2016 Northern Transportation Air Quality Summit (NTAQS)

# Evaluation of MOVES2014 Start Processes and Inputs

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# Presentation Outline

- FHWA Research Overview
- Background on Start Emissions
- Overview of MOVES Inputs for Starts
- Study Research Goals
- Analysis Results
- Findings & Conclusions

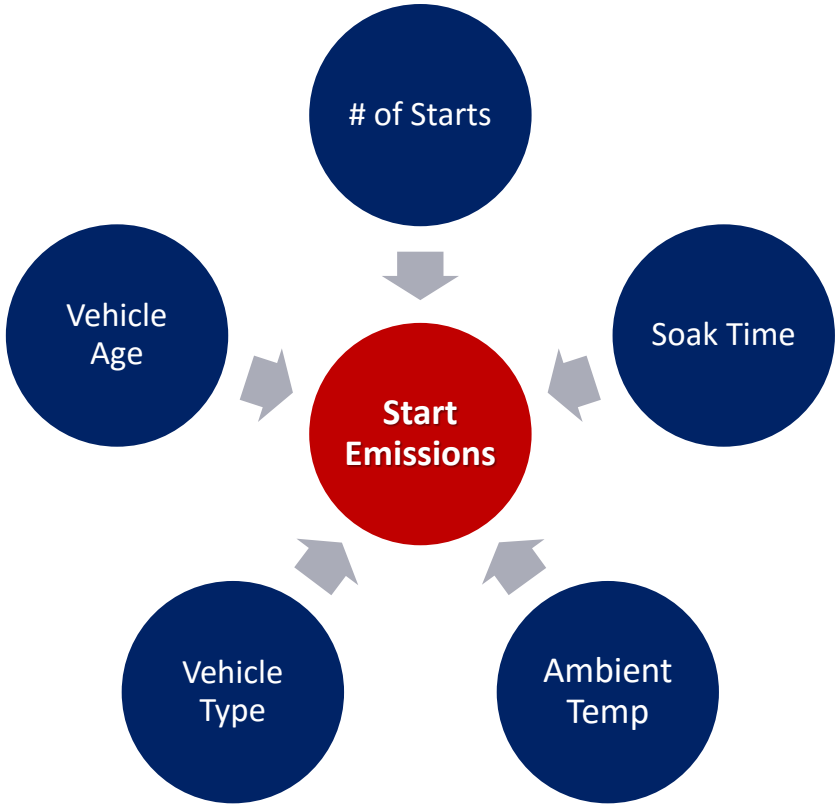
# FHWA Research Overview

## Impacts of Local Vehicle Starts and Soak Distribution on MOVES2014

- Initiated by FHWA Resource Center
- FHWA reached out to multiple agencies to help conduct analyses (TTI, PennDOT, MWCOG, BMC, GMU)
- Types of questions to answer:
  - What are impacts of using local data assumptions vs. MOVES defaults?
  - What are the best sources of local information – how to use?
  - How to address start allocation issues?
  - **Others?**

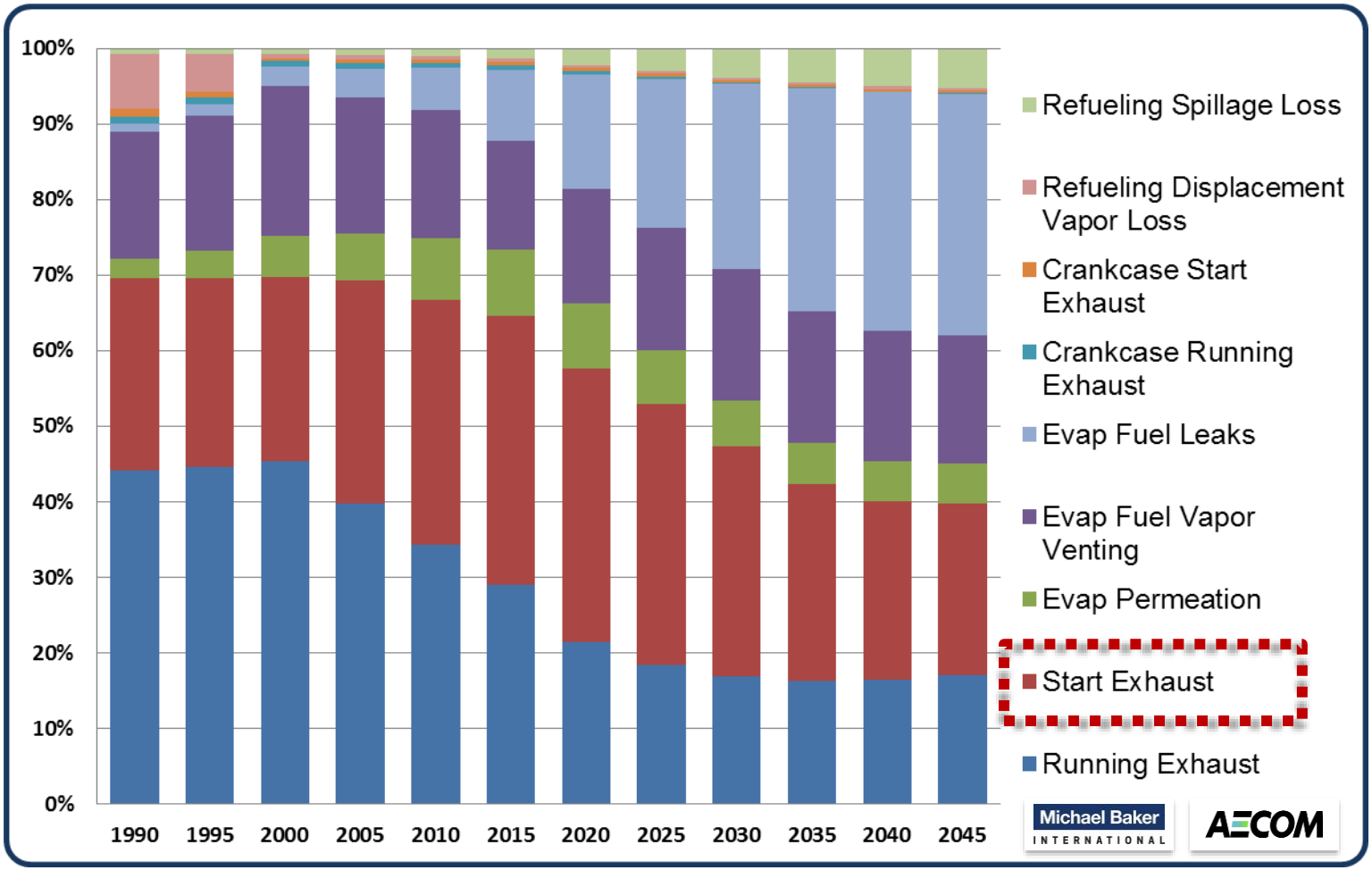
# Background on Start Emissions

- Start emissions are **tailpipe emissions produced during the period immediately following vehicle start-up**, after accounting for the baseline running emissions
- **What impacts start emissions in EPA's MOVES model**?



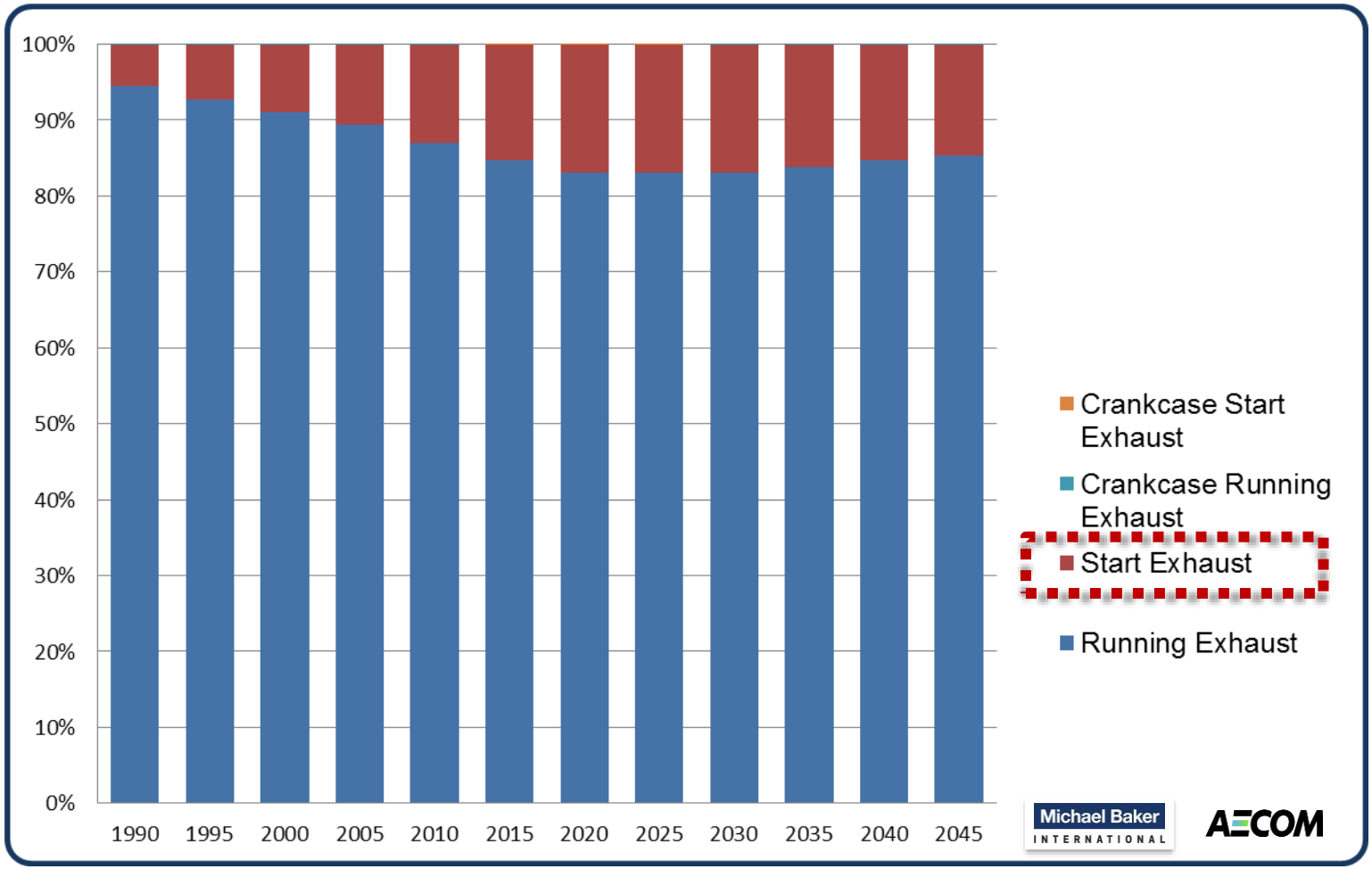
# Start Portion of Total VOC Emissions

**(MOVES2014)**



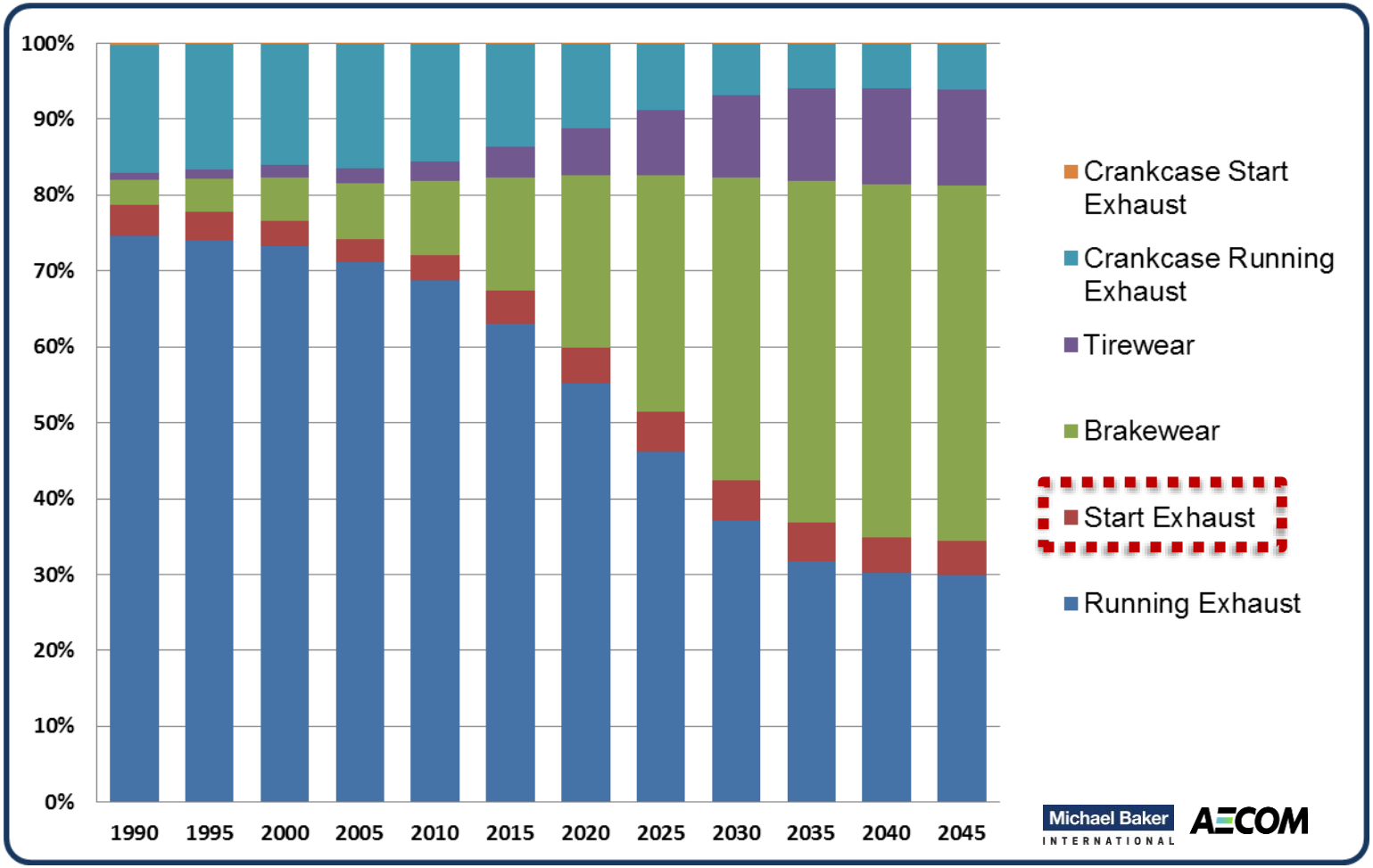
# Start Portion of Total NOx Emissions

**(MOVES2014)**



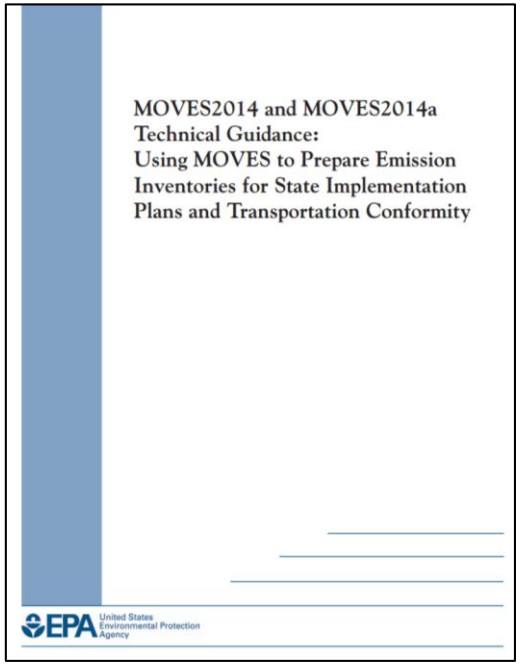
# Start Portion of Total $PM_{2.5}$ Emissions

(MOVES2014)



# How is MOVES Typically Applied?

- MOVES Start inputs in the County Data Manager (CDM) are **optional**
- If no starts information is available, MOVES will calculate start activity **based on user-supplied vehicle populations and default assumptions** of vehicle activity → **Typical process in many areas**


MOVES2014 and MOVES2014a
Technical Guidance:
Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity

EPA United States Environmental Protection Agency

- Per Technical Guidance: "*There are several sources for vehicle start information, but typically this is derived from origin/destination surveys used for travel demand modeling*"

# MOVES2014 *Optional* CDM Inputs for Starts

1. **StartsPerDay**
   - Defines the number of starts per day (for county total)
2. **StartsHourFraction**
   - Specifies the distribution of starts through out the day
3. **StartsSourceTypeFraction**
   - Allocates starts to MOVES

13 source types

| ID | Source Type |
|---|---|
| 11 | Motorcycle |
| 21 | Passenger Car |
| 31 | Passenger Truck |
| 32 | Light Commercial Truck |
| 41 | Intercity Bus |
| 42 | Transit Bus |
| 43 | School Bus |
| 51 | Refuse Truck |
| 52 | Single Unit Short-haul Truck |
| 53 | Single Unit Long-haul Truck |
| 54 | Motor Home |
| 61 | Combination Short-haul Truck |
| 62 | Combination Long-haul Truck |

# MOVES2014 *Optional* CDM Inputs for Starts

(Continued)

4. **StartsMonthAdjust**
   - Adjusts start activity by month
5. **ImportStartsOpModeDistribution**
   - Defines vehicles soak times
6. **Starts**
   - Allows users to provide the complete starts table (by source type, dayid, modelyear, monthid)

| OpModeID | OpModeName |
|---|---|
| 101 | Soak Time < 6 minutes |
| 102 | 6 minutes <= Soak Time < 30 minutes |
| 103 | 30 minutes <= Soak Time < 60 minutes |
| 104 | 60 minutes <= Soak Time < 90 minutes |
| 105 | 90 minutes <= Soak Time < 120 minutes |
| 106 | 120 minutes <= Soak Time < 360 minutes |
| 107 | 360 minutes <= Soak Time < 720 minutes |
| 108 | 720 minutes <= Soak Time |

# Study Research Goals

- To evaluate **how start emissions vary by pollutant and vehicle type**
- To initiate research to evaluate **methods and data sources** for preparing the MOVES2014 optional inputs files for vehicle start information
- To evaluate **impact of local data vs. MOVES defaults** as related to start emissions

# Research Analysis Scenarios

- **Initial Testing Data and Analysis Year**
  - 1 sample county in Pennsylvania
  - Year = 2014 (July Weekday)
- **Analysis Testing Focused On Following MOVES Input Files:**
  - **Vehicle Population** (sourcetypeyear)
  - **Starts Per Day** (StartsPerDay)

**Method currently used for conformity and SIPs**

| MOVES Input File | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|
| Vehicle Population | MOVES2014 Default ✓ | Local County Registration Data ✓ | Local County Registration Data | Local County Registration Data |
| Starts Per Day | Not Used | Not Used | 2009 NHTS* & 2014 CENSUS ✓ | County Travel Model ✓ |

* National Household Travel Survey

✓ = Starts modeled for this scenario based on designated data source

# Data Sources for Starts Per Day File

- **Default MOVES2014 Assumptions**
  - **Step 1**: Conduct a MOVES2014 run for sample county using national scale and then calculate vehicle population by source type from the run outputs
  - **Step 2**: Use vehicle population from Step 1 as input to MOVES run

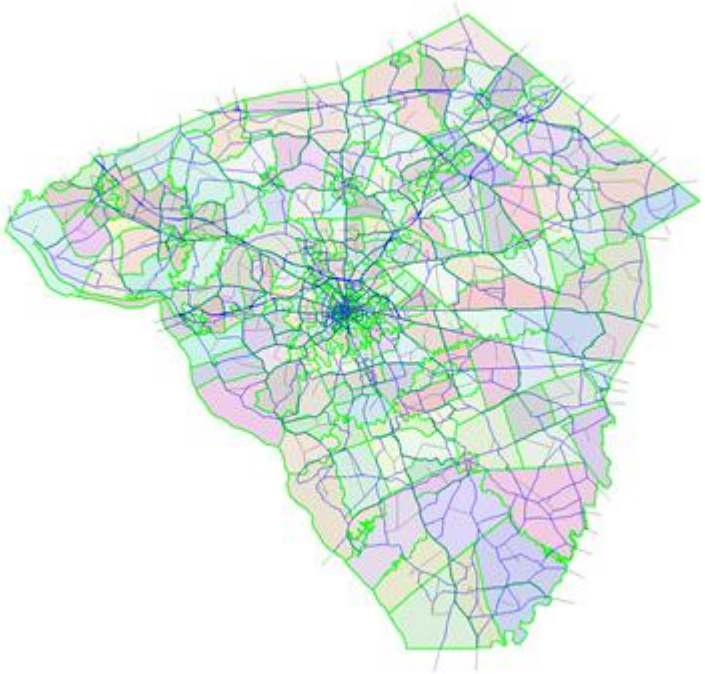
- **NHTS/CENSUS**
  - **Step 1**: Obtain statewide total **vehicle** trips and total household numbers from 2009 NHTS
  - **Step 2**: Calculate average vehicle trips per household =

    *2009 statewide vehicle trips / 2009 statewide households*
  - **Step 3**: Obtain 2014 household count data for sample county from 2014 CENSUS data
  - **Step 4**: Estimate vehicle trips count for sample county in 2014 =

    *2014 county household count x Average NHTS vehicle trips per household*
  - **Step 5**: Use the Step 4 vehicle trips as input to MOVES run

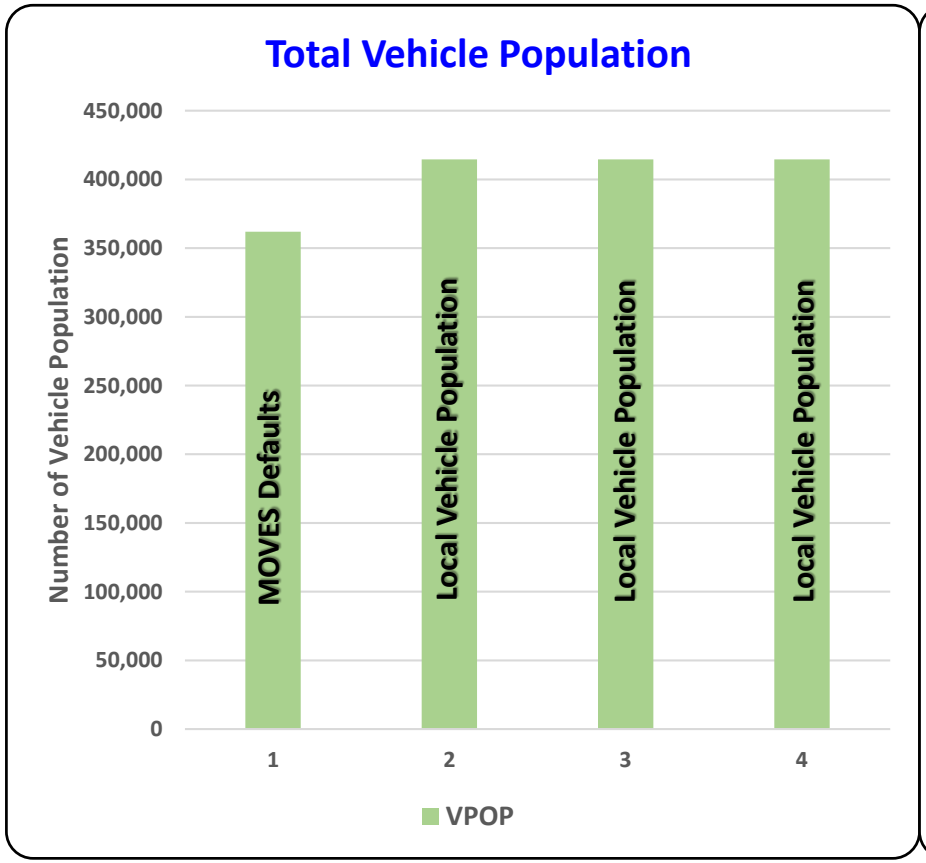
# Data Sources for Starts Per Day File

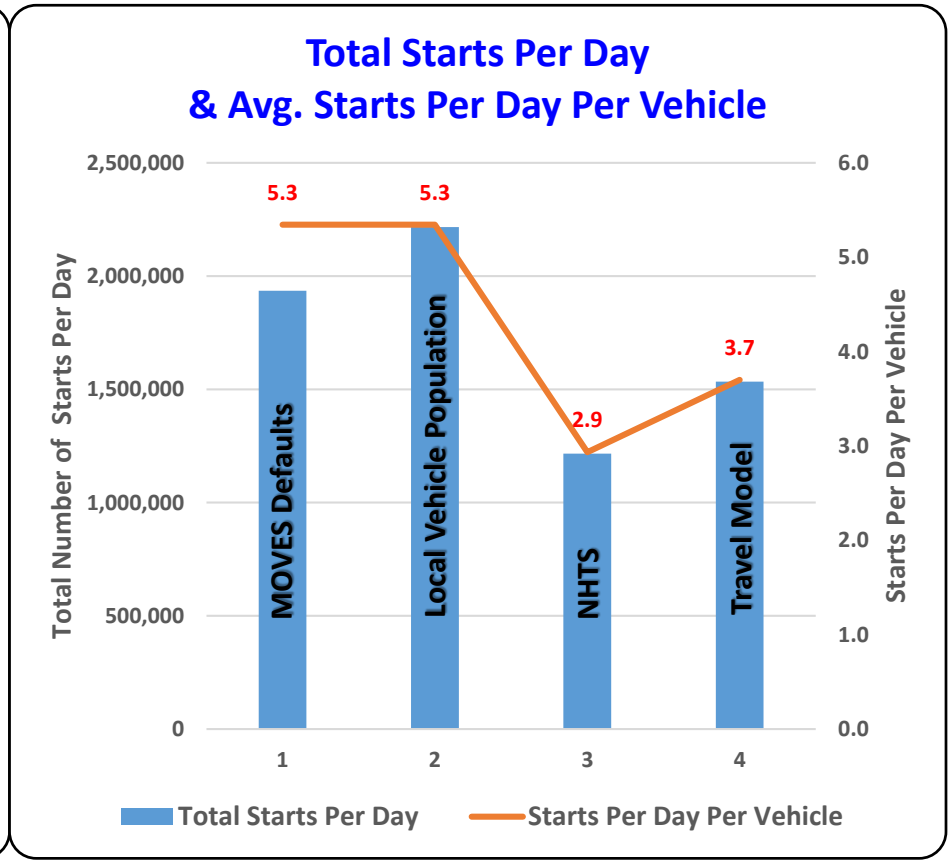
- **County Travel Model**
  - **Step 1**: Obtain model vehicle trips matrices for 4 time periods: AM, MD, PM, NT
  - **Step 2**: Sum up the vehicle trips for all vehicle types for all time periods
  - **Step 3**: Use the Step 2 vehicle trips as starts per day input to MOVES run



# Analysis Results

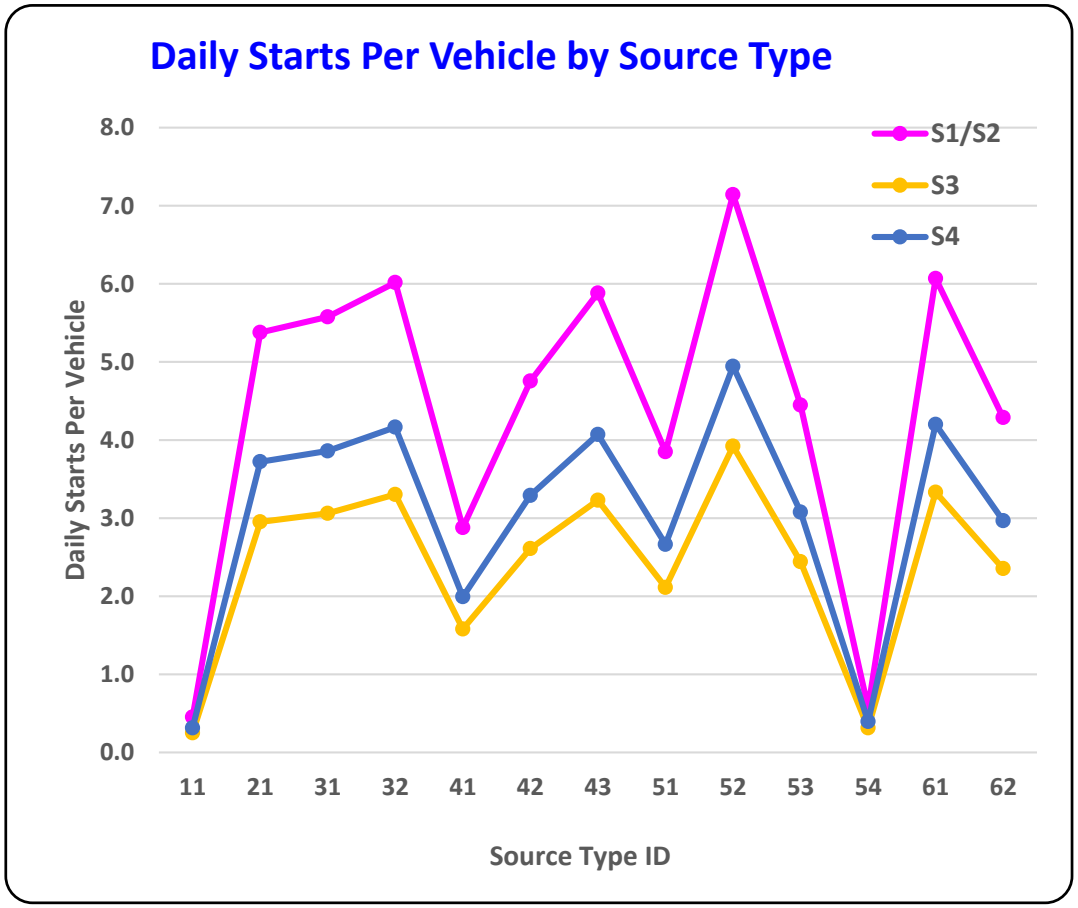
## (Population and Starts)



# Analysis Results

## (Starts by Vehicle Type)



# Findings

**(Population and Starts)**

- **Number of starts is correlated to the vehicle population input if the optional MOVES starts input files are not used**
- **In sample county, MOVES2014 defaults generates less vehicle population and starts than local registration data**
  - 12% less light-duty vehicle population than local registration data
  - 30% less heavy-duty vehicle population than local registration data
- **Local NHTS survey data generates significantly less starts per day than local registration data**
  - 45% less than starts number using local registration data
- **Travel demand model trips generates significantly less starts per day than local registration data**
  - 31% less than starts number using local registration data

# Analysis Results

## (Starts Emissions)

| Total Starts Emissions (Tons/Day) | | | | |
|---|---|---|---|---|
| | S1 | S2 | S3 | S4 |
| Starts Based On | MOVES2014 Defaults | County Registration Data | NHTS/CENSUS | Travel Model |
| VOC | 3.89 | 4.43 | 2.43 | 3.07 |
| NOX | 3.38 | 3.86 | 2.12 | 2.67 |
| PM2.5 | 0.03 | 0.03 | 0.02 | 0.02 |
| CO | 29.89 | 34.34 | 18.85 | 23.77 |
| CO2e | 225.39 | 257.90 | 141.55 | 178.50 |

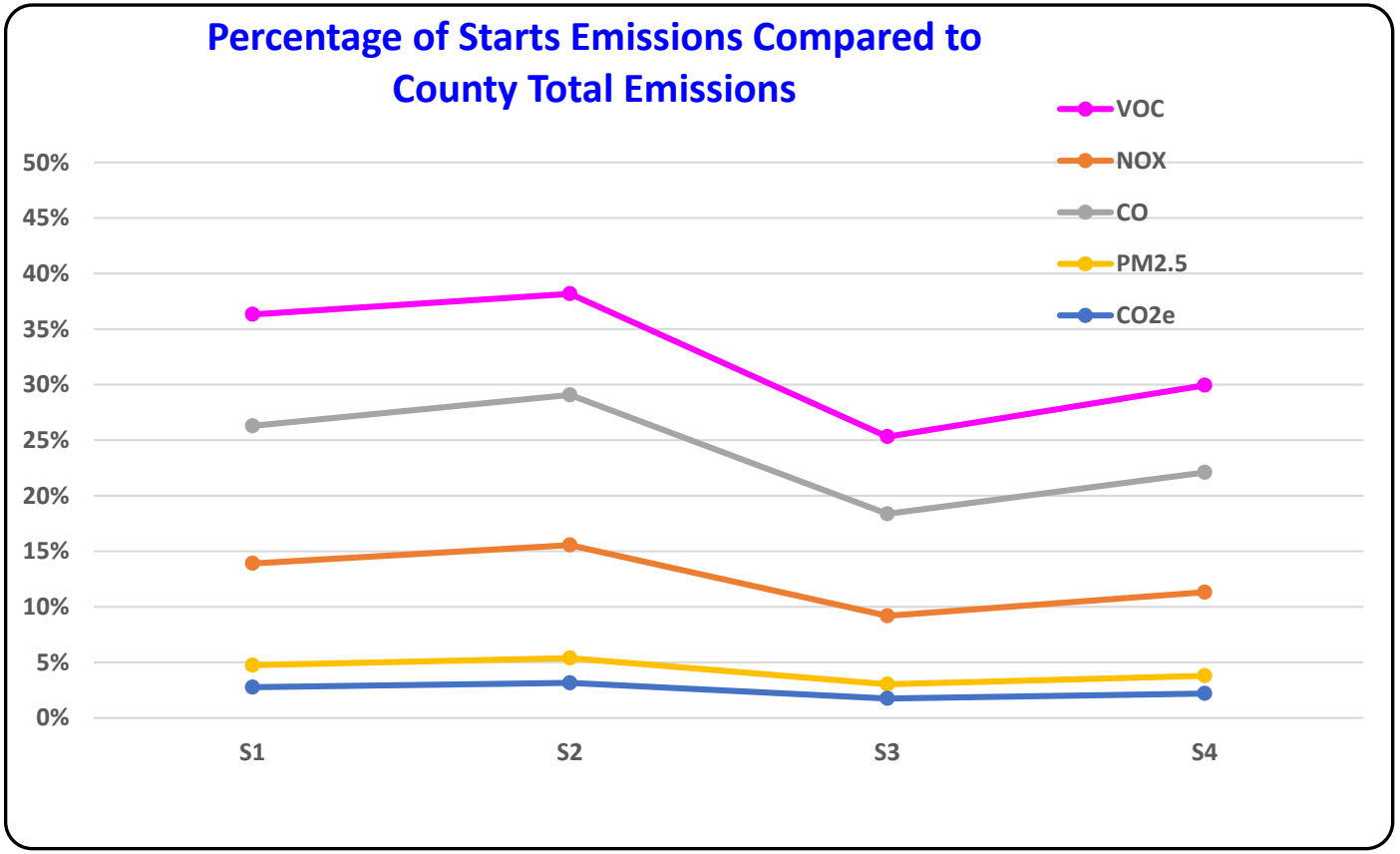
+ 14 %

- 45 %

- 31 %

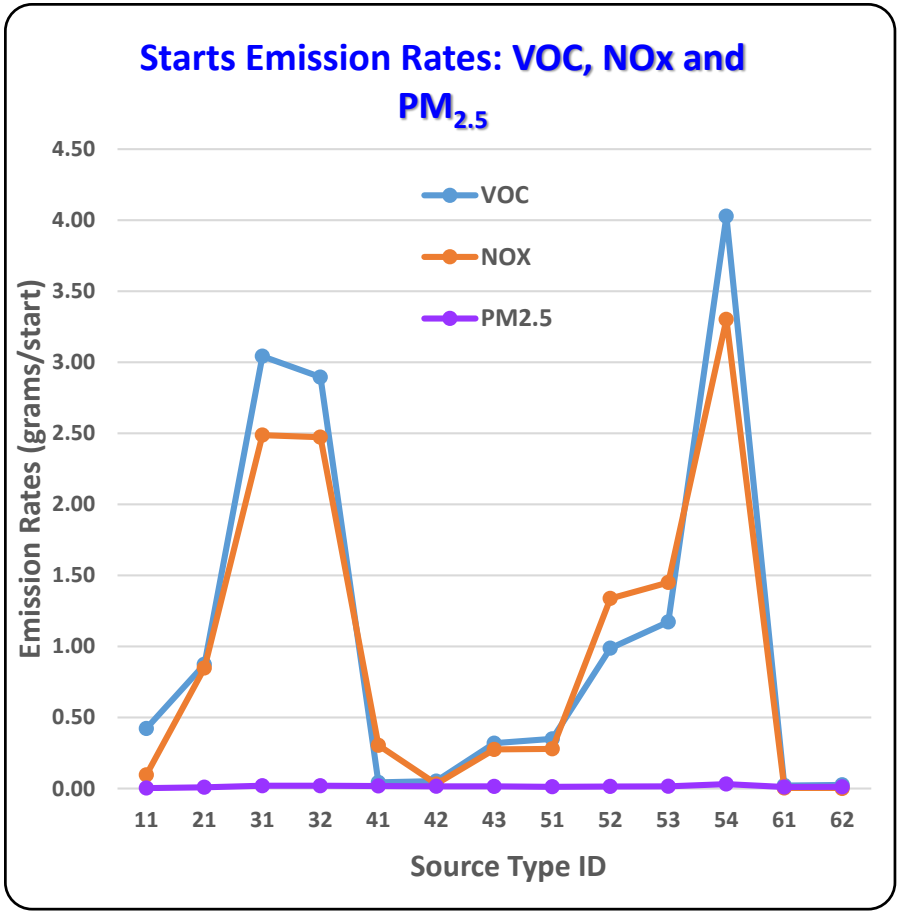
# Analysis Results

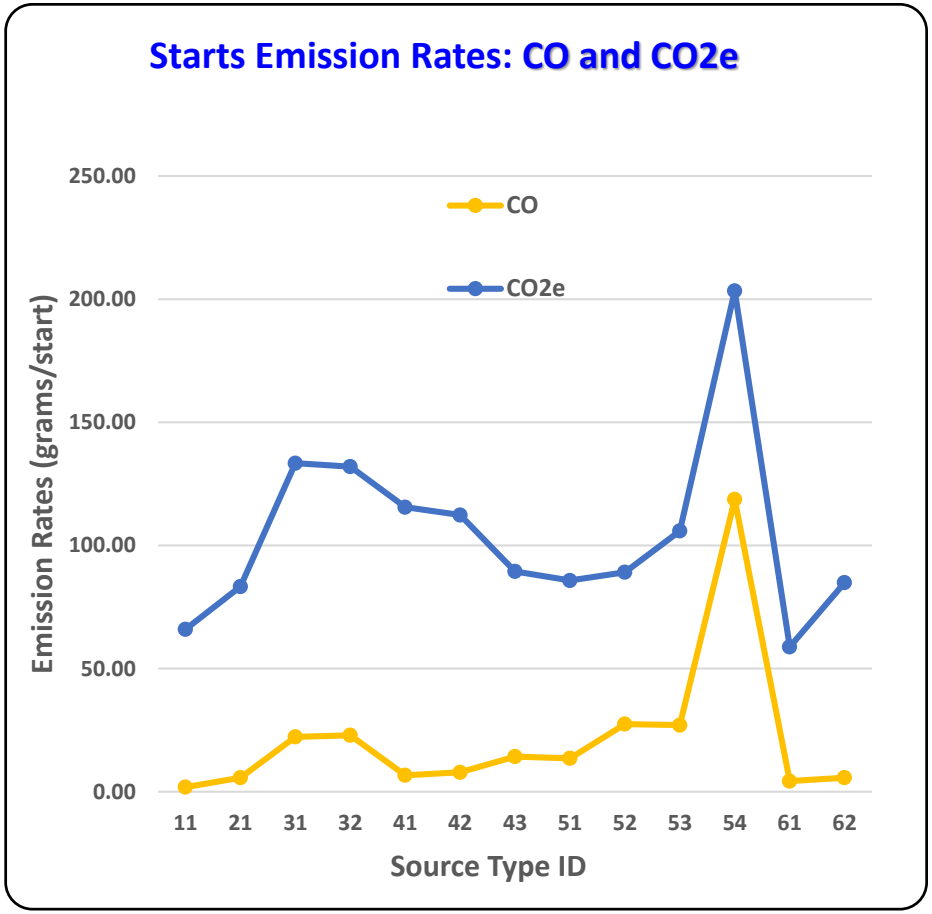
## (Start Emissions)



# Analysis Results

## (Start Emissions)



# Findings

## (Start Emissions)

- Start **emissions are correlated to total number of starts** for all the pollutants included in test runs.
- Start emissions are a **higher portion of total emissions for VOC, CO and NOx** (15-35%). Much lower portion (<5%) for $PM_{2.5}$ and CO2e.

# Questions/Comments?

**Additional research ideas?**
**Has your agency researched starts?**