2021

City of Winston-Salem Community Greenhouse Gas Emissions Inventory and Energy Report

PRESENTED BY THE OFFICE OF SUSTAINABILITY
CITY OF WINSTON-SALEM

In 2008, the City of Winston-Salem released the Local Government Action Plan and Greenhouse Gas Emissions Inventory. This plan included analysis of the greenhouse gas emissions in the Winston-Salem community. Since that report, there has not been another study continuing the work of benchmarking and analyzing greenhouse gas (GHG) emissions at a community scale.

Based on recent commitments from the local, state, and federal governments, it is important to track greenhouse gas emission changes at the community scale among different sectors. By tracking and benchmarking the level of emissions, the city will be able to set more informed reduction goals in the future and measure the impact of actions taken.

While this report covers many sources of community greenhouse gas emissions, this information is not fully comparable to peer cities' community GHG inventories due to the lack of consistency in protocols and data sources used to calculate emissions.

This report is meant as an informal summary of GHG emissions produced in the Winston-Salem community in order to identify where and how mitigation and adaptation actions are implemented to be most effective.

Background Information

Tracking greenhouse gases is an important practice for local governments to undertake. Measuring these emissions allows the city to better understand which sectors would most benefit from reduction efforts.

The following report utilizes data provided at the community level from sources that include North Carolina Southern Energy Association, Duke Energy, Google Environmental Insights Explorer Tool and the Winston-Salem/Forsyth County Utilities Department. Sectors analyzed include commercial and residential buildings and transportation emissions, emissions from wastewater treatment operations, landfill emissions, and emissions reductions opportunities through renewable energy systems.

All calculations were completed within the US Environmental Protection Agency (EPA) Local GHG Inventory Community Module Tool. According to the tool, the analysis provided is "designed to help cities evaluate and estimate greenhouse gas emissions within their communities."

While this report is created to build on the 2008 GHG Inventory and Local Action Plan, it does not consider industrial emissions, as this data was not as readily available as that from the residential, commercial and transportation sectors.

The data used in this report are from the most recent available years, which may be different depending on sector. When 2020 data was available, it is important to note that effects of COVID-19 pandemic and safer at home orders could have impacted overall emissions and caused inconsistencies and should therefore not be used as a baseline year. Because of these restrictions, the transportation sector saw the biggest changes. Worldwide emissions reductions from 2020 are estimated to be as large as 7%, significantly larger than the 1.2% reduction during the late 2000s financial crisis.

However, even with the potential decrease in emissions from 2020 worldwide, it will not be enough to avoid a temperature rise well over the 1.5-2-degree Celsius target set by the Paris Agreement. The only way to capitalize on the emissions reduction from the past year it to maintain some of the low-carbon

solutions that came from the pandemic. These solutions will be explored more in each section of this report.[1]

While most of the emissions measured and reported are carbon dioxide emissions, methane is another greenhouse gas that is important to measure due to the significant impact methane has on climate change based on its global warming potential. Even though carbon dioxide lasts longer in the atmosphere, the global warming potential from methane is 28 times more powerful than carbon dioxide on a 100-year timescale, and 80 times more powerful on a 20-year timescale[2]. So, while methane exacerbates effects of climate change to a higher degree than carbon dioxide, reducing these emissions would provide a more immediate impact as well.

The Winston-Salem/Forsyth County Utilities department measures methane production from the Archie Elledge wastewater process and the Hanes Mill landfill. The department also employs methane capture that allows that gas to be used in the respective facilities, greatly reducing the amount of gas released into the atmosphere.

Where emissions are measured in methane, the EPA Local GHG tool converted those emissions into a carbon dioxide equivalent, making those emissions more comparable to direct carbon dioxide emissions from other sectors.

[1] https://www.unep.org/news-and-stories/press-release/united-science-report-climate-change-has-not-stopped-covid19

[2] https://www.nationalgeographic.com/environment/article/methane

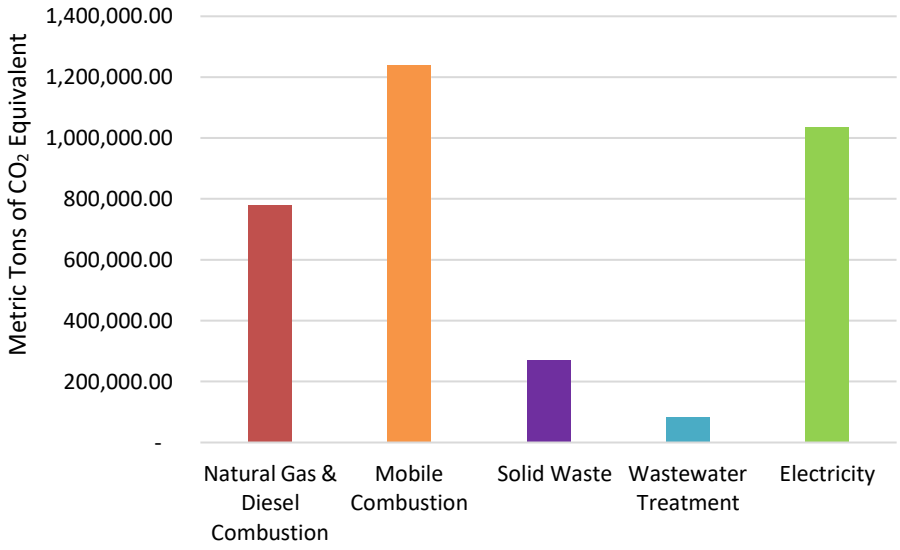
Contents

Executive Summary

This report accounts for a significant amount of greenhouse gas (GHG) emissions occurring within the City of Winston-Salem community. The data focuses on carbon dioxide and methane emissions, two of the most potent greenhouse gases. Those GHGs come from several sectors within the community including the building and transportation sectors, and Utilities' wastewater and landfill operations.

To calculate total emissions, the Office of Sustainability used the US EPA Local GHG Inventory Tool Community Module. Based on calculations by this tool, gross emissions for the City of Winston-Salem total 3,410,639 metric tons of carbon dioxide equivalent emissions (MT CO_2e).

Figure 1: Community emissions by source



As seen in Figure 1 above, emissions from electricity consumption and transportation make up a significant amount of the total emissions, about two-thirds of the total.

Broken down in another way in Table 1, residential emissions make up 63% of total emissions. This is largely due to over 98% of total transportation emissions coming from the residential sector. Residential transportation considers in-boundary trips, as well as outbound and inbound trips.

Table 1: Community emissions by sector

	Total (MT CO2e)	Percent of Total
RESIDENTIAL	2,131,781.55	63%
COMMERCIAL/INSTITUTIONAL	1,278,857.89	37%
TOTAL	**3,410,639.44**	**100%**

The largest contributor to commercial emissions is electricity use, especially when combined with natural gas and diesel use. It can be inferred that buildings, which are utilizing the energy from those sources, are therefore the likeliest sources of commercial emissions. Therefore, any efforts to reduce overall emissions would be most effective if targeted towards residential vehicle use and commercial facility electricity/energy use upgrades.

To address the commercial building sector, incentives could be offered to encourage more energy efficiency standards to be met like those of the EnergyStar or LEED programs. When compared to Durham and Greensboro, Winston-Salem has the fewest number of energy efficient certified buildings by far with only 68, compared to Durham's 158 and Greensboro's 245.

To reduce emissions from residential transportation, one solution is to implement or maintain a car-free downtown pilot program. A car-free downtown pilot program was started in Winston-Salem in 2020 in response to the COVID19 pandemic slowing economic activity in the Central Business District (CBD). The pilot programs are the Streatery and Shoppery events put on in cooperation with the Downtown Winston-Salem Partnership. While the main effort was to drive more business to downtown restaurants and retailers, limiting vehicle activity also meant reduced emissions in the CBD area. If this program was implemented in permanence, it could serve as a solution for reducing emissions in these areas, which would be especially important for the predicted population growth in the area from the residential developments by reducing air pollution in one of the most dense areas of the city.

Installing electric vehicle charging stations for public use is another solution that could lead to emissions reductions in the residential transportation sector. In Forsyth County, there were 98 new EV registrations in 2019 and 118 new EV registrations in 2020. With a total of 368 registered EVs in Forsyth County as of December 2020, the demand for public charging stations will grow as well. The city could incentivize businesses to install charging stations on their property as well as install more EV charging stations on city property as well to be used by the public.

A final solution presented in this report that would apply to both residential and commercial property is installing more renewable energy systems, such as solar PV on homes and buildings. Duke Energy currently offers rebates for residential and commercial properties installing solar PV onsite, which acts as an incentive to encourage more installations. If the full potential of solar PV was recognized, enough emissions would be prevented to almost offset those emissions completely from community electricity use.

With the residential and commercial emissions sources identified, there are also gaps in the data. One such gap is in the omission of industrial sector emissions. These emissions are not as readily available as those from the other sectors considered in this study, and solutions needed to reduce those emissions are more complicated when compared to the other sectors included in this report. Another gap is a complete and detailed study of any heat islands or areas within the community more susceptible to higher emissions and higher temperatures due to increased development and less tree canopy. Finally, a gap exists that identifies locations and capacity of any carbon sinks that may exist in the community and reduce overall emissions.

If the City of Winston-Salem is to set any further reduction goals or keep in line with those set by the state and federal governments, benchmarking community emissions data will be vital in tracking any local changes or impacts. This report will represent the baseline study of the various emissions sources and sectors and can be built upon as current data gaps get filled in.

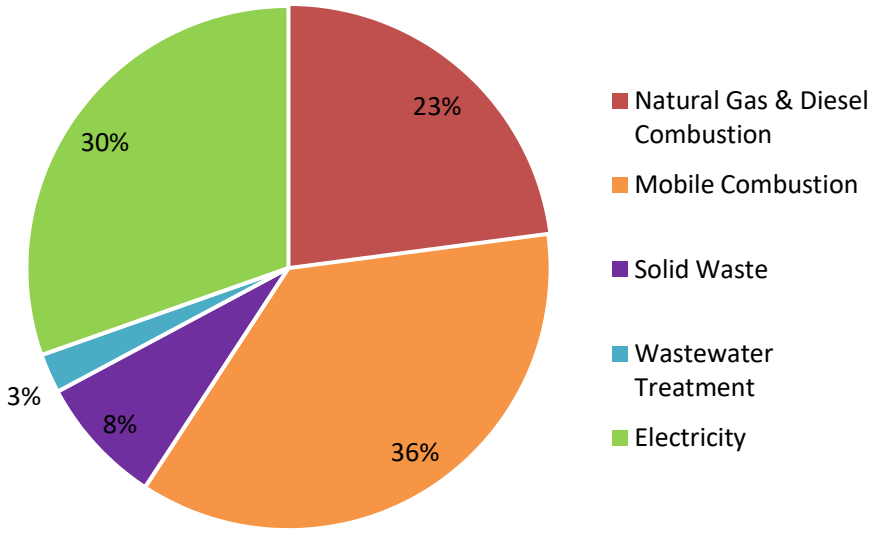
1. TOTAL EMISSIONS

According to the data presented in Table 2 and figure 2, the biggest source of emissions within the community come from electricity use and mobile combustion (transportation). This is consistent with the state and national trends of those sources accounting for a significant portion of total emissions. Combined, these sources account for two-thirds of total Winston-Salem emissions, or 2,275,160 MT CO_2e.

Table 2: Community emissions by source

SOURCE	CO2	METHANE (CH4)	N2O	TOTAL MT CO2E	% OF TOTAL
NATURAL GAS & DIESEL COMBUSTION	781,451	97.6	5.1	781,553	**22.92%**
MOBILE COMBUSTION	1,228,082	2,882	7,563	1,238,528	**36.31%**
SOLID WASTE	-	271,253	-	271,253	**7.95%**
WASTEWATER TREATMENT	-	82,673	-	82,673	**2.42%**
ELECTRICITY	1,030,591	2,322	3,718	1,036,632	**30.39%**
TOTAL EMISSIONS	**3,040,124**	**359,228**	**11,287**	**3,410,639**	**100.00%**

Figure 2: Community emissions by source



The data also shows that the solid waste operations at the landfill account for more total emissions than from wastewater treatment operations within the Utilities' department. However, these emissions account for 98.5% of all methane emissions.

The following sections provide more details about each source of greenhouse gas emissions, as well as options for emissions reductions.

2. Building Emissions

The building sector is one of the largest emitters of greenhouse gases. Through direct (from the building facility) and indirect (from electricity and natural gas use generated off-site) emissions, building emissions account for about 40% of total emissions in the United States.

The data presented in the following section was put together using building emissions data assumptions from Google Environmental Insights based on the aggregated floor space of the building by type and the consumption of the building (energy intensity). These assumptions were calculated and converted into the appropriate units and put into the EPA Local GHG Emissions Community Module Tool, which provides the data tables used in the analysis.

Residential buildings may include houses and apartments. Non-residential or Commercial/Institutional buildings may include offices, retail, warehouses, commercial and mixed-use buildings. Emissions from industrial and manufacturing facilities are not estimated separately.

2.1 Building Emissions Analysis

Based on the data presented in Table 3 and Figures 5, electricity emissions account for almost 60% of all building emissions, residential and non-residential. However, Figure 3 shows that commercial/institutional electricity emissions account for most of that usage compared to residential buildings. One reason for this may be due to the building types and sizes that are included in this sector, such as warehouses, retail and office space, and other similar commercial facilities.

Table 3: Building Emissions by Sector

SECTOR	NATURAL GAS & DIESEL EMISSIONS	ELECTRICITY EMISSIONS	TOTAL (MT CO2E)
RESIDENTIAL	474,492	438,756	**913,248**
COMMERCIAL/INSTITUTIONAL	307,061	597,876	**904,937**
TOTAL	**781,553**	**1,036,632**	**1,818,185**

Figure 3: Total Building Emissions

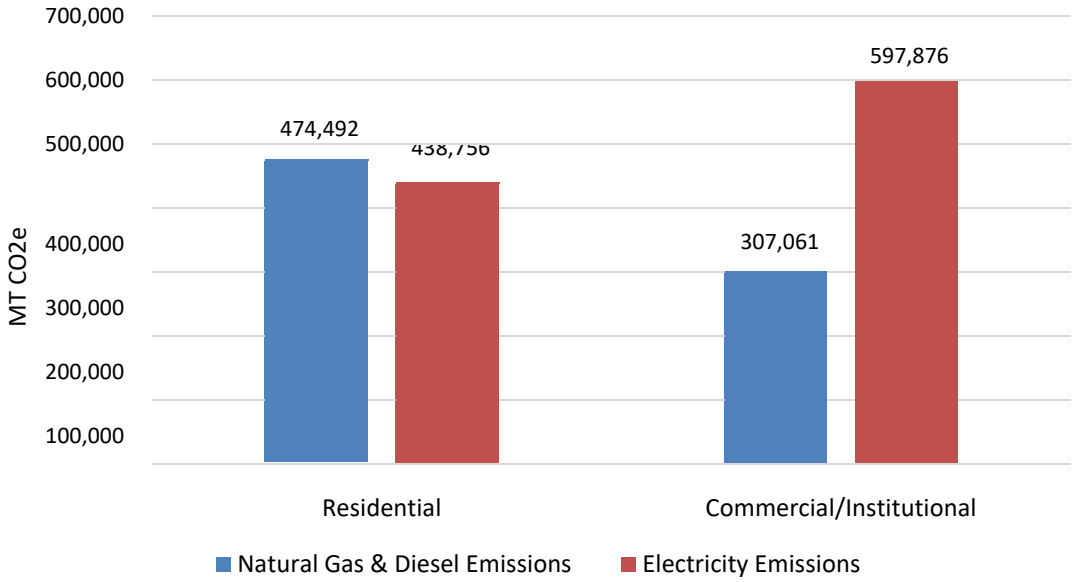


Figure 4: Building Emissions by sector

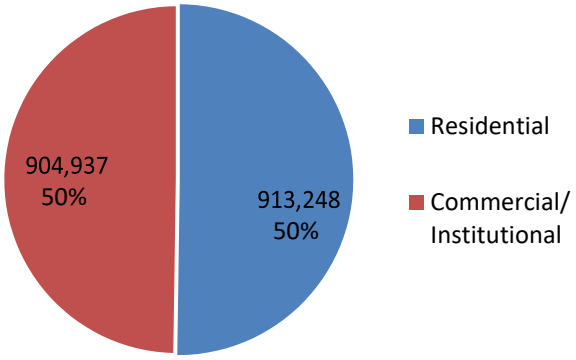
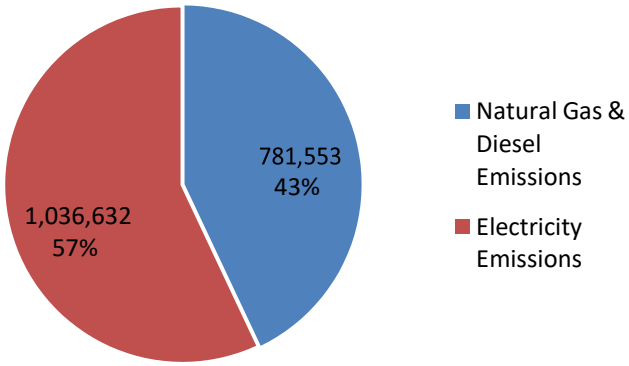


Figure 5: Building Emissions by source



2.2 Building Emissions Reduction

To reduce emissions from the building sector, a major component of this work falls under energy efficiency efforts. Because almost 60% of all emissions from buildings is from electricity, implementing efforts that directly reduce electricity use could have the most impact on overall building emissions. Current programs that exist that assist with energy efficient building improvements are EnergySTAR and LEED certifications.

When compared to Durham and Greensboro, Winston-Salem has the fewest number of energy efficient certified buildings by far. Durham has a total of 158 certified energy efficient buildings, Greensboro has 245, and Winston-Salem sits at 68, according to the North Carolina Sustainable Energy Association[3]. With only 31 Energy Star certified and 37 LEED certified buildings, there is significant room for improvement. To encourage more buildings to become certified as energy efficient, the city could incentivize businesses in the city to upgrade, retrofit or build new buildings to meet standards in either certification program.

3. Transportation Emissions

Transportation emissions account for 28% of total greenhouse gas emissions in the United States. In North Carolina, however, the transportation sector accounts for 32.5% of total state emissions at 48.72 million metric tons of CO_2 equivalent emissions in 2017[4].

Annual transportation data came from Google Environmental Insights Explorer tool. The emissions in Winston-Salem are calculated based on an extrapolation of the total distance traveled for all trips taken, the types of vehicles and average fuel consumption of each mode. Google's estimate is a total of all trips taken within the city boundary and trips that cross the city boundary.

[3] North Carolina Sustainable Energy Association. Local Government Clean Energy Report, page 11. February 2021.
[4] https://deq.nc.gov/energy-climate/climate-change/greenhouse-gas-inventory

The inferred mode of travel guides assumptions for the types of vehicles in the area, the average fuel type and consumption of each mode. Regionally estimated emissions from the Climate Action for Urban Sustainability (CURB) tool - an internationally recognized third-party data source - are applied to all trips for each mode. Assumptions for calculations could be adjusted with more localized data. The assumptions used were a combination of prepopulated data and state level data and are as follows:

- Average vehicle efficiency = 22 mpg (NC DOT)
- Average city emissions factor = 0.009

Google Maps uses aggregated location information from user trips to infer traffic, mode of travel, business, and total distances driven in a city. These are combined with an estimate of the types of vehicles and average fuel consumption of each mode.

3.1 Transportation Emissions Analysis

3.1.1 Baseline emissions in 2019

Data included in the following tables come from 2019 residential transportation data from Google Environmental Insights Tool and the commercial data for the city fleet was provided by the Fleet division.

Table 4: Total transportation emissions

SECTOR	VEHICLE GROUP	FUEL USE (GALLONS)	VMT	NET EMISSIONS (CO2E)
RESIDENTIAL	**Automobile In-Boundary**	33,817,427	814,939,553	1,218,534
	Automobile - Inbound	52,282,158	1,255,614,124	
	Automobile - Outbound	51,506,879	1,241,315,775	
	Standard Bus - In-boundary	236,364	3,056,192	
COMMERCIAL	**City Fleet**	2,005,182	26,868,740	19,994
TOTAL		**139,848,010**	**3,341,794,384**	**1,238,528**

Inbound trips have the most vehicle miles traveled for the residential transportation sector. These are trips from vehicles driving into the Winston-Salem community boundaries from outside the city. The outbound category has the next highest vehicle miles traveled, followed by in-boundary. In-boundary trips are those that are occurring within the boundaries of Winston-Salem. These three categories account for most of the residential vehicle miles traveled in 2019, and therefore are the highest contributors to the transportation emissions at 98% of the total emissions.

3.1.2 Impact from Coronavirus in 2020

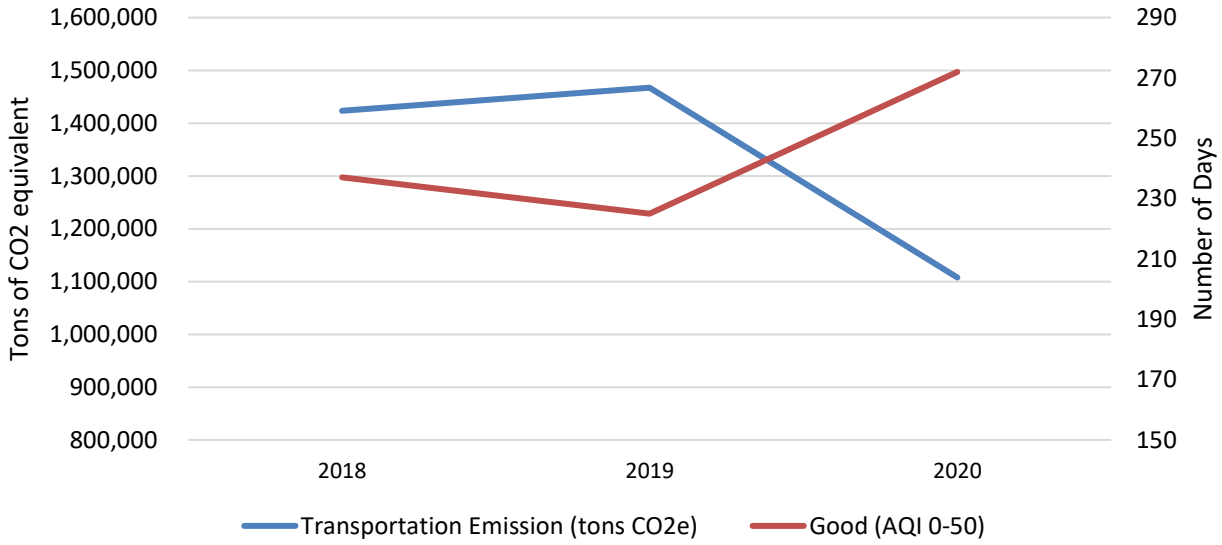
Data included in the following tables come from 2020 residential transportation data from Google Environmental Insights Tool and the commercial data for the city fleet was provided by the Fleet division.

SECTOR	VEHICLE GROUP	FUEL USE (GALLONS)	VEHICLE MILES TRAVELED	NET EMISSIONS (CO2E)
RESIDENTIAL	**Automobile In-Boundary**	23,900,415	576,000,000	919,335
	Automobile - Inbound	40,331,950	972,000,000	
	Automobile - Outbound	39,585,062	954,000,000	
COMMERCIAL	**Standard Bus - In-boundary**	302,073	10,175,322	16,973
	City Fleet	1,915,581	30,259,275	
TOTAL		**106,035,081**	**2,542,434,597**	**936,308**

In comparison between 2019 and 2020, there is a clear impact on vehicle miles travelled, and therefore total net emissions, from the pandemic. The total reduction in carbon dioxide equivalent in just one year is 24%.

3.2 Transportation Emissions Reduction

As one of the largest GHG emitting sectors, there is an opportunity to take action to reduce transportation emissions. The significant decrease in transportation emissions in 2020 when compared to the previous two years demonstrates that there are currently effective solutions that can be utilized in order to sustain emissions reduction and thereby improve local air quality. The correlation shown in Figure 6 below, where the correlation coefficient "r" is -0.991 in a range of -1 (a perfect negative correlation) to 1 (a perfect positive correlation), shows that there is an almost perfect negative correlation between local air quality and transportation emissions. This means that with almost 100% certainty, continued reduced transportation emissions in the community would improve the number



of good air quality days at the same rate.

There may be strategies from 2020 that continue post-pandemic which could continue to keep transportation emissions lower than previous years. Those strategies are identified and listed below.

<u>Car-free downtown</u>

A possible solution, that has been introduced on a small scale in the downtown Winston-Salem area during 2020, is a car-free downtown on selected streets. The goal to eliminate or reduce cars from high-density districts by creating car-free pedestrian zones and limiting vehicles on certain days of the week would not only help reduce overall vehicle emissions, but also help alleviate the urban heat island effect.

As more residential development happens in downtown Winston-Salem, the increased population density could also lead to increased traffic throughout the downtown streets in the Central Business District, leading to higher emissions and more idling vehicles. Those residents would also be impacted by poorer air quality and a hotter microclimate as those increased emissions would further exacerbate the heat island effect.

However, in 2020, the Downtown Winston-Salem Partnership began hosting The Streatery and The Shoppery programs, which exemplify an abbreviated version or a pilot program of a car-free downtown.

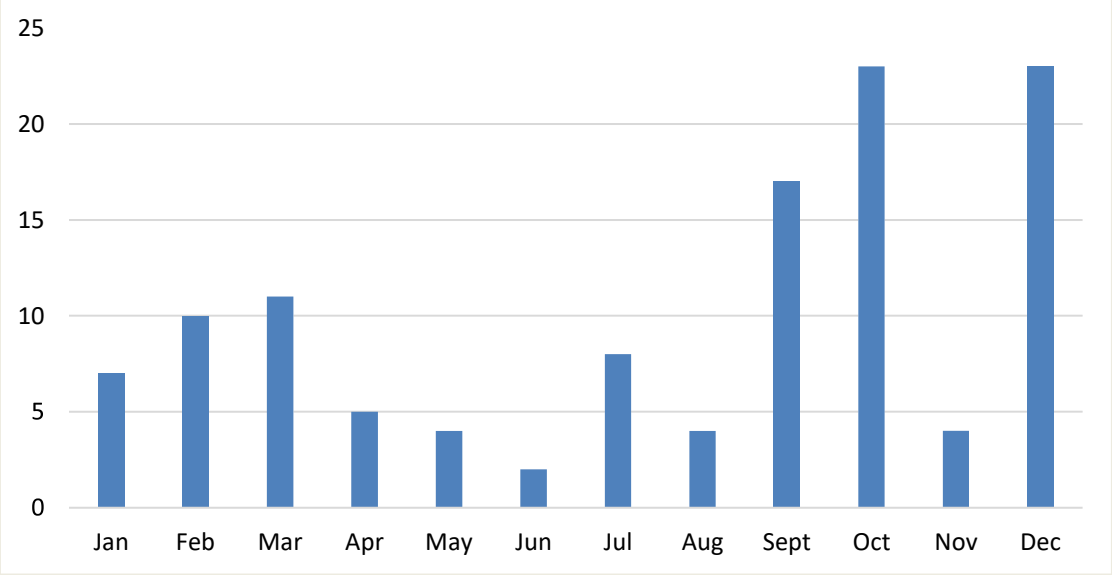
These programs closed portions of 4th Street and Trade Street in the Central Business District (CBD) to vehicle traffic during certain hours to drive economic support for businesses downtown. The events also offer the public more opportunity to walk rather than drive, especially those residents who live in and around the CBD. As the population in and around the CBD continues to increase as residential buildings are completed, participation in The Streatery and The Shoppery events may increase and further decrease emissions in the area.

Electric vehicle charging

To reduce emissions from the transportation sector, a possible solution is to expand electric vehicle (EV) charging infrastructure by directly installing public charging stations and/or incentivizing the private sector to do so. Incentivizing private sector installations could include establishing policies to reduce internal combustion engine (ICE) vehicles in city centers or providing monetary grants or incentives to encourage private businesses to install EV charging infrastructure on their properties.

According to the NC Department of Transportation, Forsyth County has 368 electric vehicles, 265 plug-in hybrid vehicles, and over 5,000 total hybrids as of December 2020[5]. These numbers have increased by 216 registrations in the last two years alone. Figure 7 shows the new EV registrations by month throughout 2020. To meet the growing demand of plug-in vehicles, there are currently three local government-owned Level 2 EV charging stations with no fee to use, and 12 privately owned charging stations. These numbers do not reflect any at-home charging stations that may exist.

Figure 7. New EV Registrations by month 2020



[5] https://www.ncdot.gov/initiatives-policies/environmental/climate-change/Pages/zev-registration-data.aspx

Opportunities exist to expand available charging station in Winston-Salem. With the federal administration and North Carolina administration both setting goals to increase access to electric vehicles and the corresponding infrastructure, it is becoming clear that EVs and charging stations are feasible solutions to reducing emissions and pollution across the country. Resources are also increasing to build the necessary infrastructure in municipalities, with assistance available from federal, state and utility-based sources.

Duke Energy launched a Park & Plug EV Pilot Program for North Carolina in 2021. Through phase one of this program, the utility allocated 100 Level 2 charging stations and 24 DC Fast charging stations to the Duke Energy Carolinas.

The North Carolina Department of Environmental Quality received millions of dollars through the Volkswagen Settlement which are being disbursed in grants throughout the state in phases. Their goal is to improve the EV charging station network across the state and help in meeting goals set by Governor Cooper that include registering 80,000 electric vehicles in the state by 2025.

Additionally, the NC DOT created a plan for Zero Emissions Vehicles with a target of registering 80,000 EVs by 2025. The plan also identified 550 state fleet vehicles that are good candidates to be replaced with ZEVs or EVs that if replaced would save $3.8 million. On the federal level, the Biden-Harris Administration set a goal of installing 500,000 electric vehicle chargers by 2030.

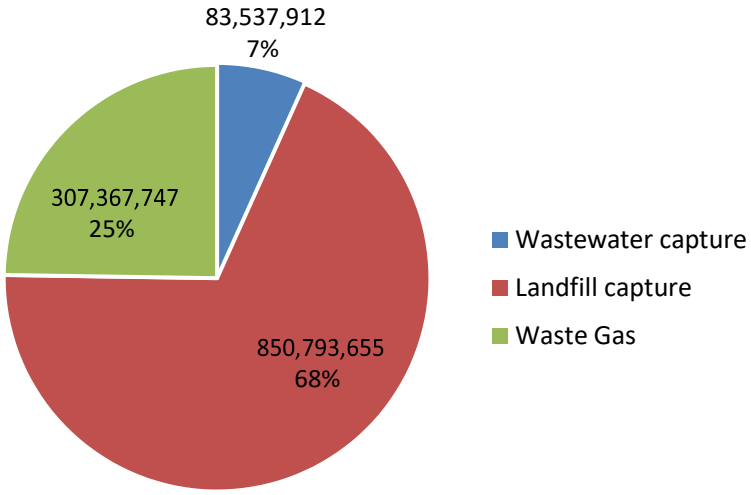
With these goals, government leaders at every level are emphasizing the importance of encouraging the transition from internal combustion vehicles to electric vehicles. To meet the growing demand of both electric vehicles and the charging infrastructure, Winston-Salem needs to continue to invest in these technologies.

4. Winston-Salem/Forsyth County Utilities Methane Analysis

The WS/FC Utilities Department oversees two of the biggest producers of methane gas in Winston-Salem - the Hanes Mill Landfill and the Archie Elledge Wastewater treatment facility. Both the landfill and wastewater divisions employ methane capture technology in order to reduce overall emissions in the community and to also utilize that gas as an energy source for the facilities.

Total methane produced from 2020 WS/FC Utilities operations is 1,241,699,314 standard cubic feet (scf). However, due to the methane capture technology employed at both the wastewater treatment plants and the landfill, 934,331,567 scf of methane was captured and utilized. This leaves the net methane emissions as 307,367,747 scf.

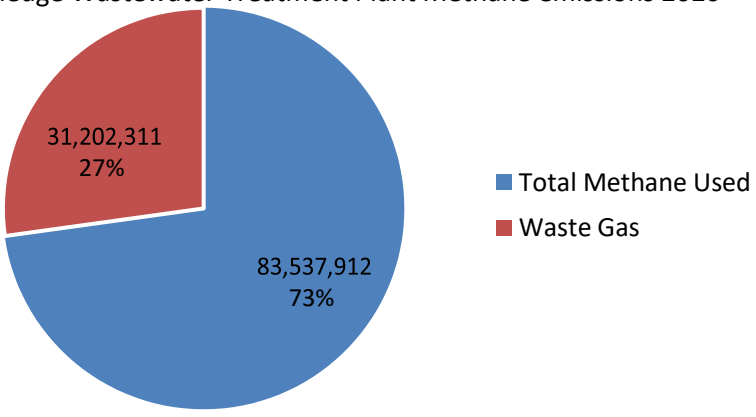
Figure 8: Utilities' Total Methane Emissions



4.1 Wastewater Methane Emissions

The Archie Elledge Wastewater Treatment Plant has a total treatment capacity of 31 million gallons a day, more than half of the total treatment capacity of the two wastewater treatment plants in Winston-Salem. Total methane gas produced by the Elledge Wastewater Treatment Plant for 2020 is 114,740,223 scf. Waste gas is the gas that is not used in any capacity and therefore emitted into the atmosphere, which accounts for 27% of total methane produced by the wastewater treatment plant, or 82,673 MT CO_2 equivalent.

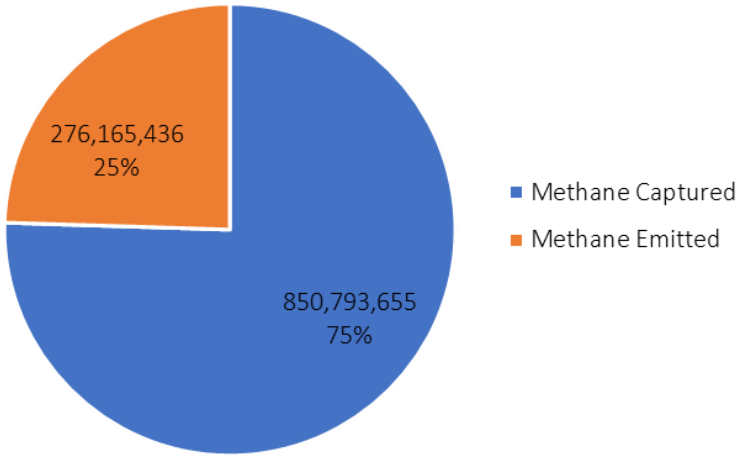
Figure 9: Elledge Wastewater Treatment Plant Methane emissions 2020



4.2 Hanes Mill Landfill Methane Emissions

The Hanes Mill Road Landfill is another major emitter of methane gas in Winston-Salem/Forsyth County. The landfill produced a total of 1,126,959,091 standard cubic feet (scf) of methane in 2020. With a 75.49% collection efficiency of the landfill gas control devices, however, about 851 million standard cubic feet of that methane was captured and destroyed through the generator/flares. Considering the captured methane, the net methane released into the atmosphere in 2020 was 276,165,436 scf for the year, or 271,253 MT CO_2 equivalent.

Figure 10: Hanes Mill Landfill methane emissions (scf) 2020



5. Rooftop Solar Potential

Solar energy is a known and accessible solution to assist cities and communities in reducing carbon dioxide emissions. This section looks at the total possible capacity of residential and commercial rooftop solar panels to reduce emissions in Winston-Salem. Data compiled from Google Environmental Insights and the Local Government Energy Report for Winston-Salem provided by North Carolina Southern Energy Association (NCSEA).

The Google Environmental Insights Rooftop Solar Potential tool estimates the technical solar potential of all buildings in a region with the most recent available data, in this case from November 2015. Technical potential includes electricity generated by the rooftop area suitable for solar panels assuming economics and grid integration are not a constraint. Based on certain assumptions determined by the Google Environmental Insights Explorer Tool, installations meet the following criteria:

- Sunlight: Every included panel receives at least 75% of the maximum annual sun in the area. For Winston-Salem, the average value of the threshold is 1084.60 kWh/kW.
- Installation size: Every included roof has a total potential installation size of at least 2kW.
- Space and obstacles: Only areas of the roof with enough space to install 4 adjacent solar panels are included. Obstacles like chimneys are taken into account.

Assuming 100% utilization of rooftop solar potential, the potential emissions reductions is equivalent to 1,140,000 total tCO_2e per year. As seen in Figure 11, the possible reductions if the full solar potential was reached would be enough to almost fully offset electricity emissions, the second largest producer of community emissions.

Figure 11: Potential solar PV emissions reductions compared to emissions by sector

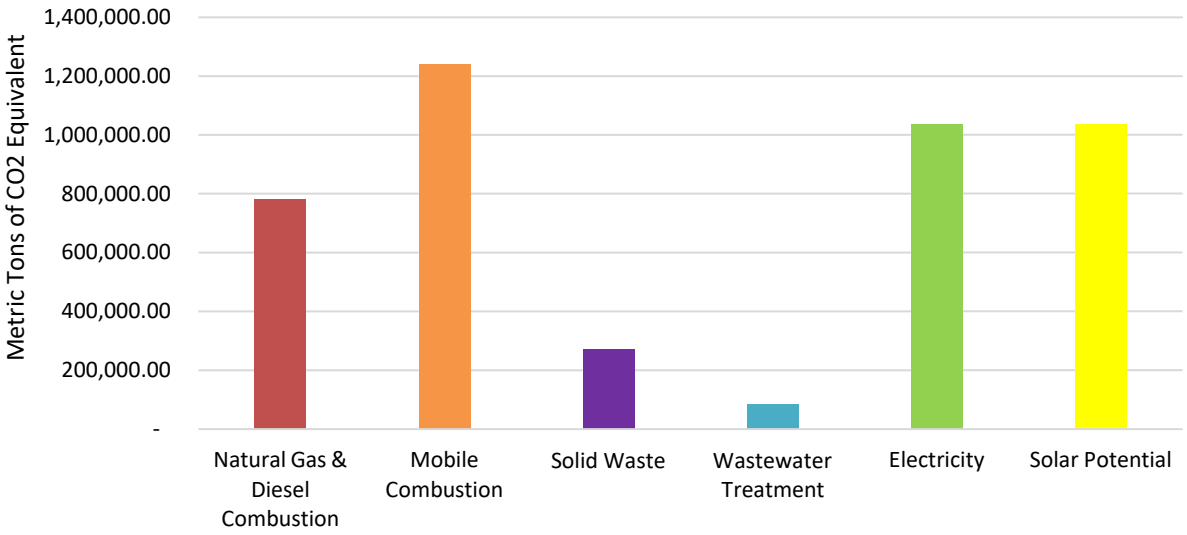
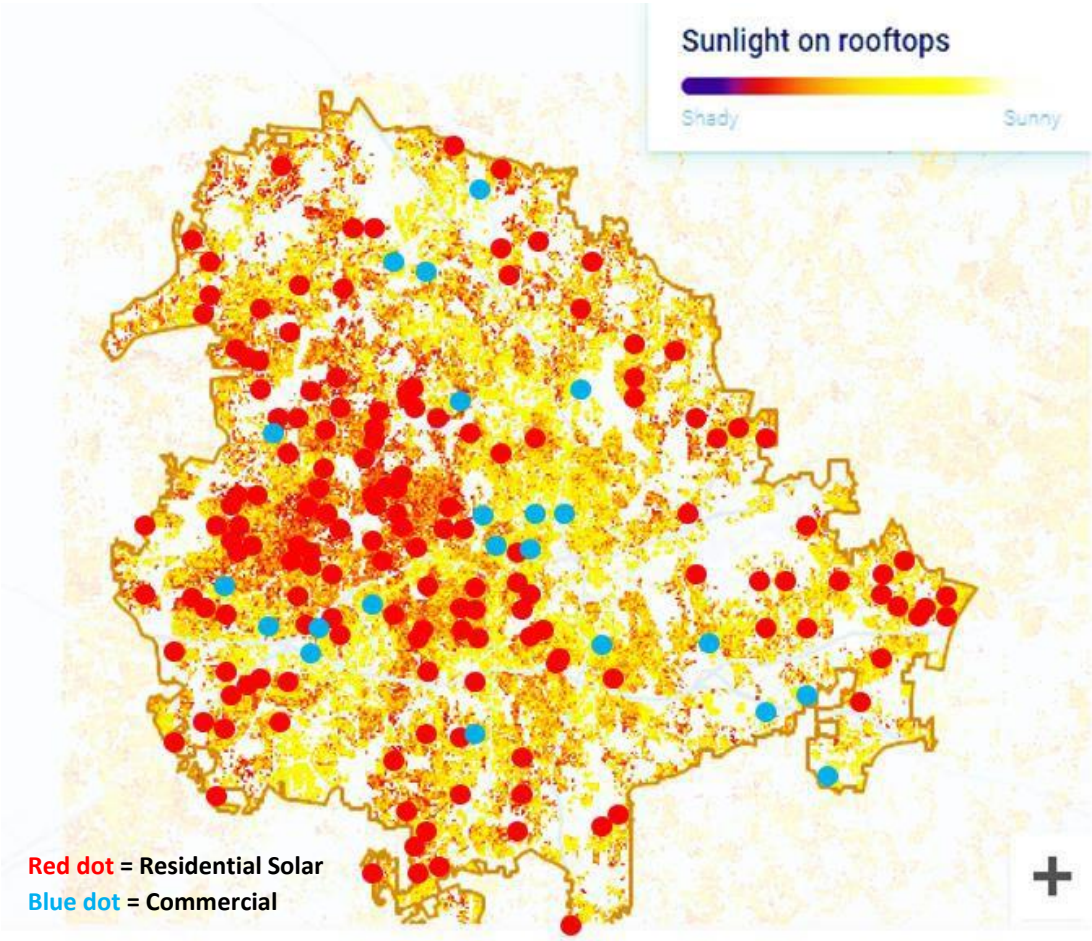


Image 1 shows the location of current renewable energy systems, all of which are solar PV, in Winston-Salem compared to where in the city the rooftops get the most sunlight. There is a total of 197 residential systems (red dots) and 27 commercial systems (blue dots).

Image 1: Sunlight availability on rooftops and current solar PV installations



5.1 Rooftop Solar Analysis

According to NCSEA, residential rooftop solar PV systems account for 88% of all installed systems in Winston-Salem. However, 59% of generating capacity comes from the commercial systems. The total capacity of these solar PV systems is 2.85 MW.

Based on the map, many residential renewable systems are in areas where there may be less optimal sunlight availability. Those systems are also located in areas of the city that are middle- or higher-income areas. For maps showing the distribution of wealth in Winston-Salem, reference Appendix A. This analysis implies that if the city or community wants to maximize the amount of energy provided by solar PV, there should be more work done in lower-income areas of the city for residents where there is more available sunlight on roofs.

When compared to other North Carolina cities of similar size, Durham has more residential solar PV systems than Winston-Salem and Greensboro combined, according to NCSEA. However, Greensboro's generating capacity is more than that of Winston-Salem and Durham combined due to the presence of a utility-scale system and capacity of commercial scale systems.

6. Identify gaps in community data

While the data in this report covers a significant portion of community emissions, there are gaps in what data is available. The following gap analysis is based on two online reporting tools the city has reported to in the past – CDP and ACEEE. These tools have helped provide a baseline understanding for local government operations data, and as they expand to cover additional topics, gaps in accessible data become clear.

6.1 Industrial Emissions

In the 2008 Greenhouse Gas Inventory and Local Action Plan to Reduce Emissions report for Winston-Salem, the data from 2006 showed that industrial emissions accounted for 18% of total community emissions. In conducting research for this report, that data was not readily available. To provide a full update to the 2008 inventory, this research would be necessary. However, this report serves beyond an inventory capacity as solutions for potential emission reductions are included. Reducing industrial emissions is a more complicated strategy, and therefore the purposes of this report to provide an overview of community emissions and possible reduction actions are met with the sectors that are included.

6.2 Urban Heat Islands

Urban Heat Islands are a threat in urban areas with dense built environment that absorbs heat making those areas warmer than surrounding areas. A visual representation of the heat island effect can be found in Appendix B. As the climate changes and the global temperature rises, the urban heat island effect becomes a likelier and more dangerous threat.

This issue could impact community greenhouse gas emissions from the energy used by the building sector. Buildings located in areas affected by the urban heat island effect are likely to use more energy than buildings in less dense areas. This is because the built environment absorbs extra heat leading to more energy used for cooling systems.

As more development takes place in and around the CBD, studying the local urban heat islands will be important to study to determine if any areas in the city are experiencing additional heat related risks and may be using more energy. Studies related to this topic can help identify at risk areas, or which populations may be more vulnerable from living in neighborhoods experiencing warmer temperatures. Once these areas are identified, steps can be taken to mitigate these threats.

6.3 Tree Canopy Analysis

Tree Canopy analysis is important to community greenhouse gas emissions as trees are a major carbon sink, which means trees have capacity to absorb carbon emissions in the community, and lower net emissions.

A thorough analysis of the tree canopy in Winston-Salem would help accurately estimate the percentage of canopy cover throughout the city. That analysis can inform future planting efforts for programs like Community Roots Day or by city parks and trails. Trees can also be used to mitigate heat stress that may occur from the Urban Heat Island effect.

7. Conclusion

In researching the community GHG emissions for Winston-Salem, local data kept consistent with state and national data. Residential transportation and commercial building energy use are the two sectors contributing the most greenhouse gases locally, contributing 62% of the total emissions in the community at 2,123,471 MT CO_2e. However, there are also possible solutions that can be implemented that target each sector to reduce future emissions, such as a car-free downtown program and increasing EV infrastructure for transportation emissions reductions, and incentivizing more energy efficient buildings for energy use reductions.

With these emissions sources identified, there are also gaps in the data. One such gap is a study of any heat islands or areas within the community more susceptible to higher emissions and higher temperatures due to higher development. Another gap exists that identifies locations and capacity of any carbon sinks that may exist in the community. If these areas were to be studies, additional solutions may present themselves as possibilities for implementation to reduce community emissions.

If the City of Winston-Salem is to set any further reduction goals or keep in line with those set by the state and federal governments, benchmarking community emissions data will be vital in tracking any local changes or impacts. This informal report establishes the baseline study of the various emissions sources and sectors and can be built upon as current data gaps get filled in.

Appendix A

Based on the two figures below, there is evidence to support that those living east of downtown Winston-Salem tend to have lower incomes and be closer to the poverty level. These are the same areas with more sunlight availability on roofs as shown in Image 1, which supports the idea that there is more solar energy potential in those areas but that there may need to be efforts to assist with the cost of solar PV installation.

Figure 12: Median Household Income

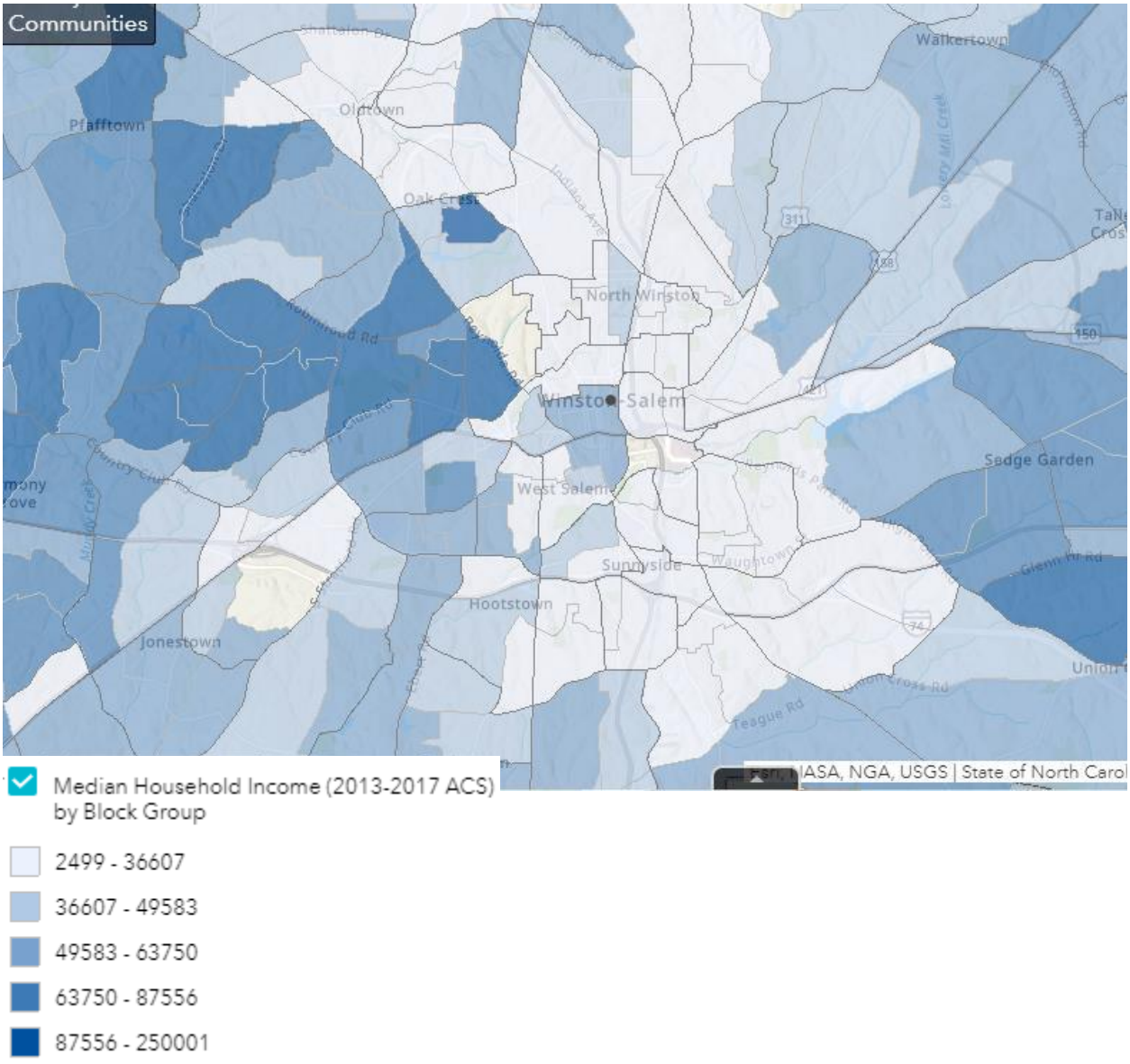
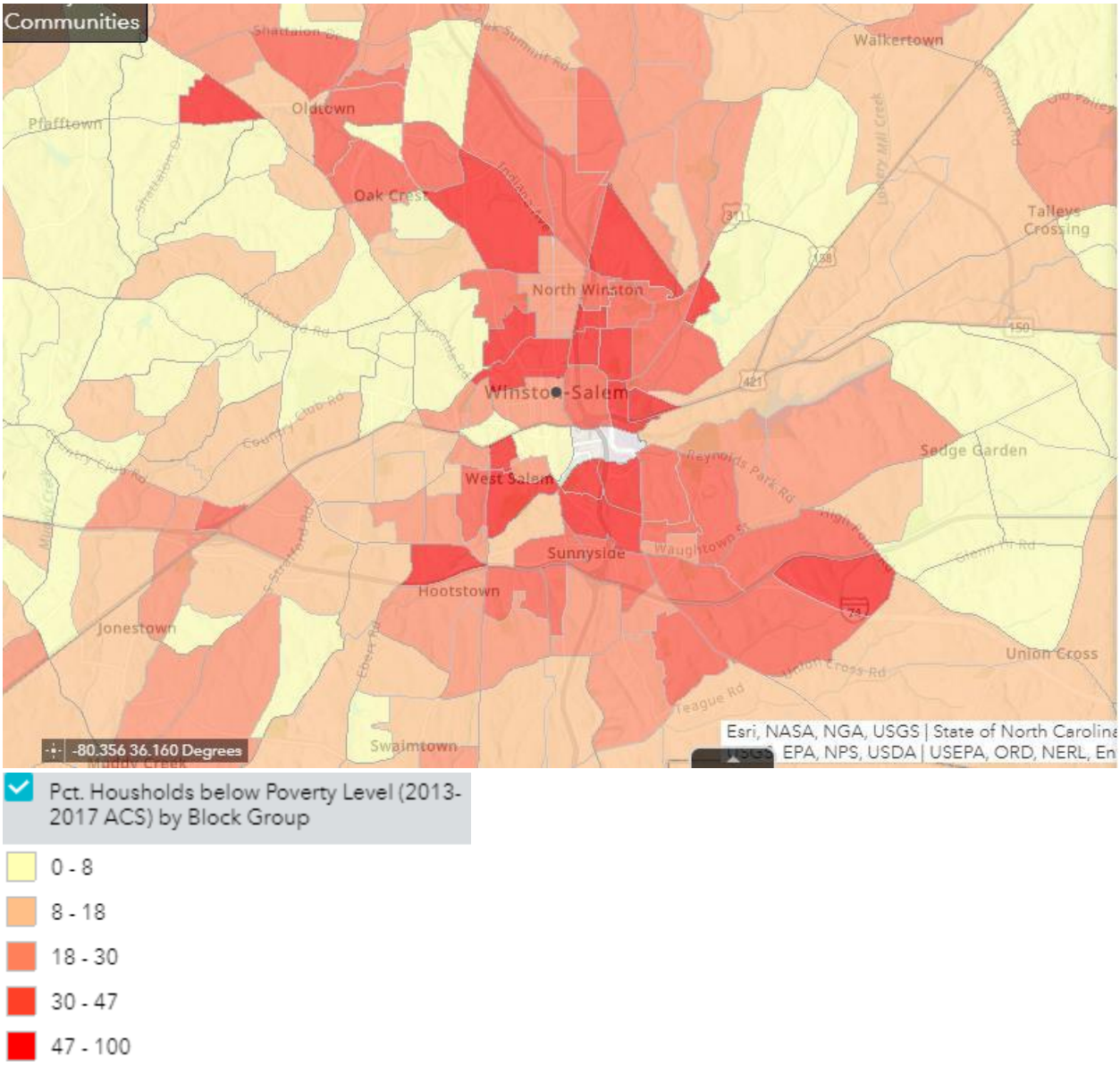


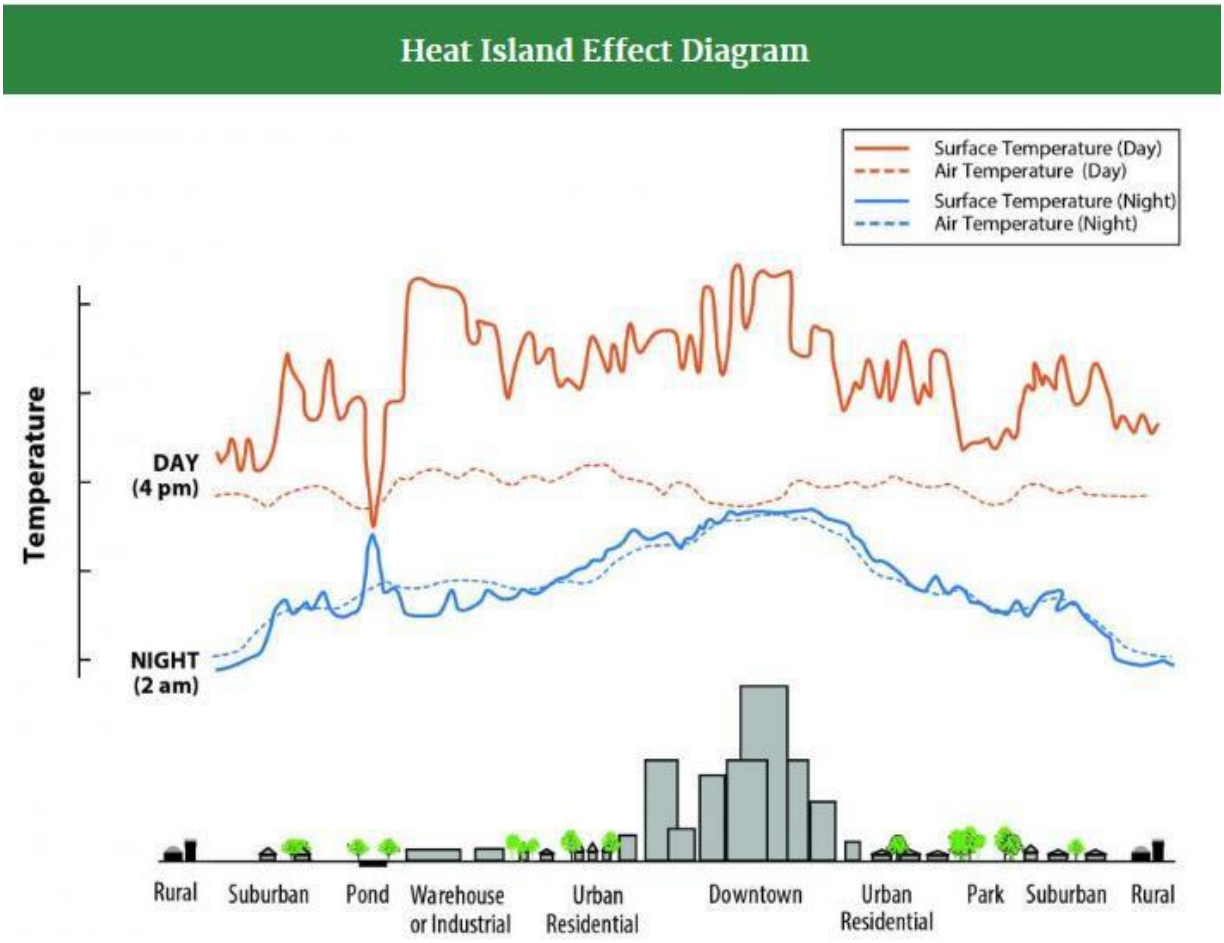
Figure 13: Percentage of households below poverty level



Appendix B

The diagram below comes from the EPA website and shows how an urban or more highly developed area can be affected by higher surface temperatures.

Image 2: Heat Island Effect



Surface temperatures vary more than atmospheric air temperatures during the day, but they are generally similar at night. The dips and spikes in surface temperatures over the pond area show how water maintains a nearly constant temperature day and night because it does not absorb the sun's energy the same way as buildings and paved surfaces. Parks, open land, and bodies of water can create cooler areas within a city. Temperatures are typically lower at suburban-rural borders than in downtown areas.