Ohio Model Users Group

Modeling for the 2024 Eclipse

November 18, 2022

Background

- There will be a total solar eclipse passing through Ohio in 2024.
- ODOT wants to be able to assist in planning for and positioning resources on eclipse day to facilitate smooth traffic operations.
- Due to the extent of the geographic impact of the eclipse on Ohio, the Ohio Statewide Model is the only tool of suitable scale for this analysis.
- Goal is to create an Eclipse Day event model for Ohio using data collected from the 2017 eclipse in Kentucky and Tennessee

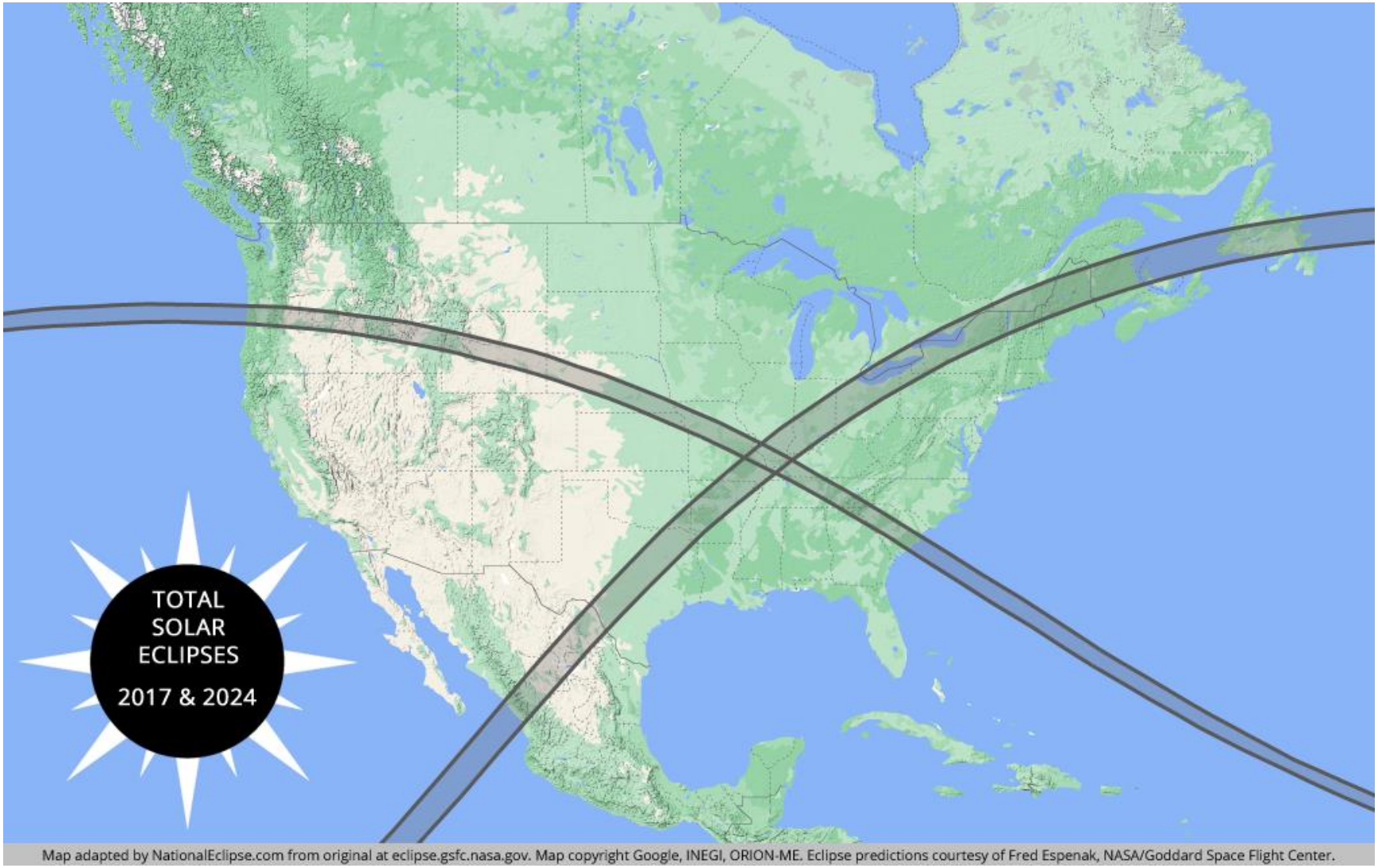
2017 Eclipse

- Total solar eclipse occurred on August 21, 2017
- 70-mile-wide path of totality (area from which a total solar eclipse can be observed)
- Stretched from Oregon to South Carolina
- Passed through Kentucky and Tennessee
- Eclipse day specific changes to traffic caused disruptions in traffic flows on key facilities entering and leaving the path of totality

2017 Eclipse Traffic

Photo: Wyoming DOT

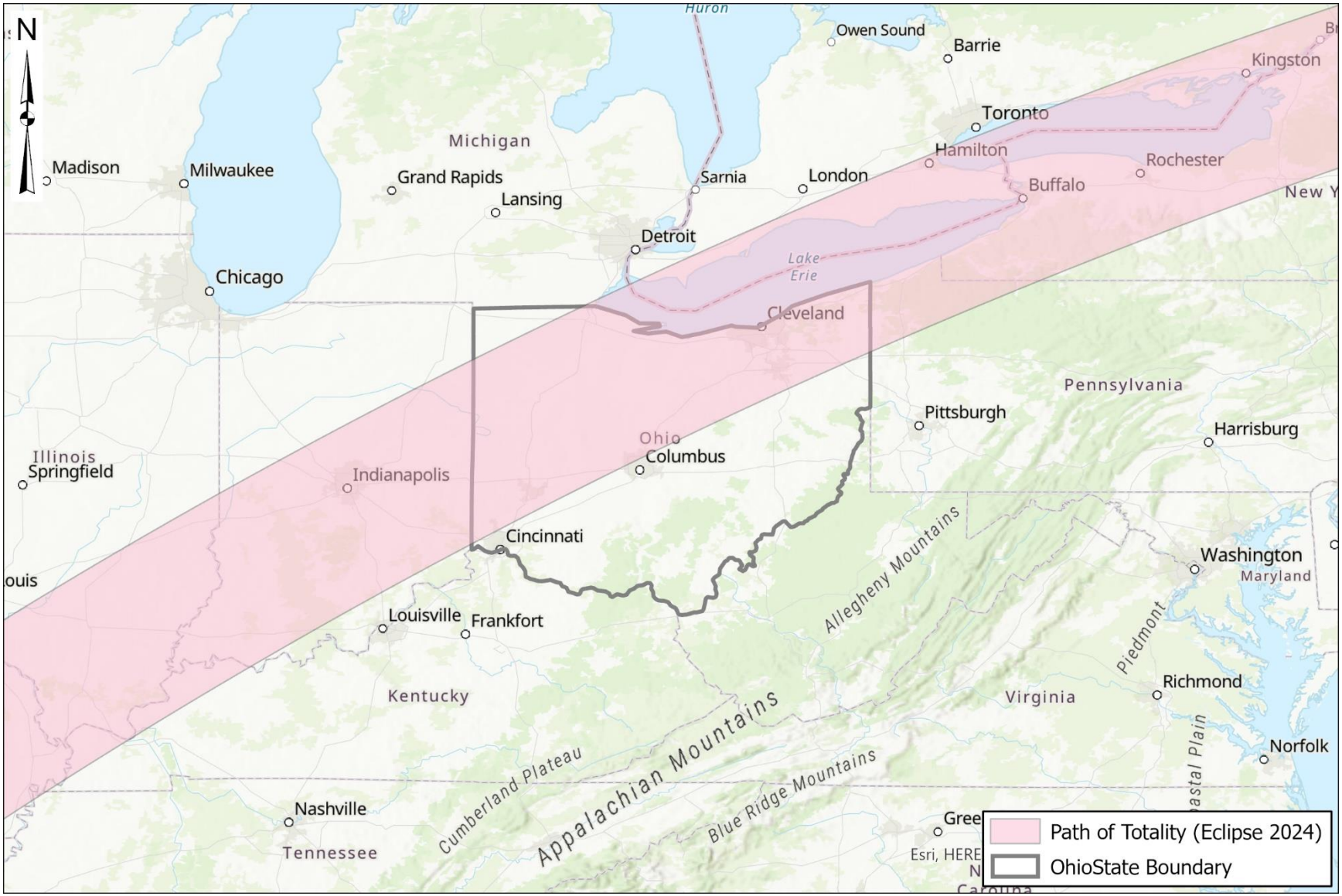
2017 vs 2024


TOTAL
SOLAR
ECLIPSES
2017 & 2024
Map adapted by NationalEclipse.com from original at eclipse.gsfc.nasa.gov. Map copyright Google, INEGI, ORION-ME. Eclipse predictions courtesy of Fred Espenak, NASA/Goddard Space Flight Center.

2024 Eclipse

- Total solar eclipse will occur on April 8, 2024
- Will stretch from Maine to Texas
- Will pass through Ohio covering approximately half of the state
- Cleveland, Dayton, and Akron are all in the path of totality.
- The northern edges of Columbus and Ohio are also in the path
- Other key population centers outside of Ohio are also in the path of totality, which may reduce trips entering Ohio on eclipse day (Indianapolis, Erie, Buffalo).

Map of 2024 Path of Totality

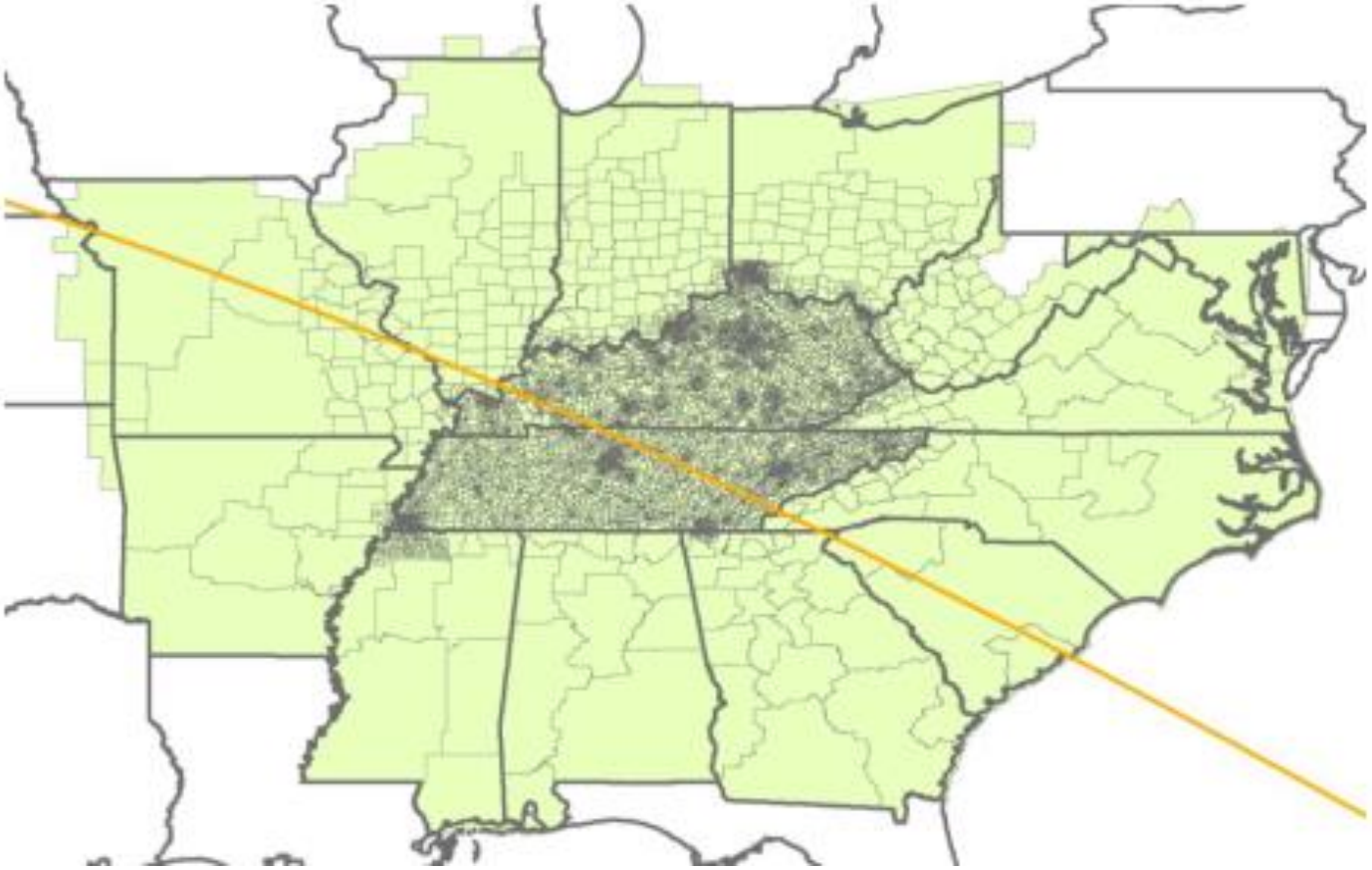


Agenda

- Background
- Classification of Trips
- Exploring Travel Patterns
- Translating Trip Length Distributions
- Identifying Changes in Trip Ends
- Allocating Trip Ends
- Diurnal Distribution of Trips
- Truck Trips
- Next Steps

Previous Work

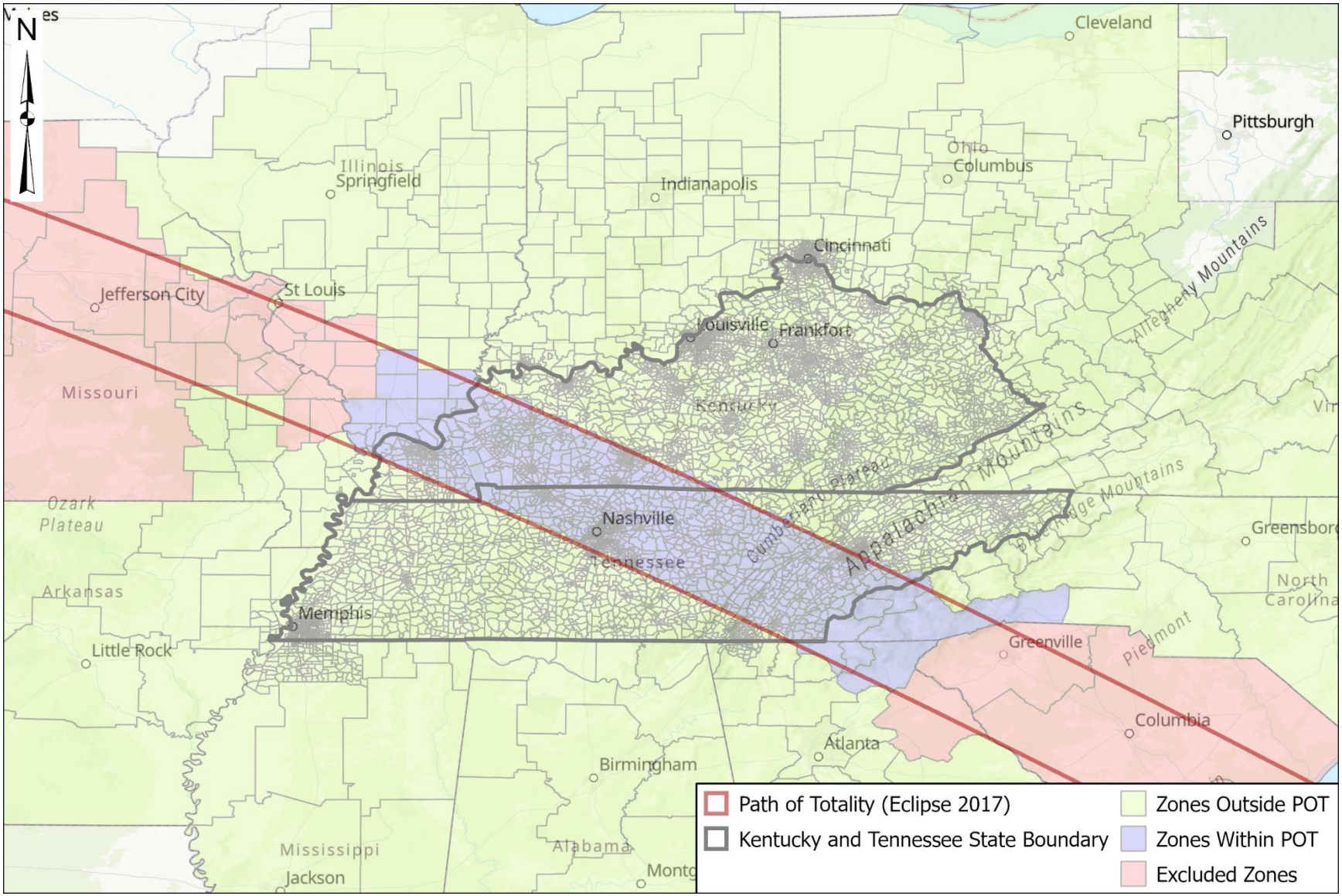
- Development of Passive OD Data for a Typical Summer Weekday vs Eclipse Day (RSG, rMerge)



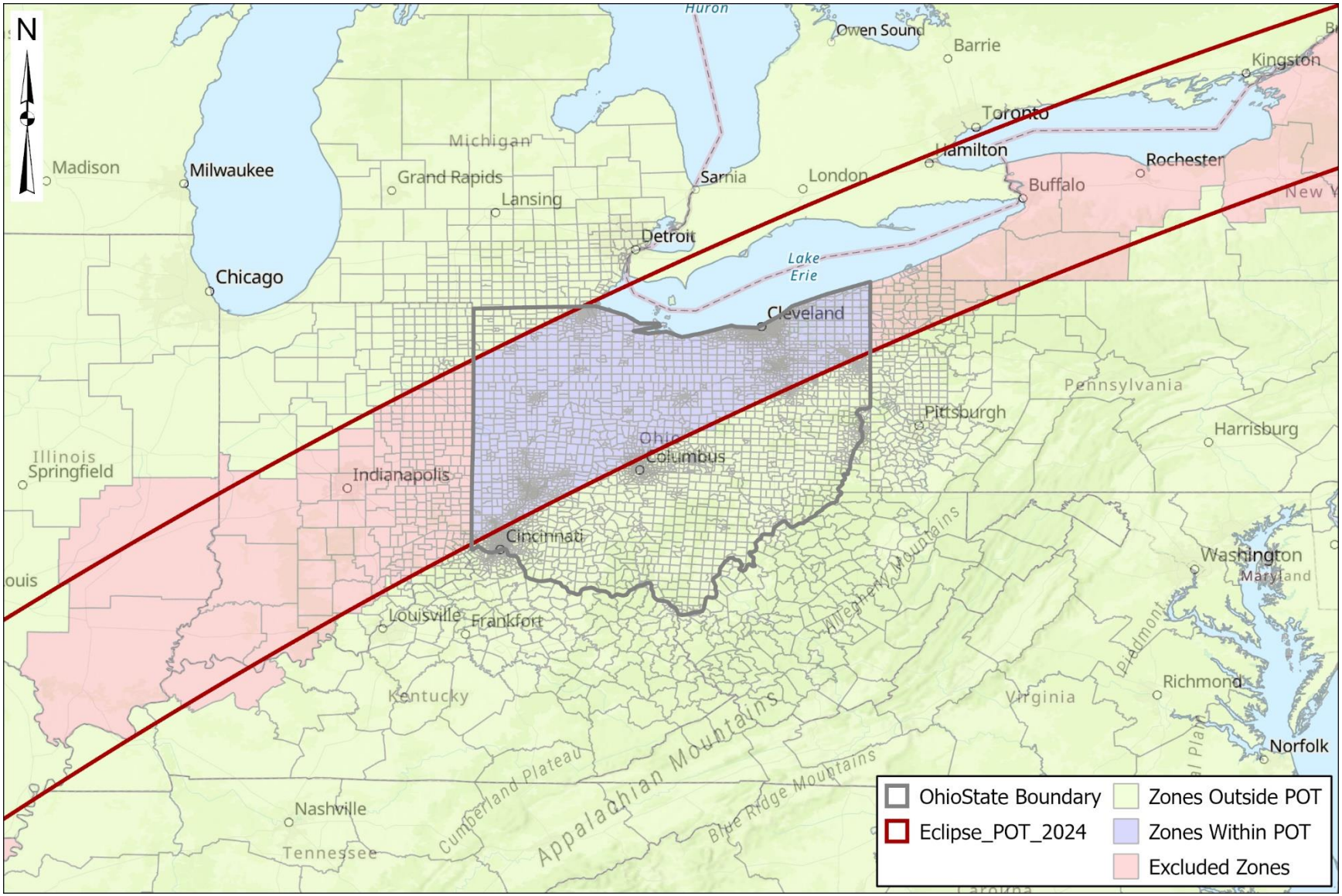
Classification of Trips

- Original classification of trips between residents and visitors
- Lack of confidence in the designation of these classes led to ultimately combining them into a single class
- Further classification of trips relative to the path of totality
  - II trips: Trips beginning and ending in the path of totality
  - IE trips: Trips traveling from the path of totality
  - EI trips: Trips traveling to the path of totality
  - EE trips: Trips traveling through or avoiding the path of totality
  - Excluded trips: Trips interacting with the path of totality in areas outside of KY/TN or Ohio

KY / TN Analysis Zones



Ohio Statewide Model TAZs



Exploring Travel Patterns

- Considerable noise in the data
- Difficulty in discerning signal from noise
- Focused on trips where changes were undeniable
- Changes in trip lengths seen as key to understanding patterns
- II trips and EE trips showed small but noticeable reductions in trip lengths
  - People in path of totality take the day off? Reduce their travel or stay near viewing areas?
- IE trips and EI trips show dramatic increases in trip lengths
  - People making non-typical trips from further away to see the eclipse?
- IE / EI trips became focus for model approach

Average Trip Lengths – KY/TN

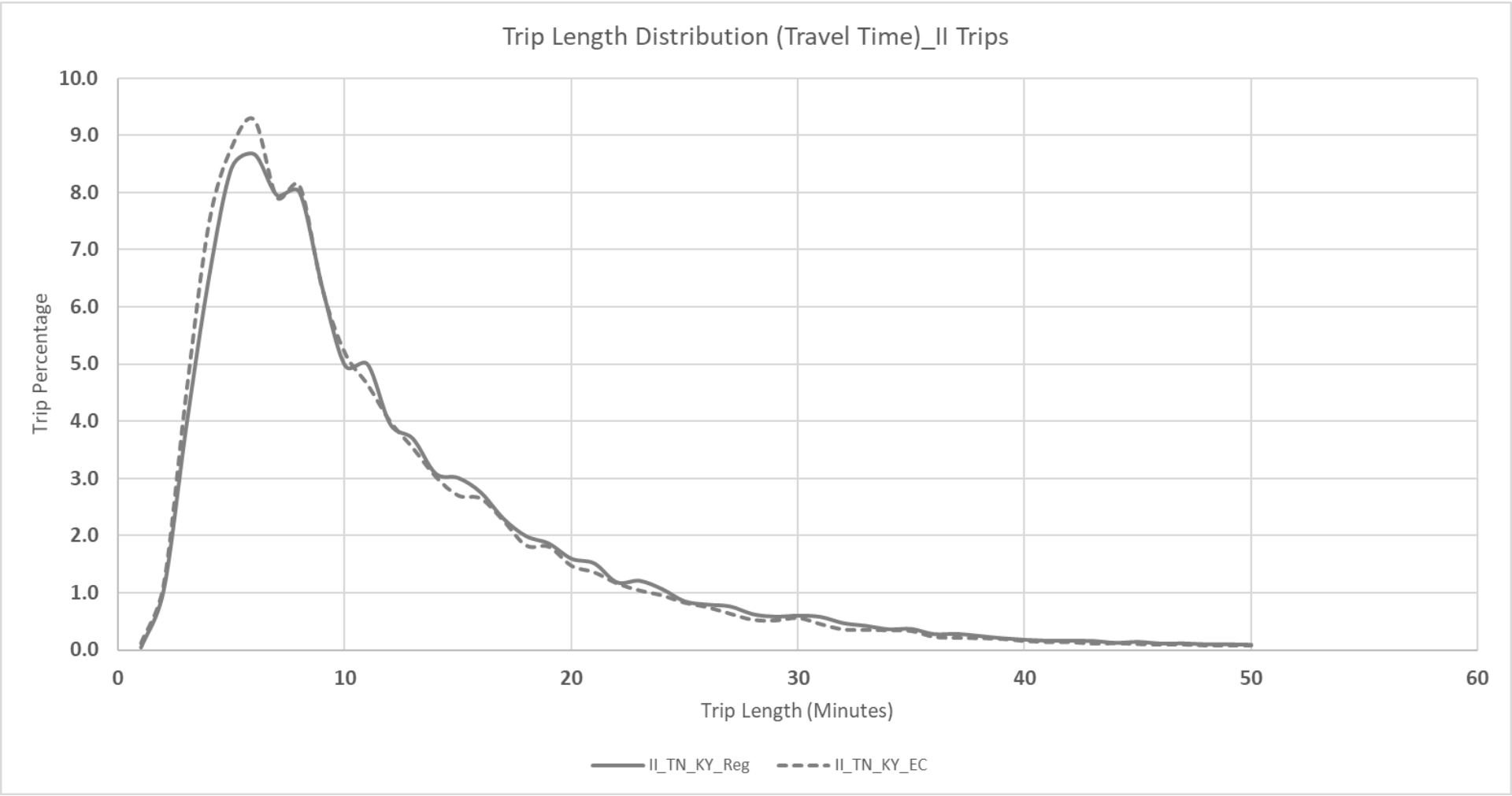
	Travel Time (Min)					
	Residents		Visitors		Combined	
	Regular	Eclipse	Regular	Eclipse	Regular	Eclipse
Overall	18	17	23	21	21	19
II	14	13	11	10	13	12
IE	35	42	72	116	46	63
EI	39	42	74	90	49	55
EE	17	15	22	19	21	18

Longer travel times for IE / EI trips on eclipse day than regular day imply that new trips are being made by people to the path of totality from farther away for the sole purpose of observing the eclipse. For example, traveling from Columbus to Nashville to view the eclipse when one otherwise would not.

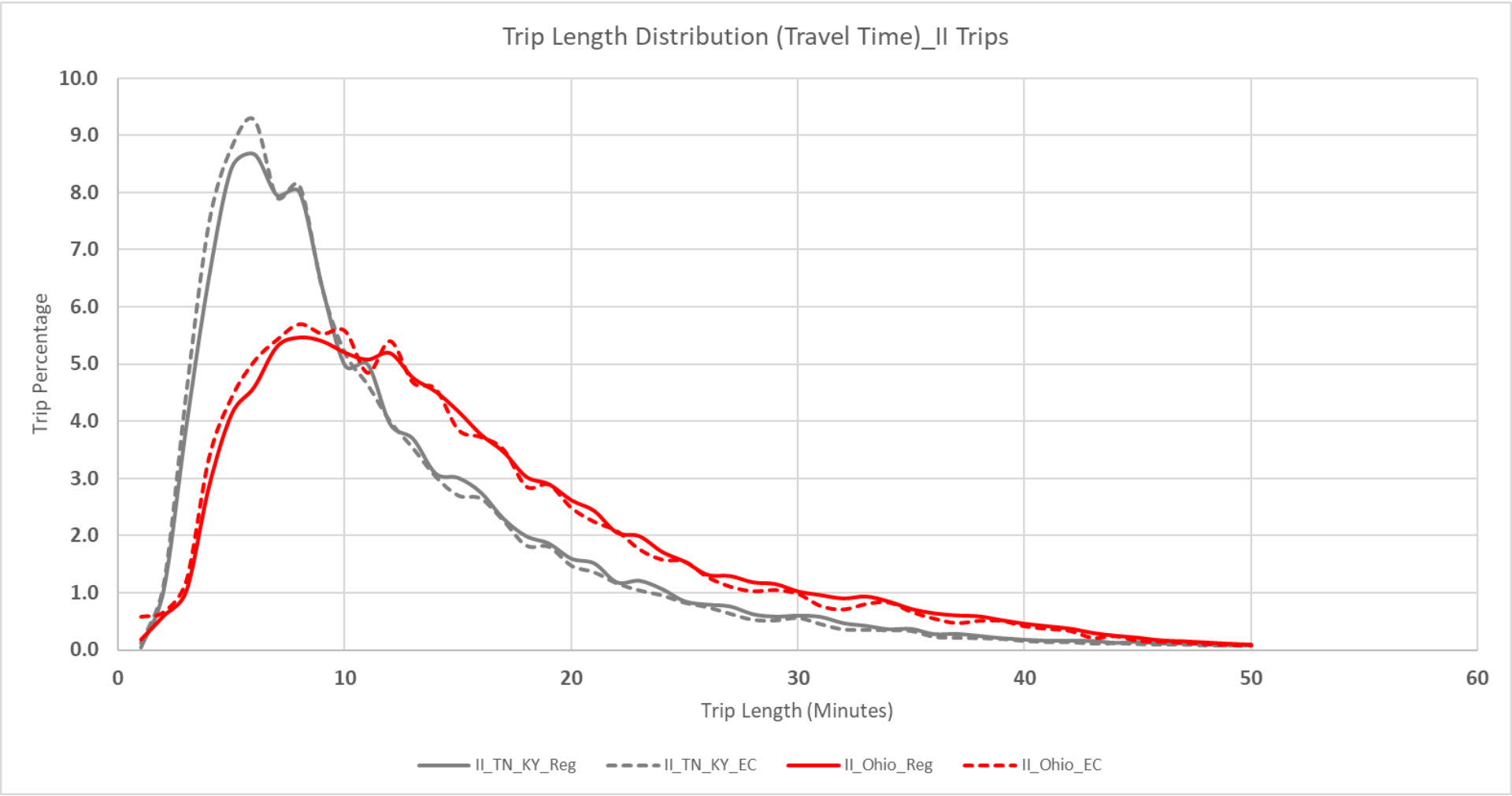
Translating TLDs

- The Ohio statewide model has different trip lengths than the ones observed in KY and TN.
- Unable to use KY and TN eclipse day trips lengths directly.
- Needed to translate KY and TN behaviors to relate to Ohio behaviors.
  - Calculate the difference in regular day TLDs and eclipse day TLDs for KY/TN.
  - Calculate the difference in regular day TLDs bin by bin between KY/TN and Ohio.
  - Factor the differences in regular day TLDs between KY/TN and Ohio by the differences between regular day and eclipse day for KY/TN.
- New eclipse day Ohio TLDs to be used for calibrating eclipse gravity models for IE and EI.

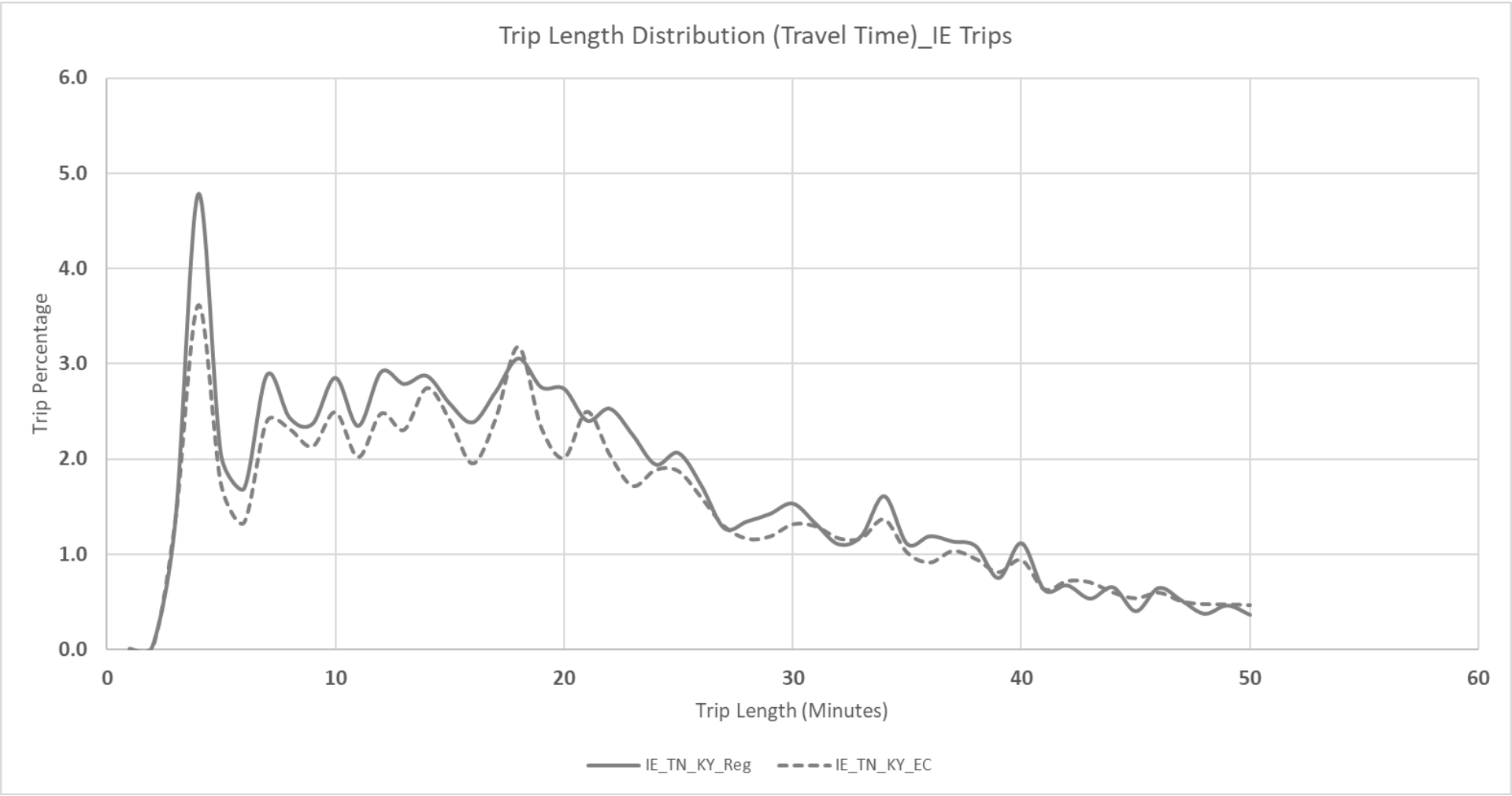
TLD – II: Observed Data in Gray



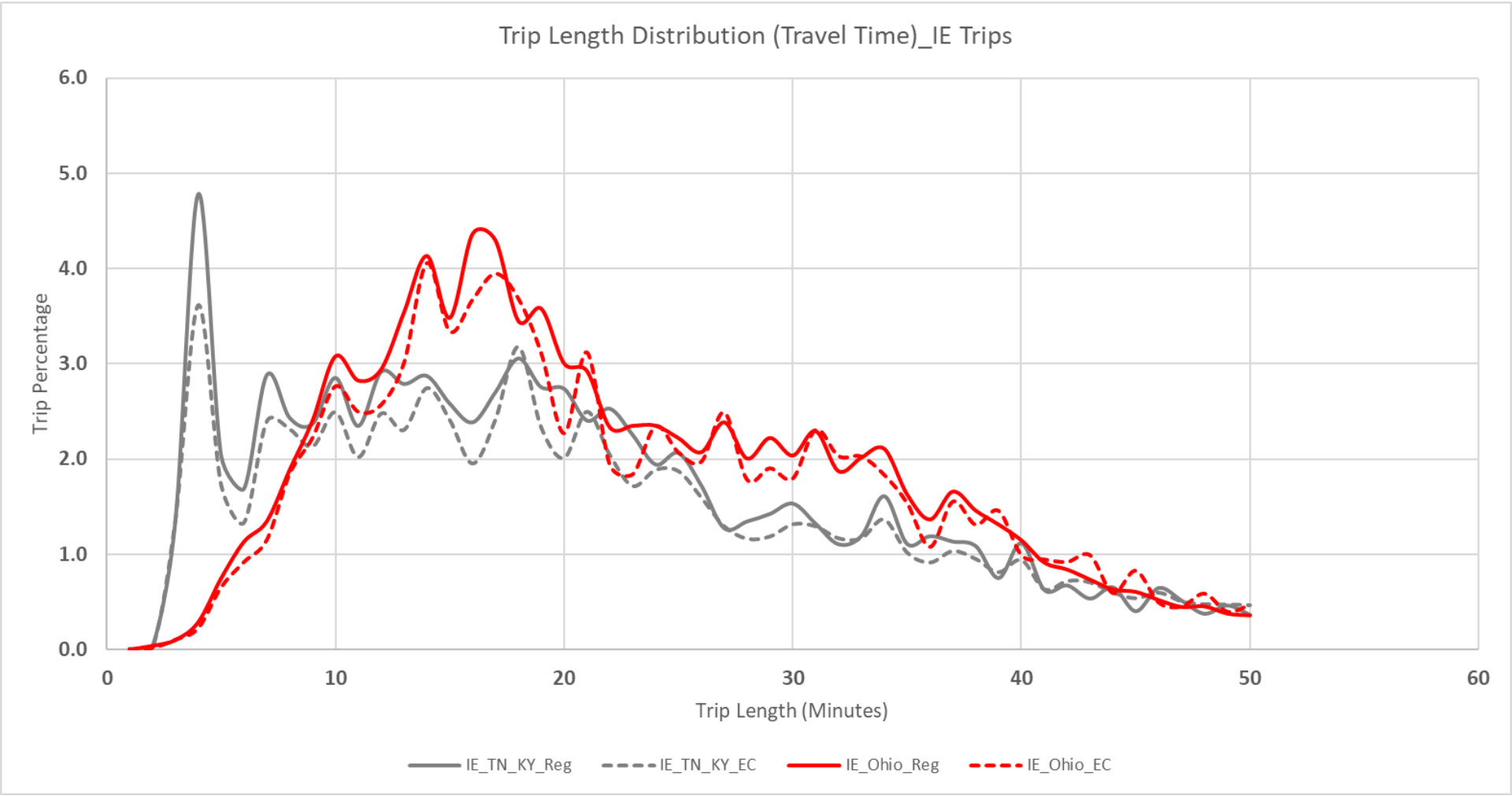
TLD – II: Ohio in Red



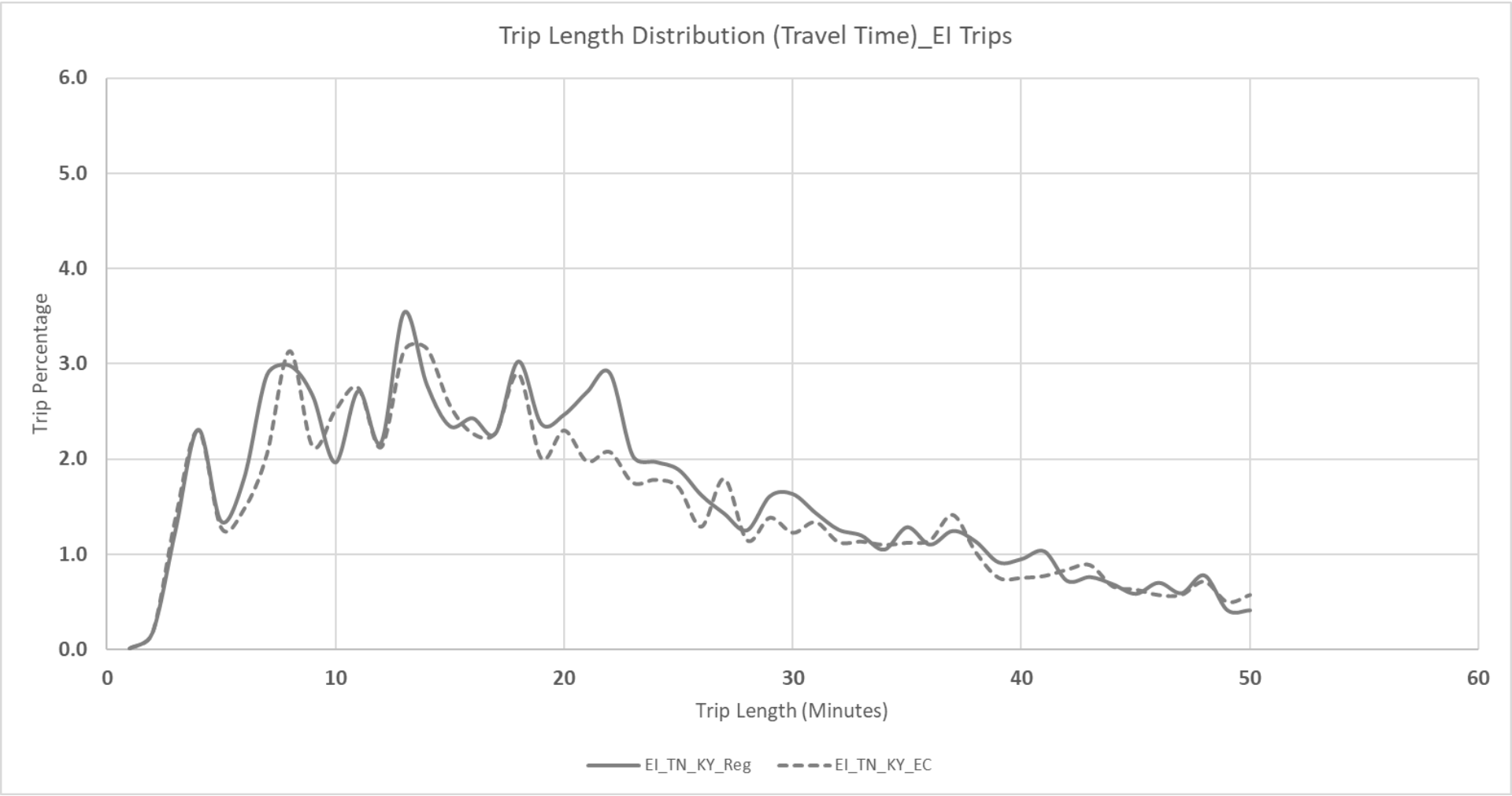
TLD – IE: Observed Data in Gray



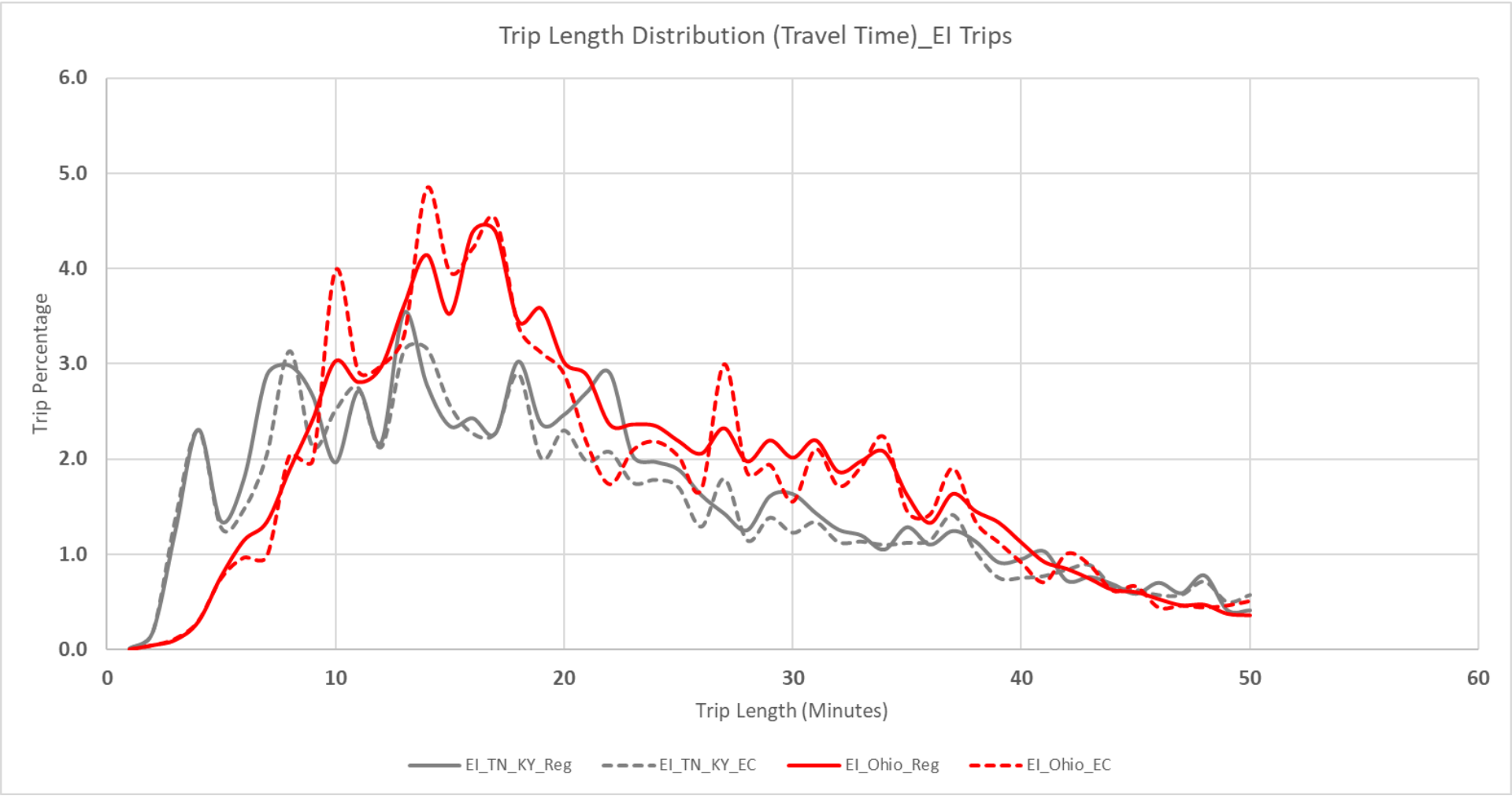
TLD – IE: Ohio in Red



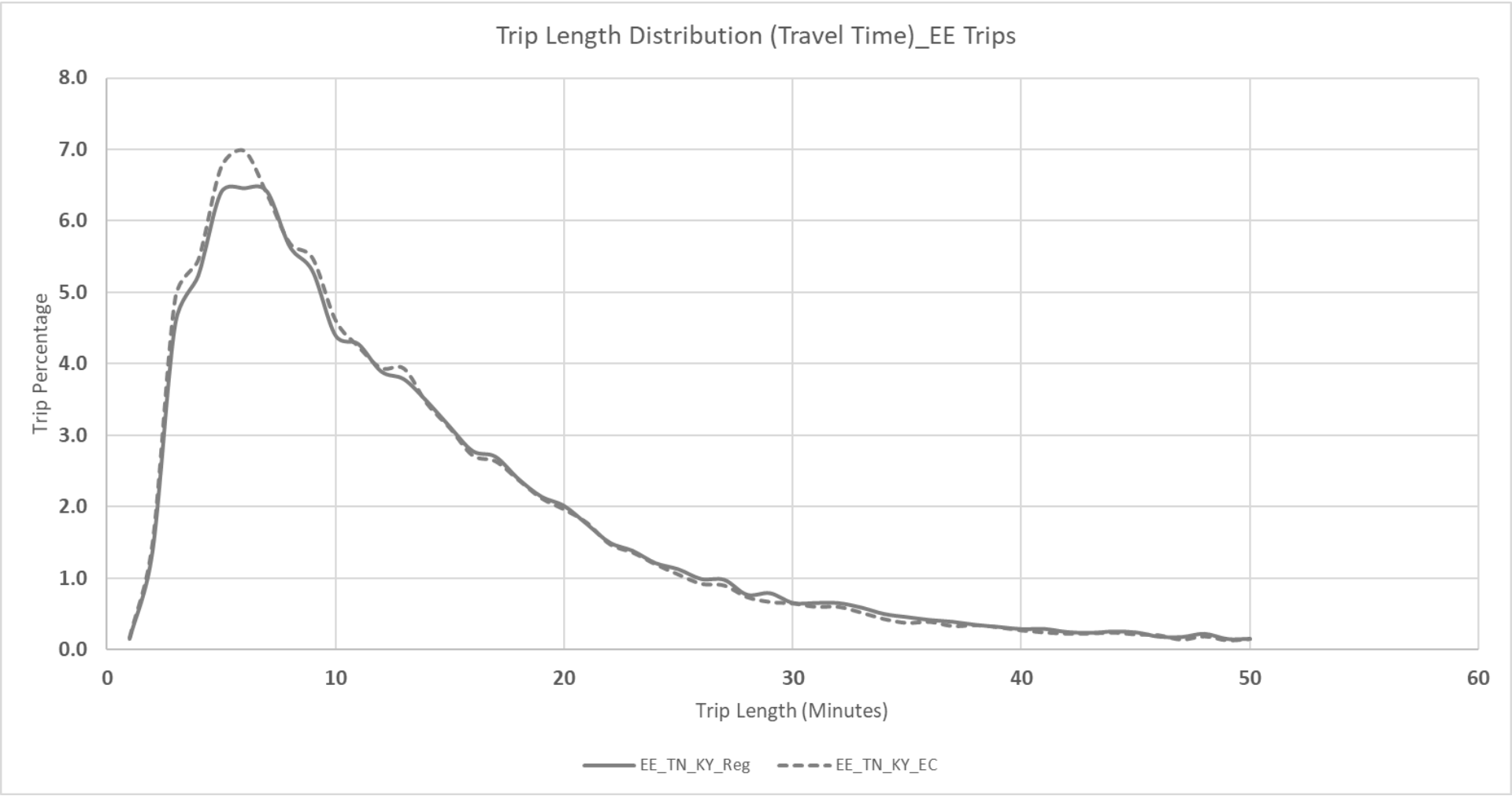
TLD – EI: Observed Data in Gray



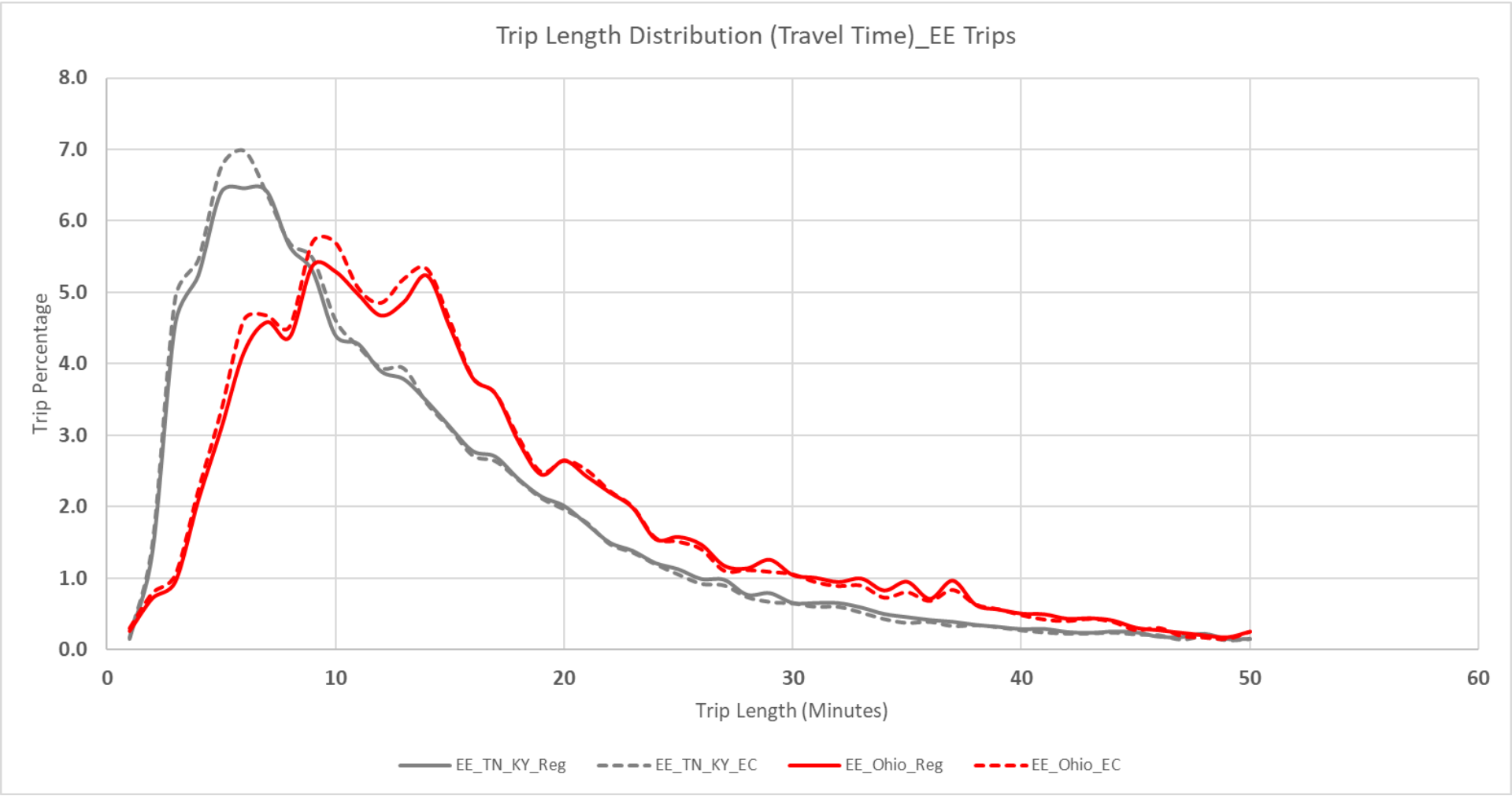
TLD – EI: Ohio in Red



TLD – EE: Observed Data in Gray



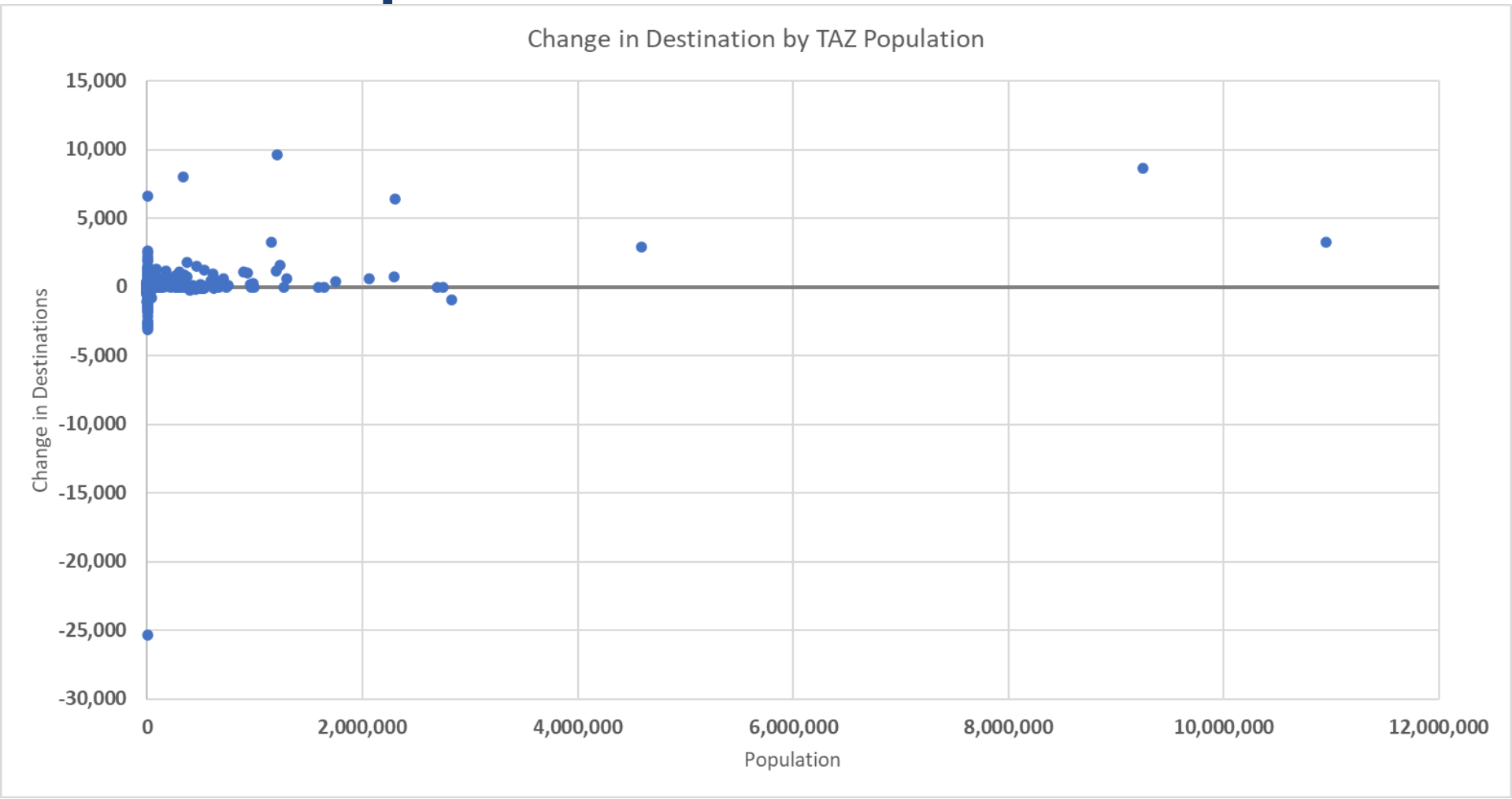
TLD – EE: Ohio in Red



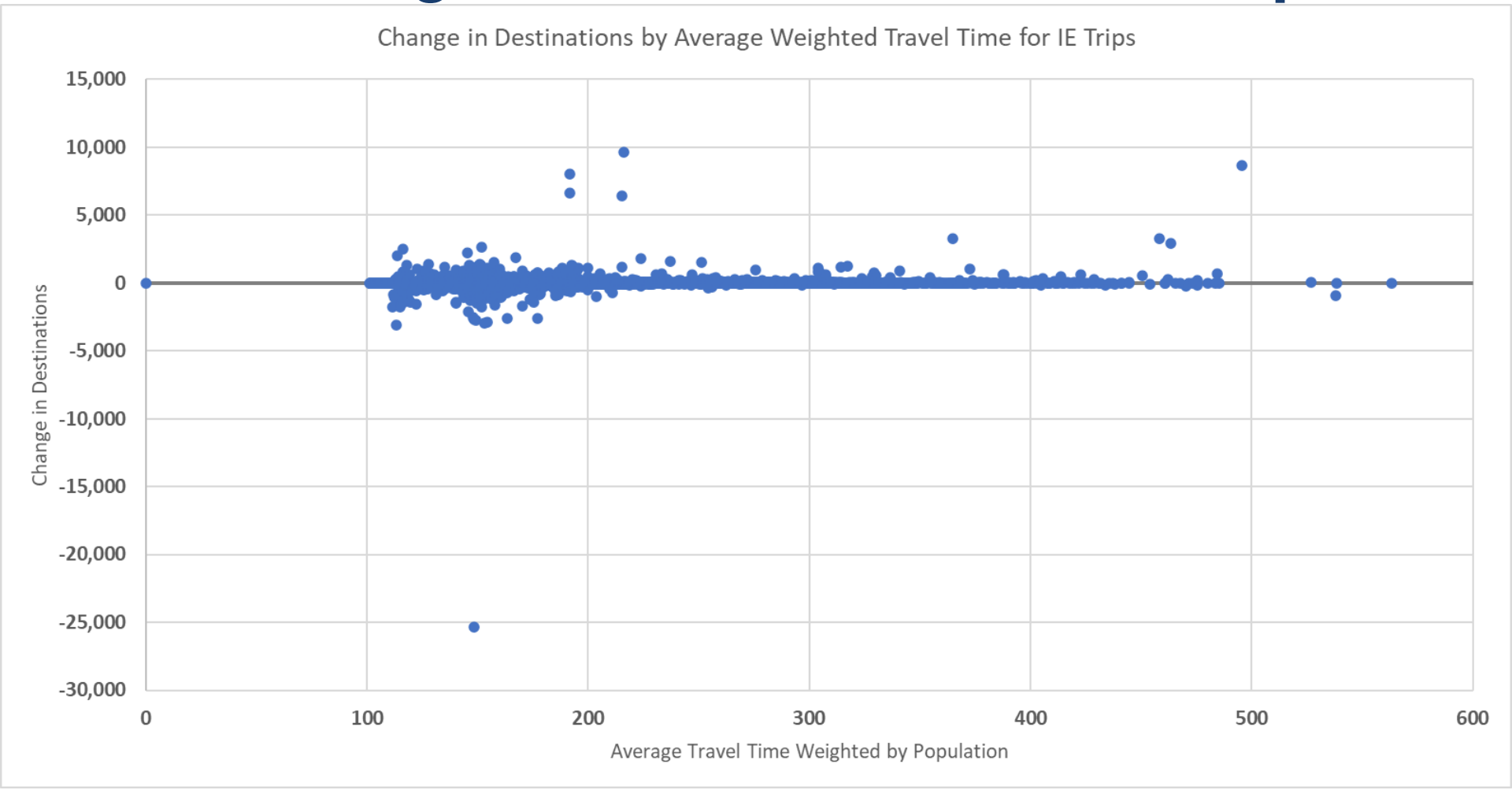
Identifying Changes in Trip Ends

- Looked at changes in trip ends between regular day and eclipse day.
- A lot of variability, especially close to and within the path of totality.
- Looked at relationships between population and other SE characteristics in trip end changes.
- Statistical Analysis (using R) to try to identify any trends.
- Changes in trip ends positively correlated with population.
- Consideration of average travel times to population.
  - Wanted to understand role of proximity.
  - As TAZs are further from the path of totality, more novel eclipse day trips are created.

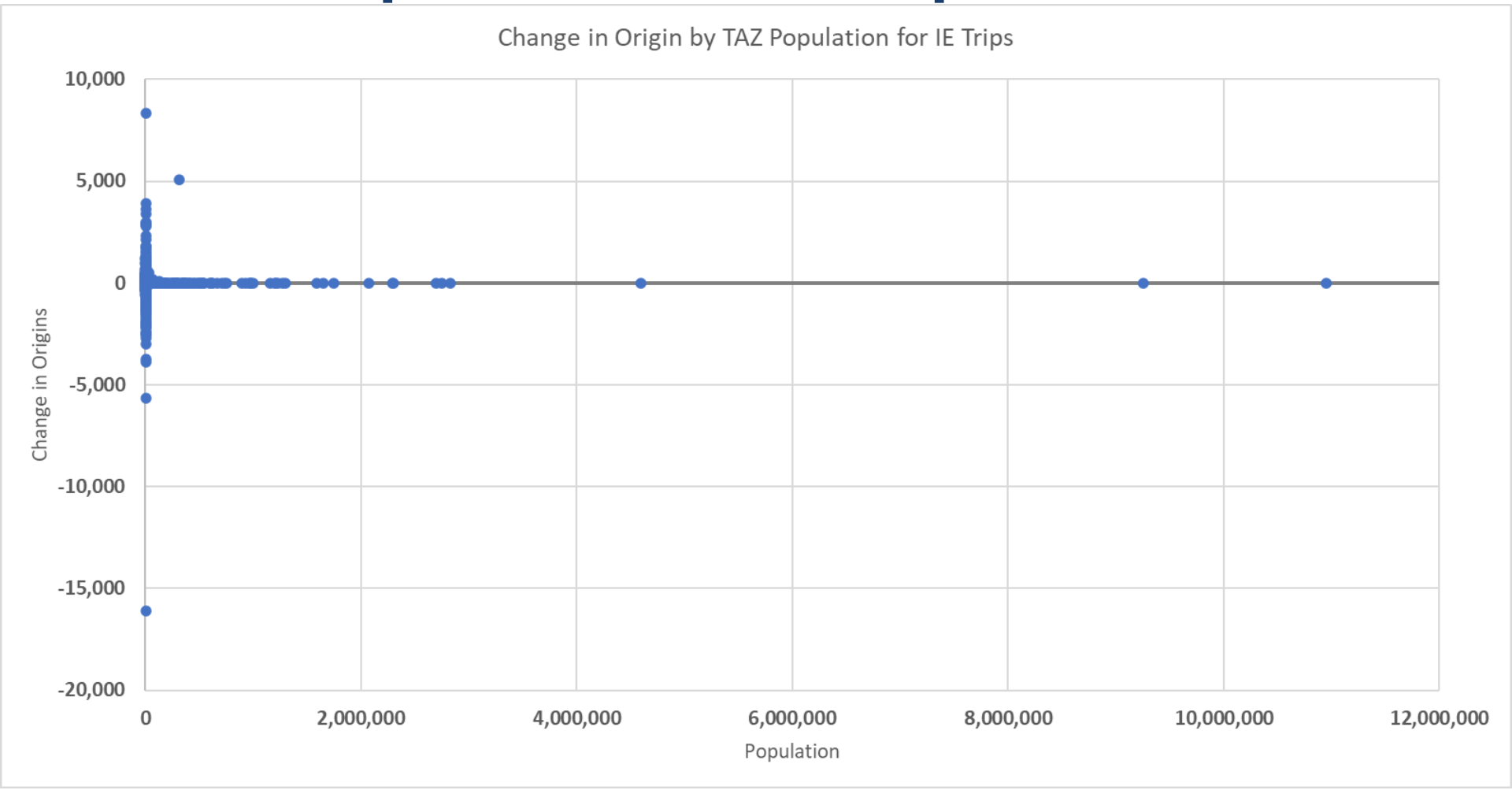
Change in Destinations by TAZ Population: KY/TN



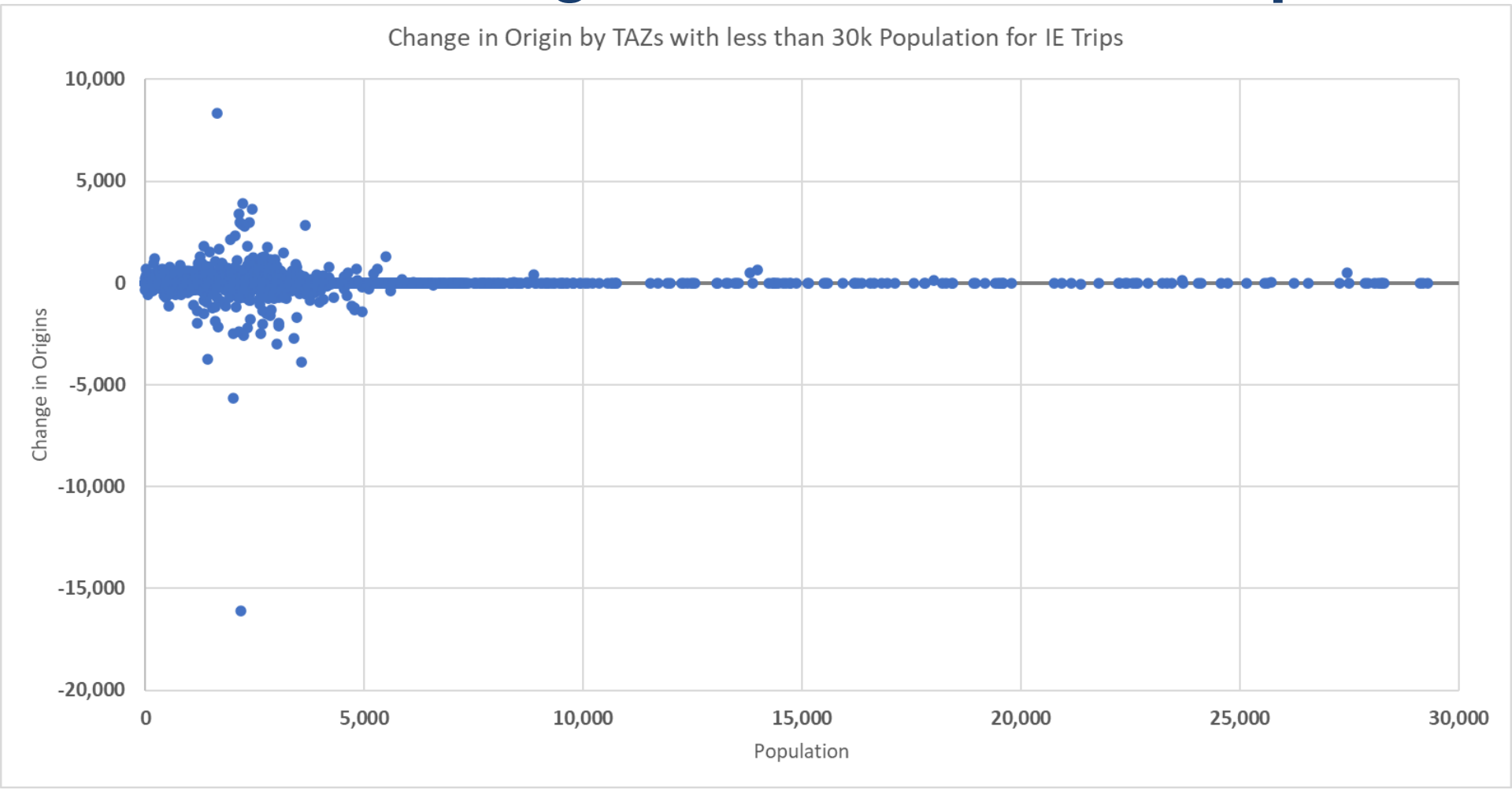
Change in Destinations by Average Weighted Travel Time for IE Trips



Change in Origins by TAZ Population for IE Trips: KY/TN



Change in Origins by Population Focusing on Less than 30K Pop

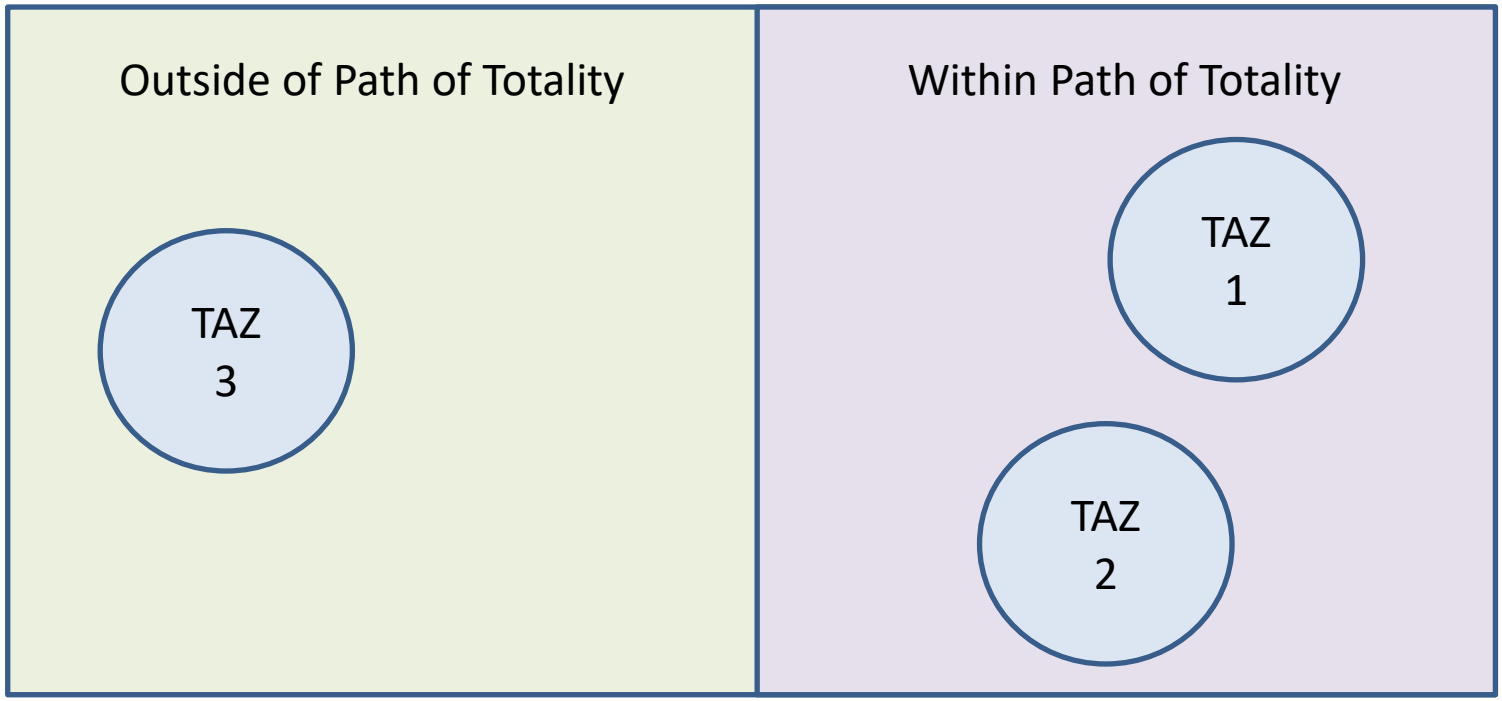


Independent Variables Analyzed

- Desire to see what if any characteristics explain where changes in demand would occur.
- Had to assess changes in origins and changes in destinations for IE trips.
- Initial variables were based on attribute already present in the model:
  - Population
  - Employment
  - Hotel Rooms
- IE destinations are outside of the path of totality.
- How do TAZs outside of the path of totality interact with the path of totality?

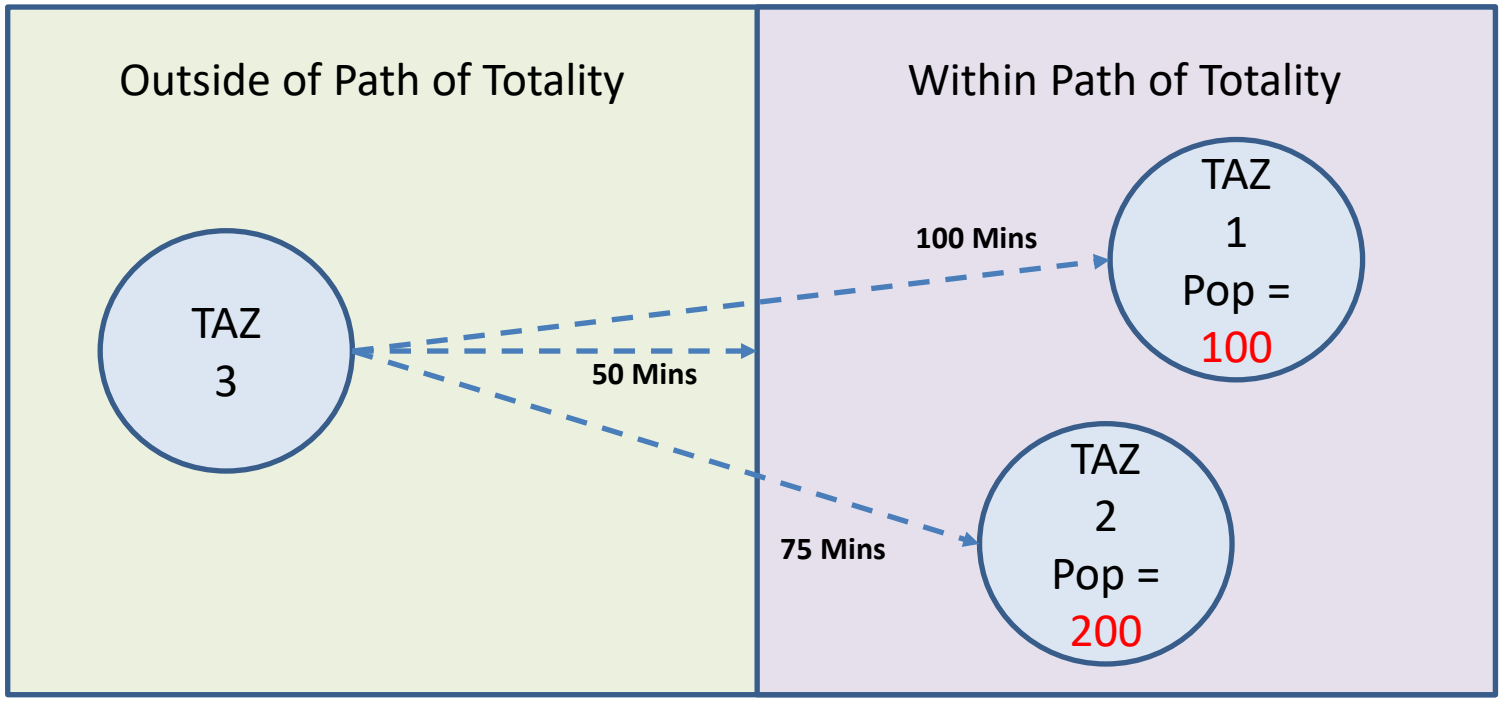
Average Weighted Travel Time

- Travel times from destination TAZs to Origin TAZs
  - Minimum travel time to path of totality
  - Average travel time to path of totality
  - Average weighted travel time to path of totality



Average Weighted Travel Time

- Example Travel Times in Minutes for TAZ 3
  - Minimum time = 50
  - Average time = (100 + 75) / 2 = 87.5
  - Average weighted time = ((100*100)+(75*200))/(100+200) = 83.3



Analysis of IE Trip End Changes

Y is Δ destinations

Y is Δ origins

		Del= IE_D(EC) - IE_D(Reg)			Del=IE_O(EC) - IE_O(Reg)			
		Slope	P-value	R2-value	Slope	P-value	R2-value	
only outside the POT	Pop				1.28E-02	***4.10E-14	2.70E-02	only inside the POT
	Emp				1.76E-02	***1.62E-07	1.28E-02	
	Pop Density				-2.24E-02	*1.92E-02	2.19E-03	
	Emp Density				-8.73E-03	1.16E-01	7.15E-04	
	Hotel Rooms				-3.18E-01	***5.07E-03	1.34E-02	
	Min FFtime to POT	3.53E-01	***8.19E-07	3.35E-03				
	Ave FFtime to POT	4.72E-01	***1.16E-07	3.89E-03				
	Weighted Pop (in POT)	5.27E-01	***2.05E-08	4.37E-03				
	Weighted Emp (in POT)	5.09E-01	***3.51E-08	4.23E-03				
	Weighted Pop Density (in POT)	4.05E-01	***1.24E-06	3.24E-03				
	Weighted Emp Density (in POT)	4.11E-01	***1.10E-06	3.27E-03				
	Weighted Hotel Rooms (in POT)	4.76E-01	***7.13E-08	4.03E-03				

Variables shaded in red selected to inform trip end allocation process.

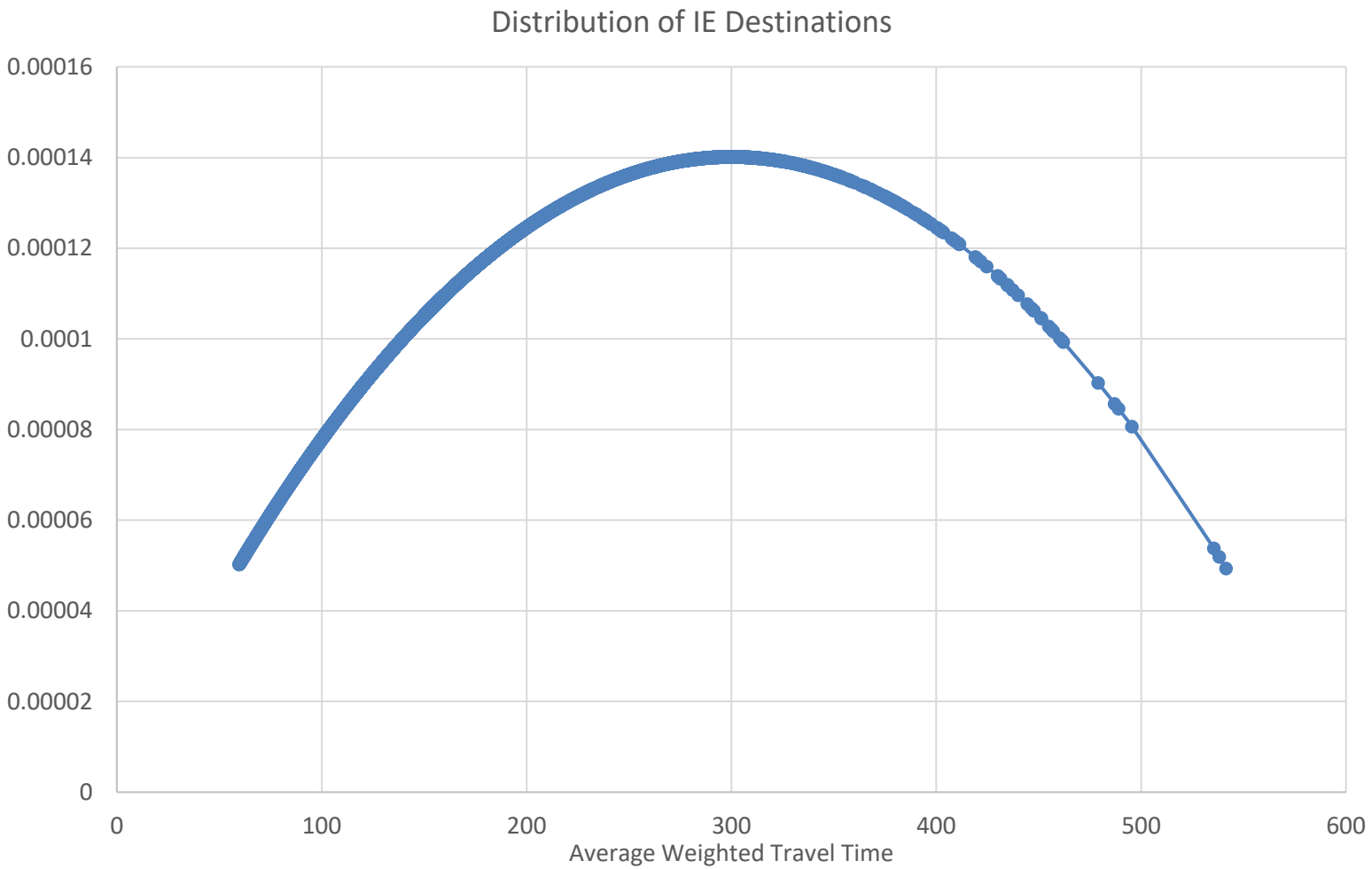
Trip End Allocation

- Unable to predict how many eclipse travelers will come to Ohio
  - Too many unknowns
  - Many distant population centers have viewing areas closer than Ohio
- Data are not suitable for creating a robust trip generation model
- Opting for an allocation of a control total approach
- Using analysis of the data to understand trip end trends and allocate accordingly
- Allocate trip ends using a parabolic curve to capture the general trends observed in the data for IE/EI trips
- Ratio based suppression of II trips

Observed Trips

	Trips					
	Residents		Visitors		Combined	
	Regular	Eclipse	Regular	Eclipse	Regular	Eclipse
II	7,643,003	7,998,897	3,702,438	3,221,731	11,345,441	11,220,628
IE	787,409	831,691	330,256	328,348	1,117,664	1,160,040
EI	793,108	834,236	332,652	316,555	1,125,760	1,150,791

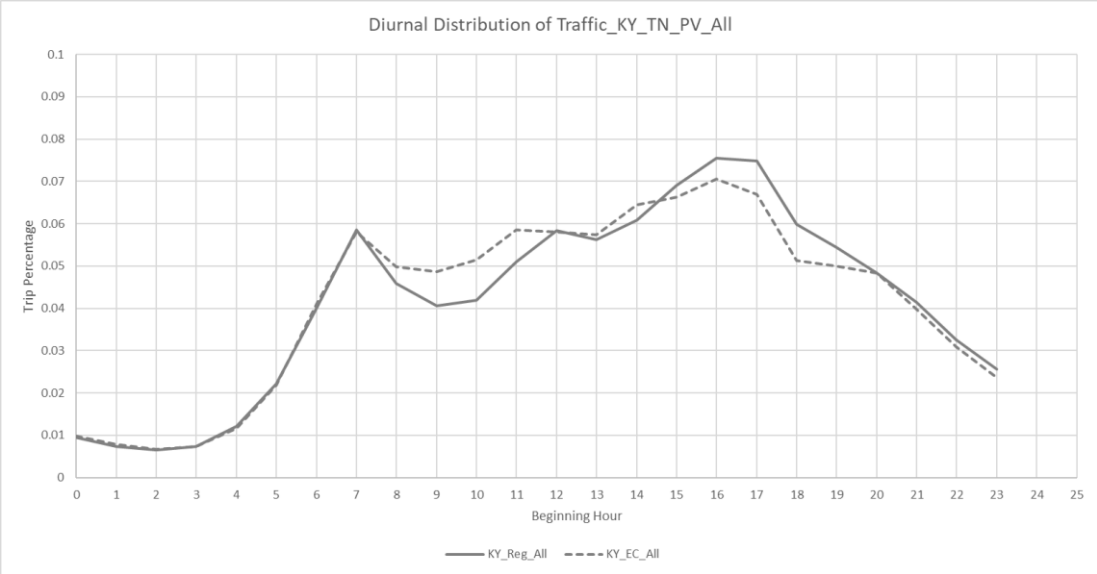
Example Distribution Curve for IE Destinations

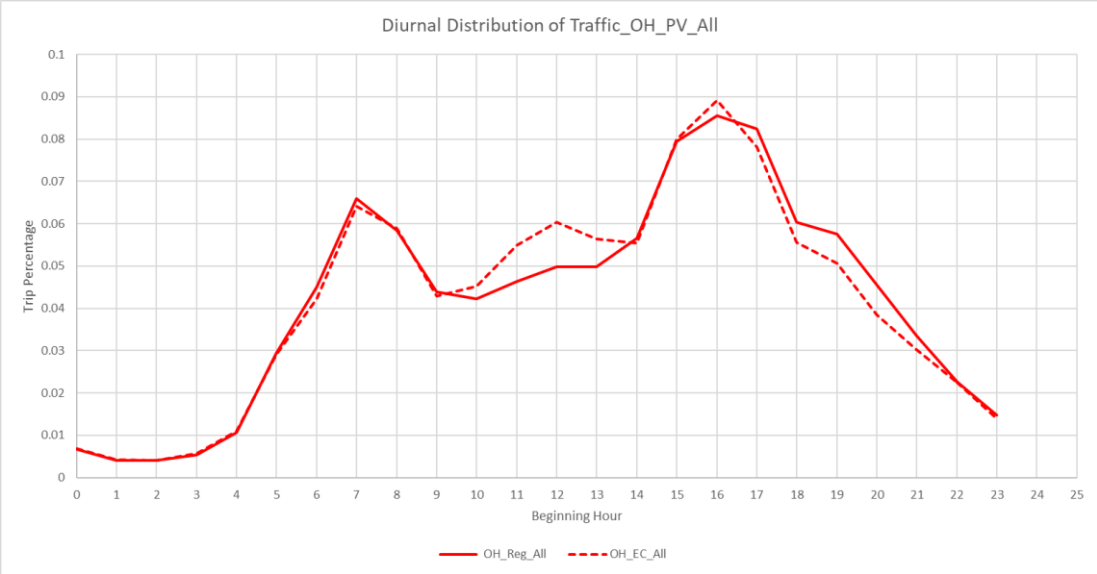


Diurnal Distribution of Trips

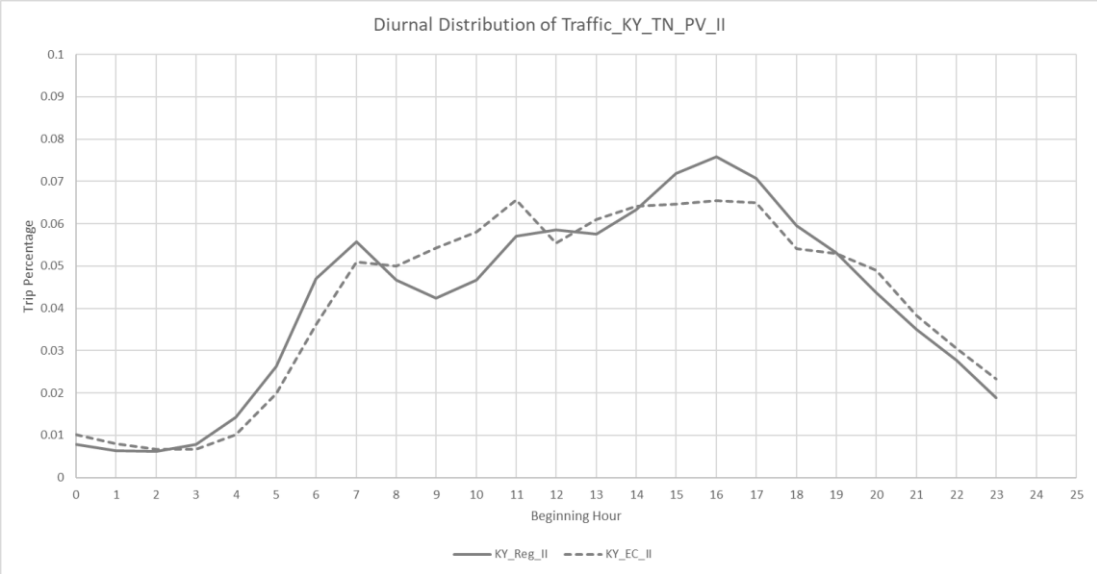
- Observed changes in diurnal distribution between regular and eclipse days.
- Changes most notable in IE and EI trips.
- Compared KY/TN distributions to Ohio model distributions.
  - Applied Ohio average diurnal distributions reported in SDE manual to Ohio model periods for passenger vehicles.
  - Applied NCHRP 765 diurnal distributions for trucks to Ohio model periods for trucks.
- Used ratio of changes between regular and eclipse days in KY/TN to create Ohio eclipse diurnal distributions.
- Needed to shift the changes to account for the fact that 2024 totality will occur later in the day than 2017 totality

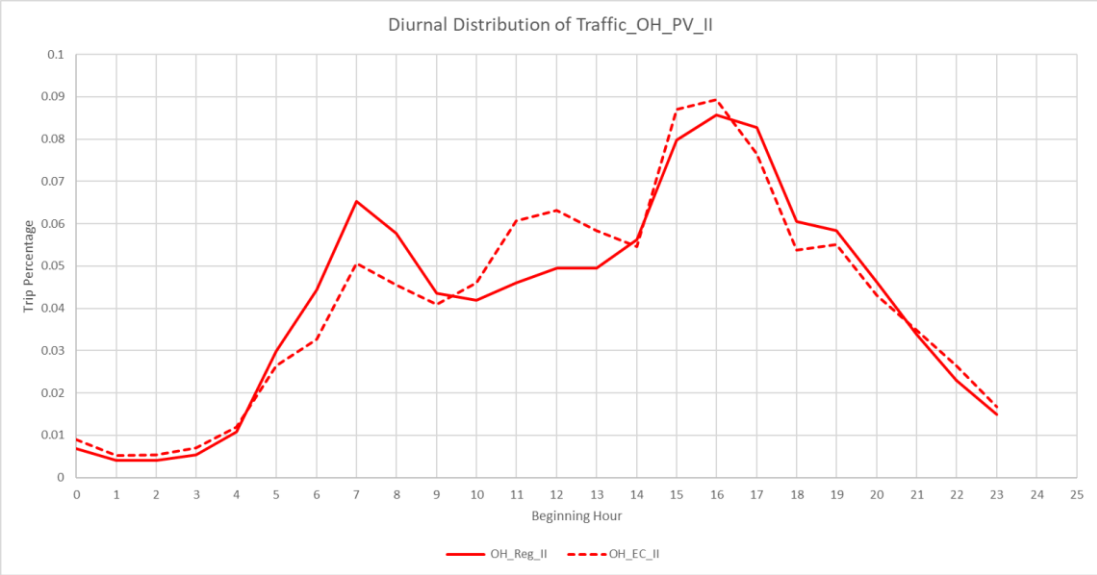
Diurnal Distribution of All Trips



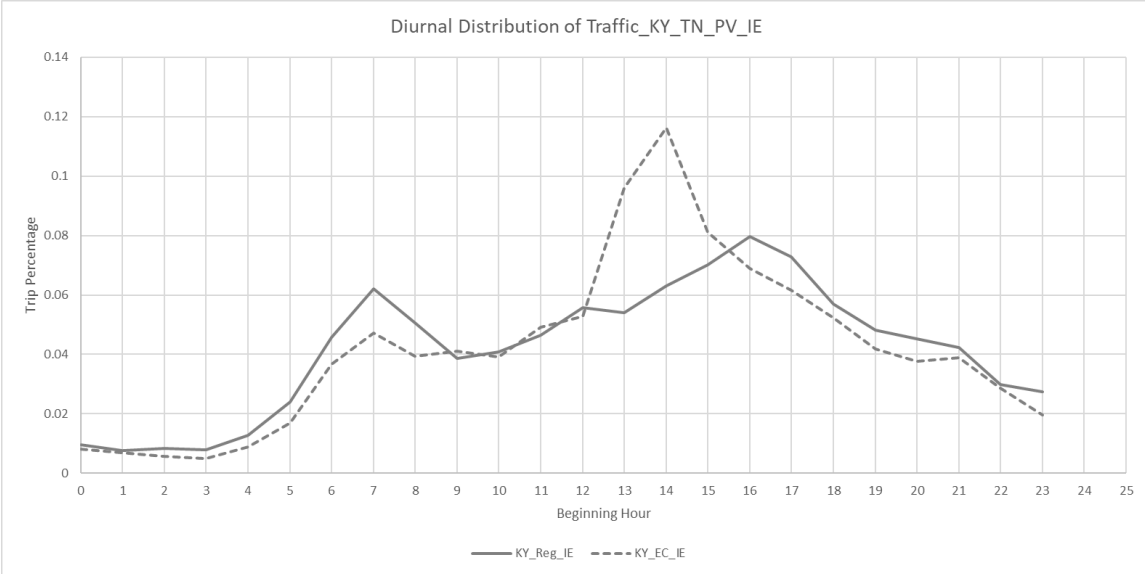


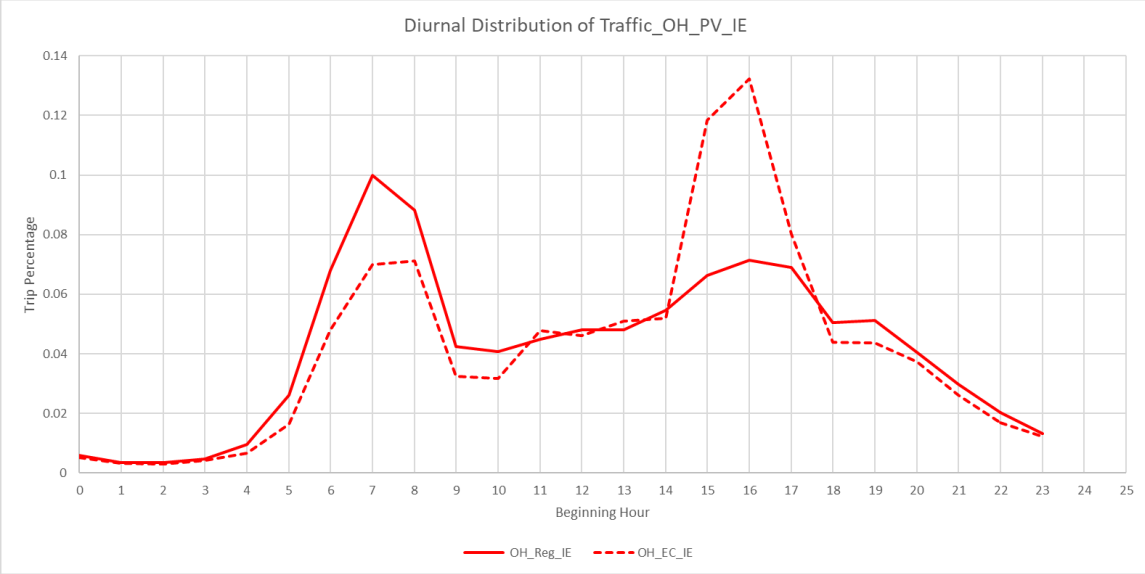
Diurnal Distribution of II Trips



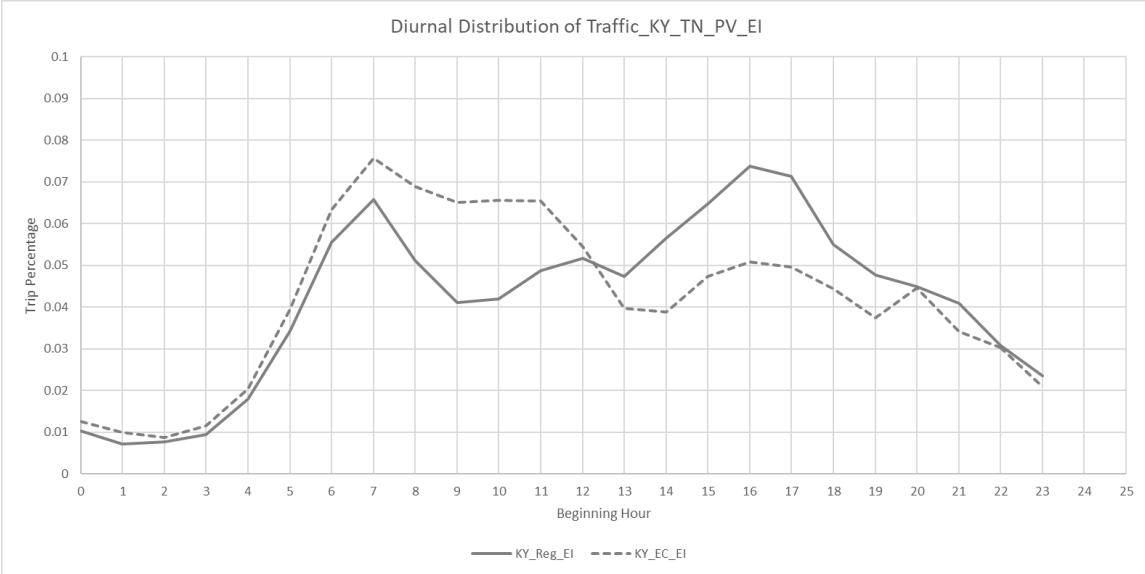


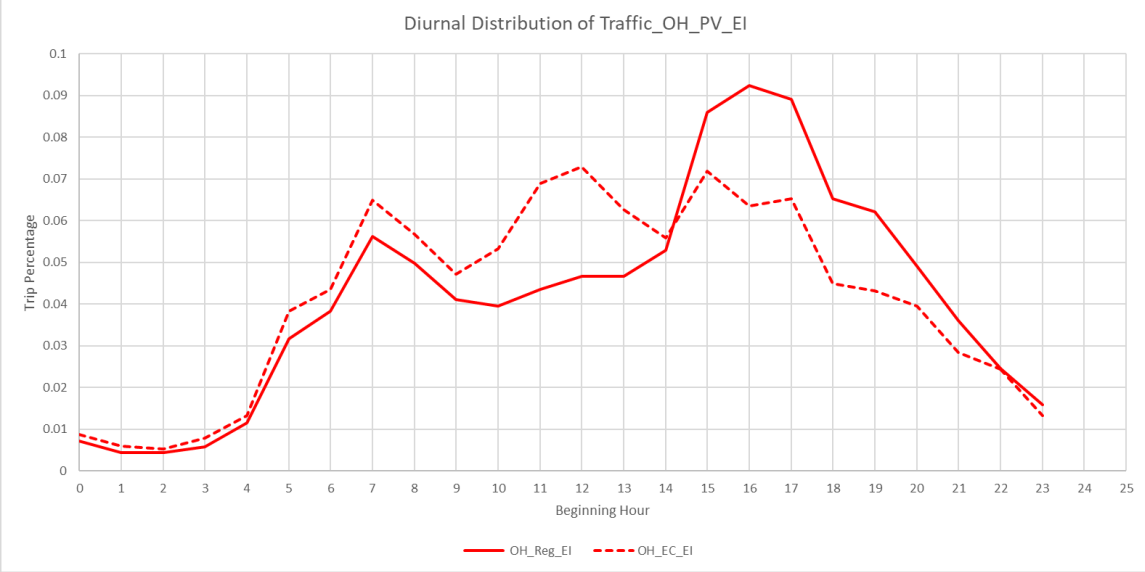
Diurnal Distribution of IE Trips



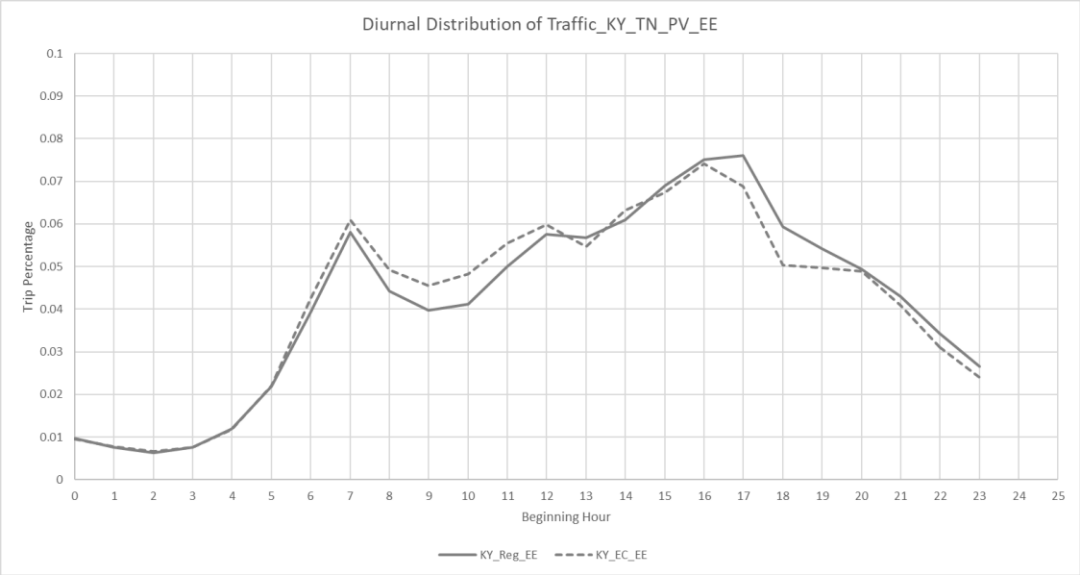


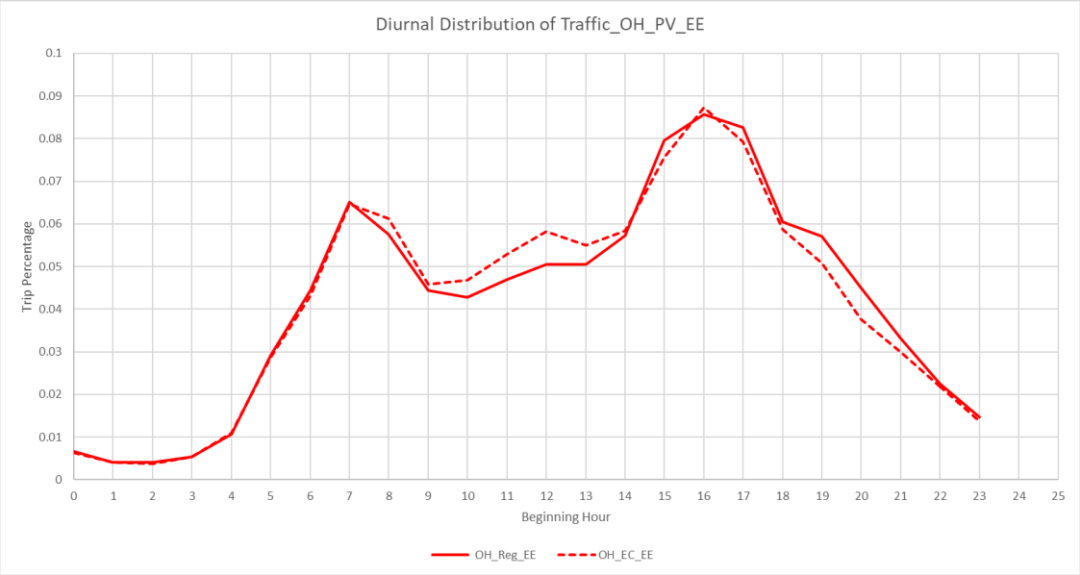
Diurnal Distribution of EI Trips





Diurnal Distribution of EE Trips

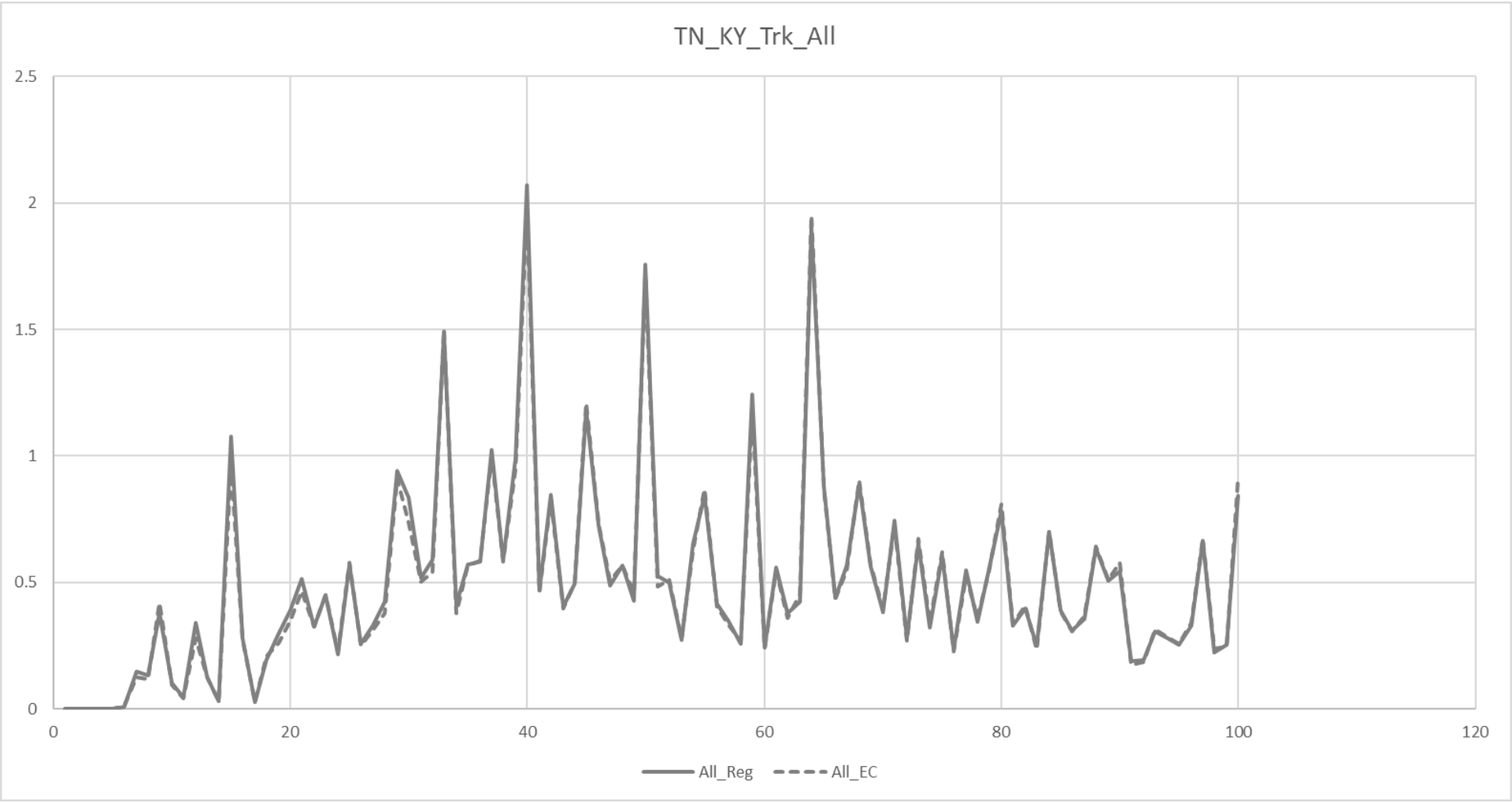




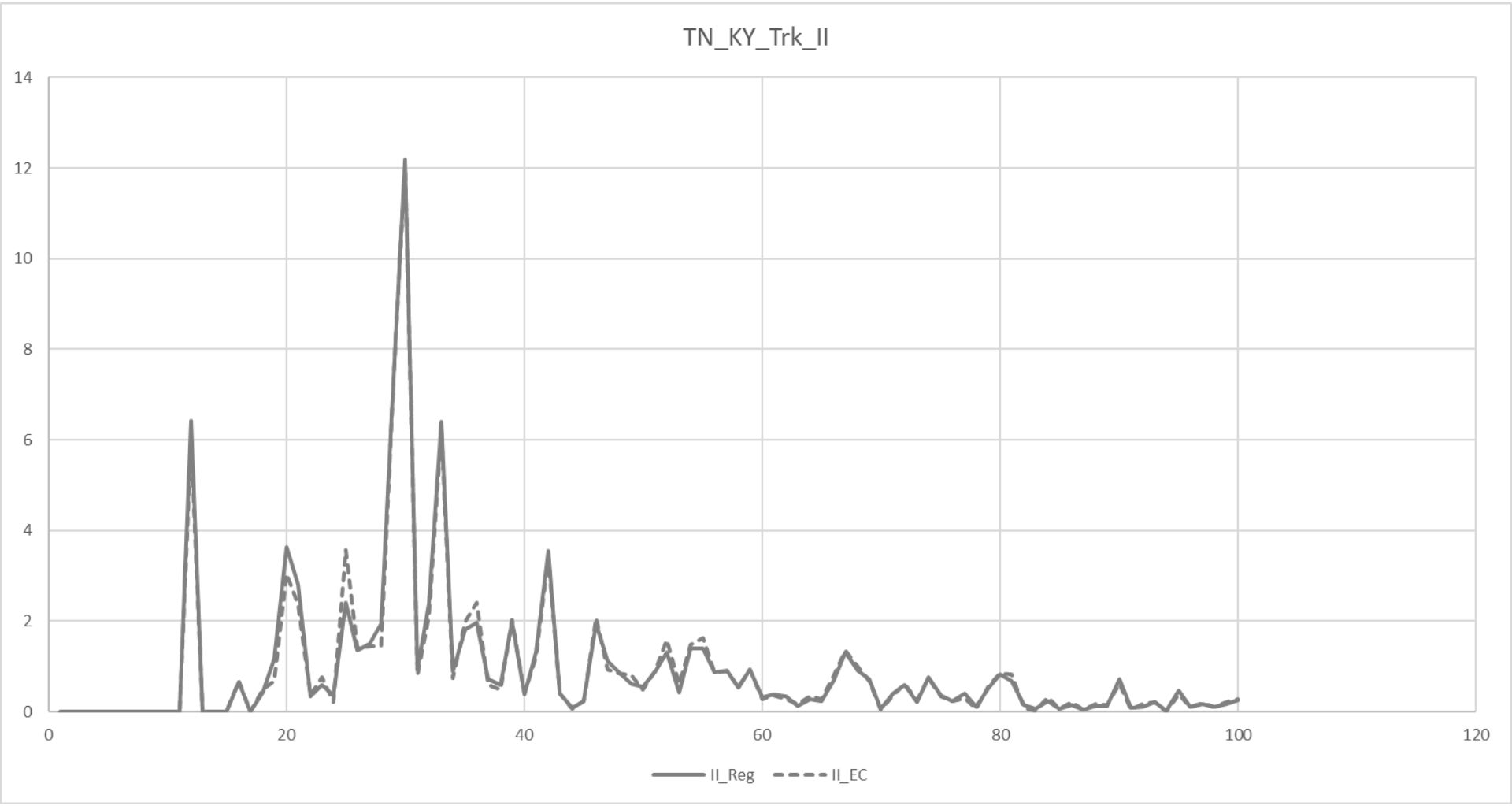
Truck Trips

- Also looked at truck trips.
- Trip lengths barely changed between regular and eclipse days.
- Some changes to diurnal distributions.
  - Drivers scheduling their mandated rest to avoid eclipse traffic?
- Decided not to alter truck demand for eclipse model but will shift diurnal distribution for model assignment.

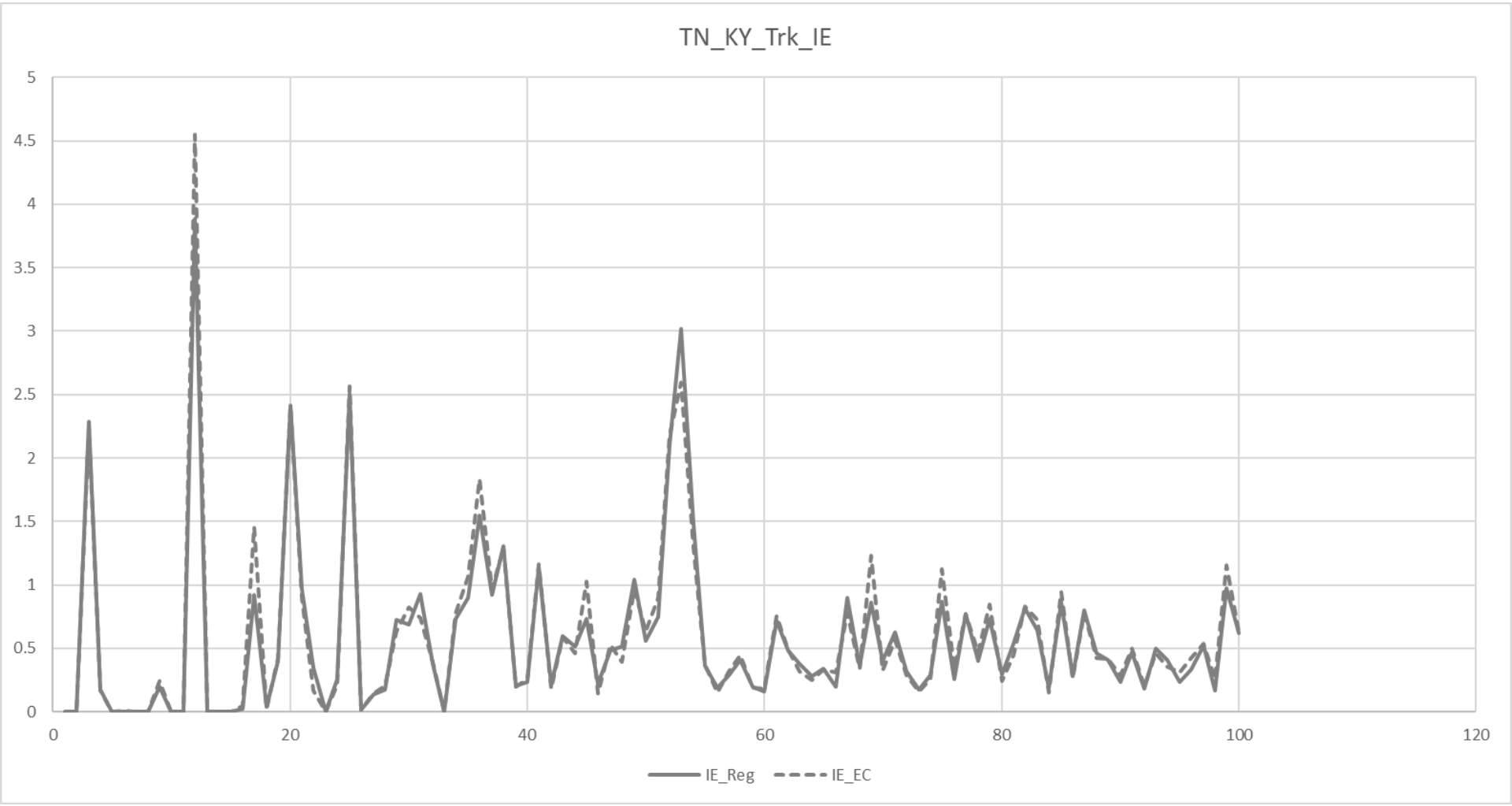
TLDs: All Truck Trips KY/TN



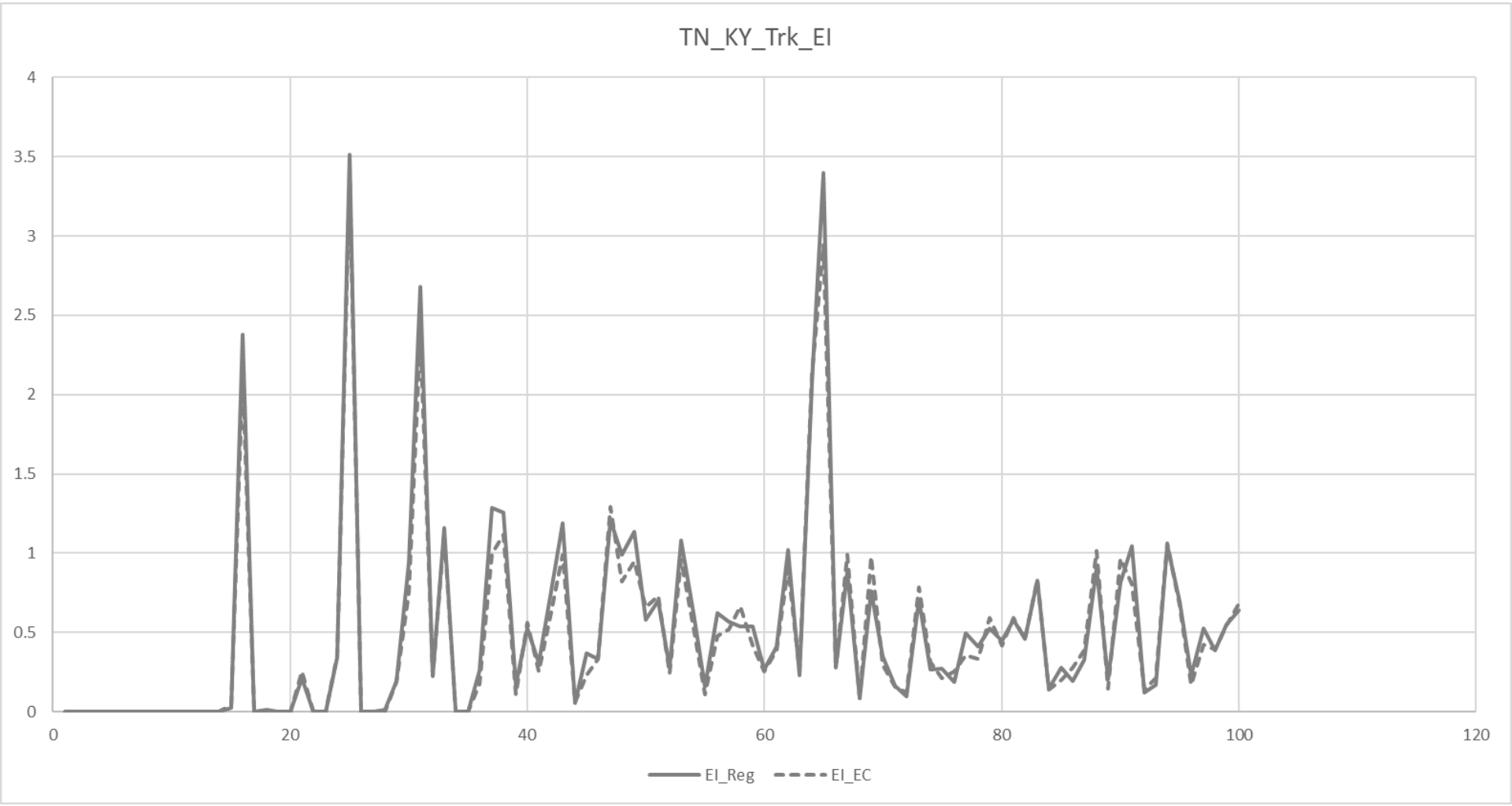
TLDs: II Truck Trips KY/TN



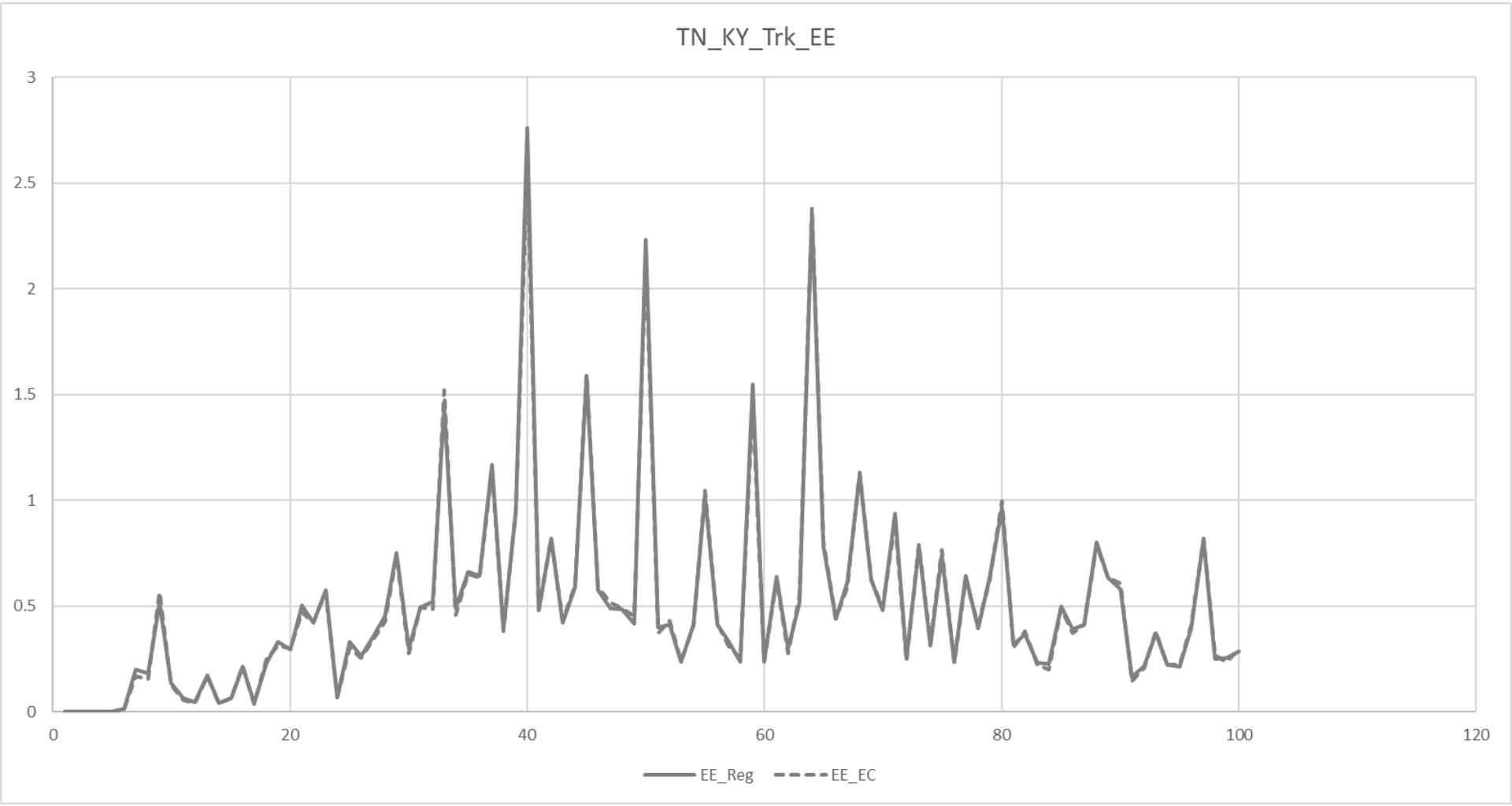
TLDs: IE Truck Trips KY/TN



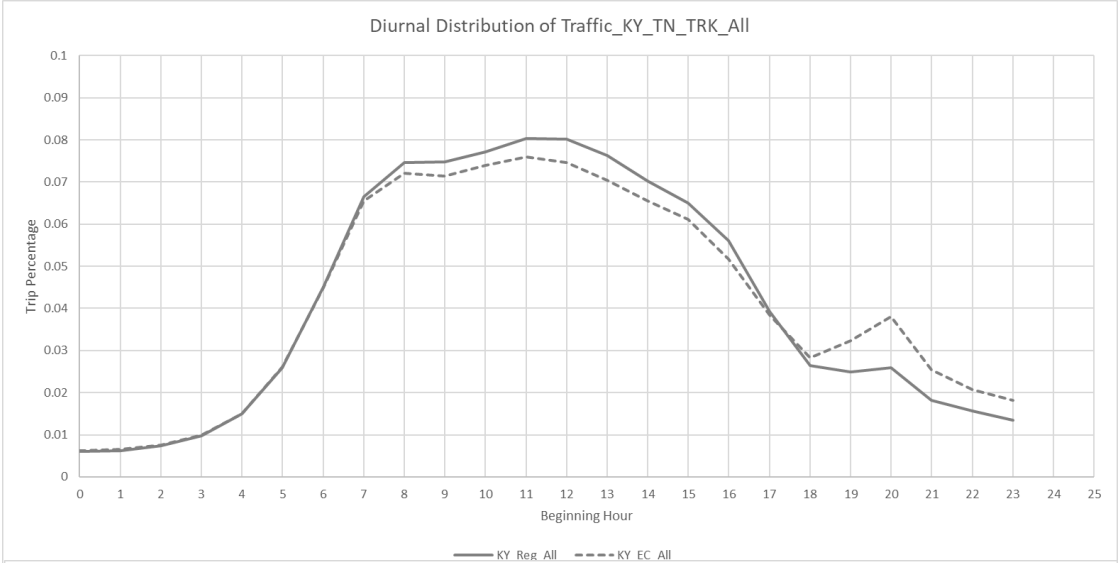
TLDs: EI Truck Trips KY/TN

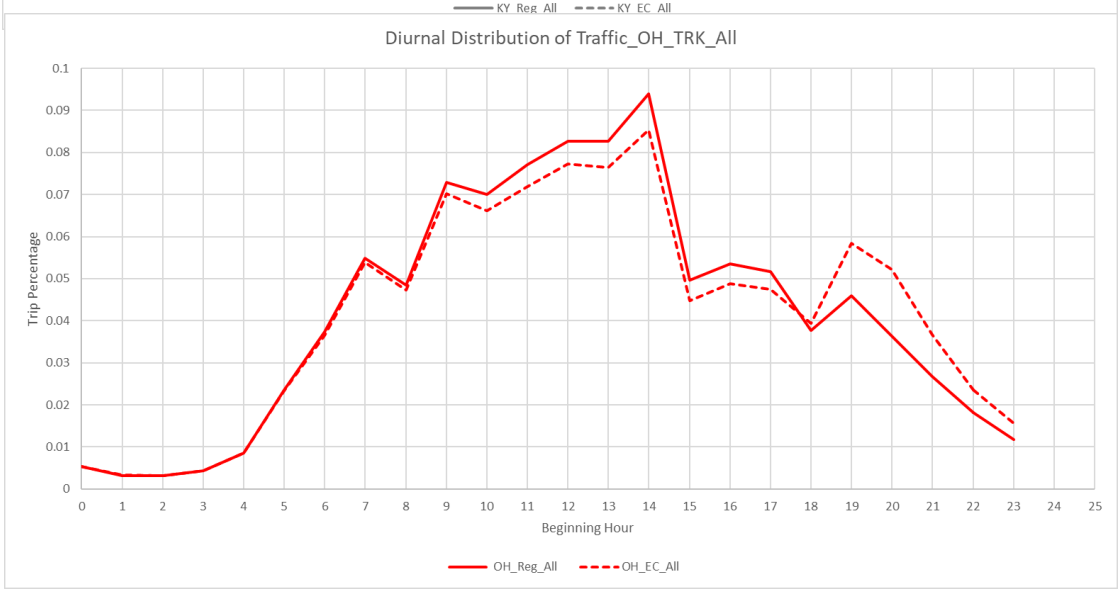


TLDs: EE Truck Trips KY/TN

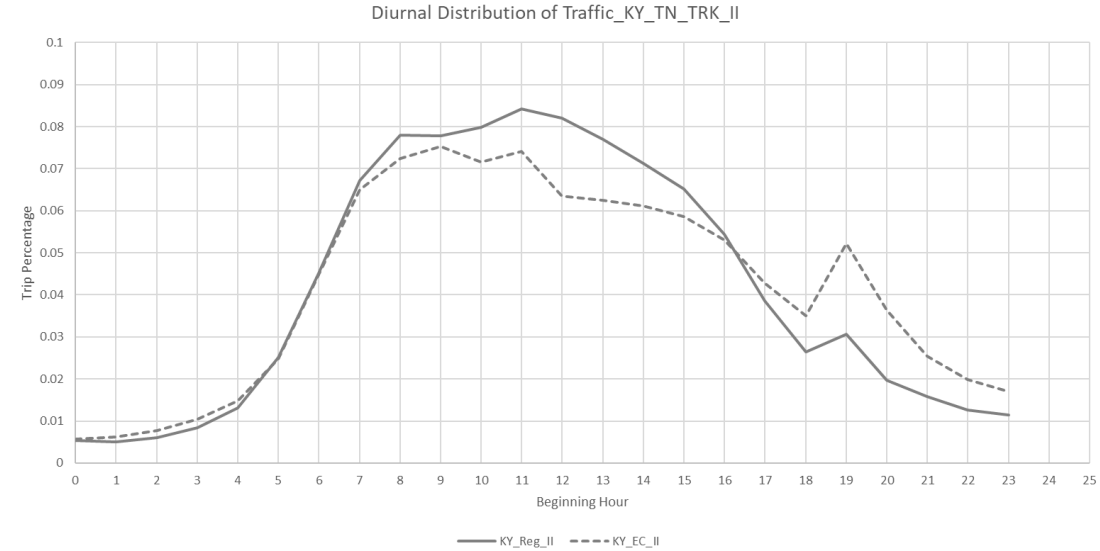


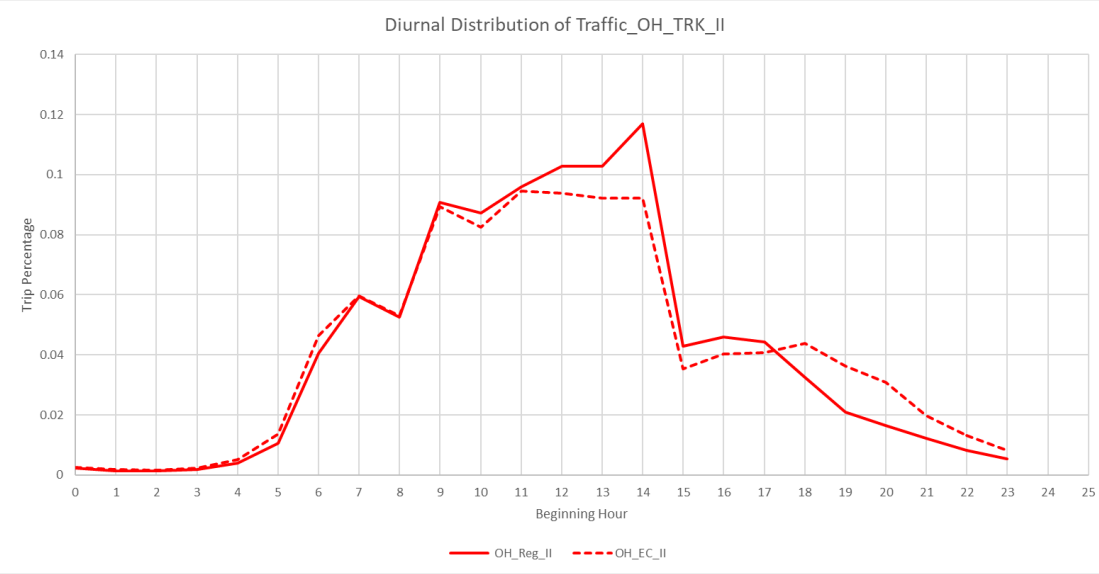
Diurnal Distribution of Truck Trips: All



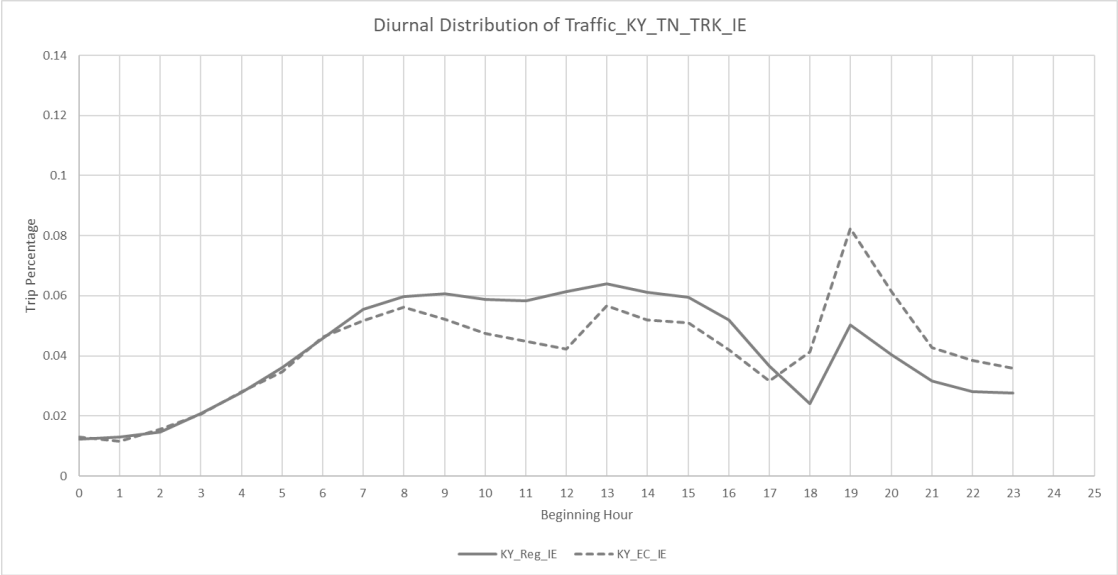


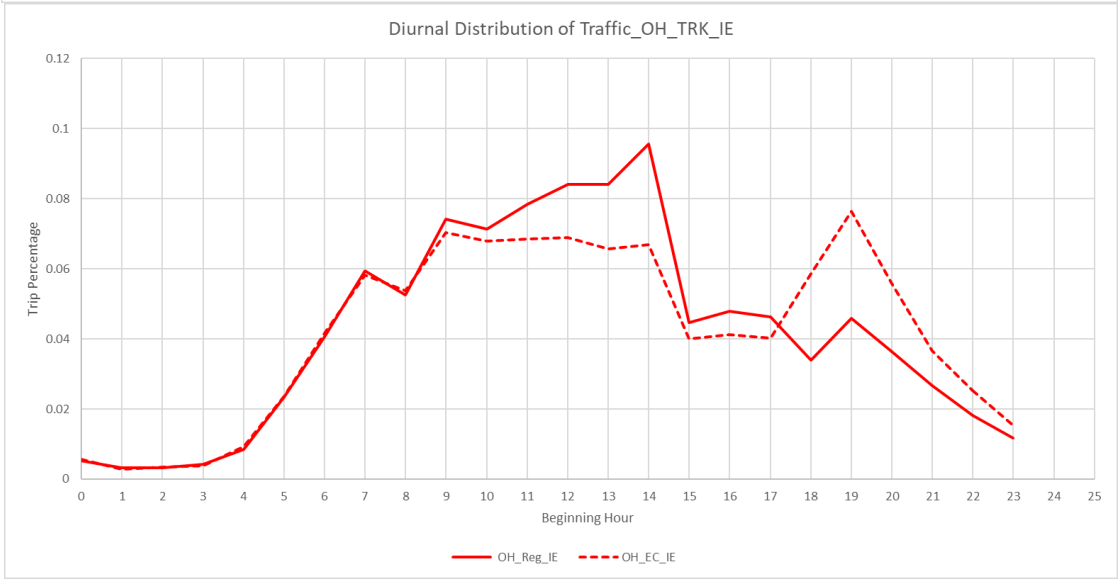
Diurnal Distribution of Truck Trips: II



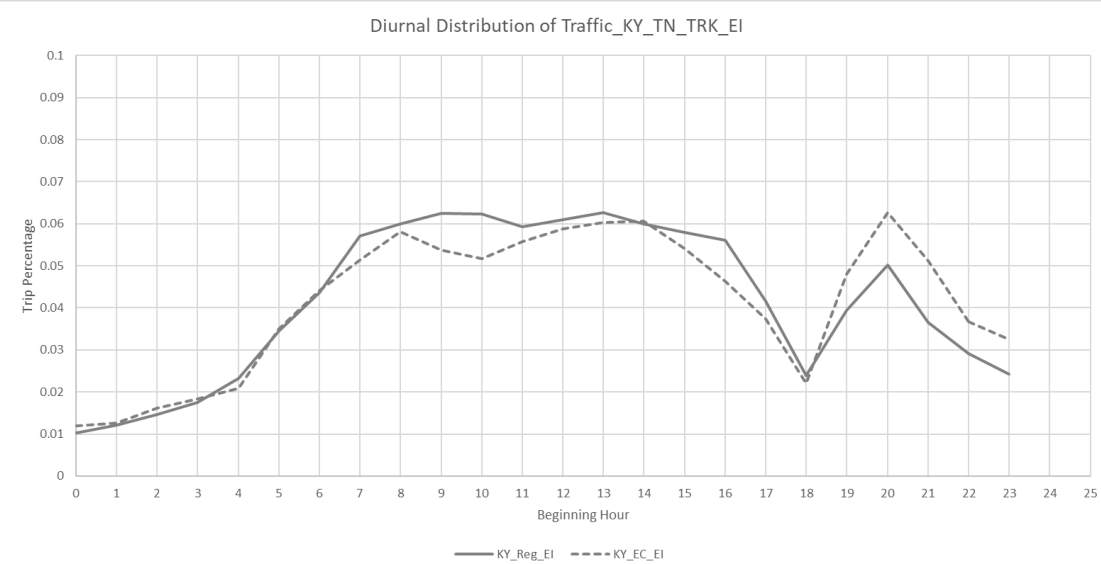


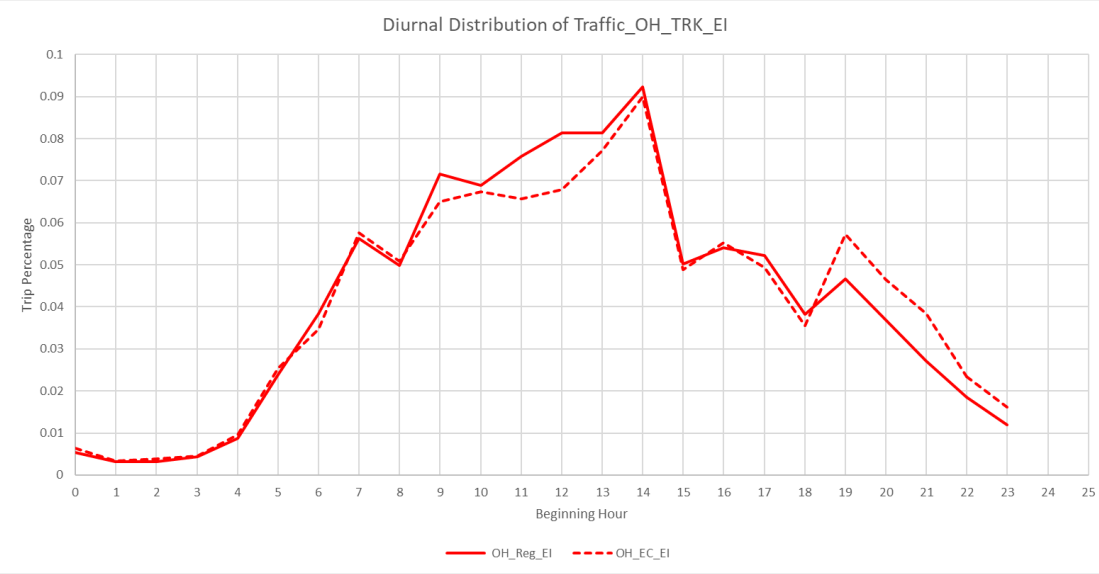
Diurnal Distribution of Truck Trips: IE



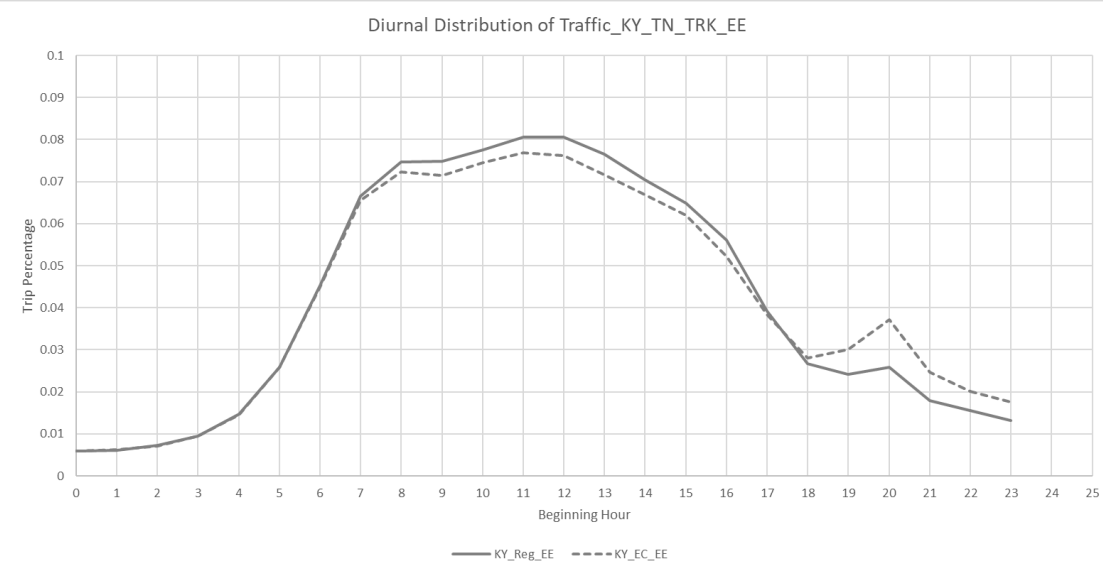


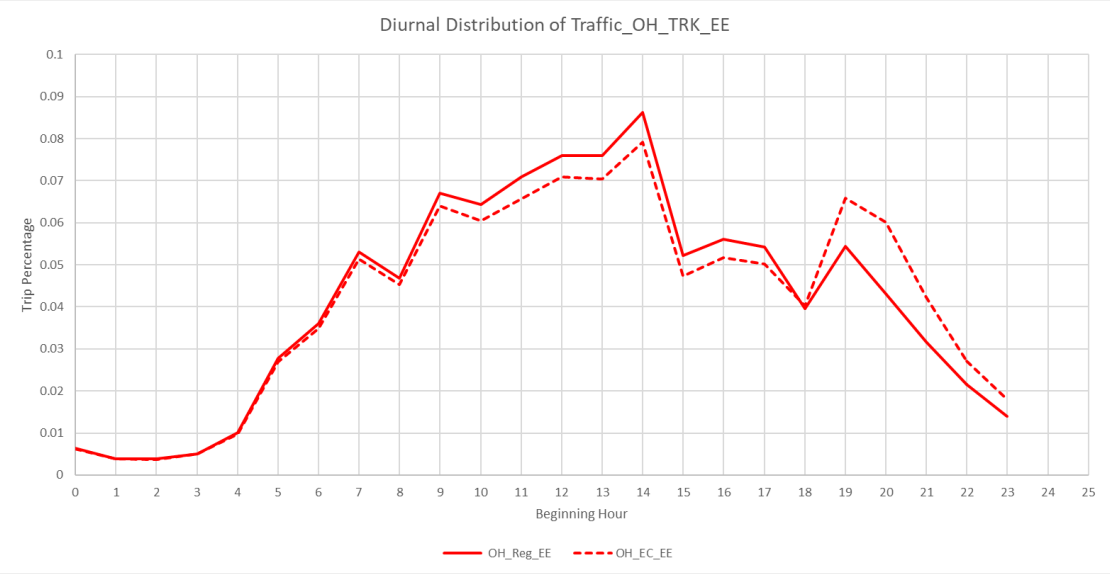
Diurnal Distribution of Truck Trips: EI





Diurnal Distribution of Truck Trips: EE





Next Steps

- Finalize allocations for Ohio eclipse model trip ends.
- Calibrate gravity model for Ohio eclipse trips.
- Develop assignment model for eclipse traffic.
  - Initial tests using Avenue proved unsuccessful
  - Storage calculations causing extreme congestion keeping the network from clearing
  - Hyper loading at certain centroid connectors appear to be the culprit
  - Increasing the number of centroid connectors has minimal impacts
  - Looking at using sequential static assignments and carrying over demand from one hour to the next.