Sustainability, Scalability and Resiliency of the Town of Innisfil Mobility-on-Demand Experiment: Preliminary Results, Analyses, and Lessons Learned

Preprint

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National Renewable Energy Laboratory

Presented at the International Conference on Transportation and Development
Seattle, Washington
May 31-June 3, 2022

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Operated by the Alliance for Sustainable Energy, LLC

Conference Paper
NREL/CP-5400-80754
April 2022

Contract No. DE-AC36-08GO28308

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Suggested Citation
Weigl, Dustin, Josh Sperling, Alejandro Henao, Andrew Duvall, and Stanley Young. 2022. *Sustainability, Scalability and Resiliency of the Town of Innisfil Mobility-on-Demand Experiment: Preliminary Results, Analyses, and Lessons Learned: Preprint*. Golden, CO: National Renewable Energy Laboratory. NREL/CP-5400-80754. https://www.nrel.gov/docs/fy22osti/80754.pdf.

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April 2022

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303-275-3000 • www.nrel.gov

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Sustainability, Scalability and Resiliency of the Town of Innisfil Mobility-on-Demand Experiment: Preliminary Results, Analyses, and Lessons Learned

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Abstract

In 2017, the Town of Innisfil, Ontario launched Innisfil Transit in partnership with Uber, a transportation network company, to provide a subsidized on-demand public mobility service as an alternative to investing in a new fixed-route bus service. The performance of Innisfil Transit is documented in a 2021 Ryerson University report which shows greater cost effectiveness of the mobility provided over the proposed bus alternative[1]. This paper expands on those findings by assessing Innisfil Transit with respect to sustainability, scalability, and resiliency. First, we quantify the energy and emissions of this program relative to traditional transit and driving alone across varying powertrains. We then characterize a conservative first-order estimate of the percentage of US communities that fall within a similar spatial-demographic tier as Innisfil. Replicability also hinges on service cost and performance in comparison to average values for low-density transit in the US. Lastly, most transit agencies experienced a significant drop in demand (as much as 90%) with slowly rebounding ridership since the onset of the COVID-19 pandemic. The resiliency of the Innisfil program to the pressures induced by the pandemic is examined in comparison to other transit operations. The lessons learned across these three dimensions complement prior work to better understand the efficiency and sustainability of on-demand public mobility service for low-density communities like Innisfil.

Word Count: 7381

Key words:
Mobility on Demand, Transport Network Companies, Transit, COVID-19 Recovery, Small Urban and Rural

Author Contribution Statement
The authors confirm contribution to the paper as follows: study conception and design: D. Weigl, J. Sperling, A. Henao, A. Duvall, S. Young; data collection: D. Weigl, J. Sperling, A. Henao; analysis and interpretation of results: D. Weigl, J. Sperling, A. Henao, A. Duvall, S. Young; draft manuscript preparation: D. Weigl, J. Sperling, A. Henao, A. Duvall, S. Young. All authors reviewed the results and approved the final version of the manuscript.

1. Introduction

Pathways toward new energy-efficient mobility and on-demand transit often include public-private partnerships, and, most recently, with on-demand and ride-hail concepts with private companies. To date, few analyses have considered the sustainability, scalability, and resilience of such an industry partnership for new on-demand mobility in a small community. Although transportation researchers have studied ride-hailing and transit extensively, there has been limited attention paid to redesigning public-private mobility partnerships in smaller communities. Small cities and communities from 25,000 to 75,000 residents as examined herein, typically lack high quality public transit, yet some have identified the local need and benefits of mobility services. The goals of these services include: "greater mobility for seniors, youth, people with disabilities and other non-drivers; increased affordability of transportation for residents who struggle with the costs of vehicle ownership and use; support for active transportation, physical activity, and public health; to resident and business attraction and retention"[2].

An initial representative case exploring these benefits is the town of Innisfil, Canada, with a population of approximately 40,000 people and located about 100 kilometers north of Toronto. Having experienced population growth over the past decade, the city considered two bus services after conducting a feasibility study. Ultimately, the town of Innisfil decided to pursue an alternative system and approached a ride-hailing company for an on-demand transit service concept. The resulting service with Uber – named Innisfil Transit for this study – began in May of 2017 and established a new partnership for the delivery of mobility services to a small community. The service provides up to 30 publicly subsidized monthly trips per resident. For trips to "key destinations", riders pay a $4-6 flat fare or for trips to any other custom destination in the service area, Innisfil Transit subsidizes the Uber trip cost by $4.

While the previous study by Sweet, Mitra, and Chemilian (2020)[2] concluded that Innisfil Transit offers substantially greater accessibility to users compared to the bus options; this study includes three additional components to completement the understanding of this public-private partnership by:

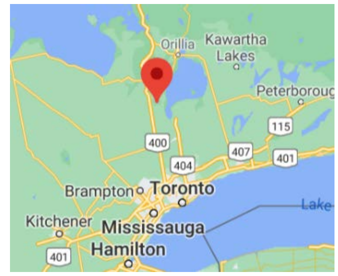
- Evaluating relevant sustainability metrics for Innisfil Transit
- Estimating potential scalability of the system in the U.S.
- Exploring the resiliency and adaptability of the on-demand transit system during COVID-19

1.1 Rationale: Why Study Innisfil?

Providing an accessible public transit system and inclusive new mobility choices is an aspiration for many smaller communities. A couple recent studies and related news articles[1,3] have noted the success of Innisfil in providing accessible public mobility services despite its low population density. The recent Ryerson University analysis came to three main conclusions relevant to the analysis presented in this paper, which compares the Innisfil experiment to the bus system that was proposed in the Innisfil Transit Feasibility Study:

- The accessibility that Innisfil Transit offered the town's residents was approximately four times higher on average than the bus network alternative (measured in terms of how many residents were accessible for a given travel time or price). The accessibility for the bus study considered only the spatial accessibility of the proposed fixed bus routes to that of the on-demand system that covers the entirety of the town without considerations for the attractiveness of on-demand service nor differences in hours of operation.
- Levels of accessibility were provided at a cost per passenger comparable to both the Innisfil bus option and to comparable bus networks serving areas with fewer than one million residents.
- The ridership for Innisfil Transit was approximately three times as high as the estimated ridership for the bus options considered by Innisfil.

1.2 Case Study Description, Primary Research Questions and Study Organizational Structure



The town of Innisfil has a population of approximately 40,000 people and is located approximately 100 kilometers north of Toronto. With a partnership that enabled residents and visitors of Innisfil to travel within the town and to specific destinations, the three primary research questions for this study included exploring:
a) What are the sustainability impacts of a partnership between a small city transit agency and a transportation network company?
b) What is the potential for scalability for similar size population communities in the United States?
c) How did this system fare in the pandemic relative to other public mobility systems?

Historically, most smaller cities and communities the size of Innisfil have had very limited local public transit services. This paper therefore aims to enumerate the risks and benefits associated with implementing on-demand transit in low-density areas. This is further motivated by estimates indicating smaller towns, cities, and rural counties (of population under 75,000) make up one third of the population in the United States[4] (see Table 6). The paper is divided into the following sections: literature and current practice review, preliminary results on sustainability, scalability, and resilience, and implications for further use of this model in the US and directions for future research.

2. Literature Review

The literature review covers two perspectives to characterize the provision of low-density public transportation service with a focus on this new mobility on-demand model. First, we review the key challenges and opportunities of the current state of practice for mobility in low-density U.S. cities. Then a summary of "What's out there like Innisfil in the US?" is included to provide a more complete context to the introduction of the Innisfil Transit experiment.

Key Challenges and Opportunities for Small City and Rural Mobility

Table 1 provides a summary of key recent publications describing the benefits and risks of current state of practice for transit and mobility options in smaller cities and rural communities. The literature identified is consistent in noting that most of these communities' mobility options are very limited beyond privately-owned vehicles. The exceptions are those recently considering emerging public mobility services such as electric vehicle car sharing or first-last mile shuttle services[5,6]. Measurable improvements have been noted based on these strategies, providing an important evidence base for decision-making. However, in many cases the factors driving these outcomes can be quite complex, and are confounded by socio-economic status, destination accessibility, and transport costs associated with new mobility services.

Table 1. Review of benefits and risks of improving small city mobility

Factors Considered	Literature review of benefits/opportunities	Literature review of risks and key challenges
Transportation / Mobility	Low-income, small city populations – access to employment, education, food, health services[7,8]. In the 30 largest U.S. cities, 60% of welfare population resides outside the urban counties; mobility could improve economic outcomes for these communities[9].	Due to aging in place[10,11] there is limited access to broadband, digital connectivity, transit, telemedicine[12,13]; Isolation, lower community connectivity[14]; limited financial capital/human resources to manage or drive new services; limited demand for new services due to private ownership model[15].
Energy Efficient Mobility and Transportation Electrification	Electric vehicles (EVs) enable lower operation/maintenance cost, less fuel dependency[16], system operations predictions for improved allocation and more passenger miles traveled per vehicle miles traveled[17], expanded coverage services (geographical areas and times of day)[18], new jobs in on-demand, flexible route options[19].	Passenger costs for on-demand services tend to be more expensive than transit, and for private vehicles, it depends on use; lock-in to inefficient choices and limited changes to energy production/ consumption; concern for jobs in resource extraction locales.

Factors Considered	Literature review of benefits/opportunities	Literature review of risks and key challenges
Affordability / Accessibility / Equity	Less of income spent on transportation and housing[20]; more populations served, especially older adults and persons with disabilities for healthcare access[21]; stronger social networks[22]	Delaying healthcare checkups; distribution options are limited for food to larger markets; lack of mobility for aging populations[8].

What's out there that's like Innisfil in the US?

Several similar services are emerging in some rural to suburban locations of varying population sizes, with outcomes that may be important to the evolution of new public transportation and on-demand mobility services. These services can be compared to Innisfil with a growing population from 30,000 in 2001 to approximately 38,000 in 2020. Highlighted below are a few recent examples:

Bastrop, TX – the Capital Area Rural Transportation System (CARTS) launched in January 2021 a fleet of vans operating as low-cost ($2), on-demand ride services in an extended service area that covers the entire City of Bastrop (estimated population of 8,776). Electric cab rides are also offered at no cost, via a partnership with Lone Star Clean Fuel Alliance and a grant provided by the US Department of Energy. Trained, certified drivers are used – with plans to serve non-urbanized areas of nine Central Texas counties (and with Bastrop County as the initial location for testing).

Wilson, North Carolina: A service called RIDE services this city of 50,000 and has partnered with the pooled mobility service platform Via to provide subsidized rides for Wilson residents. The on-demand service replaced an existing fixed route bus service for the city in September 2020. Although operations are primarily restricted to regular business hours during the week, trips are a flat fare of $1.50 and will match riders traveling along similar routes for pooled trips. This is a relatively new service for Via and largely diverges from their other partnerships which have connected primarily with dense urban areas such as Chicago and New York City. It began with funding from the Federal Transit Administration's Accelerating Innovative Mobility (AIM) fund which provided $250,000 of federal funding for a "more targeted... on-demand rural microtransit service" in place of the bus network[23].

Pinellas County, Florida: A second allocation from the AIM fund went toward bolstering the mobile app for the Direct Connect program for this county in Florida. Since 2015, the program has provided subsidized Uber trips to or from 26 bus stops to provide first/last mile connections to existing county bus network[24]. While the region is more populous than Innisfil (by a factor of ten), it is not densely populated, and therefore making traditional transit services unattractive. Additionally, seasonal tourism is significant for the region so service flexibility by time of year has been identified as important for reducing costs without sacrificing the level of service for year-round residents.

San Joaquin Valley, California: An EV carsharing pilot, called Míocar, was launched in August 2019 to explore the potential of the service to offer a cost-effective mobility option for residents of rural disadvantaged communities and help reduce greenhouse gas emissions; "keeping two (or sometimes even one) car in reliable working order can consume an estimated 22% to 56% of the household budget for low-income families"[6]

Belleville, Canada: In September 2018, City of Belleville (est. population: 50,000) in Canada (near Toronto, two hours away) started an on-demand transit pilot project, where the late-night fixed-route (RT 11) was substituted with the on-demand transit providing a real-time ride-hailing service; "areas with higher population density, lower median income, or higher working-age percentages tend to have higher [on-demand transit] trip attraction levels, except for the areas that have highly attractive places like commercial areas."[25]. More than 15 Canadian municipalities are now exploring route optimization software to help deliver on-demand transit, improved mobility and maximize fuel efficiency. One outcome noted was the prior fixed bus route "proved too sporadic to make a difference for many riders"[26].

Based on the reviewed literature and real-world application examples noted above, Innisfil Transit is unique in that (1) it is the longest running public-private partnership for on-demand public mobility, (2) was instituted as an operational system rather than a demonstration or pilot, and (3) provides end-to-end service to the community (though Bastrop is similar), rather than concentrating on first/last miles service to establish fixed-route transit service. As such, Innisfil presents a unique and valuable case-study for the effectiveness of such a novel approach for similar municipalities in the US.

3. Methods

A case study of Innisfil was conducted to explore the extent to which sustainability, scalability and resiliency to COVID-19 can be reasonably quantified with available data. Where data may be lacking (e.g. types of vehicles, deadheading rates, adoption rates of new services), the authors make reasonable assumptions based on previous literature. The key metrics associated with these three areas are described below:

- **Sustainability:** Data are collected and analyzed to assess energy use and emissions for vehicle and passenger miles traveled across the variety of options considered at Innisfil.
- **Scalability**: Associations are identified between the case of Innisfil and other U.S. communities. This includes determining how representative the Innisfil case might be and the size of potential similar deployments in the US that could use Innisfil as a template for provision of new public mobility services.
- **Resiliency with respect to COVID**: The financial and operations performance of the Innisfil transit are compared to other rural public transit systems to inform on financial resiliency and adaptability within the context of the COVID-19 pandemic.

4. Results

The next three sections present preliminary analysis and results on: Sustainability (section 4.1), Scalability (section 4.2), and Resilience (section 4.3).

4.1 Sustainability

For each of the scenarios outlined below, we present metrics of sustainability including the annual vehicle miles traveled (VMT), passenger miles traveled (PMT), fuel used, and associated annual CO_2 emissions on a system-wide and per 100 PMT basis. The definitions and basic assumptions underlying these scenarios are as follows and summarized in Table 2a with outputs based on these assumptions in Table 2b:

Baseline: The annual travel demand that was met by Innisfil Transit would instead be met through privately-owned single occupancy vehicles.
Current: A characterization of the current Innisfil Transit system based on the operational statistics (summarized in Table 3) provided in Sweet, et al. 2021[1]. Average occupancy assumptions are based on findings in Henao 2019 and are a worst-case estimate as Innisfil reports high rates of trip sharing[27].
EV: Uber meets its commitment to 100% electrified transport by 2030- all trips on Innisfil Transit are made with electric vehicles with the same operational characteristics as the Current scenario.
EV Efficient Ops: Expanding on the EV scenario with higher operational efficiencies resulting in an assumed higher average trip occupancy.
1 Bus and 2 Buses: These two scenarios characterize the two bus routes that were considered as alternatives to the Innisfil Transit Uber partnership and as described in Sweet, et al. 2021[1]. These buses are assumed to run on diesel fuel (based on the $200,000 cited price per vehicle).
2 EV Buses: An expansion of the 2 Buses scenario with the buses running on electricity rather than diesel fuel.

Assumptions by Scenario	Baseline	Current	EV	EV Efficient Ops	1 Bus	2 Buses	2 EV Buses	Source
Annual Trips/Ridership	79,118	79,118	79,118	79,118	22,200	37,000	37,000	Sweet, et al., 2021
Average Occupancy	1.0	0.8	0.8	1.2	4.5	4.5	4.5	Sweet, et al., 2021
Fuel Economy [mi/gge]	22.0	26.0	100.0	100.0	5.0	5.0	13.3	*See Notes below
Emissions [lbs CO2/gge]	19.6	19.6	31	31	22.4	22.4	31	**See Notes below
Annual VMT	278,101	347,627	347,627	231,751	69,369	91,047	91,047	Sweet, et al., 2021

Notes:
*Average in-use U.S. private light-duty vehicle fleet fuel economy used for Baseline[28]. Fuel economy for Current scenario assumed to be Uber average of 18% higher than the overall vehicle fleet[29]. EV fuel economy based on the Transportation Annual Technology Baseline mid projection value for 2030[30]. Diesel bus based on average speed of 20 mph and associated fuel economy value from Figure 1b of Wei, et al., 2017[31]. EV Bus fuel economy sourced from Eudy, 2018 Figure 2-13[32].

**Baseline and Current scenario emissions sourced from EIA, 2016 pounds of CO_2/gallon gasoline or diesel. EV emissions follow an assumed .92 pounds of CO_2/kWh average carbon intensity of electricity generation for the US[33].

Outputs by Scenario	Baseline	Current	EV	EV Efficient Ops	1 Bus	2 Buses	2 EV Buses
Annual PMT [mi/year]	447,466	447,466	447,466	447,466	312,160	409,711	409,711
Annual Fuel [gge/year]	12,640	13,390	3,476	2,317	13,873	18,209	6,845
Annual CO2 Emissions [mt CO2/year]	112	119	48	32	140	184	96
Average CO2 per 100 PMT [mt CO2/100 mi]	0.025	0.027	0.011	0.007	0.045	0.045	0.023

From this comparison, we can see the two bus options have higher annual CO_2 emissions and provide less than half the number of trips as the on-demand options (albeit a higher share of PMT due to less direct routing than the on-demand options). These trip counts are estimates from the bus system analysis projection made before the Uber partnership was selected and implemented so they may underestimate the bus system's potential usage. However, with 63% of the on-demand trips occurring outside of the proposed bus operating hours it is unlikely the bus ridership could have approached the Innisfil Transit demand without expanding operating hours which would also increase annual emissions[1].

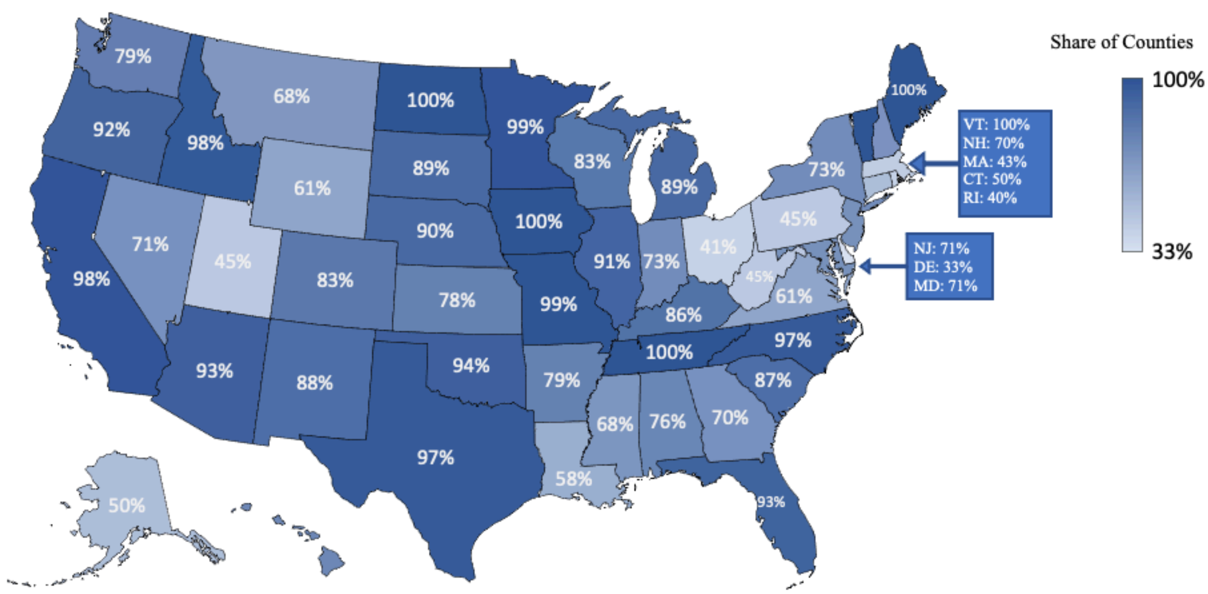
Additionally, we see the estimated Innisfil Transit emissions in the Current scenario are marginally worse than individuals continuing to use their personal vehicles (Baseline scenario). Although deadheading reduces the efficiency of the service, the 18% higher average fuel efficiency of Uber vehicles[29] offsets most of those additional emissions. The assumed average occupancy is also likely a worst-case estimate. Innisfil Transit riders must be willing to share their ride, resulting in a reported shared trip match rate of ~50% from November 2019 until trip matching ended on March 17, 2020, at the start of the Covid-19 pandemic. This is a significant increase over traditional Uber operations which, based on findings from Chicago in Hou, et al. 2020[34], have a willingness to share rate of ~24% and ~72% of those trips are matched- resulting in an overall match rate of 17%. Therefore, it is likely that the average trip occupancy is higher than assumed in the Current scenario depending on the deadheading mileage of Innisfil Transit drivers. Finally, both EV scenarios (EV and EV Efficient Ops) result in the lowest emissions by far both on an annual and per 100 PMT basis, indicating that similar programs will become more attractive as Uber works towards its goal of a 100% electrified vehicle fleet by 2030[29]. Additional analysis on the potential emission savings these scenarios might offer across the United States are presented in the next section (Figure 4).

4.2 Exploring scalability and replication potential; and impacts of deployment 'at-scale'

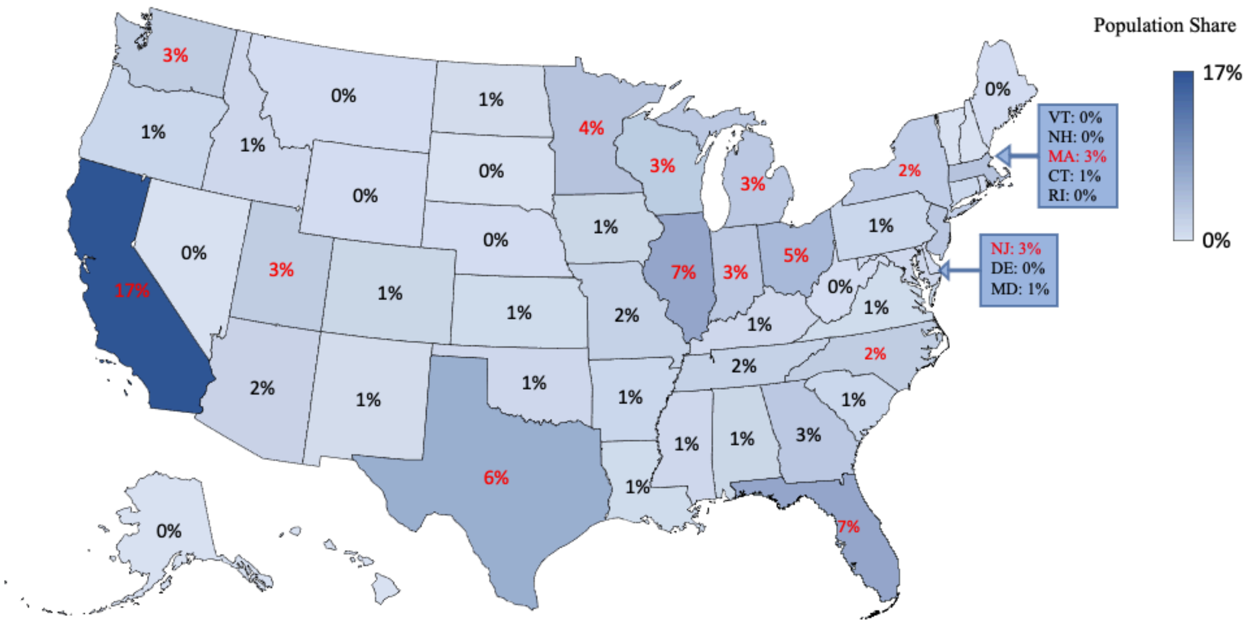
In evaluating expansion of the Innisfil experiment to locations around the United States, it is important to consider what systems are already in place in rural areas. The 2020 Rural Transit Factbook reports that in 2018, there were 1301 rural transit agencies (defined as having received 5311 Non-Urbanized Area Formula Program funding, populations less than 50,000, and a density less than 1,000 residents per square mile) in the US, representing 82% of counties nationwide[21]. As a comparison, Table 3 presents the population and count of incorporated places in the US with populations in various buckets from under 25,000 to greater than 75,000. The places ranging between 25,000-75,000 could be considered locations potentially suitable for a rollout of Innisfil-like systems. The population living in these areas totals 44.3 million or over 13% of the total US population.

	<25k	25-35k	35-45k	45-55k	55-65k	65-75k	25k-75k Total	>75k	Total
Number of places	17,978	414	246	157	124	102	1,043	477	20,064
Population	53,305,185	12,199,923	9,767,672	7,873,337	7,381,402	7,084,812	44,307,146	109,234,958	251,154,435
Percent of Population (US Places)	21%	5%	4%	3%	3%	3%	18%	43%	100%

Figures 1a and 1b inform the regional relevance of an Innisfil-like service in states across the U.S. Figure 1a maps the percentage of rural counties by state with pre-existing transit services, ranging from 41-100% of counties. 17 states have transit service in more than 90% of rural counties while just 9 are at 50% or below. While these shares are high, the levels of service in the rural counties tallied could be very limited- for example, a county could be included if a regional bus company provides intermittent service to a handful of county stops. While states with low shares of rural transit service such as Utah or Ohio could benefit greatly from the rollout of Innisfil-like programs, given the potential variability in the quality of these services, many of the states with higher shares could also see significant improvements.



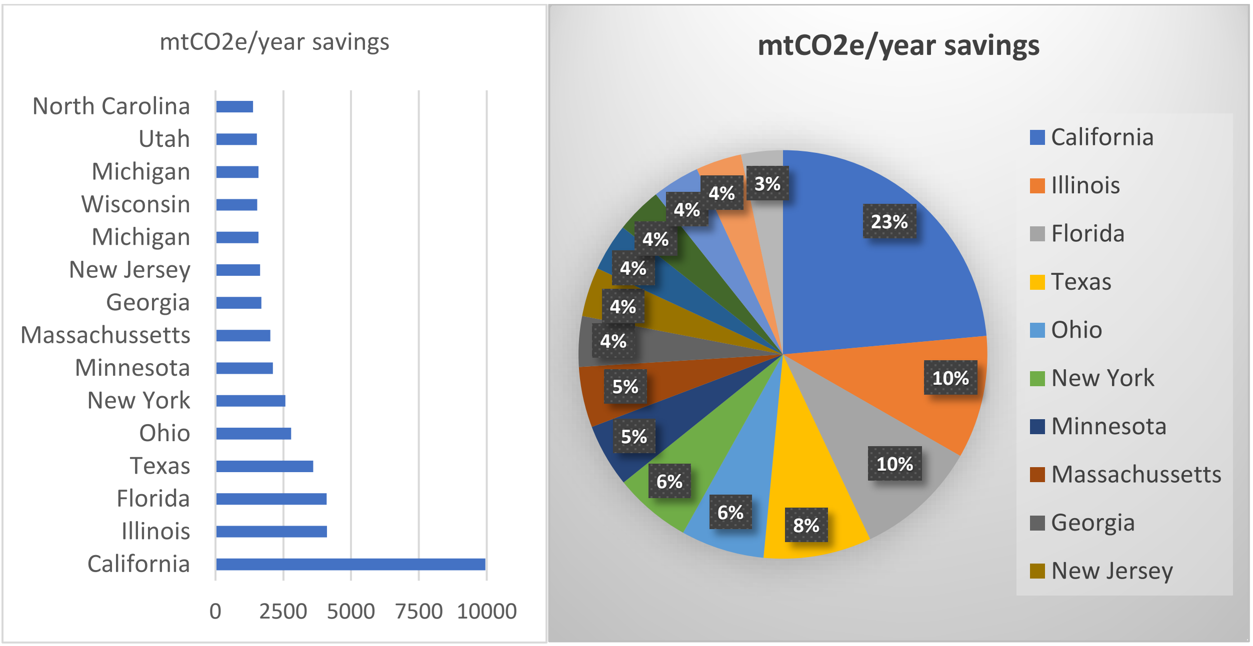
Next, Figure 1b maps the extent to which scaling potential exists in small communities by state within the bounds of 25-75k population. The percentages are a measure of what share of the national population living in these smaller communities resides in the given state. Additionally, Figure 1b identifies the fifteen U.S. states with the highest shares of this population living in small communities in-state. California has the highest share of this population with 17% of the nation's small community population.



Emissions Impacts
Figure 2 explores the potential emissions savings linked to the rollout of mobility services in communities with 25-75k population for the top fifteen states shown in Figure 3b. This analysis assumes each community uses the service according to the 'EV Efficient Ops' scenario- an electrified on-demand service with emissions impacts and operation based on the values given in Table 2b. Communities larger than Innisfil's 35k inhabitants will therefore likely show a larger annual change in emissions savings given similar levels of adoption per capita and communities of 25-35k will likely experience smaller savings.

With the greatest share of locations in this population bracket, California has the highest potential for emissions reductions via adoption of an Innisfil Transit-like system; with an annual reduction of 10,000 mt of CO_2e (carbon dioxide equivalent) the impact is akin to the annual emissions of 2100 vehicles driven at the national average of 4.6 mtCO_2e/year[35]. While this impact is relatively small compared to the reductions needed for California's climate goals, this analysis indicates that provision of electrified rural on-demand mobility services can be a win-win in terms of increasing accessibility with a small reduction in carbon footprint.

Figure 2. Estimated CO_2 emissions in mt/year and as a percent share of the 15-state total savings based on EV Efficient Ops scenario (Table 2b) for the top 15 states with greatest potential to adopt mobility services like Innisfil Transit.



4.3 Exploring resiliency impacts and implications for COVID-19 recovery and future public mobility

The COVID-19 pandemic had a sudden and drastic impact on travel behavior across the United States and the world in 2020 with transit ridership plummeting to 60% below 2019 levels[36]. This lost revenue in addition to lower state and federal tax revenue has resulted in a projected $39.3B deficit across US public transit agencies through 2023[36]. Many of these agencies operate fixed-route services and have been forced to cut back on service. While a similar decline in ridership occurred for Uber and other on-demand services, it was accompanied by an equivalent drop in incentive for gig-employed drivers to operate. The natural supply and demand balance allowed these services to respond to the rider demand shock more flexibly than traditional fixed-route services. In Chicago, for example, there were 8.9 million Uber, Lyft, and Via trips taken in April 2019 while there were under 1.5 million trips in April 2020. But for those same months, there were 7500 new drivers in 2019 whereas in 2020 there were just 2000[37].

Operating Costs

The city of Innisfil was similarly impacted by the pandemic but the flexible nature of the on-demand service has reduced its financial impact, allowing the system to scale back service organically. With both rider demand and the number of drivers down to 50% of 2019 levels through 2020, the cost of providing the service also decreased by $250,000 (30% of total costs) compared to 2019[3]. Although this difference represents an increase in cost per trip (~$8.25 in 2019 to $11.45 in 2020), this difference is due primarily to the implementation of the city's Essential Trips Assistance Program- providing free and heavily subsidized trips to essential workers during the pandemic. Furthermore, a similar scaling back of the originally proposed fixed-route bus service may have seen greater increases in per-trip costs with a similar drop in ridership due to its relatively inflexible supply of service. Additionally, cutting parts of a fixed-route service can force system users to find alternative modes of transportation if their mobility needs are no longer met (due to restricted operating hours or re-routing). Many transit agencies were also forced to halt fare collection[36] to reduce contact between system users and operators whereas contactless payment was built in to Innisfil transit from the start either through the phone app or by calling.

On costs, Innisfil Transit outperformed average operating cost of demand-response offerings from rural transit agencies in 2018 on a per trip, vehicle-mile, and vehicle-hour basis. While it is more expensive on a per trip basis than the average fixed-route options, the system is less than 60% of the cost per mile and per hour driven. This performance indicates that such a system is most appropriate for low-density regions where individuals take fewer trips per day and each trip is longer[21].

Table 4: Rural Transit Fleet Operating Costs

	Average US Rural Transit Performance			Innisfil
2018 Operating Costs	**Total**	**Fixed-Route**	**Demand-Response**	**Innisfil**
Per Trip	$ 11.41	$ 6.81	$ 18.85	$ 14.71
Per Vehicle Mile	**$ 2.90**	**$ 4.14**	**$ 2.51**	**$ 2.36**
Per Vehicle Hour	$ 51.17	$ 72.25	$ 43.67	$ 38.79

Capital Costs

The up-front cost to purchase a transit fleet is difficult for many rural regions and often requires a mix of funding sources. Of the $235.9 million in capital expenditures made by rural transit agencies in 2018, only $37.3 million was from local funding and $3.8 million was generated through farebox returns[21]. Additionally, the existing rural transit fleet is aging. 94% of fixed-route vehicles in 2018 were either buses or cutaways. Buses have gone from an average age of 6.4 in 2011 to 8.4 in 2018 while cutaways have gone from 5.4 to 6.6 in the same period[21]. As the average age of transit vehicles continues to increase, there will be a growing need to invest in replacements. Each bus purchased for the proposed fixed-route bus service in Innisfil would have cost the city $200,000. In contrast, Innisfil Transit had no capital expenditures as the vehicles used for the service are privately owned. The low startup costs of this on-demand service may make it more attractive for budget-strapped local governments seeking to add new transit services.

5. Discussion and Implications

Traditional fixed-route transit in urban areas benefits from high population density, resulting in high demand and higher vehicle occupancy. However, of the 19,498 incorporated places registered in the United States (as of July 31, 2019), ~1000 of them have a population between 25k-75k and just 477 have populations over 75k. Rural areas have a different operational paradigm making them less likely to be able to provide effective fixed-route service at a similar scale or frequency. The Innisfil Transit experiment has demonstrated that a more flexible system can adapt to this paradigm to provide an answer for the mobility needs of rural areas. The service has provided significantly higher accessibility for most of the Innisfil population at an operational cost comparable to the bus alternative with no up-front capital cost[2]. And, based on the preliminary analysis presented here, this system has the potential to increase the mobility of a significant share of the population living in rural areas in a more sustainable resilient way than traditional transit.

In addition to the operational constraints of rural areas for transit, the socio-demographics of these small cities differ from more dense urban areas. Rural places have higher shares of the population aged 65 or older, with disabilities, or below the poverty line[38]. Mobility services may be particularly important for individuals in these sociodemographic categories. Low-income individuals may be unable to purchase their own vehicle, 20% of people over 65 do not drive[39], and people of all ages with disabilities make fewer total trips and a lower share of those trips are in personal vehicles[40]. In contrast, a service like Innisfil Transit can provide door-to-door travel, representing a significant increase in accessibility for these populations at a relatively low cost and a reduced carbon footprint. This analysis shows that there is a substantial, demonstrated opportunity in the United States for suburbs and small towns that currently lack transit services to introduce new on-demand mobility through a public-private partnership similar to Innisfil Transit.

The introduction of on-demand mobility, such as transportation network companies (TNCs, like Uber and Lyft), offers many metropolitan areas and transit agencies the opportunity to explore the impacts of new service options. While TNCs may have negative impacts in terms of increased congestion and emissions by competing directly with transit in urban areas, this preliminary analysis indicates the impact in rural areas is more beneficial, especially in terms of its ability to provide effective service in low-density areas compared to traditional fixed-route transit[41,42]. And, if managed through public-private partnerships like in Innisfil, the local transit agency can work to optimize the service in terms of the split of public/private costs, service area, and hours of operation. This management can help make the service more equitable while maximizing accessibility for residents.

Finally, many in research and practice during the COVID-19 pandemic are asking what happens to transit and mobility next, given the significant drop in public transit and shared mobility ridership levels, declining revenues, and transit service cuts. Tirachini and Cats (2020) summarizes how we might "restore the ability of public transportation systems to fulfill their societal role" given the significant challenges facing transit agencies in a post-pandemic world. Ensuring systems provide sufficient service while remaining financially sustainable will be extremely difficult given the continued reductions in transit ridership since March 2020[43]. The Innisfil model offers an alternative for rural areas that can scale to meet demand while still providing high levels of service to the area's residents. Looking ahead, diverse forms of economic recovery for smaller communities may offer lessons in more adaptable systems that meet the needs and motivations of their travelers.

Furthermore, considering the continued pandemic threat (now with the delta-variant at the time of this writing), moving people in large groups continues to present a potential of contagion that more distributed or individualized transport provide some levels of protection against. Even as society is experimenting with automated mobility, the fundamental approach to delivering public mobility – either as a 'mass transit' large-vehicle ridership system, or an individualized, on-demand needs to be considered. The Innisfil Transit system provides evidence that for lower density communities like that of Innisfil, personalized, on-demand mobility service out-performs traditional bussing, while remaining price competitive.

6. Conclusion

The analysis in this study may help to determine if and how additional communities could implement public-private partnerships for on-demand transit service. While these analyses are high-level, the initial conservative estimates offer a useful starting point to determine the sustainability in terms of emissions, scalability of system rollout, and resiliency to demand shocks for Innisfil Transit-like services. The tradeoff between risks and benefits along these dimensions can be used to inform the design and operation of similar on-demand services for locations in the United States with similar characteristics to Innisfil in terms of population density and service area.

The key finding on the sustainability dimension is that TNC operations in small communities have the potential to marginally reduce emissions compared to both bus service and single-occupant private vehicles. While these differences are small, they stand in contrast to findings around the sustainability benefits of traditional fixed-route transit compared to on-demand services in urban areas. As expected, these benefits are increased with both vehicle electrification and increased average vehicle occupancy.

The United States has significant potential for scalability with 13% of the population living in locations around the country in the 25-75k population bracket. Based on the performance of Innisfil Transit, many of these locations could likely benefit from similar offerings in terms of increases in residents' regional accessibility. With 17% of the state's population living in locations of this size and as a national front-runner in the adoption of new mobility technology, California could particularly benefit from the rollout of these services. While investigation of the characteristics for individual locations is necessary for a more granular determination, this high-level accounting is a useful approximation for system scalability.

Moving forward, the challenges associated with economic recovery from the COVID-19 pandemic for transit agencies are significant. With ongoing uncertainty ahead, the importance of the operational flexibility offered by the Innisfil model relative to fixed-route service should not be overlooked. Allowing supply to rise and fall organically to meet demand could be particularly important for the continued operation of small transit agencies during a shock in demand like COVID-19. These already-limited services might risk becoming too infrequent or limited altogether if additional cuts are made. The correlation between service frequency and ridership per unit cost, means that reductions in service could lead to a transit death spiral: a feedback loop where reductions in service cause ridership to decline which leads to additional reductions in service[44]. In contrast, with no capital expenditures, the on-demand Innisfil service can scale linearly as demand shrinks or grows over time.

Future research could further explore the energy impacts, travel times, expenses and fares associated at a more granular level with future programs emerging. Questions building on this analysis include investigating how successful new mobility services such as TNCs can be in complementing existing transit service in small cities and rural areas (as most of the small communities identified in this paper have some form of existing transit services). Based on the preliminary data analysis and results for Innisfil's system, future studies could also gather different mobility metrics and gather user data to evaluate program success in comparison to other forms of transit.

Acknowledgements

The authors would like to thank Paul Pentikainen from the Town of Innisfil; Rik Williams, Chris Pangilan, and Michiko Namazu from Uber; Matthias Sweet and Raktim Mitra from Ryerson for their inputs, the data provided, and reviews. This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding was provided by the U.S. Department of Energy Vehicle Technologies Office. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

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