Residential Carshare Study for the New York Metropolitan Area

Final Report | Report Number 20-03 | February 2020

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

NYSERDA's Promise to New Yorkers:

NYSERDA provides resources, expertise, and objective information so New Yorkers can make confident, informed energy decisions.

Mission Statement:

Advance innovative energy solutions in ways that improve New York's economy and environment.

Vision Statement:

Serve as a catalyst – advancing energy innovation, technology, and investment; transforming New York's economy; and empowering people to choose clean and efficient energy as part of their everyday lives.

Residential Carshare Study for the New York Metropolitan Area

Final Report

Prepared for:

New York State Energy Research and Development Authority

New York, NY

Robyn Marquis, PhD
Project Manager, Clean Transportation

Prepared by:

WXY Architecture + Urban Design

New York, NY

Adam Lubinsky, PhD, AICP
Managing Principal

Amina Hassen
Associate

Raphael Laude
Urban Planner

with

Barretto Bay Strategies

New York, NY

Paul Lipson
Principal

Luis Torres
Senior Consultant

and

Empire Clean Cities

NYSERDA Report 20-03 NYSERDA Contract 114627 February 2020

Notice

This report was prepared by WXY Architecture + Urban Design, Barretto Bay Strategies, and Empire Clean Cities in the course of performing work contracted for and sponsored by the New York State Energy Research and Development Authority (hereafter the "Sponsors"). The opinions expressed in this report do not necessarily reflect those of the Sponsors or the State of New York, and reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it. Further, the Sponsors, the State of New York, and the contractor make no warranties or representations, expressed or implied, as to the fitness for particular purpose or merchantability of any product, apparatus, or service, or the usefulness, completeness, or accuracy of any processes, methods, or other information contained, described, disclosed, or referred to in this report. The Sponsors, the State of New York, and the contractor make no representation that the use of any product, apparatus, process, method, or other information will not infringe privately owned rights and will assume no liability for any loss, injury, or damage resulting from, or occurring in connection with, the use of information contained, described, disclosed, or referred to in this report.

NYSERDA makes every effort to provide accurate information about copyright owners and related matters in the reports we publish. Contractors are responsible for determining and satisfying copyright or other use restrictions regarding the content of the reports that they write, in compliance with NYSERDA's policies and federal law. If you are the copyright owner and believe a NYSERDA report has not properly attributed your work to you or has used it without permission, please email print@nyserda.ny.gov

Information contained in this document, such as web page addresses, are current at the time of publication.

Preferred Citation

New York State Energy Research and Development Authority (NYSERDA). 2019. "Residential Carshare Study for New York Metropolitan Area," NYSERDA Report Number 20-03. Prepared by WXY Architecture + Urban Design, Barretto Bay Strategies and Empire Clean Cities. nyserda.ny.gov/publications

Abstract

Residential Carshare–New York Metro examines the feasibility of a carshare program business model that deploys electric vehicles (EV) among the vehicle fleet mix, with deployment in different residential markets, including low- and moderate- income (LMI) housing developments. “Residential carshare” differs from many current market offerings in that it proposes carshare vehicles at multifamily residences for the exclusive use of building residents, ensuring greater certainty to building residents of vehicle availability. Examining New Rochelle, White Plains, and Yonkers as target areas for residential carshare, this study employed the expertise of project partners, market analysis, and a pro forma to assess the feasibility of the business model. The study finds that the convergence of three emerging trendlines—new multifamily development, evolving personal mobility preferences, and generational transition—has positioned Westchester County as an ideal testbed for EV carsharing. Nevertheless, a cost premium associated with EV deployment, largely untested demand among LMI consumers, and the limitations placed on the size of the market due to exclusivity of use all conspire against a rapid return on investment and a clear path to profitability. To achieve success, a clear and compelling alignment of interests between city government, the development community, and carsharing organizations will be required.

Keywords

Residential carshare, carshare, car share, car-share, electric vehicles, EV, ZEV, BEV, PHEV, municipal fleet, mobility, shared mobility, equitable mobility, sustainable transportation, sustainability, carbon, service, development, real estate, housing, pro forma, business model, policy, New York, New York State, Westchester County, Westchester, Yonkers, New Rochelle, White Plains

Table of Contents

List of Figures

List of Tables

Acronyms and Abbreviations

A	amps
BEV	battery-electric vehicle
EV	electric vehicle
EVSE	electric vehicle supply equipment
ft	feet
GHG	greenhouse gas
ICE	internal combustion engine
kW	kilowatt
kWh	kilowatt-hour
PEV	plug-in electric vehicle
PHEV	plug-in hybrid electric vehicle
POV	privately owned vehicle
sf	square foot, square feet
TNC	Transportation Network Company
V	volts
VMT	vehicle miles traveled
ZEV	zero-emissions vehicle

Executive Summary

A typical car is parked 95% of the day,[1] which suggests that many car owners could address their mobility needs through a shared vehicle. Residential Carshare–New York Metro examines the feasibility of a carshare program business model that deploys electric vehicles (EV) among the vehicle fleet mix, with deployment in different residential markets, including low- and moderate-income (LMI) housing developments. The study leverages expertise of project partners in New Rochelle, White Plains, and Yonkers as target areas for the study.

The idea behind "residential carshare" differs from many current market offerings in that it proposes carshare vehicles at multifamily residences for the exclusive use of building residents, ensuring greater certainty to building residents of vehicle availability. Using zero-emission vehicles (ZEV) as carshare vehicles can increase mobility without increasing overall greenhouse gas (GHG) emissions.

Policymaking is especially important for support in the growth of the program—public policy that facilitates expanded mobility options in LMI communities and that trades potentially outdated parking requirements for EV carsharing implementation is a promising strategy to stimulate demand. The following research questions guided the research team in identifying a feasible and scalable program and deployment model for residential carshare:

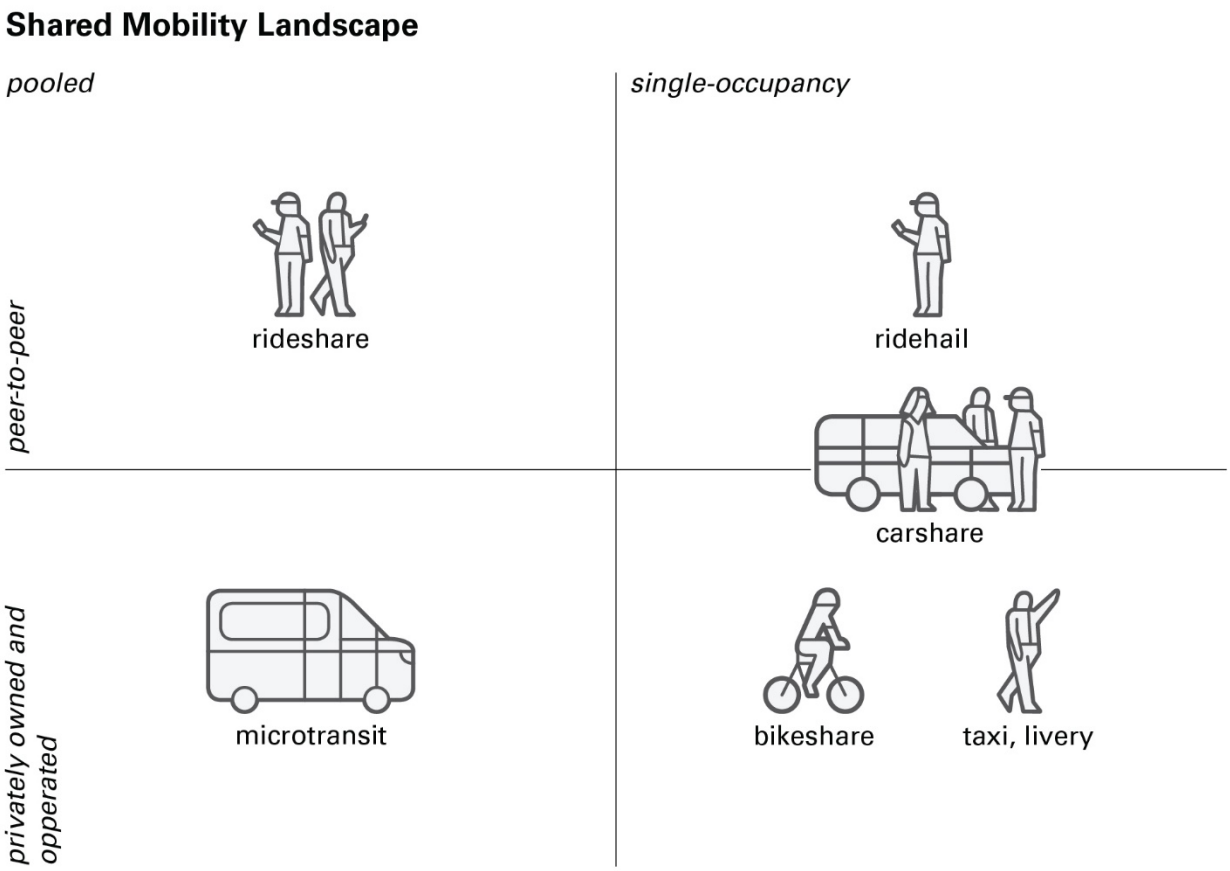
- What are the challenges to creating residential carshare, including start-up and operational costs for this program?
- What are the optimal conditions at multifamily residential developments to support a successful carshare program?
- How can a residential carshare program be leveraged to change public policy around parking requirements? Conversely, how can policymaking most effectively incentivize EV carsharing in multifamily residential settings?
- Can a supportive ecosystem of automakers, carshare operators, and residential developers alone bring about the widespread proliferation of this program, or, are other levers required?
- What are the qualitative and, when possible to establish, quantitative impacts of a residential carshare program in terms of carbon emissions saved, reduced car ownership, improvements to mobility options (particularly in the LMI communities), and developer interests?
- Is there currently a residential carshare business model that includes LMI communities to be financially viable?
- How can carshare utilization be optimized to ensure program viability?

1 Introduction

1.1 The Shared Mobility Landscape

Shared mobility is the ensemble of transportation modes where a vehicle is shared by many users, accessed on an as-needed basis, and does not follow a regular schedule or route. Shared mobility is typically used to refer to low-capacity shared modes such as carsharing, bike sharing, microtransit, ride hailing, and ridesharing services (Figure 1).

Figure 1. Shared Mobility Landscape



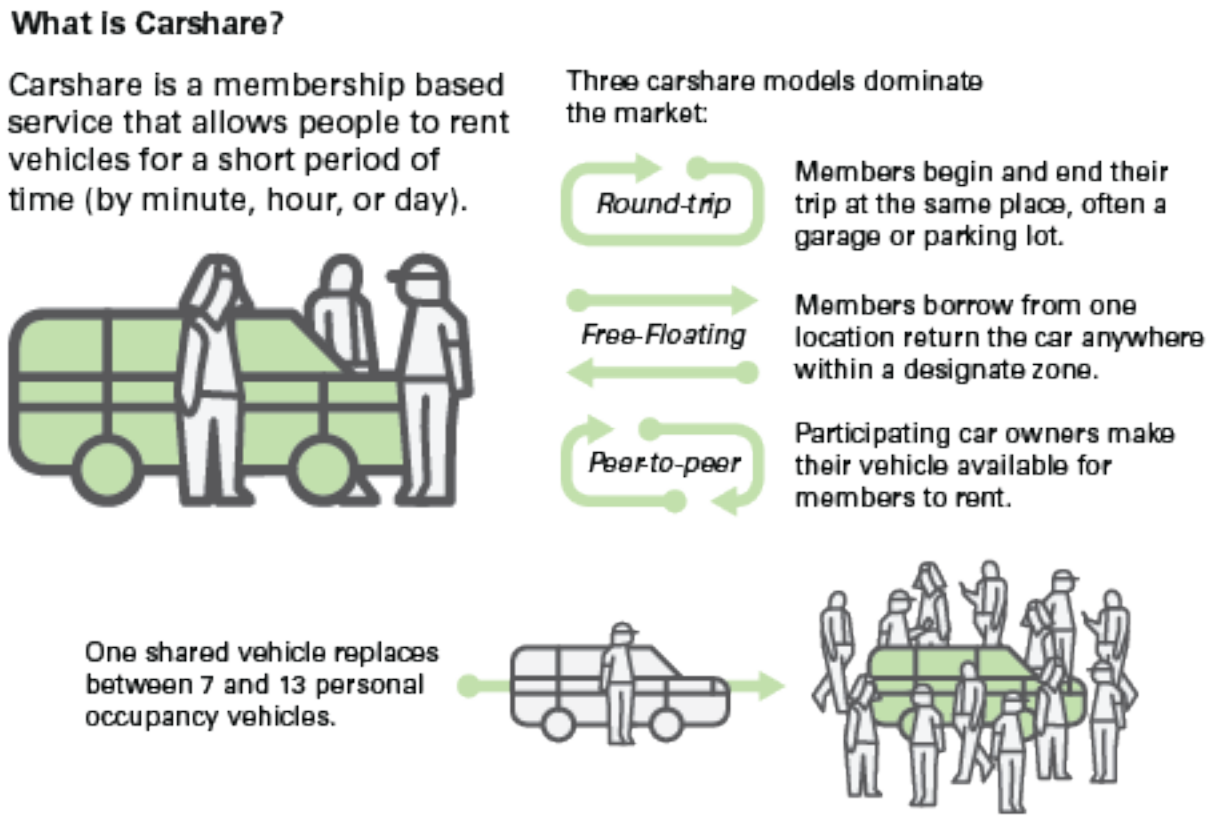
Shared mobility services promise an alternative to personal vehicle ownership. A sufficiently economical and robust network of shared mobility services could, in combination, offer the flexibility of privately-owned vehicles (POVs) without the associated challenges of ownership (e.g. cost, parking, maintenance). Shared mobility services come with the substantial benefits of reducing congestion and decreasing over all vehicle miles traveled (VMT); by sharing vehicular trips, or replacing them entirely by walking or

biking, roads will flow more smoothly, and reduced emissions can improve community health. Shared modes promise to improve asset utilization, too; using smaller fleets to fulfill transportation needs means fleet vehicles can be replaced more regularly, keeping pace with improvements in fuel efficiency and design, and reducing the total number of vehicles produced.[2]

1.2 What is Carshare?

Carshare is a service that allows users to access a vehicle for a short period of time, usually by the hour or minute, in an effort to utilize vehicles more effectively. Figure 2 shows different models of carshare available to users.

Figure 2. Carshare Models



The United States represents three-quarters of North America's carshare market.[3] Carshare membership has ballooned from less than 180,000 members in 2007 to more than 1.4 million members in 2017.[4] These figures are even higher—4.8 million members—when an ever expanding peer-to-peer carsharing network is considered.[5] Carsharing enables drivers to conveniently access a vehicle on a short-term basis and avoid

the high cost of owning and maintaining a personal vehicle. The costs of vehicle ownership are especially high in cities and on college campuses, where vehicle ownership is typically low. As such, carshare is especially popular in these markets.[6]

1.3 Benefits of Carshare

1.3.1 Reduced Car Ownership

Carsharing has potential to substantially reduce POV ownership, particularly in urban markets. Research by Susan Shaheen at University of California (UC) Berkeley's Transportation Sustainability Research Center (TSRC) suggests that one shared car under the round-trip model replaces nine to 13 POVs. One shared car in a free-floating model replaces seven to 11 POVs (Figure 2).[7]

1.3.2 Reduce Vehicle Miles Traveled and Greenhouse Gas Emissions

Shaheen's research suggests that carshare caused a 1.3% to 5.0% reduction in VMT in urban areas, correlating with estimated 0.4% to 2.1% reduction in GHG emissions. Households that adopt carshare see even more substantial savings: households that sell their POV and replace it with carshare may see annual VMT reduction of 27% to 43% with an associated 34% to 41% reduction in annual household GHG emissions.[8]

1.3.3 Transportation Equity

Overall, low-income Americans spend a higher share of their discretionary income on transportation and are often unable to afford a POV. Data from the Bureau of Labor Statistics' Consumer Expenditure Survey indicates that in 2015 and 2016, residents across the U.S. making less than the median income—$56,277 and $57,617, respectively[9]—spent 22% of their income on transportation while those making more than median income spent only 12% of their income on transportation.[10] In line with this finding, the costs of owning a POV are particularly burdensome for LMI households, who tend to have much less access to a personal vehicle. Those who have a POV often lack the savings for unexpected repairs,[11] or routine maintenance. Volatility in gas prices can further burden households on a tight budget. Carshare can help reduce the mobility gap between high- and low-income households, decreasing expenses for cost-burdened households and, in particular, increasing LMI individuals' mobility.

1.3.4 Cost Savings

New York City has the highest costs associated with owning and maintaining a POV in the U.S., around $19,000 annually[12] compared with the national average of around $10,000 per year.[13] Costs for ownership in Westchester County, where the three cities included in this study are located, are likely to be some what higher than the national average. This is especially the case in Westchester's cities because most of the costs associated with owning and maintaining a POV come from parking, and the cities in Westchester, due to their proximity to New York City, tend to have higher parking fees than the national average. Shaheen's research found that households that sell a POV and substitute their trips with carshare and other modes saw monthly household savings of $154 to $435.[14] These savings could represent more than 7.5% of household transportation costs for families in the bottom decile, whose annual incomes were less than $16,500 between 2012 and 2016.[15]

1.3.5 Appeal to Shifting Consumer Preferences

It is increasingly common for consumers in dense metro areas to relinquish car ownership. A 2015 Deloitte study revealed that just 64% of Generation Y (also called "millennials"[16]) consumers in the U.S. view the personal car as a preferred mode of transport.[17] According to the Pew Research Center, millennials are youth born between 1981 and 1996. The U.S. millennial population now numbers 83.1 million nationwide representing more than one quarter of the nation's population, surpassing the baby boomer population and making them the largest generation.[18] Rapidly evolving technology, cultural, and economic factors have been cited in consumer studies as key forces bolstering the carsharing movement, especially among urban millennials.

Major auto original equipment manufacturers (OEM) have introduced carsharing as a way of staying competitive among consumer groups that are buying fewer cars. Auto OEMs recognize that carsharing platforms can build brand awareness among sought-after millennials and start to familiarize consumers with electric drive transportation. Both General Motors (GM) and BMW Group have carsharing services using new plug-in electric vehicle (PEV) models in dense U.S. and European metros. According to Navigant Research, the incorporation of EVs in carsharing services is projected to grow as automakers continue to diversify their fleets with electric drive technology.

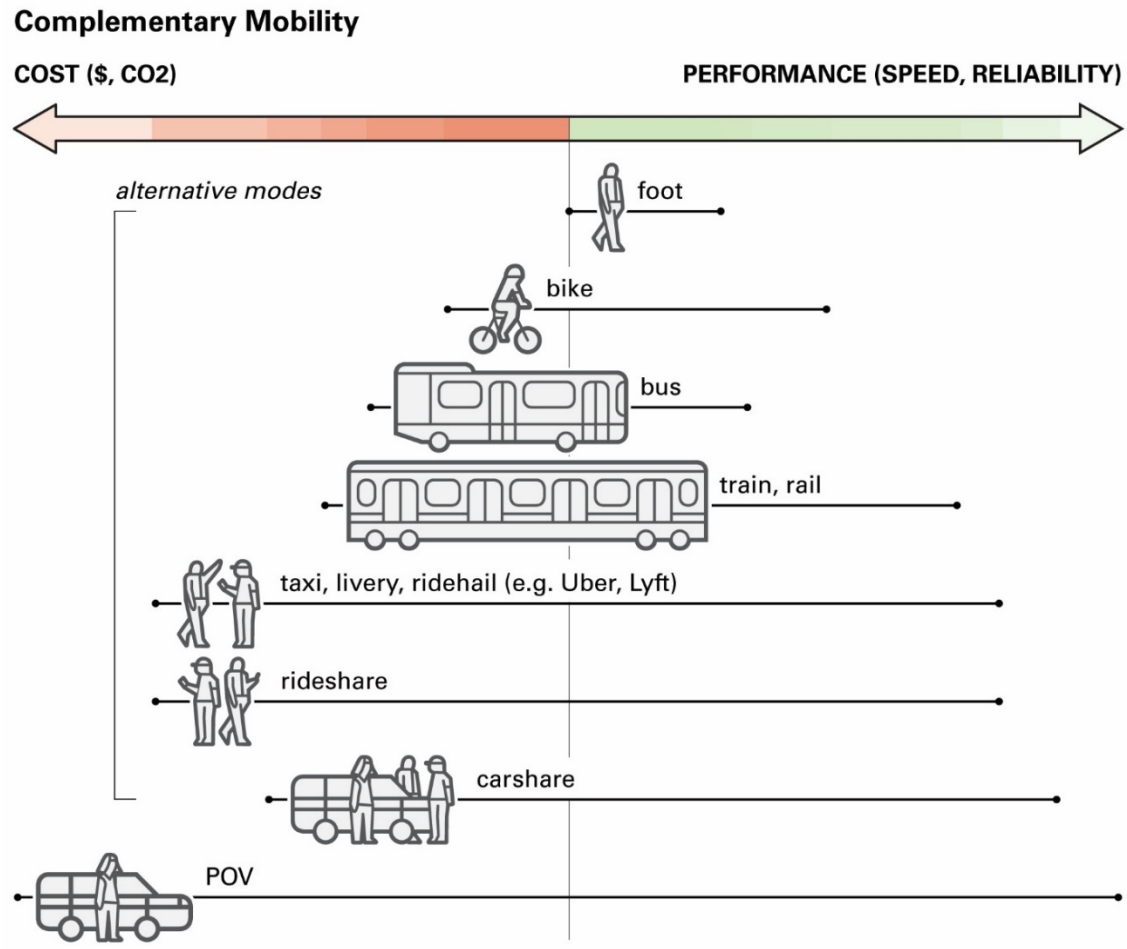
1.4 Obstacles for Shared Mobility

American attitudes towards car ownership are a big obstacle limiting the uptake of shared modes. Cars have been the dominant transportation mode for most Americans for well over a century. In 2016, 76% of Americans drove to work alone in a car; in Westchester County the percentage was 58.2%.[19] Not only are cars convenient, but they also hold enormous prominence in American culture, affection, status, and understandings of freedom. Although the U.S. saw a dip in VMT in 2014, VMT has risen sharply since 2016 and is now back to pre-recession levels.[20] Younger generations—notoriously millennials—may be opting for other modes of transportation, although evidence of this explanation is more tenuous.[21]

1.5 The Residential Carshare Opportunity

No mode of transportation offers more flexibility than POVs; cars can relatively cheaply serve trips of any length, along any route, and at any time. Residential carshare—integrating carshare vehicles in garages and lots of multifamily buildings for use by building residents and staff—is an exciting opportunity to shift American attitudes about getting around. Bringing carshare into residential developments would increase the visibility and convenience of carshare for building residents. Matching the flexibility of privately owned cars with more sustainable transportation substitutes is challenging; however, a combination of modes—public transportation, carshare, for-hire vehicles, walking, and biking—could provide households with sufficient flexibility at a lower cost and with fewer emissions (Figure 3).

Figure 3. Complementary Mobility Options

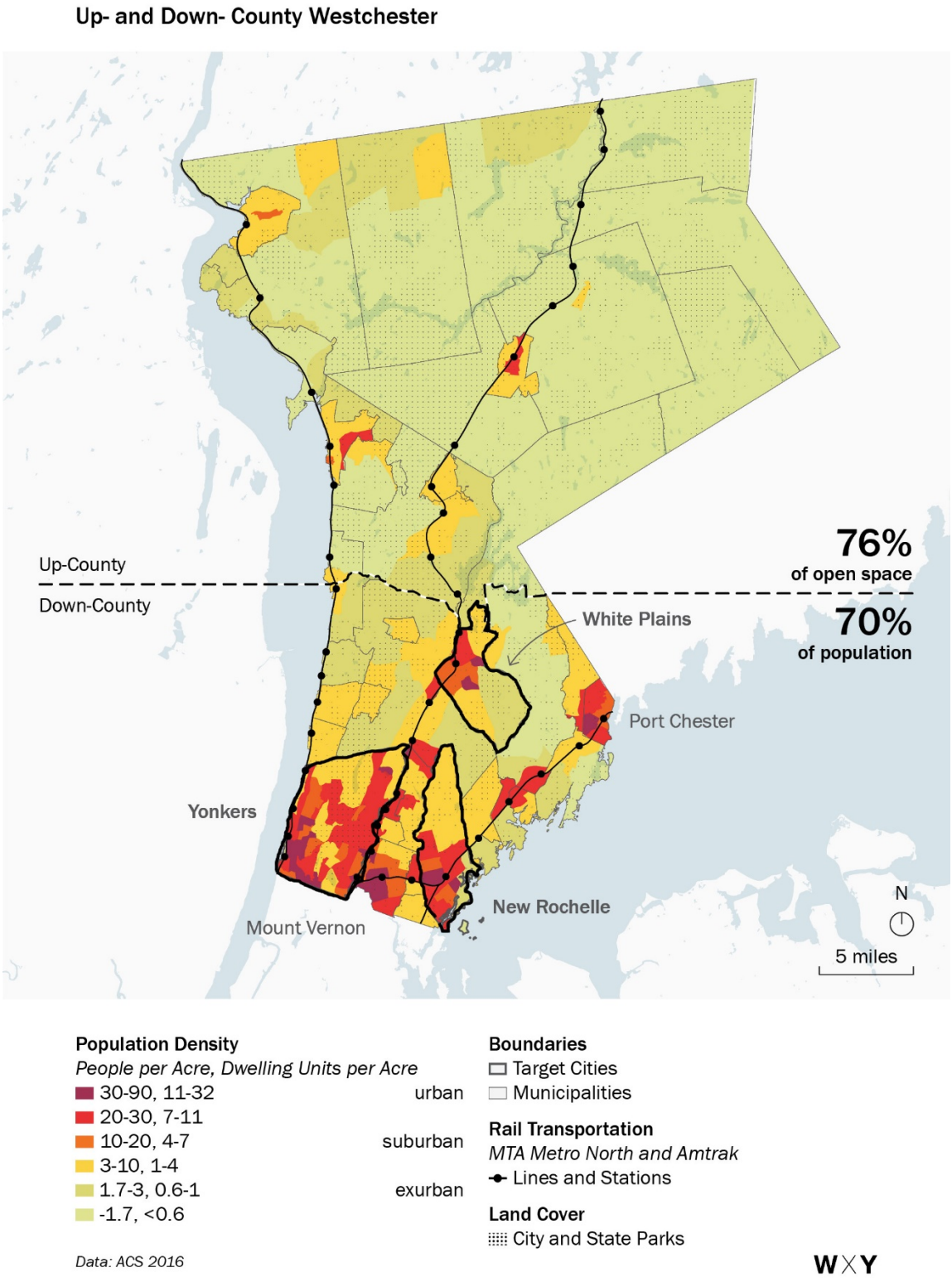


2 Westchester County

Westchester County is located north of New York City in the Hudson Valley, bordering Putnam County to the north, Rockland County to the west, Bronx County to the south and the Long Island Sound to the east. Westchester is characterized by a marked difference between its northern and southern halves (up-county and down-county).[22] Westchester's southern half hosts more jobs and people, who live more densely, closer to public transit, and are more diverse. The county's northern half, by contrast, hosts more open space, lower population density, greater prevalence of single-family homes, and higher medium income (Figure 4). The far-southern end of Westchester is primarily urban, where the county's configuration of buildings in relation to streets is consistent with that of its densely populated southern neighbor, the Bronx. Northern Westchester, by contrast, is sparsely populated and hosts large forested areas and water bodies.

Figure 4. Westchester County Up-County and Down-County Population Density

Data: ACS 2016 5-Year, Westchester County GIS



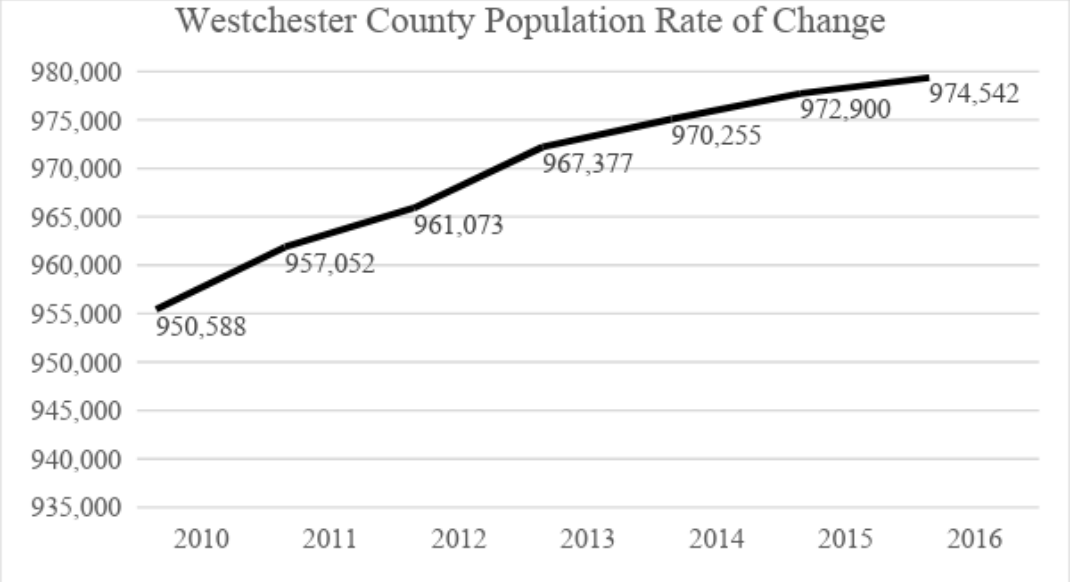
2.1 Population Growth and Density

Westchester County, the seventh most populous county in New York State after four New York City counties and both of Long Island's counties, with an estimated 974,542 people as of 2016,[23] is growing and priming itself for further growth and development. Westchester grew 2.7% from 2010 to 2016, a higher growth rate than New York State's average 0.18% growth over the same period (Figure 5).[24] Much of that growth has been concentrated in the county's six cities, where mayors and developers have shown an interest in revitalizing ailing downtowns to accommodate changing resident profiles and preferences.

Population growth in Westchester has been most pronounced along major transit routes, including three Metro-North lines, Amtrak Northeast regional service, and the Bee-Line Bus Service. More than 65% of residents live within 0.5 miles of a bus line,[25] and there has been a continuing trend emphasizing transit-oriented developments.

Figure 5. Westchester County Population Rate of Change (2010–2016)

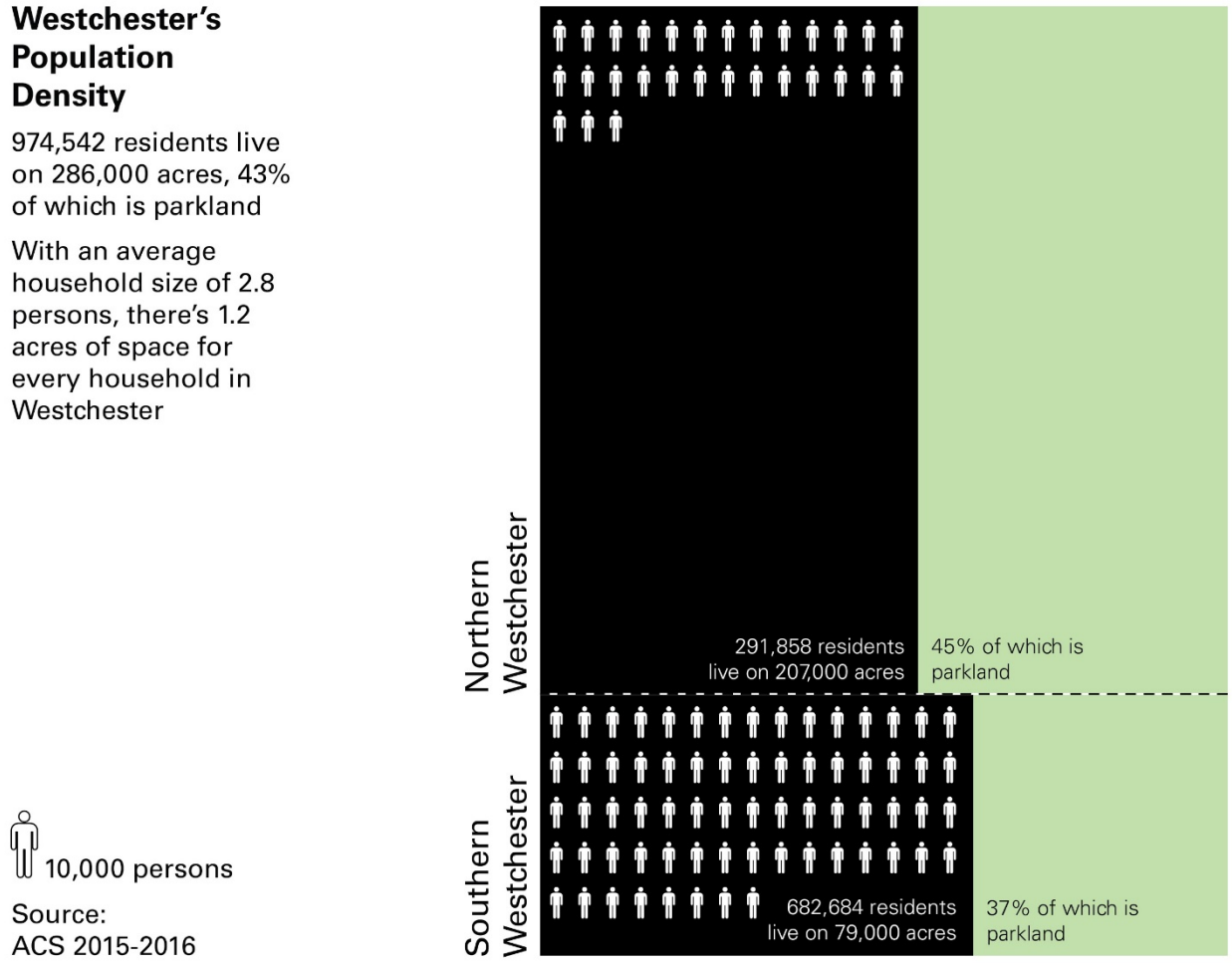
Data: ACS 2016 5-Year



Population density is an important indicator for carshare success. County-wide, population density was 2,264 persons per square mile.[26] However, there is tremendous variation in population density across Westchester, as seen in Figure 6. Only 30% of residents live up-county where the population density is only about three persons per acre (or one household) while 70% of the Westchester population lives down-county, with an average population density of nine persons per acre (or three households). By comparison, the average suburban density nationwide is three households per acre.[27]

Figure 6. Population Density in Westchester County

Data: ACS 2016 5-Year



Around 43% of Westchester residents live in the county's four biggest and densest municipalities: Yonkers, New Rochelle, Mount Vernon, and White Plains, in that order (Table 1). Westchester's densest municipality, Yonkers, has an average 11,150 persons per square mile. Together, these data suggest that Westchester's largest southern cities present the greatest opportunity for residential carshare, on account of their high-population densities.

Table 1. Comparison of Westchester County Population and Residential Density

Data: ACS 2016 5-Year

	New Rochelle	White Plains	Yonkers	Westchester
Residential Population	79,557	58,241	200,807	974,542
Population Percent Change (2010–2017)	3.2%	2.4%	2.5%	2.7%
Land Area (Square Miles)	10.4	9.8	18.0	430.5
Residential Density (per sq. mile)	7,687	5,961	11,150	2,264
Residential Density (per acre)	12.0	9.3	17.4	3.5

2.1.1 Carshare and the Built Environment

Density is an essential ingredient for successful carshare and shared mobility in general. Urban markets have quickly adopted carshare in the U.S. and abroad. Analysis of shared mobility in cities across the U.S. has found that shared mobility options do well in dense urban areas with high-median income and low-car ownership.[28] The Shared Use Mobility Center (SUMC) has found that moderately dense neighborhoods, in particular, hold great opportunity for cities looking to reduce car ownership since they still have a level of car dependence while also offering many alternative mobility options.[29] When these neighborhoods are close to major job and transit hubs, that opportunity is even greater.

Further research by SUMC suggests that drivers are also more likely to sell or postpone purchasing a car if they have access to more modes of transportation.[30] Filling Westchester's service gaps, particularly the first and last mile connections, can provide residents with more mobility while reducing the number of cars on the road.

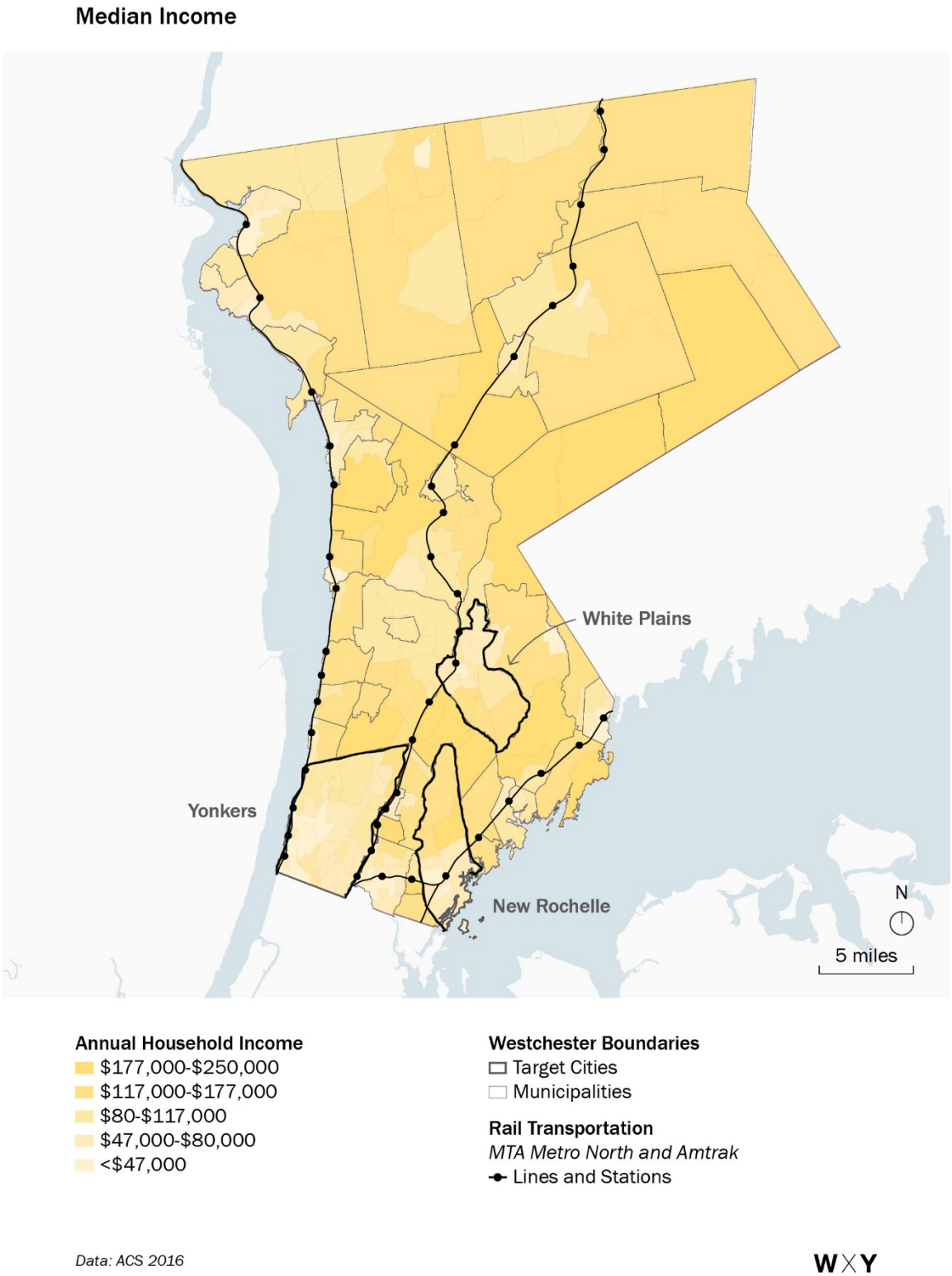
2.2 Demographic Trends

2.2.1 Median Income

Westchester County has a high-median household income of $86,226 in 2016, far above the New York State median income of $60,741 and the U.S. national median of $57,617 in 2016 dollars.[31] A closer look at income by municipality reveals a wide range across the county (Figure 7). At the higher end of the spectrum is Scarsdale, with median income exceeding $250,000,[32] Bronxville ($250,000), New Castle ($204,500), Pound Ridge ($188,400), and North Castle ($177,568). All have more than double the state median in 2016 dollars.[33] At the lower end of the spectrum are municipalities including Mount Vernon ($51,886) and Peekskill ($55,453) with median incomes below both State average and national average.[34]

Figure 7. Median Household Income in Westchester County

Data: ACS 2016 5-Year



As with population density, the Westchester up-county/down-county divide is pronounced when looking at income distribution. Table 2 shows that median household income is 138% greater in the Westchester up-county census tracts. Areas in up-county Westchester tend to have higher median household income on average, while both highest and lowest earning areas in Westchester are located down-county. These figures suggest that there is a greater wealth disparity down-county while northern Westchester is more middle-class.

Table 2. Median Household Quintiles for Westchester County

Data: ACS 5-Year 2016

Median Household Income Quintiles

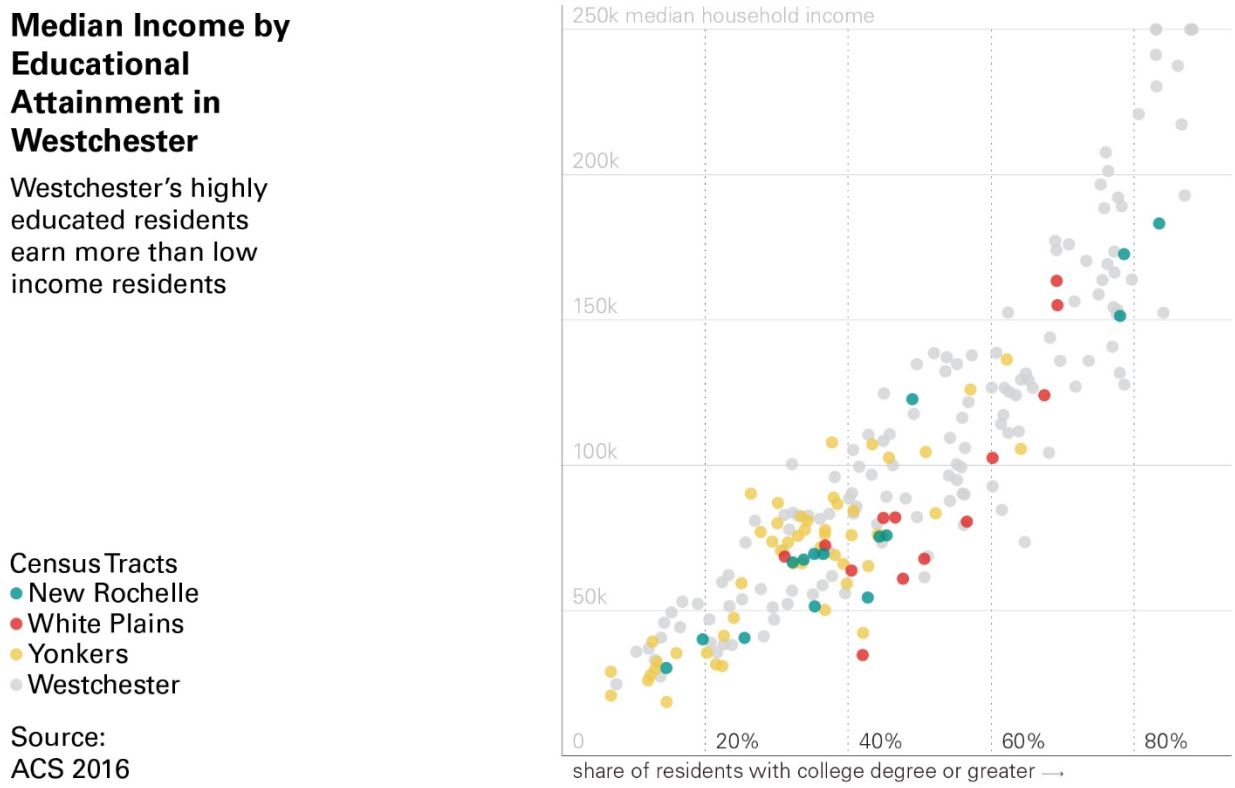
	min	1	2	median	3	4	max
Down-County	$18,482	$48,215	$69,476	$76,183	$83,634	$130,046	>$250,000
Up-County	$35,813	$68,632	$93,006	$105,256	$119,051	$141,326	$237,500
ratio	194%	142%	134%	138%	142%	109%	95%

2.2.2 Education

Westchester County has one of the highest education rates in New York State, with 47% of the population 25 years or older holding a bachelor's degree or postgraduate degree.[35] Educational attainment varies across the county. Fewer than 32% of residents in Yonkers have a bachelor's or postgraduate degree, a rate 20% lower than the New York Metro Area average. By contrast, nearly half of residents in White Plains (49%) and New Rochelle (47%) have obtained a bachelor's degree or greater. In Westchester, household income and educational attainment are strongly correlated (R=0.89), as shown in Figure 8.

Figure 8. Median Income by Educational Attainment in Westchester County

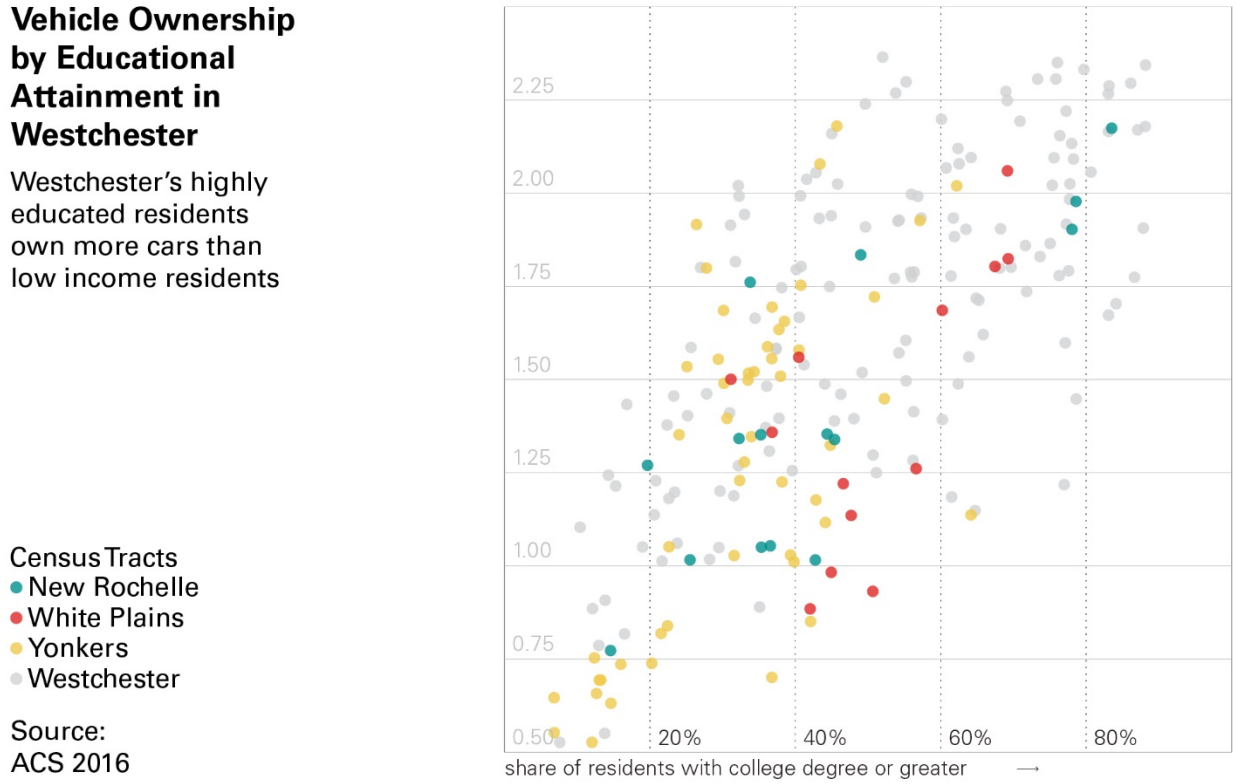
Data: ACS 2016 5-Year



Westchester residents are more likely to own a car if they have a bachelor's degree or greater (Figure 9). Although less strongly correlated than income and vehicle ownership or income and educational attainment, educational attainment and vehicle ownership are strongly correlated (R=0.71), particularly in New Rochelle.

Figure 9. Vehicle Ownership by Educational Attainment in Westchester County

Data: ACS 2016 5-Year



Carshare users have a very high level of educational attainment: 81% of carshare users have a bachelor's degree or more advanced degree, according to a 2008 survey.[36] According to the same survey, 41% of users hold an advanced degree, and just 2% of users do not have any college education.[37]

2.2.3 Diversity

Westchester is not only growing in terms of population size, but it is also diversifying (Table 3). The county is very diverse, with 45% non-White residents. Every municipality in Westchester County recorded a gain in Hispanic and Latino-identifying populations between the 2000 and 2010 Census years,[38] a gain of nearly 62,000 residents. As stated on the Westchester County website, Hispanic and Latino populations "now constitute nearly 22% of the total population and are a majority in Port Chester (59%) and Sleepy Hollow (51%)."[39]

Westchester Black and Hispanic or Latino populations disproportionately live in the county's densest areas down-county, together representing 43% of its population. Up-county Westchester is less diverse than down-county and the national average: only around one in three of its residents are non-White.

Table 3. Racial Makeup of Westchester County

Data: ACS 2016 5-Year

	Race						Total Population	Density (per acre)
	White	Black	Asian	Some Other	Two Or More	Latino		
Down-County	332,947	113,131	42,577	3,013	11,864	172,965	676,497	8.56
Up-County	198,056	17,070	12,295	640	5,247	55,461	288,796	1.39

2.3 Responding to Demographic Trends

According to the Harvard Joint Center for Housing Studies in the America's Rental Housing 2017 report, changing demographics are driving demand for rental housing and are increasing pressure on affordability in markets across the U.S.[40] The market has expanded to new demands for rental housing with new options for high-end and single-family housing. However, the market has fallen behind in providing adequate affordable options, which leads to increasing numbers of individuals who are rent burdened, spending more than 30% of their discretionary income on rent.

Demographics trends and changing resident preferences in home and mobility options has municipalities across Westchester moving toward investing in their downtowns, bolstering walkability, mixed-use downtowns, multifamily housing, and mobility amenities. The result has been a multifamily housing permitting and construction boom, with approvals for new housing units not seen since before the Great Recession (2007–2009). There is an estimated 16,000 new rental units under construction or in the planning stages to be completed in the near future in Westchester County, representing an 11% increase in the number of rental units that existed in 2017; over the last five years this number had grown less than 1%.[41]

2.3.1 Baby Boomers

Westchester County is getting older: the county median age rose from 37.6 in 2000 to 40 in 2010 Census years. According to the U.S. Census, "baby boomers" are individuals born in the U.S. between mid-1946 and mid-1964.[42] Previously the largest generation, baby boomers are now reaching retirement age as they enter their sixties and seventies.

As residents in the county get older, there has been an increasing need for additional multifamily options to allow baby boomers to downsize to more manageable and/or affordable options without leaving the county. Unlike single-family and smaller multifamily housing stock, larger multifamily buildings tend to have accessible design features, such as elevators, wide hallways and doors, and other features attractive to households with mobility challenges that become more common in older age. Harvard's Joint Center for Housing Studies 2017 report on the rental housing market in the U.S predicts that baby boomers and millennials will increasingly generate renter households across the country.[43]

Baby boomers, who started driving at a young age, were the first truly hypermobile generation. They have always been interested in cars and have relied on them for decades, making cars a central component of their definition of mobility. The challenge is for them to understand that private car ownership is not the only option for comfortable mobility, and shared car ownership can fulfill their needs while being more economical and beneficial. The baby boomer generation has been responsible for the growth in travel over the past 40 years; according to an AARP study, the number of VMT grew at twice the rate of population growth, and travel rates more than doubled from 1969–2009.[44] Some of this growth in travel can be attributed to a historic shift from single-earner to dual-earner households that helped define new patterns of commuting among the generation. In 1969, only 30% of two-adult households had two or more vehicles, a percentage that more than doubled in forty years to 77% in 2009.[45] More recently, there has been a turning point and reversal of the trend of year-over-year increases in VMT; on a per capita basis, Americans of all ages are traveling fewer miles in 2009 compared to 2001. Many factors play a role in declining VMT, including increasing and variable gas prices, unemployment, and an expansion of travel modes.[46]

As baby boomers enter retirement stages in their lives, they generally have overall lower travel rates, suggesting that many of their driving needs could be met with alternative modes of travel, including carshare. "No single solution will address the myriad mobility challenges of an aging population," writes AARP, "…A variety of individual choices, as well as public, private, and nonprofit investment tailored to the needs and desires of boomers, will help them sustain their quality of life as they age."[47]

Residential carshare offers an important opportunity for two-car households to downsize to one-car households that would complement changing living and driving patterns among boomers. According to the AARP study, medical related trips is one travel pattern that has skyrocketed as the baby boomers age and is expected to further increase.

2.3.2 Millennials

As Westchester is getting older, attracting younger generations has become a priority for many mayors across the county. According to the Pew Research Center, millennials are youth born between 1981 and 1996. The U.S. millennial population now numbers 83.1 million nationwide representing more than one quarter of the nation's population, surpassing the baby boomer population and making them the largest generation.[48] Millennials also represent more than a third of the total workforce in the U.S.[49] Thus, millennials are an important market segment that is anticipated to increase demand for rental housing over the next decade.

As Westchester residents get older, many municipalities are looking to lure millennials and young professionals to revitalize their tax base and call Westchester home. Admiral Real Estate and CoStar Group analysis found that millennials constitute 35% to 45% of the apartment rental market in Westchester.[50]

Millennial living preferences and spending habits differ greatly from previous generations. While older generations tended toward decentralized and car-dependent suburban living and homeownership, millennials tend to favor dense, walkable, mixed-use communities with easy access to services (restaurants, activities), jobs, recreation, and public transit. Another important shift in generational trends is that millennials tend to take a more pragmatic and nuanced view towards homeownership and car ownership. Since 2004, there has been a sharp decline in the homeownership rate. Proliferation of carshare and rideshare services have made prolonging or foregoing car ownership an appealing option, one that eliminates added expense and hassle.

In a Building Owners and Managers Association organized panel discussion with the mayors of Yonkers, White Plains, and New Rochelle in 2017, each of the three mayors stated that attracting and retaining young professionals was central to the future success of his/her city.[51] This is especially important since the county has seen a decline in the number of young people; the number of people between the ages of 25 and 34 in Westchester County dropped by almost 8% from 2000 to 2016.[52]

2.4 Mobility and the Built Environment

2.4.1 Car Ownership

The construction of the Bronx River Parkway in 1908, one of America's first parkways design for cars, has exerted tremendous influence on Westchester and its built form. Originally conceived for pleasure drives, the Bronx River Parkway was part of an introduction to key innovations in freeway design such as grade separation and limited access, heralding the extensive network of parkways, interstate highways, and commercial arterials in Westchester today.[53]

Cars are the dominant mode of transportation in Westchester and have greatly shaped land uses. Many of the downtowns in the county host commercial corridors four or more lanes in width, flanked by low buildings and large surface lots. The speed of the car makes it easy to live far from work, a convenience that has facilitated the separation of residential and commercial uses in Westchester, in which low-density suburbs surround moderately dense downtowns. Accordingly, Westchester's built environment encourages residents to make short trips by car rather than by other modes.

Nearly 95% of Westchester residents have access to a car. In 2016, there were 622,066 registered standard vehicles in the county (the Department of Motor Vehicles of the State of California defines "standard" as passenger vehicles that do not transport persons for hire[54]). This is about two cars for every three residents.

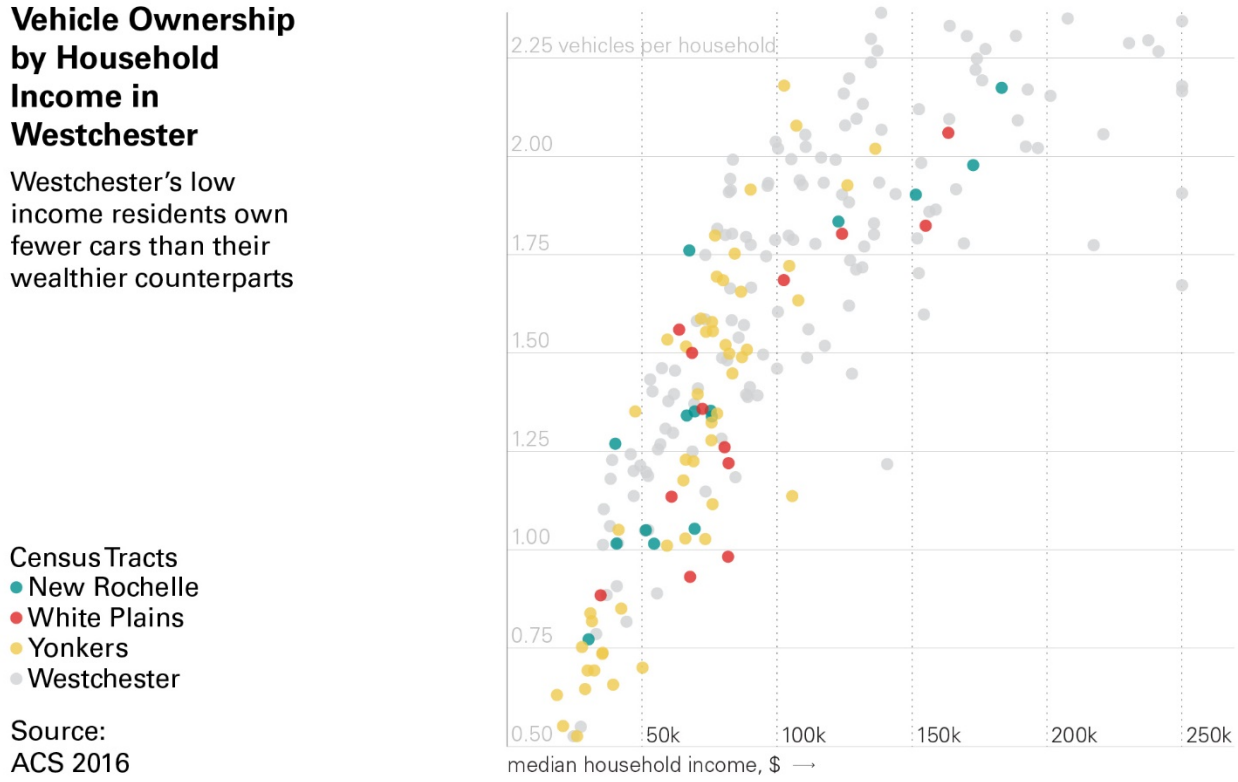
Westchester's cars are not evenly distributed across space or income bracket, however. In 2016 there were 49,680 households without access to a car, one in twenty in the county (ACS 2016). These households are strongly concentrated around core commercial areas and rail stations, generally living more densely.

The largest cities in the county—Yonkers, New Rochelle, Mount Vernon, and White Plains—have lower rates of car ownership on average than their peer municipalities (Figure 11). The average household in these cities owns 1.3 vehicles; outside these municipalities the average is 30% higher, at 1.7 vehicles. Yonkers has especially low rates of vehicle ownership, where one in three households lack access to a POV. Moreover, POV-owning households in the target cities are much less likely to own multiple cars. In Westchester as a whole, 41% of POV-owning households own a single vehicle. By contrast, 47% to 53% of POV-owning households in New Rochelle, White Plains, and Yonkers only own a single vehicle.

At first glance this is encouraging, suggesting that proximity to services and/or transit are inversely related to vehicle ownership. On closer inspection, we find that areas of low-vehicle ownership rates tend also to have the lowest rates of median household income (Figure 10 and 11).

Figure 10. Vehicle Ownership by Household Income

Data: ACS 2016 5-Year

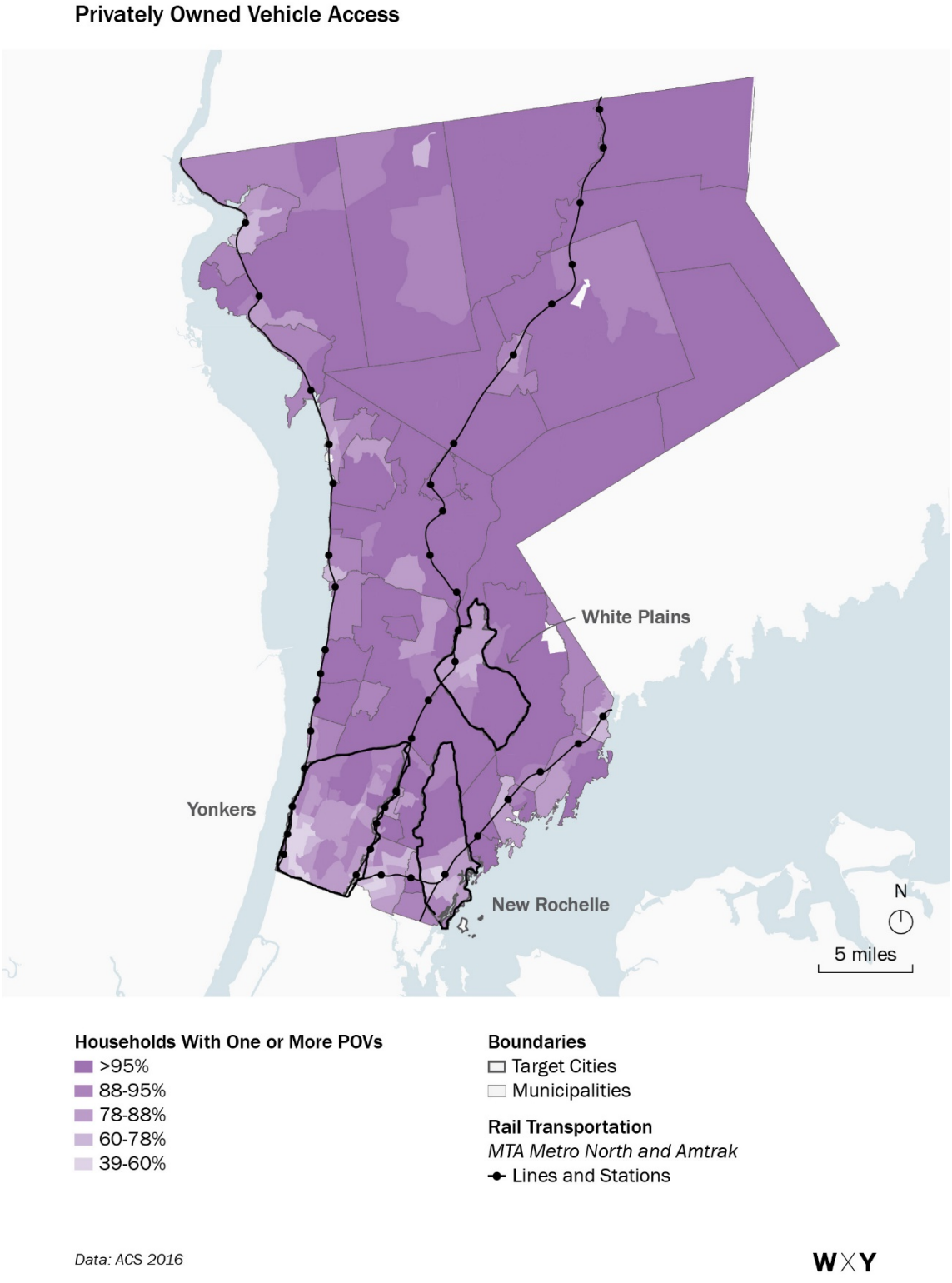


Residents in the target cities are less able to afford a vehicle. Remembering the general relation of economic growth to VMT, it is likely that economic hardship is a stronger indicator of vehicle ownership than proximity to transit or land use patterns in Westchester. Vehicle ownership is strongly correlated to income in Westchester (R=0.80), especially in Yonkers (R=0.83), White Plains (R=0.83), and New Rochelle (R=0.90).

Indeed, low-income census tracts for Yonkers, where annual median household income is less than $47,000, between 40% and 61% of households lack access to a POV. This suggests that LMI individuals, who are more likely to live in multifamily buildings in dense neighborhoods, are likely to benefit most from access to a shared vehicle and present an ideal market for carshare.

Figure 11. Household Car Ownership

Data: ACS 2016 5-Year

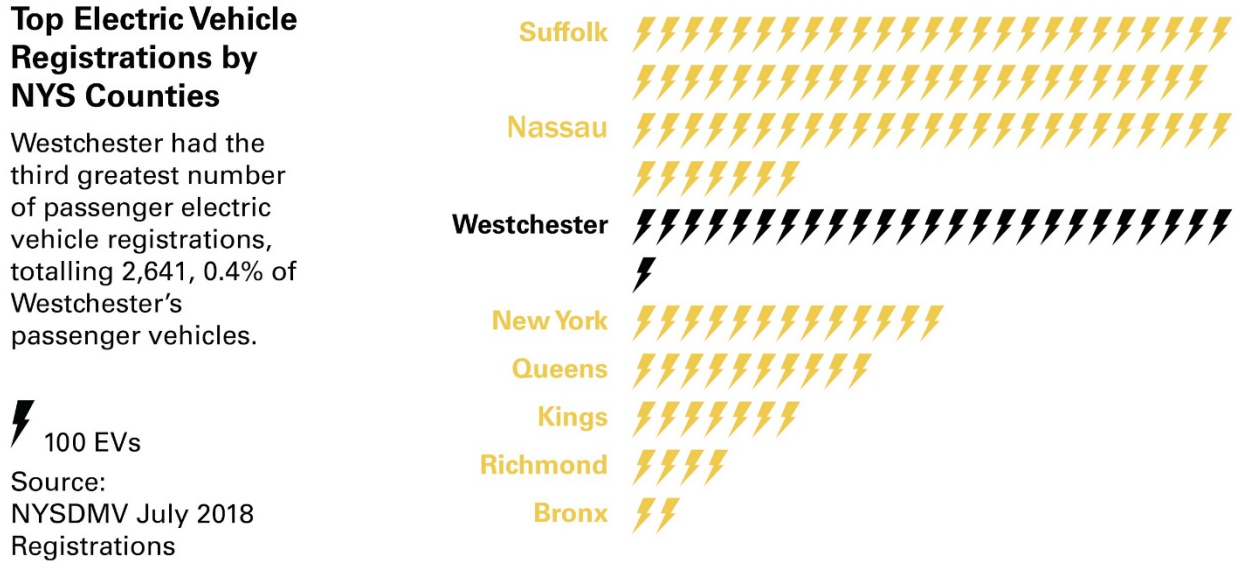


2.4.2 Electric Vehicles and Charging Infrastructure

As of June 2018, 2,641 electric vehicles were registered in Westchester County, the third greatest number among counties in New York State, according to New York State Department of Motor Vehicles registrations data (Figure 12).

Figure 12. Electric Vehicle Registration in New York State Counties

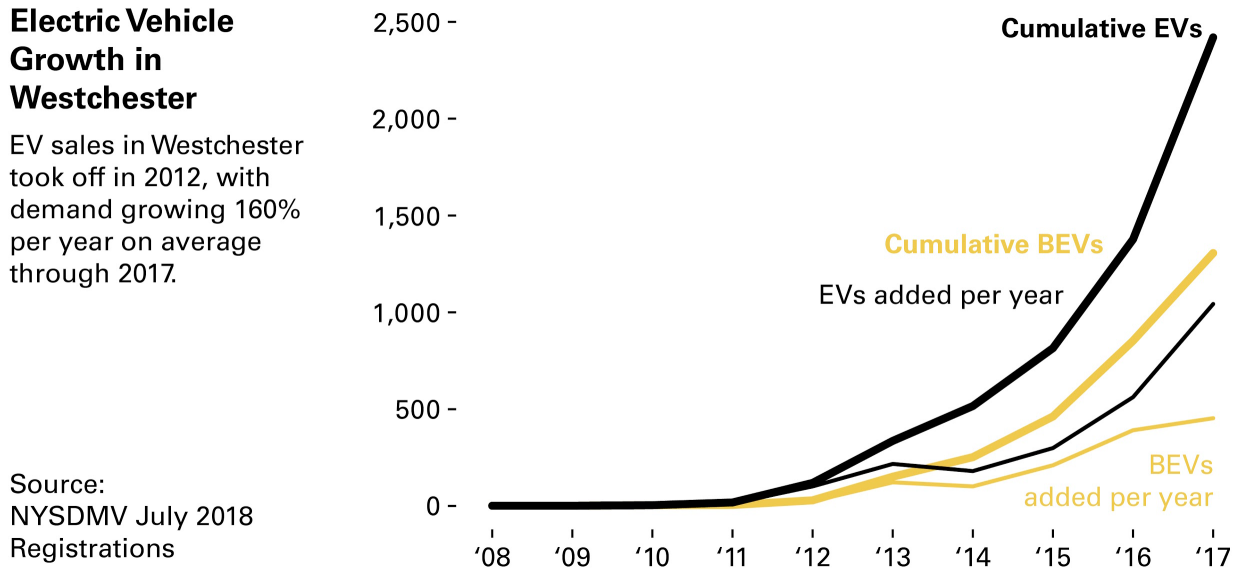
Data: NYSDMV Vehicle Registrations, July 2018



This figure has room to grow. According to a report prepared by the Columbia Master of Science in Sustainability Management Program, Westchester residents match the socioeconomic and political profile of target EV buyers.[55] In line with this finding, EV sales across the county have been steadily increasing: between 2012 and 2017, EV registrations in Westchester grew by 160% per year on average (Figure 13).

Figure 13. Electric Vehicle Growth in Westchester County

Data: NYSDMV Vehicle Registrations, July 2018



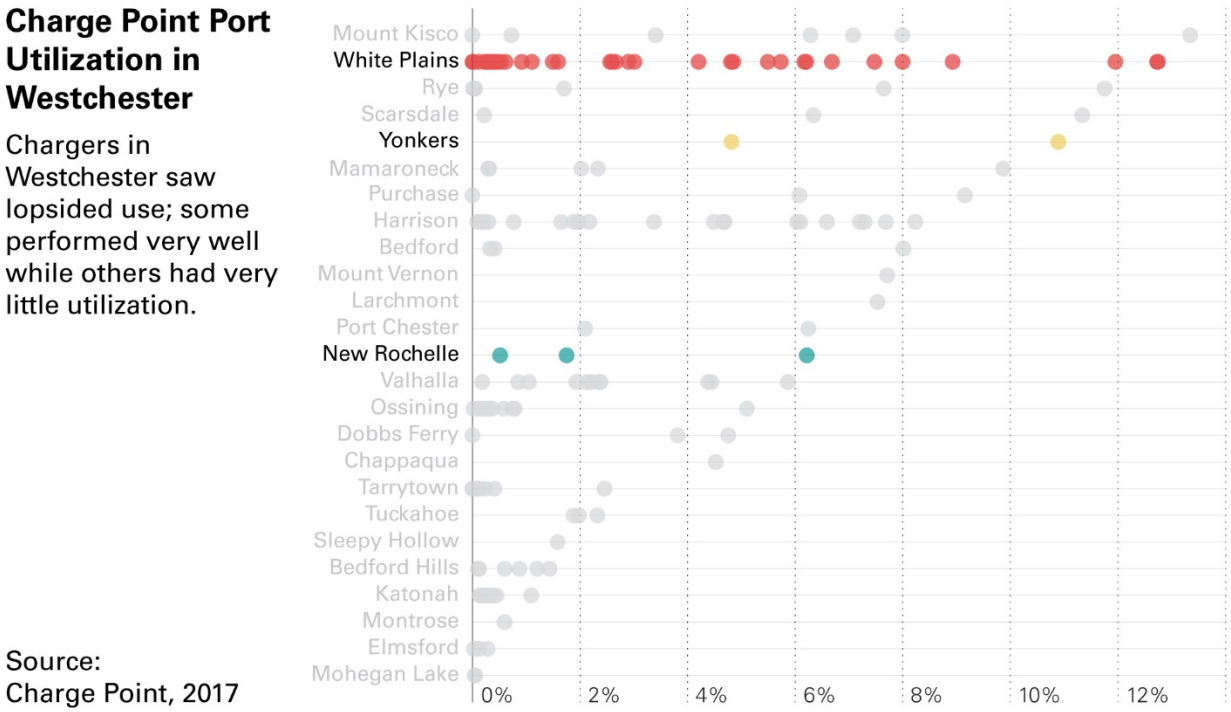
Factors that make EVs a more viable option include State and federal incentives,[56] decreasing prices for EVs, improved battery technology, and access to charging infrastructure.[57] [58] To encourage the uptake of EVs in New York State, Governor Cuomo and NYSERDA introduced, and have recently expanded, the program, which is driving the development of the county's network of charging stations, as part of a plan to reduce the State GHG emissions.[59]

As of November 2019, there were more than 240 public access Level 2 EV charging ports located throughout Westchester County.[60] These are primarily located in Westchester municipal centers along key corridors. There are 28 ports in downtown White Plains, with an additional 22 ports accessible within 3 miles. With this infrastructure in place, White Plains is Westchester's most EV-friendly city (Figure 14).

Westchester's network of public access electric vehicle supply equipment (EVSE) has the capacity to support more use. Small fleets of shared EVs would not place significant burden on the network. With access to charging infrastructure in a residential development, the vehicles in a shared electric fleet under the round-trip model would likely have the range to satisfy user demands, placing little demand on the Westchester EVSE network. However, given the additional capacity in Westchester's existing charging infrastructure, users might be further encouraged to use a shared EV because of access to privileged parking at their destinations.

Figure 14. Charging Ports in Westchester County

Data: Charge Point 2017



2.4.3 Public Transit

Westchester County has a robust multimodal transit network. Metro-North's regional rail network serves twelve counties with five rail lines, stretching 384 route miles in length. The system is increasingly popular, breaking its previous ridership record for the fourth consecutive year, providing 87 million rides in 2017. These rides are concentrated in Westchester, with 84 million (of 86 million) of its 2016 rides on the Harlem, Hudson, and New Haven lines, which serve 42 stations in the county. While some of these rides do not originate or terminate in Westchester, they demonstrate the robustness of the transit system that runs through the county. In addition to Metro-North's rail service, six Amtrak lines run through Westchester, connecting the county to the broader region.

The county Bee-Line Bus System serves 100,000 daily weekday riders with nearly sixty bus routes. The system moved a total of 28.6 million passengers in 2017. Service is primarily in southern Westchester County, where population density is greatest, with about 65% of Westchester residents living within a half-mile of a bus line. Fourteen of the Bee-Line's routes run into the Bronx, facilitating transfers between the Bee-Line and the MTA subways and buses. An integrated payment system with the MTA MetroCard facilitates these transfers, allowing riders to switch between services free-of-charge.

Although the Bee-Line service saw an overall decline in ridership, its worst-performing routes were a number of commuter routes and all of its shuttle routes, many of which saw ridership decline by more than 20% between 2013 and 2016.

Most Bee-Line riders are young, women, low income, and minorities. About 38% of riders are under the age of thirty and 62% are women. Approximately 49% of rider households in 2016 had incomes less than $25,000, 83% of whom are African American (45%) or Hispanic (38%). Although ridership has decreased with the recent economic recovery, seniors have continued to ride, with ridership of those sixty or older growing from 9% to 12% between 2013 and 2016, matching the growth in the Westchester senior population.

Bee-Line riders are transit dependent. Only 17% of riders have a driver's license and a vehicle available to them; an additional 20% of riders have a valid driver's license, but no car available. More than half of riders do not have access to a car or valid driver's license.[61] According to a survey conducted by the City of White Plains, 39% of riders departing White Plains Station during the evening-peak period got to the station by bus. These commuters are more likely to be part-time shift workers with lower incomes than morning-peak commuters, only 14% of whom said they got to the station by bus.

It is not clear whether the rides lost between 2013 and 2016 were substituted by rail trips, personal vehicle trips, hailed rides (i.e., taxi, livery, rideshare), another mode, or if Westchester residents are simply travelling less. A robust economy could have been the reason of why residents starting to choose other more comfortable methods of transportation. If Westchester residents are travelling less by bus as a result of the economic recovery, this would suggest that the bus is not a popular mode (bus ridership across the U.S. has been dropping since 2012).[62]

The concentration of residents and jobs in downtowns, and in the three target cities in particular, reflects access to mobility alternatives in the county. The county Bee-Line bus network primarily serves the target cities and Mount Vernon. These cities also exhibit the highest density of residents around Metro-North's rail stations. As noted in the first section, carshare serves well as a complement to other mobility alternatives and in combination, these mobility alternatives can encourage a shift away from the POV. The high density of transit services in the downtowns of target cities makes them particularly well-adapted to carshare.

2.4.4 Taxis and Limousines

Taxis and limousine services are popular in Westchester. As of May 2018, 317 taxi and limousine companies were licensed to operate in Westchester County, more than a third of which had their base-stations in Yonkers (68 base-stations), White Plains (23), and New Rochelle (20).[63] For the most part, these services do not serve as traditional taxis: only 20 of the 317 businesses might be considered strict taxi services.[64] Based on a survey of company websites, the Westchester limousine services principally provide chauffeured rides to New York City and airport service.

Despite their limited numbers in Westchester, taxis are popular, and often serve first and last mile connections to/from rail stations. A survey conducted by the City of White Plains of departing passengers from the White Plains Station found that around 7% of riders got there by taxi during the morning-peak period, compared to 8% during the evening-peak period. Further, according to a report produced by the Planning Division of the Westchester County Department of Public Works and Transportation, taxi-stands are common in Westchester at rail stations with many riders taking a taxi home in the evening.[65]

2.4.5 Transportation Network Companies

Transportation Network Companies (TNC) are extremely popular, with 78% of Uber users reporting the service as extremely or very satisfying.[66] TNCs increase personal mobility, especially for difficult to make trips: almost half of TNC users say they go more places because of the service and 12–22% of users say they would not have made a particular trip without the service.[67-68]

Until June of 2017, TNCs could not operate in New York State except in New York City. Before then, TNCs operated illegally in Westchester County unless going to or coming from the City. With Governor Cuomo as its champion, State legislation passed in June 2017 allowing TNCs to operate outside of NYC if they receive the county's consent to do so. Following a brief stalemate between Uber and former Westchester County Executive Robert Astorino regarding safety concerns, Astorino approved TNCs to operate in Westchester.

Little data is publicly available about the trips served by TNCs. However, survey data collected by researchers at the UC Davis' Institute of Transportation Studies suggest that riders in major U.S. metropolitan centers use the service regularly and principally to avoid parking or drinking when driving.[69] This indicates that carshare (and residential carshare) serve different use cases than ride-hailing services. As such, ride-hailing services and carshare likely act as complementary mobility services rather than substitutes.

In Westchester, passengers of the Bee-Line bus followed the national trend of declining bus ridership; this is likely in part because of the growth of TNCs. While Bee-Line ridership between 2013 and 2016 decreased by 10%, ridership on commuter and shuttle routes decreased by 19%. Shuttle routes, in particular, saw their ridership decrease by 30% in that same period. According to the 2016 Bee-Line Bus Survey, however, the principal culprit of this declining bus ridership is the continued expansion of parking facilities at rail stations.[70] Nevertheless, the popularity of taxi-stands in Westchester, noted in the above section, suggests that TNCs may be serving the same role.

Although LMI people tend to own fewer cars and ride transit more, they are also less likely to use ride-hailing services: "Respondents with an annual household income of $35,000 or less had an adoption rate of 15%, as compared with 33% of those earning $150,000 or more."[71] Other surveys have found similar results.[72] As such, TNC services may be cost-prohibitive for many of Westchester LMI residents. A subsidized residential carshare system could help fill this mobility gap. The study team weighs this possibility in the pro forma (see section 5.8).

2.4.6 Walking and Biking

Most of Westchester County presents a challenging landscape for walkers and bikers. Alhough many commercial centers in the county are walkable, they can be difficult to access by foot on account of Westchester's hilly and sprawling landscape. Irregular sidewalk networks, wide highways, rail corridors, and commercial arterials further complicate walking and biking in Westchester. Increasingly, in an effort to appeal to younger generations, Westchester cities are emphasizing pedestrian and bike infrastructure and transit-oriented development. The target city profiles in section 2.5 describe these efforts in greater detail.

2.4.7 The Potential for Carshare in the Evolving Mobility Landscape

Westchester's mobility landscape is in transition: bus ridership is rapidly declining while Metro-North's ridership has hit record highs; TNCs and taxis are popular, ferrying rail-riders to and from stations; Electric vehicles are increasingly popular; and Westchester municipalities are retrofitting their downtowns for walkers and bikers (with some introducing new bike-share systems). Nevertheless, the POV remains the dominant mode of choice for Westchester residents.

New mobility options benefit Westchester County low-income residents, who disproportionately own fewer POVs than their wealthier counterparts. However, these individuals remain much more likely to ride traditional public transit and much more likely to access rail stations by foot rather than other modes. This is in part because low-income individuals are more likely to live in high-density areas close to transit, although in large part, they are less able to afford POVs and taxi and TNC services.

As noted in the first section, carshare does best in medium and high-density areas where mobility alternatives to the POV exist. Moreover, carshare benefits LMI individuals in particular. As such, carshare is well suited to Westchester's principal municipalities—Yonkers, White Plains, and New Rochelle—particularly in downtown areas and immediately surroundings. Population density in these areas is much greater than elsewhere in the county, and the residents are more likely to have low and medium incomes. The following section explores the potential for carshare in the target municipalities in greater detail.

2.5 Target City Profiles

2.5.1 New Rochelle

New Rochelle, with a population of 79,557 residents, is the second largest city in Westchester County and had the greatest growth of the three cities, with 3.2% increase in population from 2010 to 2017.[73] New growth in the past decade represents a reversal in the trend of decline that took place from the 1960s through 1990s. New Rochelle is planning and preparing a resurgence that will bring population and commercial growth for the city, particularly the downtown area.

In December 2015, New Rochelle rezoned 279 acres in its downtown, including most of the city's commercial areas, and allowed for taller construction. Now, developers can build up to 40 stories as-of-right in certain locations, and more than 40 stories in exchange for providing certain community amenities. New Rochelle signed an exclusive master plan development agreement with RXR Realty and Renaissance Downtowns (RDRXR), that will lead "the most significant economic development initiative in the city's history."[74]

Shortly after the downtown rezoning, New Rochelle adopted The New Rochelle Comprehensive Master Plan to shape anticipated new development. The Master Plan is framed around two key concepts:

1. Direct high-density downtown development to better support its emergence as a regional center with critical regional connections.
2. To incorporate the principles of sustainability, as set forth in GreeNR.

The master plan's dual emphasis on sustainability, combining strategies to reduce emissions with providing housing opportunities "for seniors, young professionals, families and a growing regional population," make it an interesting testing ground for sustainable mobility solutions that meet changing demographics.

2.5.2 White Plains

White Plains is the smallest of the three cities, both in terms of population (58,241 people) and land area (nearly ten square miles) and is the least dense (5,961 residents per square mile). It is the county seat for Westchester and was developed as a commercial hub for the county.

The city is a regional employment center and commuter hub, anchored by its job-dense, transit-friendly downtown. White Plains is the destination of 54,000 commuters, 91% of which are workers coming from outside the municipality, and the origin of another 21,000 commuters, most destined for Manhattan. As such, the White Plains rail station is the third busiest in the Metro-North system, shuttling residents to Grand Central Terminal in about 45 minutes. To accommodate the large volume of commuters into the City, the Westchester Bee-Line Bus system runs 28 lines through White Plains, most running East-West via its centrally located transit center.

White Plains was one of the first suburban cities to develop large-scale retail, which attracted the likes of Bloomingdales, Macy's, Nordstrom and other retail giants in the post-World War II era. Urban renewal in the 1960s brought on a wave auto-oriented mixed-use redevelopment in the downtown, with

a cornerstone shopping mall, new commercial and hotel towers, parking garages and lots to accommodate visitors and commuters, and eventually large corporate office buildings. While White Plains has fluctuated in size and activity over the decades, the city's high-density mixed-use downtown has grown substantially more recently—nearly 30% since 2000.[75]

As part of its new Strategic Plan released in 2016, White Plains is undertaking a number of efforts to improve the mobility alternatives available to its residents. These strategies are divided into mid-term strategies, those that fall within the three- to five-year horizon, and long-term strategies, those that require more than five years to coordinate and implement. Notable in the Strategic Plan are its ambitious environmental goals, including the reduction of the number of VMT by 1,500 miles per capita in 30 years, or a reduction of 50 miles per person per year. This strategy has a timeline to monitor its implementation, so that in five years the city expects to reduce 124.92 VMT, in 15 years the number becomes 606.75VMT, and finally, in 30 years, the goal is to have reduced 1522.86 VMT per person per year.[76]

With these goals in mind, the city is introducing more bike infrastructure, having recently painted lanes on its important North-South connectors (Lexington Ave., MLK Blvd., and Barker Ave.) and added a protected bike path along the Bronx River Parkway. The city has also designated a large number of bike routes throughout the municipality by posting signs, drawing drivers' attention to their pedaled peers. Moreover, a number of bike racks have been installed at the White Plains Station and are well utilized.

With support through a NYSERDA grant, the city is set to expand the number of EV charging stations in the city to 30, supplementing seven existing public access EVSE in the city's downtown with 23 new charging stations. This strategy, paired with sustainable energy production, can encourage more sustainable mobility choices without requiring a modal shift of White Plains residents. The same is true of carshare: the city currently hosts two Zipcar locations, the first location in downtown in the Hamilton Garage and the second at the North White Plains Station. The locations offer a variety of internal combustion engine (ICE) cars including compacts, mid-sized, SUVs and vans.

2.5.3 Yonkers

With a population of 200,000, Yonkers is the fourth-largest city in NYS and had a growth rate of 2.5% from 2010 to 2016.[77] Yonkers is also the densest of the three cities, with 11,088 residents per square mile, a density more comparable to Washington, D.C. than other cities in Westchester with a more suburban character.

The year of 2017 was big for new construction in Yonkers. As Mayor Spano boasted in the 2018 State of the City Address, new multifamily residential projects broke ground and topped off from developers like Extell, Avalon Bay, and Hudson Park River Club; RXR began on the largest mixed-use development in Yonkers; and other developments opened including Rivertides, UNO, and the Modera.[78]

In May 2013, Mayor Mike Spano signed into law a Yonkers Green Buildings ordinance, establishing a policy for the city to design and construct its facilities to be sustainable and to encourage commercial and residential developers to do the same. In June 2013, the Commissioner of Planning and Development formally adopted the Yonkers Green Development Workbook including a checklist and standards to guide this policy.[79]

In Yonkers, the city convenes weekly meetings with developers to review new construction projects. One of the largest developments "so far might be Larkin Plaza, a three-building, $190 million juggernaut from RXR and Rising Development that will have 440 apartments and 35,000 square feet of stores when it opens next year."[80] RDRXR is also leading construction of Larkin Plaza (272-unit/25-story) and Generation Yonkers (170-units/17-story).

3 The Market for Residential Carshare in Westchester

3.1 User Profiles

3.1.1 Miscellaneous Errands and Nonwork Trips

The average nonwork-related car trip—trips for school, social, and recreational purposes, shopping, or other—in Westchester County lasts 12 minutes and is 1.25 miles in length.[81] This trip pattern and distance suggests local travel. Carshare could ideally replace many of these nonwork-related trips, assuming that the dwell time for each trip is not sufficient to make renting a carshare rental cost prohibitive. Given that 77% of all auto trips are for nonwork-related activities, availability of carshare stands to have a great impact on local travel patterns for nonwork trips.[82] Surveys of carshare users in North America suggest as much: the most frequent uses of carshare cited by respondents to a 2006 survey were "recreation and social trips," "other shopping," and "grocery shopping." Only 6% of respondents cited "trips to and from work" as a trip purpose.[83]

The four use cases identified by the study team are driven in great part by prospective user cohorts with common mobility needs. The following sections describe these likely user cohorts.

3.1.2 School Parents

TCB property management staff reported that several families in their Yonkers property enrolled children in charter and parochial schools at a distance from the location of the downtown area building. Typically, their morning routine involves bus or taxicab travel back and forth for school drop off, incurring costs and consuming additional time out of the workday. A total of 29,239 K-12 students were enrolled in private or parochial schools in Westchester County in the 2018–2019 school year, representing roughly 16% of the county student enrollment. Approximately 54% of these institutions are parochial schools.[84] An additional 991 students were enrolled in the two public charters in the county—the Charter School for Excellence in Yonkers and the Amani Charter Public Charter in Mount Vernon.[85]

New York State requires city school districts that provide transportation to students enrolled in public schools to also provide transportation to nonpublic school students who live a certain distance from their schools (more than two miles for students in grades K–8, more than three miles for students in grades 9–12).[86] Parents of nonpublic school children who do not live outside these distances may prefer driving their children to school to using public transportation. Additionally, parents of

nonpublic school students who are eligible for school transportation may still prefer to drive their children to school because work schedules conflict with the school bus schedule. A recent article in the Brookings Institute's weekly publication listed transportation as a key barrier to charter schools for disadvantaged children.[87] Thus, access to a carshare may fill a mobility need for parents in this scenario.

3.1.3 Downsizing Seniors and New Empty Nesters

Developers in Westchester County, including Wilder Balter and RXR, are reporting increasing numbers of downsizing seniors and new empty nesters who are shedding homes that are costly to maintain, as well as personal automobiles, in favor of a less "encumbered" lifestyle. Typical use cases include shopping, medical appointments, family visits, and leisure travel within the region. In 2015, the county had 204,910 residents over the age of 65, representing 21% of the total population in the county. By 2020, the senior population in the county is projected to grow to 225,820 or 23% of Westchester's projected total population.

A recent blog post on the AARP website recognized carshare as a mobility option found in livable communities for older adults.[88] In addition, a Wharton online business journal asserted that this demographic is likely to embrace mobility solutions such as carshare:

> While taxis are the traditional choice for carless [baby] boomers making short trips within the city limits, the growing presence of car-sharing [*sic*] and ride-hailing services is just as likely to appeal to seniors," Wharton management professor John Paul MacDuffie observed. "I don't see those at the more elderly end of the spectrum—at least if it's suburbanites coming into the city—being turned off by the techie-ness of it. I see them actually liking it if it solves a problem for them." A recent Zipcar study supports his view: 69% of urban boomers surveyed said mobile applications make their lives easier, and 81% were users of Facebook.[89]

3.1.4 Building Management Personnel, Office Workers, and Home-Based Business Owners

Residential developments have one or more staff members for on-site operations. These typically include property managers, leasing office administrators, superintendents, resident service coordinators and concierges. As was noted by TCB management, these employees will periodically leave the property

to purchase building, janitorial, and office supplies, meet with other professionals, attend events or run personal errands. A carshare vehicle can help address these workday transportation needs at times of day when utilization will likely ebb.

For those residents who live near their place of employment or work from home, having access to a shared vehicle is an added benefit. According to the American Community Survey estimates for 2016, 5.1% of Westchester County residents work from home. Home-based business owners and participants in the "gig economy" are likely users for whom carsharing is a cost-effective alternative to on-call car services. Other gig economy entrepreneurs may require a car off-hour or on weekends, when public transportation options are limited, and schedules are curtailed.

3.1.5 Shift Workers

Carshare offers a mobility solution for those who work shifts other than the traditional 9–5 workday—times of day when typical public transportation options are generally limited. Recent scholarship has skewed conventional wisdom that mainly considers traditional work schedules as a barrier to carshare implementation in low-income communities: "...literature and research surrounding the mobility of low-income people is largely focused on access to 9–5 jobs—a bias that is also reflected in federal funding for transport infrastructure. Today, many low-income people increasingly hold jobs during off-peak hours (such as nights and weekends) when transit routes are poorly served."[90]

TCB property management also reported significant numbers of retail shift workers at nearby shopping centers, including Cross County and Ridge Hill, whose shifts end at times when transit options are limited. Many pay for taxi cabs for travel home at the end of the workday. Others use the county Bee-Line bus service to commute, but service after 8:00 p.m. is curtailed to once hourly and terminates completely at midnight. For a night shift worker at Ridge Hill, for instance, missing the 9:37 p.m. 78 bus would mean a 50-minute wait for the next departure.

A family member or colleague with access to a carshare vehicle would offer these shift workers a more responsive and flexible transportation option. In Yonkers—where both Ridge Hill and Cross County are located—retail employment totals 11,319, making the sector the second largest employer after healthcare and social service. Countywide, 8.4% of workers in Westchester County had no vehicle available to them, according to the American Community Survey (ACS) estimates for 2016; another 25.6% had one vehicle associated with their household, the ACS projected.

3.2 Market Research

3.2.1 Multifamily Rental Construction in Westchester

According to analysis performed by the online real estate website The Real Deal, 2016 saw a peak of new multifamily housing permits approved—1,032 multifamily units were approved for construction in Westchester from January to October, nearly a 200% increase from the previous year.[91]

While fewer multifamily housing construction permits were filled in Westchester compared to nearby counties including Manhattan (4,060 units approved over the same period in 2017) and Brooklyn (4,899 units approved), it's far more than similar suburban counties in the region.

Westchester will add roughly 2,200 new multifamily market-rate rental units—units with no rent restrictions or income requirements—from 2016 to 2018 (excluding condominium and university housing); roughly 670 affordable or workforce housing will be delivered as well, primarily as part of market-rate developments.[92]

The bulk of development is in rental rather than condo development. There is some demand for condo development, especially from empty nesters looking to downsize, but wanting to stay in the same area.

3.2.2 White Plains Multifamily Rental Construction

White Plains is changing, with increased residential growth, especially in the downtown as New York City real estate costs continue to rise. White Plains has approved several significant proposals, including the following:

- 52 North Broadway-Former Good Counsel: a proposal to redevelop a 16-acre former Good Counsel property adjacent to Pace University (52 North Broadway) into two, ten story buildings, with 90–95 units of assisted living facilities, 70 dormitory suites, and 400 market-rate apartments buildings.[93]
- Hamilton Green-White Plains Mall Site: a petition for an amended zoning ordinance and proposed redevelopment of the 3.74 White Plains Mall site into a mixed-used project with retail, 900 apartments, 1,060 parking garage, and 52,000 square feet of street-level and elevated open space.
- Broadstone White Plains: a proposal to redevelop 2.1 acres with a mixed-use project in three connected buildings (6, 16, and 15 stories respectively) with retail, 434 apartments (26 of which would be affordable), 460 parking spaces, and open space.

In sum, these proposals would add significant capacity to the White Plains multifamily housing market: 1,400 new rental units were completed between 2016 and 2018. An average rent for a two-bedroom luxury apartment built after 2000 is $3,255 in the city, and the vacancy rate is 3.5%.

This attention is focused on the White Plains downtown core, which is well positioned to attract young professionals. “Downtown White Plains will continue to provide a more affordable option for young professionals and empty nesters who want an urban lifestyle but cannot afford New York City prices,” states the 2016 White Plains Transit District Strategic Plan Final Report.

Central to this strategy is the Metro-North station near the downtown core; in June of 2017, the City issued a Request for Expressions of Interest for 4.5 acres of land around the White Plains Metro-North rail station.

3.2.3 New Rochelle Multifamily Rental Construction

In December 2015, New Rochelle rezoned 279 acres in its downtown, including most of the city’s commercial areas, allowing for taller construction. Now, developers can build up to 40 stories as-of-right, and higher in exchange for providing certain community amenities.[94] Since the rezoning, “13 projects, with 1,633 apartments and 115,000 square feet of commercial and retail space, have been approved for the downtown,” according to the city’s Commissioner of Development Luiz Aragon. [95]

The New Rochelle City Council selected RDRXR, as the “master developer” for the downtown revitalization, granting them exclusive redevelopment rights for more than 10 million square feet of space. The New Rochelle Master Development Plan anticipates up to 5,500 new units of housing. The first project—587 Main Street—is a $120 million dollar, 28-story tower with 280 units (a mix of studios to two bedrooms), including 48 rent assisted units and 294 parking units. Next up will be twin 28-story tower developments on a former parking garage site that will add up to 700 apartments, with commercial and retail space.

As part of the new construction, RXR provided community benefits in exchange for height bonuses, including restoring an historic theater.

Equally important for the success of downtown redevelopment is attracting new residents and retail. The city mayor and commissioner for development have created several initiatives aiming to increase foot traffic, including a business marketing support program, installation of Wi-Fi kiosks, and plans for a bike share program.

3.2.4 Yonkers Multifamily Rental Construction

Yonkers has witnessed robust growth in its inventory of rental housing in recent years. National players such as Avalon Bay and Mill Creek Residential have joined regional and local developers to plan and deliver more than 5,000 units of new multifamily housing. New downtown developments, including RXR's 442 unit Sawyer Place and Extell's mixed-use Hudson Waterfront, which will include 1,395 rental units and nearly 50,000 square feet of commercial space, are taking advantage of lower land values and lower construction costs outside of New York City.[96] Waterfront access and short commute times to Grand Central on Metro-North's Hudson line are cited by developers as a differential advantage for Yonkers.[97]

Other notable downtown developments in the city include the following:

- The AMS Acquisitions mixed-use residential and hotel development on a former six-acre slaughterhouse site.
- The Ginsburg Development, Ludlow Point, which includes 520 units in four residential towers.
- The Rose Associates 440-unit residential development featuring 25,000 square feet of open space at the water's edge.[98]

3.3 Identifying Areas of Opportunity

The study team proposes the following priority metrics for identifying areas well-suited for residential carshare.

Table 4. Residential Carshare Evaluation Criteria

Metric	Expressed as	Low	Medium	High
Step 1				
Income	Percent of Area Median Income	>110%	110-60%	<60%
Vehicle Ownership	Vehicles per Household	>1.5	1.5-0.75	<0.75
Residential Density	Multifamily Units per Acre	<15	15-30	>30
Sustainable Mode Share	Percent of Commuters Walk, Bike, or Ride Transit to Work	<33%	33%-50%	>50%
Step 2				
Federal Opportunity Zone		No		Yes

Most carshare users are younger than 40, educated, and have a household income under $80,000. Further, nearly 70% of carshare users report that they joined carshare to gain access to an additional car; a quarter of users replaced an existing vehicle with carshare (the remaining few did not cite the reason they adopted carshare in the referenced survey). Finally, carshare users have a very high level of educational attainment: 81% of carshare users have a bachelor's degree or more advanced degree.[99]

As such, young professionals who do not own a vehicle represent the most likely user cohort for residential carshare.[100] Further, LMI individuals stand to benefit greatly from residential carshare, as noted in previous sections. These user groups often overlap in dense, transit-friendly areas.

Figure 15. Residential Carshare Suitability Metrics in Westchester County

Data: ACS 2016 5-Year

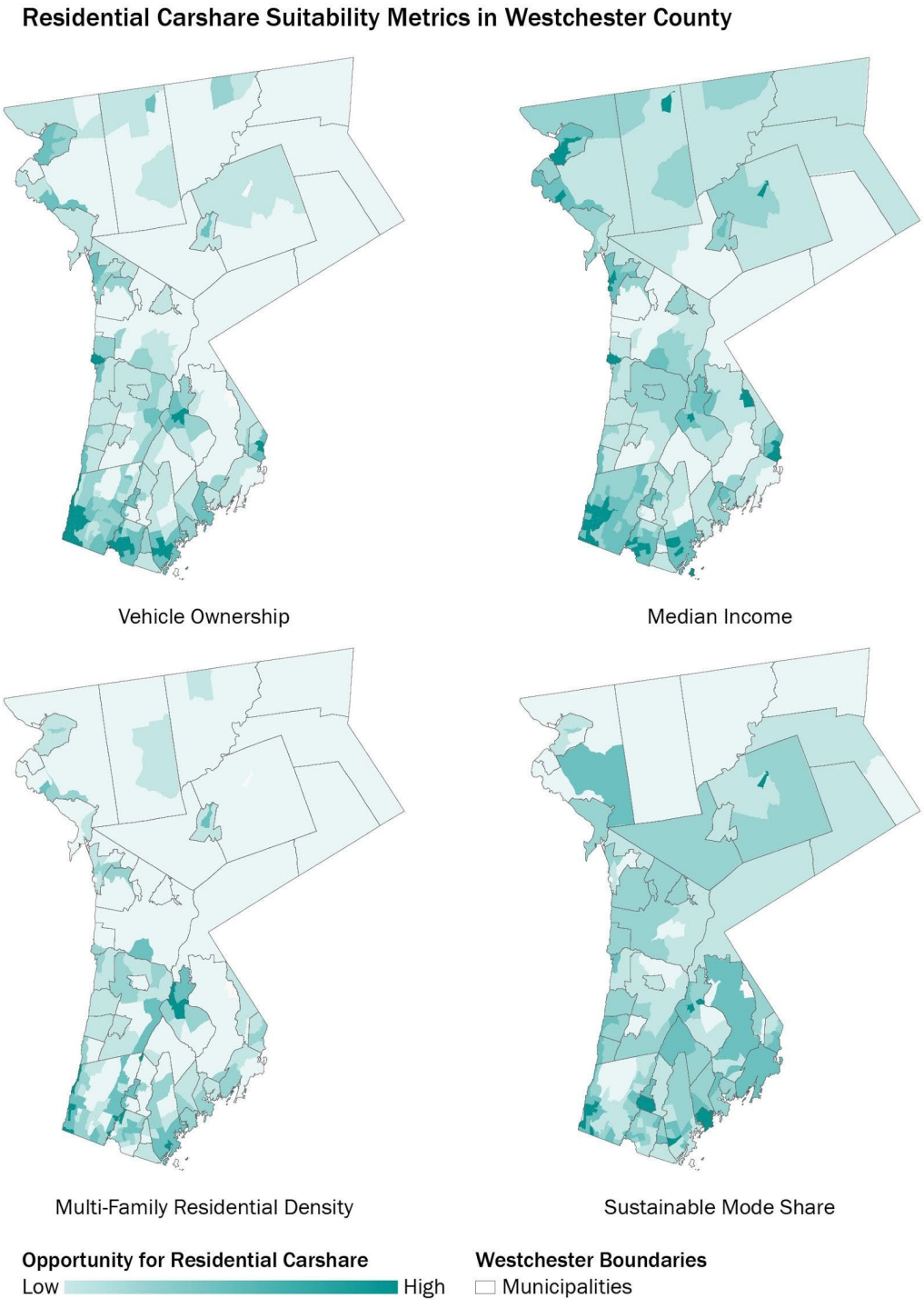
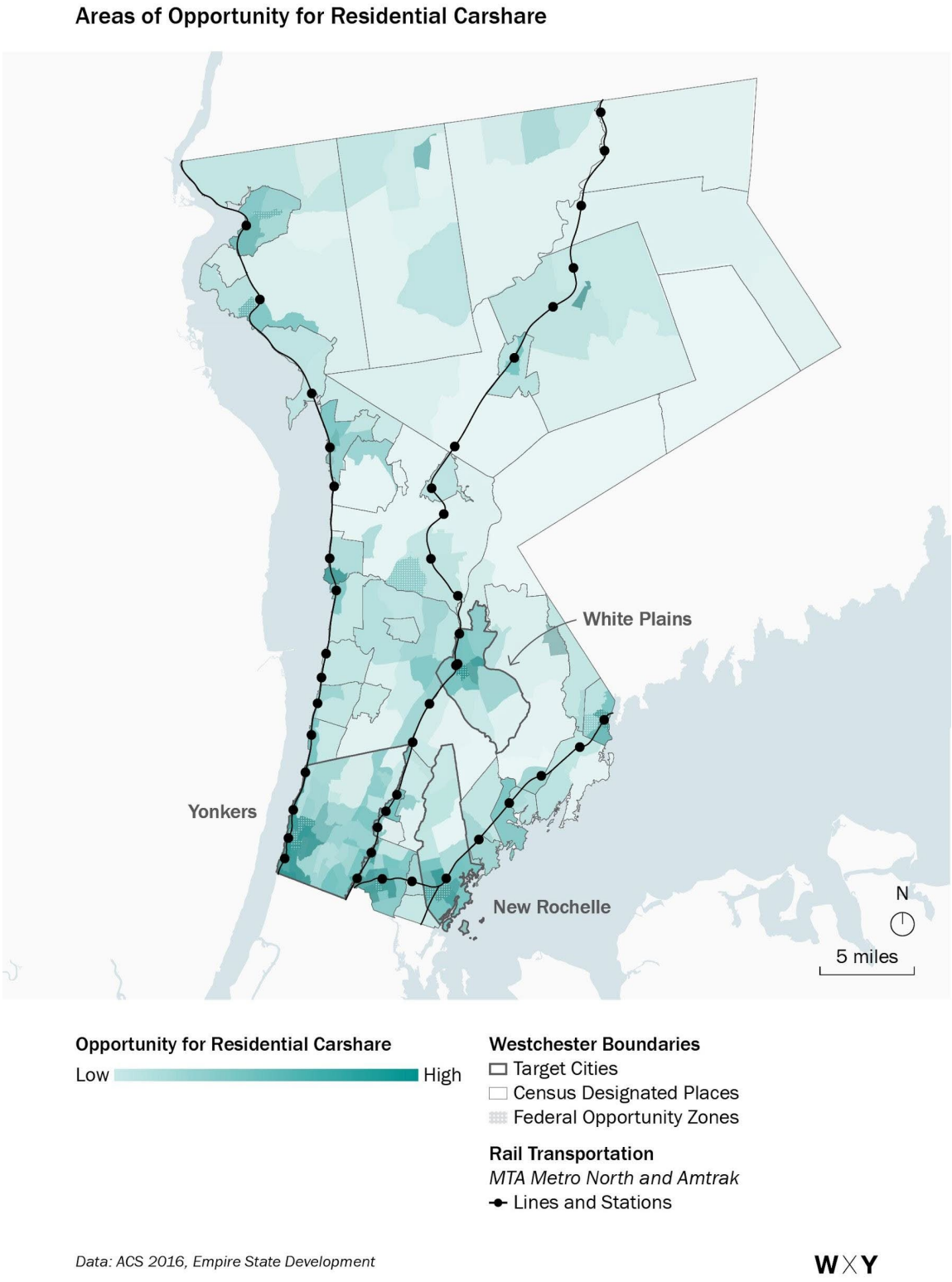


Figure 15 maps these key metrics, which we define as (1) low-vehicle ownership, (2) low-median income, (3) high-multifamily residential density, and (4) high-sustainable mode share. Overlaying these metrics in Westchester, the downtowns and rail corridors emerge as opportunity areas for residential carshare (Figure 16).

In addition to these four metrics, neighborhoods flagged as Federal Opportunity Zones may be particularly attractive to residential carshare. Federal Opportunity Zones are state-designated LMI census tracts where real estate investors can receive capital gains tax deductions for their investments. This incentive is stimulating considerable development and presents an opportunity for residential carshare. The target cities host half of Westchester's 12 designated opportunity zones, all located near their downtowns and rail stations. Downtown White Plains is itself a designated Federal Opportunity Zone.

Figure 16. Areas of Opportunity for Residential Carshare in Westchester County

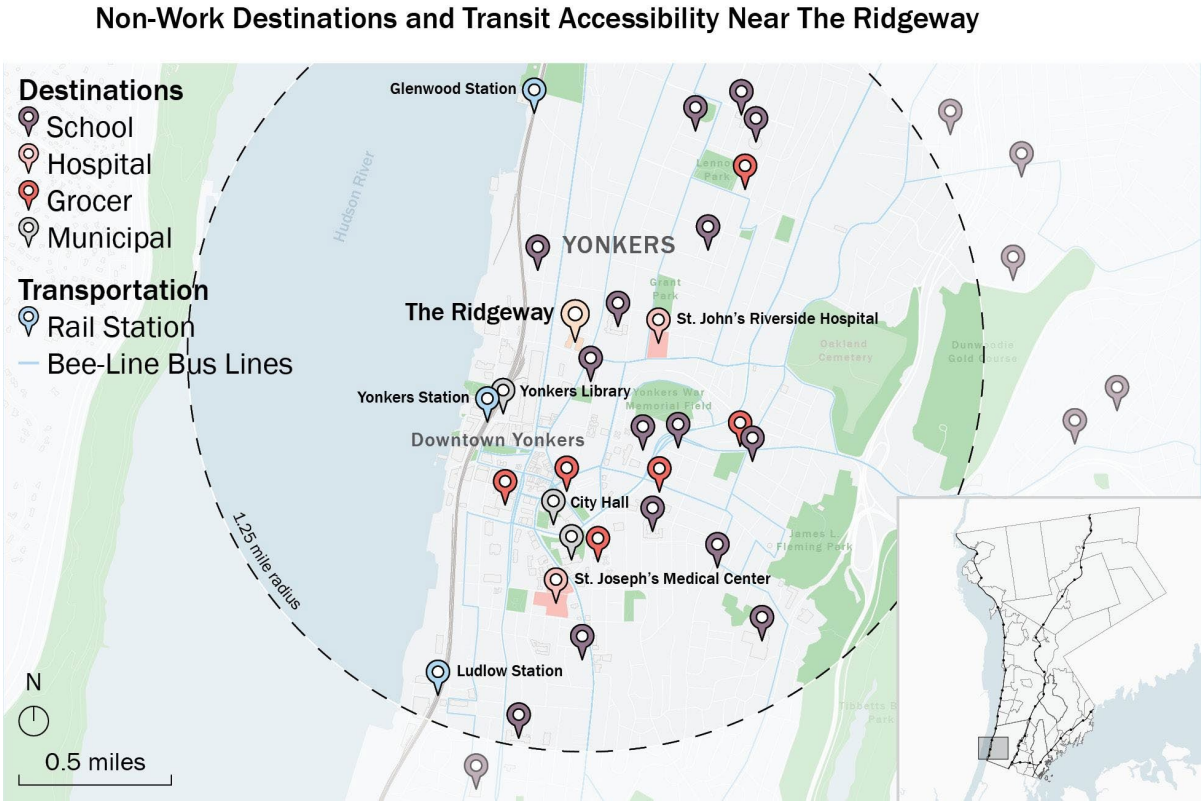
Data: ACS 2016 5-Year, Empire State Development



3.4 Site Analysis

Sites near everyday nonwork destinations and public transit present a good opportunity for residential carshare. According to survey data collected in 2010/2011 by the New York Metropolitan Transportation Council (NYMTC) and the North Jersey Transportation Planning Authority (NJTPA), the average nonwork trip in Westchester County was only 1.25 miles long and lasted only 11 minutes.[101] Nonwork trips represent the bulk of all carshare trips. According to a survey of carshare riders conducted in 2004, only 21% of respondents indicated that they used carshare for work-related trips; only 12% of respondents indicated that the last trip they made by carshare was work related.[102] As such, short, nonwork trips in the vicinity of developments represent the most likely use case of residential carshare. Figure 17 details potential frequent destinations within a 1.25-mile radius of The Ridgeway apartments. Carshare can facilitate access to these destinations, especially when transit may not be available or fast-enough, when carrying large bags, or when running many small errands in a single trip.

Figure 17. Potential Frequent Destinations near The Ridgeway Apartments



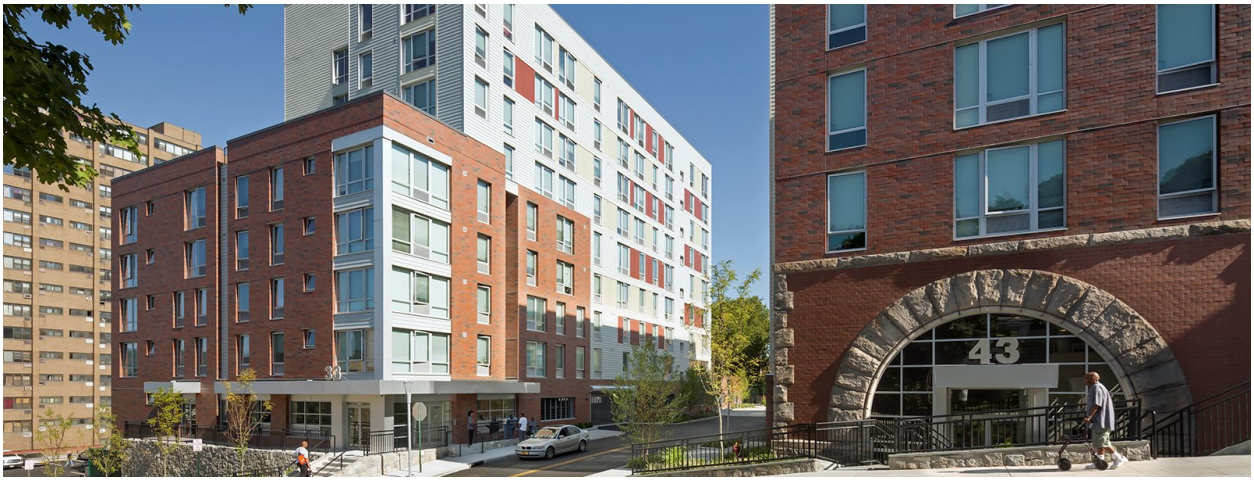
The most significant factor that determines the feasibility of residential carshare is having the cooperation and enthusiasm of the site developer and/or building manager. Once zones of interest have been identified, a scan within the zone should make a short list of developments or concentrations of developments with the desired residential density. The appendix includes the list of interview questions that were asked of building managers and developers. Further, developments with low-parking utilization present the greatest opportunity for residential carshare, as developers are likely to be more interested in leasing spaces to carshare.

Building managers and site developers are best positioned with the information to assess whether their developments are suitable for residential carshare. Developers from across Westchester County showed interest in residential carshare. The following developments are examples of some of the best opportunities for deployments based on interviews held in spring 2018.

3.4.1 The Community Builders' Ridgeway Apartments in Yonkers

Figure 18. Ridgeway Apartments in Yonkers

Source: The Community Builders



The Ridgeway is The Community Builders' (TCB) six-phased planned redevelopment of Cottage Place Gardens, a public housing built in 1945. The planned redevelopment provides affordable units conveniently located near the heart of downtown Yonkers. The Ridgeway is located 0.6 miles (or an estimated 10-minute walk) from Yonkers Station.

3.4.1.1 Schoolhouse Terrace (33 and 43 Ashburton Avenue, Yonkers)

Schoolhouse Terrace is the first phase of redevelopment at The Ridgeway and is a joint project of TCB and Municipal Housing Authority for the City of Yonkers (MHACY) that opened in 2015. The development spans two buildings: a 50-unit building for low-income seniors that transforms the old Public School 6 and another 70-unit building for low-income families. According to TCB's Community Life Coordinator, there are a total of 88 residents of driving age across the site. Schoolhouse Terrace is situated above two underground parking garages with 134 parking spaces for use by residents. As of February 2018, the garage was about one third utilized. TCB also has a small surface lot on the western edge of its property that the property manager feels would be suitable for carshare vehicles. According to the TCB property manager, the main electrical panel is near the designated spaces.

3.4.1.2 188 Warburton

Phase 2 of The Ridgeway built 51 ENERGY STAR®-certified units for low-income families. The accessible building includes a large community room where regular after-school programs, tenant meetings, and other activities are held.

3.4.1.3 The Villas at The Ridgeway

Phase 3 of the planned development will redevelop three outdated buildings into 70 residential units and a day care center at 209 Warburton Avenue and were scheduled for completion in spring 2019.

3.4.2 L + M and Wilder Balter's 14 Lecount Place, New Rochelle

Figure 19. Lecount Place Development in New Rochelle

Source: L + M

Scheduled to complete its first phase in 2022, 14 Lecount Place in New Rochelle is a mixed-use development that incorporates affordable units set aside for households between 50% and 60% of the Area Median Income (AMI). The development is currently under construction and will feature two 27-story towers with 511 apartments, outdoor terraces, a gym, children's playroom, artists' studios, and a tenant lounge.

The development is in the New Rochelle downtown overlay zone, where residential developers are required to either allocate 10% of their units to families earning 80% of the area's AMI or pay a fee to the city's affordable housing fund. Chappaqua-based Wilder Balter Inc. and L+M Development Partners Inc. of Larchmont have elected to set aside 20% of the units in the first phase of the development for low- and moderate-income households. The first phase will also include approximately 6,000 square-feet of ground floor retail and 170 parking spaces in an adjoining parking structure, which will cost $150 a month. An additional 215 parking spaces have been allocated to the development in the New Roc Garage (across Locust Avenue from the development site). Roughly 15 spaces have also been set aside for carshare vehicles.

3.4.3 Bozzuto Development's 15 Bank Apartments in White Plains

Figure 20.15 Bank Apartments in White Plains

Source: Bozzutto

A market-rate building one block from the White Plains Metro-North Station in downtown White Plains, 15 Bank Street, has 501 units and over 400 parking spaces, all managed by LAZ Parking. The spaces are located in both a surface lot and indoor garage. The garage has two dual-cord Level 2 EVSE units. A valet surface lot on the southern edge of its property is the preferred location for a carshare pilot. The valet lot is located above the subsurface garage and a mechanical room that serves the complex, facilitating EVSE installs in the preferred location.

3.4.4 Wilder Balter's Chappaqua Crossing, Chappaqua

Figure 21. Chappaqua Crossing Development in Chappaqua

Source: Wilder Balter

Chappaqua Crossing is a mixed-use development with numerous potential user cohorts in addition to residents. Office and medical tenants include a Northern Westchester Hospital health clinic and the corporate headquarters for CareMount Medical, the largest independent multi-specialty medical group in the Hudson Valley.

Residential units are comprised of 64 affordable, workforce, and market-rate apartments in the cupola building of the former 100-acre Reader's Digest corporate campus. Included are 26 affordable units that were allocated via lottery. To be eligible for affordable housing units, households had to earn up to 40% or up to 60% of Westchester's median income—$78,000 for one person or $111,400 for a family of four—depending on the size of the unit. The development also includes workforce units that are less expensive than market-rate and aimed at municipal employees as tenants.

When completed, the development will also include a 40,000 sq. ft. Whole Foods and a Life Time Fitness location, as well as 500,000 sq. ft. of Class A office space.[103] A shuttle to Chappaqua Metro-North station and a Bee-Line bus help to bridge transit gaps for residents and employees.

A small surface lot with approximately 16 spaces adjoins the entrance to the residential property and is the developer's preferred location for the EVSE-equipped parking spaces and any carshare vehicles. The mechanical room and electrical panel are 50 ft. at most from the parking spaces identified by the property manager.

4 Carshare Precedents

4.1 Electric Vehicle Carshare Precedents

4.1.1 Principal Operators

The EV carshare market is a very recent market with unforeseen challenges and great potential. While regular carshare systems are also fairly recent, cities have the infrastructure set up for ICE vehicles to function, and people understand how to use them, EV carshare systems include the added obstacle of being limited to cities that have the proper infrastructure to sustain them. Furthermore, people are just becoming familiar with EVs and their advantages. The volatility within the market converts it into a very dynamic industry; each year there are new players, and established companies continue to look for innovative and efficient ways to expand this service. Due to this unpredictability, a one-size fits all model has not yet developed. In the past five years, however, the following companies have been major players in providing new mobility solutions in the EV carsharing sector throughout the world.

4.1.1.1 Bolloré Group

Based in France, Bolloré has more than 81,000 employees across the globe engaged in telecommunications, technology, energy, logistics and transportation. Bolloré's longstanding commitment to transportation electrification is reflected by its significant investments in passenger electric vehicles, electric trams and buses, as well as EV carsharing platforms.[104] As of 2019, Bolloré operated EV carsharing programs in Indianapolis, Los Angeles, London, Bordeaux, Turin, and Singapore.[105] Notably, the city of Paris terminated its agreement with Bolloré for the carshare operation, AutoLib, in 2018.

4.1.1.2 Car2Go

In November 2011, Car2Go deployed 350 Smart Fortwo EVs in Amsterdam. This free floating carshare service enables subscribers to use vehicles by the minute and to pick up and drop them off at any public parking spot in the Amsterdam central business district.[106] The world's largest carsharing service, Car2Go also operates EV carsharing platforms in Madrid, Stuttgart, and Paris.

4.1.1.3 SelfDrive

SelfDrive is a twelve-year-old rental car company based in India, with operations across South Asia and the Middle East. The company's Smart Mass Mobility Technology platform is the backbone behind an EV carshare pilot in Dubai, which reserves Renault Zoe EVs by the hour via the company's proprietary application.[107]

4.1.1.4 BMW/ReachNow/DriveNow

In collaboration with the car rental company SIXT, BMW Group launched its first carsharing service in Europe in 2011, under the brand name DriveNow. Now operational in 13 European cities, DriveNow serves more than one million registered users in Europe who enjoy access to over 4,000 BMW and MINI vehicles—roughly 20% of which are all-electric i3 and i3 REx models. In April 2016, BMW launched ReachNow, a premium carsharing service for U.S. markets. ReachNow features all-electric vehicles in two American cities, Seattle and Portland.[108]

4.1.1.5 GM/Maven

General Motors' entrant into the personal mobility market started off in big cities and was able to expand and operate in 17 markets across North America. After some unforeseen challenges, Maven had to scale back their operations and is now available in five markets across North America. Maven offers three discrete business models—dedicated fleets for apartment complexes, weekly or monthly rentals for members who drive for ride-hailing services, and hourly/short-term rentals using a typical carshare model. Based on Maven's utilization data, Maven members have driven more than 2 million miles in the all-electric Chevrolet Bolt since the launch of the service in January 2016. Those members using Maven vehicles to drive for ride-hailing services have driven in excess of 60,000 passengers in the Bolts, according to the automaker.[109]

4.1.2 Principal Markets—International

4.1.2.1 Paris, France

Autolib, a carsharing service, was launched in December 2011 by Bolloré Group in Paris. The service was the largest EV carshare service in the world with 110,000 active users and 4,000 EVs on the streets of Paris. The system boasted an open charging network featuring 6,200 charge points, nearly all on street.[110] Members accessed the service by downloading an application and paying an hourly fee for vehicle usage.[111] Despite its success, the Paris city government ended its contract with Autolib in June 2018 due to not meeting financial expectations and Autolib ceased operations on July 31, 2018.[112]

In early 2019, Car2Go launched an electric carsharing service in Paris with 400 vehicles.[113] The vehicles will rely on the existing network of EV chargers installed as part of the previous Autolib service.

4.1.2.2 Amsterdam, Netherlands

Amsterdam's EV carsharing service, provided by Car2Go, has a fleet of 300 two-seater Smart Fortwo vehicles stationed around the central business district. Six hundred public charging stations support the program across the city. The city provides free parking for all Car2Go vehicles. The service is popular in Amsterdam, with 25,000 members in the city.[114]

4.1.2.3 Den Bosch, Netherlands

Beginning in 2010, local companies and institutions in Den Bosch, Netherlands, participated in an EV carshare pilot featuring a diverse EV fleet. The goal of the pilot was to achieve a rate of 80% for daytime work-related travel to be done with a zero-emission footprint and testing smart charging infrastructure.[115]

4.1.2.4 Copenhagen, Denmark

In September 2015, 400 BMW i3s were deployed in Copenhagen by BMW's DriveNow carshare service. Taking a unique approach, Copenhagen's largest public bus company partnered with DriveNow to promote intermodal travel and better serve individual mobility needs. One year after its launch, GreenMobility A/S deployed 400 shared electric Renault ZOEs in the city.[116]

4.1.2.5 Singapore

In December 2017, Bolloré Group's BlueSG deployed an initial fleet of 80 EVs and 32 charging stations for public use. The service has 2,000 subscribers who can choose between an annual plan with lower minute-rate or a weekly plan with a slightly higher minute-rate. Bolloré has committed to growing the carshare fleet to 1,000 vehicles supported by 500 charging stations before the infrastructure and equipment reverts to public ownership in 2026.[117]

4.1.2.6 Dubai, United Arab Emirates

Several carshare and rental services, including SelfDrive, now offer Renault ZOE EVs to members of Dubai's carsharing service. The service provides free charging at more than 90 Dubai Electric and Water Authority charging stations across the Dubai metropolitan region. Parking and charging costs in these designated areas are included in the carshare fee.[118]

4.1.2.7 London, United Kingdom

Bolloré Group's Bluecity carshare service has deployed 100 all-electric carshare vehicles in 18 of London's 32 boroughs. The service was designed with intermodal connections in mind, positioning vehicles close to tube and train stations. Affordability was another key marketing consideration, with rates of 17 pence (roughly 22 cents) per minute.[119]

4.1.2.8 Cheng Du, China

ReachNow offers station-based electric carsharing in the capital city of Southwest China, Sichuan province. By 2018, ReachNow plans to offer 25 carshare hubs, largely located in and around premium residential and commercial areas, office complexes, government buildings, and luxury hotels. The system has taken a fixed-point approach in response to difficulties in implementing a free-floating model in congested cities such as Beijing, where ReachNow was first piloted by BMW.[120]

4.1.3 Principal Markets—Domestic

4.1.3.1 Indianapolis, Indiana

In 2015, Bolloré Group launched the carsharing service BlueIndy, featuring 300 cars and 85 charging sites. The service currently has 3,000 active members.[121] Indianapolis invested $6 million in the overall project, but 80% of the cost was funded by Bolloré.[122]

4.1.3.2 Portland, Oregon

Forth Mobility offers daily rentals of used Honda Fit EVs for $10 to $12 in Portland, Oregon. The carsharing service has vehicles stationed at Vista de Rosas, an affordable housing complex managed by Hacienda Community Development Corporation. Hacienda staff and Vista de Rosas residents share access to the EVs through the Turo peer-to-peer sharing application.[123]

4.1.3.3 Los Angeles, California

BlueLA, in collaboration with the office of the Mayor, launched a 100-vehicle EV carshare pilot to serve disadvantaged communities in Central L.A. (Downtown L.A., Westlake, and parts of Koreatown). EV carsharing stations are planned for communities within the top 10% of the highest need communities on the CalEnviroScreen index. A programmatic goal of the initiative is to engage community-based organizations to enroll an estimated 7,000 new EV users from these communities by community-based organizations. The project promises to offer affordable last mile/first mile solutions for LMI families and other residents who do not own a car or need a second car for trips requiring a light-duty passenger vehicle.[124] Since launching, the program has expanded and offers a discounted rate for qualifying LMI participants.

4.1.3.4 Chattanooga, Tennessee

Launched in October 2016 by the Chattanooga Area Regional Transportation Authority, Green Commuter is a membership-based platform that offers individuals and businesses 24-hour access to a network of electric vehicles.[125] Green Commuter members can utilize a Nissan Leaf for $9/hour or $45/day. The program launched with 20 vehicles and 20 charging stations clustered in the downtown at two large shopping malls and at the regional airport.[126]

4.1.3.5 Seattle, Washington

BMW's ReachNow has deployed roughly 700 vehicles in Seattle, 80 to 90 of which are EVs. The rental cost of $0.41 a minute and $80 a day is the same for an ICE vehicle or EV. To support the project, BMW invested $1.2 million to build out a citywide charging network of 100 new EVSE units.[127]

4.1.4 Electric Vehicle Carshare Precedents in Low- to Moderate-Income Communities

For most Americans, transportation constitutes 16% of household spending, the second highest expense category, just behind housing.[128] Low- to moderate-income Americans, however, spend an even greater percentage of their income on transportation than other Americans. While second-hand EVs are increasingly available and affordable, and the manufacturer's suggested retail price of some EVs is approaching $20,000, electric vehicles are seldom marketed to LMI communities and charging infrastructure is rarely targeted to low- and moderate-income areas.

Several cities across the U.S. have, however, begun to pilot EV carsharing initiatives aimed at LMI communities. In May 2017, the Sacramento Metropolitan Air Quality District launched Our Community CarShare Sacramento, a clean vehicle sharing program serving LMI residents. The initiative stationed six electric Kia Souls at three public housing developments in the city, offering a zero-emission mobility solution to 2,000 residents.[129]As referenced in the section 4.1.3.2 and 4.1.3.3, both Portland and Los Angeles have piloted carshare programs targeted to underserved communities. In Portland, the State of Oregon has funded Forth, a new public-private partnership aimed to accelerating uptake and ensuring that EVs and other emergent transportation technologies serve LMI populations and communities of color. Forth has partnered with the Hacienda Community Development Corporation, a Portland-based affordable housing organization to provide the agency with used EVs and EV chargers for work-related site visits. These vehicles can also be utilized by Hacienda tenants through a peer-to-peer carsharing application.[130]

Lastly, the City of Los Angeles' EV carsharing Pilot for Disadvantaged Communities provides EV carsharing services to low-income Angelenos. Championed by LA Mayor Eric Garcetti, this 100-vehicle carshare pilot addresses mobility needs in Central LA's LMI neighborhoods, including Westlake, and parts of Koreatown.[131]

4.1.5 Electric Vehicle Carsharing—Challenges

4.1.5.1 Lack of Suitable Infrastructure

Infrastructure continues to be the most significant limiting factor impeding broad market acceptance of EV carsharing. Car2go launched the nation's first all-electric carsharing service in San Diego in 2011 with the expectation that a comprehensive charging network would emerge following its initial rollout. Five years later, the city's utility announced plans to install 3,500 charging stations, but the infrastructure project did not launch until 2017. Due to the lack of charging infrastructure to support its EV carshare fleet, Car2go switched back to gas-powered cars in 2016.

4.1.5.2 High Costs Associated with Bringing Power to Charging Stations

The burden of installing new infrastructure to serve carshare fleets can require complex funding agreements between public agencies and private sector entities, as well as costly upgrades to current electrical service at the location. These costs can be prohibitive and may preclude the expansion of carshare services into new markets. A review of projected installation costs for two proposed residential carshare projects is instructive. In one case, a 2016 installation of one single-port DC Fast Charge unit in a market-rate residential building in lower Manhattan totaled nearly $35,000, attributable in part to the added cost of a transformer and signal repeater as well the expense of running power to the location. In another project, a quote for the installation of a single DC unit alongside three Level 2 units at a residential building in Long Island City, Queens exceeded $72,000.[132] While the cost of labor and materials may be slightly lower in the counties outside the five boroughs of New York City, neither project relied on union labor nor required electrical panel replacement. Such upfront costs can meaningfully prolong an operator's return on investment and, absent significant public investment, may pose challenges to widespread adoption.

4.1.5.3 Unfamiliarity with Charging Equipment

New carshare members are likely to be unfamiliar with protocols for plugging in EVs upon returning to a hub or home station. While the carshare operator can presumably monitor power levels in a carshare vehicle, the end user is responsible for connecting the car to a power source. The reliability of the service will ultimately depend on the actions of each driver at the conclusion of their session.

4.1.5.4 Costs and Competing Services

Making carshare EVs accessible to communities without high-median incomes will likely require significant subsidies from utilities or public agencies. Unsubsidized usage rates may cause prospective carshare users to consider competing modes. If accessing carshare vehicles requires an additional trip—and presumably, an additional expense—to a fixed station, the value proposition becomes less appealing. Prospective carshare users may find that the cost of competing modes, such as ride-hail or rideshare services, may be more attractive given the added convenience of door-to-door transportation.

4.1.6 Electric Vehicle Carsharing—Opportunities

4.1.6.1 The Autonomous Future

EV carshare platforms offer a transitional approach to autonomous mobility, since both carsharing and autonomous vehicles will chip away at the imperative of vehicle ownership. In this way, EV carsharing enables the autonomous future by leveraging technology to offer the user on-demand mobility.

Mobility Services: The Customer Perspective,[133] a 2019 report issued by Accenture, investigated the emerging challenge posed by autonomous vehicles (AV) and new mobility services to the traditional ownership model. In December 2018 and January 2019, Accenture conducted an online survey of 7,000 consumers in China, Europe, and the United States—85% of whom were car owners. Accenture found that 48% of respondents would consider relinquishing their personal vehicles in favor of using autonomous mobility solutions, including self-driving buses or autonomous taxis. What are the likely economic and technological motivations of this projected transition away from ownership and toward shared utilization? In first generation AVs, acquisition cost is a probable factor, since the sensor technology and associated guidance systems required for full autonomy are currently more costly than the vehicle itself.[134] While costs for autonomous technology are projected to decline, a recent UBS study suggests that the incremental cost of a fully autonomous vehicle will still exceed a standard a vehicle MSRP by approximately $15,000 as late as 2030.[135]

As a function of this enduring added cost, it is likely that full autonomy will be limited to robotaxis and other shared mobility services that could enable cost sharing among a number of parties and amortize the initial investment of the car over more miles than a traditional privately-owned vehicle. In this way, an AV can offer shorter investment payback periods through higher vehicle utilization.[136] Due in great part to the pairing of AV technology with shared mobility business models, the UBS (a global financial services company) study forecasts that by 2035, urban car ownership will decline by 70%.[137]

While original equipment manufacturers (OEM) ranging from industry stalwarts like Ford to disrupters like Tesla have all variously predicted that the autonomous future is imminent, full "Level 5" autonomy is now acknowledged to be a much more complex undertaking than was previously assumed. In April 2019 Ford Motor Company CEO Jim Hackett remarked that Ford "overestimated the arrival of autonomous vehicles" and reported that the applications for its first autonomous vehicle "will be narrow, what we call geo-fenced."[138] Other automakers are similarly retreating from their earlier optimism about the commercialization of full autonomy. Still, OEMs are devoting significant resources to autonomous development programs and are eagerly pursuing new investment for their fledgling efforts. GM's AV subsidiary, GM Cruise LLC, recently secured an equity investment of $1.15 billion from a group of institutional investors; Ford, has ploughed $1 billion into Argo AI, while Volvo has formed a $300 million joint venture with Uber Technologies Inc. and Toyota has allocated $1 billion for AV research.[139]

4.1.6.2 Suitability of Electric Vehicles for Carsharing

Carshare members typically use a shared vehicle for between two and four hours per session, and carshare trips are generally short, with the grocery store as one of the most common destinations. As such, EVs would seem to be ideal for carshare applications. And because many carshare members cite environmental concerns as their principal reason for choosing to forego car ownership, EVs will likely strengthen the appeal of carsharing for sustainably inclined consumers.

4.1.6.3 Bridging Transit Divides

If affordable and reliable, EV carsharing can offer geographically marginalized communities access to jobs, shopping, and other opportunities that have been historically inaccessible to them due to distance from transit nodes. The value proposition of EVs over ICE vehicles for such transit-starved communities is largely connected to the lower operating costs of electric drive technology. Reduced fueling costs, the value of state and federal tax credits, as well as the lower maintenance expenses typically associated with EVs can be passed on to the carshare members to keep usage fees low.

4.2 Municipal Fleets and Electric Vehicle Carsharing

The three subject Westchester cities are in the process of establishing EV fleets and installing EVSE to serve their fleet vehicles, as well as the general public. Each municipality has embraced the concept of an EV ecosystem in which EVs will play an increasingly important role—both as municipal fleet vehicles as well as a mode of transportation that complements but does not replace efficient public transportation and

alternate transportation. Fleet sharing with municipalities offers one attractive opportunity to ensure adequate levels of utilization, thereby hedging potential operator losses by backfilling weekday "demand troughs" in the midday hours when carshare use is typically low. Carshare is typically most utilized in evenings and weekends (Thursday through Sunday), according to industry experts from GM Maven. While the three subject cities have demonstrated some interest in the concept of EV fleet sharing, each also expressed concerns about operationalizing such a strategy.

4.2.1 New Rochelle

The New Rochelle fleet already features four all-electric cars and has four EVSE, one of which is publicly accessible. The city has put forth an ambitious sustainability agenda. It is exploring solar farms on vacant city-owned property and recently launched CircuitNR, an EV shuttle service that will take riders through several areas of downtown.[140] New Rochelle's sustainability agenda includes a commitment to create financial incentives to discourage single-occupancy vehicle commuting by municipal employees, while also encouraging the adoption of similar policies by major local employers[141]

Luiz Aragon, Planning Director for City of New Rochelle, is optimistic about the benefits that a joint residential-municipal carsharing program could offer the city, stating that it could alleviate stress on the existing fleet while reducing maintenance costs and enabling a more efficient fleet. However, Aragon cautioned that several hurdles would need to be overcome: (1) integrating such a service into the fleet and (2) meeting the logistics needs of nonemergency agencies.[142]

To validate the model and minimize challenges, New Rochelle would require relevant data from a similarly sized city or a pilot fleet with a sufficiently large sample size. Absent a municipal pilot, it will likely be difficult to persuade New Rochelle (or any city its size, for that matter) to adopt a joint EV carsharing strategy on a scale that would be meaningful. Mr. Aragon did, however, cite noncritical scheduled maintenance of current fleet vehicles as a possible but limited use case, especially since it would enable the municipality to take advantage of off-peak hours.

Mr. Aragon suggested that the New Rochelle City Hall (which is expected to be completed in 2021 to replace the current city hall) could offer an ideal site for a joint residential/municipal carshare operation. The city hall building will be located on Main Street in a planned 45 story mixed-use tower featuring residential, commercial and municipal space and a four-story parking garage.[143] Whether this development will be completed within a useful timeframe for the first stage of a carshare pilot remains to be seen, however.

Mr. Aragon also recommended a surface lot on Maple Avenue, six blocks from the planned location of the new City Hall. While this property will soon adjoin a new multifamily development, it is currently in a low-density neighborhood that is unlikely to offer the rates of utilization needed to sustain a carshare initiative.

4.2.2 White Plains

The White Plains clean energy initiatives, including its sustainable fleet initiative, helped the city attain the Clean Energy Community designation by NYSERDA.[144] About 20% (65 vehicles) of the White Plains fleet utilizes some form of alternative fuel, including six electric-drive vehicles. White Plains has also deployed 20 publicly accessible electric vehicle charging stations, the most by any municipality in Westchester County. In addition, the city has partnered with Zipcar and hosts a carshare program with two locations and conventional cars for general public use.

"We currently have six electric/hybrid vehicles in the fleet and are excited about getting more," reports Linda Puoplo, Deputy Commissioner with the White Plains Department of Planning. "In the past, the cost of an electric vehicle versus a traditional fuel vehicle was sometimes prohibitively restrictive; however, currently, we find the cost to be negligible and certainly worth the cost in the long run."[145]

The city's commitment to clean transportation extends beyond automobiles—in June 2018, White Plains also launched a dockless bike share pilot program using Lime dockless bicycles.[146]

4.2.3 Yonkers

The City of Yonkers has also embraced EV and alternative fuel vehicles by making them the first priority in vehicle purchase and replacement programs and through other initiatives to prepare for large-scale EV use. In 2017, Yonkers purchased six EVs and a charging station for its municipal fleet, as well as nine charging stations for installation at three public locations. These acquisitions were part of a larger sustainable energy initiative funded through New York Power Authority (NYPA).[147]

Jason Baker, the Director of the Office of Sustainability in Yonkers, spoke about the pace of integrating EV vehicles into the city fleet and on the corresponding (and necessary) expansion of EVSE infrastructure. He identified EVSE sharing as a likely best case scenario for a carshare (and preferable to shared vehicle use). With 11 existing Level 2 charging stations spread across two city garages (the Buena Vista and the Government Center Garage) already open to the public, Mr. Baker identified an expanded EVSE-sharing program as a natural area for partnership. However, he

registered concerns regarding city workforce using carshare vehicles chiefly: (1) possible union grievances should the arrangement require extended travel to and from vehicle pickup/drop-off points or any additional difficulties and (2) a carshare arrangement resulting in vehicles not being immediately available when needed.[148]

With the possible large-scale, long-term EV and EVSE expansion, Mr. Baker stressed that city locations would have priority for city funding/scheduling/installation of EVSE infrastructure. He also identified a larger question of what actor would take financial leadership for such a project. This could be an excellent opportunity for city partnership with a private enterprise to greatly expand EVSE use across Yonkers—making EV ownership a much more attractive proposition for municipalities[149] and private individuals.

Ron Kamen, CEO of Earthkind Energy and an advocate for sustainable energy and EV adoption in Westchester County, indicated that Yonkers has been pursuing increased EVSE access and has (along with the City of New Rochelle) explored increasing EVSE access in and around municipal parking lots, including local MTA Metro-North parking lots.[150]

4.2.4 County of Westchester

Westchester County has purchased 40 plug-in electric vehicles and 78 articulated hybrid electric buses. The county has also obtained grant funding for charging stations to meet its fleet charging needs. Because the county has the infrastructure and personnel to store, service, and repair all of its own vehicles, the county's merged Department of Public Works and Department of Transportation typically owns and maintains its fleet and is unlikely to embrace carsharing scenarios, according to Peter McCartt, Director of Energy Conservation and Sustainability for the county. More exploration of this opportunity is however warranted, according to McCartt.[151]

5 The Feasibility of Residential Carshare

The LMI residential carshare business model entails the siting of EVs and associated charging infrastructure directly in parking garages or surface lots associated with large-scale LMI and mixed-income developments. The model is, therefore, a closed loop where carsharing services are mainly available to residents as well as commercial and office tenants of targeted mixed-use developments. While this design contrasts with the many "opensource" models employed by major carshare providers, the project team goals are not limited to profit maximization, and, therefore, the LMI carsharing model parameters have been adjusted accordingly.

The proposed model has been designed to meet the triple-bottom-line of economic feasibility: energy efficiency and social equity. As discussed, the model aims to achieve social equity by granting low- and moderate-income households access to carsharing; the model will also spur considerable improvements in air quality and energy efficiency. As with any double, or triple, bottom-line model, the need for subsidy is paramount to balance market realities with public policy goals.

The following business plan and annexed pro forma (see attachment A) illustrate the specific costs which will be incurred during operations as well as the types of revenues that will need to be earned to prove the model. The breadth of the funding gap will then be quantified to determine the level of public subsidy necessary for project feasibility.

5.1 Customer Segments

There are two principal customer segments served under our model: (1) low- to moderate-income individuals residing in selected LMI developments and (2) market-rate housing tenants who happen to live in these same developments. A third segment—commercial and office tenants of mixed-use developments that incorporate residential units for LMI households—is an intriguing addition but without a clear demonstration of demand. This third segment could not be included in the model. A fourth segment—public agencies associated with municipal governments in each of the targeted cities—has similarly been omitted from the model due to lack of documented demand. While the model seeks to serve LMI households, LMI and mixed-income developments themselves are typically not restricted to one income band alone, and, as such, the model needs to balance the needs of market-rate, near-market-rate, and subsidized tenants.

The revenue section that follows highlights a cross-subsidy model where market-rate consumer usage helps to ease the cost burden on LMI users.

5.2 Value Proposition

The LMI residential carsharing model will deliver gains to both customer segments and to the broader public via enhanced air quality, reduced congestion, and decreased demand for parking.

5.2.1 Value Proposition for Carshare Customers

- **Increased choice and flexibility**: Carshare can help reduce the mobility gap between l ow- and high-income households, decreasing expenses for rent-burdened households and increasing mobility for LMI individuals.
- **Less hassle, relieved burden:** The costs of owning a vehicle are particularly burdensome for LMI households and shared mobility offers the flexibility of POVs without the associated challenges of ownership (e.g., cost, parking, insurance, and maintenance).
- **Lower transportation costs:** Households that have sold a POV and substituted their trips with carshare and other alternative modes have realized monthly household savings of $154 to $435. For an American household earning the median income, these savings would represent 7.5% of their annual household income. For American households with incomes in the bottom decile, these savings would represent 28% of their annual household income.[152]
- **Convenience and exclusivity of use:** The proposed closed loop model will make EVs available exclusively to the tenants of a targeted development thereby ensuring greater certainty to building residents on vehicle availability.
- **Alignment with consumer trends:** Relinquishing the cost and responsibility of owning a personal automobile has become an increasingly common consumer behavior in dense metros across the U.S.

5.2.2 Value Proposition for the Broader Public

- **Reduced GHG emissions**: Lower VMT per household means fewer GHG emissions. Carshare using zero-emission vehicles has even greater potential GHG savings benefits, as carshare vehicles can increase mobility without increasing overall GHG.
- **Reduced congestion**: Carshare can contribute to lower overall VMT and fewer cars on the road.
- **Increased mobility options:** Bringing carshare into residential developments will increase the visibility and convenience of carshare, potentially reducing user anxiety about access, reducing car ownership and VMT. When carsharing is combined with EVs, an increase in carshare usage over POVs is positively correlated with reductions in GHG emissions.

5.3 Customer Channels and Relationships

There are advantages and disadvantages to soliciting carshare customers in a closed model. In one sense, customer outreach is simpler in that it is designed to reach a targeted—and limited—market. In such a scenario, the extent of the market is easily identified and high-touch, personalized marketing efforts via existing communications platforms and purpose-designed events may be more likely to make an impact than large-scale marketing campaigns aimed at creating general brand awareness. However, in a closed model, marketers must be able to be savvy enough to win over a critical mass of tenants in a small setting where the risk of one failure is not mitigated by the ability to endlessly move on to the next potential customer.

Considering the above, the main channels to consumers will be multifamily housing developers, their building and parking managers, tenant associations, and other governing or informational bodies that can reach out to tenants and encourage participation. These grassroots ambassadors are a perfect complement to existing carshare operators with more traditional marketing departments.

Carshare operators will also need to be active and involved at selected developments to present at scheduled meetings and gatherings. An operator will need directly engage residents in building lobbies and to engage with individual tenants seeking information and clarification. Finally, marketing efforts will also need to ensure that information is appropriately, and equitably disseminated to the two customer segments: both LMI and market-rate tenants, particularly if these customer types reside in different buildings.

5.4 Key Assumptions

The proposed model is based on a set of assumptions regarding residential development size and carshare utilization.

5.4.1 Development and User Assumptions

- Carshare will be deployed at LMI developments.
- Deployment sites will have a minimum of 200 residential units.
- The average household size for deployment sites is 2.8 people, based on U.S. Census estimates for average household size in Westchester County.[153]

- A 200-unit development will have an estimated 560 total residents.
- Ten percent of deployment site residents are assumed to become carshare users, or 56 users for a development with 200 units and 560 total residents.
- LMI and market-rate tenants will use carshare services equally regardless of income.[154]

Total usage hours are then estimated for a high- and a low-utilization case. In the high case, the model assumes that each of the carsharing vehicles will be utilized for 24% of Monday–Thursday hours and 50% of weekend hours. In the low case, the model assumes that each of the carsharing vehicles will be utilized for 12% of Monday–Thursday hours and 25% of weekend hours. When annualized, the high-utilization model projects 3,079 hours of use, per vehicle, while the low-utilization model projects 1,540 hours. Separately, estimates for average charging hours needed to power carshare vehicles have been derived from the Westchester County average trip distance and vehicle miles traveled as reported by NYMTC and Clipper Creek.[155] Using these sources, we estimate hours of charging (aggregate for both vehicles) for the high-utilization case at 2,250, and 1,126 for the low case.

5.5 Key Activities and Partners

Key project activities include placement of a plug-in hybrid EV—the Chevy Volt— and a full-battery EV—the Chevy Bolt—at a pre-selected, mixed-income development. The model assumes that the development has its own garage or surface lot and that a nearby distribution panel can service one dual-corded Level 2 charging station. The model provides for an upgrade if panel capacity is inadequate to meet the charging station power demands.

The project calls for two carshare vehicles equipped with built-in reservation and scheduling technology that is accessible via mobile applications. A keyless entry system is to be built into the vehicles, and a 24-hour customer service line will be available to all users.

Importantly, a carshare operator and a charging network operator both need to be engaged to supply the technology and services behind this effort. In the present model, it is assumed that the carshare operator assumes full-project responsibility and personally engages the charging network operator to obtain and service the necessary charging equipment. The carshare operator also collaborates with the property management entity to upgrade the electrical panel and orchestrates the installation of the charging equipment.

Once activated, tenants in the development log on to the carshare application and reserve a vehicle. Fueling or charging costs are also be built into the hourly rate so customers pay one flat fee based on hourly usage and no more.

Key partners in a demonstration could include a carsharing operator with significant experience that also features plug-in vehicles in its fleet and a charging station network operator with experience in carshare deployments. The project team has had in depth discussions with such companies, including GM Maven and Chargepoint throughout the course of the study as project advisors. While Maven does not yet envision itself in Westchester, its decision could be influenced by the opportunity to launch an LMI pilot with enough public subsidy to underwrite both costs and return on investment (ROI).

5.6 Cost Structure

The cost structure for the model is built on actual income and expense reports from Avis. While Avis is a more traditional rental car company, its cost structure bears strong similarities to carshare programs with large fleets.[156] Additionally, Avis is the parent company of Zipcar, a leading carshare operator in the New York City Metropolitan region.[157]

The first section of the cost model is derived by taking annual costs as presented in the Avis 2017 income statements. The major costs are (1) operating expenses, (2) depreciation, (3) selling and general administrative costs, (4) vehicle interest, (5) nonvehicle interest, and other costs. The firm also incurs taxes and records provisions to offset these taxes.

In the model, the Avis cost categories are amended by zeroing out depreciation and by instead including a cost for vehicle purchase. This is done under the assumption that vehicles for the carshare program will be purchased and sold in the same year. This means purchase and resale may be totally reflected on the income statement, rather than on the balance sheet with an expense offset for depreciation. This method has been discussed at length in a white paper by Investor Campus which details how rental car firms buy vehicles at a discounted price and resell them back to manufacturers at a prearranged price, thereby avoiding the risks of long-term wear and tear, and simultaneously monetizing the cars usage over a one-year term.[158]

The revenue streams of the model include resale values to offset the full-expense line of buying a new car each year (discussed further below). Subtracting purchase costs from resale revenues results in an excess of expenses over revenues for this category and a $10,205 deficit for the line in both the high

and low cases. If depreciation costs are simply taken as a percentage of total revenues, then deficit totals $26,642 for the high-utilization case and $20,486 for the low-utilization case.[159] Calculating depreciation as a percentage of total revenue negates the need to include resale and purchase values. However, these larger deficit numbers undoubtedly include accumulated depreciation from multiple vehicles at a company such as Avis. Since a two-vehicle model is proposed, and it is a plausible assumption that both cars will be resold in the same year, the lower estimate is more reflective of a residential carshare model with limited vehicle deployments.

Total carshare operator cost for all expense categories combined equals $144,240 in the high-utilization model, and $126,510 in the low-utilization model, each year for five-years assuming constant 2019 dollars (note: these estimates exclude charging, parking, and other costs as detailed below).

The above expenses represent the typical cost structure of a carsharing company (using rental car income statements as a proxy). However, as the present model is based at a residential development, the cost of charging equipment acquisition and installation, as well as electric panel upgrades, need to be calculated. Make-ready and equipment cost for electric vehicle charging station installations are estimated at $29,800 per residence (calculated in year one), assuming a panel upgrade and one Level 2 charging station installed at a surface lot or garage associated with the targeted development. This represents the total installation and upgrade costs per development under the assumption that no further work will be needed over the five-year projected term.

The cost of two parking spaces is estimated at $3,000 per year in both scenarios while the cost of fuel/electricity is estimated at $4,388 per annum in the high case and $2,196 per annum in the low case. These amounts differ because the high case assumes cars will be utilized twice as much as the low case. As such, charging/fueling needs are also proportionally higher.

Finally, the requisite profit margin necessary to attract a carshare operator to this type of model is calculated using Avis's aggregate after-tax profit margin of 4% as a baseline and then adding 3.5% for a total of 7.5%; a closed model carsharing scenario has a higher risk to reward ratio than the typical open model where cars are utilized with greater frequency.

5.7 Revenue Streams

Across the field, carshare providers are charging an average fee of $8 per hour, although in the New York Metropolitan region the Zipcar standard hourly rate is $10 per hour.[160] In the proposed model, this fee schedule is adjusted slightly to create a cross-subsidy model whereby market-rate tenants underwrite some of the costs borne by potential LMI users.

5.7.1 Two-Tiered Pricing Model

The pricing model assigns LMI tenants a below-average rate of $6 per hour, and market-rate tenants a rate of $10 per hour, corresponding to the Zipcar regional standard. For LMI tenants, this means that the convenience and flexibility of carsharing can be price competitive with other transportation schemes, especially taxicab use.

The two-tiered pricing model described above will work best in a development that includes both market-rate and LMI housing in the same development, such as Wilder-Balter's Chappaqua Crossing. While questions might naturally be raised about a pricing model that advantages some tenants over others, it should be noted that preferential pricing for amenity fees at some mixed-income developments has been provided to LMI tenants. In one notable example, The Windermere West End, an apartment complex on Manhattan's Upper West Side, ultimately arrived at preferential pricing model for use of a pool that it added in 2013. In this instance, rent stabilized tenants initially were unable to access new building amenities, including the pool, that were made available to market-rate tenants. Stellar Management, the company that manages The Windermere, now offers discounted swimming lessons and discounted pool fees to children of LMI tenants through its pool operator, SwimJim.[161] As such, there is precedent for offering two-tiered pricing on amenity services within the same building.

Finally, the model assumes an even number of market-rate and LMI users will opt into the on-site carsharing program. Should the pricing structure described not be feasible, it can easily be substituted by charging the going rate of $8 to all users. At a minimum, however, it is recommended that the two-tiered pricing model be tested at an actual development to accurately determine what the two different market segments will bear.

Total carshare revenue under this model is projected to be $49,264 per year in the high case, and $24,640 in the low case each year for five years (constant 2019 dollars).

5.7.2 Other Revenue

As stated above, the model includes both the cost of acquiring new vehicles from year-to-year as well as the expected resale price on vehicles. Once again, adhering to the Investor Campus projections, the model estimates resale prices at 73% of sticker price. As such, total revenues from resales amount to $57,305 (2019 dollars) per year in both the high and low. Although resale values for EVs in the retail market have a precipitous drop, the present model assumes that all resale pricing (within one year) is pre-negotiated with the car manufacturer.

Total overall annual revenues are projected to be $106,569 in the high case and $81,945 in the low case (in 2019 dollars).

5.7.3 Funding Gap

Based on the revenues and costs laid out thus far, the funding gap is projected to be $82,852 (high utilization) and $85,707 (low utilization) in year one and $53,052 (high utilization) and $55,907 (low utilization) in years two through four (2019 dollars). The numbers are similar due to the fact that carshare operator costs are calculated as a percentage of total revenues and, as such, they scale downwards when total revenues decrease.

The following are major cost factors generating these deficits:

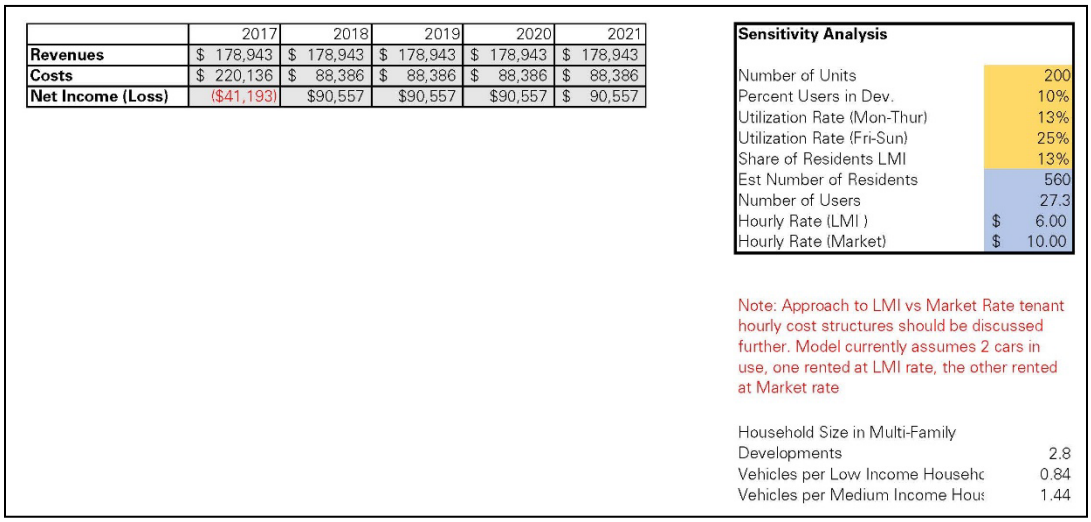
- the costs of charging equipment, panel upgrade, and installation in year one.
- to a lesser extent: the purchase price of EVs.

In addition, carshare vehicles associated with one development in a closed-loop model are not optimized at the same rate as those deployed in comparable opensource models such as Zipcar.

5.8 Pro Forma

The pro forma allows the user to experiment with different modeling assumptions. By adjusting variables in the Assumptions sheet and Sensitivity Analysis box, cost-benefit projections are updated on the Summary slide (see Figure 22).

Figure 22. Pro Forma Summary Slide Preview



	2017	2018	2019	2020	2021
Revenues	$ 178,943	$ 178,943	$ 178,943	$ 178,943	$ 178,943
Costs	$ 220,136	$ 88,386	$ 88,386	$ 88,386	$ 88,386
Net Income (Loss)	($41,193)	$90,557	$90,557	$90,557	$ 90,557

Sensitivity Analysis

Number of Units	200
Percent Users in Dev.	10%
Utilization Rate (Mon-Thur)	13%
Utilization Rate (Fri-Sun)	25%
Share of Residents LMI	13%
Est Number of Residents	560
Number of Users	27.3
Hourly Rate (LMI)	$ 6.00
Hourly Rate (Market)	$ 10.00

Note: Approach to LMI vs Market Rate tenant hourly cost structures should be discussed further. Model currently assumes 2 cars in use, one rented at LMI rate, the other rented at Market rate

Household Size in Multi-Family Developments	2.8
Vehicles per Low Income Household	0.84
Vehicles per Medium Income Hous	1.44

The full pro forma is provided as attachment A. The results of the pro forma are discussed in section 5.7: Revenue Streams, and section 6: Discussion.

6 Discussion

6.1 Aligning Incentives

The potential benefits and impacts of a residential carshare service in Westchester vary for each of the different stakeholders: municipal governments and their constituents, carshare operators, and the development community. A successful program requires an alignment of interests for all three stakeholders. Fostering this alignment will likely require an effective policy framework, including potential subsidies, development bonuses, and other incentives. As such, early buy-in and investment from public sector decision-makers is a key prerequisite to the success of the proposed residential carshare program.

6.2 The Residential Carshare Opportunity in Westchester

In Westchester County, three converging trends present an especially ripe opportunity for residential carshare:

- Shifting mobility attitudes
- Investment in dense, mixed-use downtowns
- Generational change

The rise of new multifamily and mixed-use developments across Westchester is likely to increase the demand for carsharing as well as meaningful market opportunities for carshare operators in locations beyond New York City. New developments in the county—including The Collection, City Square, and Broadstone in White Plains; 101 Wolfs Lane in Pelham; and Chappaqua Crossing on the site of the former Reader's Digest corporate campus in Chappaqua—combine housing with office and commercial uses and are likely to offer carshare operators multiple use cases as well as efficient calendaring for carshare vehicles, such asa balance of workday, weekend, and evening usage. Some of these developments are explicitly marketed to two groups that are fueling the county surge in multifamily development,[162] young adults "transitioning" to the suburbs and downtown "empty nesters" seeking a low-maintenance alternative to homeownership.[163] These two market segments are also prime demographics for participation in the sharing economy. A 2015 study conducted by KRC Research on behalf of Zipcar revealed that nearly 15% of Zipcar members were over 50 and that percentage was projected to increase.[164]

In addition to the millennials and empty nesters now flocking to the revitalizing downtowns in the county, a third group—LMI households in new affordable and mixed-income housing in and around these downtowns—represent another potential market segment for residential carsharing in Westchester. As noted earlier, Westchester LMI households in multifamily buildings typically have lower rates of car ownership than higher income households in the county. For households without sufficient resources to purchase or lease a vehicle and without nearby transit options, carsharing represents a potential strategy to bridge transit gaps and improve access to services, schools, shopping, and even employment opportunities.

6.3 Policy Implications

The introduction of new affordable and market-rate rental housing, bolstering density in county downtowns, is an indicator of generational change and a shift in attitudes among both new and longtime residents. These development trendlines have informed local policymaking aimed at mitigating congestion, reducing parking requirements, and responding to new mobility options and preferences.

Within the downstate region, only the City of New Rochelle has, however, implemented a carsharing incentive for developers. In 2015, New Rochelle amended its city code to provide allowances for carshare parking within its Central Parking Area (CPA), or downtown district, which effectively trims a developer's parking requirements. The amendment enables a development with 20 or more spaces to reduce its required parking by three standard spaces for every one space designated for carshare, up to a maximum 15% reduction of the total parking requirement.[165] Outside the CPA, the city offers a similar parking credit for facilities of 50 spaces or more up to maximum of 15% of the total parking requirement and subject to approval by the city planning board.[166]

Because a relaxation of parking requirements can be readily translated into reduced development costs and a reallocation of precious ground floor space for additional housing or commercial activity, the carshare incentive is likely a compelling one for developers.[167] While still too recent to offer much substantiation of its effectiveness, New Rochelle carshare development bonus is an important precedent that could ease the glidepath for future parking demand incentives, including zero-emission carshare initiatives.

In a number of markets beyond New York State, carsharing has also been piloted as an explicit strategy to shrink parking demand and mitigate congestion.[168] In some jurisdictions, incentives are offered to projects that incorporate carsharing; in others, carsharing is a requirement in developments of a certain size. In a third scenario, bonuses for carsharing are awarded on a discretionary basis. Austin, Vancouver, and San Francisco have adopted carshare ordinances that reflect the disparate development pressures and public policy concerns prevalent in each jurisdiction.

6.3.1 Case Studies

6.3.1.1 Austin, Texas

University Neighborhood Overlay Zoning District (UNO) in Austin was formed to advance the goals of the Central Austin Combined Neighborhood Plan, a land use plan for three adjoining neighborhoods near the University of Texas campus. Increasing the use of sustainable and alternative transportation modes is among the plan objectives for these adjoining neighborhoods. The UNO's parking provisions enable a multifamily developer to reduce parking requirements by up to 40% if the development incorporates a carsharing operation.[169]

6.3.1.2 Vancouver, British Columbia

The parking by-law was amended in 2005 in Vancouver to incorporate carsharing as a strategy to reduce required parking in multifamily developments. The amendment enables a development to offset three conventional parking spaces for each carshare parking space.[170] This provision was first utilized in a mixed-use development known as #1 Kingsway, which features a public library, community center, and cafe, as well as nearly 100 units of rental housing. The development incorporated two carshare spaces, yielding a reduction of six conventional spaces in the parking requirement for the property.[171]

6.3.1.3 San Francisco, California

The City of San Francisco has adopted perhaps the most aggressive carsharing mandate. The city requires newly constructed residential developments with a minimum of 50 units and on-site parking to set aside at least one carsharing space at no charge to an operator. For multifamily buildings with at least 200 units, the city requires a minimum of two carsharing spaces plus one for buildings with significantly more units than 200.[172]

In other jurisdictions, carsharing is employed as a mitigation measure for developments that are projected to spur congestion or that are not in conformity with customary levels of off-street parking. The City of Boston, Massachusetts, for instance, employs carsharing requirements as an ad hoc mitigation measure but does not place any blanket carshare mandates on developers.[173] Similarly, the City of Berkeley, California imposed a carshare requirement on the Gaia Cultural Center, a 91-unit, mixed-use development with off-street parking for only 42 vehicles—less than half a parking space per unit. The developer allocated two parking spaces for carsharing and provided two vehicles for building residents on a reservation basis. Residents with auto insurance can also take advantage of three electric vehicles supplied by the developer.[174]

While the discretionary imposition of carshare requirements as a mitigation strategy offers cities flexibility, both Austin and Vancouver have elected to embed carsharing into their zoning requirements and land use policies. Regardless of the methodology employed, a number of cities have identified carsharing as a promising parking demand management strategy. This approach offers clear benefits to carshare operators by aligning carsharing with broad public policy goals and ensuring the continued growth and viability of the sector by dint of municipal ordinance. But it also can assist communities in meeting smart growth goals and enhancing the vitality of neighborhoods burdened by congestion from high levels of car ownership.

In addition to policy precedents cited above, cities have other tools at their disposal: tax credits, density bonuses, low-emission or green transportation districts, fleet-sharing, and backstopping losses through a risk-sharing subsidy can all be used to promote carsharing. The risk-sharing model ensures profitability through payments to an operator to offset shortfalls for a predetermined period. In 2004, Arlington County, Virginia initiated a carsharing program in collaboration with Flexcar and Zipcar to serve communities along its transit corridors. At the outset, the county offered operating subsidies due to uncertainty regarding demand and risk associated with the cost of start-up in a new market. As membership grew over the course of the inaugural year, the revenue guarantee tapered until the county completely discontinued it in May 2005 due to rapid revenue growth.[175]

6.3.2 Fleet Sharing

Fleet sharing is an alternate public sector strategy for supporting carshare initiatives. For cities with the flexibility to replace owned or leased fleet vehicles with carshare vehicles, fleet sharing offers the operator a revenue guarantee while enabling a municipality to reduce its operating costs. The certainty of a revenue stream in a new market enables an operator to finance start-up costs and expand its service

area. City CarShare, a West Coast nonprofit that was founded in 2001 and was absorbed by a competitor in 2016, provided the City of Berkeley, California with exclusive workday access to three hybrid electric vehicles at two off-street downtown locations through a 2004 fleet sharing agreement. These vehicles were restricted for use by Berkeley employees from 8 a.m. to 6 p.m. each weekday. After 6 p.m. and on weekends, the vehicles were made available to other City CarShare members, offering access to the public at periods of peak demand. Berkeley paid a monthly fee to City CarShare, based on the number of hours each car was reserved for exclusive use by its employee.[176]

As interviews with officials in Yonkers and New Rochelle municipal government indicate, fleet sharing does, however, present a number of complexities for the municipal fleet operator.[177] The strategy requires motor pool locations in close proximity to other carshare members who would have access to these vehicles after the workday and on weekends. Residents of neighborhoods that lack a government agency footprint would largely be excluded from the program. Collective bargaining agreements or other city contracts may prescribe the types of vehicles that city employees drive and where those vehicles are domiciled. And lastly, municipalities that have existing motor pool operations and dedicated personnel for vehicle maintenance may be extremely reluctant to outsource services.

6.4 Equity and Carsharing

A key policy consideration when weighing a public sector role for advancing carshare within a municipality is equity. Data on the demographics of carsharing, however, does not precisely align with an equity-based approach since early studies indicate that lower income households are less likely to utilize carsharing than other households in a given community.[178] Research has shown the challenges of establishing and maintaining carsharing operations in low-income communities. However, they have also provided analyses, frameworks, and recommendations that may be useful to serving equity goals.

6.4.1 The Equity Policy Imperative

Due to the heavy costs, burden, and impacts of transportation disparities on the most vulnerable segments of society, a carshare policy informed by equity considerations is a necessity. LMI communities tend to be effected the most by climate change and gas price volatility.[179] One third of household costs go toward transportation, and two thirds of U.S. jobs are not accessible by public transportation.[180] Mobile sources are a leading cause of pollutant emissions and climate change that disproportionately affect low-income individuals and households.[181] Land use and transportation policy decisions have disparate impacts across ethnic, gender, and ability lines. These are some of the reasons why equity in transportation policy is an

important consideration. Therefore, we will consider equity issues for carshare because they have the potential to increase mobility for users who are unable to access private cars or forego ownership altogether, potentially reducing household transportation costs while providing a mobility alternative.[182] EV carshare systems located in underserved communities will help reduce emissions, increase mobility, save families money, and introduce clean, safe transportation to neighborhoods that lack it. Underserved communities are a growing consumer segment and their inclusion is pivotal to expanding the EV market and creating a sustainable future.[183] Equity in carshare deployments increases space for shared use that would normally be dedicated for single-occupancy vehicles.[184] This helps promote more sustainable communities and allows land and building space to be put toward other uses, such as additional housing, open space, or commercial activity.[185]

Studies have shown that carshare operations, like bike-share systems, are typically located in densely populated, higher income, mixed-use areas with good infrastructure to ensure adequate membership and revenue to cover operating costs. Moreover, shared mobility networks operate most effectively when they form a tight contiguous cluster of stations so the siting of hubs outside of a core, high-demand deployment zone can diminish the quality of the service and the profitability of the operation. While many systems have tried to place some stations in low-income neighborhoods, if these stations are not fully integrated with the main contiguous cluster of stations, they provide fewer accessible destinations, limiting their usefulness for adjacent members.[186]

Shaheen et. al. have developed a transportation equity analysis called the STEPS (Spatial, Temporal, Economic, Social) framework to consider meaningful access to shared mobility.[187] Others have used similar constructs that examine structural, financial, informational, cultural and operational barriers to shared mobility.[188] Applying these analyses to shared mobility systems, researchers have identified a number of challenges and opportunities for equity in carsharing.

- Spatial factors and equity
- Temporal factors and equity
- Economic factors and equity
- Mobility impairment and equity
- Social factors and equity

6.4.1.1 Spatial Factors and Equity

Carshare siting becomes an issue when distance impedes a user's ability to access the service in a timely and affordable manner.[189] Carshare operators have historically targeted upper income neighborhoods with good public transportation access, thereby making their services less accessible to potential users with lower incomes residing outside of those neighborhoods.[190] Reasons for not siting carshare in LMI neighborhoods—whether real or perceived—include risk of lower utilization, attitudes against the sharing economy, risk of vandalism, and others.

Some nonprofits have focused on serving LMI communities. For example, City CarShare program in San Francisco and the LMI program in Los Angeles provided carshare access to LMI families in partnership with affordable housing and social service agencies, while Buffalo carshare established a neighborhood storefront to serve a low-income community.[191] Ithaca Carshare (now defunct) served unbanked and individuals without credit cards by allowing its members to deposit cash and checks into carshare accounts.[192]

Policymakers are positioned to set requirements and incentives for locating shared mobility services in underserved areas. Denser urban areas that have a large enough market to cross-subsidize less profitable car dispatches are better positioned to take on the risk of requiring that carshare service be deployed in underserved neighborhoods as a condition of approval. The San Francisco on-street carshare pilot required carshare vendors to locate 15% of vehicles in zones outside the central core.[193] However, that strategy alone is not a guarantee that vehicles will be accessible to disadvantaged communities.

Awarding parking spaces in higher revenue generating neighborhoods to operators that also locate in low-income neighborhoods may be a more flexible approach to ensuring equitable access to services in their jurisdictions. Risk sharing partnerships between operators and the risk partner are another opportunity. In such a scenario, the operator values the monthly cost of vehicle placement and subtracts monthly revenue from that collected value and bills the shortfall to the risk partner.[194]

Experts emphasize the need for nonprofit operators or governmental subsidies to provide affordable services outside of the urban core. Local government, in particular, has several avenues through which it can push for improved system siting, which range from leveraging its executive authority to the regulation of system siting. For example, Washington D.C. agreed to let carshare vehicles owned by

Zipcar and Flexcar park at public curbside spaces on condition that at least two carshare stations and up to seven vehicles are positioned in low-income neighborhoods. In Denver, the Department of Public Works required carshare companies to place vehicles in "opportunity areas," where 30% or more of the population lives below the poverty line.[195]

6.4.1.2 Temporal Factors and Equity

Temporal factors become an issue when travelers are unable to complete time sensitive trips in a reliable and cost-effective manner.[196] Many LMI residents experience temporal challenges due to conflicts between their work schedules and availability of public transportation. About 17% of the U.S. workforce has unstable shift schedules.[197] By income level, the lowest income workers have the most irregular work schedules.[198] One policy opportunity is a potential partnership with employers that could help offset costs, especially if businesses see benefits—such as reduced turnover and increased productivity and satisfaction in their employees. State and local government agencies could also play a role by piloting an off-hours incentive program to ensure that late-shift worker have access to this service.[199]

6.4.1.3 Economic Factors and Equity

Economic factors become an equity issue when basic travel costs such as commute, errands, appointments, and social interaction preclude a traveler from buying other basic goods or being able to save money.[200]Although cost-burdened households could experience savings from shared mobility access, many services require payment with a credit or debit card, which can impose a barrier for the 15% of American consumers who are unbanked (have no bank account). This barrier has been somewhat mitigated by the recent introduction of general purpose reloadable (GPR) prepaid cards available in corner stores, as well as from more traditional financial institutions.[201] Many shared mobility providers require an Internet connection to request or book rides, which may leave these services out of reach for users without mobile connectivity[202] or users conscious of data accrued. Additionally, hourly charges for use can add up quickly, especially if the car is parked for a significant part of a session. While most of the hourly price covers the operational cost, a study of taxes imposed on carshare services across the U.S. discovered that carshare transactions are being taxed at approximately double the rate of normal sales tax in the cities they operate.[203] Rental car taxes, favored by politicians as revenue from visitors as opposed to residents, have been applied to carshare vehicles despite the fact that these are overwhelmingly used by residents.[204]

Insurance is a key challenge for equity in carshare deployment. Buffalo Carshare (BCS) was ultimately acquired by Zipcar in 2015. BCS had to sell its stake not because it lacked membership but because it was unable to get replacement coverage after its insurer cancelled the policy (the insurer based its decision on New York State's no-fault insurance scheme).[205] Some insurance networks, such as the Alliance of Nonprofits for Insurance (ANI), specialize in covering shared mobility systems. Nonprofit systems such as the Denver eGo and San Francisco City CarShare are both covered by ANI, which is a nonprofit itself and has a board of directors comprised of nonprofit members. BCS and Ithaca Carshare (ICS), were covered by Porter and Curtis LLC, a private insurer specializing in risk management coverage related to collaborative consumption.[206]

Two of the strongest examples of logistical barriers are driver's license and internet access requirements. A valid driver's license is the top requirement for joining a carshare program. As research has shown, license suspensions have an overwhelming impact on low-income people and their ability to access jobs.[207] These suspensions are often for unpaid fines rather than for posing a threat to public safety. The lack of a valid driver's license also disproportionately effects immigrant populations, especially undocumented immigrants, who must look to other forms of transit for job access. It is currently unknown to what extent low-income people within the catchment area of a carshare system are challenged by the lack of a valid driver's license. Similarly, access to internet or to a smartphone is required to use most carshare programs. Membership applications along with vehicle reservations are often made online. Since a significant proportion of low-income communities are unable to afford internet access at home, this barrier makes it difficult and inconvenient to participate in carshare systems. However, there is a growing trend of low-income people accessing the internet on their smartphones. Many systems also allow users to register or reserve vehicles by a mobile phone, which despite the new trend is out of reach for some low-income individuals.[208]

Carshare vendors can operate profitably by providing a valuable service that many low-income users would be willing to support, especially with the right mix of marketing and product-market. BCS was conceived to specifically target low-income users. Unlike most other carshare operators, two thirds of BCS users came from households making less than the city median income of $30,000. Several effective strategies employed by BCS included allowing unbanked users to pay via money order and locating its vehicles on affordable housing properties.[209] Also, increased piloting through public/private partnerships can build up knowledge and capacity for carshare.

Policy opportunities include a mixed approach by state and local governments of reducing costs for operators by reducing taxes and fees where appropriate, subsidizing shared mobility use for those still unable to afford the market-rate for the service, or both.[210] As is the case with subsidized housing vouchers, user subsidies help reduce the perceived risk of locating in low-income communities. To compare, public transit agencies are subsidized in recognition of the value they provide to the public and are thus expected to only partially recover costs from fares. However, shared mobility programs that similarly extend mobility services have yet to receive consistent subsidies that recognize their value to the same extent.[211]

Another policy opportunity is offering an alternative to card-based payment. Such an alternative is account-based payment, which is used by most shared mobility vendors via smartphone applications. While account-based systems would allow users to reload their account value with cash, it would still be difficult to use without a smartphone. Some have suggested that the potential role of strategically placed mobility hubs that would allow un-phoned users to hail a variety of shared mobility services. Some variants of this idea already exist, such as the LinkNYC Wi-Fi kiosks in New York City.[212] Although Wi-Fi kiosks have potential in denser urban areas, most users would still be better served by a mobile phone service. To address this gap, the Federal Communications Commission, through its Universal Service Fund (USF), offers Americans up to 135% of the poverty line a $10 subsidy to help pay for either Internet at home or a mobile phone service.[213]

Another approach to addressing payment challenges includes the use of public transit subsidies to apply to carsharing services and the use of Electronic Benefit Transfer (EBT) cards to pay for carshare services.[214] EBT cards allow state welfare departments to issue food stamp benefits and cash benefits (e.g., Temporary Assistance for Needy Families) through a payment card. Depending on the program, cash benefits can be used to pay for nonfood items and services such as transportation, utilities, clothing, medical care, among others.[215] Some have suggested measures such as establishing pooled risk funds, up front nominal fees to put toward a deductible if needed, developing liability levels for those from underserved communities, using cameras at locations to minimize theft and vandalism, and compiling and sharing actuarial data to better manage risks as ways to contain insurance costs.[216]

To make carsharing more affordable, some states have revised their car rental taxes to reflect the difference between carsharing and car rentals.[217] In New York State, for example, the rental car tax is at least 6% and can be as high as 11%.[218] State and local governments thus need to consider how the regulation of shared mobility affects the profitability of different systems and thereby influences their ability to expand into LMI neighborhoods.[219]

6.4.1.4 Mobility Impairment and Equity

Physiological factors become an issue when a traveler has physical or cognitive difficulty navigating the transportation options available.[220] Special mobility needs for aging users, wheelchair access, and additional room needed by families with small children present physiological challenges for carshare.[221] Carshare may not be directly accessible for those who are not cognitively or physically capable of driving, but it can be beneficial to disabled users with a family or friends who can drive. City CarShare, a nonprofit carshare organization that operated in the San Francisco Bay Area, had wheelchair-accessible vans available to members for $12 per hour. The accessible vehicles became unavailable when City CarShare made their fleet exclusively accessible via Getaround in 2016, a peer-to-peer carshare company. Stipulations in the grant that paid for the accessible vans prohibited other organizations from operating them,[222] underscoring the importance of managing shared mobility mergers carefully so as not to leave users stranded.[223] The variety of physiological challenges presents a need for flexibility by regulators to ensure that subsidies do not favor one underserved group over another.[224]

6.4.1.5 Social Factors and Equity

Social factors can emerge as a challenge to transportation access when they inhibit a traveler's comfort or ease of use.[225] Researchers have identified a number of social barriers that operators and their partners need to address to make shared mobility accessible to disadvantaged communities. To overcome these barriers, operators should apply the following considerations to their approach:

- Understand the social context
- Develop effective marketing and educational materials
- Engage with relevant community-based organizations (CBOs)
- Create meaningful avenues for community input and feedback [226]

An example of a carshare operation that has addressed these four factors is Ithaca Carshare. In order to appeal to and best serve LMI applicants, ICS developed a specific, targeted strategy to identify the needs of and adjust its processes to attract, retain, and better serve these members. ICS streamlined the application process in order to accommodate those applicants without access to the Internet. ICS made

similar changes for the orientation of new members in conjunction with information sessions held directly in neighborhoods, often in LMI housing complexes. ICS also formed a unique partnership with a local community development credit union, allowing members that do not have a debit or credit card the opportunity to deposit funds into a special account at the credit union. The credit union had established an array of financial services and products to support financial literacy and independence among those with lower incomes and was willing to co-market services with ICS. One example of co-marketing is working with AFCU free income tax preparation service to reach those who might otherwise spend their "windfall" tax refund on less cost-efficient transportation, such as a new car. This partnership is one solution to a barrier that many other carshare organizations face.[227]

BCS was able to attract many low-income members through its community-based marketing. The organization operated out of a storefront enabling curious customers to walk-in and learn about the service in-person. BCS also made use of community outlets, such as neighborhood meetings and church functions to promote its service. These efforts helped BCS attract LMI members, with more than half earning less than $25,000 a year.[228]

6.4.1.6 Equity Facilitators and Intermediaries

Through both regulatory action and funding, government can incentivize or simply require for-profit and nonprofit carsharing organizations to make efforts to serve low-income communities. In some cases, municipalities have considered laws requiring carshare operations in designated zones, in return for operating rights. This has been the case with carshares in Washington, D.C. where the local Department of Transportation requires vehicles to be placed in low-income neighborhoods. Other municipalities have offered grants that require expansion efforts as well as reporting focused on low-income users such as with Boston's Hubway system. The public sector can also attain full control over the goals and programs of a given shared-mobility system by owning and operating the system itself.[229]

Another important player in overcoming barriers, especially for users, will be intermediaries, or third party brokers who help bridge the barriers that keep LMI communities from accessing shared mobility services.[230] Potential intermediaries often have preexisting relationships with low-income communities and are therefore well suited to connect these groups with efforts to reduce usage barriers. Intermediaries can identify specific barriers, help devise solutions to overcome them, and advise on messaging and outreach mechanisms. Advocacy groups, community organizations, and even city departments are some

examples of entities that play this role. Due to potential ties with a local community, an intermediary can play a key role in implementing outreach and education programs to share knowledge of the system itself, available subsidies, or logistical fixes with potential low-income users. They may also provide new avenues for financial support by tapping into non-transit funds, such as health or community focused grants.

6.4.1.7 Ensuring Equity: Recommendations

In jurisdictions where a carsharing policy is under consideration, policymakers can incorporate best practices to ensure equity and equal access. These include the following:

- Target Environmental Justice communities and Federal Opportunity Zones for pilot deployments.
- Identify and engaging with trusted nonprofit intermediaries to facilitate carsharing in LMI communities by conducting outreach, providing validation, and reducing overall costs.
- Secure grant funding or tax levy dollars for subsidies for carshare members on public assistance or residents of public housing.
- Provide promotional and explanatory materials in languages other than English in communities with large numbers of non-English speakers.
- Require operators to locate a minimum number of carshare vehicles in handicapped accessible spaces and whenever possible, incorporating vehicles customized for the mobility impaired into their fleets.
- Require operators to partner with a local credit union or a federally certified Community Development Financial Institution (CDFI) to provide alternative payment mechanisms for carshare members without access to a credit or debit card.
- Support statewide efforts to address taxation and insurance challenges that add to cost and impede the ability of LMI consumers to take advantage of carsharing.

6.5 Summary of Benefits

Incorporating residential carsharing—and especially EV carsharing—into a public policy framework promises to confer several advantages on municipalities and their private sector partners. For operators, the benefits of residential carsharing mandates, inducements, and outright subsidies include the following:

- Promotion and validation of carsharing as a viable transportation option.
- Allocation of dedicated parking spaces for carshare vehicles.
- Incentivizing or mandating new collaborations with residential and mixed-use developers.
- Exposure to and engagement with customer segments new to carsharing.

For cities, public policy that supports residential carsharing can advance sustainability and even social equity goals in the following ways:

- Curtailing vehicle miles traveled, and the emissions associated with local travel.
- Reducing demand for parking, enabling more cost-effective development and additional ground floor activation.
- Mitigating congestion and improving the quality of life in traffic-choked neighborhoods.
- Bridging gaps in transit-starved neighborhoods and offering LMI households a new lower cost personal mobility option.

For developers, policymaking that encourages residential carsharing can facilitate development in the following ways:

- Reducing parking requirements, enabling the development of additional residential units and commercial spaces.
- Lowering construction costs.
- Creating new opportunities for development on space-constrained sites and transit-starved locations.
- Offering a new class of amenities for tenant attraction and retention.

7 Conclusion

The convergence of three emerging trendlines—new multifamily development, evolving personal mobility preferences, and generational transition—has positioned Westchester County as an ideal testbed for electric vehicle carsharing. In New Rochelle, White Plains, and Yonkers, density attributable to new affordable and mixed-income developments is yielding a critical mass of residents with disparate transportation requirements but converging attitudes toward personal mobility. As cities on metro New York's periphery grapple with both an influx of newcomers priced out of the five boroughs and the retention of empty nesters, who in a prior era would have departed for more traditional retirement destinations, many of the challenges typically associated with large cities are emerging as key policy motivation.

In a public policy context, EV carsharing represents a low-carbon strategy to address spiraling demand for parking, growing downtown congestion, emerging transit gaps, and costly transportation options for cash-strapped households unable to afford a vehicle. Given the downtown revival that is ongoing in Westchester cities and a growing policy preference for sustainability strategies, the county seems to be an especially apt ecosystem for EV carshare operations.

The residential carshare model proposed in this study has at least three significant variations from more traditional models, all of which may ultimately emerge as competitive disadvantages. Incorporating plug-in electric vehicles, targeting LMI and mixed-income communities, and offering exclusivity to tenants of residential and mixed-use developments are all features that incur additional risk to the operator. A cost premium associated with EV deployment, largely untested demand among LMI consumers, and the limitations placed on the size of the market due to exclusivity all conspire against a rapid return on investment and a clear path to profitability. These factors may limit the potential appeal of the EV carsharing model to the small cohort of operators that have emerged in recent years.

To broaden its appeal and hedge these risks, a partnership with municipal government is proposed as a narrow path to viability for the model. This partnership could take the form of fleet sharing with city agencies to backfill projected midday and weekday demand troughs or public subsidy to help bridge the likely funding gap between costs and revenues. Public sector fleet sharing does not, however, offer an immediate opportunity in the three jurisdictions examined under this study. As such, public subsidy seems a more likely near-term springboard to a pilot.

To achieve success, a clear and compelling alignment of interests between city government, the development community, and carsharing organizations will be required. Whether such alignment can be achieved is still unclear. What is certain, however, is that both the sharing economy and low-carbon transportation are transforming urban economies and everyday lives in ways unimaginable to the mid-20th century city dweller. EV carsharing offers a bridge between the legacy transportation systems of the last century and the modes and technologies that are today reshaping urban mobility. It represents both our future and our past and a hopeful remedy to the challenges of our present.

Appendix: Additional Tables and Figures

A.1 Carshare Savings

Table A-1. Carshare Savings

Data: ACS 2016 5-Year, U.S. BLS Consumer Expenditure Survey

		Income Decile									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Income	*2015*	$6,350	$16,522	$24,461	$33,006	$41,678	$51,938	$64,275	$80,472	$103,181	$181,774
	2016	$6,774	$16,841	$25,423	$33,404	$42,410	$52,949	$66,676	$83,424	$108,743	$205,391
	Avg	$6,562	$16,682	$24,942	$33,205	$42,044	$52,444	$65,476	$81,948	$105,962	$193,583
Transportation Costs	*2015*	$3,616	$3,504	$5,389	$6,459	$8,081	$9,558	$10,795	$11,865	$16,492	$19,178
	2016	$3,379	$4,153	$5,371	$6,610	$7,638	$9,290	$10,136	$11,722	$14,495	$17,724
	Avg	$3,498	$3,829	$5,380	$6,535	$7,860	$9,424	$10,466	$11,794	$15,494	$18,451
Transportation Cost Burden	*2015*	56.94 %	21.21 %	22.03 %	19.57 %	19.39 %	18.40 %	16.80 %	14.74 %	15.98 %	10.55 %
	2016	49.88 %	24.66 %	21.13 %	19.79 %	18.01 %	17.55 %	15.20 %	14.05 %	13.33 %	8.63 %
	Avg	53%	23%	22%	20%	19%	18%	16%	14%	15%	10%
	Income and transportation cost data from 2015 and 2016 U.S. Bureau of Labor Statistics Consumer Expenditure Survey.										

Table A-1 continued

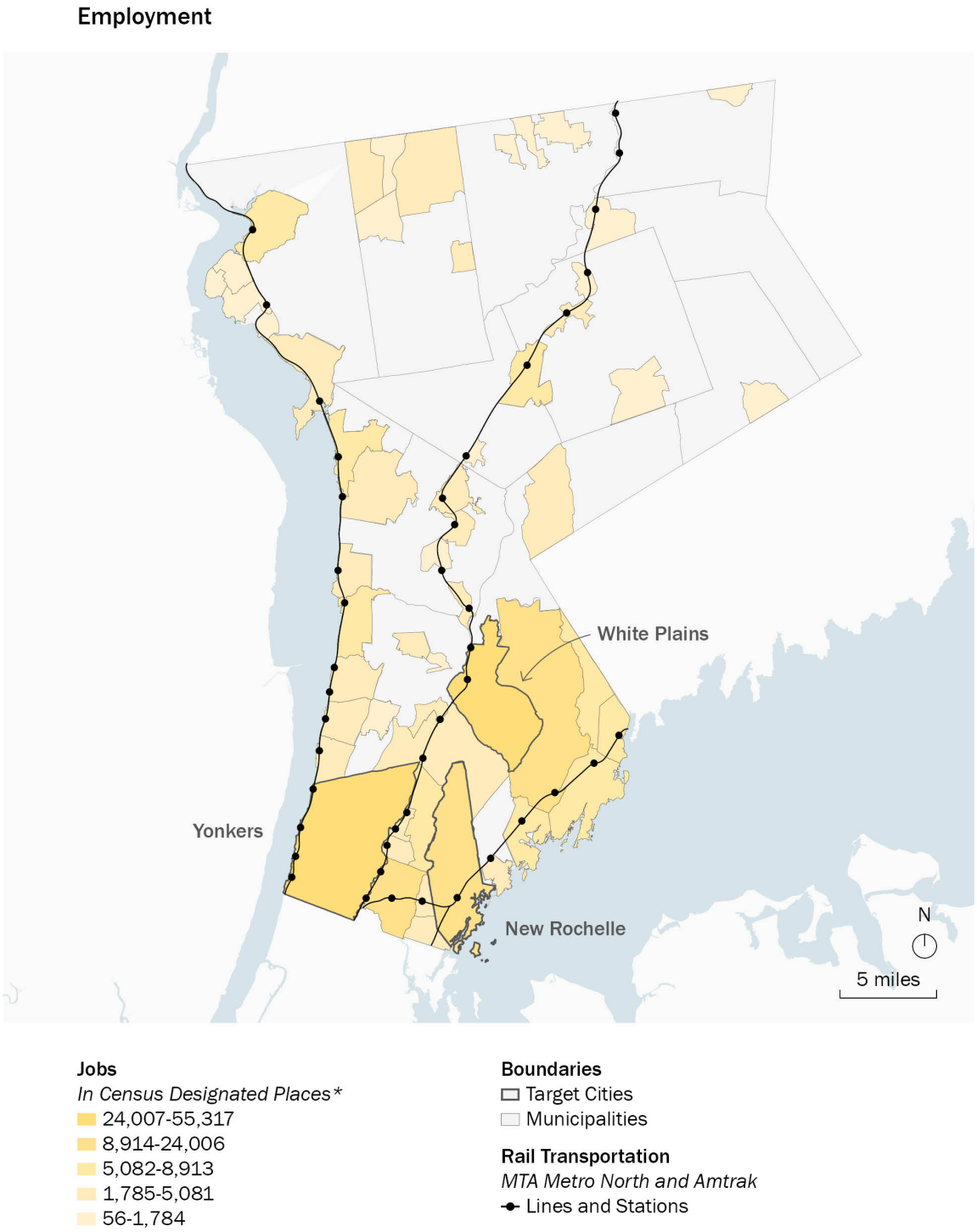
GROSS SAVINGS											
Yearly Carshare Savings		$1,848	$2,223	$2,597	$2,972	$3,347	$3,721	$4,096	$4,471	$4,845	$5,220
Transportation Costs After Carshare Savings	*2015*	$1,768	$1,656	$3,541	$4,611	$6,233	$7,710	$8,947	$10,017	$14,644	$17,330
	2016	$1,531	$2,305	$3,523	$4,762	$5,790	$7,442	$8,288	$9,874	$12,647	$15,876
	Avg	$1,650	$1,981	$3,532	$4,687	$6,012	$7,576	$8,618	$9,946	$13,646	$16,603
Transportation Cost Burden After Carshare	*2015*	28%	10%	14%	14%	15%	15%	14%	12%	14%	10%
	2016	23%	14%	14%	14%	14%	14%	12%	12%	12%	8%
	Avg	25%	12%	14%	14%	14%	14%	13%	12%	13%	9%
RELATIVE SAVINGS											
Savings as Share of Previous Transportation Costs	*2015*	51%	53%	34%	29%	23%	19%	17%	16%	11%	10%
	2016	55%	44%	34%	28%	24%	20%	18%	16%	13%	10%
	Avg	53%	48%	34%	28%	24%	20%	18%	16%	12%	10%
Savings as Share of Income	*2015*	29%	13%	11%	9%	8%	7%	6%	6%	5%	3%
	2016	27%	13%	10%	9%	8%	7%	6%	5%	4%	3%
	Avg	28%	13%	10%	9%	8%	7%	6%	5%	5%	3%

A.2 The Distribution of Jobs in Westchester

Westchester's largest municipalities are centers for employment. Together, Yonkers, White Plains, and New Rochelle host approximately 132,000 jobs, representing roughly 33% of the county's total employment.[231] A further 30% of Westchester jobs are down-county outside of these three target cities, with Harrison Village and Mount Vernon the next largest jobs centers.[232]

Figure A-1. Job Distribution in Westchester County

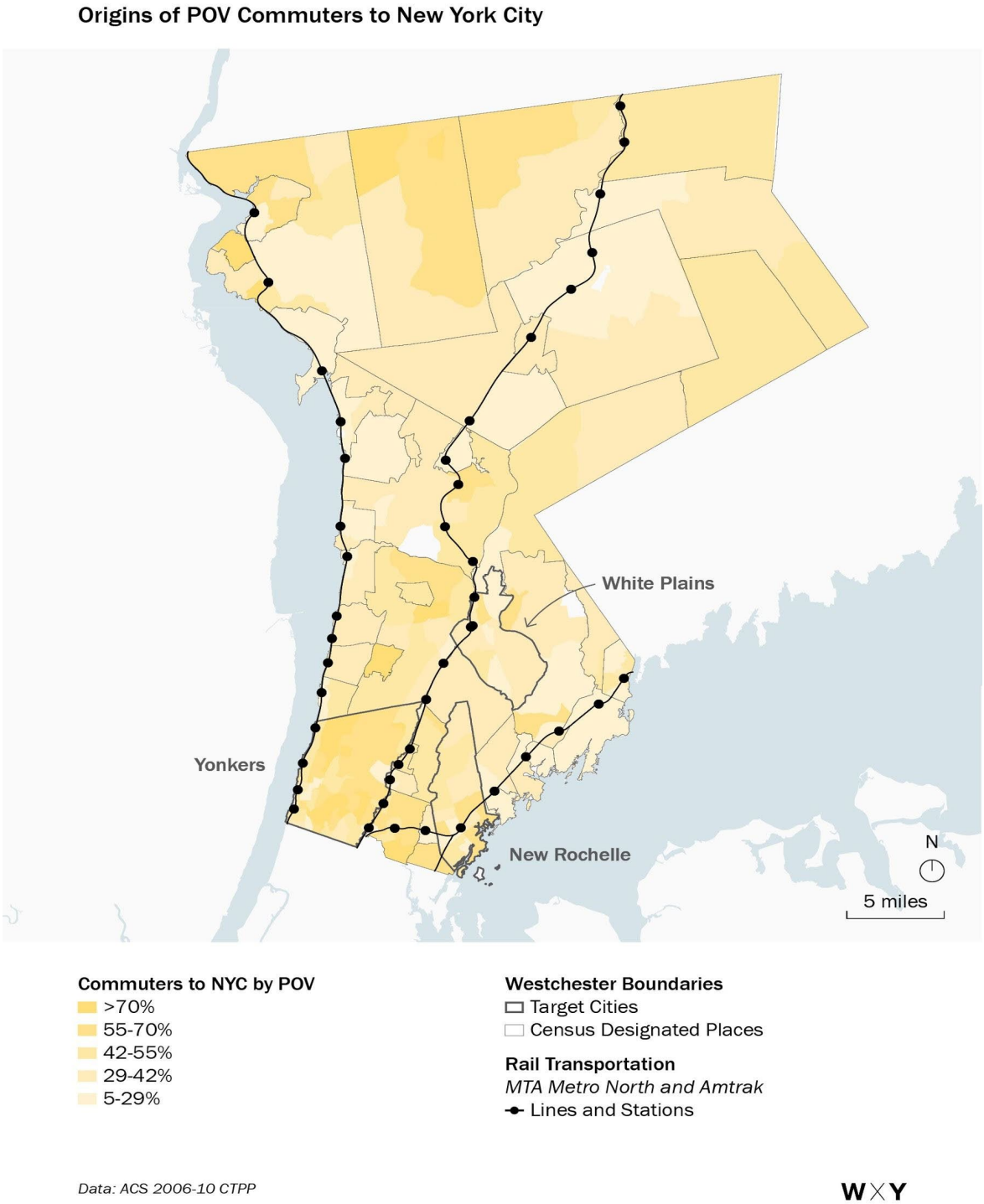
Data: ACS 2016 5-Year



A.3 New York City Privately Owned Vehicle Commuter Origins in Westchester

Figure A-2. New York City Privately Owned Vehicles Commuter Origins in Westchester County

Data: 2006-2011 CTPP



A.3 Travel and the Built Environment

Economic indicators like median income, household debt, and the cost of owning a vehicle tend to be more strongly associated with VMT than land use patterns or transit access.

Surveying residents of Transit-Oriented-Developments (TOD) in New Jersey, professor of transportation planning at UC Berkeley Daniel Chatman found that residents drove less not because of proximity to transit but because of a greater parking scarcity. Chatman found that households without off-street parking had 0.16 fewer cars per adult and those with low off- and on-street parking had 0.29 fewer cars per adult. Overall, his analysis found that residents of New Jersey TODs had 44% fewer cars than their suburban peers, an effect mostly "due to parking availability" (Chatman 2015).

At a national level, the effect is less pronounced. Meta-analyses examining the relation of density to VMT find a consistently weak effect. (Ewing and Cervero 2010, Knaap et al. 2017, Stevens 2017, Ewing and Cervero 2017). Generally, for every doubling of density, VMT is reduced by around 20%. These meta-analyses find similar (although usually weaker) relations to VMT for other characteristics of the built environment, such as distance to downtown, intersection density, land-use mix, and job accessibility by transit. The combined effect of these "D-variables" may be large. However, it is equally likely that they are so strongly spatially correlated with one another as to be showing the same effect.

As such, if transportation planners seek to make more-than-modest reductions in VMT, economic tools in addition to design tools will be required. One way to increase the cost of parking is to eliminate—or reduce—minimum parking requirements.

A.4 Automobile Loans

According to the New York Federal Reserve, the volume of automobile loans has grown significantly since 2008, more than a third of which (Figure A-3) have gone to borrowers with a credit score less than 620. Loans to these low-credit borrowers are commonly delinquent after ninety days, averaging 7.5% between 2008 and May 2017 (Figure A-4) and climbing to a rate of nearly one in nine in early 2009.

Figure A-3. Volume of Automobile Loans by Credit Score Borrower

Data: New York Federal Reserve

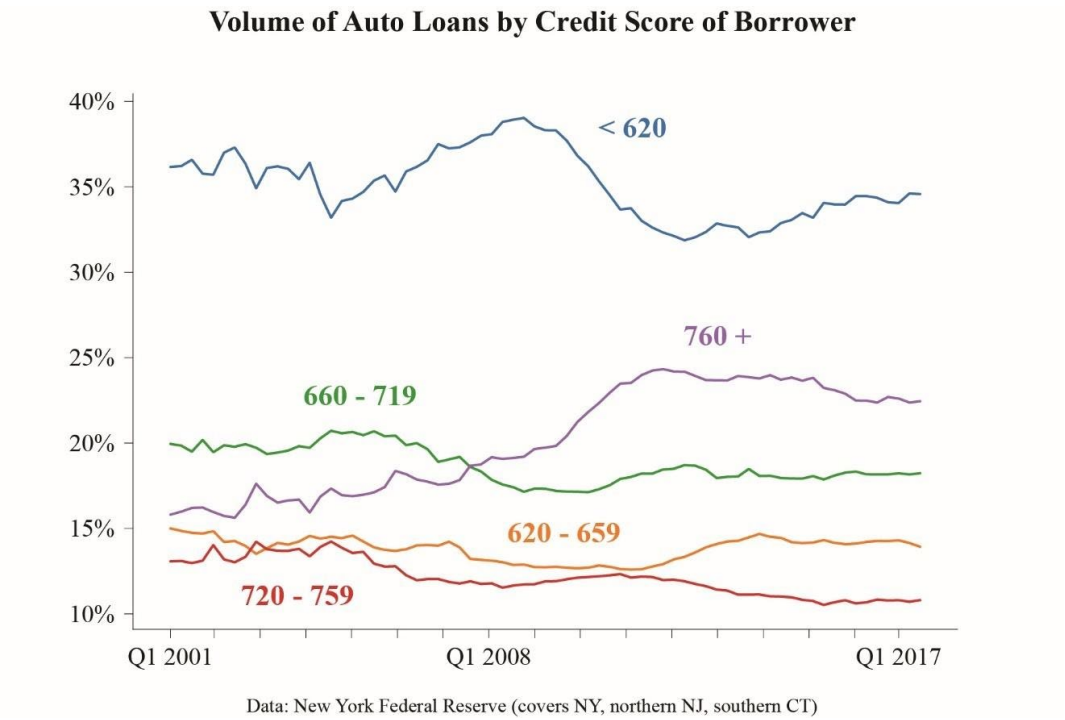
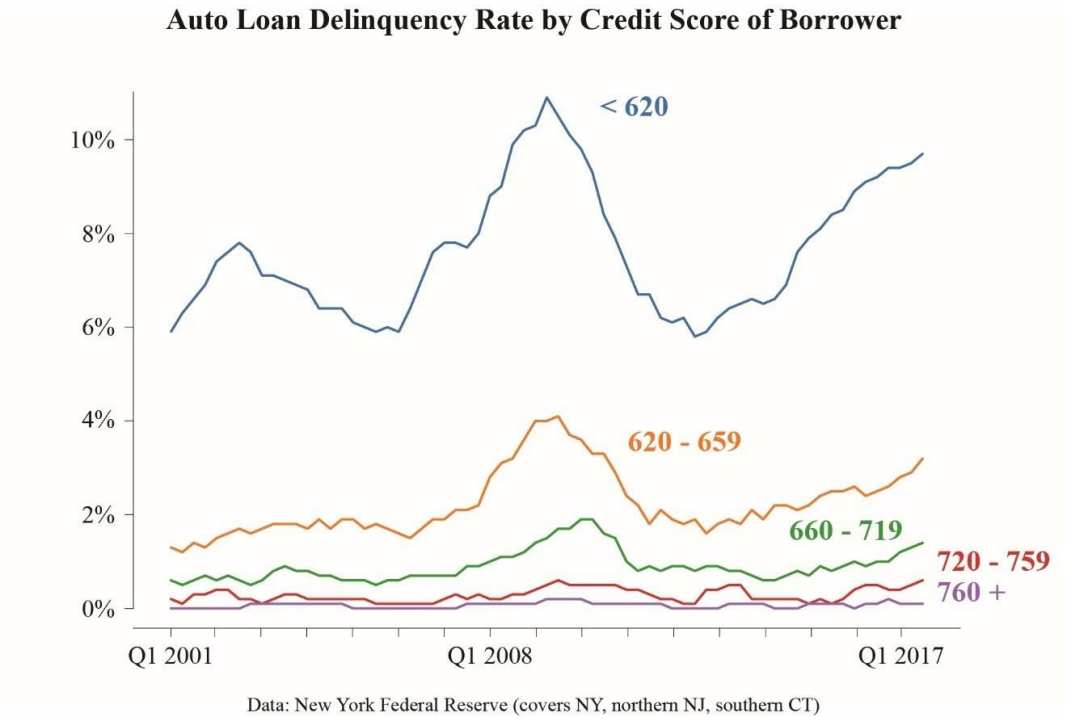


Figure A-4. Automobile Loan Delinquency Rate by Credit Score Borrower

Data: New York Federal Reserve



Together, these data suggest that many Westchester County low-income residents prefer other modes of transportation (POVs, in particular) to buses. While we may encourage public transit use for its ability to move many people compactly and at a lower environmental cost, public transit is not a perfect substitute for the personal auto and many low-income individuals find themselves in a mobility vacuum.

A host of mobility options are available to the residents of Westchester County. Beyond the personal car, residents can get around by train, bus, carpool, rideshare, carshare, bike, bike share, hired car (taxi, Uber, Lyft, et al.), or simply by foot. Understanding this landscape helps us identify where service gaps exist, and which transit modes are most suited to fill them.

Research by the Shared Use Mobility Center suggests that drivers are more likely to sell or postpone purchasing a car if they have access to more modes of transportation.[233] As such, filling these service gaps can provide residents with more mobility, while reducing the number of cars on the road.

Beyond increasing customer choice, a richer transportation landscape can also allow transit agencies to provide better and more efficient service, while reducing greenhouse gas emissions (GHG). If alternate modes like carshare, walking, biking, or hired car fulfill less-common trips, transit agencies can increase frequencies on their most popular routes, improving their service and farebox recovery.

A.5 Interview Questions for Developers

A.5.1 Management and Parking

1. How many units are in the building? What is the estimated number of residents?
2. Who manages the building? The owner or a second party operator?
3. How many units of parking are there?
4. Is parking offered in garages or lots?
5. How is parking managed (Valet, self-park, assigned)?
6. What is the cost to rent a parking spot per month/year?
7. Do residential units have multiple vehicles?
8. Is parking in high demand? Is there a waitlist for parking?
9. Would you be interested in providing carshare as an amenity for your building?
10. How many spaces would you be willing to offer or rent for carshare?

A.5.2 Residents

1. How do you contact your residents (Email, App, Mail)?
2. Are there any resident portals where a carshare program could be advertised?
3. Do you have any regular resident meetings or gatherings?
4. Do you have a sense of the typical driving needs of residents?

A.5.3 Electric Vehicle Supply Equipment

1. Do you have EVSE in your parking garages? Or, has EVSE ever been requested?
2. What are the barriers to installing EVSE in your buildings? Would you invest in makeready and upgrades for EVSE? Have residents requested EVSE?

A.6 Interview Summaries

A.6.1 Jesse Batus, The Community Builders

- **Location**: *Schoolhouse Terrace*, 43 Ashburton Avenue, Yonkers, NY
- **Date**: March 15, 2018
- **Interview Notes**: Mr. Batus is the Senior Project Manager for the TCB Schoolhouse Terrace development project, which is a $63 million transformation of a Yonkers public housing development that will ultimately replace 14 obsolete buildings with 15 modern structures. The development is targeted to residents of the site's existing public housing as well as others seeking affordable housing in the city. In its first phase, the development has completed two multifamily structures—a 50-unit building for low-income seniors and another 70-unit building for low-income families. Mr. Batus identified two parking areas that are likely candidates for EV carsharing and discussed potential use cases, including worker transportation to Ridge Hill mall, school drop-offs, and occasional errands by building staff.

A.6.2 Gary Friedland, Wilder Balter

- **Location**: *Chappaqua Crossing*, 480 Bedford Road, Chappaqua, NY
- **Date**: May 10, 2018

Interview Notes: Mr. Friedland is Chief Operating Office of Wilder Balter Properties, a developer of senior housing as well as affordable multifamily and luxury communities throughout the Hudson Valley, Long Island, and Connecticut. Wilder Balter is a co-developer and property manager for Chappaqua Crossing, a mixed-use reimagining of the former Reader's Digest campus in Chappaqua, NY. Office/medical tenants include Northern Westchester Hospital health clinic and corporate headquarters for CareMount Medical, the largest independent multispecialty medical group in New York State.

Residential units are comprised of 64 affordable, workforce, and market-rate apartments in the cupola building of the former 100-acre Reader's Digest corporate campus. Included are 26 affordable units that were allocated via lottery. To be eligible for affordable housing units, households had to earn up to 40% or up to 60% of Westchester median income—$78,000 for one person or $111,400 for a family of four—depending on the size of the unit. The development also includes workforce units that are less expensive than market-rate and aimed at municipal employees as tenants. When completed, the development will also include a 40,000 sq. ft. Whole Foods and a Life Time, Inc. fitness location, as well as 500,000 sq. ft. of Class A office space. A shuttle to Chappaqua Metro-North station and a Bee Line bus help to bridge transit gaps for residents and employees.

A.6.3 Karyn Jordan, Bozzuto Group

- **Location**: *15 Bank,* 15 Bank Street, White Plains, NY
- **Date**: May 10, 2018

Interview Notes: Ms. Jordan is the Property Manager for the Bozzuto Group *15 Bank* market-rate rental property. Ms. Jordan was not certain if Bozzuto can re-purpose parking spaces designated for retail tenants for carshare due to limited parking availability. To gauge tenant interest in carsharing, she indicated that Bozzuto can implement a tenant survey through the Building Link concierge service. Typically, Bozzuto sees a 10 % response rate on surveys and items requesting a response. They tend to limit surveys to about five questions. If bigger, they will use Survey Monkey. Typically, they can send out a survey with 10-day turnaround. They have monthly events, but turnout is low if there are no refreshments. She also indicated that setting up a kiosk in the building lobby is also possible. Ms. Jordan said she can introduce the consulting team to her colleague Barbara at the other Westchester locations.

A.6.4 Jason Baker, City of Yonkers

- **Location**: Conference call
- **Date**: June 20, 2018

Interview Notes: Jason Baker is the Director of the City of Yonkers Office of Sustainability. Baker emphasized Yonkers commitment to substantially increasing the city EV fleet and with it, bringing about a corresponding increase in EVSE infrastructure. The majority of this increase would be for light vehicle fleet (SUVs, sedans, vans). The Yonkers municipal fleet currently includes five plug-in hybrid electric

vehicles (PHEV), deployed from the government center garage. These vehicles tend to be used by the planning, housing, and mayor's offices, and are managed and maintained by the city Department of Public of Works.

The city also has eleven existing Level 2 EVSE spread across two centrally located garages (four units at Buena Vista garage and seven at the Government Center Garage), all of which are open to the public. Baker emphasized cars used by city employees are generally used all day. Building inspectors, for instance, will use a municipal vehicle to make multiple stops around the city throughout the workday. Baker also noted that changes to policies that impact the selection of vehicles available to municipal workers could prompt opposition from public sector unions based on concerns about driver comfort.

While Baker stated that the city would review any proposals in good faith, he was doubtful that carsharing for the municipal fleet could meet city needs. According to Baker, the city would only consider carshare scenarios that would guarantee access to cars for designated times. Yonkers would, however, be interested in using carshare EVSE units for charging its own vehicles "in the wild." A final area of potential collaboration that Baker cited is in emergency use cases—where a Hurricane Sandy-type weather event could generate a need to dramatically increase the city fleet.

A.6.5 Ms. Kimberley Ryan, Battle Hill Houses

- **Location**: *Battle Hill Houses,* 13–15 Harmon Street, White Plains, NY
- **Date**: May 10, 2018

Interview Notes: Kimberley Ryan is the property manager for *Battle Hill Houses*, an all-affordable development managed by a subsidiary of Wilder Balter Partners. The building is located on a hill, distant from transit. Its 49 units are largely 1 and 2 bedrooms and the majority of its residents are over 55 years old. Ms. Ryan reports that a significant share of residents have some physical disability or mobility impairment. The site has a 16-car garage, with two spaces currently vacant. Few residents own cars so building staff also park their vehicles in the garage. Ms. Ryan herself is an auto-commuter who drives in from Manhattan each day. For the residents who own cars, vehicle trip use cases cited by Ms. Ryan include medical appointments, grocery shopping, and family visits.

A.6.6 Peter McCartt, Director of Energy Conservation and Sustainability, Office of the Westchester County Executive

- **Location**: Conference call
- **Date**: August 3, 2018

Interview Notes: Peter McCartt is the Director of Energy Conservation and Sustainability for the Westchester County Executive. Westchester County has purchased 40 plug-in electric vehicles and 78 articulated hybrid electric buses. The county has also obtained grant funding for charging stations to meet its fleet charging needs. Because the county has the infrastructure and personnel to store, service, and repair all of its own vehicles, the merged Department of Public Works and Department of Transportation typically owns and maintains its fleet and is unlikely to embrace carsharing scenarios, according to McCartt.

Other challenges for the county include logistics and service reliability. Most county vehicles are deployed from White Plains, the county seat. The county also has fleet vehicles that operate in New Rochelle and Yonkers. Sedans are typically used by social workers, inspectors, and managers to make site visits. The vehicle-miles-traveled for vehicles deployed in southern Westchester is relatively low, but the round-trip route lengths for fieldwork in the northern part of the county are significantly greater. As such, it is likely that EVs would be more appropriate for the southern half of the county than the its northern reaches.

Identifying a central location that could best serve all potential users of county vehicles would be difficult, according to McCartt. No matter where they are domiciled, ensuring continuity of service and vehicle availability would be decisive in determining the viability of this approach for county government. For McCartt, more exploration on this opportunity is however warranted.

A.6.7 Luiz Aragon, Commissioner of Development, City of New Rochelle

- **Location**: 515 North Avenue, New Rochelle, NY 10801
- **Date of call:** May 9, 2018. **Site visit:** May 16, 2018

Interview Notes: Luiz Aragon Planning Commissioner for the City of New Rochelle presides over a surge in residential and commercial development in the city. In 2015, due in great part to his leadership, four leased Nissan Leaf EVs were added to the fleet and two charging stations were installed by the city–one at City Hall and the other at the New Roc City garage. Today, the fleet features seven EVs, but the number of passenger cars is still insufficient, so some staff use their personal vehicles while on city business.

Commissioner Aragon is optimistic about the benefits that a joint residential-municipal carsharing program could offer the city, stating that it could alleviate stress on the existing fleet while reducing maintenance costs and enabling a more efficiency. However, Aragon cautioned that several hurdles would need to be overcome: (1) integrating such a service into the fleet and (2) meeting the logistics needs of nonemergency agencies.

At a minimum, the city would require guaranteed access whenever a city employee might need a vehicle to carry out their duties. While some city agencies have only an occasional and ad hoc need for transportation, others—such as the Bureau of Buildings—require access to a vehicle every day, primarily between the hours of 8:30 a.m. to 4:30 p.m. Worker comfort and familiarity are also concerns. Compact cars, for instance, can be challenging for drivers accustomed to SUVs or full-size sedans. Obtaining initial buy-in from the municipal workforce would be important since carsharing is disruptive to the current fleet operation and workers may be unfamiliar with some EV models.

To validate the carshare model and minimize challenges, New Rochelle would require relevant data from a similarly sized city or a pilot fleet with a sufficient sample size. Absent a municipal pilot, it will likely be difficult to persuade New Rochelle (or any city its size, for that matter) to adopt a joint EV carsharing strategy on a scale that would be meaningful. Mr. Aragon did, however, cite noncritical, scheduled maintenance of current fleet vehicles as a possible but limited use case, especially since it would enable the municipality to take advantage of off-peak hours.

Mr. Aragon suggested that the downtown location of the New Rochelle City Hall (which will replace the current city hall and is expected to be completed in 2021) could offer an ideal site for a joint residential/municipal carshare operation. The city hall building will be located on Main Street in a planned 45 story, mixed-use tower featuring residential, commercial, and municipal space and a four-story parking garage. Whether this development will be completed within a useful time frame for the first stage of a carshare pilot remains to be seen, however.

Mr. Aragon also recommended a surface lot on Maple Avenue, six blocks from the planned location of the new city hall. While this property will soon adjoin a new multifamily development, it is currently in a low-density neighborhood that is unlikely to offer the rates of utilization needed to sustain a carshare initiative.

A.6.8 Joseph Graziose, Jared Dworkin, RXR

- **Location**: Conference Call
- **Date**: May 7, 2018

Interview Notes: Joseph Graziose is RXR's Project Executive *587 Main*, a mixed-use development now under construction in downtown New Rochelle. As of the date of this call, 587 Main had the concrete topped off and the building facade was under construction. The target date for completion is February 1, 2019. The building has 280 units and features a community theater, four retail spaces and an attended garage with just under 300 spaces. The likely tenant mix at 587 Main will include millennials and empty nesters. Because the property is the furthest residential building in the city from the New Rochelle train station, it is likely that car ownership will be high. One challenge regarding carshare implementation at this property is that residents will not have direct access the garage—a valet brings tenants their vehicles. The attended garage model could add a layer of cost and complexity since it requires that the attendant have access to the carshare vehicle to both retrieve and store the vehicle. In the case of EVs, this would mean that the attendant would also be responsible for plugging in and disconnecting the carshare vehicle.

RXR has large residential developments in its pipeline in Yonkers but these locations are well served by public transportation. The first phase of RXR's Larkin Plaza, a 439 unit mixed-income development (90–10) with a 530-space garage, is scheduled to open in November 2018.

A.6.9 Ron Kamen, EarthKind Energy and Sustainable Westchester

- **Location**: Conference call
- **Date**: August 2, 2018

Interview Notes: Ron Kamen is principal at EarthKind, a consulting firm that advises Sustainable Westchester, a collaboration of Westchester County local governments that empowers municipal leaders, concerned citizens, businesses, and local organizations to partner in the development of sustainability initiatives and share resources for healthy, vibrant, and attractive communities. Ron offered guidance on carshare deployment opportunities in Westchester, directing the project team to Wilder Balter's *Chappaqua Crossing* development which he felt was especially appropriate due to its distance from transit and its mixed-use elements.

A.6.10 Katherine Kelman and Jonathan Cordell, L + M Development Partners

- **Location**: Conference call
- **Date**: April 10, 2018

Interview Notes: L + M is a 34-year-old developer of quality, affordable, mixed-income, and market-rate housing throughout the New York metro area. Katherine Kelman, Associate Director and Jonathan Cortell, Vice-President at L + M Development offered their perspectives on opportunities for implementing EV carsharing on their property. Cortell cited the Warburton Riverview at 49 North Broadway in Yonkers, which offers off-site parking for 78 vehicles at the Warburton Garage, a public-private partnership that is controlled by the City of Yonkers. Cortell felt the garage would make a plausible location but stated the municipal administers the property. Ms. Kelman stated EV carshare would be more appropriate for projects developed by an associate developer, Wilder Balter.

Endnotes

[1] Donald Shoup, "The High Cost of Free Parking," Routledge, 2017.

[2] The same is true of buses. Transit providers can cut their most inefficient lines and improve service on those that are most popular by serving irregular trips with shared mobility services rather than traditional fixed-route bus services.

[3] Shaheen, Susan. "Carsharing Trends and Research Highlights." Berkeley Transportation Research Center. May 31, 2017. https://www.epa.gov/sites/production/files/2017-06/documents/05312017-shaheen.pdf

[4] Shaheen, S. and Cohen, A. "North American Membership Growth; North American Vehicle Growth." UC Berkeley Transportation Research Center. May 20,2017.

[5] Shaheen, S., Cohen A., and Jaffe, M. "Carsharing Outlook: Carsharing Market Overview, Analysis, and Trends." UC Berkeley Transportation Research Center. January 2018.

[6] Shaheen, S., Cohen A., and Jaffe, M. "Carsharing Outlook: Carsharing Market Overview, Analysis, and Trends." UC Berkeley Transportation Research Center. January 2018.

[7] Shaheen, S. and Cohen, A. "North American Membership Growth; North American Vehicle Growth." UC Berkeley Transportation Research Center. May 20,2017.

[8] Shaheen, S. and Cohen, A. "Impacts of Shared Mobility." UC Berkeley Institute of Transportation Studies. 2018. http://innovativemobility.org/wp-content/uploads/UCB-ITS-PB-2018-02_SharedMobilityImpacts.pdf

[9] Guzman, G, G. "Household Income: 2016." American Community Survey Briefs. September 2017. https://www.census.gov/content/dam/Census/library/publications/2017/acs/acsbr16-02.pdf

[10] Bureau of Labor Statistics. "Consumer Expenditures in 2016." April 2018. https://www.bls.gov/opub/reports/consumer-expenditures/2016/pdf/home.pdf.

[11] Research from the National Bureau of Economic Research surveyed Americans in 2011 and found than a quarter could not come up with $2,000 in the event of an emergency.
Lusardi, Annamaria et al. "Financially Fragile Households: Evidence and Implications." National Bureau of Economic Research. May 2011. http://www.nber.org/papers/w17072.pdf

[12] This number comes from Inrix, a transportation analytics firm. Their study suggests that driving in NYC is more expensive primarily because of higher parking costs–in the form of payments, lost productivity sitting in congestion, overpayments, fines, and additional fuel/carbon costs–accounting for $12,000 of annual costs.
"New INRIX Study Finds Parking is the Largest Cost of Driving." Press Releases. Published April 8, 2018. Retrieved July 11, 2018. http://inrix.com/press-releases/cod-us/

[13] In Westchester's dense southern cities, the costs of vehicle ownership may be similar to those in New York City, while in the County's suburban neighborhoods may have costs closer to the nationwide average.

[14] Shaheen, Susan. "Carsharing Models, Impacts + Latest Understanding", UC Berkeley Transportation Sustainability Research Center, 2015.

[15] This calculation is explained in more depth in the 'Carshare Savings' section in the Appendix.

[16] This paper will use the generation definitions proposed by the Pew Research Center. In that regard, Boomers are those born between 1946-64, Generation X are those born between 1965-80, Millennials are those born between 1981-96, and Gen Z are those born between 1997-2012. Gen Z already has people who are driving/potentially own a car. Dimock, M. "Defining generations: Where Millennials end and Generation Z begins." Pew Research Center. January 17, 2019. https://www.pewresearch.org/fact-tank/2019/01/17/where-millennials-end-and-generation-z-begins/

[17] Deloitte, "2014 Global automotive consumer study," p. 9. June 2014. https://www2.deloitte.com/content/dam/Deloitte/au/Documents/manufacturing/deloitte-au-mfg-2014-global-automotive-consumer-study-changing-nature-mobility-290914.pdf

[18] ACS 2016 5-Year.

[19] American Communities Survey 2016-1 year. "Table B08006: Sex of Workers by Means of Transportation to Work." Retrieved August 28, 2018. https://censusreporter.org/data/table/?table=B08006&primary_geo_id=01000US&geo_ids=01000US

[20] Jeff Davis, "VMT Hits Nominal High, Approaches All-Time Per Capita Mark", Eno Center for Transportation, February 23, 2017, Accessed June 15, 2018, https://www.enotrans.org/article/vmt-hits-nominal-high-approaches-time-per-capita-mark/

[21] Michael Manville, David A. King, and Michael J. Smart. "The Driving Downturn." Journal of the American Planning Association, January 2017.

[22] The calculations that follow are based on the dividing line indicated on Figure 1. This North-South divider was drawn along municipal boundaries that provide a relatively flat East-West line around the County's geographic North-South center.

[23] U.S. Census Bureau, Population Estimates Program (PEP), V 2016.

[24] U.S. Census Bureau, Population Estimates Program (PEP), V 2016.

[25] Westchester County Government, "Bee-Line Bus." http://transportation.westchestergov.com/bee-line

[26] U.S. Census Bureau, Population Estimates Program (PEP), V 2016

[27] These estimates come from Vishaan Chakrabarti's A Country of Cities, which cites the U.S. average exurban density at 0.7 to 1 dwelling units per acre, suburban density at 3-4 dwelling units per acre, and urban density at 30 or more dwelling units per acre. Chakrabarti, Vishaan. "A Country of Cities." New York, NY: Metropolis Books. 2013.

[28] Gray, Leslie, "6 Opportunity Areas Cities Can Pursue to Expand Shared Mobility", Shared Use Mobility Center, November 17, 2017, Accessed February 15, 2018, http://sharedusemobilitycenter.org/news/6-opportunity-areas-cities-can-pursue-to-expand-shared-mobility/

[29] Ibid.

[30] SUMC, "Toolkit Final Report," 2016, http://sharedusemobilitycenter.org/wp-content/uploads/2016/07/SUMC-Toolkit-Final-Report.pdf

[31] U.S. Census Bureau, American Community Survey (ACS) and Puerto Rico Community Survey (PRCS), 5-Year Estimates 2012-2016.

[32] The U.S. Census Bureau, American Community Survey uses income brackets that are specific at the lower end (less than $10,000, $10,000 to $14,999, etc.) but not specific at higher income levels ($150,000-$199,999) and they do not indicate specific median income above $250,000.

[33] ACS 2016 5 Year (S1901)

[34] ACS 2016 5 Year (S1901)

[35] ACS 2016 5-year.

[36] At the time of writing this report, Elliot Martin and Susan Shaheen's research on carsharing in North America was the most recent robust scientific study on the impacts of carshare. User trends in this industry have likely changed given the proliferation of carshare services since the research was published.

[37] Martin, E, W., Shaheen, S, "Greenhouse Gas Emissions Impacts of Carsharing in North America," IEEE Transactions on Intelligent Transportation Systems 12, No. 4, P. 1078, December 2011

[38] Race and ethnicity terms are as defined by U.S. Census, not the research team.

[39] Westchester County, "Population" https://planning.westchestergov.com/population-stats. Accessed November 14, 2019.

[40] Joint Center for Housing Studies of Harvard University. "The State of the Nation's Housing." 2017. https://www.jchs.harvard.edu/sites/default/files/harvard_jchs_state_of_the_nations_housing_2017_0.pdf

[41] Donelson, Dave. "Development Boom Strengthens Commercial Real Estate Market," Westchester Magazine, n.d. http://www.westchestermagazine.com/914-INC/Q2-2019/Westchester-Development-Boom-Signals-Health-Commercial-Real-Estate-Market/

[42] Same definition that the Pew Research Center and this paper use.

[43] Joint Center for Housing Studies of Harvard University. "The State of the Nation's Housing."

[44] McGuckin, N., Lynott, J, "Impact of Baby Boomers on U.S. Travel, 1969 to 2009," Washington, DC: AARP Public Policy Institute, October 2012.

[45] Ibid.

[46] Lynott, J., Figueiredo, C. "How the Travel Patterns of Older Adults Are Changing: Highlights from the 2009 National Household Travel Survey." Washington, DC: AARP Public Policy Institute. April 2011. https://assets.aarp.org/rgcenter/ppi/liv-com/fs218-transportation.pdf

[47] McGuckin N., Lynott, J, "Impact of Baby Boomers on U.S. Travel, 1969 to 2009," Washington, DC: AARP Public Policy Institute, October 2012. https://www.aarp.org/content/dam/aarp/research/public_policy_institute/liv_com/2012/impact-baby-boomers-travel-1969-2009-AARP-ppi-liv-com.pdf

[48] ACS 2016 5-Year.

[49] Fry, Richard. "Millennials are the largest generation in the U.S. labor force," Pew Research Center, April 11, 2018, http://www.pewresearch.org/fact-tank/2018/04/11/millennials-largest-generation-us-labor-force/

[50] "What's Coming on-line in Westchester Multifamily Rental Market." Admiral Real Estate Services, September 12, 2016, http://admiralrealestate.com/whats-coming-line-westchester-multifamily-rental-market/

[51] Matsuda, Akiko. "3 Mayors Detail Efforts to Attract Young Adults to Their Cities." LoHud, April 14, 2017. https://www.lohud.com/story/news/local/westchester/2017/04/14/westchester-mayors-millennial/100414106/

[52] Vasishta, Jeff. "The Balancing Act of Westchester Multifamily Building." The Real Deal, August 29, 2017. https://therealdeal.com/2017/08/29/the-balancing-act-of-multifamily-building/

[53] Brown, Jeffrey. "A Tale of Two Visions: Harland Bartholomew, Robert Moses, and the Development of the American Freeway." Journal of Planning History. February 2005, p. 3-8.

[54] State of California Department of Motor Vehicles. "Vehicle Definitions." https://www.dmv.ca.gov/portal/dmv/detail/online/fee_calc/vehdef. Accessed November 6, 2019.

[55] Aline B. Costa De Oliveira et al, "Bringing Electric Vehicles to Fruition in Westchester County, New York," Sustainable Westchester, Columbia University: Master of Science and Sustainability Management Program. Spring 2017., Accessed August 2018, http://sustainability.ei.columbia.edu/files/2017/05/Sustainable-Westchester-Capstone-Final-Report-Spring-2017.pdf

[56] "Governor Cuomo Announces 74 Percent Increase in Electric Car Sales Since Launch of Drive Clean Rebate in March." NYS State Office of Governor Andrew M. Cuomo. September 27, 2017. https://www.governor.ny.gov/news/governor-cuomo-announces-74-percent-increase-electric-car-sales-launch-drive-clean-rebate-march

[57] Sierzchula, W., Bakker, S.., Maat, K., van Wee, B. "The influence of financial incentives and other socio-economic factors on electric vehicle adoption." Energy Policy, Volume 68. May 2014. Pages 183-194. https://doi.org/10.1016/j.enpol.2014.01.043

[58] Galizia, M., Hochster, E. "Financing Electric Vehicle Markets in New York and Other States." Clean Energy Finance Forum / Yale Center for Business and the Environment. June 5 2015. Retrieved August 2 2018. http://cbey.yale.edu/files/YALE-CBEY-EVSE%20PAPER_FINAL.pdf

[59] "Governor Cuomo Announces New Campaign to Install Charging Stations and Promote Electric Vehicle Use Across New York State." NYS State Office of Governor Andrew M. Cuomo. March 6, 2017. https://www.governor.ny.gov/news/governor-cuomo-announces-new-campaign-install-charging-stations-and-promote-electric-vehicle

[60] EV HUB. "Evaluate." Evaluate NY. https://www.atlasevhub.com/materials/evaluate/. Accessed November 14, 2019.

[61] CJI Research Corporation. "Bee-Line System 2016 On-Board Passenger Survey." Westchester County Department of Public Works and Transportation. November 2016, p.18 https://transportation.westchestergov.com/images/stories/Planning/2016PassSurvey.pdf

[62] Bus ridership even dropped during the recession, from its peak in 2008. Ridership briefly rose again after the recession, peaking in 2012, but has since fallen again. Between 2008 and 2015, bus ridership declined by 350 million annual rides, according to ACS 2005-2015 data.

[63] Westchester Taxi and Limousine Commission. "List of Base Stations." Westchester.gov. May 30 2018. Retrieved August 2018. https://tlc.westchestergov.com/images/stories/pdfs/baseStations201808.pdf
Data analysis conducted by the study-team.

[64] Of the 318 taxi and limousine services licensed to operate in Westchester County, only 20 included the word 'taxi' and did not also include the word 'limo' (and by extension, 'limousine') in their name.

[65] Lader, C., Klein, N. "Westchester County Bee-Line System First and Last Mile Connections Mobility Study." Westchester County Department of Public Works and Transportation, Planning Division. February 2018. Accessed June 2018. https://nytransit.org/images/First_Last_Mile_Final_Report_-_February_2018_1.pdf

[66] Kulkarni, Rohit. "Uber and Ride-Sharing: The $650 Billion Question." SharesPost. 2017. http://media.cygnus.com/files/base/MASS/document/2017/01/SharesPost-Ride-Sharing-Uber-Lyft-Research-Report.pdf

[67] Henao, Alejandro. “Impacts of Ridesourcing – Lyft and Uber – on Transportation Including VMT, Mode Replacement, Parking, and Travel Behavior.” University of Colorado. 2017. http://digital.auraria.edu/content/AA/00/00/60/55/00001/Henao_ucdenver_0765D_10823.pdf

[68] Clewlow, R., Mishra, G., “Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-Hailing in the United States.” Institute of Transportation Studies University of California, Davis . 2017. Research Report UCD-ITS-RR-17-07.

[69] Clewlow and Mishra: “24% of ride-hailing adopters in metropolitan areas use a ride-hailing service on a weekly or daily basis,” 37% of respondents used ride-hailing services to avoid parking, and 33% of respondents used ride-hailing services to avoid drinking when driving.

[70] CJI Research Corporation. “Bee-Line System 2016 On-Board Passenger Survey.”

[71] Clewlow and Mishra.

[72] Rayle et al. “App-Based, On-Demand Ride Services: Comparing Taxi and Ridesourcing Trips and User Characteristics in San Francisco.” University of California Transportation Center University of California, Berkeley. November 2014. https://www.its.dot.gov/itspac/dec2014/ridesourcingwhitepaper_nov2014.pdf

[73] U.S. Census ACS 2016 5-Year.

[74] New Rochelle. "EnvisionNR. " https://www.newrochelleny.com/944/EnvisioNR Accessed November 14, 2019.

[75] “White Plains Transit District Strategic Plan Final Report.” Final Report. December 2016. https://www.cityofwhiteplains.com/DocumentCenter/View/2296/White-Plains-Transit-District-Strategic-Plan

[76] Ibid.

[77] ACS 2016 5-Year.

[78] Mayor Mike Spano, “2018 State of the City: Yonkers,” March 14, 2018, http://www.yonkersny.gov/government/mayor-s-office/state-of-the-city.

[79] Mayor Mike Spano. “City of Yonkers Green Development Workbook.” September 2014. http://www.yonkersny.gov/home/showdocument?id=10836

[80] Hughes, C.J. “A Flurry of Development Hits Westchester”. August 8, 2017 https://www.nytimes.com/2017/08/08/realestate/commercial/westchester-development.html

[81] NYMTC / NJMTA. “2010-11 Regional Household Travel Survey: Final Report.” October 2014. , https://www.nymtc.org/portals/0/pdf/RHTS/RHTS_FinalReport%2010.6.2014.pdf. Accessed September 2018.

[82] NYCMTC / NJMTA. “2010-11 Regional Household Travel Survey.”

[83] Buckhardt, J., Millard-Ball, A. “Who is Attracted to Carsharing?” Transportation Research Record: Journal of the Transportation Research Board, No. 1966. January 1, 2006. pgs. 98-105.

[84] Private School Review. “Top Westchester County Private Schools.” https://www.privateschoolreview.com/new-york/westchester-county, Accessed October 30, 2018.

[85] Niche. “Best Charter Schools in Westchester County.” https://www.niche.com/k12/search/best-charter-schools/c/westchester-county-ny/, Accessed October 30, 2018.

[86] New York State Education Law Section 3635.

[87] Valant, J., Lincove, J., “The barriers that make charter schools inaccessible to disadvantaged families.” Brown Center Chalkboard. March 16, 2018 https://www.brookings.edu/blog/brown-center-chalkboard/2018/03/16/the-barriers-that-make-charter-schools-inaccessible-to-disadvantaged-families/.

[88] LeaMond, Nancy A. “Moving forward: Mobility Options are Key Element of Livable Communities.” Where We Stand, AARP Blog. July 31, 2018. https://blog.aarp.org/2018/07/31/moving-forward-mobility-options-are-key-element-of-livable-communities/

[89] “Demographic Shifts: Shaping the Future of Car Ownership.” Knowledge@Wharton. February 21, 2017. http://knowledge.wharton.upenn.edu/article/demographic-shifts-shaping-future-car-ownership/#

[90] Kodransky, M., Lewenstein, G. “Connecting Low-Income People to Opportunity with Shared Mobility.” Institute for and Development Policy. December 2014. p. 5. https://itdpdotorg.wpengine.com/wp-content/uploads/2014/10/Shared-Mobility_Full-Report.pdf

[91] Hughes, C.J. “The multifamily wave continues to crest in Westchester.” The Real Deal. January 4, 2018. https://therealdeal.com/issues_articles/the-multifamily-wave-continues-to-crest-in-westchester/.

[92] “What’s Coming On-Line in the Westchester Multifamily Rental Market”, Admiral Real Estate Services Blog, September 12, 2016.

[93] The City of White Plains. “52 North Broadway.” https://www.cityofwhiteplains.com/706/52-North-Broadway, Accessed September 12, 2018.

[94] Hughes, C.J. “A Flurry of Development Hits Westchester.” New York Times. August 8, 2017. https://www.nytimes.com/2017/08/08/realestate/commercial/westchester-development.html

[95] Ibid.

[96] Cary, Bill. “The Rental Rush.” The Real Deal. February 2019. https://therealdeal.com/issues_articles/westchester-multifamily-market/

[97] Ibid.

[98] Ibid.

[99] Martin, E, W., Shaheen, S, “Greenhouse Gas Emissions Impacts of Carsharing in North America,” IEEE Transactions on Intelligent Transportation Systems 12, No. 4, P. 1078, December 2011.

[100] The study team suggests avoiding the use of educational attainment as a metric for selecting sites suitable for residential carshare: educational attainment is strongly correlated with both income and vehicle ownership; as such, including it weakens the desired effect of household income and vehicle ownership in our selection calculus.

[101] NYMTC / NJTPA. “2010/2011 Regional Household Travel Survey.” p. 111-3.

[102] Buckhardt, J., Millard-Ball, A. “Who is Attracted to Carsharing?”.

[103] Office buildings are divided into three classes: A, B, and C with their definitions defined relative to other buildings in the area. Class A buildings are generally the most attractive and luxurious office space, usually in a central business district or prominent location, with high quality architecture and construction, and typically with a professional manager. Class A will typically yield the highest rents. Class B buildings are generally older than Class A buildings but still have good amenities, are well maintained and functional. They could targeted for investment and restored to Class A. Class C are buildings is the lowest grade and are generally older buildings located in less desirable areas that may only yield low rent or have high vacancy rates.

[104] Bolloré Electricity Storage and Systems. “Blue Applications.” https://www.bollore.com/en/activites-et-participations-2/stockage-delectricite-et-systemes/blue-applications/, Accessed August 12, 2018.

[105] Ibid.

[106] "Electromobility in the Netherlands – Highlights 2014." Netherlands Enterprise Agency. April 2015. https://www.rvo.nl/sites/default/files/2015/04/Electromobility%20in%20the%20Netherlands%20Highlights%202014.pdf

[107] “Electric selfdrive launched for UAE.” Smart Cities World. November 28, 2018. https://www.smartcitiesworld.net/transport/transport/electric-selfdrive-launched-for-uae.

[108] “BMW Group extends car-sharing programme and launches enhanced mobility services in Seattle under the new brand name ‘ReachNow’.” BMW Group. August 4, 2016. https://www.press.bmwgroup.com/global/article/detail/T0259003EN/bmw-group-extends-car-sharing-programme-and-launches-enhanced-mobility-services-in-seattle-under-the-new-brand-name-%E2%80%9Creachnow%E2%80%9D?language=en, Accessed August 12, 2018.

[109] Burke, Katie. “GM’s Maven Drives Interest in Chevy Bolt.” Automotive News. September 10, 2017. http://www.autonews.com/article/20170910/MOBILITY/170919953/maven-chevy-bolt-popularity.

[110] Cambier, Claire. “Places de stationnement et bornes Autolib' : que vont-elles devenir.” LCI. October 10, 2018. https://www.lci.fr/automobile/places-de-stationnement-et-bornes-autolib-que-vont-elles-devenir-paris-bollore-anne-hidalgo-2096672.html.

[111] Feron, Sylvain. “A brief history of Autolib.” Paris Innovation Review. March 3, 2016. http://parisinnovationreview.com/articles-en/a-brief-history-of-autolib.

[112] Autolib. https://www.autolib.eu/. Accessed October 12, 2018.

[113] Roller, Kevin. “Allez les Bleus! Car2Go Débarque a Paris.” Car2Go. October 2, 2018. https://blog.car2go.com/2018/10/02/allez-les-bleus-car2go-kommt-nach-paris/.

[114] “Car2go - Amsterdam's innovative electric car-sharing scheme.” Eltis: The Urban Mobility Observatory. May 21, 2015. http://www.eltis.org/discover/case-studies/car2go-amsterdams-innovative-electric-car-sharing-scheme-netherlands.

[115] Tuinenberg, Paul. “User Involvement in Dutch Niche Experiments in the Transition Towards Electric Mobility.” Master Thesis, Utrecht University, Faculty of Geosciences. 2012.

[116] Kane, Mark. “Green Mobility To Expand Car Sharing Fleet In Denmark By 450 Renault ZOE.” Inside EVs. August 2, 2016. https://insideevs.com/green-mobility-expand-car-sharing-fleet-denmark-450-renault-zoe/.

[117] “BlueSG Launches Singapore’s First Large-Scale Electric Vehicle Car Sharing Programme Developed by the Bolloré Group.” December 12, 2017. https://www.bluesg.com.sg/news/bluesg-launches-singapores-first-large-scale-electric-vechicle-car-sharing-programme-developed

[118] Selfdrive. “Renault Zoe.” https://www.selfdrive.ae/rent-a-electric-car/renault-ZOE.php, Accessed August 12, 2018.

[119] Boagey, Rachel. “BlueCity to Spread Its Electric Fleet Across London.” Business Car UK. November 6, 2017. http://www.businesscar.co.uk/analysis/2017/bluecity-to-spread-electric-fleet-across-london.

[120] “BMW Group, in partnership with EVCARD, launches ReachNow car-sharing service in China.” BMW Group. January 12, 2017. https://www.press.bmwgroup.com/global/article/detail/T0276714EN/bmw-group-in-partnership-with-evcard-launches-reachnow-car-sharing-service-in-china?language=en.

[121] Colombo, Hayleigh. “Four years in, Blue Indy car-sharing service still stuck in the red.” Indianapolis Business Journal, August 2, 2019. https://www.ibj.com/articles/four-years-in-blue-indy-still-stuck-in-the-red

[122] Durish Cook, Amanda. ”BlueIndy EV Sharing Program Seeks Rebound.” RTO Insider. May 15, 2017. https://www.rtoinsider.com/blueindy-indianapolis-charging-stations-42909/.

[123] Profita, Cassandra. “Are The Car-Sharing And EV Revolutions Leaving Poor People Behind?” Oregon Public Broadcasting. September 15, 2017.

[124] Spacek, Rachel. “New L.A. car-sharing service aims to serve low-income neighborhoods.” The Los Angeles Times. June 9, 2017. https://www.latimes.com/business/la-fi-bluela-20170609-story.html

[125] https://greencommuter.org/chattanooga.

[126] As of August 23, 2019, the service is no longer running due to “unforeseen circumstances.” Green Commuter CHA. Twitter Post. https://twitter.com/gcCHATT/status/1164938854782177280. Accessed November 14, 2019.

[127] Levy, Nat. “ReachNow installs new BMW electric car chargers on street lamps throughout Seattle.” GeekWire. May 15, 2017. https://www.geekwire.com/2017/reachnow-installs-new-bmw-electric-car-chargers-street-lamps-throughout-seattle/.

[128] Bureau of Labor Statistics. “Consumer Expenditures - 2018.” News Release. September 10, 2019. https://www.bls.gov/news.release/pdf/cesan.pdf. Accessed November 14, 2019.

[129] Sacramento Metropolitan Air Quality Management District. “Sacramento AQMD Launches State’s First electric Vehicle car Share Program for Disadvantaged Communities.” Press Release. May 5, 2017. http://www.airquality.org/Communications/Documents/CarShare%20Press%20Release%20FINAL%202017.pdf.

[130] Profita, Cassandra. “Are The Car-Sharing And EV Revolutions Leaving Poor People Behind?”

[131] Spacek, Rachel. “New L.A. car-sharing service aims to serve low-income neighborhoods.”

[132] ABM, AllCom Electric, Bryan Electric Quotes solicited by Barretto Bay Strategies, June 2016 for 4545 Center Drive and 20 River Terrace proposed electric vehicle car-share projects

[133] “Mobility Services: The Customer Perspective, Accenture,” September 17, 2019, https://www.accenture.com/_acnmedia/PDF-109/Accenture-Mobility-Services.pdf#zoom=50

[134] “Why driverless cars will mostly be shared, not owned,” The Economist, March 5, 2018, https://www.economist.com/the-economist-explains/2018/03/05/why-driverless-cars-will-mostly-be-shared-not-owned

[135] “Longer Term Investments Series: Smart mobility, UBS Financial Services,” March 11, 2019, https://www.ubs.com/global/en/wealth-management/chief-investment-office/investment-opportunities/digital-disruptions/2017/smart-mobility.html

[136] Ibid

[137] Ibid

[138] “*Ford CEO Tamps Down Expectations for First Autonomous Vehicles,”* Bloomberg, April 19, 2019, https://www.bloomberg.com/news/articles/2019-04-09/ford-ceo-tamps-down-expectations-for-first-autonomous-vehicles

[139] “*Automakers Are Rethinking the Timetable for Fully Autonomous Cars*”, Design News, May 17, 2019, https://www.designnews.com/electronics-test/automakers-are-rethinking-timetable-fully-autonomous-cars/93993798360804

[140] City of New Rochelle. “CircuitNR.” https://www.newrochelleny.com/circuitnr. Accessed November 11, 2019.

[141] City of New Rochelle. “GreenNR - the New Rochelle Sustainabilty Plan 2010-2030.” April 2011. p. 16; https://www.newrochelleny.com/DocumentCenter/View/2054/GreeNR?bidId=.

[142] Interview with Luiz Aragon, May 16, 2018.

[143] Ibid.

[144] Sieminsky, Barb. “White Plains, NY Designated Green Community The Municipal. September 15, 2017. http://www.themunicipal.com/2017/09/white-plains-n-y-designated-clean-energy-community/.

[145] Ibid.

[146] “Bike White Plains.” City of White Plains official website. https://www.cityofwhiteplains.com/CivicAlerts.aspx?AID=652.Accessed November 14, 2019.

[147] “N.Y. Power Authority Announces $400,000 in Clean Energy and Transportation Projects for the City of Yonkers.” NYPA press release. November 16, 2017. https://www.nypa.gov/news/press-releases/2017/20171116-nypa-yonkers-clean-energy.

[148] Interview with Jason Baker, June 20, 2018.

[149] An expanded EVSE footprint could encourage the County of Westchester to also increase EVSE usage and to pursue a larger, county-wide program, with implications for other municipalities.

[150] Interview with Ron Kamen, August 2, 2018.

[151] Interview with Peter McCartt, August 3, 2018.

[152] Shaheen, Susan. “Carsharing Models, Impacts + Latest Understanding.” UC Berkeley Transportation Sustainability Research Center. 2015.

[153] U.S. Census Bureau, American Community Survey (ACS) and Puerto Rico Community Survey (PRCS), 5-Year Estimates, 2012-2016.

[154] The model has been built to meet the objective set forth in the original proposal to NYSERDA, which is subsidized utilization by a building’s LMI tenants such that the cost of car-sharing is equally cost effective as competing modes—i.e. car service, transportation network company, etc. While there will clearly be variations based on raw numbers of licensed drivers and proportions of LMI vs. market-rate tenants in a property, the assumption is a conservative one anchored to the basic law of consumer demand—by lowering prices for one set of consumers, demand can be induced even if that set of consumers has less disposable income than their neighbors. Because the model is informed by a policy-based imperative—increasing transportation options for LMI residents—it is, however, inherently aspirational so it still must be tested in a pilot to be proven.

[155] NYMTC, NJTPA. “2010/11 Regional Household Travel Survey.” Final Report. October 2014. P.150: https://www.nymtc.org/portals/0/pdf/RHTS/RHTS_FinalReport%2010.6.2014.pdf;
Clipper Creek. “Electric Vehicle Charge Times/Miles Range per Hour.” https://www.clippercreek.com/wp-content/uploads/2017/12/SMUD_Charge-Times-Chart-20171208_Final_Low-Res.pdf

[156] Although Zipcar publishes annual reports, unlike for Avis and Hertz, it has been difficult to ascertain the line-by-line cost allocations.

[157] Avis Budget Group. “Our Brands.” https://avisbudgetgroup.com/brands/, accessed October 11, 2018.

[158] Investor Campus. “How to Analyze a Rental Car Company.” http://www.investorcampus.com/courses/thehowtoanalyseseries/commerceandindustry/howtoanalyseacarrentalcompanyfree/502.pdf. Accessed November 11, 2018.

[159] Avis’ depreciation costs represent 25% of Avis’ total revenues; we apply the same formula to high and low case total revenues.

[160] Zipcar New York/New Jersey Pricing Plans, https://www.zipcar.com/pricing

[161] Ransom, Jan. “Outsiders Welcomed, Rent Stabilized Tenants Banned at Upper West Side. Indoor Pool.” N.Y. DAILY NEWS. April 20, 2014. http://www.nydailynews.com/new-york/uptown/indoor-upper-west-side-pool-open-public-rent-stabilized-tenantsarticle-1.1752497

[162] Westchester County: The New Northern Frontier, Market Report Q4 2017, GFI Realty Services, January 2018.

[163] 101 Wolfs Lane. “Principles.” https://www.101wolfslane.com/create-needed-housing.html, Accessed October 2, 2018..

[164] Zipcar. “Zipcar releases new independent study on ‘urban boomers’.” May 18, 2015. https://www.zipcar.com/press/releases/urbanboomers2015.

[165] Ordinance Creating the Downtown Overlay Zone, City of New Rochelle, Off-Street Parking and Loading Zone Requirements, Section 331-126, November 25, 2015.

[166] Code of the City of New Rochelle, City of New Rochelle, Schedule of Parking and Off-Street Loading Requirements, Section 331-126.

[167] Dentel-Post, Colin. "Less Parking, More Carsharing: Supporting Small-Scale Transit-Oriented Development." Institute of Urban and Regional Development at the University of California, Berkeley. October 2012. https://escholarship.org/uc/item/374228kz

168 Filosa, Gina, "Carsharing: Establishing its Role in the Parking Demand Management Toolbox." Master's Thesis in Urban and Environmental Policy and Planning, Tufts University. May 2006. https://www.vtpi.org/filosa_carsharing.pdf

[169] Austin City Code, Section 25-6-601.

[170] Vancouver Parking By-Law No. 6059, Section 3.2.2.

[171] Filosa, p. 49.

[172] City of San Francisco Planning Code--carshare Controls, Ordinance #0286-10, August 17, 2010.

[173] Filosa, p. 52.

[174] California Planning and Development Report. "Project Finds The Formula To Build In Berkeley." April 1, 2003. http://www.cp-dr.com/articles/node-795,.

[175] Arlington County Commuter Services. "Arlington Carshare Program: 2006 Report." Arlington County Division of Transportation. June 15, 2006. https://1105am3mju9f3st1xn20q6ek-wpengine.netdna-ssl.com/wp-content/uploads/2012/01/Arlington-Carshare-Program-2006-Report.pdf.

176 Memo on Contract No. 9470 Amendment: City CarShare for City of Berkeley Fleet carshare Program, Dee Williams-Ridley, Interim City Manager, City of Berkeley, September 15, 2015.

[177] See Appendix 'Interview Summaries'.

[178] Dentel-Post, p. 24.

[179] Espino, J., Truong, V. "Electric Carsharing in Underserved Communities: Considerations for Program Success." Greenlining Institute. January 2015. p. 5. http://greenlining.org/wp-content/uploads/2015/01/Electric-Carsharing-in-Underserved-Communities-spreads.pdf

[180] Halls, Cassie. "Shared Mobility as an Equity Strategy." Presentation on behalf of the Shared Use Mobility Center at the 4th Annual Summer Conference on Livable Communities at Western Michigan U. in Kalamazoo. June 1-2, 2017. https://wmich.edu/sites/default/files/attachments/u883/2017/5-1%20Cassie%20Halls.pdf.

[181] Ibid.

[182] Shaheen, S., Bell, C., Cohen, A., Yelchuru, B. "Travel Behavior: Shared Mobility and Transportation Equity." Office of Policy & Governmental Affairs- Federal Highway Administration. August, 2017 p. 14. https://www.fhwa.dot.gov/policy/otps/shared_use_mobility_equity_final.pdf

183 Espino and Truong at p. 6.

[184] Cassie Halls, supra.

[185] Ibid.

[186] Shaheen, et al., Shared Mobility and Transportation Equity, supra, at pp. 18-19 and 25.

[187] Id. at pp. 22-23.

188 See Kodransky and Lewenstein, "Connecting Low Income People to Opportunities with Shared Mobility", Institute for Transportation and Development Policy, December 2014, pp. 12-19.

[189] Shaheen, et al., Shared Mobility and Transportation Equity, supra, at p. 23.

[190] Id. at p.13.

[191] Shaheen, et al., Shared Mobility and Transportation Equity, supra, at pp. 25-26.

[192] Ithaca Carshare. "Do I need to have a credit card?" Frequently Asked Questions. https://www.ithacacarshare.org/how/faq/. Accessed November 7, 2019.

[193] Shaheen et al., Shared Mobility and Transportation Equity, supra. at 27 (citing Cabanatuan, 2014).

[194] Ibid.

[195] Kodransky,Lewenstein, p. 14; citing Shaheen, Susan. 2010. Carsharing and Public Parking Policies: Assessing Benefits, Costs, and Best Practices in North America. Mineta Transportation Institute, San Jose University.

[196] Shaheen, et al., Shared Mobility and Transportation Equity, supra, at p. 28.

[197] Golden, Lonnie. “Irregular Work Scheduling and its Consequences.” Economic Policy Institute Briefing Paper. April 9, 2015, p.1. https://www.epi.org/files/pdf/82524.pdf

[198] Ibid.

[199] Id. at 30, Halls at 10.

[200] Shaheen, et al., Shared Mobility and Transportation Equity, supra, at p. 30.

[201] Id. at p. 31 (citing Wolff, 2015).

[202] Shaheen, et al., Shared Mobility and Transportation Equity, supra, at p. 31.

[203] Id. at 33 (citing Schwieterman and Spray, 2016).

[204] Id at p.33.

[205] Mahoney, Bill. “Insurance Issue Threatens Upstate carshare Service.” Politico. May 28, 2015. https://www.politico.com/states/new-york/albany/story/2015/05/insurance-issue-threatens-upstate-carshare-service-022490.

[206] Kodransky and Lewenstein at p. 22.

[207] Id. at 15 (citing Cockrey, 2004).

[208] Id. at pp. 14-15.

[209] Shaheen, et al., Shared Mobility and Transportation Equity, supra, at p. 33 (citing Snyder, 2014).

[210] Id. at p. 34.

[211] Kodransky and Lewenstein, p. 21(citing Feigon, 2014).

[212] Shaheen, et al., Shared Mobility and Transportation Equity, supra, at p. 34, (citing Mcgeehan, 2016).

[213] Shaheen, et al., Shared Mobility and Transportation Equity, supra, at p. 34 (citing Risen, 2016).

[214] Ibid.

[215] Espino and Troung at p. 11, citing others.

[216] Espino and Troung, supra at pp. 10-11.

[217] Ibid, citing Shaheen et al., 2016.

[218] There are two NYS taxes at play--a statewide special tax is 6% tax on state-only sales or use on the short-term rental of a passenger car and a special supplement tax is additional to the statewide 6% tax, and is a 5% special supplemental tax on all passenger car rentals where delivery occurs within the metropolitan commuter transportation district (MCTD), or when the car is rented outside but used within the MCTD. https://www.tax.ny.gov/pdf/tg_bulletins/sales/b14_825s.pdf

[219] Kodransky and Lewnstien, p. 22, citing Badger, 2012.

[220] Id. at p. 34.

[221] Id. at 34-35.

[222] Id. at p. 36 (citing Said, 2016).

[223] Id. at 36.

[224] Id. at p. 37.

[225] Id. at p. 40.

[226] Id. at 40.

[227] Dotson, J.,Blair, A. “Carsharing in a Small City: Ithaca Carshare’s First Two Years.” NYSERDA final report. March 2011. https://www.dot.ny.gov/divisions/engineering/technical-services/trans-r-and-d-repository/C-06-33%20Ithaca%20Carshare%20Final%20Report%20NYSERDA%20Agreement%209821.pdf

[228] Shaheen, et al., Shared Mobility and Transportation Equity, supra, at p. 42 (citing Gottlieb, 2015).

[229] Kodransky and Lewenstien at pp. 28-29.

[230] “Bike Share Strategic Business Plan Highlights.” Philadelphia. August 2013. https://www.phila.gov/bikeshare/Documents/Highlights.pdf

[231] This data only represents jobs in Westchester’s Census Designated Places (CDP). Looking at land use, relatively few commercial and office areas are not captured within a CDP. As such, we may expect these percentages to be slightly imprecise though accurate.

[232] U.S. Census Bureau (2015). American Community Survey 1-year estimates. Retrieved from Census Reporter Profile page for Westchester County, NY https://censusreporter.org/profiles/05000US36119-westchester-county-ny/.

[233] SUMC, "Toolkit Final Report." 2016. http://sharedusemobilitycenter.org/wp-content/uploads/2016/07/SUMC-Toolkit-Final-Report.pdf.

NYSERDA, a public benefit corporation, offers objective information and analysis, innovative programs, technical expertise, and support to help New Yorkers increase energy efficiency, save money, use renewable energy, and reduce reliance on fossil fuels. NYSERDA professionals work to protect the environment and create clean-energy jobs. NYSERDA has been developing partnerships to advance innovative energy solutions in New York State since 1975.

To learn more about NYSERDA's programs and funding opportunities, visit nyserda.ny.gov or follow us on Twitter, Facebook, YouTube, or Instagram.

New York State Energy Research and Development Authority

17 Columbia Circle
Albany, NY 12203-6399

toll free: 866-NYSERDA
local: 518-862-1090
fax: 518-862-1091

info@nyserda.ny.gov
nyserda.ny.gov

State of New York
Andrew M. Cuomo, Governor

New York State Energy Research and Development Authority
Richard L. Kauffman, Chair | Alicia Barton, President and CEO