Impact of vehicle emissions on air quality in Mexico

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Strategies for Mitigating Air Pollution

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THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

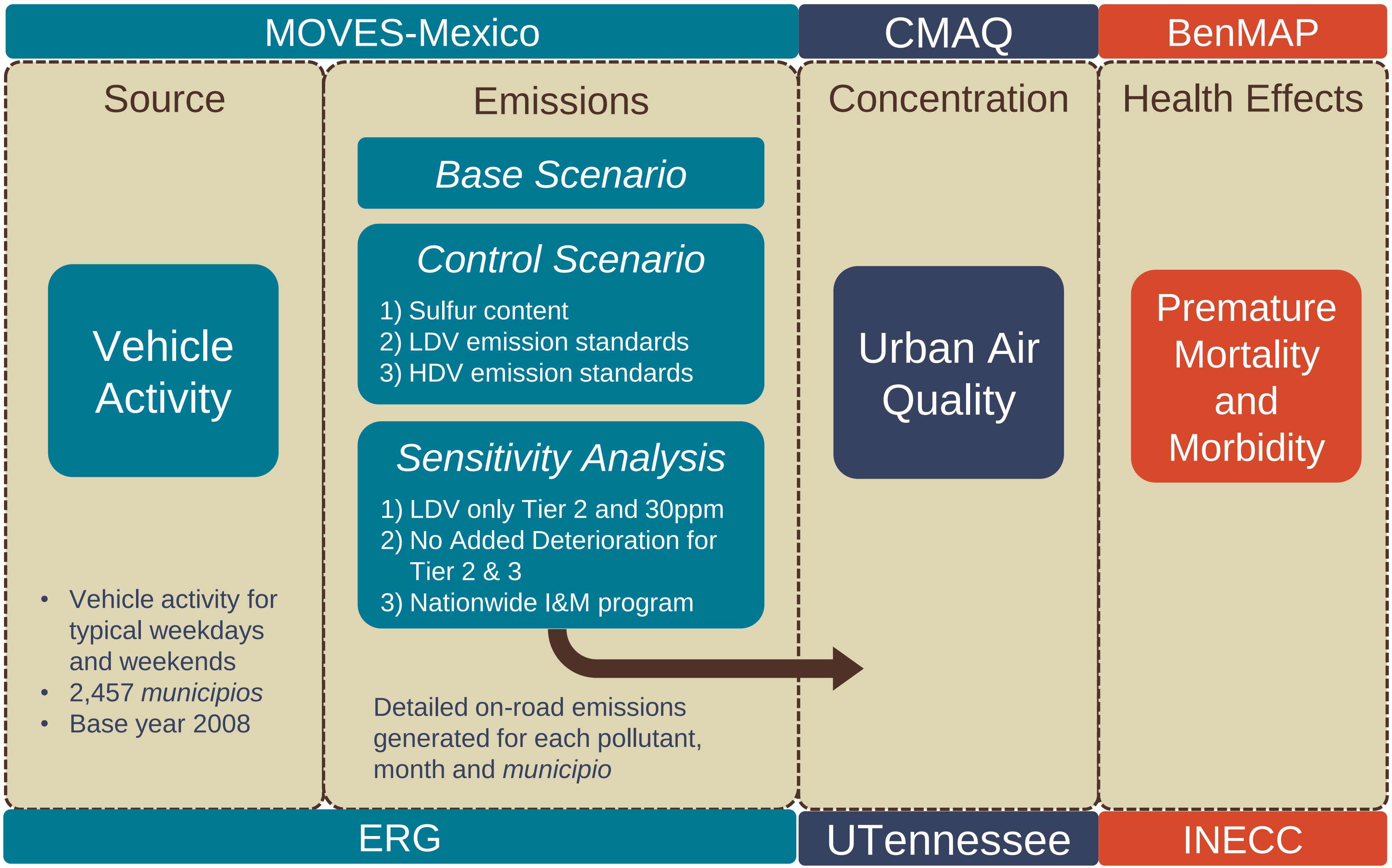
Outline

- Health assessment of on-road sector for Mexico
  - Potential to reduce impact on air pollution and mortality
- On-road emissions concerns
  - Diesel NOx
  - Flawed European type approval process
  - Higher evaporative emissions with Euro standards
- Options for city to improve emissions
  - Improving I&M
  - Eliminating LDV diesels
  - Strengthening the regulatory program (including emissions limits, certification, enforcement, durability, etc) has by far the greatest impact

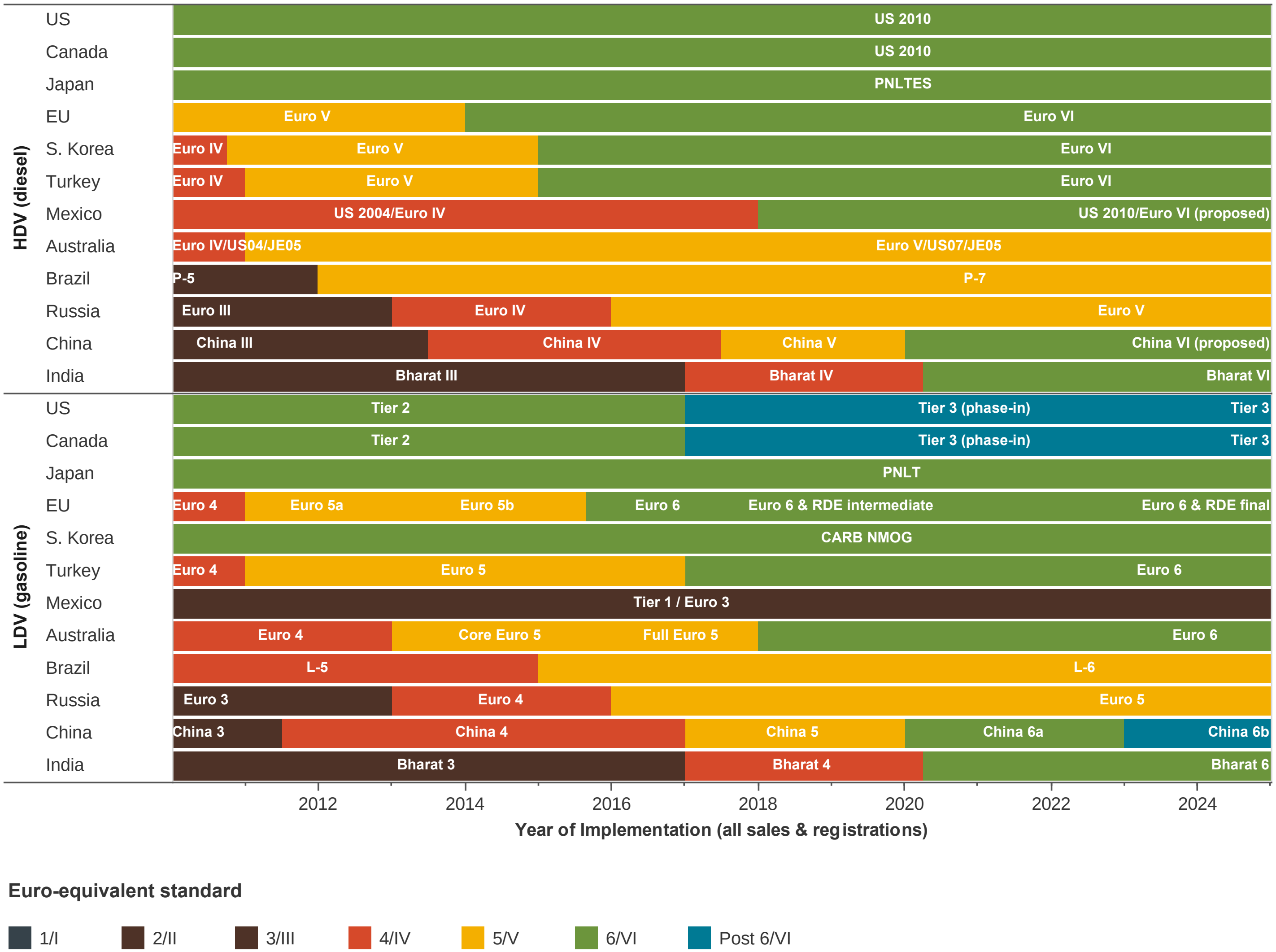
Health impact assessment

Potential benefits of on-road vehicle standards

Approach overview for health assessment



El mundo ha notado: se mueve hacia Euro VI



Las normas de las mejores prácticas para México se requiería:

NOM 044

Norma para vehículos pesados equivalente a US2010 o Euro VI

NOM 042

Norma para vehículos ligeros equivalente a los Estados Unidos Tier 2 y Tier 3, incluyendo emisiones del escape y emisiones evaporativa

NOM 016

Diésel de 15 ppm de azufre Gasolina de 10 ppm de azufre

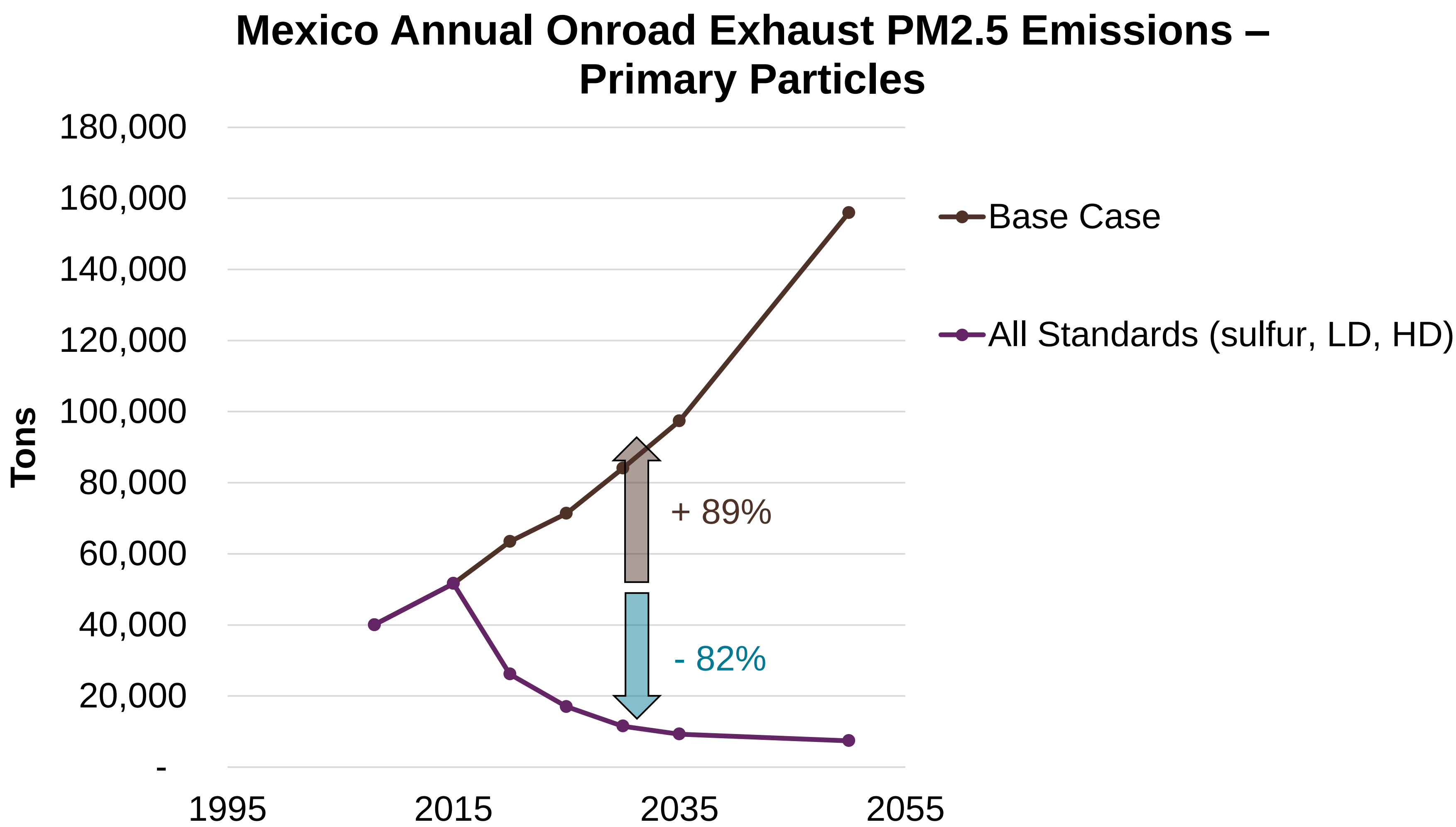
Base, control & sensitivity scenarios

Regulation	Fuels / Vehicles	Base scenario	Control scenario
Fuel standards	Gasoline	Metro areas: 30 ppm Rest: 85% 300 ppm; 15% 30 ppm	2016: 150 ppm 2017-2019: 30 ppm 2020+: 10 ppm (Subtract)
	Diesel	Metro areas: 15 ppm Rest: 500 ppm	2016-2017: 500 ppm 2018-2019: 15 ppm 2020+: 10 ppm
Vehicle emission standards	Light-duty	PM: US Tier 1 NOx: US Tier 2 bin 7 Phase-in complete after 2013	2018-2020: U.S. Tier 2 2021-2024: U.S. Tier 3 phase-in (phase-in) (Subtract) 2025+: U.S. Tier 3 (Subtract)
	Heavy-duty	U.S. 2004	U.S. 2010
I&M sensitivity	Light-duty	Add nationwide I&M	Add nationwide I&M

Sensitivity scenarios would change steps in red:

1) The Base scenario plus a nationwide I&M program
2) Control scenario minus 10 ppm sulfur gasoline and Tier 3 harmonization
3) Control scenario plus a nationwide I&M program

HD US 2010 and 15 ppm sulfur diesel are the most important driver of direct $PM_{2.5}$ reductions



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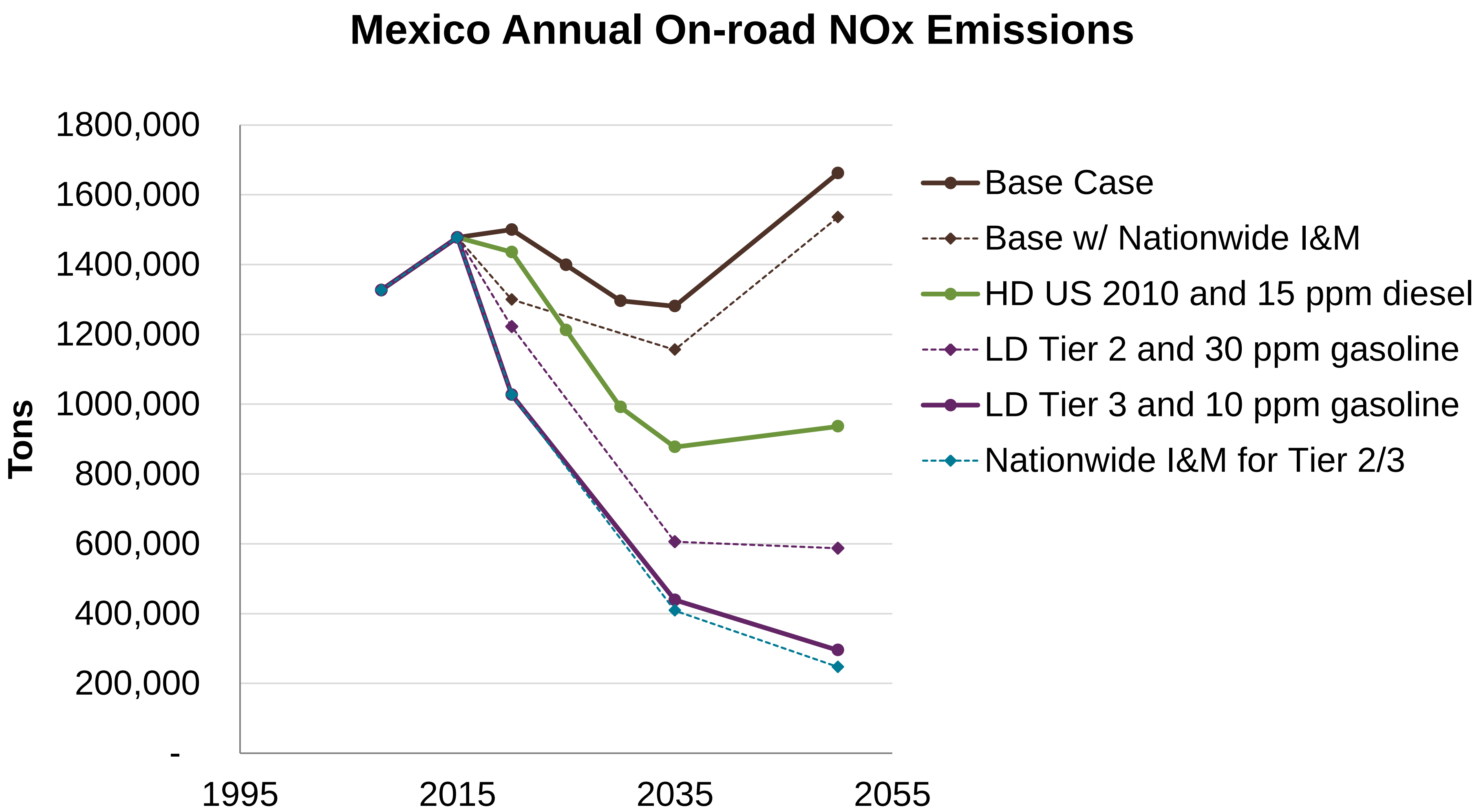
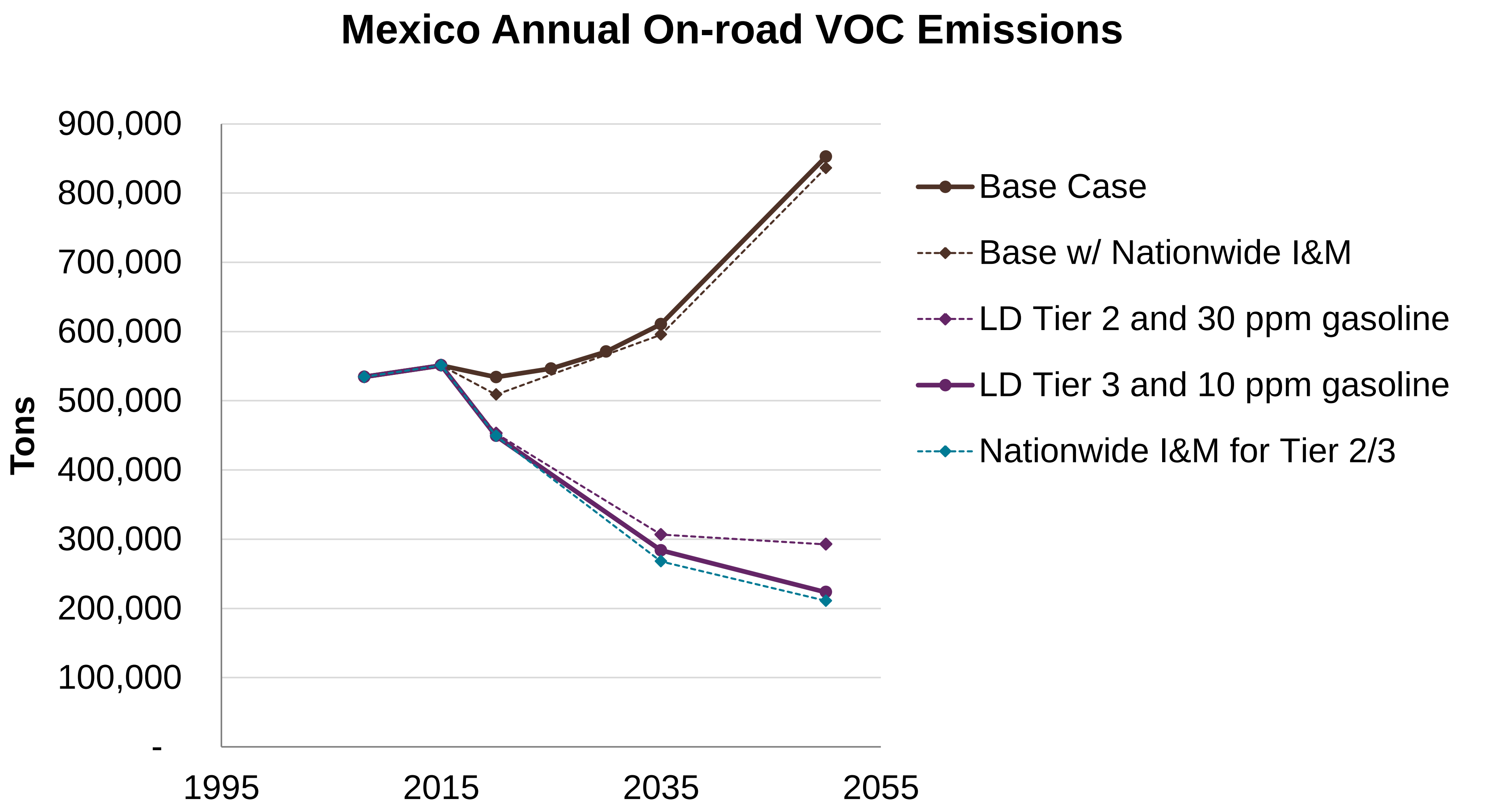
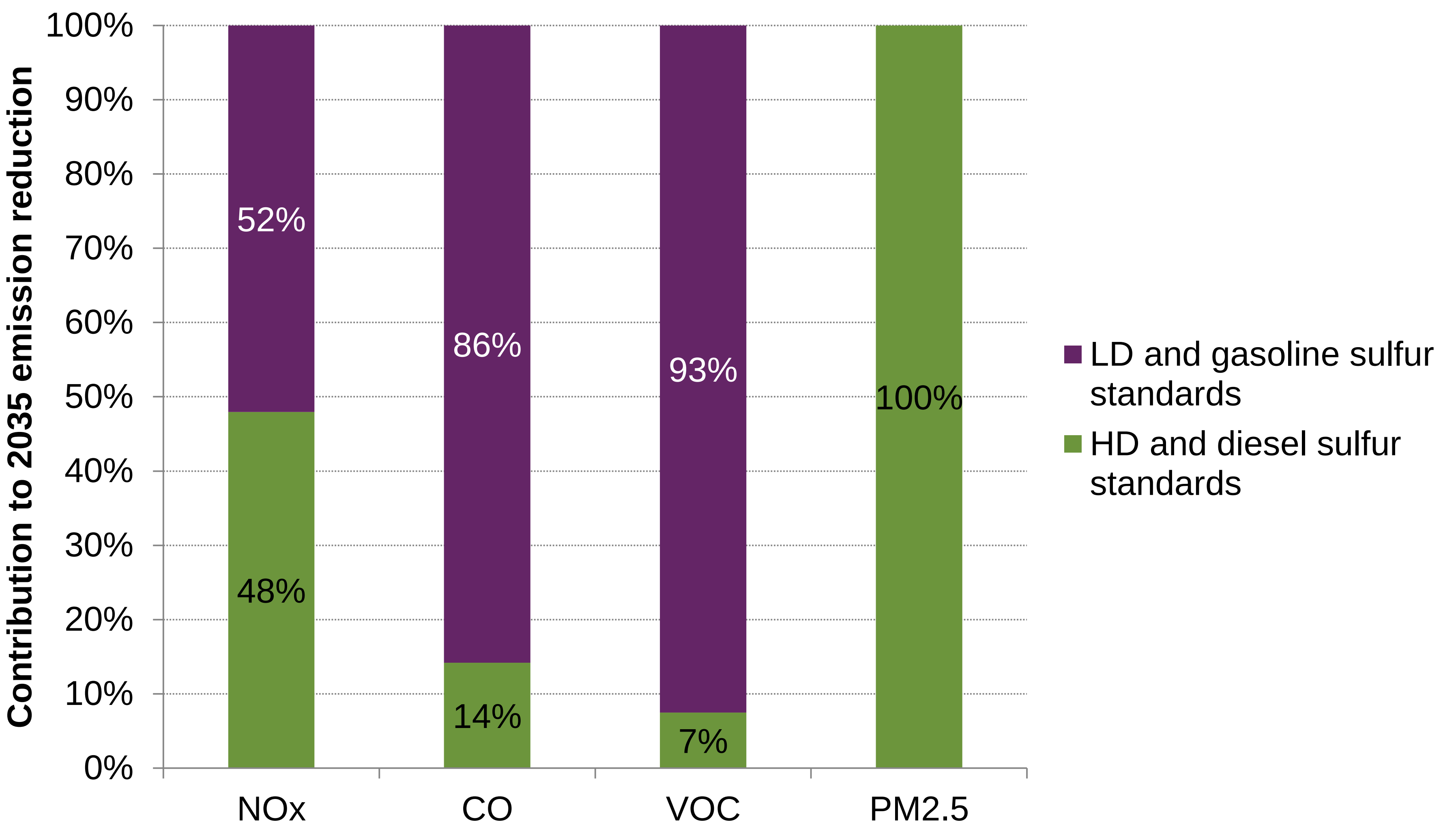
Tier 3 and 10 ppm gasoline are important to sustain long-term NO_X reductions; I&M augments benefits



LD and gasoline sulfur standards are critical for reductions in VOC emissions



Contribution of standards to emission reductions in 2035 varies by pollutant



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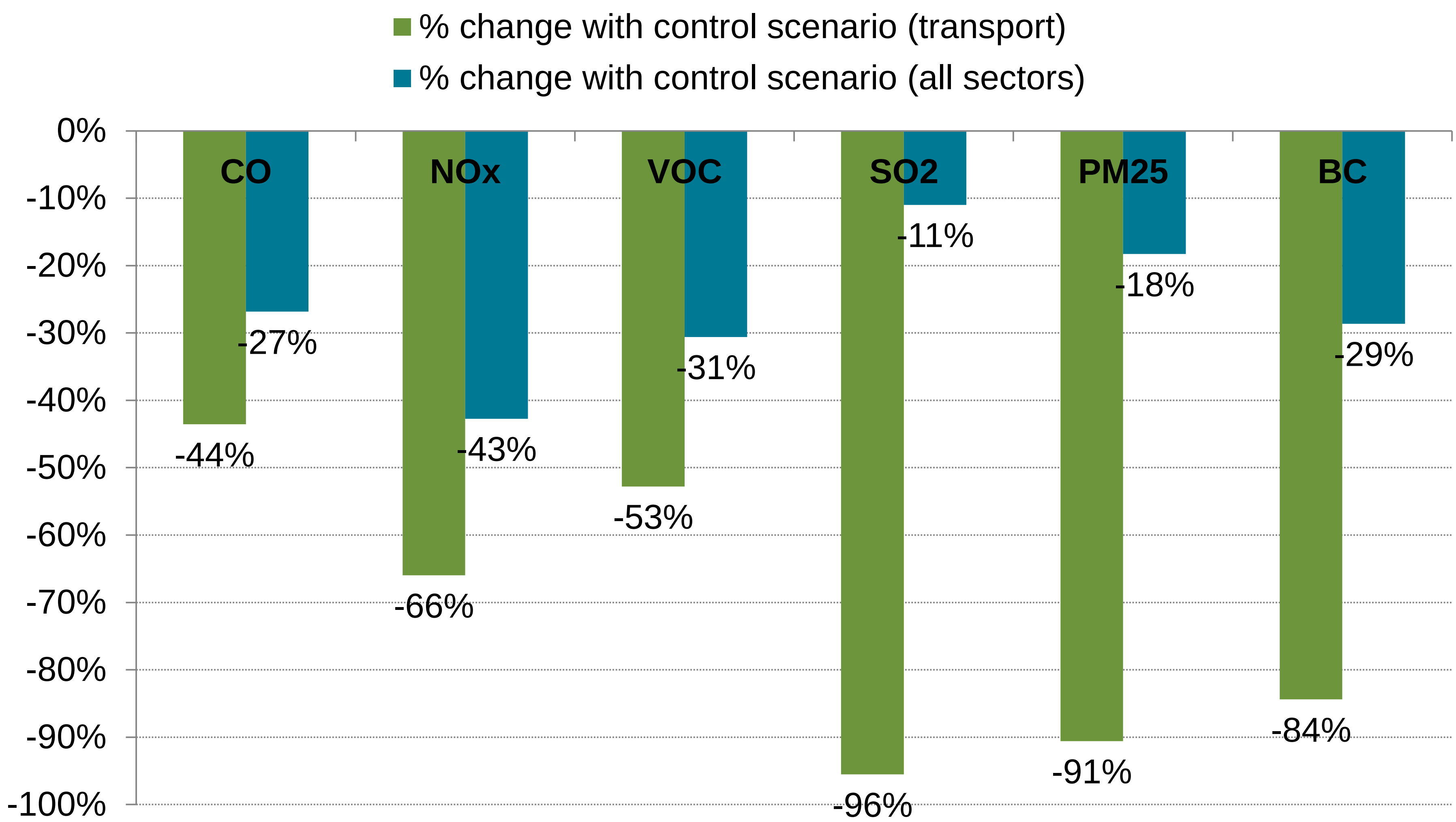
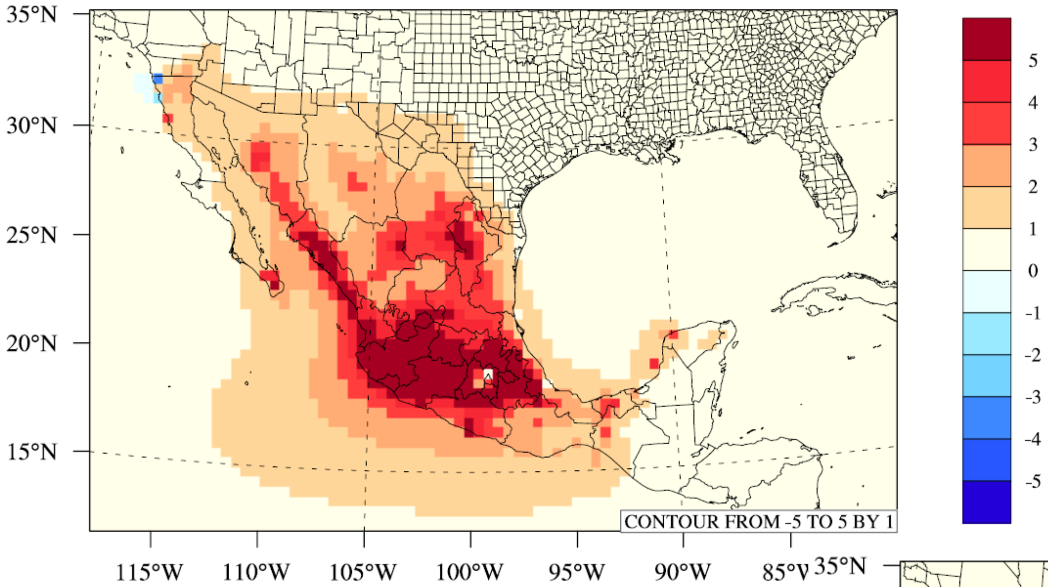
On-road emission reductions are significant when compared to emissions from all sectors

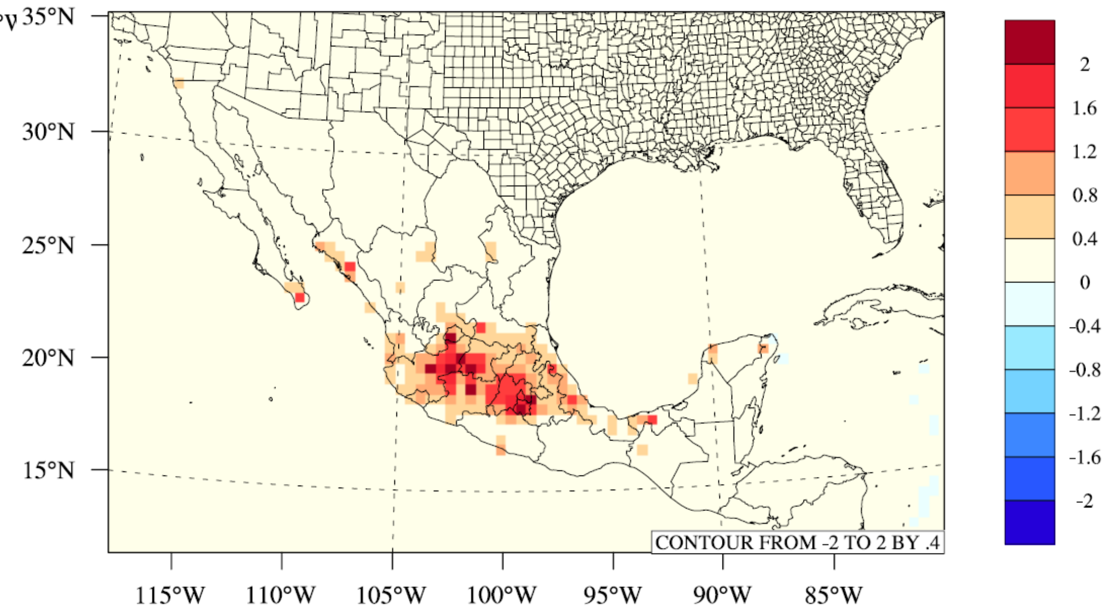


Vehicle standards would contribute to dramatic reductions in pollutant concentrations



Ozone 8-hour (ppb)
Difference (Base minus Control)

PM2.5 (ug/m3)
Difference (Base minus Control)



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On-road emission reductions result in significant air quality improvements

Difference in air quality with control scenario compared to base case in 2035

Air quality indicator (population-weighted)	Nationwide	Mexico City
Annual mean $PM_{2.5}$	-17.6%	-19.5%
8-hour maximum ozone	-8.1%	-4.9%
1-hour maximum ozone (annual mean)	-9.5%	-6.3%
1-hour maximum ozone (spring mean)	-11.8%	-13.7%

Draft allocation of avoided deaths in 2035

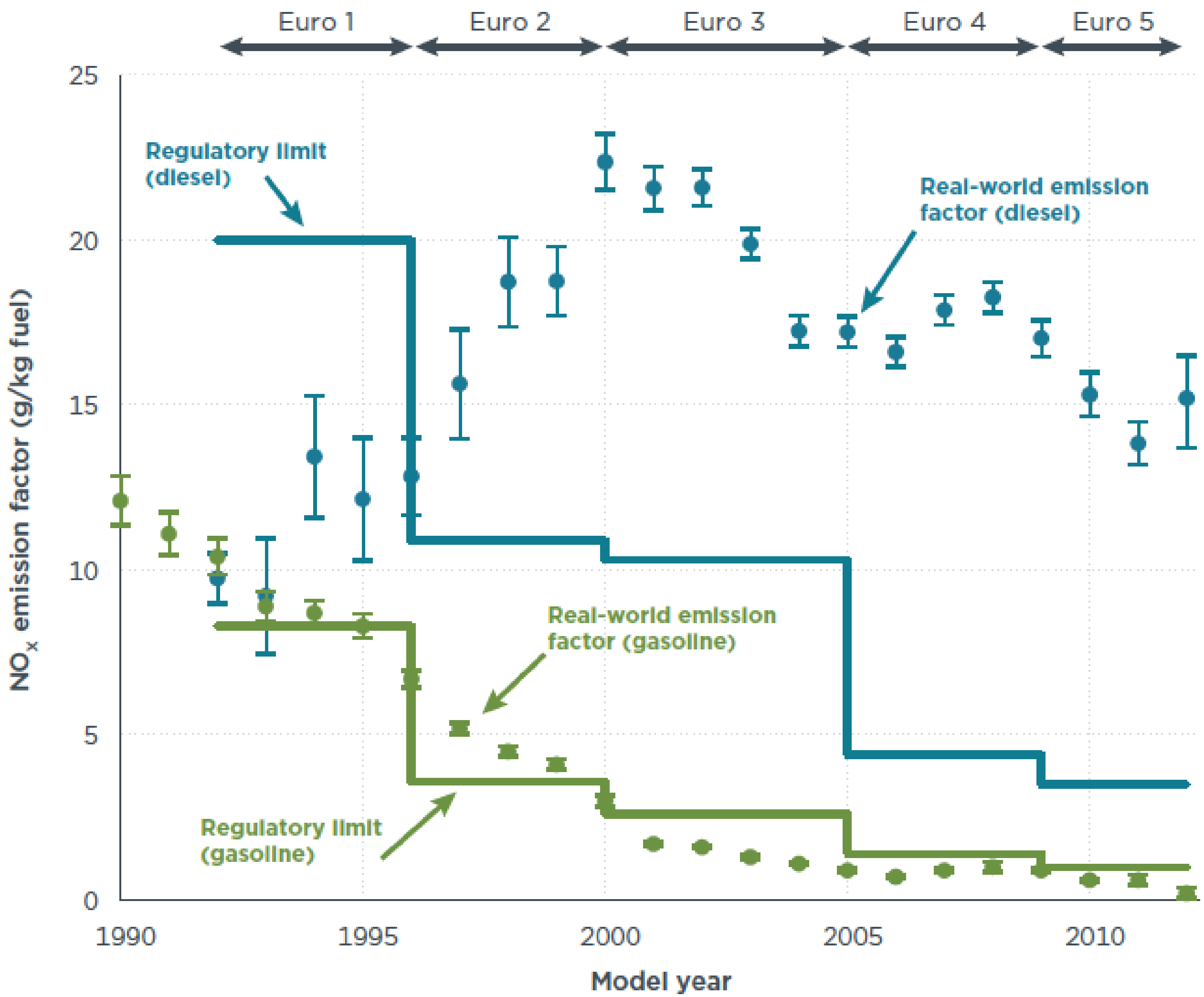
Pollutant	Total Mortality	HDV Mortality	LDV Mortality	LDV Tier 3 Mortality
Ozone	2922	1071	1851	590
Secondary PM	3432	1478	1954	644
Primary PM	3297	3297	0	0
Total PM	6729	4775	1954	644
Total	**9651**	**5845**	**3806**	**1234**
Share	**100%**	**61%**	**39%**	**13%**

- Draft allocation assumes:
  - NOx and VOC have approximately equal impact on ozone formation nationwide
  - SOx has a 10 times greater impact than NOx and almost 40 times greater than VOC on formation of secondary PM
- Impact of each precursor on air quality concentrations varies dramatically depending on location, season, time of day, etc.
  - We are working with air quality modelers to refine this allocation and expect the final shares to shift somewhat

Real-world emissions & compliance

Significantly higher emissions associated with diesel vehicles

While emissions standards decline, real-world diesel NO_x remained high



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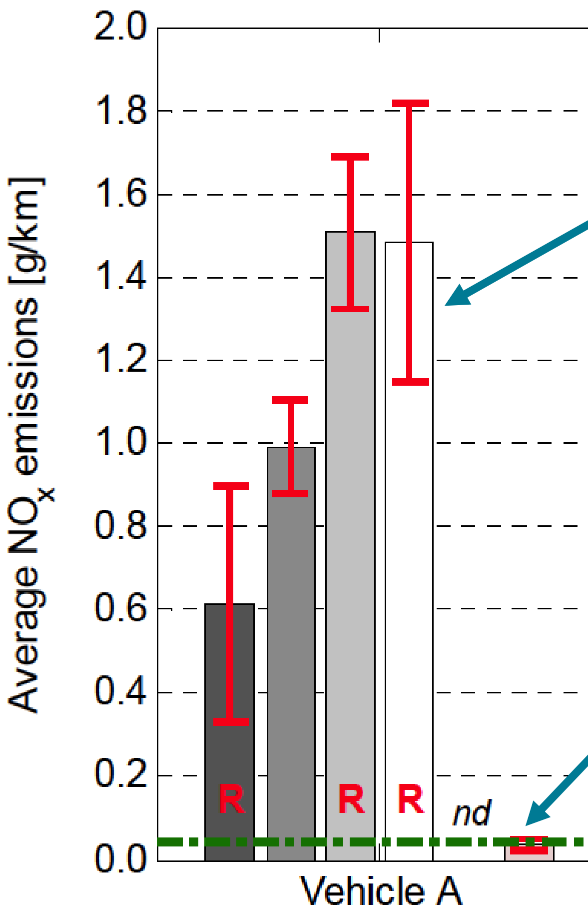
Source: http://www.theicct.org/environmental-risks-diesel-passenger-vehicles-brazil-2016, based on Chen and Borken-Kleefeld (2014)

Comparison of laboratory vs. on-road tests for 3 diesel cars in the US triggered “Dieselgate”



On-road test

Laboratory test

Source for photos: AVL / ERMES
Vehicles shown on photos are not related to test results shown

Source: http://www.theicct.org/use-emissions-testing-light-duty-diesel-vehicles-us

Nearly all manufacturers in the EU make use of the “thermo-window” defeat device

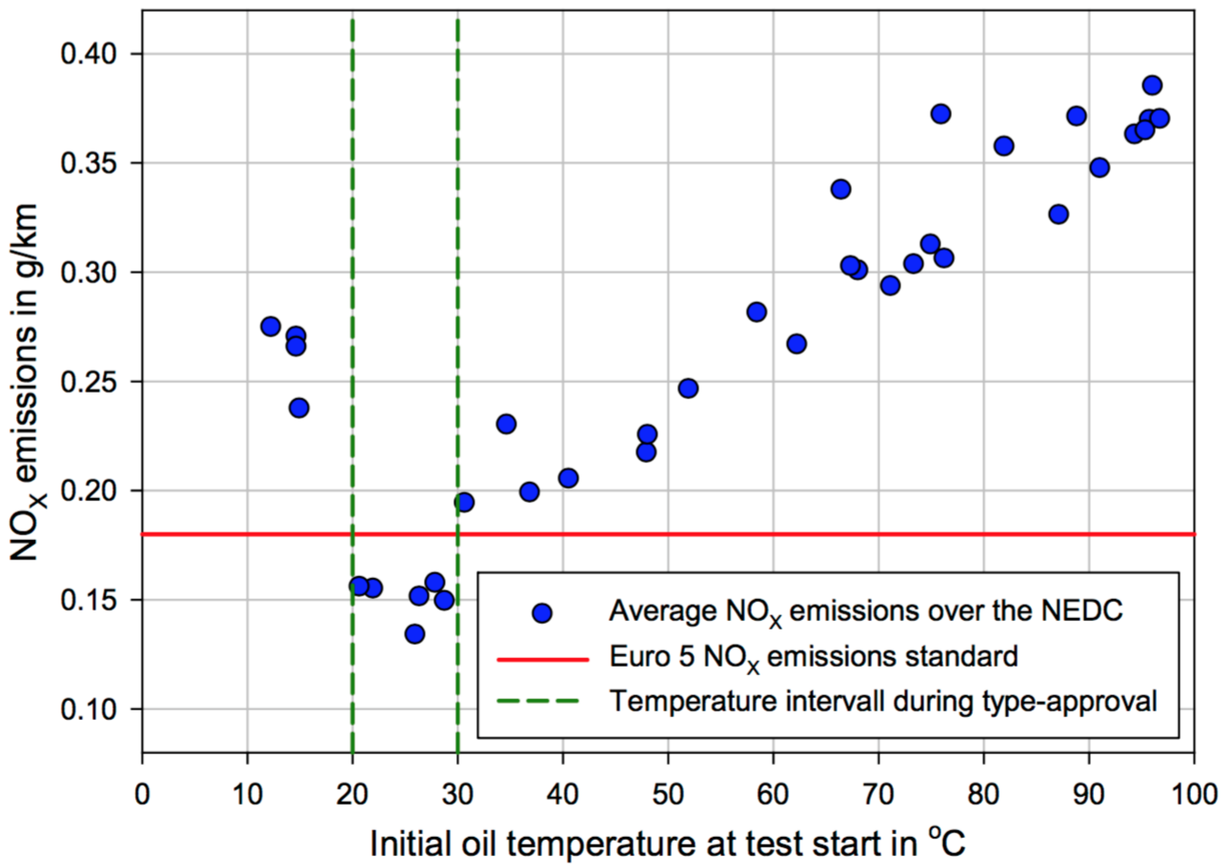
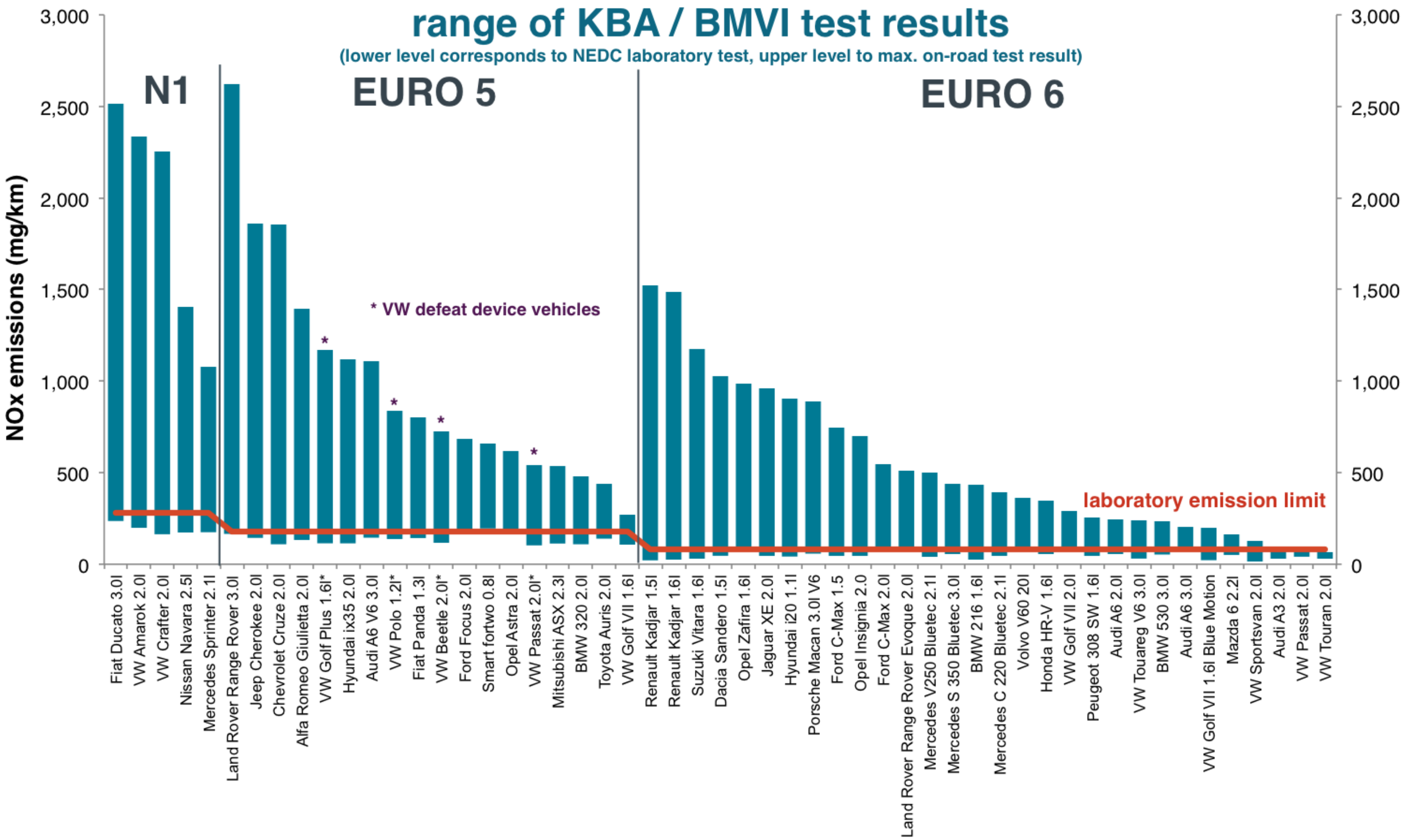


Figure 9: Average NO_X emissions of a Euro 5 diesel vehicle over the NEDC at various initial engine temperatures (Data source: Kühlwein, 2012)

Source: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC75998/ld-na-25572-en-n_online.pdf

Government testing confirmed earlier findings, points to numerous other defeat devices



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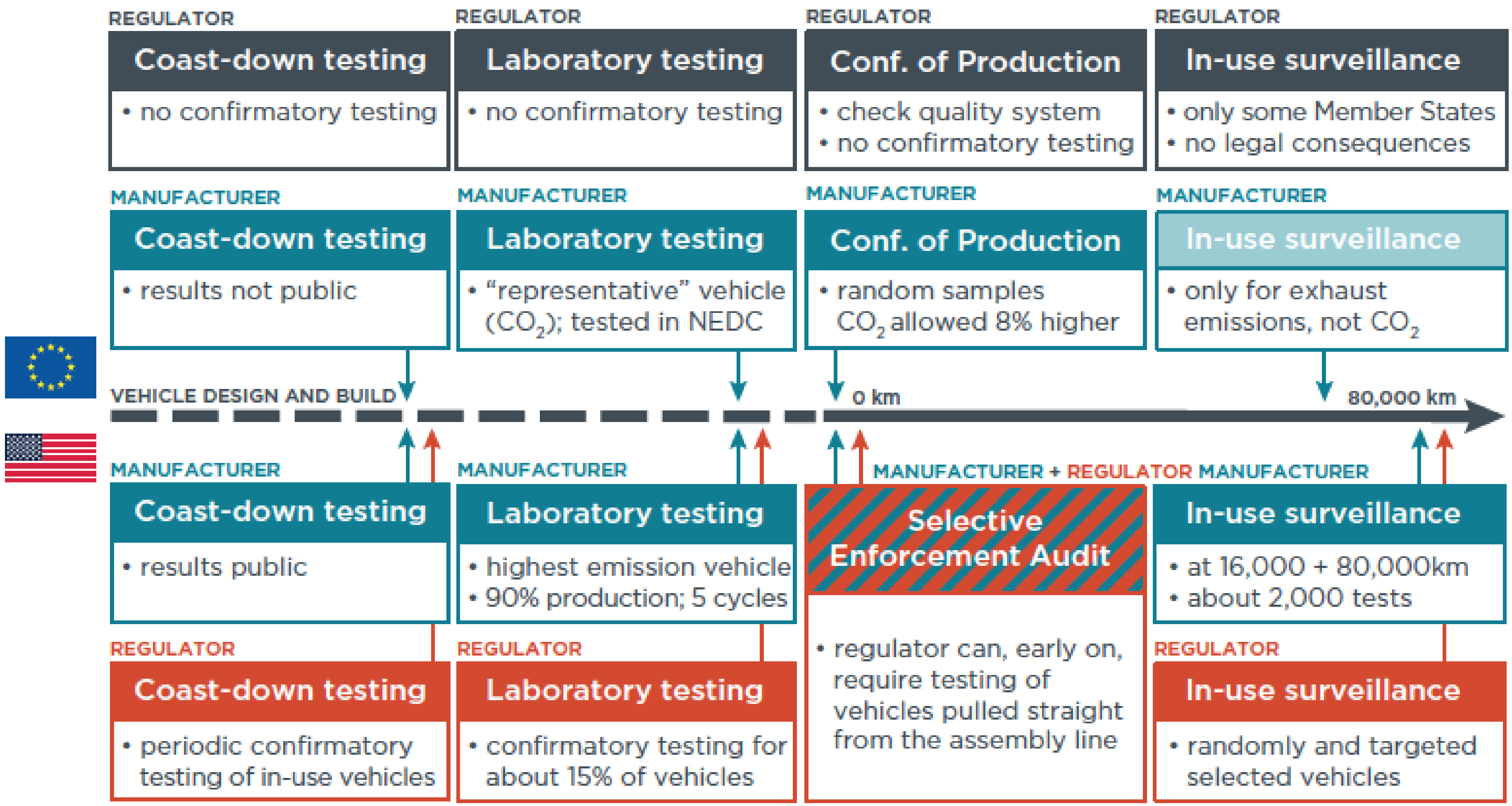
Source: http://theicct.org/blogs/staff/first-look-results-german-transport-ministrys-post-vw-vehicle-testing

Lack of emissions regulation enforcement in Europe



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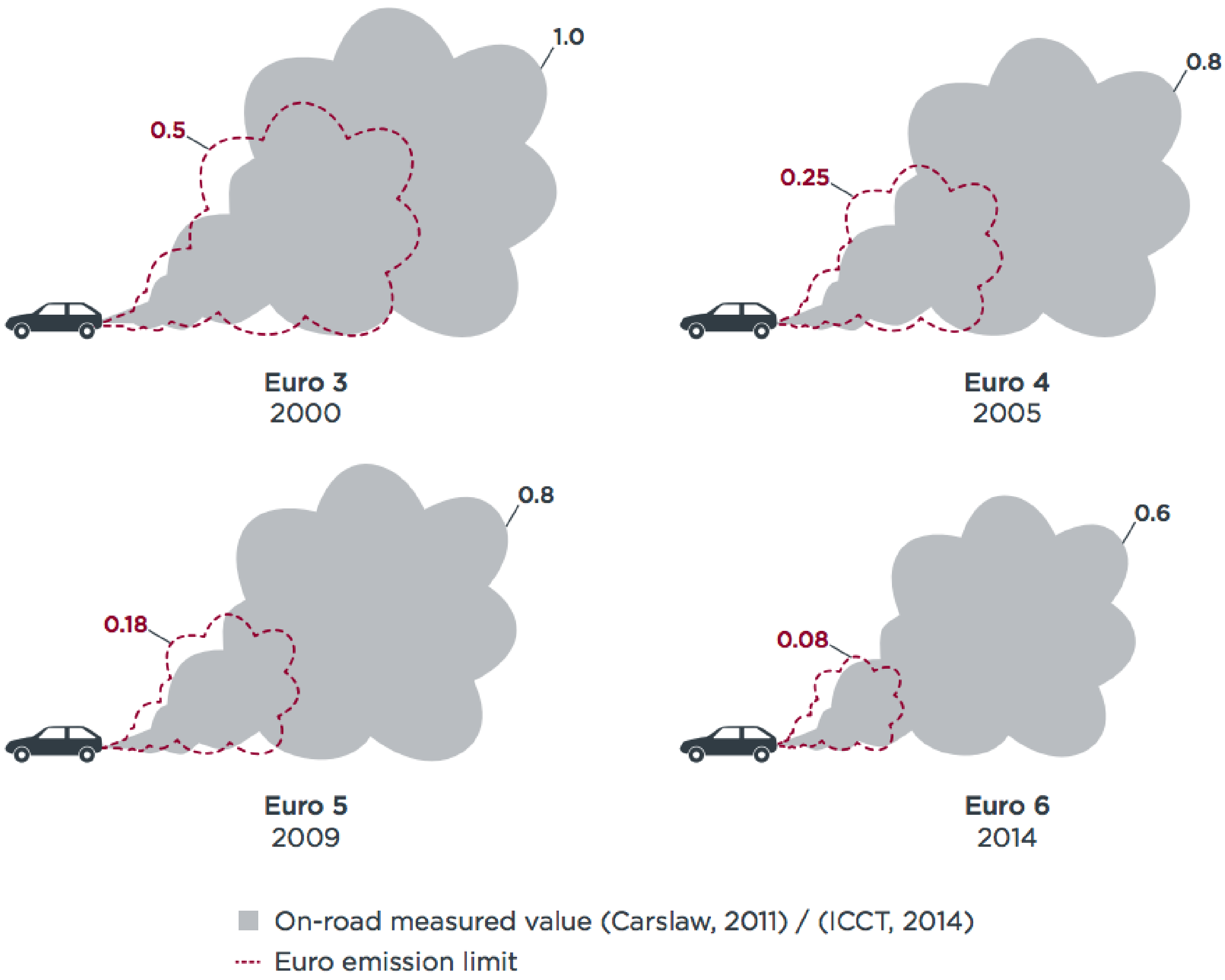
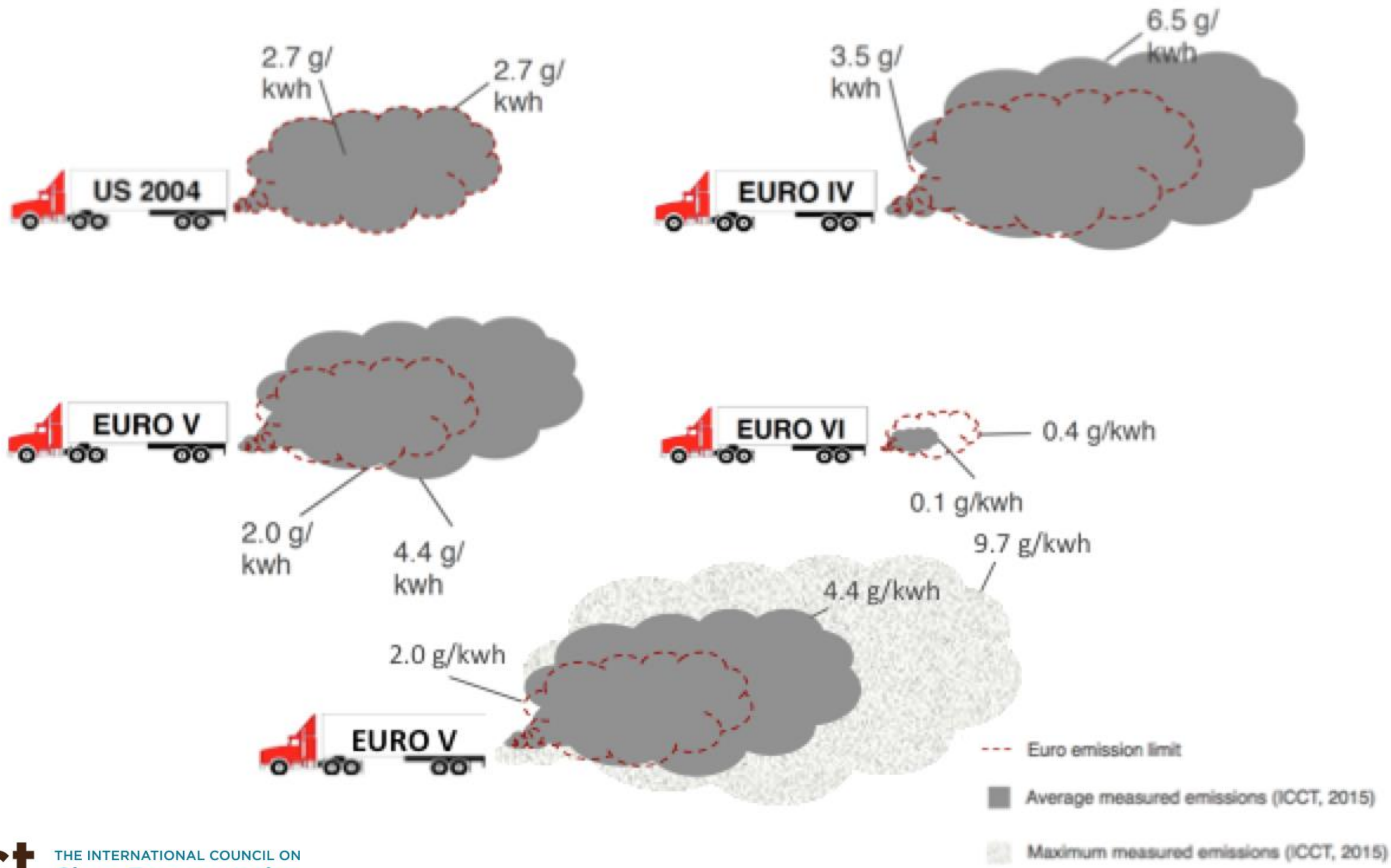
Source: http://www.theicct.org/future-of-vehicle-testing

NOx emissions from Euro standard diesel cars have not decreased as intended



Source: http://eupocketbook.theicct.org

Euro IV and V standards have also failed to reduce heavy-duty diesel NOx



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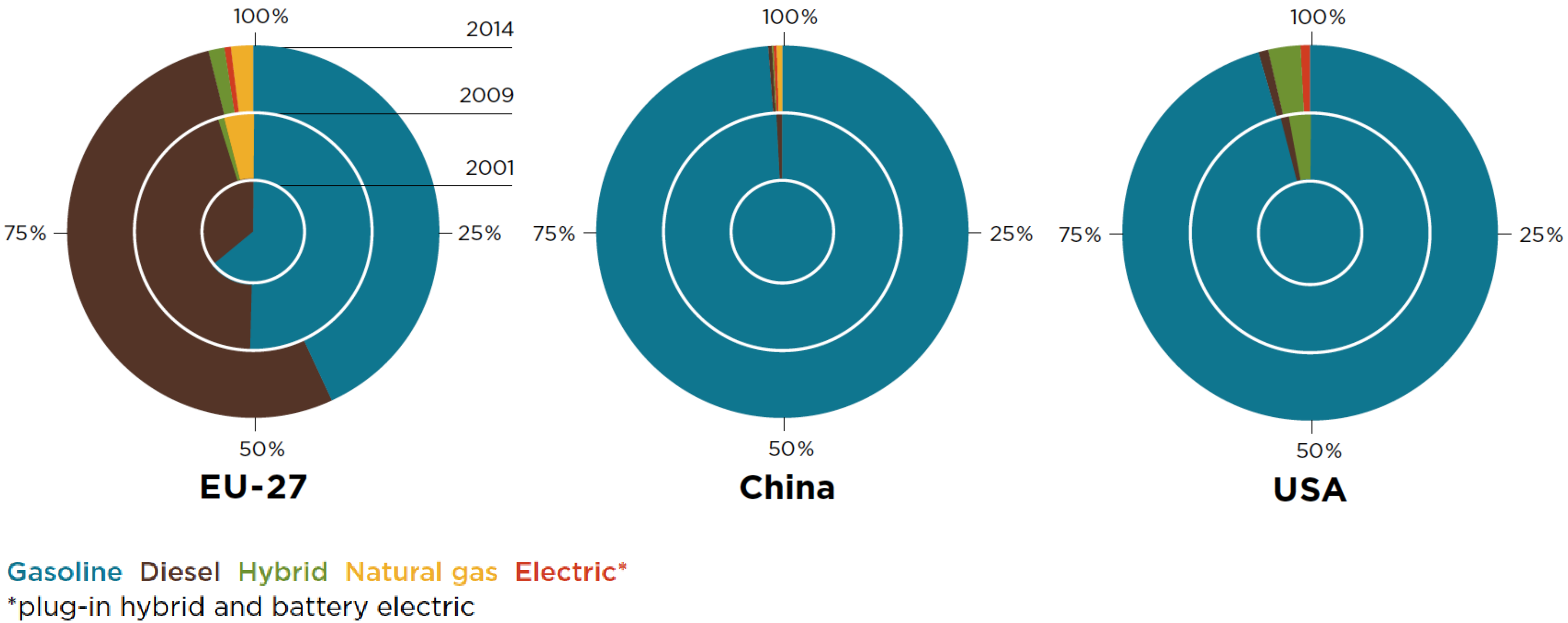
Mexico market is most similar to the U.S.



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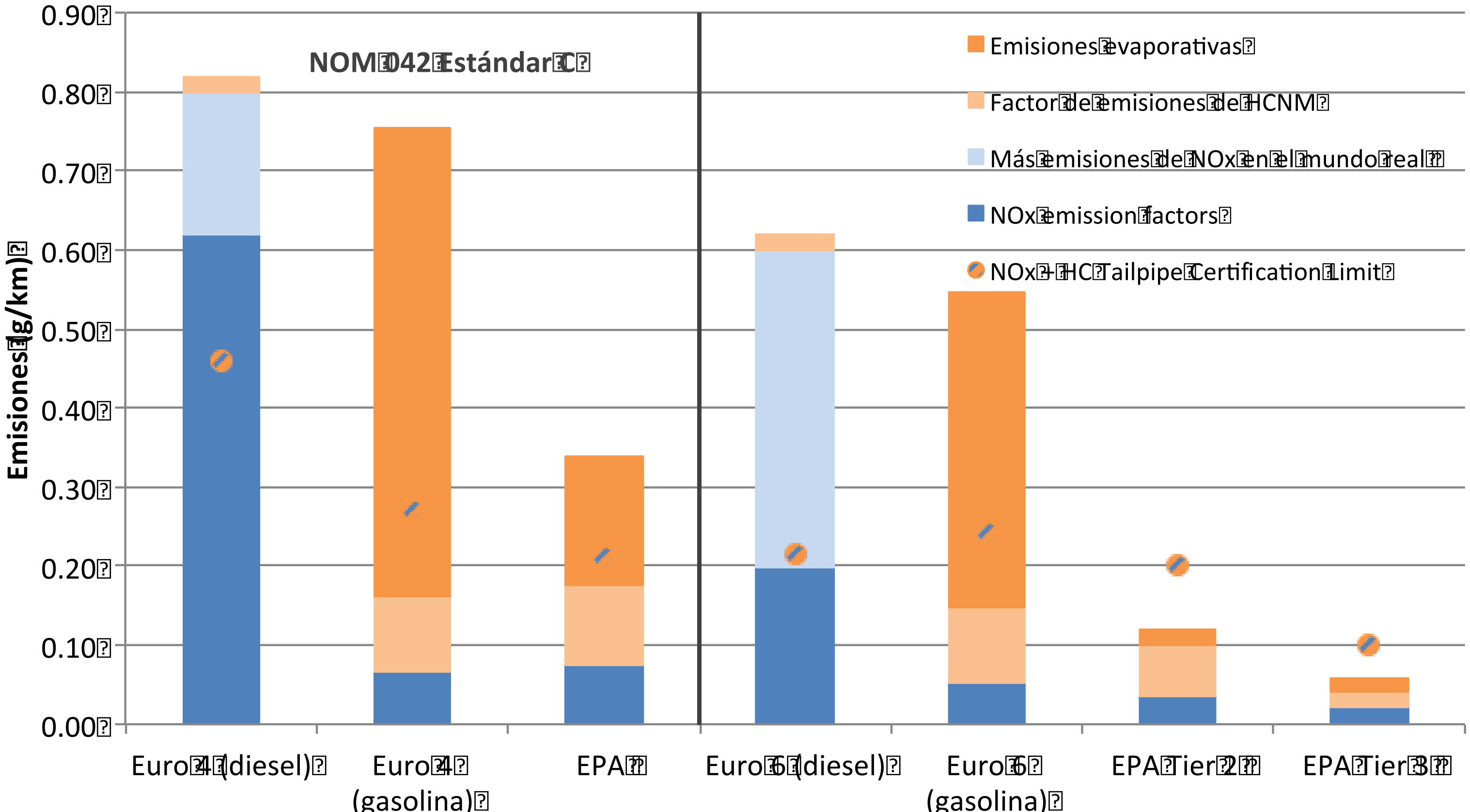
Source: http://eupocketbook.theicct.org

Euro standard options allow for much higher emissions



Notes:

1. Evap emissions under EPA option for NOM 042 assumes 75% comply with Tier 2 std and the rest with Euro std.
2. Emissions factors come from COPERT for Euro and EMFAC for EPA. EPA under NOM 042 is MY 2005, Tier 2 is MY 2010, Tier 3 is MY 2030.
3. NMHC emissions are assumed to be 85% of total HC emissions, slightly higher than 82% assumed by the COPERT model.
4. NOx emission factors are from the models, excess real-world emissions are from Carslaw et al. 2011 and Franco et al 2014.
5. All EPA-based standards are fuel neutral and assume compliance by both gasoline and diesel vehicles. Only a small portion of vehicles sold in the US or Mexico, ~2% or less, are use diesel engines. All diesel vehicles sold in Mexico currently compy with Euro-based standards.
6. Certification limits are for the N1, class III vehicles under Euro standards and the highest bin included for light-duty vehicles under EPA standards.

Options to reduce vehicle impacts in Mexico City

- Updating vehicle standards to meet current best practices would have a tremendous impact on air quality & health
  - Accelerate implementation of Euro VI/US 2010 standards for HDVs
  - Adopt LD standards harmonized with US Tier 2 & 3
- Clean up existing vehicles
  - Strengthen Programa de Autorregulación Ambiental for diesel fleets
  - LEZ
  - Improve inspection and maintenance program
- Transition to new vehicle types
  - Ban LD diesels (low impact but not unreasonable)
  - Move to electric vehicles (taxis and buses are good options)
- Tools include local standards, LEZs, fiscal incentives

Thank you!

- Many ICCT staff contributed to these slides, including Josh Miller, Ulises Hernandez, Maita Schade, Peter Mock & Yoann Bernard
- Please contact me with questions:

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