# resources to meet needs

Earlier sections of this chapter identified a range of needs that are not adequately met by existing public transit service in Vermont. The next logical step is to estimate how much it would cost to address all of those needs so that policy-makers and decision-makers can make informed choices about future investments in service, technology, vehicles, facilities and other infrastructure.

By its very nature, such an estimate would be a very rough approximation since it is impossible to quantify precisely all of the travel demand of Vermont residents—not to mention the added demand of visitors to the state—and determine how much of it would be served by transit routes and demand response vehicles. To produce a reasonable, if very rough, estimate, available data was compiled and processed with a series of assumptions described below, to yield estimates of the number of annual transit trips to meet the “basic” needs of Vermonter and the number to provide a “full” level of mobility to Vermonters. In both cases, it is assumed that automobile ownership would remain at its current level and that people who drive themselves or family members to accomplish their daily needs would continue to do so. The potential for public transit to carry more people who currently drive is considered in the section on scenarios below.

## Data Sources and Assumptions

Two primary data sources were used for this analysis: the American Community Survey (ACS) of the US Census Bureau and the 2017 National Household Travel Survey (NHTS). The ACS provided estimates of the number of Vermonters in seven demographic categories (see below) divided into Urban and Rural areas. For the purpose of this analysis, Urban was defined as Chittenden County which contains the only urbanized area in Vermont, and Rural was defined as all of the rest of Vermont.[[1]](#footnote-2)

Several tabulations from the ACS were used to estimate the number of people by age group, by disability status, and by income. These include S0101 for the counts by age group, B18101 for disability status by age group, B17001 for poverty status by age, and C18130 for disability status by poverty status by age. These tables were cross-referenced to produce the urban and rural estimates by demographic category shown below and used extensively in the Needs Assessment, described above.

The NHTS was used to estimate daily trip rates by demographic category. A trip is defined as travel between two activities and is not necessarily based at the person’s home. Separate sets of trips rates were developed for the Urban (Chittenden County) and Rural areas. These are all based on travel diaries filled out by a sample of Vermonters during the 2017 NHTS. The Urban trip rates vary from 2.15 for people over the age of 80 to 4.09 for non-disabled people above the poverty line age 25-64. The Rural rates are generally lower than the Urban rates by about 0.2 trips. The national average daily trip rate from the NHTS across all of the demographic categories was 2.95 person trips per day. The Vermont average is slightly higher at 3.26 trips.

The “full” level of mobility was based on these daily trip rates, thereby assuming that the portion of the population that was assumed to need transit service (i.e. not be able to drive themselves) would be taking all of their trips via public transit. An adjustment was made (described in more detail below) to subtract out non-motorized trips (mostly walking and bicycling).

The “basic” level of mobility was assumed to consist of 12 round-trips per month (24 one-way trips), or about 3 round-trips per week. This figure seems to be a reasonable estimate of the minimum number of trips needed for basic subsistence and is consistent with a similar analysis done as part of the 2012 PTPP.

For each of the seven demographic categories, two factors needed to be assumed:

* Non-auto factor – this is the percentage of people in the category who cannot drive or are unlikely to have access to an automobile
* Independent trip factor – this the percentage of people in the category who would be likely to making trips on their own, independent from an adult (parent) or caretaker

The factors assumed by demographic category, split by urban/rural are as follows:

|  |  |  |
| --- | --- | --- |
|  | **Non-Auto factor** | **Independent Trip factor** |
| **Population Segment** | Urban | Rural | Urban | Rural |
| Non-Disabled, Under 18 | 90% | 90% | 10% | 5% |
| Non-Disabled, 18-24 | 40% | 20% | 90% | 90% |
| Non-Disabled, 25-64, Above Poverty | 10% | 4% | 100% | 100% |
| Non-Disabled, 25-64, Below Poverty | 30% | 20% | 100% | 100% |
| Non-Disabled, 65-79 | 15% | 7% | 90% | 90% |
| Disabled, Under 80 | 60% | 60% | 75% | 75% |
| All 80+ | 60% | 30% | 65% | 65% |

It can be seen that the Rural non-auto factors are lower than the Urban ones for many categories, reflecting that urban residents have more transportation options available and generally shorter trips. The independent trip factors are the same for Urban and Rural residents by category, except for youth, for whom it is assumed that urban youth have more access to public transit and can walk to more places than rural youth. The vast majority of non-disabled people between 18 and 79 are assumed to make independent trips, with small percentages of the youngest and oldest of these assumed to depend on assistance.

When the non-auto factor is multiplied by the number of people in each category, the product is about 197,000, which is similar to the figure obtained by summing all of the people who live in zero-vehicle households plus all of the people who live in single-vehicle households (less the number of households to account for the drivers) and so forth.

## Full Level of Mobility

The total population and daily trip rates by demographic category are shown below:

|  |  |  |
| --- | --- | --- |
|  | **Population** | **Daily Trip Rate** |
| **Population Segment** | Urban | Rural | Urban | Rural |
| Non-Disabled, Under 18 |  27,894  |  84,836  | 2.93 | 2.70 |
| Non-Disabled, 18-24 |  25,068  |  37,389  | 3.27 | 3.10 |
| Non-Disabled, 25-64, Above Poverty |  70,456  |  194,523  | 4.09 | 3.76 |
| Non-Disabled, 25-64, Below Poverty |  4,007  |  17,030  | 2.81 | 2.59 |
| Non-Disabled, 65-79 |  12,364  |  51,766  | 3.39 | 3.18 |
| Disabled, Under 80 |  15,341  |  56,640  | 2.75 | 2.55 |
| All 80+ |  6,047  |  20,337  | 2.15 | 2.01 |

If these figures are multiplied through and summed, the total number of annual person trips in Vermont comes out to a figure over 741 million. Of those, just under 600 million are assumed to be independent person trips (or could be). Among independent trips, about 92 million would be taken by people without easy access to automobiles (applying the non-auto factor). This then is the maximum potential market for public transit trips.

Many of those 92 million trips are completed by non-motorized means, including walking and cycling. Someone who is running errands in a city may drive into the city and park, but then go to four different shops, or the bank and post office, walking in between each of those stops. In total, that would count as five trips for NHTS purposes: (1) home to stop #1, (2) stop #1 to stop #2, (3) stop #2 to stop #3, (4) stop #3 to stop #4, (5) stop #4 to home. However three of those five trips would be non-motorized.

To estimate the number of non-motorized trips, two other data sources are employed. The ACS publishes figures on mode of transportation use for commuting. In Chittenden County 9.7% of commuters either walk or bike to work. In the rest of Vermont, the figure is 5.1%. Multiplying those percentages by the number of commuters in each region (also derived from the ACS) and multiplying by the typical number of worktrips per year (245 days times two trips each day) results in just under 10 million commuting trips by walking and biking.[[2]](#footnote-3)

The second data source was a study done by the Victoria Transport Planning Institute (based in Vancouver, BC). This study, *Evaluating Active Transport Benefits and Costs[[3]](#footnote-4)*, cites an earlier study from 2008 which estimated that for every commuting trip made by walking or biking, there are 10 other such trips make for utilitarian purposes (such as shopping) and 9 other such trips made for recreation. Thus commuting trips represent only 5% of total walking/biking trips made. In a Vermont context, an adjustment was made to these rates to reflect the harsh weather conditions for part of the year; while people may continue to walk to work even in winter, they are much less likely to make recreational trips or shopping trips on foot or by bike. Thus it was assumed that in Chittenden County, about half as many non-motorized utilitarian trips would be made and in the rest of Vermont, only 40% as many trips would be made. Trips for recreation purposes were assumed to happen at only 20-25% the rate cited in the study.

Multiplying all of these factors through results in about 35.5 million utilitarian trips and 24.7 million recreational trips made by walking or biking. Adding these to the commuting trips results in a total of 69.8 million annual non-motorized trips in Vermont. Subtracting these from the 92 million trips cited above as the maximum potential market gives us a total of 22 million trips that could be served by public transit. In FY2018, about 4.3 million transit trips were provided[[4]](#footnote-5), meaning that **17.7 million additional transit trips would be carried to meet the “full” needs of Vermonters who don’t have easy access to automobiles.** This figure can be considered the upper bound of “needs” for the near term. It does not include riders who might be drawn to public transit for convenience, environmental concerns or cost savings and thus give up driving for some of their travel.

At the end of the 10-year timeframe, it can be assumed that the needs would be greater because of the aging of the population. A few simple assumptions were added to model to predict the impact of the forecast 60% increase in people over the age of 80 referred to earlier in this report. It was assumed that the overall population would remain the same, but that the over 80 cohort would grow by 60%, the number of people with disabilities under 80 would grow by 10%[[5]](#footnote-6), the number of people 65-79 would remain the same[[6]](#footnote-7), and that all of the other categories would shrink proportionally so that the bottom line is unchanged. The result of this change in the composition of the Vermont population is that the number of additional transit trips needed rises from 17.7 million to 21.2 million, an increase of 3.5 million trips, or almost as much as the total number of transit trips carried in FY2018.

## Basic Level of Mobility

As stated earlier, the “basic” level of mobility was defined as 12 round-trips per month (essentially 3 per week), and this rate was applied across the board to all demographic categories. This trip rate is roughly one quarter of the average trip rate from the NHTS. Applying that trip rate to the full population yields an annual number of “basic” trips of 180 million (compared to the 741 million for “full” mobility).

Applying the non-auto and independent trip factors to this total results in an estimate of about 24.5 million trips that could be served by public transit. As before, we need to subtract trips that are likely to be accomplished by non-motorized means. Using the walk/bike commuting factor and an expansion factor to take account of other utilitarian trips, 13.8 million non-motorized trips were estimated. Subtracting these and the current 4.3 million transit trips from the 24.5 million left a total of **6.5 million additional transit trips would be carried to meet the “basic” needs of Vermonters who don’t have easy access to automobiles.**

At the end of the 10-year timeframe, using the same assumptions as above, the number of additional transit trips needed rises from 6.5 million to 7.9 million, and increase of 1.4 million trips.

## Costs

In order to calculate the costs of carrying all of those additional transit trips, it is necessary to split the totals into urban and rural figures, because the operating subsidy per trip is very different for the two environments. It is assumed that the FY2018 net cost per trip (gross operating cost less fare revenue) for urban and rural trips remains the same for the millions of additional trips that would be added to the system. The FY2018 net costs (operating subsidies) are as follows:

* Urban operating subsidy: $4.64 per trip
* Rural operating subsidy: $10.11 per trip

These costs exclude routes in the Intercity and Tourism categories as defined in the VTrans Route Performance Report. Many of the people riding routes in those categories are not Vermont residents, and they are very different from the rest of the public transit services operated in Vermont. Volunteer driver trips are also excluded from this analysis because the Route Performance Report only tracked the administrative cost of those trips, rather than the full cost. The great majority of trips are still included, with a total of 2.3 million Urban trips and 1.5 million Rural trips.[[7]](#footnote-8)

It is also important to note that this financial analysis applies to the unmet needs based on the current population, rather than the 10-year forecast. It is likely that costs will have changed substantially in 10 years, so applying the current net subsidy per passenger to 2029 estimates makes the figures even more speculative.

Among the 17.7 million additional trips estimated for the “full” level of mobility, 4.2 million apply to the Urban area and 13.5 million apply to the Rural area. Multiplying those figures by the respective operating subsidies per trip produces a cost estimate to serve those new trips of $19.6 million for the Urban area and $136.2 million for the Rural area, resulting in a statewide total of $156 million. Urban spending would nearly triple from its currently level of $10.5 million, but Rural spending would increase by a factor of 10, from its current level of about $15.5 million.[[8]](#footnote-9)

For the “basic” level, among the 6.5 million new trips, 730,000 would occur in the Urban area and 5.7 million in the Rural area. Multiplying those figures by the respective operating subsidies per trip produces a cost estimate to serve those new trips of $3.4 million for the Urban area and $60 million for the Rural area, resulting in a statewide total of $63.4 million. These figures are summarized in the table below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Statistics Excluding Intercity, Tourism and Volunteer Driver Trips** | **Urban** | **Rural** | **Statewide** |
| FY2018 Riders | 2.3 million | 1.5 million | 3.8 million |
| FY2018 Net cost per rider | $4.64 | $10.11 |  |
| FY2018 Total subsidy | $10.5 million | $15.5 million | $26 million |
| “Full” additional riders | 4.2 million | 13.5 million | 17.7 million |
| “Full” additional net cost | $19.6 million | $136.2 million | $156 million |
| “Basic” additional riders | 0.7 million | 5.7 million | 6.5 million |
| “Basic additional net cost | $3.4 million | $60.0 million | $63.4 million |

# future Scenarios and ridership

It is unlikely that conditions will remain the same as they are today for the next ten years. The environment in which public transit operates and the costs it faces are very likely to change. This section examines three possible scenarios that would affect ridership and costs in various ways, thus having a significant impact on the cost efficiency of the transit system and the resources necessary to operate it.

It is important to note that none of the scenarios envisage signficant changes in housing or in other land use/development patterns. Even if there were a consensus now that development patterns need to change and a strong impetus to invest, the results of this change would only begin to take effect toward the end of the ten-year timeframe of the PTPP. A more appropriate timeframe for land use changes is 20 or even 30 years.

It is also important to note that this analysis mainly concerns the existing ridership base and people on the margins who may become transit riders or stop riding based on external factors. It is separate from the prior analysis looking at the needs of the whole population of Vermont.

### Scenario 1 – High Fuel Prices

In 2019, retail gasoline prices (adjusted for inflation) are low by historical standards. They are slightly higher than 2016, but otherwise they are lower than they have been since 2006. They are moderately higher than they were between 1986 and 2006, but substantially lower than they were in the 1979-1983 period.[[9]](#footnote-10) In those periods of suddenly high prices (1979-80 and 2012-14) many people made different choices about the vehicles they purchased and the modes of transportation they used. Carpooling and public transit ridership grew significantly when prices spiked, and then slowly subsided as people “got used to” the higher prices, and as prices themselves started to fall.[[10]](#footnote-11)

In this scenario, it is assumed that gas prices double sometime within the ten-year timeframe. That would mean a retail price above $5.50 per gallon based on prevailing prices in 2019. Such an increase, especially if it happened in a short time, would cause substantial shifts in mode choice. It is assumed that drastic changes in fuel prices would affect the mode choice of people in the 18-24 and 25-64 age groups most signficantly. It was reasoned that other groups have more constrained choices about transportation options (people over 80 or people with disabilities) or have a reduced amount of travel (fewer commuters) which would make fuel prices less important to them (people in the 65-79 age group).

For the purpose of this analysis, a cross-price elasticity of +0.12 was used, based on research contained in a Victoria Tranport Policy Institute study.[[11]](#footnote-12) A range of elasticities could apply, and most of the research on this topic was based on large cities with rail systems, but this figure seems reasonable. It means that for a 10% increase in fuel prices, roughly a 1.1% increase in transit ridership would be expected.[[12]](#footnote-13) Elasticities are generally less appropriate for use in the context of large and sudden changes, such as the doubling of fuel prices discussed here. A study of large cities in 2008 suggested that the impact of $6 per gallon gas would increase ridership on urban rail systems in nine large US cities by between 17% and 55%. (VTPI p. 17.) Overall, the +0.12 elasticity will produce relatively conservative estimates for the impact of a drastic change in fuel prices, at least for the short term.

#### Urban Service

In Fiscal Year 2018, about 2.3 million passenger trips were carried on urban and express commuter routes in Vermont. Applying the +0.12 elasticity to a doubling of fuel prices translates into an 8% gain in ridership, or about 190,000 trips. It is likely that the impact of higher gas prices would be seen more strongly on the express commuter trips. An elasticity of +0.3 applied to those trips results in a 22% rise in ridership, or about 50,000 new trips over and above the 223,000 carried in FY2018. Adding those trips to the total increases the overall ridership gain to about 10%, about 220,000 riders.

Comparing that estimated ridership increase, which is modest in the context of a doubling of fuel prices, to the number of trips generated by people in the 18-24 and 25-64 age group who live in Chittenden County, indicates that 220,000 riders is only about 1% of the annual non-auto trips made by people in those groups. After discounting 60% of the 18-24 year-olds, 90% of the 25-64 year-olds above the poverty line and 70% of the 25-64 year-olds below the poverty line, there are still about 22.5 million annual trips made by this group. This figure suggests that the switch to transit may be significantly higher than 220,000.

Another point of reference is the overall transit mode share in Chittenden County. Using Census data, the Chittenden County regional model, CCTA/GMT ridership data and traffic counts on regional highways, CCTA/GMT has tracked the transit mode share for the core of Chittenden County for many years. The transit mode share for work trips is approximately 3% and the mode share for all types of trips is approximately 2%.[[13]](#footnote-14) The last time there was a significant spike in gasoline prices, from 2006 to 2008, there was a jump in transit mode share of about 0.7% for worktrips and 0.4% for all types of trips. The nominal price increase at that time, was “only” about 25%. With a 100% increase in fuel prices, it would not be unreasonable to expect a 1.5% increase in worktrip mode share and a 1% increase overall. That would translate into roughly 1.1 million new transit trips.

Urban bus routes and commuter express routes operated by GMT and other providers in Vermont could easily accommodate a 10% increase in ridership without having to operate additional buses. However, a 50% increase in ridership would lead to overcrowding in peak periods and would require additional service. Not every route would need extra service and some degree of crowding may be acceptable. Thus, it is assumed that service would need to expand by 10% to avoid severe overcrowding. Of course, a doubling in fuel prices would also affect the operating costs of transit providers, but fuel currently accounts for only about 8% of the operating budget of GMT, so a doubling of fuel prices would increase their bottom line expense by about that same 8%.

Even with the increased costs, the additional riders would cause the net cost per passenger to drop. At the lower end of the range (10% increase), it would drop from $4.64 to $4.59 and at the higher end, it would drop from $4.64 to $3.47. Total gross operating cost for the current amount of service would be $13.8 million and for the increased level of service, $15.2 million.

#### Rural Service

The ridership response in rural areas is likelier to be more limited than in the urban area because bus service is generally less available. As in the urban area, rural commuter routes would be more likely to see a significant ridership gain than other rural and small town local services, since they tend to travel longer distances and thus would afford their riders more substantial savings on fuel.[[14]](#footnote-15) Using the same lower-bound elasticities for local and commuter routes, respectively, yields an overall ridership gain of 154,000.

Comparing that estimated ridership increase to the number of trips generated by people in the 18-24 and 25-64 age group who live outside of Chittenden County, indicates that 150,000 riders is only about 0.7% of the annual non-auto trips made by people in those groups. After discounting 60% of the 18-24 year-olds, 90% of the 25-64 year-olds above the poverty line and 70% of the 25-64 year-olds below the poverty line, there are still about 21.5 million annual trips made by this group. In the urban area, the tiny percentage suggested that the switch to transit may be much larger, but in the rural area, the fact is that the great majority of residents do not have access to a bus route and so could not switch even if they wanted to. The upper bound is therefore likely to be much lower than the figure in the urban area. Rather than a figure 5 times higher than the lower bound, the upper bound in the rural area is likely to be no more than twice the lower bound, or about 300,000 riders.

With these more moderate ridership increases of 11% at the lower bound and 22% at the upper bound, capacity is not an issue for rural services. Thus, the only cost increase faced by the transit providers would be the more expensive fuel. The portion of the operating budget attributable to fuel is somewhat higher in rural areas because the overall operations are smaller. A 10% rate is a reasonable estimate based on the budget of Advance Transit. Using that rate, the net cost per passenger for rural services (excluding demand response) would drop from $8.84 to $8.74 with the lower-bound estimate, and to $7.95 with the upper bound estimate. Total gross operating cost for these rural services would be $14 million.

### Scenario 2 – Low Fuel Prices

While fuel prices are relatively low now, they could go even lower. As fuel prices have dropped over the past five years, transit agencies nationally have seen their ridership decrease.[[15]](#footnote-16) As most of the research points out, fuel prices are not the only factor affecting transit ridership, but there is an undeniable correlation between the drop in fuel prices since 2014 and the decline in transit ridership. If fuel prices were to go even lower, dropping by 30% to under $2 per gallon, what would be the impact on transit?

It is already the case that the majority of riders on bus routes in Vermont are there because they did not have a car available for that trip. Passenger survey data is not available for the entire state, but surveys taken in 2017 in the GMT and Advance Transit service areas show that 79% of GMT-Urban, 84% of GMT-Rural and 69% of Advance Transit (Vermont routes only) did not have a car available for the trip on which they were surveyed.[[16]](#footnote-17) Furthermore, the percentage of transit-dependent riders rose in all surveys by 10 to 15 percentage points from the prior survey (taken in 2014 or 2015), indicating that many of the non-transit-dependent riders who had used the bus when gasoline prices were higher were no longer riding by 2017. Express commuter routes operated by CCTA/GMT have much lower percentages of transit-dependent riders, but even these routes have fewer choice riders than before. In 2014, only 32% of riders on LINK Express and Commuter routes operated by CCTA did not have a car available for their trip. By 2017, that figure had jumped to 43%, and it is likely even higher in 2019.

The fact that people who could have driven make up only 15-30% of riders on transit systems in Vermont suggests that the impact of a drop in fuel prices would be limited to that range. Indeed, it is very unlikely that all of these riders would stop riding the bus since gasoline price is only one cost factor that they face, and because many of them use the bus for other reasons, such as environmental concerns, avoiding traffic and parking hassles, and using the commuting time productively.

Employing the same elasticities used in the prior section (+0.12 for local routes and +0.3 for commuter routes) translates into a 4% ridership loss for local routes and a 9% loss for commuter routes if gasoline prices should drop 30% to $2 per gallon.

#### Urban Service

Applying those elasticities to the FY2018 ridership for urban local routes and express commuter routes results in a 76,000 trip loss for the former and and 20,000 trip loss for the latter, summing to 96,000 lost trips overall. These losses would raise the net cost per passenger of the remaining trips.

The operating cost of the transit providers would drop moderately as a result of the cheaper fuel. Multiplying the 30% drop in prices by the 8% portion of the budget represented by fuel yields a 2.4% savings in the total operating budget.

The combination of the loss in ridership and the lower operating expenses yields a net cost per rider of $4.75, about 11 cents higher than the FY2018 baseline. The gross operating cost would drop to $12.5 million.

#### Rural Service

Applying those elasticities to the FY2018 ridership for rural local and commuter routes results in a 42,000 trip loss for the former and and 25,000 trip loss for the latter, summing to 67,000 lost trips overall. These losses would raise the net cost per passenger of the remaining trips.

The operating cost of the transit providers would drop moderately as a result of the cheaper fuel. Multiplying the 30% drop in prices by the 10% portion of the budget represented by fuel yields a 3% savings in the total operating budget.

The combination of the loss in ridership and the lower operating expenses yields a net cost per rider of $9.02, about 18 cents higher than the FY2018 baseline. The gross operating cost would drop to $11.9 million.

### Scenario 3 – Changed Technological Landscape

While technological advances have been affecting people’s lives and livelihoods for decades, the impacts on public transportation have accelerated quickly in the last five years. For instance, real-time passenger information systems have been around since the early 2000s, but those early systems were expensive and required significant investments to get the information on vehicle locations and arrivals into the hands of passengers. With the widespread availability of smartphones in the past few years, however, the cost to provide real-time information has dropped precipitously and transit agencies no longer need to install video screens and message boards at stops to tell passengers when the next bus will arrive.

Better information is not the only major change brought about by technology. Automakers and technology companies are working hard to implement autonomous vehicle technology, and eventually this technology will find its way into buses and other transit vehicles. In addition, companies such as Uber and Via have been working on algorithms to create shared-ride trips in real time. The old model of having to call 24 or 48 hours in advance to request a trip is giving way to the new model of using a smartphone to request a trip 15 minutes hence and then the database engine creating driver manifests in real time that maximize the efficiency of fulfulling all outstanding trip requests. The drivers receive those manifests via tablets in their vehicles, and these are updated constantly.

There is no way to forecast precisely how these technological advances, and others that have not even been thought of yet, will affect public transit over the coming decade. Fully autonomous vehicles are still several years off, and they are most likely to be available in urban areas well before than can navigate the dirt roads that are prevalent in most rural areas. An optimistic forecast would say that by 2029, 10% of bus service in the urban portion of Vermont would be operated by autonomous vehicles. While there would be expenses associated with their implementation, the autonomous buses would allow for a reduction in the labor cost of bus operators. Since bus operator labor accounts for about 50% of the total operating budget of GMT, this technological change would result in a 5% reduction in operating costs. The net cost per rider would drop from $4.64 to $4.36.

A larger impact could be seen on the demand side, where widespread and accurate real-time information and a much more convenient way of requesting demand-response rides could make service more attractive and efficient. To date, there has not been a large amount of research on the effects of real-time information on ridership, especially outside of large metropolitan areas. A study in New York found that the availability of real-time information increased ridership by about 2%.[[17]](#footnote-18) One could theorize that real-time information could have a larger impact in small urban and rural areas where service is more sparse and fewer people are aware of the service.[[18]](#footnote-19) If it were possible to make people more aware of the existing service, and if people knew exactly where the bus was and when it was going to arrive, it is possible that more people would choose to use it. Thus, for the purpose of this study, it is assumed that real-time information applied to every route in Vermont would lead to an increase in ridership of 5%. In the urban area, the net cost per rider would drop from $4.64 to $4.37. In the rural area it would drop from $8.84 to $8.42. The combined impacts of autonomous vehicles and better information in the urban area would reduce the net cost per passenger to $4.10.

A wholly new way of requesting and scheduling rides could transform demand-response services in Vermont. The impacts are most likely to be felt in small towns and moderate density areas where there would be enough demand to lead to more efficient use of demand-response vehicles. The productivity of these services is currently low, with a statewide average of 2.4 boardings per vehicle hour (a person boarding every 23 minutes on average). Making ride scheduling easier would both increase demand for the service (more people would find it convenient) and increase efficiency (more riders could be grouped together on the same trips). If members of the general public began to use demand-response service for local trips, perhaps in a microtransit model such as that proposed for Montpelier, productivity could rise substantially. For the purpose of this study, it is assumed that overall demand response productivity rises by 50%, excluding the Northeast Kingdom, the most rural portion of Vermont where the vast majority of trips are carried in volunteer driver vehicles. It is further assumed that half of the productivity increase is due to more demand and half is due to more efficient scheduling (thereby reducing revenue hours operated). The result of these assumptions is that productivity would rise to 3.6 boardings per vehicle hour and the cost per trip would drop from $21 to about $14. Gross operating costs (excluding volunteer driver trips and Medicaid trips) would drop from about $3 million to about $2.5 million.

### Summary

The impacts on net cost per rider and gross operating cost for each scenario are summarized in the table below. High fuel prices have the greatest potential impact on cost effectiveness, but technology could have a very significant impact on demand response transportation.

|  |  |  |
| --- | --- | --- |
| **Scenario** | **Urban** | **Rural** |
| Baseline net cost per rider | $4.64 | $8.84 |
| Baseline gross operating cost | $12.8 million | $12.7 million |
| 1 – High fuel prices net cost per rider | $3.47 to $4.59 | $7.95 to $8.74 |
| 1 – High fuel prices gross operating cost | $13.8 to $15.2 m | $14 million |
| 2 – Low fuel prices net cost per rider | $4.75 | $9.02 |
| 2 – Low fuel prices gross operating cost | $12.5 million | $12.3 million |
| 3 – Technology net cost per rider | $4.10 | $8.42 |
| 3 – Technology gross operating cost | $12.2 million | $12.7 million |

1. It is recognized that portions of Chittenden County are rural, and portions of the rest of the state qualify as urban clusters or micropolitan areas, but given the large amount of uncertainty associated with the rest of the analysis, it made no sense to rework the numbers based on these distinctions. [↑](#footnote-ref-2)
2. Note that the ACS is conducted continually through the year and these figures reflect a five year average. Thus, even though it might be obvious that fewer walking and biking commutes happen in the winter than in the summer, the overall percentages already reflect this seasonal variation. [↑](#footnote-ref-3)
3. <https://www.vtpi.org/nmt-tdm.pdf> [↑](#footnote-ref-4)
4. The statewide reported total for FY2018 was 4,742,202, but that includes 452,000 trips on tourism services—bus routes serving Sugarbush, Killington and Mt. Snow during the ski season. For the purpose of this analysis, we are focusing on Vermont residents and the services that meet their daily travel needs. [↑](#footnote-ref-5)
5. As medical technology improves, people with disabilities tend to live longer, resulting in an expansion of this population over time. According to the 2017 Disability Statistics Annual Report (<https://disabilitycompendium.org/sites/default/files/user-uploads/2017_AnnualReport_2017_FINAL.pdf>) the number of people with people with disabilities in the US increased from 11.9% in 2010 to 12.8% in 2016. That represents a 7.5% increase in 6 years, but includes people over 80. There are no official forecasts for the coming decade, but it seems reasonable that a 10% increase over ten years, excluding people over 80, is well within the realm of possibility. [↑](#footnote-ref-6)
6. People 65 years of age in 2029 represent the tail end of the Baby Boom generation, thus the overall size of the cohort should remain relatively stable. [↑](#footnote-ref-7)
7. The difference between the 3.8 million trips combined and the 4.3 million transit trips referred to earlier is primarily the volunteer driver trips (458,000 in FY2018). [↑](#footnote-ref-8)
8. As with the ridership figures, these cost figures exclude intercity, tourism and volunteer driver services. [↑](#footnote-ref-9)
9. <https://www.eia.gov/outlooks/steo/realprices/> [↑](#footnote-ref-10)
10. <http://chicagopolicyreview.org/2013/10/17/rising-fuel-costs-drive-up-carpooling-rates/> and <https://pdfs.semanticscholar.org/c735/72e50808b6dc6cb4d32f7a1f33b4644d7a43.pdf> [↑](#footnote-ref-11)
11. <https://www.vtpi.org/tranelas.pdf> [↑](#footnote-ref-12)
12. Elasticities are applied in a non-linear equation so that it is not a straight relationship of 10% translating to a 1.2% increase. [↑](#footnote-ref-13)
13. Figures drawn from internal memos prepared by Steadman Hill Consulting for CCTA/GMT. [↑](#footnote-ref-14)
14. Demand-response service is excluded from this analysis because it is assumed that there are virtually no choice riders on demand-response service. [↑](#footnote-ref-15)
15. <https://www.govtech.com/fs/transportation/2018-Was-the-Year-of-the-Car-and-Transit-Ridership-Felt-It.html> and <https://fas.org/sgp/crs/misc/R45144.pdf> [↑](#footnote-ref-16)
16. All survey data statistics from memos and reports prepared by Steadman Hill Consulting for GMT and AT. [↑](#footnote-ref-17)
17. <https://www.sciencedirect.com/science/article/pii/S0968090X15000297> [↑](#footnote-ref-18)
18. Most bus routes in New York are very frequent so that it does not matter when a passenger arrives at the bus stop. For a bus that runs once or twice per hour, having precise information about the arrival time could make a big difference in whether people would be willing to ride, since the penalty for missing the bus is a much longer wait. [↑](#footnote-ref-19)