

MOVES Review Work Group Update

September 17, 2019

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Office of Transportation & Air Quality



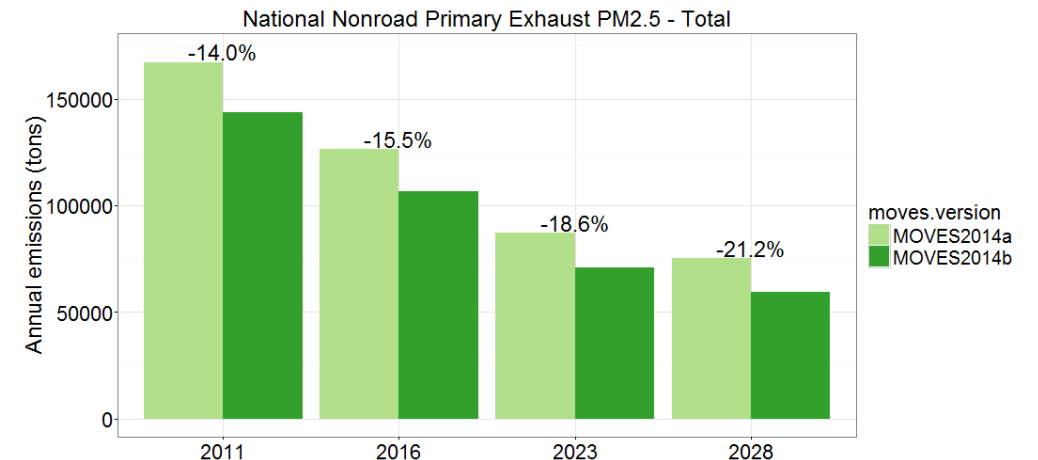
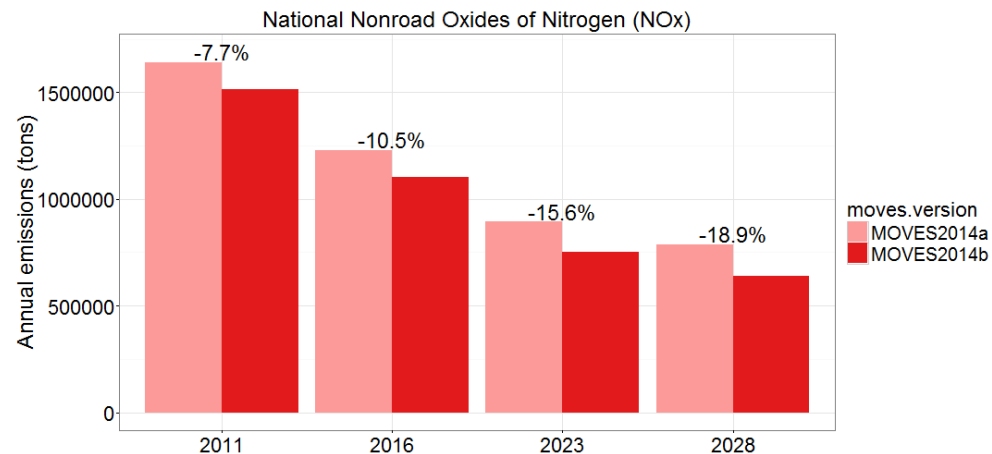
EPA MOVES Model

- U.S. EPA's **M**otor **V**ehicle **E**mission **S**imulator estimates emissions and energy use from
 - Onroad vehicles: passenger cars, light- and heavy-duty trucks, buses, motorcycles
 - Nonroad equipment: construction, agricultural, industrial, lawn & garden, commercial, logging, airport support, oil & gas, mining, railroad service, recreational vehicles and boats
- MOVES accounts for national emission standards, vehicle populations and activity, local rules, fuels, and meteorology
- EPA uses MOVES to estimate emission impacts of mobile source emissions regulations and policies and to generate national inventories of air pollutants
- State and local agencies use MOVES to prepare emission inventories for State Implementation Plans and transportation conformity
- MOVES is also used in academic research and to model effects of policy choices



MOVES Status

- Current public version of MOVES: MOVES2014b
 - MOVES2014 released in October 2014; updated to MOVES2014a in November 2015; MOVES2014b in August 2018
 - MOVES2014b
 - Did not change onroad inventories
 - Improves nonroad emission estimates:
 - NR engine population growth rates, NR Tier 4 emission rates, sulfur levels of NR diesel fuels



MOVES Plans

- Next major version of MOVES
 - Release date TBD
 - Will include:
 - New data based on latest test programs and analyses
 - Latest vehicle population and activity data
 - Newer rules (e.g. Heavy-Duty Greenhouse Gas Phase 2)
 - Improved functionality and performance
 - Peer reviewed draft reports available.
<https://cfpub.epa.gov/si/>
Search “MOVES201X” or “NONROAD”



MOVES Review Work Group

- Created by MSTRS to provide input on the development of MOVES
- Members have expertise in modeling emissions from highway and nonroad vehicles and represent a spectrum of stakeholders, including vehicle and engine manufacturers, fuel producers, state and local emission modelers, academic researchers, environmental advocates, and affected federal agencies
- EPA has been presenting planned updates to MOVES, including underlying data and analyses
 - Work group members coordinate within their organizations and with their constituents to solicit specific comments on EPA's work
- Starting in December 2017, presentations were invited by the work group committee members
- The work group develops recommendations to the MSTRS based on the proceedings of work group meetings

Recent & Future Work Group Topics

- **June 2018 Meeting:**

- MOVES2014b Plans and Comparisons
- Heavy-Duty Vehicle Activity in MOVES: Idle, Starts, Soaks and Hotelling
- Update: Revising Start/Soak Relationships for Light-Duty Gaseous Emissions
- *Utilizing MOVES for Evaluating Shared, Electric, Connected and Automated Vehicles – Prof. Matthew Barth**

- **April 2019 Meeting:**

- Updates to EPA's Motor Vehicle Emission Simulator
- Updates to "High-Power" Emission Rates and Start Deterioration for Light-Duty Vehicles
- Updates to MOVES Heavy-Duty Running Exhaust Rates: Diesel Gasoline and Natural Gas
- Modeling of Gliders in MOVES

- **October 2019 Agenda:**

- **Prof. Matthew Barth, University of California, Riverside**, on adapting MOVES to better model autonomous & connected vehicles*
- **Prof. Randall Guenther, Georgia Tech**, on the MOVES-Matrix system for storing MOVES rates in a large look-up matrix*
- **Christopher Voigt, Virginia DOT**, on potential MOVES improvements from the perspective of project-level modeling*

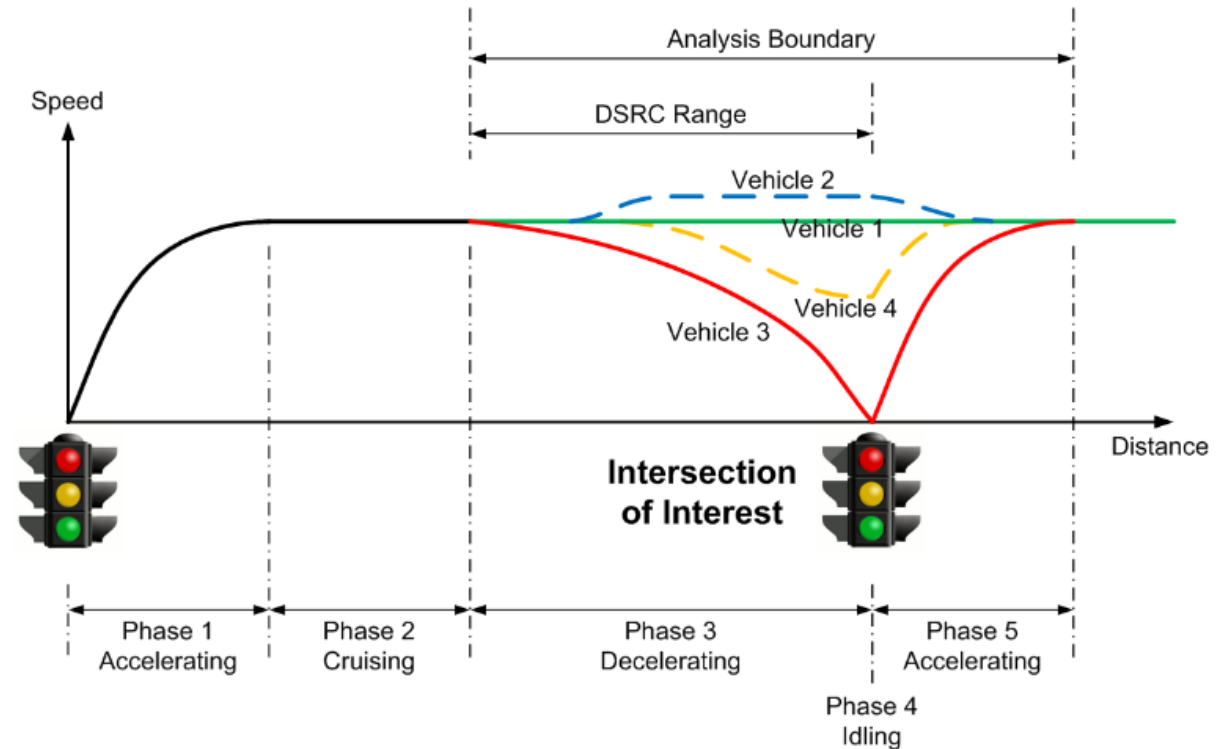
- **Future topics:**

- Stakeholder ideas on longer-term MOVES design
- EPA proposals for longer-term MOVES design
- Draft results from upcoming MOVES update

*Member presentation

Highlights—Work Group Member Comments

- Co-chair Matthew Barth has shared his research, including work modeling connected and automated vehicles emissions.
 - Results suggest that MOVES operating bins are too coarse to estimate emission benefits of the modelled scenario.
- Recent member comments have mostly been detailed questions regarding EPA presentations.
- Our meeting next month will focus on ideas for future improvements to the MOVES design

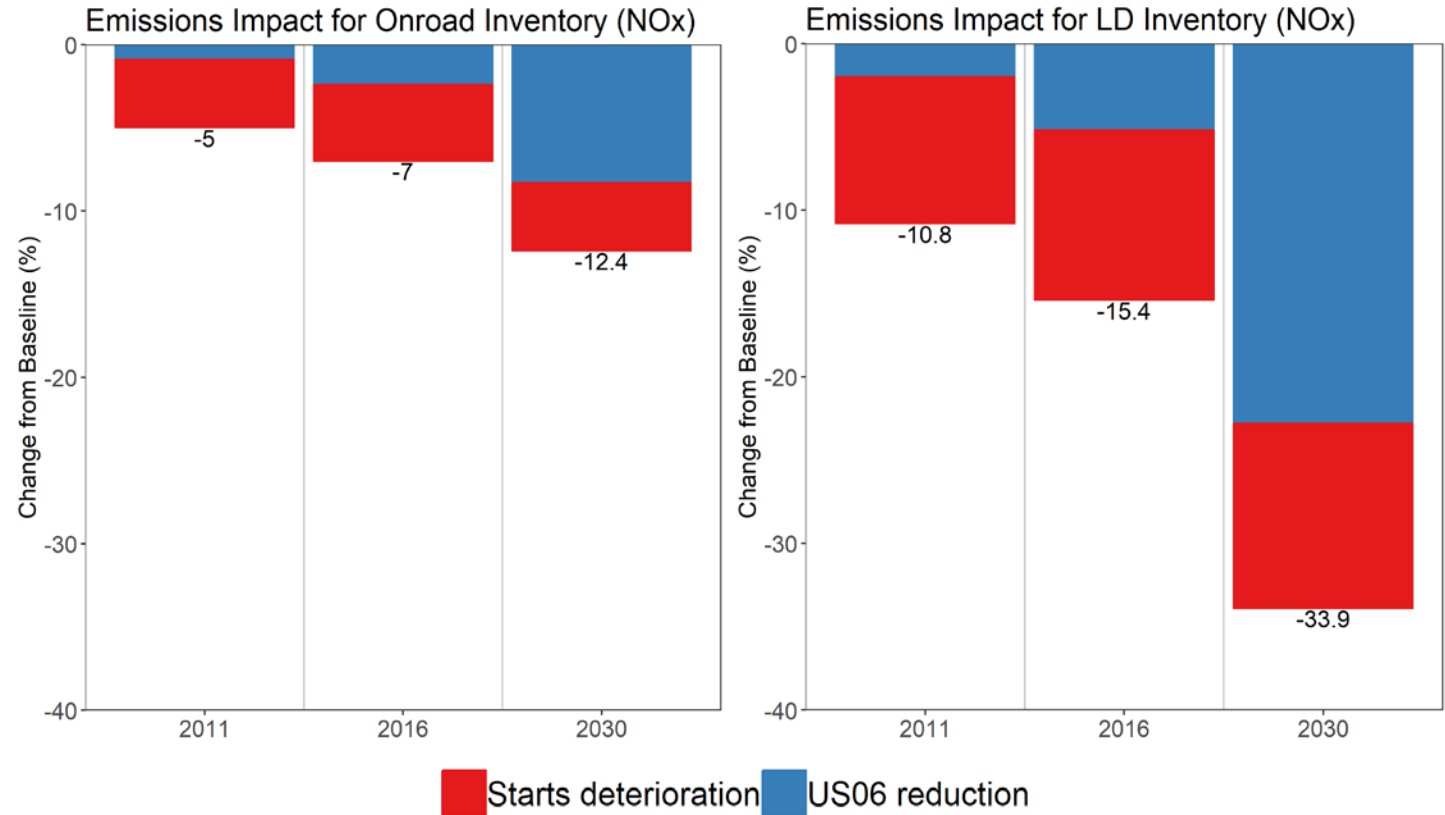


Example connected and automated vehicle application: Eco-Approach and Departure at Signalized Intersections

Highlights—LD NOx Update

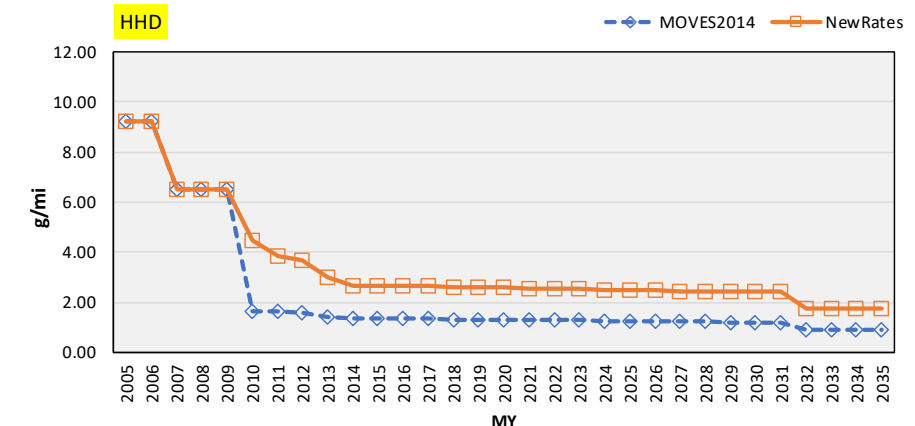
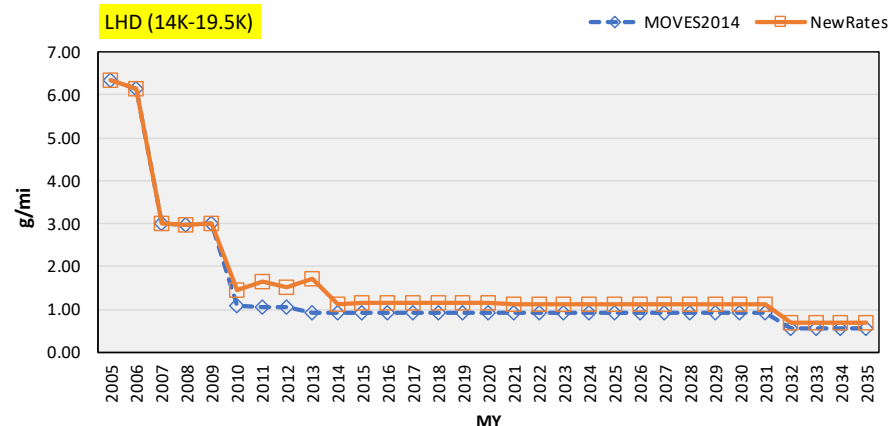
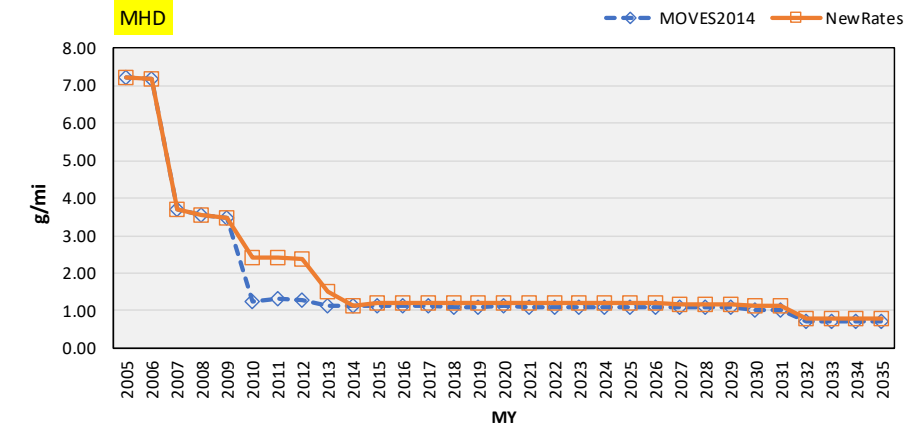
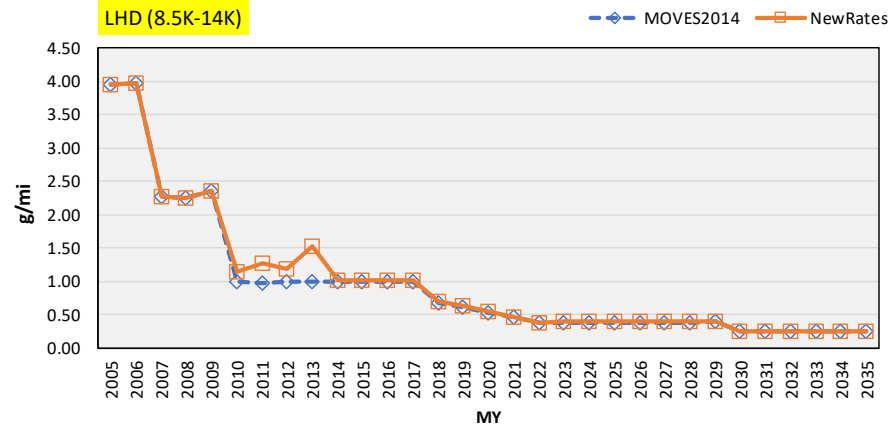
Preliminary results of national level sensitivity runs

- Preliminary review of Colorado IM data led to revised assumptions regarding
 1. high-power emission rates
 2. deterioration of starts
- These changes lead to a significant decrease in LD NOx in future years.
- **Sensitivity results do not include other planned changes or account for local impacts.**



Highlights—HD Running Emissions Update

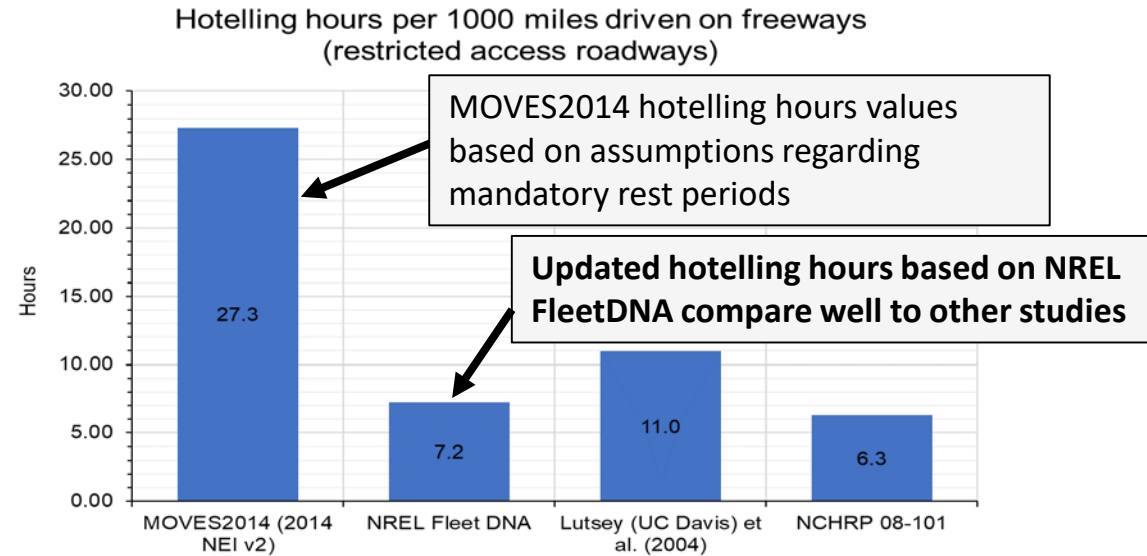
- Heavy-duty In-Use test data was used to update running emission rates from MY 2010+ HD trucks for diesel, gasoline and CNG trucks
- This data captures real-world emissions of trucks equipped with SCR and DPF exhaust aftertreatment systems.



*Heavy-duty diesel emission rates by regulatory class and model year
MOVES 2014 in blue; new rates in orange*

Highlights—Hotelling Updates

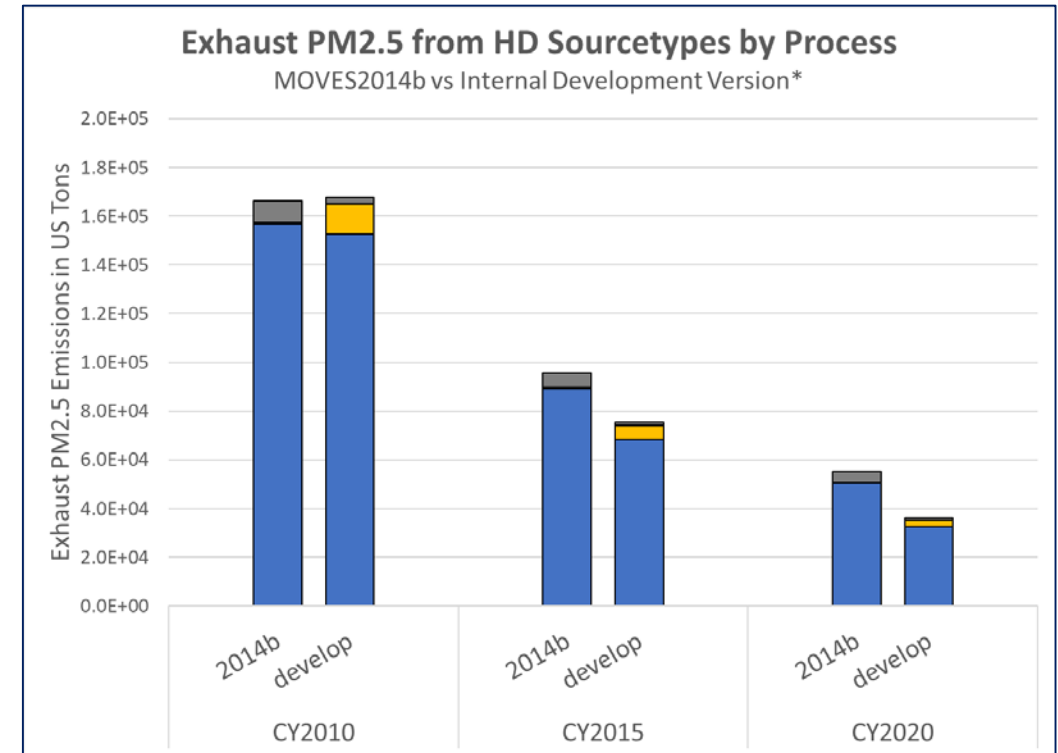
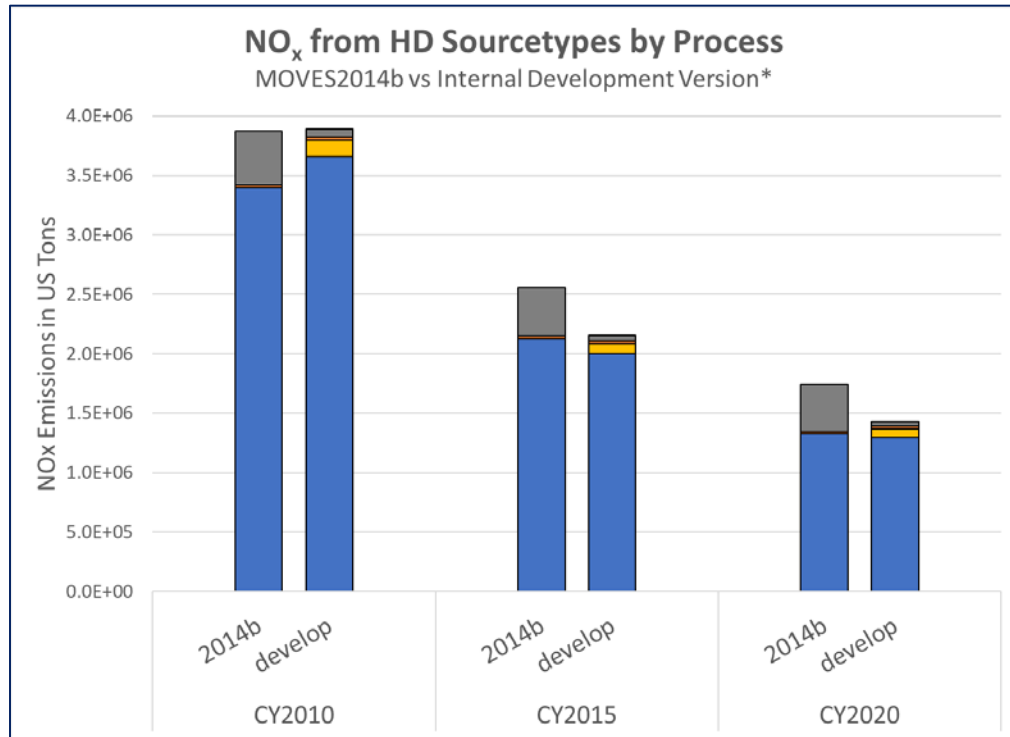
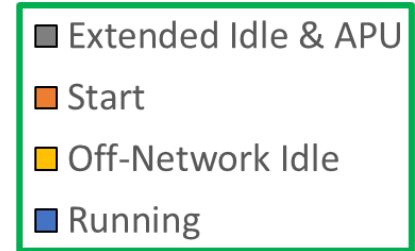
- We used data from instrumented trucks to update of heavy-duty hoteling activity estimates (amount of time spent resting during long-haul operation)
 1. National hoteling time reduced by ~2/3
 2. Local impact will vary
- Also updated truck emission rates for idling while hoteling.
 1. Reduced g/hr for both NO_x and PM



Note: Hotelling hours estimated based on extended idling data recorded in the NREL, Lutsey, and NCHRP studies combined with MOVES VMT on restricted access roadways and % of hotelling time spent in extended idle.

Preview—Preliminary Net HD Emissions

At next month's work group meeting we will share information presented at the IEIC conference in July, including a preliminary comparison between MOVES 2014b and the current development version of MOVES of national net HD emissions.



* Preliminary estimates based on EPA's development version of MOVES, July 2019.

Additional Resources

For Workgroup presentations and minutes:

<https://www.epa.gov/moves/moves-model-review-work-group>

For more information on MOVES, please see the MOVES web page:

<https://www.epa.gov/moves>

Questions: Contact the MOVES Team at mobile@epa.gov

Earlier Work Group Topics

- **September 2016:**
 - WorkGroup Introduction
 - MOVES2014 Overview and Plans for the Future
 - Options for Simplifying MOVES Onroad Source Types and Ramps
 - MOVES-NONROAD Model Plans and Data Updates
 - Heavy-Duty Greenhouse Gas Phase 2 in MOVES
- **December 2016:**
 - Update to Running Exhaust Criteria Pollutant Emission Rates for Model Year 2010+ Heavy-Duty Diesel Vehicles
 - Updated Emission Rates for Extended Idle and Auxiliary Power Units
 - MOVES Onroad Population and Activity Update
 - Updating Hotelling Hours in MOVES
- **March 2017:**
 - Vehicle Idle Activity in MOVES
 - Model Evaluation
 - Light-Duty Particulate Matter Emission Rates Update
- **June 2017:**
 - Revising Start/Soak Emissions for LDGV and HDV
 - Heavy Duty CNG category
 - Telematics: valuable for many aspects of MOVES
 - Updated Speciation Profiles
 - Updated Total Organic Gases
- **September 2017:**
 - Updated NONROAD population rates
 - Updated LD Emission Rate Comparison
 - MOVES Future Fuel Supply Updates
- **December 2017:**
 - Update for Tier-4 Nonroad Diesel Engines
 - Draft Tool to Model Ramps in Project Scale
 - Updates to MOVES HD Source Masses using VTRIS
 - Updates to HDV Fixed Mass Factor and Diesel PM rates
 - *CRC 2017 and 2018 MOVES related projects**
- **March 2018:**
 - *Ethanol Emission Effects in MOVES2014**
 - *Growth Energy Ethanol and Aromatics Testing**
 - *Implications of Emerging Trends and Needs for MOVES**

*Member presentation