Agenda

• Introduction
• MOVES2014 data sources and methodology
• Proposed updates for next MOVES release
• Request for feedback
Introduction

• MOVES links vehicle population and activity information to emission processes and rates

• The primary data are national default:
  – VMT
  – Vehicle Populations
  – Age Distributions

• These are then distributed among the following to link the activity to an emission rate:
  • Calendar Year
  • Source Type
  • Regulatory Class
  • Age
  • Fuel Type

• This information is primarily used at National Scale
Vehicle Miles Travelled (VMT)
Historic VMT in MOVES2014

• Calendar years 1990 and 1999-2011
• All data come from FHWA’s Highway Statistics\textsuperscript{1}
• National default VMT are input by HPMS class*
  – VMT is allocated to source type, reg class, fuel type, and model year during model run time through Relative Mileage Accumulation Rates (from VIUS) and the Sample Vehicle Population
  – LD categories are combined because MOVES does not differentiate by wheelbase

*HPMS classes are groupings used by the Dept. of Trans. Highway Performance Monitoring System.
Historic VMT in MOVES2014

Highway Statistics (VM-1)
- Motorcycle
- Light Duty Short Wheelbase
- Light Duty Short Wheelbase
- Bus
- Single Unit Truck
- Combination Truck

MOVES2014
- Motorcycle
- Light Duty
- Bus
- Single Unit Truck
- Combination Truck
Projected VMT in MOVES2014

- VMT projections from Dept. of Energy’s Annual Energy Outlook\(^2\) (AEO) 2014
  - Year-over-year growth rates in VMT were calculated by AEO vehicle classifications
    - Light duty
    - Freight: Light Medium, Medium, and Heavy heavy duty
  - Growth rates applied to last historic year (2011) VMT through a mapping between AEO classes and HPMS classes
  - Average VMT growth rate for 2031-2040 used for 2041-2050
Projected VMT in MOVES2014

AEO VMT Growth

- Light Duty
- Light Medium Trucks
- Medium Trucks
- Heavy Trucks

MOVES

- Motorcycle
- Light Duty
- Bus
- Single Unit Truck
- Combination Truck
Proposed VMT Changes for Next Version of MOVES

• Historic VMT
  – Include data up to 2015 from *Highway Statistics* if available, otherwise use 2014
    • Highway Statistics 2015 scheduled to be released Dec 2016

• Projected VMT
  – Calculate from AEO2017 if available, otherwise use AEO2016
    • AEO2017 scheduled to be released Jan 2017
  – Project beyond final year of AEO using the final year growth as a surrogate
    • AEO2016 projects out to 2040
    • AEO2017 will project out to 2050
    • The next version of MOVES will project out to 2060
Vehicle Populations
Sample Vehicle Population

• Based on EPA Sample Vehicle Counts
  – Contains representative vehicle counts by source type, fuel type, model year, and regulatory class
  – Distributions calculated from the vehicle counts are used in MOVES
    • To allocate default activity to fuel types and regulatory classes
    • With Alternative Vehicle and Fuel Technologies (AVFT) importer to allocate user input activity
  – Combines 2011 registration data from IHS Automotive with 2002 Vehicle Inventory and Use Survey (VIUS) for most source types
    • Bus distributions come from unpublished FHWA data and published National Transit Database\textsuperscript{3} data. Motor home distributions come from same FHWA data
Historic Populations in MOVES2014

- Calendar years 1990 and 1999-2011
- Principal data source is FHWA’s *Highway Statistics*
- Bus populations also use National Transit Database
Historic Populations in MOVES2014

Highway Statistics (MV-1)
- Motorcycle
- Passenger Car
- Truck
- Bus

Highway Statistics (VM-1)
- Single Unit
- Combination

National Transit Database
- Intercity Bus
- Transit Bus

Remainder
- Light Truck

MOVES2014
- Motorcycle
- Passenger Car
- Passenger Truck
- Light Commercial Truck
- Refuse Truck
- Single Unit Truck (Short-haul)
- Single Unit Truck (Long-haul)
- Motor Home
- Combination Truck (Short-haul)
- Combination Truck (Long-haul)
- Intercity Bus
- Transit Bus
- School Bus

Using EPA Sample Vehicle Count distributions
Projected Vehicle Populations in MOVES2014

• Used VMT projections from AEO 2014
  – VMT per vehicle by HPMS class was relatively constant from 1999-2011
  – Year-over-year growth rates in VMT were calculated by AEO vehicle classifications
    • Light duty
    • Freight: Light Medium, Medium, and Heavy duty
  – Growth rates applied to last historic year (2011) populations through a mapping between AEO classes, HPMS classes, and MOVES source types
Projected Vehicle Populations in MOVES2014

AEO VMT Growth
- Light Duty
- Light Medium Trucks
- Medium Trucks
- Heavy Trucks

MOVES Source Types
- Motorcycle
- Passenger Car
- Passenger Truck
- Light Commercial Truck
- Intercity Bus
- Transit Bus
- School Bus
- Refuse Truck
- Single Unit Truck (Short-haul)
- Single Unit Truck (Long-haul)
- Motor Home
- Combination Truck (Short-haul)
- Combination Truck (Long-haul)

AEO / HPMS / MOVES Mapping
- Bus
- Single Unit Truck
Proposed Vehicle Population Changes for Next Version of MOVES

• For both Historic and Projected Populations
  – Correct an error in EPA Sample Vehicle Counts, which impacts fuel and regulatory class distributions for class 2a/2b trucks

• Historic Populations
  – Include data up to 2015 from *Highway Statistics* and *National Transit Database* if available, otherwise use 2014

• Projected Populations
  – Calculate from AEO2017 if available, otherwise use AEO2016
  – Use vehicle stock instead of VMT projections
Proposed Vehicle Population Changes for Next Version of MOVES

**AEO Stock Growth**
- Cars
- Light Trucks
- Light Medium Trucks
- Medium Trucks
- Heavy Trucks

**MOVES Source Types**
- Motorcycle
- Passenger Car
- Passenger Truck
- Light Commercial Truck
- Intercity Bus
- Transit Bus
- School Bus
- Refuse Truck
- Single Unit Truck (Short-haul)
- Single Unit Truck (Long-haul)
- Motor Home
- Combination Truck (Short-haul)
- Combination Truck (Long-haul)
Age Distributions
Historic Age Distributions in MOVES2014

• Calendar years 1990 and 1999-2011
• Vary by source type
• 2011 age distributions from EPA Sample Vehicle Count (IHS + VIUS)
• Algorithm to backcast from 2011 to 1999:
  \[ P_{y-1} = P_y - N_y + R_{y-1} \]
  – \( P \) is population in year \( y \) or \( y-1 \)
  – \( N \) is new vehicle sales in year \( y \)
  – \( R \) is the removed (scrapped) vehicles in year \( y-1 \)
Historic Age Distributions in MOVES2014

• Source type populations known
• Historic sales data sources:
  – Motorcycle Industry Council\textsuperscript{4}: motorcycles
  – \textit{Transportation Energy Data Book}\textsuperscript{5} (TEDB): light duty, single unit trucks, combination trucks
  – \textit{School Bus Fleet Fact Book}\textsuperscript{6}: school buses
  – EPA Certification Data: transit buses
  – No known source for intercity bus sales, so these are estimated based on the other two bus categories
Historic Age Distributions in MOVES2014

• No known source for annual scrappage, so we calculate it from:

\[ P_{y-1} = P_y - N_y + R_{y-1} \]

• Distribute scrapped vehicles by age:
  
  – Start with a base scrappage profile
    
    • Light duty scrappage from 2002 National Highway Traffic Safety Administration (NHTSA) study
    
    • Heavy duty scrappage from TEDB
  
  – Scale scrappage profile so the sum total of scrapped vehicles satisfies the above equation
  
  – Calculated at HPMS level, and applied to each source type within HPMS class
Historic Age Distributions in MOVES2014

Passenger Truck Age Distributions

Age Distribution

Model Year

1980 1990 2000 2010
Projected Age Distributions in MOVES2014

- Calculated for calendar years 2012-2050
- Vary by source type
- Based on 2011 age distributions from EPA Sample Vehicle Count (IHS + VIUS)
- Algorithm to forecast from 2011 to 2050:
  \[ P_{y+1} = P_y + N_{y+1} - R_y \]
  - \( P \) is population in year \( y \) or \( y + 1 \)
  - \( N \) is new vehicle sales in year \( y + 1 \)
  - \( R \) is the removed (scrapped) vehicles in year \( y \)
Projected Age Distributions in MOVES2014

• Source type populations known
• Sales fractions calculated from AEO using sales and stock numbers for each of the AEO categories
  – E.g.: LD sales fraction = \( \frac{\text{Car Sales} + \text{Truck Sales}}{\text{Car Stock} + \text{Truck Stock}} \)
• Projected sales by HPMS class calculated from sales fractions and populations, using AEO to HPMS mapping
  – E.g.: LD sales = LD sales fraction \(*\) LD population
Projected Age Distributions in MOVES2014

• No known source for projected scrappage, so we calculate it from:

\[ P_{y+1} = P_y + N_{y+1} - R_y \]

• Distribute scrapped vehicles by age using same technique as historical age distributions
  – Start with a base scrappage profile
  – Scale scrappage profile so the sum total of scrapped vehicles satisfies the above equation
  – Calculated at HPMS level, and applied to each source type within HPMS class
Projected Age Distributions in MOVES2014
Proposed Age Distribution Changes for Next Version of MOVES

• Historic Age Distributions
  – Recalculate historic age distributions using updated historic populations
  – Use calendar year 2014 for base year age distributions from a new IHS data purchase
  – Use latest sales data from Motorcycle Industry Council, TEDB, and School Bus Fleet Fact Book
  – Use latest data from National Transit Database for transit buses
  – Update algorithm:
    • In $P_{y-1} = P_y - N_y + R_{y-1}$, the distribution of scrapped vehicles depends on the age distribution for $P_{y-1}$ which is the output of the algorithm. Use an iterative approach to calculate the scrappage distribution
Proposed Age Distribution Changes for Next Version of MOVES

• Projected Age Distributions
  – Calculate from AEO2017 if available, otherwise use AEO2016
  – Perform calculations at the source type level, instead of HPMS class
    • Use same AEO / HPMS / Source Type mapping
Other Potential Changes

• If timing and resources allow:
  – Update base scrappage profiles using IHS registration data from 2011 and 2014
  – Update EPA Sample Vehicle Counts dataset and the Sample Vehicle Population table for model years 2012+ using 2014 IHS registration data
  – Include default age distributions by county
    • Use national sales estimates for projecting and backcasting from 2014
    • Adjust scrappage for counties with a younger or older average age in 2014 to maintain that delta
Requested Feedback

• Are we missing any data sources for national scale vehicle population or activity?
• Feedback on our proposed changes