7. Toolkit: Policy instruments available to improve the fuel economy of cars

Jacob Teter - IEA

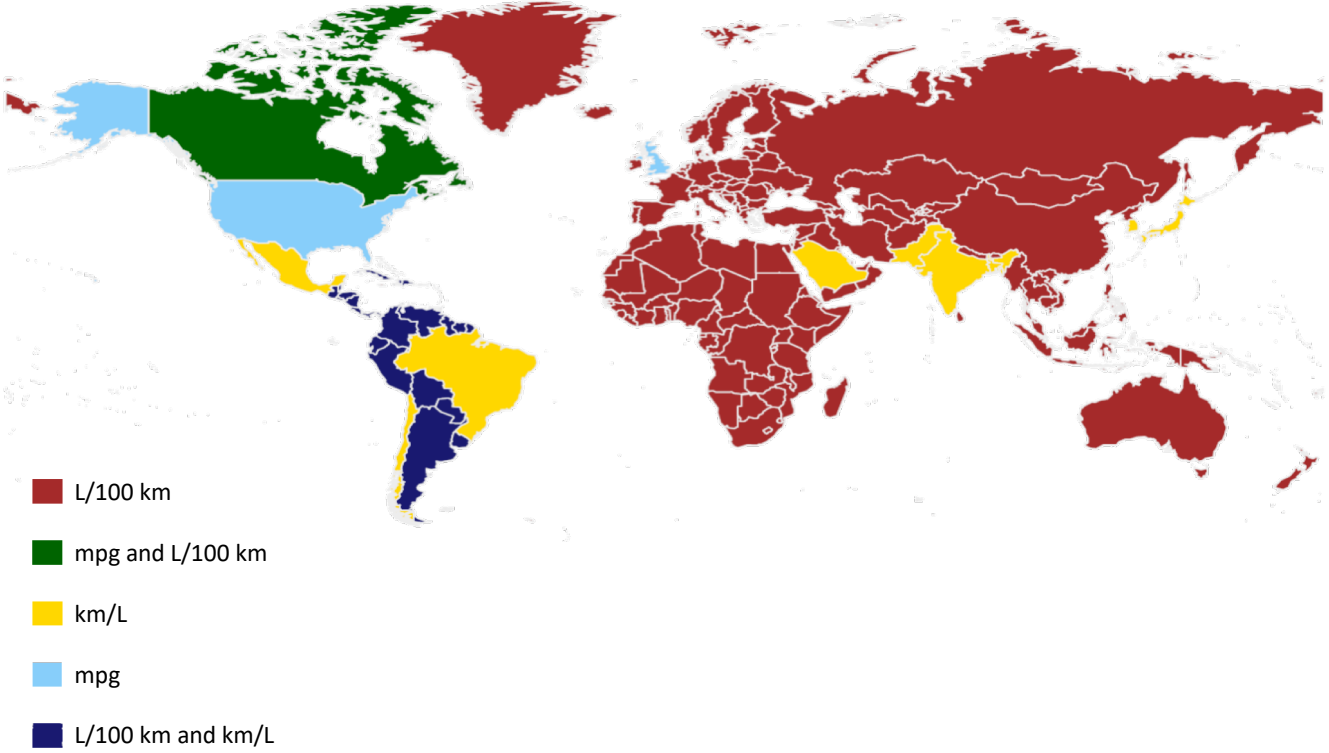
17 May, IEA Energy Efficiency Training Week

IEA

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What is fuel economy?

Fuel economy: the relationship between the fuel used and distance travelled by a vehicle



This map is without prejudice to the status of or sovereignty over any territory, to the delineation of international frontiers and boundaries, and to the name of any territory, city or area.

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What is fuel economy?

Important relationship:

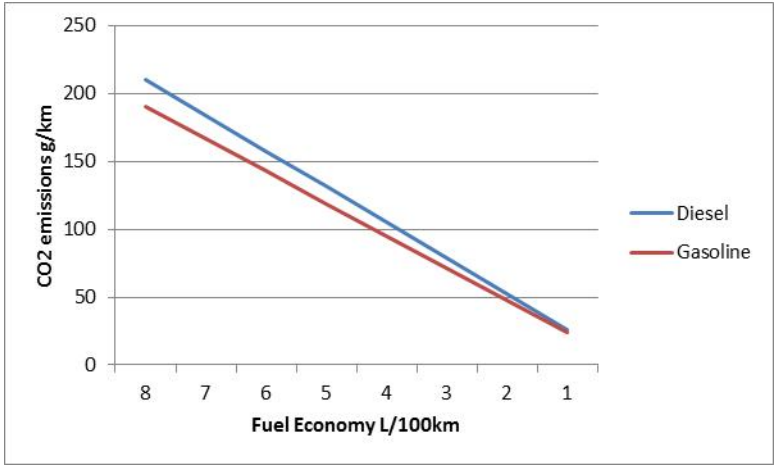
About 2.4 kg of CO_2 emitted per litre of gasoline burned, 2.6 for diesel.

- For gasoline vehicles, 8 L/100 km = 189 g/km CO2 emissions, 7 L/100 km = 165 L/100km, etc.
- It's a fixed relationship.

  So the only way to cut CO_2 emissions is to burn less fuel (you can't capture it at the tailpipe).

If you improve vehicle fuel economy, you:

- Save fuel
- Reduce costs
- Cut CO_2 emissions
- **Don't** help air quality very much (though complex and important topic)



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What is fuel economy?

Fuel economy improvements can be achieved through:

- Technical changes to vehicles
- Changing the types of vehicles bought
- Improving vehicle maintenance
- Changing the way vehicles are driven (ecodriving)
- Reducing traffic congestion

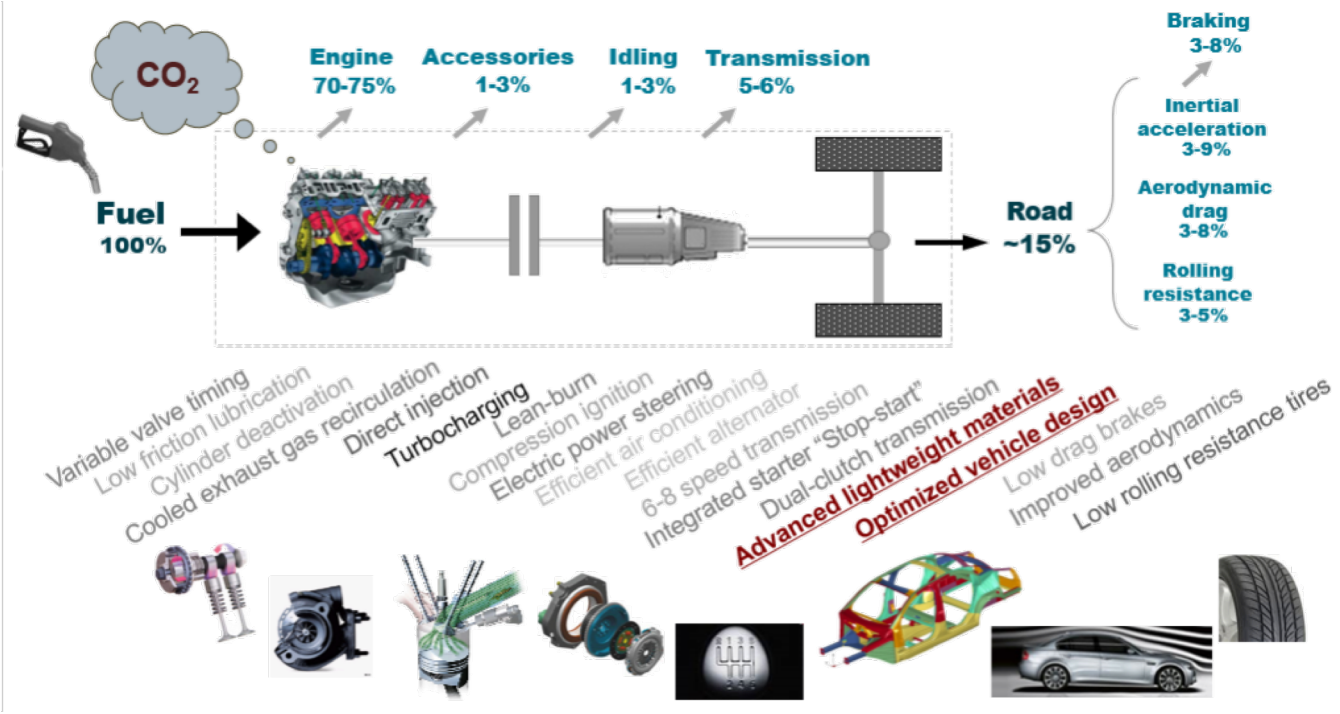
Fuel economy improvement to vehicles should be part of a broader strategy:

- Traffic management
- City and regional planning
- Promotion of public transit
- And many others…(avoid-shift)

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How to improve vehicle fuel economy

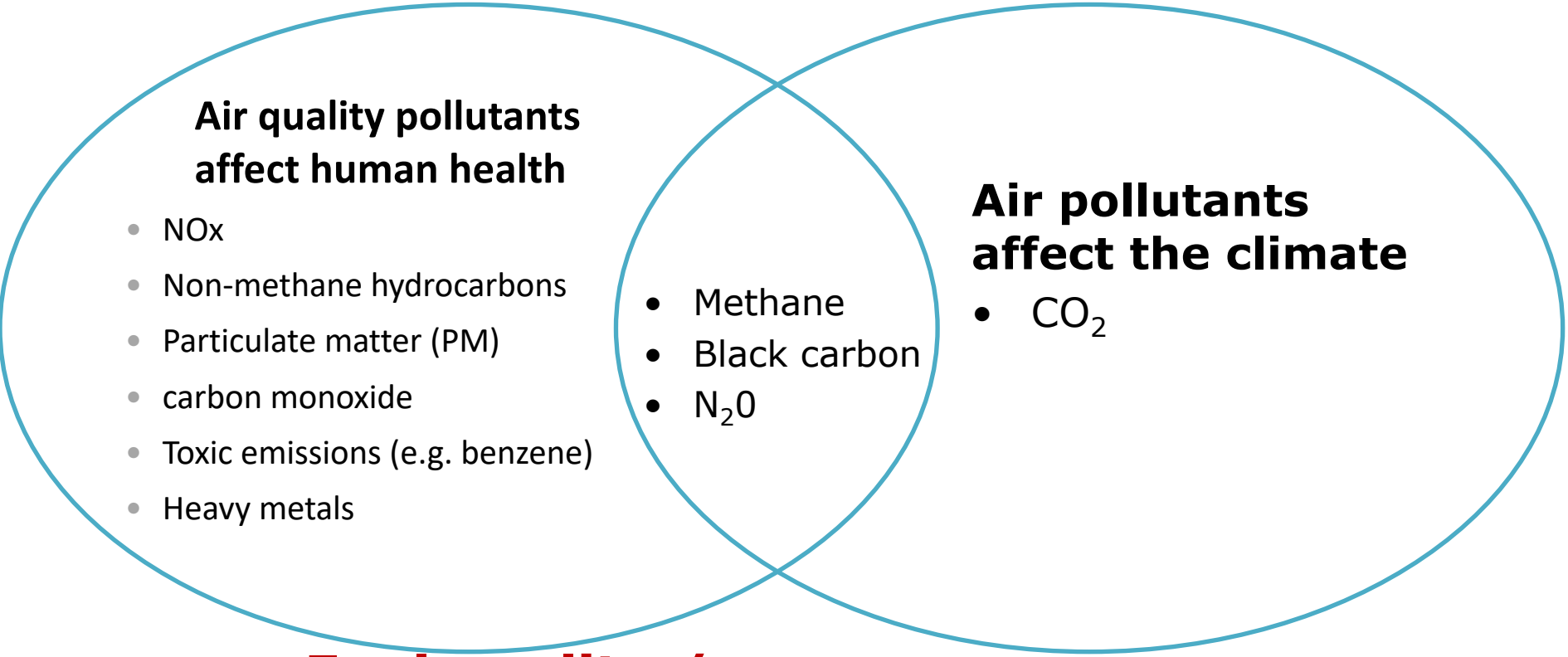
- The average 2015 car, at 15-25% efficiency, has many energy losses – and many efficiency opportunities



Sources: Lutsey, 2012; Kromer and Heywood, 2007; U.S. EPA (http://www.fueleconomy.gov/feg/atv.shtml)

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Types of Air Pollutants



Fuel quality / tailpipe controls

Fuel economy improvement

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GFEI Targets

	2020	2030	2050
New Cars	**30%** reduction* in L/100km compared to 2005 Engines, drive- trains, weight, aerodynamics.	**50%** average improvement globally Hybridisation of most models.	**50% +** globally Significant contributions from Plug-in vehicles
Total fleet	**20%** reduction With lag time for stock turnover; includes eco-driving, maintenance	**35%** reduction	**50by50**

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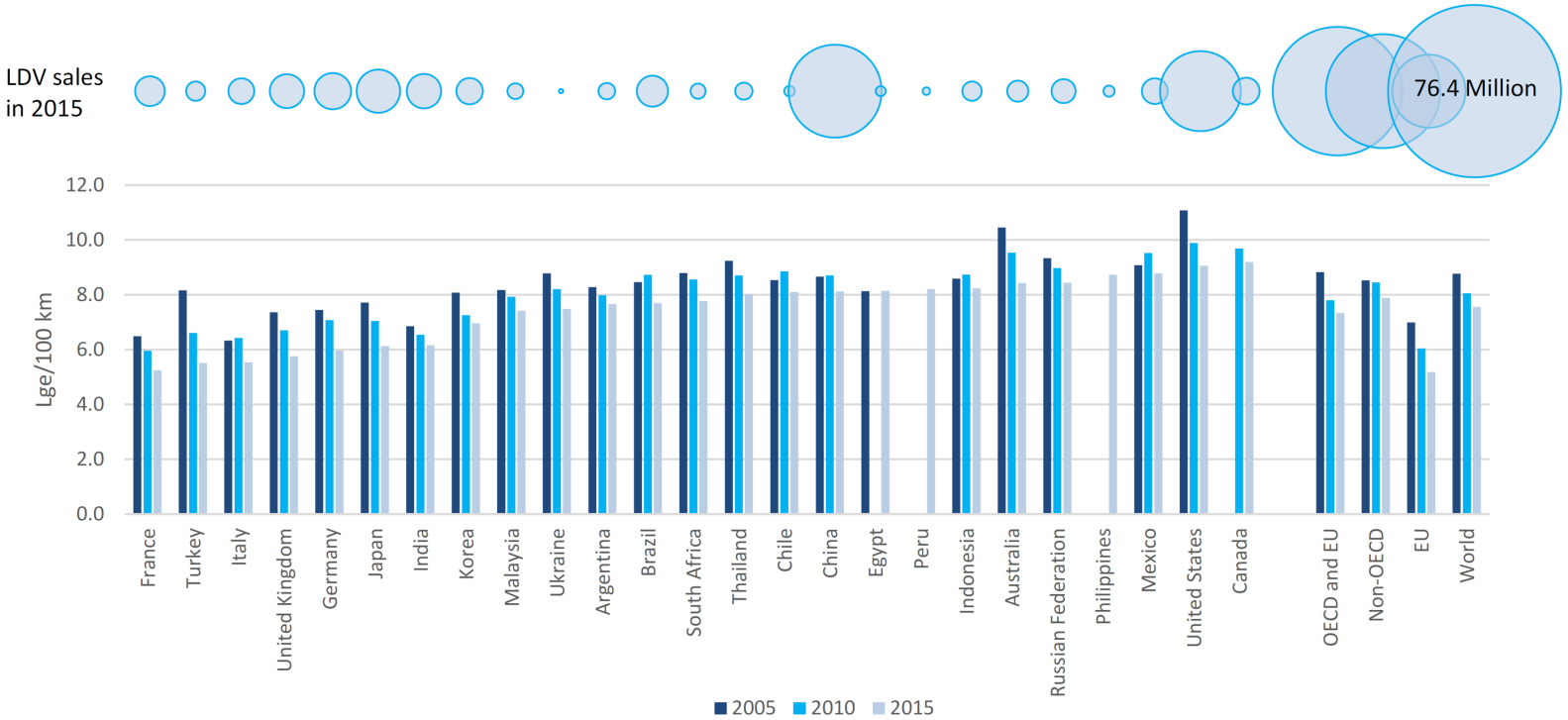
Fuel economy improving, but not fast enough…

Table 1 ● Global fuel economy developments, 2005-15

			2005	2008	2010	2012	2014	2015	2030
OECD and EU average	average fuel economy (Lge/100 km)		8.8	8.2	7.8	7.6	7.4	7.3	
	annual improvement rate (% per year)			-2.3%	-2.8%	-1.6%	-1.3%	-0.5%	
					-1.8%				
Non-OECD average	average fuel economy (Lge/100 km)		8.5	8.5	8.4	8.2	8.0	7.9	
	annual improvement rate (% per year)			-0.1%	-0.3%	-1.4%	-1.2%	-1.6%	
					-0.8%				
Global average	average fuel economy (Lge/100 km)		8.8	8.3	8.1	7.8	7.6	7.6	4.4
	annual improvement rate (% per year)			-1.8%	-1.6%	-1.3%	-1.3%	-1.1%	
					-1.5%				
GFEI target	required annual improvement rate (% per year)	2005 base year	**-2.8%**						
		2015 base year						**-3.7%**	

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Fuel economy trends and market size



- Significant fuel economy improvement if policies are in place
- Size shift vs. technology evolution moderates Non-OECD improvement
- Growth of markets with worse fuel economy affects global trend

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Light duty vehicle efficiency improvements

Even ICE LDVs still have tremendous potential:

ICE potential, through hybridization and light-weighting (NRC, 2013)

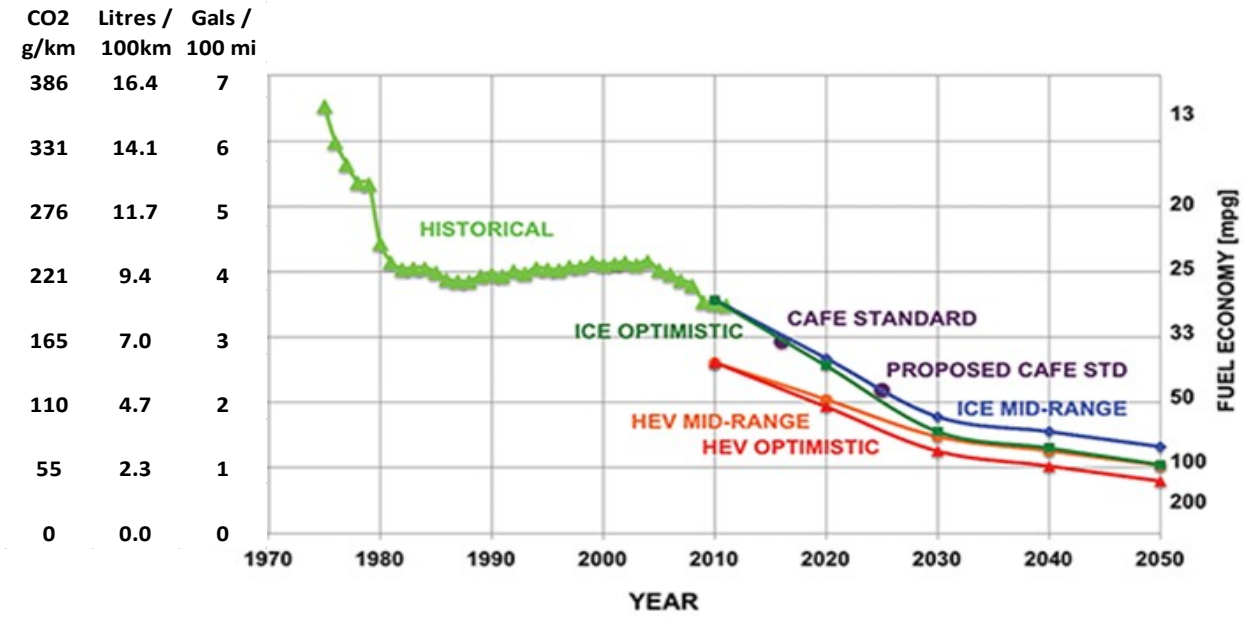
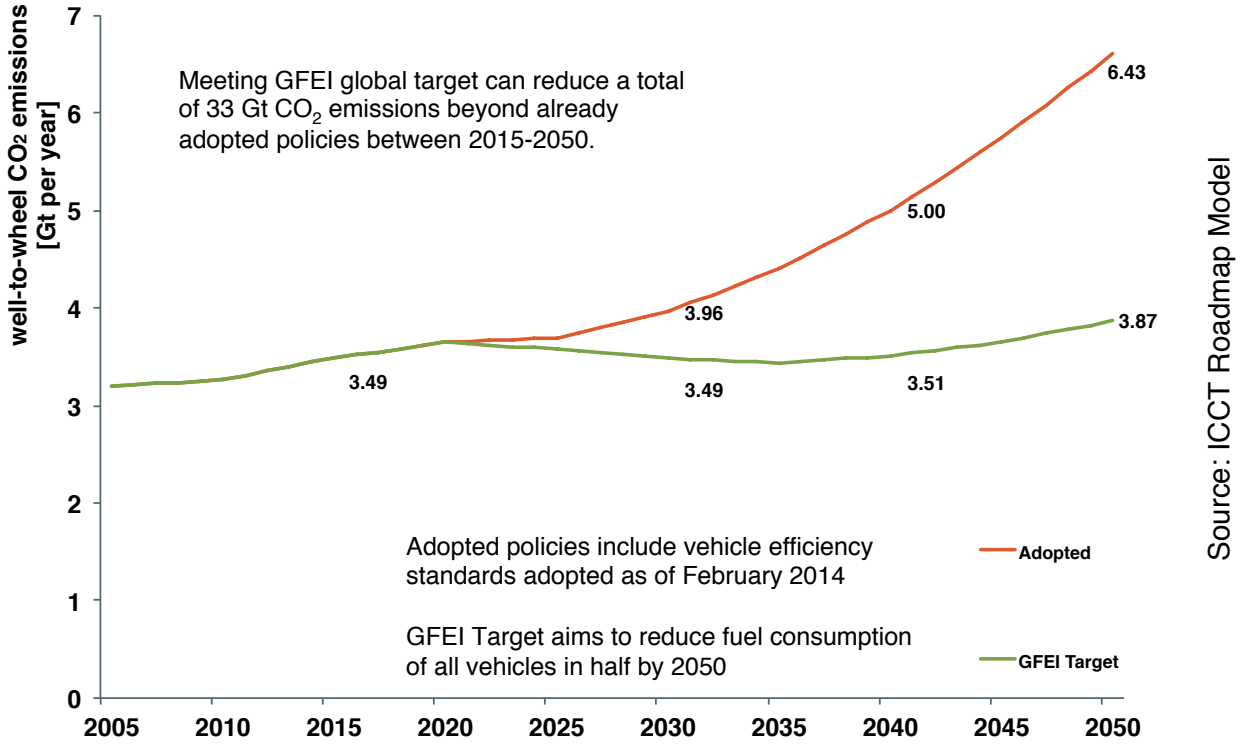


FIGURE 2.1 Historical and projected light-duty vehicle fuel economy.
NOTE: All data is new fleet only using unadjusted test values, not in-use fuel consumption.

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What can the GFEI targets achieve?

Meeting GFEI targets can stabilize global light-vehicle CO_2 emissions, despite more than a doubling of vehicle fleet.



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Four key fuel economy policies

I. Fuel economy labeling

- Based on tested fuel economy
- Need to make available to consumers before purchase (internet, car window stickers)

II. Fuel pricing

- Taxation system should at least internalize externalities
- CO_2 tax will help diversify fuels as well as encourage fuel economy

III. Fuel Economy Standards

- Typically corporate average standards
- Typically either vehicle mass or size based
- Can be applied to 2nd hand vehicles

IV. Vehicle purchase taxes

- Sales tax, registration tax, import duties
- Can be differentiated by fuel economy or CO2 emissions
- Germany also differentiates by pollutant emissions levels

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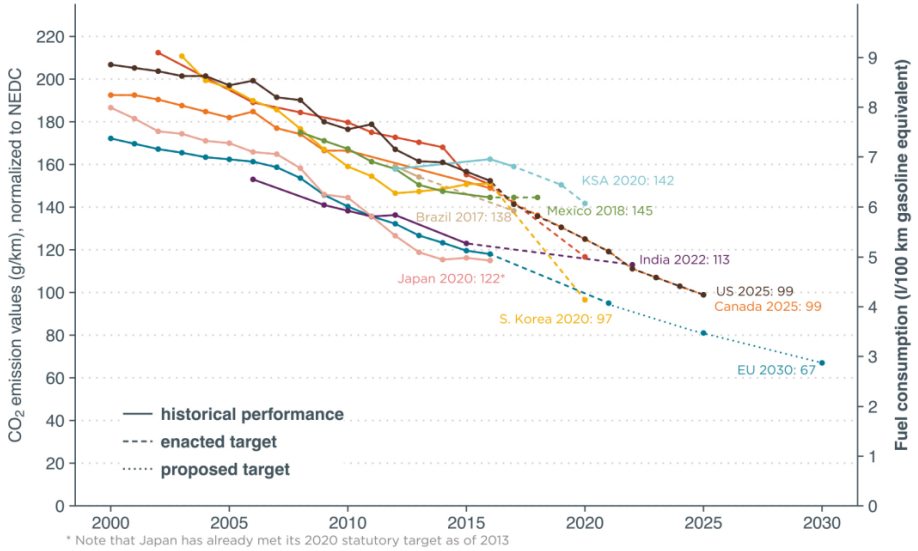
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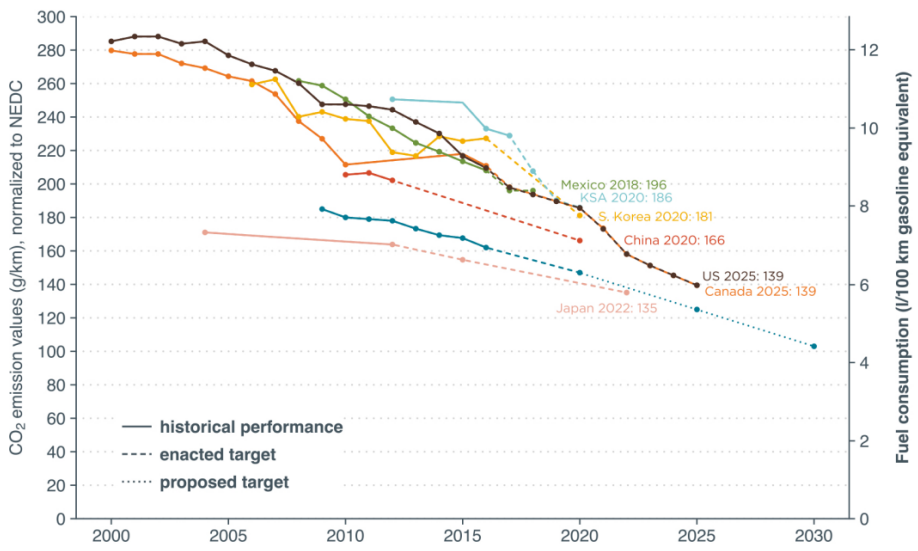
Fuel Economy Standards

- Global fuel economy standards for passenger cars (left) and light trucks (right), normalized to NEDC

Passenger cars



Light trucks



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Fuel Economy Standards

Key elements to consider when introducing fuel economy standards

1. **Regulated metric**
2. **Form of target curve + underlying attribute**
3. **Target timeframe/limit value**

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1. Regulated metric

Country or Region	Target Year	Regulated metric	Unadjusted Fleet Target/Measure	Form of target curve	Test Cycle
EU	2015 2021	CO_2	130 gCO_2/km 95 gCO_2/km	Weight-based	NEDC
China	2015 2020	Fuel consumption	6.9 L/100km 5 L/100km	Weight-class based	NEDC
U.S.	2016 2025	Fuel economy/ GHG	36.2 mpg or 225 gCO_2/mi 56.2 mpg or 143 gCO_2/mi	Footprint-based	U.S. combined
Canada	2016 2025	GHG	217 gCO_2/mi N/A	Footprint-based	U.S. combined
Japan	2015 2020	Fuel economy	16.8 km/L 20.3 km/L	Weight-class based	JC08
Brazil	2017	Fuel consumption	1.82 MJ/km	Weight-based	U.S. combined
India	2017 2022	CO_2	130 g/km 113 g/km	Weight-based	NEDC for low-powered vehicle
South Korea	2015 2020	Fuel economy/GHG	17 km/L or 140 gCO_2/km 24 km/L or 97 gCO_2/km	Weight-based	U.S. combined
Mexico	2016	Fuel economy/GHG	39.3 mpg or 140 g/km	Footprint-based.	U.S. combined
Saudi Arabia	2020	Fuel economy	17 km/L	Footprint-based	U.S. combined

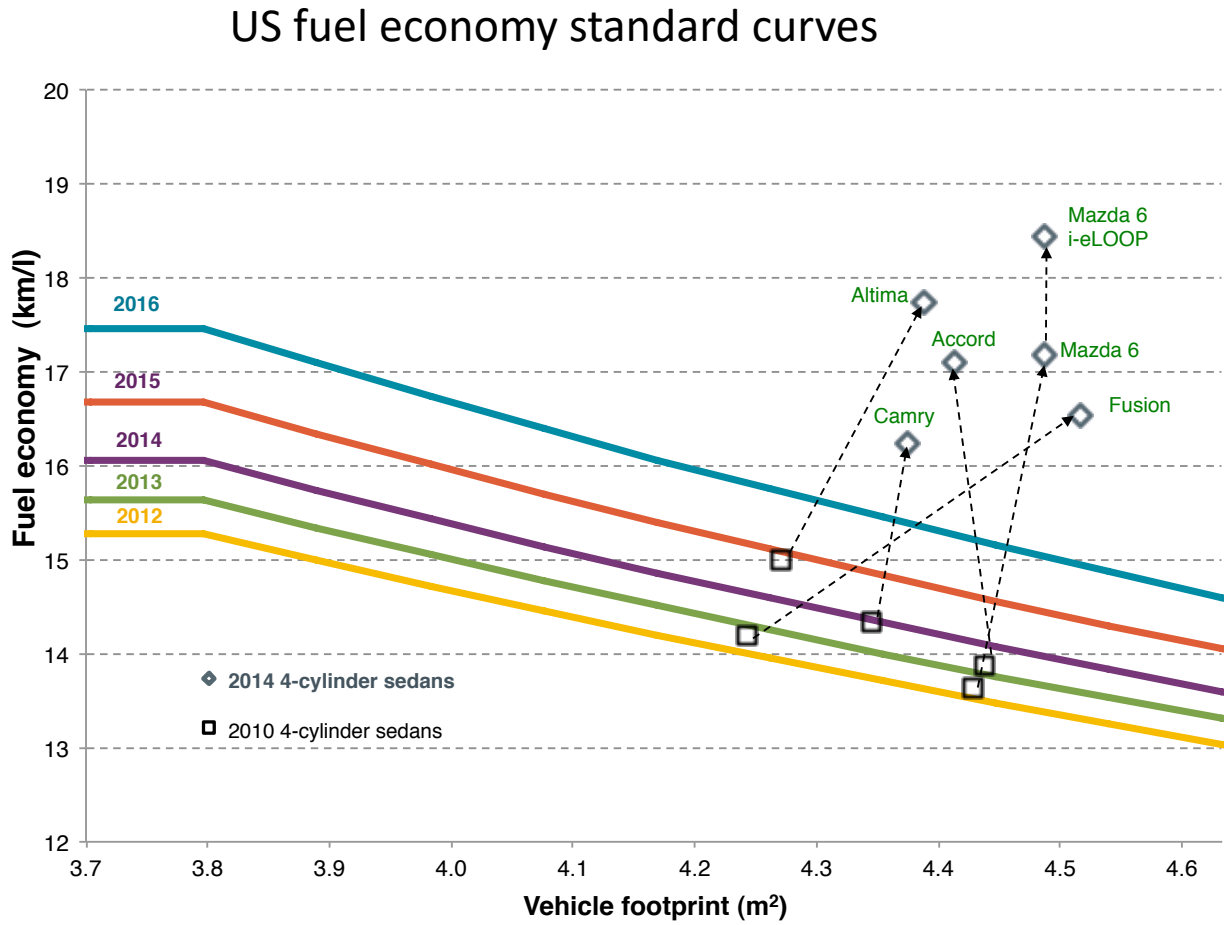
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2. Form of target curve and underlying attribute

Country/ Region	Attribute		Form		
	Weight	Footprint	Class	Continuous	Bins
European Union#	X			X	
United States		X	X	X	
Japan	X				X
China	X		X		X
Canada		X	X	X	
South Korea*	X			X	
Mexico		X	X	X	
India	X			X	

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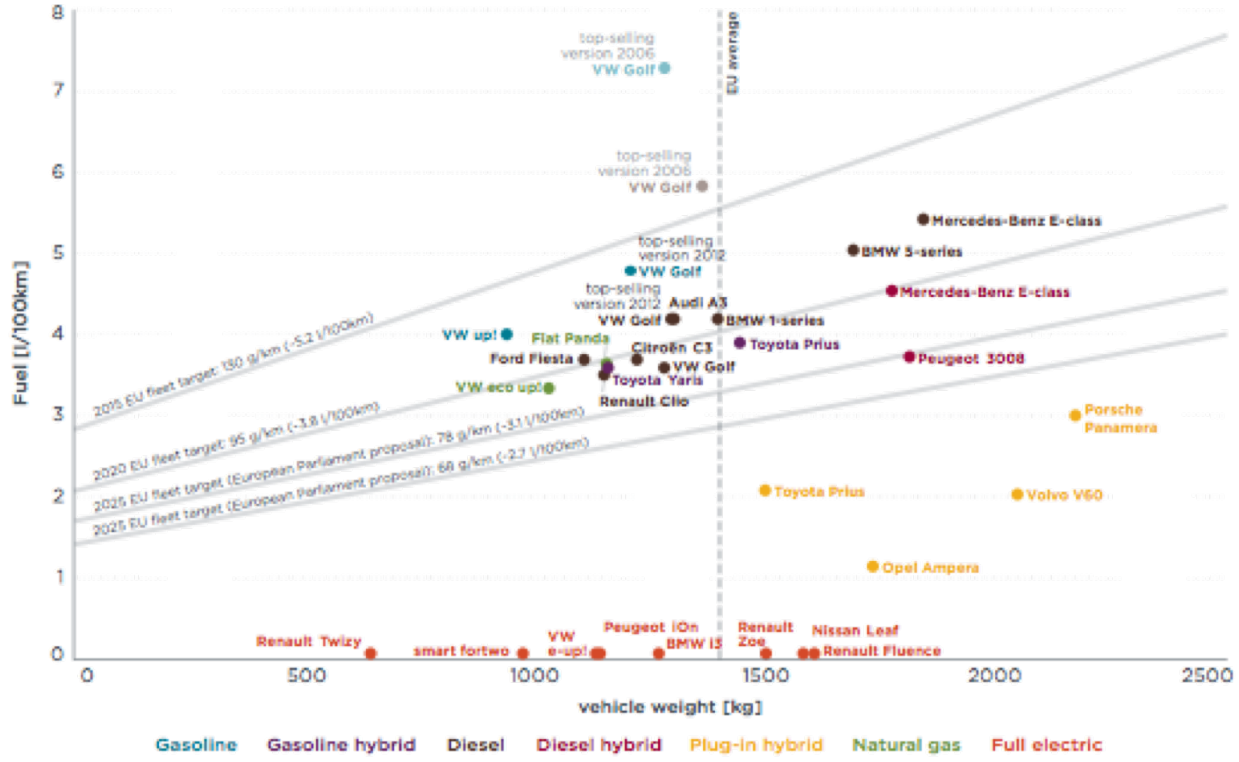
3. Target timeframe / limit value



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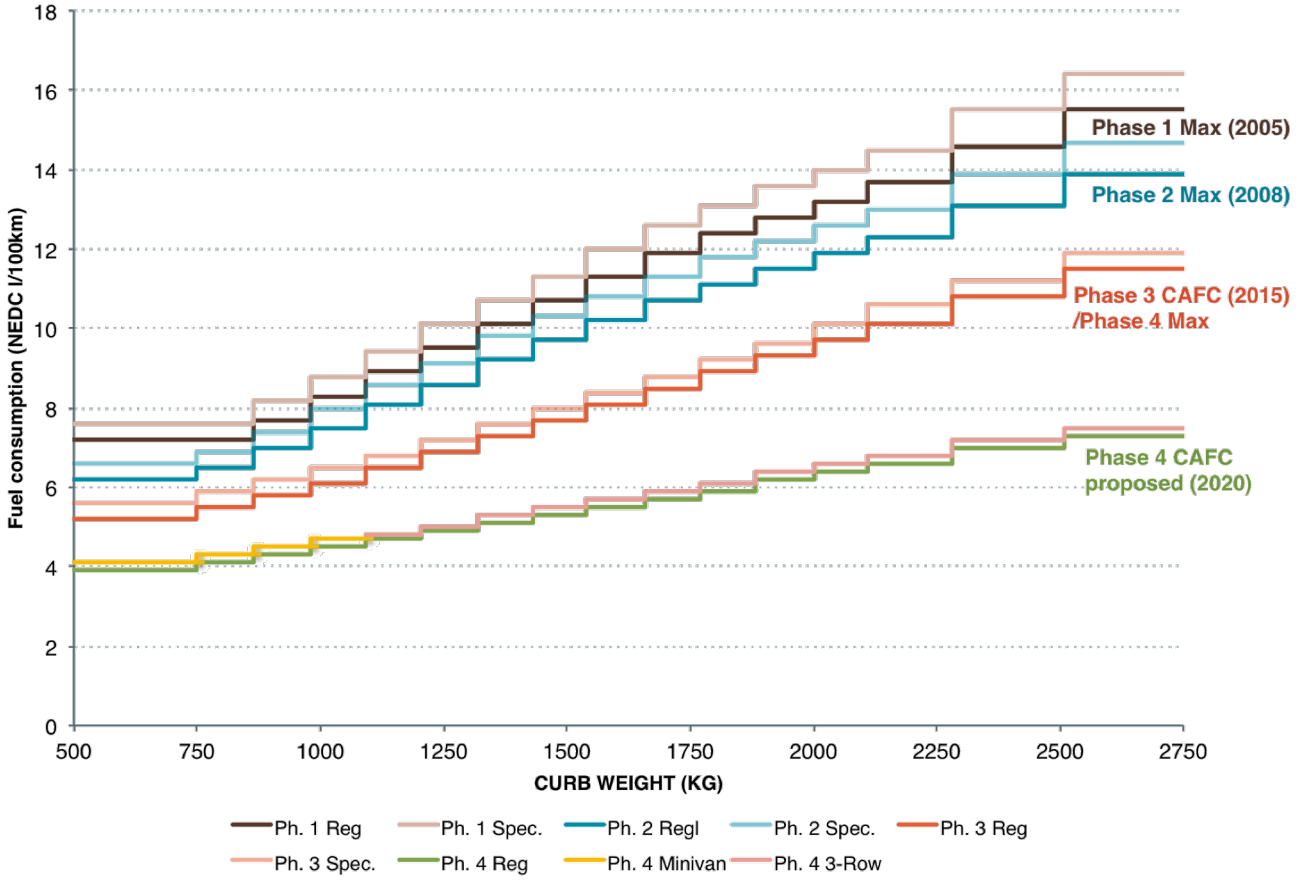
European Standards: CO_2 Emissions of Selected Vehicle Models by Technology (2013)



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3. Target timeframe / limit value

China standards curves



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Baseline analysis

Basic specifications: engine size, curb weight, footprint…

Utility: power, max speed…

Fuel consumption, CO_2 emissions…

Technology adoption: fuel type, transmission, air intake…

China 2010 passenger car data

Segment	Mini	Small	Lower medium	Medium	Large
Market share	6%	15%	32%	10%	4%
Representative model	Chery QQ3	BYD F3	Hyundai Elantra	Honda Accord	Audi A6
Diesel share	0%	0%	0%	0%	1%
Cylinder	3.5	3.9	4.0	4.1	5.0
Displacement [L]	1.1	1.4	1.6	2.0	2.4
Power [kW]	50	71	84	112	141
Auto. transmission share	17%	26%	44%	67%	89%
Curb weight [kg]	918	1080	1258	1464	1684
CO_2 [g/km] (NEDC)	150	157	173	199	211

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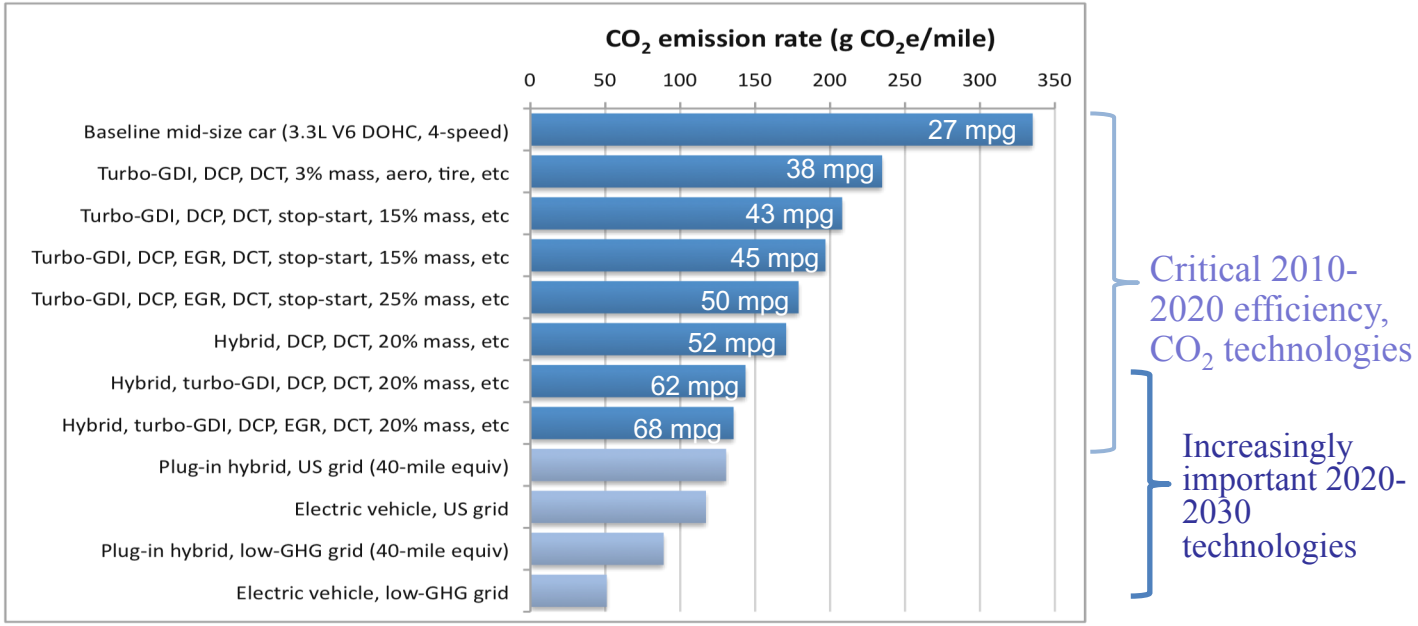
Technology feasibility

Top runner (e.g. Japan)

- Best available technology

Technology forcing

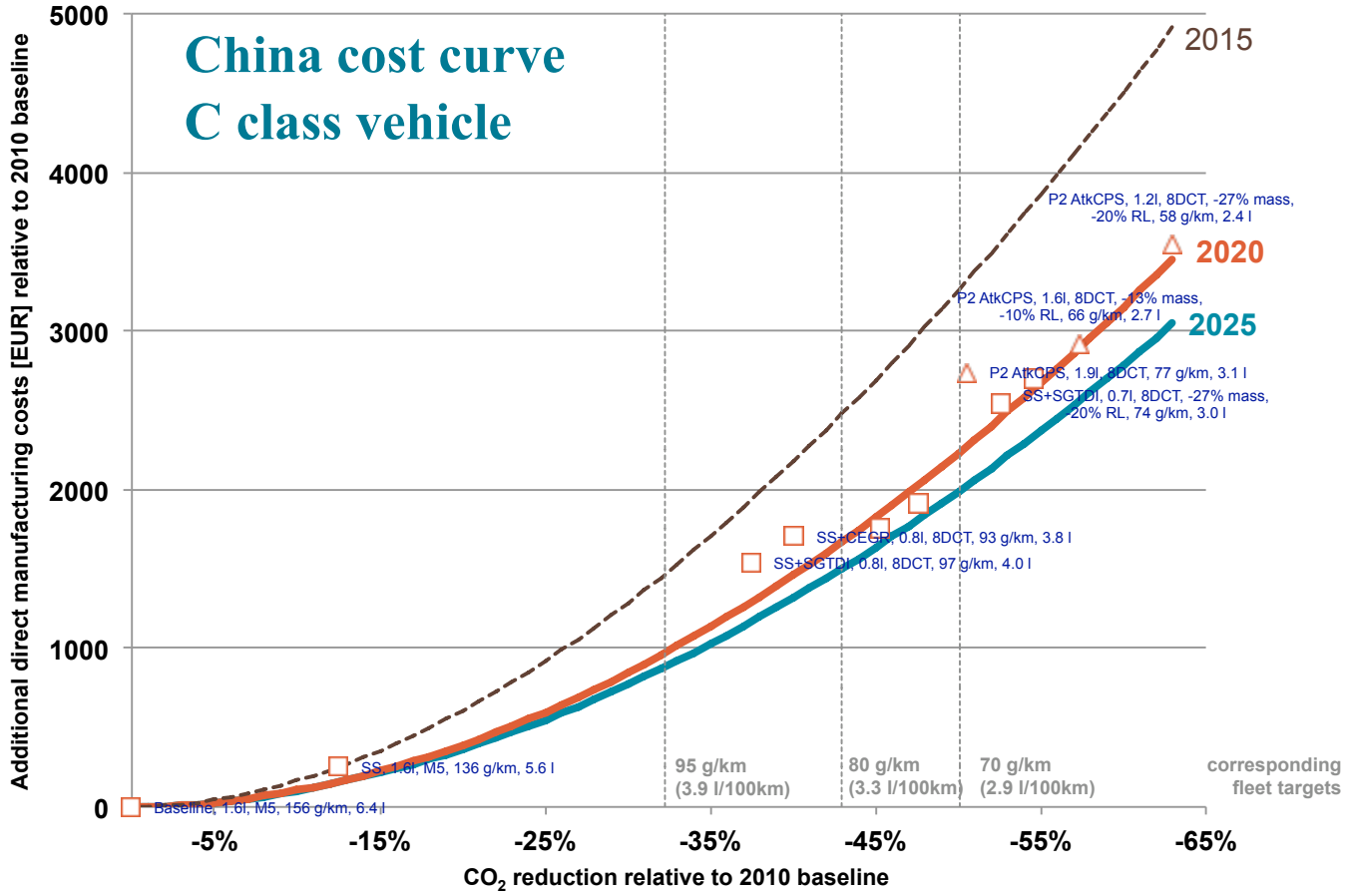
- Emerging off-the-shelf technology now; advanced technology later



Emission rates are test-cycle (not adjusted real world);
See CARB, 2010. http://www.arb.ca.gov/msprog/levprog/leviii/meetings/111610/ghg_11_10.pdf

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Cost curve



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Cost-benefit analysis

Net cost:

- Investment cost

Net benefit:

- Lifetime fuel cost saving
- Environmental benefit (climate change)
- Oil security

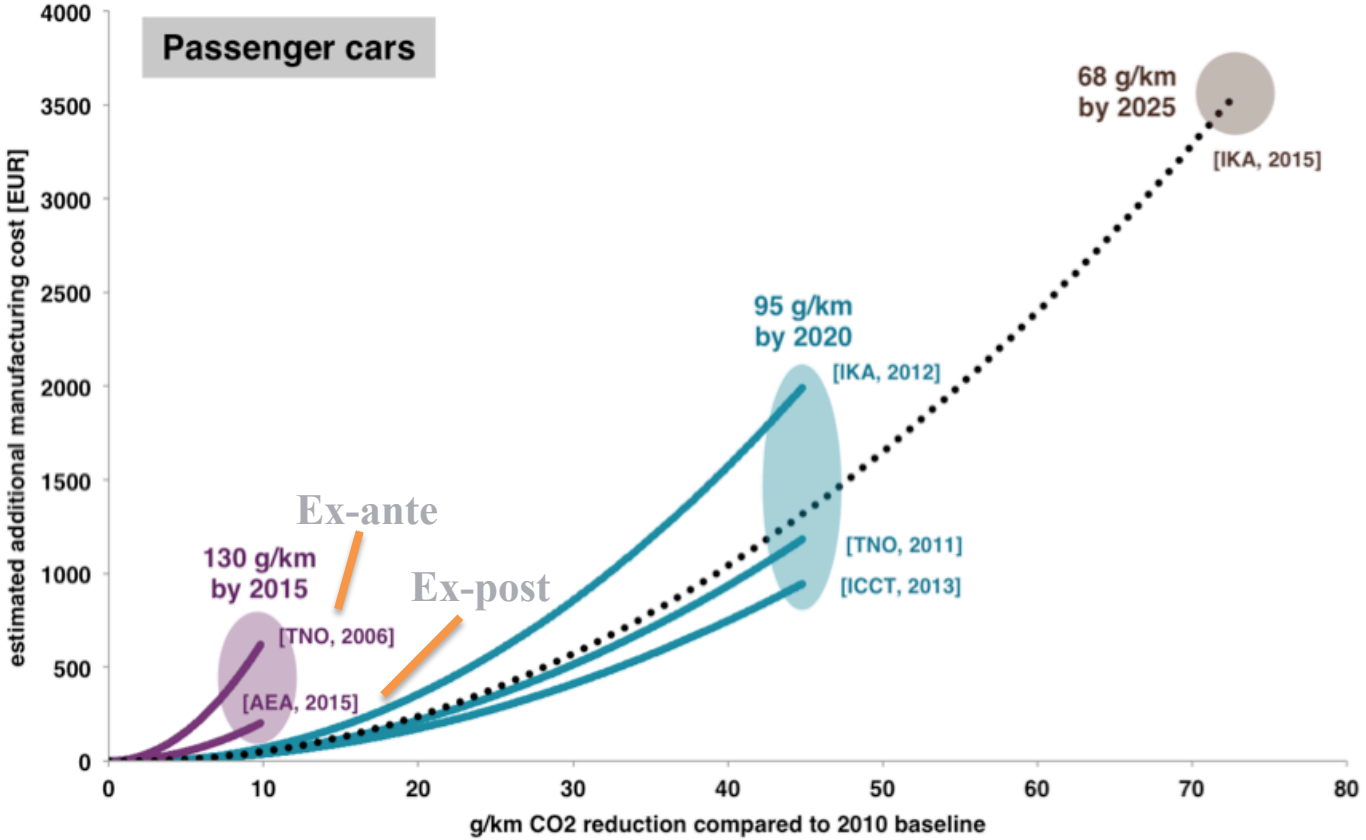
$$\text{CO}_2\text{-abatement costs} = \frac{\text{investment} - \text{NPV (lifetime fuel cost savings)}}{\text{lifetime CO}_2\text{-reduction}}$$

CO_2 abatement of of 2015 EU regulation evaluation is:

-101 EUR/t CO_2

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Regulation evaluation: estimates vs. reality



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Conclusions

- Fuel economy improvement is very cost effective;
  using social discount rates the GFEI targets are cost effective

- Strong fuel economy improvements will save enormous amounts of energy, CO_2 and fuel costs over the next 35 years

- Fuel economy could get us half way to a low carbon LDV system, but we will likely need PEVs and other solutions to get the rest of the way, especially after 2030.

- Enacting and progressively strengthening strong policies around the world will be the key

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Fiscal Measures

Fiscal policy type	Characteristics
Fuel taxes, CO2 taxes	Set by fuel type; paid upon refueling
VMT taxes	Typically paid at annual registration; could be CO2-adjusted
Road pricing	Paid by km of driving or when passing a cordon line
Vehicle purchase taxes/feebates	Paid at time of purchase; can be differentiated by fuel economy or CO2

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Role of fiscal policies in promoting fuel efficiency

- Encourage manufacturers to adopt technologies to improve fuel efficiency and reduce emissions
- Send consumers appropriate price signals to purchase fuel-efficient and low carbon vehicles
- Support fuel efficiency and emission regulatory targets
  - Regulatory standards set the minimum requirement and need to be strengthened overtime
  - Fiscal policies provide continuous incentive to improve
  - Easy to establish, does not require detailed knowledge of vehicles and technology costs, only needs to establish “rate, or value of fuel or GHG savings”, “revenue target”, and “test method and enforcement”

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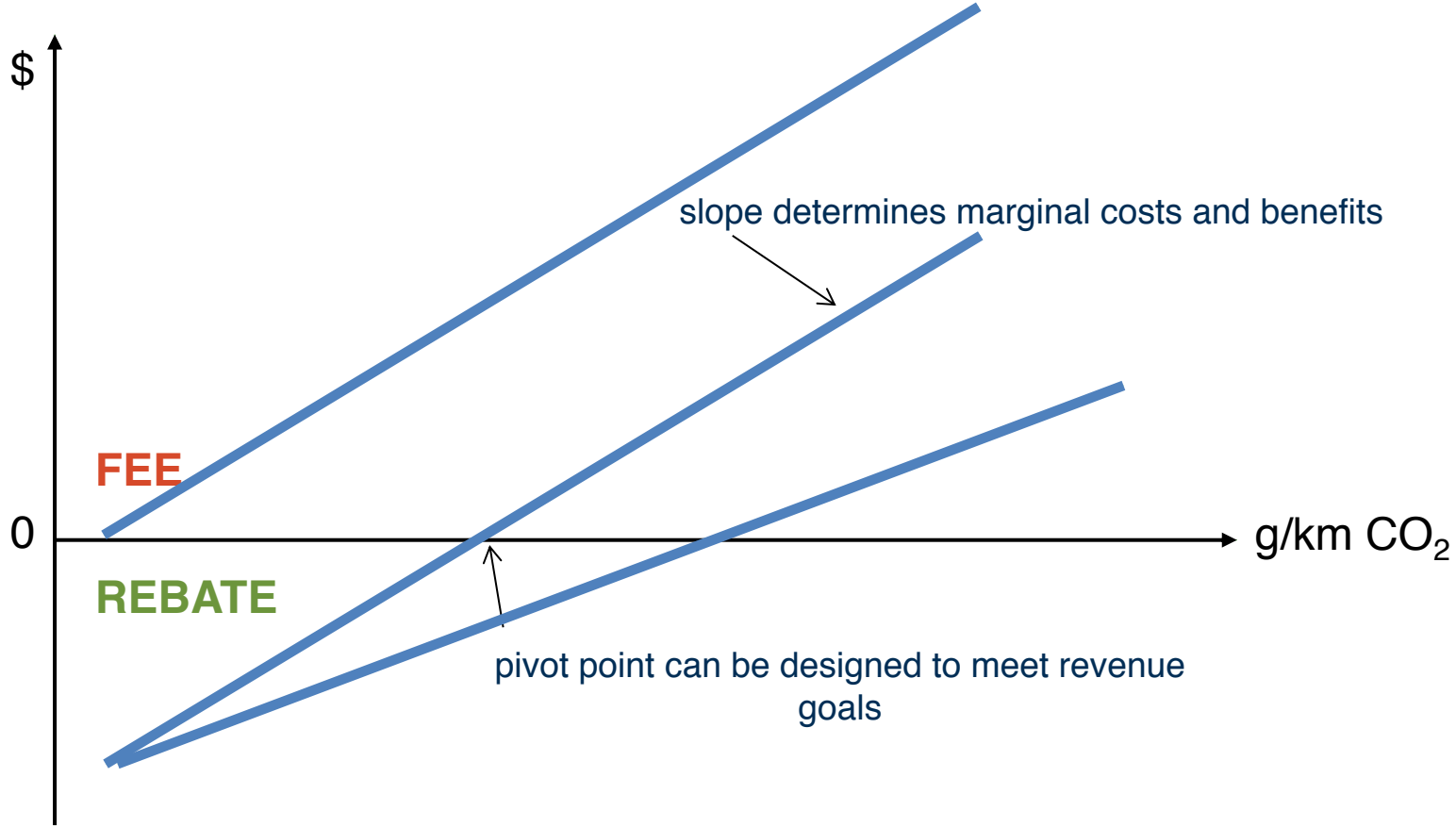
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Feebate = Fee + Rebate

- Market-based policy that shifts consumer purchases (and potentially manufacturer production) by encouraging GHG reductions by placing a fee on higher-emitting vehicles and providing a rebate to lower-emitting vehicles
- Based on fuel economy or CO2 differential between vehicles
- Could also take into account vehicle attributes like size or weight

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How to design a feebate system



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Design elements for effective incentives

- Base fiscal charges directly on vehicle fuel consumption levels, instead of vehicle physical attribute, avoid fixed charges.

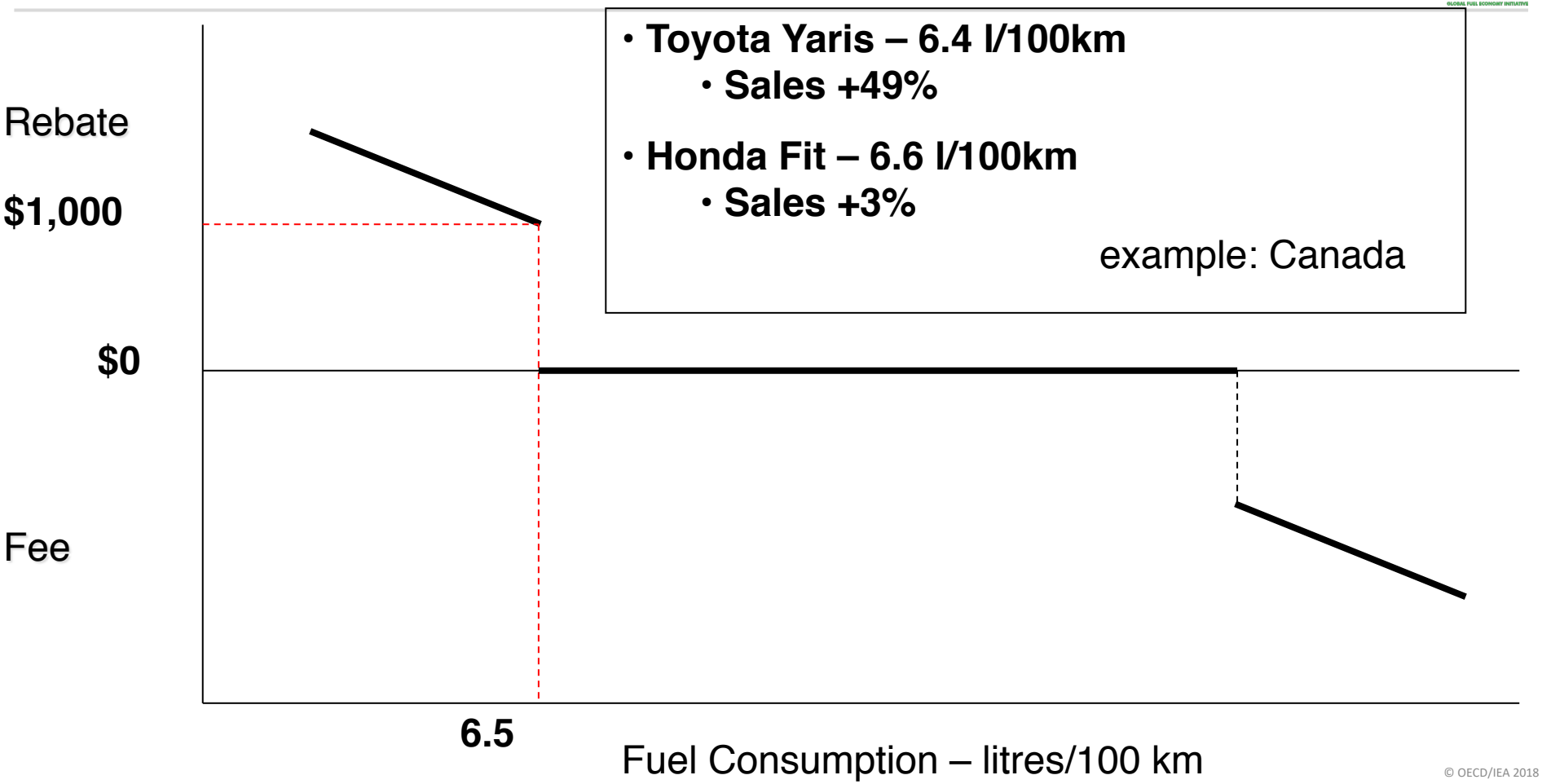
  Mandatory labeling for fuel consumption is an enabler.

- Apply the incentive widely across fleet, instead of limiting to a portion of the fleet.
- Provide continuous incentive on every fuel consumption or fuel consumption level.
- Targeted incentive programs should also be linked to fuel consumption.

  A targeted incentive program refers to incentive provided to vehicles with special features (such as a certain fuel type, or vehicles equipped with certain technologies).

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Important to have a continuous slope, no steps



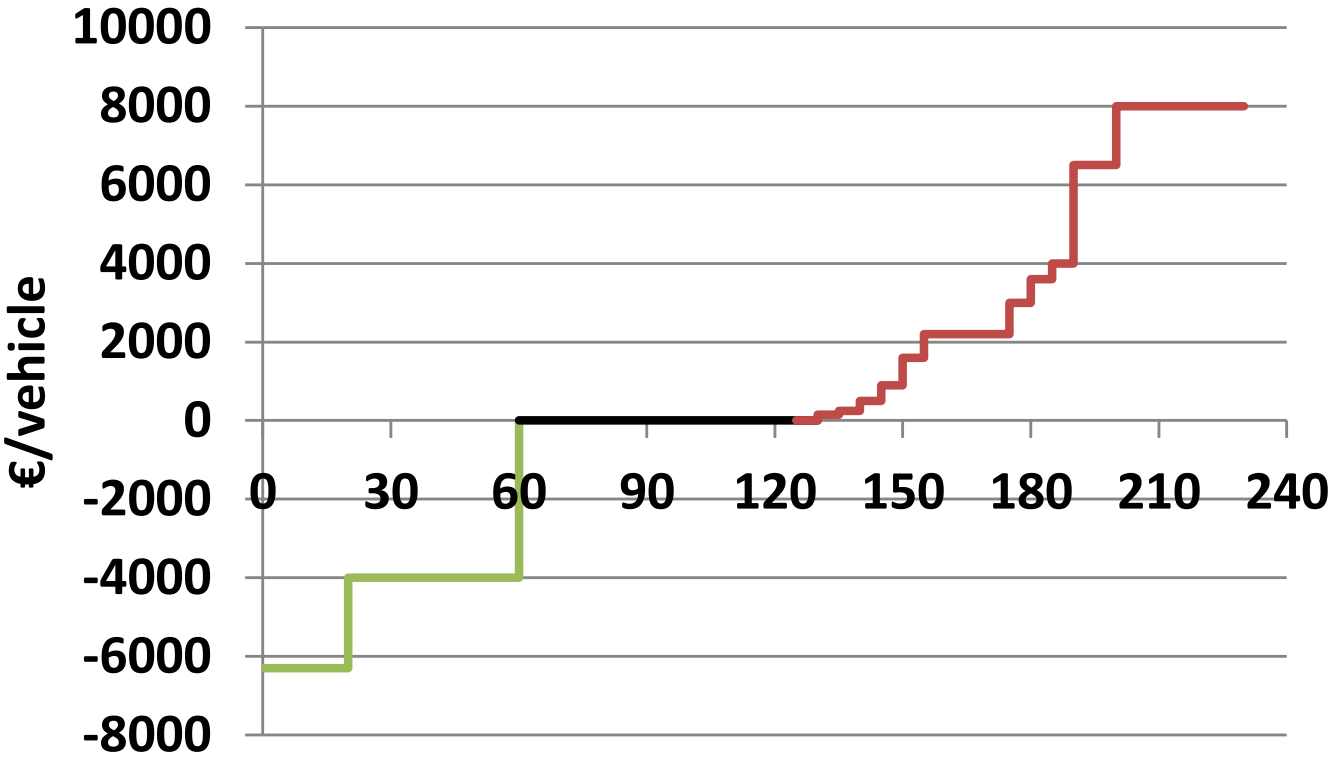
- **Toyota Yaris – 6.4 l/100km**
  - **Sales +49%**
- **Honda Fit – 6.6 l/100km**
  - **Sales +3%**

example: Canada

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An example: French feebate schedule, 2015

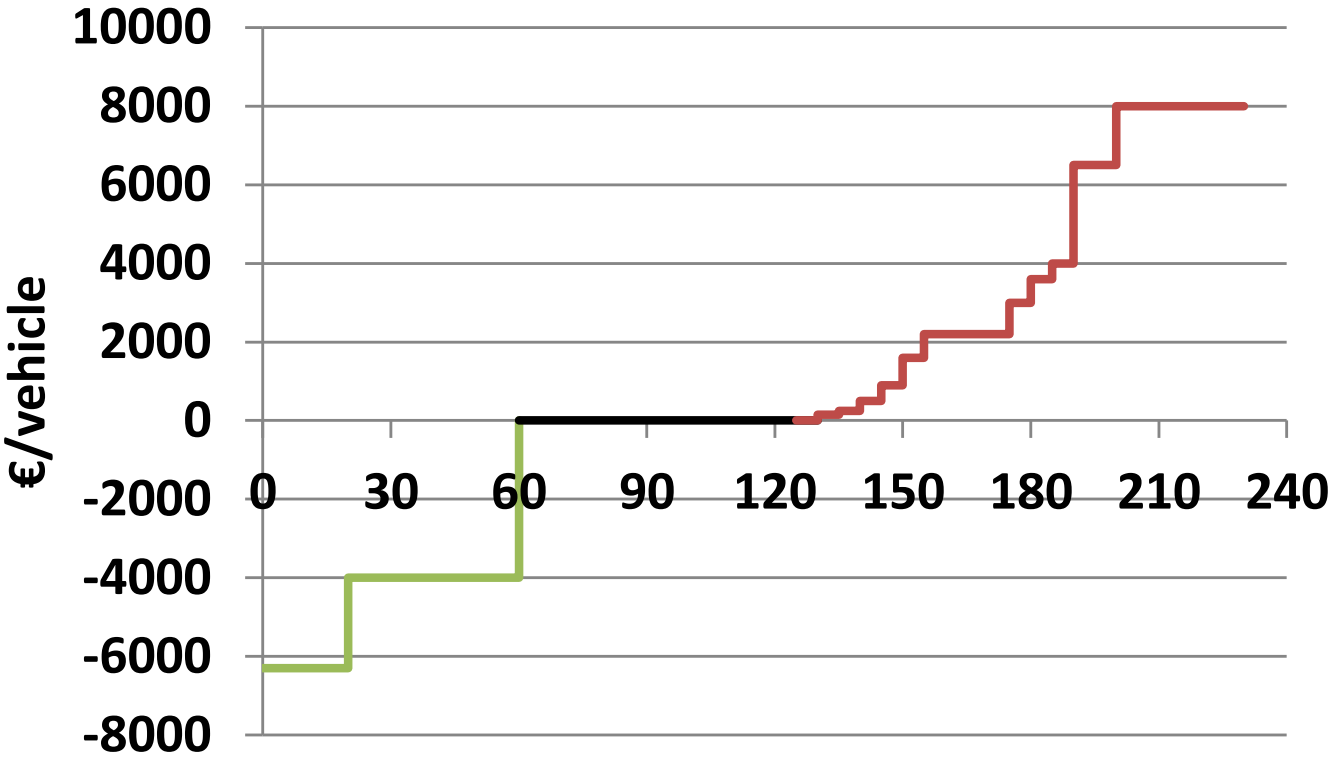
The only vehicles that receive rebates have CO_2 emissions of 60 g/km or less



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An example: French feebate schedule, 2015

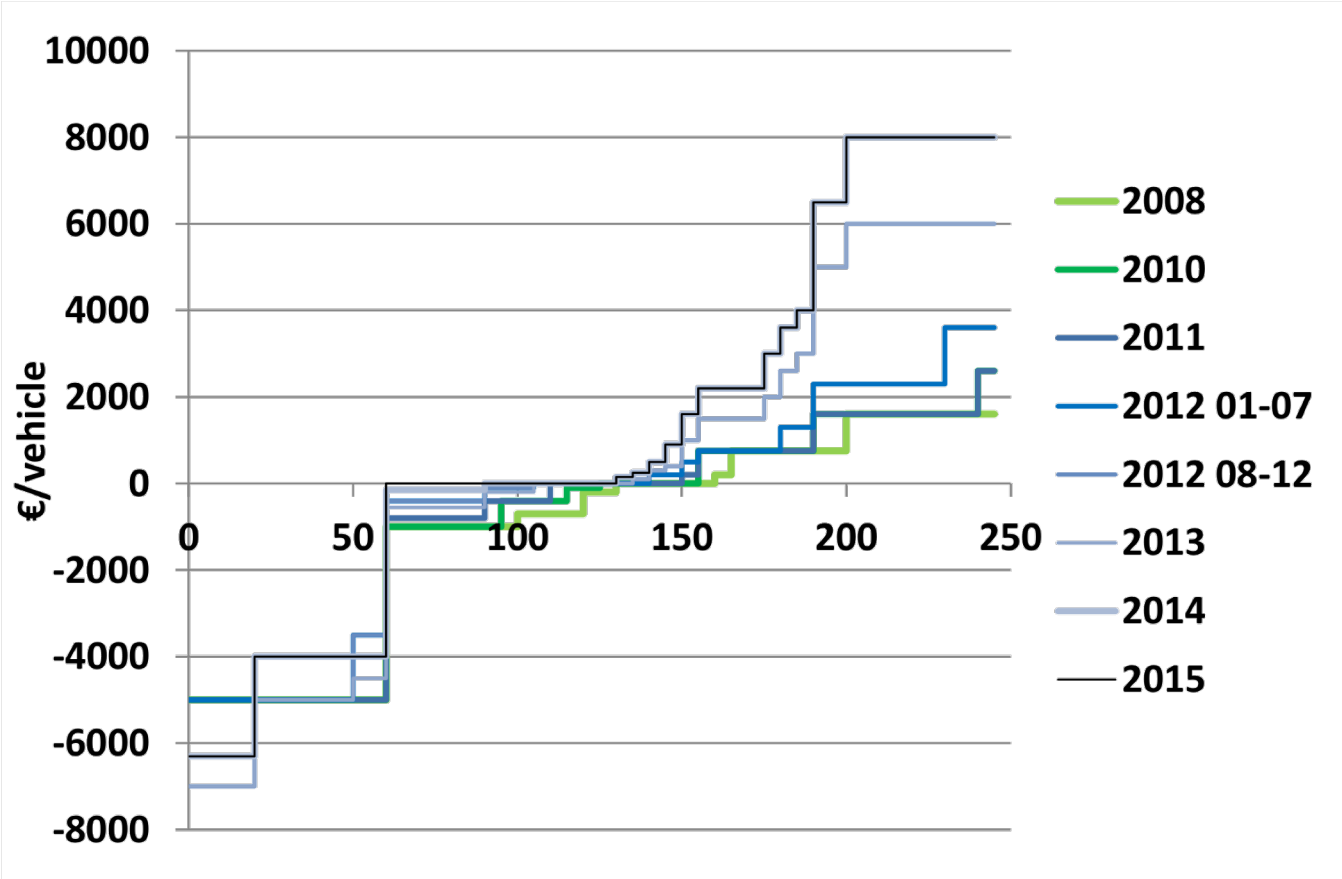
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The French feebate schedule over time

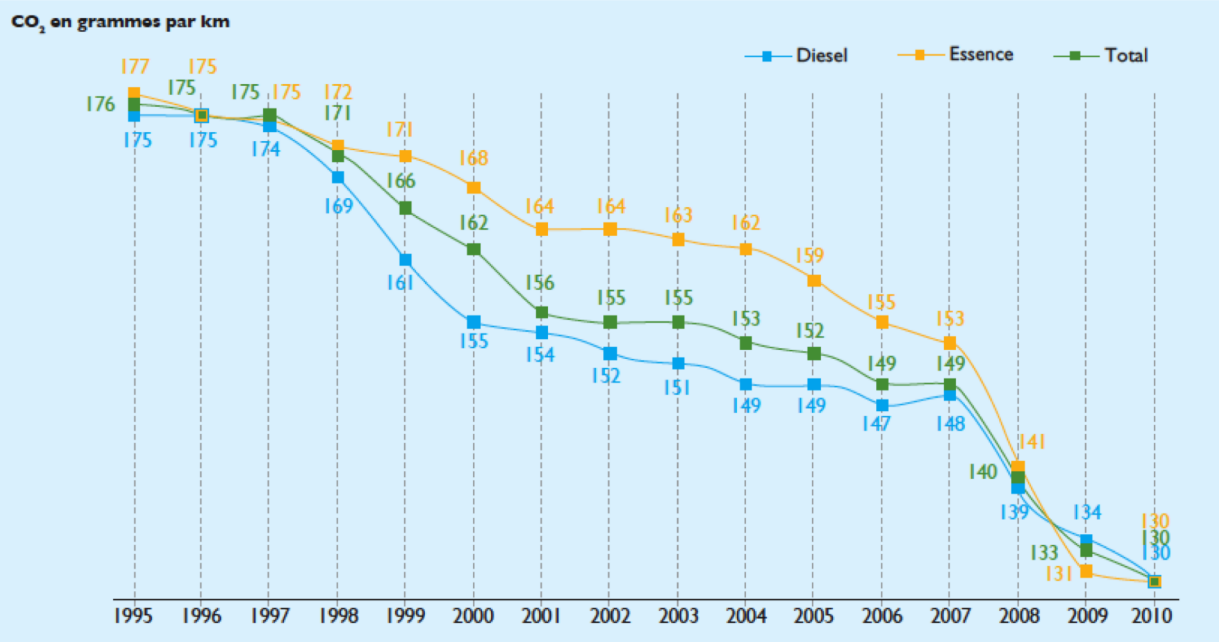
The fees have risen and the rebates declined…



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The French feebate system led to drop in CO_2 emissions

- 2001–2007 avg. reduction new vehicle CO_2 = 1 g/km per year
- 2008: emissions drop 9 g/km and 2009 by 7 g/km,
  The Ministry of Transport attributes this to introduction of the bonus/malus system



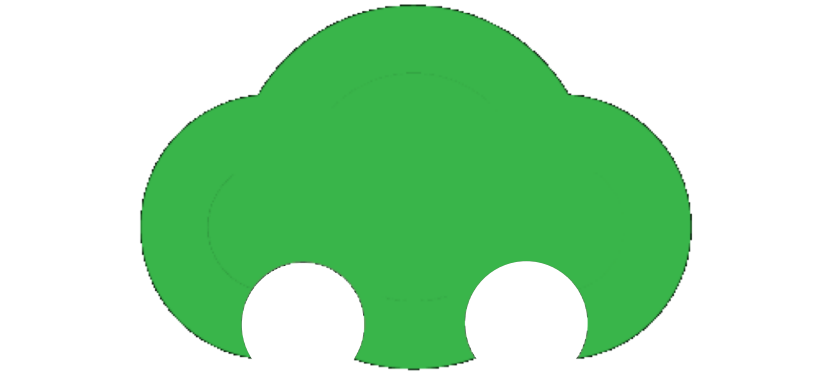
Source: Les véhicules particuliers en France (Ademe), March 2011

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Standards versus feebates

Standards	Feebates
"Guarantee" a minimum level of fuel economy	Do not guarantee level
No incentive to go beyond minimum	On-going incentive
Must be regularly updated to maintain pressure	Must be regularly updated to meet revenue targets
No cap on costs	Provide a cap on cost
Could ban some vehicles	Wouldn't ban any vehicles
No clear price signals	Clear price signals to consumers and producers

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GFEI

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