LANCASTER COUNTY INVENTORY REPORT - 2020

# REGENERATION STARTS HERE

A greenhouse gas inventory of the 2018 calendar year, and suggestions for Lancaster County moving forward

ICLEI Local Governments for Sustainability

REGENALL

## Authors

Sophia Martin
*Analyst, RegenAll*
*Lead Author*

Maddie Huelbig
*Analyst, RegenAll*

Eric Sauder
*Director, RegenAll*

## Acknowledgements

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# What is RegenAll?

RegenAll is a 501c3 nonprofit, based in Lancaster, PA with the mission to unite businesses, communities, and individuals to identify and implement local climate solutions for a more resilient future. Solutions that not only protect our shared resources, but that help our families and economy thrive. Bringing together urban and rural stakeholders, RegenAll analyzes community greenhouse gas emissions, identifies place-based solutions, and examines the economic impacts to create a roadmap for policy, individual action, and community engagement. RegenAll also creates opportunities to invest in community climate solutions through local carbon offsets. With RegenAll, there is a role for everyone in securing an economically-thriving, climate-resilient future.

Learn more at RegenAll.org.

# Foreword:

This report marks a key first step on Lancaster County's journey to slow, halt and ultimately reverse our greenhouse gas emissions. Why is this important? Greenhouse gases (GHG's) -- such as carbon dioxide, methane and nitrous oxide -- trap heat in the atmosphere. And currently, humans are emitting greenhouse gases faster than trees and other carbon sinks are removing them. The resulting greenhouse gas buildup in the atmosphere has led to temperature rise and changes in climate patterns on earth. Floods, fires and droughts already affect many communities, domestically and globally.

In Lancaster County, we have yet to feel the full effects of a climate out of control, but our heavily agriculture-dependent region is already seeing impacts of increased annual rainfall and more intense storms. Impact is inevitable, no matter where you live. But at this point, in 2020 -- a decade before leading climate scientists agree that our greenhouse gas emissions must be cut in half -- our actions still determine the degree of severity. We can not wait for the full, calamitous potential of climate projections to materialize. By addressing the causes of climate change now, we can decrease the risks and emerge more resilient.

Before our community can take collective steps towards a regeneration, a society in which the human and non-human worlds are not at odds, but mutually beneficial, we must know where we currently stand. To that end, RegenAll measured greenhouse gas emissions from transportation, agriculture, electricity, stationary fuel combustion, fuel use, water treatment and management, and solid waste to determine Lancaster County's current contribution to climate change.

Though the numbers on the following pages may, at first incite feelings of sadness or hopelessness, it is our intention that this report be just as hopeful as it is humbling. In fact, we hope that it is energizing. What an incredible opportunity it is to live during such a pivotal moment in global history. And what better place to capitalize on the moment's opportunities than Lancaster County, where rural and urban communities are uniquely poised to unite to slow GHG emissions and build a sustainable economy? The nation lacks examples of places that look like Lancaster showing that bipartisan climate action can create jobs and build local resilience while implementing local climate solutions.

Economic resilience and environmental sustainability are not at odds. In fact, they're increasingly entwined, interdependent. By participating in this global movement, we will be making strides toward economic and environmental resilience within county boundaries. We're eager to begin this journey with all of you.


GO

# Key Terms

**AFOLU:** Agriculture, forestry, and other land use

**Climate change**: Global warming driven by human emissions of greenhouse gases, and the resulting large-scale shifts in weather patterns.

**Carbon dioxide equivalent (CO2e)**: This inventory quantifies emissions of all greenhouse gases, but often refers to carbon-dioxide equivalent (CO2e) values. We do this largely in order to increase the report's intelligibility. Here's how it works: Each greenhouse gas warms the atmosphere to a varying degree. In order to demonstrate the cumulative contribution from a mixture of greenhouse gasses such as methane, nitrous oxide, and carbon dioxide, each gas is recorded by its relative warming in relation to carbon dioxide. This is where we get a single "carbon-dioxide equivalent" value.

**Carbon sequestration**: Removal of CO2 from the atmosphere. Also referred to as "carbon removal." The scope of this report accounts for carbon sequestration from forest cover.

**Carbon storage**: Carbon that is held in a carbon sink, such as living plant biomass, soil, or long-lived wood products, rather than existing in the atmosphere. Disturbance of ecosystems with stored carbon can lead to significant CO2 emissions.

**Drawdown**: The moment in the future when levels of greenhouse gases stop climbing and start declining.

**Direct emissions**: Greenhouse gas emissions that occur within the community inventory's geographic boundary.

**Greenhouse gas (GHG)**: Gases that cause the greenhouse effect; preventing heat from being radiated to space and effectively trapping it in the Earth's atmosphere. Though carbon dioxide (CO2) is the most well known GHG, water vapor (H20), methane (CH4) and nitrous oxide (N2O), and hydrofluorocarbons (HFC's) also contribute greatly to warming.

**Indirect emissions**: Greenhouse gas emissions that occur outside the community inventory's geographic boundary.

**MTCO2e**: Metric tons of carbon dioxide equivalent.

**Net zero emissions**: A situation where GHG emissions and carbon removals are balanced. Also known as “carbon neutral.”

**Scopes framework**: GHG accounting protocols divide emissions into three categories: Scopes 1, 2 and 3.

**Scope 1 emissions**: All direct emissions, such as fuels burned in buildings or vehicles within the community.

**Scope 2 emissions**: Indirect emissions from electricity use.

**Scope 3 emissions**: All indirect emissions other than from electricity use. In a community inventory includes emissions from solid waste sent to landfills outside the community, community use of air travel, and emissions to produce materials, goods and services used in the community. For the purposes of this inventory, we have chosen to omit much of Scope 3 emissions.

# Executive Summary

Climate change is upon us. Myriad environmental, social and economic impacts of an ever-warming planet will continue to escalate unless humans take significant action. Though the problem is global in nature, powerful solutions can and must take place on the local level.

With this knowledge directing our initiative, a team from RegenAll measured Lancaster County's GHG emissions to approximate how much we, as a community, contribute to climate change. Our team measured energy use from six sectors: industrial energy, commercial energy, residential energy, transportation, AFLOU, and solid waste. Using ICLEI's ClearPath tool, the industry standard tool for community inventories, we then converted that energy into emissions. Here we report those emissions in the form of Metric tons of Carbon Dioxide Equivalents (CO2e).

We measured emissions and removals from the year 2018 to establish a baseline for climate action moving forward. As Lancaster County develops a Climate Action Plan (CAP), we will measure our progress against the 2018 inventory.

The results of our inventory suggest that Lancaster County was responsible for emitting 10,582,141 MTCO2e into the atmosphere in 2018. Emissions from the industrial energy sector contributed the most to this total, followed closely by transportation and commercial energy.

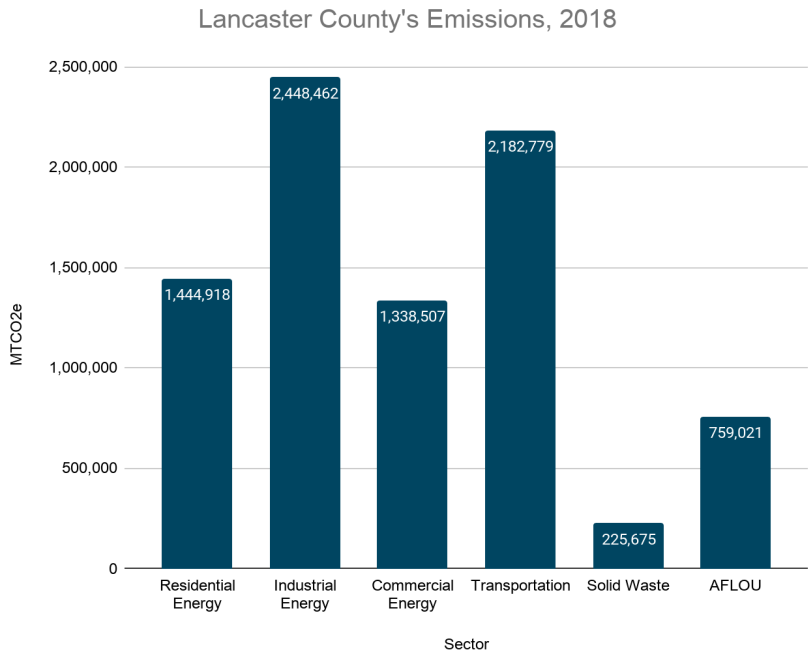



Figure 1. Lancaster County's Emissions, 2018

Currently, our emissions surpass our estimated carbon removals by approximately 95.8 percent.

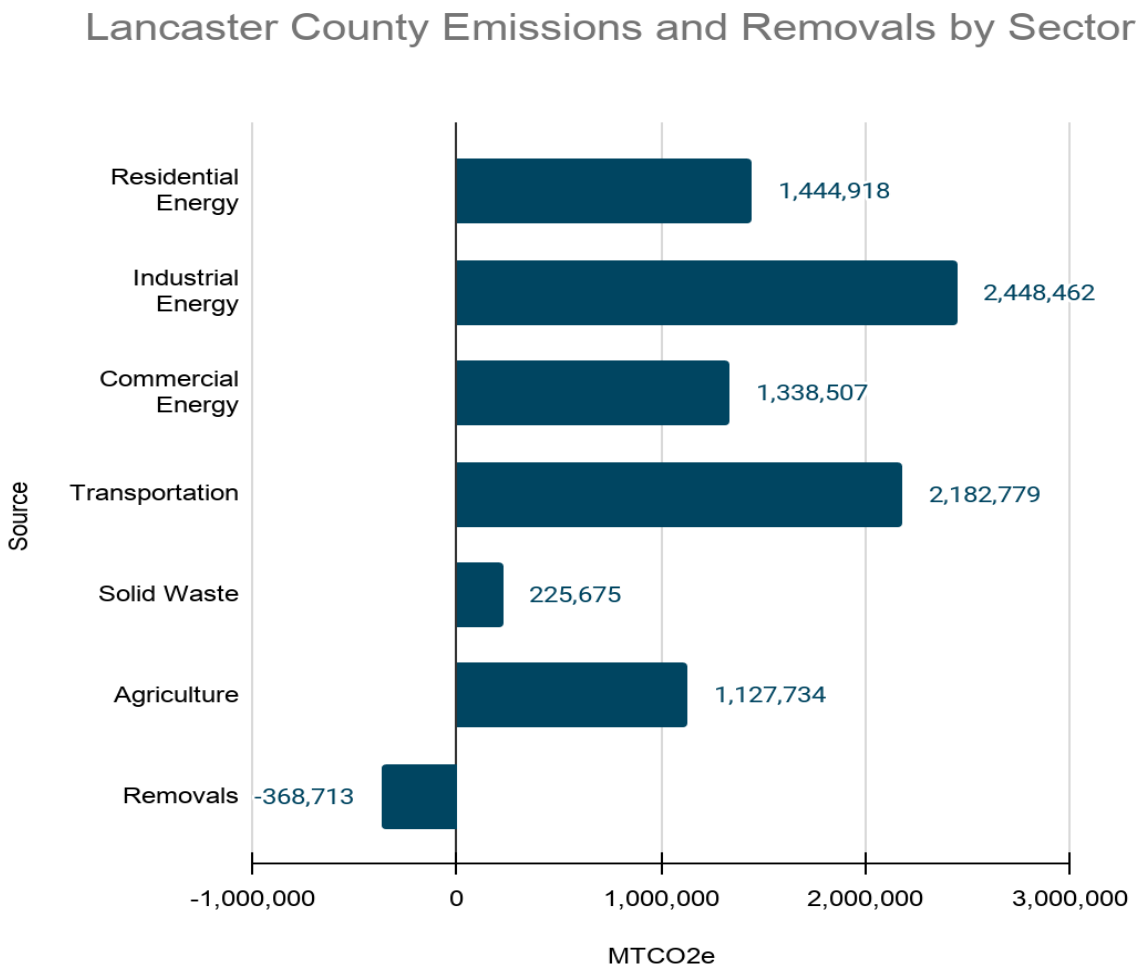



Figure 2. Emissions and Removals by Sector

This inventory marks the first step towards net carbon neutrality -- the moment when GHG emissions and removals are equal. In fact, the primary purpose of establishing Lancaster County's net GHG emissions baseline is to inform the development of the Climate Action Plan (CAP). Our county's CAP will outline measurable steps that the local government, community partners, and individuals can take to lower our collective carbon footprint to the point of carbon neutrality and beyond.

In accordance with international efforts set in place by the Paris Climate Agreement of 2015, Lancaster County must plan to cut GHG emissions in half by 2030. By 2050, the county must be carbon neutral.

# Introduction

**Why conduct a greenhouse gas inventory?**

Our Earth is ablaze, from the Amazon, to Oregon, to the melting caps of Arctic ice. Time no longer separates us from climate change; the moment of consequence is now. And the facts are undeniable: climate change's environmental, social and economic impacts will continue to escalate unless humans take significant action. In the coming decades, major changes to our way of life are unavoidable. But whether they are proactive, life-giving and regenerative, or reactive damage control is up to us.

In October 2018, the United Nations Intergovernmental Panel on Climate Change (IPCC) determined that to avoid the most destructive potential of climate change, global society will have to limit warming below 1.5°C from pre industrial levels. The panel laid out benchmarks that we must hit if we hope to achieve this goal. The first deadline is 2030, when global greenhouse gas emissions must be cut in half. From there, our collective goal must be to achieve carbon neutrality — when human-caused greenhouse gas (GHG) emissions are balanced by emissions removals from the atmosphere — by 2050. The task is steep -- and will require unprecedented global collaboration.

At the same time, given the uncertainty of rapid, expansive international action, we must explore all local climate solutions. The scale of climate change underscores its urgency. Yet its global nature can also, ironically, discourage individuals from taking action. In the face of a world-wide catastrophe, individual, and even community action can feel insignificant. But we can not afford such thinking. Rather, we must acknowledge greenhouse gases are emitted -- and can be removed -- locally. Every bit of carbon emitted contributes to warming. Therefore, every bit of carbon *not* emitted (or even removed from the atmosphere) slows the progression of climate change.

It is from that fundamental precept of climate responsibility that Lancaster County is embarking on the journey to carbon neutrality. As this project has matured, the COVID-19 pandemic has opened a door to rethink how we live. Not only has it proven large-scale reconstruction possible, but this breach in business as usual has also given individuals, companies, and municipalities the opportunity to reimagine their operations. Post-pandemic life is an opportunity to reinvision Lancaster County's normal.

## Background on our inventory

In 2015, Lancaster City conducted an analysis of greenhouse gas emissions within city limits. Though the report is comprehensive, it is limited by its boundaries. Cities can only do so much in isolation. On the county level, however, there exist opportunities for emissions reduction and even the creation of carbon sinks -- a pathway to a local carbon-offset marketplace and eventual regional carbon neutrality by 2050.

Our team set out to fill that gap. In the fall of 2020, RegenAll assembled a team of community members (Eric Sauder, Maddie Huelbig, and Sophia Martin) to conduct a county-wide greenhouse gas inventory. The team joined ICLEI, a global network of local and regional governments committed to sustainable development, and began collecting data on Lancaster County energy usage and converting it into emissions with ICLEI's Clearpath calculator.

The first step was to determine which year to inventory. With ICLEI's guidance, our team landed on 2018 for a number of reasons. In the Fall of 2020, 2018 data was still readily available and the year 2018 represents a somewhat normal level of activity and subsequent emissions in Lancaster County. It is also recent enough that it remains relevant to our current lives and operations. Though we would have hoped to conduct the inventory for 2020 (the most recent year), the COVID 19 pandemic altered activity far beyond what could be considered normal. Therefore, for the sake of data accessibility and accuracy, we chose to inventory Lancaster County's 2018 GHG emissions.

Our partners at ICLEI assisted us in determining which emissions sources to measure and which, for the sake of time, accuracy and remaining actions-oriented, to omit. All GHG inventories must include data on five main sources: transportation, grid electricity, fuel combustion, solid waste, and water treatment and wastewater management. For the purposes of our inventory, we chose also to include data on agriculture. Given the large agricultural presence in Lancaster County, overlooking emissions associated with agriculture would produce an inaccurate report and prevent us from seizing opportunity to decrease and sequester carbon in our county. Additionally, we included data on carbon removals in our county. Though Lancaster County contains many carbon sinks (some of them being regenerative agricultural fields), we chose only to measure carbon sequestration from forests. Our team made this decision largely as a result of data accessibility. In future years, as data and agricultural carbon methodologies become more readily available, we hope to better model agricultural emissions and sequestrations.

Though we have spent months compiling and analyzing data from the aforementioned categories, we must note that our estimations of Lancaster County's CO2e emissions are just that, estimations. As is the case with all GHG inventories, approximations fill gaps in data. No inventory can flawlessly account for all of the carbon equivalents emitted and sequestered in the region. In the absence of county-specific data for some sources, we referred to regional or national factor sets. As a result, readers should assume that our team under-reported Lancaster County's emissions.

Limitations notwithstanding, this report makes clear that we will have to transform our community, from how we live daily life to how we manage our land. And we must do it within the span of approximately ten years, working together across the varying lines that divide us.

The remainder of this report is organized as follows: an outline of primary methods in data collection and analysis, summary of key findings, discussion of implication of the results, acknowledgement of the report's challenges and limitations, and finally, a short conclusion.

# Methods

**Tools**

ICLEI's online greenhouse gas inventory tool, ClearPath, assists communities in measuring GHG emissions, forecasting change in emissions over time, and producing climate action plans. When RegenAll paired with ICLEI in the Fall of 2020, Lancaster County became one of over 600 communities to use ClearPath to inventory current emissions and create climate planning scenarios.

In addition to the ClearPath tool (which has not been developed in the Agricultural sector), we relied on Appendix G of ICLEI's community protocol for greenhouse gas inventory to guide our Agricultural calculations. We supplemented that guidance with the EPA's *State Greenhouse Gas Inventory Tool, Module 7 - Agricultural Module*, where we converted enteric fermentation and manure management data into GHG emissions.

**Sectors**

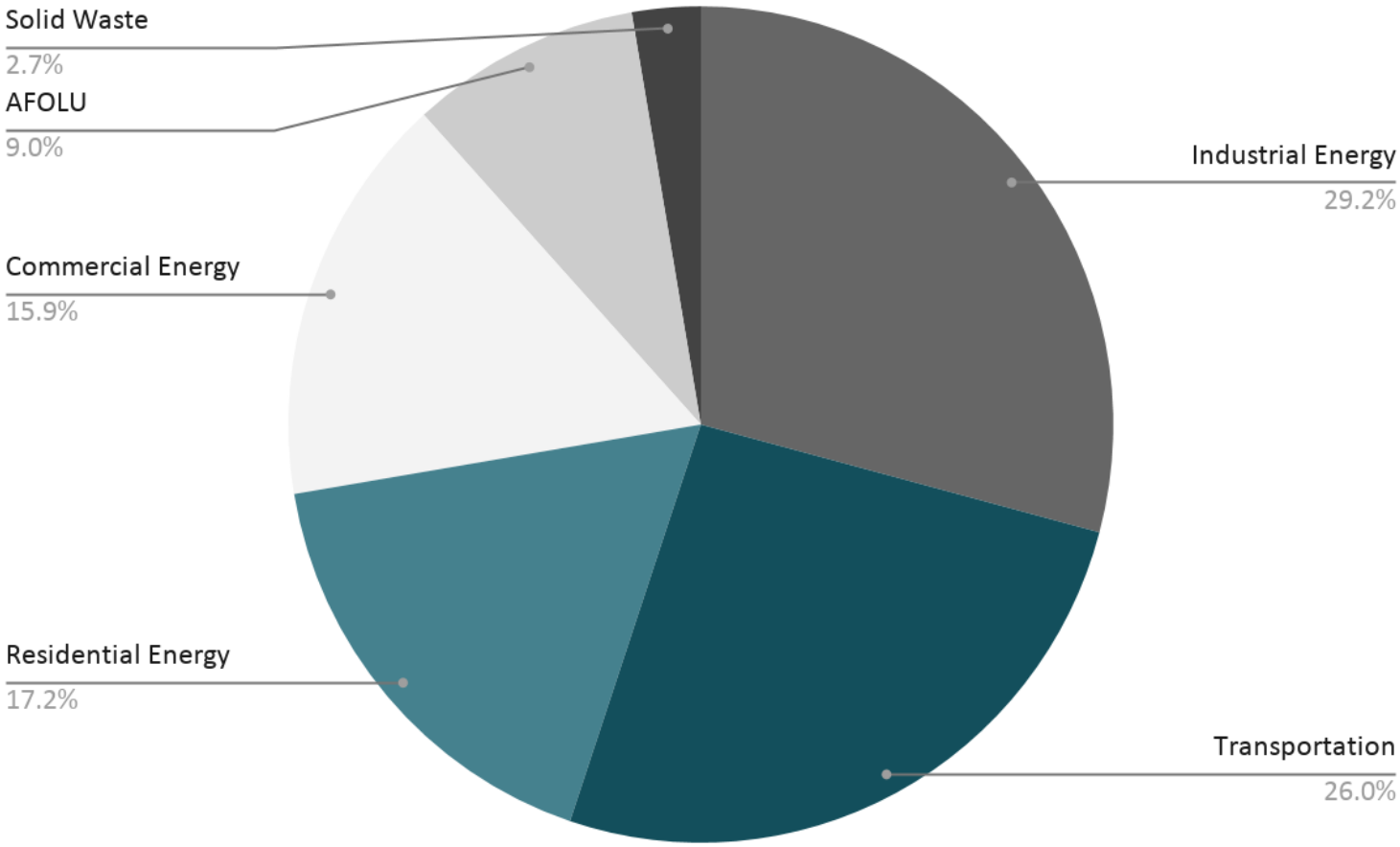
The *US Community Protocol* requires emissions data from five main sectors in production-based accounting: transportation, electricity use, stationary fuel combustion, solid waste generation, water and wastewater. Our report also includes data on emissions related to agriculture, as well as carbon removals from forest ecosystems. The specifics of each sector are as follows:

- **Transportation** includes on-road data from passenger vehicles and freight vehicles.
- **Electricity** details the county's use of grid-supplied electricity in the residential, commercial and industrial sectors.
- **Stationary fuel combustion** includes natural gas, LPG, kerosene, distillate fuel oil, fuel use in the residential, commercial and industrial sectors.
- **Solid waste generation** encompasses the emissions related to all aspects of solid waste generation, transportation and removal.
- **Waste and wastewater** includes electricity use and stationary fuel combustion associated with wastewater treatment processes.
- **Agriculture, forestry and other land use (AFOLU)** accounts for emissions associated with enteric fermentation of livestock and manure management. It also includes data on net carbon removals from trees (both in forests and otherwise).

# Results

In 2018, Lancaster County emitted approximately 10,582,141 metric tons of carbon dioxide equivalents into the atmosphere. Industrial energy is the largest contributor to Lancaster County's emissions. The sector is responsible for 2,182,779 MTCO2e, constituting 29.2 percent of the county's total emissions (approximately 1.5 percent of industrial energy use is associated with wastewater treatment). On-road transportation from both gasoline and diesel passenger and freight vehicles resulted in 26 percent of emissions, or 2,182,779 MTCO2e in the inventory year. Residential and commercial energy are the third and fourth highest emitting sectors, respectively. With 144,918 MTCO2e from the former and 1,338,506 MTCO2e from the latter. Agricultural, or AFOLU, emissions totalled 759,021 MTCO2e. It must be noted that included in this number are the carbon sequestration data: the 368,713 MTCO2e that Lancaster County forests and tree canopies removed was subtracted from the total tonnage of agricultural emissions. Emissions from solid waste contributed, but with significantly less input than the other sources: 225,674 MTCO2e.

Figure 3. Lancaster County Sector Breakdown



The following table provides a more detailed breakdown of the sources of greenhouse gas emissions.

| SECTOR | SOURCE | USAGE | USAGE UNIT | EMISSIONS (MTCO2e) |
|---|---|---|---|---|
| Residential Energy | Grid Electricity | 2,363,420,026 | kWh | 1,016,289 |
| | Natural Gas | 56,075,376 | Therms | 298,245 |
| | LPG | 15,551,055 | Gallons | 90,953 |
| | Wood | 1,579,981 | MMBtu | 15,738 |
| | Kerosene | 312,955 | MMBtu | 23,693 |
| **RESIDENTIAL ENERGY TOTAL: 1,444,918 MTCO2e** | | | | |
| Commercial Energy | Grid Electricity | 2,302,007,050 | kWh | 989,881 |
| | Natural Gas | 40,509,911 | Therms | 215,458 |
| | LPG | 3,861,396 | Gallons | 22,584 |
| | Kerosene | 56,448 | Gallons | 577 |
| | Distilate Fuel Oil | 6,336,920 | Gallons | 65,112 |
| | Gasoline | 5,076,792 | Gallons | 44,895 |
| **COMMERCIAL ENERGY TOTAL: 1,338,507 MTCO2e** | | | | |
| Industrial energy | Grid Electricity | 1,731,329,944 | kWh | 744,485 |
| | Natural Gas | 137,568,729 | Therms | 730,139 |
| | LPG | 15,790,824 | Gallons | 92,046 |
| | Gasoline | 4,349,688 | Gallons | 38,343 |
| | Kerosene | 61,092,696 | Gallons | 622,516 |
| | Residual Fuel Oil No. 6 | 76,000 | Gallons | 859 |
| | Distilate Fuel Oil No. 2 | 21,482,832 | Gallons | 220,074 |
| **INDUSTRIAL ENERGY TOTAL: 2,448,462 MTCO2e** | | | | |
| On- Road Transportation | Gasoline | 4,178,098,985 | VMT | 1,717,027 |
| | Diesel | 317,655,655 | VMT | 465,752 |
| **TRANSPORTATION TOTAL: 2,182,779 MTCO2e** | | | | |

Table 1: Emissions and Removals by Source

| SECTOR | SOURCE | USAGE | USAGE UNIT | EMISSIONS (MTCO2e) |
|---|---|---|---|---|
| Agriculture | Enteric Fermentation of Livestock | NA | NA | 629,000 |
| | Manure Management | NA | NA | 498,734 |
| | CO2 Removals | NA | NA | (368,713) |
| **AGRICULTURE, LAND USE, FORESTRY TOTAL: 759,021 MTCO2e** | | | | |
| Solid Waste | Landfilled | 362,404 | Tons | 93,575 |
| | Waste Composted | 40,702 | Tons | 1,685 |
| | Combustion of Solid Waste | 364,744 | Short Tons | 126,424 |
| | Waste Transportation | 250,977 | Wet Short Tons | 3,991 |
| **SOLID WASTE TOTAL: 225,675 MTCO2e** | | | | |
| On-Road Transportation | Gasoline | 4,178,098,985 | VMT | 1,717,027 |
| | Diesel | 317,655,655 | VMT | 465,752 |
| **TRANSPORTATION TOTAL: 2,182,799 MTCO2e** | | | | |

Table 2: Emissions and Removals by Source

# The Economic Impact

In 2018, approximately 10.5 million metric tons of carbon dioxide equivalents entered the atmosphere from Lancaster County alone. This, it is simple to understand, is no small amount. At the same time, the authors have found that these numbers and units can be difficult to conceptualize. And if we are unable to internalize the gravity of these sums, then they don't end up meaning much to us.

With that in mind, we converted emissions into something that is easier to comprehend: money. We used the above fuel amounts to calculate approximate costs of emissions per sector. Broken down by sector, Lancaster County spent the most on Transportation, approximately $801,326,086. Industrial Energy came next with $555,528,002 in fuel costs. Commercial Energy and Residential Energy were similar in cost, with the $351,213,375 spent on the former and $358,514,998 on the latter. Taken together, Lancaster residents and businesses spent over $2 billion in 2018 on fossil fuels. Without local mining or extraction industries, nearly all of this money is leaving the county.

| Residential Energy | | | | |
|---|---|---|---|---|
| **Name** | **Fuel Type** | **Value** | **Units** | **Fuel Cost** |
| Stationary Fuel Combustion - LPG - Residential Emissions | LPG | 15,551,055 | Gallons | $39,421,924 |
| Stationary Fuel Combustion - Wood - Residential Emissions | Skipped | | | |
| Grid Electricity - Residential Emissions | Electricity | 2,363,420,026 | kWh | $307,244,603 |
| Stationary Fuel Combustion - Natural Gas - Residential Emissions | Natural Gas | 56,075,376 | therms | $10,878,623 |
| Stationary Fuel Combustion - Kerosene - Residential Emissions | Kerosene | 312,955 | MMBtu | $969,848 |
| | | | **Total Cost** | $358,514,998 |

| Commercial Energy | | | | |
|---|---|---|---|---|
| **Name** | **Fuel Type** | **Value** | **Units** | |
| Grid Electricity - Commercial Emissions | Electricity | 2,302,007,050 | kWh | $299,260,917 |
| Stationary Fuel Combustion - Natural Gas - Commercial Emissions | Natural Gas | 40,509,911 | therms | $7,858,923 |
| Stationary Fuel Combustion - LPG - Commercial Emissions | LPG | 3,861,396 | Gallons | $9,788,639 |
| Stationary Fuel Combustion - Distilate Fuel Oil - Commercial Emissions | Distillate Fuel Oil No. 2 | 6,336,920 | Gallons | $17,762,387 |
| Stationary Fuel Combustion - Gasoline - Commercial Emissions | Gasoline | 5,076,792 | Gallons | $16,367,577 |
| Stationary Fuel Combustion - Kerosene - Commercial Emissions | Kerosene | 56,448 | Gallons | $174,932 |
| | | | **Total Cost** | $351,213,375 |

| Industrial Energy | | | | |
|---|---|---|---|---|
| **Name** | **Fuel Type** | **Value** | **Units** | |
| Stationary Fuel Combustion - Gasoline - Industrial Emissions | Gasoline | 4,349,688 | Gallons | $14,023,394 |
| Stationary Fuel Combustion - LPG - Industrial Emissions | LPG | 15,790,824 | Gallons | $40,029,739 |
| Stationary Fuel Combustion - Natural Gas - Industrial Emissions | Natural Gas | 137,568,729 | Therms | $26,688,333 |
| Stationary Fuel Combustion - Kerosene - Industrial Emissions | Kerosene | 61,092,696 | Gallons | $189,326,265 |
| Stationary Fuel Combustion - Residual Fuel Oil No. 6 - Industrial Emissions | Residual Fuel Oil No. 6 | 76,000 | Gallons | $171,000 |
| Grid Electricity - Industrial emissions | Electricity | 1,731,329,944 | kWh | $225,072,893 |
| Stationary Fuel Combustion - Distillate Fuel Oil No 2 - Industrial Emissions | Distillate Fuel Oil No. 2 | 21,482,832 | Gallons | 60216378.1 |
| | | | **Total Cost** | $555,528,002 |

| Transportation | | | | |
|---|---|---|---|---|
| **Name** | **Fuel Type** | **Value** | **Units** | **Fuel Cost** |
| Gasoline Fossil Fuel Energy Equivalent (Calulated result in Clearpath) | Gasoline | 24,230,000 | MMBTU | |
| Gasoline Gallons | Gasoline | 208,717,374 | Gallons | $672,904,815 |
| Diesel Fossil Fuel Energy Equivalent (Calculated result in Clearpath) | Diesel | 6,294,200 | MMBTU | |
| Diesel Gallons | Diesel | 45,815,651 | Gallons | $128,421,271 |
| | | | **Total Cost** | $801,326,086 |
| | | | **Total Annual Fuel Cost** | $2,066,582,461 |

| Estimated Fuel Costs | | |
|---|---|---|
| **Fuel Type** | **Value** | **Units** |
| LPG | **2.535** | $/Gallon |
| Electricity | **0.13** | $/kWh |
| Natural Gas | **0.194** | $/therm |
| Kerosene | **3.099** | $/gallon |
| Distillate Fuel Oil No. 2 | **2.803** | $/gallon |
| Gasoline | **3.224** | $/gallon |
| Residual Fuel Oil No. 6 | **2.25** | $/gallon |

Table 3: Fuel Costs by Sector

# Opportunities for Emissions Reduction

This inventory and report are intended to help Lancaster County develop a Climate Action Plan (CAP). While the GHG inventory details where we currently stand, the CAP outlines where we are going. It's a set of steps and recommendations that the county and its residents can take to reduce emissions, sequester carbon, and reach carbon neutrality. This section is not intended to function as a CAP, as the solutions have not yet been adopted by Lancaster County. Rather, the authors of this report hope that our suggestions will aid the eventual development of a county-wide CAP, and, in the meantime community members, businesses and institutions a template for personal climate action

Ridesharing, and the expansion of bike lanes, electric vehicle charging stations, and rural and urban public transportation

District heating, refrigerant management, solar photovoltaics, geothermal energy, insulation, low-flow fixtures, heat pumps, LED lighting refrigerant management, solar photovoltaics, geothermal, insulation, low-flow fixtures, heat pumps, led lighting, alternative cement, wind turbines

Reducing food waste, composting what can’t be eaten, and altering consumption patterns; for those who have the means, consider buying goods of higher quality to avoid the need to constantly replace items

Implementing regenerative agriculture practices such as silvopasture, tree intercropping, managed grazing, multistrata agroforestry, and methane digesters; eating and promoting plant-rich diets

# Challenges and Limitations

As is the case with any greenhouse gas inventory, this report's results are in no way comprehensive. Readers should assume that emissions are greater than what is noted in this report.

- In the absence of local data, we referred to national sources in the following instances:

    - Our electricity provider, PPL, did not have site specific factor sets. However, PPL Electric operates within PJM Interconnection whose system average GHG emissions factor for 2018 was 948lbs CO2/MWh. We referred to that factor, and eGrid averages for N20 and CH4 for our factor sets in ClearPath

    - We estimated the number of gas and diesel trucks in Lancaster County based on the percentage of trucks of each fuel type in the United States

    - A number of wastewater treatment plants were unresponsive when we requested data. In the absence of comprehensive data on water treatment and wastewater management our team averaged the energy use data that we did receive (from about 40 percent of plants in the county), and applied that average to the remainder of the population served by the unresponsive plants.

- Sources of greenhouse gas emissions that went unmeasured:

    - Had we had more time and expansive resources, we would have measured Scope 3 emissions, the community's consumer-based emissions. Readers should note that our consumption of food, goods and services, as well as forms of travel not included in this inventory also contribute greatly to climate change.

    - Our data on carbon sequestration remains limited to forests in the county

# Conclusion

Necessary approximations in our calculations notwithstanding, this analysis found that Lancaster County as a whole was responsible for emitting an estimated 10,582,141 MTCO2e in 2018. Emissions from the industrial energy sector contributed the most to this total, followed closely by transportation and commercial energy. That being said, targeted action to decrease emissions from *all* of the measured categories will be imperative as the decade progresses.

This report marks the first step on a journey to net-zero GHG emissions. The primary purpose of establishing Lancaster County's net GHG emissions baseline is to inform the development of the Climate Action Plan (CAP). Our county's CAP will outline measurable steps that the local government, community partners, and individuals can take to lower our collective carbon footprint.

In accordance with international efforts set in place by the Paris Climate Agreement of 2015, we recommend that Lancaster County aim to cut GHG emissions in half by 2030. By 2050, the county must be carbon neutral. We emit over ten million metric tons of CO2e in the atmosphere annually. Reducing these emissions is necessary, and possible if we work together.

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Pg 19: https://www.lancompo.org/atp

# Appendix A

**Residential Energy**

I. **Grid Electricity:**
Electricity use data was provided by PPL Electric. We received this data in the form of the total number of kWh purchased within county boundaries in 2018. PPL did not supply our team with an emissions factor. However, PPL Electric operates within PJM Interconnection whose system average GHG emissions factor for 2018 was 948lbs CO2/MWh. *https://www.pjm.com/-/media/library/reportsnotices/special-reports/20180315-2017-emissions-report.ashx?la=en* We applied that emissions factor to our PPL data. We gathered the remaining factor sets from eGRID values, included in preloaded factor sets in ClearPath: CH4 lbs/GWh: .05 and N20 lbs/GWh: .009

II. **Natural Gas:**
Data was provided directly from UGI in the form of the total number of therms purchased within county lines. Emissions factors for the combustion of natural gas are standardized and included in preloaded factor sets in ClearPath.

III. **Non-natural gas:**
To determine emissions from all heating sources besides electricity, we first had to obtain the number of housing units using each fuel type from the US census' factfinder function, by searching for Lancaster County "house heating fuel" in 2018.

Next, we obtained the total statewide usage of each fuel type in 2019 from the EIA. And, using the US census' factfinder function, determined the number of housing units statewide.

Now that we had the total number of housing units using each fuel type for both Lancaster and the state of Pennsylvania, as well as statewide usage of each fuel type, we could create a ratio to estimate Lancaster County usage per household. And finally, total community heating fuels data for each heating source.

This total (for each of the heating fuel sources) was then entered into ICLEI's ClearPath calculator to convert the amount of fuel used into GHG emissions.

**Commercial Energy**

I. **Grid Electricity:** *See Residential Energy*

II. **Natural Gas:** *See Residential Energy*

III. **Non-natural gas:**

We used data from the PA and Lancaster County census to calculate the percentage of statewide commercial establishments that are in the county (excluding those dedicated to manufacturing): https://www.census.gov/quickfacts/fact/table/lancastercountypennsylvania,PA/PST045219.

Next, we applied that percentage to statewide fuel usage by type to calculate county-wide commercial fuel usage for each of the heating fuel sources. https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_use/com/use_com_PA.html&sid=PA

This total was then entered into ICLEI's Clearpath calculator to convert the amount of fuel used into GHG emissions.

**Industrial Energy**

We calculated the percentage of statewide manufacturing establishments that exist in Lancaster County using Census Table EC1700BASIC:

Total manufacturing establishments in PA: 13537
Total manufacturing establishments in Lancaster County: 923

Next we applied that scaling factor to statewide fuel usage by type to calculate county-wide industrial fuel usage. https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_use/ind/use_ind_PA.html&sid=PA

**On-Road Transportation**

We received PennDot's data on daily Vehicle Miles Traveled (VMT) for passenger vehicles: 12,317,136. To determine the annual VMT, we multiplied the sum by 365: 4,495,754,640 annual VMT.

After establishing annual VMT our team used PennDot's data on car registration in Lancaster County(http://www.dot.state.pa.us/public/dvspubsforms/BMV/Registration%20Reports/ReportofRegistration2018.pdf ) to determine the percentage makeup of each vehicle category registered in the county: 67.42 percent passenger vehicles, 4.08 percent motorcycles, 21.55 percent light truck, 6.95 percent heavy truck. We then applied those factors to the annual VMT to determine the annual VMT by each vehicle type.

Next we determined the percent of each vehicle type using diesel and gas using ICLEI's models:

| | |
|---|---|
| Heavy truck (diesel) | 85.42% |
| Heavy truck (gas) | 14.58% |
| Light truck (diesel) | 3.86% |
| Light truck (gas) | 96.14% |
| Passenger vehicle (diesel) | 0.43% |
| Passenger vehicle (gas) | 99.57% |
| Motorcycles (diesel) | 0.00% |
| Motorcycles (gas) | 100.00% |

We applied those percentages to the VMT for each respective vehicle category to estimate the VMT associated with each fuel type per vehicle category. We then summed the gas VMT from all of the vehicle categories to determine the total gas VMT, and did the same for diesel. Using those numbers, we calculated the percent of VMT associated with each vehicle type.

**Solid Waste**

Collection and Transportation

Combustion

Landfills

Composting

**Water and Wastewater**

To determine emissions associated with Waste and Wastewater, we relied on data provided by NWLCA, Lititz Sewage Treatment Plant, and Salisbury WTP.

**AFLOU**

To calculate emissions from the agricultural sector, we utilized the EPA's Agricultural Module State Inventory tool. First, we gathered information on the county's livestock populations from the National Agricultural Statistics Service (NASS). We then plugged the number of dairy cows, beef cows, steer-stockers, turkeys, broilers, sheep, goats, horses, and swine into the tool to calculate emissions from enteric fermentation. The tool comes populated with emissions factors by state, and converts the units to CO2

equivalents. Given the absence of an agricultural calculator on ICLEI's ClearPath tool, we plugged the total number of metric tons of CO2e emitted directly into ClearPath.

To determine emissions from manure management, our approach was similar, but with a few extra steps. We relied on preloaded emissions factors for manure management, and of course kept the number of livestock consistent with the enteric fermentation calculations. The tool calculates CH4 and N20 emissions from manure management on separate sheets. So after we had data on those emissions, we converted them into CO2e using the EPA's carbon equivalent calculator, summed the two totals, and again, entered the sum directly into ClearPath.