Annual Vehicle Emissions at U.S-Mexico Border Crossings

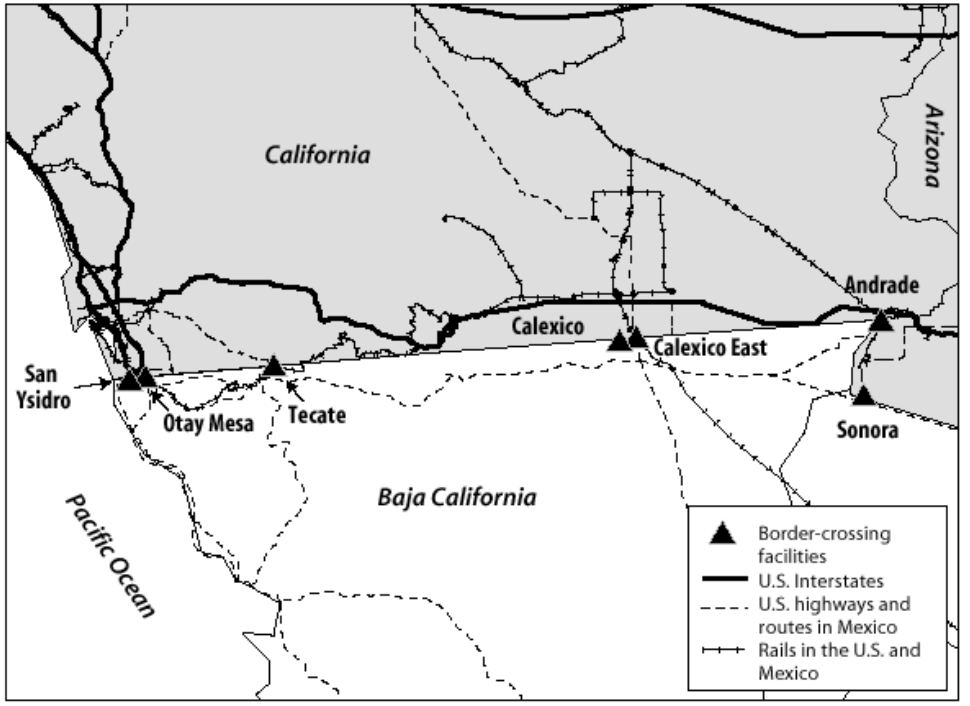
2019 International Emission Inventory Conference
Dallas, Texas August 1, 2019

John Koupal
Marty Wolf
Eastern Research Group, Inc.

Lizzy Melgoza
Leo Ramirez
California Air Resources Board

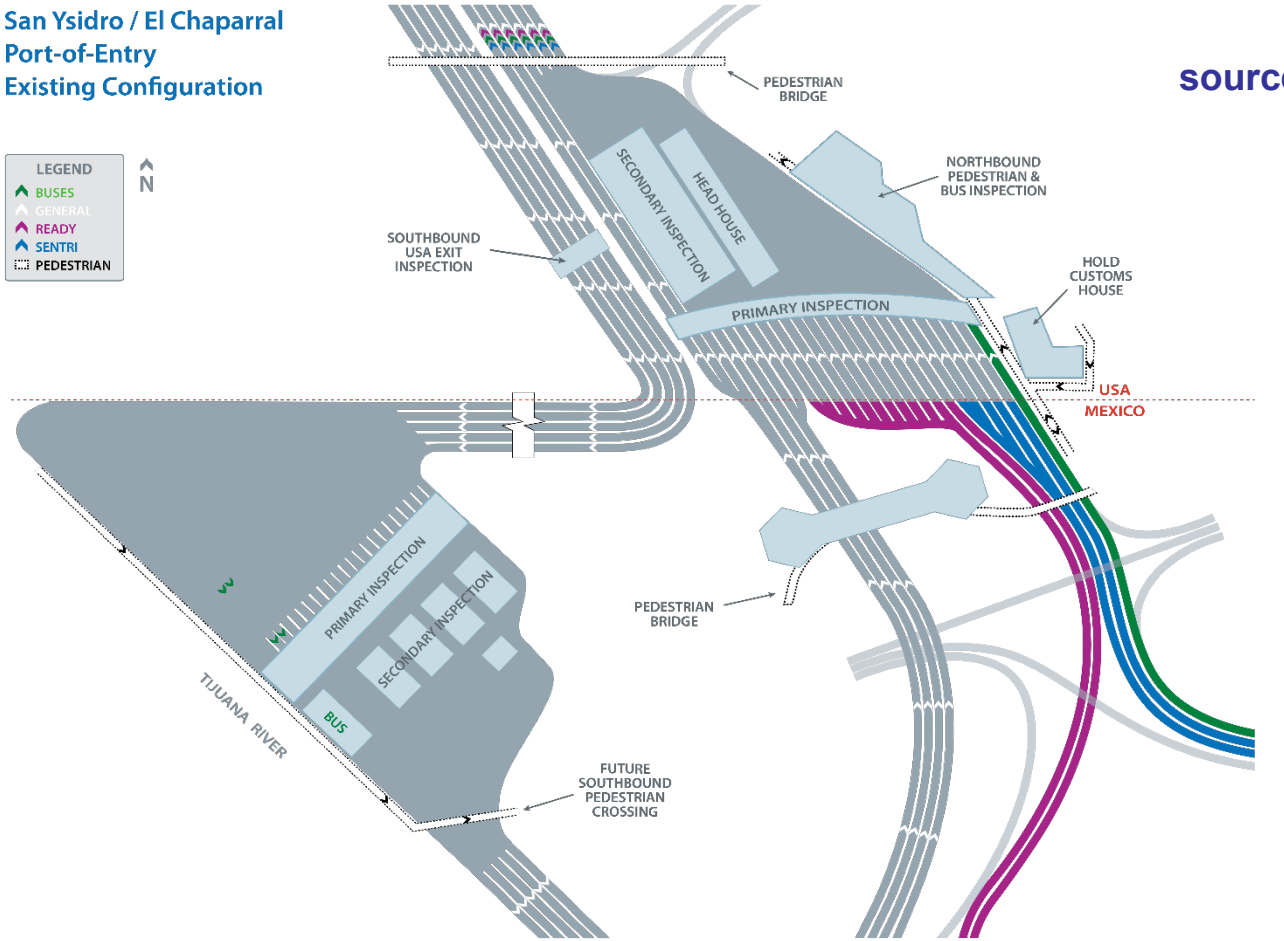
Overview

- ERG updating 2014 Baja California emissions for ARB air quality planning
- Estimated vehicle emissions at California's crossings
  - > 30 million northbound vehicle crossings in 2018
  - Wait times often > 1 hour



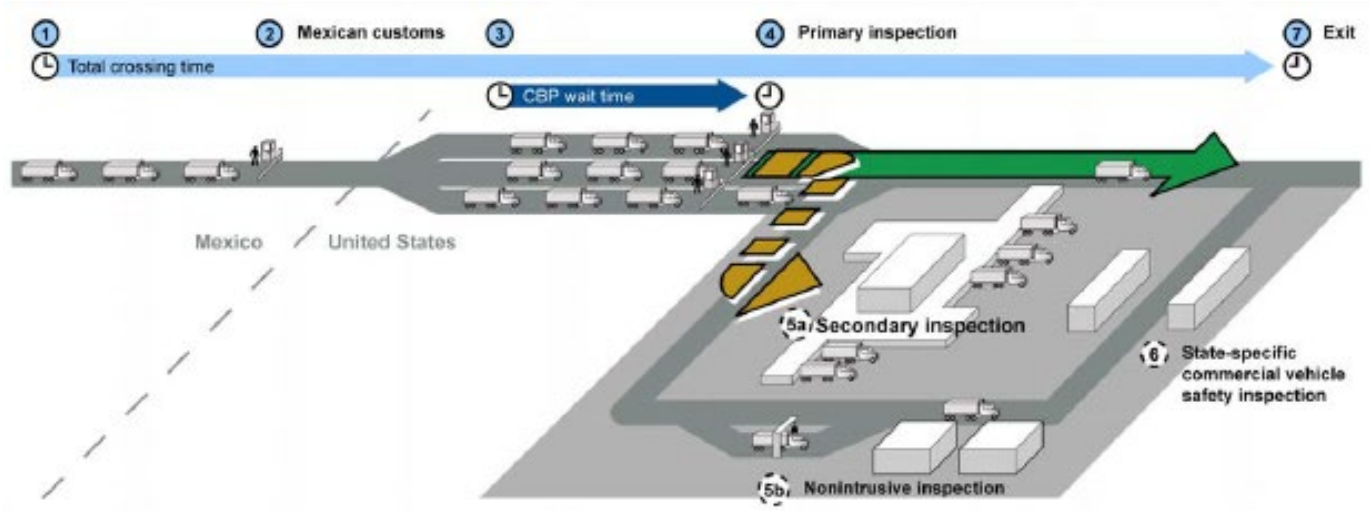
San Ysidro Border Crossing
(CC-by-SA-3.0/Matt H. Wade)

A Complex Environment



source: CEC

Truck Inspections Add Time at Commercial Crossings

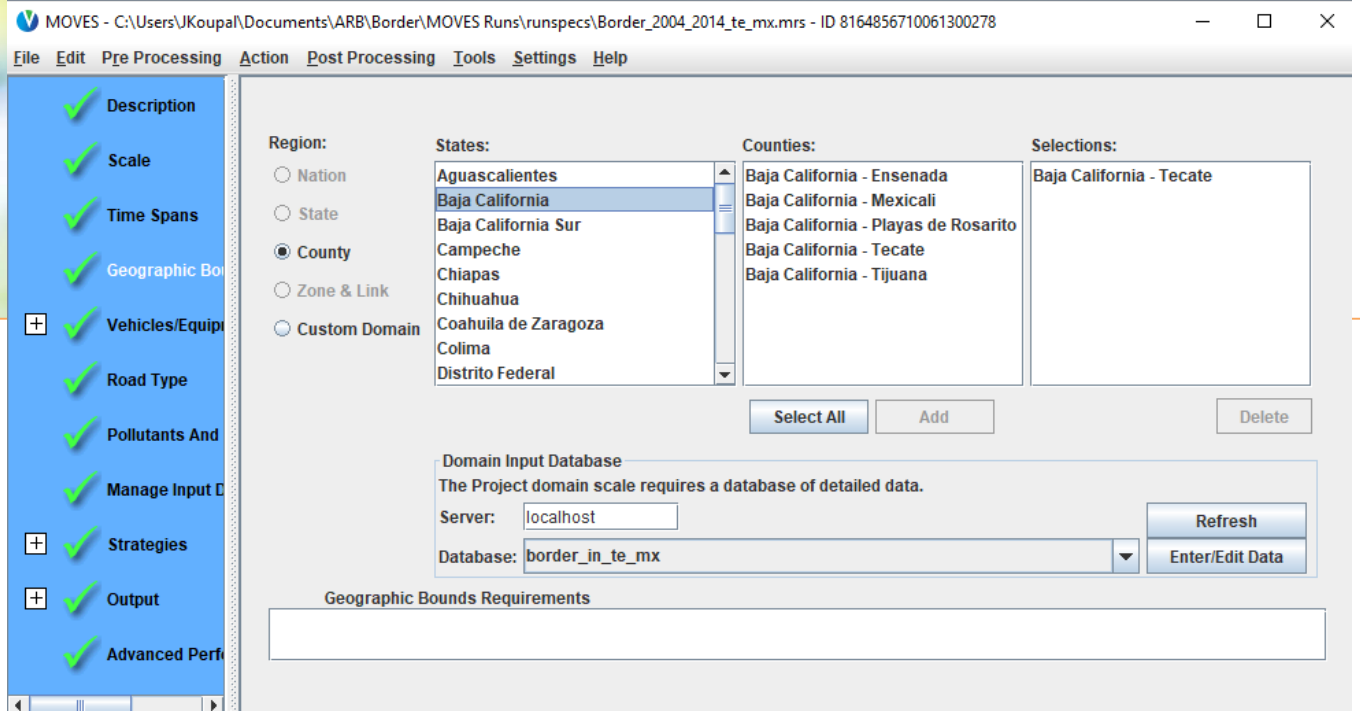


source: GAO 2013

Recent Emissions Studies

- SDSU (2011-2012)
  - 2009 annual emissions @San Ysidro, Otay Mesa, Tecate (Northbound)
  - Used U.S. MOVES (MOVES2010)
- Imperial County (2015)
  - Daily emissions @Calexico East & West (Northbound)
  - Surveys over select days in May/August/December 2014
  - Based on EMFAC2014 w/ some adjustment for Mexico fleet/fuels
- Commission for Environmental Cooperation (unpublished)
  - Daily emissions @San Ysidro (North & Southbound)
  - Based on EMFAC2014 w/ some adjustment for Mexico fleet/fuels
- SANDAG (Border Survey 2017, Final Report TBD)
  - Surveys over select days in Aug-Dec 2016 @all crossings
  - Published activity data only thus far
- FHWA Analysis Template (2012)
  - Define MOVES operating mode distributions at border

MOVES Mexico



- MOVES2014a adapted to Mexico by ERG (USAID 2016)
- Same software,"swap out" U.S database w/ Mexico database
- Mexico-specific vehicle fleet, activity, fuels, I/M, meteorology
- Emissions from RSD & mapping of Mexico standards vs. U.S.
- O_3 model-to-monitor comparison improved (Guevara et. al 2017)
- Applications:
  - National onroad emission inventory & trends (USAID, EPA, INECC)
  - Policy evaluation (ICCT, Jalisco state gov)
  - Refined Mexico City onroad inventory (SEDEMA)

Approach

- MOVES project scale
  - U.S. MOVES for U.S. vehicles &trucks
  - MOVES-Mexico for Mexico vehicles (taxis removed)
- 12 project scenarios (6 crossings x U.S. &Mexico fleet)
  - Annual inputs built up from hourly volumes &wait times
  - Accounts for 3 separate fuel seasons
- Multiple links per scenario
  - General, Ready, SENTRI grouped as individual links
  - Separate links: Waiting (stop-and-go), exit acceleration
  - Northbound / southbound
  - Off-network (primary &secondary inspections)
- Off-model analysis for evaporative running loss
  - MOVES g/hr rates x time operating at crossing

Required Data & Sources

	San Ysidro	Otay Mesa	Tecate	Calexico West	Calexico East	Andrade
Total Volume	U.S. CBP 2014 Northbound Volumes (Southbound assumed the same)					
Lane Split	CEC	SANDAG 2017		Imperial County 2015	→	
Vehicle Class Split	←			Imperial County 2015	→	
U.S. / Mexico Split	CEC	→		Imperial County 2015	→	
Age Distribution	CEC	→ SANDAG 2017		Imperial County 2015	→	
Wait Time	Provided by CBP via FOIA Request Added truck inspection time at commercial POEs based on SANDAG2017					
Drive Pattern	FHWA Border Analysis Template "Stop-And-Go" MOVES Operating Mode Distribution					
Fuels	MOVES2014a & MOVES-Mexico Default – Accounting for 3 Seasons					
Meteorology	Tijuana Annual Avg			Mexicali Annual Avg		

2014 Northbound Vehicle Crossings

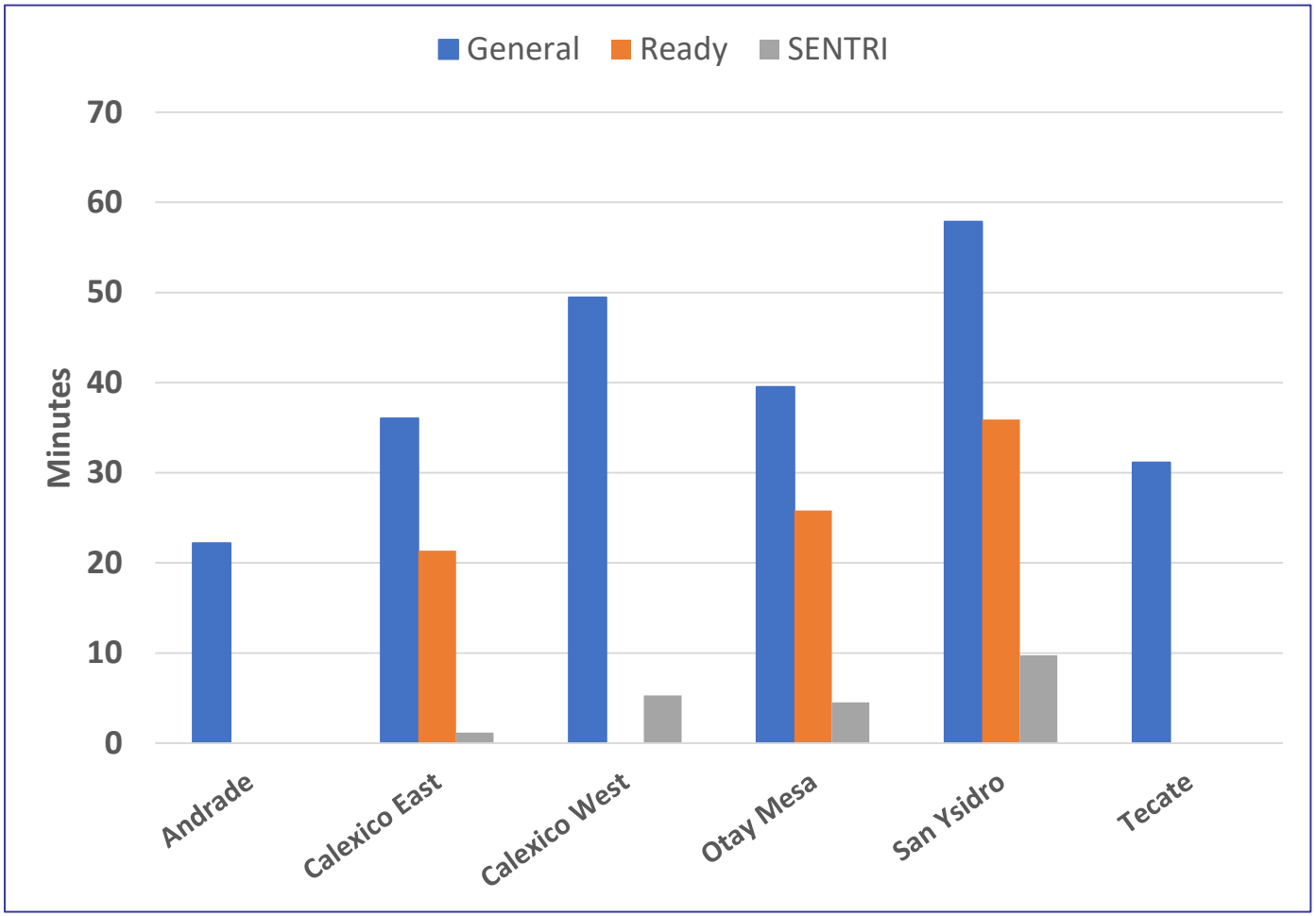
Source: CBP via Bureau of Transportation Statistics

Crossing	Personal Vehicles	Trucks	Buses
Andrade	453,079	0	0
Calexico East	3,399,697	325,243	2,785
Calexico West	4,071,666	0	0
Otay Mesa	6,910,219	810,193	41,222
San Ysidro	11,946,060	0	57,171
Tecate	812,540	52,239	237
Total	**27,593,261**	**1,187,675**	**101,415**

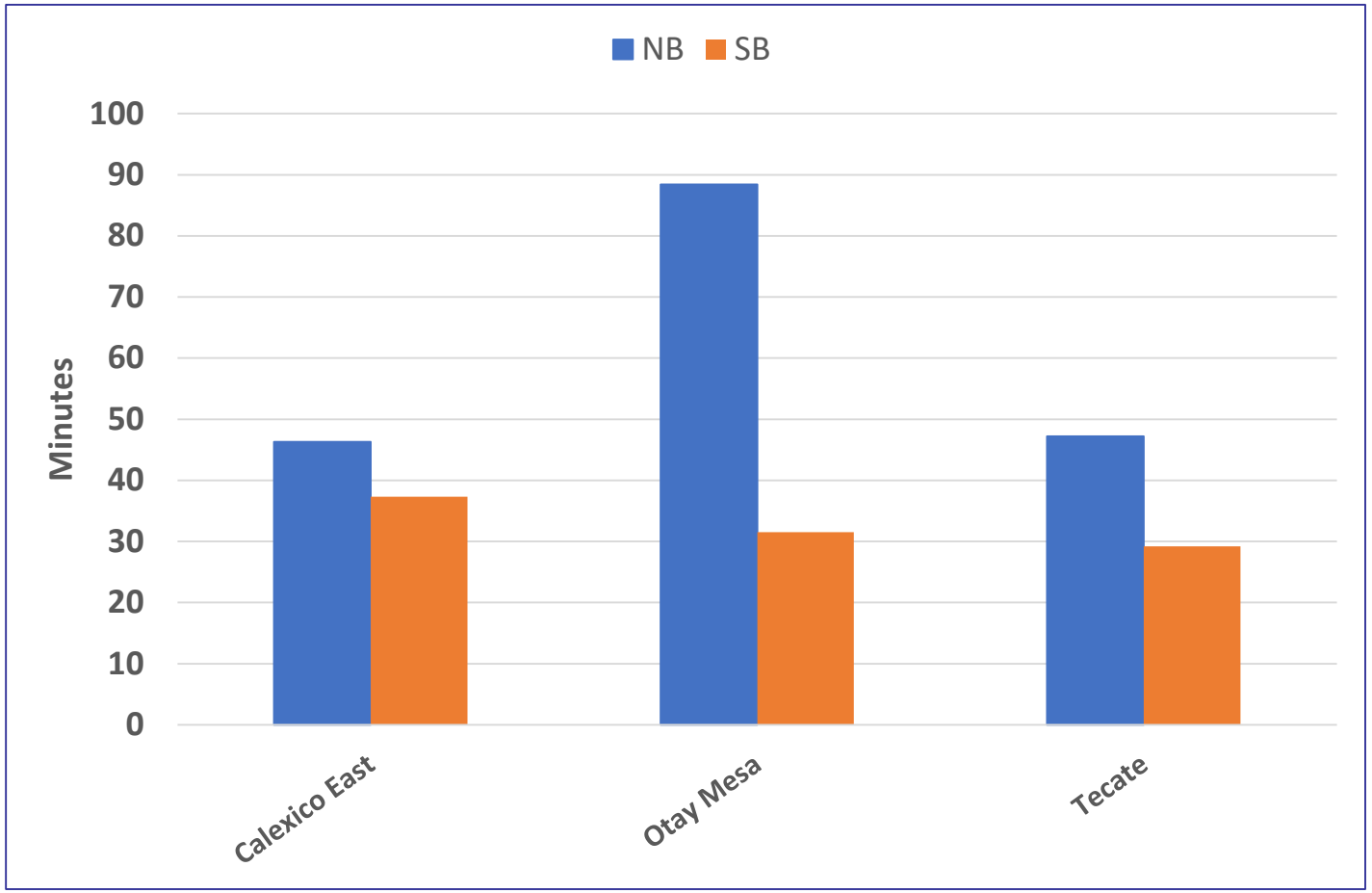
ERG

2014 Avg NB Passenger Vehicle Wait

Source: U.S. CBP

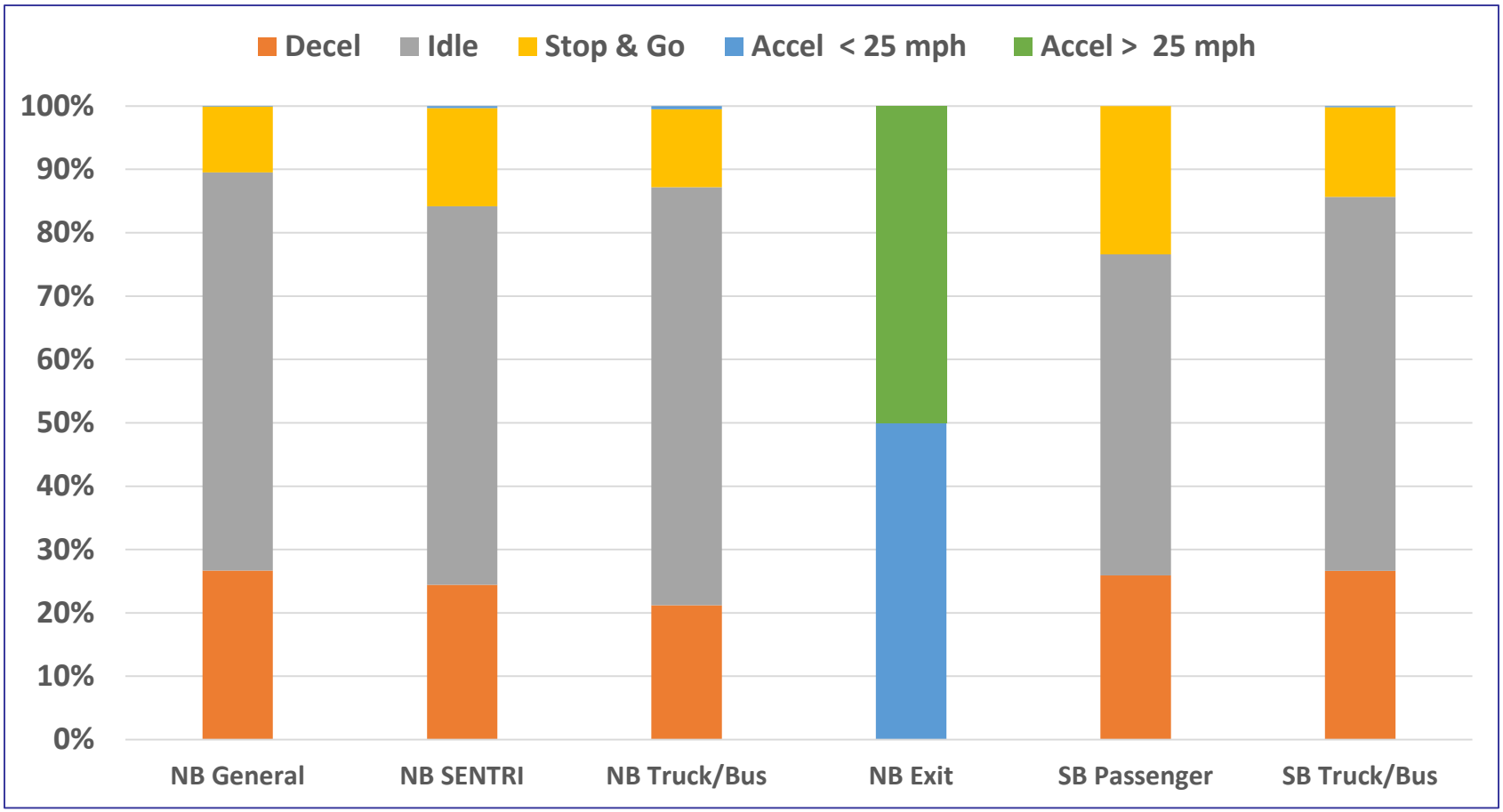


Estimated Commercial Vehicle Crossing Times



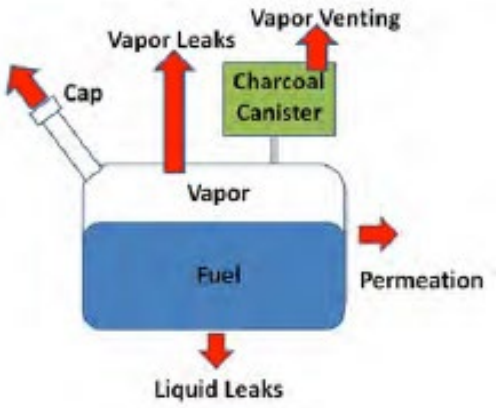
Operating Mode Distributions

Source: FHWA 2012

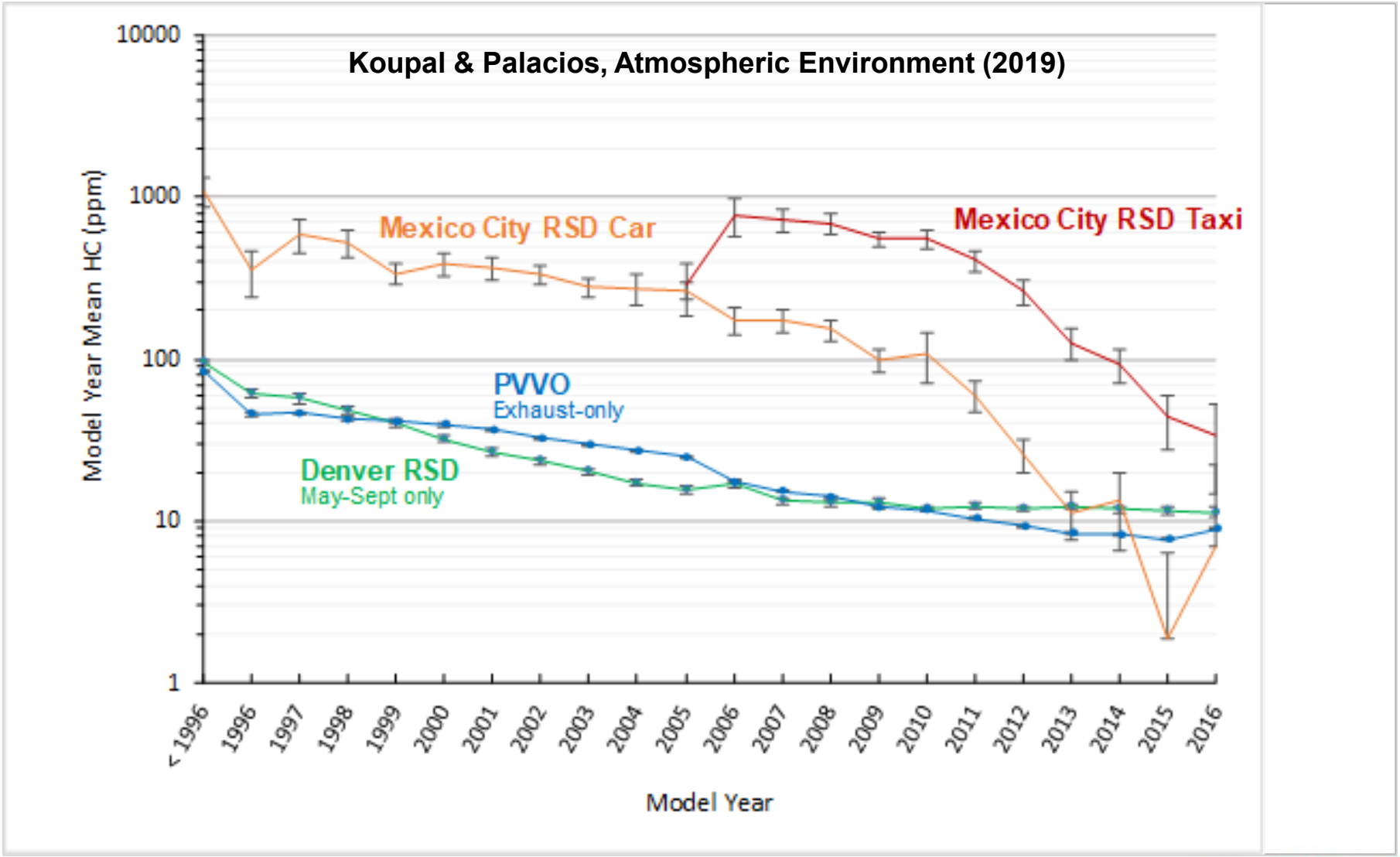


Evaporative Emissions

- "Running loss" evap VOC emitted from gasoline vehicles when operating
  - MOVES mechanisms: permeation, vapor, liquid leaks
- Driven by fuel temperature → elevated during long idle/stop &go periods
- Not included in MOVES project scale
- Estimated for Baja inventory with off-model approach



- Analysis of Mexico City RSD suggests high evaporative emissions
- Euro IV standards ~ U.S. Pre-Enhanced from early 1990s



Running Loss (RL) Emission Factor

2014 RL VOC Emission Factors at Border Crossing

(grams of VOC per vehicle-hour operating)

MOVES Source Type	Mexican Vehicles		U.S. Vehicles	
	Gas Only	All Vehicles	Gas Only	All Vehicles
Passenger Car	9.85	9.85	1.62	1.61
Passenger Truck	9.85	9.80	1.70	1.67
Light Commercial Truck	9.85	9.80	1.70	1.59
Single Unit Long-Haul	9.71	3.63	5.29	0.26
Combination Long-Haul	-	0.0	-	0.0

Aggregated RL Emission Factors (apply to total vehicle -hours)

(grams of VOC per vehicle-hour operating)

Border Crossing Vehicle	Mexican Fleet	U.S. Fleet
Passenger Vehicle	9.82	1.64
Commercial Vehicle	1.10	0.13

Evap Inventory Calculation

- Emission factors applied to total vehicle-hours
- Total vehicle-hours = "link volume" derived for MOVES exhaust runs (vehicle count x wait times)

$$EI_{C,V,L,F} = EF_{V,F} \times Link\ Volume_{C,V,L,F}$$

Where:

EI = Running Loss VOC emission inventory (grams per year)
EF = Running Loss VOC emission factor (grams / veh-hour)
C = Border Crossing
V = Vehicle class (passenger or commercial)
L= Lane type (e.g. NB general/ready/SENTRI, SB)
F = Fleet (Mexican or U.S.)

Results– Annual Short Tons

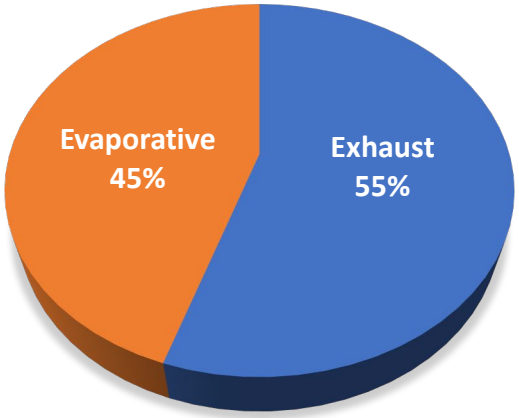
	NO_x	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Andrade	1.9	0.1	1.8	14.8	0.3	0.1	0.1
Calexico East	75.6	0.7	23.1	151.4	11.1	5.0	0.9
Calexico West	24.2	1.1	26.3	200.8	4.3	0.8	1.2
Otay Mesa	227.1	1.9	66.5	357.5	36.9	17.1	2.6
San Ysidro	47.0	3.2	78.7	516.9	14.2	2.8	3.7
Tecate	10.9	0.2	5.5	32.4	2.0	0.8	0.2
Total	**384.8**	**7.0**	**201.9**	**1,273.8**	**68.8**	**26.6**	**8.7**

- 1-3% of Baja California Mobile Source Inventory

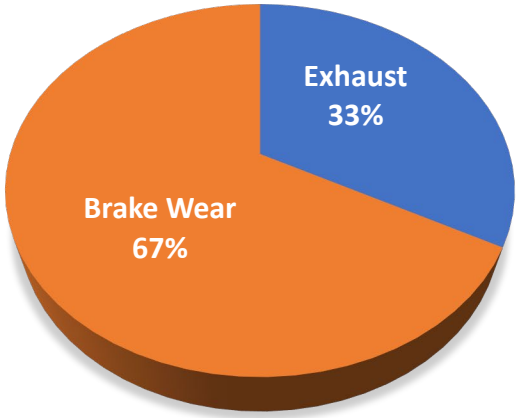
ERG

Process Breakdowns

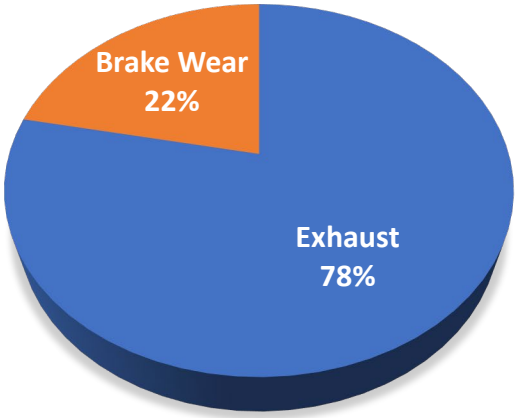
VOC Emissions



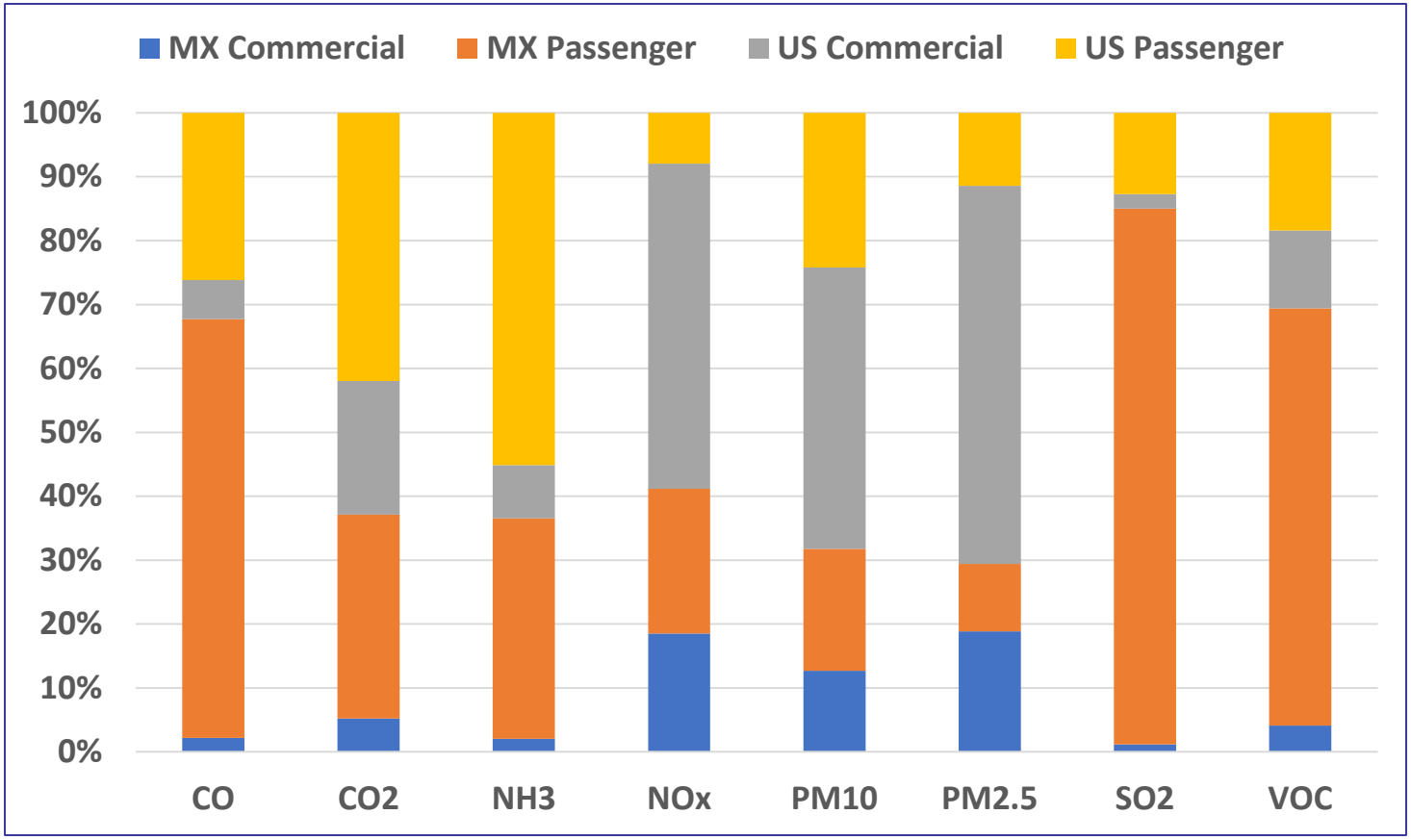
PM_{10} Emissions



$PM_{2.5}$ Emissions



Vehicle Fleet Breakdowns



Summary

- 2014 emissions estimated for 6 CA border crossings
- Applied MOVES2014a & MOVES-Mexico project scale
  - Input data compiled from prior studies & newly acquired data on wait times from U.S. CBP
  - New off-model analysis for evaporative running loss
- Total emissions ~ 1-3% of Baja California mobile source inventory
  - Non-exhaust emissions significant for VOC, PM
  - Commercial trucks contribute majority of PM & NOx
  - Mexico passenger vehicles contribute majority of VOC & SO_2