How to get to Euro VI

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Regulatory development

1. Regulatory design
2. Regulatory impact assessment & benefits of leapfrogging
3. Fuel quality & urea supply
4. Compliance, enforcement & verification

Latin America Euro VI

Euro VI has been adopted by four countries: Mexico, Brazil, Colombia and Peru.

Costa Rica requires DPFs.

Mexico has now rolled back standards by at least four years.

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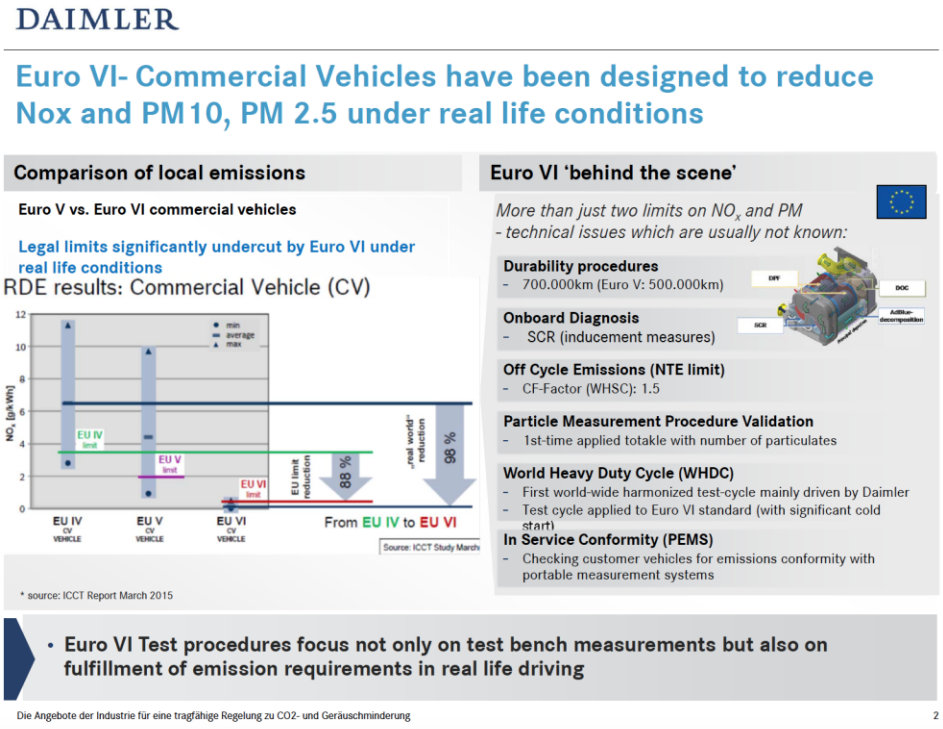
1. Regulatory design

Regulatory design

Full standard includes

- Durability
- OBD
- NTE
- WHDC
- In-service conformity



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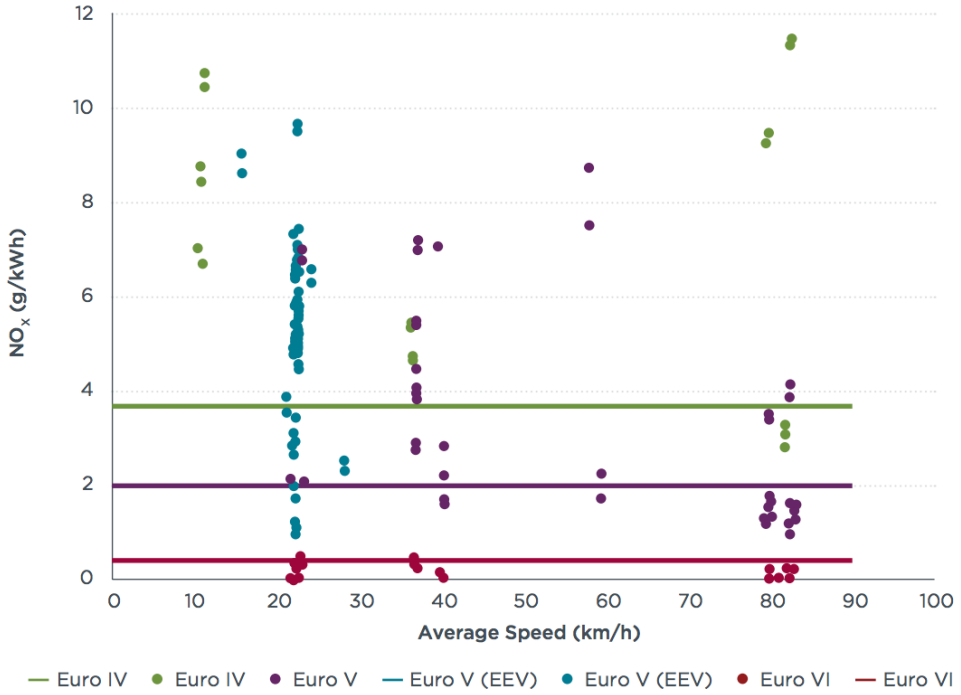
WHDC, NTE, OBD as important as g/kWh

Euro IV and V standards did not achieve reductions off the certification test cycle.

Real-world benefits are a result of comprehensive regulatory design.



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Fuente: http://www.theicct.org/sites/default/files/publications/ICCT_Briefing_EuroIV-V-VI-NOx_Mar2015.pdf

Cautionary tale #1: Brazil

Defeat Pathway	OBD monitoring strategies		Inducement Triggered	
	ARLA-32 Level	ARLA-32 Consumption*/Quality or Direct NO_x monitoring		
EURO V				
Disrupt signal from sensors	●	●	→	NO
Use an alternate fluid	●	●	→	YES
Loop outflow back into tank	●	●	→	YES
Use no fluid	●	●	→	YES
P-7				
Disrupt signal from sensors	●	●	→	NO
Use an alternate fluid	●	N/A	→	NO
Loop outflow back into tank	●	N/A	→	NO
Use no fluid	●	N/A	→	YES**

● Monitoring strategy does not indicate malfunction; ● Monitoring strategy indicates malfunction; N/A Monitoring strategy not available

* Consumption may be inferred, not directly measured.

**If system is reset within 48 hours of malfunction being detected, inducement will not be triggered.

Brazil weakened Euro V standards, allowing for even higher emissions than in EU.

- With proper OBD design, vehicle use is inhibited if system cannot function.
- Vehicles in Brazil do not incorporate these critical sensors and inducements.

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2. Regulatory impact assessment & benefits of leapfrogging

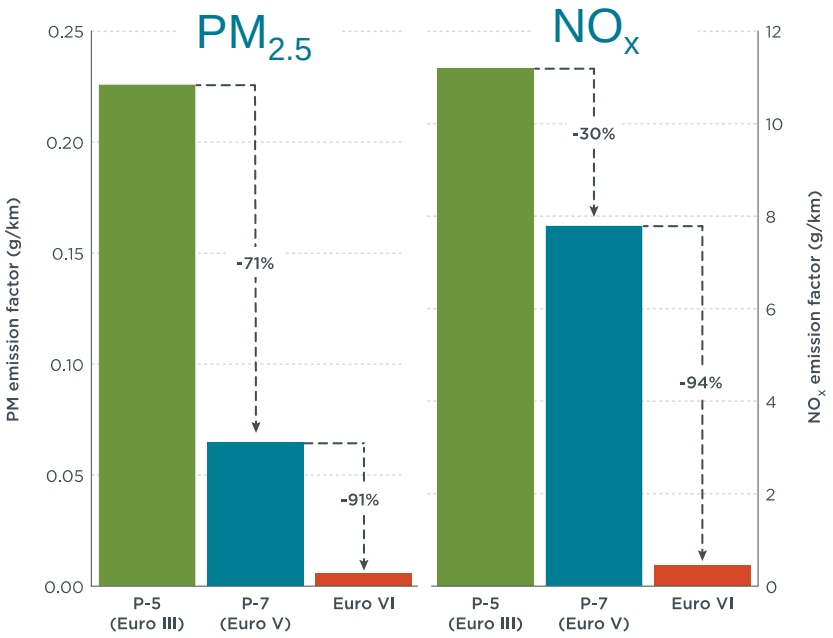
Regulatory impact assessment

Cost-benefit assessments regularly find benefits of Euro VI adoption are several times greater than the costs.

- Leapfrogging from Euro II or III to Euro VI provides a greater benefit to cost ratio as health impacts related to particulate matter are estimated based on mass of emissions reduced. Mexico benefit to cost ratio = 11
- But benefits still outweigh costs from Euro IV or V to Euro VI. Argentina benefit to cost ratio = 3.6

Emissions factors

- While Euro VI reduces PM emissions from Euro V by a greater %, the total mass of emissions reduced by Euro V is greater.
- NOx emissions reductions are greater in both % and mass.



Dallmann, 2019
HBEFA, 2017

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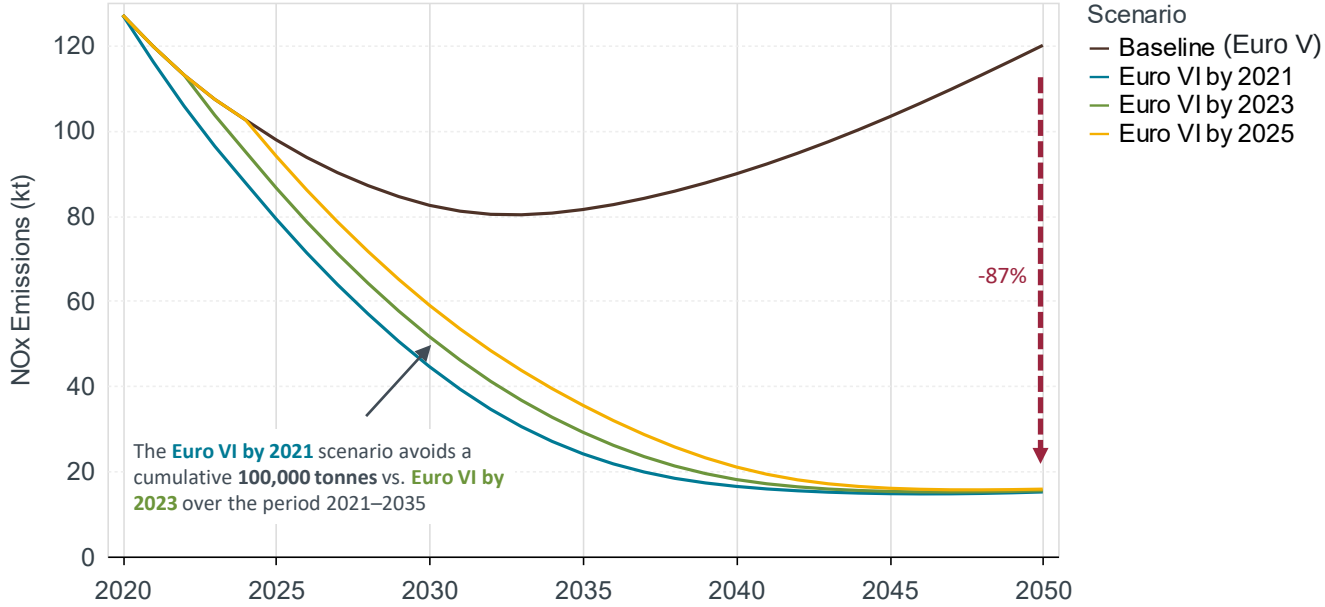
Argentina cost-benefit: NOx emissions



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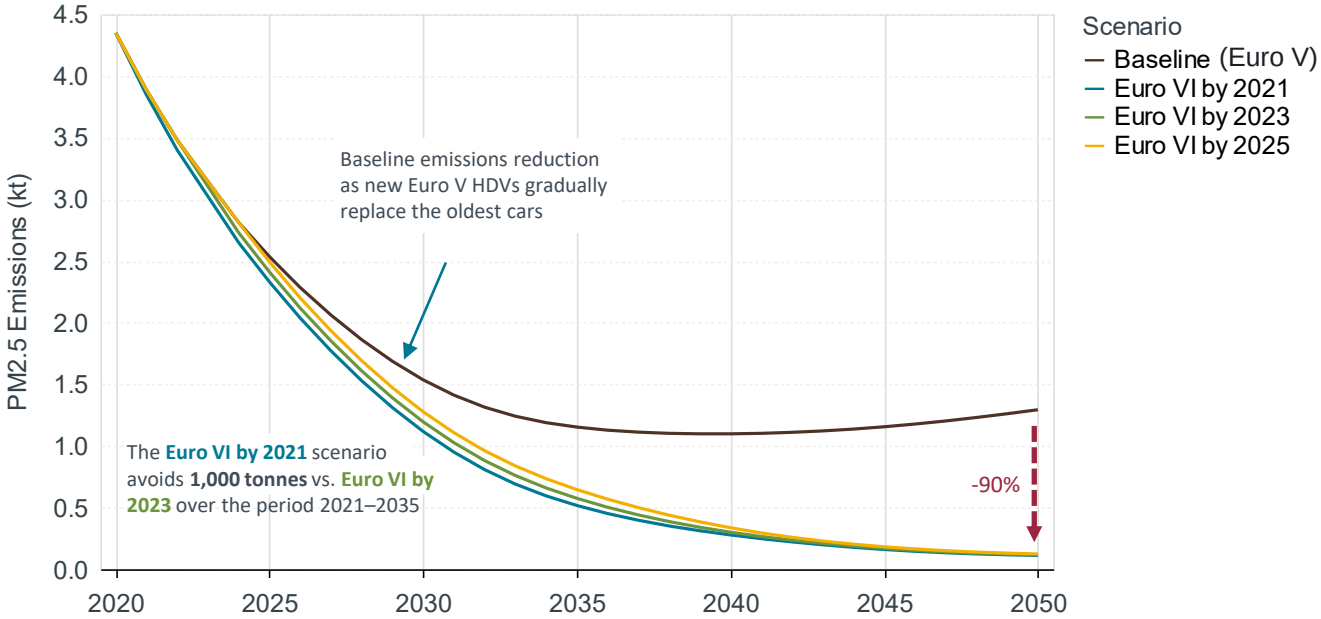
Argentina cost-benefit: $PM_{2.5}$ emissions



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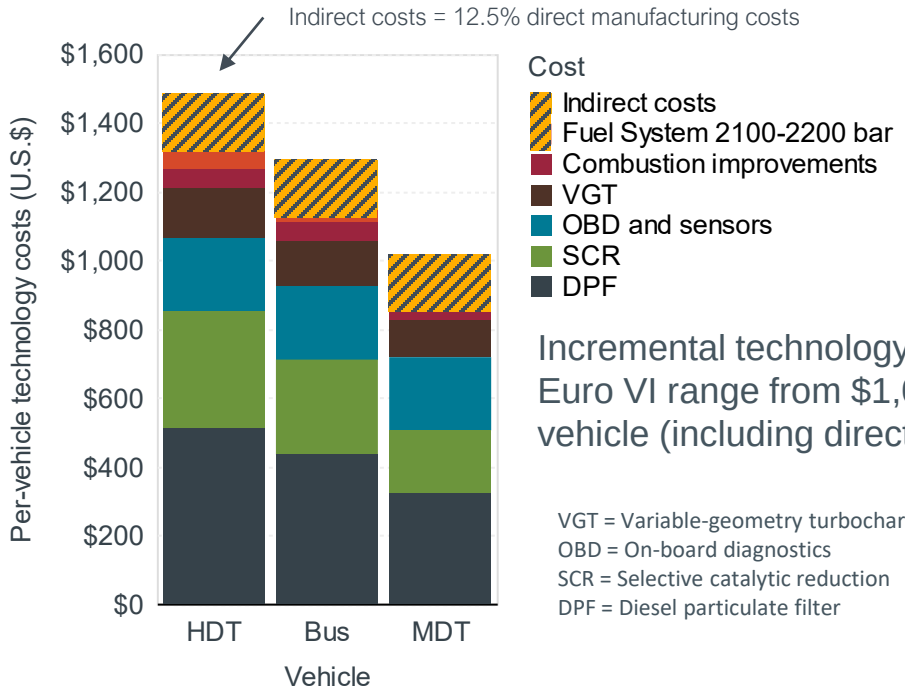
Argentina cost-benefit: Technology costs



Incremental technology costs from Euro V to Euro VI range from $1,000–$1,500 per vehicle (including direct and indirect costs).

VGT = Variable-geometry turbocharger
OBD = On-board diagnostics
SCR = Selective catalytic reduction
DPF = Diesel particulate filter

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Argentina: Costs and benefits

Net benefits over the period 2021–2035 (15 years)

Scenario	Cumulative private costs (million U.S.$)	Cumulative health benefits (million U.S.$)	Net benefits (million U.S.$)
Euro VI by 2021	325	776	451
Euro VI by 2023	267	593	327
Euro VI by 2025	213	433	219

Over 15 years, benefit to cost ratio > 2.

Net benefits over the period 2021–2050 (30 years)

Scenario	Cumulative private costs (million U.S.$)	Cumulative health benefits (million U.S.$)	Net benefits (million U.S.$)
Euro VI by 2021	620	2,202	1,583
Euro VI by 2023	559	1,990	1,432
Euro VI by 2025	502	1,787	1,285

Over a 30-years, every $1 invested in Euro VI would produce $3.6 in health benefits.

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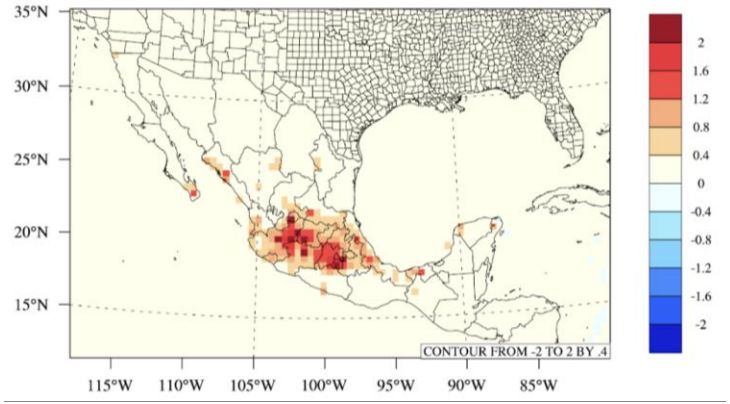
Mexico: Air quality benefits

Air quality indicator (population-weighted)	Nationwide	Mexico City
Annual mean $PM_{2.5}$	-18%	-20%
8-hour maximum ozone	-8%	-5%
1-hour maximum ozone (spring mean)	-12%	-14%

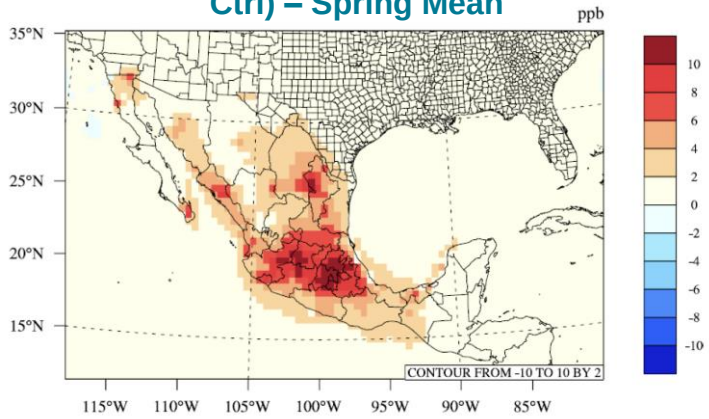
PM

Difference in annual mean $PM_{2.5}$



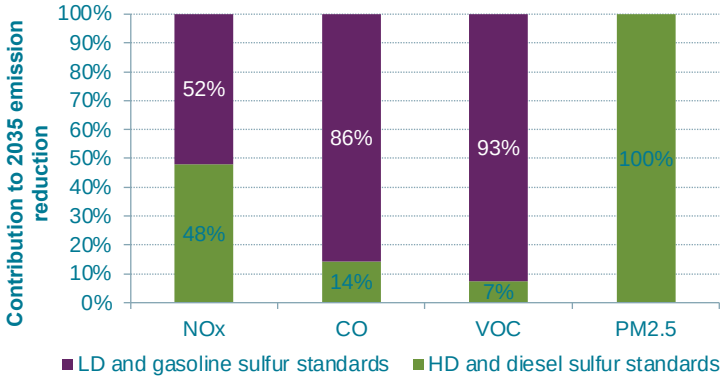
Ozone

Reduction of 1 hr O3 max (Base - Ctrl) – Spring Mean



Fuente: https://www.theicct.org/sites/default/files/publications/Mexico-emissions-review_ICCT-Working-Paper_03012018_vF_0.pdf

Mexico: Comparing LDV and HDV benefits



In the example of Mexico, updating HDV emissions standards will have ~twice the benefit of updating LDV standards. Direct diesel PM emissions have the greatest health impact.

	HDVs	LDVs	Total	%
Ozone	900	1,100	2,000	22%
Secondary PM	1,400	1,700	3,100	34%
Primary PM	3,900	0	3,900	43%
Total PM	5,300	1,700	7,000	78%
Total	6,200	2,800	9,000	100%
%	69%	31%	100%	

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3. Fuel quality & urea supply

Fuel quality & urea supply

10-15 ppm sulfur diesel is important

- Euro VI vehicles need this fuel to meet emissions standards
- PM emissions are also reduced for older vehicles in the fleet using lower sulfur fuel
- Emissions controls can recover from occasional use of higher sulfur fuel, but regular use could cause lasting damage and would reduce durability of systems

Diesel exhaust fluid is also important

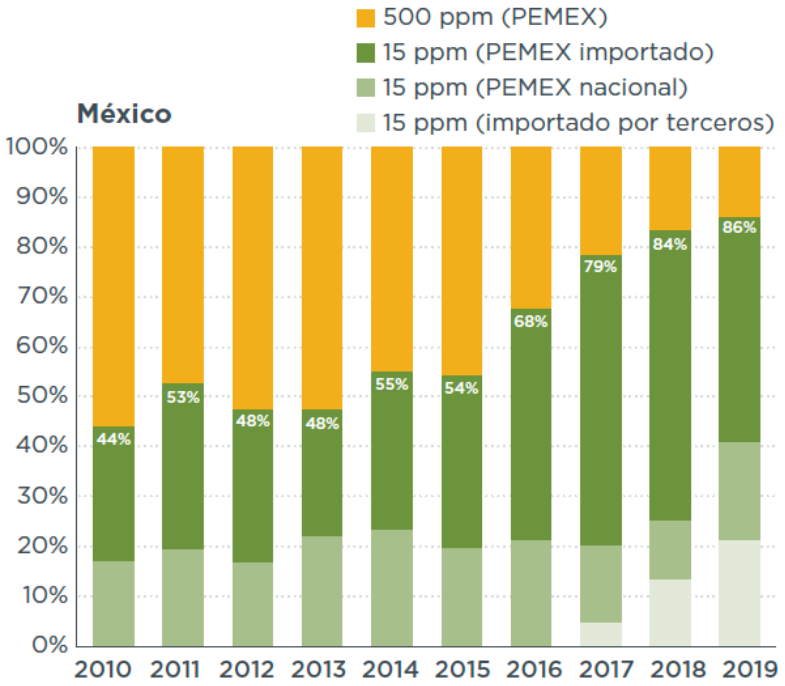
- The main component of DEF is urea, a common product with many uses
- Distribution systems have generally sprung up quickly for this product to be sold in fuel stations, as soon as vehicles require it.

Cautionary tale #2: Mexico

Mexico's HDV emissions standard (NOM-044) is linked to the fuel quality standard, requiring 100% of the diesel to meet the 15-ppm sulfur standard.

Full implementation of diesel standard has been delayed from 2009 to 2019, now to 2025 at the earliest.

SEMARNAT rolled back vehicle standards to match this date even though more than 80% of the diesel meets 15 ppm standards.



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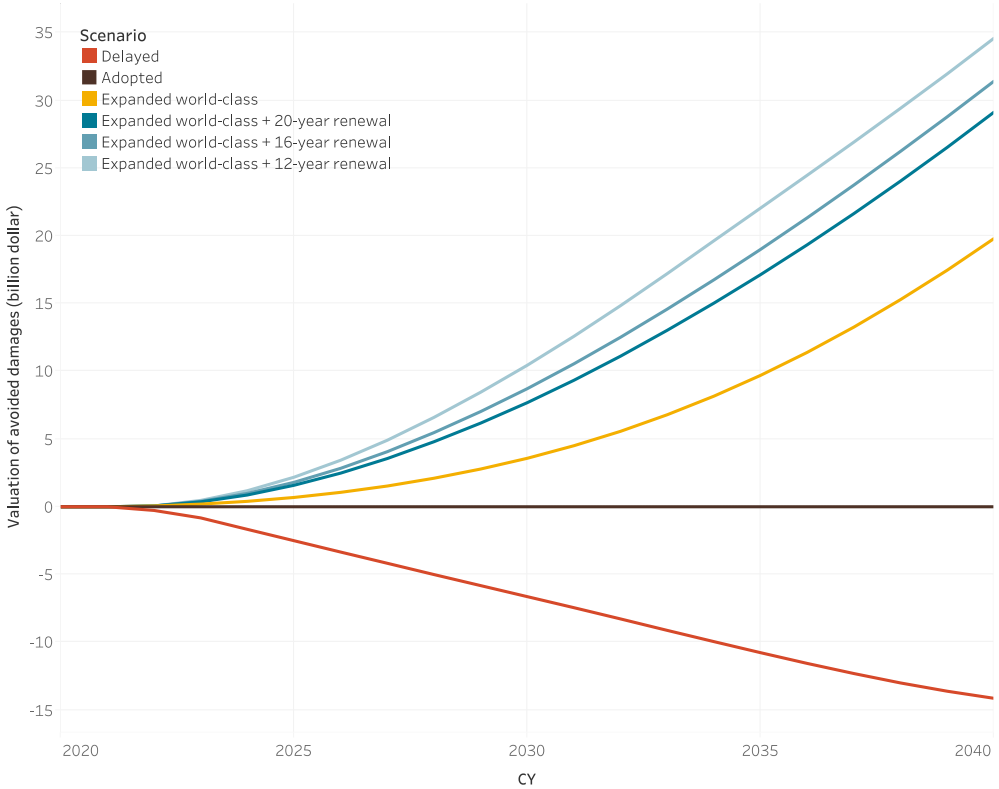
Cautionary tale #2: Mexico

The cost of the 3-year delay:

- Aproaches USD 15 billion over 20 years
- On the other hand, expanding standards to used vehicles offers USD 20 billion in value
- Acclerating fleet renovation almost doubles that
- USD 15-50 billion in benefits lost through the 3-year rollback



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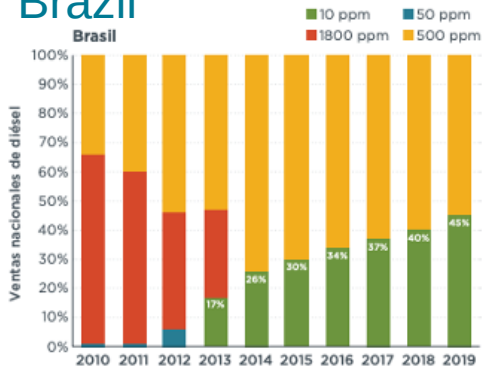
A dual fuel approach can work

MX truck manufacturer association told the government, “There is no country in which a technology has been made obligatory, if the fuel is not available first.”

TRUE, but many countries have not required compliance for 100% of the fuel.

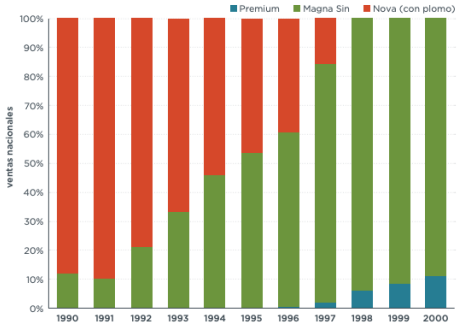
A few examples…

Brazil



United States

Mexico



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* https://www.milenio.com/negocios/anpact-pide-ajustar-norma-camiones-pesados

Dual fuel requirements for success

Distribution

- Lower sulfur fuel must be available on major corridors & at regular intervals, accompanied by consumer awareness campaigns

Pricing

- Lower sulfur fuel must be priced competitively with higher sulfur fuel, even better is to provide a price or tax advantage

Labeling

- Fuels must be clearly labeled at the pump and there should also be labeling on the vehicle stating the need to refill with lower sulfur diesel

Enforcement

- Enforcement campaigns should provide consumers with confidence that they are getting the proper fuel

4. Compliance, enforcement & verification

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Compliance, enforcement, & in-use verification

Compliance

Ensure that the registered vehicles meet regulatory requirements:
- Identify cases of noncompliance when they exist
- Such as pre-, in-, and post-production vehicle

Enforcement

Hold responsible parties accountable and correct the situation:
- When vehicles are found to be out of compliance with the standards
- Such as noncompliant vehicle recalls and financial penalties

Verification

Ensure vehicles are operating as intended
- Remote sensing
- Fleet programs

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Maintenance requirements

	Euro IV	Euro V	Euro VI
Technologies	EGR or SCR	EGR / SCR	EGR / SCR / DPF
Lubricating oil			E9, APT CJ-4 (low SAPS)
Fuel			Low sulfur diesel
AdBlue DEF	Standard 2-4%	Standard 3-5%	Standard 4-7%
DPF			Maintenance after 300’000-500’000 km
SCR dosing unit	Filter replacement	Filter replacement	Filter replacement
Breather filter	Replacement	Replacement	Replacement
Sensors	NOx sensor	NOx sensor	NOx/NH3 sensor

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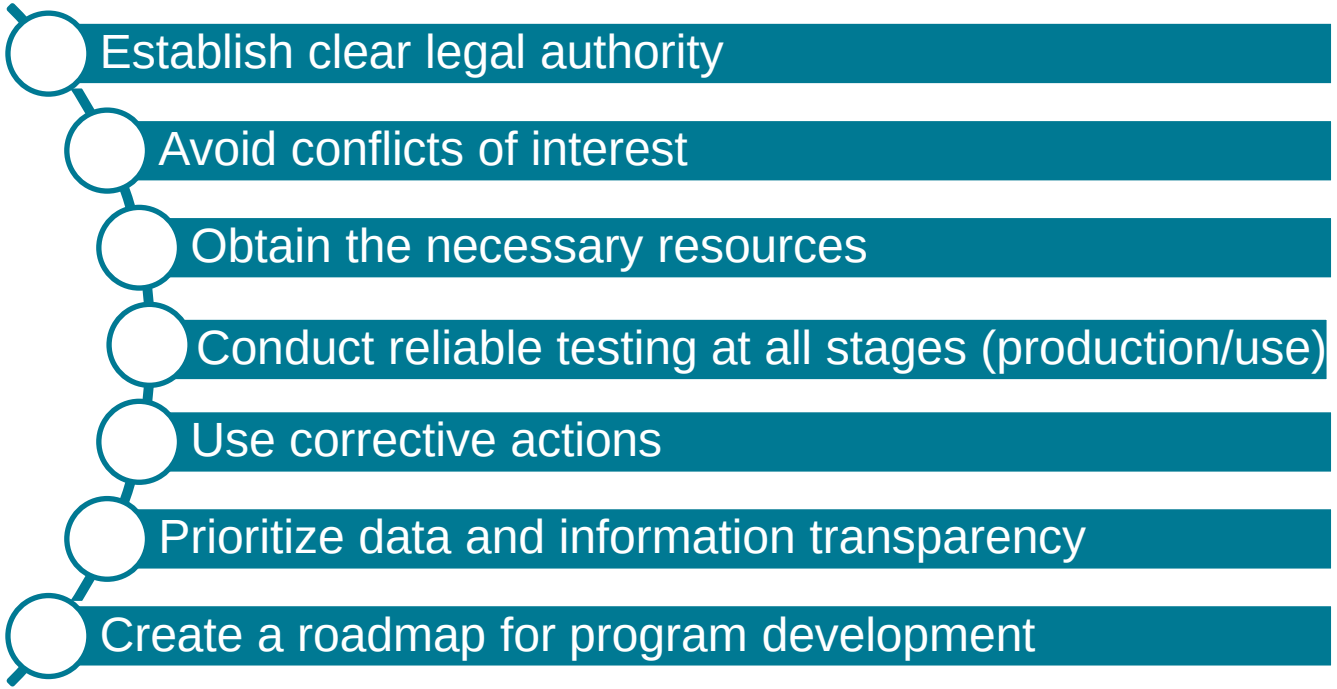
7 C&E Best Practices



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Recommendations for developing countries

Sufficient funding for enforcement programs

- Example: Certification fees covering the costs

Clear legal authority for compliance & enforcement activities

- Need authority to conduct in-use testing, investigate defeat devices, force recalls for failure to comply, and impose fines

In-use testing and **recalls**

- Include vehicles at higher mileage (50,000 km - 100,000 km)
- Recall if > 50% of the tested vehicles fail to meet the standards
- A robust in-use testing program can reduce effort needed on the pre-production program

Remote sensing programs

- Low-cost way to help track and identify issues that need more attention: New vehicles, deterioration, differences between manufacturers, high emitters, defeat devices for SCR systems
- Provide support for and confirmation of inspection & maintenance programs

Additional Recommendations

Independent testing

- Having access to independent laboratory facilities for pre- and post-production tests is best.

Emission warranty provisions

- Defect reporting requirements
- Puts pressure on manufacturers to develop and provide more robust emissions control systems, better for consumers

OBD and I&M

- Detect use of consumer defeat devices for SCR systems, when the urea tank has not been refilled with urea or is not dosing properly

Defeat device provisions

- These require a high degree of expertise for enforcement
- Remote sensing can help identify problems

Data transparency

- Difficult in all markets

Recommendations

1. Adopt the full standards, especially including test cycles and OBD
   - Emissions limits are not sufficient to achieve the real-world benefits
2. Leapfrog directly to Euro VI
   - Most cost-effective approach
3. A dual fuel approach can work well & the private sector will meet the urea demand
   - Distribution & marketing, pricing, labeling and enforcement will make this approach successful
4. Compliance, enforcement & verification is increasingly important
   - Funding and authority are the 1st priority, in-use testing and remote sensing are the 2nd

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Thank you!

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