City of Terre Haute
Greenhouse Gas Inventory Report

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[1] Image Source: https://indianapublicmedia.org/wpimages/digital1229/2018/03/The-Haute-header.jpg

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Michigan City Inventory of Community Greenhouse Gas Emissions

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Introduction

In 2020, a group of sustainability-minded kids came together to form EARTHlings, a youth environmentalist group in Terre Haute, Indiana. The acronym 'EARTH' in the name stands for 'Environmental Activists for a Resilient Terre Haute'. This group had a simple mission: to make a positive difference in their community by promoting sustainability and climate change awareness. Aided by environmental leaders such as Jim Poyser from Earth Charter Indiana and Shikha Bhattacharyya from reTHink, Inc., EARTHlings decided to pass a climate change resolution in Terre Haute. They approached the Mayor and City Council for help and were blessed to receive enormous support from both parties. After months of hard work, EARTHlings were able to present their climate change resolution on August 5, 2021. This bill was sponsored by 6 city council members and was passed by a vote of 7:1. With this motion passing, Terre Haute became the 10th city in Indiana to pass a climate change resolution.

In the resolution, the first section clearly outlined that the City of Terre Haute would acknowledge the threat of climate change and treat the climate crisis as an emergency. The second section outlines the creation of a Sustainability Commission composed of local leaders and community representatives. This section also ensured the appointment of a Sustainability Coordinator, which would lead the Sustainability Commission. The third section noted the Sustainability Commission's major task, which is to use data from the Resiliency Cohort's Greenhouse Gas Inventory (in partnership with Indiana State University) to create the Resilient Terre Haute Climate Action Plan. The fourth through eighth sections of the resolution outlined further steps regarding the Resilient Terre Haute Climate Action Plan and additional tasks for the Sustainability Commission.

As noted in the third section of the Climate Change Resolution, the Resilient Terre Haute Climate Action Plan will be based on data found in the Greenhouse Gas Inventory carried out through ISU and the Resiliency Cohort. This report will analyze the data from the inventory to aid the Sustainability Commission in crafting the climate action plan.

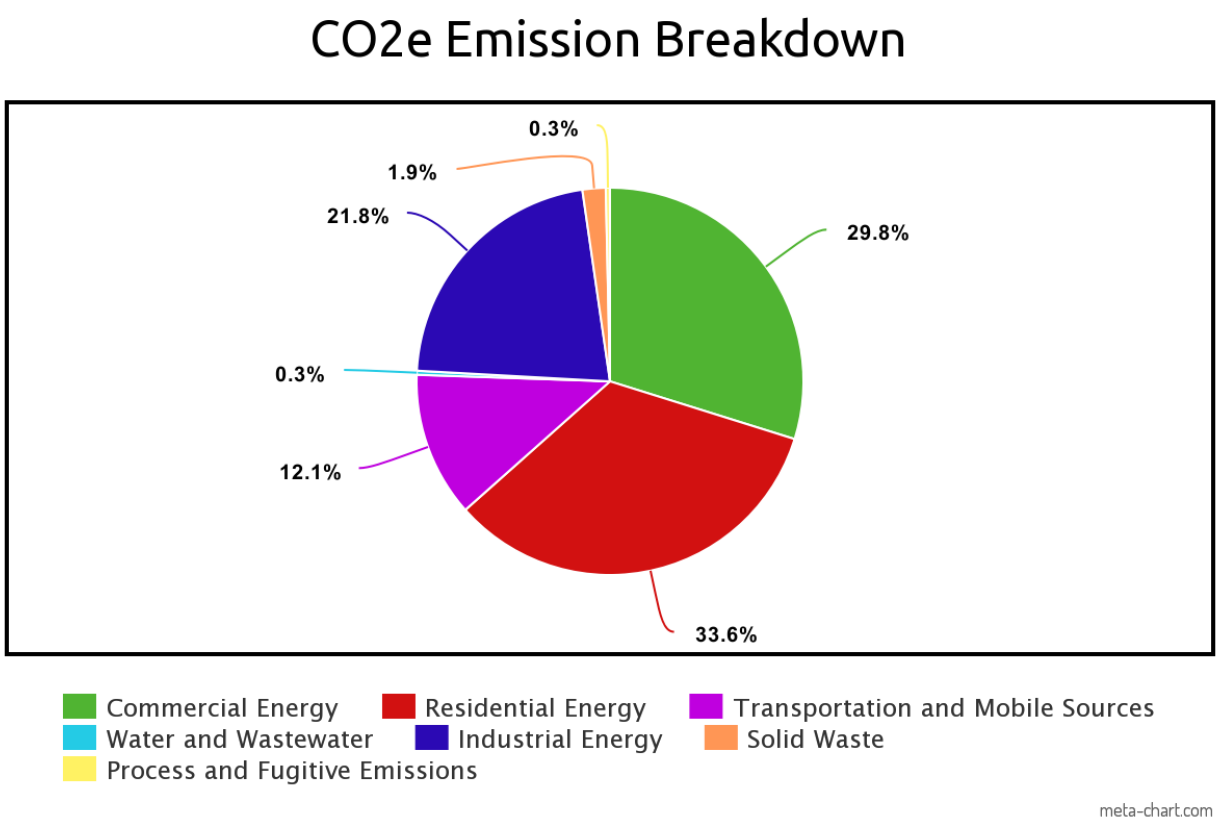
Executive Summary

As per the Climate Change Resolution, the Sustainability Commission will use data from the Greenhouse Gas Inventory to craft the Resilient Terre Haute Climate Action Plan. The Resiliency Cohort arranged the Greenhouse Gas Inventory which was carried out by Indiana State University's Office of Sustainability. The inventory collected data from 2019, and the results were published in 2022. This report is designed to convey the data from the inventory to the public in a simple, easily comprehensible format. Additionally, it will be used to help the Sustainability Commission in its various tasks and also serve as the foundation for the Resilient Terre Haute Climate Action Plan.

Key Findings

The Greenhouse Gas Inventory measured data in metric tons for CO2, CH4, and N2O. For the sake of clarity and simplicity, all numerical values in this report will be in CO2e. CO2e converts all the greenhouse gas emissions (that were measured in the inventory) into the equivalent amount of carbon dioxide, which means that CO2e can represent emissions for all three greenhouse gasses that were included in the Greenhouse Gas Inventory. The results of the Greenhouse Gas inventory show that the greatest source of CO2e emissions for Terre Haute in 2019 was Residential Energy, with the next two largest sources being Commercial Energy and Industrial Energy. For the percent distribution of emissions from different sources, see *Figure 1*.

Figure 1: Emissions Breakdown Based on Categories in the Greenhouse Gas Inventory



Next Steps

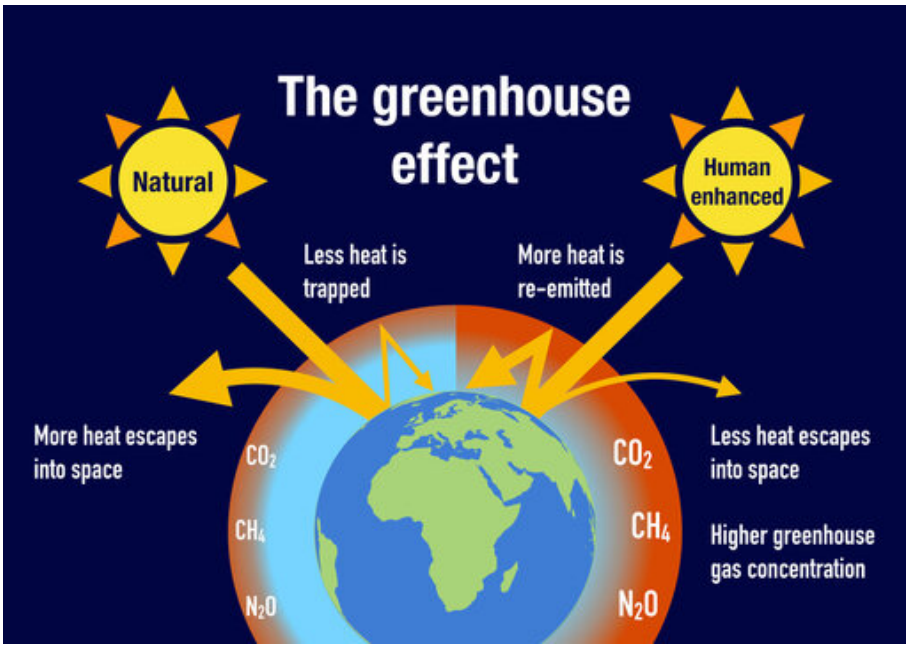
Terre Haute's Sustainability Commission will use the results from the Greenhouse Gas Inventory and the analysis from this report to craft the Resilient Terre Haute Climate Action Plan. The Sustainability Commission will focus on the largest sources of emissions when designing methods to reduce emissions, and will thus put more attention on reducing emissions from residential, commercial, and industrial energy sources. This report will also outline some simple methods for reducing emissions throughout all the measured categories, which the Sustainability Commission can draw on for ideas and inspiration when designing the Resilient Terre Haute Climate Action Plan.

Understanding Climate Change

Greenhouse Gasses

A greenhouse gas (GHG) is a gas with a complex structure that can absorb and radiate heat. Some examples of these gasses are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). These gasses are necessary, as they are what enable our planet to have a suitable temperature to sustain life. Under normal circumstances, GHGs can trap some of the sun's heat and radiate it back to the earth, which keeps our planet at a sort of "Goldilocks" temperature that is just right. This natural phenomenon of GHGs trapping heat in the earth's atmosphere is known as the Greenhouse Effect. However, when too many GHGs are present in the atmosphere, too much heat is trapped. This results in the earth's surface and lower atmosphere temperatures increasing.

Figure 2: An Explanation of the Greenhouse Effect



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[2] Image Source: https://t3.ftcdn.net/jpg/03/84/88/34/360_F_384883425_ZlOehcrKZm3Snaig2zUVnJKoB2Lm49yU.jpg

Global Warming and Anthropogenic Climate Change

Since the Industrial Revolution began, the amount of GHGs in our atmosphere has increased dramatically. This occurred through the overuse of fossil fuels such as coal, which release carbon dioxide and other GHGs when burned for fuel. Increasing the amount of GHGs in our atmosphere further enhanced the greenhouse effect, leading to more heat being trapped and the earth's temperature rising. This trend of global temperature increase due to high greenhouse gas concentrations in the atmosphere is known as global warming.

Although global warming and climate change are often used interchangeably, there is a distinction between the two terms. Global warming specifically deals with a gradual increase in temperature due to GHGs, while climate change refers to long-term change in weather patterns - which includes temperature, precipitation, and wind patterns. Therefore, global warming is one aspect of climate change. Climate change also happens naturally as well, such as shifts in and out of ice ages. To better label the current type of climate change, scientists use the term anthropogenic (human-caused) climate change. This includes global warming but also encompasses related effects such as melting glaciers, increased droughts, and more severe weather.

Evidence and Global Impacts

Climate change is real and is caused by humans - that is a fact. According to a survey done by Cornell University, "more than 99.9% of peer-reviewed scientific papers agree that climate change is mainly caused by humans."[3] In the article publishing these findings, the authors of the study note the need for public and political unity over anthropogenic climate change and stress the need to come up with solutions to the climate change problem.

There is much work being done by scientists to study the impacts of climate change and identify the steps that must be taken to avert it. One of the largest and most comprehensive such studies is done by the IPCC - Intergovernmental Panel on Climate Change. This body is a part of the United Nations and its Sixth Assessment has produced three reports pertaining respectively to the science behind climate change, the impacts of climate change, and methods of combating climate change.

[3] https://news.cornell.edu/stories/2021/10/more-999-studies-agree-humans-caused-climate-change

The Sixth Assessment's first report was published in August 2021 and served as a wake-up call to the dangers of climate change. Some worrying facts from the report include: 2019 had the highest CO2 concentrations for at least 2 million years, temperatures in the last decade (2011-2020) were higher than the previous warm period, and the global sea level is rising at the fastest rate in over 3,000 years. In the words of UN secretary-general Antonio Guterres, these facts come together in "a code red for humanity."[4]

The Sixth Assessment's second report came in February 2022 and provided harrowing facts about the catastrophic impacts that climate change could have. For decades, scientists have warned about keeping global warming levels to less than 1.5℃ above pre-industrial levels, and this is also the benchmark set in the Paris Climate Accords. However, out of 5 projected scenarios regarding emissions reductions, only the lowest emission scenario would result in reaching the goal of staying under 1.5℃ of warming. The projected increase of more than 1.5℃ would be catastrophic. At only 2℃ of warming, up to 18% of all land animals would face extinction. Ecosystems such as coral reefs are already seriously degrading, and this would only get worse with more warming. Places that store GHGs such as permafrost and forests could also release those gasses due to more warming, resulting in a positive feedback loop that would result in more GHG emissions, which is certainly a negative for the earth. In addition to just having environmental effects, people will be harmed by further temperature increases. Global warming and sea levels rising will impact coastal communities, and at the same time, "up to 3 billion people will face water scarcity" at an increase of 2℃.[5]

Climate Change Graphs

[4] https://news.un.org/en/story/2021/08/1097362
[5] https://www.cnn.com/2022/02/28/world/un-ipcc-climate-report-adaptation-impacts/index.html

Figure 3: Global Temperature Increase from Common Baseline

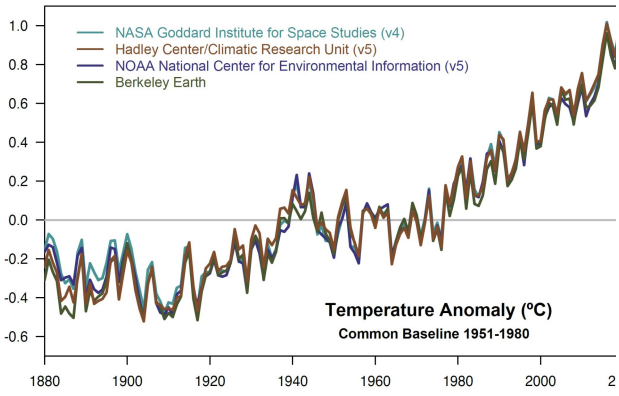

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Figure 4: Comparison of Historical and Current CO2 Levels

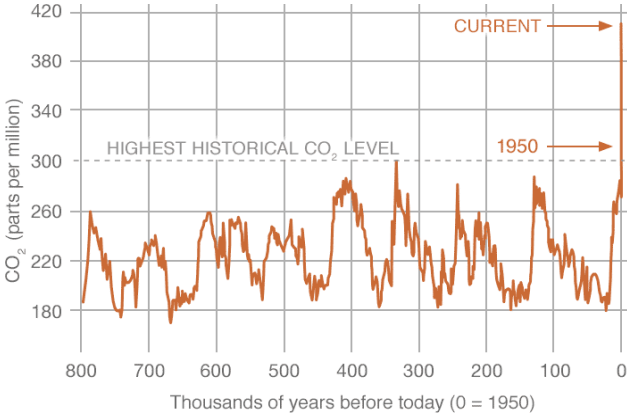

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Figure 5: Rise in Sea Level in Recent Decades

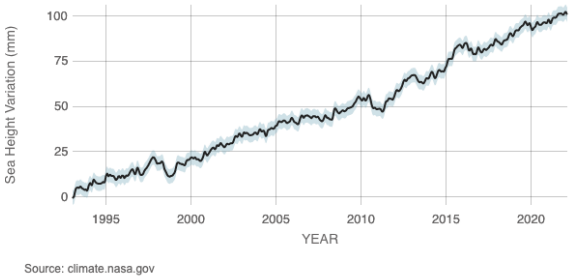

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Figure 3 shows the general upward trend in temperature since the year 1890. The common baseline was from 1951-1980 and the temperature has risen more than 1℃ since that time. *Figure 4* shows the normal cycle of CO2 levels in the atmosphere fluctuating between 180 and 300 ppm. A dramatic increase since 1950 when the concentrations skyrocketed to more than 400 ppm. *Figure 5* shows the steady sea level rise that occurred over the past 25 years.

6 https://www.nasa.gov/press-release/2020-tied-for-warmest-year-on-record-nasa-analysis-shows/

7 https://climate.nasa.gov/vital-signs/carbon-dioxide/

8 https://climate.nasa.gov/vital-signs/sea-level/

Local Impacts and Action

The IPCC's reports are harsh, and worrying, and paint a bleak picture of what the world will be if climate change remains unchecked. However, it is also important to note the local effects of climate change, as these are what will be felt by the community. Purdue University has created the Indiana Climate Change Impacts Assessment, which is a very useful source for seeing how climate change will impact Indiana specifically.

Indiana has already warmed 1.2℉ (.7℃) since 1895 and this temperature increase is projected to reach over 5℉ by mid-century. Additionally, the number of extremely hot days in Indiana will increase while the number of cold-weather events will decrease. This is significant because rising temperatures negatively affect farming, improve conditions for pests and invasive species, and pose a greater threat of heat-related illness for humans. Additionally, the average precipitation in Indiana has increased by about 5.6 inches. The western and southern areas of the state received more precipitation, with Terre Haute being located in an area where precipitation increased by about 6.5 inches. Most of this precipitation change happened in the spring, with summers and falls actually being drier. Additionally, snow will gradually shift to rain. This trend of wetter springs and winters is only projected to increase. This is troubling news for Terre Haute in particular. With increased precipitation comes a greater chance of flooding, which is a big problem for a city on the Wabash River. This flooding will impact farming and can also cause sanitation issues, which could affect public health.[9]

Overall, the projected impacts of climate change will have considerable effects on Terre Haute. More heat and precipitation will negatively impact both public health and the economy (through farming). However, there is still hope in curbing climate change and its associated consequences. The IPCC's third report deals with ways to reduce global warming and climate change. Combining these methods with data from the Greenhouse Gas Inventory will provide the best solutions that Terre Haute can take to combat climate change. Eventually, Terre Haute's Sustainability Commission will take the data analysis and possible solutions in this report to create the Resilient Terre Haute Climate Action Plan.

[9] https://ag.purdue.edu/indianaclimate/indiana-climate-report

Conducting the Inventory

What is a Greenhouse Gas Inventory?

A greenhouse gas inventory is a list of emission sources with a breakdown of quantities for each source. The inventory measures the emissions of different greenhouse gasses, namely carbon dioxide, methane, nitrous oxide, and water vapor. It can also show the results in carbon dioxide equivalent, which essentially combines the different GHGs into a single emission source by converting the emission values to that of CO2. A GHG inventory for a city (Terre Haute) follows the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). The GPC provides the standards and tools necessary for a city to perform the GHG Inventory, set reduction targets, and track its performance.

Methodology

The first step in conducting the GHG inventory was to define a specific study area. The jurisdiction was the City of Terre Haute's borders. The base year - the first year data was collected - was determined to be 2019, because it was the last year unaffected by the COVID-19 pandemic. The second step in conducting the inventory was identifying contacts from which to collect data. The main contacts were Duke Energy, Centerpoint, Terre Haute Wastewater Utility, American Water, Terre Haute Transit Utility, EIE Google estimation, and a calculator from ICLEI. The next couple of steps were to contact these entities and request data, and then wait to receive the information. The fifth step was to enter the data received from the different entities into Clearpath, from which the various emission values would be calculated. After all the calculations were completed, it was just a matter of organizing the results into the Inventory.

Quantifying Emissions Data

There are many ways to quantify emissions data, so it is important to have specific definitions behind different categorizations. One important distinction is between the different greenhouse gasses. In this inventory, emissions of CO2, CH4, and N2O were measured. However, to make the results more easily understood, the data presented in this report will be measured in CO2e, which can convert the emissions values from the

other two greenhouse gasses into that of CO2 and then combine them for a total representation of greenhouse gas emissions.

One of the most important classifications in a greenhouse gas inventory is to categorize the different sources that produce emissions. This inventory was split into 7 main sources, which are: Commercial Energy, Residential Energy, Transportation and Mobile Sources, Water and Wastewater, Industrial Energy, Solid Waste, and Process and Fugitive Emissions. For most of these major 7 sources, there are multiple smaller emissions causes, and these more specific causes are going to be important in determining where the highest and most reducible emissions come from.

Table 1: Description of the Different Sections of Emissions

SOURCE	**DESCRIPTION**
Commercial Energy* *This source includes Commercial Energy as well as Non-Residential Grid Electricity	• Data from Duke Energy and Google Environmental Insights Follower • Emissions from grid electricity and stationary fuel combustion
Residential Energy	• Data from Duke Energy and Google Environmental Insights Follower • Emissions from grid electricity and stationary fuel combustion
Transportation and Mobile Sources	• Data from Terre Haute City Transportation and EIE • Emissions from public transit and on-road transportation
Water and Wastewater	• Data from City of Terre Haute Wastewater Utility, Duke Energy, and Vectren (Centerpoint) • Emissions from wastewater treatment energy use and supply of potable water
Industrial Energy	• Data from Duke Energy • Emissions from grid electricity
Solid Waste	• Data from Vigo County Solid Waste Management • Emissions from waste generation
Process and Fugitive Emissions	• Data from Fugitive Emissions from Natural Gas Distribution • Emissions from fugitive emissions from natural gas

Inventory Results

Community Profile

A community profile is needed to understand the context behind a greenhouse gas inventory. It is especially important when the inventory results from different cities are being compared because comparing just the data values is not enough. The simplest way to have a profile for a community is to look at its population. Terre Haute's population in 2019 (the year the inventory was conducted) was approximately 60,673. Using population for comparisons is done by comparing emissions per capita (CO2e per person).

Emissions Data

Table 2: Greenhouse Gas Emissions by Source

SOURCE	GREENHOUSE GAS EMISSIONS (metric tons of CO2e)
Commercial Energy	701,110.5412
Residential Energy	790,716.6856
Transportation and Mobile Sources	284,209.6373
Water and Wastewater	7,796.8754
Industrial Energy	513,650.9267
Solid Waste	45,452.6844
Process and Fugitive Emissions	8,052.8801
TOTAL	**2,350,990.231**

Looking at the inventory results, Residential, Commercial, and Industrial Energy are the three largest sources of emissions. Therefore, these are the biggest areas to focus on when designing emission reduction plans.

Further Emissions Breakdown

In addition to simply looking at the largest emission sources, it is important to note the breakdown of what constitutes each emission source. This is significant because it shows more specific areas and how they contribute to the total emissions. Eventually, the Sustainability Commission will look at this deeper breakdown to determine which areas to focus on when designing the Resilient Terre Haute Climate Action Plan.

Figure 6: Emissions Breakdown for Commercial Energy

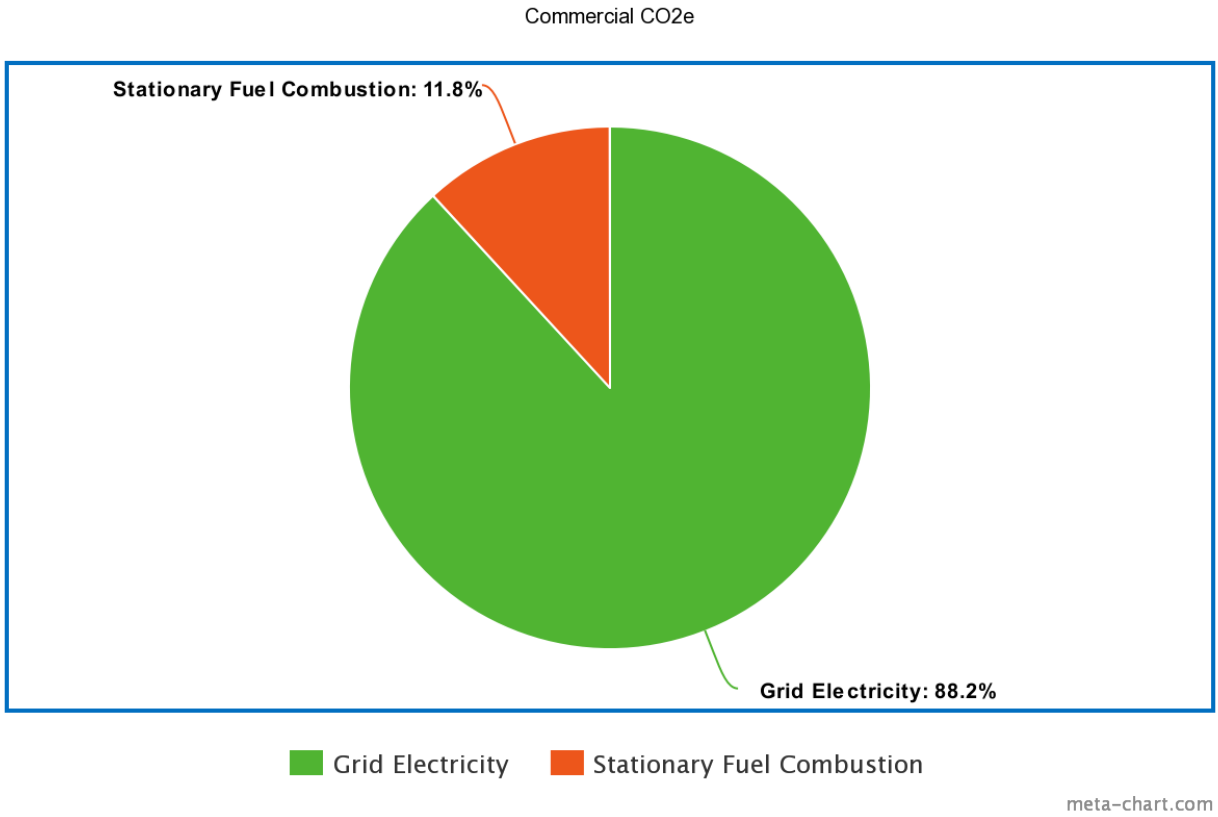


Figure 7: Emissions Breakdown for Residential Energy

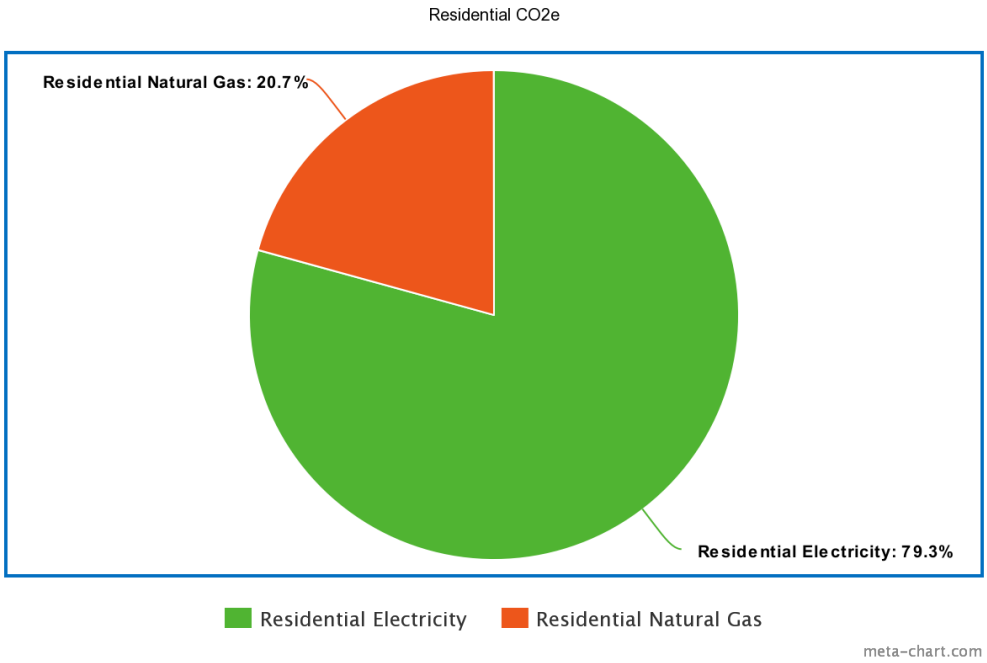


Figure 8: Emissions Breakdown for Transportation and Mobile Sources

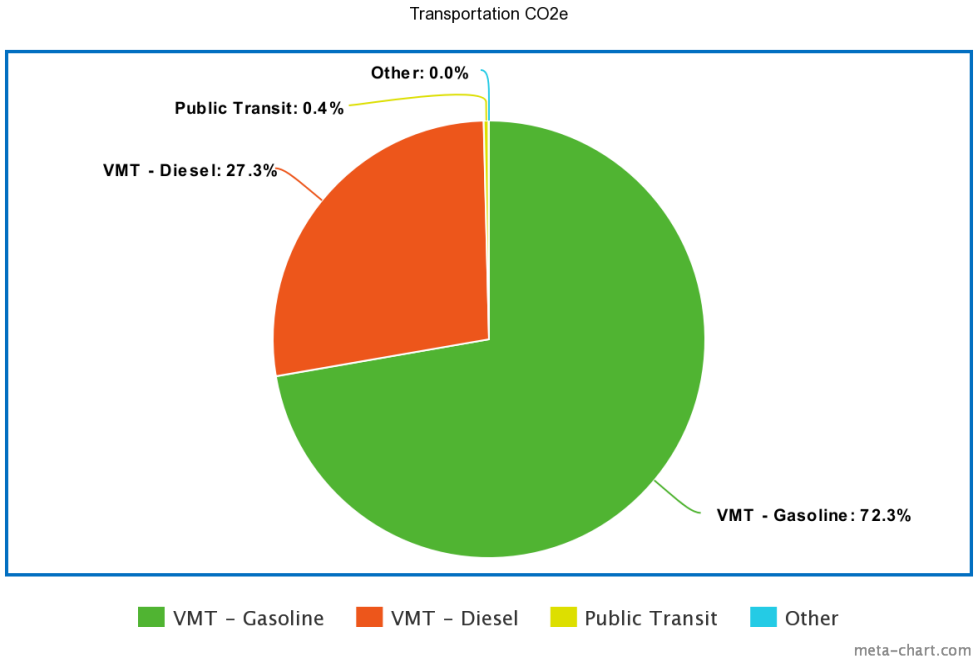
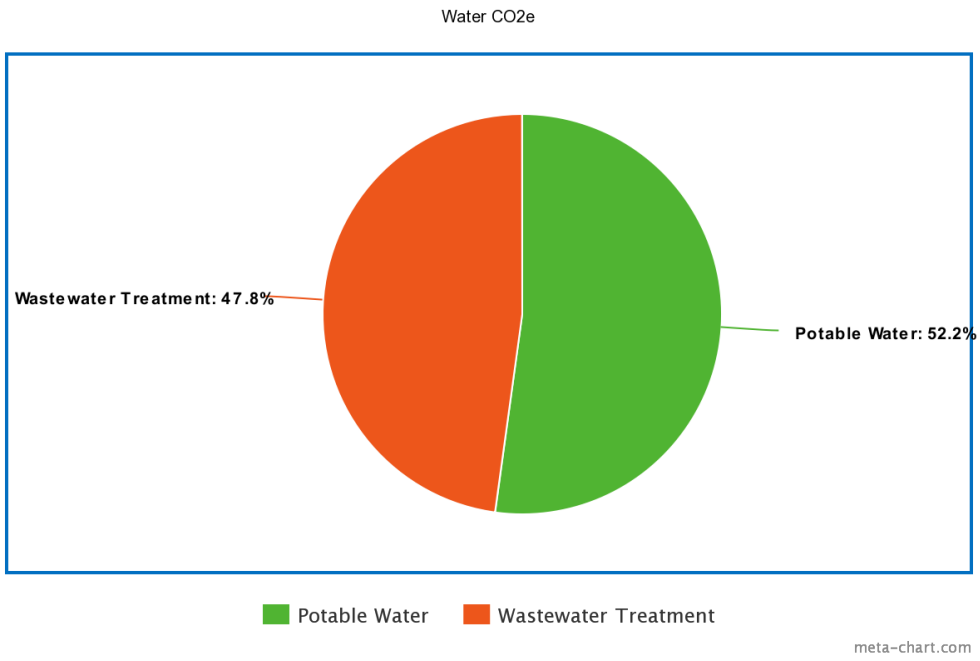


Figure 9: Emissions Breakdown for Water and Wastewater

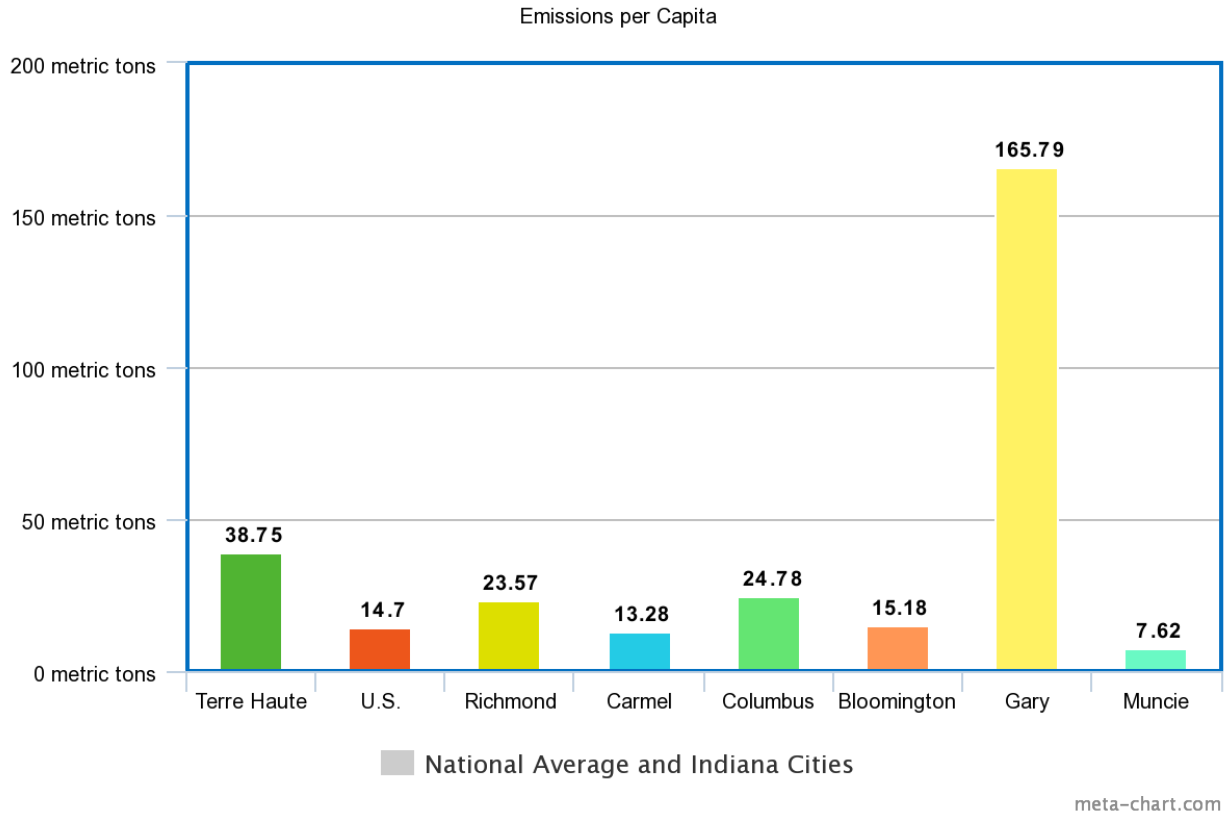


Analysis and Comparison

The data from the inventory showed that the City of Terre Haute produced 2.35 million metric tons of CO2e emissions in 2019. The three major sources of the emissions were Residential, Commercial, and Industrial Energy. But what do these facts mean? In order to understand these results, it is important to give them context. One way to do this is to compare emissions per capita, which deals with the amount of emissions produced per person. In 2019, Terre Haute had produced 2,350,990 metric tons of emissions and had a population of 60,673 people. Using this simple calculation, Terre Haute's emissions per capita for 2019 are 38.75 metric tons per person. This is worrying news, as this is well above the national average in 2019, which was 14.7 metric tons per person[10]. See *Figure 10* below for a comparison of Terre Haute's emissions per capita with other Indiana cities.

[10] https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?locations=US

Figure 10: Terre Haute vs National Average vs Other Cities Emissions per Capita[11] [12]



Looking at *Figure 10*, Terre Haute's emissions per capita are well above the national average, but also that of other Indiana cities. Gary is an exception, but that is attributed to the city's extreme industrial nature. With Terre Haute's emissions per capita being more than twice the national average, it is clear that there is definitely work to be done. As a community, Terre Haute needs to lower its emissions and work on reaching emission levels that are lower than the national average.

11 https://www.richmondindiana.gov/resources/greenhouse-gas-inventory#:~:text=Richmond's%20emissions%20are%20well%20above,tons%20of%20CO2e%20vs%2016.06

12 https://eri.iu.edu/documents/2019-resilience-cohort-results-summary-report-202004.pdf

Possible Solutions

To be able to lower its emissions, Terre Haute needs to follow a plan. The Resilient Terre Haute Climate Action Plan will be made by the Sustainability Commission and published by August 2023. The following section of this report will lay out a variety of different methods for the city to reduce emissions, in the hope that it will serve as a foundation for the solutions that will be presented in the climate action plan. These methods have been broken down by the sources used in the Greenhouse Gas Inventory and will all help to reduce emissions and/or increase awareness about climate change.

Commercial and Industrial Energy

- Implement high efficiency and low emission standards for new buildings
- Change street lights to LEDs
- Encourage use of ENERGY STAR and LEED/LEED-EBOM
- Promote grants and funding for solar power and renewable energy

Residential Energy

- Encourage residents to use renewable (solar) power
- Promote the usage of energy-efficient appliances
    - ENERGY STAR products
- Encourage individuals to access utility companies' Energy Audits of residential buildings

Transportation and Mobile Sources

- Build more EV charging locations
- Transition into hybrid/EV fleet vehicles
- Optimize public transit to meet demand
- No-idle policy/campaign
- Upgrade certain intersections with roundabouts
- Encourage biking/pedestrian traffic
    - Build and improve bike lanes and sidewalks

    - Improve bike infrastructure (electric bikes, bike parking, etc.)

Water and Wastewater

- Separate sewage and stormwater pipes
- Explore hydropower options on the Wabash River

Solid Waste

- Create an Integrated Waste Management Plan
    - Build recycling and composting programs
    - Encourage/incentivize local businesses to use more sustainable packaging (partner with reTHink)
    - Education and awareness campaign

Process and Fugitive Emissions

- Repair/prevent any leaks in the grid or due to natural gas distribution

Other Recommendations

- Overall education and awareness
    - Email newsletter from the City/Sustainability Commission
- City tree planting program
- Replace city grass with native/perennial plants
- Build and promote community gardens (partner with reTHink)
- Convert all lights in city buildings to LEDs
- Take advantage of grants and funding whenever possible

Conclusion

As per the 2021 Climate Change Resolution, Terre Haute created a Sustainability Commission and was involved in conducting a Greenhouse Gas Inventory. This inventory found that the City of Terre Haute produced 2.35 million metric tons of CO2e emissions in 2019. Additionally, Terre Haute's emissions per capita are well above the national average and other Indiana cities, meaning that an emissions reduction plan is necessary. Thankfully, as outlined in the Climate Change Resolution, the Resilient Terre Haute Climate Action Plan will be published in August 2023. This plan will use the emissions data and suggestions provided in this report to create a climate action plan that will help Terre Haute lower its emissions and become more sustainable.