

# Briefing on EMFAC-HK Update

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# Background

- \* EPD has adapted the vehicle emission model, EMFAC, developed by California Air Resources Board (CARB) for use in Hong Kong since 2005.
- \* EMFAC-HK calculates emission rates<sup>#</sup> from all on-road vehicles.
- \* For territory-wide emission inventories, emission factors in EMFAC-HK are multiplied by territory-wide vehicle activity data.
- \* For other vehicle emission assessment like EIA, EMFAC-HK provides fleet average emission factors and the consultants will provide case specific activity data
- \* We have promulgated updates every January, if needed, since 2013
- \* EMFAC-HK Webpage:  
[https://www.epd.gov.hk/epd/english/environmentinhk/air/guide\\_ref/emfac-hk.html](https://www.epd.gov.hk/epd/english/environmentinhk/air/guide_ref/emfac-hk.html)

<sup>#</sup>Emission rate = Emission Factor (g/km) x Vehicle activity (km/day)

# Outline

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- \* Application of EMFAC-HK
- \* Timeline of updates of Vehicle Emission Model
- \* Changes made in EMFAC-HK update (V4.1)
- \* Comparison of emissions and fleet average emission factors (FAEF)
- \* Transitional Arrangement
- \* Meeting Air Quality Objectives

# Application of EMFAC-HK

- \* EMFAC-HK is a tool for estimating vehicle emissions with default vehicle emission factors and assumptions#. As the emission factors and assumptions may change over time due to new data collected, some default data may become outdated. Also due to changes in policy, we will issue new version of EMFAC-HK in early part of the year when necessary.
- \* When using EMFAC-HK, users can apply other appropriate assumptions in estimating vehicle emissions to suit their projects/purpose.
- \* The users should judge whether the default values of EMFAC-HK are applicable to their case and how robust their assessments are.

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# Timeline of updates of Vehicle Emission Model

- Updated Euro VI schedule
- Fixed a bug on NOx for CAT-replaced taxis
- Updated emission factors for Private Cars (PC) & Motorcycles (MC)
- Applied A/C correction factors to High/Super emitters...

## Planned changes:

- Incorporate appropriate changes from CARB's EMFAC
- Further updates due to Policy changes or other changes
- ...

EMFAC-HK  
V3.4  
Released:  
Early 2018

EMFAC-HK  
V4.1  
To be  
Released:  
Jan 2019

EMFAC-HK  
V?  
Released:  
Early 2020

...

- Changed compiler from Compaq FORTRAN to Intel FORTRAN
  - Changed some parts of GUI%
- Updated default base year to 2016
- Updated zero mile emission factors, deterioration rates, regime growth rates, speed correction factors
- Added start emissions for diesel SCR## vehicles
- Policy Implementation:
  - Euro 4 motorcycles and Euro VI light buses/buses
  - Phasing out Euro IV DCV\*

% GUI – graphical user interface

##SCR - Selective Catalytic Reduction device

\* DCV - diesel commercial vehicles except franchised buses

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# Changes in EMFAC-HK V4.1

## Technical Items

- A. Changed program compiler from obsolete Compaq FORTRAN to Intel FORTRAN. (No emission impact)
- B. Updated the base year from 2015 to 2016 including traffic data and vehicle population distribution (usually 2-3 years)
- C. Updated model parameters based on
  - Much more real-world vehicle emission data by using PEMS\* (PEMS data) for Euro IV to VI vehicles
    - used 242 vehicle data since V3.1 (1/2016) (120 Euro IV-VI)
    - use 320 vehicle data now (200 Euro IV-VI)
  - 2016/17 remote sensing data (used 2015 since V3.3 (1/2017))
- D. Added Start Emissions for SCR diesel vehicles to align with update of CARB's EMFAC2014 (USEPA approved its release in Dec. 2015). (Only occurs when engine is ignited)

\* PEMS - Portable Emission Measurement System

# Changes in EMFAC-HK V4.1

## Policy Changes

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- E. Tightening emission standards of newly registered motorcycles to Euro 4 in 2020 except motor tricycles
  
- F.
  - i. tightening emission standards of newly registered light buses of design weight more than 3.5t and buses of design weight 3.5 to 9t to Euro VI in 2021
  - ii. no newly registered LPG light buses from 2021 (business decision)
  
- G. Progressively phasing out Euro IV DCV by end 2023
  - depending on different deadlines for retirement, the emission projection will be different

# Comparison of Current EMFAC-HK V3.4 & EMFAC-HK update(V4.1)

## Activity Related

Current	Update
2015 vehicle population distribution from TD (updated in 1/2017)	2016 vehicle population distribution from TD
2015 VKT from TD	2016 VKT from TD
2015 survey on vehicle classification on 100 road segments from TD and EPD in-house surveys	2016 survey on vehicle classification on 100 road segments from TD and EPD in-house surveys
EPD conducted surveys in 2012-15 on vehicle classifications to supplement TD's data (from 11 p.m. to 7 a.m.) and 64 additional road segments	EPD conducted surveys in 2012-16 on vehicle classifications to supplement TD's data (from 11 p.m. to 7 a.m.) and 64 additional road segments
2015 speed limits from TD & HyD	2016 speed limits from TD & HyD
2015 speed surveys from TD	2016 speed surveys from TD
2015 ambient temperature & relative humidity from HKO	2016 ambient temperature & relative humidity from HKO

# Comparison of Current EMFAC-HK V3.4 & EMFAC-HK update (V4.1)

## Emission Factor Related

Current	Update
<p>Updated Speed Correction Factors (SCF), zero mile emission factors (ZMEF) and deterioration rates (DR).</p> <p>Real-world vehicle emission data (242 vehicles with 120 of Euro IV-VI) are used to determine these factors or as references.</p> <p>International emission factors are used using local data as reference if few data are collected in some tech groups.</p>	<p>Same approach but having more real-world vehicle emission data (320 vehicles with 200 of Euro IV-VI).</p>
<p>Estimated occurrence of normal, high and super emitters for petrol cars and LPG taxis based on 2015 remote sensing data.</p>	<p>Estimated occurrence of normal, high and super emitters for petrol cars and LPG taxis based on 2016/17 remote sensing data.</p>
<p>No start emission for diesel vehicles.</p>	<p>Added start emissions for SCR diesel vehicles, aligning with CARB's EMFAC.</p>

# Comparison of Current EMFAC-HK V3.4 & EMFAC-HK update (V4.1)

## Modelling Methodology Related

<b>Current</b>	<b>Update</b>
Population Forecast: <ul style="list-style-type: none"><li>All except franchised buses, taxis &amp; public light buses (PLB) used a smoothing function to mitigate sharp new sales in population forecast.</li></ul>	Population Forecast: <ul style="list-style-type: none"><li>Disabled the smoothing function in mitigating sharp new sales in population forecast.</li></ul>
<u>Exhaust Tech Group description:</u> No Euro 4 motorcycle (MC)	<u>Exhaust Tech Group description:</u> Added Euro 4 MC (TG278)

# Comparison of Current EMFAC-HK V3.4 & EMFAC-HK update (V4.1)

## Policy Related

Current	Update
Updated Euro VI implementation dates according to legislative amendments	Implemented - <ul style="list-style-type: none"><li>• Euro 4 MC in Jul 2020</li><li>• Euro VI light buses more than 3.5t and buses 3.5- 9t in Jan 2021</li></ul>
LPG light buses are available	Based on the information from Trade, no newly registered LPG light buses from 2021 ( <b>for assessment purpose only</b> ).
No program to phase out Euro IV DCV	Plan to progressively phase out Euro IV DCV by end 2023

# Changes in Implementation Dates of Vehicle Emission Standards

Current EMFAC-HK (V3.4)

Vehicle Class\ Fuel Type		Euro VI		
		LPG	Petrol	Diesel
Private Car		NA	1.7.17	1.10.17 <sup>#</sup>
Goods Vehicle	<= 3.5t		1.1.18	
	>3.5 t	1.10.18		
Bus	<= 9 t	NA	No schedule	
	>9 t		1.10.18	
Light Bus	<= 3.5t	1.1.18		
	>3.5 t	No schedule		
Taxi		1.7.17	NA	

EMFAC-HK update (V4.1)

Vehicle Class\ Fuel Type		Euro VI		
		LPG	Petrol	Diesel
Private Car		NA	1.7.17	1.10.17 <sup>#</sup>
Goods Vehicle	<= 3.5t		1.1.18	
	>3.5 t	1.10.18		
Bus	<= 9 t	NA	1.1.2021 (tentative)	
	>9 t		1.10.18	
Light Bus	<= 3.5t	1.1.18		
	>3.5 t	1.1.2021 (tentative)		
Taxi		1.7.17	NA	

*Changes highlighted in red.*

*Emfac-HK homepage, Appendix III*

*Notes: # HK adopted California LEV III Standards on 1 October 2017 for diesel PC.*

# Changes in Implementation Dates of Vehicle Emission Standards

Current EMFAC-HK (V3.4)

Vehicle Class\ Fuel Type	Euro IV		
	LPG	Petrol	Diesel
Motorcycle	NA	No Schedule	

EMFAC-HK update (V4.1)

Vehicle Class\ Fuel Type	Euro IV		
	LPG	Petrol	Diesel
Motorcycle	NA	1.7.2020 <i>(tentative)</i>	NA (from 1.7.2020 <i>tentative)</i>
Motor tricycle	No Schedule		

*Changes highlighted in red.*

*Emfac-HK homepage, Appendix III*

# Addition of Exhaust Tech Group

Exhaust Tech Group Added:

Vehicle Class	Vehicle Emission Standards	Technology Group Index
Motorcycle	Euro 4	278

# Comparison of Current EMFAC-HK V3.4 & EMFAC-HK update (V4.1)

## Graphical User Interface (GUI) Related

Current	Update
Main screen size is pretty long	Resized main screen for easier operation
<p>For Population, Accrual, Trip &amp; VKT editing:</p> <ul style="list-style-type: none"><li>• Direct cell-by-cell editing in 2D grid</li><li>• Multiple cells editing by copying, editing and pasting to and from external spreadsheets</li></ul>	<p>For Population, Accrual, Trip &amp; VKT editing:</p> <ul style="list-style-type: none"><li>• Disabled direct cell-by-cell editing in 2D grid</li><li>• Multiple cells editing by copying, editing and pasting to and from external spreadsheets</li></ul> <p>Note: Nothing is changed from input file point of view.</p>

# Main Screen Size Changed

Current

Update

Emfac-HK V4.0.5 -- Editing data

File Run Help

Environmental Protection Department  
The Government of the Hong Kong  
Special Administrative Region

HONG KONG

permitted by  
Air Resources Board  
California

Emfac-HK

MAIN

List of Available Scenarios

01 Hong Kong SAR Annual C'y 2031 Default Title

No file or scenario

Current Scenario Data

Number: 1 of 1  
Name: Hong Kong SAR Annual C'y 2031 Default Title  
Calendar Year: 2031  
Season: Annual  
Type: Burden

IM Program Parameters Save  
Save As...  
Add New Scenario Run  
Edit Scenario Finish Editing  
Delete Scenario Cancel

\* Denotes currently active scenario

Regime Size Change Data

Apply Regime Changes \*

Category-Fuel	% Reduction Highs	Supers	Start Year
Private Car-Petrol	0	0	2020
Taxi-LPG	0	0	2020
Public Light Bus-LPG	0	0	2020
Private Light Bus >3.5-LPG	0	0	2020
Public Light Bus-Diesel	0	0	2020
Light Goods Vehicle <=3.5-Diesel	0	0	2020
Light Goods Vehicle 3.5-5.5-Diesel	0	0	2020
Medium Goods Vehicle 6.4-15-Diesel	0	0	2020
Medium and Heavy Goods Vehicle >15-Diesel	0	0	2020
Non-Franchised Bus <=6.4-Diesel	0	0	2020
Non-Franchised Bus 6.4-15-Diesel	0	0	2020
Non-Franchised Bus >15-Diesel	0	0	2020
Motorcycle-Petrol	0	0	2020

\* The Model has taken into account the existing I/M Programs for PC-Petrol, Taxi-LPG, PLB-LPG and PrLB-LPB

Relocated button positions in first screen which is also resized.

Emfac-HK V4.0.5 -- Editing data

File Run Help

Environmental Protection Department  
The Government of the Hong Kong  
Special Administrative Region

HONG KONG

permitted by  
Air Resources Board,  
California

Emfac-HK

MAIN

List of Available Scenarios

No file or scenario

Current Scenario Data

Number: 0 of 0  
Name:  
Calendar Year:  
Season:  
Type:

IM Program Parameters Save  
Save As...  
Add New Scenario Run  
Edit Scenario Finish Editing  
Delete Scenario Cancel

Apply Regime Changes \*

Category-Fuel	% Reduction Highs	Supers	Start Year	Category-Fuel	% Reduction Highs	Supers	Start Year
Private Car-Petrol	0	0	2020	Medium Goods Vehicle 6.4-15-Diesel	0	0	2020
Taxi-LPG	0	0	2020	Medium and Heavy Goods Vehicle >15-Diesel	0	0	2020
Public Light Bus-LPG	0	0	2020	Non-Franchised Bus <=6.4-Diesel	0	0	2020
Private Light Bus >3.5-LPG	0	0	2020	Non-Franchised Bus 6.4-15-Diesel	0	0	2020
Public Light Bus-Diesel	0	0	2020	Non-Franchised Bus >15-Diesel	0	0	2020
Light Goods Vehicle <=3.5-Diesel	0	0	2020	Motorcycle-Petrol	0	0	2020
Light Goods Vehicle 3.5-5.5-Diesel	0	0	2020				
Medium Goods Vehicle 6.4-15-Diesel	0	0	2020				
Medium and Heavy Goods Vehicle >15-Diesel	0	0	2020				
Non-Franchised Bus <=6.4-Diesel	0	0	2020				
Non-Franchised Bus 6.4-15-Diesel	0	0	2020				
Non-Franchised Bus >15-Diesel	0	0	2020				
Motorcycle-Petrol	0	0	2020				

\* The Model has taken into account the existing I/M Programs for PC-Petrol, Taxi-LPG, PLB-LPG and PrLB-LPB

# 2D Grid Editor Changed

Current

Update

Editing Cal Pop data for scenario 1: Hong Kong SAR Annual CYr 2009 Default Title

Total Cal Pop for area

Editing Mode

Vehicle Class				
	1	2	3	4
1	27942.0	0.0	0.0	48.0
2	33898.0	0.0	0.0	59.0
3	32415.0	0.0	0.0	186.0
4	26875.0	0.0	1.0	195.0
5	26068.0	0.0	2.0	69.0
6	26192.0	0.0	0.0	77.0
7	21526.0	0.0	5.0	55.0
8	28004.0	0.0	15.0	67.0
9	30617.0	0.0	8.0	175.0
10	28774.0	0.0	8.0	271.0
11	23332.0	0.0	3.0	75.0
12	24053.0	0.0	0.0	35.0
13	26712.0	0.0	2.0	6.0
14	11063.0	0.0	8.0	3.0
15	8084.0	0.0	41.0	4.0
16	8137.0	0.0	12.0	8.0
17	4481.0	0.0	23.0	5.0
18	2508.0	0.0	8.0	2.0
19	1144.0	0.0	11.0	2.0
20	661.0	0.0	11.0	2.0
21	466.0	0.0	14.0	0.0

Fuel Type

Editing Cal Pop data for scenario 1: Hong Kong SAR Annual CYr 2031 Default Title

Total Cal Pop for area

Editing Mode

**Grid Control Removed/Deactivated (Replaced with 5-step process).**

-> 1. Press "Copy with Headings" button to copy data to clipboard.  
-> 2. Open spreadsheet and paste clipboard contents to spreadsheet for viewing/editing.  
-> 3. Perform edits.  
-> 4. Highlight Data Only portion in spreadsheet and copy to clipboard.  
-> 5. Press "Paste Data Only" to paste edits back into program.

Fuel Type

- Cell-by-cell online editing disabled
- Multiple cells editing remains similarly (i.e. copy out, edit and paste it back).

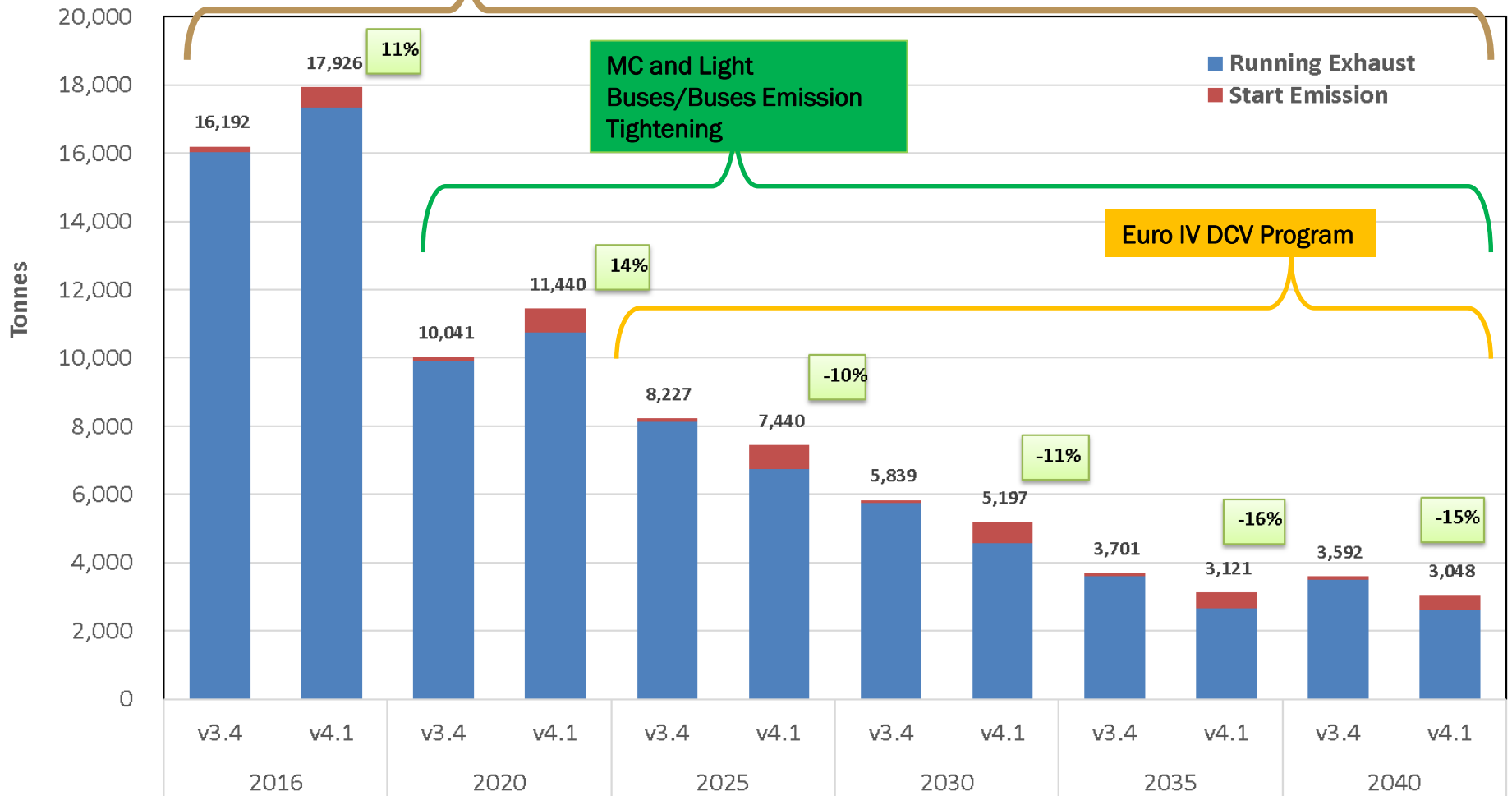
# Outline

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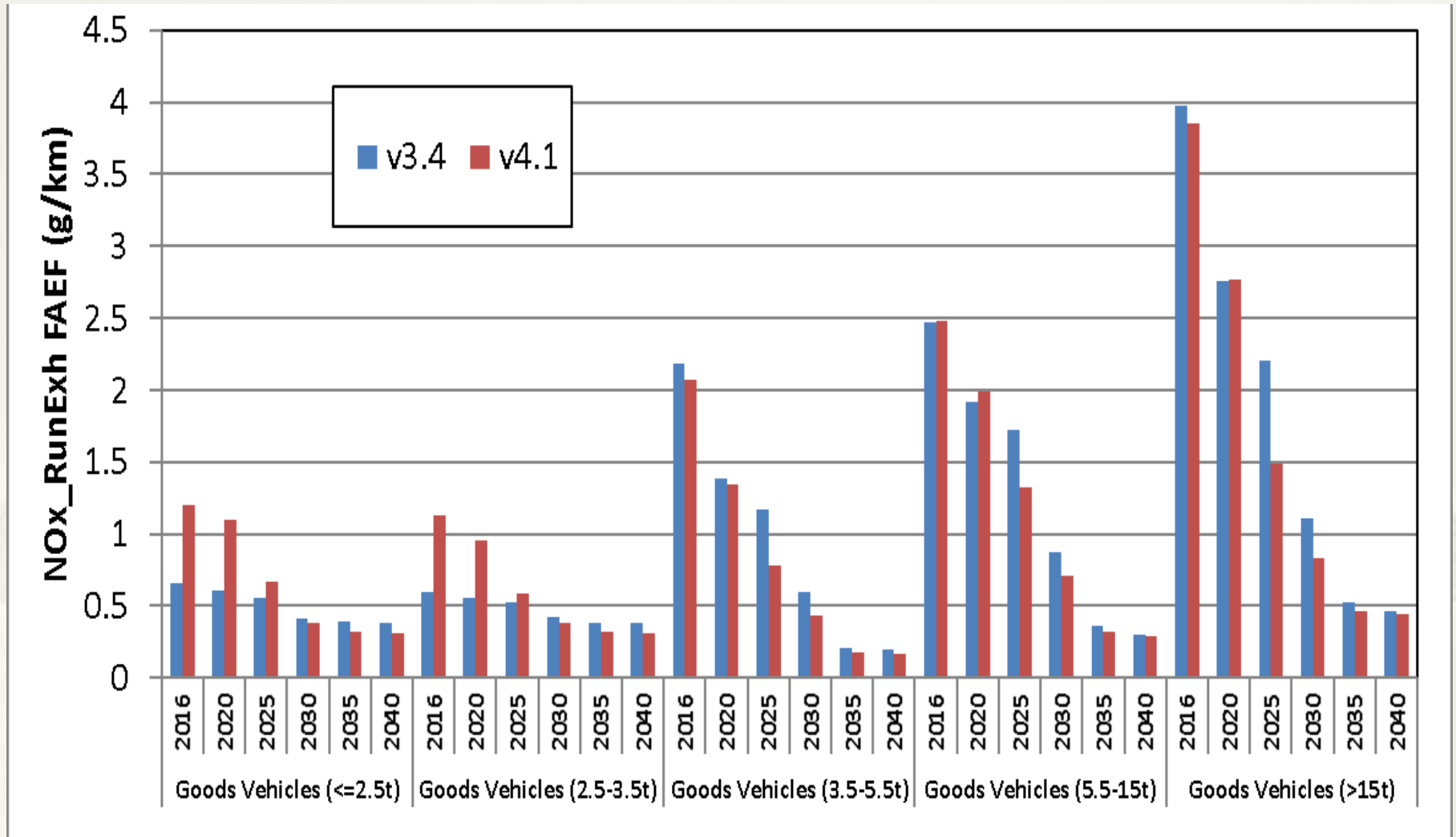
- \* Application of EMFAC-HK
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# Comparison of Territory-wide NOx Emissions in Current (V3.4) and EMFAC-HK update (V4.1)

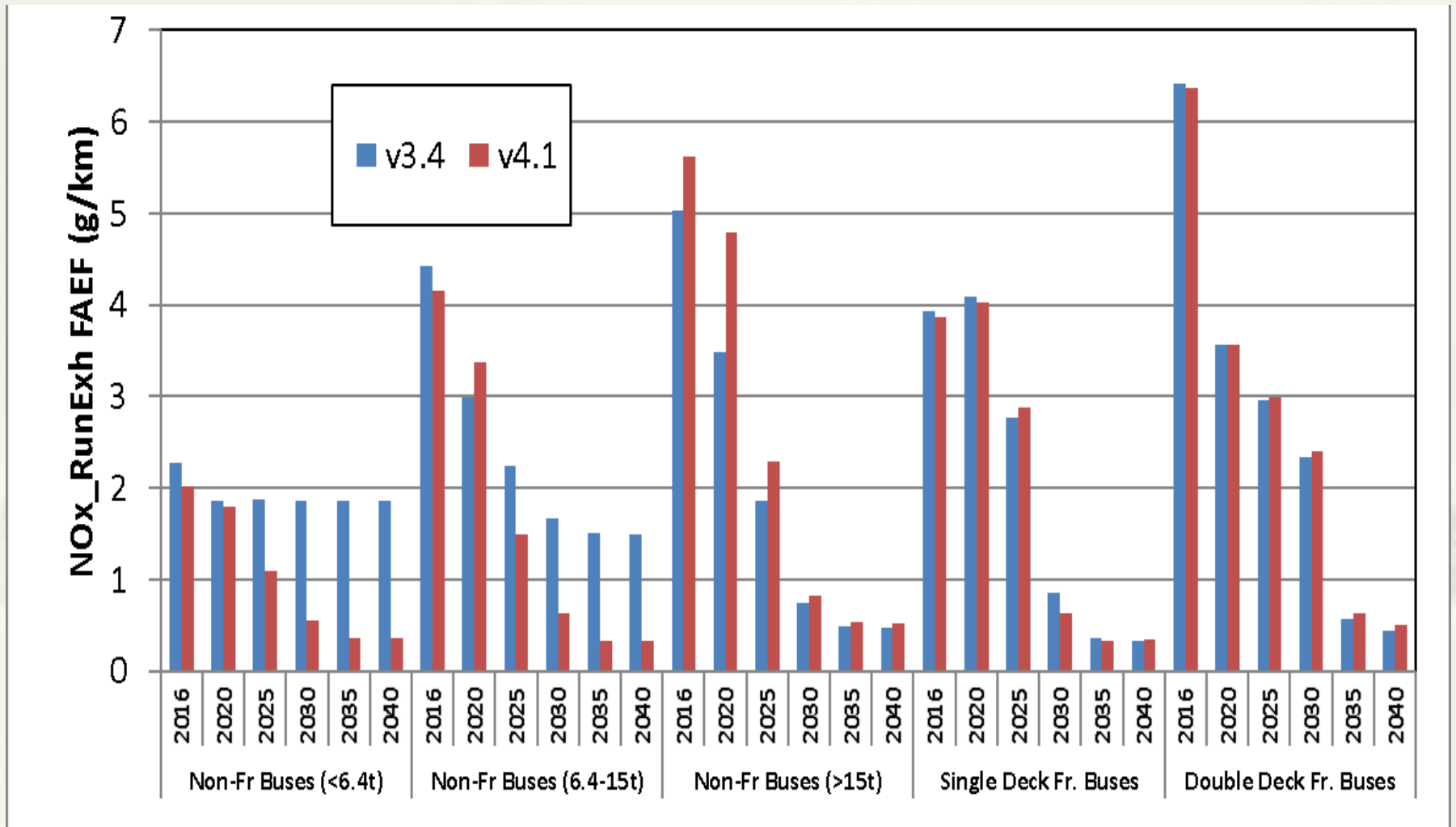
- Default Base Year Change
- Model Parameters Change
- SCR Start emission Addition



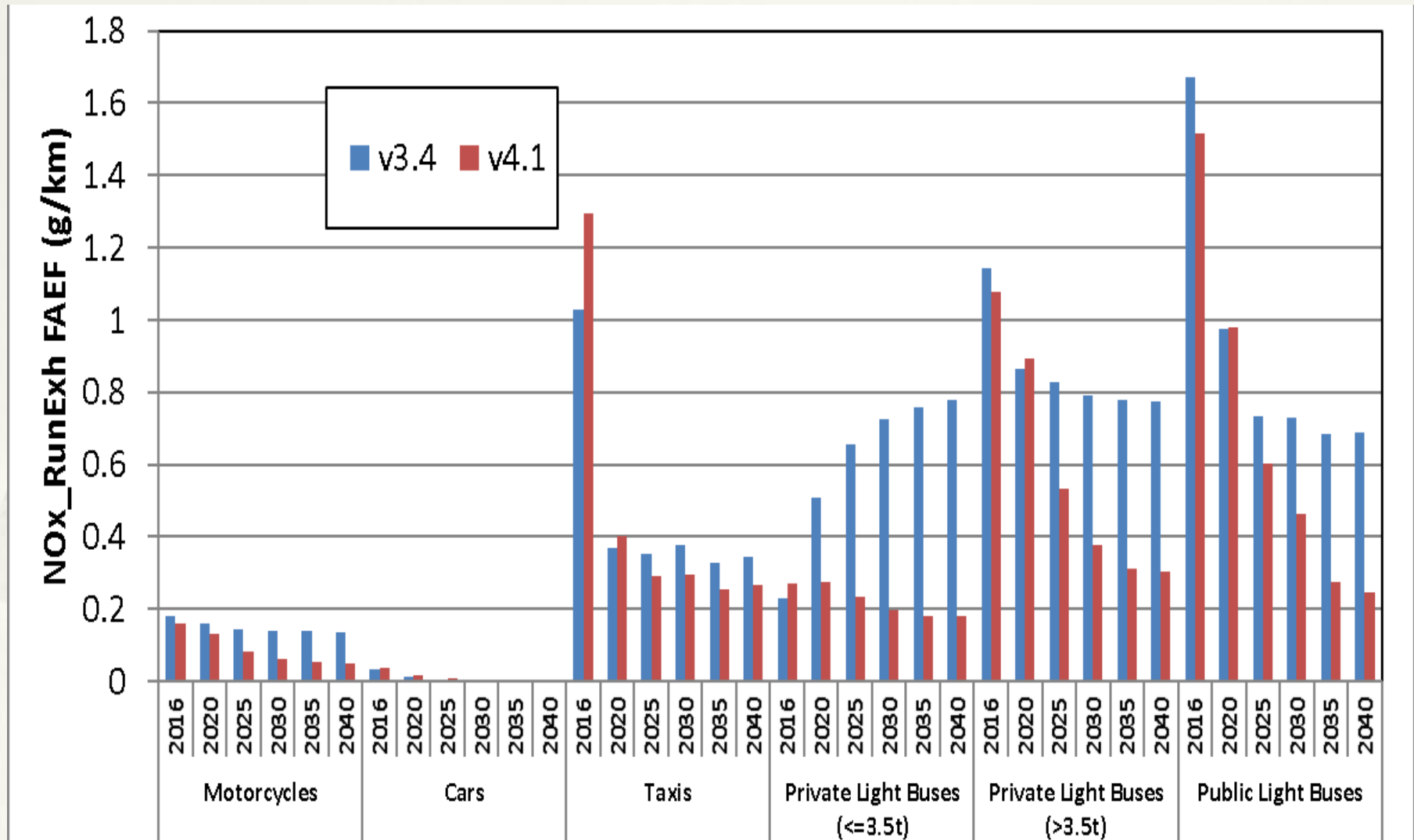
# Comparison of NOx (Running Exhaust) FAEF – Goods Vehicles



# Comparison of NOx (Running Exhaust) FAEF – Buses



# Comparison of NOx (Running Exhaust) FAEF – Others



# Comparison of Territory-wide PM10 Emissions in Current (V3.4) and EMFAC-HK update V4.1

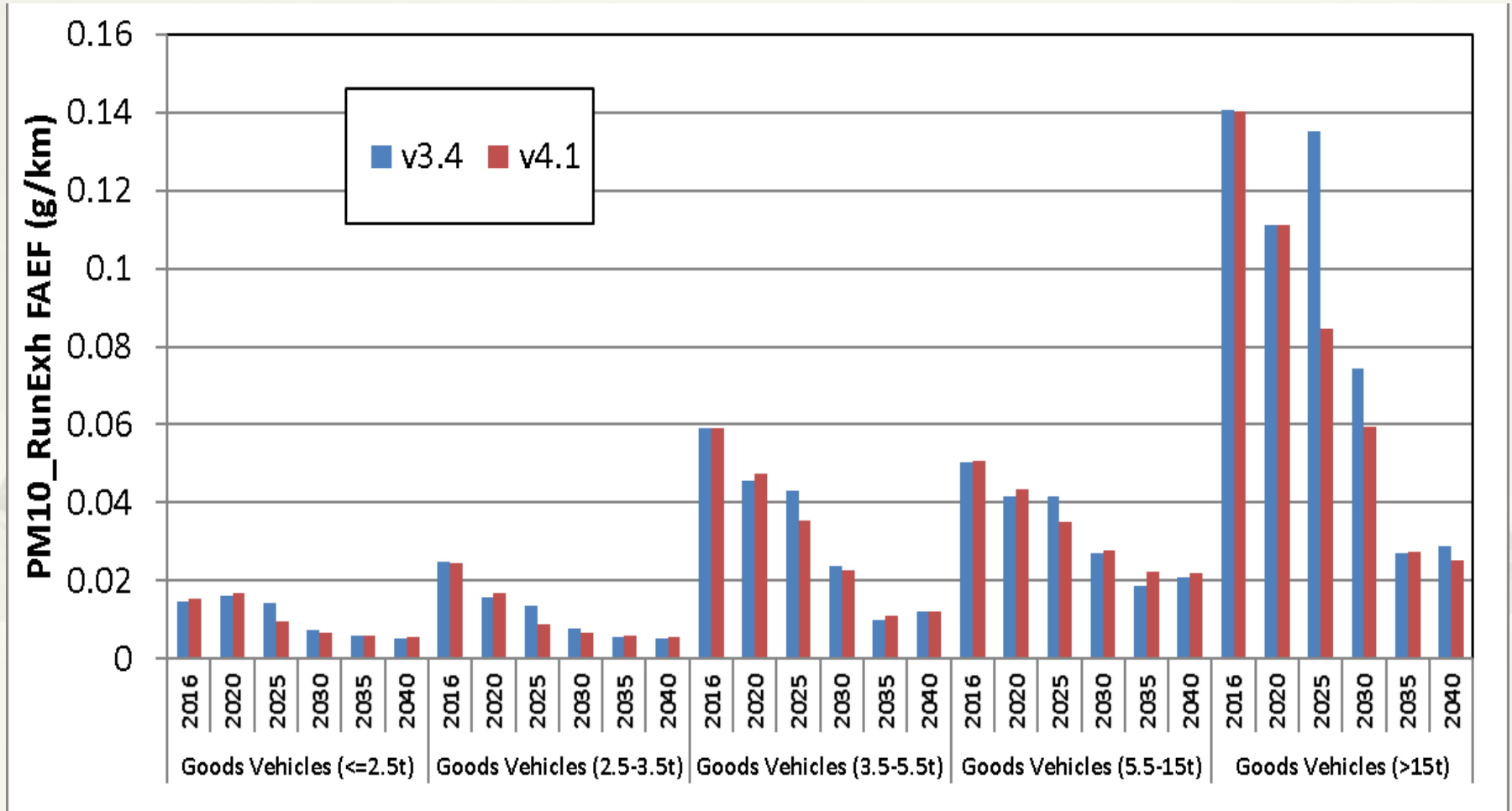
- Default Base Year Change
- Model Parameters Change

Light Buses/Buses Emission Tightening

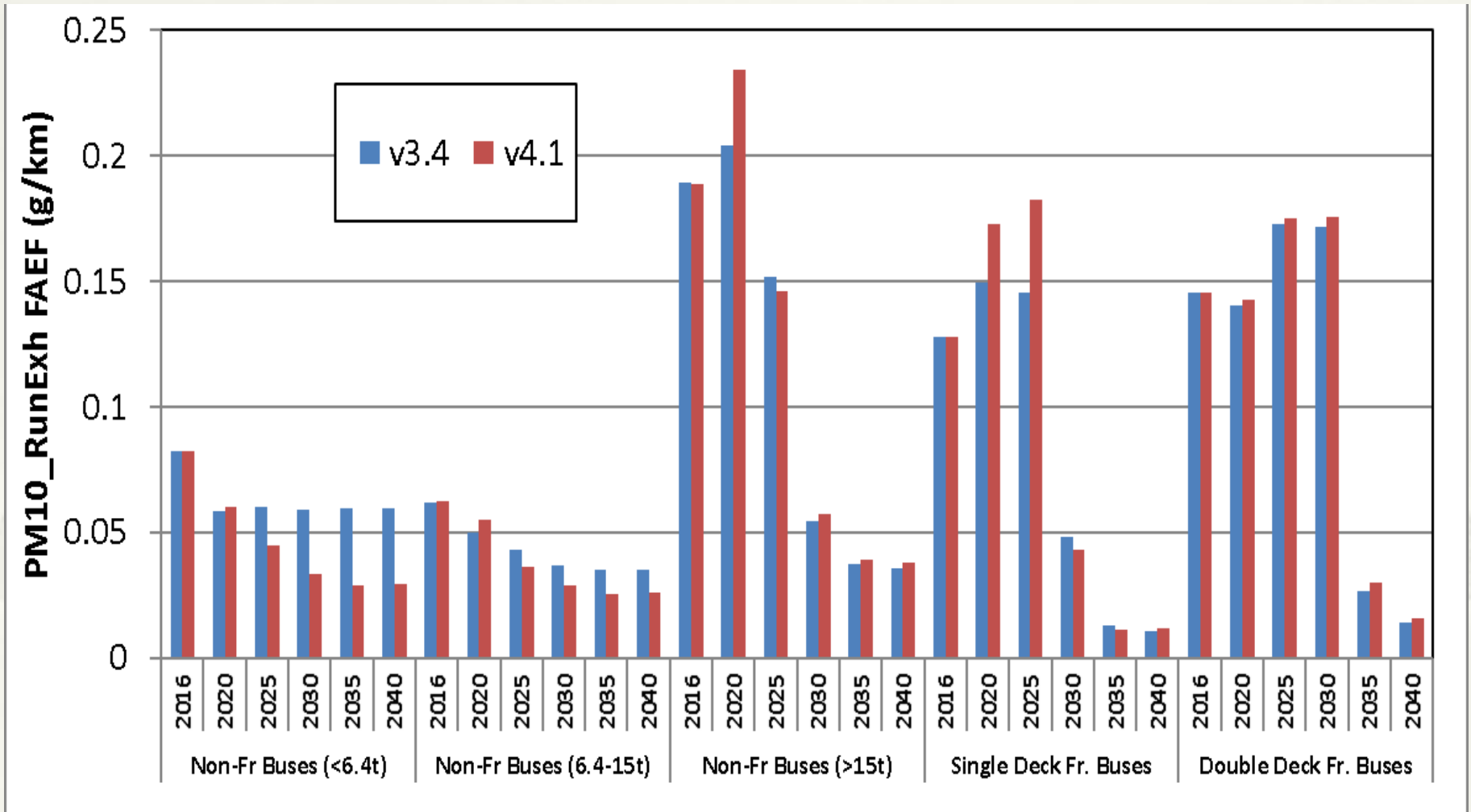
Euro IV DCV Program



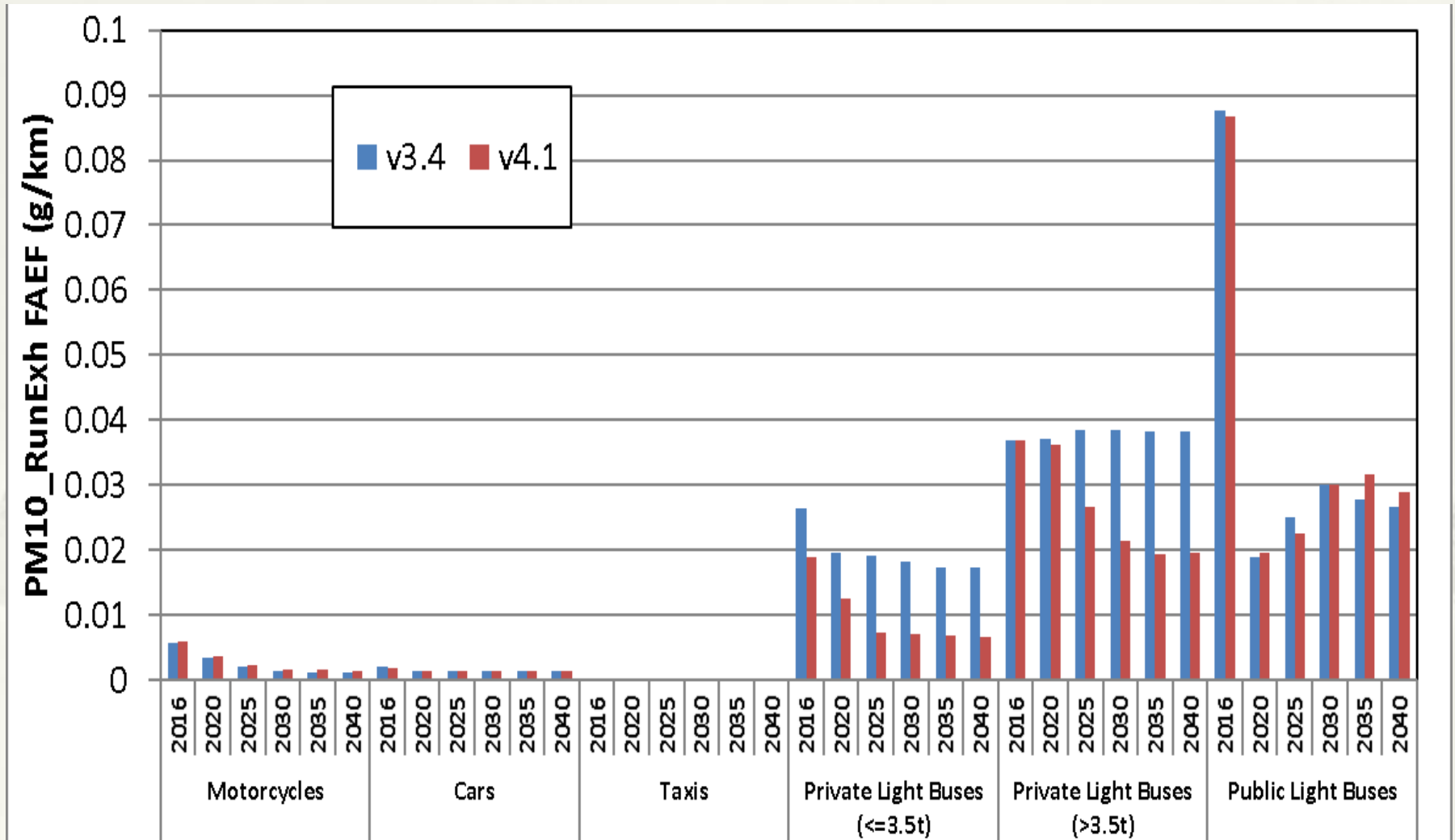
# Comparison of PM10 (Running Exhaust) FAEF – Goods Vehicles



# Comparison of PM10 (Running Exhaust) FAEF – Buses



# Comparison of PM10 (Running Exhaust) FAEF – Others



# Release of EMFAC-HK

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- \* Will release EMFAC-HK V4.1 in January 2019.

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# Transitional Arrangement for Use of EMFAC-HK in EIA Studies

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- \* Provision of 6-month transition period for EIA studies being conducted for adaption to the new model and reduction of abortive work (same as the current arrangement)
- \* During the transition period, EIA reports submitted under Section 6 of the EIAO may continue to use the previous old model version for the air quality impact assessment. After the transition period, all EIA report submissions must use the new model version

# Meeting Air Quality Objectives

- \* **Air Quality Objectives (AQOs) are the principal air quality standards** in determining the acceptability of air quality impacts of development projects
- \* Annex 4 of the Technical Memorandum on EIA Process (TM) issued under the EIAO sets out the criteria for evaluating air quality impact in EIA studies. The key criterion is that AQOs and other standards established under the Air Pollution Control Ordinance have to be met. The same criterion applies to non-EIAO case.
- \* Project proponents need to demonstrate that, by means of various mathematical air quality assessment models, upon inclusion of the impacts caused by the project, the **cumulative air pollutant concentration** at identified air sensitive receivers would **comply with the AQOs** during the **construction and operation phases** of the project.
- \* Meeting the annual concentration standard of NO<sub>2</sub>, i.e. 40ug/m<sup>3</sup>, is challenging in urban districts and at the vicinity of trunk roads
- \* Appropriate **mitigation measures** have to be adopted to **control and prevent non-compliance**, if necessary.

Thank you.

