RDE-LDV process. ICCT's views and presentation of PEMS meta-study results

Vicente Franco, Peter Mock
vicente@theicct.org

AECC Technical Seminar on Real-Driving Emissions (RDE)
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Real Driving Emissions

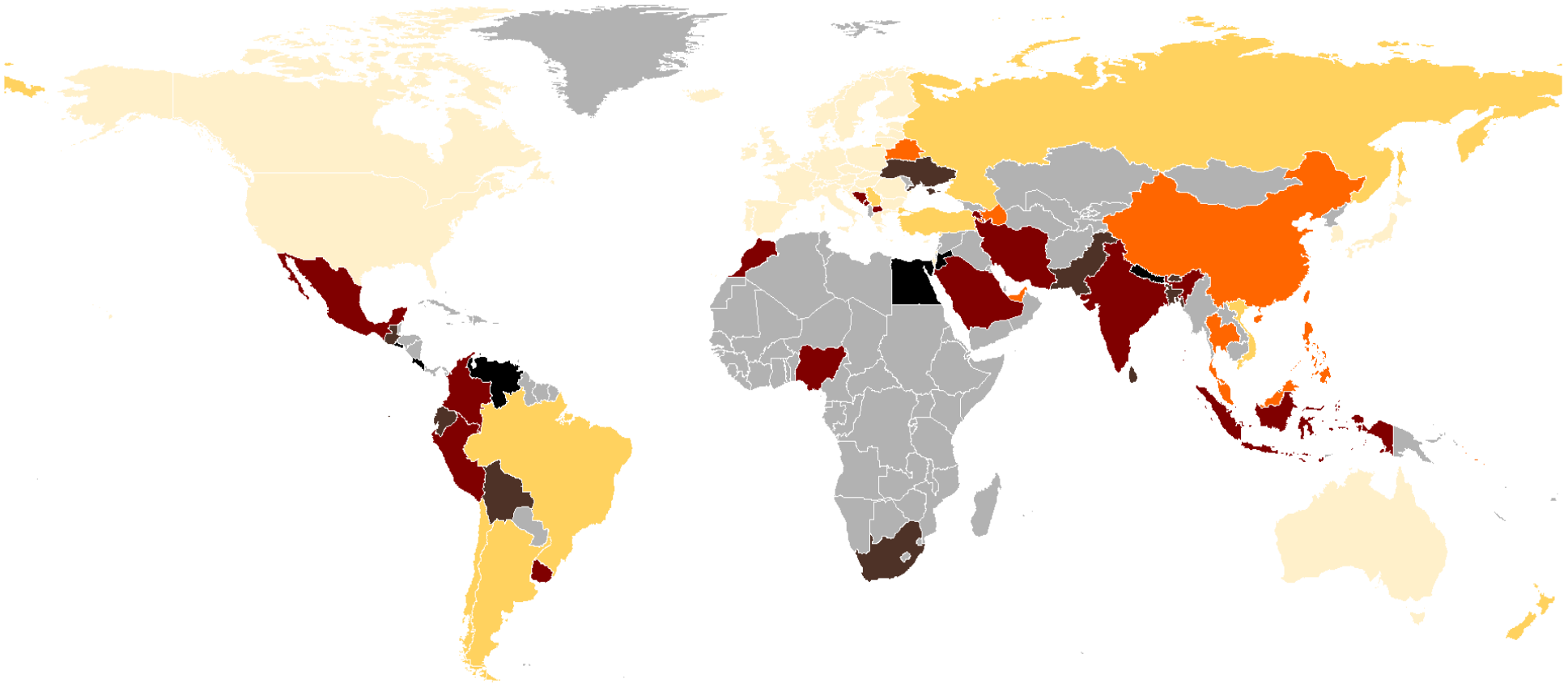
Introduction. Vehicle emission standards worldwide

the ICCT: mission and activities

The mission of ICCT is to dramatically improve the environmental performance and efficiency of cars, trucks, buses and transportation systems in order to protect and improve public health, the environment, and quality of life.

- Non-profit research organization
- Air pollution and climate impacts
- Focus on regulatory policies and fiscal incentives
- Activity across modes including aviation and marine
- Global outreach, with special focus on largest markets

Vehicle emission standards worldwide



Standards shown for LDVs

1 /I | 2 /II | 3 /III | 4 /IV | 5 /V | 6 /VI

Grey: no standards/import standards or unknown.

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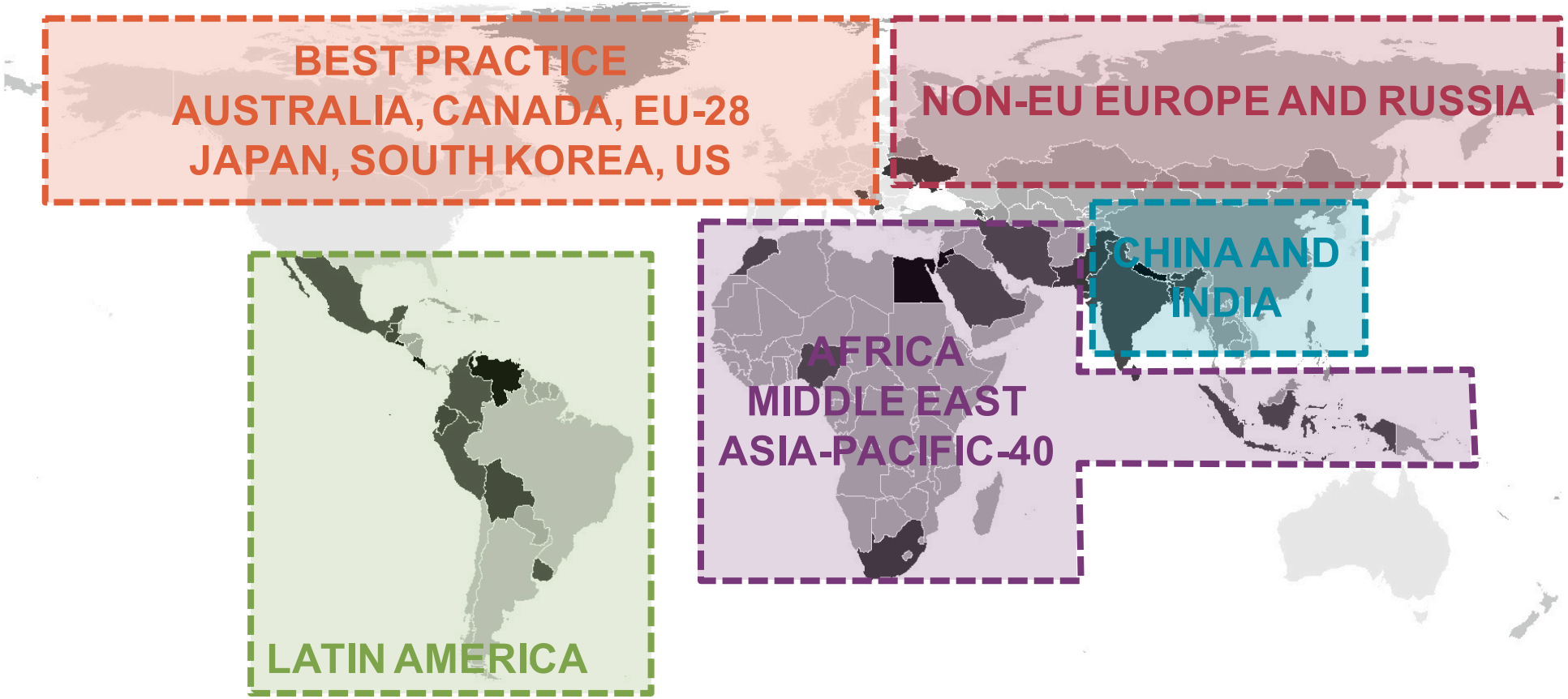
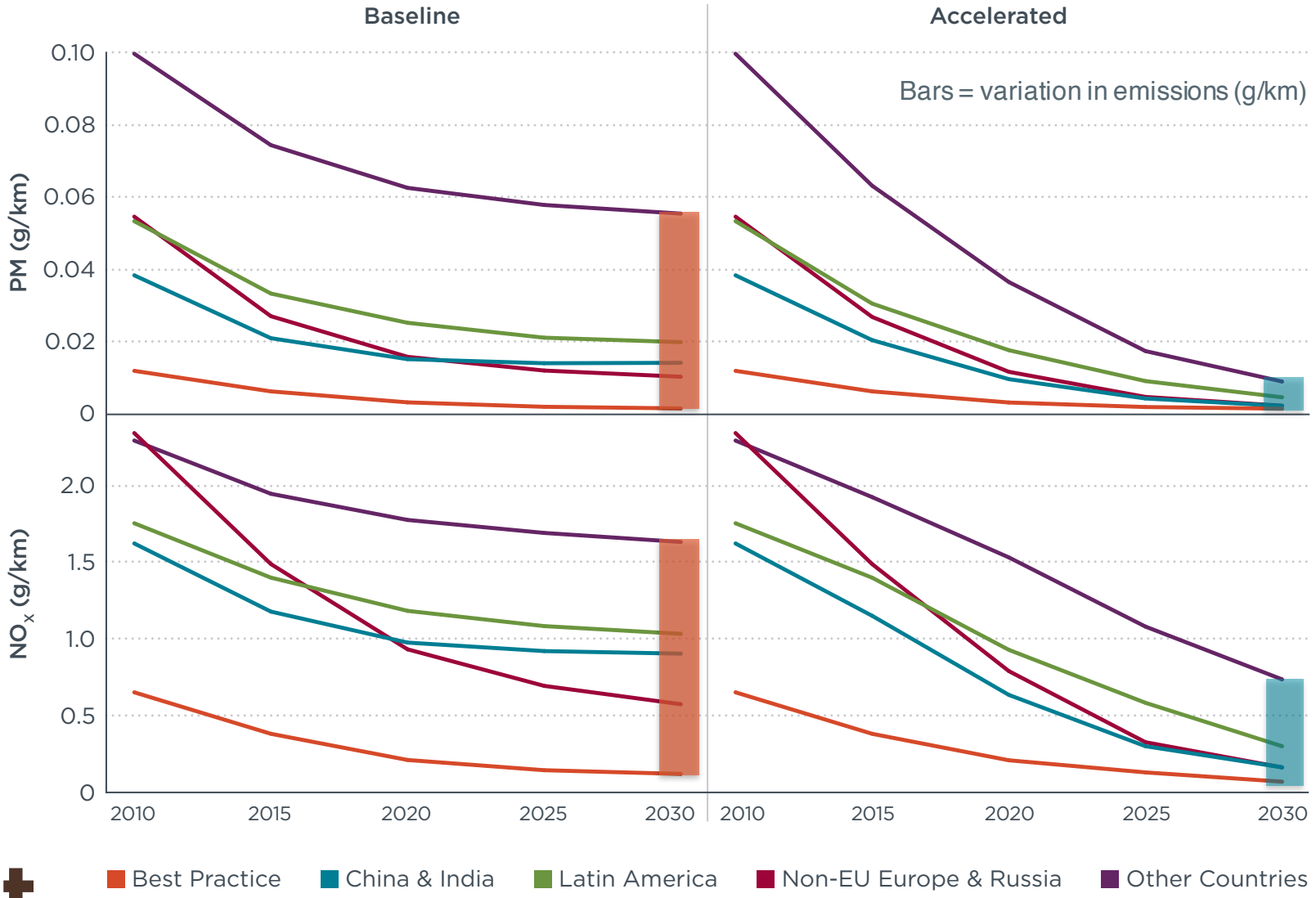
Vehicle emission standards worldwide



Emission standards drive convergence in average emission levels…



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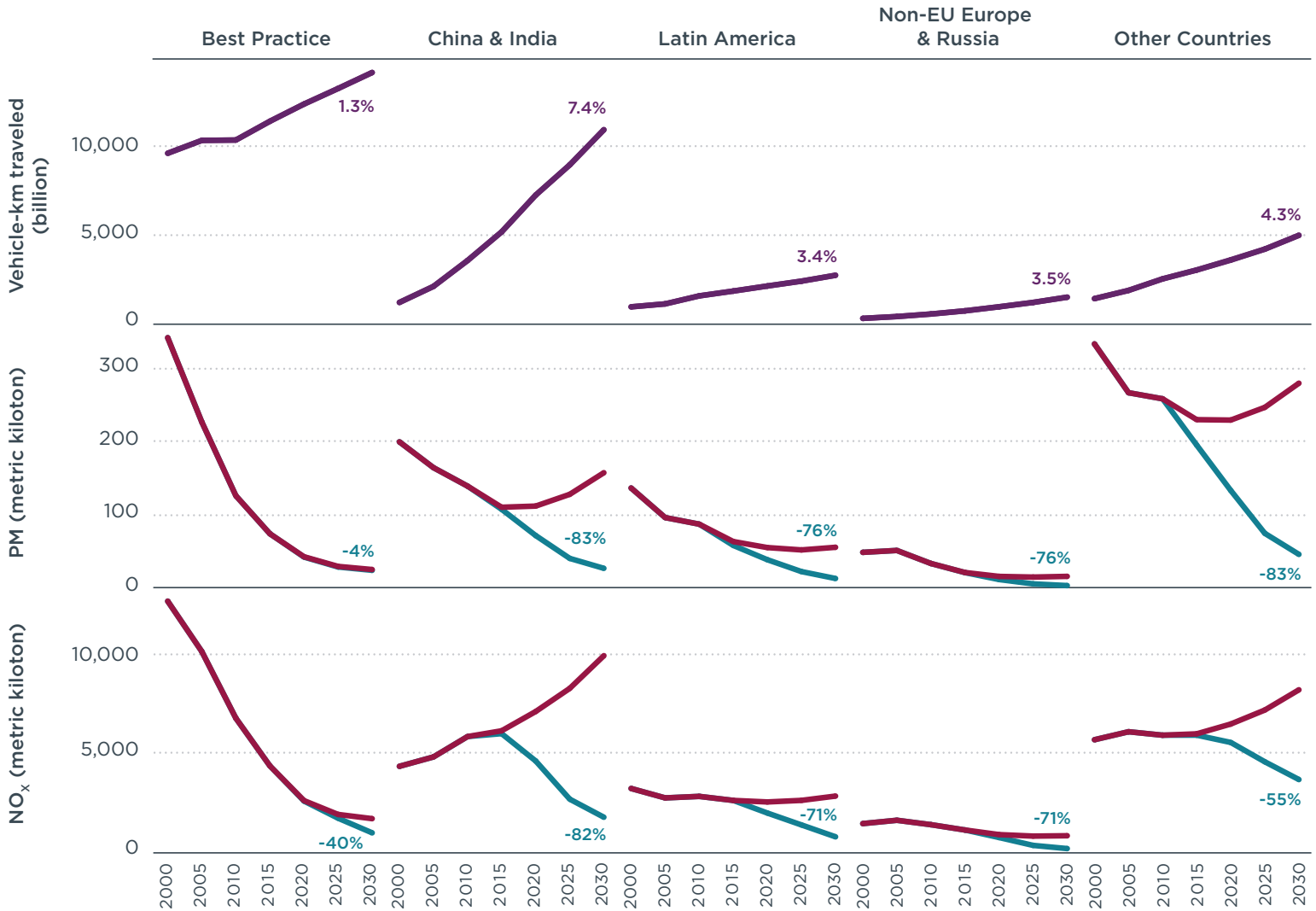
...and they can make a difference in air quality...



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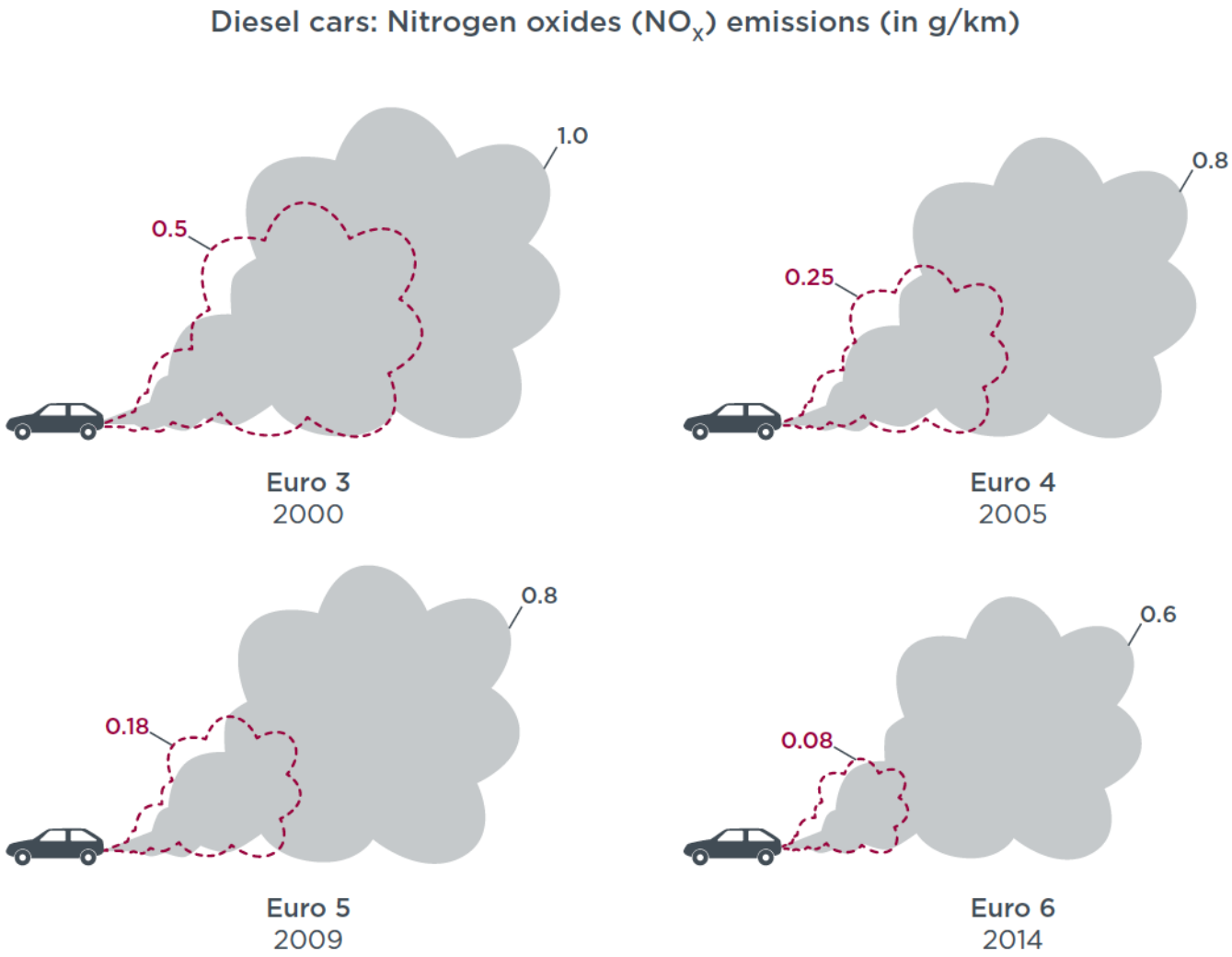
...but sometimes they are not successful: NOx emissions from Euro 6 Diesel cars are (on average) worse than they should have been 15 years ago!!



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Real Driving Emissions

The RDE-LDV process.
ICCT PEMS metastudy

Introduction: RDE-LDV process

Why does RDE-LDV matter?

- Air quality problems in Europe related to NO_X from road vehicles
- Driver of changes in Diesel NO_X aftertreatment; implications on small Diesel PC market
- Novel use of PEMS in LDV regulations. Other regions are looking at the EU!

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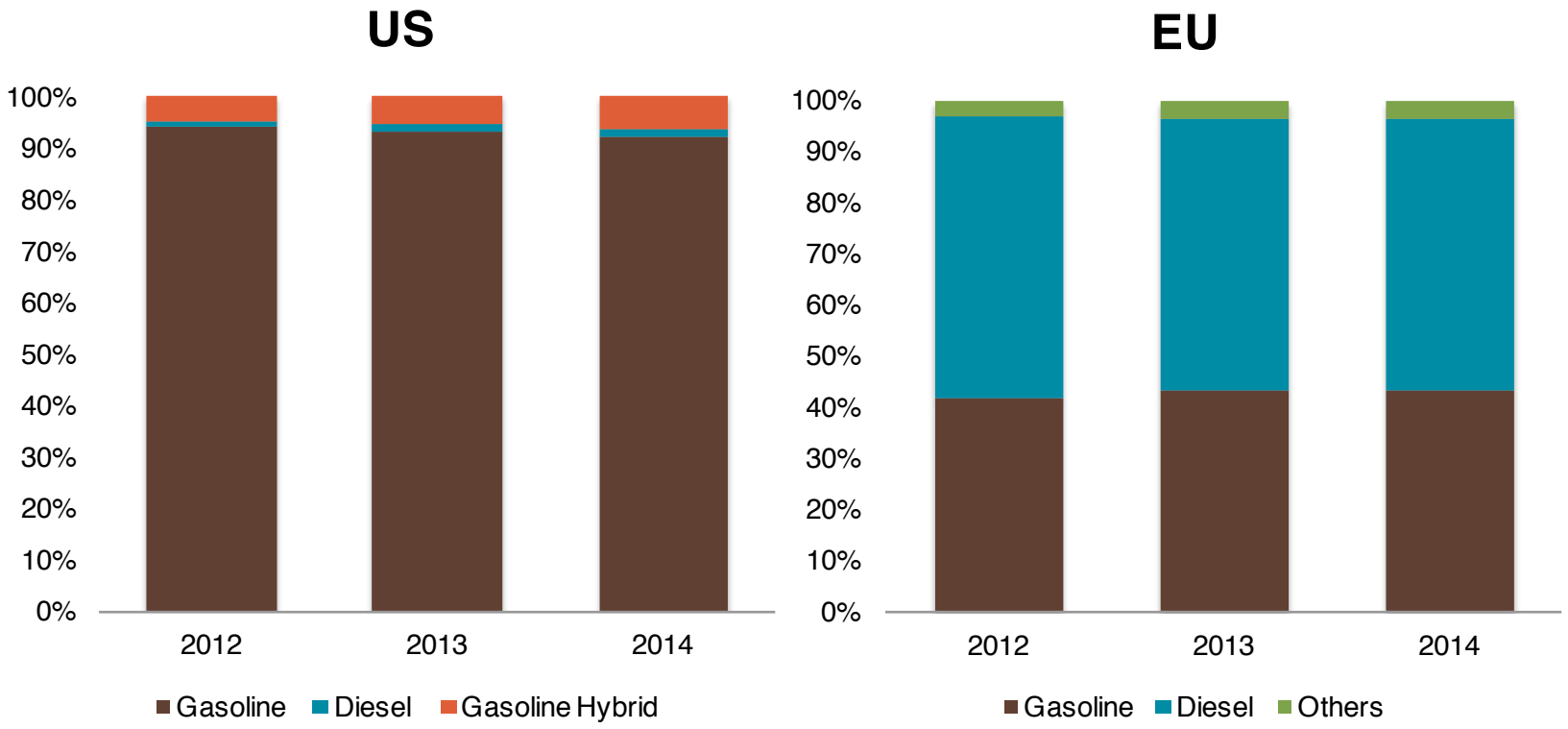
Introduction: RDE-LDV process

Why does RDE-LDV matter?



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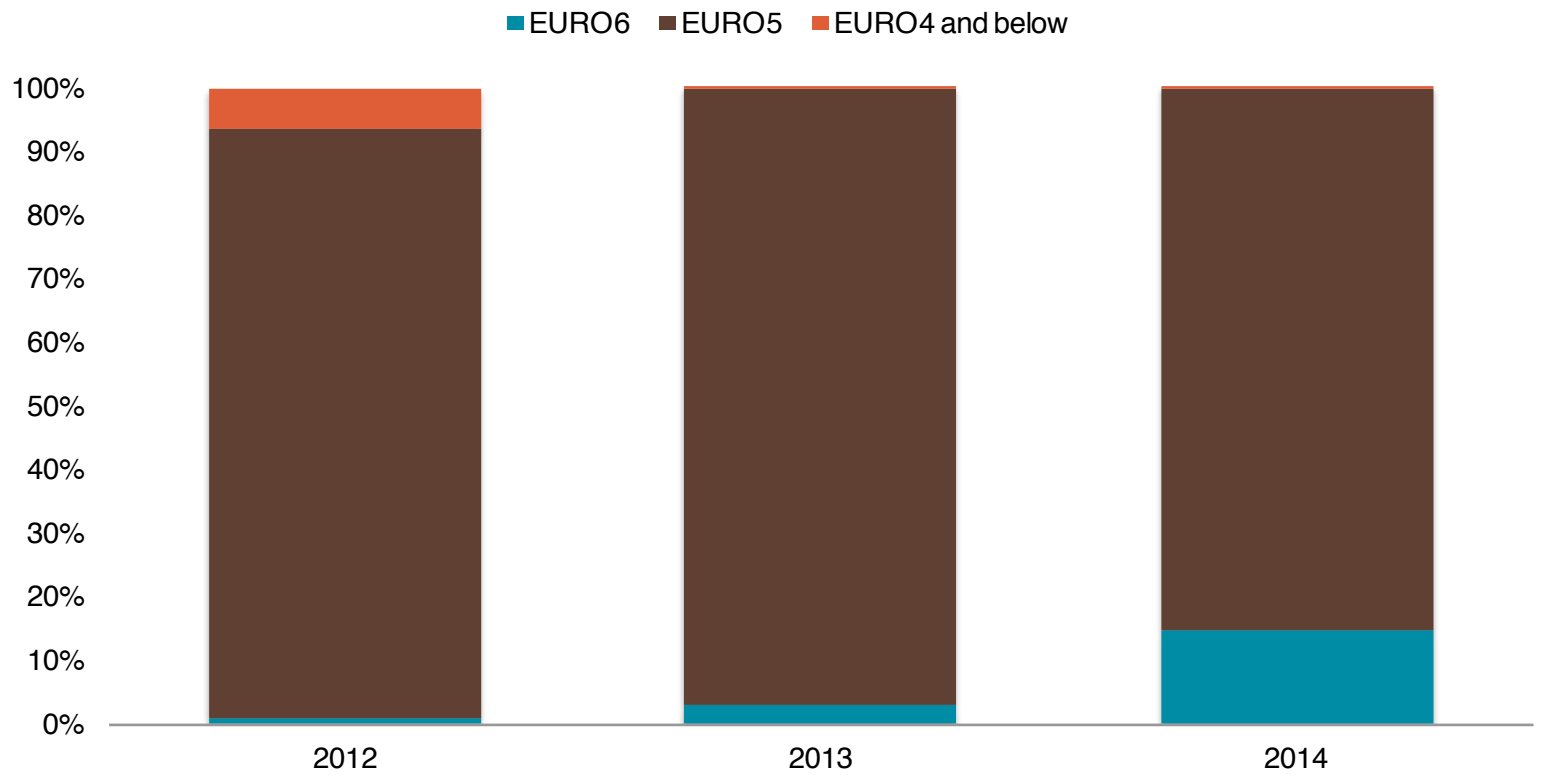
Introduction: RDE-LDV process

Why does RDE-LDV matter?



Diesel passenger cars meta-study

Real-world Emissions Report 2014: Modern Diesel Cars

- Multiple data sources
  - 15 vehicles (3 Tier 2 Bin 5 + 12 Euro 6)
  - 5 different sources
  - 96 trips/ 140 hrs / 6,400 km of recorded data

- One multi-level analysis and reporting framework
  - Raw emission factors (trip averages)
  - Windowed emissions ('on-road compliance')
  - Situation-specific emissions
  - Instantaneous emissions

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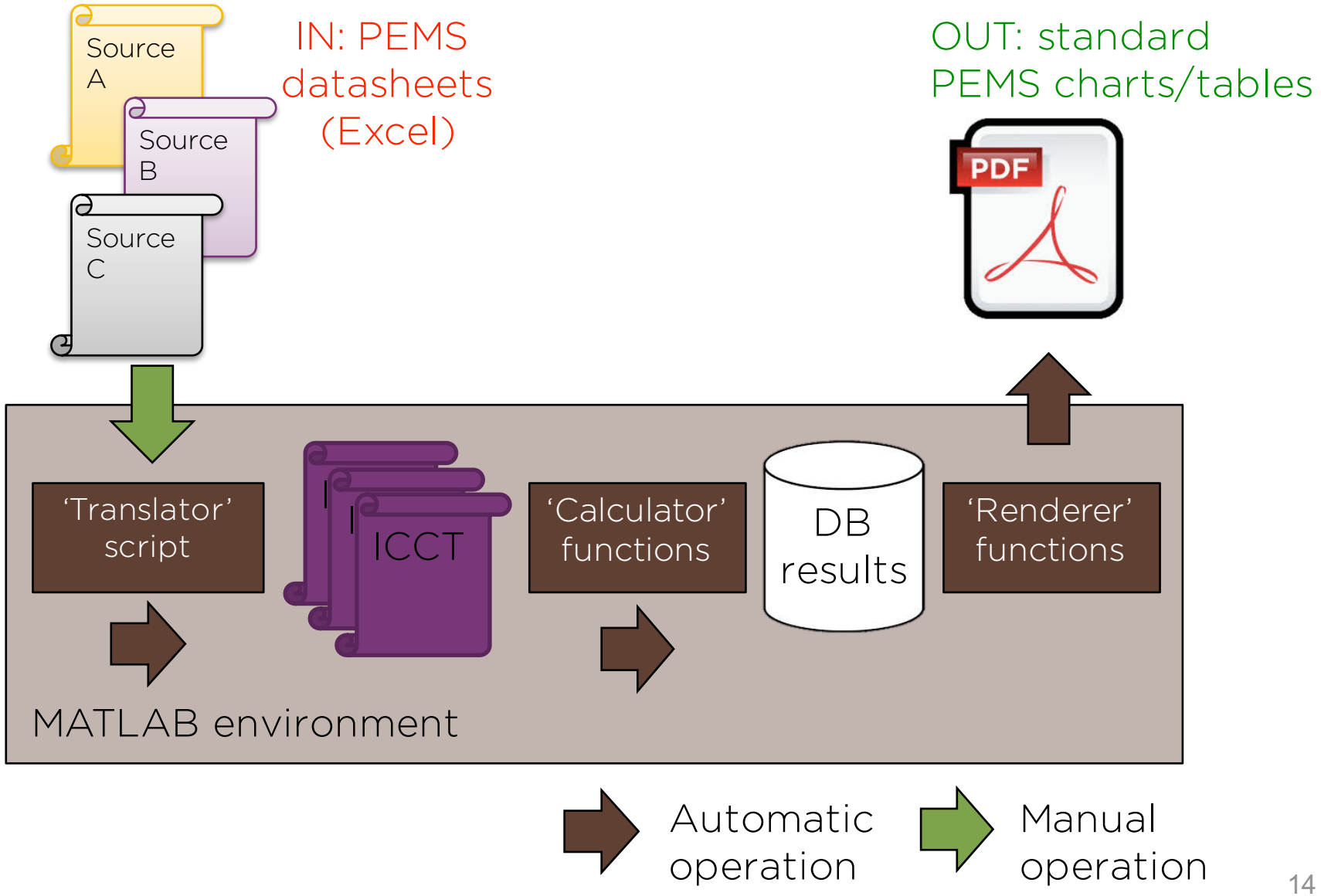
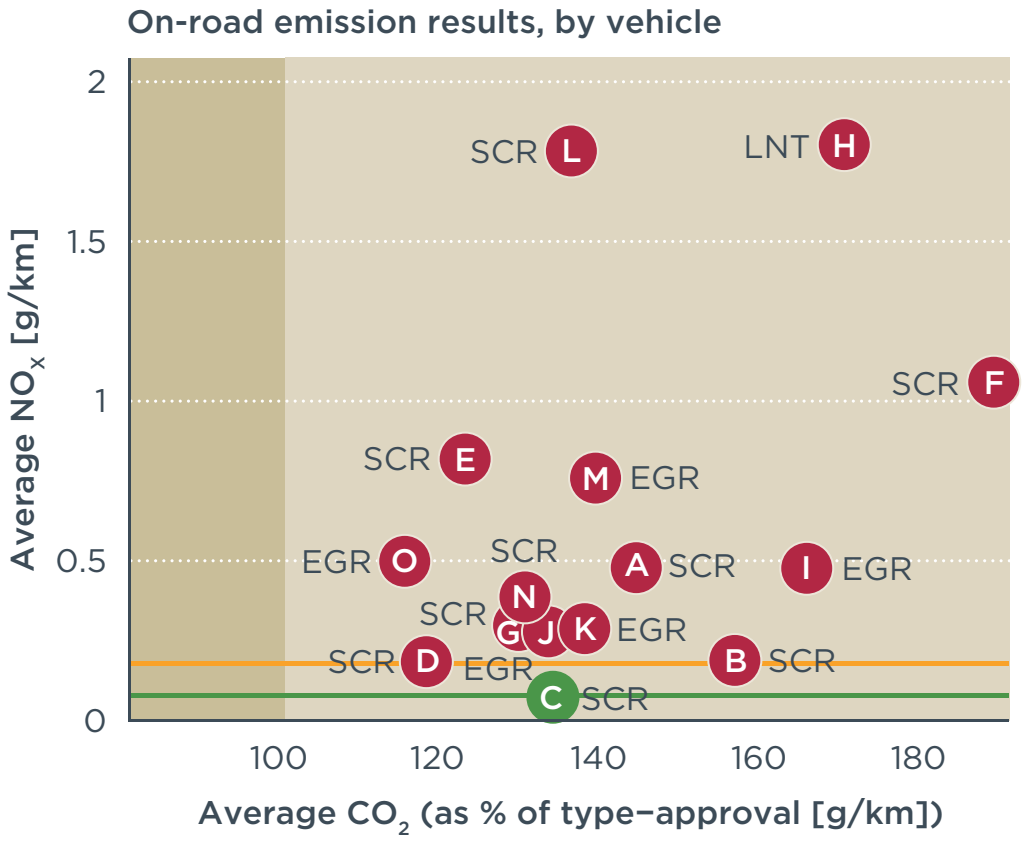
http://www.theicct.org/real-world-exhaust-emissions-modern-diesel-cars

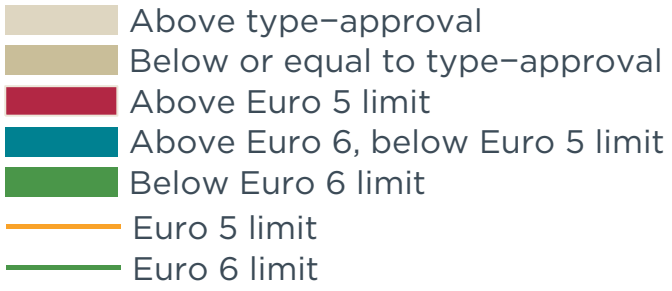
PEMS data analysis method



Diesel PEMS meta-study: Overall results

‘Raw’ average distance-specific emissions, by vehicle





15 test vehicles in total (6 manufacturers), with different NO_x control technologies:
- 10 selective catalytic reduction (SCR)
- 4 exhaust gas recirculation (EGR)
- 1 lean NO_x trap (LNT)

Average Euro 6 NO_x conformity factors (ratio of on-road emissions to legal limits):
- all cars: 7.1
- best performer (Vehicle C, SCR): 1.0
- bad performer (Vehicle H, LNT): 24.3
- worst performer (Vehicle L, SCR): 25.4

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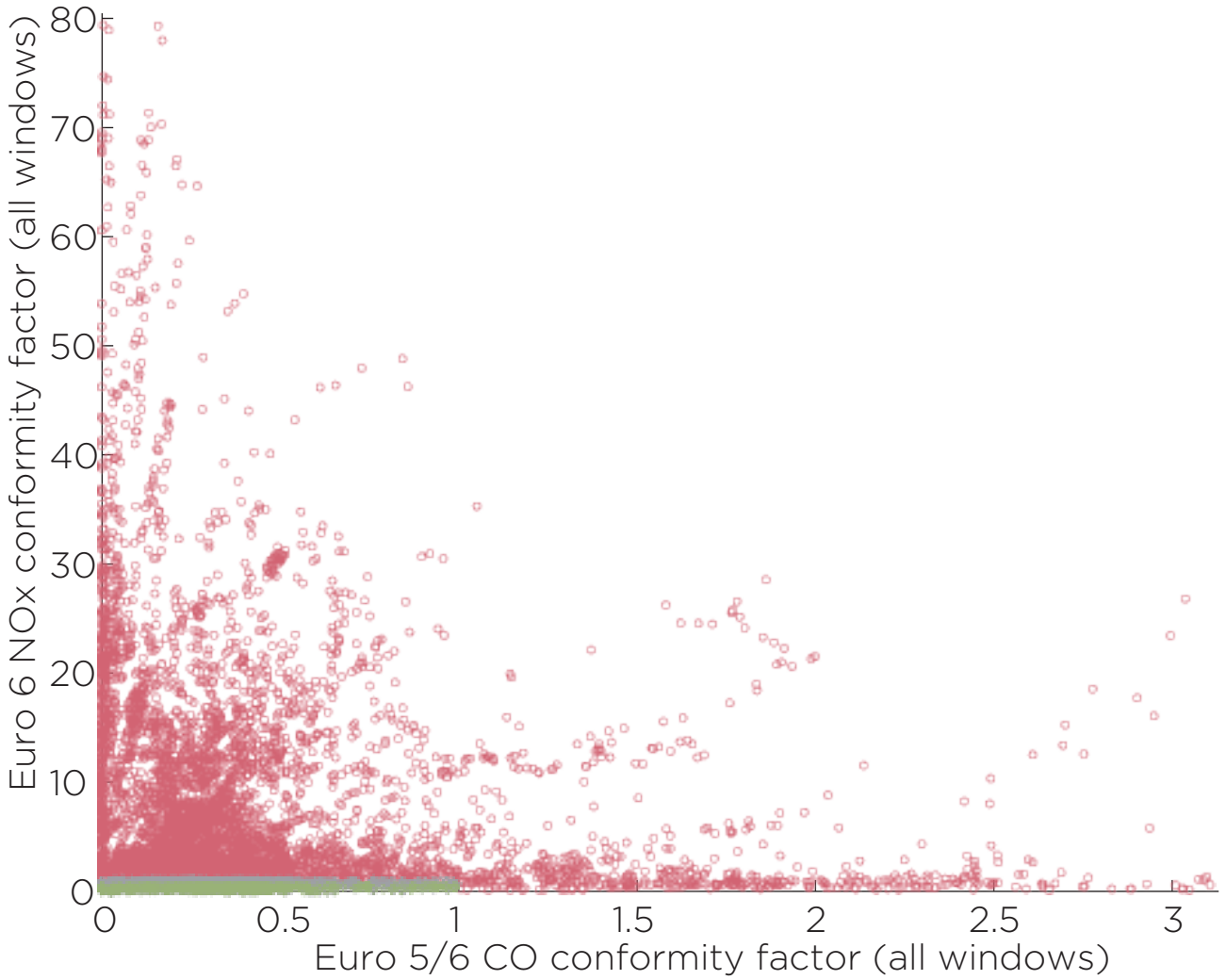
http://www.theicct.org/real-world-exhaust-emissions-modern-diesel-cars

Diesel PEMS meta-study: Results

On-road compliance (all CO_2 windows of all trips)



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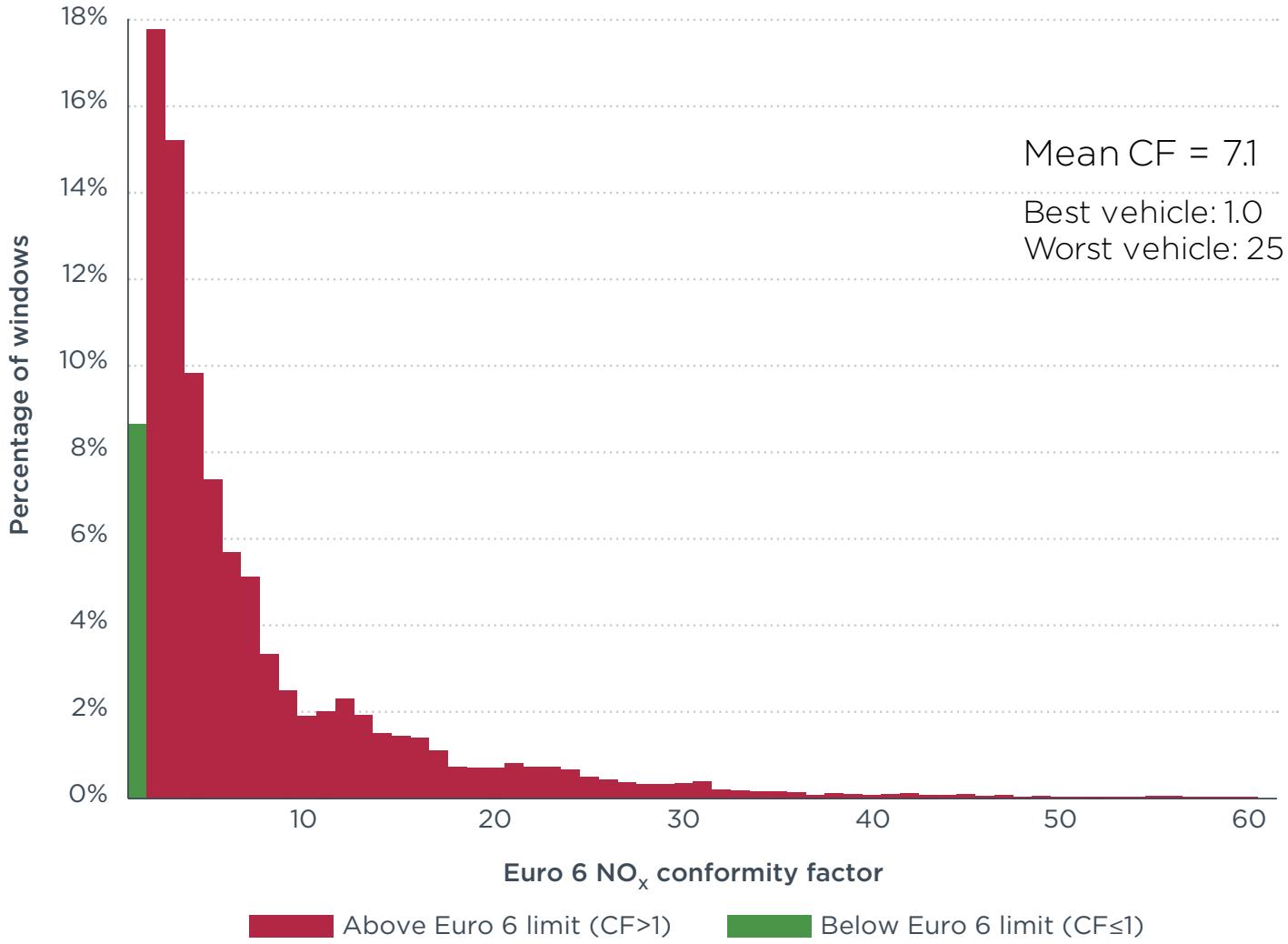
Diesel PEMS meta-study: Results for NO_x

Euro 6 conformity factor for NO_X, all vehicles



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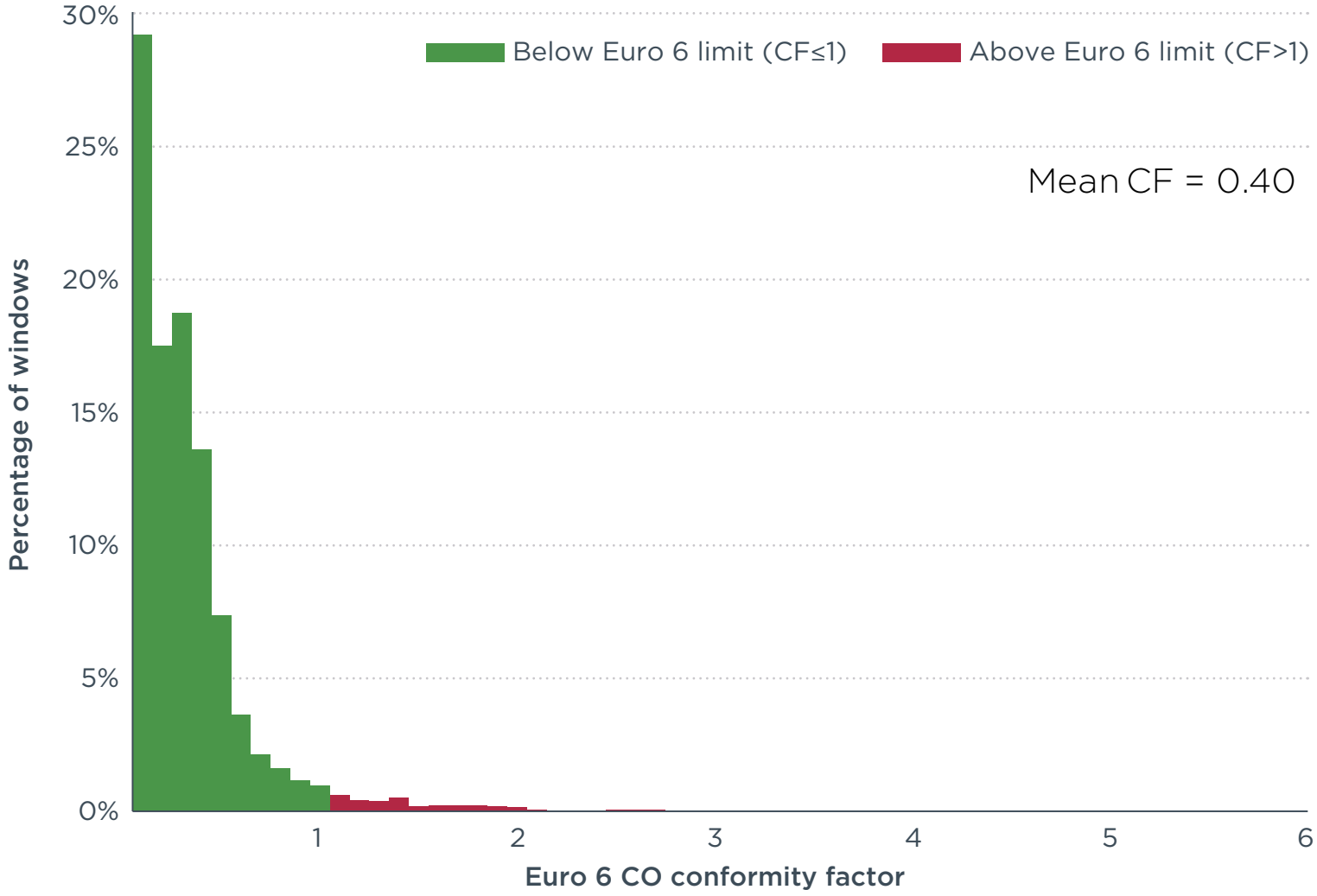
Diesel PEMS meta-study: Results for CO

Euro 6 conformity factor for CO, all vehicles



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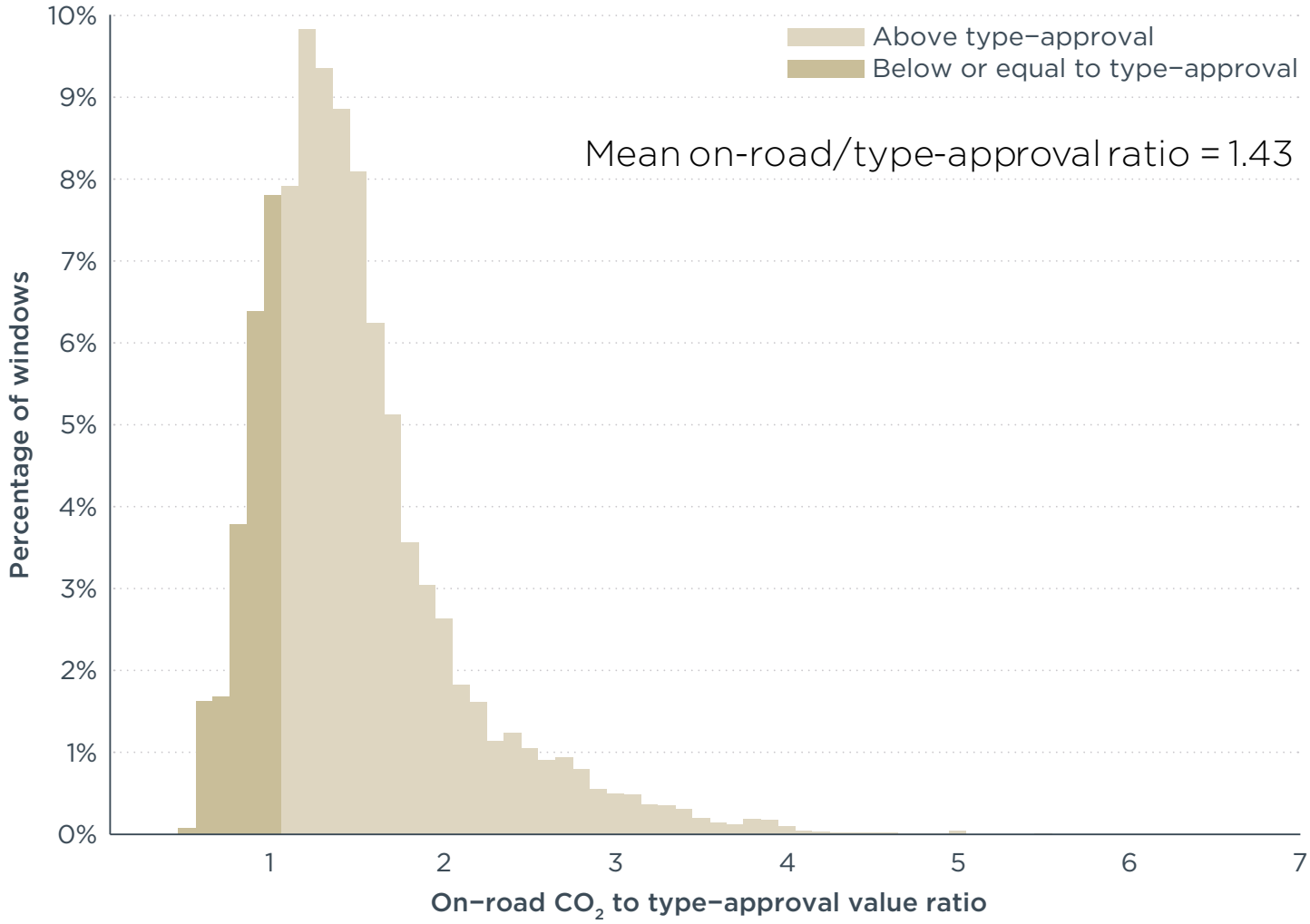
Diesel PEMS meta-study: Results for CO_2

Real-world CO_2 ratios, all vehicles



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Meta-study: Results in more detail

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Diesel PEMS meta-study: Results by driving condition

Situation-specific analysis: undemanding driving conditions

Combination	*Filtering*	*Descriptor*	*Color ID*
Undemanding driving (1)	Data are binned by velocity. Only Points with motorway speed below 120 km/h are included. Likewise, only the points in the 'Pretty flat', 'Medium temperature' and 'Mild negative a*v' or 'Zero or mild positive a*v' bins are included.	Undemanding Urban 1	
		Undemanding Rural 1	
		Undemanding Motorway 1	
Undemanding driving (2)	Same as 'Undemanding driving (1)', but including the 'Mild uphill' and 'Mild downhill' bins.	Undemanding Urban 2	
		Undemanding Rural 2	
		Undemanding Motorway 2	

Meta-study: Results by driving condition

NO_X emission factors [mg/km]

	All driving conditions					Undemanding 1			Undemanding 2		
	Raw	Idle*	Urb.	Rur.	Mwy.	Urb.	Rur.	Mwy.	Urb.	Rur.	Mwy.
Vehicle A	482	17	234	177	841	142	121	136	160	126	110
Vehicle B	235	12	206	331	81	65	27	31	77	68	26
Vehicle C	72	14	93	79	47	85	88	33	85	78	32
Vehicle D	171	35	253	130	82	247	112	62	227	126	62
Vehicle E	819	114	860	521	982	917	471	631	853	470	545
Vehicle F	908	183	1522	1083	533	1433	664	297	1429	792	426
Vehicle G	294	49	373	231	268	348	207	143	361	211	201
Vehicle H	1809	423	2166	1906	1471	1684	1232	1350	2054	1617	1380
Vehicle I	438	30	561	373	332	372	321	192	386	310	177
Vehicle J	279	12	362	317	199	360	277	163	364	288	151
Vehicle K	289	34	533	236	147	547	162	89	527	182	114
Vehicle L	1783	222	2350	1478	1544	2511	1250	1272	2346	1265	1290
Vehicle M	758	59	884	716	653	907	663	629	906	712	591
Vehicle N	388	45	558	297	271	545	277	165	558	275	172
Vehicle O	504	89	325	428	631	316	337	390	320	386	516

*Idling emissions in mg/min

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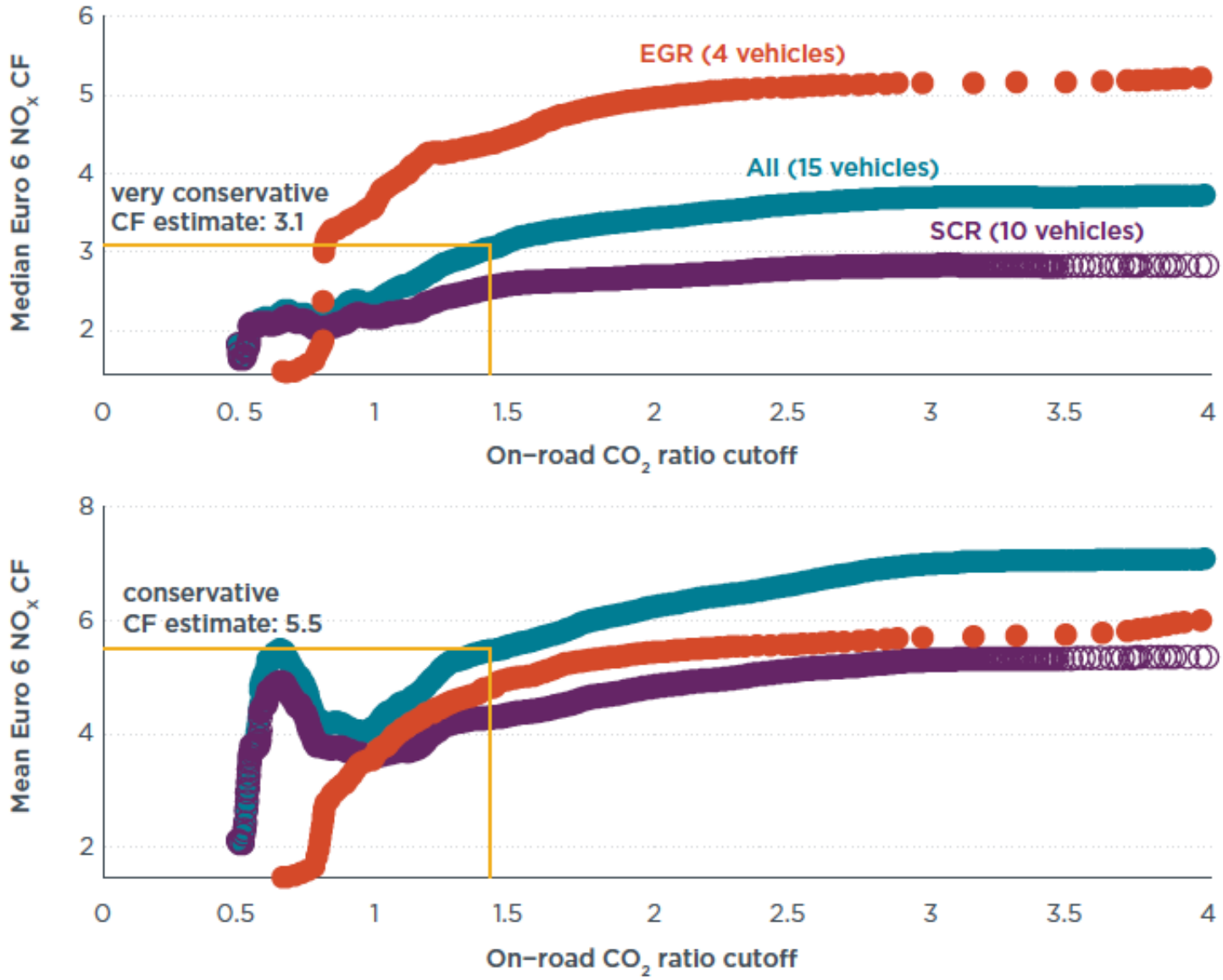
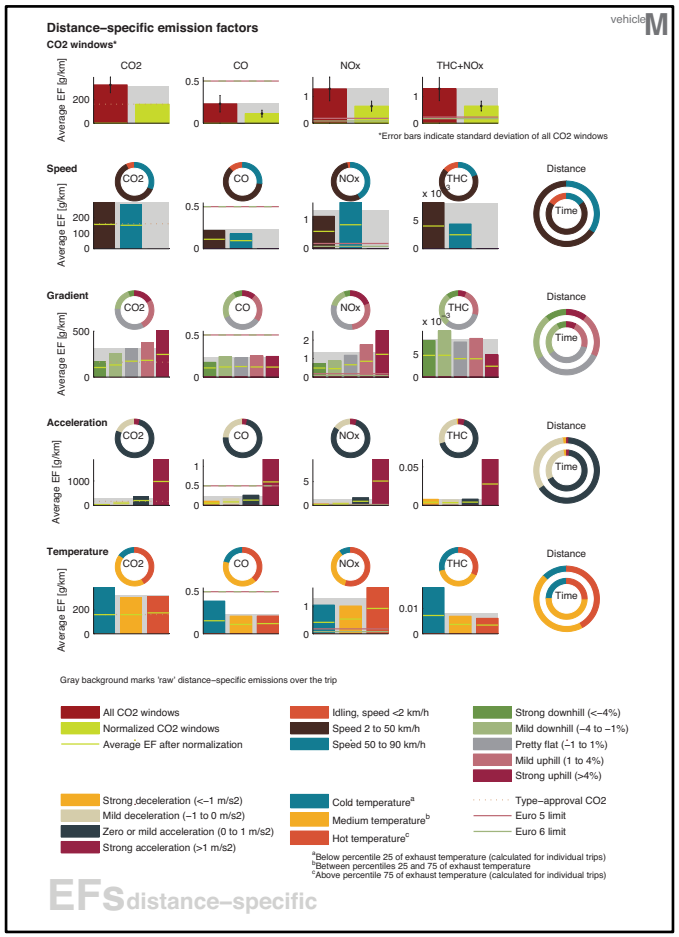
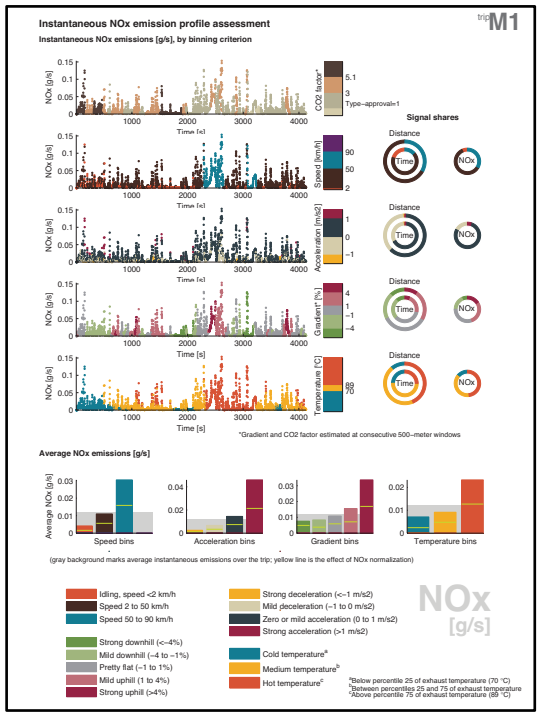
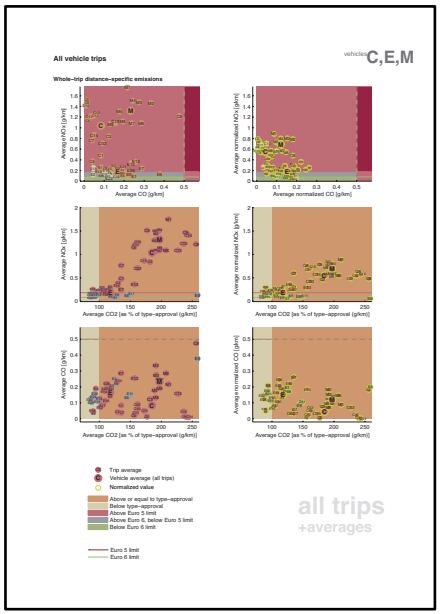
Diesel PC meta-study: Results by aftertreatment technology



Diesel PC meta-study: Part 2





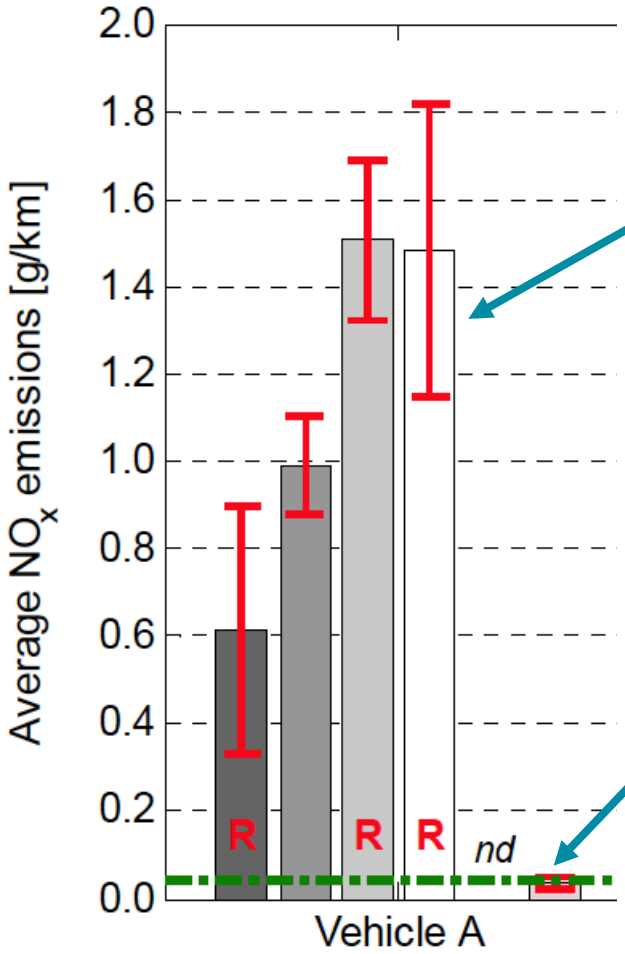


Coming soon, with additional vehicles and a detailed analysis of real-world emissions

Real Driving Emissions

Final thoughts

From laboratory to road: PEMS makes it possible to accurately measure real-world emissions



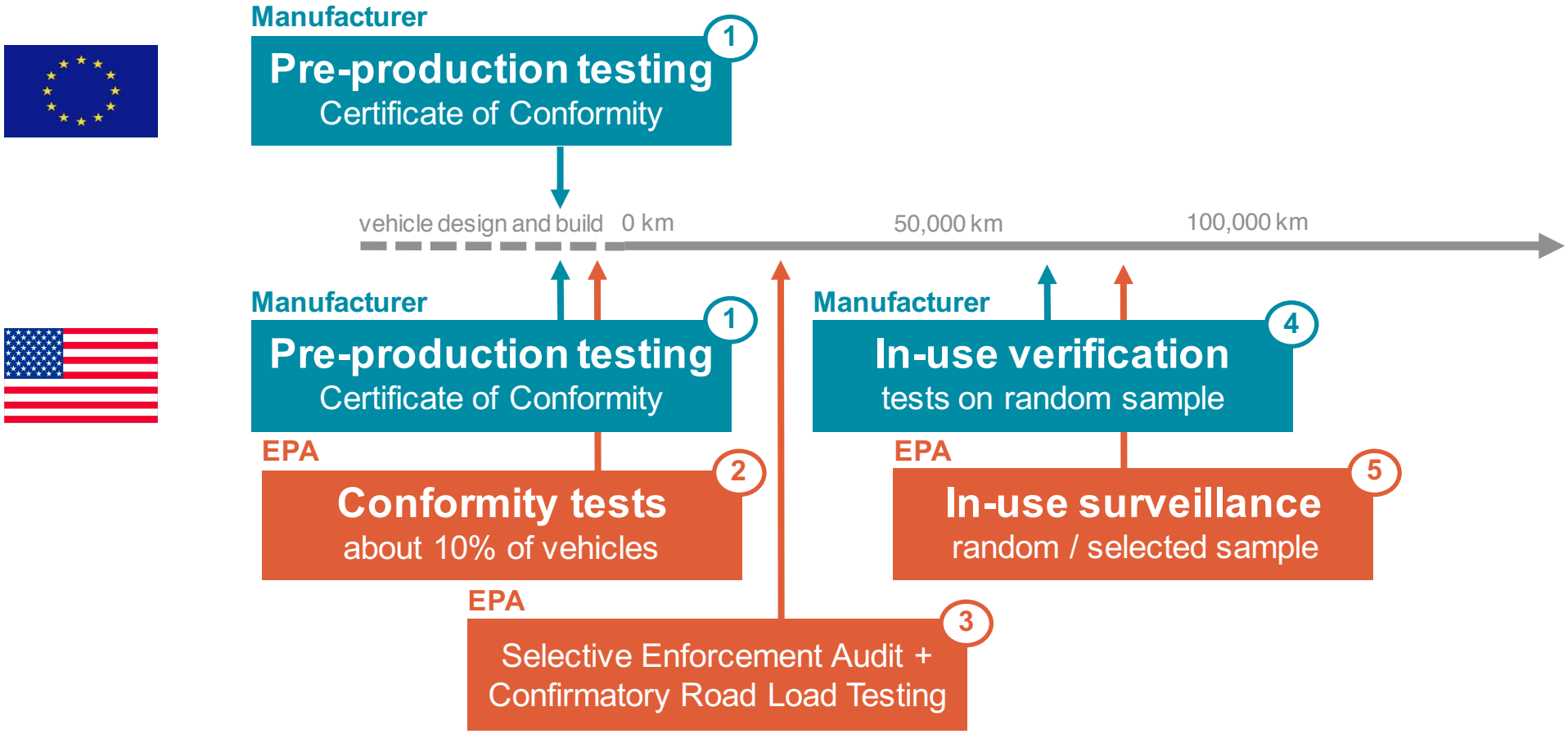
Road tests with PEMS

Chassis dyno measurements

Photo credit: AVL / ERMES Group
Vehicle photos unrelated to the results shown

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

Trust is good – control is better!
Vehicle emissions certification/testing in the EU and US



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http://www.theicct.org/blogs/staff/bought-tiger-got-hello-kitty-how-fix-vehicle-fuel-economy-fraud-china

In a nutshell

A robust pollutant / CO_2 regulation requires:

- A modern test procedure
- Independent retests
- On-road testing
- Transparency of test results

More info:

http://www.theicct.org/blogs/staff/trend-that-cant-continue-europes-car-co2-emissions-gap
http://www.theicct.org/blogs/staff/will-new-test-procedure-solve-problem-latest-developments-eu-vehicle-testing
http://www.theicct.org/blogs/staff/art-cooking-popcorn-and-2013-eu-statistical-pocketbook
http://www.theicct.org/wltp-how-new-test-procedure-cars-will-affect-fuel-consumption-values-eu
http://www.theicct.org/laboratory-road-2014-update
http://www.theicct.org/real-world-exhaust-emissions-modern-diesel-cars
http://www.theicct.org/wltp-november2013-update

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Thank you for your attention!

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