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Assessing the Impacts of Increasing the Availability of Non-Automobile Modes of Transportation on Carbon Emissions and Accessibility in Worcester

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Note: This policy brief was written as an assignment for EN 101 (Environmental Science & Policy Introductory Case Studies) taught by Morgan Ruelle (PhD) in Spring 2023.

Introduction

Though there are countless ways in which people can get from one destination to another, including planes, boats, bikes, and even their own feet, no other mode of transit rules the United States quite like the personal vehicle. According to the United States Census Bureau, an outstanding 84.8% of respondents to the 2019 American Community Survey said that they go to work via a personal vehicle like a car or truck (Burrows et al., 2021). Most of these personal vehicle users also drove alone, with only 8.9% of respondents stating that they regularly carpooled to work (Burrows et al., 2021). These survey results become concerning when viewed in conjunction with facts from the Environmental Protection Agency (EPA) about the relationship between personal vehicles and greenhouse gas (GHG) emissions. The EPA reports that up to 28% of 2020 United States emissions came from the transportation sector, of which personal vehicles comprised the largest share (US EPA, 2023). GHG emissions from cars are the primary driver of human caused climate change, leading to negative impacts all around the planet.

The issues presented by climate change may seem too expansive to be handled on a local level, however, some of the most productive changes can be made from the bottom up. Using the city of Worcester, Massachusetts as an example, this moderately sized city of over 200,000 people has the power to make a real impact on emissions. Worcester is no different from anywhere else in the United States – it is car-dependent and is impacted by the changing climate. In 2018, the Worcester Regional Research Bureau released a report stating that 72% of commuters in Worcester got to work via a personal car, and an overwhelming majority of those car rides were short trips (5-29 minutes) (Worcester Regional Research Bureau, 2018). The warming of Earth's average temperature could also have harsh negative impacts on Worcester, one example being a higher risk of invasive species (USGS, 2023). In the past, Worcester has had major issues with invasive species like the Asian Long-Horned Beetle, so the city has a vested interest in countering climate change.

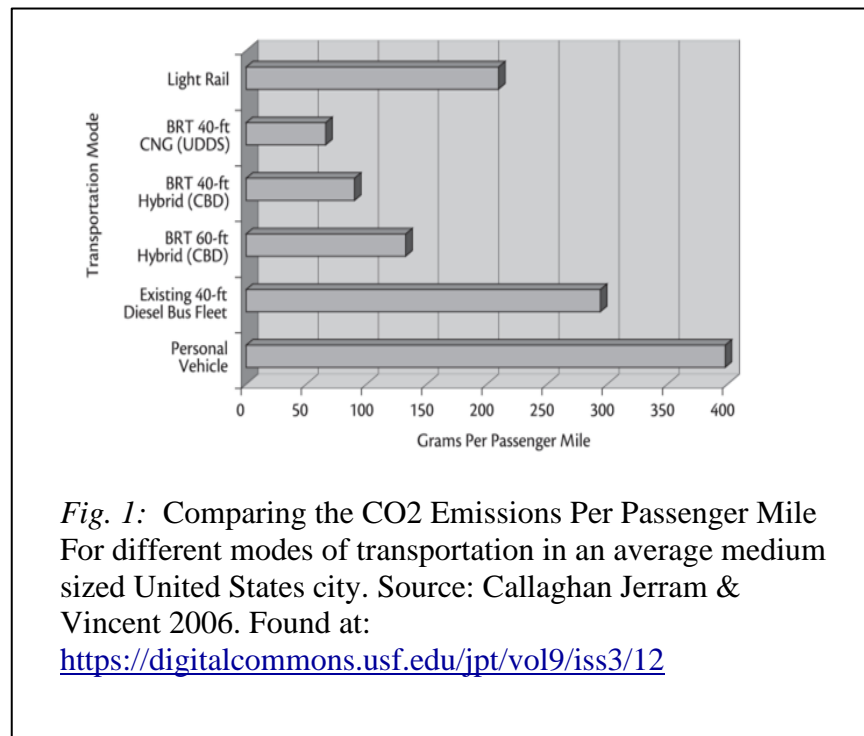
The following set of policy recommendations, while specifically intended for Worcester, Massachusetts, could be a viable blueprint for personal vehicle reduction in most urban areas. This brief is aimed specifically at Worcester City Council – the legislative body of the city. Worcester City Council is comprised of eleven members, each having the power to vote on legislation that could be implemented in the city. This brief will present a framework for a course of policy action that will decrease Worcester's GHG emissions significantly in the long term. These reductions in GHG emissions will be accomplished through major increases in the availability of non-automobile modes of transportation: walking/use of assistive equipment, cycling, and busing. In addition, the brief will show that increasing these alternate modes of transit will also make Worcester a far more accessible city, no matter disability status.

First, this brief will outline the primary drawbacks of personal vehicle overreliance – GHG emissions and lowered accessibility. Next, the brief will cover possible solutions to the problem, focusing heavily on alternative modes of transit. Third, the brief will look at existing policies from the city of Worcester on climate change and its relation to transportation. Finally, this brief will offer two policy recommendations to the Worcester City Council, one will be an incremental proposal and the other will be more expansive in its envisioned overhauls.

Summary of Science

A. Personal Vehicle Emissions

To begin, what is currently known about the issue of overreliance on personal vehicles? For starters, it is clear that personal vehicles are the primary driver of transportation-based emissions in the United States. On average, private vehicles not only make up an overwhelming majority of trips (91.2%), but they also release the most grams (g) of carbon dioxide (CO₂) per passenger mile (Callaghan Jerram & Vincent, 2006). According to one study, personal vehicles



on average released 397.89 g of CO₂ per passenger mile; existing transit buses released over 100 g of CO₂ per passenger mile fewer than personal vehicles for comparison, at 294.2 g/passenger mile (Callaghan Jerram & Vincent, 2006). What this means is that not only are personal vehicles used the most, but they are also the most inefficient. Clearly, there is evidence that lowering personal vehicle miles would have a positive impact on reducing emissions.

In connection with the high per-passenger-mile GHG emissions of personal

vehicles, most car trips are short distances. In a study attempting to measure the impacts of replacing short car rides with walking, 50% of measured car rides were under three miles long (Brand & Neves, 2019). These sub-three-mile trips hold high potential for the substitution of walking/use of assistive equipment in place of personal vehicle usage. Researchers estimate conservatively that 41% of short car trips could be replaced with a zero-carbon form of transit based on certain time and load constraints (Brand & Neves, 2019). This 41% modal shift alone would ultimately result in a 4.5% reduction in carbon output (Brand & Neves, 2019). Though this experiment was conducted in England, the merit still stands elsewhere and can be applied to Worcester and beyond.

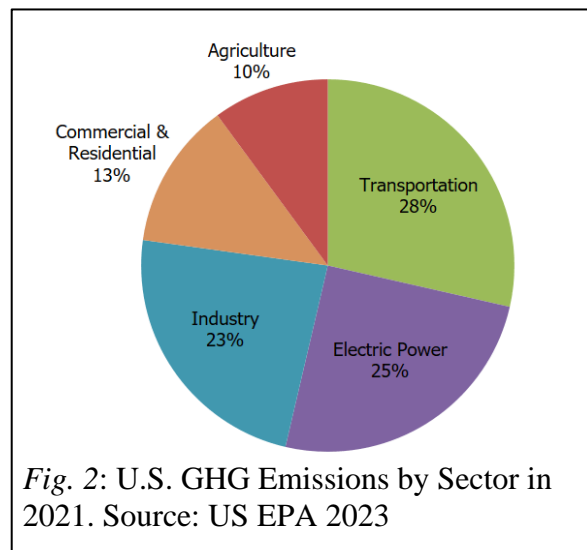
It has been established that (1) cars emit more than any other mode of transit and (2) cars are highly inefficient. The question then is, how can the issue of car overreliance be linked to rapid human-caused climate change?

B. Continued Growth of Transportation Emissions

Transportation comprises 26% of global emissions (US EPA, 2023). Looking at transportation emissions within the United States specifically, they are even more worrisome than the picture painted by global emission. Carbon dioxide equivalent (CO₂e) scales can be used to compare emissions across different GHGs, by standardizing measurements according to the impacts of different gasses¹. Looking at emissions from a CO₂e perspective, transportation accounted for 28% of the 6,340 million metric tons of CO₂e released by the United States in 2021 (US EPA, 2023). The 1,775.2 million metric tons of CO₂e released by transportation in 2021 was the largest by any single emissions source. Additionally, while other sectors are lowering their GHG output, the transport sector continues to emit more (Chapman, 2007). It is for this reason that the transportation sector – and personal vehicles by extension – must become the highest priority target for emissions reduction.

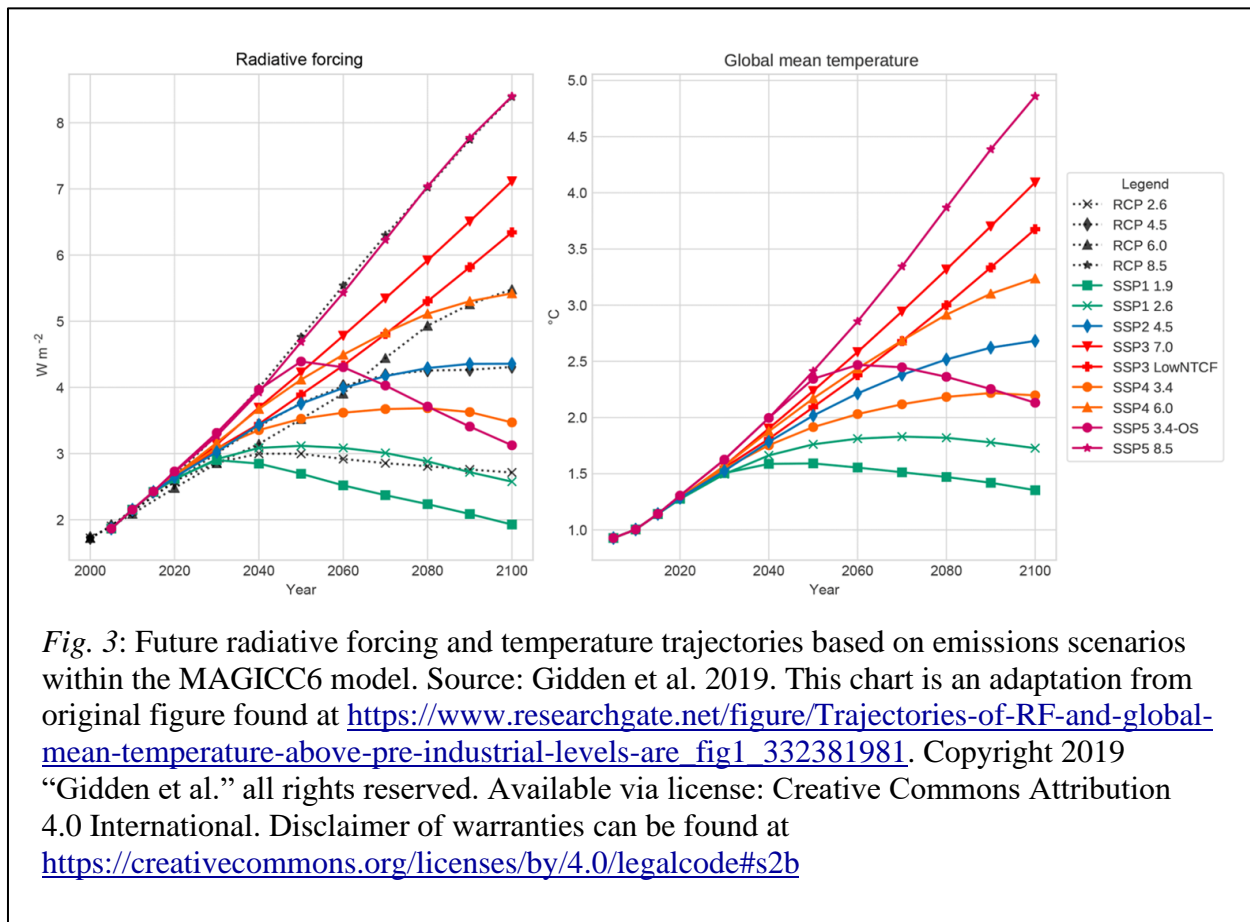
The continued growth in transportation emissions is largely due to personal vehicles. On a micro-scale, personal vehicles have become more climate-friendly over time as modern cars emit far fewer GHGs than those of the past. While the reduction in car emissions on a car-to-car basis may seem promising, these reductions have been offset by the increase in car use (Chapman, 2007). As societies become more and more dependent on cars, transport emissions will continue to rise – regardless of a car’s fuel efficiency.

The continued growth of transport emissions is having major climate ramifications. Radiative forcing is equal to the amount of incoming energy on Earth minus the amount of outgoing energy. In theory, this equation should amount to zero; however, human activity has caused there to be positive radiative forcing – more incoming energy than outgoing. This is why the Earth is experiencing climate change, an imbalance in energy leading to higher than natural temperatures. Models of future emissions consistently find that CO₂ is the primary contributor to radiative forcing (Gidden et al., 2019). As the different temperature predictions show, if humanity is able to lower radiative forcing, global mean temperature rise can also be lessened (Gidden et al., 2019). Cars continue to present a large threat to long-term climate goals because personal vehicles continue to emit increasing quantities of CO₂ – the primary driver of radiative forcing – which is warming the planet even more, and causing dangerous consequences.



¹ CO₂e is calculated by multiplying the amount of a GHG released with its global warming potential (how potent the GHG is at warming the atmosphere).

Thus, new technology will not make a big enough difference and can no longer be relied on to save the planet. Rather, places like Worcester need to make modal shifts away from cars entirely.



C. Negative Impacts of Cars on Other Transit Methods

Personal vehicle overuse has negatives beyond just high GHG emissions – the spatial inefficiency of cars also hampers the effectiveness of other modes of transit. Due to high traffic, passenger buses are less fuel efficient during midday peak hours than off-peak hours (Chen et al., 2017). A study measuring the impacts of traffic congestion on emissions found that buses consumed 5.56% more fuel and released 7.19% more carbon monoxide during peak hours (Chen et al., 2017). This shows that not only are cars bad for the environment in a vacuum, but they also interfere with the efficiency of other modes of transit. Transferring more of these peak-hour travelers away from car use would make buses more efficient, further lowering emissions.

Personal vehicles also lower rates of zero-emission non-motorist modes of transit. Comparing the United States to other countries like Canada, Germany, and Switzerland, non-motorist rates in the U.S are up to four times lower (Dijkstra & Pucher, 2003). One reason for this is that walking and biking in the United States is far more dangerous than it is in any peer nation (Dijkstra & Pucher, 2003). Even when taking into account possible undercounting in nations like Germany and Switzerland, non-motorists in the United States are still two to six

times more likely to be killed by cars (Dijkstra & Pucher, 2003). The United States has not put the proper protections in place for non-motorists and is catering the entire built environment to those in cars.

D. Accessibility Concerns of Personal Vehicles

Finally, overdependence on automobiles makes areas far less accessible for many with disabilities, and as a result, the sustainability and accessibility movements have many shared goals. Ultimately, personal vehicles serve to reinforce stereotypes of disability equating to inability (Aldred & Woodcock, 2008). Modern capitalist-built environments are centered around distances easily covered by cars, but this excludes those without car access. For example, 60% of persons with disabilities in the United Kingdom in 2002 did not have access to a car, compared to just 27% of the whole population (Aldred & Woodcock, 2008). This shows that environments built around cars alienate those unable to obtain or use automobiles. Ultimately, car over-dependency does not shorten distances as many may claim, it simply redistributes the area people live in. Unfortunately, those with disabilities or who cannot afford a car are typically disadvantaged by car-centric land distributions (Aldred & Woodcock, 2008).

This brief has raised three fundamental issues that need to be addressed: cars are harmful for the climate, car use makes other more climate-friendly modes of transit less effective and/or prevalent, and car overuse presents a major barrier to accessibility for those with disabilities. Something must be done in Worcester to lower personal vehicle usage while making alternative modes of transport more enticing. Doing so will help the environment in the long term and individuals living in Worcester in the short term.

Potential Solutions

Most potential solutions involve a modal shift away from cars and towards busing, biking, walking, and using assistive equipment. There are two main categories of solutions this brief will present: improving the availability and accessibility of alternate modes of transit and decreasing personal vehicle usage. It should be noted that these categories are not absolute, and given that everything is interconnected, a wide array of solutions involving different types of city planning will be needed to create real change.

A. Increasing Bus Usage

The solution that has the most potential for an immediate impact is increased bus use. As stated before, existing bus fleets emit over 100 fewer g of CO₂/passenger miles than personal vehicles (Callaghan Jerram & Vincent, 2006). The beauty of buses is that this solution is instant – increasing the bus-to-car use ratio would decrease emissions, with no other changes needed. Ways to increase the bus-to-car use ratio include: eliminating bus fares, improving bus quality, creating more bus routes/stops, building designated bus lanes, and running more buses.

Improving the accessibility of buses for all will be vital in increasing bus ridership. The use of the *universal design concept* could greatly improve public transit accessibility. The universal design concept can be summed up as something that is both flexible and equitable, has proper space for all approaches, presents easily understood information, and, critically, poses a

tolerance for mistakes (Zajac, 2016). The universal design concept is not commonly implemented in public transportation, leading to difficulty in use (Zajac, 2016). Implementing wider platforms that are level with buses, getting rid of steps, increasing grab bars, making bus stops more frequent as well as door-to-door, providing drivers with proper accessibility training, and providing information in more ways (including a variety of communication forms such as route stops displayed on a screen and braille) are just some of the ways public transit can be brought in line with the universal design concept (Zajac, 2016).

B. Non-motorist Transit

A study of the impacts on emissions of replacing one, five, ten, and thirty percent of short urban car trips (under seven kilometers) with bike trips indicated that replacing just 5% of short personal vehicle trips with bike trips would save over 50,000 tons of CO₂ emissions (Lindsay et al., 2011). This research shows us that even changes that seem small can have major impacts on emissions. To incentivize the 5% modal shift from cars to bikes, Worcester could give bikers tax breaks, create a safer biking environment, and change zoning laws to move necessary destinations into biking range.

In terms of increasing rates of walking/use of assistive equipment, altering the physical layout of Worcester is necessary. The key here is mixed-use development. Mixed-use zoning would allow for the widespread adoption of five-over-ones, which have five floors of residential housing over one floor of commercial businesses. Developments like five-over-ones increase density, which in turn increases the number of needs and wants within walking/assistive equipment range. Making Worcester more hospitable to those not in cars by moving side paths away from roads, creating limited-traffic zones, smoothing side paths, and creating plenty of rest areas would increase walking/assistive equipment usage rates.

C. Lowering Personal Vehicle Use

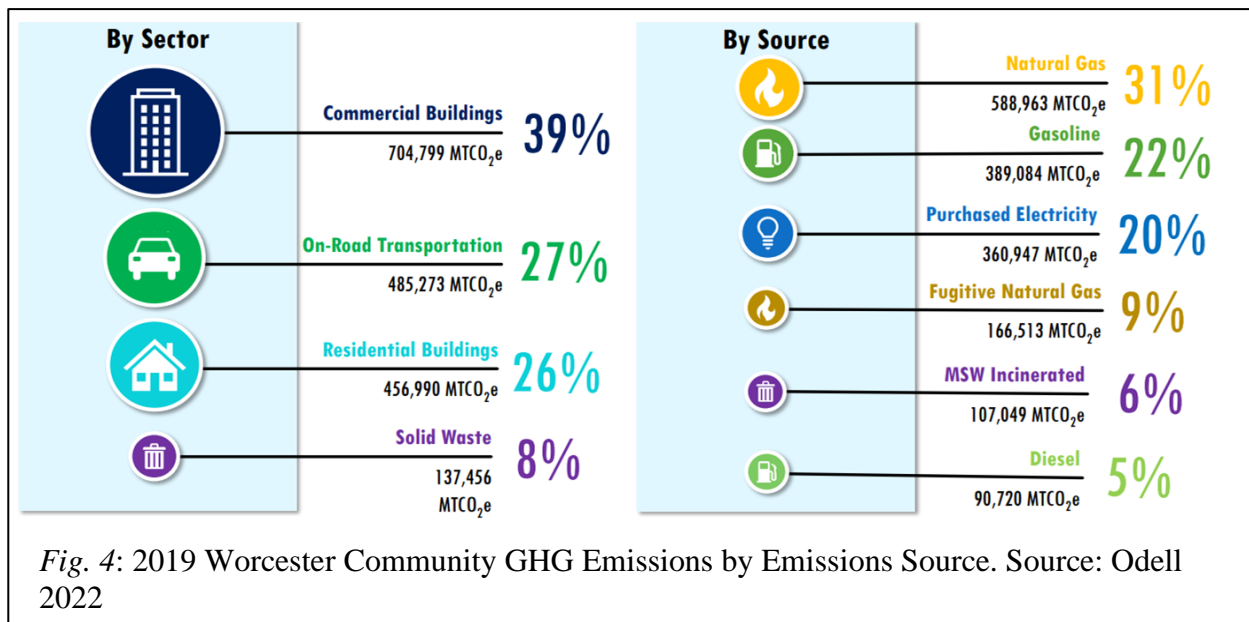
Shifting focus from increasing alternate modes of transit towards lowering car usage, there are several policies that could be implemented to lower personal vehicle usage rates. As mentioned above, limited-traffic zones could be instituted in certain areas to lower driving rates within the densest parts of the city. In addition, altering the availability and cost of parking throughout the city could encourage potential drivers to take alternate modes of transit. If there are fewer parking spots and/or parking prices are increased across the board, driving will become a far less appealing mode of transit. In connection with parking changes, limits on parking lot sizes for commercial enterprises like grocery stores (alongside better alternative modes of getting there to make up for fewer available spots) would make more shoppers seek alternate modes of transit.

Taking the goal of lowering personal vehicle usage a step further, Worcester could attempt to lower car ownership entirely. This could be done by creating a driving tax, meaning that the more an individual drives, the more it would cost them. This presents a loophole for non-Worcester residents, as they cannot be taxed by the city. However, this loophole would for the most part be closed by policies mentioned above like limited-traffic zones. Worcester could also create a car-weight-tax; such a tax considers that, since larger cars are worse for the environment, safety, and road health, it is only fair that those who drive larger vehicles be taxed

accordingly. Worcester could even ban cars above a certain weight from being sold within the city limits.

Existing policies

The city of Worcester released a presentation on May 26, 2022 covering the city’s GHG emissions inventory. It was shown that, similar to national figures, transportation made up 27% of community GHG emissions in 2019 (Odell, 2022). Even more concerning is that the transportation sector was the only major emissions source that was growing rather than shrinking, at 17% growth from 2009 to 2019 (Odell, 2022). In this presentation, “Sustainable Transportation Choices” was listed as one of ten goals in the Green Worcester Plan, but what does that mean to the city in terms of concrete policy (Odell, 2022)?



Chapter VI of the Green Worcester Plan covers “Sustainable Transport Choices” (City of Worcester and Green Worcester Working Group, 2020). The introduction of this chapter echoes many of the issues already outlined in this brief: personal vehicles being the worst mode of transit for the climate, Worcester being overly car-dependent, and there being weak infrastructure for alternate modes of transit. By 2040, the plan aims to increase the availability of alternate transit modes. This will be accomplished by adding at least 200 miles of non-motorist infrastructure and decreasing the amount of side paths in bad condition by up to 10% (City of Worcester and Green Worcester Working Group, 2020). The plan also intends to try and reduce solo personal vehicle usage while commuting to work.

The information presented in this section of the Green Worcester Plan is very promising for the future – especially as it acknowledges that there is a major issue with personal vehicle overreliance. Despite this, the plan is still lacking in terms of concrete policy proposals. Especially in the short term, of the plan does little to try and tackle personal vehicle emissions. For example, electrifying the entire Worcester Regional Transit Authority (WRTA) bus fleet is listed as an ongoing action (City of Worcester and Green Worcester Working Group, 2020, p.

87). Though electrification would be a positive change, and is even advocated for in this brief, the report lacks specific details on how the city aims to work alongside WRTA in accomplishing the goal. Worcester’s report simply says that the city will attempt to electrify half of the bus fleet by 2025, three-quarters by 2030, and the whole fleet by 2035. The report makes no mention of how the electrification process will be accomplished.

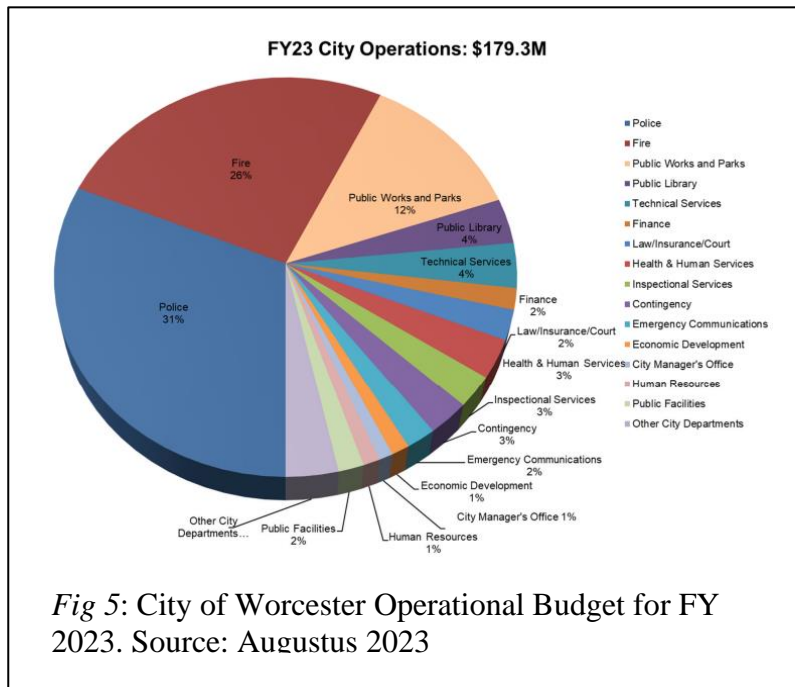
This lack of concrete actions to accomplish the stated sustainability goals is an unfortunate pattern within the city’s report; despite using appealing language, Worcester’s report lacks the specific policies needed to move past personal vehicle overreliance, instead falling back on tropes like electric vehicles. Electric vehicles are not the path forward, not for sustainability and certainly not for increasing accessibility. Most actions listed under this section are simply outlining plans or strategies. A proper strategy is certainly important for long-term success, however, the lack of specific actions in the report means that it will likely fail to tackle transportation emissions.

One current Worcester policy that should be mentioned is the COVID-19 era policy instituting free bus fares. The WRTA instituted a suspension of bus fares in March of 2020, using funds from the Coronavirus Aid, Relief, and Economic Security (CARES) Act as support. Though the fare suspension was meant to be temporary, it has been extended for over three years now and is still ongoing. Free bus fares in Worcester were originally designed to lessen the financial burden on residents during the peak of the pandemic, however, this policy also has a side benefit of increasing bus ridership – which will lessen personal vehicle emissions.

Though Worcester has signed on to other climate initiatives, like the U.S. Department of Energy’s Better Climate Challenge, these initiatives are plagued by the same bureaucratic issues seen in the Green Worcester Plan. This means that better policy alternatives are required to solve the many issues presented by personal vehicle overuse.

Policy Options

The reality of the situation is that many of the needed solutions, no matter the path, will require spending changes to be successful. That means before we present the two potential policy paths for The City of Worcester, we must cover the city’s budget. Though there will be some differences in the budget between each path, they still share some commonalities. Looking at the city’s budget for the fiscal year of 2023, an outlier is the police department. Worcester Police Department (WPD) received 31% of the budget – amounting to over 55 million dollars, making them the single largest monetary



recipient (Augustus, 2023). The police budget in Worcester was also increased by more than 2.4 million dollars from fiscal year 2022. The Department of Public Works and Parks (DPWP) – those in charge of managing public infrastructure – received just a little over 22 million dollars for 2023. The DPWP budget was also decreased by 27%, losing over 8 million in funding. Finally, Worcester’s Sustainability department was given a budget of just \$520,003 for 2023.

Mentioning the Worcester city budget is important because it shows where the city’s priorities are, and clearly the current budget reveals that sustainability and infrastructure are not at the top of the list. This means that both policy paths will involve budget shifts for The City of Worcester.

Incremental path – Rather than transforming the entire system, this path would aim to find cost-effective solutions to personal vehicle overuse. With that being said, money will still be needed to enact some solutions. Under this plan, 25% of the current WPD budget would be moved to other departments. This would give the city \$13,700,000 extra to spend each year improving the lives of Worcester residents.

The new influx of funds would allow DPWP and the Sustainability department to work on implementing changes to improve alternate modes of transit. Only six buses of the WRTA’s 52 bus fleet are currently electric Proterra buses (Worcester Regional Transit Authority, 2018). The entire bus fleet can be electrified in just five years with budget increases. Alongside an all-electric bus fleet, the number of stops and frequency of buses will both be increased. New stops will be placed closer to areas where people would have driven in the past – like shopping centers and work complexes. Small changes should also be made, such as installing heated shelters powered by solar panels at all bus stops. Finally, the suspension of bus fares (mentioned above) must be made permanent, rather than being a temporary measure that could be taken away with a single vote.

Increasing bike usage would also have positive impacts. To see this implemented, many changes will be needed - more so than with buses. Worcester needs to prioritize biker safety first and foremost and this can be done with a combination of several methods. Lowering and enforcing speed limits will help make any collisions less damaging. In addition, extending bike lanes so that bikers always have a designated lane for themselves and placing pylons along bike lanes as an extra layer of protection will aid in increasing biker safety. With biking hopefully being safer, increasing the availability of bikes would come next. The city should set up a public bike-sharing program – free of charge. With stations set up all around the city, residents would have easy bike access.

As for walkers and assistive equipment users, DPWP should use some of its new funds to make paths smooth and wide. Alongside improved side paths, the city should raise every street crossing to increase safety. Covered rest areas should be placed every half mile to give those using the side path a place to take a break if they need to do so. These changes will make walking easier and safer. The city could also run campaigns through advertisements promoting zero-carbon transit modes, the health and environmental benefits would hopefully encourage citizens to drive less.

Moving on to cars themselves, some quick changes the city could make to lower personal vehicle usage are a reduction in parking spots, increasing the price of parking, limited-traffic zones, and vehicle weight taxes. All of these new policies, while not altering the structure of the system, would aim to lower personal vehicle usage by using financial disincentives.

Finally, increasing accessibility in Worcester is an important aspect of this policy path. All bus stops in the city should be made accessible, meaning no steps or sharp inclines to the stops. All stops should be level with the buses, making it much easier to get on and off the bus. Within the buses themselves, there should be designated areas near the entrance for those with mobility disabilities, including several wheelchair locks on the floor to secure those using wheelchairs. Also, all bus drivers should go through proper accessibility training courses to ensure they have the knowledge to provide aid to any passengers. Lastly, information should be presented in a multitude of different ways, including different languages, Braille, and on a screen within the bus.

There are some disadvantages to keep in mind with these policy options. Though electric buses may lower transit-based emissions greatly, they may not lower total emissions a great deal unless the electric power that charges the buses is green. Another possible drawback for several of the policies listed above, especially those that involve construction of new infrastructure, is that they may take several years to start making a noticeable impact on GHG emissions. Though it is true that this process will not be immediate, the fact remains that the City of Worcester has to start somewhere in order to decrease personal vehicle emissions.

The **transformative path** would institute larger changes to alter the system itself, creating more impactful holistic change. Unless specified, these policies are in addition to those outlined in the incremental path. As with the previous path, a large share of the police budget will be diverted to other areas. For the transformative path, 50% of WPD's annual budget will be reallocated. This will give Worcester an extra \$27.5 million per year to be used to improve the city. Under this plan, there is potential to move towards 75% reallocation after the first decade and 100% after the second.

Turning to improving Worcester's bus transit, dedicated bus lanes will be created across the city, giving buses priority to zoom past traffic. This should be done by removing regular lanes and replacing them with bus lanes – which will also improve car traffic in the process. The temporary free fare program in Worcester will be made permanent; not only will bus rides be made free, but residents who ride the bus enough will be rewarded through tax incentives based on distance. As long as Worcester and Massachusetts shift away from fossil fuels as a power source, the electrified bus fleet from the first path should do well here. More buses should be added to the fleet over time to meet the newly increased demand due to lower car use.

Bikes will gain newly designated bike zones, places where bikes can go from residential areas to city centers will have zero car interference. This could be made by shrinking large roads like Park Ave to just two lanes of cars, one bus lane, and one designated bike zone separated but alongside the road. This will give bikers peace of mind, knowing they are free from the dangers presented by cars. There will also be designated non-motorist zones, these will be dense areas of primarily five-over-ones where only biking, walking, and assistive equipment is allowed. As with bus ridership, bikers will be rewarded monetarily for biking in place of driving; bikers can track themselves with a GPS and report how much they have biked in a year, earning tax breaks.

To increase the availability of walking and assistive equipment users, dense urban design will be needed. Worcester will need to shift away from single-family housing and towards constructing mixed-use complexes. This means the City Council will need to alter the zoning ordinances, making units like five-over-ones the norm rather than an exception to the rule. Once zoning rules are changed, the city can start constructing five-over-ones in key parts of the city like Main South, Downtown, and the Canal District. Long term, the ultimate goal would be to

put people's needs, wants, jobs, and fellow community members in closer proximity. In the short term, those walking or using assistive equipment could be aided even more by blocking off certain roads to all traffic except buses, allowing people freer reign.

As for lowering car use even more, there should be no roads with more than two car lanes (one going each way). As mentioned above, there will be designated car-free zones where non-motorist frequency is highest. Parking in the city will be significantly less appealing due to greatly increased city-wide parking costs, large-scale reduction in parking spots available, and caps on parking lot size for private businesses like grocery stores. Car and road taxes will also be instituted, meaning owning any car will cost more and the more people drive – the more expensive it will be. To go alongside the car ownership/weight tax, cars above certain sizes will not be allowed to be sold within the city, and any residents owning a vehicle above this weight will be taxed an additional amount.

Finally, to increase accessibility, the existing WRTA paratransit system should be strengthened. The paratransit system should have a larger fleet, be of no cost to the user, and be on-call for high demand areas. These paratransit vehicles will be given the same priority as buses, meaning they can use the bus lane. Frequent areas to rest with cover and heat in the winter should be placed all around side paths in the city, this will give people a place to sit and rest while moving around outside of a vehicle. Bus stop size should be greatly increased, alongside altering the locations of stops and adding more stops to be closer to the start and end of public transit journeys (thus providing door-to-door service). As mentioned before, side paths should be widened, flattened, smoothed out, and clearly marked, making it much easier for those using assisted equipment to travel. With the density increased by mixed-use developments mentioned in the section above, it will be much easier for everyone to go where they need to go.

The biggest disadvantage to keep in mind with the transformative track is how disruptive it will be to everyday life. The changes listed above will lead to a major lifestyle change for a large number of Worcester residents, something that may not be popular at first. Though it is true that major lifestyle changes will be needed, many will see that the necessary lifestyle changes will positively impact their day-to-day lives. Another potential downside to keep in mind is how some of these policies, especially those that would make driving more expensive, could impact lower-income residents of Worcester. In a vacuum it would be true that increasing the cost of driving would be a large financial burden on the most vulnerable in Worcester, however, these policies would all exist in conjunction with each other. As the cost of driving increases, the financial benefits of busing or biking will also increase, offsetting any potential ramifications.

Policy Recommendations

Two policy paths have now been presented, one more aggressive in its reform than the previous. The beauty of these two paths is that they are not mutually exclusive; policies from each path can be picked at will. With that being said, there is one clear favorite path: transformative change. Changes that have long term outcomes, especially those focused on increasing density within Worcester, should be started as soon as possible. While people adjust, less aggressive measures tackling car use would be more helpful to ease people into these large lifestyle changes.

To go into more depth on the short-term mix of incremental and transformative, first off all changes surrounding buses under the moderate plan can be implemented right away. The entire fleet should be electrified in five years and the number of stops will be increased to ensure

people can easily get where they need to go. Construction of the bus lanes should begin right away, but they will take several years to go into full effect. The changes targeting decreased car use outlined under the moderate path will be put into effect first, then a move to the transformative path will be made once the city has increased the availability of other modes of transit. This means implementing policies that make driving less appealing while not fully altering people's ability to drive if they still wish to do so. vehicle weight taxes, parking price increases, a reduction in parking availability, and some usage of limited-traffic zones should be put in place right away.

Major infrastructure changes outlined in the transformative path should start right away. Specifically, the city should begin constructing more five-over-ones, altering major roads like Park Ave to be more non-motorist friendly, and smoothing side paths to increase accessibility. All accessibility changes listed under the transformative route should be worked towards as soon as possible – increasing paratransit availability, improving side path quality and providing frequent rest areas on side paths, and making bus stops much more accessible.

Again, in the end, the recommendations made in this brief are simple: all policies in the transformative path should be adopted by Worcester City Council in the long term. After adopting the above mix of incremental and transformative policies in the short term, a movement towards all transformative policies should start within five years. The mix of incremental and transformative in the short term will ease Worcester citizens into a lifestyle not centered around cars, preparing citizens for some of the more major changes outlined in the transformative path. Though some of these policies may take years to implement, and may be costly, the proposed budget changes will allow Worcester to accomplish all of the transformative path's changes in ten to fifteen years.

Conclusion

To recap, it should be stressed that car overreliance presents a major challenge for Worcester, as well as the entire United States. Car overreliance is killing people and the planet at alarming rates, being the largest threat to climate goals. Transit emissions are the only large sector still growing, mostly due to personal vehicles. Not only are personal vehicles bad themselves, they also slow down buses and discourage non-motorist modes of transit. Finally, cars also present a major barrier when looking at the intersection of the environmental and accessibility movements, alienating many disabled persons.

In terms of policy, Worcester currently has big ideas in mind but lacks some of the more concrete policies to make that vision come to fruition. Furthermore, Worcester is currently pushing in the direction of electric vehicles – a nonsolution that still presents major barriers for disabled persons. Rather than falling into the trap of electric vehicles as a savior, Worcester should focus on altering the city to make its layout denser, increasing biker safety, ramping up bus service, creating more opportunities for non-motorists, discouraging personal vehicle use all together, and making Worcester more accessible.

Worcester, as a city, finds itself in a similar position to many other American cities – bogged down by personal vehicle overreliance. Now is the time for Worcester to be a leader, not just in the United States, but for the whole world. With some of the policies noted in this brief, Worcester can become a model city globally for sustainability and accessibility.

Work Cited

- Alred, R. & Woodcock, J. (2008). Transport: challenging disabling environments. *Local Environment*, 13(6), 485-496. <https://doi.org/10.1080/13549830802259847>
- Brand, C. & Neves, A. (2019). Assessing the potential for carbon emissions savings from replacing short car trips with walking and cycling using a mixed GPS-travel diary approach. *Transportation Research Part A: Policy and Practice*, 123, 130-146. <https://doi.org/10.1016/j.tra.2018.08.022>
- Burrows, M., Burd, C., & McKenzie, B. (2021). Commuting by Public Transportation in the United States: 2019.
- Callaghan Jerram, L., Vincent, W. (2006). The Potential for Bus Rapid Transit to Reduce Transportation-Related CO2 Emissions. *Journal of Public Transportation*, 9(3), 219-237. <https://doi.org/10.5038/2375-0901.9.3.12> Available at: <https://digitalcommons.usf.edu/jpt/vol9/iss3/12>
- Chapman, L. (2007). Transport and climate change: A review. *Journal of Transport Geography*, 15(5), 354–367. <https://doi.org/10.1016/j.jtrangeo.2006.11.008>
- Chen, X., Shan, X., Wang, Y., Ye, J., & Yi, F. (2017). Evaluating the Effects of Traffic Congestion and Passenger Load on Feeder Bus Fuel and Emissions Compared with Passenger Car. *Transportation Research Procedia*, 25, 616-626. <https://doi.org/10.1016/j.trpro.2017.05.446>
- City of Worcester and Green Worcester Working Group. (2020). *The Green Worcester Sustainability and Resilience Strategic Plan* [slideshow]. <https://www.worcesterma.gov/uploads/32/47/3247f56d4bf2cafa84be33a9f71592c5/green-worcester-plan.pdf>
- Dijkstra, L. & Pucher, J. (2003). Promoting Safe Walking and Cycling to Improve Public Health: Lessons From The Netherlands and Germany. *American Journal of Public Health*, 93(9), 1509-1516. DOI: <https://doi.org/10.2105/ajph.93.9.1509>
- Edward M. Augustus. (2023). *Fiscal Year 2023 Annual Operating Budget* [slideshow]. <https://www.worcesterma.gov/uploads/35/a1/35a1a557d4674540e9caf7cba692af32/budget-fy23.pdf>
- Gidden, Matthew & Riahi, Keywan & Smith, Steven & Fujimori, Shinichiro & Luderer, Gunnar & Kriegler, Elmar & Vuuren, Detlef & Van den Berg, Maarten & Feng, Leyang & Klein, David & Calvin, Katherine & Doelman, Jonathan & Frank, Stefan & Fricko, Oliver & Harmsen, Mathijs & Hasegawa, Tomoko & Havlík, Petr & Hilaire, Jérôme & Hoesly, Rachel & Takahashi, Kiyoshi. (2019). Global emissions pathways under different socioeconomic scenarios for use in CMIP6: A dataset of harmonized emissions

- trajectories through the end of the century. *Geoscientific Model Development*. 12. 1443-1475. 10.5194/gmd-12-1443-2019.
- Lindsay, G., Macmillan, A., Woodward, A. (2011). Moving urban trips from cars to bicycles: impact on health and emissions. *Australian and New Zealand Journal of Public Health*, 35(1), 54-60. DOI: 10.1111/j.1753-6405.2010.00621.x
- Odell, J. (2022). *Reducing Greenhouse Gas Emissions in Worcester* [slideshow].
<https://www.worcesterma.gov/uploads/bc/e4/bce42fbcf70ff21cb03469c63b5a3275/worcester-ghg-inventory-presentation.pdf>.
- The City of Worcester. (2023). *Renewable Energy & Energy Efficiency*.<https://www.worcesterma.gov/sustainability-resilience/renewable-energy-efficiency#:~:text=In%20early%202022%2C%20the%20City,least%2050%25%20within%2010%20years>
- US EPA. (2023, April 28). *Sources of Greenhouse Gas Emissions* [Overviews and Factsheets].
<https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>
- USGS. (2023, February 2) *How does climate change affect the challenge of invasive species?*.
<https://www.usgs.gov/faqs/how-does-climate-change-affect-challenge-invasive-species>
- Worcester Regional Transit Authority. (2018). *Welcome to the WRTA* [slideshow].
<https://www.therta.com/wp-content/uploads/2016/11/WRTA-Communities-Information-Dec16.pdf>
- Zajęca, A., P. (2016). City Accessible for Everyone – Improving Accessibility of Public Transport Using the Universal Design Concept. *Transportation Research Procedia*, 14, 1270-1276. <https://doi.org/10.1016/j.trpro.2016.05.199>