Photo from the town of Fort Erie.

NREL On-Demand Transit Research and Fort Erie Case Study

Presented by Bonnie Powell

Washington State Transportation Commission Meeting

March 14, 2023

NREL at-a-Glance

2,926
Workforce, including
219 postdoctoral researchers

60 graduate students

81 undergraduate students

World-class
facilities, renowned technology experts

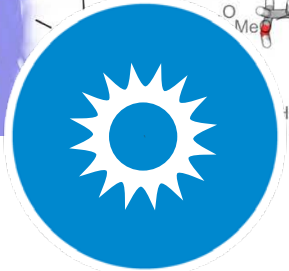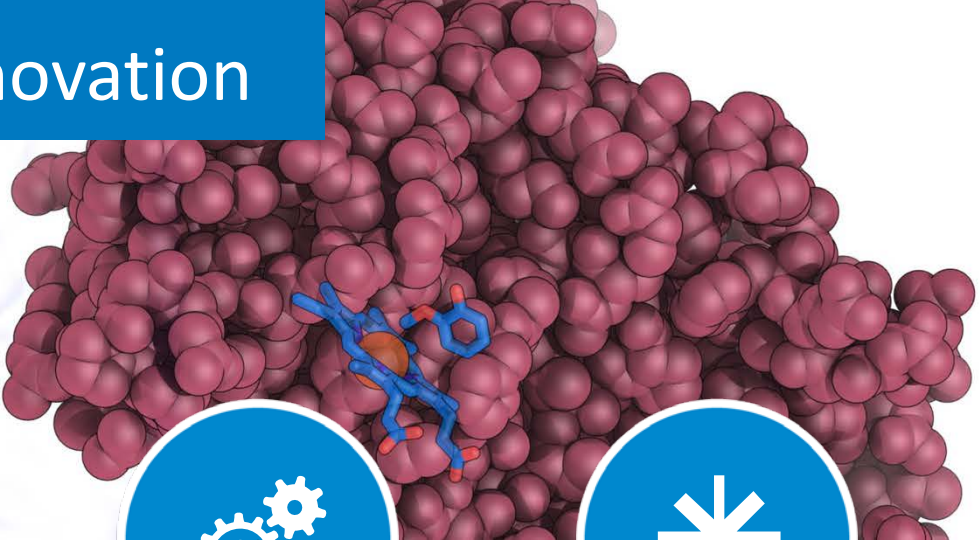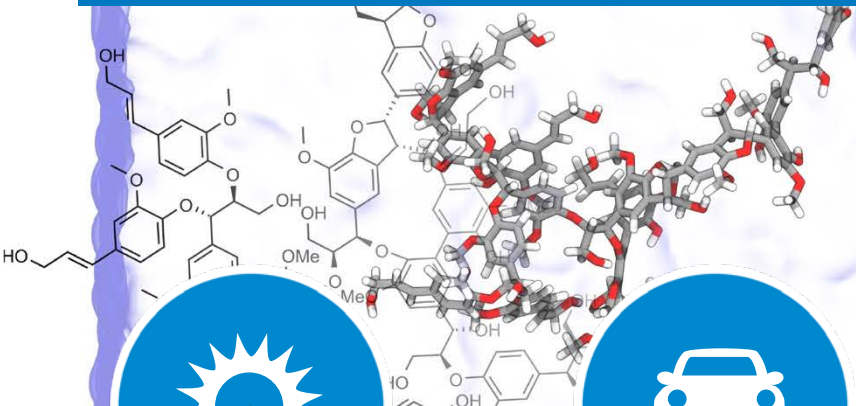## More than 900
Partnerships
with industry, academia, and government

Campus
operates as a living laboratory

NREL Science Drives Innovation

Renewable Power

Solar

Wind

Water

Geothermal

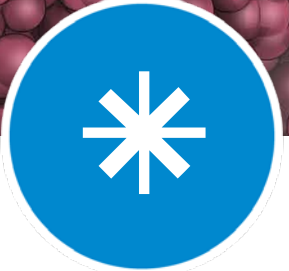## Sustainable Transportation

Bioenergy

Vehicle Technologies

Hydrogen

Energy Efficiency

Buildings

Advanced Manufacturing

Government Energy Management

Energy Systems Integration

Grid Integration

Hybrid Systems

Security and Resilience

Motivation & Background

- NREL performing an ongoing series of On-Demand Transit (ODT) case studies

  – Accessing the Mobility Energy Productivity (energy/emissions, travel/wait time, cost)

- Funding - DOE VTO Technology Integration program through the Technologist in Community project
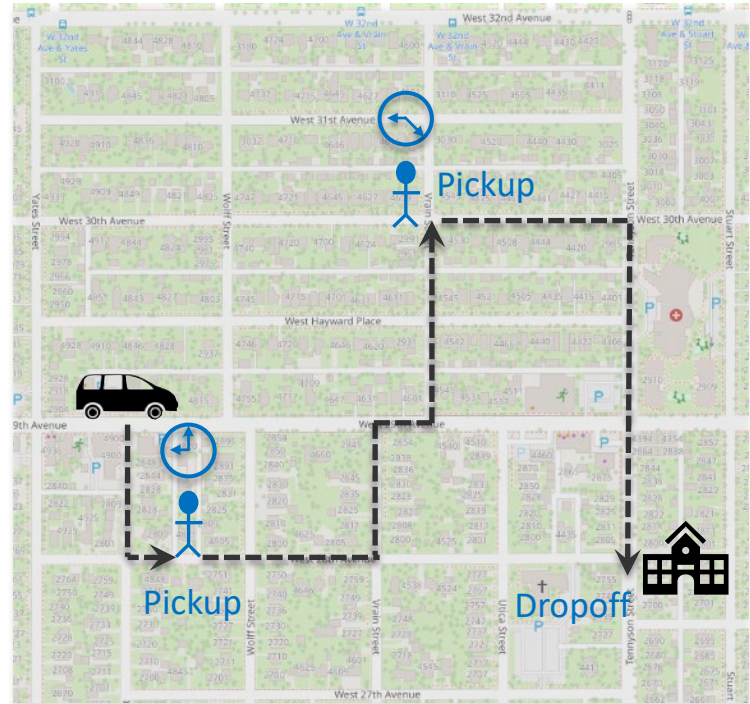
On-demand transit:
- Flexible schedule, flexible stop locations
- Suburban, exurban, rural areas

Fort Erie Case Study

Transition from Fixed-Route to On-Demand Transit

Methodology

- Interviews with Fort Erie Transit and Pantonium (software partner)

- Data provided by Fort Erie Transit and the software partner

- Analyzed trips between October 2017 and July 2022

Photo from the town of Fort Erie.

Fort Erie, Ontario

- Close to Niagara Falls and Buffalo

- Population: 32,901 (plus ~10,000 seasonal residents)

- Area: 64 mi^2 (166 km^2)

- "Community of communities", spread out population centers
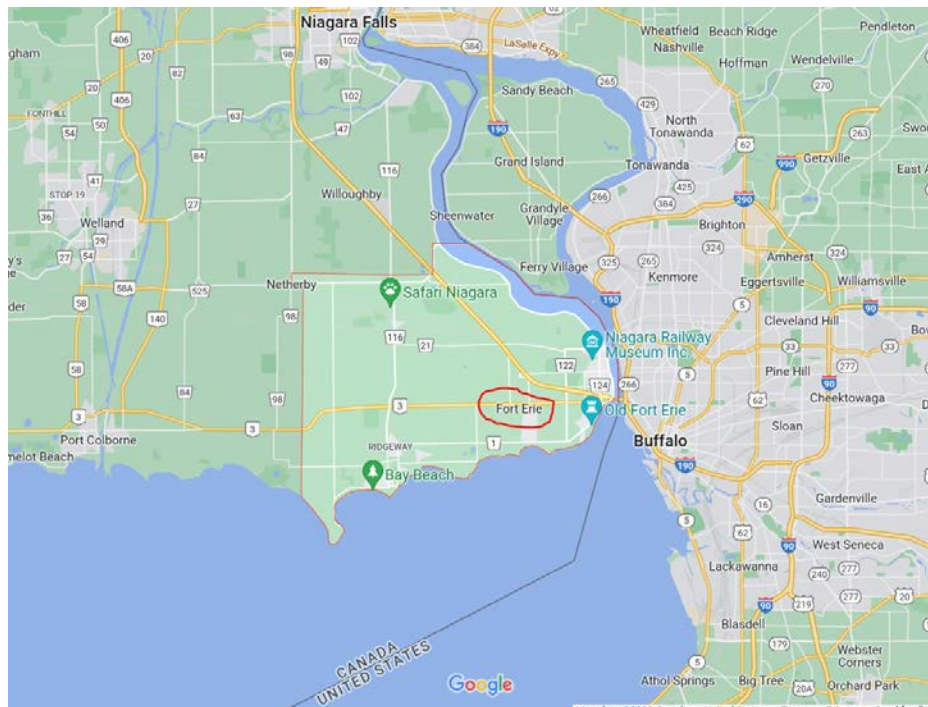
Previous Fixed Route Bus System

- Fixed-route offered about 70% of population reasonable access to transit

- Low ridership, even lower during the pandemic

- Long ride and wait times

Photo from the town of Fort Erie

The fixed routes included four lines: East Blue, East Green, West Yellow, and North Red. Image from the town of Fort Erie.

Options Considered

- Research conducted in 2019/2020
- Options:
  - Switching direction of buses
  - First-mile/last-mile service
  - Partnering with a TNC
  - <mark>Fully on-demand with designated smaller vehicles and software partner</mark>
    - Regional Limousine owns and operates vehicles and manages call center, Pantonium handles scheduling and dispatching software

Photo from the town of Fort Erie.

On-Demand System

- Launched October 2021
  - Two-week overlap with fixed-route system
- Fleet – 7 regular Dodge Caravans, 2 wheelchair-accessible vans
- Schedule using phone call, webpage, or mobile app
- Walk-on boardings allowed at certain stops
- $3/ride – cash, credit/debit, reloadable smart card
- Operating hours: 6 a.m. – 9 p.m., Mon-Sat
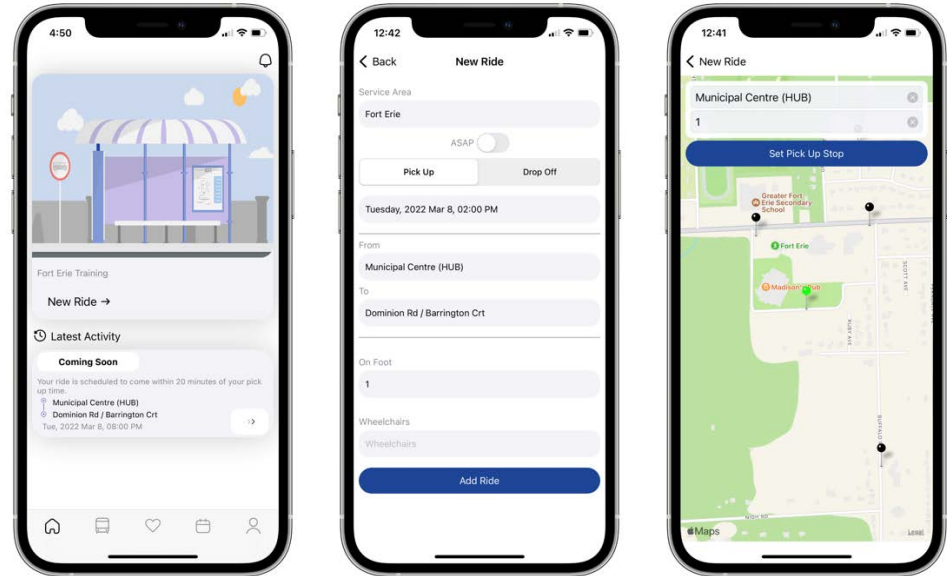
Fort Erie's On-Demand Transit – Rider App. Images from the town of Fort Erie.
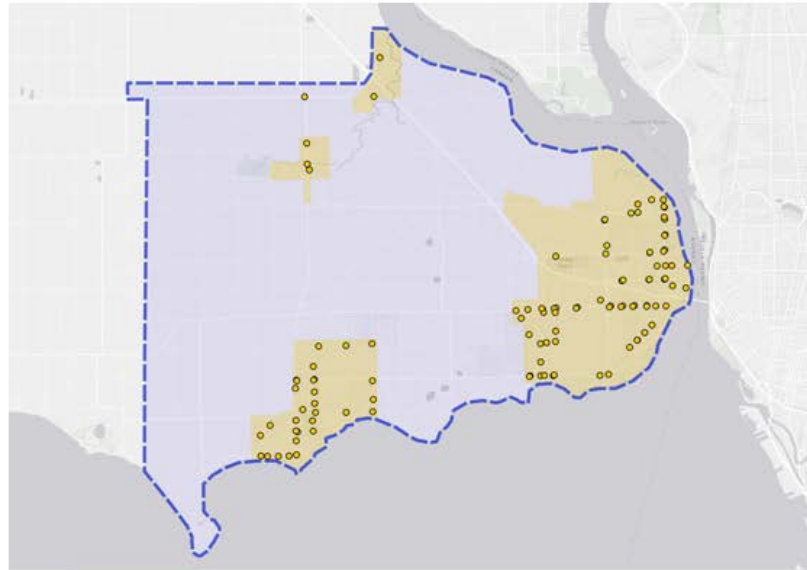
On-Demand System

Before

After
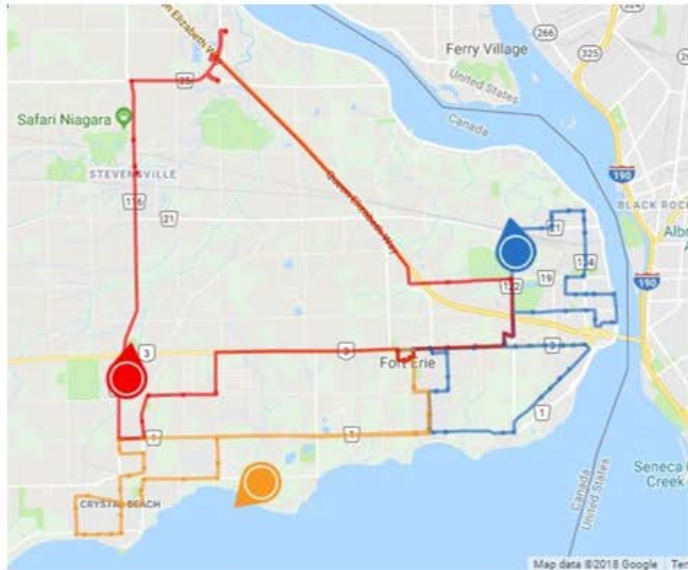
- North Line
- West Yellow Line
- East Blue Line

- Urban Area (stop to stop)
- Rural Area (curb to curb)
- Transit Stop
- Area Boundary

Fixed routes (left) were "reasonably accessible" to 70% of Fort Erie residents. On-demand now serves the full town of Fort Erie. Images from the town of Fort Erie.

ADA Accessibility and Other User Features

- 2 wheelchair-accessible vans

- Bikes can be stored on trunk rack

- Strollers can be loaded in truck

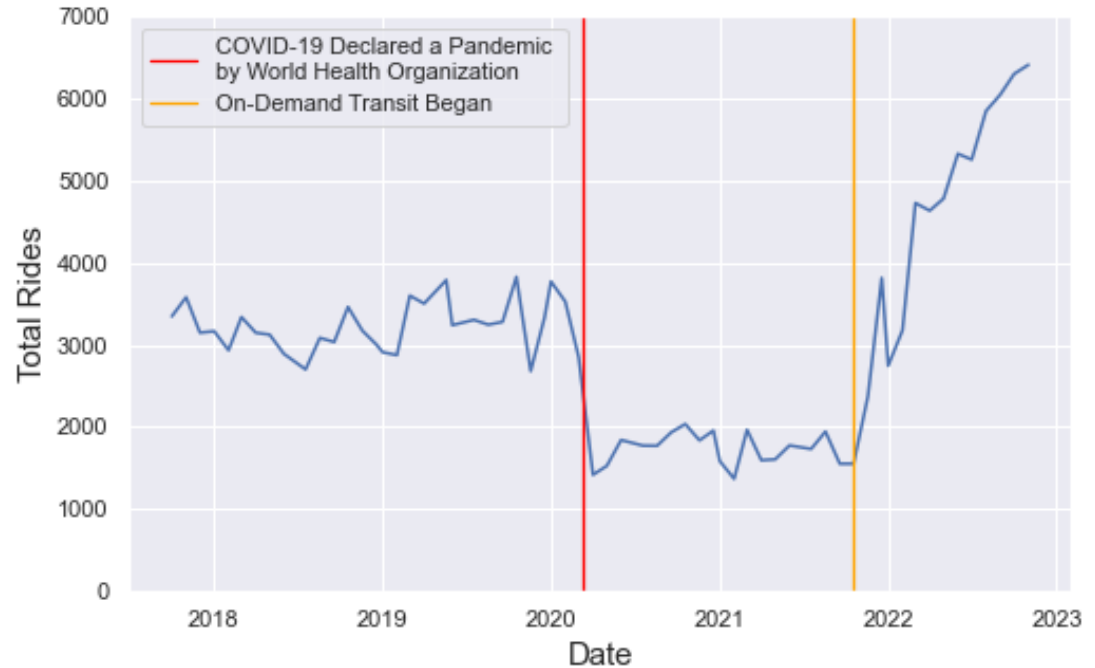- Passengers can bring their own car seats (optional)

Fort Erie Transit wheelchair-accessible van. Photo from the town of Fort Erie.

Fort Erie Results
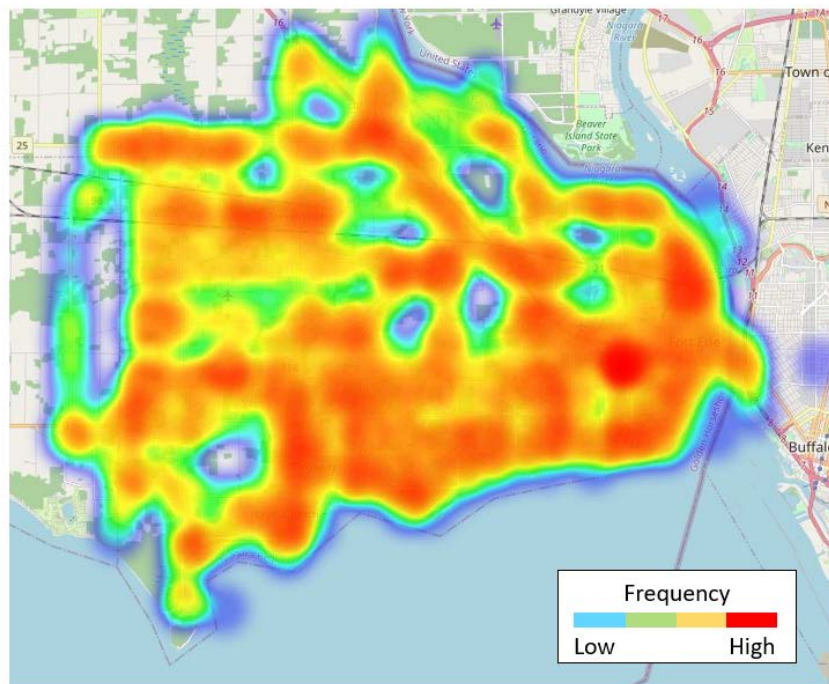
Increased Ridership

Ridership has exceeded pre-COVID levels and is still increasing.

Total monthly riders before and after the on-demand system was instituted (October 1, 2017 to November 30, 2022)
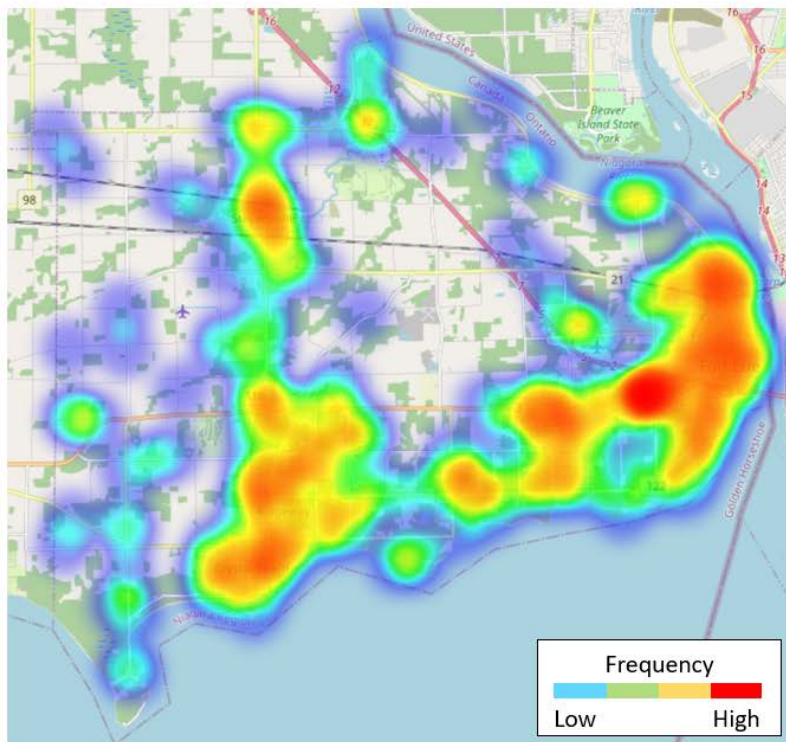
Increased Service Area
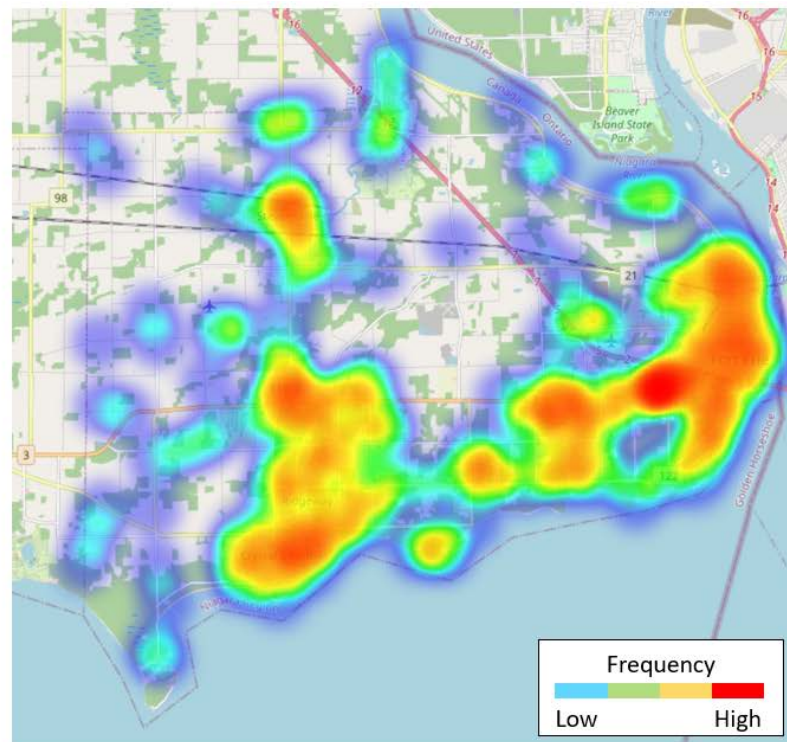
- On-Demand captures remaining 30% of population

A heat map showing where vehicles providing trips traveled, using latitude and longitude coordinates recorded every 30 seconds for all assigned trips from October 4, 2021, to July 19, 2022.
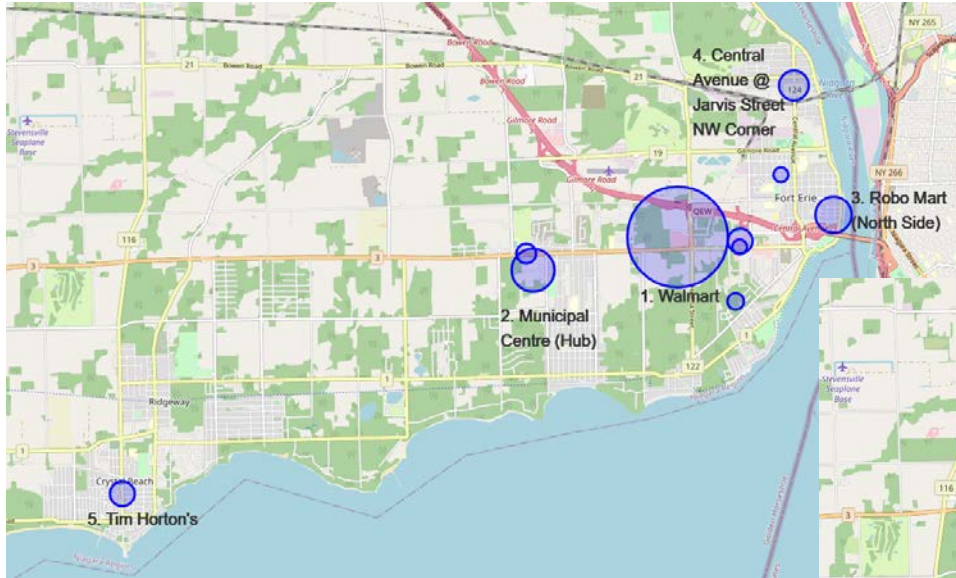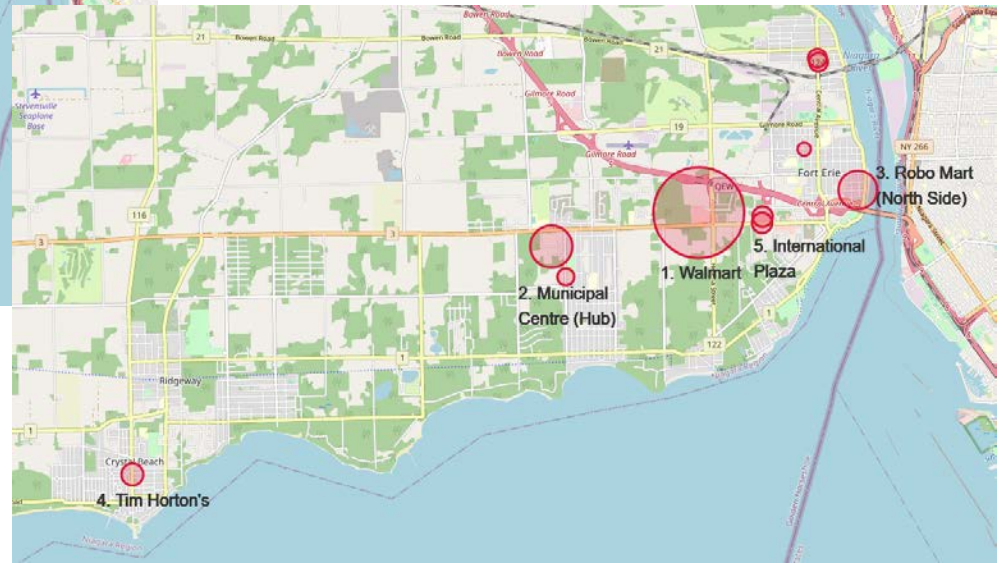
Pickup/Dropoff Locations

Pickup Locations

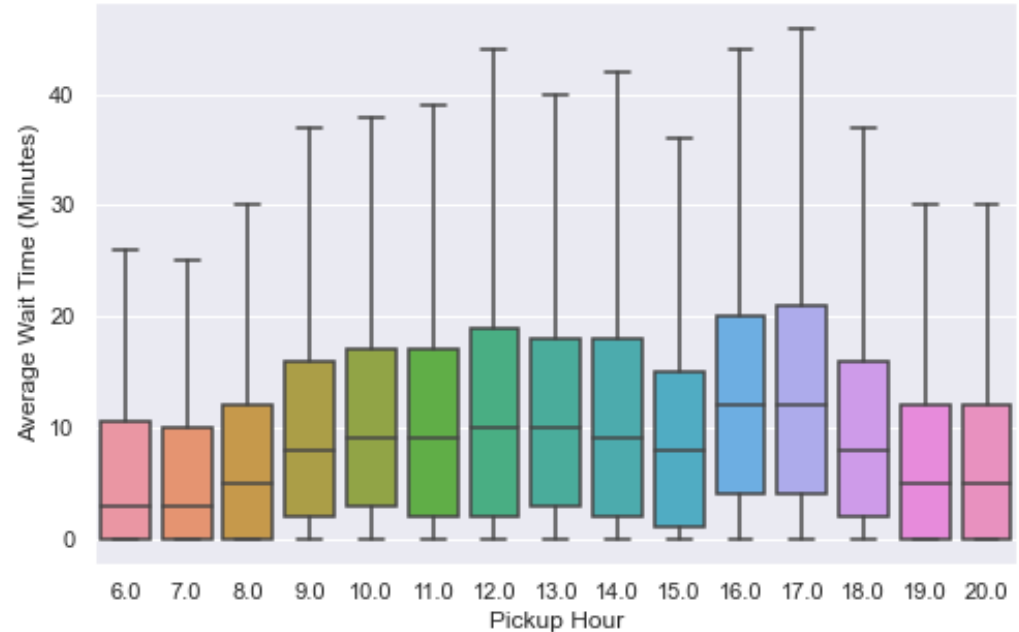Drop-Off Locations

Pickup/Dropoff Locations

Top 10 Pickup Locations

Top 10 Dropoff Locations

Wait Times

	Average Wait Time
Overall	10.5 minutes
For passengers using a wheelchair	14 minutes

*Average **wait time** for each operating hour of the day, for all trips between October 4, 2021, and July 19, 2022. Outliers 1.5x the inter-quartile range, representing approximately 1.7% of trips, are not shown.*

* Wait time is the time from trip request to vehicle arrival at pickup site.
**Box and whisker plot: the box extends from quartile 1 (Q1) to Q3 and has a line at the median. The whiskers extend to 1.5x the inter-quartile range.

Wait Times

	Average Wait Time
Overall	10.5 minutes
For passengers using a wheelchair	14 minutes

*Average **wait time** for each operating hour of the day, for completed trips with a **passenger using a wheelchair**, between October 4, 2021, and July 19, 2022. 12 outliers 1.5x the inter-quartile range are not shown.*

* Wait time is the time from trip request to vehicle arrival at pickup site.
**Box and whisker plot: the box extends from quartile 1 (Q1) to Q3 and has a line at the median. The whiskers extend to 1.5x the inter-quartile range.

Ride Times

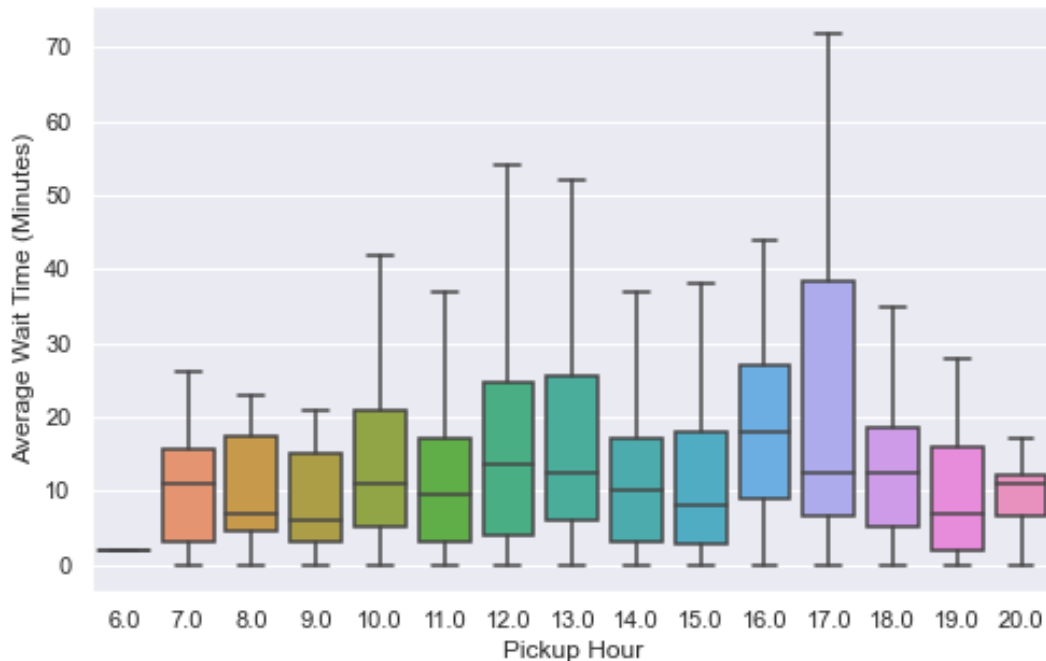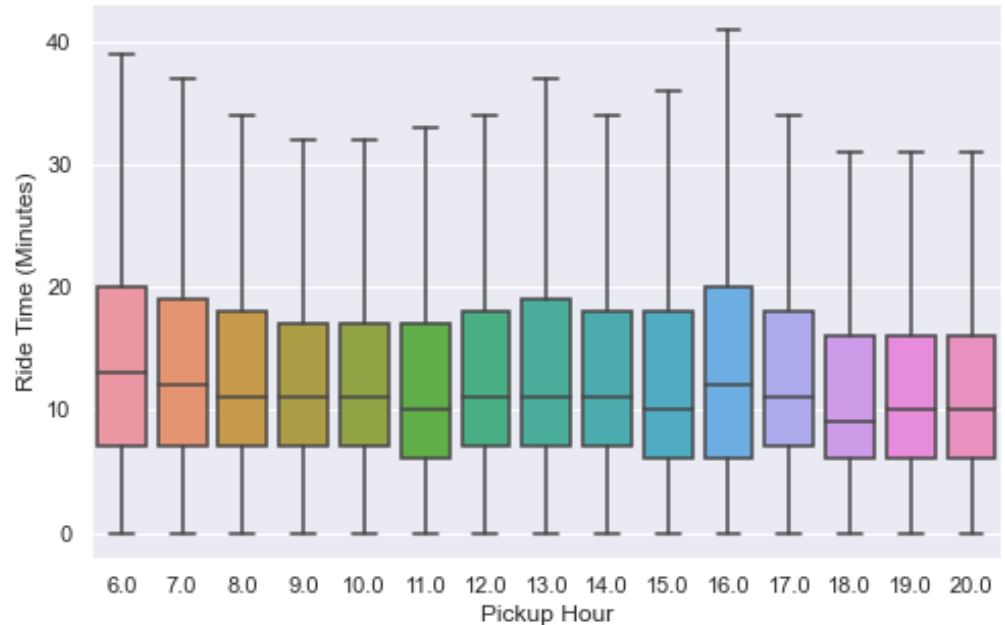|	Average Ride Time
Overall	13.5 minutes

*Average **ride time** for each operating hour of the day, for all trips between October 4, 2021, and July 19, 2022. Outliers 1.5x the inter-quartile range, representing 3.7% of trips, are not shown.*

*Ride time is the time from vehicle arrival at the pickup location to arrival at the dropoff location
**Box and whisker plot: the box extends from quartile 1 (Q1) to Q3 and has a line at the median. The whiskers extend to 1.5x the inter-quartile range.

Lower Fuel Consumption

- Lower fuel consumption after on-demand (both total and per-ride)
- Fuel consumption now demand-responsive, proportional to ridership. Vehicles do not move until called.
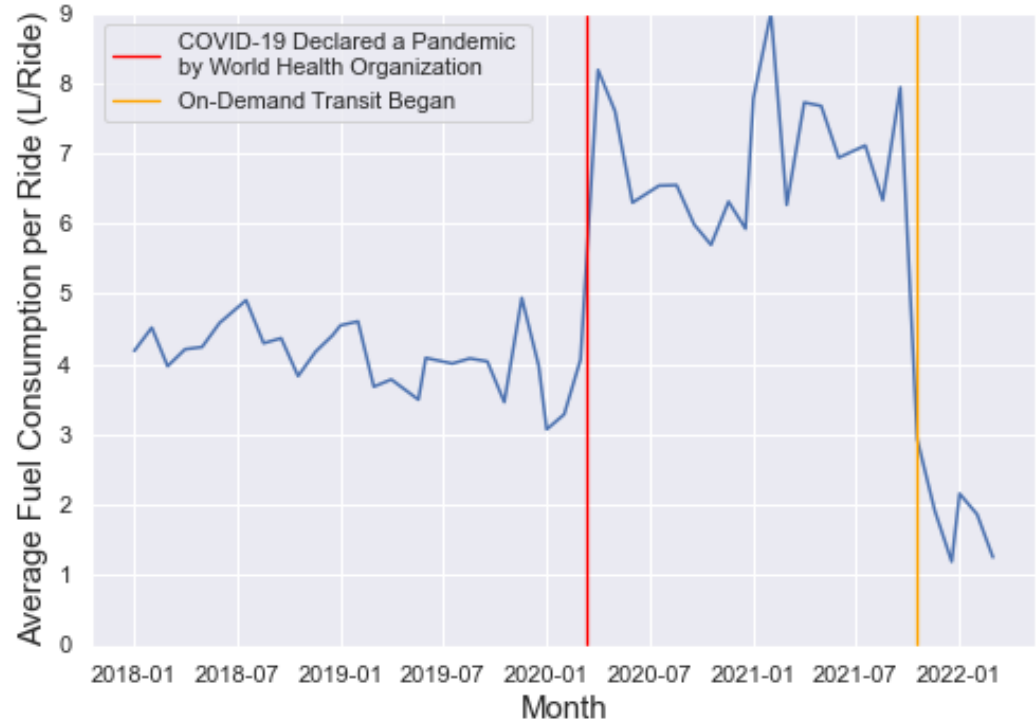
Average fuel consumption per ride before and after the on-demand system was instituted (October 1, 2017 to May 1, 2022)

Carbon Dioxide Emissions

Emissions per ride decreased by 63%

| Year	Time Period	System	Total Rides	Km Traveled (miles)	Fuel Consumed [Liters] (gal)	Avg L/100 km (gal/100 mi)	Emissions [kg CO2]	Emissions [kg CO2/km]	Emissions [kg CO2/ride]
2019	Six months*	Fixed Route	19,784	205,976 (127,988)	79,402 (20,976)	38.55 (16.39)	213,590	1.04	10.80
2021-2022	Six months**	On-Demand	18,381	180,908 (112,411)	31,373 (8,288)	17.34 (7.37)	72,785	0.40	3.96

*Annual 2019 data divided by two
**October 2021 – March 2022

Table: Distance traveled, fuel consumed, and carbon dioxide emissions for half of 2019 (fixed route system) and a six month period from October, 2021 to March, 2022 (on-demand system).

Emissions Scenarios

- Current on-demand system uses Dodge Caravans.

- Potential to further reduce CO_2 emissions by using hybrid or plug-in hybrid mini-vans, or electric buses.
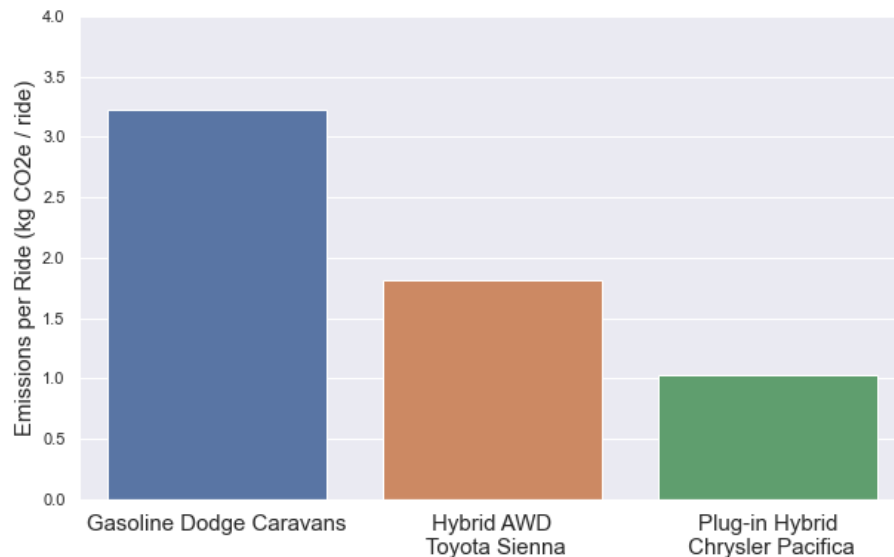
Estimated emissions per ride for the baseline case (Dodge Caravans) and two hypothetical scenarios where all vehicles are replaced with hybrid all-wheel drive Toyota Siennas or plug-in hybrid Chrysler Pacificas. Both upstream and tailpipe emissions are included, using an electricity grid mix for Buffalo, New York

Operating Costs

- Single ride costs the customer $3 (same as fixed-route system)
- Costs per ride to Fort Erie Transit
  - Fixed-route: ~$24/ride (2019)
  - On-demand: ~$17/ride
- Annual budget
  - Fixed-route: $1.4 million
  - On-demand: originally proposed at $950,000, increased to $1.4 million after ridership increases offset the decrease in operating costs
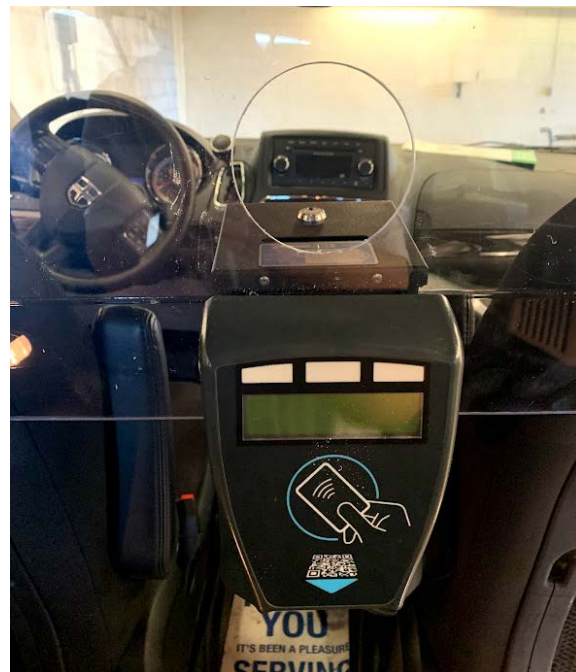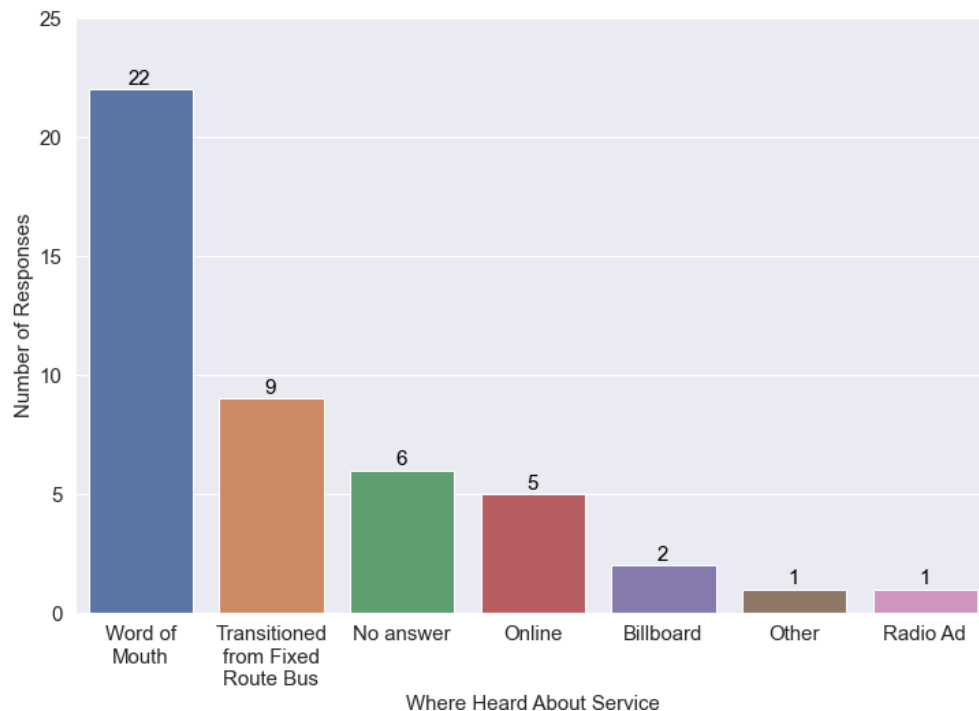
*All costs in Canadian dollars

Photo from the town of Fort Erie

Outreach and Customer Feedback

- Word-of-mouth was the most common way riders heard about the on-demand system.

- 84% of survey respondents rated their overall trip satisfaction as either a 4 or 5, average rating was 4.48

Preliminary results from onboard comment cards, collected April and May 2022, show how riders heard about the on-demand system. The sample size was 46 respondents.

Conclusions

- Fort Erie's on-demand system moves more people using less fuel and same annual budget
- Guided by Mobility Energy Productivity
  - Travel time / wait time
  - Cost (traveler/agency)
  - Energy & emissions
- High value of automatically collected data, potential to inform future changes to transit
- Scalability is a key consideration
- Just one case study, but shows potential of on-demand transit

Photo from the town of Fort Erie.

Related Work at NREL

Other On-Demand Projects

Community	System Details
Innisfil, Ontario	No prior public transit, subsidized Uber rides only (Innisfil.ca, NREL Case Study, Innisfil Report)
Bastrop, TX	Low-speed electric "cabs", popular with tourists. Partner is Electric Cab of North America (eCab) (Bastrop)
St. Louis, MO	Low-speed electric vehicles connecting lower-income neighborhoods to downtown St. Louis. Operated by Labyrinth Smart Mobility (St. Louis Downtown Connect)
Arlington, TX	City-wide on-demand transit system partnered with Via (Arlington on-demand)
Fort Erie, Ontario	Standalone service replaced all fixed routes, software and vehicles/operations contracted out to two separate companies – Regional Limousine and Pantonium (Fort Erie, NREL Case Study)

'How-to Guide' for On-Demand Transit

Developing a **slide deck** overview to on-demand transit with background, examples, resources

Contents

1. What is on-demand transit?
2. Benefits
3. Challenges
4. ODT Service Designs
5. System Costs and Funding
6. Resources and References

Sustainable Mobility Tools

Integrated Data and Analysis Tools

Our integrated data and analysis tools inform the development of innovative mobility technologies and systems.

- MEP: Mobility Energy Productivity Tool
- EVI-Equity: Electric Vehicle Infrastructure for Equity Model
- EVI-Pro: Electric Vehicle Infrastructure Projection Tool
- FASTSim: Future Automotive Systems Technology Simulator
- EVI-X Modeling Suite of Electric Vehicle Charging Infrastructure Analysis Tools
- HIVE: Highly Integrated Vehicle Ecosystem Simulation Framework
- NREL OpenPATH: Open Platform for Agile Trip Heuristics
- TSDC: Transportation Secure Data Center
- See our full collection of tools.

NREL Sustainable Mobility Webpage

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Questions?

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Special thanks to Jennifer Pennell-Ajie from the town of Fort Erie and Luke Mellor and Remi Desa from Pantonium

https://www.nrel.gov/docs/fy23osti/84578.pdf

www.nrel.gov

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