



MID-OHIO REGIONAL
MORPC
PLANNING COMMISSION

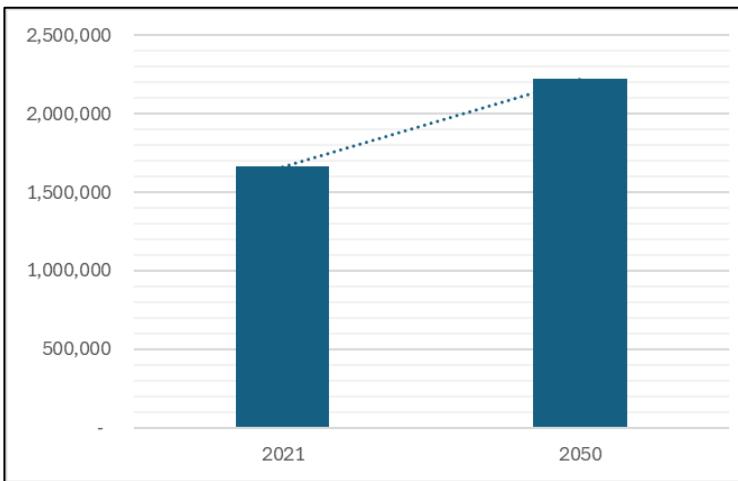
Evaluating Emissions Reduction through Bus Rapid Transit in Central Ohio: An Activity-Based Approach

Raj Roy, PE, AICP

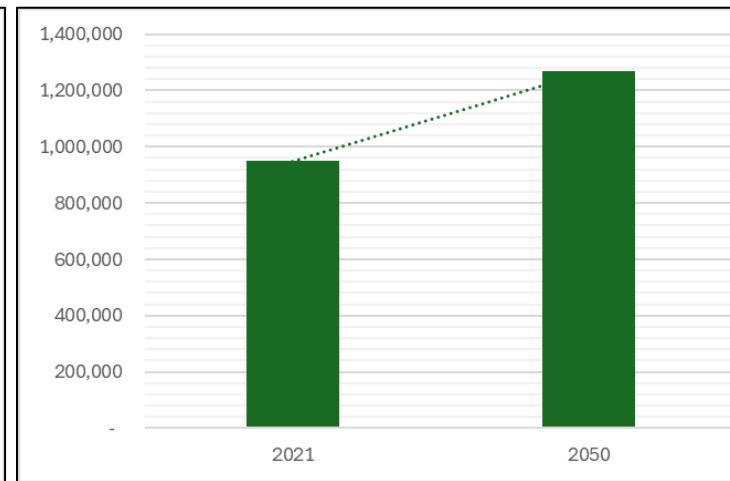


What is MORPC?

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

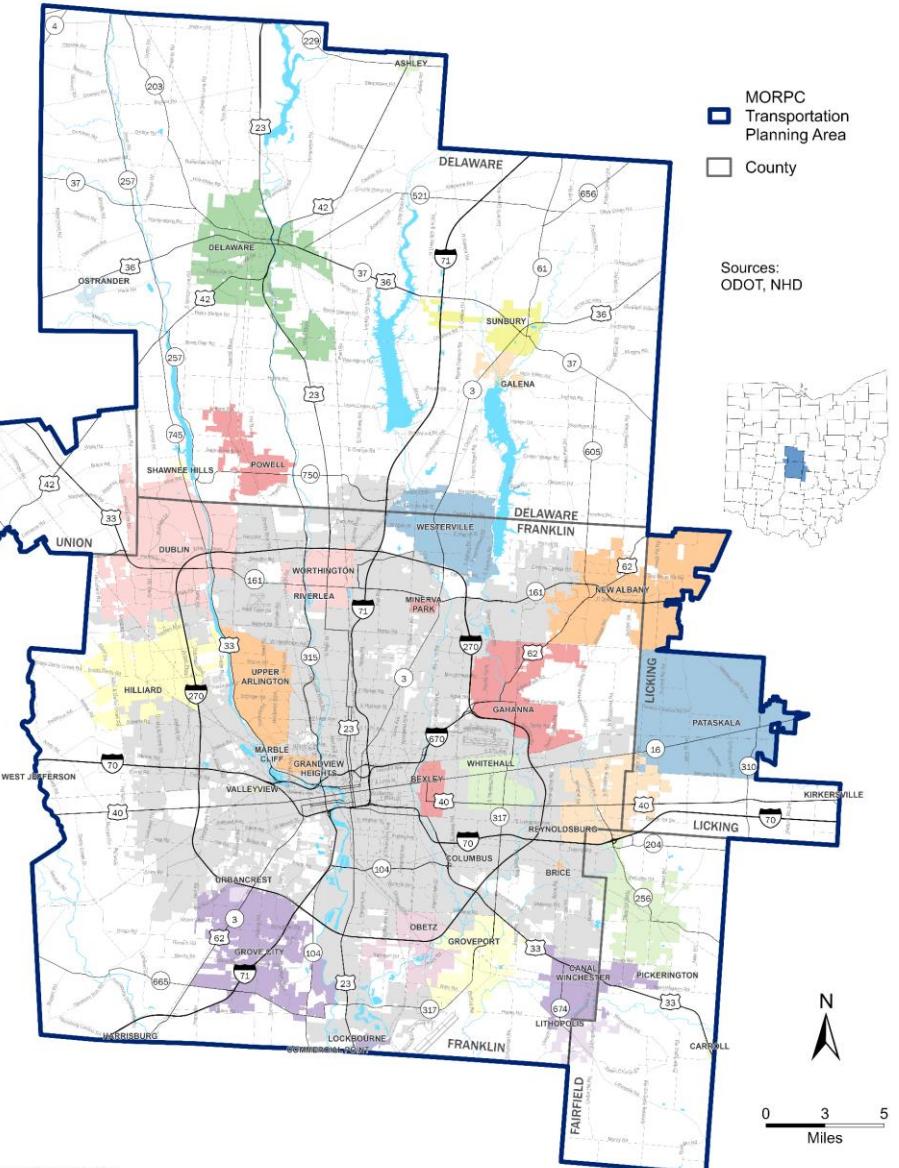


Population

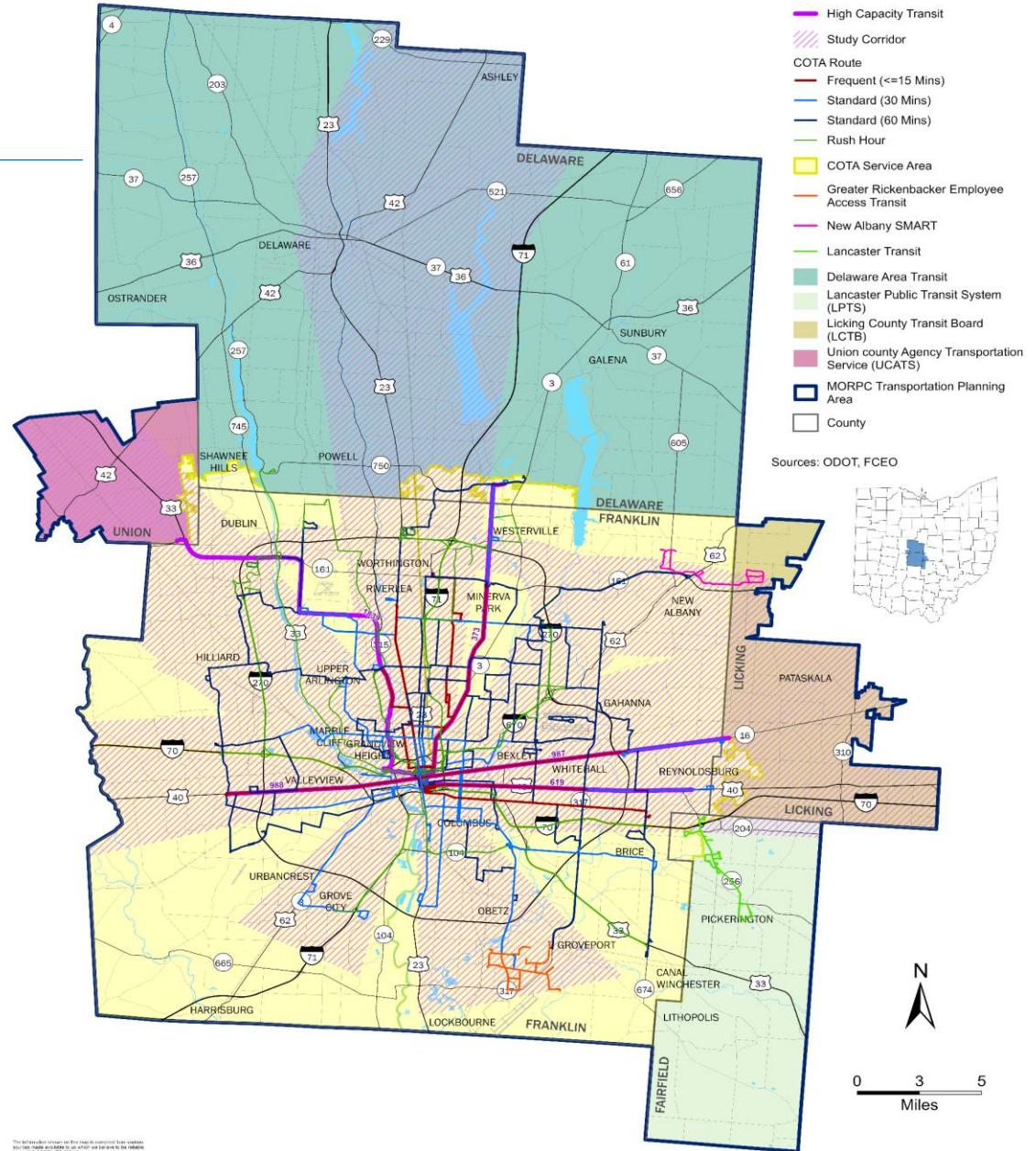


Employment

- ▲ Conducts regional transportation studies
 - ▲ LinkUS



Transit Infrastructure



What is LinkUS?



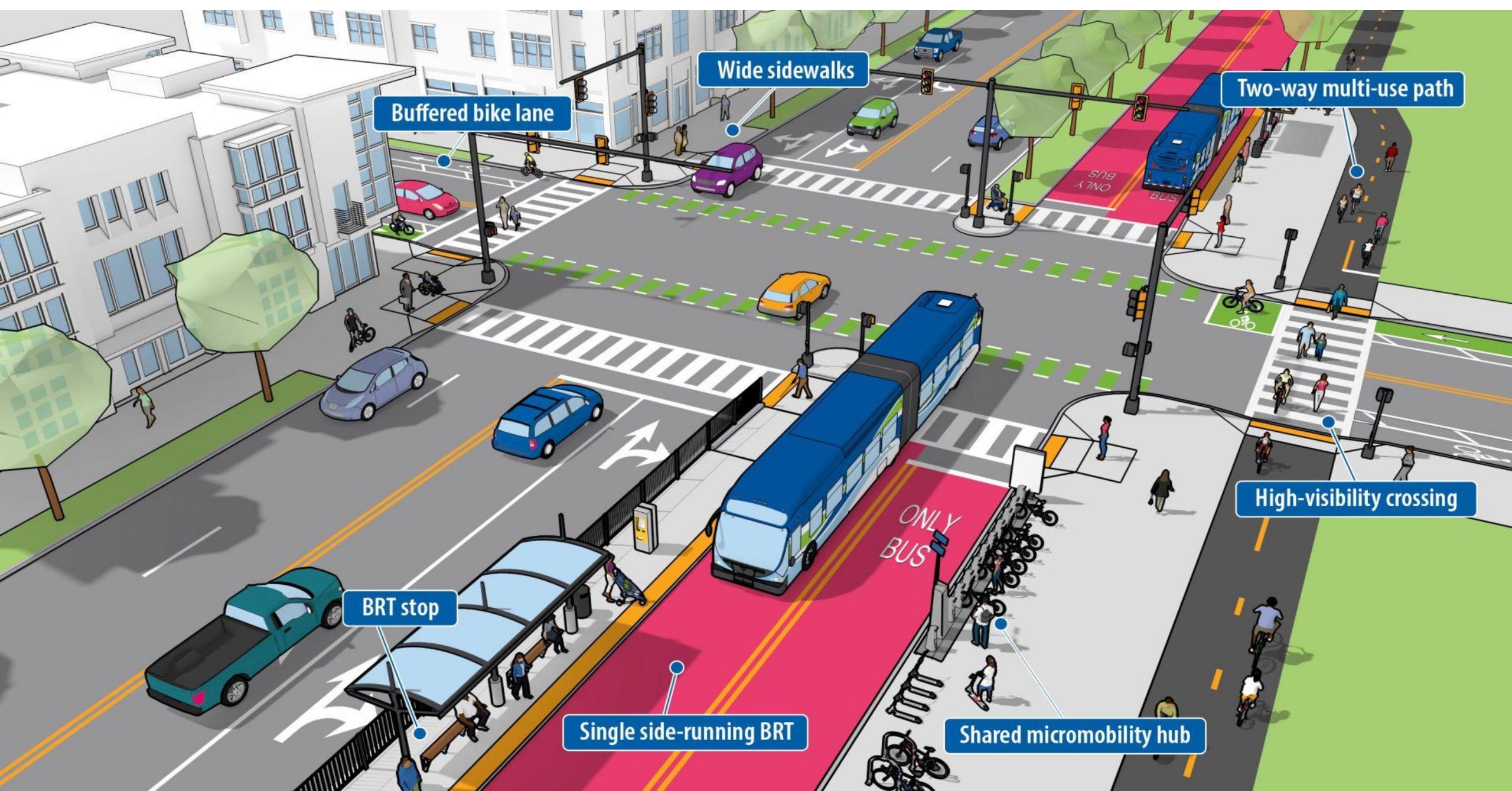
About BRT Corridors Sidewalks & Bikeways Progress



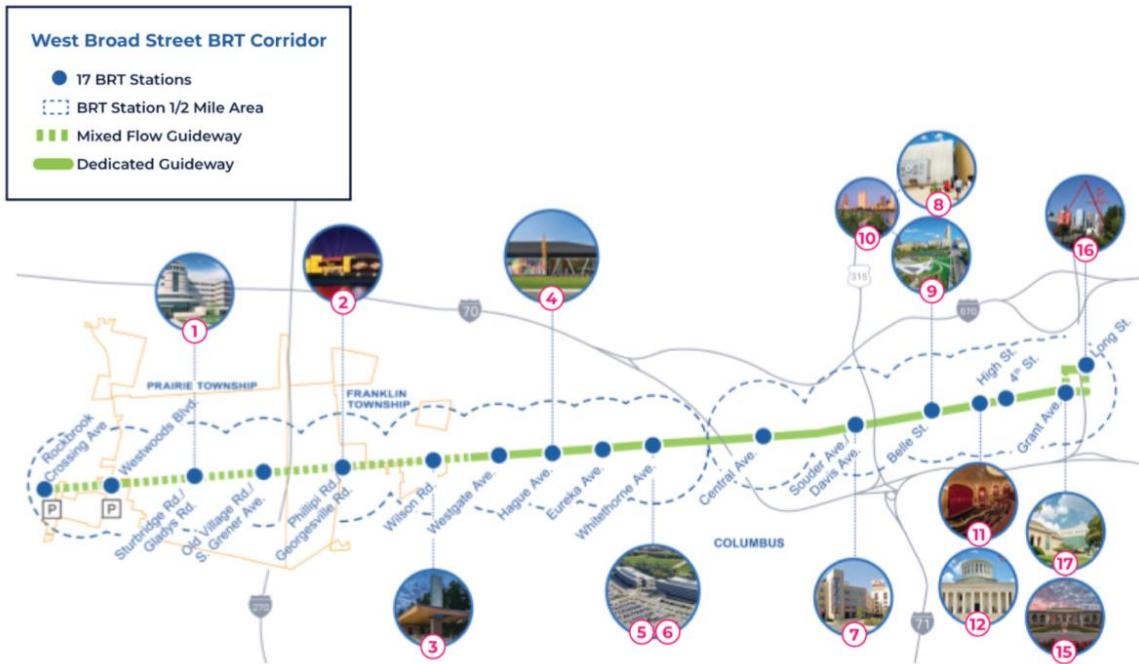
Modernize the Transit System

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

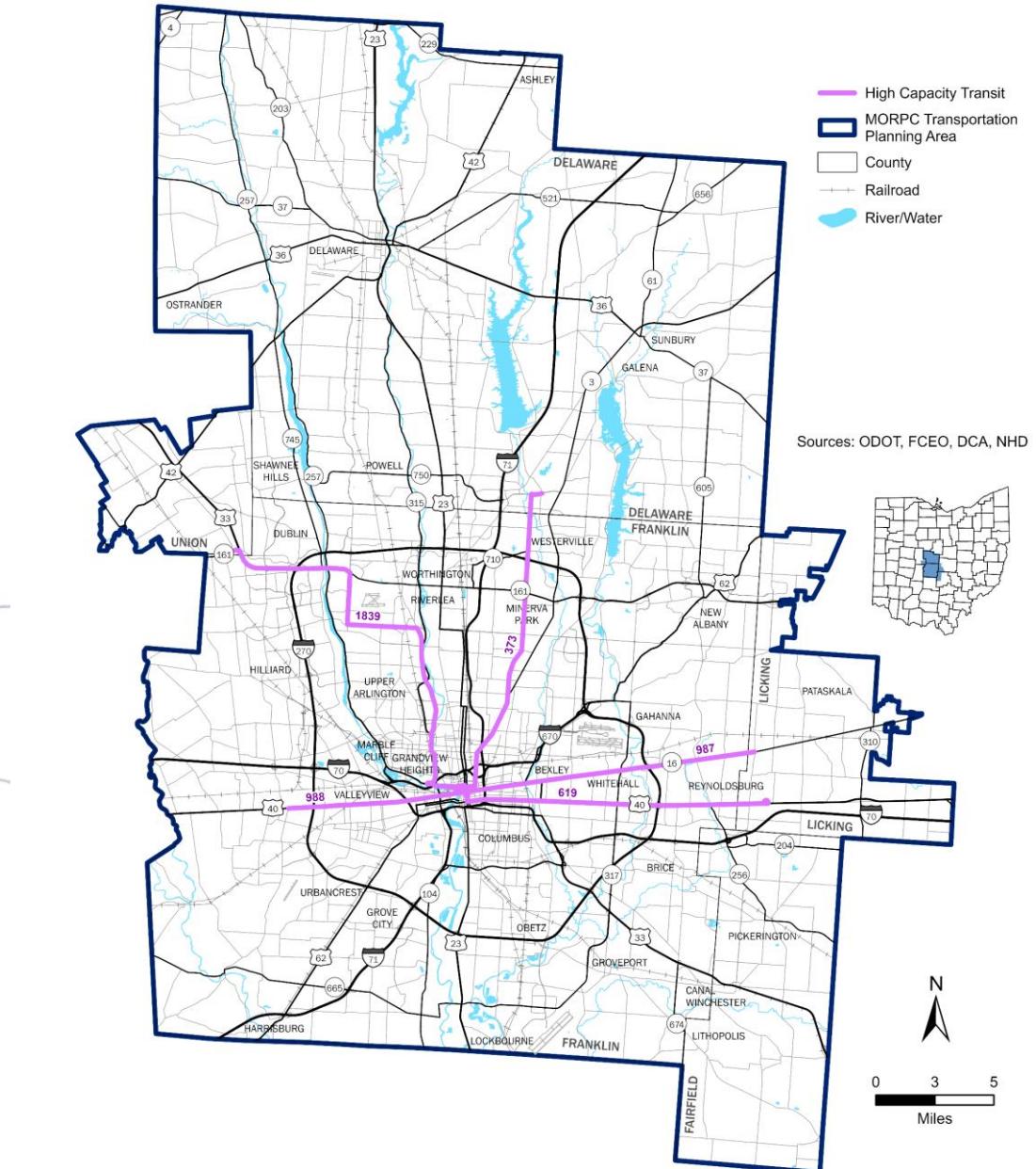


5 Rapid Transit Lines



Activity Centers / Trip Generators

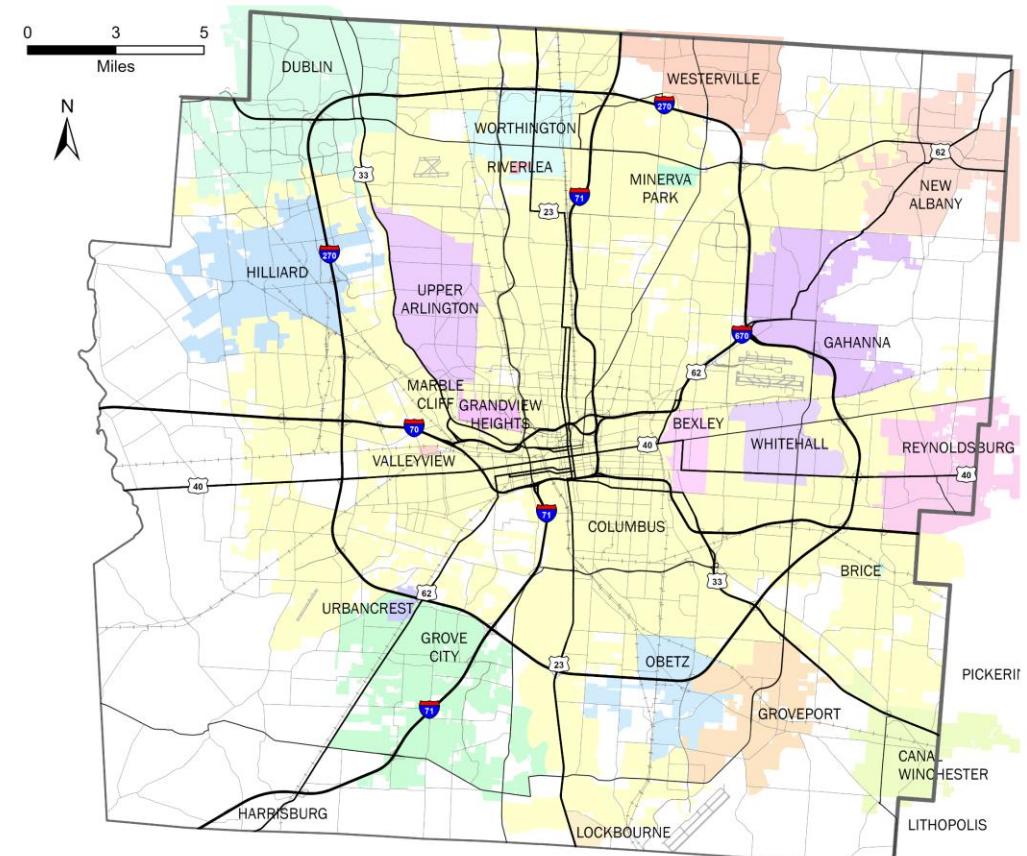
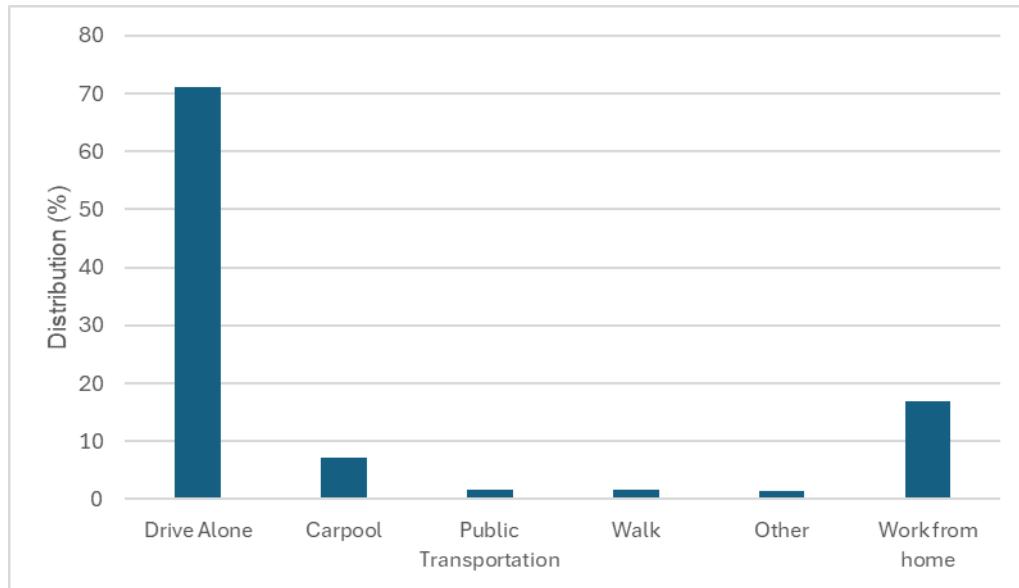
1. OhioHealth Doctors Hospital	7. Mount Carmel Hospital	13. Capital University Law School
2. Hollywood Casino	8. Center of Science and Industry (COSI)	14. OhioHealth Grant Medical School
3. Wilson Road Park	9. Veterans Memorial	15. Columbus Metropolitan Library
4. Hilltop Branch Library	10. Scioto Mile	16. Columbus College of Art & Design
5. Ohio Department of Transportation	11. Palace Theatre	17. Columbus Museum of Art
6. Ohio Department of Public Safety	12. Ohio Statehouse	



Study Area

-  Total Roadway Lane-Miles: ~10,500
-  Total Transit Route Miles: ~3,000
-  Population: ~1.3M
-  Employment: ~800K

Modal Distribution



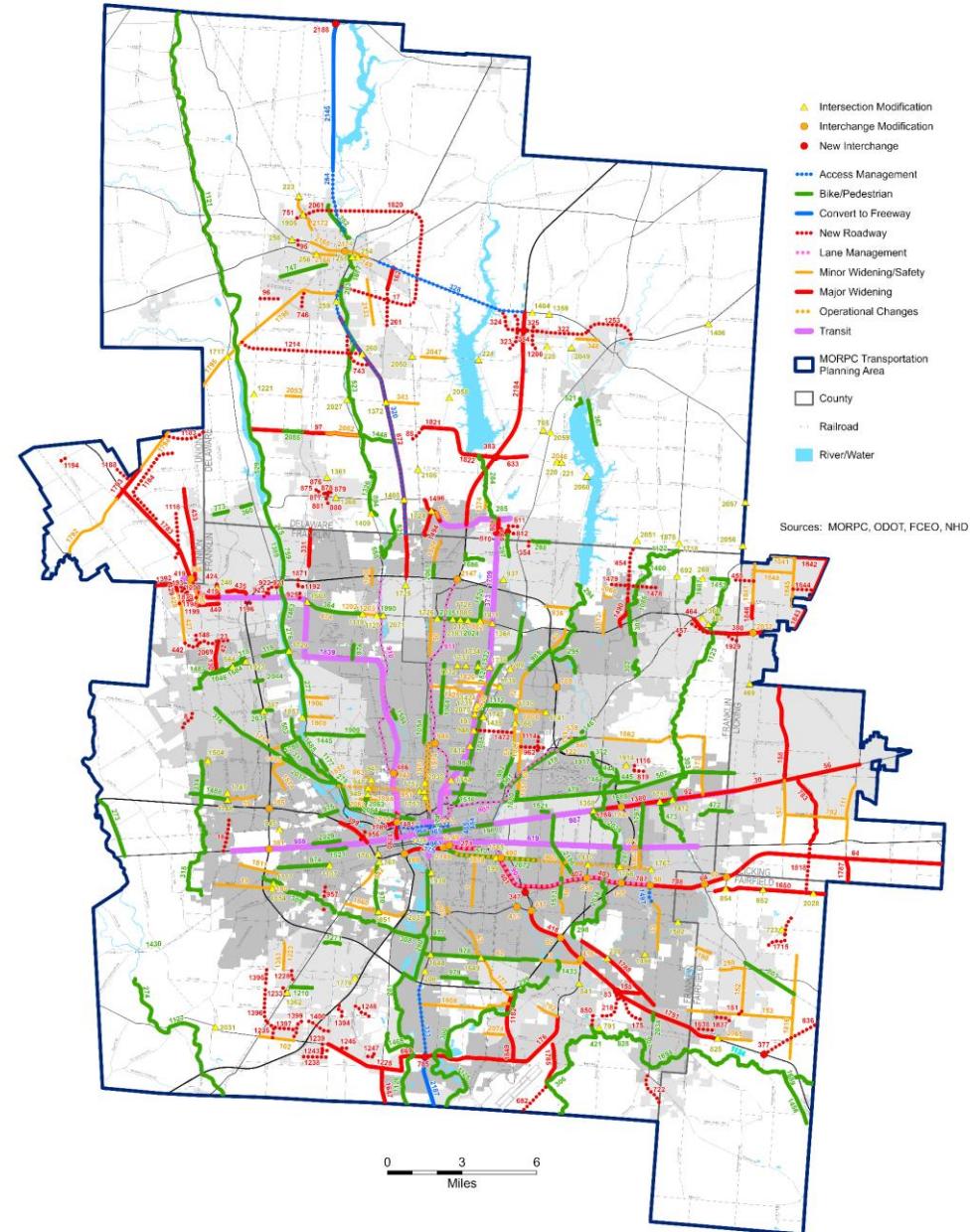
Methodology

- ▲ 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 NOx)

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

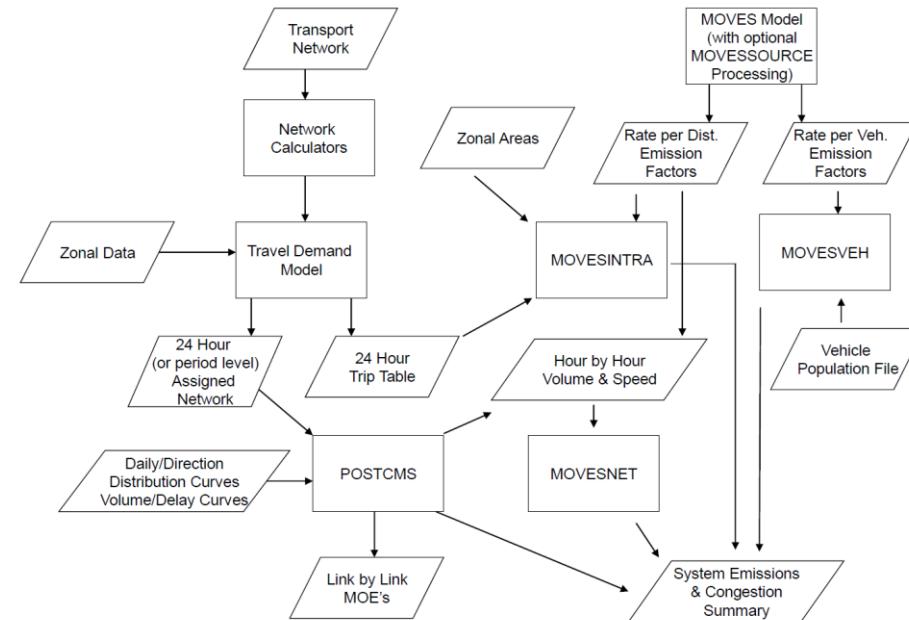


Figure 1. Overall CMAQ Process

* Courtesy: Gregory Gaimo

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**



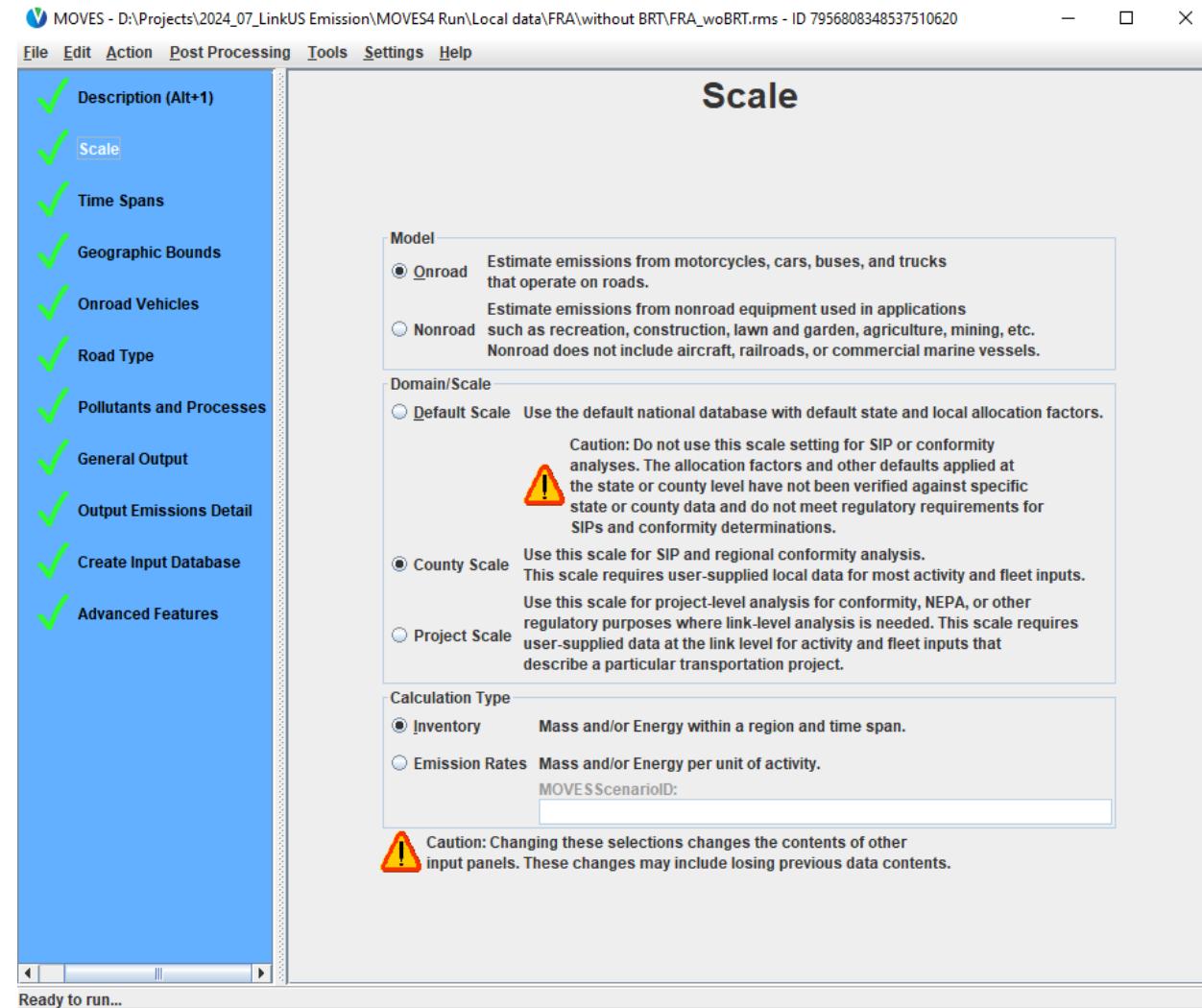
**175 HOMES'
ENERGY USE
FOR ONE YEAR**

* 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...



GHG Emission Analysis

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...

Table 4-1: MOVES Source Types and HPMS Vehicle Type

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

Age Distribution Projection Tool

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

Calculation Inputs: follow the numbered steps below and make your selection or input data into the black outlined boxes.

1) Please specify an analysis year

2) Enter a base year age distribution by source type below (max 403 rows)

sourceTypeID	yearID	ageID	ageFraction

3) Once you have completed step 2, click "Start"

> SourceTypeAgeDistribution Inputs +

AVFT Tool

Tool Input Selections

Last complete model year in input data: Analysis year:

Gap-filling Method:

Projection Method:
Passenger Cars (21): <input type="button" value="Fill with 0s"/>
Passenger Trucks (31): <input type="button" value="Fill with 0s"/>
LD Commercial Trucks (32): <input type="button" value="Fill with 0s"/>
Other Buses (41): <input type="button" value="Fill with 0s"/>
Transit Buses (42): <input type="button" value="Fill with 0s"/>
School Buses (43): <input type="button" value="Fill with 0s"/>
Refuse Trucks (51): <input type="button" value="Fill with 0s"/>
Single Unit Short-haul Trucks (52): <input type="button" value="Fill with 0s"/>
Single Unit Long-haul Trucks (53): <input type="button" value="Use defaults and renormalize"/>
Motor Homes (54): <input type="button" value="Fill with 0s"/>
Combination Short-haul Trucks (61): <input type="button" value="Fill with 0s"/>
Combination Long-haul Trucks (62): <input type="button" value="Use defaults and renormalize"/>

Projection Method:

Input/Output Files

Input AVFT File:

Known Fractions:

Output AVFT File:

Messages

Run AVFT Tool Done



GHG Emission Analysis

Input Database

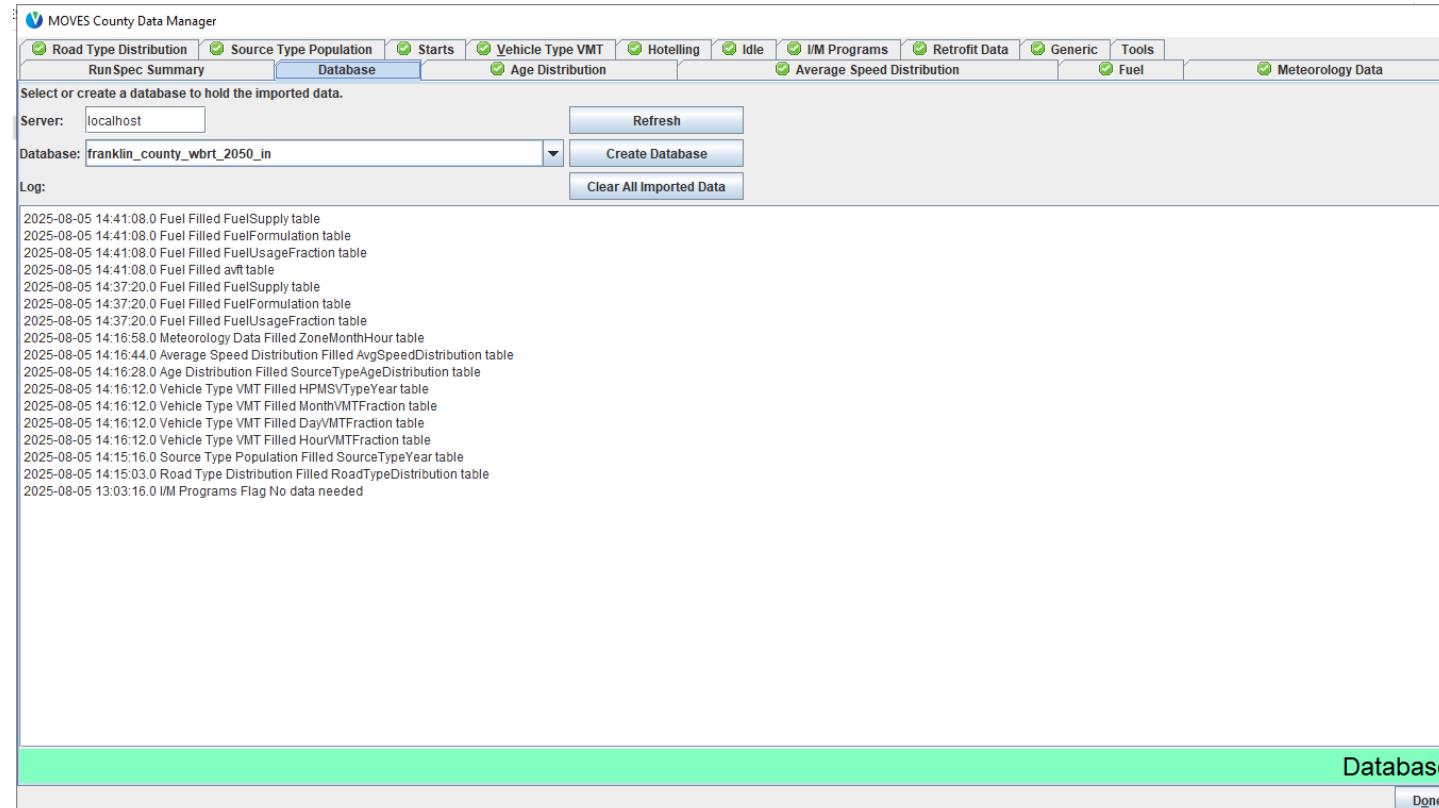
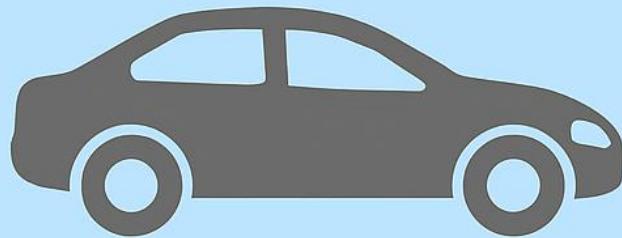


Table 3-3: CO₂ Equivalence Factors in MOVES

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

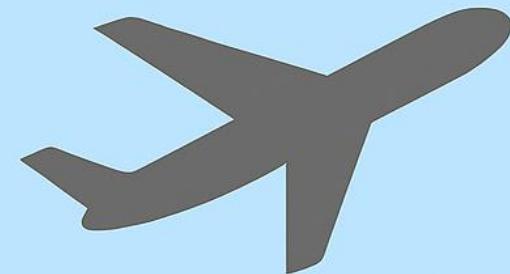
How big is 2100 metric tons of CO₂e?



**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”



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