

Clean Commute Orange County: The Express Route to Lower GHG's
Technical Appendix

Measure-Specific Documentation:

GHG Reduction Estimate Method:

The proposed reduction measure for this Orange County, Florida application focuses on “Reduced Vehicle Miles Travelled (VMT)”, a High Impact Action identified within the East Central Florida Priority Climate Action Plan. The identified means of implementation to achieve this combines the reduction of reliance on gasoline-powered passenger vehicles through the use of a new mass transit route.

To prepare for the calculations associated with these reduction measures, data about the route was captured from LYNX and is presented in the table below.

Annual service hours	48,614 hours
Point-to-point mileage for the route	27.15 miles
Daily miles for route	2,647 miles
Expected days of operation annually	365 days
Anticipated annual ridership	321,162 riders

Additionally, because estimated annual ridership must build over time, the following estimates were used as ridership estimates each year for the five years of implementation.

Year of implementation	Estimated Percentage of anticipated ridership occurring
Year 1	30%
Year 2	50%
Year 3	75%
Year 4	90%
Year 5	100%

In order to calculate emissions eliminated due to gasoline -powered vehicles removed from the roadways annually, the following assumptions were made and used in subsequent calculations.

Estimated car trips removed as a percentage of estimated ridership	50%
Estimated miles per car trip removed (based on point-point route miles)	20 miles
Average miles per gallon for a gasoline powered passenger vehicle as of 2021	25.3 miles per gallon of gasoline

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In order to calculate anticipated emissions from a transit bus in operations, LYNX also provided data about fuel usage.

Typical mileage of a diesel-fueled bus	4.3 miles per gallon of diesel fuel	
Typical mileage of a CNG-fueled bus	3.49 miles per diesel gallon equivalent (DGE)	1 DGE = 126.67 cubic feet

Finally, given these activity-data related assumptions used within an Excel spreadsheet and the ICLEI ClearPath tool for calculating emissions, the net emissions reductions are shown in the table below.

2030	-3,380
2050	-23,858

Models/Tools Used:

The pieces of provided, researched, and estimated data described above were used in calculations within an Excel spreadsheet to generate the inputs required to feed the ICLEI ClearPath tool used to calculate emissions.

The ICLEI ClearPath tool is an emissions management software suite developed by ICLEI-USA and allows the management of energy and green house gas emissions for local government and community scales. Within the ICLEI ClearPath tool, there are multiple ClearPath modules for inventory capture, forecasting, action planning, and monitoring of emissions and emissions reduction scenarios. For this emissions reduction measure, there are two specific calculators being used from the Transportation & Mobile Sources Sector; **On Road Transportation** and **Emissions from Public Transit**. The global warming potentials for CO₂, CH₄ and N₂O from the IPCC 5th Assessment 100 years values were used in the emissions calculations. Transportation Factor sets were based on the U.S. National Defaults for 2022. These emissions factors are found within the attached spreadsheet under source information.

For estimating ridership and services hours for the new route, LYNX used the TBEST (Transit Boardings Estimation and Simulation Tool) program to model estimated ridership for the proposed route. TBEST is a Transit Planning Software developed as a partnership between the Florida Department of Transportation, Service Edge Solutions, and the University of South Florida Center for Urban Transportation Research (CUTR). The tool uses transit data analytics to support Transit Service Planning and strategic transportation planning initiatives such as route optimization studies, mobility analysis, and transit development plans. The support data is pulled from Census/ACS data as well as parcel level land use GIS data and is updated annually. LYNX has also incorporated APC Stop-Level ridership numbers to further bolster the accuracy of the model for operations and performance analyses.

Measure Implementation Assumptions:

The plan for implementation of a transportation-related reduction measure began with the need to address overarching transportation challenges with the Central Florida region and a dedication to reducing

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GHG emissions spanning 20 years in Orange County. The route selected by LYNX for this reduction measure was based on data captured during community outreach and some of the long-term planning going on over several years.

In the LYNX-Orange County Transit Plan from 2018 several actions were reviewed to better connect the workforce to major employers within the tourist areas of International Drive, Universal Studios, and Walt Disney World. One of these actions was a High-Speed Regional Express Routes within a 300 series to allow passengers to move quickly across the transit system to reach activity centers and areas of high employment.

Additionally, in 2019 an effort began in Orange County to push for a 1% Regional Transportation Sales Tax which was projected to raise approximately \$600 million per year to be used to address current transportation challenges and plan for future growth throughout the region both with permanent residents and additional visitors. This initiative did not receive the required votes by County residents. However, because the need is great, Orange County presented and approved \$100 million in the FY24 County Budget for an Accelerated Transportation Safety Program which includes some funding for transit enhancements but includes efforts to address pedestrian, bicycle, and motorist safety and aligns with the County's Vision Zero Initiative.

The implementation of this express route incorporates several assumptions related to daily operations, costs for operations, and costs for capital investment, all of which play a role in estimating the GHG emissions reductions both by 2030 and 2050. The first table below shows the activity-level data for the route. The second table indicates the operational and capital costs anticipated for the route.

Point-to-Point mileage for the route	27.15 miles
Daily miles for route	2,647 miles
Expected days of operation annually	365 days
Anticipated annual ridership	321,162 riders

Annual service hours	48,614 hours
Operational cost per service hour	\$105.43
Estimated cost increase percentage annually for the first five years	3%
Total number of buses to purchase	9
Cost per CNG-fueled bus to purchase	\$759,130

Because this route serves an identified need throughout the region, its permanence will be part of the long-term solution to the transportation challenges currently faced and projected into the future.

GHG Reduction Estimate Assumptions:

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The key assumptions used to calculate emissions reduction include the following list.

- 1) Global warming potential for CO₂, CH₄ and N₂O from the IPCC 5th Assessment 100 years values as indicated in the chart below.

Global Warming Potentials (GWP) for Greenhouse Gases			
Greenhouse Gas	100-Year Global Warming Potential ^a	Greenhouse Gas	100-Year Global Warming Potential ^a
Carbon dioxide (CO ₂)	1	HFC-245fa	858
Methane (CH ₄) ^b	28	HFC-365mfc	804
Nitrous oxide (N ₂ O)	265	CF ₄	6,630
HFC-23	12,400	C ₂ F ₆	11,100
HFC-32	677	C ₃ F ₈	8,900
HFC-41	116	C ₄ F ₆ ^c	0.003
HFC-125	3,170	c-C ₅ F ₈	2
HFC-134a	1,300	C ₄ F ₁₀	9,200
HFC-143a	4,800	c-C ₄ F ₈	9,540
HFC-152a	138	C ₅ F ₁₂	8,550
HFC-227ea	3,350	C ₆ F ₁₄	7,910
HFC-236fa	8,060	SF ₆	23,500
HFC-43-10mee	1,650	NF ₃	16,100

- 2) The following MPG estimates were used for estimating fuel usage and the resulting emissions.
 - a. Gasoline-powered passenger vehicle at 25.3 MPG
 - b. Diesel-fueled transit bus at 4.3 MPG
 - c. CNG-fueled transit bus at 126.67 cubic feet per mile
- 3) The following emissions factors were used to calculate resulting emissions from VMT and Fuel Use
 - a. Gasoline-powered passenger vehicle = g CH₄/mi = 0.0180
 - b. Gasoline-powered passenger vehicle = g N₂O/mi = 0.0069
 - c. Diesel-powered transit bus = g CH₄/mi = 0.001
 - d. Diesel-powered transit bus = g N₂O/mi = 0.0015
 - e. CNG fuel = 0.054/standard cubic foot

Reference Case Scenario (GHG Emissions or Activity Level):

This reduction measure uses an activity-level reference scenario to produce GHG emissions reduction calculations. The scenario considers the assessment of current routes and the overall bus transit system and applies that data to the new transit route incorporated into that system. Calculations are completed based on the miles for the route point-to-point, daily, annually, and use estimates for operations and costs based on current routes, buses, and ridership. All of the data points are then used for calculations that allow the prediction of GHG emissions each year based on implementation of the reduction measure in 2025 and continuing to 2030 and then to 2050.

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For this activity-level reference, GHG emissions resulting from diesel-fueled buses existing in the transit system in the past provided the assumption of diesel miles per gallons fuel efficiency. The emissions resulting from this scenario were compared to the newer transit system use of CNG-fueled buses and the resulting emissions. The CNG fueled buses produce only 4% of the emissions its diesel-fueled counterpart would produce.

This prediction of GHG mission reduction is also aligned with the overall GHG emissions inventory for the region as documented in the ECFRPC PCAP and is compared to the projected “business as usual” (BAU) GHG emissions out to 2030. The BAU projection assumes growth for the region both in GDP and population, both of which are sourced within the PCAP, but it does not include the implementation of any other measures for the purposes of estimating the impact of the reduction measure on the overall inventory. Although the impact may be minimal, it is one step towards larger initiatives and plans begin developed for region and expected to be implemented by many partners of the ECFRPC Regional Resilience Collaborative (R2C).

Measure-Specific Activity Data:

Using the data pertaining to the route and several researched pieces of data, the following calculations were completed in an Excel spreadsheet.

Total Annual Miles = Daily total miles X operational days per year
966,155 = 2,647 X 365

Annual car trips eliminated = annual ridership / estimated percentage of ridership
160,581 = 321,162 / 0.50

VMT eliminated annually = Annual car trips eliminated * miles per car trip
3,211,620 = 160,581 * 20

Gallons of Gasoline saved = VMT eliminated annually / mile per gallon gasoline
126,942 = 3,211,620 / 25.3

Gallons of diesel fuel for route annually = Total Annual Miles/ miles per gallon of diesel-fueled bus
224,687 = 966,155 / 4.3

Fuel economy of CNG bus in cubic feet = Miles per diesel gallon equivalent * cubic feet per DGE
442.08 = 3.49 miles per DGE * 126.67 cubic ft per DGE
Cubic Feet of CNG fuel for route annually = Total Annual Miles/ fuel economy of CNG-fueled bus
2,185.48 = 966,155 / 442.08

In addition to the data necessary to calculate emissions, the following data was provided by LYNX as **operational** cost estimates to provide the new Express Route 301.

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Annual service hours	48,614 hours
Operational cost per service hour	\$105.43
Estimated cost increase percentage annually for the first five years	3%

Along with operational costs, the following information and capital costs were provided by LYNX to support the new route.

Total number of buses in operation daily	7
Number of Backup buses	2
Total number of buses to purchase	9
Cost per CNG-fueled bus to purchase	\$759,130

To calculate total costs for the implementation of this reduction measure, providing a new transit route, the following calculations were executed in Excel.

Total operational cost per year = annual service hours * operational cost per service hour		
Year 1	\$5,125,374	48,614 hours * \$105.43
Year 2	\$5,279,135	48,614 hours * \$108.59
Year 3	\$5,437,509	48,614 hours * \$112.00
Year 4	\$5,600,635	48,614 hours * \$115.21
Year 5	\$5,768,654	48,614 hours * \$118.66
Total costs over the five years	\$27,211,307	

Total capital costs = total number of buses to purchase * \$ per bus		
\$6,832,170	= 9 * \$759,130	

Total cost to implement the reduction measure = total operational costs over 5 years + total capital costs		
\$34,043,477	= \$27,211,307 + \$6,832,170	

Total funding request for this reduction measure = \$34,418,477 (assuming an additional \$75,000/year for administrative costs)

To calculate the emissions eliminated based on the reduced VMT and MPG for a gasoline passenger vehicle, the **On-Road Transportation Calculator** was used with the following inputs.

On Road Transportation Calculator	
Calculation Method:	VMT & MPG
VMT location:	In Boundary
Travel Type:	Passenger

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Fuel type:	Gasoline
Annual VMT: based on full ridership	3,211,620
Percentage of Passenger vehicles:	100
Resulting CO2equivalent emissions:	1,122.0 metric tons

To calculate the emissions resulting from the use of diesel-fueled transit bus to serve the route, the **Emissions from Public Transit Calculator** was used. This number was calculated in order to compare the emissions of a CNG-fueled bus. Both calculations assume 100% anticipated ridership.

Emissions from Public Transit Calculator	
Calculation Type:	Fuel Use & VMT
Activity location:	Within Jurisdiction
Fuel type:	Diesel
Vehicle Type:	Transit Bus
Annual Fuel Use:	224,687
Annual Revenue Miles Traveled:	966,155
Passenger Boardings:	321,162
Resulting CO2equivalent emissions:	2,294.5 metric tons

To calculate the emissions resulting from the use of CNG-fueled transit bus to serve the route, the **Emissions from Public Transit Calculator** was used. This number was calculated in order to show the expected emission for this new express route with 100% anticipated ridership.

Emissions from Public Transit Calculator	
Calculation Type:	Fuel Use & VMT
Activity location:	Within Jurisdiction
Fuel type:	CNG
Vehicle Type:	Transit Bus
Annual Fuel Use:	2,185.48
Annual Revenue Miles Traveled:	966,155
Passenger Boardings:	321,162
Resulting CO2equivalent emissions:	98.108 metric tons

However, in order to show that ridership is not instantaneous at the start of a new route but instead grows over time, and therefore impacts the amount of reduction that could occur over the course of the five years of implementation, the following assumptions were made:

Year of implementation	Estimated Percentage of anticipated ridership occurring
Year 1	30%
Year 2	50%
Year 3	75%
Year 4	90%
Year 5	100%

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With those assumptions for ridership applied, the following results in emissions were calculated using the **Emissions from Public Transit Calculator**

Year of Implementation	Annual ridership	VMT eliminated based on annual ridership	MT CO ₂ e emissions eliminated
Year 1	96,349	963,486	337
Year 2	160,581	1,605,810	561
Year 3	240,872	2,408,715	842
Year 4	289,036	2,890,458	1010
Year 5	321,162	3,211,620	1122

GHG Emissions Reduced:

To then estimate the **net emissions** resulting from the overall reduction measure to reduce VMT through the reduction of reliance on a personal vehicle due combined with the opportunity of a new transit bus route, the following calculations were completed in an Excel spreadsheet.

Net annual MT CO ₂ e = annual emission from CNG transit bus – annual emission from VMT eliminated	
Year 1	-239 = 98 - 337
Year 2	-463 = 98 - 561
Year 3	-743 = 98 - 842
Year 4	-912 = 98 - 1010
Year 5	-1024 = 98 - 1122

To then calculate the total emissions reduction estimated over the five-year period of implementation, the following equation was used in an Excel spreadsheet:

Net emissions by 2030 = Net emissions from year 1 + Net emissions from year 2 + Net emissions from year 3 + Net emissions from year 4 + Net emissions from year 5
-3381 = -239 + -463 + -743 + -912 + -1024

Finally, to calculate the total emissions reduction estimated over the twenty-five-year period including the five years of implementation and the following twenty years, the following equation was used in an Excel spreadsheet:

Net emissions by 2050 = Net emissions from first 5 years + net emissions from year 5 * 20 years
-23,858 = -3380.4 + (-1023.9 * 20)

It is also important to see how this application's reduction measure impacts the overall inventory of the region. The current 2019 inventory for the region captures transportation sector emissions are 19,160,670 MT CO₂e and projects these emissions in a "business as usual" (BAU) forecast to be 20,873,247 MT CO₂e. This reduction measure will have a small impact of 0.016% of the BAU forecasted emissions given no other

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reduction measures being implemented. The PCAP also indicates a VMT emissions reduction goal of 1,681,895 MT CO₂e in the transportation sector by 2030. The impact of this application's reduction measure on that goal is 0.201%, once again, given no other reduction measures being implemented.

Cost per MT CO₂e eliminated:

Finally, the total cost per MT CO₂e reduced is calculated using the total requested funding for this reduction measure and the expected MT CO₂e eliminated over the five (5) year implementation period.

Total Cost per MT CO ₂ e by 2030	Total requested funding	Expected MT CO ₂ e reduction
\$ 10,181.72	\$ 34,418,477	3380