

MEMORANDUM

March 15, 2010

To: MOVES Task Force
From: Jinchul (JC) Park, MWCOG/DTP
Subject: MOVES2010 Testing: Draft Results with Default Data

I. Introduction

COG/TPB staff tested the MOVES2010 model, released in December 2009, with national default data and compared the results against Mobile 6 and MOVES 2009 results. This memo documents: (1) the MOVES2010 modeling process; (2) 2005 and 2030 daily and annual emissions (using the District of Columbia data as illustration) to those of Mobile 6 and MOVES2009 models when national default data are applied to both MOVES models; and (3) MOVES2010 and Mobile 6 emissions summarized for each non-attainment area.

II. MOVES2010 Tests and Comparisons

1. MOVES2010 Modeling Process

The MOVES2010 model carries new features such as 'Placeholder' Fuel Type and crankcase-related processes, in comparison to MOVES2009, as shown in Table 1. COG's initial MOVES2010 tests included these new elements with national default data, and the test results were compared to model results from Mobile 6 and MOVES2009. Initial comparisons showed unreasonable increases in comparison to MOVES2009 emissions results.

While 'crankcase emissions' are a new separate category, COG staff learned through sensitivity analyses that 'Placeholder' Fuel Type, a new fuel type capability added to MOVES2010, caused several pollutants to significantly increase. We closely replicated MOVES 2009 daily VOC and NOx after removing the placeholder fuel type, as shown in Table 2.

Documentation of the model runs includes a flowchart and a run specification each for daily ozone and annual pollutants testings to keep track of model inputs and outputs. An example of a flowchart is attached in Figure 1.

2. MOVES2010 Tests with Default Data – DC as illustrative jurisdiction

Figures 2 and 3 illustrate the data from Table 2. The charts show greater emissions with the MOVES models compared to Mobile 6. However, MOVES2010 shows slightly lower VOC and

slightly higher NO_x emissions in comparison to MOVES2009. It is also worth noting that daily VOC emissions in the MOVES2010 model calculated more 'Start' and 'Vehicle Related' emissions than the Mobile 6 model, however, 'Running' emissions are reduced somewhat. Both MOVES models calculate much more 'Start' and 'Running' NO_x than the Mobile 6 numbers.

Calculations of 2005 annual pollutants in DC are shown in Figures 4 through 6. All annual pollutants are greater in MOVES2010 in comparison to Mobile 6 and MOVES2009.

3. Mobile 6 Vs. MOVES2010 with Default Data – Non-attainment Area Summaries

Following test model runs for sample jurisdictions, staff ran MOVES in batch mode to produce summaries at the non-attainment area level of aggregation. Figures 7 through 11 compare the MOVES' regional emissions to Mobile 6's by daily and annual pollutants for 2005 and 2030. The 2005 MOVES' results are higher than Mobile 6's for all pollutants: annual PM_{2.5} in MOVES shows the biggest difference in comparison to those of Mobile 6, which is followed by daily NO_x. However, all the emissions totals in MOVES2010 are significantly reduced in 2030 (except for annual CO₂ emissions) in comparison to those of Mobile 6.

III. Summary Conclusions

Staff reiterate that MOVES model inputs must be carefully specified, otherwise, mis-specifying could result in incorrect emissions results. Formal documentation and a modeling routine are required to ensure correct model execution and consistent model results for each MOVES run.

The MOVES model runs generally indicate much higher emissions than results obtained with Mobile 6. However, these test runs also show greater reductions through time for VOC, NO_x and PM_{2.5} emissions.

Attachments:
Tables 1-2
Figures 1 – 11

Table 1. Comparison of MOVES Model Specification: MOVES 2009 Vs. 2010

Section	Category	DRAFTMOVES2009	MOVES2010
Scale	Domain	National	National
	Scale	Inventory	Inventory
Time spans	Time Aggregation Level	Hour	Hour
	Years	2005	2005
	Months	July	July
	Days	Weekdays	Weekdays
Geographic Bounds	Hours	Select All	Select All
	Selections	DC	DC
Vehicles/Equipment	Fuels	CNG, Diesel, Electricity, Ethanol, Gasoline, LPG	CNG, Diesel, Electricity, Gasoline, Placeholder Fuel Type
	Source Use Types	Combination Long-haul Truck, Combination short-haul Truck, Intercity Bus, Light Commercial Truck, Motor Home, Motorcycle, Passenger Car, Passenger Truck, Refuse Truck, School Bus, Single Unit Long-haul Truck, Single Unit Short-haul Truck, Transit Bus, Off-Network, Rural Restricted Access, Urban Restricted Access, Urban Unrestricted Access	Combination Long-haul Truck, Combination short-haul Truck, Intercity Bus, Light Commercial Truck, Motor Home, Motorcycle, Passenger Car, Passenger Truck, Refuse Truck, School Bus, Single Unit Long-haul Truck, Single Unit Short-haul Truck, Transit Bus, Off-Network, Rural Restricted Access, Rural Unrestricted Access, Urban Restricted Access, Urban Unrestricted Access
Pollutant & Process	Road Type	Total Gaseous Hydrocarbons, Non-Methane Hydrocarbons, Non-Methane Organic Gases, VOC, Nox, Total Energy Consumption, Methane	Total Gaseous Hydrocarbons, Non-Methane Hydrocarbons, Non-Methane Organic Gases, VOC, Nox, Total Energy Consumption, Methane
	Pollutant	all 14 Processes	all 14 Processes (Crankcase Start, Crankcase Running, Crankcase Extended Idle, Extended Idle are included, Well-to-Pump are eliminated by pollutant)
Output - General Output	Process	checked	Shown in another category
	Distance Traveled		
	Database		
	Mass Units	U.S. Ton	U.S. Ton
	Energy Units	Joules	Joules
Output - Emission	Distance Units	Miles	Miles
	Activity	Not Available	Distance Traveled
Output - Emission for All Vehicle/Equipment Categories	Always: Analysis Time Frame	24-Hour Day, County, Pollutant	24-Hour Day, County, Pollutant
	On Road/Off Road	Emission Process On Road/Off Road	Emission Process On Road/Off Road

* Note: Red-colored items in DRAFTMOVES 2009 are not available in MOVES2010, vice versa.

Table 2. 2005 DC VOC and NOx Emissions Comparison: Mobile 6 Vs. MOVES2009 Vs. 2010 MOVES w/ No Placeholder Fuel Type													
Model	Mobile6			MOVES2009			MOVES2010 No Placeholder Fuel			Difference MOVES 2009 Vs. MOVES 2010 w/ No Placeholder Fuel			
	from 2009 CLRP			VOC	NOx		VOC	NOx		Absolute		Percent	
Pollutant													
Start	2.22	1.17		3.15	3.69		3.15	3.55		0.00	-0.15	0.1%	-4.0%
Running	5.04	15.10		4.15	24.45		4.08	25.92		-0.07	1.47	-1.7%	6.0%
Vehicle Related*	1.09	0.00		4.85	0.00		4.12	0.00		-0.73	0.00	-15.1%	NA
School Bus, Transit, and Auto Access	0.16	1.64		0.00	0.00		0.00	0.00		0.00	0.00	NA	NA
Total	8.51	17.91		12.16	28.14		11.36	29.46		-0.80	1.32	0.3%	4.7%
VMT (Distance in MOVES)					12,022,940			12,260,030			237,090		2.0%
Note:													
<ul style="list-style-type: none"> *MOVES2010 No Placeholder Fuel' is a sensitivity test without No Placeholder Fuel Type 													
<ul style="list-style-type: none"> **Vehicle Related includes 'refuelling spillage loss,' 'refueling displacement vapor,' 'evap fuel leaks,' 'evap vapor venting' and 'evap permeation' for VOC 													
<ul style="list-style-type: none"> Vehicle Related for Nox includes 'extended idle exhaust,' and 'crankcase extended idle exhaust.' 													
<ul style="list-style-type: none"> Vehicle Related for the Mobile 6 VOC includes 'diurnal' and 'RESTGL.' 													

Figure 1. A Flowchart for MOVES2010 Test with Default Data

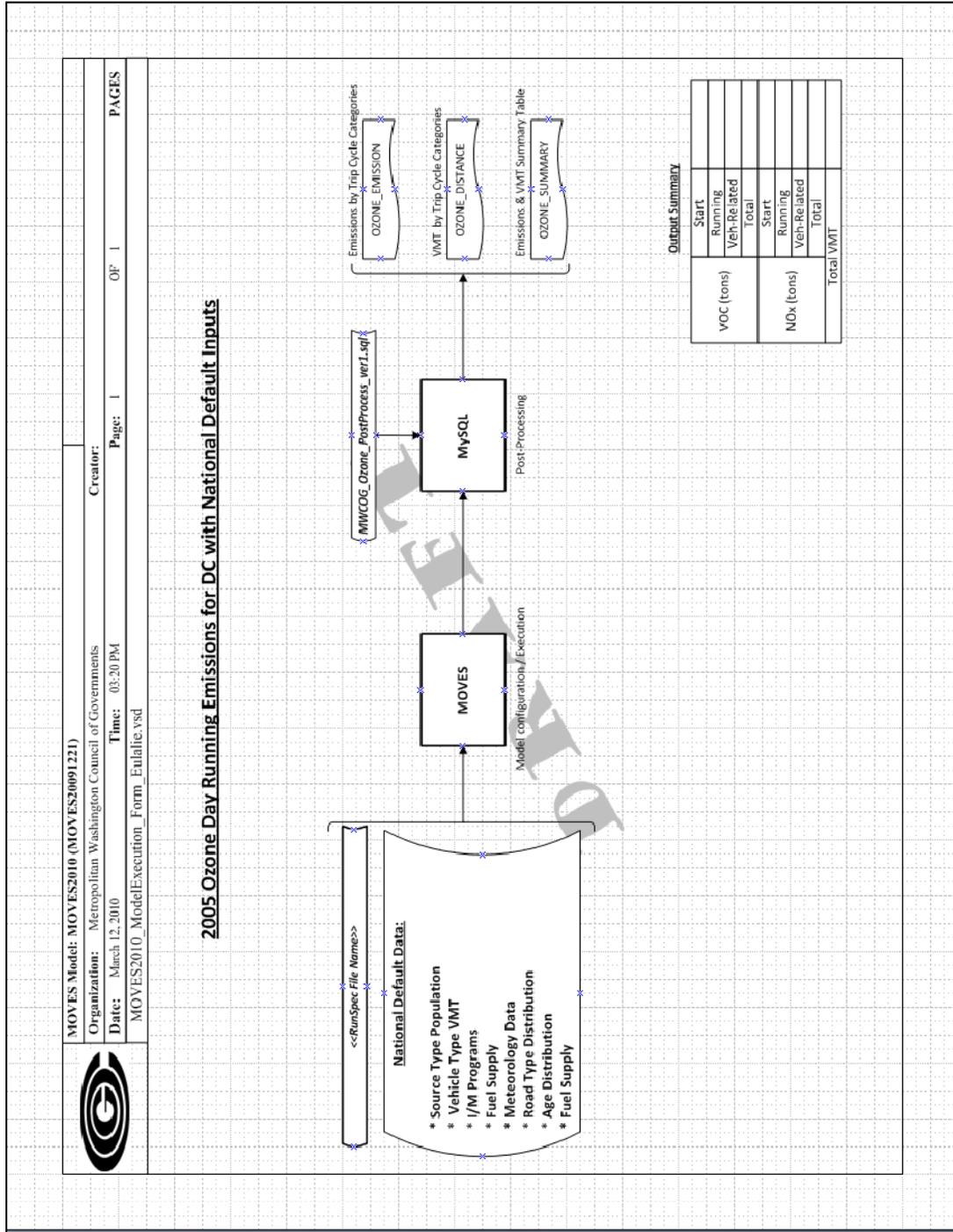


Figure 2. 2005 DC Daily VOC Emissions



Figure 3. 2005 DC Daily NOx Emissions

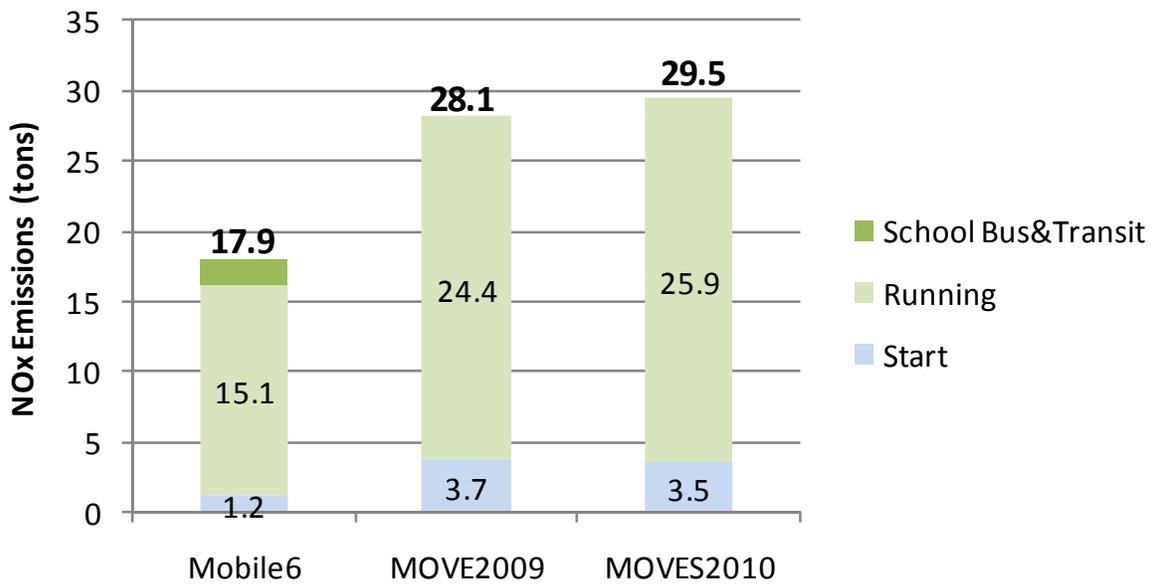


Figure 4. 2005 DC Annual PM2.5 Emissions

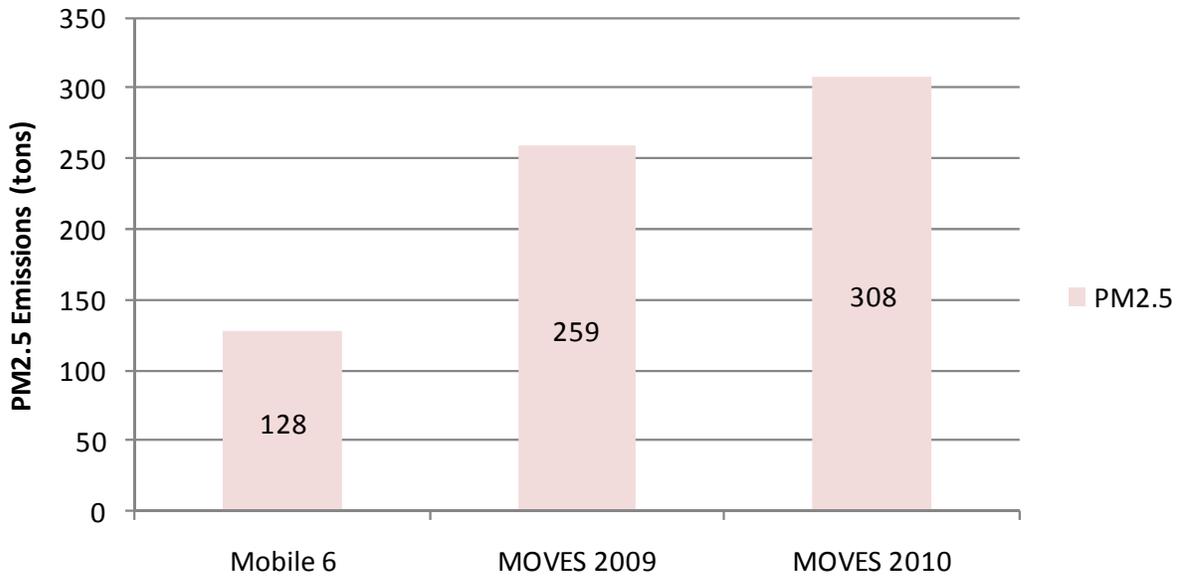


Figure 5. 2005 DC Annual NOx Emissions



Figure 6. 2005 DC Annual CO2 Emissions

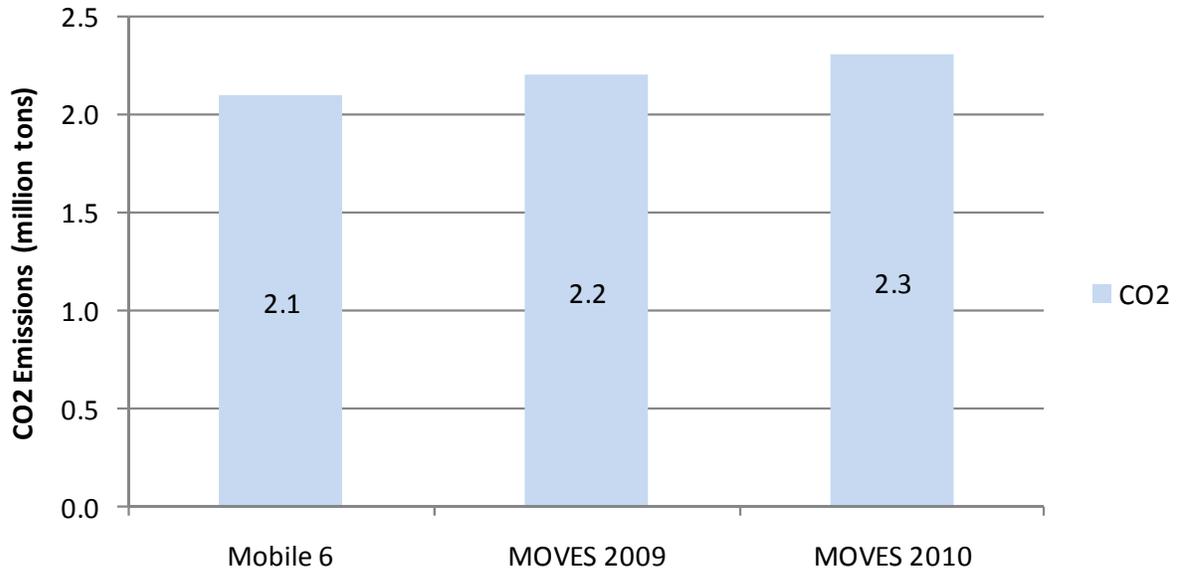


Figure 7. Regional Ozone Day VOC Emissions

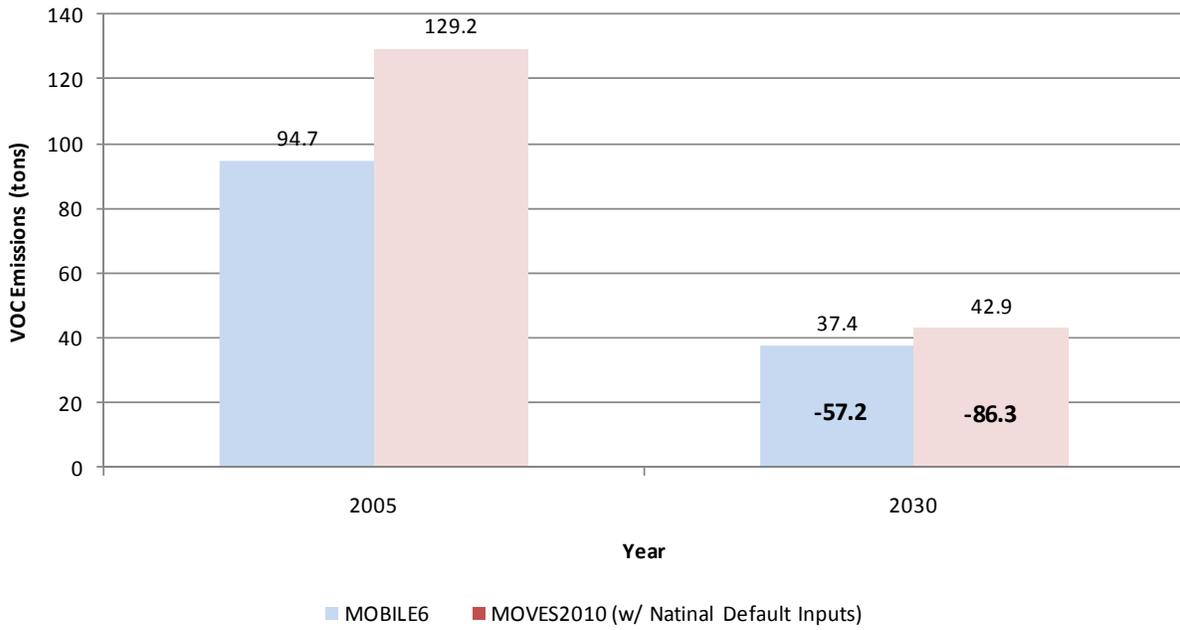


Figure 8. Regional Ozone Day NOx Emissions

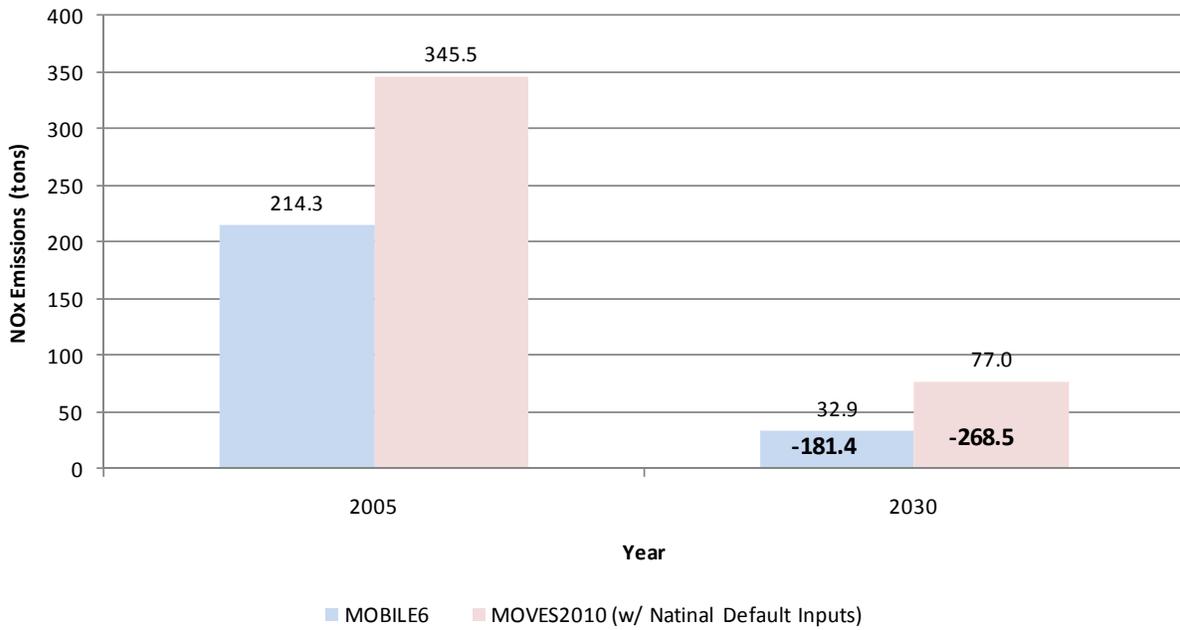


Figure 9. Regional Annual PM2.5 Emissions

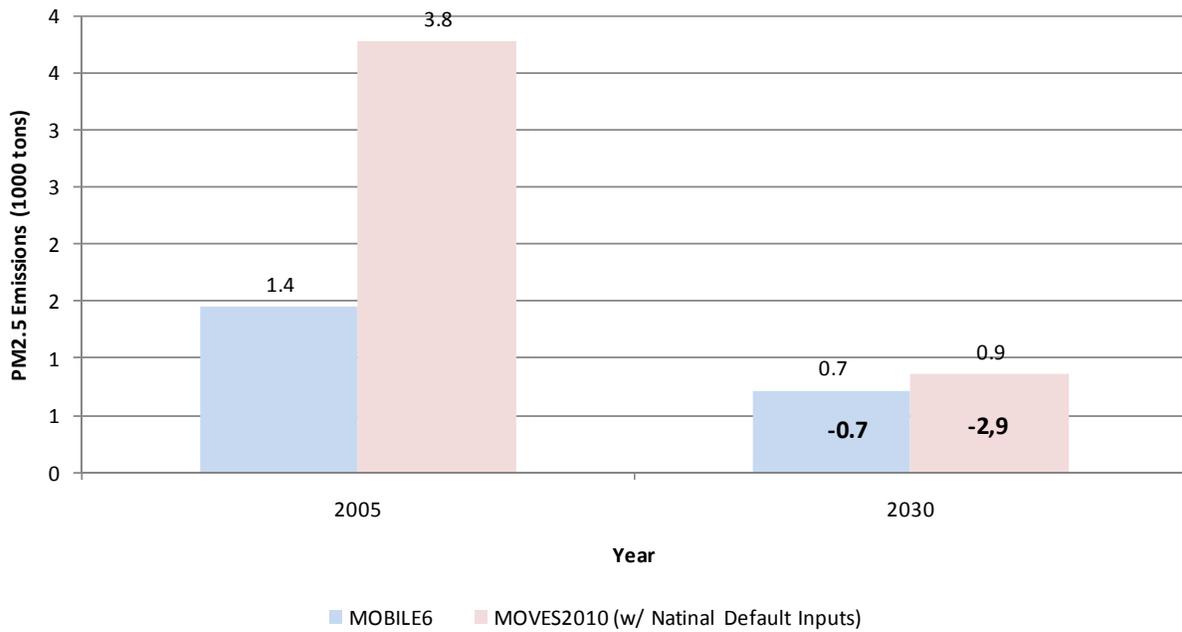
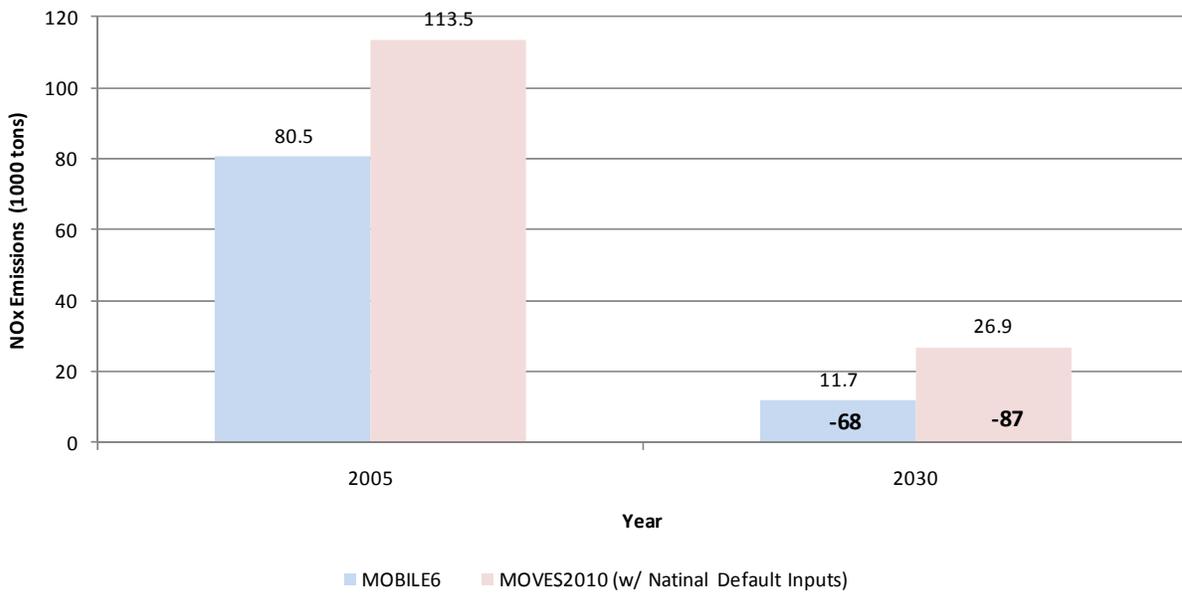
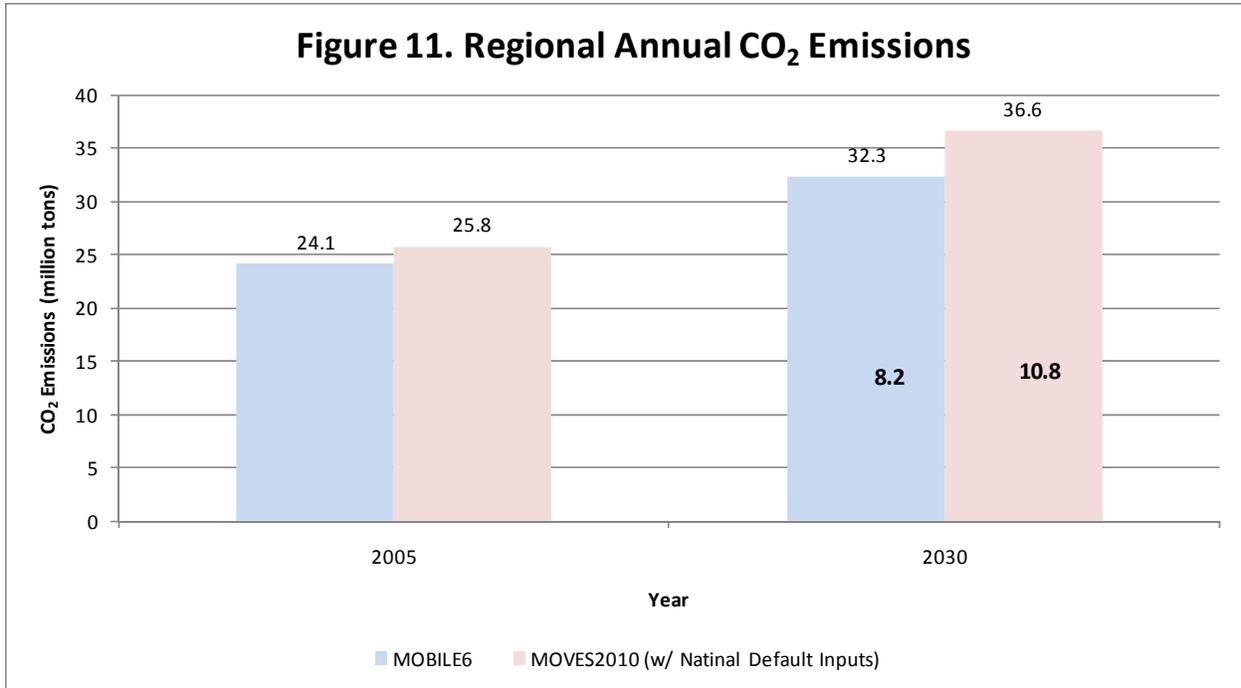


Figure 10. Regional Annual NOx Emissions





Notes: The following assumptions are assumed in Figure 7 to Figure 11:

- 2005 MOBILE6 annual CO₂ emissions are from 2009 CLRP & FY2010-2015 TIP Conformity Analysis.
- 2005 MOBILE6 annual NO_x & PM_{2.5} emissions are from backtracking process with 2009 CLRP 2002, and 2010.
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