Fuel Economy Policy Options and Target Setting

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Dr. Francisco Posada
Senior Researcher

FIA FOUNDATION

GFEI
GLOBAL FUEL ECONOMY INITIATIVE

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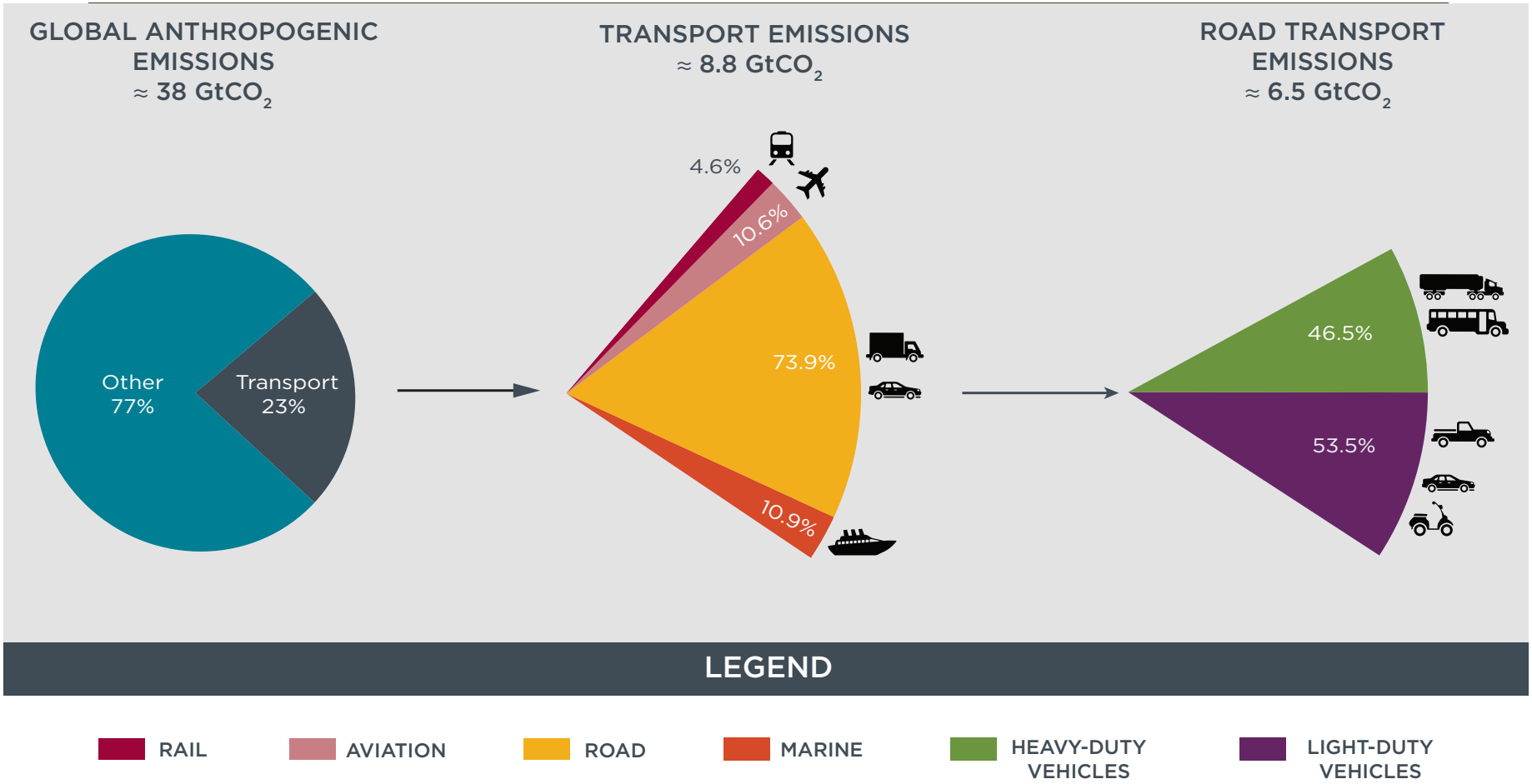
Vehicles make up more than 23% of all sectors greenhouse gas emissions …



Notes:
Global anthropogenic CO_2 emissions in 2010 based on IPCC (2014).
Transport CO_2 emissions in 2010 estimated by ICCT (2014) include the full fuel lifecycle, including direct emissions from combustion & upstream emissions from extraction, refining, & distribution of fuels.

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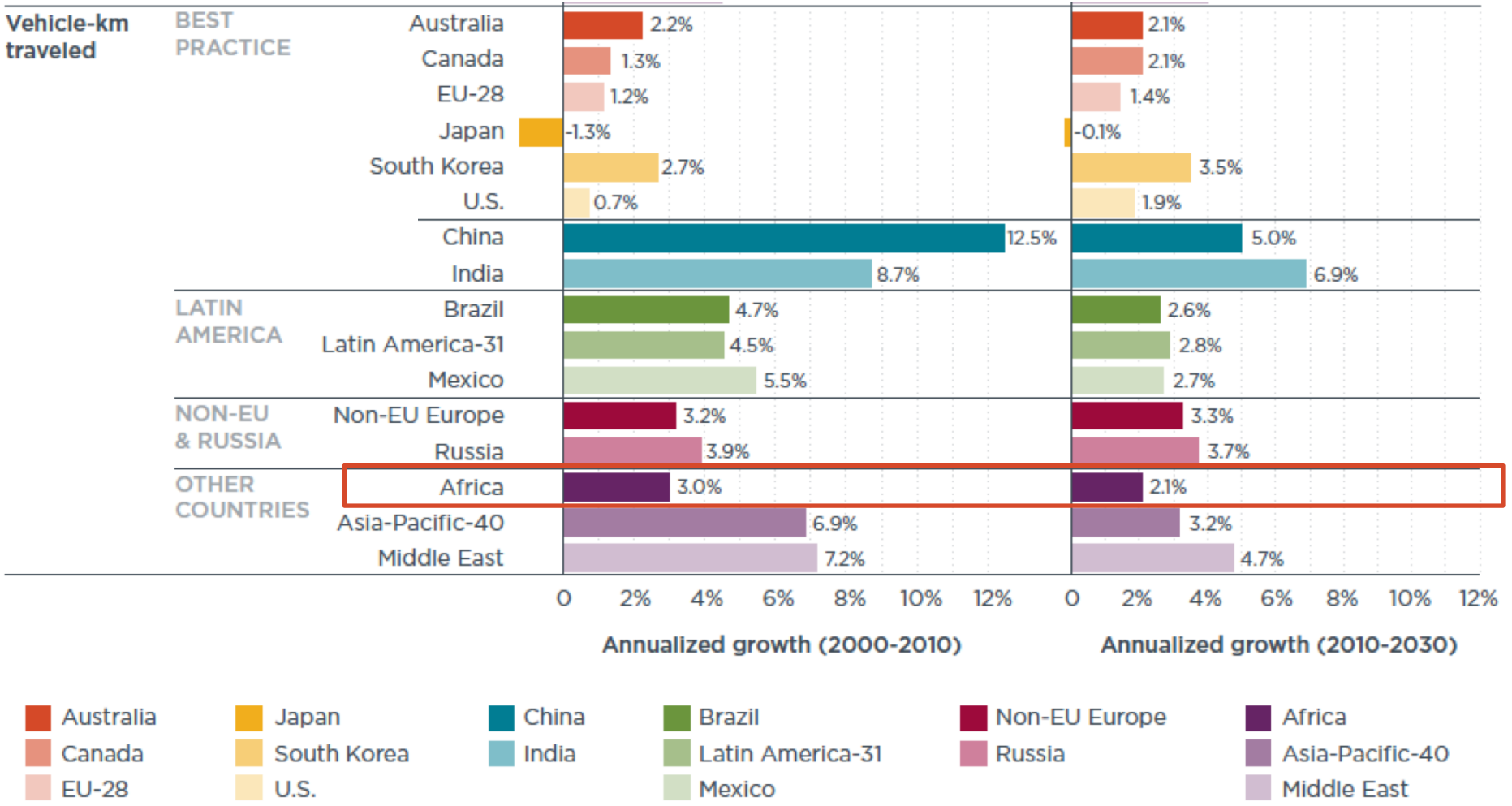
And the vehicle population, and activity, is expected to grow in the next decades



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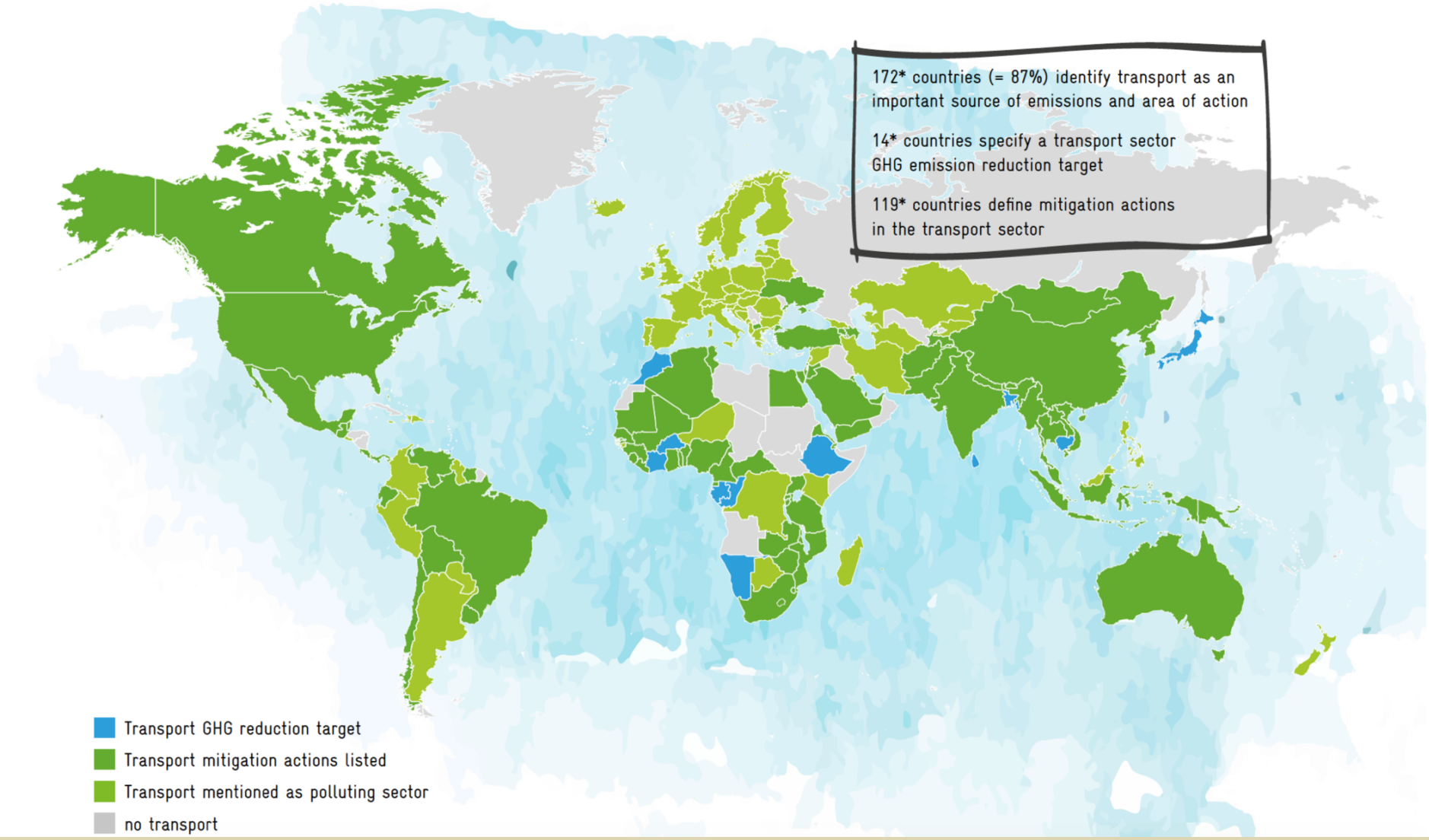
http://www.theicct.org/sites/default/files/publications/ICCT_HealthClimateRoadmap_2013_revised.pdf

GIZ-Ricardo review of NDCs shows a strong focus on vehicles and fuels mitigation actions

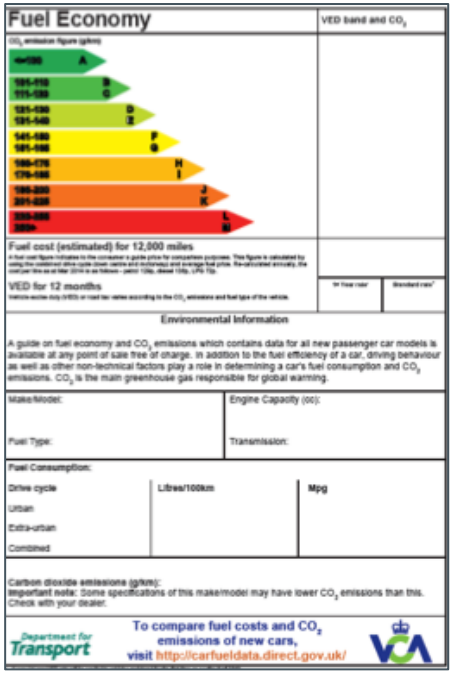


Transport in Nationally Determined Contributions (NDCs).Lessons learnt from case studies of rapidly motorising countries Synthesis Report. Edina Löhr, Nipunika Perera, Nikolas Hill (Ricardo Energy & Environment), Daniel Bongardt, Urda Eichhorst (GIZ) https://www.changing-transport.org/wp-content/uploads/2017_Transport-in-NDCs.pdf

Main vehicle fuel economy policies

Consumers

Fuel Economy Label



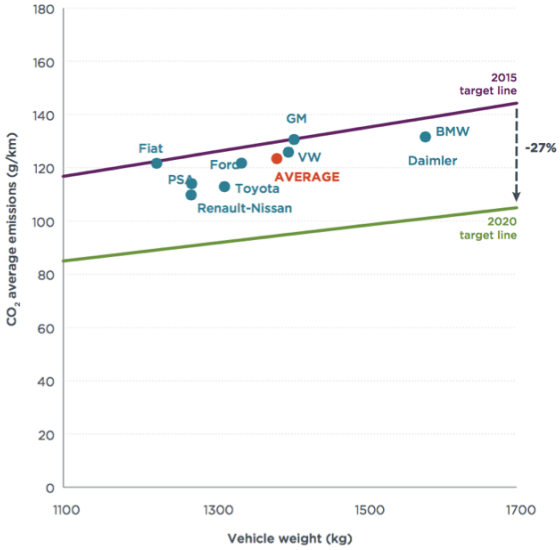
Fiscal Measures CO_2/FE based Taxes

South Africa:
DA 177
ENVIRONMENTAL LEVY ACCOUNT FOR CARBON DIOXIDE EMISSION LEVY

Vehicle Tax is proportional to Vehicle CO_2 emissions

Manufacturers

Fuel Economy/CO_2 emission Regulation



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The basics

What are Vehicle Fuel Economy CO_2 emissions?

Vehicle fuel economy and CO_2 emissions are obtained under chassis laboratory testing

Certification test cycle (vel. & accel. traces) e.g., NEDC, WLTC

Spinning roller bench

Gas analyzer

Regulated pollutants (per vehicle max or fleet average):
NOx, NMHC, NMOG, HC (EU), CO, PM, PN (EU), HCHO (US)

Fuel Economy (km/L) and CO_2 (gCO_2/km)

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Vehicle Fuel Economy Policy

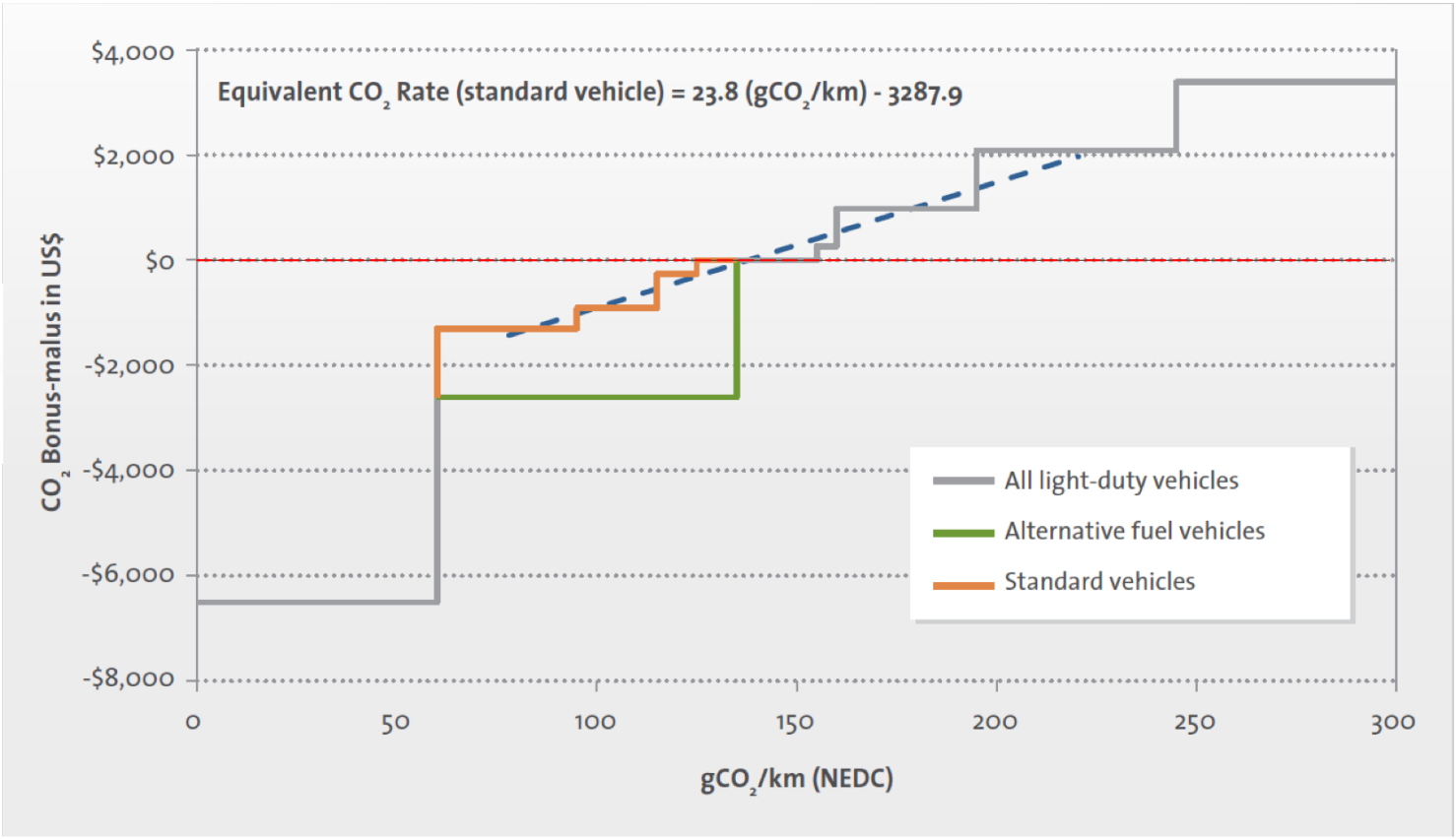
1. Fiscal measures to promote FE

Fiscal measures to improve vehicle fuel efficiency

- Vehicle tax/fee
  - Based on CO_2 emissions or fuel efficiency
  - One-time (e.g. at registration) or annually(e.g. circulation tax)
- Incentive schemes for very fuel-efficient vehicles
- Feebate- a mix of fees/tax and rebate/incentives
- Fuel tax

Progressive fiscal incentives: France's Bonus/Malus program

Bonus-malus program penalizes buyers of high CO_2 emission models while rewarding buyers of lower CO_2-emitting vehicles at the time of first sale.



According to the French government, the program lowered fleet CO_2 emissions by 9 g/km during the single year of 2008

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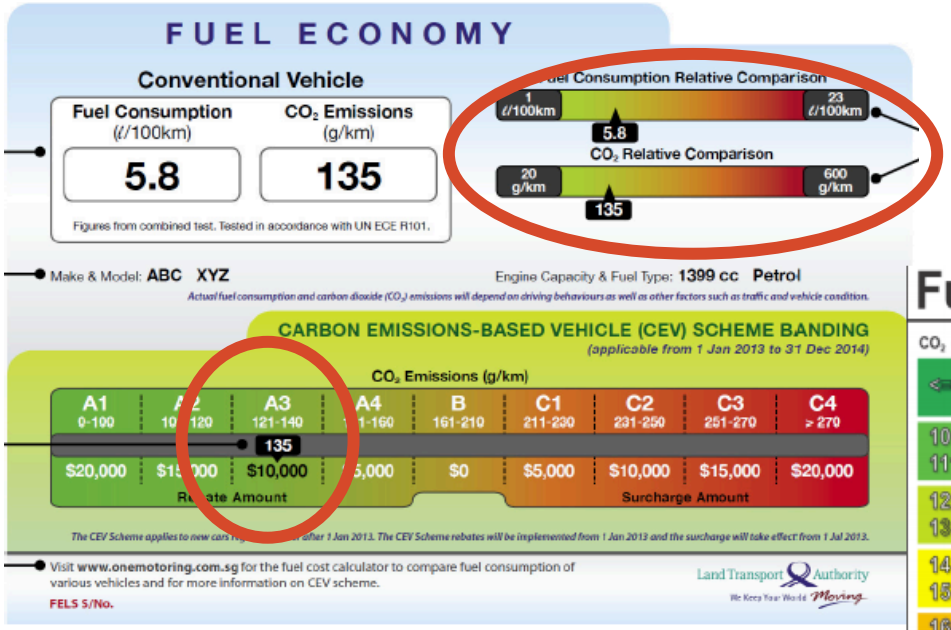
http://www.theicct.org/review-and-comparative-analysis-fiscal-policies

Vehicle Fuel Economy Policy

2. Fuel Economy Label

Fuel economy label

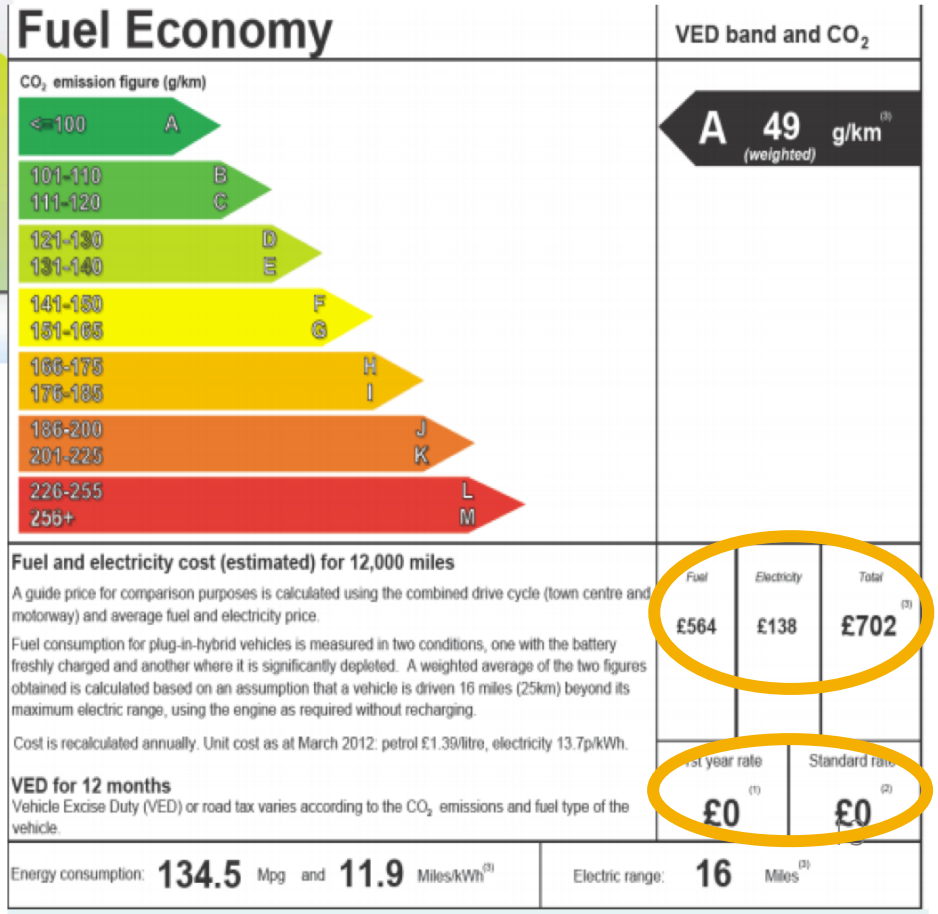
Label design and information



Vehicle fuel economy labels in Singapore since 2012

Singapore label

- Absolute fuel economy value
- Fuel economy/GHG range
- Fiscal policy information



UK vehicle label

- Comparable CO_2 emission
- Fuel saving
- Fiscal policy information
- Additional EV information

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Vehicle Fuel Economy Policy

3. Fuel Economy and CO_2 emission standards

What are vehicle fuel economy **standards**?

- National level regulation
- Fuel economy standards imply a legal framework
  - National Energy efficiency act or mandate
  - Petroleum conservation act or mandate
  - UN agreements on Climate Change (NDCs)
- Compliance:
  - per vehicle Minimum Efficiency Performance Standard (MEP)
  - corporate average fuel economy (CAFE)
- Regulated entity: new vehicle manufacturers and importers
- Metric

Fuel economy = How many kilometers per liter of fuel? [mpg]

Fuel consumption = How much fuel per kilometer driven? [L/100km]

CO_2 emission = How much CO_2 per kilometer driven? [g/km]

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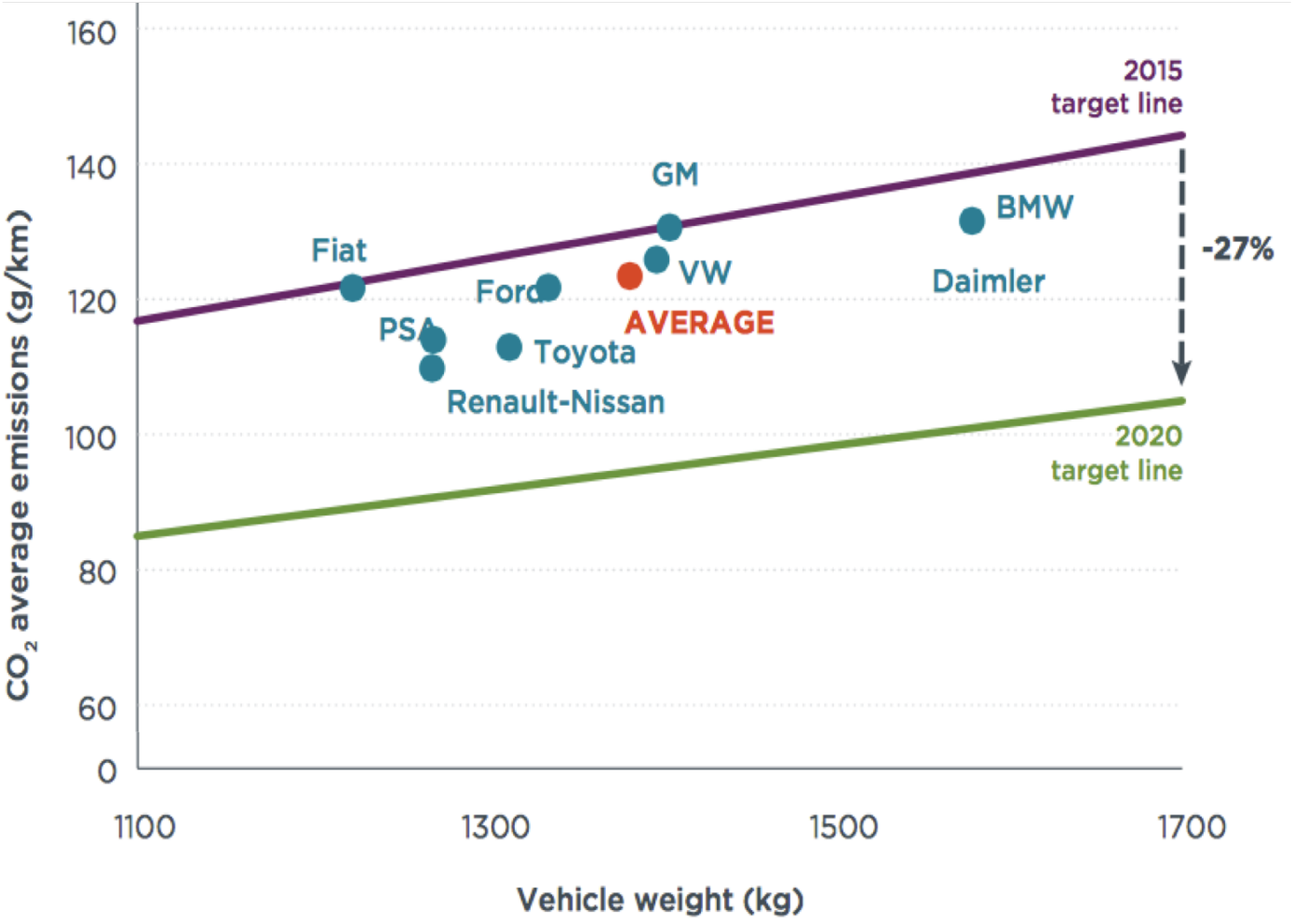
Regulating all manufacturers ensures that the overall fleet meets the target – Targets change over time



FE Standards set long term goals
FE Standards set the pace for GHG reductions
FE Standards provides certainty to stakeholders

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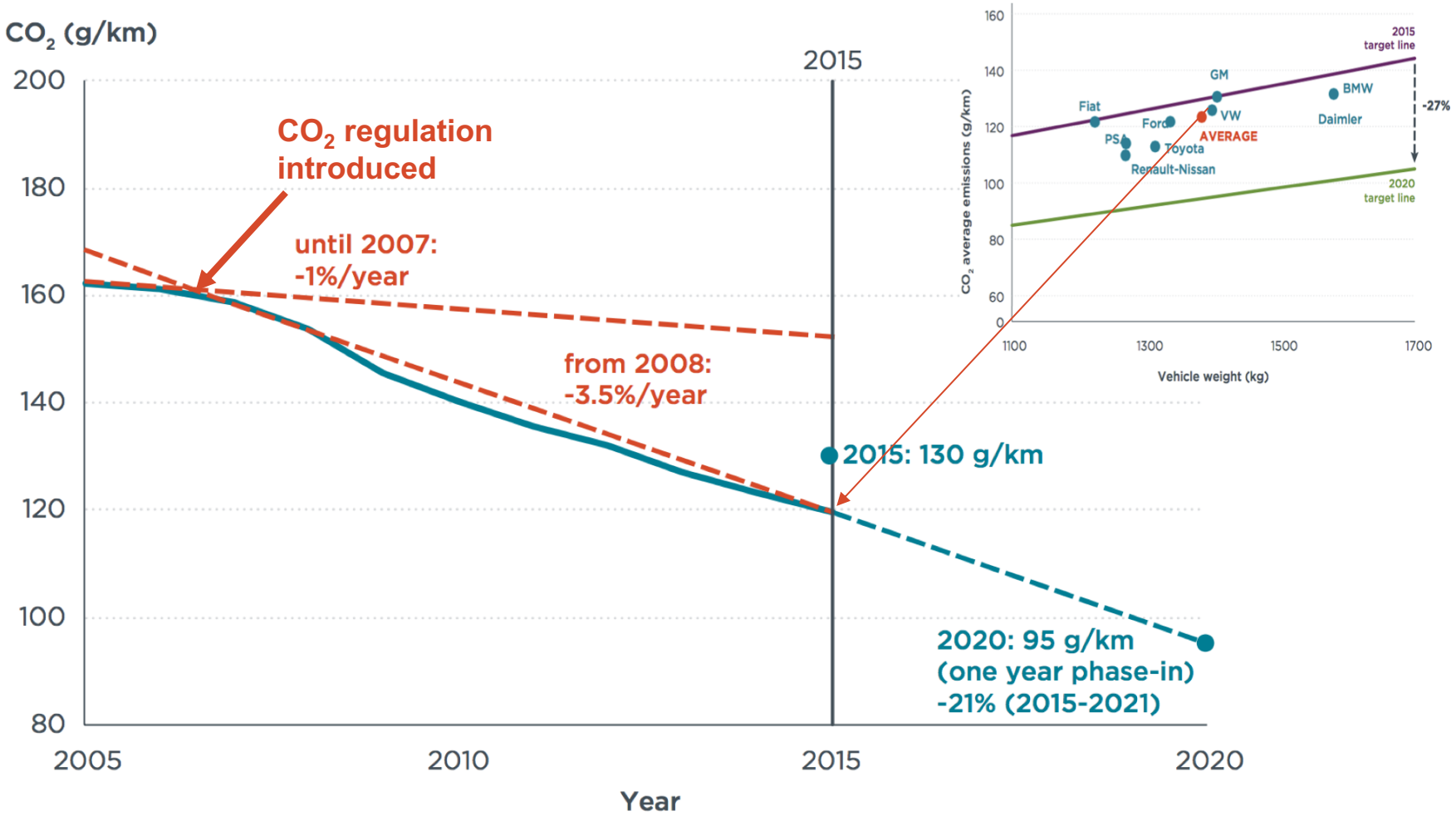
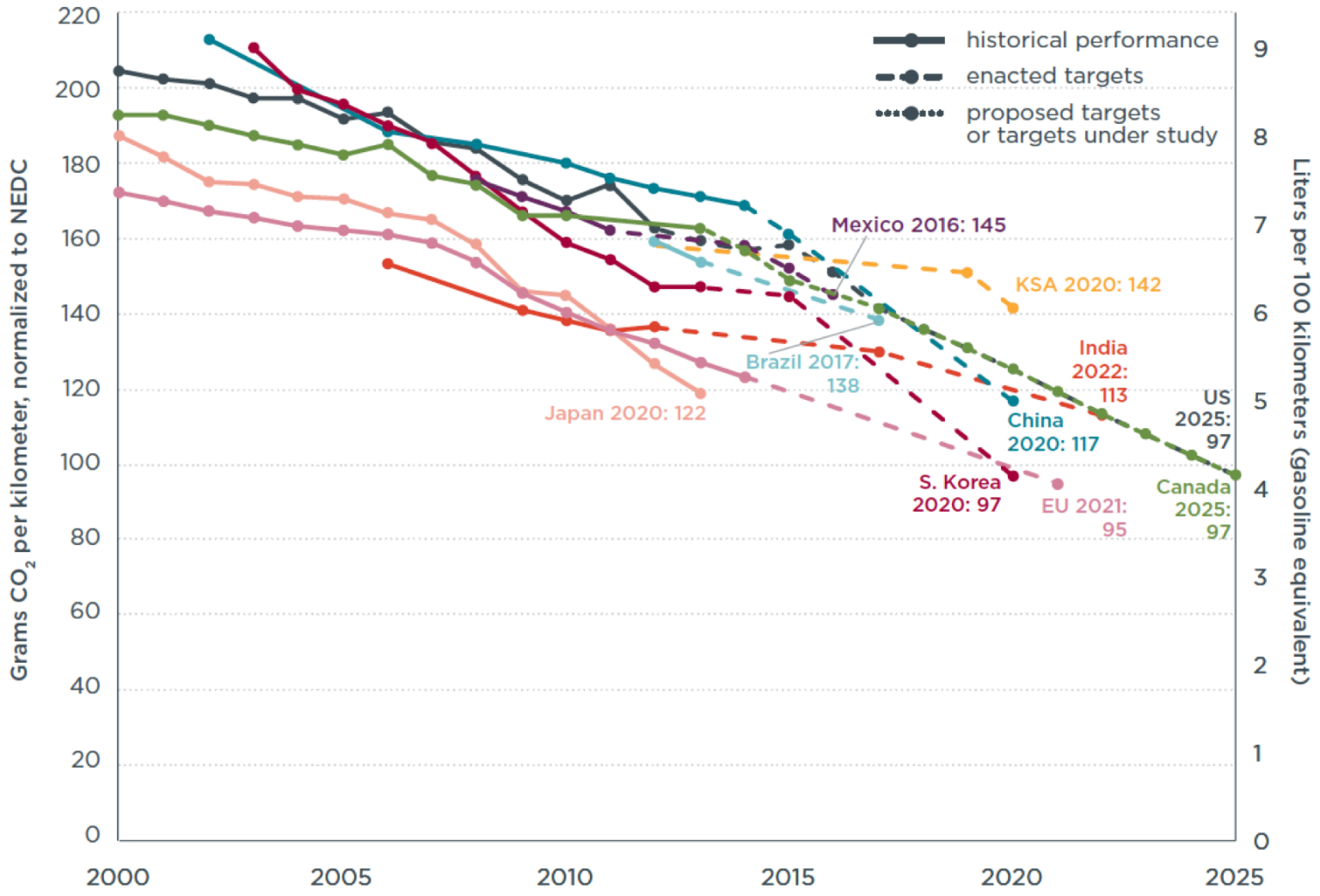
In the EU, mandatory CO_2 standards for new cars have quadrupled the reduction rate



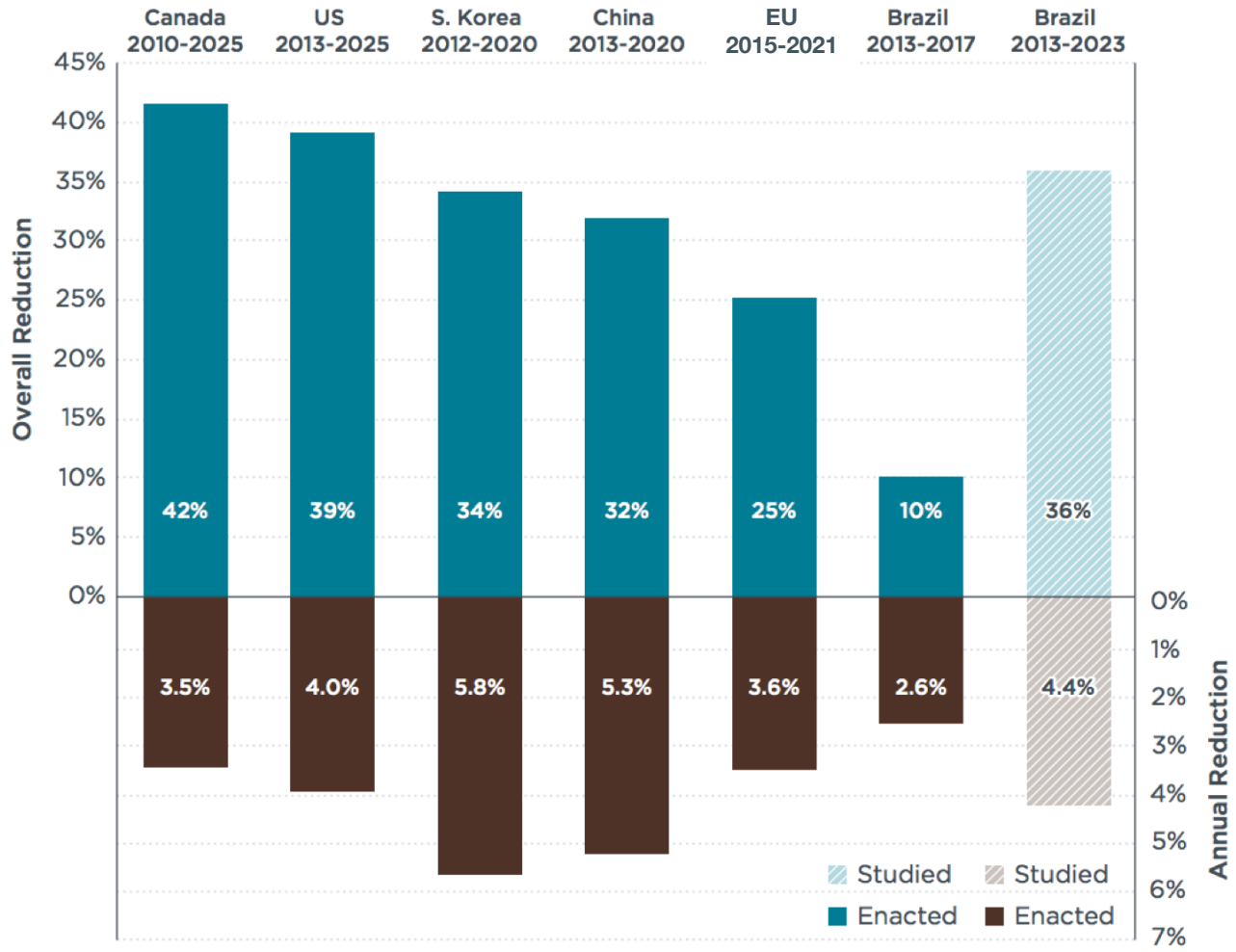
http://theicct.org/co2-new-cars-eu-manufacturer-performance-2014

More and more countries introduce CO_2 standards, with converging target values



Source: http://www.theicct.org/info-tools/global-passenger-vehicle-standards

Vehicle efficiency targets for different countries



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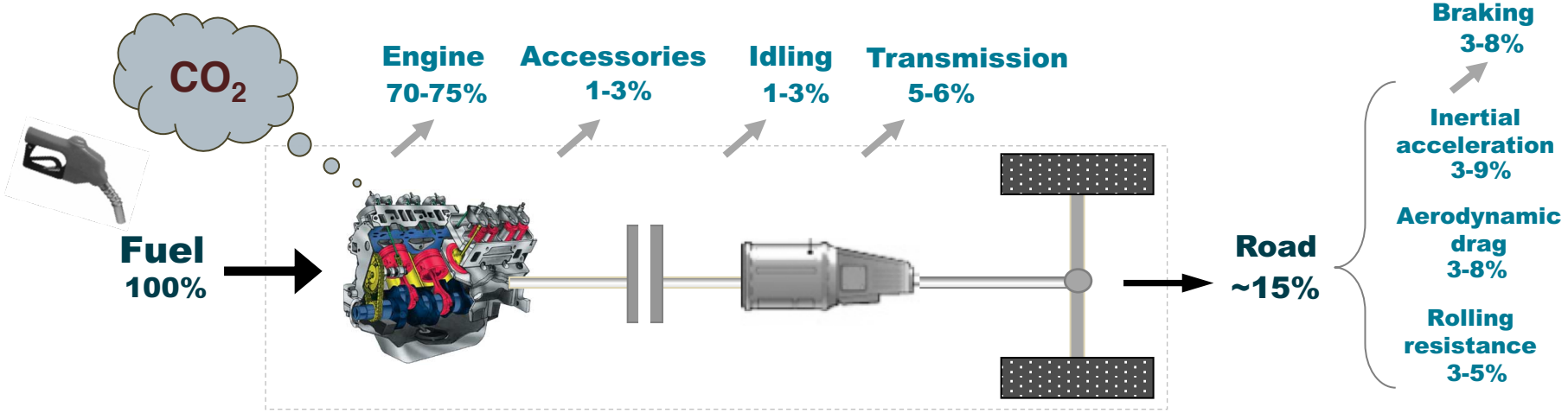
What would happen to the vehicle itself?

Vehicles would be fitted with technologies that improve efficiency

There are many different technical options how to reduce CO_2 emissions

- The average 2015 car, at 15-20% efficiency, has many efficiency losses – and many efficiency opportunities



Variable valve timing
Low friction lubrication
Cylinder deactivation
Cooled exhaust gas recirculation
Direct injection
Turbocharging
Lean-burn
Compression ignition
Electric power steering
Efficient air conditioning
Efficient alternator
6-8 speed transmission
Integrated starter "Stop-start"
Dual-clutch transmission
Advanced lightweight materials
Optimized vehicle design
Low drag brakes
Improved aerodynamics
Low rolling resistance tires

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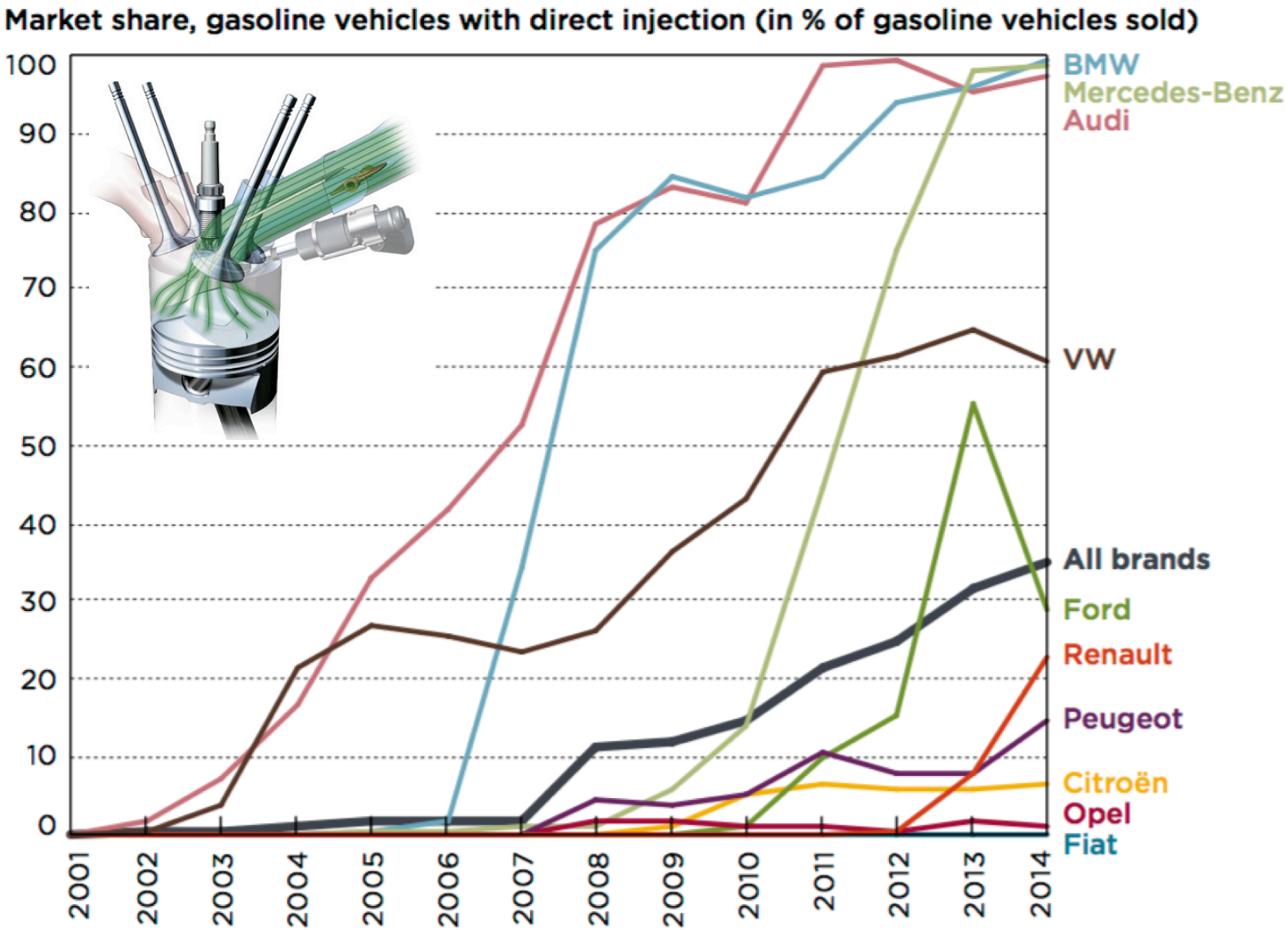
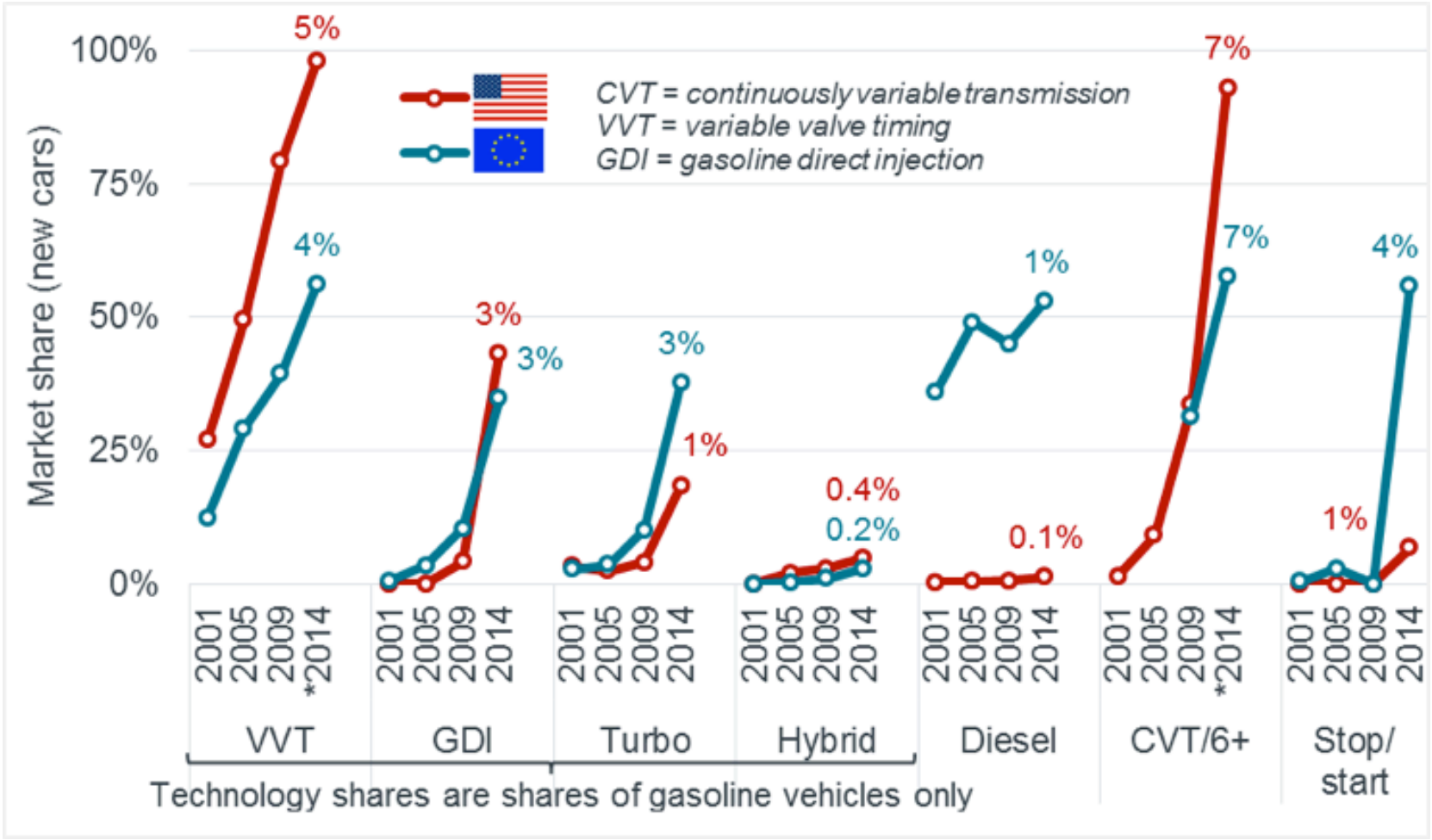
Sources: Lutsey, 2012; Kromer and Heywood, 2007; U.S. EPA (http://www.fueleconomy.gov/feg/atv.shtml)

Gasoline Direct Injection (GDI) adoption in Europe



Regulation has been driving efficiency technology uptake in both, the EU and US in recent years

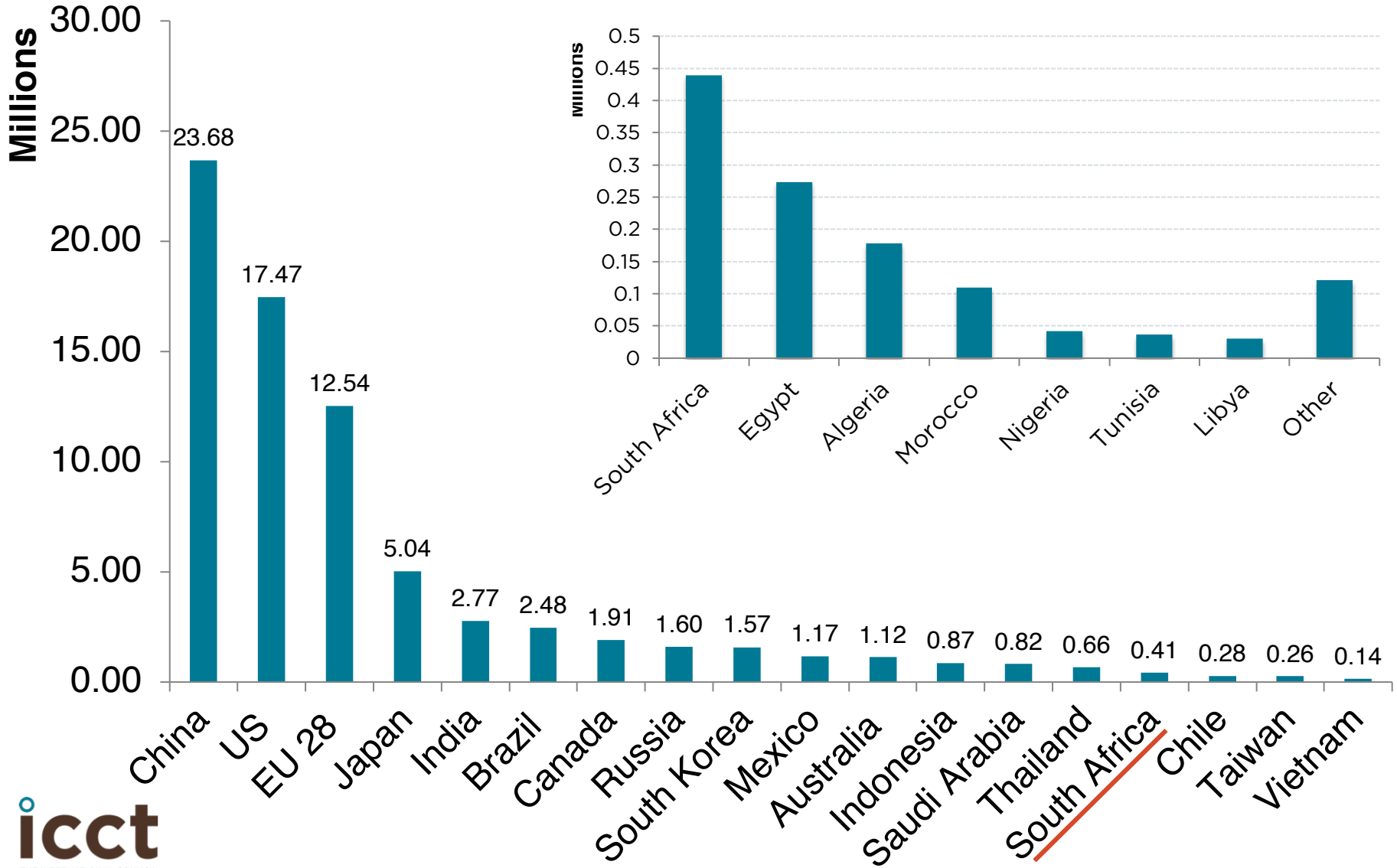


EU CO_2 emission standards are mandatory since 2008

Case study

South Africa Fuel Economy Standards

The South African new passenger vehicle fleet is the largest in the African continent and the 18th largest globally.



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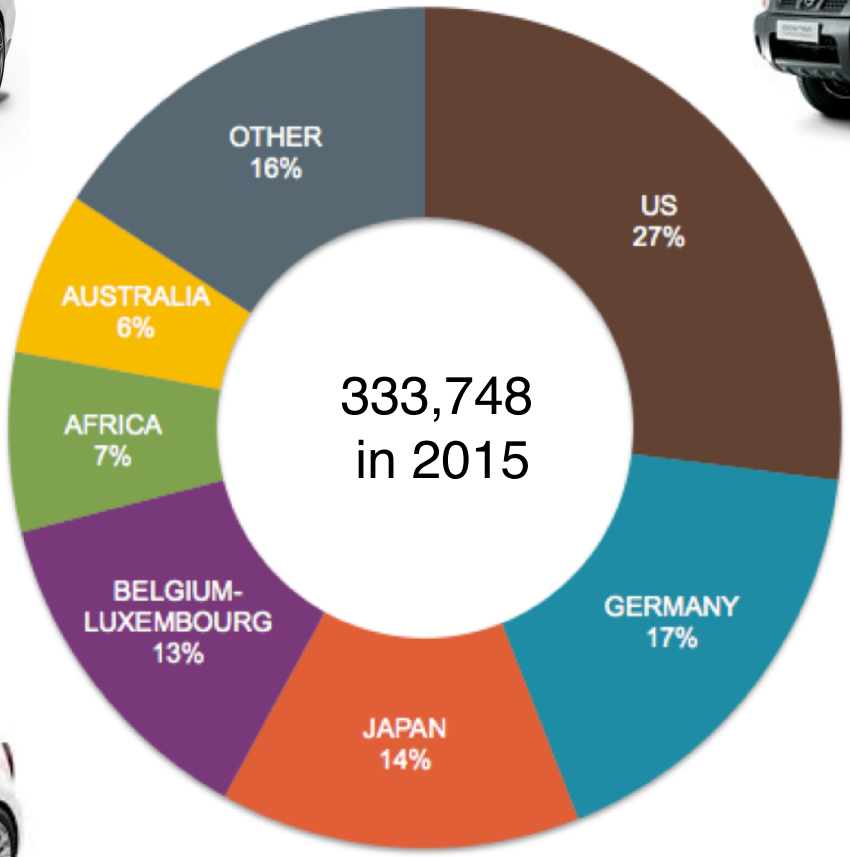
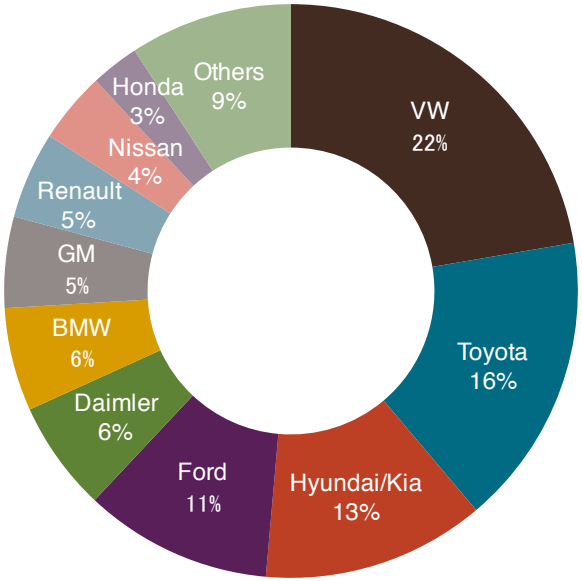
South Africa vehicles are exported to markets with new vehicle FE/CO_2 standard regulations

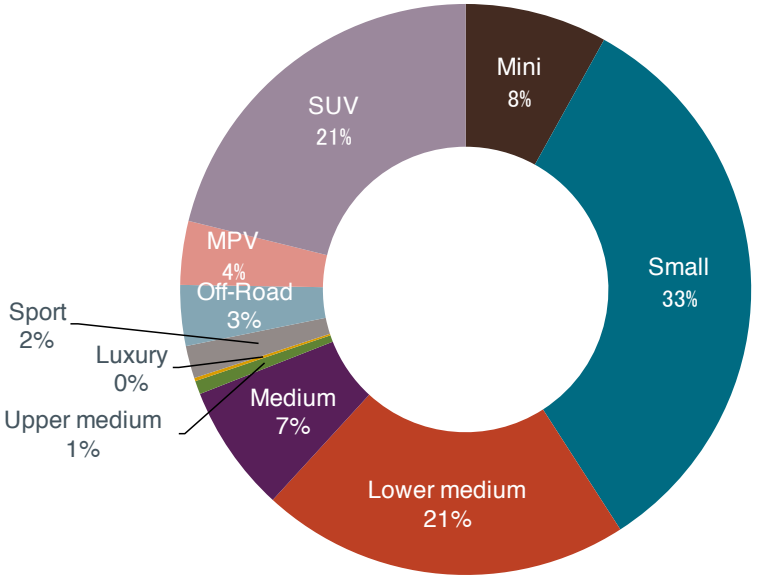


Every single FE Policy starts with a Baseline Analysis

- ICCT purchased 2015 dataset from NAAMSA
- Data for more than 2100 model variants
  - CO_2, g/km
  - Fuel Consumption , L/100km
  - Vehicle characteristics (Mass, Power,…)
- Covering more than 98% of the market

SA passenger car market characteristics – CY2015





VW and Toyota are the two largest manufacturers

Diesel share: 17%

The South African market aligns in terms of market composition with most global markets: a contrasting combination of large shares of small vehicles and SUVs

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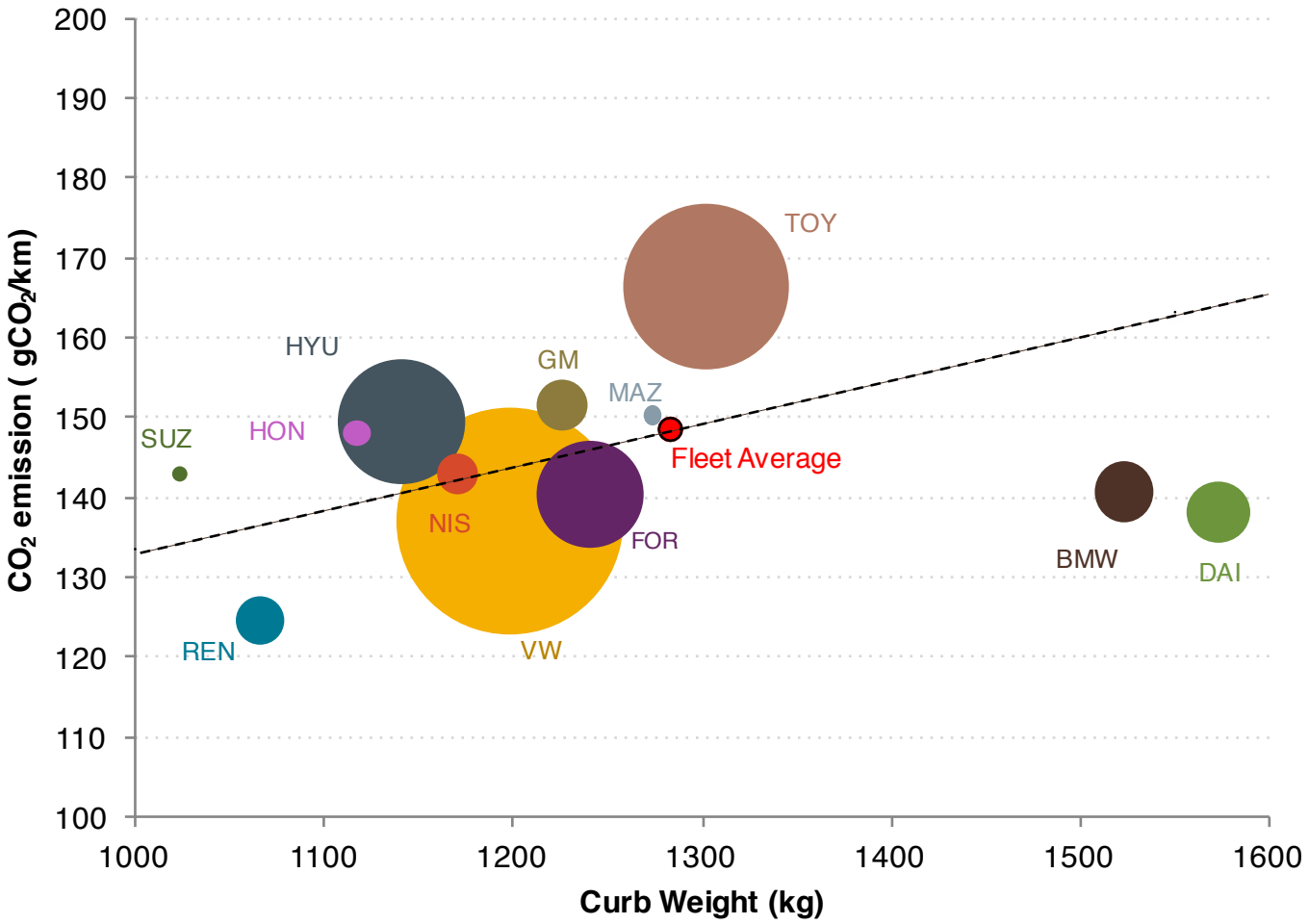
TOYOTA

CO_2 emissions by manufacturer

FE Passenger Vehicle Baseline for South Africa



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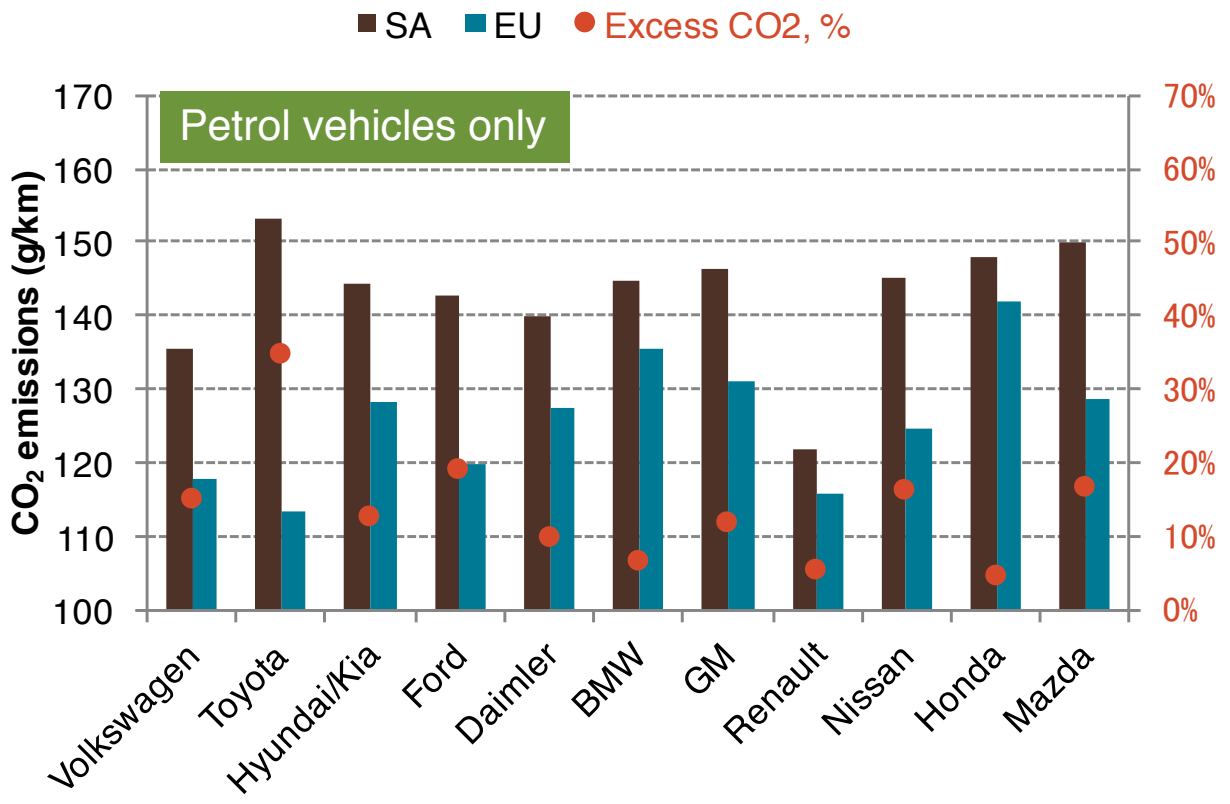
Comparison of average new vehicle CO_2 emissions by manufacturer in South Africa and Europe, gasoline vehicles only



- Fleet average difference is 20% higher CO_2 emissions in SA
- The red dot shows the excess CO_2 that the average PV is emitting in SA with respect to the European market, by manufacturer.
- Toyota presents the largest difference, partially explained by high SUV share in SA and reduced uptake of efficient technologies

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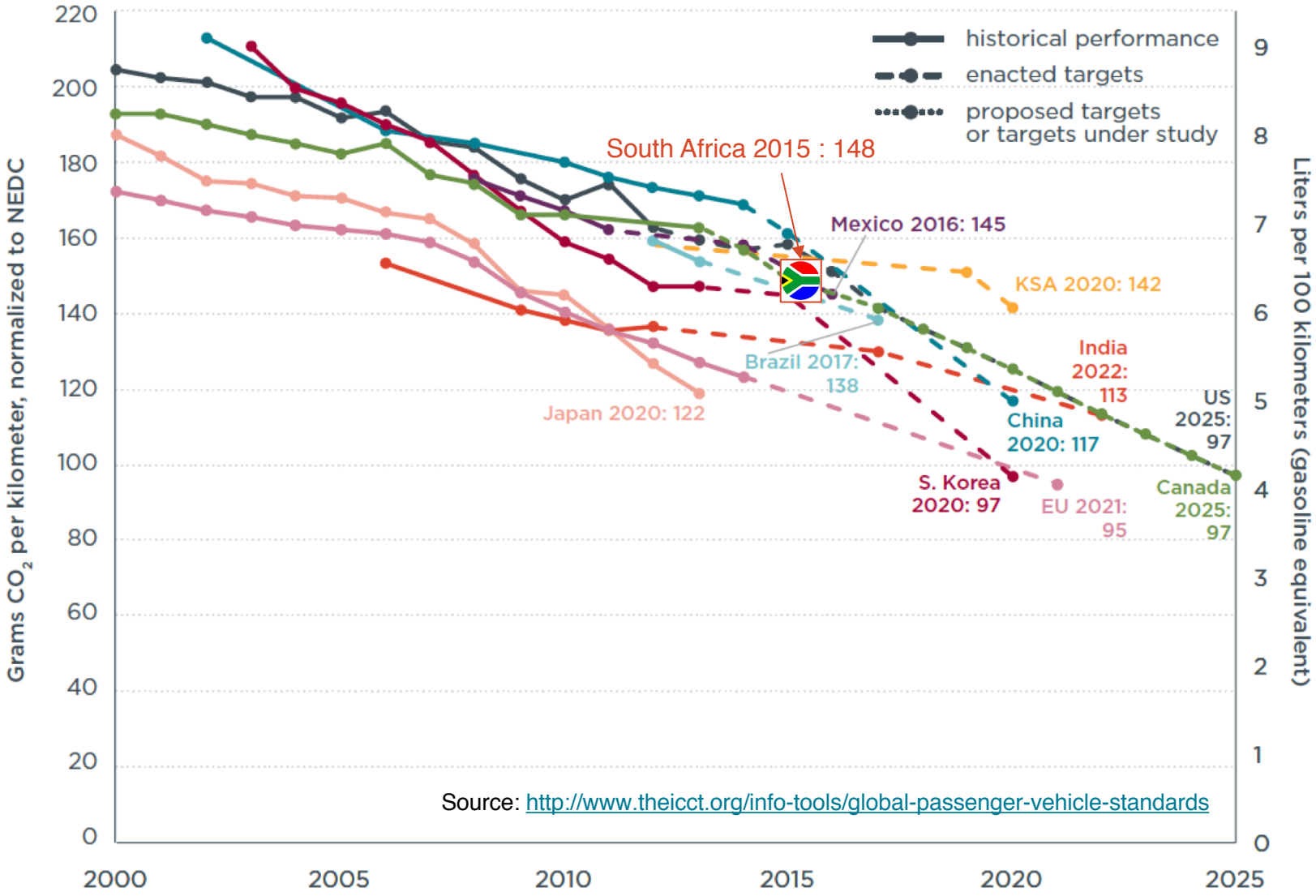
Average PC in SA emits 148 gCO_2/km. Significant potential for improvement when compared to other markets



Source: http://www.theicct.org/info-tools/global-passenger-vehicle-standards

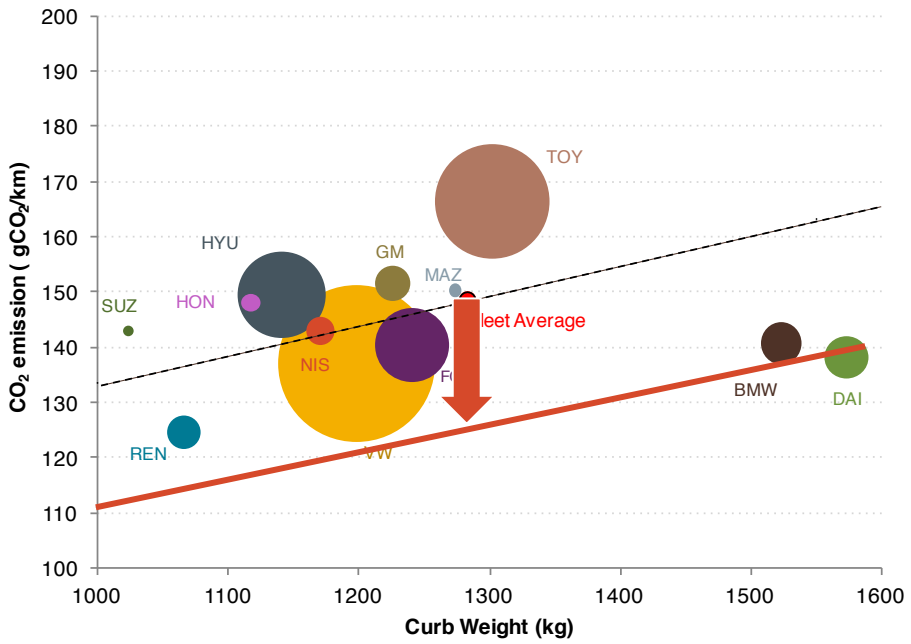
Adopting PV FE/CO_2 emission standards in South Africa

Policy scenario analysis

Key variable to improve: FE Standards

$\sum$ annual

Average vehicle FE/CO_2 performance × Number of vehicles × Distance traveled per year (km/year) = Annual Tons CO_2



Considerations

- Stringency: stringent targets results in higher CO_2 rates of reduction but increase technology demand and cost
- Long-term targets are preferred
- Independent of fuel and technology

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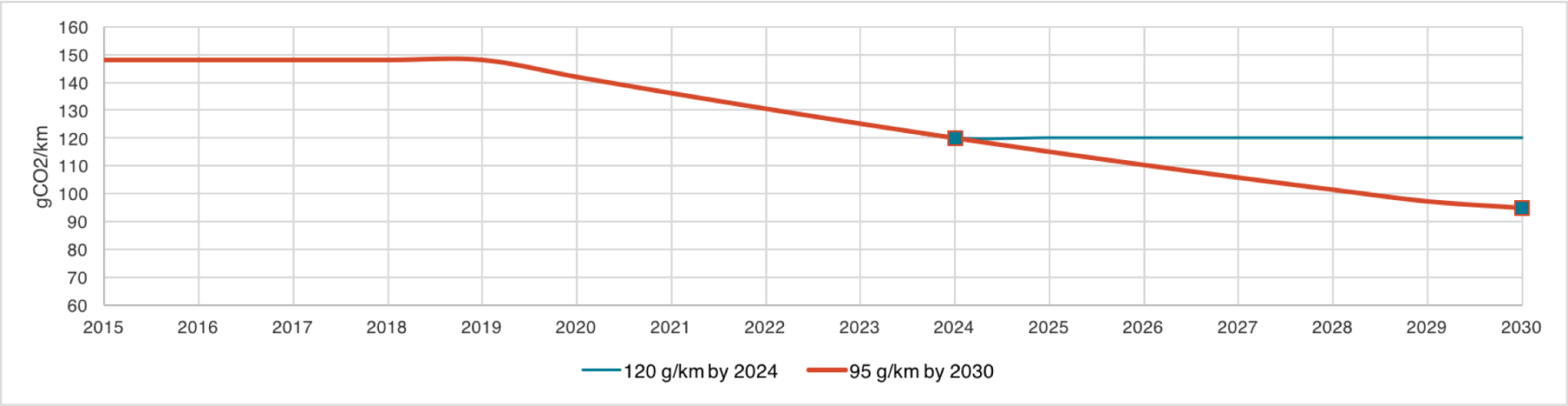
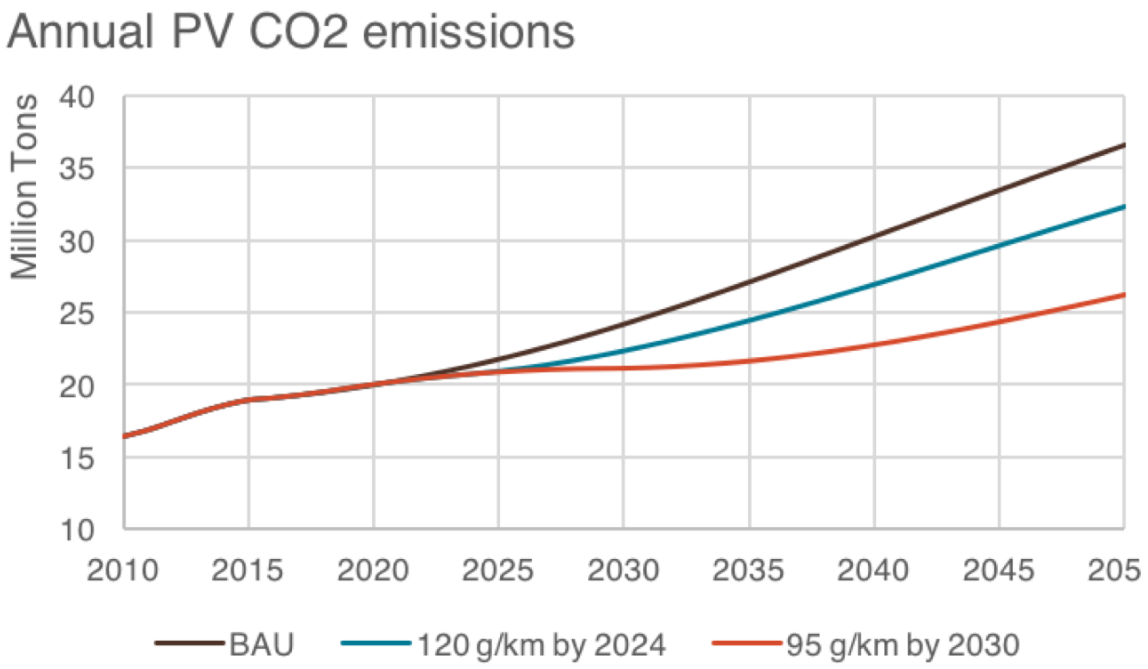
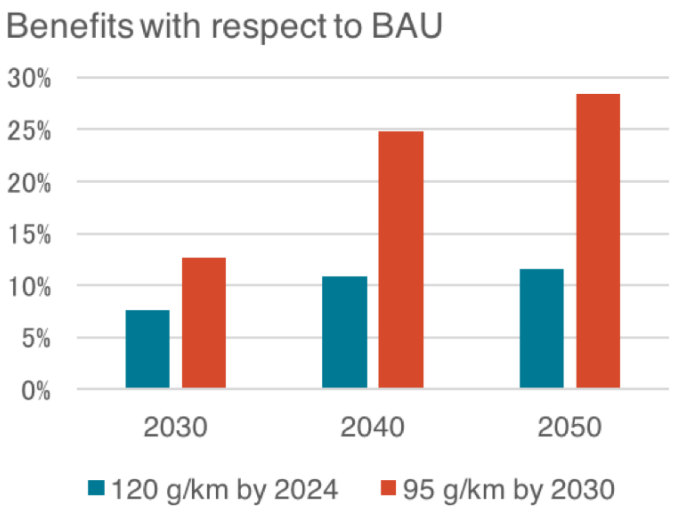
Policy scenarios on potential FE/CO_2 emission standard adoption

- Business as usual
- Adoption of CO_2/FE standards
  - 120 gCO_2/km by 2024 (19% improvement)
  - 95 gCO_2/km by 2030 (36% improvement)
  - 4.1% per year improvement



Model results: FE policy scenarios show large CO_2 reductions even with double the fleet size by 2050





Assumptions

- Projected fleet growth 2%/year
  - **PV Fleet size doubles: from 6 MM in 2015 to 14 MM by 2050**
- VKT average 15000 km/year
- CO_2 gap: 18%
- Rebound effect: 10% per % of fleet CO_2 reduction
- FE/CO2 standards scenario assumes 4.1% per year improvement
- Non-regulated years assume a 0.5% per year efficiency improvement

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Next steps

ICCT's workplan

ICCT's workplan

2016 — Completed

- Baseline analysis
- Workshop 1 (Pretoria – October 2016)

2017 — Completed

- FE Standards Policy Scenarios and Benefits Assessment
- Workshop 2 (Pretoria – Nov 2017)
- Baseline and Benefits report

2018 — In process

- Technology potential analysis
- Technology cost and payback analysis
- Workshop 3 (Pretoria – Oct 2018)
- Final report and final workshop

Government to take decision on whether to start regulatory phase

2019

- Regulatory proposal development (with final regulation completed to allow for implementation in 2020)

2020 Potential regulatory start date

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More information …

Additional resources online:

- South Africa FE Standards Project:

https://www.theicct.org/publications/south-africa-new-PV-CO2-emission-stds

Francisco Posada
francisco@theicct.org

Thank you!

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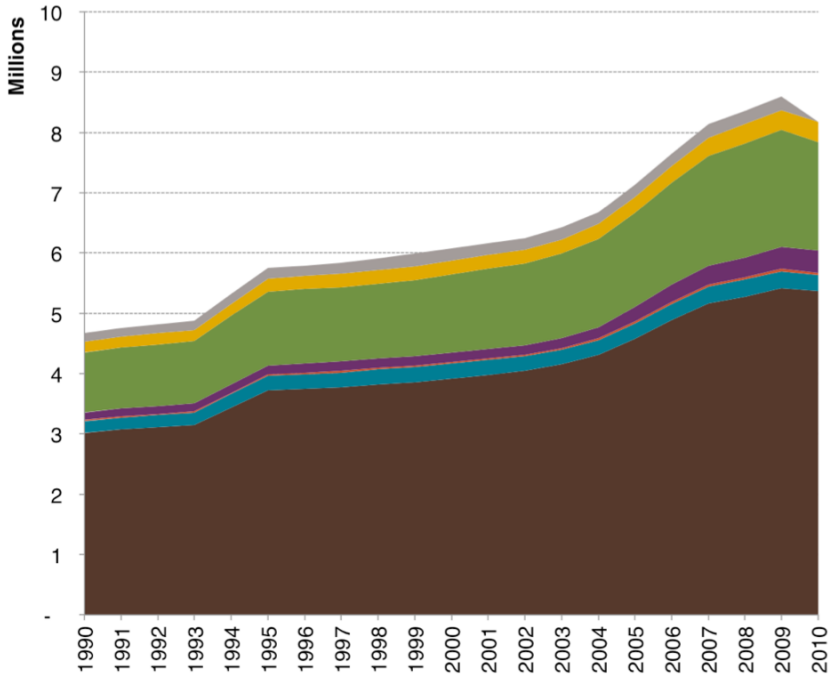
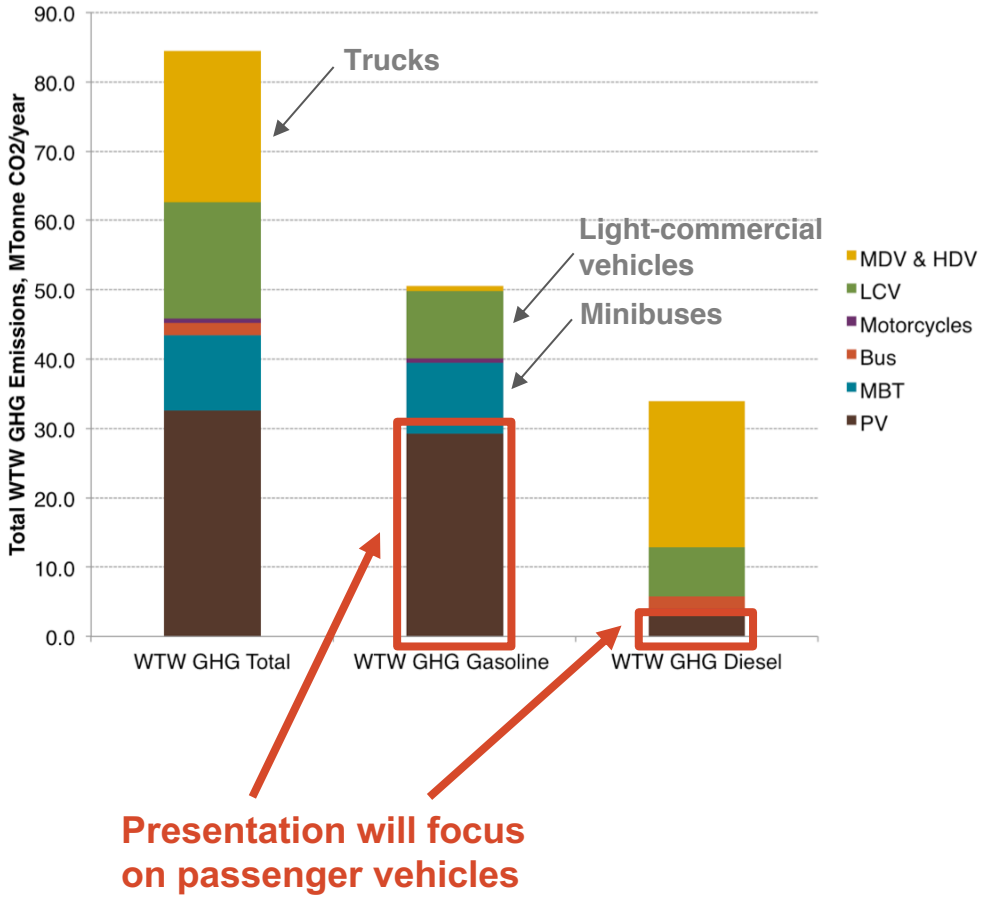
South Africa's vehicle fleet is growing – passenger cars account for large portion

Number of vehicles registered in South Africa:



Greenhouse gas emission levels:



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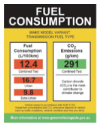
Posada, F., NAMA Mitigation Potential – Preliminary Analysis. Prepared for TRANSfer project. The international Council on Clean Transportation. Washington DC. July, 2015.

Implementation of vehicle fuel economy labeling scheme



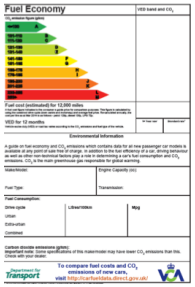
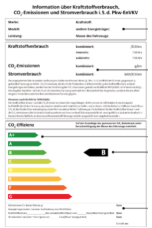


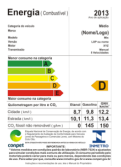


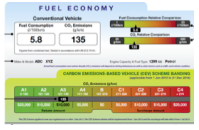

MANDATE
VOLUNTARY
Market size covered by program

US
South Korea
Canada
Japan
Australia
Germany
China
New Zealand
India
Chile
Vietnam
Thailand
UK
Austria
Netherlands
Singapore
Chinese Taipei
Saudi Arabia
Brazil

1978
1988
1999
2000
2005
2010
2015
2020






Manufacturer Sales weighted average CO_2 emissions - Example

Manufacturer X	Model A	Model B
Sales 2015	1000	500
CO_2 emissions	150 g/km	300 g/km
Mass	1000 kg	2000 kg
Manufacturer X, Sales Weighted Ave CO2	$\frac{(1000*150)+(500*300)}{1000+500}$ = **200 g/km**	
Manufacturer X, Sales Weighted Ave Mass	$\frac{(1000*1000)+(500*2000)}{1000+500}$ = **1333.3 kg**	

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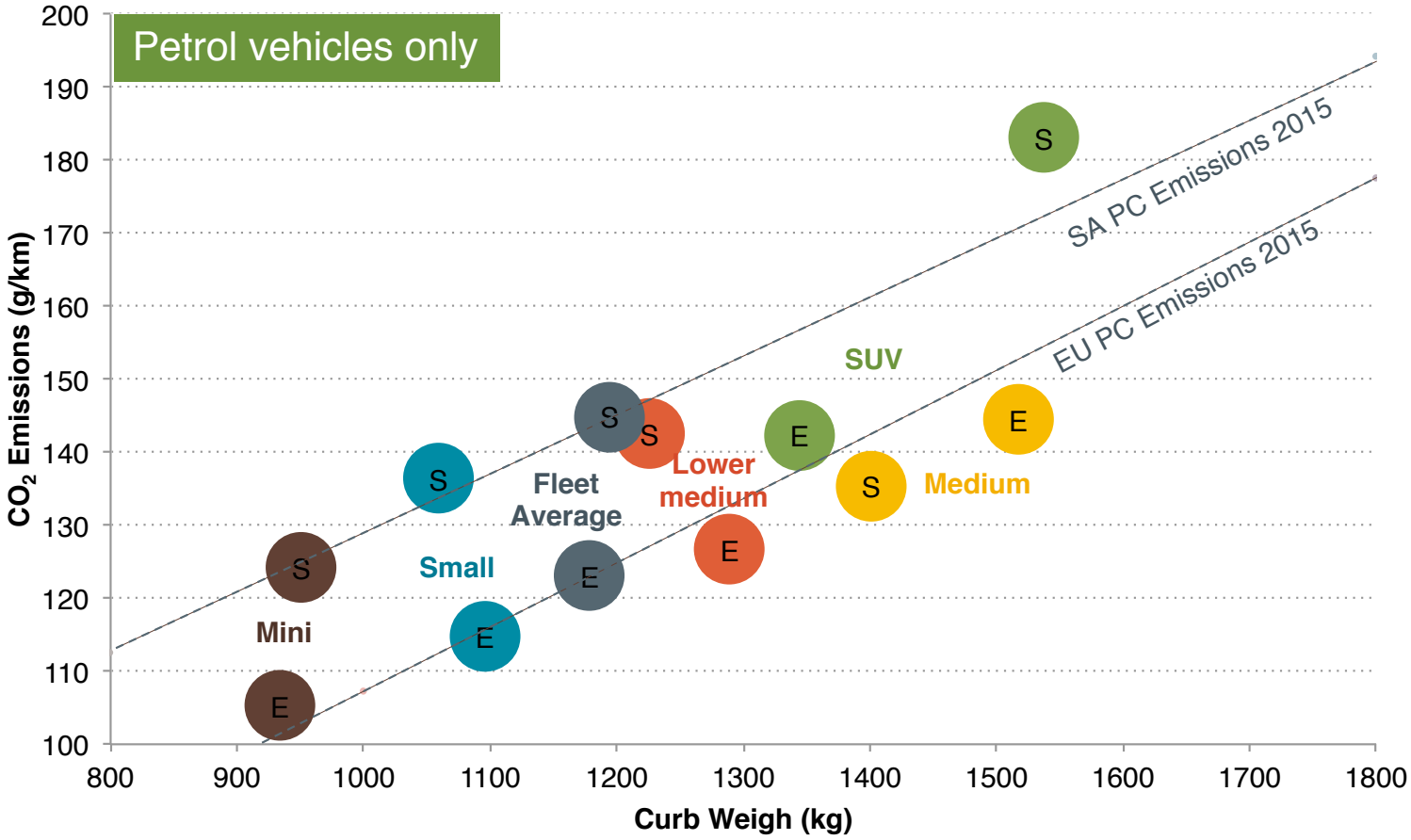
Average new vehicle sales-weighted CO_2 emissions as a function of curb weight, by segment - gasoline vehicles only



- Compared to Europe, South African SUVs are 14% heavier and 29% less efficient
- Small vehicles are more efficient in Europe by around 18%.

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International market comparison of new passenger car fleet characteristics

Region	South Africa	EU-28	U.S.	China	Japan	Brazil	India	South Korea
Data year	**2015**	2015	2015	2014	2013	2013	2015	2014
Sales (million)	**0.4**	13.7	16.7	20.7	3.5	3.0	2.8	1.4
Number of cylinders	**3.9**	3.9	4.6	---	3.8	4.0	3.6	4.3
Engine displacement (l)	**1.7**	1.6	2.5	1.7	1.4	1.4	1.3	2.0
Engine power (kW)	**97**	93	171	93	78	76	59	120
Curb weight (metric tons)	**1.3**	1.4	1.8	1.4	1.2	1.1	1.1	1.5
Footprint (m^2)	**---**	4.0	4.6	4.0	3.7	3.7	3.5	4.2
Power-to-weight-ratio (kW/kg)	**0.073**	0.067	0.093	0.066	0.065	0.067	0.052	0.084
CO_2 emissions - NEDC (g/km)	**148**	121	185	171	119	151	123	148
Gasoline	**83%**	43%	96%	98%	86%	6%	47%	51%
Diesel	**17%**	52%	1%	2%	0%	0%	50%	39%
Hybrid-electric	**< 0.1%**	3%	3%	0%	13%	0%	0%	0%
Others (Ethanol, CNG, LPG)	**0%**	2%	0%	0%	1%	94%	3%	10%
Manual transmission	**67%**	75%	5%	49%	1%	83%	98%	9%
Automatic transmission	**33%**	25%	95%	51%	99%	17%	2%	91%

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Methodology for CO_2 benefit analysis

Classic bottom up analysis for GHG emissions inventory

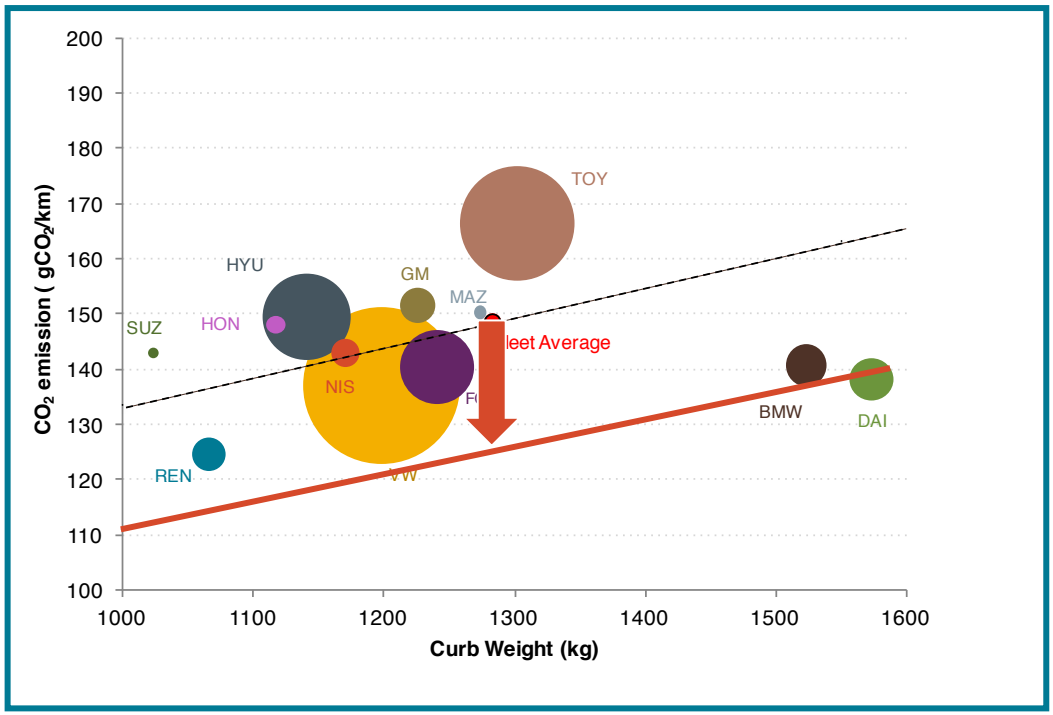
Key variable to control	Observation	Observation
Average new vehicle FE/CO2 standards	Statistical data	Statistical data

Key variable to improve: FE Standards

$\sum$ annual

Average vehicle FE/CO_2 performance × Number of vehicles × Distance traveled per year (km/year) = Annual Tons CO_2

Real world CO_2 emissions gap



Considerations

Real world CO_2 emissions gap is the difference between the value obtained during certification testing (laboratory) and the value obtained on the road (real world driving).

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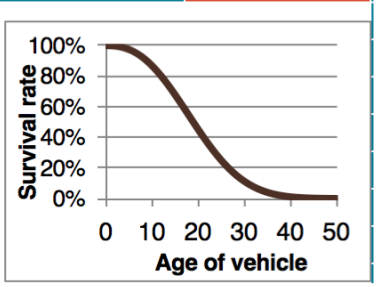
Key variable to monitor: Number of vehicles

$\sum_{annual}$ Average vehicle FE/CO_2 performance × Number of vehicles × Distance traveled per year (km/year) = Annual Tons CO_2

ANNUAL VEHICLE SALES	
Year	New sales
2005	419,868
2006	481,558
2007	434,653
2008	329,262
2009	258,129
2010	337,130
2011	396,292
2012	440,002
2013	450,561
2014	439,264
2015	412,670

Vehicle survival function	
f=e-(x/b)^a	
a value	2.5
b value	22



Considerations

- FE/CO_2 standards are not designed to change market composition or total sales
- National vehicle data are required
- Annual updates needed
- Fleet growth projections are required
- Vehicle retirement rates are needed to estimate the outflow of vehicles

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Key variable to monitor: activity

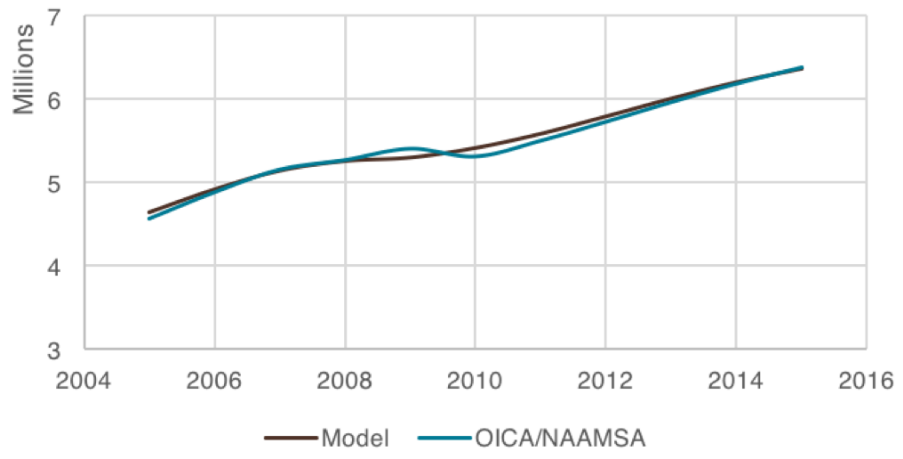
Considerations

- National VKT data are required
- Vehicle VKT degradation curves are needed
- Updates every new regulatory update

Rebound effect: potential increase in vehicle activity due to drivers experiencing lower driving cost

Model validation – Fleet size and fuel consumption

SA Passenger vehicle fleet, parc



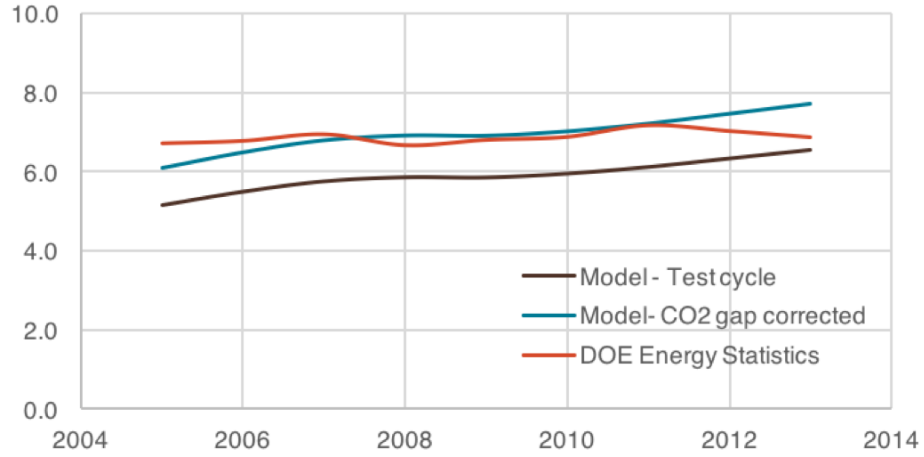
Average error 2005-2015: +0.4%

Retirement rates adjusted:
a=2.5, b=22

Vehicle survival function	
f=e-(x/b)^a	
a value	2.5
b value	22

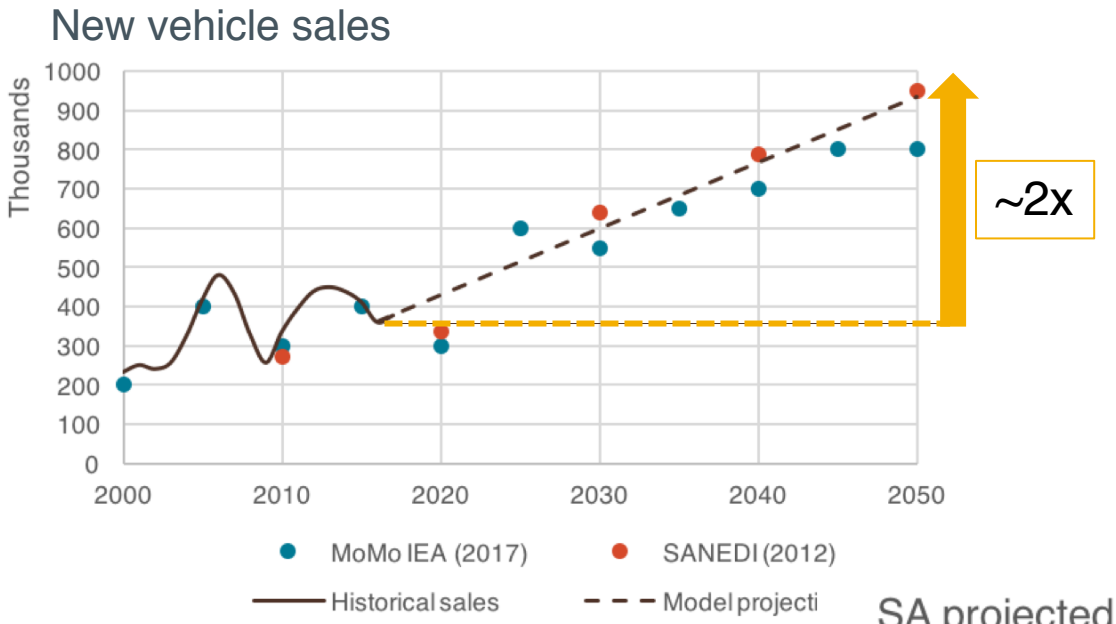
Sources:
OICA: http://www.oica.net/category/vehicles-in-use/

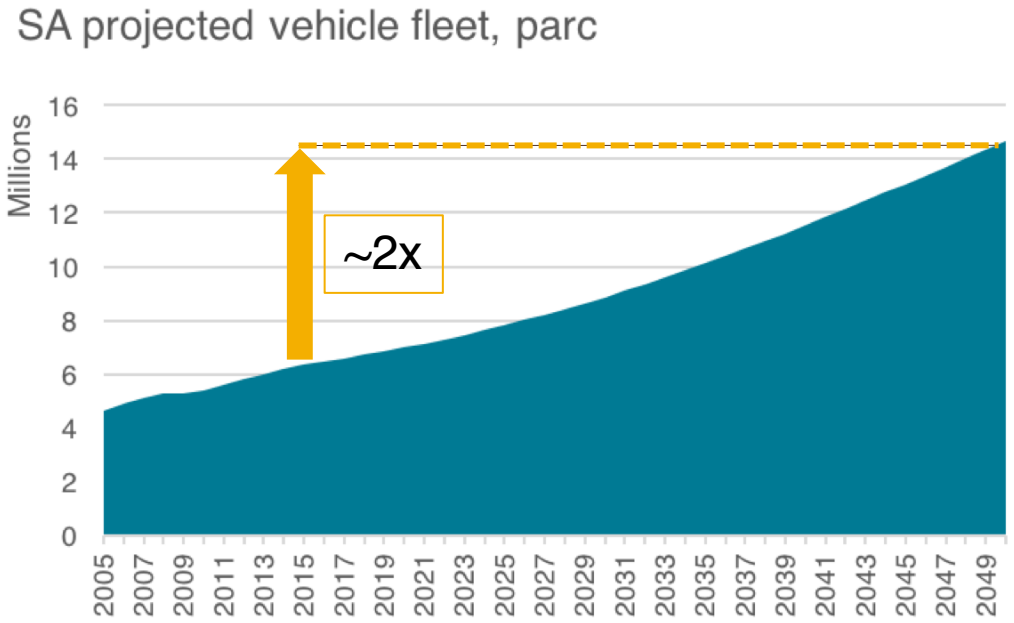
Total fuel consumption, billion Litres



Sources:
DoE
http://www.energy.gov.za/files/media/media_SAVolumes.html

Fleet projections: South Africa PV sales expected to double by 2050





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CO_2/FE Standards promote early and accelerated adoption of efficient technologies

	GDI	Turbo	VVT	6+ speed	CVT	**Start Stop**	Hybrid
2005	-	2.4%	49.4%	6.2%	1.1%	-	1.9%
2006	-	3.2%	58.2%	14.4%	1.2%	-	1.5%
2007	-	3.6%	63.3%	18.8%	6.7%	-	3.2%
2008	3.1%	4.5%	62.7%	21.6%	7.7%	-	3.3%
2009	4.2%	4.0%	79.1%	22.4%	8.3%	-	2.9%
2010	9.2%	4.1%	91.8%	36.4%	8.4%	-	5.6%
2011	18.4%	8.2%	94.9%	59.2%	8.8%	-	3.4%
2012	27.6%	9.7%	97.7%	63.3%	11.0%	0.9%	4.7%
2013	37.7%	15.3%	98.1%	67.5%	13.7%	3.0%	5.4%
2014	43.2%	18.4%	97.9%	68.1%	21.3%	6.8%	4.2%

Source: 2015 EPA Fuel Economy Trends Report – **Cars only**
GDI: Gasoline Direct Injection
CVT: Continuously Variable Transmission
VVT: Variable Valve Timing

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