

NC STATE UNIVERSITY | ES 400

CHATHAM COUNTY

GREEN TRANSPORTATION PROGRAM

FINAL REPORT | 2019

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Introduction

Global and national leaders have become invested in reducing carbon dioxide emissions across different sectors of the economy due to the present and future impacts of climate change. Chatham County's Climate Change Advisory Committee has requested the ES 400 spring semester class to develop emission reducing programs across different sectors. There are five groups working on reducing emissions for Chatham County in biodiversity/wetlands/invasive species, community outreach/public policy, renewable energy production, agriculture and forest conservation and transportation. This group will be focusing on the transportation sector. Chatham County is a predominantly rural county in North Carolina with a population of approximately 72,000. If projections hold, the county's population may grow by 37% from 2010 to 2030 rising to 86,776 That translates to an average gain of 1,164 people per year (Triangle Community Foundation, 2014). Urbanization and development will occur as a result. Despite the primarily rural environment of Chatham County, high per capita income is commonplace as urbanization and development continues across the county.

Chatham County's Climate Change Action Plan (CCCP) from November 2, 2017 outlines the County's mission to increase and promote the use of public transportation countywide to significantly reduce greenhouse gas emissions from transportation. Transportation is one of the highest contributors of carbon dioxide emissions, accounting for 74% of Chatham County's greenhouse gas emissions per the 2015 Greenhouse Gas Inventory for the county compiled by the Chatham County Climate Change Advisory Committee (Chatham County CCAC). Per this report, the primary source of transportation in Chatham County is individual vehicles and data

obtained from the Chatham County online data portal, <https://www.chathamnc.org>, imparts that Chatham County has an above average commute time of 28.7 minutes, likely contributing to overall transportation emissions. Public transportation is limited to the Chatham Transit, a request service in place for individuals who require assistance to get around (Chatham Transit, n.d.). Chatham transit consists of vans, lift vans and light transit vehicles with and without lifts (Chatham Transit, n.d.). Transportation service is provided to agencies including Central Carolina Community College, Chatham County Department of Social Services, Chatham County Health Department, Chatham County Partnership for Children, Chatham County Together, Chatham Trades, Inc., Family Resource Center, Laurels of Chatham, Lee County Industries, Siler City Care and Rehabilitation, etc. (Chatham Transit, n.d.). The network is mainly made up clients from these organizations (Chatham Transit, n.d.). Public transportation is difficult to implement in the county due to 65.9% of Chatham County residents living in a rural environment (Table 1). Most roads are still dirt roads and there isn't a countywide bus transit system. Chatham County has conflicting factors both geographically and in terms of transportation in NC. More than 11,500 more residents commute to areas outside of Chatham County to work compared to the small influx that commute into the county. Those commuters experience a mean travel time of 28.7 minutes, the fifteenth longest commute, ranked by county, in the state. 78.1% of employees travel to their work in a vehicle alone, and only 0.8% utilize public transportation.

After discussing possible projects with the Chatham CCC, our group proposed a Chatham County Green Transportation Program that targets individual vehicle emissions. This plan will incentivize individuals who invest in hybrid and electric cars and reduce individual commute time. The incentivization will be based on research of the Energy Innovation and Carbon

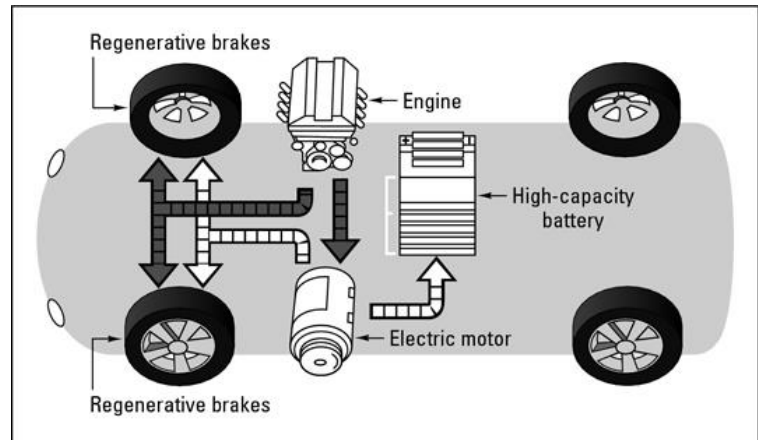
Dividend Act and its impact on individual incomes and a community outreach program to raise awareness of environmental issues. If the Energy Innovation and Carbon Dividend Act is passed, money collected from a carbon emission tax will be redistributed to American households. The community outreach program in addition to this will encourage individuals to invest in environmentally conscious products. Easy access to charging stations and internet cafes will potentially increase the use of hybrid and electric cars and reduce commuter times for individuals. The focus of this research project will be to look at population concentrations for Chatham County and develop potential areas for internet cafes, hybrid and electric car charging stations for residents that have limited access to broadband and causes individuals to commute for longer periods of time.

Literature Review

Hybrid and Electric Vehicles

Hybrid and electric vehicles provide a myriad of environmental and economic benefits and could be used by Chatham County residents to reduce their carbon footprint and save money. Hybrid vehicles are powered by a normal combustion engine in combination with an electric motor that stores energy in batteries (Figure 1). Electric vehicles are powered by an electric motor with batteries to store the energy and require charging instead of gasoline ("Alternative Fuels Data Center", n.d.).

Hybrids can be further broken down into two categories: mild hybrids and full hybrids ("Alternative Fuels Data Center", n.d.). Mild hybrids, or micro-hybrids, use an electric motor



and battery to allow the engine to turn off when the vehicle is stationary (e.g. traffic or a stop-light). Mild hybrids cannot depend on the electric motor independently and it must be used supplementary. Full hybrids have more powerful electric motors and can independently power the vehicle "for short distances and at low speeds" ("Alternative Fuels Data Center", n.d.).

Electric vehicles are generally more expensive than hybrid and conventional combustion vehicles, though, they can produce less emissions depending on where the energy is sourced ("Alternative Fuels Data Center", n.d.). According to the U.S. Energy Information Administration (EIA) North Carolina State Profile, Chatham County likely sources the majority of their energy from Shearon Harris Nuclear Powerplant, which is located about 1.5 miles outside of Chatham County. Nuclear power is generally classified as a clean energy with underlying controversies. Even with nuclear power, if commuting residents of Chatham County invested in hybrid and electric vehicles, CO2 emissions could have great potential to be reduced.

According to the book, *Electric and Hybrid Vehicles*, if electricity is generated from renewable sources, electric vehicles are generally more energy efficient and carbon neutral than hybrids. When generated from non-renewables, the electric vehicle must generate

electricity “on-board” to remain competitive. (Pistoia, 2010, p.15). Therefore, an electric vehicle with energy from renewable sources should be the primary goal (aside from reduction in travel time and vehicle use) to reduce carbon footprints.

Energy Innovation and Carbon Dividend Act

The Energy Innovation and Carbon Dividend Act (H.R. 7173) was a bill proposed by the House of Representatives (H.R.) this year that “amends the Internal Revenue Code to impose a fee on the carbon content of fuels, including crude oil, natural gas, coal, or any other product derived from those fuels that will be used so as to emit greenhouse gases into the atmosphere.” The bill exempts fuels used for agricultural or non-emitting purposes, rebates for facilities that capture and sequester carbon dioxide, and border adjustment provisions for exported and imported goods (H.R. 7173, 115th Cong. 2017-2018).

H.R. 7173 proposes a carbon fee on any covered entity’s emitting use, sale or transfer for an emitting use, of any covered fuel. This fee will be calculated by multiplying the greenhouse gas content and the carbon fee rate. The proposed carbon fee for the year of 2019 is \$15 and will be an additional \$10 per passing year. The first emission reduction target will be for the year 2022 with 2015 as a reference point. The bill also amends the Clean Air Act to suspend certain regulations that limit greenhouse gas emissions. This will expire if the emissions targets established by the bill are not reached after a specified time period (H.R. 7173, 115th Cong. 2017-2018). This means that the Environmental Protection Agency (EPA) will not be able to monitor emission levels of greenhouse gases under the act for the first ten years.

If emission levels are not being met, the federal government will be required to instruct the EPA to regulate greenhouse gas emissions.

Collected income from the carbon fee would be evenly distributed among American households. The carbon fee would also cover governmental costs of the bill. This is meant to help lower- and middle-income families while also boosting the economy and creating jobs. Initially there will be no income from the tax, but future projections show an expected annual dividend of \$3,456 for a family of four or an average \$500 per person annually. The bill is expected to create 2.1 million new local jobs and reduce greenhouse gas emissions by 40%.



Figure 2: Diagram explaining the Energy Innovation and Carbon Dividend Act (Source: <https://energyinnovationact.org/how-it-works/>)

With the enactment of this policy, families will receive more in carbon dividends than they pay

in fuels and other products. This money will be spent in their communities and consequently create jobs in the local community (The Bipartisan Climate Solution).

Methods

Initially, the focus of this research project was geared toward implementing a gradual, county-scale phasing out of diesel buses and replacing the existing motor pool with hybrid buses to be employed in the public transportation system. We used ArcGIS Desktop version 10.3.1 to map potential bus stop locations based on population concentrations in Chatham County. This program would have also included the outreach program to encourage more environmentally-conscious choices such as taking public transportation over individual vehicles. However, consulting with the Chatham County CCAC revealed how our proposed plan would be difficult to implement due to the predominantly rural environment of Chatham County. Thus, per the suggestion of the committee, emphasis would be placed on targeting individual emission from vehicles as a more efficient way to reduce overall carbon dioxide emissions in the transportation sector, also known as the Green Transportation Program. This would be achieved through a comprehensive analysis of population and demographic data to lay a foundation and current transportation-based emissions in part already tabulated by the Chatham County CCAC in the 2015 Greenhouse Gas Emissions Inventory for Chatham County, North Carolina (2015 GHG Inventory). The committee also suggested to research the scope of broadband internet access and bandwidth across Chatham County, for an unspecified amount of residents had no internet access at home, necessitating transportation to urban areas for internet access to carry out basic tasks such as schoolwork, paying fees and dues online, and simply for leisure. In addition, the Chatham County CCAC advised in-depth research the Energy

Innovation and Carbon Dividend Act to explore how effective legislation could be used to reduce individual emission levels. Analysis of how to mitigate impacts from a large-scale problem such as county-wide greenhouse gas emissions requires careful analysis of how specific facets of the problem contribute to the overall footprint of the issue at hand. With transportation emissions constituting the greatest portion of total greenhouse gas emissions in Chatham County, North Carolina, examination of the individual components that in part determine citizens' use of transportation characterize the approach taken in this study (2015 GHG Inventory).

In order to acquire a detailed demographic portrait of Chatham County, we obtained publicly-available tabular data consisting of socioeconomic status, employment information, housing statistics, health, and transportation metrics from both a county-level government portal, chathamnc.org, and a federal-level dataset obtained from United State Census Bureau's QuickFacts Database, (<https://www.census.gov/quickfacts>). Most data were either estimates valid as of 2017, arithmetic averages over a specified period, or consisted of calculated percentages of the total population of Chatham County. Quantifying the difference in urban and rural population, the age of residents, and percentages of Chatham County citizens of specified races yielded information that factored into better understanding the scope of transportation in the county; For instance, knowing the age of residents of legal driving age, or greater than 16 years, provides a better representation of the number of people contributing to transportation emissions compared to the total population of Chatham County. In addition, income statistics, the number of persons living with a disability (Table 2), and the percentage of residents with a working broadband internet subscription (Table 1) were tabulated. All of these

data may affect the type of transportation used or required by residents, for income directly dictates choice of transportation, disabilities may warrant specialized transportation, and internet availability requires some residents to commute to urban areas to utilize online services, per anecdotal evidence from the Chatham County CCAC.

this project is focused on reducing carbon dioxide emissions in Chatham County, particularly concerned with the transportation sector, we concluded that developing visuals of transportation patterns and employing GIS technologies would convey our findings with the greatest efficacy. ArcGIS was used to analyze and display data related geographical location and to present information in the form of graphical presentation. For this particular project, different geospatial layers such as county boundary, road segments, census blocks, and gas stations across the state were collected and analyzed to produce a map of potential locations to install hybrid-vehicle charging stations or retrofit existing service stations to accommodate electric vehicles. Meanwhile, applying information of internet connectivity within Chatham County and overlaying county population concentration yielded a digital map showing the county's internet shortage combined with the greatest population concentrations. Thus, by presenting several digital maps using data collected from various official website such as <http://www.nconemap.com/> and <http://www.nconemap.com/> and <http://chathamncgis.maps.arcgis.com/home/index.html>, people can easily find the nearest internet connectivity hotspots if they are suffering from poor internet connectivity or charging stations for their electric vehicles.

The Chatham County CCAC also recommended an outreach program that primarily focuses on the economic benefits of hybrid and electric vehicles which simplifies the

information so that residents can better understand the process of purchasing a vehicle.

PowerPoint was used to develop the poster. To begin the informational graphic on hybrids and electrics, the economic aspect of gasoline, hybrid, and electric vehicles was researched using data on average fuel price in North Carolina, average charge price, and average mpg for each vehicle. A yearly distance traveled of 15,000 miles was chosen as a slightly above-average value to account for the long commutes taken by Chatham County drivers. Information on federal tax credits was sourced from fueleconomy.gov, and main points were summarized. Information on estimated life emissions of different types of vehicles were sourced from a table on The Green Market Oracle which is cited to have been prepared by “Ricardo1for in collaboration with The Low Carbon Vehicle Partnership.” The values were converted from metric tons to US tons for easier comprehension. Information on HOV lane use and emission inspections were sourced from the National Conference of State Legislature website, where state-specific legislature could be selected and viewed. The two seemingly most beneficial policies were selected for the poster. Finally, the locations of charging stations were sourced from plugshare.com, where there is a map of all charging stations in the United States. Locations within Chatham County were sourced then overlaid on a Google Maps screenshot.

Additionally, an outline of an “Earth Fair” was developed as a concept to promote electric and hybrid vehicles and sustainable businesses in Chatham County. PowerPoint was also used to develop the graphic. To begin, an image from Google Maps of the location of Siler City Farmers’ Market was sourced to use as a background for the layout. Sustainable businesses were researched using the Chatham Chamber of Commerce’s Alphabetical Business Directory. Any business related to plants, animals, or other ecological subjects were selected and listed.

Other concepts such as food trucks and sustainable associations were researched using Google. NC Clean Energy Technology Center was listed because Emma Craig, a group member contributing to this project, previously volunteered with the business. The Center is known for promoting green energy in North Carolina and was determined to be a potential resource for Chatham County.

Results

Tabular Data Analysis and Findings

Upon analysis of collected tabular data, a sufficient understanding of the general demographic makeup, wealth distribution, and basic transportation patterns of Chatham County was established. Demographic summary statistics retrieved from the United States Census Bureau QuickFacts Database are given in Table 1, relevant socioeconomic, health, and agricultural parameters from both the same source and also the U.S. Department of Agriculture National Agricultural Statistics Service are presented in Table 2, and Table 3 shows Annual Average Daily Traffic data from the North Carolina Department of Transportation and other miscellaneous transportation statistics found through the Chatham County Government Data Portal. Table 3 corresponds to Figure 3 where the most heavily traveled routes in Chatham County are highlighted. Overall, tabular data proved useful in serving as a foundation for depicting how and why Chatham County residents traveled within and through the county.

Table 1: Demographic summary statistics of Chatham County, per U.S. Census Bureau*, 2017

People of Chatham County	
Demographic	Value
Population (est. July 2017)	72,736
Annual Population Growth Rate	2.9%
Urban Population	21,461 (34.1%)
Rural Population	41,684 (65.9%)
White, not Hispanic or Latino	71.6%
Black or African-American	12.7%
Hispanic or Latino	12.5%
Asian	2.0%
Multiracial	1.8%
Native American	1.2%
Pacific Islander	0.1%
Population of age < 24	18,171 (26.5%)
Population of age 25-34	6,182 (9.0%)
Population of age 35-44	8,441 (12.3%)
Population of age 45-54	9,375 (13.6%)
Population of age 55-64	10,219 (14.8%)
Population of age > 65	16,390 (23.8%)
Population w/ computer at home	85.9%
Population w/ broadband internet subscription	76.2%

*Data acquired from U.S. Census Bureau QuickFacts database, <http://www.census.gov/quickfacts>, with data valid as of 2017.

Table 2: Basic socioeconomic, health, and agriculture statistics for Chatham County*

Socioeconomics, Health, and Agriculture	
Parameter	Value
Median Household Income	\$63,373
Per Capita Income	\$51,839
Population Below Poverty	9,374 (14.4%)
Persons with a disability, under 65 years of age, percent (2013-2017)	8.7%
Persons without health insurance, under 65 years of age, percent	10.2%
Number of farms in county (2012)	1,138
Land contained in farms in county (2012)	111,778

Market value of crop sales (2012)	\$9,001,000 (5% total agriculture sales)
Market value of livestock sales	\$154,908,000 (95% total agriculture sales)

*Data acquired from two sources: 1) U.S. Census Bureau QuickFacts database, <http://www.census.gov/quickfacts>, with data valid as of 2017, and 2) United States Department of Agriculture National Agricultural Statistics Service Report for North Carolina, https://www.nass.usda.gov/Statistics_by_State/North_Carolina/index.php, with data valid as of 2012.

Table 3: Transportation Statistics and Summary for Chatham County, 2019*

Chatham County Transportation Summary (2019)			
Chatham County Annual Average Daily Traffic (AADT)		Employee Transportation Modes and Transit Patterns	
Busiest Routes (> 5,000 AADT)	Route AADT	Employment Travel Flow	Number of Residents
US Highway 1	30,250	Residents who live/work in Chatham County	5,124
US Highway 64	16,789	Worker Inflow	8,997
US Highway 15-501	16,250	Resident Outflow	20,551
US Highway 64 Bypass	14,000	New Flow	-11,554
US Highway 421	13,636	Mean Travel Time to Work	28.7 minutes*
NC Highway 751	8,967	Mode of Transportation to Workplace	Percentage of Employees
US Highway 64 Business	7,700	Drove Car, Truck, or Van alone	78.1%
Farrington Road	7,250	Carpooled in Car, Truck, Van	10.8%
Manns Chapel Road	7,100	Worked at Home	7.8%
US Highway 15-501/NC Highway 87	6,925	Walked	1.3%
NC Highway 87	6,500	Taxi, Motorcycle, Other	1.1%
Siler City Glendon Road	6,500	Public Transportation	0.8%
NC Highway 87/NC Highway 902	6,450	Bicycle	0.1%
Jack Bennett Road	6,300	-	-
Lystra Road	6,000	-	-
Old Farrington Point Road	5,100	-	-

*Data acquired from the North Carolina Department of Transportation (NCDOT), <https://connect.ncdot.gov/resources/State-Mapping/Pages/Traffic-Monitoring-Reports-Statistics.aspx>, AADT refers to Annual Average Daily Traffic, a computed metric representing the number of vehicles utilizing a specified route on any given day of the year. AADT can be used as a proxy for estimating the routes that experience the most traffic within Chatham County.

GIS figures

Most Heavily Traveled Routes (AADT > 5,000) in Chatham County, NC

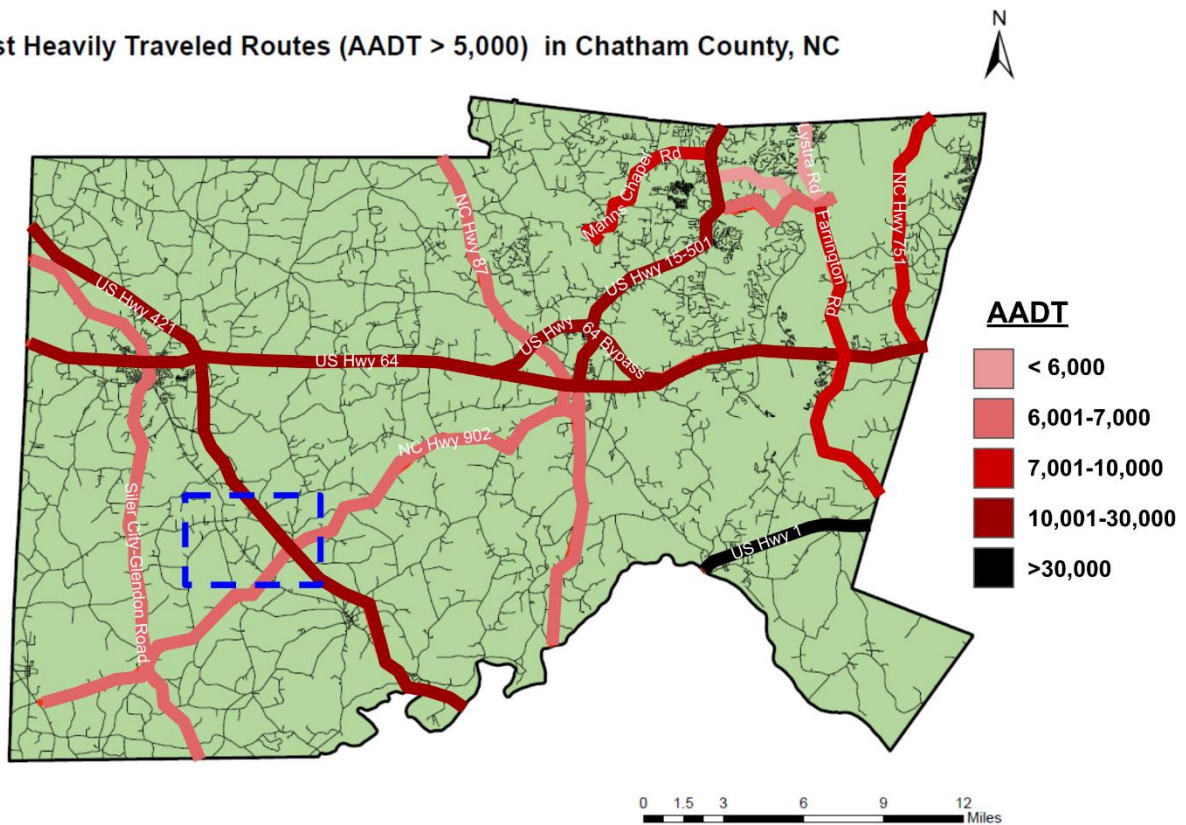


Figure 3. Chatham County basemap with all North Carolina Department of Transportation (NCDOT) recognized routes overlaid. All 16 routes in the county with Annual Average Daily Traffic (AADT) exceeding 5,000 vehicles/day are highlighted in red. See Table 3 for a listing of these routes. Map produced with ArcMap 10.3.1.

Possible Charging Stations for People Driving Electric Vehicles

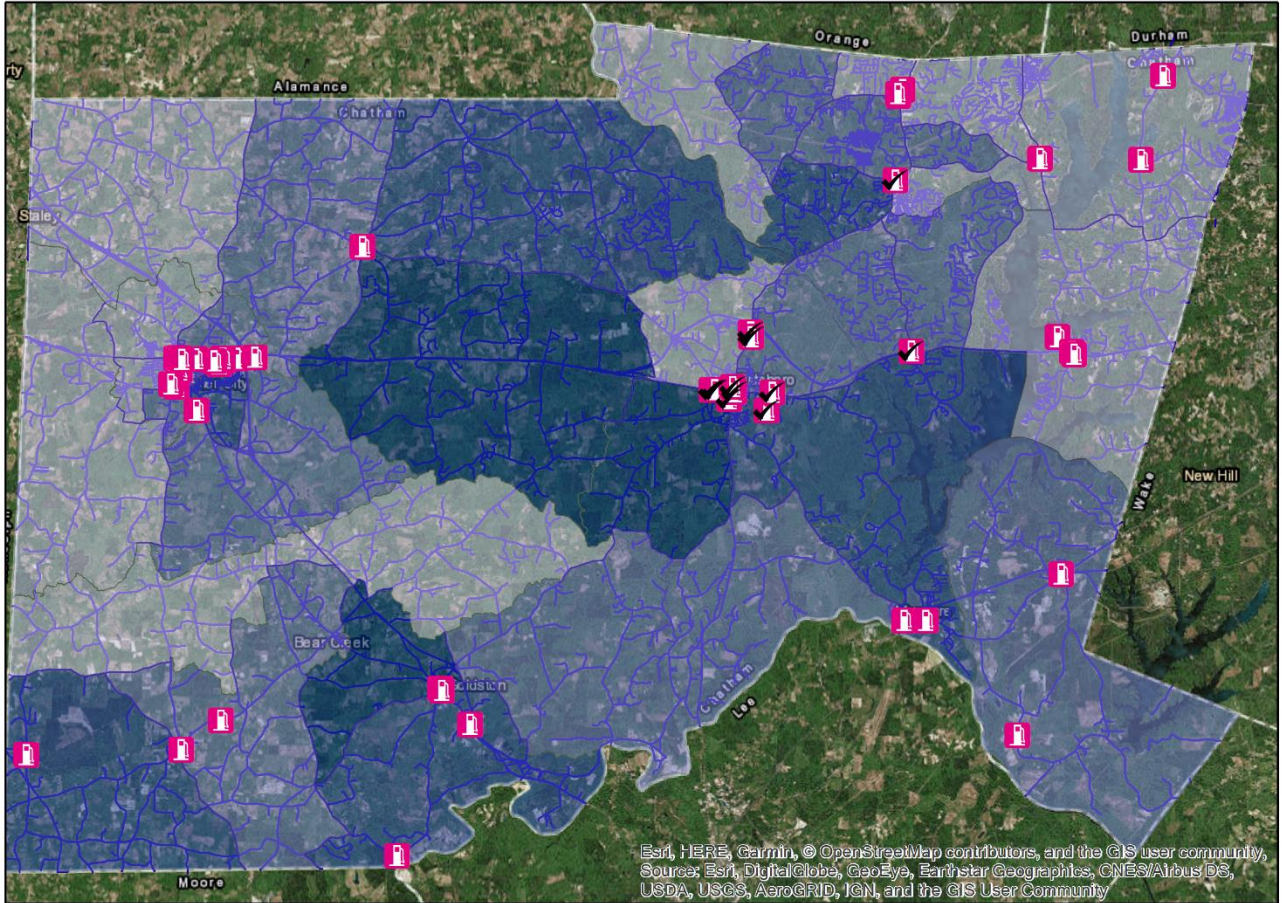
ArcMap was used to present map data. While upgrading existing service stations to include infrastructure for charging electric vehicles can be expensive, identifying the most used and centralized stations could prove cost effective as the most use would likely result from these most populous locations (shown on the figure 4 as highlighted blue spots). Using this visual in tandem with tabular data of annual average daily traffic (AADT) and vehicle miles

traveled (VMT) (Figure 3) will depict the most frequently traveled and visited locations in Chatham County. We will then use this data to plan the most effective grid of charging stations possible with current data. First, by using the Select by Attributes tool, the proper locations can be acquired and pulled out as a new layer for analysis (narrow the gas station information from the whole North Carolina area to Chatham County for Figure 4). Then, filtering the census block layer and its attribute table and set each block with proper color degree we are able to acquire the location with highest population concentration (Labeled as 1-4 as 1 presents as the base number of 600-3000 people in this area and 2, 3, and 4 is the factor to multiply by the base number). Finally, using the Select by Location tool, desired gas stations to install charging stations for electric vehicles in Chatham County with minimum distance (marked with a check mark above the gas station symbols) from the locations that have the highest population concentration can be shown on the graph and ready for audiences to get proper data they want. By using data collected from the Figure 4, Chatham County's Climate Change Committee may be able to find the gas stations that have highest effectiveness to install charging stations. The gas station marks represent all the gas stations within Chatham County and the colored polygons represent each census block and the darker the color, the higher the population concentration is inside a particular area. Thus, they can use the two provided visual maps (Figures 3 and 4) together and find out the best candidates for installing charging stations that will provide the most convenience and highest efficiency.

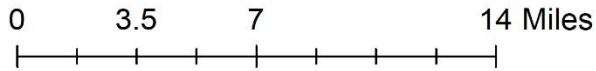
By using data collected from the first map, Chatham County's Climate Change Committee will be able to find the possible gas stations that have highest effectiveness to install charging stations. The gas station symbols represent all the gas stations within Chatham

County and the colored polygons represent each census block and with the darker the color, the higher population concentration is inside a particular area. Thus, they can use the two provided visual maps together and find out the best candidates which are the gas station symbol with a check mark next to them for installing charging stations that will provide the most convenience and highest efficiency.

Possible Charging Stations In Chatham County




Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



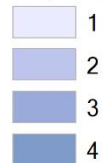
Coordinate System: NAD 1983 StatePlane North Carolina FIPS 3200 Feet
 Projection: Lambert Conformal Conic
 Datum: North American 1983
 False Easting: 2,000,000.0026
 False Northing: .0000
 Central Meridian: -79.0000
 Standard Parallel 1: 34.3333
 Standard Parallel 2: 36.1667
 Latitude Of Origin: 33.7500
 Units: Foot US

Information Used Above

- ✓ Possible Charging Stations
-  Gas Stations In Chatham County

Chatham County Population Concentration

Population Concentration



— Chatham County Roads

Figure 4: Population concentration, gas stations, and road locations combined to determine the best charging station locations

Possible Locations to Establish Internet Hotspots for Chatham County

In the map listed (Figure 5), there are multiple layers of variables such as zip codes, census blocks, and internet connectivity within Chatham County. However, the method used to present this data is slightly different from the first map (Figure 4). Other than using ArcMap desktop version, this map is composed by ArcGIS online, which is an online mapping program that extends its accessibility to various audiences. Users are not required to understand the fundamentals of GIS mapping such as reading ArcMap and receiving data through the specific applications (ArcGIS and ArcMap). All data used to present this map can be found online at ArcGIS official website and the final map (Figure 5) is able to be opened with a single click of a public link.

Web mapping application URL:

<https://ncsu.maps.arcgis.com/apps/View/index.html?appid=0fc43def0cfd44d796222266aee30fd6>

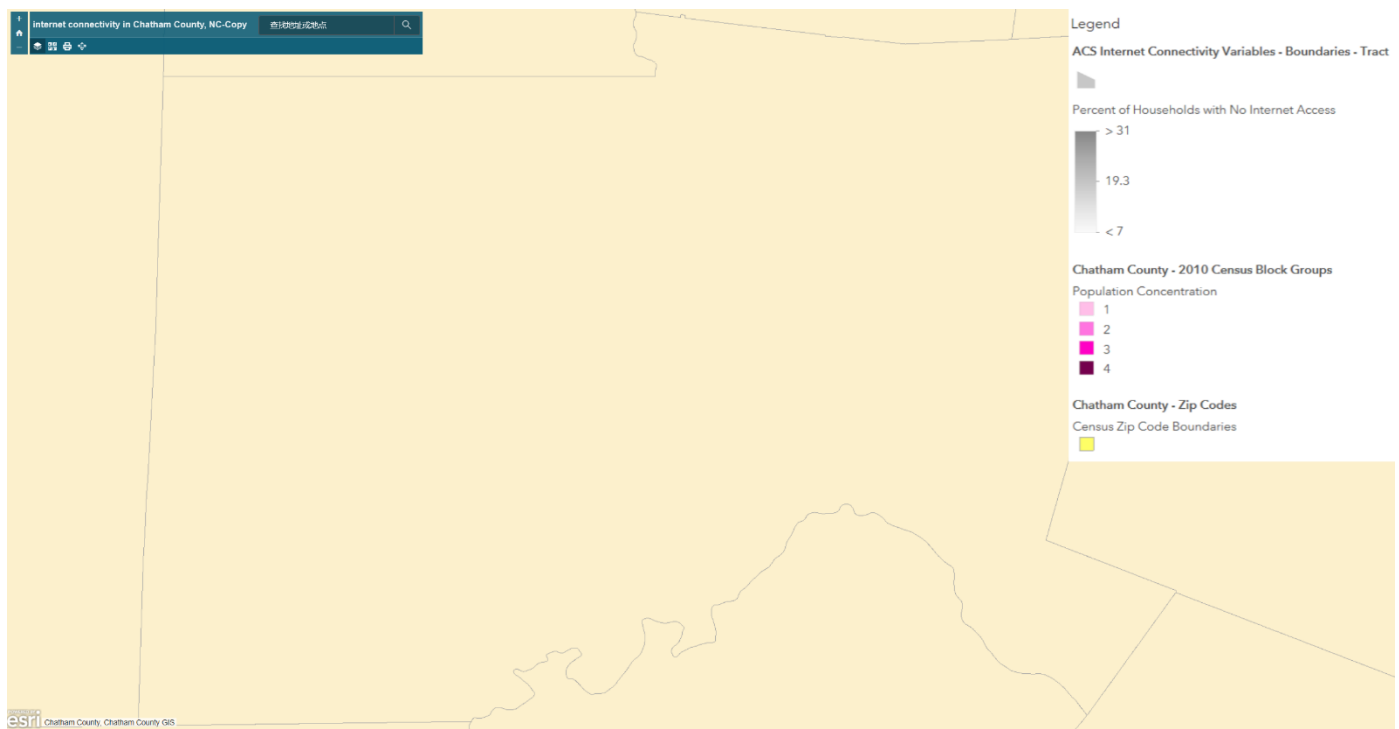
Online map can be acquired through a simple click on:

<https://ncsu.maps.arcgis.com/home/webmap/viewer.html?webmap=9b239865e31d4c5b9786d187e34d5be3>

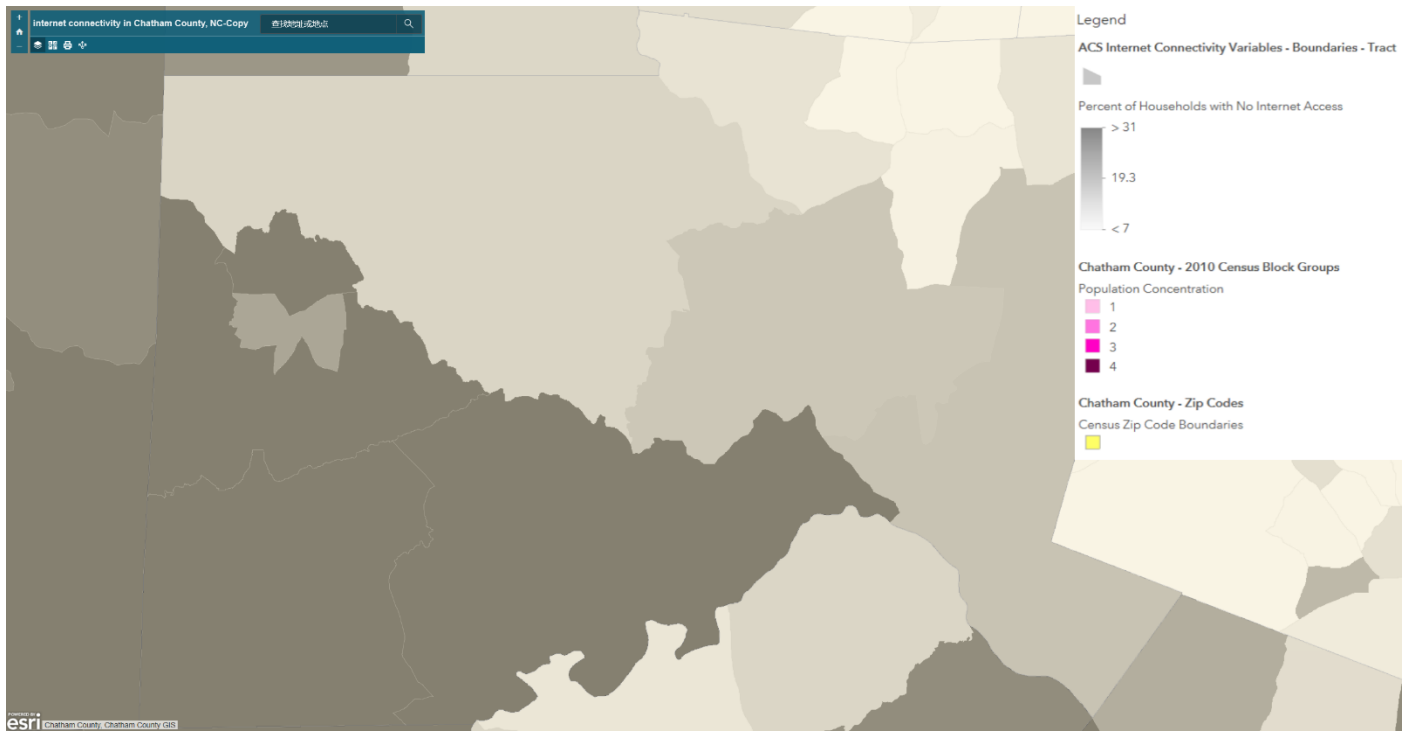
The main purpose of the Figure 5 map is to determine proper locations to install internet cafés in order to help those people who have poor internet connectivity in Chatham County. Additionally, the café aims to reduce commuters' travel mileage for acquiring fast and

stable internet connections. On the map below (Figure 5), the two different color scales used in this map represent two different variables: the black to white color scale represents internet connectivity with darker colors indicating lower internet access, and the pink to purple color scale represents population with darker colors indicating higher populations. Additionally, zip code layers have been included in this map so that it helps viewers determine where the best locations for potential installation of internet cafés could be.

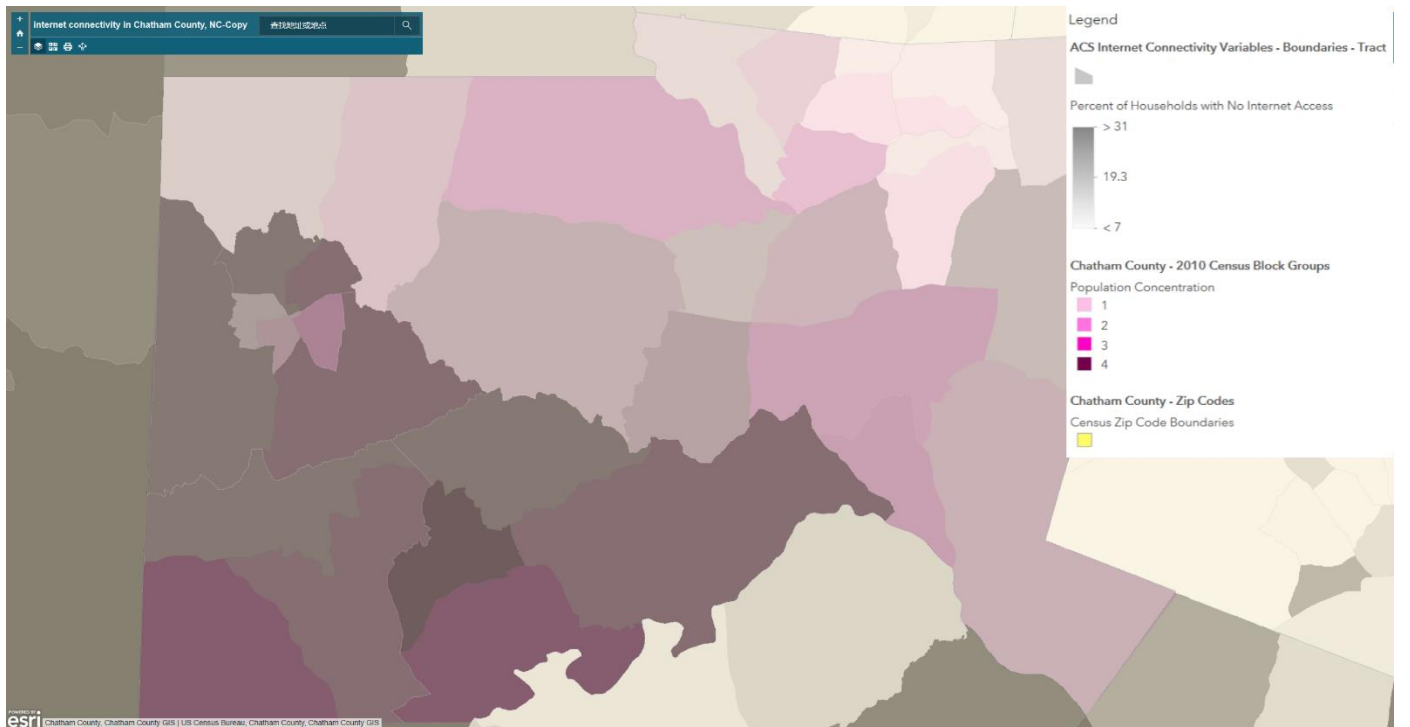
Step 1: Outline of Chatham County



Step 2: Internet connectivity over Chatham County



Step 3: Broadband access overlaid on population density



Step 4: Final Map; coloring adjusted and lowest broadband access with highest population indicated with "1"

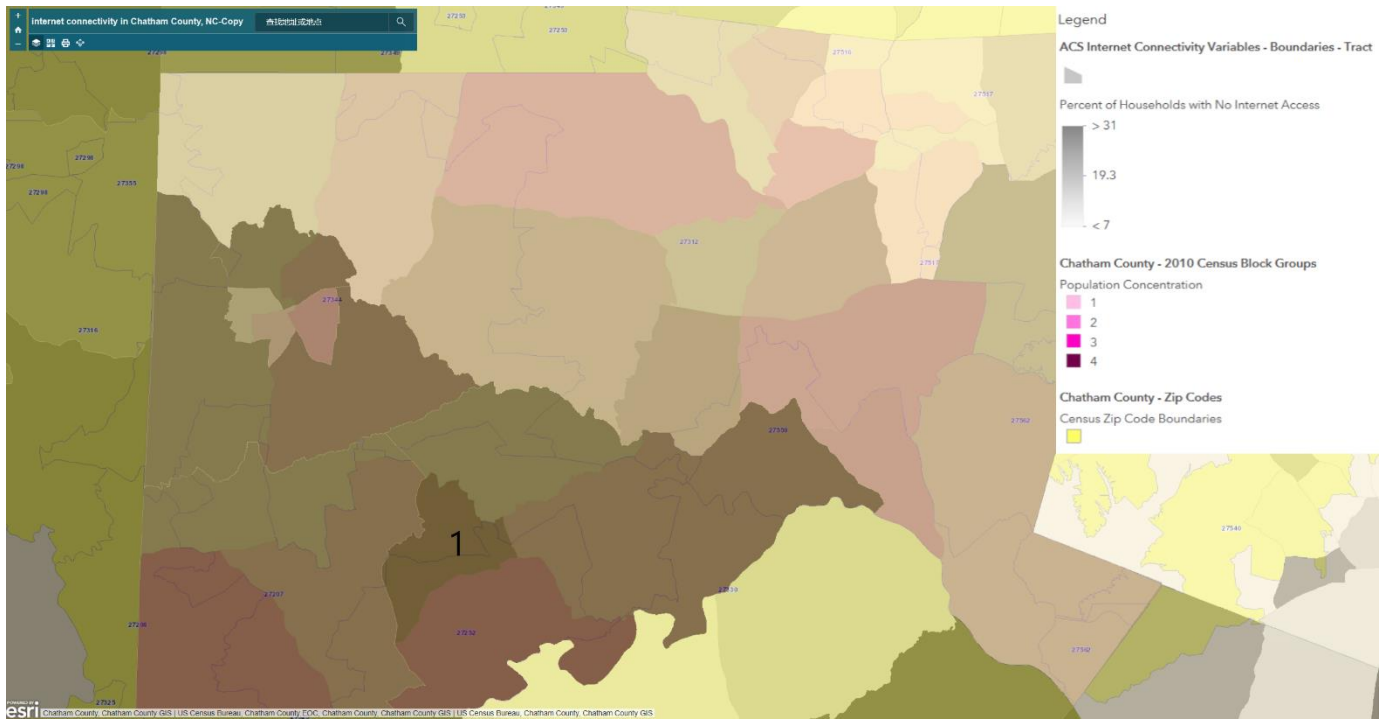
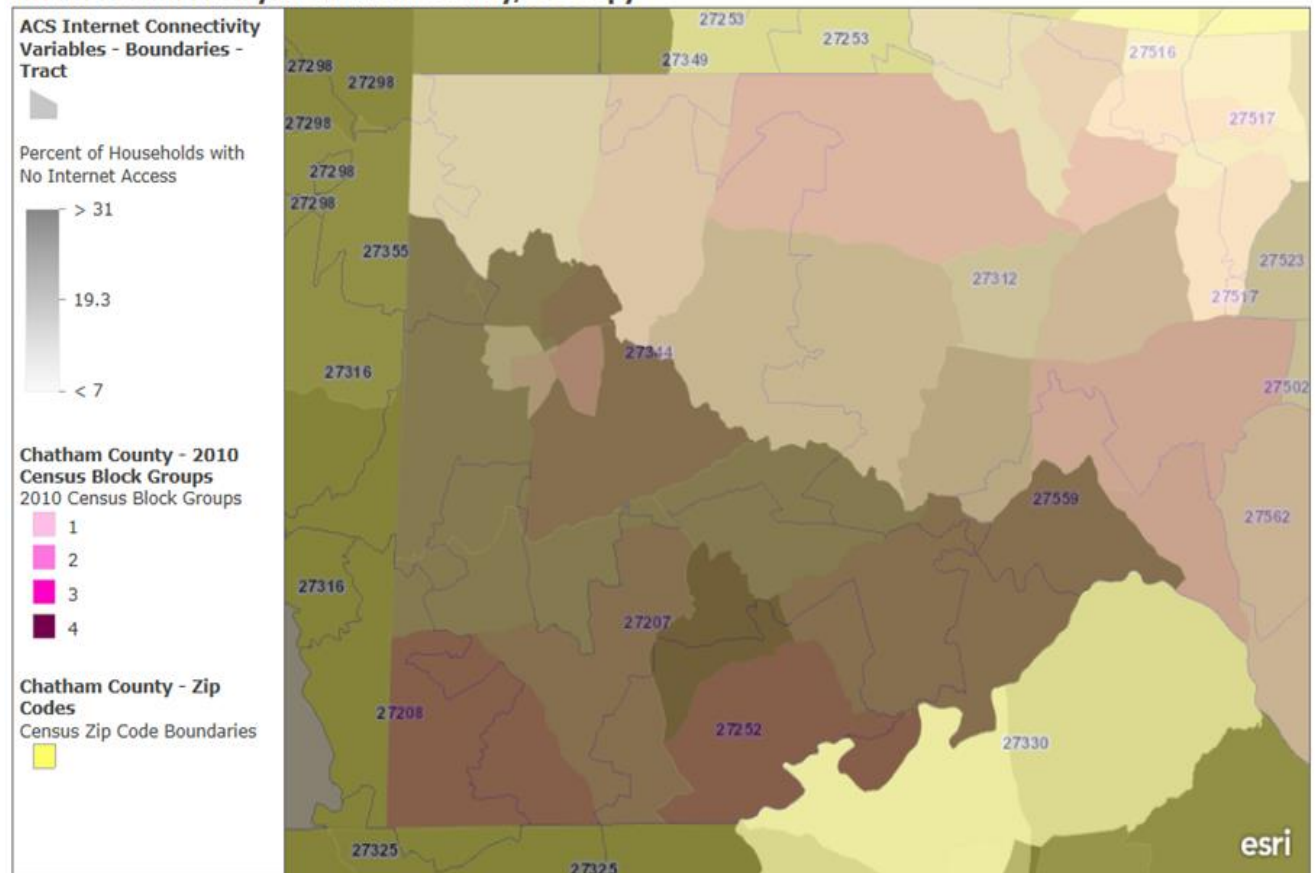


Figure 5: Percentage of households with internet connectivity overlaid with census block groups; the four images displayed show the step-by-step process of developing the map; number “1” on the final map indicates the lowest broadband access in the highest population area

internet connectivity in Chatham County, NC-Copy




Chatham County, Chatham County GIS | US Census Bureau, Chatham County EOC, Chatham County, Chatham County GIS | US Census Bureau, Chatham County, Chatham County GIS

Public Outreach Program

For the hybrid and electric informational poster, Figure 6 was produced. Hybrid and electric vehicles were determined to be cheaper to charge or refill with gasoline annually with an estimate of 15,000 miles per year, which was chosen with reasoning mentioned in the Methods section. The federal tax credit was determined to be a maximum of \$7,500 with several requirements that were summarized in the poster. The link was listed below the information to provide additional information to those who are interested and to avoid misleading the reader due to the summarized nature of the information. Overall, the poster

was able to fit basic information on the cost, CO2 emissions, other benefits, and charging locations.



GOING HYBRID OR ELECTRIC IN CHATHAM COUNTY

GAS & CHARGING PRICES

SAVE MONEY

On average, spend...

Vehicle	Gas	Charge
Gasoline ^{1,2}	\$1,560/year	-
Hybrid ³	\$750/year	-
Electric ^{1,2}	-	\$626/year

Based on 15,000 miles/year

FEDERAL TAX CREDITS


\$7,500

...when you buy a plug-in hybrid or electric vehicle that is...

- Bought new
- In the first 200,000 cars produced
- Has at least 4kWh of battery

<https://www.fueleconomy.gov/feg/taxevb.shtml> for more information

CHARGING LOCATIONS



plugshare.com
google.com/maps

GO GREEN

ESTIMATED LIFETIME EMISSIONS⁴

(Tons CO₂)

20.94		Electric
20.94		Plug-in Hybrid
23.15		Hybrid
26.46		Gasoline

SOURCES

1. <https://www.energy.gov/articles/egallon-how-much-cheaper-it-drive-electricity>
2. <https://afdc.energy.gov/data/10310>
3. <https://www.fueleconomy.gov/>
4. The Green Market Oracle; Prepared by Ricardo1for in collaboration with Low Carbon Vehicle Partnership
5. <http://www.ncsl.org/research/energy/state-electric-vehicle-incentives-state-chart.aspx>

AND MORE⁵

- Qualified plug-in and electric vehicles can use **HOV lane regardless of passengers***
- Qualified plug-in and electric vehicles are **exempt from state emissions inspections**

*Expires 09/30/19

Figure 6: Hybrid and Electric Informational Poster with information on economic, environmental, and miscellaneous benefits of purchasing a vehicle as well as charging locations in Chatham County.

The Earth Fair outline was created with an outline of potential locations for businesses, organizations, and other interactive events (Figure 7). Businesses suggested were listed as supplemental information and to exist as potential resources for Chatham County. Other potential locations were listed and are typically used for other farmers' markets throughout the county. The Earth Fair layout was created as a recommendation and source of ideas for future sustainable events with the objective to draw in normal residents of Chatham County.



Figure 7: Earth Fair outline which suggests a layout of businesses, organizations, and other interactive events

Discussion

Data Analysis and Contribution to Objective

Analysis of data acquired through this project revealed a relatively homogeneous distribution of socioeconomic status across Chatham County, yet showed how certain portions

of the county, namely the southwestern half of the county, may face a steeper climb in working toward sustainable methods of transportation. An exception to the aforementioned homogeneity is areas such as Siler City and locations south and west where broadband access is at its lowest values in the entire county (Fig. 5). The lack of access to broadband internet is noteworthy, because this elicits auxiliary transportation effects in how residents will travel to more urban locations to obtain temporary internet access for work and/or leisure. Consultation with the Chatham County Climate Change Advisory Committee and subsequent discussion yielded the understanding that targeting a reduction of single-point emissions would likely have a more tangible impact on cumulative transportation-borne greenhouse gas emissions compared to a more ambitious approach of implementing large-scale hybridized transportation alternatives. The tabular and GIS data obtained further supported this approach by way of identifying hotspots within the county that would most benefit from sustainable transportation planning.

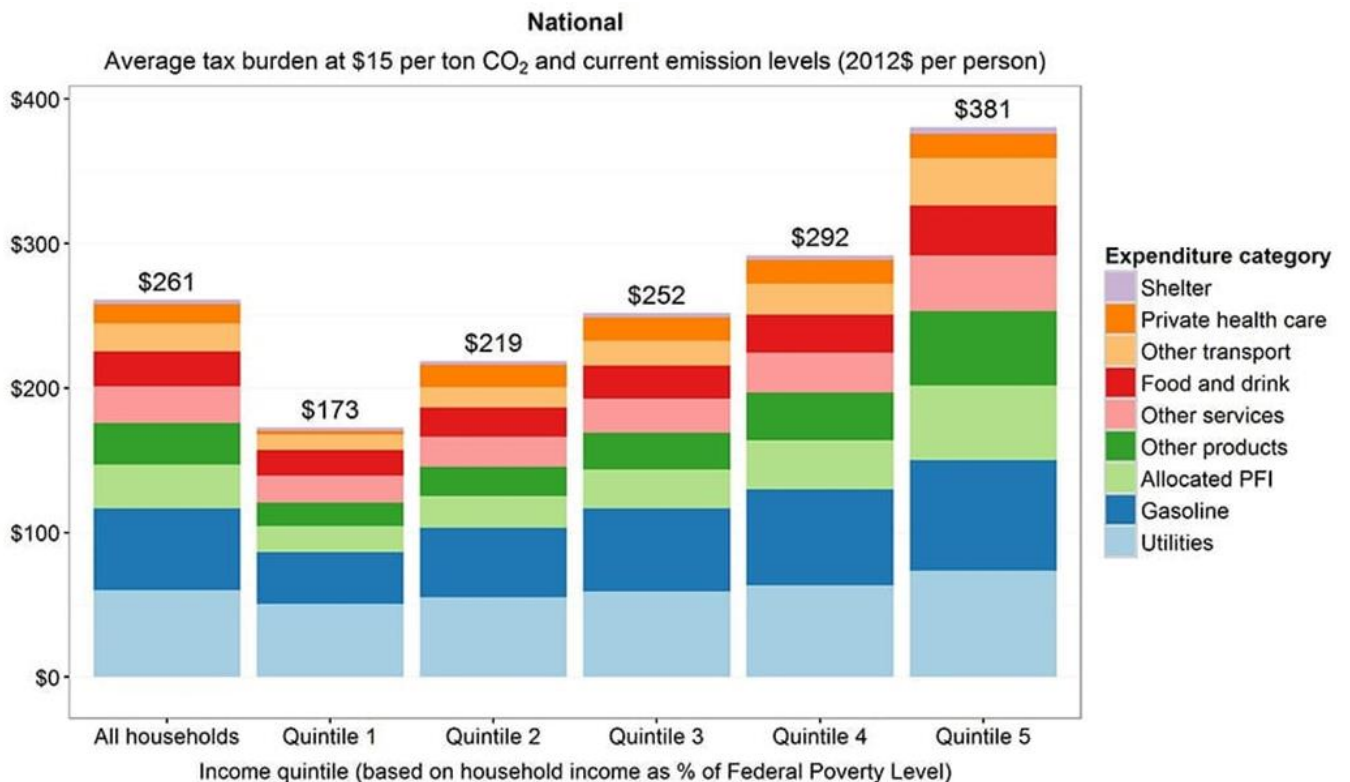
Figure 1 exhibited clustering of gas/service stations in the Siler City proper (west central Chatham County) and Pittsboro proper (east central Chatham County), in addition to evenly-distributed stations in the northeastern region of the county where urban development is a priority south of Chapel Hill. The central tract of the county and the northwestern corner of the county is void of convenient locations for gas stations, which becomes problematic for those commuting to the Piedmont Triad region for their occupations. Retrofitting some of these gas stations with hybrid vehicle charging and maintenance infrastructure is likely to yield dividends in sustainable transportation methods for residents of Chatham County.

Figure 5 displays a dichotomy of internet connectivity and convenience in the county, with the northeastern half of the county with seemingly no significant gaps in internet access, while the southwestern half of the county containing much more sporadic coverage. Thus, installation of multiple internet cafés in the southwestern region of Chatham County near the communities of either Goldston, Bennett, or Bear Creek is also likely to produce positive results toward our primary objective of increasing sustainable transportation education, maintaining the character and tradition of Chatham County, and building toward a more sustainable future for the county. Implementation of this internet café and how it attends to auxiliary causes to increased transportation will hopefully generate discussion on how to mitigate unnecessary transportation by way of proposing solutions to underlying roots of why people need to commute. Perhaps this outside-in approach will enhance the efficacy of sustainability discussions and projects in Chatham County.

Energy Innovation and Carbon Dividend Act (H.R. 7173) Household Impact Study

Taxes are a common way of reducing an unwanted behavior in society. An example of this is the tax on cigarettes. Cigarettes are not only a harm to the smoker but pose health risks for innocent bystanders. This led to a tax on cigarettes. The increased cost of cigarettes reduced consumption while increasing overall public health and creating a source of revenue for the government (Ummel, 2016). A carbon tax will have the same effect on carbon dioxide emissions. The increased cost of emitting carbon dioxide will result in a reduction in emissions in addition to increased air quality standards and revenue that will be redistributed to American households. The reduction will also have an overall benefit on the mitigation of the effects of climate change.

One of the most significant factors in the Energy Innovation and Carbon Dividend Act is its bipartisanship. In the current political climate, there has been a reduction in environmental regulations and standards that has caused tension between both political parties. This bill provides a way in which the country will be able to reduce carbon dioxide emissions whilst not restricting the emissions of carbon dioxide. This appeals to both Democrats and Republicans, as well as special interest groups. The legislation also appeals to voters who in return will be receiving the annual carbon dividend. The bill has a high probability of being passed and is gaining lots of support. The passing of this legislation will create a significant decrease in carbon dioxide emissions and increase on quality of life.



Bar graph showing estimated increase in costs for all US households, as well as for each of 5 income quintiles (quintile 1 = lowest income, quintile 5 = highest income). The average household in any quintile with a cost below \$261 would be expected to experience a net benefit from the policy. (Ummel, 2016)

In February 2016, Citizens' Climate Education (CCE) and Citizens' Climate Lobby (CCL) released a working paper that assessed the net financial impact on U.S. households of a \$15/ton of CO₂ carbon fee in which all proceeds are returned to households on a per-capita basis (figure above) (Ummel, 2016). The figure shows the impact on all households and households of different income levels starting from lowest income level and increasing per quintile. As the income level increases, the expenditures become costlier from the tax. The study assumes that firms pass the entire carbon fee on to consumers in the form of higher prices and there is no change in employment, technologies, or consumer behavior. The net financial effect becomes the difference between the increased price of the good or service and the additional income from the dividend. An estimated 53% US households or 58% of individuals would see a positive net benefit from the policy. Although higher income families have a net loss, the loss will be minimal. 15% of households in the 5th quintile benefit while 42% experience a minor loss which can be defined as a loss of less than 0.2% of their annual income (Ummell, 2016). Higher income families are generally taxed higher because they emit more carbon dioxide. The tax also incentivizes households to reduce their individual carbon footprint. They can reduce their carbon footprint through different avenues such as more efficient modes of transportation, more efficient living conditions, and more environmentally friendly consumer choices (Ummell, 2016).

The Climate Citizen's lobby has created a tool that generates an estimated annual carbon dividend initially based on the number of adults, minors, and the annual household income. It goes on to ask for a zip code, type of home, number of vehicles, and type of fuel used to heat your home, gas expenditure, price of monthly electricity bill, and price of monthly

heating bill. Looking at the average of all these factors for Chatham County using data from the United States Census Bureau, Data USA, and Electricity Local, a household could make an average of \$13/month when the policy is enacted (The Bipartisan Climate Solution). This does not seem significant in the short term, but with the increase of the tax every year, individuals can expect for the annual carbon dividend to increase as well. It is also important to note that this annual dividend was collected without knowing the type of fuel used for heating homes and could not input the price of a monthly heating bill. The monthly dividend is most likely to increase with this information.

Along with creating jobs and reducing greenhouse gas emissions, the Energy Innovation and Carbon Dividend Act will have a significant impact on lower income families. The distribution of the carbon dividend is highly progressive, with 90% of people below the Federal Poverty Line benefiting from the policy. (Ummell, 2016) This policy will consequently decrease the wage gap between higher income and lower income families. The annual dividend can provide individuals with the help they need to take different opportunities to raise their economic status. It also provides them with money to spend on everyday things, where they would otherwise struggle to obtain.

Conclusion and Recommendations

Chatham County's population growth should represent an opportunity to implement sustainable technologies for long-term economic and environmental impacts. Chatham county

can implement sustainable practices in a way that fits their environment and means. The county's most significant problem within transportation seems to be the average commuting time. Based on the obtained research, suggestions for Chatham county to reduce their individual carbon dioxide emissions include:

1. Establish **electric charging stations** at gas stations and grocery stores along commuting routes
 - i. Consider [solar recharge stations](#) to solve potential problem of sourcing from non-renewables and increasing carbon footprint
2. Aim for completely "**renewable**" (**not nuclear**) **energy** for new technologies but continue use of nuclear since it is available and a clean energy despite the technicalities
3. Establish at least one **internet café** in areas shown to have low broadband connectivity to reduce the need for commuting
4. Host an **Earth Fair** to educate and engage the community in clean energy, including hybrid and electric vehicles
5. Closely monitor the **Energy Innovation and Carbon Dividend Act** and possibly work to gain citizen support for local politicians to see

Works Cited (APA)

Alternative Fuels Data Center: Hybrid Electric Vehicles. Retrieved from

https://afdc.energy.gov/vehicles/electric_basics_hev.html

Energy Innovation and Carbon Dividend Act, H.R. 7173, 115th Cong. (2017-2018).

Joca, L. & Kolosna, C. (2016). 2015 Greenhouse Gas Emissions Inventory for Chatham County, North Carolina. Retrieved from

<https://www.chathamnc.org/home/showdocument?id=31260>

Schroeder, A., & Traber, T. (2012). The economics of fast charging infrastructure for electric vehicles. *Energy Policy*, 43, 136-144. doi: 10.1016/j.enpol.2011.12.041

The Bipartisan Climate Solution. (n.d.). Retrieved from <https://citizensclimatelobby.org/energy-innovation-and-carbon-dividend-act/>

Ummel, K. (2016). Impact of CCL's proposed carbon fee and dividend policy: A high-resolution analysis of the financial effect on U.S. households. International Institute for Applied Systems Analysis (IIASA), 1(4), 1–40. Retrieved from https://11bup83sxdss1xze1i3lpol4-wpengine.netdna-ssl.com/wp-content/uploads/2016/05/Ummel-Impact-of-CCL-CFD-Policy-v1_4.pdf

Energy Innovation and Carbon Dividend Act: The Bipartisan Climate Solution. (n.d.). Retrieved from <https://energyinnovationact.org/how-it-works/>

CHATHAM COUNTY, NC. (n.d.). Retrieved from <https://datausa.io/profile/geo/chatham-county-nc/#top>

Pittsboro, NC Electricity Statistics. (n.d.). Retrieved from

<https://www.electricitylocal.com/states/north-carolina/pittsboro/>

QuickFacts Chatham County, North Carolina. (n.d.). Retrieved from

<https://www.census.gov/quickfacts/fact/table/chathamcountynorthcarolina/HSD31021>

[7](#)

Come Ride With Us. (n.d.). Retrieved from <https://chathamtransit.org/transportation-services/>

Snapshots of the Triangle Chatham County. (2014). Triangle Community Foundation, 1–6.