



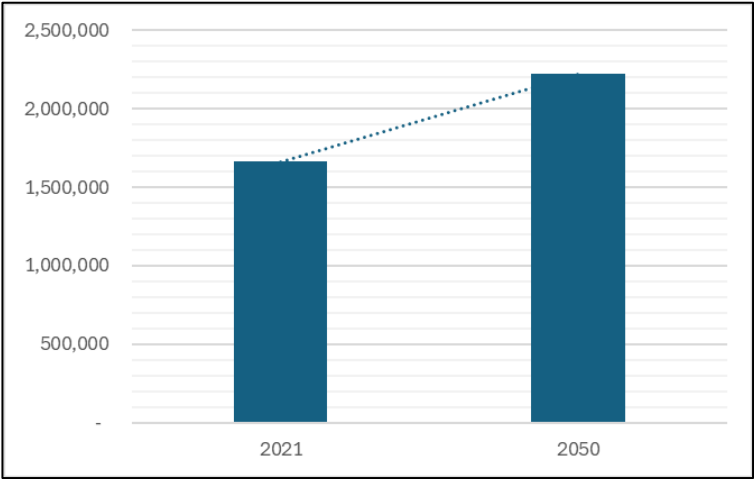
MID-OHIO REGIONAL
MORPC
PLANNING COMMISSION

Evaluating Emissions Reduction through Bus Rapid Transit in Central Ohio: An Activity-Based Approach

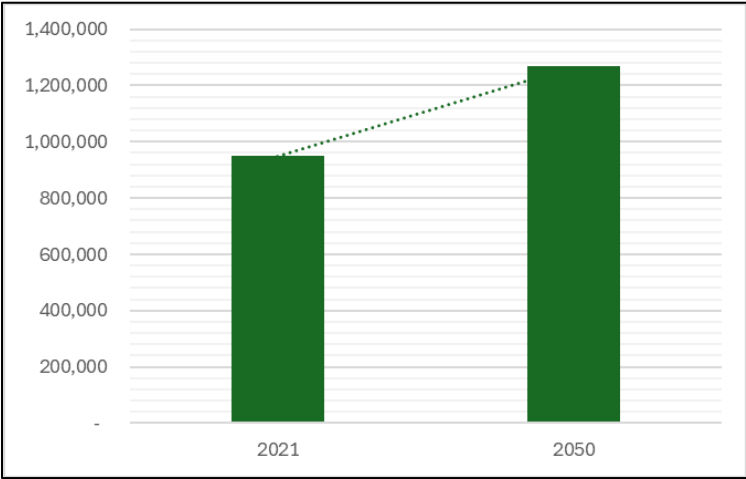
Raj Roy, PE, AICP

What is MORPC?

- Designated MPO for Columbus UA, OH
 - 2 full and 3 partial counties (~ 1,200 sq. miles)

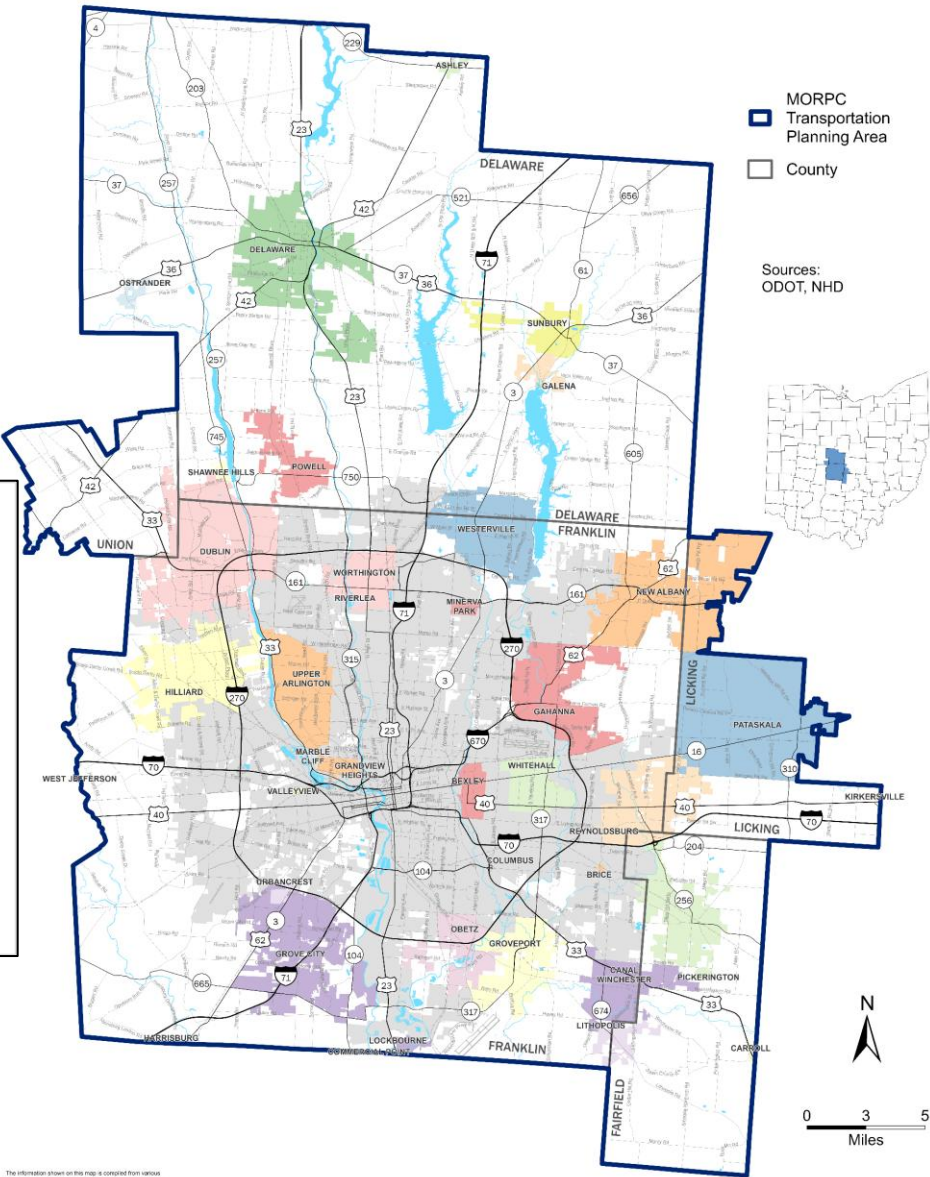


Population

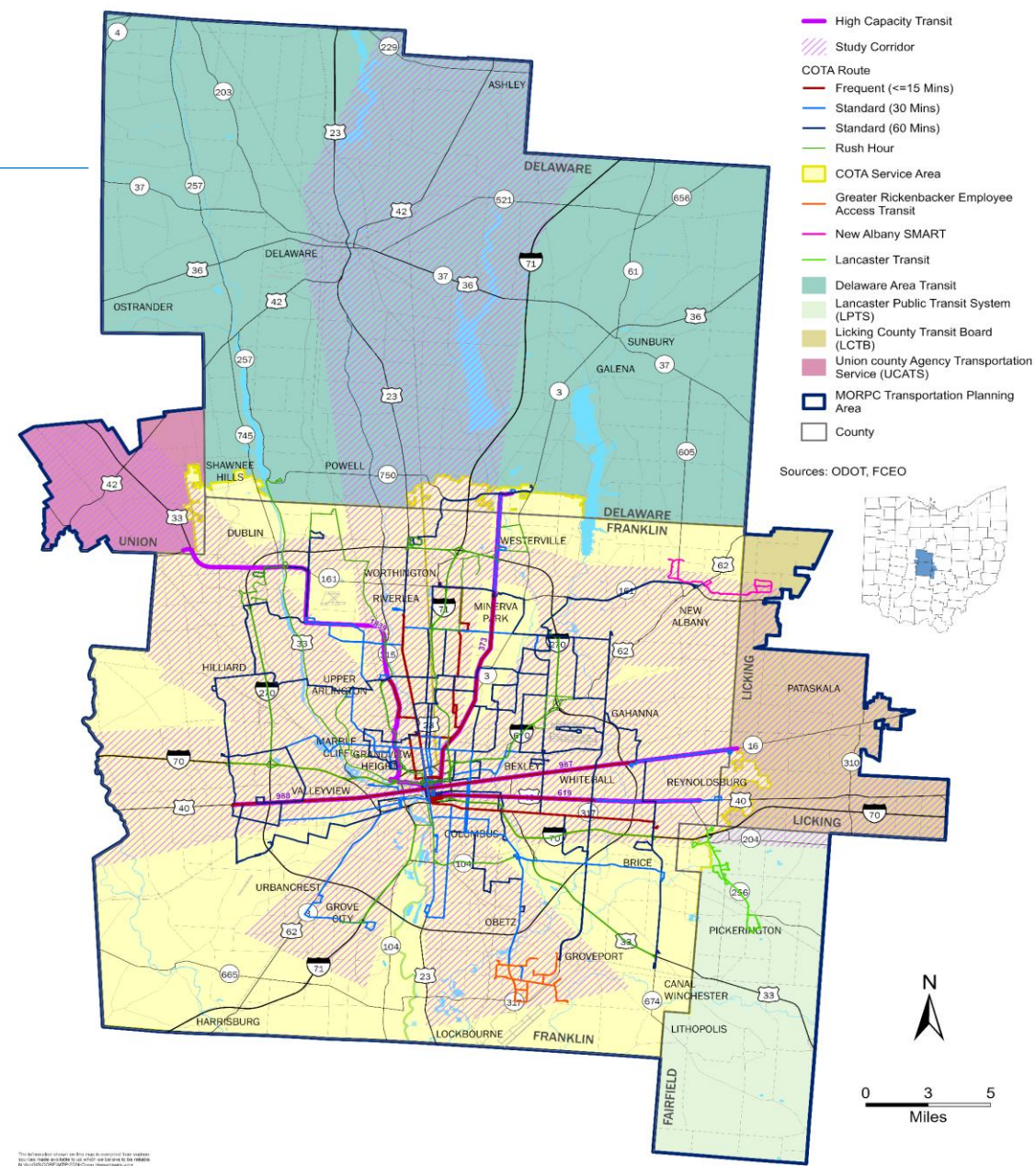


Employment

- Conducts regional transportation studies
 - LinkUS



Transit Infrastructure



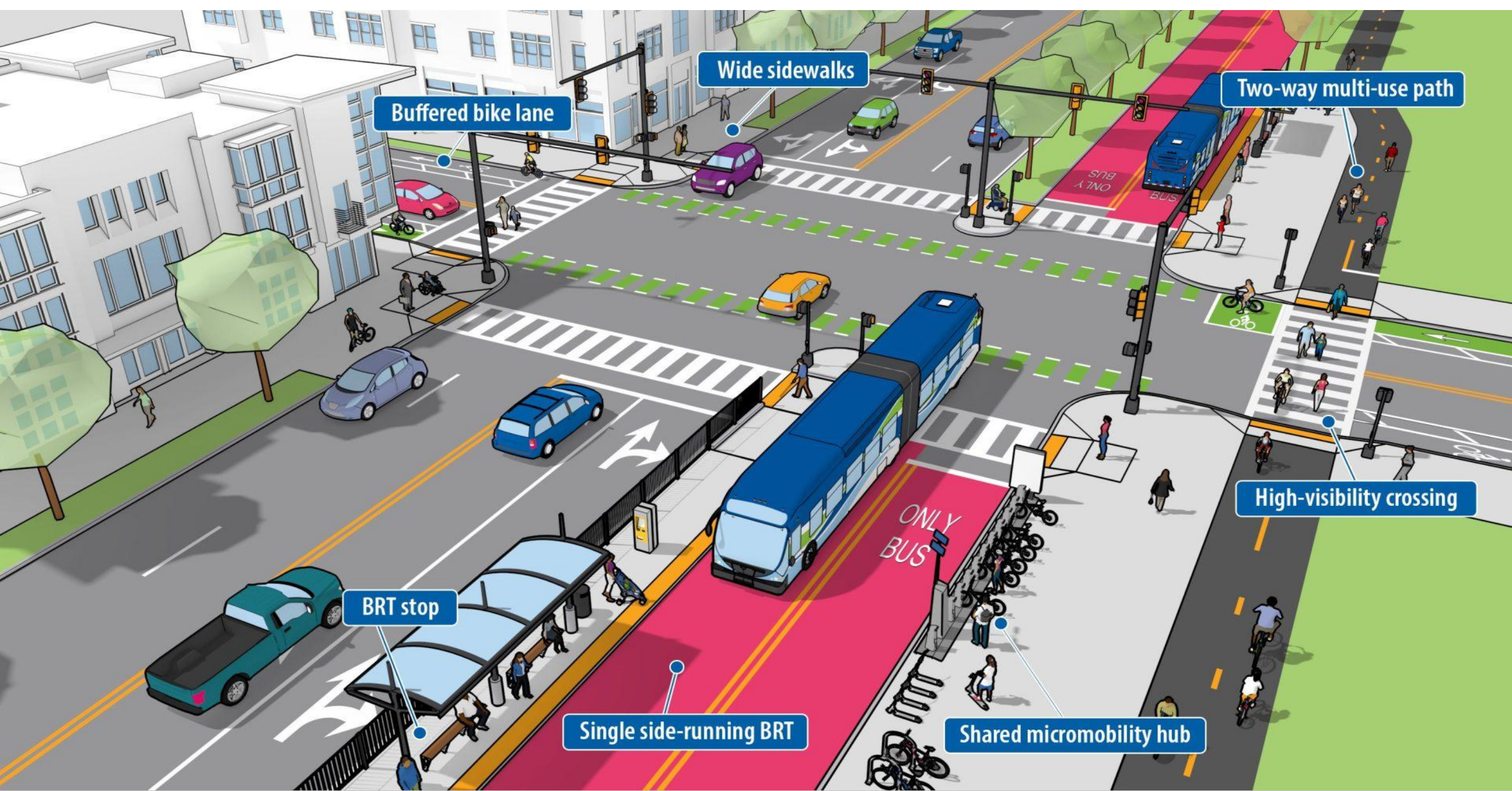
What is LinkUS?



Modernize the Transit System

Expand Sidewalks, Trails and Bikeways

- ▲ Significantly expand COTA services by 45%
- ▲ 5 rapid transit lines
- ▲ 8 new COTA//Plus zones
- ▲ 14 new or improved transit lines
- ▲ Increased existing service with more frequency
- ▲ 500+ miles of sidewalks, bikeways and trails
- ▲ New and improved transit amenities including transit centers, park and rides, shelters and more



Buffered bike lane

Wide sidewalks

Two-way multi-use path

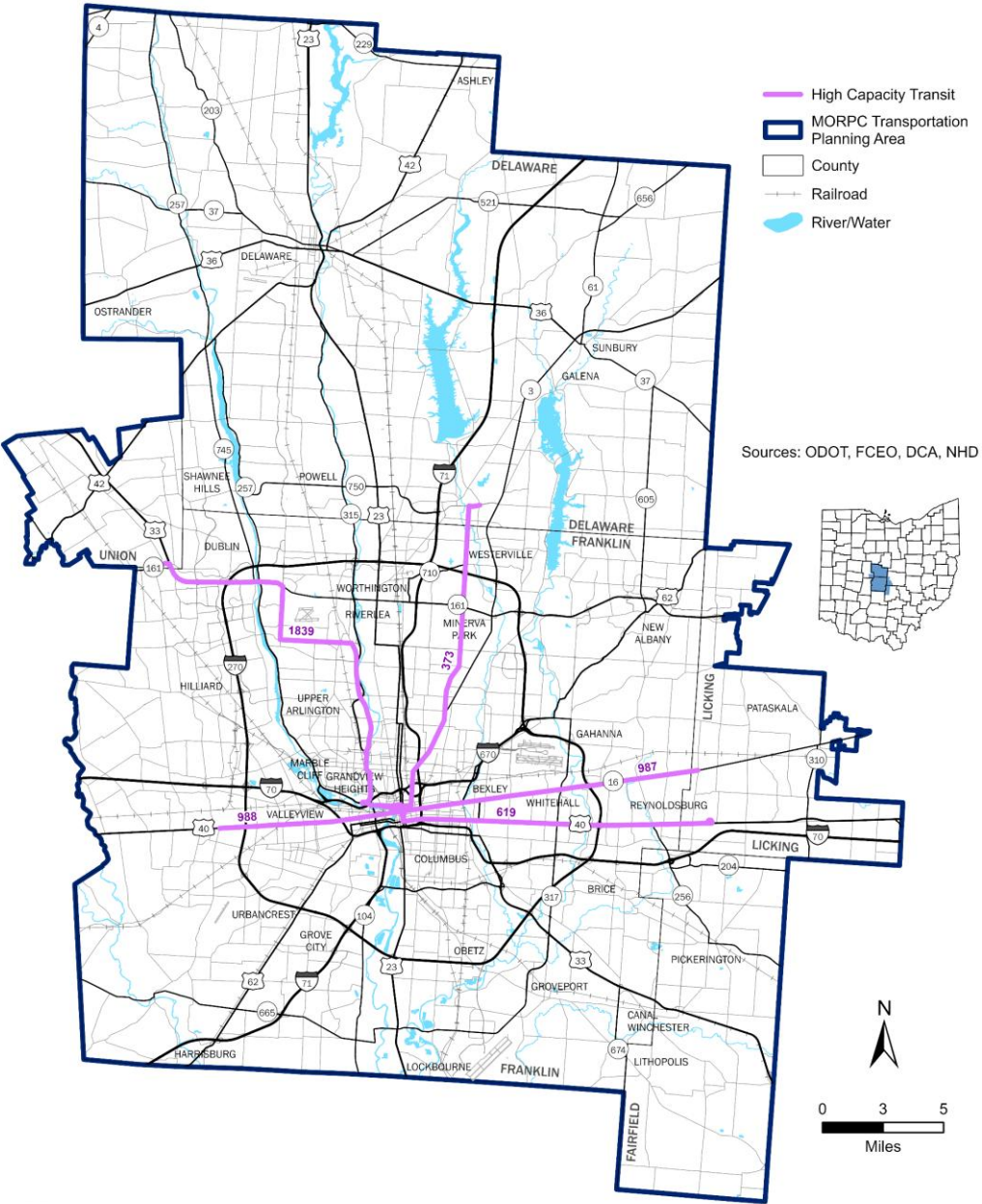
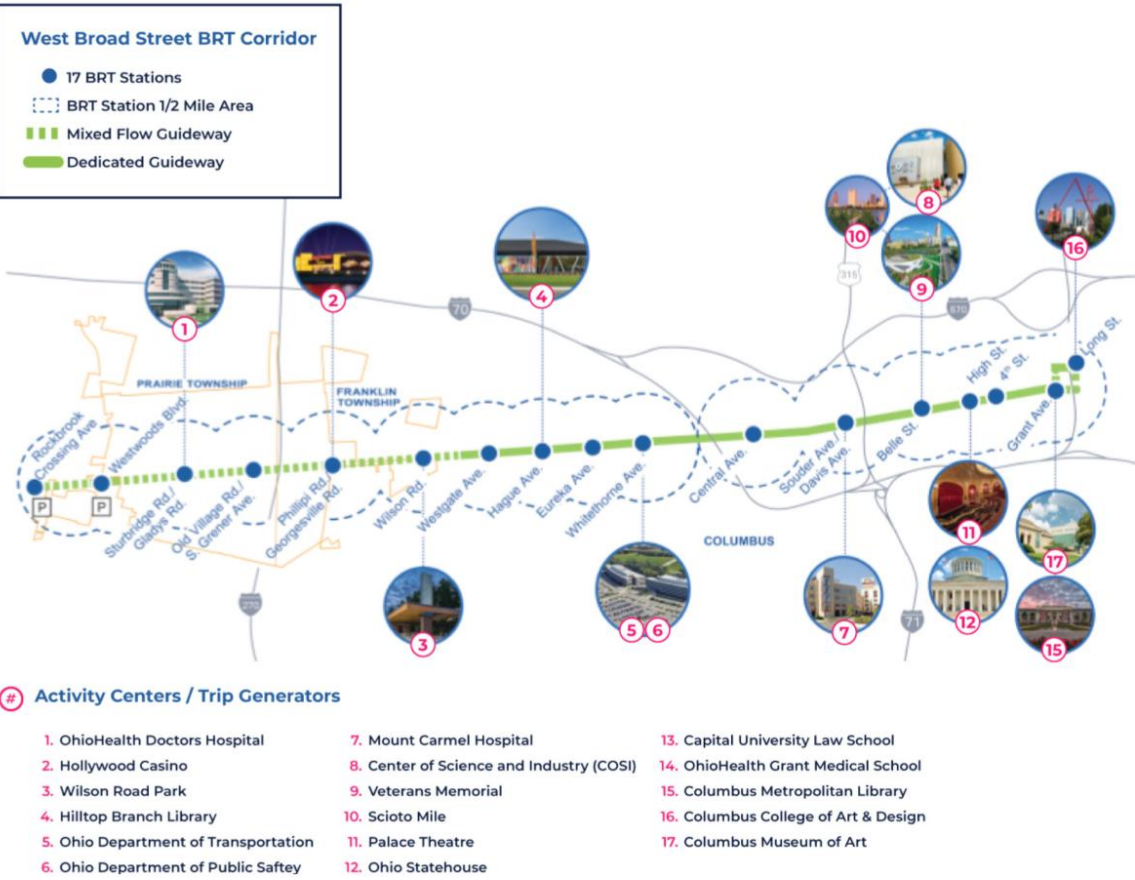
BRT stop

Single side-running BRT

High-visibility crossing

Shared micromobility hub

5 Rapid Transit Lines





Methodology

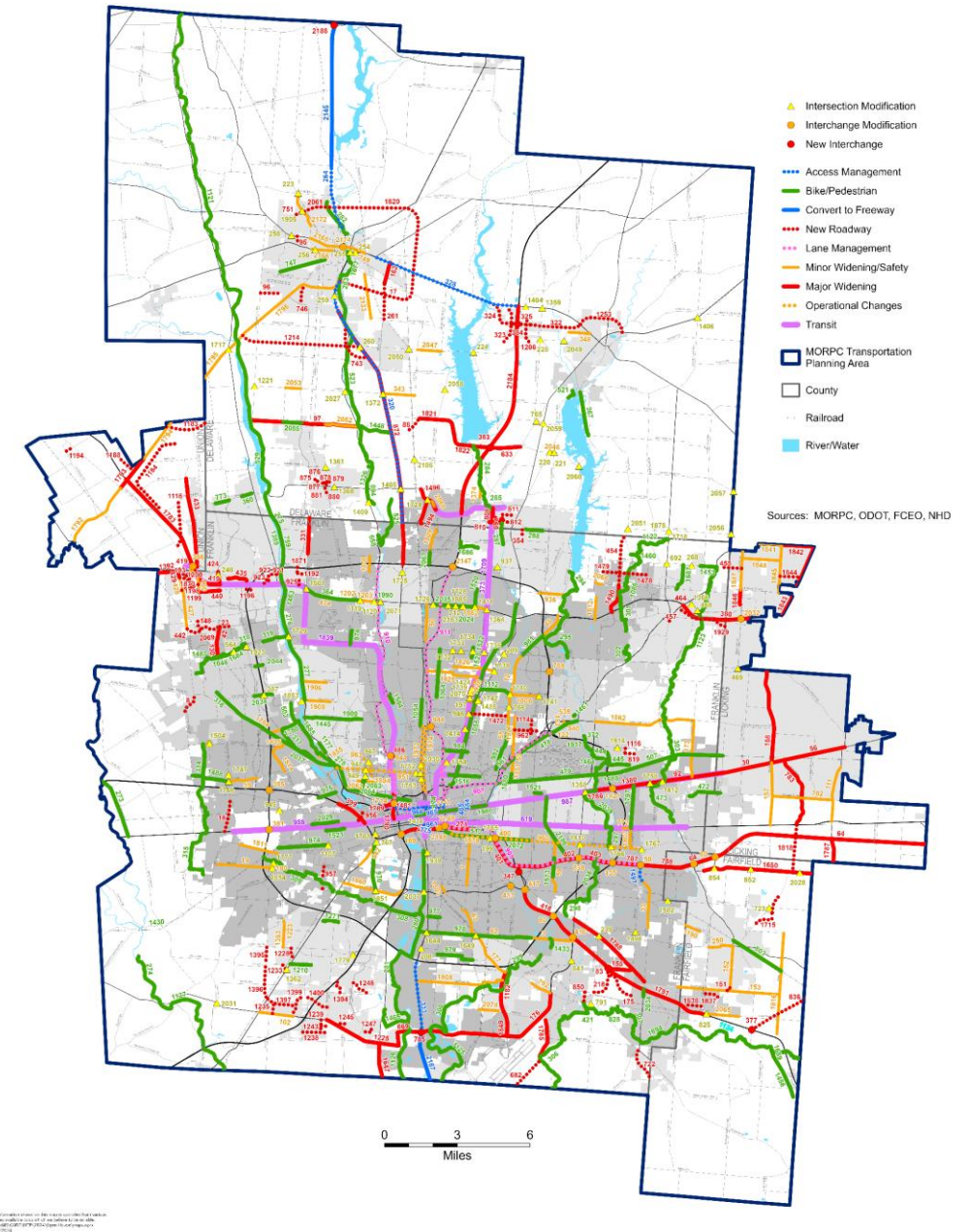
- ▲ MORPC's regional activity-based travel demand model used to simulate two 2050 scenarios: BRT build and no-build
- ▲ Reasonable assumptions made for stop locations and lane configurations
- ▲ Metropolitan Transportation Plan (2024-2050 MTP) projects are included
- ▲ VMT projections combined with local and default data sources used in US EPA MOVES4 modeling
- ▲ Air Quality Conformity Analysis: VOC and NOx (Ozone standards)
- ▲ GHG emissions: CO2 equivalent

Overview of MTP

\$35 billion in strategies and projects



- ▲ Widen 48 miles of freeways
- ▲ Convert 17 miles of four-lane divided roadways to freeways
- ▲ Modify 23 freeway interchanges
- ▲ Add 7 new interchanges
- ▲ Add 94 miles of through lane additions
- ▲ Add 95 miles of new roadway connections
- ▲ Include 122 roadway miles with minor widening
- ▲ Modify 117 intersections
- ▲ Add five high-capacity transit projects covering 50 miles



AQ Conformity Analysis

Study area is in nonattainment for 8-hour ozone standard (VOC and NO_x)

Required to perform Transportation Conformity Procedures

- ▲ Distribute 24-hour model volumes into hourly directional components
- ▲ Calculate an hourly, directional speed for the link based on V/C ratio
- ▲ Apply MOVES emission factors to calculate link based and intrazonal trips emissions

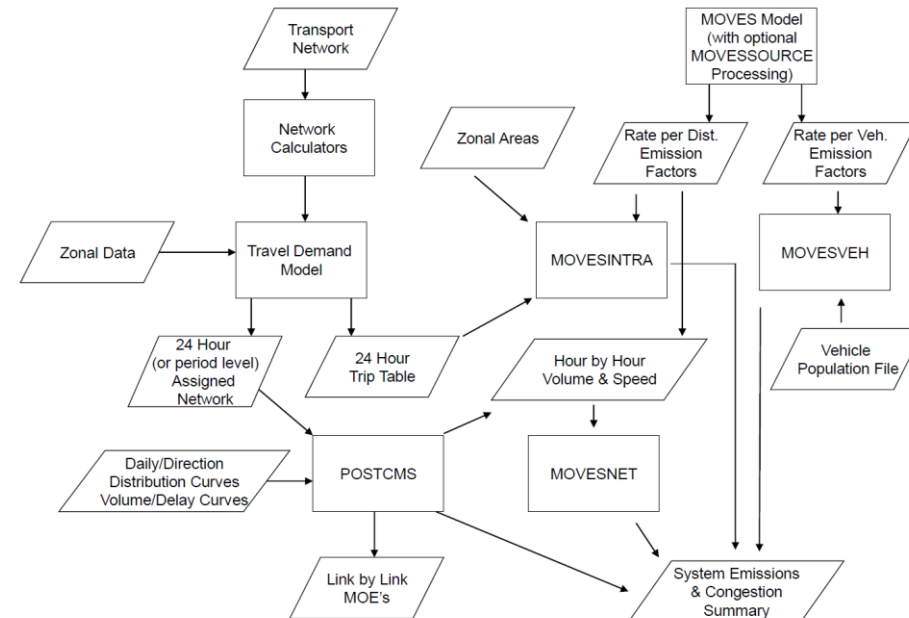


Figure 1. Overall CMAQ Proces

* Courtesy: Gregory Giaimo

AQ Conformity Analysis

- ▲ July Weekday
- ▲ AQ Season Factor: 8% higher than model VMT
- ▲ Weekend ADT 78% of Weekday (Based on StreetLight OD analysis)
- ▲ No. of Weekdays and Weekends by month in 2050 (using LLM)
- ▲ Emission factors from MOVES4 modeling (Ohio DOT)
- ▲ Estimate yearly emission for BRT build and no-build scenarios

Year: 2050

Month	Total Days	Weekdays	Weekends
January	31	23	8
February	28	20	8
March	31	21	10
April	30	22	8
May	31	23	8
June	30	21	9
July	31	21	10
August	31	22	9
September	30	21	9
October	31	23	8
November	30	21	9
December	31	22	9
Total	365	260	105

* Courtesy: M365 Copilot

~ 500 kg of VOC and ~2,800 kg of NOx emission will be reduced per year

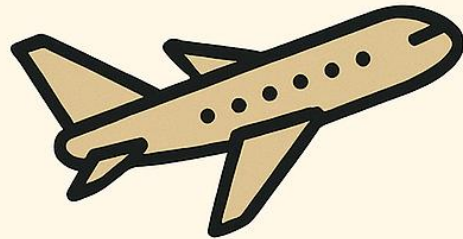
What does that mean?



600
PASSENGER
VEHICLES
DRIVEN FOR ONE YEAR



10
DIESEL
TRUCKS
DRIVEN FOR ONE YEAR



100
FLIGHTS
FROM NEW YORK TO LA



175 HOMES'
ENERGY USE
FOR ONE YEAR

* Courtesy: M365 Copilot

GHG Emission Analysis

Input Database

- ▲ Meteorology Data
- ▲ Source Type Population
- ▲ Age Distribution
- ▲ Vehicle Type VMT
- ▲ Average Speed Distribution
- ▲ Road Type Distribution
- ▲ Fuel (Supply, Formulation, Usage Fraction, AVFT)
- ▲ I/M program, Starts, Hotelling...

MOVES - D:\Projects\2024_07_LinkUS Emission\MOVES4 Run\Local data\FRA\without BRT\FRA_woBRT.rms - ID 7956808348537510620

File Edit Action Post Processing Tools Settings Help

Scale


Model

☒ Onroad Estimate emissions from motorcycles, cars, buses, and trucks that operate on roads.

☐ Nonroad Estimate emissions from nonroad equipment used in applications such as recreation, construction, lawn and garden, agriculture, mining, etc. Nonroad does not include aircraft, railroads, or commercial marine vessels.

Domain/Scale

☐ Default Scale Use the default national database with default state and local allocation factors.

 Caution: Do not use this scale setting for SIP or conformity analyses. The allocation factors and other defaults applied at the state or county level have not been verified against specific state or county data and do not meet regulatory requirements for SIPs and conformity determinations.

☒ County Scale Use this scale for SIP and regional conformity analysis. This scale requires user-supplied local data for most activity and fleet inputs.


☐ Project Scale Use this scale for project-level analysis for conformity, NEPA, or other regulatory purposes where link-level analysis is needed. This scale requires user-supplied data at the link level for activity and fleet inputs that describe a particular transportation project.

Calculation Type

☒ Inventory Mass and/or Energy within a region and time span.

☐ Emission Rates Mass and/or Energy per unit of activity.

MOVES ScenarioID:

 Caution: Changing these selections changes the contents of other input panels. These changes may include losing previous data contents.

Ready to run...

Meteorology Data	32
Source Type Population	41
Age Distribution	42
Vehicle Type VMT	43
Average Speed Distribution	51
Road Type Distribution	52
Fuel (Supply, Formulation, Usage)	53
I/M program, Starts, Hotelling...	54
	61
	62

MOVES		HPMS	
Source Type ID	Source Types	Vehicle Type ID	Vehicle Type
11	Motorcycle	10	Motorcycles
21	Passenger Car	25	Light Duty Vehicles
31	Passenger Truck		
32	Light Commercial Truck		
41	Other Buses	40	Buses
42	Transit Bus		
43	School Bus		
51	Refuse Truck	50	Single Unit Trucks
52	Single Unit Short-haul Truck		
53	Single Unit Long-haul Truck		
54	Motor Home		
61	Combination Short-haul Truck	60	Combination Trucks
62	Combination Long-haul Truck		

Welcome to the Age Distribution Projection Tool for MOVES4. This macro-based excel file projects a base year age distribution by source type to a future distribution using a similar algorithm to what was used to generate the national projected age distributions in MOVES4. It also generates charts on new worksheets allowing you to visually inspect the differences between the base year and analysis year age distributions. **YOU MUST ENABLE MACROS FOR THIS TOOL TO WORK.**

Instructions: First, enter the future analysis year (Step 1). Then, enter the base year age distribution by source type in the space provided (Step 2). The base year age distributions should be formatted as they are accepted into MOVES; see step 2 below. After inputting the base year age distribution, click the green button labeled "Start" to run the tool. Lastly, if the your analysis requires multiple analysis years, click the red button labeled "Reset" to clear the previous results and generated graphs.

NOTE: This calculator will only work with base year age distributions from 2011 or later. The output page "SourceTypeAgeDistribution" contains the future year age distribution formatted for use in MOVES. This tool is a macro-enabled Excel template (.xlsm). Therefore, MOVES cannot import it directly into an input database. To import the projected age distribution, users can either 1) copy the calculated SourceTypeAgeDistribution into a blank spreadsheet and import from there, or 2) re-save this file by selecting File > Save As, choosing either an .xls or .xlsx file, and then selecting "Yes" when prompted to confirm saving a macro-free version of this workbook.

Updated 8/23/2023

[illegible]

AVFT Tool

Tool Input Selections

Last complete model year in input data:

2019

Analysis year:

2050

Open Help

Gap-filling Method:

Passenger Cars (21):

Fill with 0s

Passenger Trucks (31):

Fill with 0s

LD Commercial Trucks (32):

Fill with 0s

Other Buses (41):

Fill with 0s

Transit Buses (42):

Fill with 0s

School Buses (43):

Fill with 0s

Refuse Trucks (51):

Fill with 0s

Single Unit Short-haul Trucks (52):

Fill with 0s

Single Unit Long-haul Trucks (53):

Use defaults and renormalize

Motor Homes (54):

Fill with 0s

Combination Short-haul Trucks (61):

Fill with 0s

Combination Long-haul Trucks (62):

Use defaults and renormalize

Projection Method:

Proportional

Proportional

Proportional

Proportional

Proportional

Proportional

Proportional

Proportional

National Average

Proportional

Proportional

National Average

Input/Output Files

Input AVFT File: ... data\FRA\AVFT_tool_in.xlsx [AVFT]

Browse...

Create Template...

Known Fractions: Browse for the known fractions input file...

Browse...

Create Template...

Output AVFT File: Specify the output file name and location...

Browse...

Messages

Run AVFT Tool

Save Messages

Done

GHG Emission Analysis

Input Database

MOVES County Data Manager

✓ Road Type Distribution

✓ Source Type Population

✓ Starts

✓ Vehicle Type VMT

✓ Hotelling

✓ Idle

✓ I/M Programs

✓ Retrofit Data

✓ Generic

Tools

RunSpec Summary

Database

✓ Age Distribution

✓ Average Speed Distribution

✓ Fuel

✓ Meteorology Data

Select or create a database to hold the imported data.

Server: localhost

Refresh

Database: franklin_county_wbrt_2050_in

Create Database

Log:

Clear All Imported Data

2025-08-05 14:41:08.0 Fuel Filled FuelSupply table

2025-08-05 14:41:08.0 Fuel Filled FuelFormulation table

2025-08-05 14:41:08.0 Fuel Filled FuelUsageFraction table

2025-08-05 14:41:08.0 Fuel Filled avft table

2025-08-05 14:37:20.0 Fuel Filled FuelSupply table

2025-08-05 14:37:20.0 Fuel Filled FuelFormulation table

2025-08-05 14:37:20.0 Fuel Filled FuelUsageFraction table

2025-08-05 14:16:58.0 Meteorology Data Filled ZoneMonthHour table

2025-08-05 14:16:44.0 Average Speed Distribution Filled AvgSpeedDistribution table

2025-08-05 14:16:28.0 Age Distribution Filled SourceTypeAgeDistribution table

2025-08-05 14:16:12.0 Vehicle Type VMT Filled HPMSVTypeYear table

2025-08-05 14:16:12.0 Vehicle Type VMT Filled MonthVMTFraction table

2025-08-05 14:16:12.0 Vehicle Type VMT Filled DayVMTFraction table

2025-08-05 14:16:12.0 Vehicle Type VMT Filled HourVMTFraction table

2025-08-05 14:15:16.0 Source Type Population Filled SourceTypeYear table

2025-08-05 14:15:03.0 Road Type Distribution Filled RoadTypeDistribution table

2025-08-05 13:03:16.0 I/M Programs Flag No data needed

Database

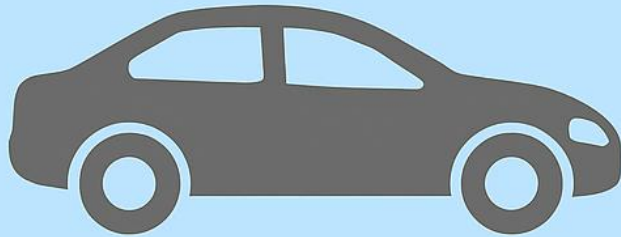
Done

Table 3-3: CO₂ Equivalence Factors in MOVES

Pollutant	CO ₂ Equivalent ³⁵
CO ₂	1
Methane (CH ₄)	25
Nitrous Oxide (N ₂ O)	298

~2,100 Metric tons of CO₂ Equivalent emission will be reduced per year

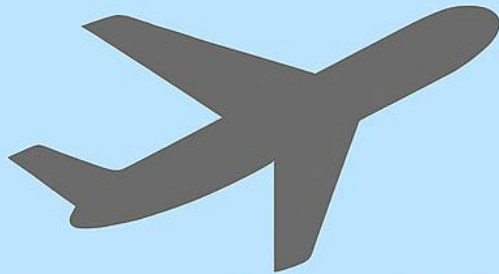
How big is 2100 metric tons of CO₂e?



**456 passenger vehicles
driven for one year**



**280 homes' energy use
for one year**



**2100 round-trip flights
from New York to London**



**256 million
smartphone charges**

* Courtesy: M365 Copilot

How many trees are needed for offsetting?



95,454 trees

* Courtesy: M365 Copilot

Final Remarks

- ▲ Can BRT reduce emission? Yes
- ▲ Models (Modelers) are useful
- ▲ Transit Supportive Infrastructure: 500+ miles of sidewalks, bikeways and trails – not part of modeling
- ▲ Providing yearly emissions helped clear the air with policymakers!

“Everyone wants transit, for the other guy”



Raj Roy, PE, AICP

Senior Modeler

Mid-Ohio Regional Planning Commission

rroy@morpc.org

111 Liberty Street, Suite 100 Columbus, OH 43215

