Clean Transportation Strategies for Rural Communities in the Northeast and Mid-Atlantic States

With Analysis of Maine, Vermont, Virginia, and Maryland

November 2020

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Acknowledgements

The following report provides an independent technical analysis exploring the potential benefits that rural communities could derive from clean transportation policies in the Northeast and Mid-Atlantic region, focusing specifically on Maine, Vermont, Virginia, and Maryland. These four states capture a wide geographic region, with varying degrees of rural and urban communities. The study discusses programs to encourage electric vehicle adoption and other clean transportation options in rural communities, ensuring that the benefits of a clean transportation system are felt broadly across rural, suburban, and urban communities. The project was a joint effort of the Union of Concerned Scientists and M.J. Bradley & Associates with funding from Merck Family Fund and Daniel Hildreth.

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Executive Summary

Opportunities are available to achieve significant emissions reductions from the transportation sector in the Northeast and Mid-Atlantic states by transitioning to electric vehicles and other clean transportation strategies. Not only will this transition benefit communities by improving air quality and reducing emissions, it also has the potential to significantly benefit communities that are disproportionately burdened by transportation emissions, lack access to reliable transportation services, or that devote a disproportionate share of their household income to transportation costs—frequently communities located in urban or rural areas.

This report utilizes demographic and vehicle fleet data in four Northeast and Mid-Atlantic States—Maryland, Virginia, Maine, and Vermont—to evaluate the potential barriers and opportunities for transitioning rural communities to a clean transportation system by: (1) assessing existing demographic and vehicle fleet usage patterns, (2) identifying potential policy options to encourage the development of a clean transportation system, and (3) providing real-world examples of clean transportation opportunities within rural communities.

All four states discussed in-depth within this analysis have significant rural populations. By combining several different data sources, this study is able to shed light on some of the distinguishing characteristics of rural communities in this part of the country, as well as the opportunities and challenges they might face in transitioning to clean transportation alternatives.

Key Findings from Analysis

1) **Rural counties have: (1) more families living in single family homes; (2) an older population; (3) lower household income; (4) more large vehicles; (5) an older vehicle fleet; and (6) more vehicles with lower miles per gallon (MPG).** Each of these characteristics will have varying impacts on clean vehicle uptake within rural communities. Some characteristics will positively impact clean vehicle uptake (e.g., it is easier to install home chargers for single family homeowners) whereas others will necessitate the use of other policy approaches to create a clean transportation system for rural communities (e.g., older populations may need access to more public and shared transportation options).

2) **Due to differences in fleet characteristics and driving behavior, rural communities stand poised to reap the financial benefits of electric vehicles and advances in clean transportation, both from fuel cost savings and reduced maintenance costs over the lifetime of a vehicle.** Across these four states, rural households could save between about $1,900 and $2,800 per year by switching from conventional gasoline vehicles to electric vehicles (EVs).

3) **A clean transportation system for rural communities includes: (1) the use of cleaner, more efficient vehicles; (2) more expansive public and shared transportation opportunities; (3) more active transportation, like walking and biking; and (4) better access to telehealth and telecommuting by expanding communication infrastructure.** Rural communities can share in the benefits of a clean transportation system by reducing household expenses, improving access to critical services, and delivering public health benefits.

Introduction

Access to reliable, convenient, and affordable transportation options is critical to the economic health and vitality of rural communities, just as it is for larger urban centers. But the challenges and opportunities for rural and urban transportation landscapes vary. On average, rural households spend more of their budgets on transportation compared to urban households. According to the Bureau of Labor Statistics, rural workers must travel on average 38 percent more miles than their urban counterparts, while rural low-income workers travel 59 percent more.[1] Motor vehicles also produce harmful air pollution and the transportation sector is the leading source of greenhouse gas emissions in the United States, accounting for 28 percent of total greenhouse gas emissions.[2] In the Northeast and Mid-Atlantic region, the transportation sector accounts for approximately 40 percent of total emissions.[3] Transitioning to clean transportation alternatives can improve quality of life, support vibrant rural communities, reduce air pollution, and help to address climate change.

This report evaluates the existing demographic and vehicle usage patterns of four states—Maine, Vermont, Virginia, and Maryland—and utilizes that data to inform a series of clean transportation policy options for rural residents to ensure all rural communities have access to a clean transportation system that is safe, reliable, and that increases access to health care, employment, and educational opportunities. Throughout this analysis, we explore the unique characteristics of this representative sample of rural communities to explore the challenges and opportunities that they face in adopting clean transportation solutions. We hope that this analysis will inspire further discussion about the design and implementation of the Transportation Climate Initiative program in the Northeast, described below, with a focus on rural communities, as well as other clean transportation policies.

Background —Transportation Climate Initiative

In December 2019, a bipartisan group of Northeast and Mid-Atlantic states and the District of Columbia announced a draft plan (or "Draft Memorandum of Understanding") for a regional program to limit the greenhouse gas emissions resulting from the use of motor vehicle fuels (gasoline and diesel). The states had initially called for a final plan to be completed by the Spring of 2020, but with the COVID-19 pandemic taking priority, the schedule has been pushed back to the Fall. Once the plan is complete, each jurisdiction will decide whether to sign the regional agreement and participate in the regional program.

At the heart of the current draft plan is a proposal to implement a regional "cap-and-invest" program. States would set a limit on CO_2 emissions from motor vehicles. Regulated fuel suppliers would be required to purchase allowances to cover the carbon in the gasoline and diesel fuel they sell. As outlined in the draft Memorandum of Understanding, each jurisdiction would invest the proceeds in programs to help the region "transition to affordable, low-carbon transportation options that provide substantial public health benefits, reduce congestion, and increase economic and job opportunities." This might include investment in public transit, financial incentives to purchase electric vehicles, or incentives to invest in electric vehicle charging equipment, among many other options.

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1 Todd Litman, Public Transportation's Impact on Rural and Small Towns: A Vital Mobility Link, American Public Transportation Association (2017), https://www.apta.com/wp-content/uploads/Resources/resources/reportsandpublications/Documents/APTA-Rural-Transit-2017.pdf, at 15.

2 "Fast Facts on Transportation Greenhouse Gas Emissions." U.S. Environmental Protection Agency. https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions.

3 Gabe Pacyniak, Kathryn Zyla, Vicki Arroyo, Matthew Goetz, Christopher Porter, and David Jackson, Reducing Greenhouse Gas Emissions from Transportation Opportunities in the Northeast and Mid-Atlantic (November 2015), www.georgetownclimate.org/files/report/GCC-Reducing_GHG_Emissions_from_Transportation-11.24.15.pdf, at 25-26 and 32.

The draft agreement also commits the participating states to work with their local communities to ensure that "the benefits of a cap-and-invest program flow equitably to communities that are underserved by clean transportation alternatives, disproportionately bear the costs of the current transportation system, or suffer disproportionate impacts of vehicular pollution and climate change". This emphasis on equity and the needs of historically underserved communities was part of the motivation for this report. Rural communities, in the past, have sometimes struggled to access funding for transportation and communication infrastructure; public transit options are often limited due to geography; access to healthcare and other basic services may be difficult; and income may limit a household's ability to access clean transportation alternatives. Preliminary research also shows that rural communities support the idea of a clean transportation fund, but more outreach and focus on solutions for rural communities is necessary.[4][5]

[4] A poll published by the Nature Conservancy in 2019 found that three-quarters of small town and rural voters in the Northeast and Mid-Atlantic support the creation of a state clean transportation fund.

[5] Andrew Tuck, Small Town & Rural Voters' Views of Investments Related to the Transportation and Climate Initiative a Clean Transportation Fund in the Northeast & Mid-Atlantic (2019). https://www.nature.org/content/dam/tnc/nature/en/documents/TNC_TCI_Survey_2019_Public.pdf.

Data Analysis—Examining the Demographics and Motor Vehicle Fleets of Rural Communities

We begin this report by evaluating the demographics, the motor vehicle fleets, and the driving habits of four states in the Northeast and Mid-Atlantic region: (1) Maine, (2) Maryland, (3) Vermont, and (4) Virginia. All four states have significant rural populations, and by combining several different data sources, this study is able to shed light on some of the distinguishing characteristics of rural communities in this part of the country, as well as the opportunities and challenges they might face in transitioning to clean transportation alternatives.

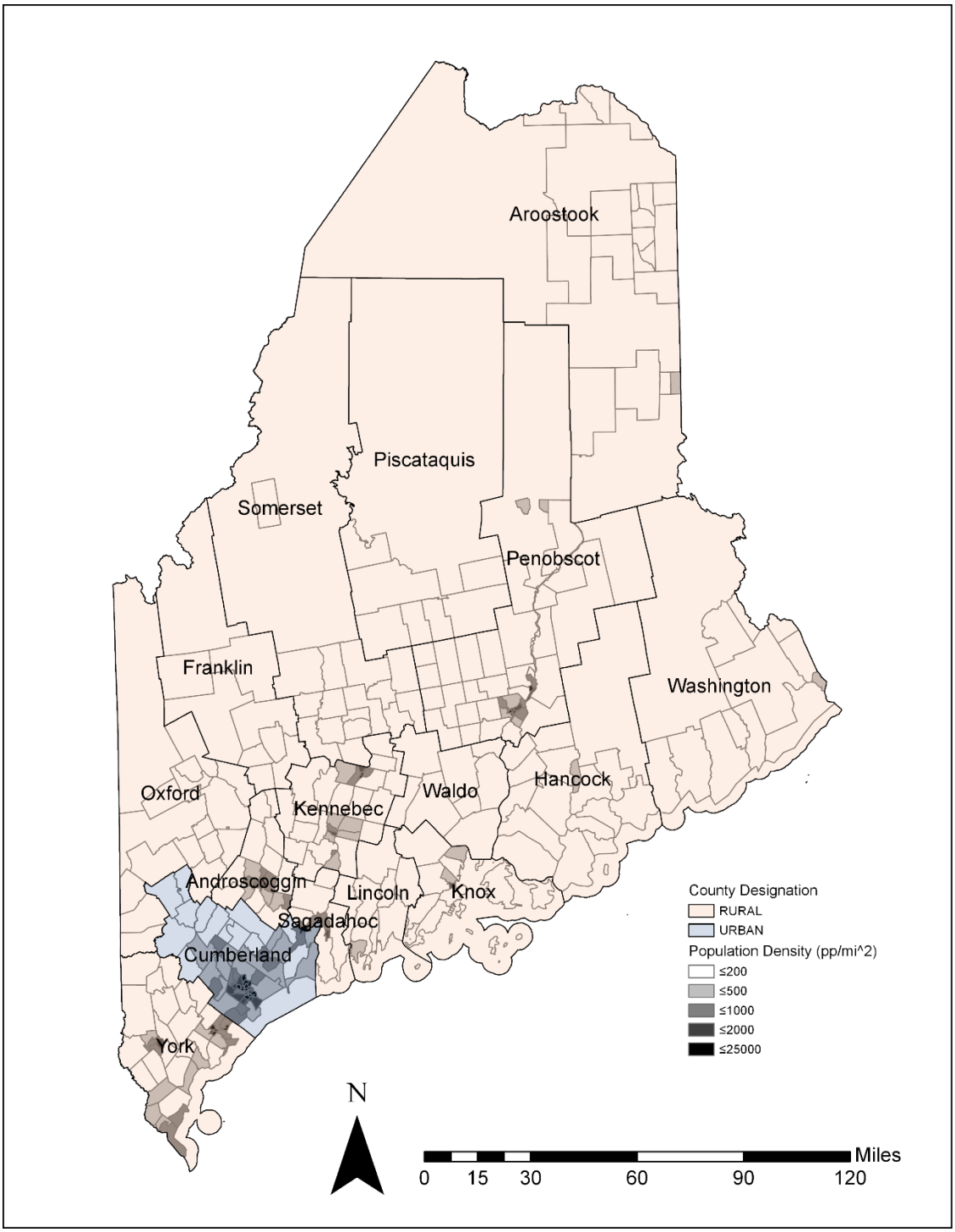
County Designations

For each of the states evaluated, this study compiled the various data sources at the county level. This required designating each county as Urban, Suburban, or Rural based on population density and percent of the population living in an "urbanized area" (UA). An Urbanized Area is defined by the Census Bureau as "a continuously built-up area with a population of 50,000 or more. It comprises one or more places (central places) and the adjacent densely settled surrounding area (urban fringe) consisting of other places and nonplace territory."

For the purposes of this analysis, the study designated counties as "Urban" (1) if population density was greater than 1,000 persons per square mile, or (2) if 55 percent or more of the population within a county lives in an "urbanized area." This two-part definition avoided designating some large counties, with low population density as Rural, despite having most of the population living within an urbanized area. The study designated counties as "Suburban" if they had a population density between 500 and 1,000 persons per square mile, and counties with a population density below 500 persons per square mile were designated "Rural". By these definitions, only 1 of Maine's 16 counties and only 1 of Vermont's 14 counties were designated Urban.[6] Virginia's county designations are unique in that the state contains 38 independent cities, which are administered as counties themselves. This methodology often classifies these "counties" as Urban due to their relatively small land area and dense population, despite most independent cities in the western part of the state being surrounded by low-density rural areas. Table 1 summarizes the county designations for the four states, including the percent of land area and the percent of total state population within each category. Maps showing population density by Census Tract and county type designation – in the style shown for Maine below – are included in the Appendix.[7]

[6] While there are portions of the other counties within Maine that are more densely populated, Maine's large county sizes result in very low population density leading to all but one of Maine's counties being designated as Rural within this study.

[7] These maps present two independent sets of overlaid data: census-tract population density and county type designation as described above.



Maine County Type and Census Tract Population Density

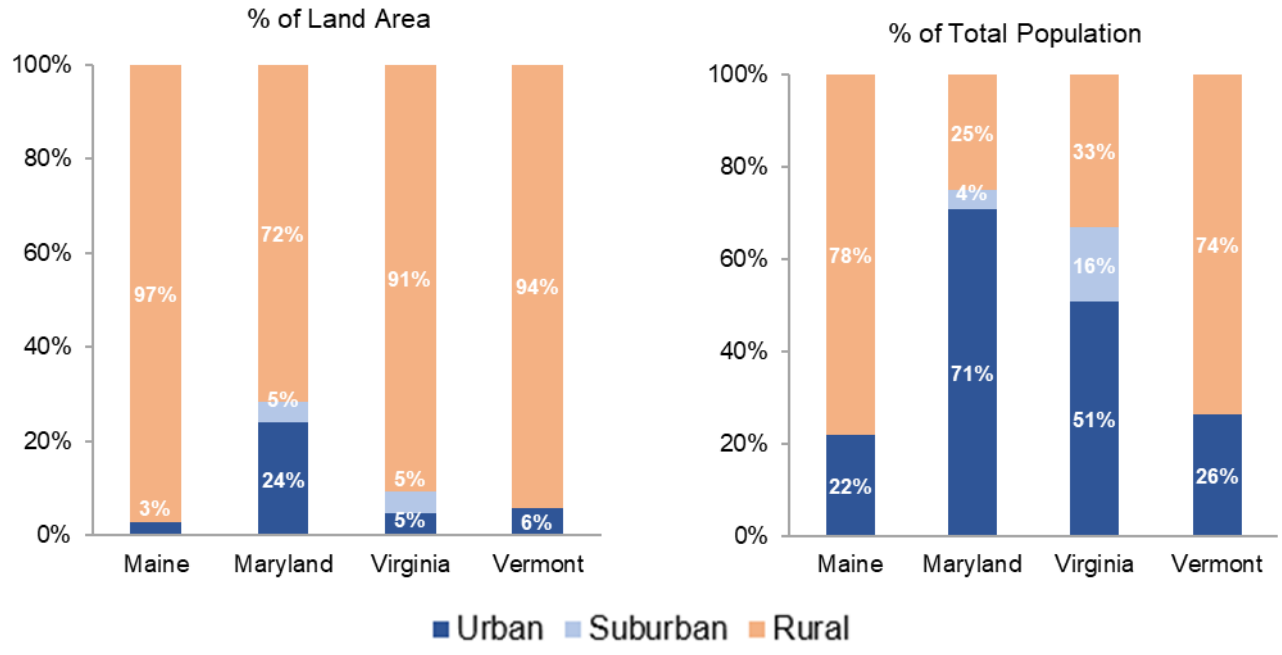
TABLE 1. DEMOGRAPHIC DATA IN MAINE, MARYLAND, VERMONT, AND VIRGINIA

State	# of Counties			% of Land Area			% of Total Population		
	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural
Maine	1		15	3%		97%	22%		78%
Maryland	6	1	17	24%	5%	72%	71%	4%	25%
Virginia	33	13	87	5%	5%	91%	51%	16%	33%
Vermont	1		13	6%		94%	26%		74%

Note: Urban counties = population density greater than 1,000 persons/square mile or 55 percent or more of the population within an urbanized area; suburban counties = population density between 500 and 1,000 persons/square mile; rural counties = population density below 500 persons/square mile.

Rural counties make up a majority of land area in all four states, ranging from 72 percent in Maryland to 97 percent in Maine. Even as the 12th most populous state, Virginia is 91 percent Rural by land area. By contrast, Urban counties in Maryland and Virginia contain the majority of the states' population: 71 and 51 percent of the state's population, respectively. The sole Urban counties in Maine and Vermont contain approximately one quarter of each state's populations, and less than 10 percent of the states' land area. Though Chittenden and Cumberland Counties, containing Burlington, Vermont and Portland Maine, respectively, are relatively sparsely populated compared to other Urban counties, the cities themselves have population densities of 4,119 and 3,905 persons per square mile, respectively. These densities put the two cities on par with cities in Urban counties such as Richmond, Virginia (3,873 persons per square mile, pp/mi^2) and Rockville, Maryland (5,531 pp/mi^2).

Figure 1. Land area and Population in Urban, Suburban, and Rural Counties



DEMOGRAPHICS

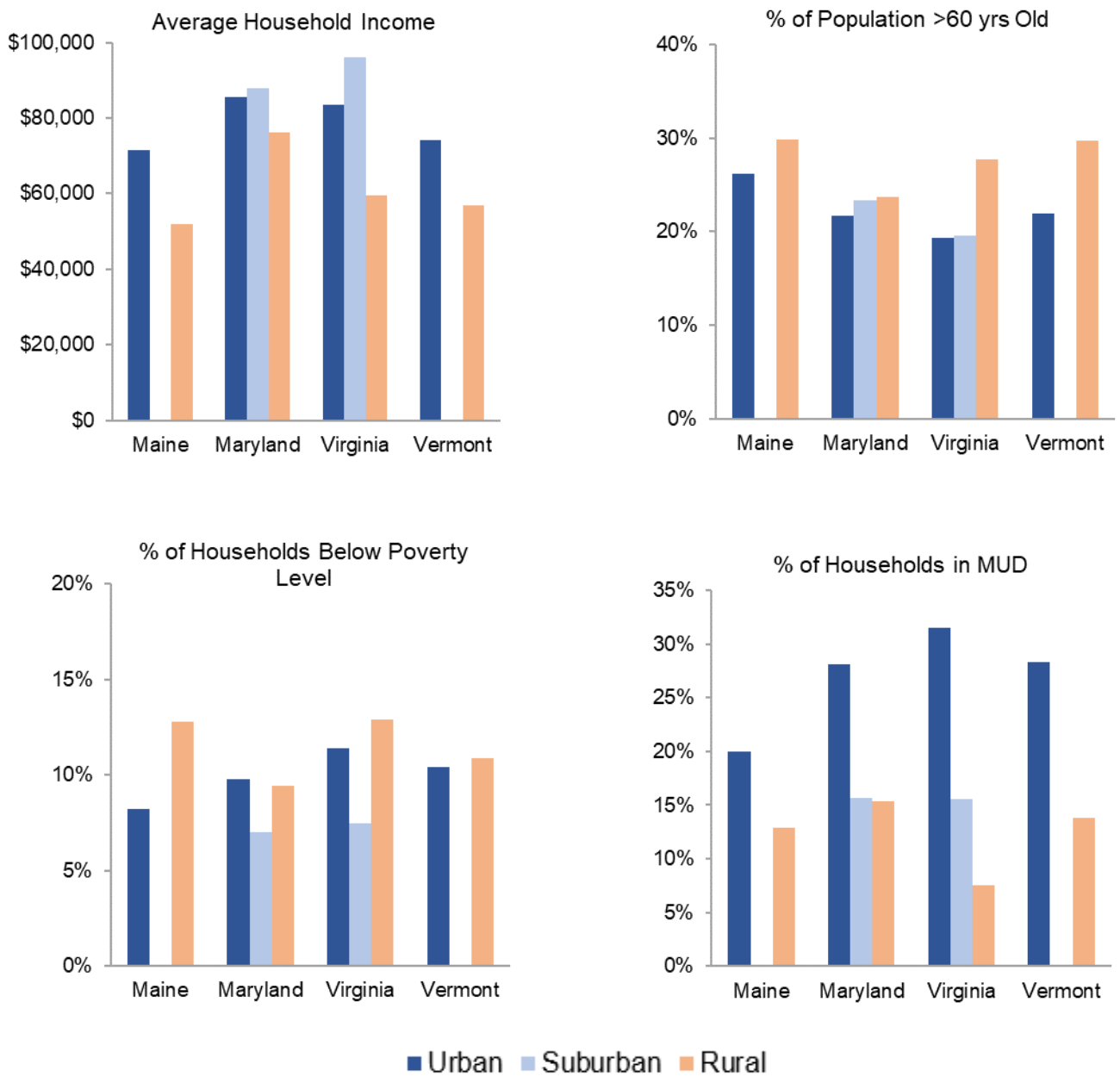
Across all four states, the population of Rural counties were found to be older, on average, than their Urban and Suburban counterparts. For example, in Virginia, 19 percent of the Urban population is over the age of 60, compared to 28 percent for the Rural designated counties.

Average household incomes also vary across Urban, Suburban, and Rural counties. In Virginia, the average household income in a Suburban county is $96,194, compared to $59,578 in a Rural designated county (i.e., Rural is 38 percent lower). In all four states, the average household income was lower in Rural counties, ranging from 13 percent lower in Maryland to 38 percent lower in Virginia (both compared to Suburban county averages). Similarly, poverty rates tended to be highest in Rural counties, except for Maryland.

Additionally, as one would expect, census data show that in all four states, Urban households are significantly more likely to live in Multi-Unit Dwellings (MUDs).[8] In Urban Virginia counties, 32 percent of households live in MUDs, compared to just 8 percent of Rural households. In Maine, Virginia, and Vermont, less than 15 percent of households in rural counties live in MUDs.

[8] This analysis considers MUDs to be units which are part of a group of 3 or more. Single- and two-family homes generally have dedicated parking spaces which would facilitate at-home charging.

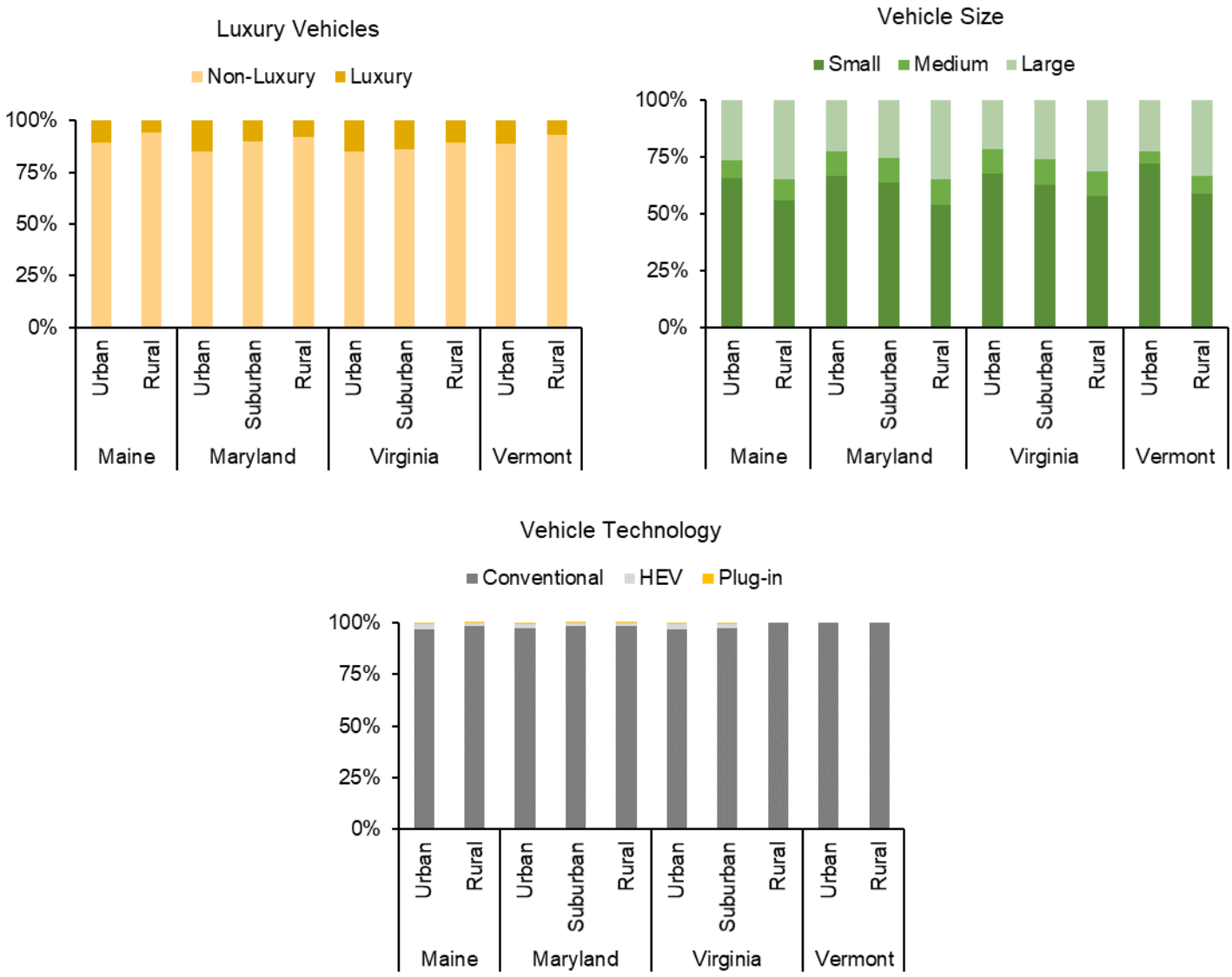
Figure 2. Demographic Data for States in Study Area



Motor Vehicle Fleets

Vehicle registration data in the study region reveals information about the number and types of personal vehicles owned by residents. Passenger vehicle fleets in rural and urban counties vary in terms of vehicle type/size, classification as luxury or non-luxury, and vehicle technology. In all four states, Rural counties had a higher proportion of Large passenger vehicles (i.e., full-size SUVs, pickup trucks, and vans). In Urban counties, Small vehicles dominate; this includes compact cars, mid-size cars, and sports cars. Medium size vehicles include full-size passenger cars and mid-size SUVs. Additionally, there are a greater share of luxury vehicles in Urban counties, as well as a higher percentage of hybrid or plug-in vehicles.[9][10]

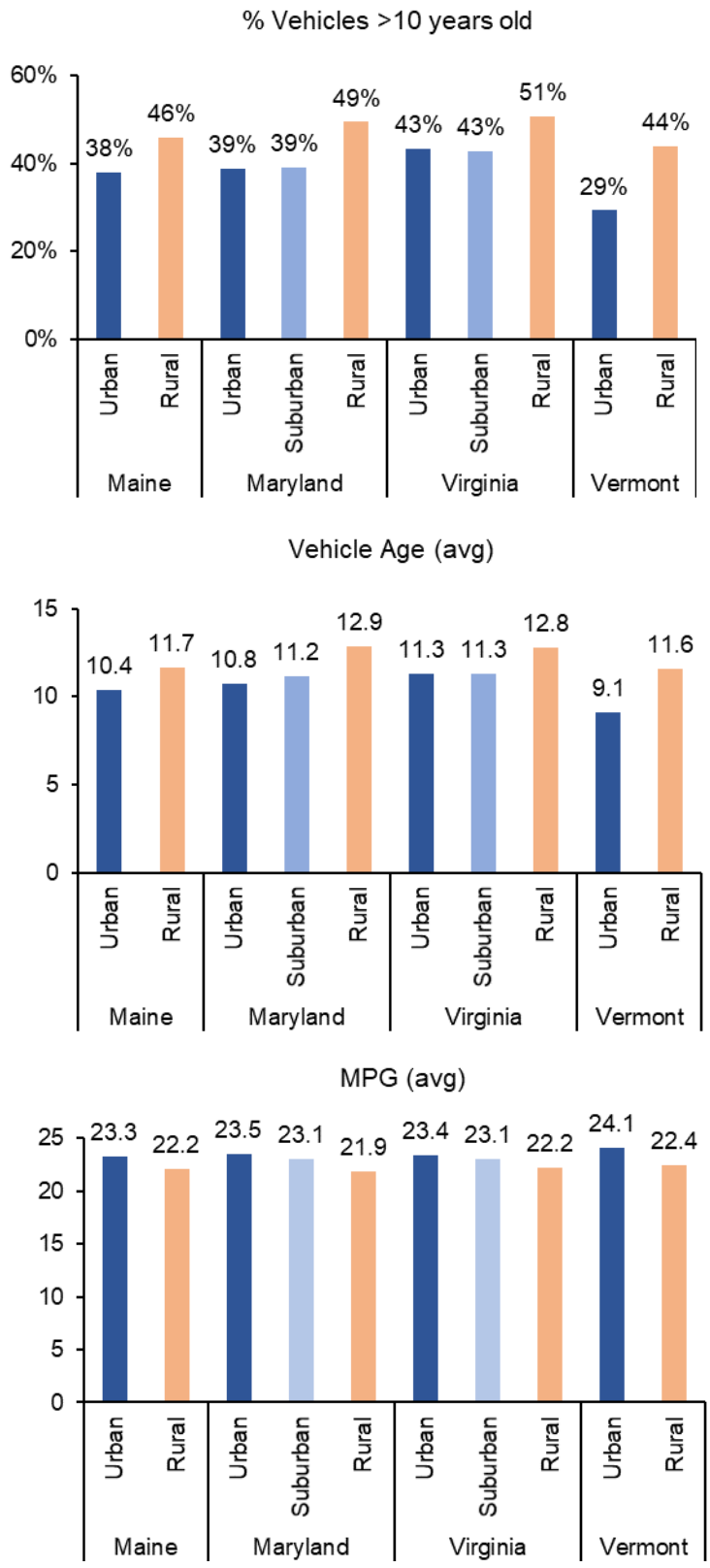
Figure 3. Vehicle Fleet Characteristics – Size, Technology, Luxury



[10] Luxury vehicles as defined by IHS Markit. Vehicles may include amenities such as heated seats, high-end sound systems, and features that may include lane-assist or autopilot.

The differences in vehicle fleets in Urban and Rural counties extend to vehicle age and fuel efficiency, which in turn, will have an influence on the operating costs of the vehicles. Vehicle age skews older in Rural counties. On average, vehicles in Rural counties are 1.3 years older in Maine and 2.5 years older on average in Vermont. There are more vehicles in Rural counties older than 10 years and average fleet fuel efficiency in Rural counties is lower than that of Urban counties by between 1.1 and 1.6 miles per gallon. The lower average fuel economy of vehicles in rural areas is the result of vehicles being both older and larger.

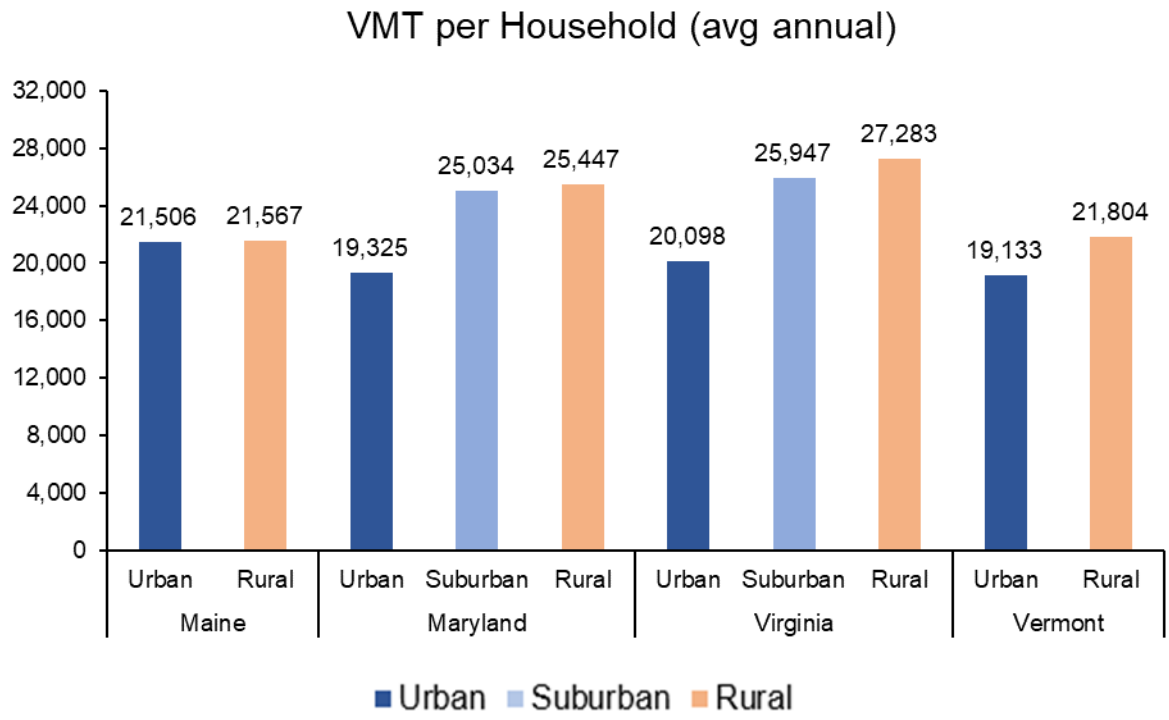
Figure 4. Vehicle Fleet Characteristics – Age, Fuel Economy

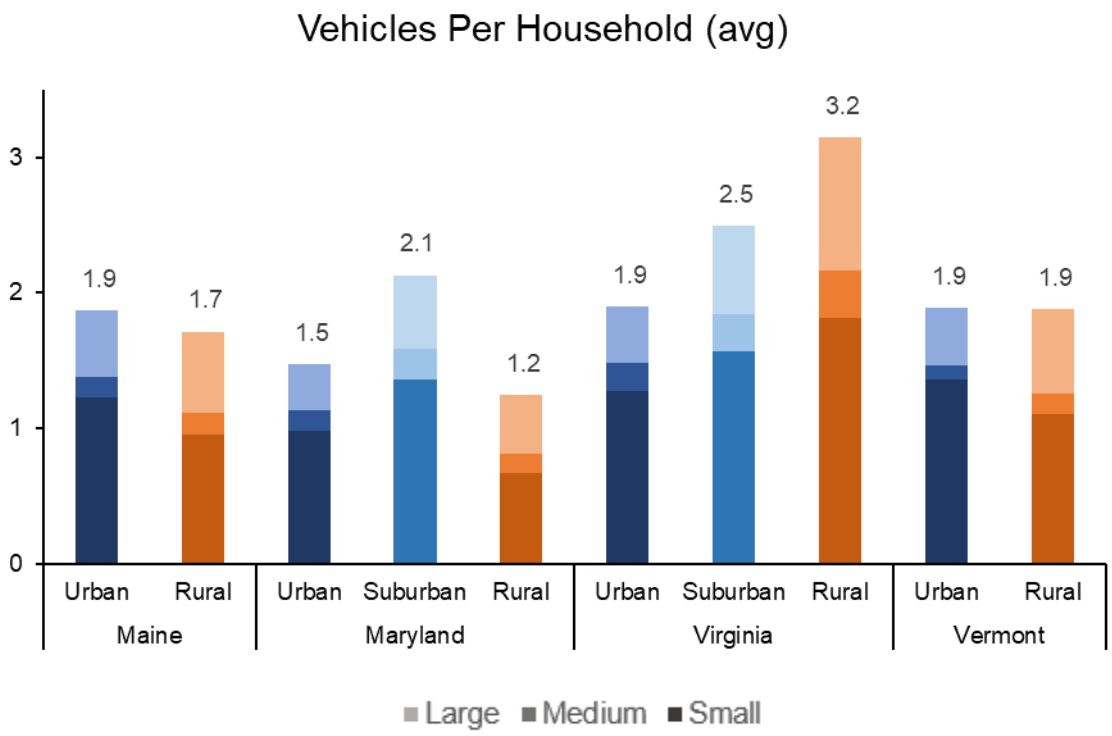


Vehicle Fleet Vehicle Usage

The National Household Travel Survey, conducted by the Federal Highway Administration (FHWA), gathers information from a sampling of households throughout the U.S. on their travel behavior. MJB&A used data from the National Household Travel Survey to draw conclusions about differences in vehicle usage behavior in Urban and Rural counties. Data were aggregated at the household level to determine rates of vehicle ownership by community type. Survey responses were grouped by population density to attribute vehicle usage patterns to each of the county designations. The data show that, on average, Rural and Suburban households drove more miles than their urban counterparts. For example, in Virginia, rural households drove 7,000 miles per year more than Urban households. The number of vehicles per household did not show a consistent pattern across the four states. In Maine and Vermont, the number of vehicles per household was very similar between Urban and Rural counties. In Maryland, suburban counties had the most vehicles per household. In Virginia, Rural counties had the most vehicles per household.

Figure 5. VMT and Vehicle Ownership by County Type



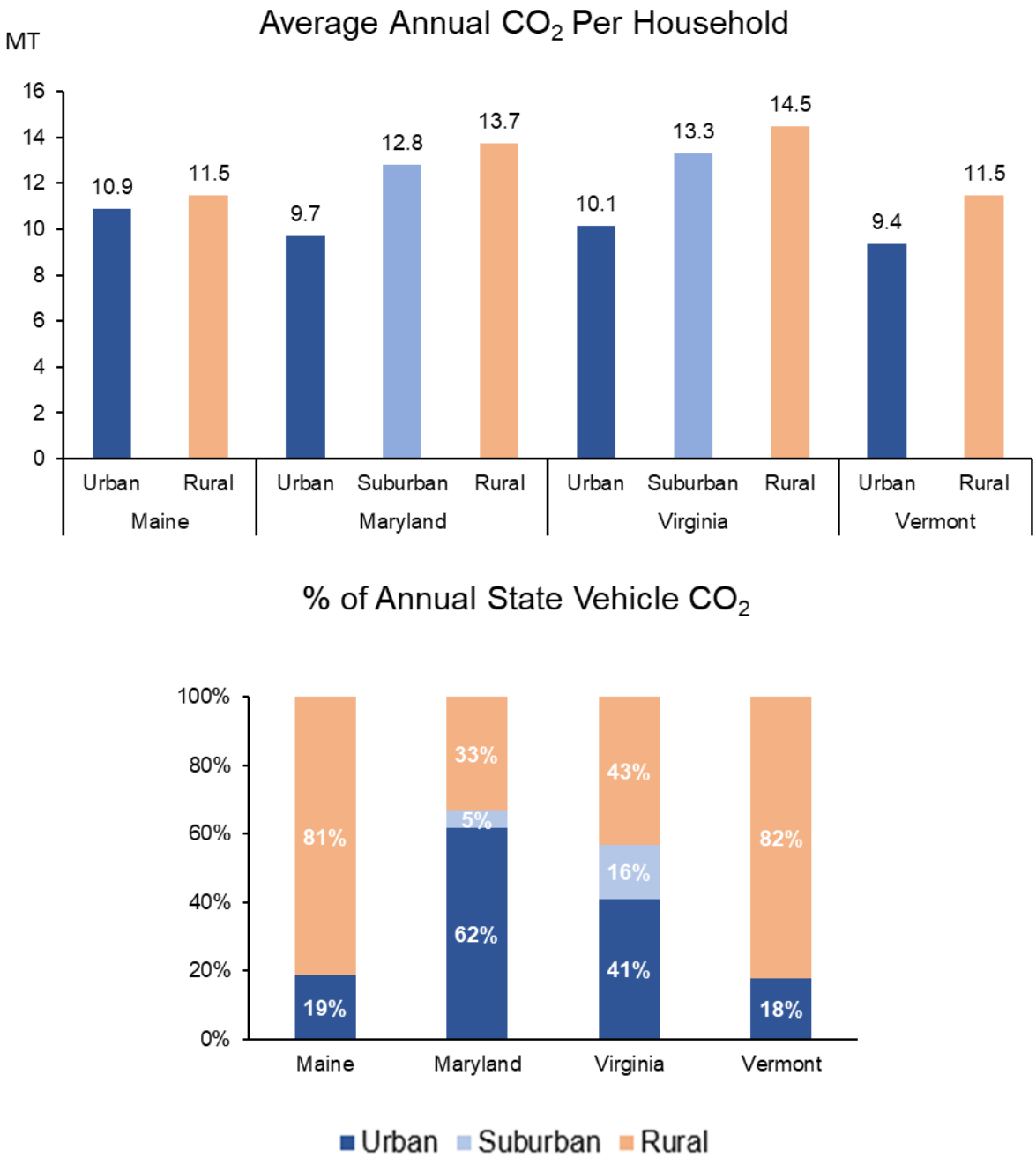


URBAN AND RURAL FLEET CARBON DIOXIDE EMISSIONS

Average annual CO_2 emissions per household from motor vehicle travel were estimated to be higher in Rural areas due to the higher average age, lower average fuel economy, and greater overall vehicle use in Rural counties. In all four states, Rural households were estimated to produce between 8.5 and 10.8 metric tons of CO_2 per year from personal motor vehicle travel. Urban households produced less CO_2 on average: between 7.0 and 8.1 metric tons per year.

The share of total motor vehicle emissions, however, varied widely across the four states. In the more Rural states, Maine and Vermont, motor vehicles in Rural designated counties accounted for approximately 80 percent of light-duty vehicle emissions. In Maryland and Virginia, Rural counties accounted for only 33 percent and 43 percent of motor vehicles emissions, respectively, which is consistent with the total share of population living in these counties.

Figure 6. Carbon Dioxide Emissions by County Type



Electric Vehicle Replacement and Fuel Savings

The demographic and vehicle fleet analysis suggests several factors that would tend to favor the adoption of electric vehicles by rural households, but also several factors that may present challenges for the uptake of electric vehicles. Table 2 summarizes the various factors effecting clean vehicle uptake. In general, Rural households stand to enjoy greater financial benefits from adopting an electric vehicle because the existing vehicles in rural counties tend to be heavier and less efficient. Switching from an older, less efficient vehicle

to a newer, more efficient vehicle will generate maximum fuel savings, in addition to reducing CO_2 emissions. Rural households also tend to drive more miles per year, which also translates to higher fuel savings and financial benefits. Rural households also tend to live in single-family homes, which can readily accommodate charging equipment, supplementing public charging networks. By contrast, it can be challenging to accommodate charging equipment in crowded urban areas and multi-unit dwellings. A survey of Northeastern drivers found that the number of charging stations is their biggest concern in purchasing an electric vehicle.[11]

On the negative side, census data show that Rural households have lower average incomes; this could pose a barrier to electric vehicle uptake because of the current higher upfront cost of an electric vehicle. Rural households also tend to be older on average, and a survey of Northeastern drivers found that Millennials (born 1981-1996) are more likely than Baby Boomers (born 1946-1964) to say they would consider an electric car (63% vs. 38%).[12] Rural households also tend to own older vehicles and may be more likely to purchase a used vehicle. The market for used electric vehicles is fairly limited at this time.

TABLE 2. POTENTIAL EFFECT ON CLEAN VEHICLE UPTAKE

Rural counties have…	Potential Effect on Clean Vehicle Uptake	
	Positive/Negative	Discussion
More people living in single family homes	Positive	Home charging is more widely accessible, complementing public charging network
Older population	Negative	Perhaps less willing to adopt new technologies, absent sufficient education and outreach
Lower household income	Negative	The current up-front cost of purchasing an electric vehicle can present a barrier to entry
More large vehicles	Positive/Negative	Drivers will enjoy higher fuel cost savings with the purchase of an electric vehicle/ currently fewer electric vehicle models in larger vehicle sizes
More vehicles with lower MPG	Positive	Drivers will enjoy higher fuel cost savings with the purchase of an electric vehicle
More used vehicles in their fleets	Negative	Limited opportunities to purchase used electric vehicles given the nascent market

Due to differences in fleet characteristics and driving behavior, Rural communities stand poised to reap the financial benefits of electric vehicles and advances in clean transportation, both from fuel cost savings and reduced maintenance costs over the lifetime of a vehicle. Figure 7 shows the economic benefit of switching to electric vehicles on a per household basis. Compared to their Urban counterparts, Rural households could save between $1,903 and $2,837 per year in Vermont and Virginia, respectively, by switching from a conventional gasoline vehicle to an EV. Over the expected 15-year lifetime of an electric vehicle, a Rural household in Maine would save 6 percent more on fuel costs compared to its Urban counterpart. In Rural Virginia, a household stands to save 43 percent more compared to an Urban household by switching to electric vehicles.

[11] Green Car Reports. Step Aside, Boomers: New Electric-Car Buyers in the Northeast may be Millennials. April 18, 2019.

[12] Ibid.

Figure 7. Potential Per Household Savings by Switching to Electric Vehicle

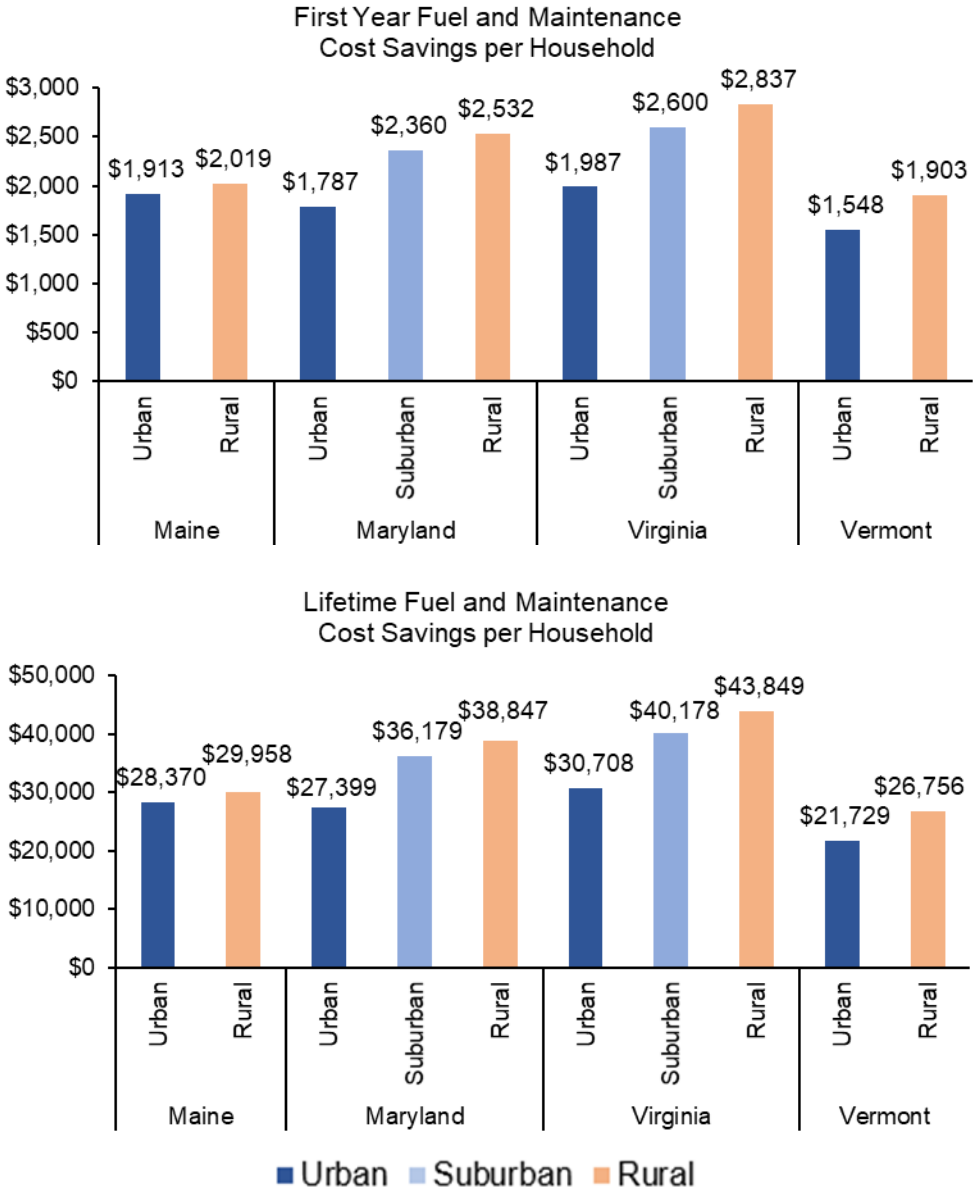
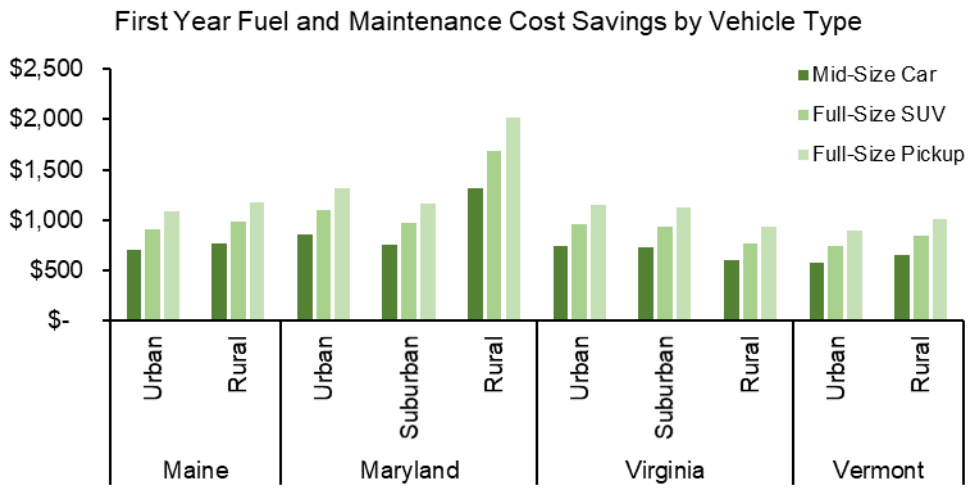


Figure 8. Potential Per Vehicle Savings by Switching to Electric



The savings (fuel and maintenance costs) from selecting an electric vehicle versus an equivalent gasoline model will also vary depending on the type of vehicle purchased. Using model year 2021 fuel economy ratings as a basis for comparison, and state-specific gasoline and electricity prices, this study estimates that switching to an electric vehicle could save up to $1,311 per year in Rural Maryland for a full-size car and $2,018 for a full-size pickup.[13] In all cases (urban, rural, or suburban), electric vehicles are estimated to provide savings of over $700 per year for fuel and maintenance costs. The savings are generally greater in Rural counties versus Urban counties. For drivers in Rural counties, in all states but Virginia, benefits to EV ownership outweigh those of their Urban counterparts, saving 8.2% more per year in Maine to 34.7% in Maryland.

TABLE 3. POTENTIAL PER VEHICLE SAVINGS BY SWITCHING TO ELECTRIC

	County Type	Mid-Size Car	Full-Size SUV	Full-Size Pickup
Maine	Urban	$705	$906	$1,084
	Rural	$768	$986	$1,180
Maryland	Urban	$857	$1,101	$1,319
	Suburban	$756	$971	$1,163
	Rural	$1,311	$1,685	$2,018
Virginia	Urban	$745	$959	$1,150
	Suburban	$730	$939	$1,126
	Rural	$602	$775	$929
Vermont	Urban	$583	$748	$893
	Rural	$657	$843	$1,007

[13] While there are no electric pickup trucks currently on the market, Tesla's Cybertruck is set to go into production in 2021 and Ford's Electric F-150 in 2022.

Policy Approaches—Clean Transportation for Rural Communities

In order to achieve rapid and significant emissions reductions from the transportation sector within the Northeast and mid-Atlantic states, all communities must transition to a clean transportation system that includes the use of cleaner, more efficient vehicles, provides more expansive public and shared transportation opportunities, and encourages the use of alternative modes of transportation within communities. Not only will this transition benefit all communities by improving air quality and reducing emissions, it has the potential to significantly benefit communities that are either burdened by transportation emissions or that devote a significant share of their household income to transportation costs—frequently communities located in urban or rural areas—by providing better access to lower-cost clean transportation. While not a traditional "transportation" policy, expanding broadband throughout rural communities has the ability to increase telecommuting and telehealth opportunities thereby reducing the need for personal travel and therefore reducing transportation emissions. This report considers broadband expansion to be an important element of a broader clean transportation strategy for rural communities.

A clean transportation system for rural communities: (1) includes the use of cleaner, more efficient vehicles; (2) provides more expansive public and shared transportation opportunities; (3) encourages active transportation, like walking and biking; and (4) enables better access to telehealth and telecommuting by expanding communication infrastructure.

Urban, suburban, and rural communities face different challenges when developing clean transportation systems that are safe, reliable, and reduce vehicle emissions and improve air quality. Rural communities across the country often lack adequate access to transportation alternatives and typically rely heavily on personal vehicles that are often older, inefficient, and expensive to maintain and fuel. Rural residents often have to travel farther than suburban or urban residents to work, buy groceries, and seek other services like healthcare or education, making them highly dependent on their vehicles to live and work.

The demographic data analyzed in this report displayed a number of key differences between urban and rural locations that should be considered when implementing policies designed to foster a clean transportation system within rural communities. Not only do rural households tend to have more vehicles but these vehicles tend to be older and larger which impacts their fuel economy. There is an opportunity to improve fuel efficiency and reduce emissions within rural communities—where emissions from the transportation sector make up a large percentage of overall emissions. While increasing EV deployment will allow for some vehicle replacement, the current upfront cost of EVs, especially for lower income residents, and the lack of charging infrastructure within rural communities creates a barrier to increased EV deployment and data show that most EVs are registered in urban counties. While incentives will help lower these barriers, older and low-income populations—who make up a large percentage of rural households—will still find the upfront cost of EVs to be a significant barrier. Policymakers will have to deploy a wide range of different policies throughout rural communities to increase a clean transportation system that both serves communities and lowers emissions. By increasing the use of electric vehicles, increasing zero emission transit that utilizes flexible routes both regionally and locally, by encouraging alternative modes of transportation through more connected streets, and by enabling better access to telehealth and telecommuting by increasing broadband

access, rural communities could see reduced transportation costs and emissions and increased economic opportunities and improved quality of life for both young and old populations.

Finding ways to reduce emissions from these rural communities, while also revitalizing them, has the potential to make rural America a leader in equitably developed clean transportation systems. States, regional organizations and local governments will be critical to ensuring that each of these transportation opportunities are adequately funded and that funded projects benefit community members that are currently disproportionately burdened by the existing transportation system. The following sections provide greater detail on each of these opportunities and provide examples of ways in which these policies and programs could be implemented throughout the Northeast- and mid-Atlantic using case studies primarily from the states analyzed in the demographic data analysis described above but also highlighting examples of best practices in rural communities throughout the United States.

Incentivizing the Use of Clean Vehicles

Most rural communities have low population density, making it difficult to access all parts of the community using non-personal vehicle modes of transportation. While there are innovative solutions to increasing the use of public transit and making rural communities more walkable and bikeable, it is likely that personal vehicle use will remain the dominant transportation option for rural communities. Therefore, transitioning these vehicles to lower emitting electric vehicles will be essential to reducing transportation emissions within rural communities. Not only are electric vehicles lower emitting but they have reduced vehicle fueling and maintenance costs which can lead to reduced lifetime vehicle costs. As was discussed above, rural households within the case study states reviewed for this report have the potential to save between $1,903 and $2,837 per year by switching from a conventional vehicle to an electric vehicle.

While electric vehicle costs are declining and the secondary market for light-duty electric vehicles is expanding, for many, the upfront cost of electric vehicles are still a significant barrier to entry. Prospective buyers also lack vehicle model options especially for pick-up trucks.[14] As more electric vehicle models come to market and vehicle costs continue to decline and as battery technology improves, rural drivers will feel more confident in choosing an electric vehicle as their next vehicle purchase.

State and Local governments can lower these barriers to electric vehicle procurement by utilizing a number of different measures, outlined below.

Policies to Incentivize deployment of clean vehicles

[14] Trucks that are classified as light- and medium-duty weigh between 6,000 to 19,000 pounds. An example of a Class 2 truck would be the Ford F-150 and an example of a Class 5 truck would be a Chevrolet Silverado F-550.

Electric Vehicle Incentives

Low-to-moderate income residents in both rural and urban communities face a number of the same barriers to procuring electric vehicles— two primary barriers being high upfront costs and lack of financing options to purchase new vehicles. As was discussed in the demographic data analysis portion of this report, rural residents tend to own larger vehicles when compared to urban or suburban residents. This presents an additional challenge for rural residents looking to procure a similar type of vehicle to their current vehicle as medium-and light-duty electric trucks are not currently commercially available (though several models have been announced).[15] Addressing these barriers and increasing the deployment of electric vehicles in rural communities will require action from all levels of government. Federal, state, regional and local governments can work towards addressing these barriers by deploying the policies described below.

- **Ensure that rural households are included in federal and state electric vehicle incentive programs:** Federal and state governments should ensure that electric vehicle incentives are offered at point-at-sale—reducing the vehicle price when a consumer buys a vehicle. State and local leaders should also ensure that incentives are not limited by vehicle sticker price. Rural residents tend to drive larger vehicles (e.g. pick-up trucks), which are more expensive than the average sedan. Setting an overly restrictive limit on the incentive based on the manufacture suggested retail price (MSRP), for example, could lead to the exclusion of larger vehicles, making it difficult for rural vehicle owners to qualify for the incentive.
- **Increase communication and education campaigns around the benefits of electric vehicles within rural communities:** Regional and local leaders should promote state and federal electric vehicle tax incentives and provide additional information on the benefits of vehicle electrification by increasing outreach campaigns to make residents aware of the available incentive options and potential benefits they could receive by purchasing an electric vehicle. For example, households may experience lower maintenance costs by switching to an electric vehicle but may be unaware of these benefits. State and local governments can also partner with utilities to ensure that utility electric vehicle programming communicates not only charging infrastructure incentives and electricity rates for EV drivers offered by the utility but also communicate existing state and federal vehicle incentives eligible to customers within their service territory.
- **Offer additional financing options for low-to-moderate income residents and small businesses:** Low-to-moderate income residents in rural communities, like urban communities, often lack the credit required to purchase a new car which limits their ability to purchase electric vehicles. Lack of credit can also be a significant barrier to small businesses looking to electrify their fleet. State and local leaders should work with community members and dealerships to create financing options (e.g., leasing, purchasing coops to bid down sales prices, and microfinancing approaches) for both of these customer segments.
- **Tier rebates based on income eligibility**: Prioritizing charger and vehicle incentives by offering higher incentive levels and/or having carve-outs for low-income customers helps disadvantaged communities in both rural and urban populations better access electric vehicles.

[15] Recently, a number of manufactures have announced plans to introduce electric pick-up trucks including announcements from Ford to produce an electric F 150 by 2022 and from Lordstown Motors to produce an electric truck by 2021. For more information on the current state of the market, see MJB&A's Electric Vehicle Market Status Update 2020, https://www.mjbradley.com/sites/default/files/EDF_EV_Market_Report_September_2020_Update.pdf.

The following incentives are currently available to residents within the case study states.

Existing Incentives — Electric Vehicles

ME	Efficiency Maine offers rebates for plug-in electric or plug-in hybrid electric vehicles ranging from $1,000 to $7,500 to Maine residents, businesses, government entities, and tribal communities. Central Maine Power also received approval from the public utilities commission to offer electric vehicle rebates to customers.
MD	The State of Maryland does not currently offer vehicle incentives but offered a plug-in electric vehicle tax credit of up to $3,000 from July 2017 to July 2020.
VA	The State of Virginia does not currently offer incentives to purchase electric vehicles. The Virginia Department of Mines, Minerals and Energy, in cooperation with the Departments of Environmental Quality and Motor Vehicles and Taxation launched a 2020 Summer Working Group to evaluate how an electric vehicle rebate program could work throughout the state. The working group submitted recommendations on November 1, 2020 per HB 717 requirements.
VT	The Vermont Agency of Transportation provides incentives for low- and moderate-income residents to purchase or lease a new plug-in electric vehicle. Incentives range from $1,500 to $4,000 for plug-in hybrid electric vehicles and from $2,500 to $5,000 for all-electric vehicles. The Burlington Electric Department also provides low-or no-interest loans for the purchase of a new plug-in electric vehicle. The Vermont Electric Co-Op also offers a $250 bill credit to members who purchase a new or used plug-in hybrid electric vehicles and a $500 bill credit to members who purchase a new or used all-electric vehicle.

Charging Incentives

To date many rural communities, suffer from a lack availability and access to charging which creates another significant barrier to electric vehicle deployment in rural communities. While there are some elements of rural living that make addressing this issue easier—for example, rural communities tend to have better access to off-street parking making it easier for them to install home charging—increased traveling distance and the lack of reliable charging infrastructure deployed in rural communities today makes purchasing an electric vehicle appear more risky. Increasing and incentivizing residential and public charging infrastructure is essential to increasing the deployment of electric vehicles within rural communities. There are a number of ways that state, regional and local communities can increase access to public and residential charging locations, outlined below.

- **Support for placement of public chargers in rural areas:** Improving access of charging options for rural community members by creating new corridors of travel for electric vehicles can enable reliable and efficient travel options for electric vehicle owners in rural areas.
- **Increase grant funds to small businesses to encourage both public and private charger purchases**: State and local governments should consider increasing grant funding to encourage the deployment of community charging sites , and in certain situations private charging for small business fleets, located near local businesses. Not only could these grants incentivize small businesses to electrify their fleets but the charger(s) could also provide a meaningful service to the local community by building out publicly accessible charging infrastructure.
- **Increase vocational training for electric vehicle technicians and electrical workers to ensure electric vehicle and charger maintenance skills are available in rural communities:** State and local governments should provide grant funds for community colleges, technical schools, and universities that engage in workforce development programs for electric vehicle technicians and electricians.
- **Tier residential charger rebates based on income eligibility**: Prioritizing charger and vehicle incentives to low-income communities helps community members in both rural and urban populations better access electric vehicles.[16] Programs that are targeting rural communities need to be designed to meet the needs of low-income drivers.[17]
- **Partner with utilities:** Local utilities can offer technical expertise on charging infrastructure upgrades, support charging stations and can provide, pending regulatory approval, a number of different types of programs designed to incentivize the deployment of chargers within both public and private spaces. Utilities across the country currently offer rebates for chargers, have developed programs that encourage smart charging (e.g., some utilities offer separate or sub-metering and separate tariffs that encourage the timing of charging for grid management), support the development of either front of or behind-the-meter infrastructure up to the actual charger— commonly referred to as "make-ready" infrastructure— and, more recently, have started to offer transportation advisory services for commercial entities looking to install electric service supply equipment (EVSE). Utilities have long standing relationships with community members and have the technical skills required to coordinate the type, location and power requirements for EVSE deployment throughout their service territory making them a critical stakeholder to the development of charging infrastructure throughout all communities, including rural communities.

Understanding Electric Vehicle Charging Infrastructure Types

There are several types of electric vehicle charging equipment that are associated with different voltages meant to serve differing charging needs depending on the location and desired charging time. Three common charger types, their voltage, and common use type are described below.

Charging Type	Level 1	Level 2	DCFC
Voltage	120 V	208-240 V	480 V
Use	Residential	Residential, public, work	Public, highway corridors

[16] Rogotzke, M., Eucalitto, G., & Gander, S. (2019, September). Transportation Electrification: States Rev Up. Washington, D.C.: National Governors Association Center for Best Practices. https://www.nga.org/wp-content/uploads/2019/09/2019-09-15-NGA-White-Paper-Transportation-Electrification-States-Rev-Up.pdf

[17] Jones et al., The Future of Transportation Electrification: Utility Industry and Consumer Perspectives (2018). Lawrence Berkely National Laboratory. https://www.nclc.org/images/pdf/energy_utility_telecom/electric_vehicles_evs/future-transportation-report-2018.pdf

Existing Incentives - Charging Incentives

ME	Efficiency Maine partnered with ChargePoint to install DC Fast Chargers (DCFC) and Level 2 chargers along a number of pre-identified corridors. As of June 2020, Efficiency Maine had completed its first phase of charger installation and funded the installation of 12 dual plug DCFC and six dual plug L2 fast chargers. Central Maine Power also received approval from the public utilities commission to subsidize make-ready costs up to $4,000 for 60 L2 chargers.
MD	The Maryland Energy Administration offered rebates for EVSE ranging from $700 to $5,000 to Maryland residents, businesses, state or local governments, or retail station dealers. The program was completed in June 2020. A number of local utilities offer charging rebates including Potomic Edison which serves Maryland's rural western region and Delmarva which serves Maryland's rural eastern shore.
VA	Dominion Energy provides EVSE rebates ranging from $2,000 to $11,000 for L2 make-ready infrastructure and between $35,000 to $73,000 for DCFC make-ready infrastructure.
VT	The Vermont Department of Housing and Community Development provides funding to governments, businesses, non -profit organizations, homeowners associations, electric utilities, and EVSE providers for the cost and installation of eligible EVSE. Several utilities provide rebates or bill credits for charging infrastructure.

Lead by Example Programs

Local governments can lead by example by deploying and promoting clean transportation systems both within their own fleets and throughout the community. These government driven initiatives not only increase electric vehicle awareness, but they also improve air quality and have the potential to create government fleet operation and maintenance savings from lower maintenance costs over the lifetime of the vehicles. Within their own light-duty fleets, government fleet operators can begin transitioning to electric vehicles by setting fleet electrification procurement targets. In the short term, when access to certain vehicle types are unavailable (e.g. light-duty trucks), it will be important for fleet operators to consider vehicle usage patterns to determine if certain vehicles that do not currently have an electric vehicle alternative could be replaced with other light-duty electric vehicles.

Local governments should also consider setting procurement targets for their transit fleets and public school buses. Local governments have a unique opportunity to lead in the transition to electric vehicles and to do so in a way that creates increased mobility options for community members who may not have access to a personal vehicle. As is discussed below, as rural communities think about ways to decrease emissions from the transportation sector, increasing access to reliable public transit could be part of the solution. In some rural communities, this may mean creating a public transportation system where it may not have existed

previously. This may enable rural communities to leap-frog traditional diesel transit vehicles and to deploy electric transit buses. Outside of their own fleet, local governments can encourage electric vehicle procurement by deploying vehicle charging infrastructure networks and by educating the public on the benefits of electric vehicles.

State and local government should consider implementing the following policy approaches.

- **Electrify Transit and Public Service Fleets:** Within their own fleet, local governments can set procurement targets to ensure that their fleet will be lower emitting as the fleet turns over. Within the light-duty space, local governments should consider both increasing procurement targets and evaluating their current fleet to determine if the fleet could be reduced or if vehicle types could be changed (e.g., procuring an electric sedan in place of a pick-up truck) to enable a faster fleet electrification. Within transit and school bus fleets, regional and local agencies should develop electric vehicle procurement goals and should consider bus size when making procurement decisions. Rural communities may not require the same number of seats per bus as an urban community enabling rural transit operators to procure smaller buses which may help reduce the upfront cost of buses in addition to lowering charging needs.
- **Develop Local and Regional Charging Networks:** State, regional and local governments should collaborate to invest in developing regional charging networks.
- **Increase Awareness around the benefits of electric vehicle ownership:** Local governments should increase awareness by partnering with utilities and dealerships to conduct marketing campaigns and ride and drives.
- **Create rural job opportunities by incentivizing electric vehicle manufacturing in rural communities:** State and local leaders should consider providing incentives to vehicle manufactures that are looking to build electric vehicles within rural communities.

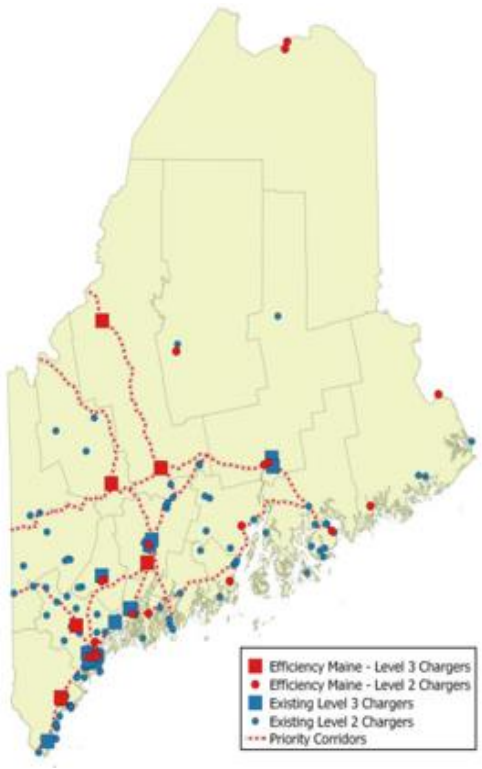
Developing a Statewide Charging Network

Efficiency Maine, in an effort to reduce vehicle emissions and to promote tourism from urban centers in surrounding states and provinces, has developed an electric vehicle supply equipment program to develop both fast charging corridors and local access and publicly accessible level two chargers throughout the state.

The program is funded through Maine's VW Environmental Mitigation Trust and follows three program phases:

- Phase I: Expand Maine's EV Fast Charging Network,
- Phase II: Improve local access and destination charging with publicly available Level 2 chargers
- Phase III: Extend Maine's EV Fast Charging Network

Each phase of the program focuses on a different customer segment which, together, will lead to a more robust statewide charging network. As a large and primarily rural state, Maine hopes to reduce range anxiety concerns for electric vehicle owners thereby encouraging Maine residents to consider buying an electric vehicle and to encourage intrastate business and recreational EV travel to Maine destinations. The state hopes that developing the initial structure of a statewide charging network will make the state a more eligible and attractive candidate for future federal, corporate and national initiatives and funding opportunities.



Public EV Charging Infrastructure
(Source: Efficiency Maine)

Vehicle Scrappage Programs

While incentivizing the installation of chargers and the procurement of vehicles will encourage increased vehicle deployment, electric vehicle purchases are not progressing at the scale and speed required to meet transportation electrification goals or transportation GHG emission reduction targets. One potential way to speed up this transition would be to encourage faster fleet turnover by providing incentives for vehicle scrappage. Scrappage programs were deployed widely during the economic recession of 2008 and 2009 as a form of economic stimulus for domestic car manufacturers and to incentivize the procurement of more efficient vehicles. Within the United States, the Consumer Assistance to Recycle and Save (CARs) program led to the implementation of vehicle scrappage, or "cash for clunkers" programs across the country but, once the funding for this program was depleted, many of these programs disappeared with few in existence today. The need for more rapid fleet turn-over to spur the electric vehicle deployment necessary to meet 2050 GHG

reduction goals within the transportation sector has led to a reevaluation of the effectiveness of these programs in the context of electric vehicles.

Since being broadly implemented, scrappage programs have been criticized for not being the most effective or efficient way to reduce transportation emissions. Multiple studies have highlighted that, if not effectively implemented, scrappage programs can be inefficient and costly when compared to more top-down policy mechanisms (e.g. gas tax) and can lead to inconsistent reductions in lifetime vehicle emissions depending on program requirements (e.g. vehicle age requirements and eligible replacement vehicles). Importantly, several studies have noted that program benefits are not always broadly felt in low-income and disadvantaged communities. Scrappage programs can overly benefit individuals who have the ability to purchase newer, more efficient —and often, more expensive—vehicles without appropriately creating incentives for low-income communities.[18] They also are often utilized by consumers with vehicles with the least remaining life which makes them less effective at encouraging broader fleet turnover. Additionally, scrappage programs have been shown to be more effective if they target higher polluting vehicles, like diesel trucks, which limits the applicability of scrappage programs within the residential customer space.

To date, studies have shown that vehicle scrappage programs are more effective in high polluting urban areas where the air pollution is more significant and therefore where air quality improvements could be higher. Additionally, urban areas are likely to have better access to other forms of transportation and other complementary policies (e.g. low emission zones) which have also been shown to increase program effectiveness.[19] A study conducted by the ICCT in 2015 found that effective vehicle scrappage programs deployed the following approaches[20]:

- Replacement vehicles need to be as clean as possible;
- Program implementation, management, and enforcement should ensure expected benefits are actually achieved;
- Fiscal incentives should be carefully tailored to optimize both environmental benefits and cost-effectiveness;
- Program design should carefully consider and balance the different roles of national, regional, and local policy makers;
- Governments should consider implementing complementary fiscal policies with additional incentives such as low emission zones and regulatory backstops.

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[18] "Scrappage Programs for old vehicles." County Health Rankings & Roadmaps. https://www.countyhealthrankings.org/take-action-to-improve-health/what-works-for-health/strategies/scrap-programs-for-old-vehicles; Tyrrell, Marianne & Dernbach, John. (2010). The 'Cash for Clunkers' Program: A Sustainability Evaluation. Univ. Toledo. Law Rev. 42. https://www.researchgate.net/publication/228297190_The_'Cash_for_Clunkers'_Program_A_Sustainability_Evaluation; Antweiler et. al, Scrapping for clean air: Emissions savings from the BC SCRAP-IT Program (2015) https://www.sciencedirect.com/science/article/abs/pii/S0095069615000248; "Car Scrapping schemes." Organization for Economic Co-operation and Development. https://www.oecd.org/greengrowth/greening-transport/car-scrapping.htm;

[19] Tyrrell, Marianne & Dernbach, John. (2010). The 'Cash for Clunkers' Program: A Sustainability Evaluation. Univ. Toledo. Law Rev. 42. https://www.researchgate.net/publication/228297190_The_'Cash_for_Clunkers'_Program_A_Sustainability_Evaluation

[20] Posada et al. Survey of Best Practices in Reducing Emissions through Vehicle Replacement Programs. (2015). ICCT. https://theicct.org/sites/default/files/publications/ICCT_HDVreplacement_bestprac_20150302.pdf.

States considering implementing a scrappage program should ensure that rural communities are included and that outreach is done to encourage program usage within rural communities. Scrappage programs, if effectively implemented, could be beneficial to rural communities which tend to have older, larger, and more inefficient vehicles. These programs could be more beneficial if they incentivized vehicle right-sizing by offering funds to trade-in larger vehicles for smaller, more efficient vehicles. States should also consider creating scrappage programs that encourage broader program usage beyond residents with vehicles that are likely to reach their end-of-life shortly. A recent study produced by Resources for the Future suggested differentiating program payments based on the estimated remaining mileage of the vehicle (e.g., participants would receive more money if they traded in an inefficient vehicle that had a higher amount of remaining vehicle life).[21]

As is true in many parts of the country, no scrappage programs are currently in operation for light-duty vehicles within the case study states though some states have implemented vehicle trade-in programs to incentivize vehicle owners to buy more efficient vehicles. For example, the State of Vermont's Mileage Smart Program allows low-income earners to trade in older, lower milage vehicles for more efficient, higher milage ones if they are at or below 80% of the median income based on household size.[22] Programs like this, and the two programs that are highlighted below display key components that should be considered when developing scrappage programs within rural communities in Northeast and mid-Atlantic states.

[21] Joshua Linn, How Targeted Vehicle Scrappage Subsidies Can Reduce Pollution Effectively (2020). Resources for the Future. https://media.rff.org/documents/IB_20-09_Linn_vWnxgDH.pdf.

[22] "MileageSmart VT." Capstone Community Action. (2020). https://www.mileagesmartvt.org/.

Encouraging Equity and Transportation Alternatives in Scrappage Programs

There are several key elements that must be considered when developing a vehicle scrappage program to ensure that the program is as efficient and effective as possible. Defining which vehicles meet program requirements (e.g. which vehicles are eligible for retirement and replacement), determining program duration, and assessing where incentive levels should be set are all critically important to ensuring that program funds are used effectively while enabling the retirement of the most inefficient and polluting vehicles. These factors, while important, fail to take into account low-income community members who many may rely heavily on an older, more polluting vehicles and may not be able to participate in a scrappage program that only provides a relatively small amount of cash for a vehicle that is essential to their ability to work and live within a rural community. For scrappage programs to be successful within rural communities and to encourage the retirement of the oldest, most polluting vehicles, they must address these equity concerns. The programs discussed below—British Columbia's BC Scrap-It program and California's Replace Your Ride programs— provide examples of ways to increase the equity of vehicle scrappage programs by providing incentives that encourage low-income participation.

The BC Scrap-it program, unlike other scrappage programs, encourages participants to choose alternative forms of transportation by offering alternatives to vehicle purchases. Participant can choose between a transit pass, ride sharing pass, or a bicycle in addition to the typical scrappage program cash payment option. By encouraging alternative modes of transportation, which are accessible within the program region, the program encourages lower emitting alternatives to personal vehicles and creates viable alternatives for community members who may not be able to purchase a more efficient vehicle with only the funding from the scrappage program.

The California Replace Your Ride program focuses on increasing equity by offering allowing plug-in and hybrid electric vehicles to qualify as vehicle replacement options among drivers with low incomes. Like the BC Scrap-it program, income eligible vehicle retirement incentives can also be combined with incentives for purchasing electric vehicles or with incentives for alternative modes of transportation such as ride share memberships, public transit passes, or bicycle purchases to achieve greater emissions reductions.

In order for scrappage programs to reach low-income populations, greater attention needs to be placed on providing incentives that enable and encourage participation. By incentivizing alternative forms of transportation and by enabling low-income community members to pursue more efficient vehicles, like hybrid electric vehicles, that reduce pollution and have a more robust used market, scrappage programs can be broadened beyond populations who are able to purchase a new electric vehicles. When developing a scrappage program within a rural context, it will be important to consider if these alternative modes of transportation are actually viable alternatives to personal vehicles. Greater expansion of public transportation and increased shared mobility options could enable a more effective deployment of scrappage programs within low-income communities.

Creating Regional Connectivity and Increased Mobility

Rural communities need safe, inexpensive, and reliable transportation both within their communities and to connect them to other communities. These connection points across regions are critical to ensuring increased access to jobs, education, and healthcare for all members of the community including those who may not have access to a personal vehicle. By increasing corridor planning within regions, expanding public transit within communities, developing flexible bus route services, and by implementing rapid transit connections between rural areas and job centers, rural community members are able to seek opportunities within the region without incurring vehicle ownership costs or having to relocate to urban economic centers.

The lack of reliable public and shared transportation places a significant burden on populations that either cannot afford a vehicle or are unable to operate a vehicle which tend to be low-income populations, elderly populations, and people with disabilities. As was discussed in the demographics portion of this analysis, the rural communities within the case study states are both older and have lower household incomes, on average. Without access to a personal vehicle, communities are subject to public transportation systems that lack frequent service and are unable to service first-last mile transportation needs. This can lead to more time spent commuting to and from work or appointments and can impact consistent access to health care services which can delay treatment and can lead to more serious health-related issues. This has been shown to be incredibly impactful on elderly populations which make up a significant portion of rural communities. Without access to transportation opportunities, elderly populations are less likely to socialize or attend regular medical check-ups which can lead to both feelings of social isolation and more long-term serious medical conditions that could have been addressed more easily if caught earlier. Not only does this impact individual community members but it puts a strain on the entire medical system. Preemptive care has been shown to dramatically reduce healthcare cost by reducing costly emergency room trips.[23] According to one study an estimated 3.6 million Americans miss getting medical care because of lack of transportation. These transportation barriers could lead to worse clinical outcomes and can lead to more emergency department visits whereas timely care can lead to improved outcomes.[24]

The lack of reliable transportation not only impacts elderly populations but it also impacts younger populations looking to live and work in rural communities. In recent years, rural communities have been dramatically impacted by the loss of young populations leaving communities to seek economic opportunities in urban areas. Some of these young people would prefer to live in rural communities but feel unable to support themselves due to a lack of jobs and access to education. Having a clean transportation system that provides frequent and reliable service from rural communities to urban centers could allow younger community members to both seek economic opportunities and invest in their local community during their most productive years. Increasing broadband service within rural communities could also enable younger populations to work and go to school remotely providing multiple co-benefits including reduced commuting time, vehicle cost savings, and better quality of life. The COVID-19 pandemic has shown that it is possible for many office workers to work from home provided they have adequate access to high speed internet. With the expansion of broadband, it is possible for jobs to migrate beyond cities and in the process, make it possible for young people to be productive members of rural communities.

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[23] Langabeer et al, "Cost-Benefit Analysis of Telehealth in Pre-hospital Care." (2016) Journal of Telemedicine and Telecare. https://journals.sagepub.com/doi/abs/10.1177/1357633X16680541.

[24] "Case Study: A Transportation Solution for Rural Communities."(2019). Center for Care Innovation. https://www.careinnovations.org/resources/case-study-a-transportation-solution-for-rural-communities/.

The following policies, outlined below, can enable greater regional connectivity.

Corridor planning within Regions

Shared Use Mobility

CORRIDOR PLANNING WITHIN REGIONS

Transportation systems in rural communities rely heavily on the ability to travel from one community to the next. Developing transportation corridors that provide opportunities for transit, train, and low emitting vehicles is critical to creating a robust transportation system for rural communities. Often these plans—either developed by a regional transportation agency, county, council of government, among others—have 10-year planning horizons that include a proposed transportation funding expenditure within the region. Ensuring that these planning documents are evaluating and preparing for an electrified transportation future will be critical to ensuring that communities do not fall behind in a changing transportation sector. State, regional and local community leaders can support effective corridor planning in the following ways.

- **Coordinate regional and local planning processes**: State, regional, and local planning documents provide longer term visions for urban, suburban and rural planning within a given state and region. Coordinating these planning approaches could lead to more thoughtful transportation corridor development by aligning project goals to leverage existing funding opportunities.
- **Evaluate future corridor needs:** State, regional and local governments need to think beyond current vehicle types and usage patterns when developing regional plans and should begin investing in charging corridors, evaluating truck stop electrification, improving or restoring freight rail connections, in addition to increasing regional public transportation options.
- **Support rural transit services that facilitate access to jobs and schools:** State and local governments should consider investing in transportation options that link rural communities with urban job centers and markets. Depending on the rural community, this could include some combination of bus rapid transit, high speed rail service, or shared mobility services.
- **Develop flexible bus routes:** Traditional fixed route transportation can fail to meet the needs of rural community members who have to travel far on foot in order to reach transit stops. Developing flexible bus routes that can divert from the fixed route to pick-up or drop-off riders creates a “hub-and-spoke” model for transit that, in low density areas, can improve ridership experience.

Developing Regional Transit Corridors

States across the country are seeking innovative solutions to create regional transportation hubs that connect rural communities to urban city centers. The development of the the following transit corridor in Michigan's Upper Peninsula (UP) displays one way that multiple state and county departments can work together to develop regional transit corridors that connect rural and urban communities.

The 15 counties in Michigan's UP are sparsely populated and are relatively spread out between town centers. Many of the communities within the UP lack access to social services, medical services and employment and must rely on the larger town centers to access those resources and employment opportunities. The Michigan Department of Transportation (MDOT) found that many rural residents were able to utilize the transit services within their counties but were unable to adequately access transportation services across counties limiting residents' abilities to access jobs and medical services. In an effort to create greater regional services, MDOT, Alger County Transit (ALTRAN) and the City of Marquette partnered to increase transit services from the more rural Alger County to the more developed City of Marquette. This regional transit route provides weekday commuter services and picks up passengers with a reservation along the 45 mile commute including within the 15 miles of the route that fall within Marquette County. For those unable to drive or without access to a vehicle, this regional transit route provides a vital transportation option.

Source: National Cooperative Highway Research Board

Shared-Use Mobility

Shared mobility services have expanded dramatically in recent years in urban communities with a significant increase in bike, scooter, and car sharing opportunities. These shared mobility options have provided meaningful solutions to gaps in mobility created by more traditional public transportation services such as reducing first-last mile transportation concerns and increasing flexible travel timetables for commuters. While many of these services have been negatively impacted by the COVID-19 pandemic due to their shared nature and concerns around risk of infection—with the exception of shared biking which has grown during the pandemic—it is likely that these services will rebound after the pandemic.

Rural communities have not seen as dramatic of an increase in shared use mobility services due in part to the lack of availability of transportation network companies (TNC) drivers within rural communities. Improved transportation services, including expanded shared mobility programs, can empower residents to retain their independence by connecting them to vital services such as doctors' appointments and can decrease social isolation leading to overall better health and wellbeing. Rural patients often have a higher burden of travel to and from medical facilities which can lead to more infrequent health and wellness trips which can be vital to catching and treating illnesses before they become harder to manage. A literature review published in the National Library of Medicine finds that rural patients across a number of studies reported having to travel farther to health care providers and having a higher burden of travel for health care when measured by distance and time traveled.[25] Further, the report found that access to a vehicle was consistently associated with increased access to health care and that patients from lower economic backgrounds may receive less health care due to transportation. A 2015 survey conducted by the Maryland Rural Health Office found that

[25] Syed et.al., Traveling Towards Disease: Transportation Barriers to Health Care Access (2013). U.S. National Library of Medicine. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4265215/.

consumers identified transportation as the most common barrier to care and that bus routes were not comprehensive enough to allow rural residents to make it to their appointments on time without committing a significant portion of their day to traveling.[26] Surveyors found that even when transit options were available, the bus routes and hours of operation placed a significant commuting burden on residents. Health care provider hours —which are typically weekdays—exacerbate this transportation dilemma. Not only must community members make their travel arrangements fit within, often, limited bus schedules but they must also work within limited health care windows. These scheduling constraints can lead to health care visits taking an entire day which may not be possible for some community members who are unable to take an entire day off from work for a check-up.

Mobility as a service programs can provide meaningful assistance and flexibility to rural communities looking to access healthcare or other services. There are a number of ways that state, regional and local communities can increase mobility as a service programs, outlined below.

- **Increase state funding for medical transportation services:** Many states offer medical transportation services through federal funding (e.g., Medicaid and FTA Section 5310 and 5311 programs) but services fail to meet existing needs. Increasing funding for these services would lead to improved health within disadvantaged rural communities.
- **Increase car-sharing availability within rural communities:** State and local communities could increase mobility options for their residents by encouraging and developing car-sharing options within their communities. Several examples and approaches to increasing ridesharing within rural communities are described below.
- **Identify and address community specific mobility gaps:** Different communities will have different mobility needs. Some, for example, may have large populations of retirees who need increased medical transportation services whereas other communities may have large populations of low-income commuters looking to solve first-last mile travel issues. Focusing on the needs of the community will enable greater overall access to transportation services.

As will be discussed in the next section, increasing broadband access can also improve rural community access to health care by enabling greater access to telehealth services.

[26] Wallace, Richard & Hughes-Cromwick, Paul & Mull, Hillary & Khasnabis, Snehamay. (2005). Access to Health Care and Nonemergency Medical Transportation: Two Missing Links. Social Research in Transport (SORT) Clearinghouse. https://www.researchgate.net/publication/39967547_Access_to_Health_Care_and_Nonemergency_Medical_Transportation_Two_Missing_Links

Using Public and Private Avenues to Increase Shared Mobility within Rural Communities

States and private industry can have an important role to play in increasing shared mobility options within rural communities by increasing availability of shared transportation options that increase access to jobs and healthcare. While many states currently offer some services, few provide access to all residents and, even for those who do qualify for existing programs, program capacity often does not meet program needs. For example, many rural health departments receive funding for health care transportation services but this funding is not enough to provide adequate service to all community members. The following programs demonstrate how public and private industry are working to increase shared mobility options within rural communities.

GO MAINE Statewide Commuter Program
The State of Maine's Department of Transportation and Turnpike Authority has taken an innovative approach to increasing mobility within the state through its GO MAINE statewide commuter program. The program provides ride matching for carpoolers and provides emergency ride home benefits to carpoolers who sign up for the program. Commuters are rewarded for taking greener trips including walking, biking telecommuting, carpooling, vanpooling, or taking public transit by receiving discounts from local, regional and national retailers for participating in the program.

California Green Raiteros Rideshare Program
The Green Raiteros rideshare program provides a green and innovative solution to increasing mobility in rural communities that are disproportionately burdened by poor air quality in California's San Joaquin Valley. The program came out of a self-organized dial-a-ride program run by community members and was expanded through a partnership between EVgo and the Environmental Advancement and Policy Institute (LEAP) organization — a local environmental justice non-profit. The program is accessible to residents through multiple different communication portals. Residents looking to book a ride can do so by phone, through an app, or by visiting the Green Raiteros Office.

Lyft Partnership with Medicaid Agencies
Lyft has started to collaborate with Medicaid Agencies, Health Plans, and Transportation Managers to bring non-emergency medical transportation (NEMT) to Medicaid recipients in Georgia, Michigan, Tennessee, and Virginia. Partnering with TNCs to provide greater access to these services within rural communities is a potentially innovative solution to increasing access to health care services.

Revitalizing Main Street

Having greater regional access not only enables rural residents to have access to urban centers but the reverse is also true. Creating accessible regional and local transportation could lead to increased tourism to rural areas from urban and suburban locations in addition to improving quality of life for residents. This leads to another potential benefit from creating clean transportation systems within rural communities—main street revitalization. Main streets and town centers provide vital community services to rural communities by creating jobs, providing opportunities for tourism, and by creating community gathering locations. By investing in the use of alternative modes of transportation such as increasing rail-trails and other complete street initiatives that create more walkable and bikeable communities and by providing increased and more flexible transit service opportunities, rural communities could create main streets that are easily accessible and more pedestrian friendly leading resident and visitors to stay longer and potentially spend more time in rural centers. Creating more bikeable and walkable communities have also been shown to have other co-benefits including improved health.

The following policies, outlined below, can enable a more accessible and vibrant main street in rural communities.

Policies to Revitalize Main Street

Investing in Active Transportation

While improving vehicle emissions by enabling transportation electrification is one component of increasing cost effective and cleaner transportation options in rural communities, land use and planning options can also enable safer, more vibrant streets by creating more walkable and accessible street usage patterns. These policies not only enable greater access to community centers but can create placemaking opportunities that encourage both residents and visitors alike to live, work, and play in rural main streets.

Active transportation planning, planning that prioritizes human-powered transportation such as biking or walking, is often thought of within the context of urban environments, but rural communities can also benefit greatly from active transportation planning approaches in several unique ways. A primary one is safety— a disproportionate number of bicycle and pedestrian fatalities occur in rural areas. According to a review by the Active Transit Alliance in 2016, while only 20% of the U.S. population lives in rural areas 26% of all pedestrian fatalities and 31% of all bicyclist fatalities occur in rural areas.[27] Economic opportunity and equity is another. As has been discussed in other sections of this report, rural communities often lack reliable transit services which can dramatically impact their access to jobs and health care. Even in communities that have public transportation services, community members will likely have to walk in order to reach a bus stop. This portion of the trip can be dangerous if the stop is not easily or safely accessible which can limit transit usage and can endanger those who may have no other alternative. The goal of active transportation planning, like complete street planning, is to encourage safe, comfortable, and integrated transportation networks for all street users. These policies often require significant community engagement which can lead to specific street

[27] Complete Streets Complete Networks Rural Contexts. (2016). Active Transportation Alliance. http://atpolicy.org/wp-content/uploads/2016/04/CSCN-Rural-Companion-v3-LOW-RES-PROOF.pdf.

plans that are designed with community usage patterns in mind, increasing the safety and usability of the street. Not only do these pathways provide meaningful transportation opportunities for residents but they can also provide placemaking opportunities for "active" tourism, described below in case study on the Great Allegheny Passage Trail.

There are a number of ways that state, regional and local communities can increase access to active transportation, outlined below.

- **Implement planning that incorporates many different modes of transportation:** Local and regional planning organizations should work with community members to identify areas for multi-modal transportation planning that could include complete street planning or the development of rail trails to encourage mode shifting from personal vehicle use to other types of transportation options (e.g. transit, biking, walking). The "completeness" of a rural street should vary depending on the use case of the street and, importantly, what the community considers to be important.
- **Maintain existing infrastructure:** Just as it is important to maintain roadways for motorists, it is equally critical to ensure that pedestrians and other non-vehicle commuters have safe and reliable pathways. Investing in improving existing infrastructure to ensure that pedestrians feel safe in accessing pedestrian pathways, transit stops, and bike paths is essential to ensuring alternative modes of transportation are utilized within a community.

Creating Active Tourism in Rural Communities through Rail Trail Development

Rail trails and greenways not only provide opportunities for residents to bike, walk and explore their communities but they can also create meaningful networks that can enhance the mobility and livability of a rural community, making it a more enticing place to live, work, and visit. Increasing rail trails have been shown to increase property values, improve health, and increase tourism within rural communities. The Great Allegheny Passage Trail— a 132 mile trail that runs from McKeesport, Pennsylvania to Cumberland, Maryland, described below— highlights the economic opportunity that investing in rail trail communities can foster.

The Great Allegheny Passage Trail, since it was completed in 2006, has attracted an additional 700,000 yearly users to the region, generating an additional $40 million into eight small towns. A study evaluating the economic impacts of the trail on its surrounding community found that since the since 2007, 54 businesses have opened or expanded within region creating an additional 83 new jobs. The trail continues to to provide meaningful year-around biking and hiking tourism within the region with business owners indicating that one-quarter of their gross revenue is directly attributed to trail users with two thirds of those surveyed indicating that they experienced at least some increase in gross revenue because of their proximity to the trail.

Source: Rails to Trails Conservancy, Allegheny Trail Alliance

Increasing Broadband Access

A critical goal of developing a clean transportation system within rural communities is reducing the amount of time spent within older, inefficient, single occupancy vehicles. This can be done by implementing several of the policies described above—increasing the use of electric vehicles, increasing public transportation options including shared mobility options, among others. Each of these approaches focuses on reducing vehicle emissions through improved vehicle or rider efficiency. Another approach to addressing this issue is to remove the need for the commute or trip entirely. By increasing the deployment of telehealth and telecommuting opportunities, community members can significantly reduce vehicle miles traveled ultimately leading to emissions reductions and potential consumer savings from decreased wear and tear on the vehicle and lower fueling costs. Critical to the deployment of these services is the increased deployment of broadband within rural communities.

According to the Federal Communications Commission, over 20 million Americans, primarily those living in rural areas, lack access to high speed broadband services.[28] Since 2018, the USDA has funded the Rural e-Connectivity Pilot Program (ReConnect Program) which supports the build out of essential infrastructure for internet e-connectivity services to rural areas without sufficient access to broadband. But, even with these increased funds, the Congressional Research Service found in 2019 that broadband buildout has not dramatically expanded in rural communities since 2013. They further found that, ultimately, further expansion falls on internet service providers who find investing in rural communities unprofitable because of the increased amount of infrastructure required and lack of customers serviced leading to high per customer connection costs.

Not only would increasing broadband enable telehealth and telecommuting opportunities within rural communities, but there are many other benefits to increasing broadband access within rural communities including reduced commuting time, increased health and education access, as well as providing much needed support for businesses looking to have a stronger e-commerce base. The COVID-19 pandemic has displayed the disparity in broadband access across the country. Some students in rural communities, for example, were unable to participate in online education during the pandemic due to a lack of access to internet services. It also exposed the disparity in internet access between middle class and low-to-moderate income residents in both urban and rural communities. Both of these factors need to be addressed to ensure more equitable access to broadband services for all communities.[29] In order to increase broadband services, federal and state governments can increase broadband access in rural communities in the following ways.

- **Increase state and federal funding for the buildout of broadband services within rural communities:** Federal and state government should continue to fund increased broadband expansions within rural communities and should work to streamline processes to make per customer connections less expensive.
- **Develop public-private partnerships to expand broadband services:** Federal and state governments should partner with internet service providers to continue efforts to expand broadband access to enable increased telecommuting and telehealth services.
- **Provide subsidized broadband options for low-to-moderate income residents:** Federal and state governments should provide subsidies for low-to-moderate income residents to ensure that all community members have access to broadband services once they are developed within a community.

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[28] Demand for Broadband in Rural Areas. (2019). Congressional Research Service. https://fas.org/sgp/crs/misc/R46108.pdf.

[29] Doug Brake. "Lessons from the Pandemic: Broadband Policy After COVID-19."(2020) https://itif.org/publications/2020/07/13/lessons-pandemic-broadband-policy-after-covid-19.

Case Studies

ME	The Maine Statewide Broadband Action Plan set a goal to provide access to at least one broadband provider with sufficient capacity to 95% of all potential subscriber locations statewide. Under this proposed plan, the state would contribute 25% of the total cost required to increase broadband access in rural Maine, totaling $30 million dollars in FY20/21 and $42.5 million each year until 2025. In January 2020, the state was awarded $9.87 million in investments in four infrastructure projects through the USDA ReConnect Pilot Investments Program. These investments are estimated to create or improve rural e-Connectivity for 4,527 households and 215 businesses in rural Maine.
MD	The Maryland Rural Broadband Program offers grants of up to $200,000 to local jurisdictions for 50% of the construction costs related to extending internet service provider (ISP) service to unserved households. The ISP would partner with the local jurisdiction and use their existing network to provide service. A 100% match is required for this grant opportunity.
VA	In March 2019, Governor Northam announced over $4.9 million in grants through the Virginia Telecommunication Initiative for 11 projects within 12 counties throughout Virginia. The program provides targeted funding to extend service to areas that are presently unserved by any broadband provider.
VT	Vermont Rural Broadband Project is designed connect individuals who need service with local community groups working to bring service to their area. The Vermont Rural Broadband Project has provided consultation services to over 50 Vermont communities, helping many of them access and aggregate their demand and negotiate with potential providers to draw services.

Conclusion

This report identified a number of policy approaches and opportunities to develop a clean transportation system within rural communities that factors in existing vehicle usage patterns and demographics to ensure that clean transportation strategies benefit all communities. This study finds that, without these important complimentary policy approaches, households that spend a disproportionate share of their household budget on transportation, households that commute further to access work and health care services, and households that don't have the resources to access alternative technologies may be disproportionately affected by a price on carbon emissions. On the flip side, we have highlighted in this report the ways in which some of these very same factors will mean the potential for even greater savings from transitioning to cleaner, more efficient vehicles. The policies and programs outlined in this report showcase some potential elements that can be incorporated in partnership with local officials, community residents, and other stakeholders to head off potential equity issues with a carbon pricing policy.

We hope that this analysis will inspire further discussion and debate about the best ways to ensure that the benefits of a clean transportation system can be enjoyed broadly across all households and communities.

TABLE 3. POTENTIAL EFFECT ON CLEAN VEHICLE UPTAKE AND EXAMPLE POLICY APPROACHES

Rural counties have…	Potential Effect on Clean Vehicle Uptake		Potential Policies to Support a Clean Transportation System
	Positive/ Negative	**Discussion**	**Example policy approaches**
More people living in single family homes	Positive	Home charging is more widely accessible, complementing public charging network	EV/EVSE Incentives; Lead by Example programs
Older population	Negative	Perhaps less willing to adopt new technologies	Regional corridor planning; increased shared use mobility; expanding broadband access
Lower household income	Negative	The up-front cost of purchasing an electric vehicle can present a barrier to entry	EV/EVSE Incentives; corridor planning; increased shared use mobility; expanding broadband access; investing in active transportation
More large vehicles	Both	Drivers will enjoy higher fuel cost savings with the purchase of an electric vehicle/fewer electric vehicle models in larger vehicle sizes	EV/EVSE Incentives; Lead by example; future vehicle scrappage opportunities
Older vehicle fleet	Negative	Perhaps more likely to purchase a used vehicle - nascent market for electric vehicles	EV/EVSE Incentives; Lead by example; future vehicle scrappage opportunities
More vehicles with lower MPG	Positive	Drivers will enjoy higher fuel cost savings with the purchase of an electric vehicle	EV/EVSE Incentives; Lead by example; Regional corridor planning; increased shared use mobility

Appendix – Methodology Supplement

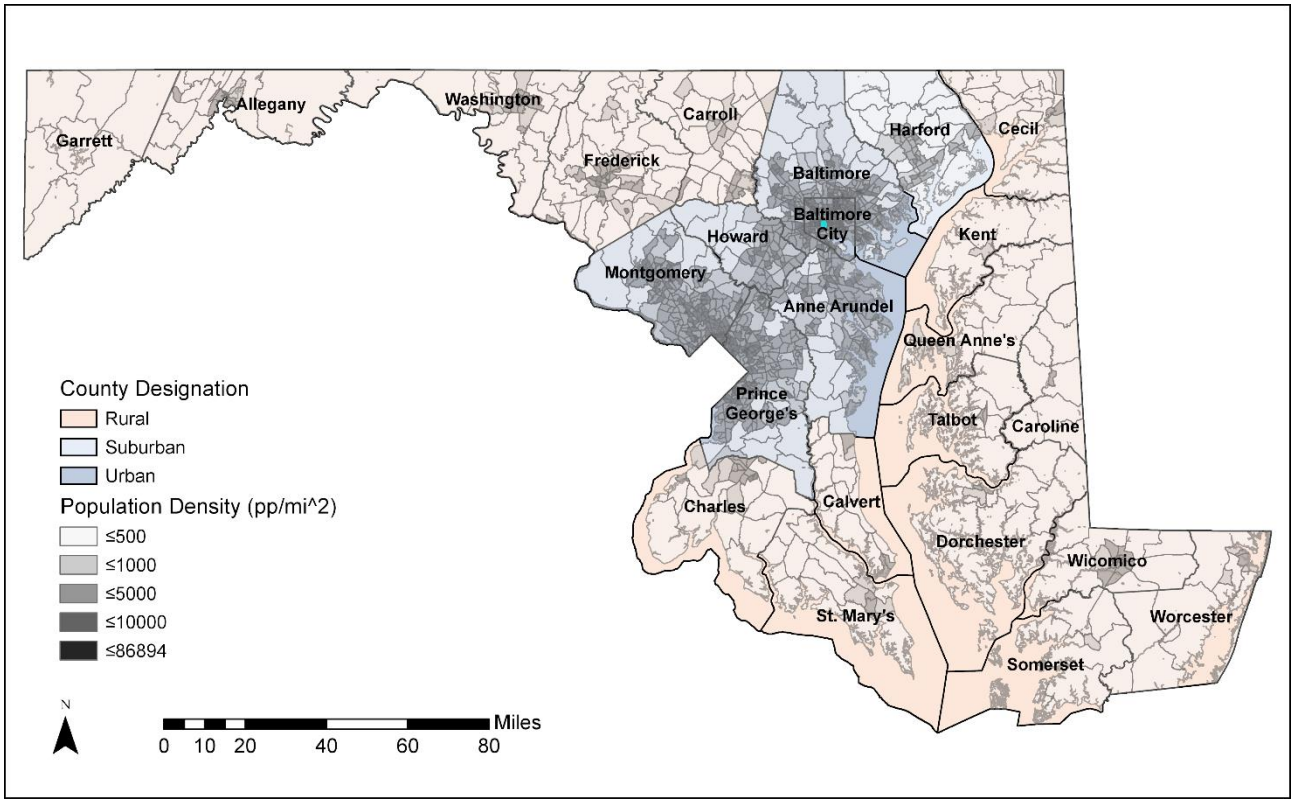
County Designations

Population Density

Population density was calculated at the county level for the four states assessed. Demographic data, including population, age, gender, household income, poverty level, housing units, and population living in urbanized areas were gathered from the US Census Bureau.[30] Maps showing population density by census tract were created with ArcGIS Pro using data from ESRI's ArcGIS Living Atlas of the World.[31]

County-Level determinations of Urban, Suburban, or Rural are denoted by color. Counties are considered "Urban" (1) if population density was greater than 1,000 persons per square mile, or (2) if 55 percent or more of the population within a county lives in an "urbanized area.," defined by the Census Bureau as a continuously built-up area of 50,000 or more people. "Suburban" counties had a population density between 500 and 1,000 persons per square mile, and counties with a population density below 500 persons per square mile were designated "Rural".

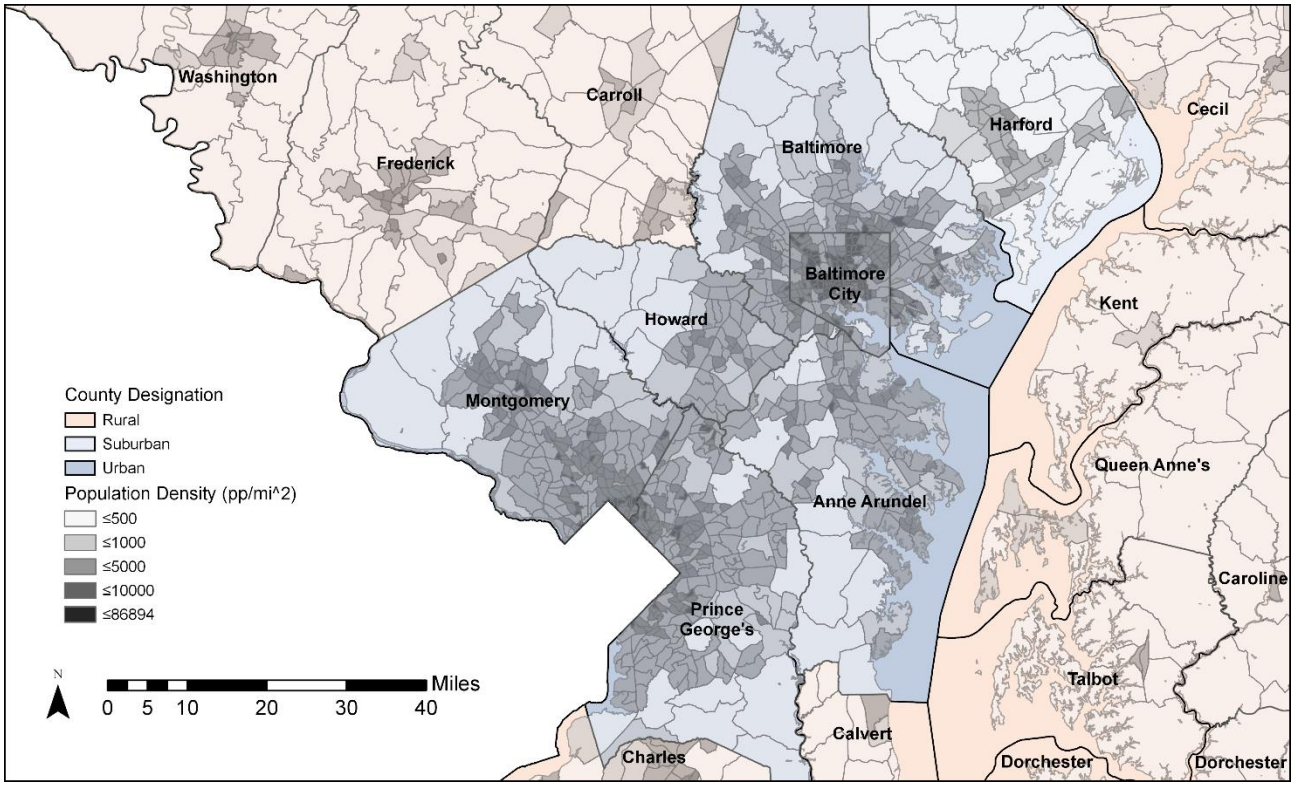
Maryland



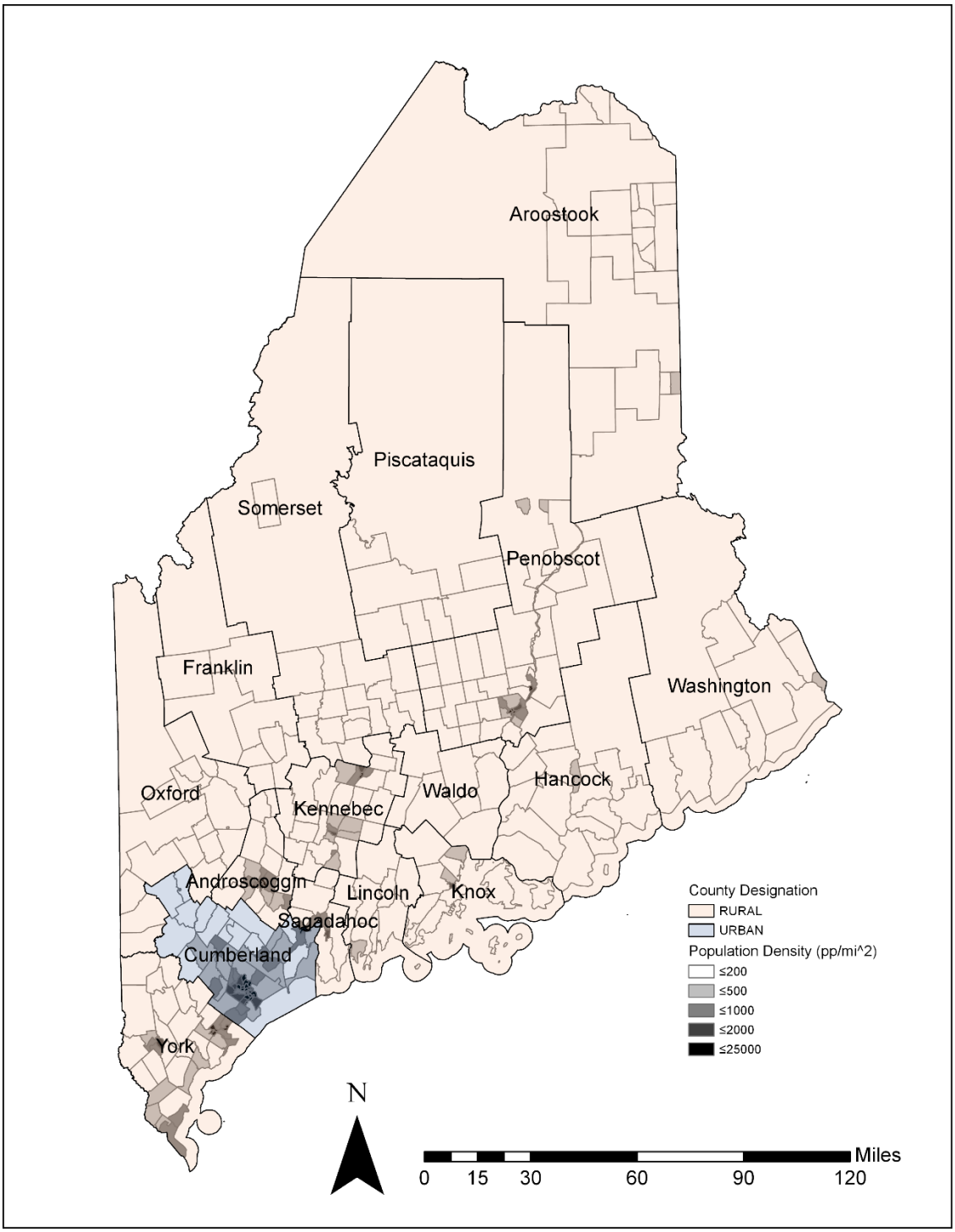
Maryland

[30] "ACS Demographic and Housing Estimates." U.S. Census. (2017). https://data.census.gov/cedsci/table?q=United%20States&g=0100000US&tid=ACSDP1Y2017.DP05.

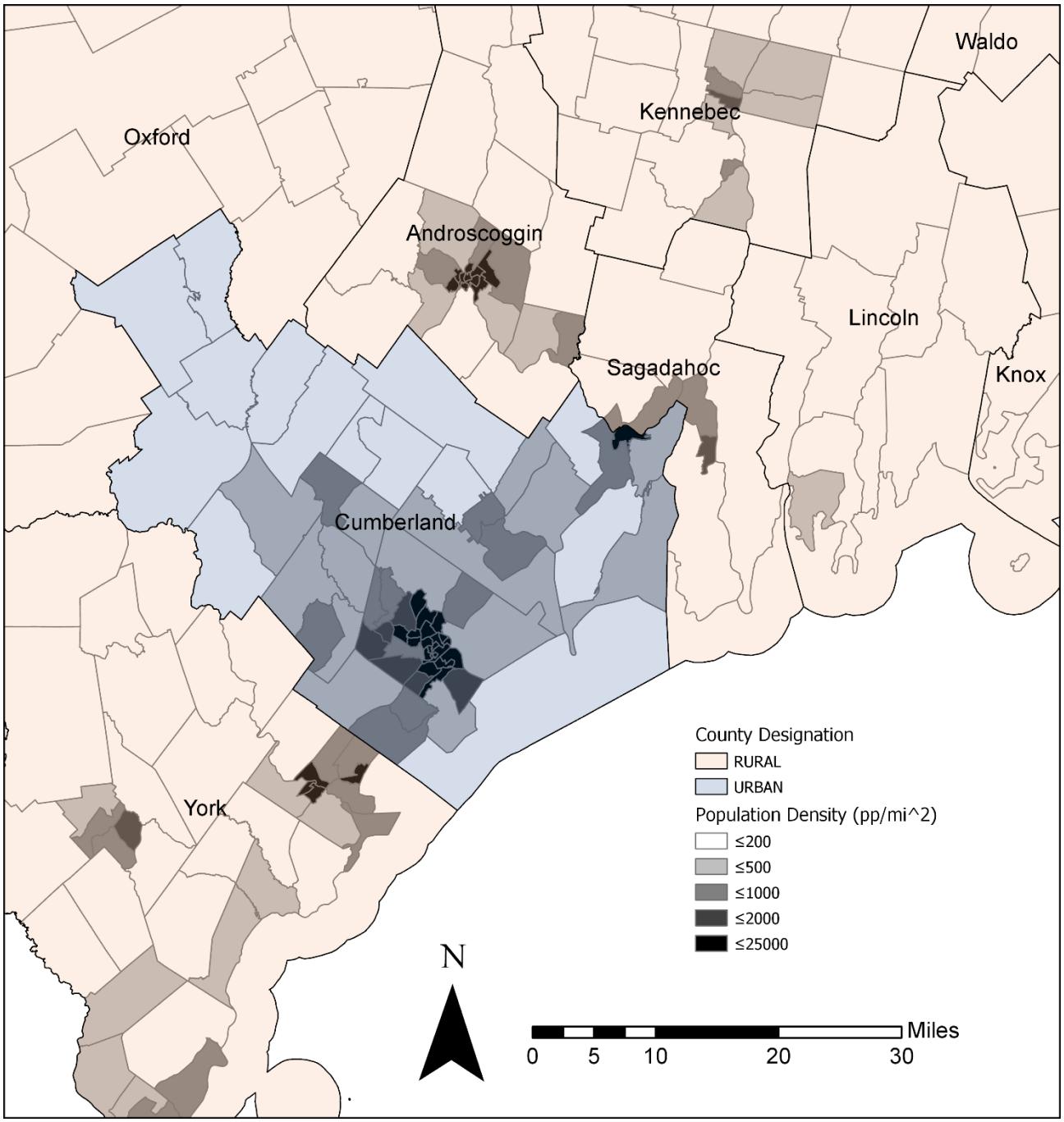
[31] "ArcGIS Living Atlas of the World." ESRI. (2020). https://livingatlas.arcgis.com/en/home/.



Baltimore City and DC Metropolitan Area

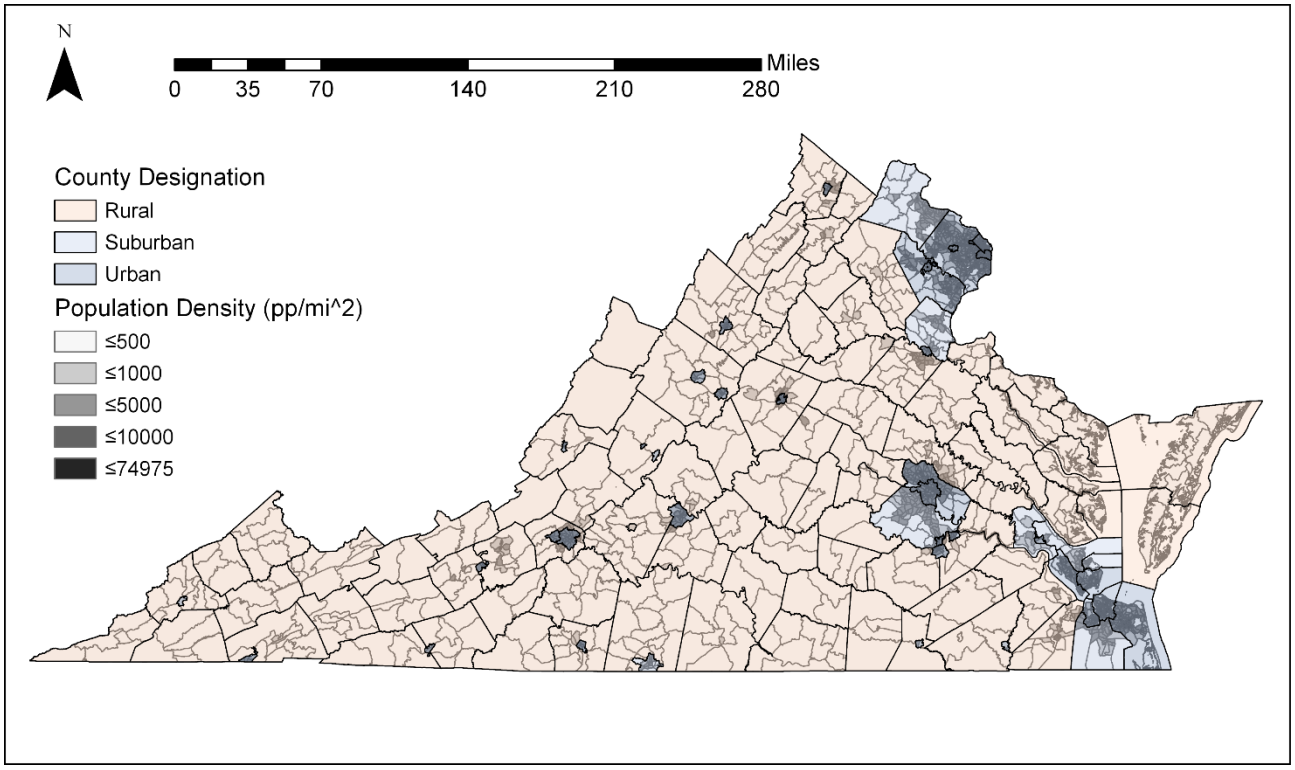

Aroostook
Piscataquis
Somerset
Penobscot
Franklin
Washington
Oxford
Kennebec
Waldo
Hancock
Androscoggin
Lincoln
Knox
Sagadahoc
Cumberland
York
County Designation
RURAL
URBAN
Population Density (pp/mi^2)
≤200
≤500
≤1000
≤2000
≤25000
N
Miles
0 15 30 60 90 120

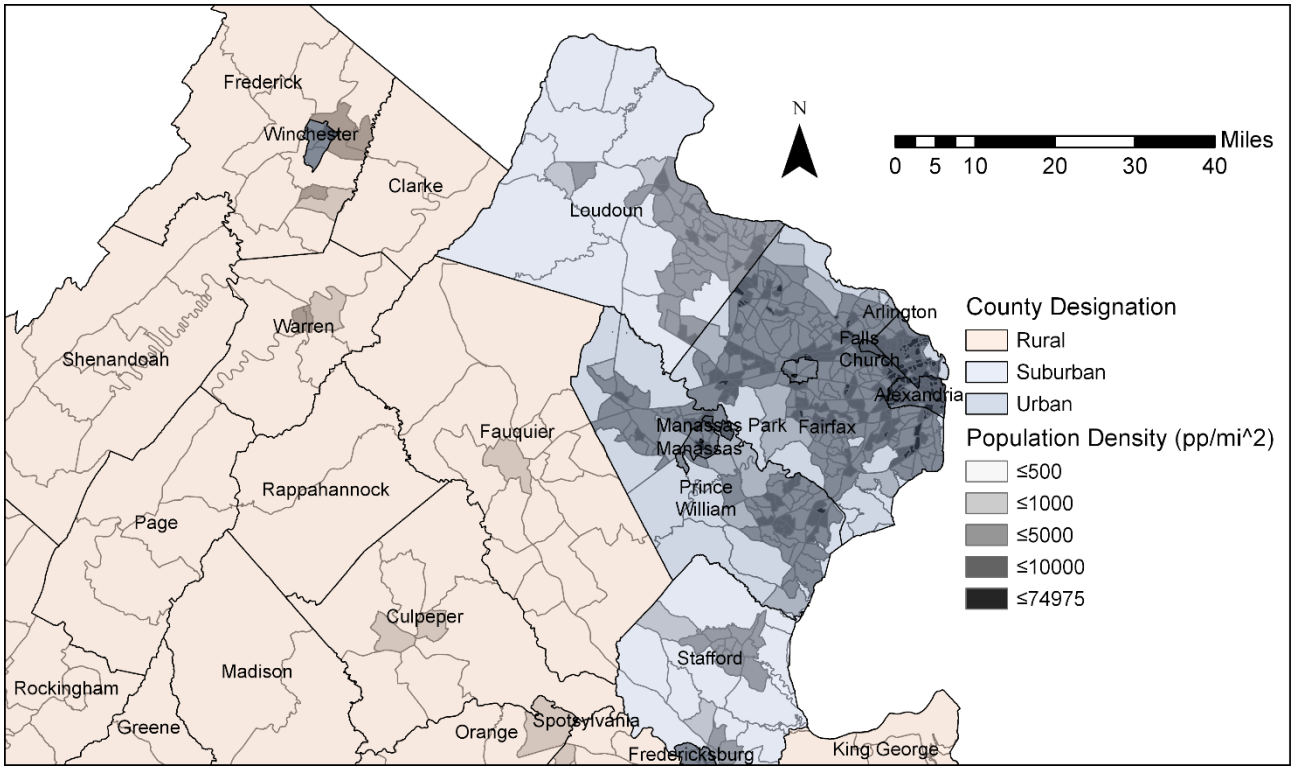
Maine



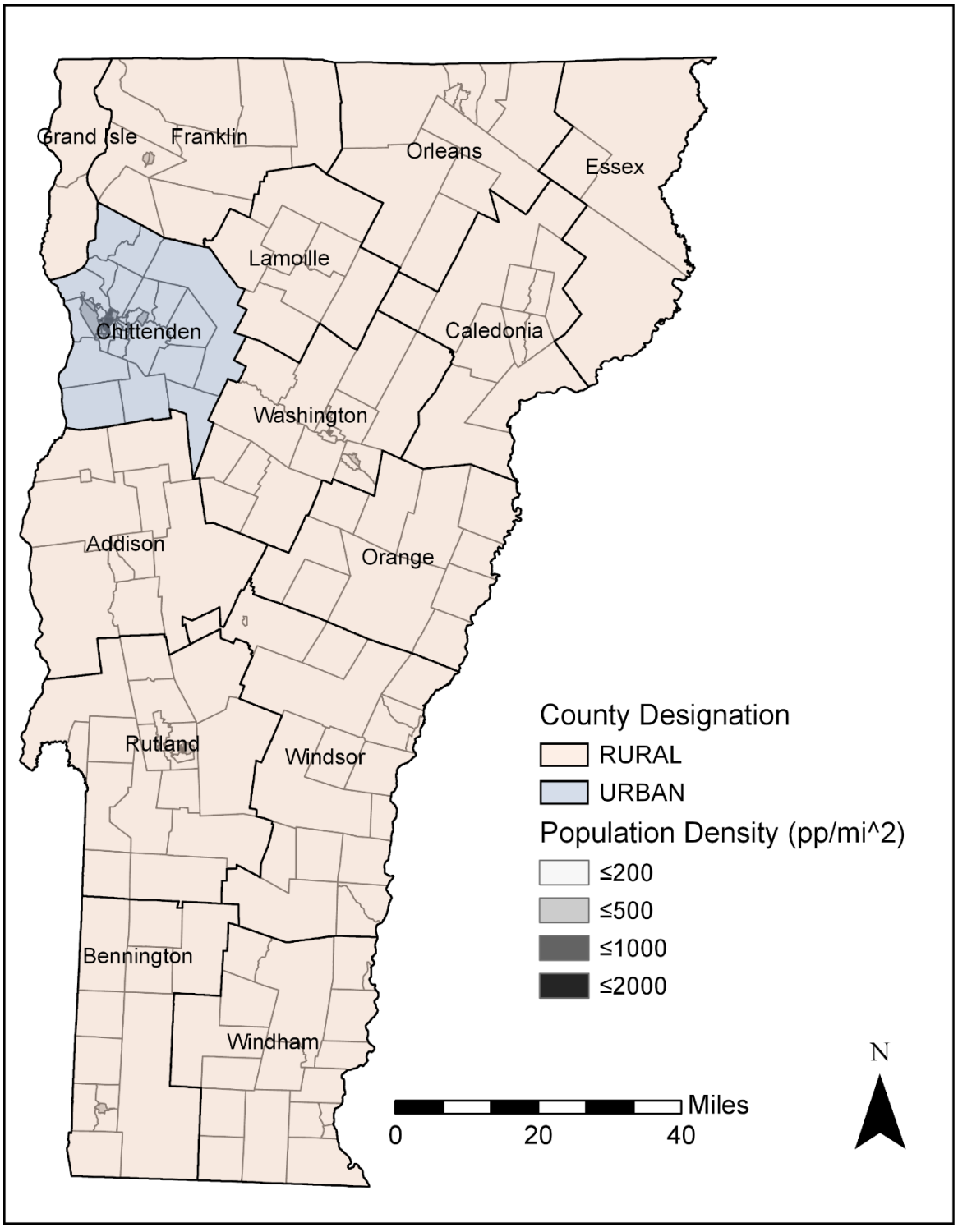
Portland and Surrounding Areas

Virginia

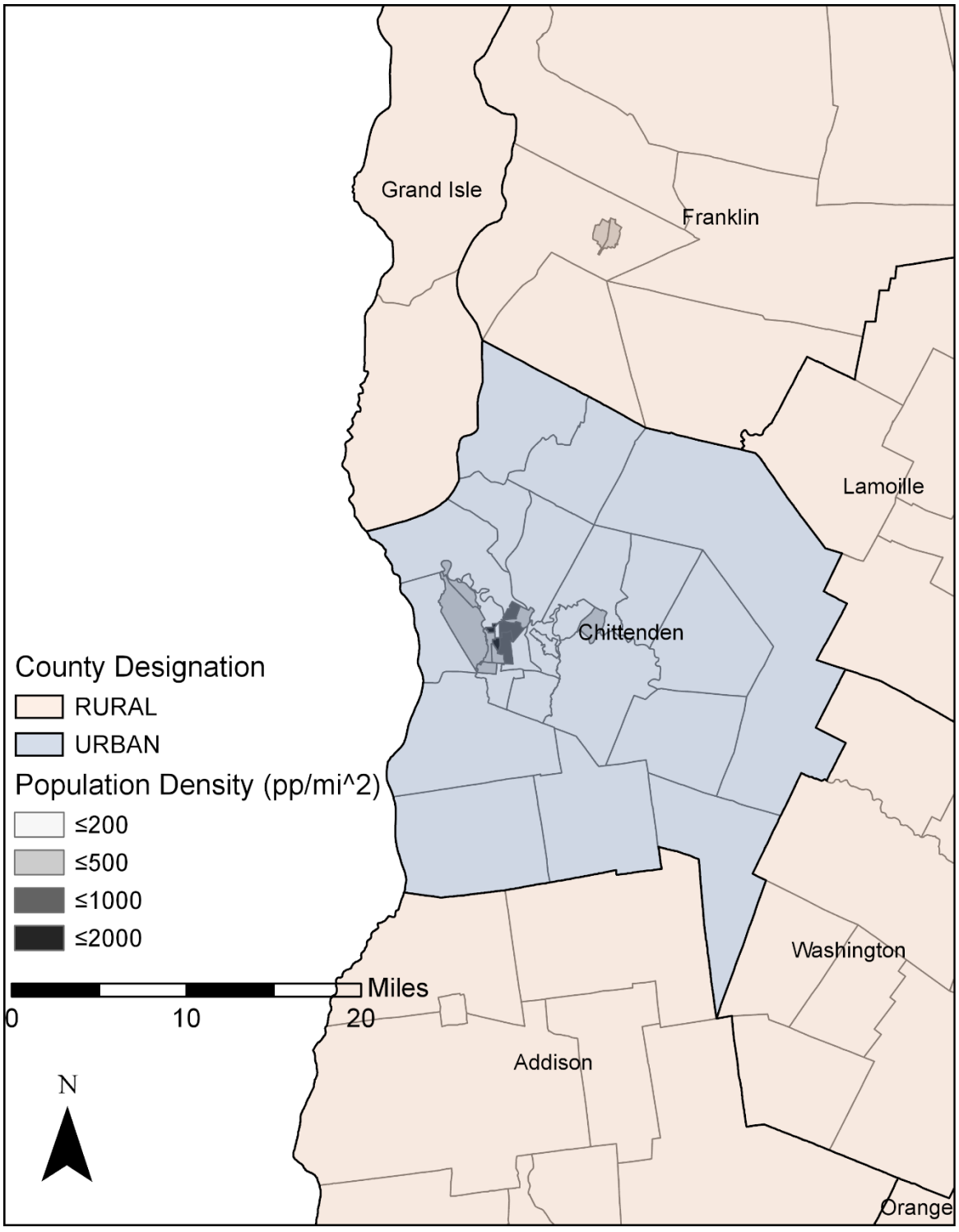




Northern Virginia and DC Metro Area


Grand Isle
Franklin
Orleans
Essex
Lamoille
Chittenden
Caledonia
Washington
Addison
Orange
Rutland
Windsor
Bennington
Windham
County Designation
RURAL
URBAN
Population Density (pp/mi^2)
≤200
≤500
≤1000
≤2000
N
Miles
0
20
40

Vermont

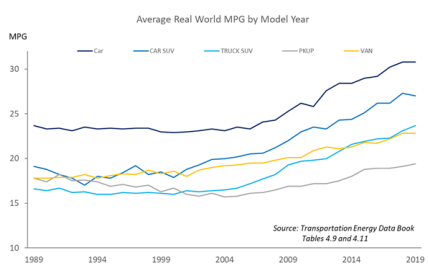


Burlington and Surrounding Area

County-Level Vehicle Registration

Vehicle types and model year data were purchased through IHS Markit. These fleet data are the basis for conclusions for vehicle class, age, trends in vehicle size, status as a luxury or alternative fuel vehicle, and fuel economy. For each vehicle class and model year, fuel economy was calculated by averaging the miles per gallon of the top 3 selling models in each class.

MJB&A used data on historical fuel economy by model year for 5 different vehicle segments and EPA window sticker values for the most popular vehicle models in a list of 11 segments to estimate fuel economy by model year.[32,33] Values applied to IHS Markit fleet data collected for Urban and Rural counties are used to calculate fleet average MPG for each group. Estimates of fleet average fuel economy account for differenced in fleet composition: vehicle type and size, as well as differences in fleet age distribution between urban and rural counties in each state. The chart and table below represent the process which combines fuel economy for each vehicle class and model year and maps the result to the 11 vehicle segments.



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		MAKE	MODEL	COMBINED MPG MY2016	MY2017	MY2018	MY2019	MY2020
CCAR	COMPACT CAR	TOYOTA	RAV4	26	25	25	30	30
		Honda	CR-V AWD	27	28	28	28	34
		NISSAN	ROGUE AWD	28	27	27	27	27
MCAR	MID SIZE CAR	TOYOTA	CAMRY	27	26	30	30	30
		Honda	ACCORD	27	29	32	33	33
		NISSAN	ALTIMA	31	29	29	32	32
FCAR	FULL SIZE CAR	Dodge	Charger	21	21	21	21	20
		Chevrolet	IMPALA	23	23	23	23	22
		NISSAN	MAXIMA	25	25	25	24	24
SPORT	SPORTS CAR	Ford	MUSTANG	22	21	22	22	22
		Subaru	WRX	21	21	21	21	21
		Porsche	Cayenne	21	20	20	21	20
MSUV	MID SIZE SUV	Jeep	Grand Cherokee 4X4	21	19	21	21	19
		Toyota	HIGHLANDER	22	23	23	23	24
		Ford	EXPLORER AWD	19	19	19	19	22
FSUV	FULL SIZE SUV	Chevrolet	K1500 TAHOE 4WD	18	18	18	17	17
		GMC	ACADIA FWD	18	22	22	22	23
		Ford	Expedition 4WD	17	17	19	19	19
CPKUP	COMPACT PICKUP	TOYOTA	TACOMA 4WD	20	20	19	19	19
		Chevrolet	COLORADO 4WD	21	21	21	21	21
		Ford	RANGER 4WD				22	22
MPKUP	MID SIZE PKUP	NISSAN	FRONTIER 4WD	18	18	18	18	19
		Jeep	Gladiator Pickup 4x4					19
		Honda	RIDGELINE FWD		22	22	22	22
FPKUP	FULL SIZE PKUP	Ford	F150 PICKUP 4WD	20	20	20	21	20
		RAM	1500 4X4	18	18	18	19	20
		Chevrolet	SILVERADO 4WD	18	18	18	18	19
CVAN	SMALL VAN	Ford	Transit Connect Van 2WD	24	23	23	24	24
MVAN	MINI VAN	Dodge	Grand Caravan	20	20	20	20	20
		Chrysler	Pacifica		22	22	22	22
		TOYOTA	SIENNA	21	22	22	22	21

For each category of vehicle these were the top-selling models in 2019
Combined MPG is window sticker value per Fuel Economy.gov

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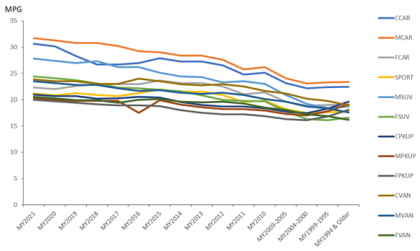

National Household Travel Survey

Annual Vehicle Miles Travelled (VMT) for each county type was calculated using data accessed through the Federal Highway Administration's National Household Travel Survey.[34] Survey data contains information on state and population density of respondents' census tract, but not county. Consequently, consistent with our methodology for designating counties "Urban", "Suburban", or "Rural", survey respondents in a census tract with population greater than 1,000 persons per square mile were considered Urban, between 500 and 999, Suburban, and less than 500, Rural. Though the NHTS does not provide details about the home county of the survey respondents, the reported population density of the census tract serves as a proxy for county level population density and type. This allows for comparison of fleet characteristics and driver behavior based on community type.

Calculating Savings for Electric Vehicles

To calculate savings from switching to an Electric Vehicle, gasoline consumption was calculated based on driver behavior acquired from the National Household Travel Survey and vehicle registration data from IHS Markit. Savings were calculated for both an average Urban, Suburban, and Rural household and driver for the four states considered. The VMT for each driver were applied to both a model year 2021 conventional internal combustion vehicle and an EV delivering equivalent utility. For the purposes of this report, the three most common vehicle types – mid-size car, full-size SUV, and full-size pickup truck – were selected.

[32] "Transportation Energy Data Book: Edition 38.2." Oak Ridge National Laboratory. (August, 31, 2020) https://tedb.ornl.gov/data/.

[33] "Fuel Economy.Gov." Department of Energy Office of Energy Efficiency and Renewable Energy.(2020). https://www.fueleconomy.gov/.

[34] "National Household Travel Survey." Federal Highway Administration. (2017). https://nhts.ornl.gov/.

Gasoline prices were extrapolated according to EIA's Annual Energy Outlook (AEO) 2020 projections for the New England (Maine and Vermont) and Mid Atlantic (Maryland and Virginia) regions[35]. Oil prices have been depressed since the start of the Covid-19 pandemic but are expected to rebound in the short term, according to EIA outlooks. Electricity prices were taken from EIA's state electricity profiles[36] for 2019 and indexed to AEO 2020 regional forecast for retail electricity prices. It is assumed that Urban and Rural customers receive the same electricity rates in each state.

Inputs	Value	Unit	Note
Gasoline Energy Content	**33.7**	**kWh/gal**	**Standard value[37]**
Average Engine Efficiency	**28%**		**EPA Estimate[38]**
Gasoline Useful Energy	**9.44**	**kWh/gal**	**Calculated**
EV Chassis Efficiency	**80%**		**EPA Estimate[39]**

We convert fuel efficiency in miles per gallon to kilowatt-hours per mile, as shown in the example below for an electric vehicle with the equivalent utility of an internal combustion vehicle achieving 35 miles per gallon.

$$EV\ Efficiency = \frac{1}{MPG} * Gasoline\ Useful\ Energy * Chassis\ Efficiency$$

$$EV\ Efficiency = 0.029 \frac{gal}{mi} * 9.44 \frac{kWh}{gal} * 80\%$$

$$EV\ Efficiency = 0.216 \frac{kWh}{mi}$$

Gasoline and Electricity Prices for ICE-to-EV Switch

$/gal	2020	2025	2030	2035	2040
New England	$2.73	$2.66	$2.80	$2.98	$3.11
Mid Atlantic	$2.72	$2.82	$2.96	$3.14	$3.28

$/kWh	2020	2025	2030	2035	2040
Maine	$0.131	$0.140	$0.141	$0.140	$0.142
Maryland	$0.114	$0.133	$0.137	$0.138	$0.139
Virginia	$0.094	$0.109	$0.112	$0.113	$0.114
Vermont	$0.149	$0.174	$0.179	$0.181	$0.181

[35] "Petroleum and Other Liquids" U.S. Energy Information Administration. (2020). https://www.eia.gov/outlooks/aeo /.
[36] "State Electricity Profiles." U.S. Energy Information Administration. (2019). https://www.eia.gov/electricity/state/.
[37] "Where the Energy Goes: Gasoline Vehicles." U.S. Department of Energy Office of Energy Efficiency and Renewable Energy.(2020). https://www.fueleconomy.gov/feg/atv.shtml.
[38] Thomas, J. 2014. Drive Cycle Powertrain Efficiencies and Trends Derived from EPA Vehicle Dynamometer Results. SAE Int. J. Passeng. Cars - Mech. Syst. 7(4):2014, doi:10.4271/2014-01-2562.
[39] "Where the Energy Goes: Electric Cars." U.S. Department of Energy Office of Energy Efficiency and Renewable Energy.(2020). https://www.fueleconomy.gov/feg/atv-ev.shtml.