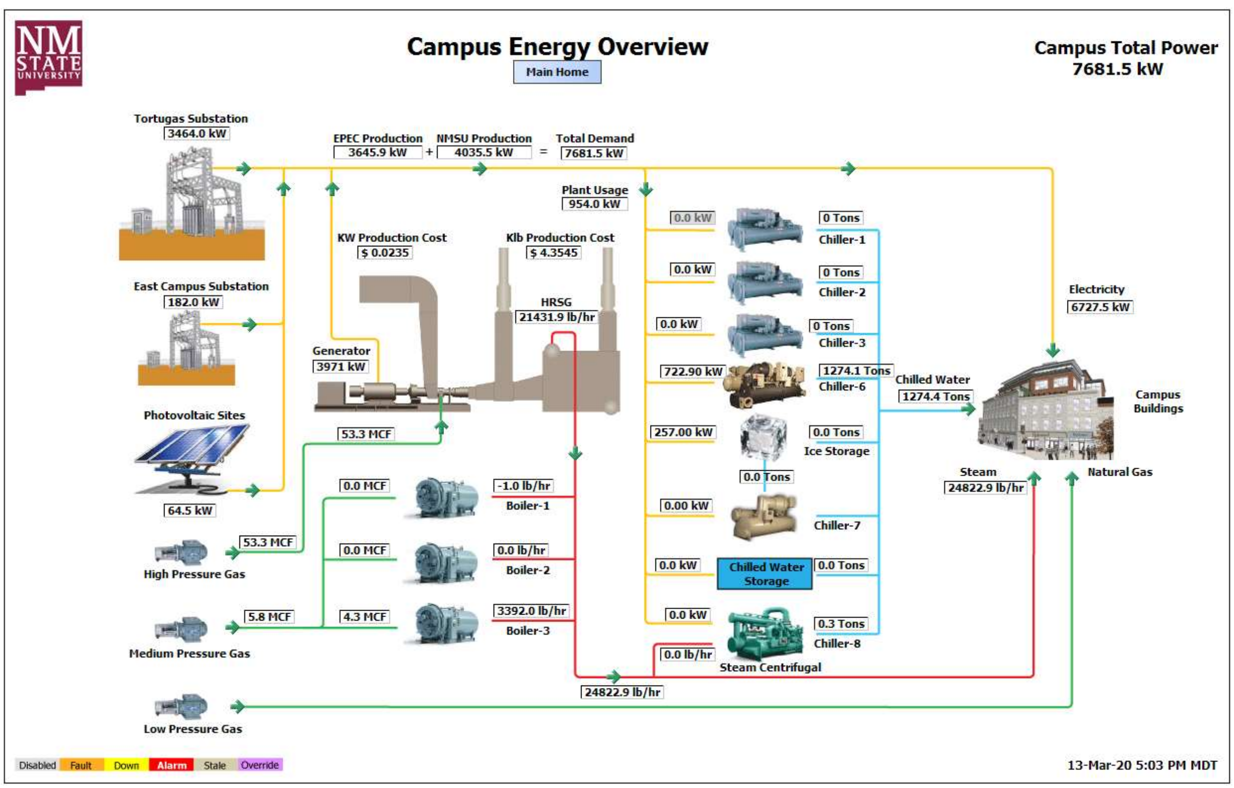

FIGURE 2: OVERVIEW OF THE NMSU CAMPUS ENERGY SYSTEM.

In the inventory, the calculation of emissions from the use of low-pressure natural gas to heat buildings are separated from the use of high-pressure natural gas used in the boilers and cogeneration facilities.

Likewise, emissions from electricity used directly in buildings are calculated separately from the calculation of emissions from electricity used in the chiller system. This allows NMSU to see the impact of the production-level systems (i.e., cogeneration and chillers) separately from the consumption-level energy use in campus buildings.

Assumptions used in this tab and all other source tabs are explained in the Refrigerant Use Data Assumptions

- Lotus assumed 25 percent of refrigerants are leaked based on data from the EPA.

section of this plan. Where possible, consumption-level energy use and correlated emissions were calculated at the disaggregated level by the type of campus buildings using the energy. Campus buildings were grouped into the following types: Academics, Administration, Athletics, Housing/Residential Life, and Research. Emissions from stationary energy use were then aggregated to show total emissions from stationary energy.

Electricity
El Paso Electric provides electricity to NMSU.

ELECTRICITY USED IN BUILDINGS

Data on consumption-level electricity use was provided by Patrick Chavez (Director, Utilities and Plant Operations) and included total kilowatt hours (kWh) consumed in FY 2019.

Per guidance from El Paso Electric, Lotus used the emission factor shown on line 5.3.2.2 in El Paso Electric's *ESG/Sustainability Template – Section 2: Quantitative Information*; the emissions factor is provided in metric tons of carbon dioxide equivalent (mt CO_2e). It should be noted that this emission factor is approximately half of what is shown in U.S. Environmental Protection Agency's (EPA) eGRID values; however, El Paso Electric confirmed that the one published in their report was the more appropriate one to use. This email correspondence is on file.

GHG emissions from electricity = kWh * emission factor

ELECTRICITY USED IN CHILLERS

The same formula as above is used to calculate the emissions from electricity used in the NMSU chillers. Patrick Chavez also provided data on this production-system level use of electricity on campus.

TRANSMISSION AND DISTRIBUTION LOSS

A portion of electricity that is transported through the grid is inherently lost in the transmission process—this is known as transmission and distribution (T&D) loss. The inventory team calculated an average transmission and distribution loss rate based on the U.S. Energy Information Administration's 2017 New Mexico Electricity Profile.[9] By dividing the total estimated lost electricity from T&D by the total electricity consumed in the state, a loss factor of 3.7 percent was determined. This loss factor was entered in the Stationary Energy tab and then multiplied by the amount of electricity consumed (both in buildings and in the chiller system) to generate the total kWh of electricity lost due to T&D.

GHG emissions from T&D loss = kWh * T&D loss factor * emission factor

[9] For more information please see: https://www.eia.gov/electricity/state/newmexico/.

Natural Gas

The City of Las Cruces provides natural gas services to NMSU.

LOW-PRESSURE NATURAL GAS USED IN BUILDINGS

Data on low-pressure natural gas consumption to heat buildings was provided by Patrick Chavez. Although the data set indicates that data is provided in units of cubic feet of natural gas, Patrick confirmed that the natural gas usage is actually reported in dekatherms; email of this correspondence is on file. Dekatherms must be converted into therms to calculate emissions.

GHG emissions from natural gas = dekatherms/10 * emission factor*GWP

HIGH-PRESSURE NATURAL GAS USED IN COGENERATION AND BOILERS

The cogeneration facility at NMSU includes two units for cogeneration and three units that are large steam boilers. Data on the use of high-pressure natural gas in these production-level facilities was provided by Patrick Chavez. The same formula as described above for low-pressure natural gas is used to calculate emissions from the use of high-pressure natural gas.

Propane

A small amount of propane is used on campus in three facilities; only one of these facilities, the Insect Research Farm, is located within the ‘triangle’ of the emissions inventory study area. Propane use data was provided by Drew Kaczmarek.

GHG emissions from propane = gallons propane * emission factor*GWP

Renewable Energy

A small amount of solar energy is generated on campus through rooftop solar arrays at the Photovoltaic Lab and Photovoltaic Center on the Las Cruces campus. Solar generation capacity was provided by Patrick Chavez.

Avoided GHG emissions from renewable energy = - kWh * emission factor

It should be noted that EPE owns the RECs associated with all solar within their power territory, meaning that the utility alone can claim ownership of the environmental attributes of this solar, and the zero-carbon energy produced by these panels is included in the calculation of EPE’s overall emissions factor.

Cogeneration Facility

The cogeneration facilities on the NMSU campus result in the generation of electricity that is used in campus buildings; while this electricity is not generated from renewable resources, it also does not come from EPE’s grid supply. Therefore, the emissions that were avoided by not generating and purchasing that additional electricity from EPE are calculated in the Stationary Energy tab. Data on cogeneration electricity production was provided by Patrick Chavez.

Avoided GHG emissions from cogeneration electricity production = - kWh * emission factor

Stationary Energy Data Assumptions

- Electricity emission factor was provided in El Paso Electric's Quantitative Information, line 5.3.2.2. It should be noted that El Paso electricity emission factors differ from eGrid, but Lotus was advised to use them by Jessica Christianson at El Paso Electric.
- El Paso Electric did not provide a transmission and distribution loss value and recommended that we use EIA's value for New Mexico of 3.7 percent.

- Propane data was provided by Drew Kaczmarek with NMSU. Data was for three campus buildings: the rodeo, the Insect Research Farm, and the golf course. Since the Insect Research Farm is the only building located in the NMSU "triangle," the propane total was divided by 3 to estimate propane use at that facility.
- Source data on low-pressure natural gas use states that the units are in dekatherms. Per conversations with Patrick Chavez, the units are actually in therms.

Fugitive Emissions Tab

A small amount of natural gas is leaked in the process of transporting and using the gas. Fugitive emissions account for this leakage from natural gas distribution systems and are based on an assumed methane leakage rate of 0.15 percent. The leakage rate was based on data tracking conducted by the City of Las Cruces, NMSU's natural gas provider.

GHG emissions from fugitive natural gas = (th/(1 – leakage rate)) * 100,000/natural gas energy density * 0.02832 cubic meters/cubic foot* density of natural gas * percent of CO_2 (or CH_4) * leakage rate* GWP

Fugitive Emissions Data Assumptions

- Per the kick-off call with NMSU, there are no oil and gas wells located within campus limits. There are no coal mines on campus either. Emissions account for fugitive emissions from the natural gas distribution systems.
- Based on data provided by the City, the leakage rate for natural gas distribution is assumed to be 0.15%. Fugitive emissions are based off an assumption of the amount supplied to the system, which is calculated from the amount consumed and the leakage rate.
- Assume that the density of natural gas is 0.8 kg per cubic meter and that natural gas is 93.4% methane and 1% carbon dioxide.
- No N_2O is recorded from leakage from natural gas.

Fleet Data Tab

Data on vehicle miles traveled (VMT) and gallons of fuel consumed are used to calculate emissions from on-road transportation.

Data on gallons consumed by campus fleet vehicles and equipment was provided by Esther Amezquita and Phillip Robles, both with NMSU. This data was broken down by the specific fleet vehicle. After a review, it was determined that the data provided for Facilities Services vehicles by Esther was included in the data set for all vehicles provided by Phillip. Therefore, only the dataset provided by Phillip was used for calculations.

An assumption that 10 percent of standard gasoline is comprised of ethanol was used to calculate biogenic carbon and ethanol emissions. It was assumed that standard diesel contains no biodiesel.

Vehicles were classified by Lotus into seven broad categories to match the emission factors provided by the Climate Registry. These categories were: gasoline passenger vehicle, gasoline light duty truck, gasoline heavy duty vehicles, diesel light duty trucks, diesel heavy duty vehicles, gasoline-powered equipment, and diesel-powered equipment. Where necessary, assumptions were applied to the vehicles and pieces of equipment to categorize them; these assumptions are further detailed below.

Gallons of fuel consumed by vehicle type were summed to calculate total gallons of fuel consumed. The same methodology was applied to calculate the gallons of gasoline, diesel, propane, and ethanol consumed. To calculate vehicle miles traveled, fuel efficiencies for five vehicle types (excluding equipment) were applied to total gallons of fuel for the designated vehicle types. Fuel emission factors were provided by The Climate Registry and applied to the total gallons consumed and VMT estimates.[10]

GHG emissions from fleet vehicles = SUM(gallons of fuel consumed * emission factor * GWP) + (VMT * emission factor * GWP)

Fleet Vehicle Data Assumptions

- Lotus assumed all standard gasoline used contains 10 percent ethanol.
- Climate Registry breaks equipment down into categories. The equipment fuel data given to Lotus was categorized based on Climate Registry options; most equipment was assumed to fall into the construction/mining equipment category. No ethanol equipment emissions factors are provided, so gasoline equipment emissions factors are used.
- Fleet vehicles were categorized based on fuel type and vehicle type. Some assumptions were made to help determine the category of vehicles that had no description or had "Generic Card" as a description. After a conversation with NMSU, Lotus assumed that 75% of the unknown fleet vehicles were gasoline light duty trucks and 25% of the unknown fleet vehicles were gasoline passenger vehicles.
- For vehicles that have both gasoline and diesel purchases noted Lotus assumed that all purchases are of one fuel type based on the vehicle. For example, if an Impala has both gasoline and diesel purchases noted, Lotus assumed that all purchases noted as diesel were actually gasoline.
- Any entries in the dataset with the "Fuel Can" description were assumed to be the fuel used in equipment on campus.
- Entries in the dataset that were for NMSU Athletics were removed per the recommendation of NMSU staff as it was assumed that fuel use was for sports team travel (i.e., that would fall under the business travel category).
- Entries in the dataset for "other fuel" were assumed to be the same as the fuel type designation of the car. For example, if a gas passenger vehicle had a fuel purchase described as "other fuel," that fuel was counted as gasoline.

Campus Plane Tab

Data on jet fuel used by the NMSU campus plane was provided by Rich Clayton, Director, University Flight Operations. EPA emission factors for jet fuel were applied to gallons of fuel to calculate total emissions.

GHG emissions from campus plane = gallons of fuel * emission factor * GWP

Because NMSU owns the plane, all of the emissions associated with its use are Scope 1 emissions. Rich Clayton also provided data on the fuel used in road vehicles that are operated by his department. The data on this use is included in the Campus Plan tab for information-only purposes; these values are included in the emissions calculations in the Fleet Data tab.

Campus Plane Data Assumptions

- Motor gasoline use reported by the University Flight Operations team was used in on-road vehicles, not in aircraft.

Employee Commute Data Tab

[10] See Local Government Operations Protocol May 2019: https://www.theclimateregistry.org/wp-content/uploads/2019/05/The-Climate-Registry-2019-Default-Emission-Factor-Document.pdf.

Data on employee commute activities were provided in the 2017 Sustainability Engagement Survey Report provided by Allison Jenks, Facilities Sustainability Manager at NMSU. The report detailed data from a voluntary survey that was completed by students, faculty, and staff at the campus, and includes data on the locations from which people are commuting to get to campus (based on zip codes) and the modes of travel they are taking.

Lotus determined a mid-point in each zip code from which employees were commuting and determined a distance from that zip code to the Corbett Center Student Union on Campus. The number of full-time-equivalent (FTE) faculty and staff commuting to campus was distributed to the zip codes based on the percent of people traveling from each zip code. It was assumed that for all those who reported driving alone or carpooling to campus, half of those people drive gasoline-powered cars, and the other half drive gasoline-powered pick-up trucks. It was assumed that each FTE commuted five days a week, fifty weeks out of the year. Emissions were based on the total number of miles driven and estimated gallons of fuel used by each mode type for the entire employee population, where gallons of fuel were estimated based on the average miles per gallon of gasoline cars and trucks and diesel buses.

GHG emissions from employee commuting = sum(total FTE *total annual trips*percent coming from zip code*round trip miles from zip code to campus*percent commuting by each mode type*emissions factor for each vehicle type * GWP)

Data on employee commuting is often difficult to track and requires several assumptions. The assumptions used in this section of the inventory are further detailed below, and suggestions on ways to improve data collection are included in the Process Improvement Plan section, below.

Employee Commute Data Assumptions

- It is assumed that standard gasoline purchased at the pump contains 10% ethanol.
- To calculate the average travel distance for the provided zip codes, Lotus took a midpoint address and mapped the distance (one-way) to the Corbett Center Student Union on campus. Not all the addresses are perfectly midpoint as some of the zip codes cover a large area where the majority is remote or is owned by federal agencies, so in those cases, Lotus took a central address from the nearest populated subdivision or place that was populated.
- Each staff/faculty FTE commutes five days a week for fifty weeks of the year.
- The 'other' category under mode shift in the source data is employees who are walking/scootering/otherwise using a form of transportation that doesn't generate emissions.
- The 'other' category for zip codes in the source data was assumed to be 88021 for Anthony, New Mexico, which is a mid-point between Las Cruces and El Paso.
- Of those that are carpooling or driving alone, 50% are doing so in a light duty gasoline car and 50% are in a light duty gasoline truck.
- CH_4 and N_2O emissions factors for gasoline are assuming vehicle model years of 2008 or newer.

Student Commute Data Tab

Data on student commute activities were provided in the same source as data for the employee commute activities. The same approach and assumptions as described above were used to calculate emissions from student commuting.

Waste and Recycling Data Tab

The Corralitos Landfill is not located within the campus, and it does not have a methane gas collection system. Emissions factors for waste were derived from the EPA's Waste Reduction Model (WARM) for the state of New Mexico, a landfill with no landfill gas recovery, a dry climate, and a distance of 18.1 miles from NMSU to the landfill.[11]

Pamela Izzo of NMSU provided FY 2019 tonnage data.

GHG emissions from landfilled waste = tons of waste * Mixed MSW emissions factor

Recycling

Avoided emissions from recycling were calculated based on the tons of recycled material collected on campus and the emissions factors from WARM. Recycling emissions factors include avoided emissions from both not landfilling the materials and from recycling.

Waste and Recycling Data Assumptions

- Emissions factors from WARM were generated using the following assumptions:
  - Specific to the state of New Mexico.
  - Dry climate.
  - No landfill gas recovery.
  - 18.1 miles from NMSU to Corralitos Landfill.

Wastewater Data Tab

The wastewater generated from activity at NMSU is treated by the City of Las Cruces; there are reports of additional septic tanks on campus, but no data is available to verify whether those are inside of the triangle and therefore no septic tanks are included in the GHG inventory. John Mrozek, City of Las Cruces Director of Wastewater, provided data on wastewater treatment activities in place at the City of Las Cruces facility. Wastewater emissions for the following sources were calculated using ICLEI's wastewater calculations:

- Process N_2O emissions for WWTPs with nitrification and denitrification.
- Fugitive N_2O emissions from effluent discharge.
- Combustion emissions and flared gas emissions.

The total number of FTE students, faculty, and staff for NMSU in FY 2019 was used as a proxy for the population served in the below equations.

GHG emissions from process emissions = population served * industrial commercial discharge multiplier * emission factor * GWP

GHG emissions from fugitive emissions = total nitrogen discharged * days per year * molecular weight ratio of N_2O to N_2 * emission factor * GWP

GHG emissions from combustion of gas = digester gas produced * methane content * heat content * days per year * natural gas energy density * GWP

GHG emissions from flaring gas = digester gas flared * methane content * density of methane * days per year * (1 – methane destruction efficiency) * GWP

Wastewater Data Assumptions

- The Las Cruces wastewater treatment plant serves approximately 33,305 FTE students, faculty, and staff at NMSU.

[11] For more information please see https://www.epa.gov/warm.

- A standard industrial commercial discharge multiplier of 1.25 was used assuming that the wastewater treatment accepts some level of commercial and small industrial sites.

Refrigerant Use Data Tab

Data on refrigerant use was provided by Paul Ponce with NMSU. Based on the available data, only the refrigerant R-134a was used in campus buildings during the inventory year. Emissions from refrigerant leakage were calculated assuming a 25% leakage rate per best available data from the EPA.[12] Each refrigerant type has a specific global warming potential associated with it, which was sourced from The Climate Registry.

GHG emissions from refrigerant leakage = [Refrigerant use (pounds)/pounds to metric ton conversion*0.25] * R134a GWP

Refrigerant Use Data Assumptions

- Lotus assumed 25 percent of refrigerants are leaked based on data from the EPA.

PROCESS IMPROVEMENT PLAN

Every inventory sheds light on possible improvements for the next iteration. NMSU's campus community did an excellent job providing data, helping track down difficult datasets, and brainstorming data assumptions. Future inventories could benefit from the following three process improvements:

- Improvements in data tracking on fleet activity in the University's WEX system will reduce the number of assumptions required when calculating fleet emissions. Specifically, better tracking of vehicle miles traveled and of the type of fuel used in vehicles, as well as better notations on the types of vehicles associated with each asset ID, will lead to higher-quality data.
- No data was available regarding business travel at the University. If the University were to collect this data in a centralized format that is straightforward, including collecting data on the use of rental vehicles and gasoline in those vehicles and origin and destination data for flights made for business travel (not on the campus plane), emissions from business travel could be calculated for future inventories.
- Employee commuting data is, for most entities, generally hard to track and quantify. However, if the university were to conduct a commuter survey that collects data on the commuting activities of staff and faculty (including the number of days a week and weeks a year that they travel to the university, the distance of their commute, and the mode of transportation they take, including the type of vehicle and fuel used) the calculation of emissions from employee commuting could use this higher-quality data. The same applies for calculating emissions from student commuting.

CONCLUSION

The fiscal year 2019 GHG emissions inventory provides NMSU with a robust and defensible baseline of carbon emissions with which to base future policies and programs. NMSU is now prepared to effectively monitor and track progress against carbon reduction goals and will be better informed when choosing specific sustainability efforts. Greenhouse gas emission inventories should be updated at regular intervals to capture changes over time, and the IMP contained herein, alongside the GHG emissions inventory workbook, will enable NMSU staff to update GHG emissions in the future.

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[12] For more information please see https://www.epa.gov/sites/production/files/documents/GChill_Retrofit.pdf.

APPENDIX A: EMISSION FACTORS

See Table 3 for an overview of the emission factors that were used for calculations throughout the inventory. The Notes column provides detail as to which emission factors need updated regularly.

TABLE 3. SUMMARY OF EMISSION FACTORS

Building Emissions Emission Factors—Electricity, Natural Gas & Propane					
Emission Source	**GHG**	**Value**	**Unit**	**Source**	**Notes**
Electricity	CO_2	0.244	mt CO_2e/MWh	El Paso Electric's 2018-EEI-ESG-Sustainability-Template-Section-2-Quantitative-Information, line 5.3.2.2	Verify with each inventory; likely to change annually.
Natural Gas	CO_2	0.0053	mt CO_2/therm	Tables 1.1 and 1.9 The Climate Registry 2019 Default Emission Factors	Should remain constant but verify with each inventory.
	CH_4	0.0000005	mt CH_4/therm		
	N_2O	0.00000001	mt N_2O/therm		
Propane	CO_2	0.0057	mt CO_2/gal	Table 1.1 and 1.9, The Climate Registry 2019 Default Emission Factors (propane is categorized as a petroleum product, thus those estimates were used).	Should remain constant but verify with each inventory.
	CH_4	0.000000273	mt CH_4/gal		
	N_2O	5.46E-08	mt N_2O/gal		
Transportation Emission Factors—Ethanol, Gasoline, and Diesel					
Emission Source	**GHG**	**Value**	**Unit**	**Source**	**Notes**
Gasoline	CO_2	0.009	mt CO_2/gal	The Climate Registry, May 2019	Should remain constant but verify with each inventory.
	CH_4	Varies by vehicle	g/mile		
	N_2O		g/mile		
Diesel	CO_2	0.01	mt CO_2/gal	The Climate Registry, May 2019	Should remain constant but verify with each inventory.
	CH_4	Varies by vehicle	g/mile		
	N_2O		g/mile		
Ethanol	CO_2	0.006	mt CO_2/gal	The Climate Registry, May 2019	Should remain constant but verify with each inventory.
	CH_4	Varies by vehicle	g/mile		
	N_2O				
Propane	CO_2	0.006	mt CO_2/gal	The Climate Registry, May 2019	Should remain constant but verify with each inventory.
	CH_4	0.450	g CH_4/gallon of fuel		
	N_2O	0.028	g N_2O/gallon of fuel		

Aviation Emission Factors					
Emission Source	**GHG**	**Value**	**Unit**	**Source**	**Notes**
Jet Fuel	CO_2	9.57	kg CO_2/gallon	EPA Emissions Factors: https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf	Should remain constant but verify with each inventory.
	CH_4	0	g CH_4/gallon		
	N_2O	0.31	g N_2O/gallon		
Motor Gasoline	CO_2	8.78	kg CO_2/gallon	EPA Emissions Factors: https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf	Should remain constant but verify with each inventory.
	CH_4	2.744	g CH_4/gallon	The Climate Registry, May 2019	
	N_2O	0.251	g N_2O/gallon		
Waste Emission Factors					
Emission Source	**GHG**	**Value**	**Unit**	**Source**	**Notes**
Municipal Solid Waste	CH_4	Varies by waste type	mt CH_4/ ton waste	EPA WARM Tool Mixed MSW using New Mexico factors, no landfill gas recovery, a dry climate, and 18.1 miles to the landfill from NMSU.	Should remain constant but verify with each inventory.
Recycled Waste	CH_4	Varies by waste type	mt CH_4/ ton waste	EPA WARM Tool Mixed MSW using New Mexico factors, no landfill gas recovery, a dry climate, and 18.1 miles to the landfill from NMSU.	Should remain constant but verify with each inventory.
Wastewater	CH_4	Varies by treatment	Varies	2013 ICLEI US Community Protocol, Appendix F	Should remain constant but verify with each inventory.
	N_2O				
Refrigerant Emission Factors					
Emission Source	**GHG**	**Value**	**Unit**	**Source**	**Notes**
R-134a (GWP)	N/A	1,300	N/A	2019 Climate Registry Default Emissions Factors: https://www.theclimateregistry.org/wp-content/uploads/2014/11/2016-Climate-Registry-Default-Emission-Factors.pdf.	Should remain constant but verify with each inventory.

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