Non-fiscal measures to improve fuel economy

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June 11, 2015

GFEI Vehicle Fuel Economy Policy Training

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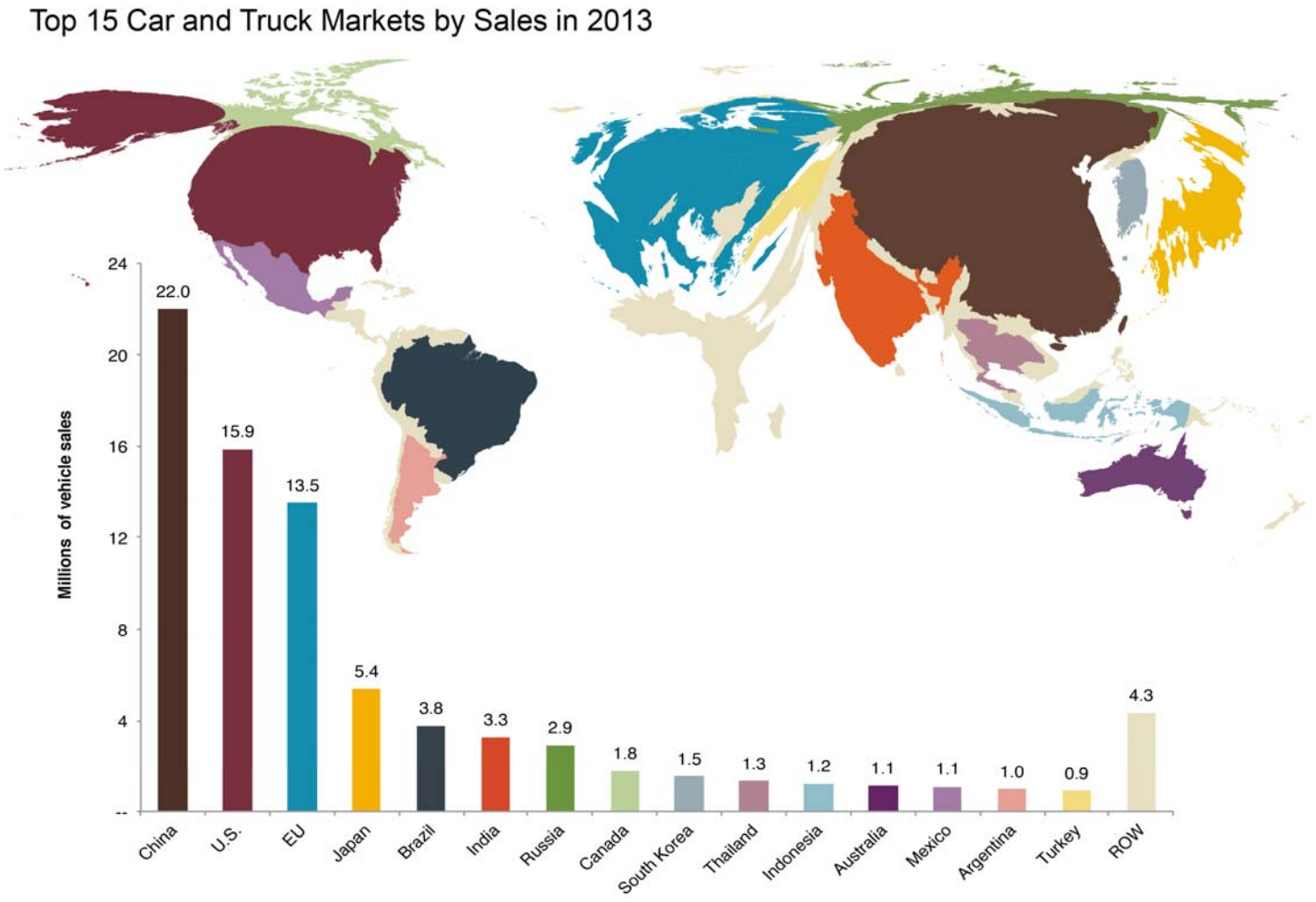
Overview

- About ICCT
- Background information
- How to develop fuel economy standards?
- How to develop fuel economy labeling schemes?
- Panel discussion/questions

What is ICCT?

- **ICCT is an independent non-profit research organization that provides technical support on transport efficiency and emission policies in major auto markets**



What to Know about Fuel Economy Regulation

- **Policy options**
- **Metric**
- **Technologies**
- **Consumer attitude**

Policy options

VEHICLE FUEL EFFICIENCY STANDARDS	• Introduce and regularly strengthen mandatory standards • Establish and harmonize testing procedures for fuel efficiency measurement.
FISCAL MEASURES	• Fuel taxes and vehicle taxes to encourage the purchase of more fuel-efficient vehicles. • Infrastructure support and incentive schemes for very fuel-efficient vehicles.
MARKET-BASED APPROACHES	• Voluntary programs such as U.S. SmartWay and other green freight programs
INFORMATION MEASURES	• Vehicle fuel economy labels • Improving vehicle operational efficiency through eco-driving and other measures.

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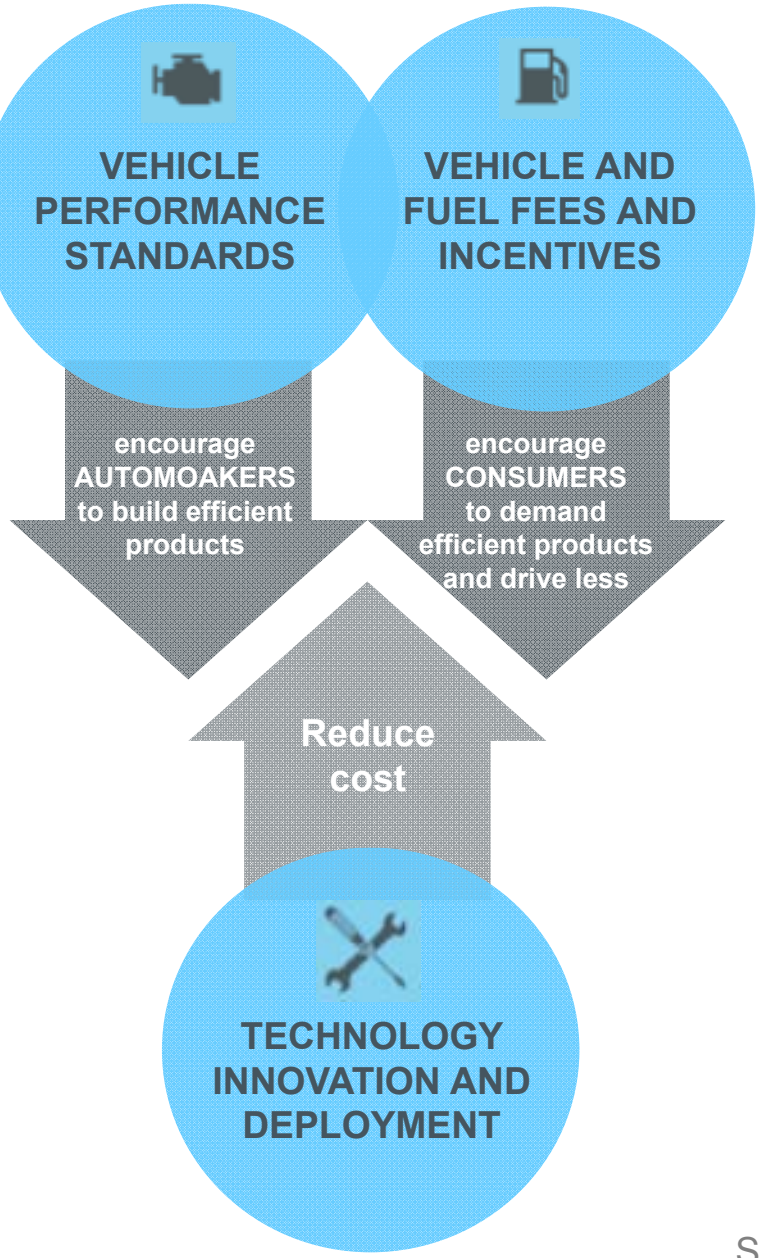
Performance standards, economic signals, and technological innovation complement each other.



Regulatory metric

- **Fuel economy** (mile/gallon, km/L)
  - Used in U.S., Japan
- **Fuel consumption** (L/100km, gal/mi)
  - Used in China, Australia
  - The inverse of fuel economy
- **Carbon dioxide** (CO_2/mile, CO_2/km)
  - Used in EU
  - Require simple conversion with fuel-carbon contents
  - Gasoline (~2350 gCO_2/liter); Diesel (~2700 gCO_2/liter)
- **Greenhouse gas** (CO_2e/mile, CO_2e/km)
  - Used in U.S., Canada
  - Can include other non-CO_2 emissions (e.g., CH_4, N_2O, HFC, black carbon)

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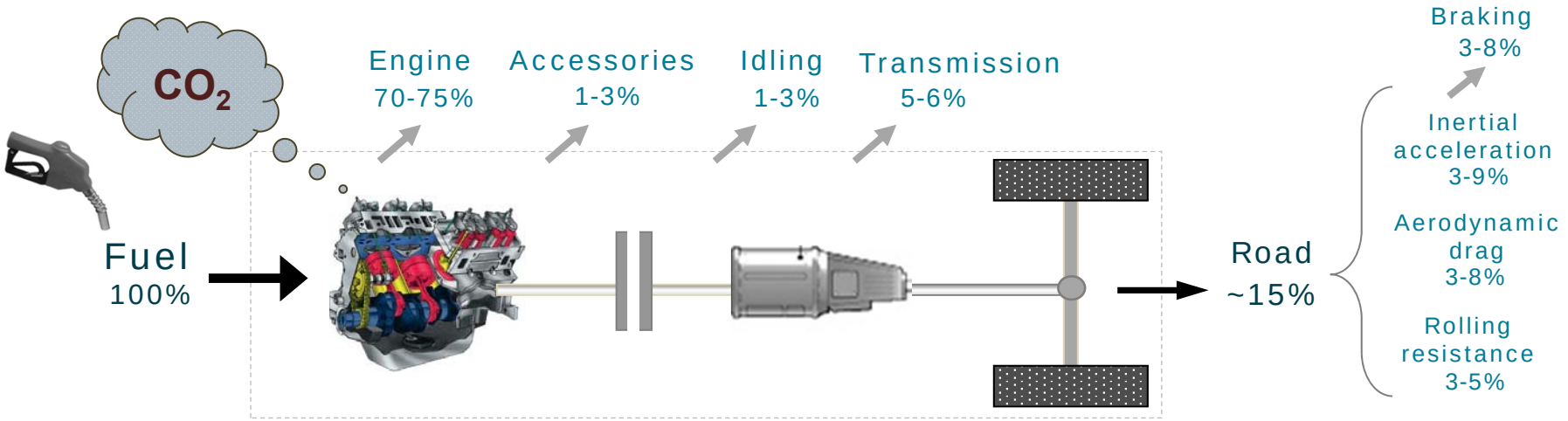
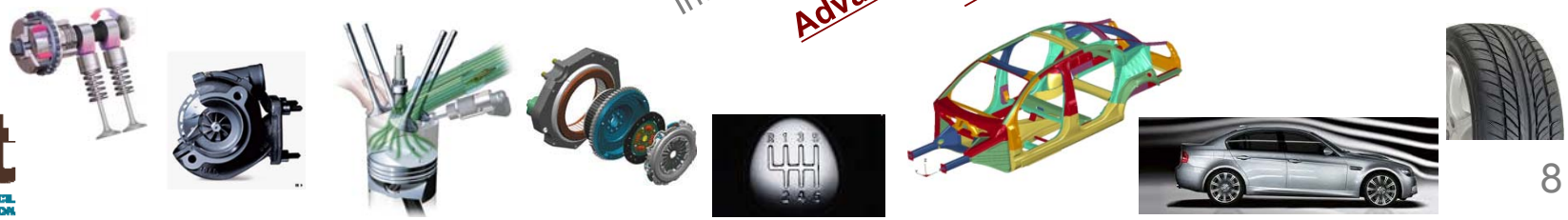
How to improve vehicle fuel economy?

- The average 2010 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)

What's consumer attitude?

- Consumers in the US
  - 85% concerned about gas prices; 79% concerned about mid-east oil dependence
  - 81% general support of fuel economy standards; 64% support 60 mpg standard
- Cost and payback
  - Technology cost of $1500-2500/vehicle; Fuel savings of $500-1000/year;
  - Consumer payback in 2-4 years; all scenarios offer benefits >3 times initial costs

Scenario	Technology Case in 2025	Per-vehicle price increase ($/vehicle)	Average payback period (yr)	Net lifetime owner savings ($)
51 mpg 173 gCO_2/mi 4%/year	Path A	1,700	2.5	5,900
	Path B	1,500	2.2	6,000
	Path C	1,400	1.9	6,200
	Path D	1,900	2.9	5,300
56 mpg 158 gCO_2/mi 5%/year	Path A	2,500	3.1	6,500
	Path B	2,300	2.8	6,700
	Path C	2,100	2.5	7,000
	Path D	2,600	3.6	5,500

Scenario labels are based on regulatory two-cycle fuel economy and CO_2 (various credits, like for air-conditioning technology are available)

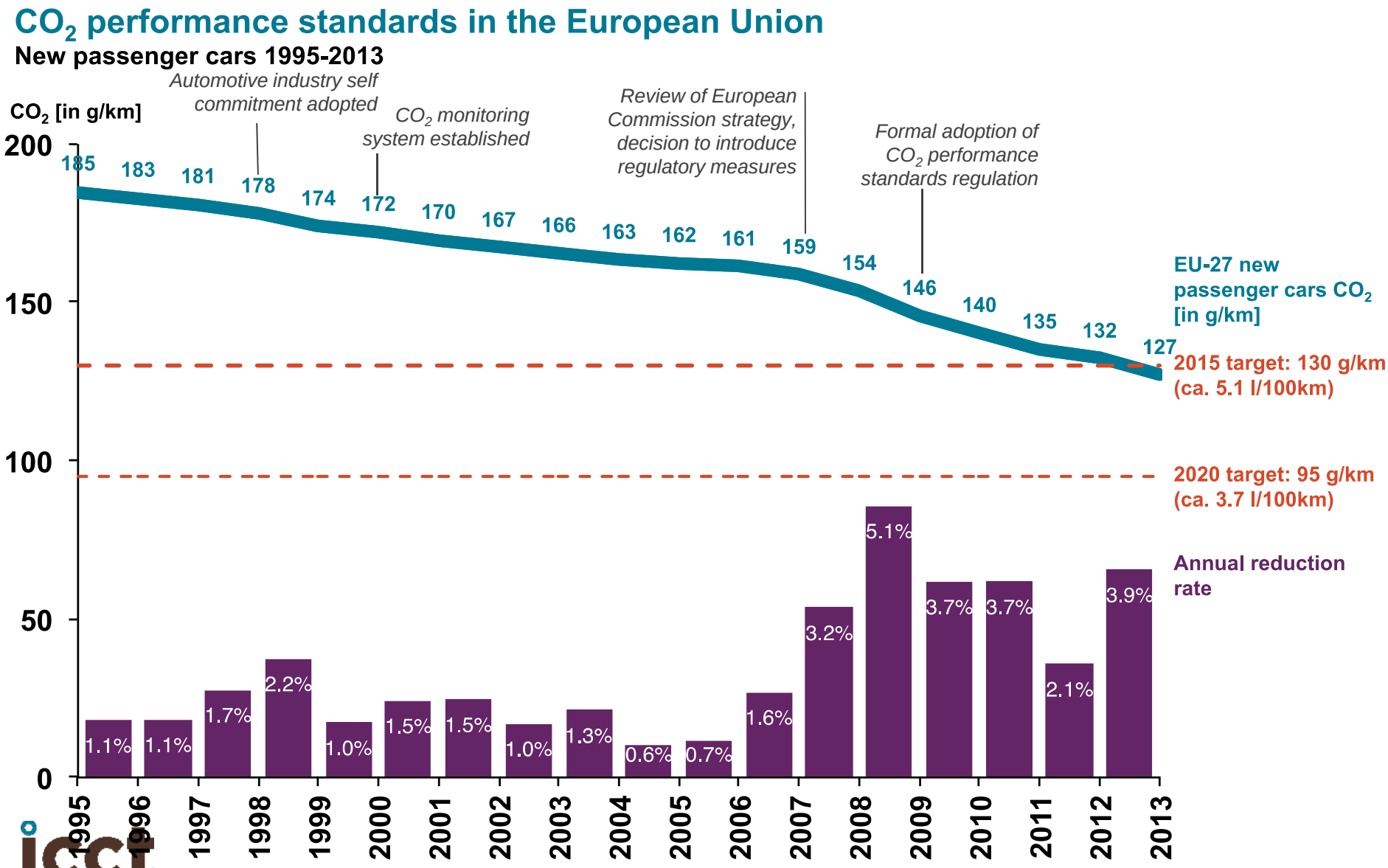
CFA, 2011. Rising Gasoline Prices and Record Household Expenditures. http://www.consumerfed.org/pdfs/CFA-Auto-Standard-Report-May-16-2011.pdf

US EPA/NHTSA/CARB 2010 Interim Technical Assessment Report. http://www.arb.ca.gov/msprog/clean_cars/ldv-ghg-tar.pdf

How to develop fuel economy standard?

- **Why important**
- **Key elements**

The importance of mandatory standards



Data sources: 1995-1999 ACEA data for EU-15; 2000-2013 EU CO_2 monitoring data (2000-2003 EU-15, 2004-2006 EU-25, 2007-2013 EU-27). Note that changes in the number of member states (from 15 to 27) have only minor effects on the overall emission level (about 0.5 g CO_2/km) as passenger car sales numbers in the new member states are relatively low.

Fuel economy standards around the world

Table 1. Comparison of the latest adopted regulations for light- and heavy-duty efficiency in selected regions

		Light-duty vehicles			Heavy-duty vehicles		
Region[a]	Percent of world vehicle sales, 2013	Baseline model year[b]	Implementation period (model year)	Reduction in average CO_2 rate (grams/vehicle-km)	Baseline model year	Implementation period (model year)	Reduction in average CO_2 rate (grams/vehicle-km)
China[c]	25%	2011	2012-2015	9%	2012	2014-2015	11%
EU	19%	2015	2020-2021	27%			0%
US	17%	2017	2017-2025	35%	2011	2014-2018	14%
Japan	6%	2015	2020	16%	2006	2015	12%
Brazil[d]	4%	2013	2013-2017	12%			0%
India	4%	2012	2017-2021	17%			0%
Russia	3%			0%			0%
Canada[e]	2%	2011	2011-2016	20%	2011	2014-2018	14%
South Korea	2%	2011	2012-2015	9%			0%
Australia	1%			0%			0%
Mexico	1%	2012	2014-2016	13%			0%

Adopted or newly implemented between Jan. 2013 and Aug. 2014 | Adopted or implemented prior to Jan. 2013

[a] Includes eleven major vehicle markets
[b] Percent reduction in new fleet fuel consumption estimated from a baseline year (determined by expert judgment rather than regulatory requirement) to the final model year covered by the regulation. Reductions for HDVs are activity-weighted by vehicle type.
[c] China has adopted separate standards for passenger cars and light commercial vehicles. The latest adopted standard for passenger cars (Phase 3) is summarized here.
[d] Brazil's Inovar-Auto program requires a 12.1% improvement for manufacturers to qualify for a 30% reduction in vehicle sales tax.
[e] Canada has announced intention to harmonize with the US 2017-2025 GHG standards; however formal adoption has not occurred as of August 2014.

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Challenges for HDV fuel economy standards

Key elements to consider when introducing fuel economy standards

1. Regulated metric

(fuel consumption, GHG, CO_2…)

2. Form of target curve + underlying attribute

(flat, steps, continuous, … weight, footprint, …)

3. Target timeframe/limit value

(level of ambition: baseline analysis, technology feasibility, cost and benefit)

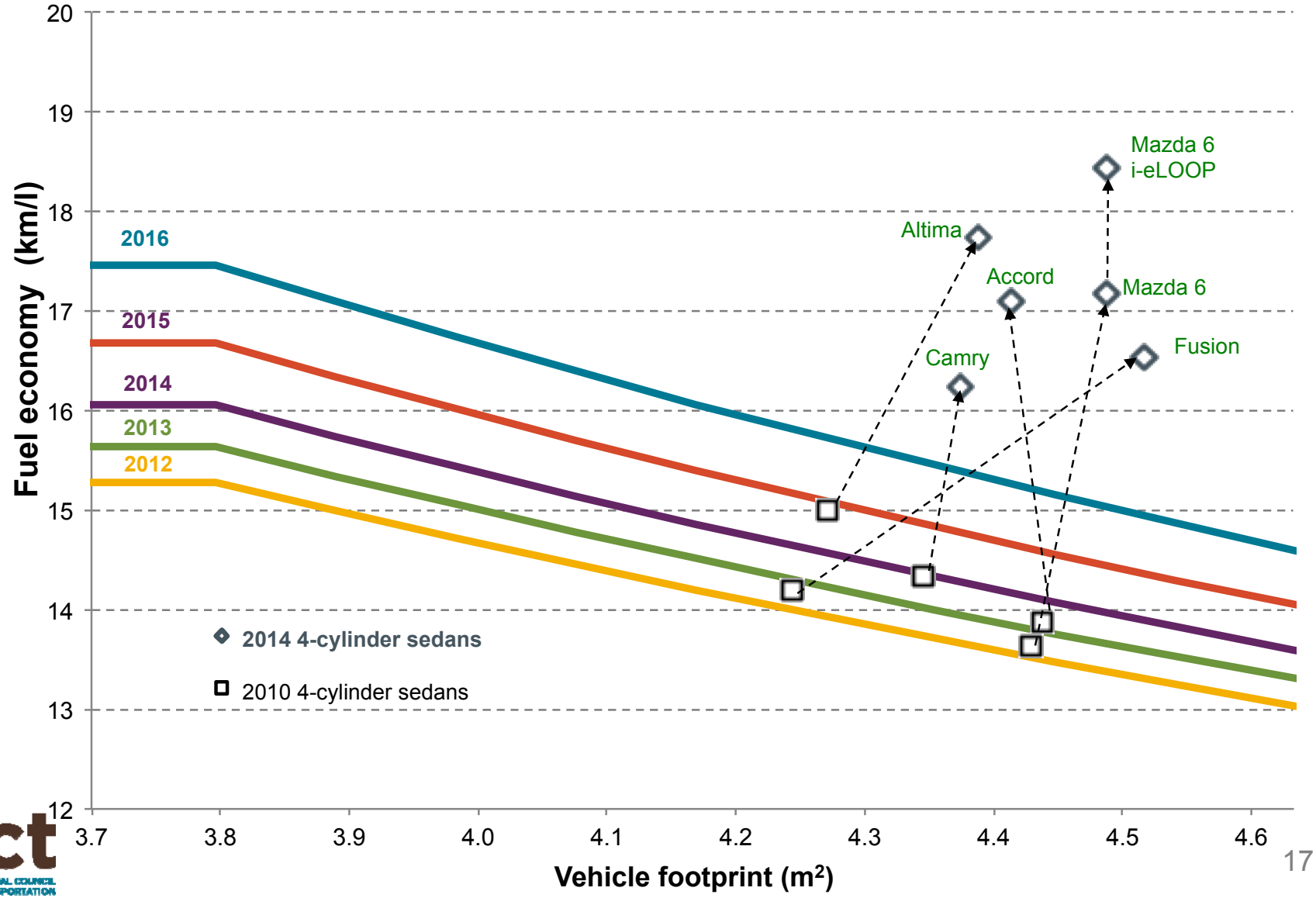
1. Regulated metric

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

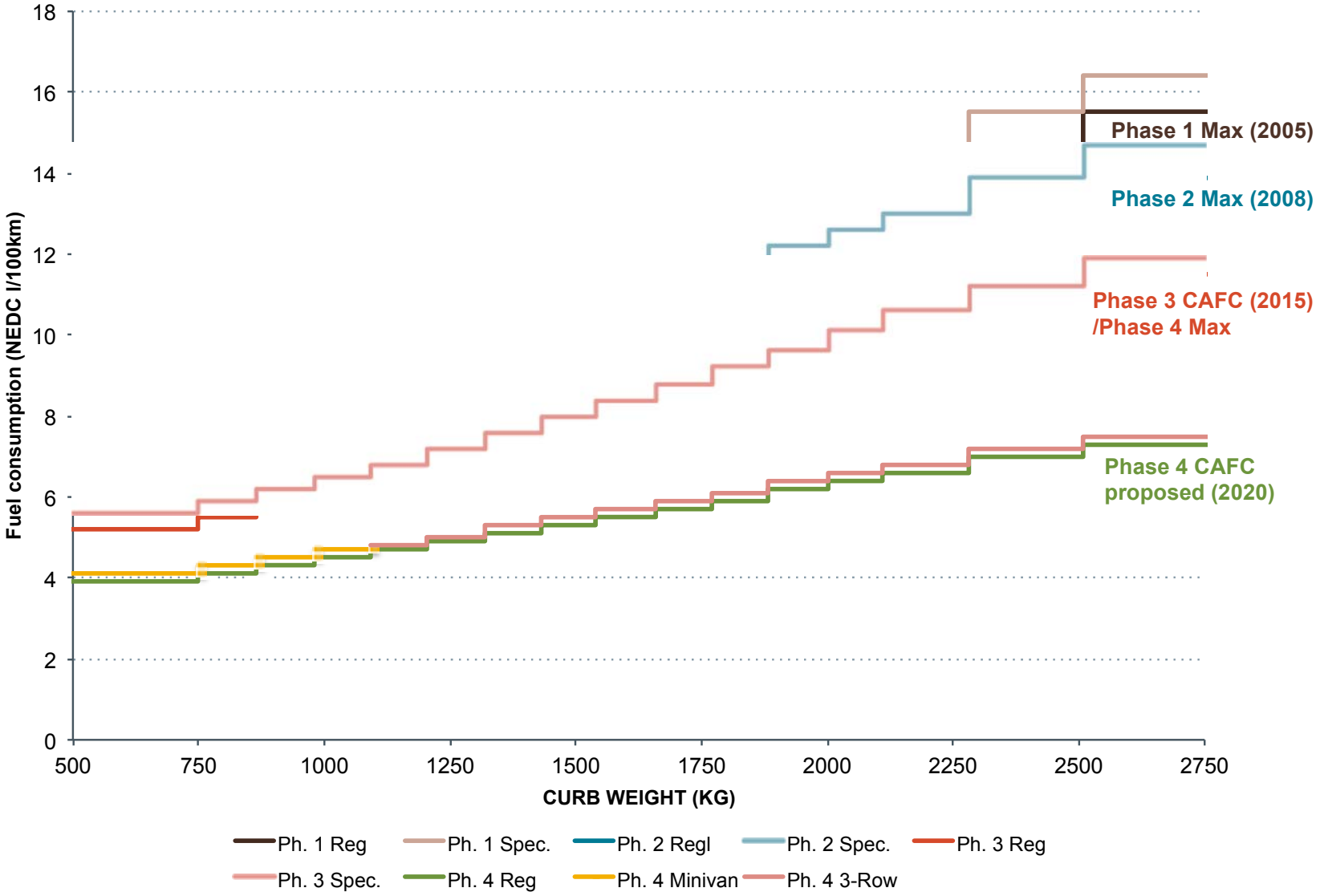
2. Form of target curve and based attribute

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	

US fuel economy standard curves

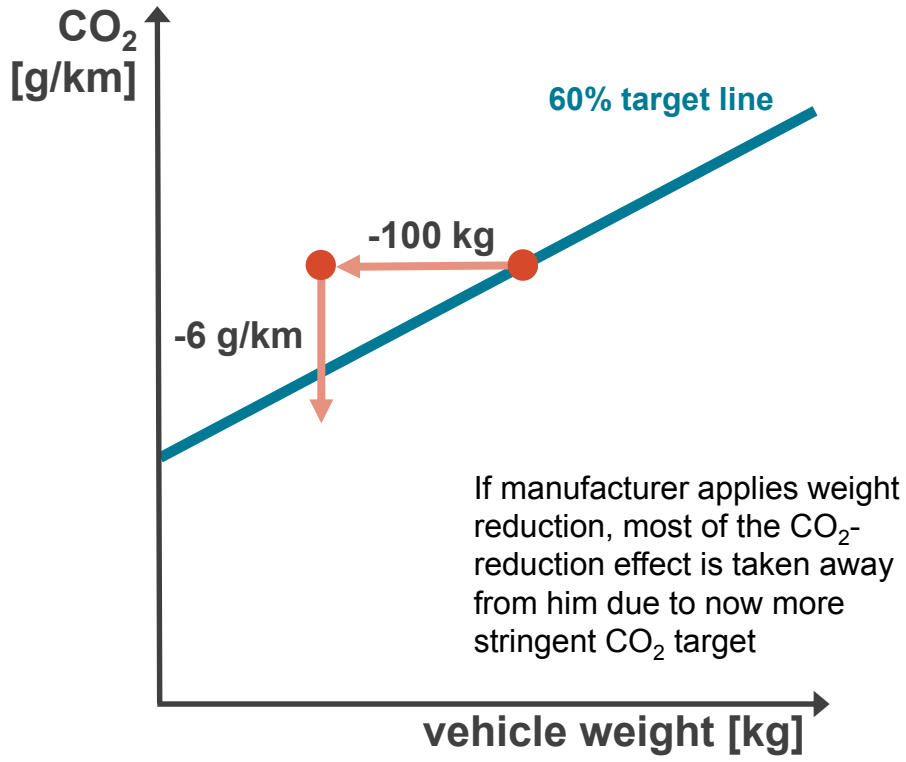


China standard curves

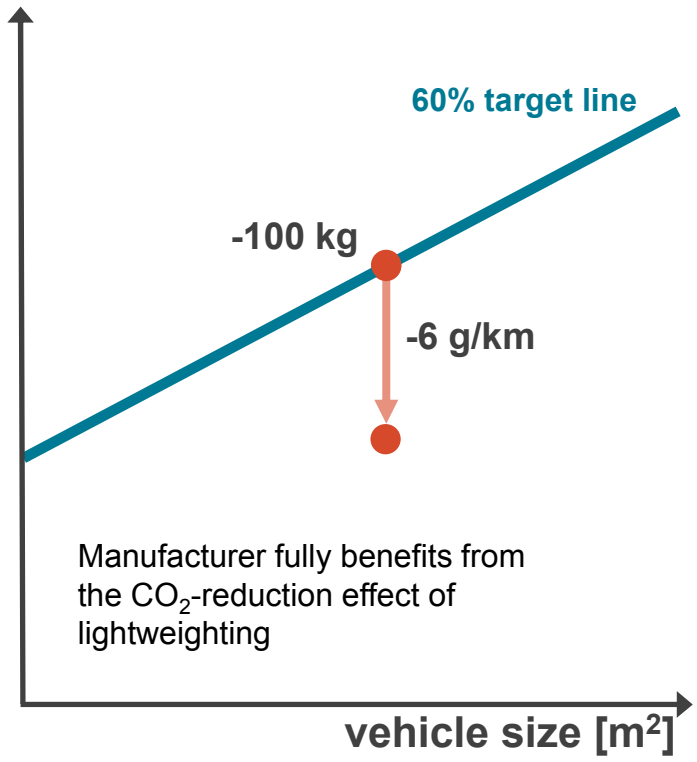


Weight-based system strongly reduces weight reduction incentive; not technology neutral

Weight-based target system



Footprint-based target system



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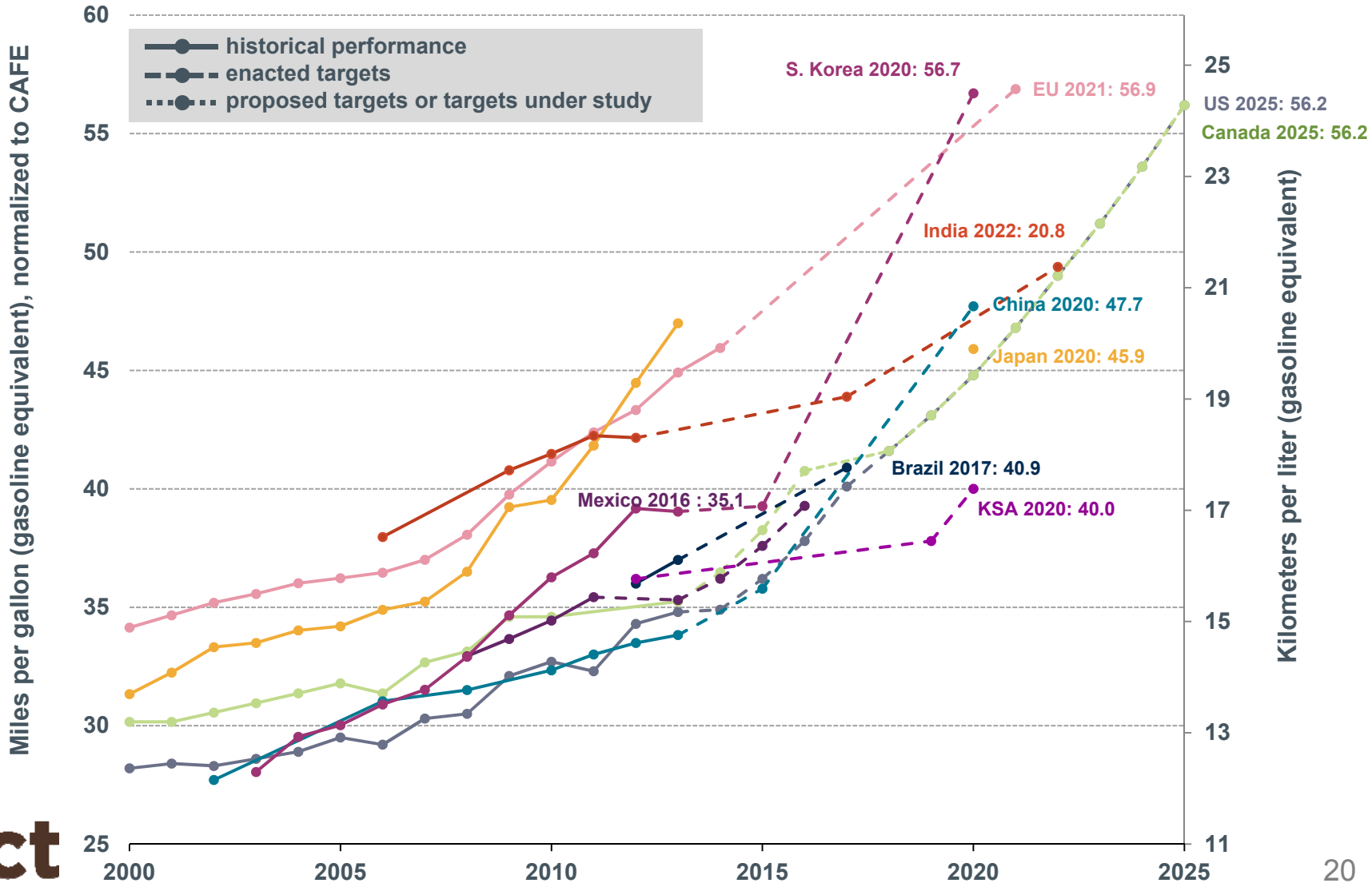
3. Target time frame/stringency



Baseline analysis

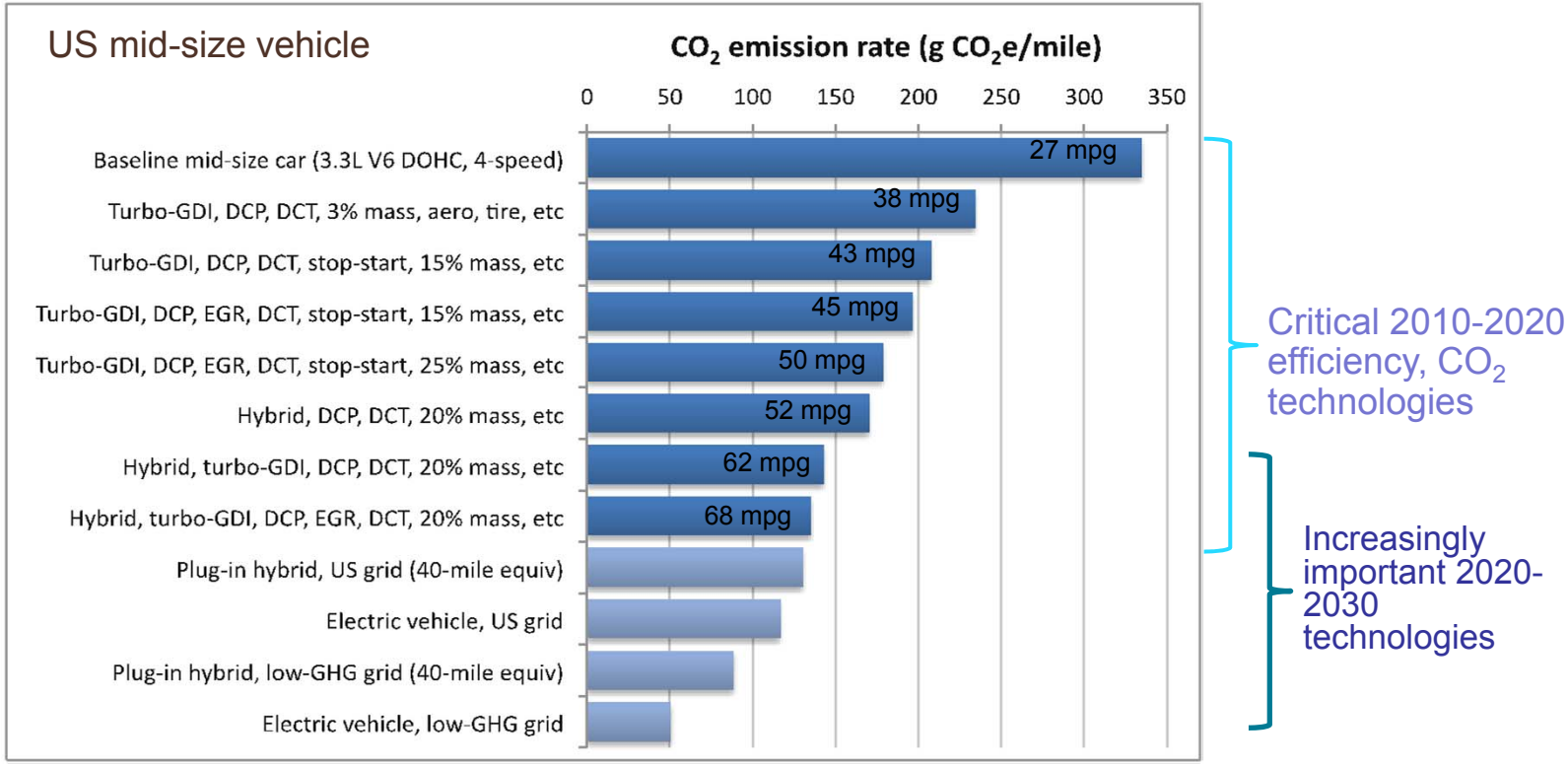
- Basic specifications: engine size, curb weight, footprint…
- Utility: power, max speed…
- Fuel consumption, CO_2 emissions…
- Technology adoption: fuel type, transmission, air intake…

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

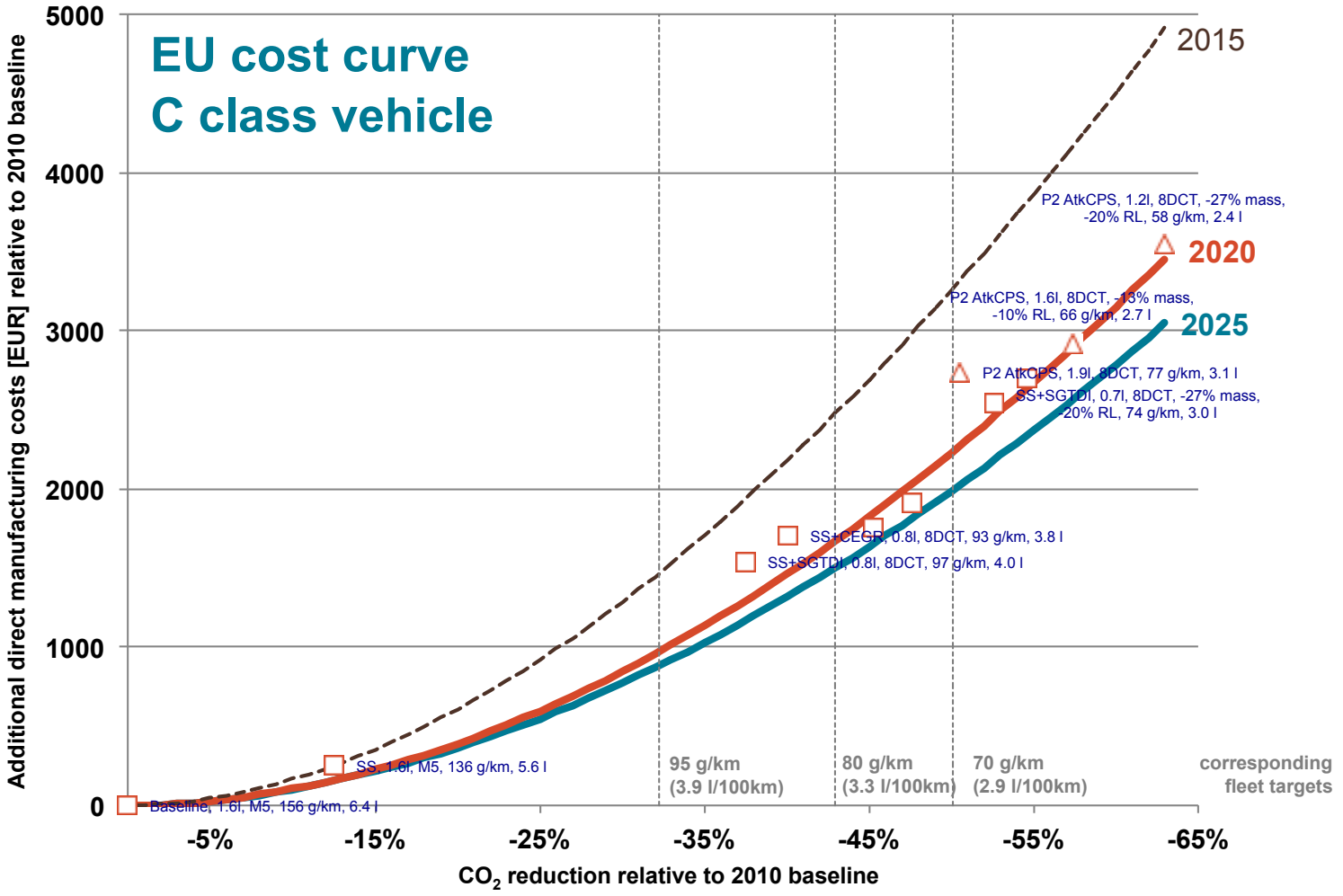
Technology feasibility

- 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

Cost curve


EU cost curve
C class vehicle
Additional direct manufacturing costs [EUR] relative to 2010 baseline
5000
4000
3000
2000
1000
0
2015
2020
2025
P2 AtkCPS, 1.2l, 8DCT, -27% mass, -20% RL, 58 g/km, 2.4 l
P2 AtkCPS, 1.6l, 8DCT, -13% mass, -10% RL, 66 g/km, 2.7 l
P2 AtkCPS, 1.9l, 8DCT, 77 g/km, 3.1 l
SS+SGTDI, 0.7l, 8DCT, -27% mass, -20% RL, 74 g/km, 3.0 l
SS+CEGR, 0.8l, 8DCT, 93 g/km, 3.8 l
SS+SGTDI, 0.8l, 8DCT, 97 g/km, 4.0 l
SS, 1.6l, M5, 136 g/km, 5.6 l
Baseline, 1.6l, M5, 156 g/km, 6.4 l
95 g/km (3.9 l/100km)
80 g/km (3.3 l/100km)
70 g/km (2.9 l/100km)
corresponding fleet targets
-5%
-15%
-25%
-35%
-45%
-55%
-65%
CO2 reduction relative to 2010 baseline

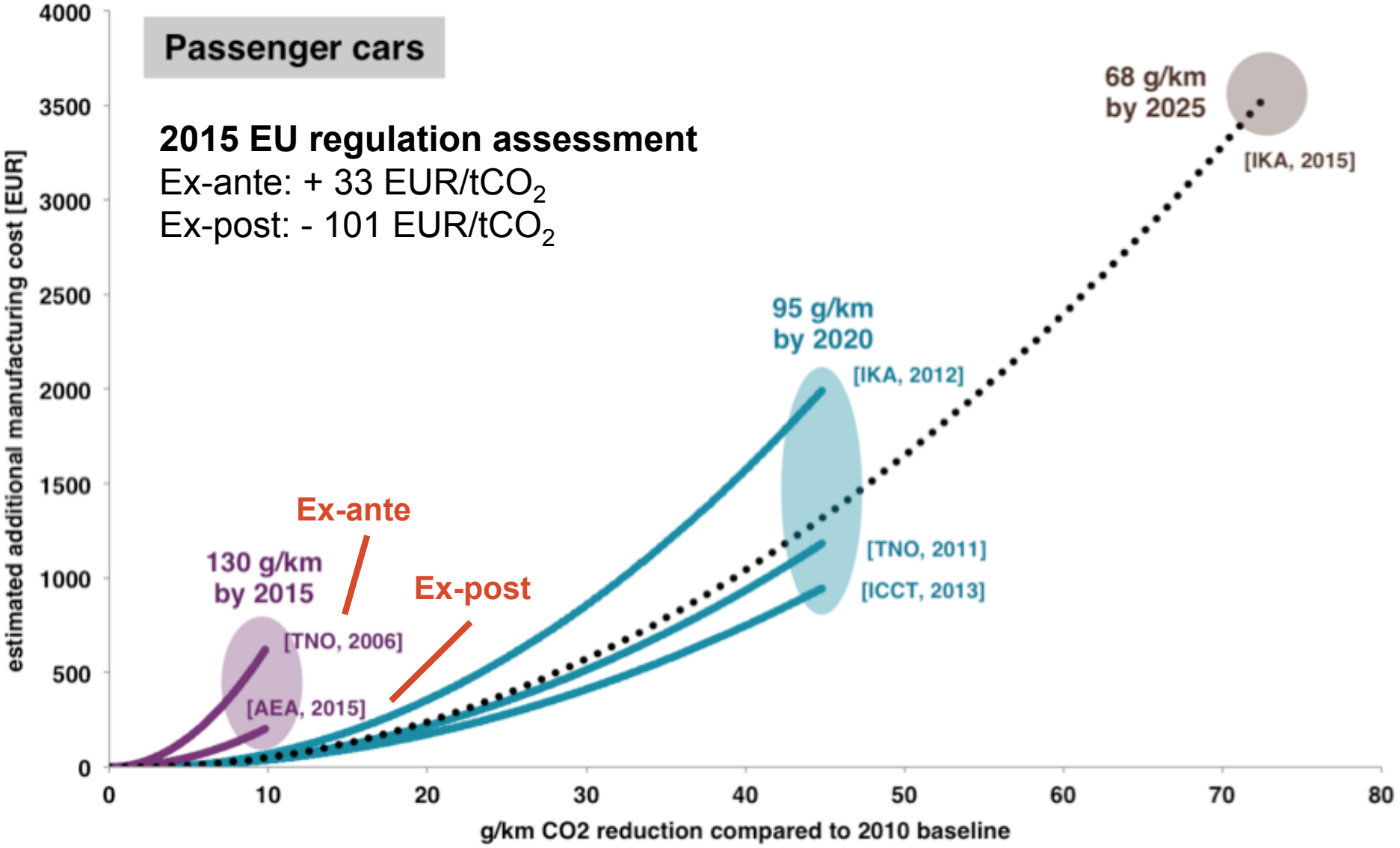
Cost and benefit analysis

- 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/tCO2

Regulation evaluation: estimates vs. reality



Take away on fuel economy standards

- Regulated metrics are interchangeable
- Establish continuous and footprint-based standard curve
- Set longer term target with 3-6% annual improvement
- Baseline analysis→ technology feasibility→ cost curve → cost and benefit analysis
- Fuel economy standards and fiscal measure complement with each other

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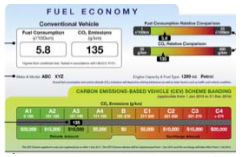
How to develop fuel economy labeling scheme

- **What is FE label**
- **What's the impact**
- **Key elements**

Implementation of vehicle fuel economy labeling scheme

Adoption of vehicle fuel effiency label

Mandatory
Voluntary



Thailand

Vietnam

Chile

Singapore

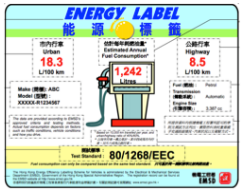
Chinese Taipei

China

Brazil

New Zealand

Germany



Hong Kong, China

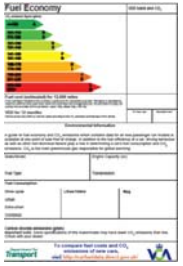
Netherlands

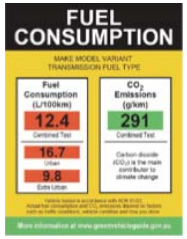
Austria

Australia

Japan

Canada





Korea

UK

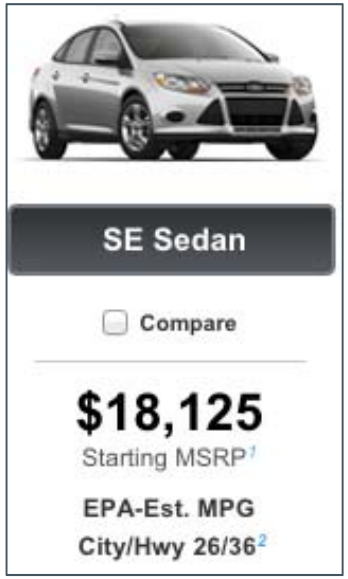
US

1975 1980 1985 1990 1995 2000 2005 2010 2015 2020

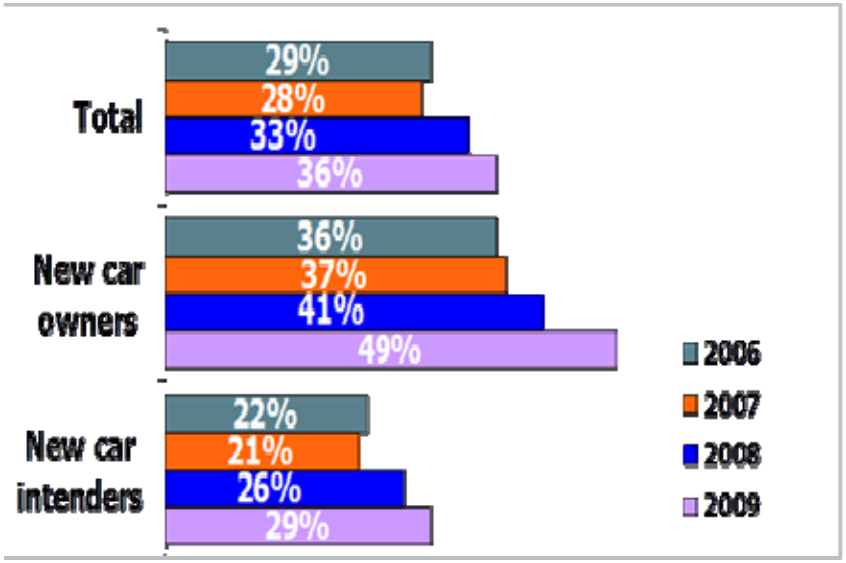
Vehicle fuel economy labeling schemes

VFEL schemes include

- The “fuel economy label” referring information that is displayed about the car in the showroom, online or through other media
- Associated consumer information campaign

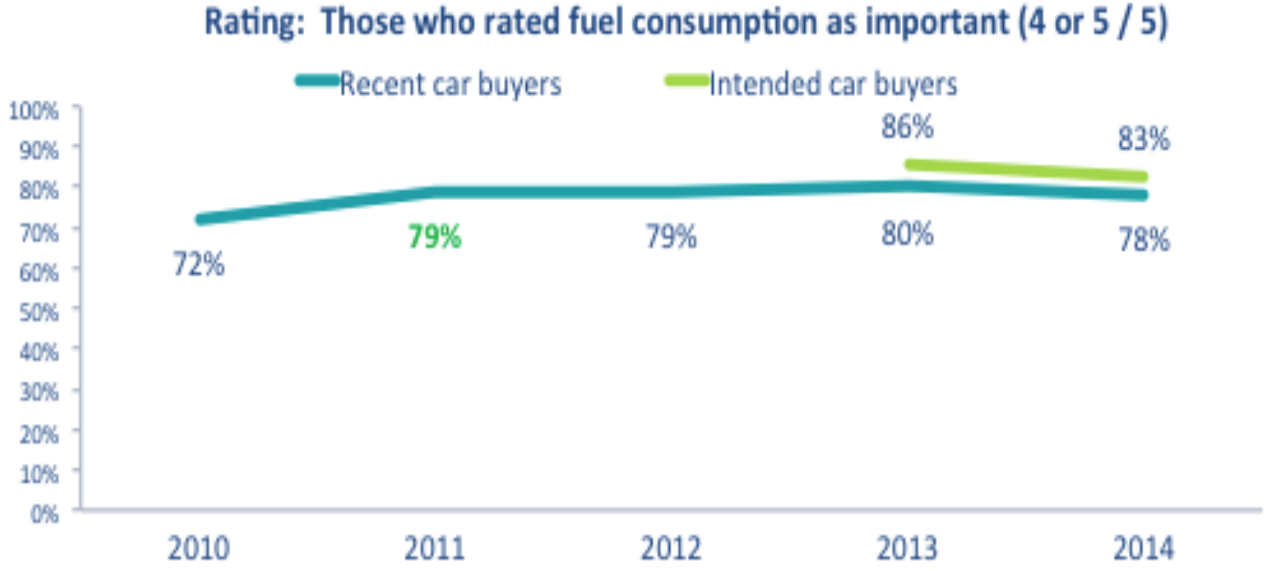


Label can raise consumer awareness



UK: Consumers awareness of the fuel economy label, 2006-2009

Source: Esposito G. (2014) A summary of LowCVP research on the UK fuel economy label and recommendations for future label design



New Zealand: Those who rated fuel consumption as important

Source: Ipsos, (2014). Vehicle fuel economy labeling 2014.

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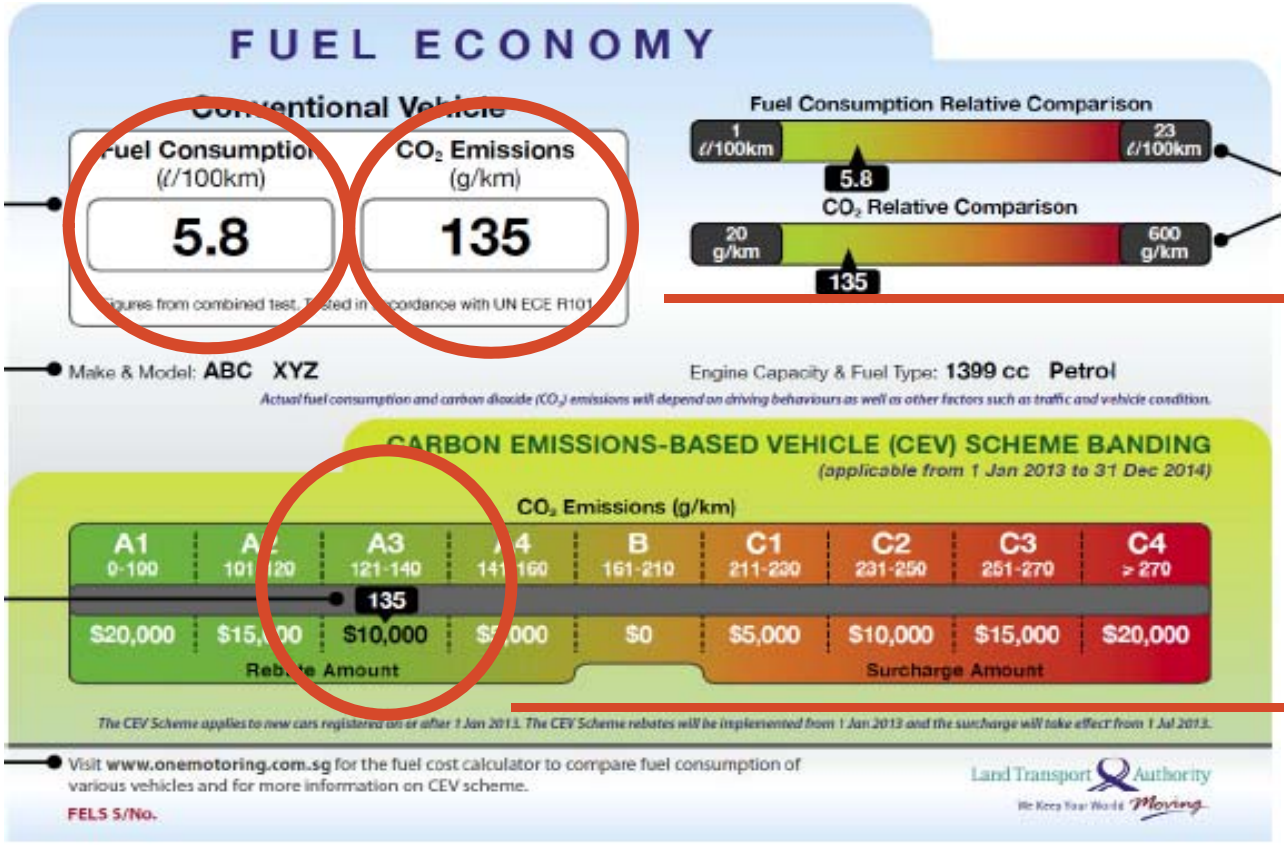
Label is enabler for other policies



Fuel economy information to establish **fuel economy standards**

Fuel economy based **fiscal policy**

Vehicle fuel economy labels in Singapore

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Label can contribute to fuel saving

- Estimated Savings Attributable to the VFEL Program in New Zealand

Year	Estimated savings achieved in the one year. (million litres)	Estimated cumulative savings achieved by the programme (million litres)	Estimated carbon emission savings achieved in the one year ($kT\ CO_2$)	Estimated financial savings achieved in the one year ($ million)
2008	**1.17**	**1.17**	**2.8**	**2.1**
2009	**1.73**	**4.08**	**4.2**	**2.7**
2010	**1.22**	**8.21**	**2.9**	**2.0**
2011	**1.02**	**13.37**	**2.5**	**2.0**
2012	**1.50**	**20.02**	**3.6**	**3.0**
2013	**1.32**	**28.00**	**3.2**	**2.6**

Source: Hamish Trolove, Christine Patterson, 2013 Review of the Vehicle Fuel Economy Labelling (VFEL) Programme

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Key elements to consider when introducing fuel economy label

1. Scope

(Mandatory/voluntary, LDV/HDV, new/used, fuel type…)

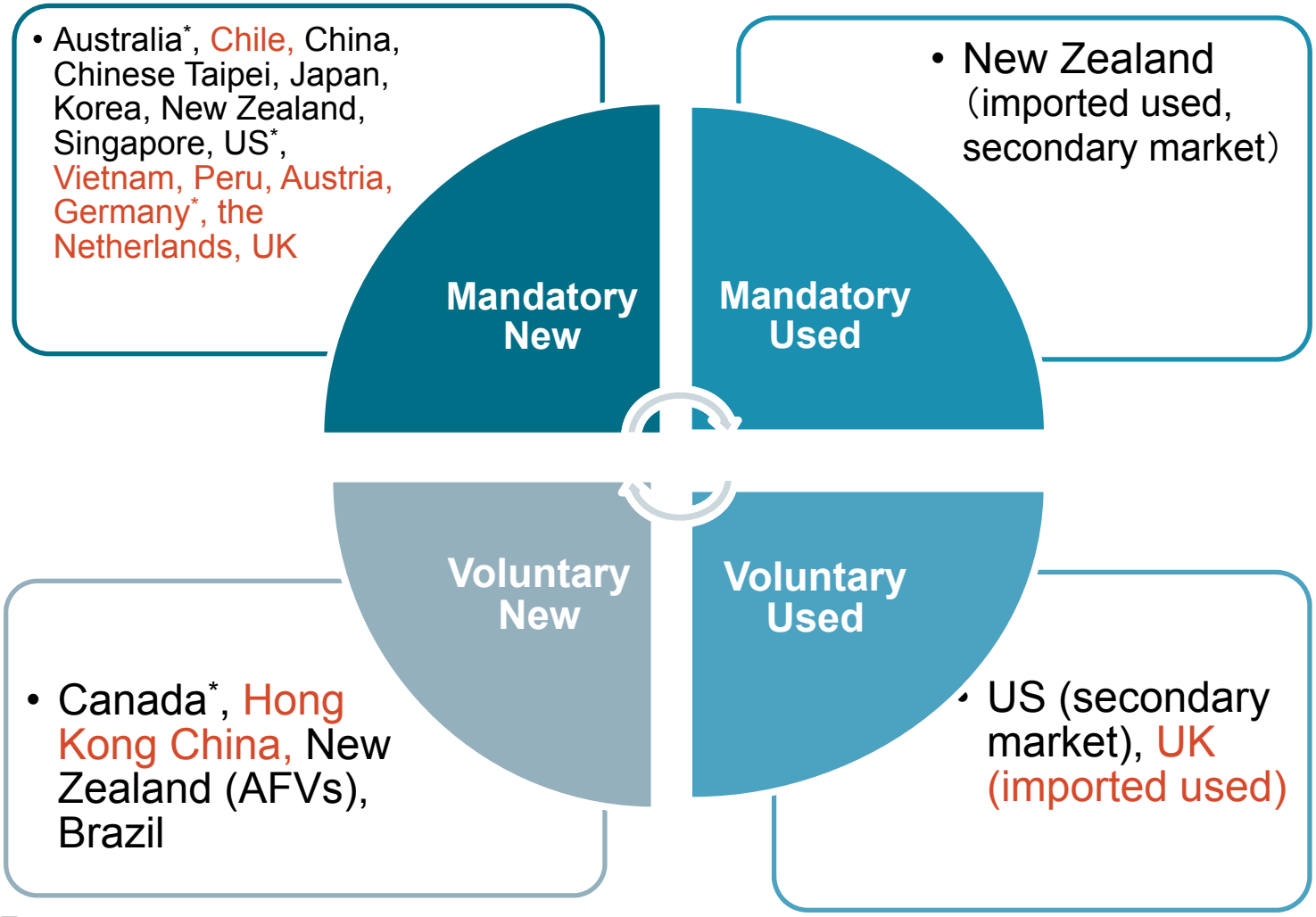
2. Label design/information display

(Fuel economy/CO_2 value, absolute/rating, fiscal/running cost, others)

3. Consumer outreach

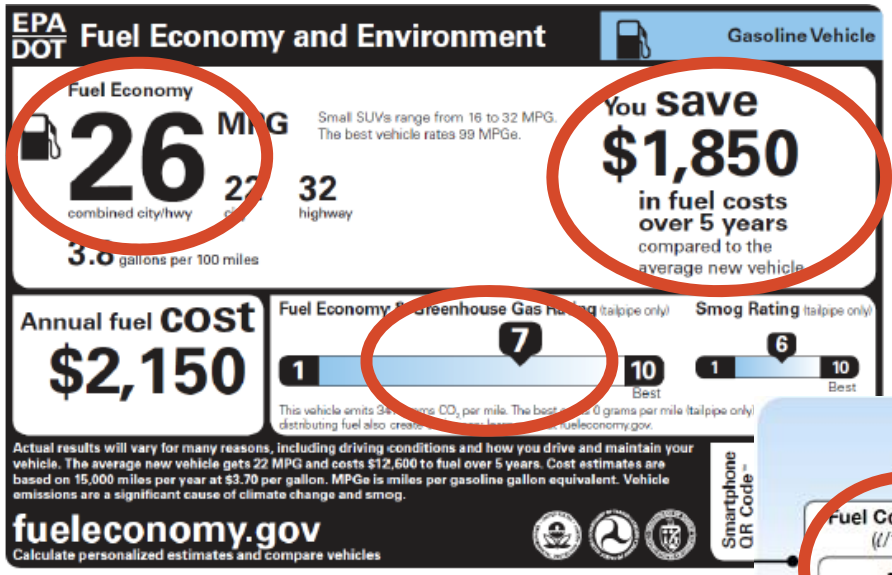
(Dedicated website, label on the car/online/other media…)

Labeling program scope



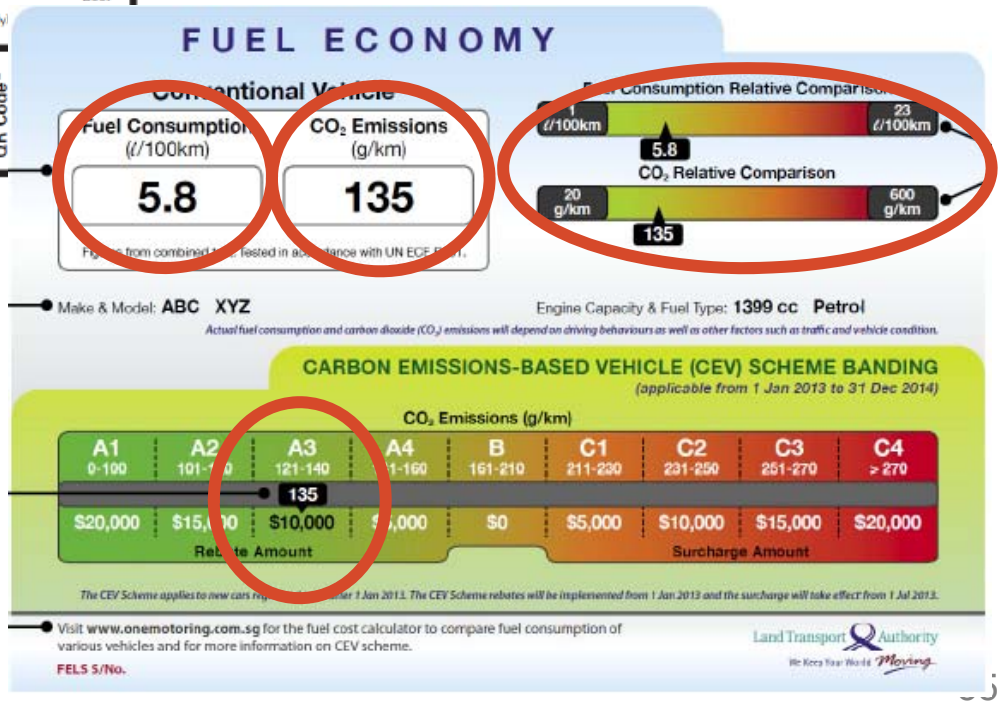
Economies with * apply VFEL program to vehicles with **all fuel types**;
Economies in **red** apply VFEL program to **passenger cars** only;
Others apply to **passenger cars and light truck/light-commercial vehicles**

Label design/information



US label

- Absolute fuel economy value
- Fuel economy/GHG rating
- Annual fuel cost saving



Singapore label

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

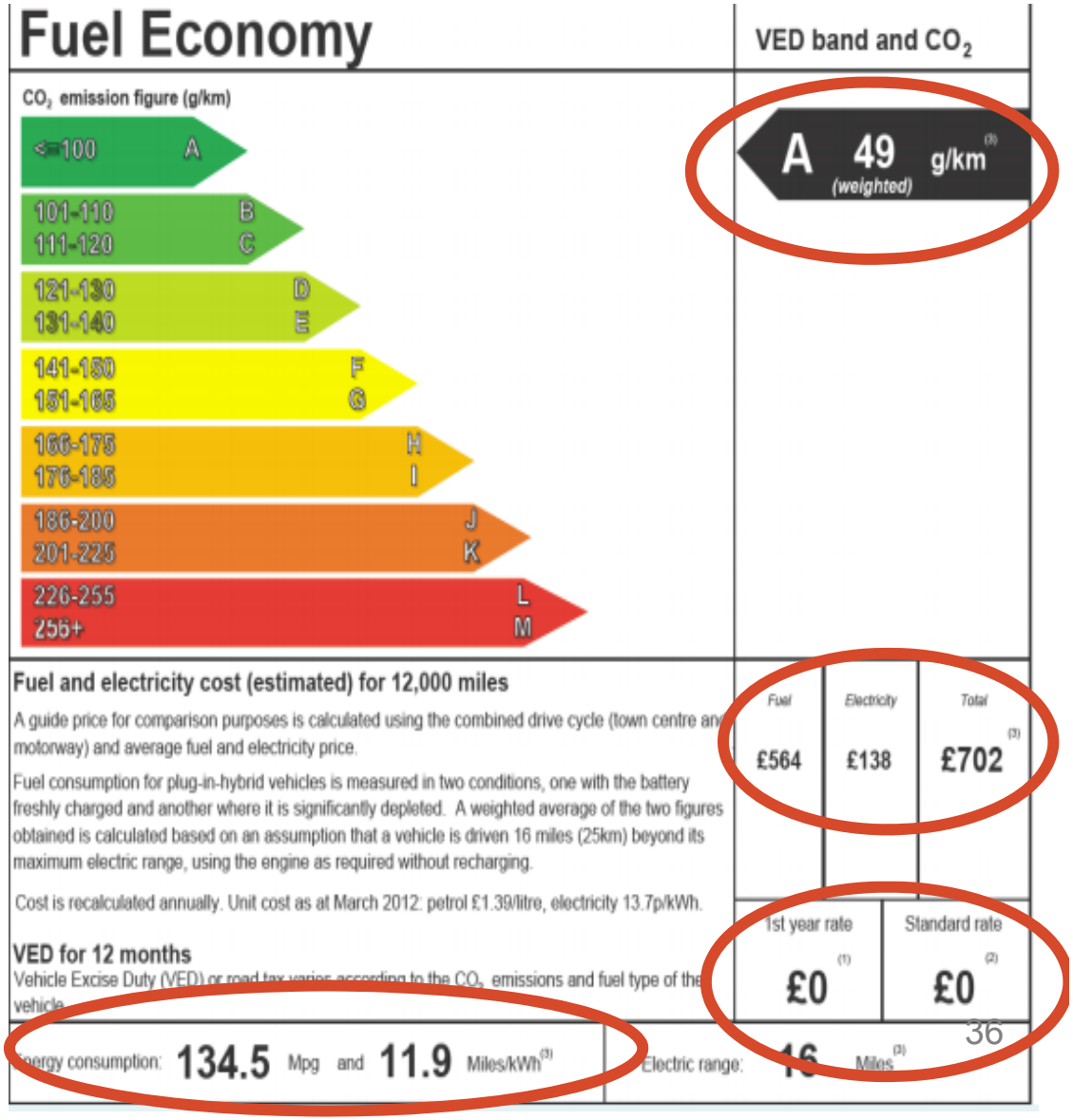
Vehicle fuel economy labels in Chile

Vehicle fuel economy labels in Singapore

Label information for alternative fuel vehicles

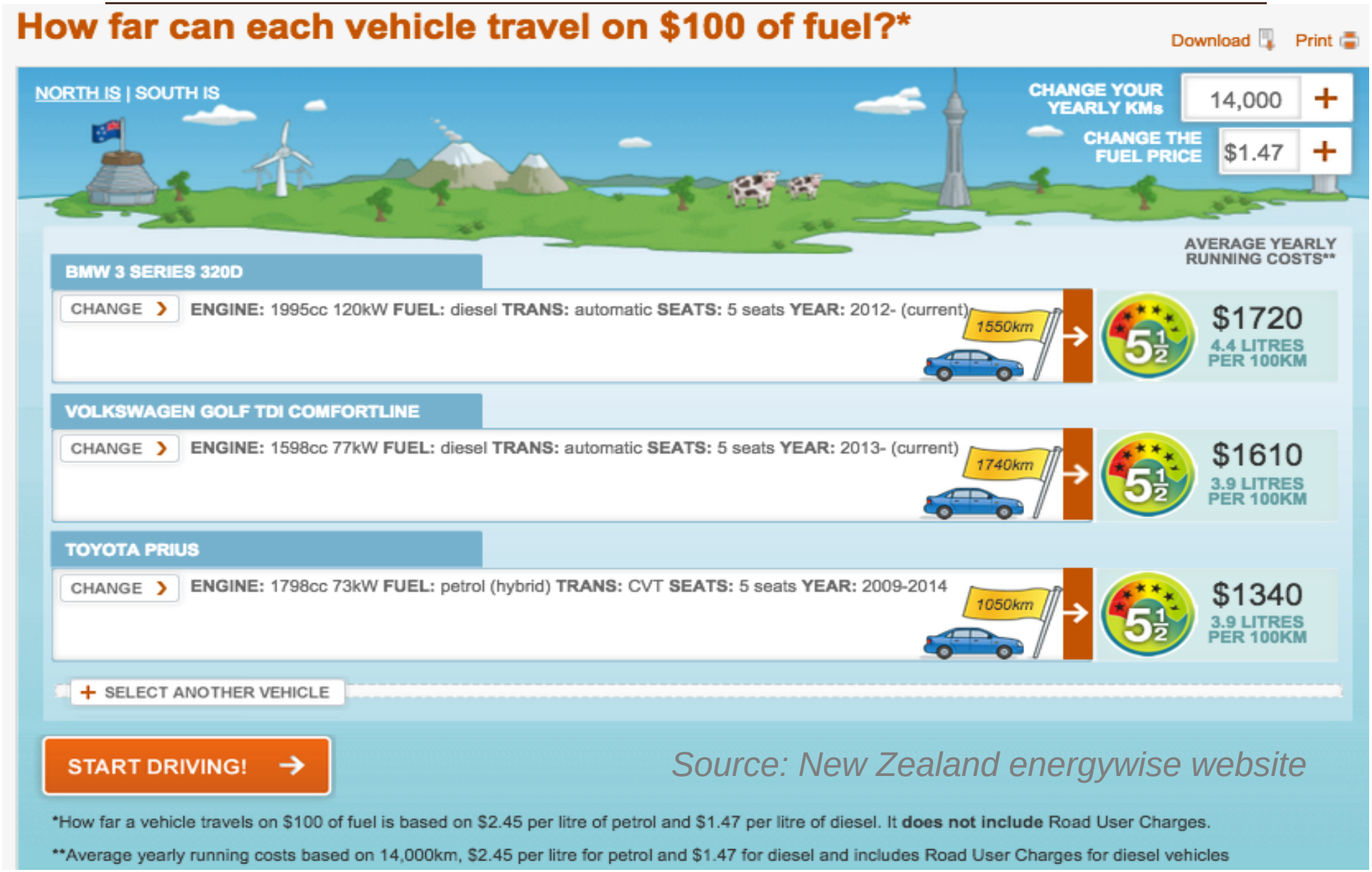
Special considerations for AFVs

- Fuel efficiency/consumption equivalent (MPGe?)
- CO_2 emissions (Inclusion of upstream emissions?)
- Refueling cost
- Financial information
- Others (Electricity consumption, range, charge time, operation information of AFVs)



Label in the UK

Consumer outreach

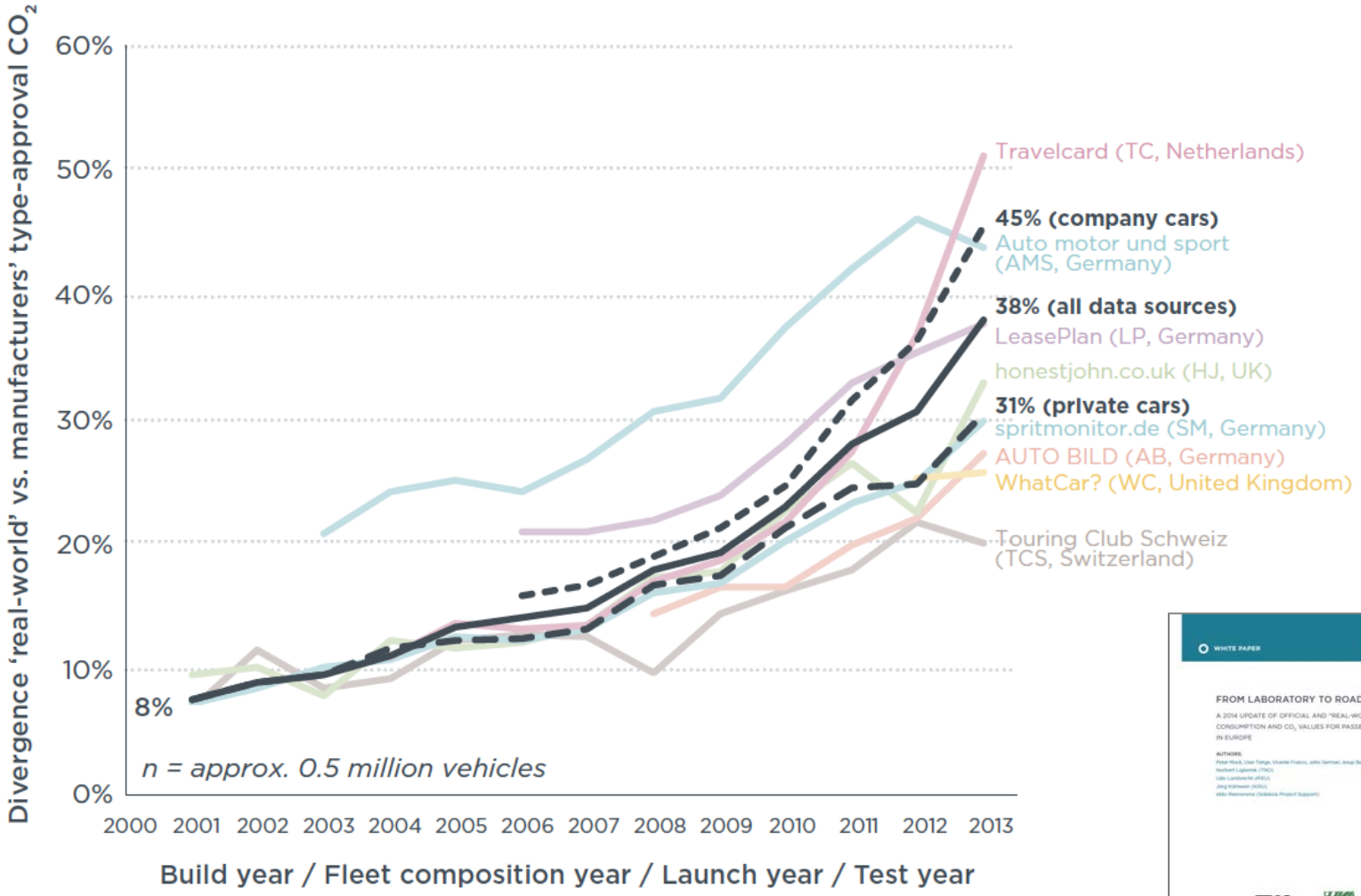


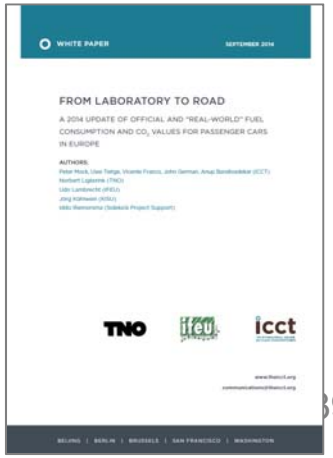
Find what consumers like

- Understand car-purchase behavior
- Consumer attitudes on what constitutes as effective information changes over time
- Characteristic of different methods of collecting consumer information

	Comprehensiveness	Depth of insight	Representativeness	Accuracy	Speed	Cost effectiveness
Literature review	High	Medium	Medium	Medium	Fast	High
Focus groups	Medium	High	Medium	Medium	Medium	Medium
Interview	Medium	High	Low	High	Medium	Medium
Survey	High	Low	High	Low	Fast	High
Expert panel	Medium	High	Low	Medium	Medium	Medium

Rising concern: real world emissions diverging from standards



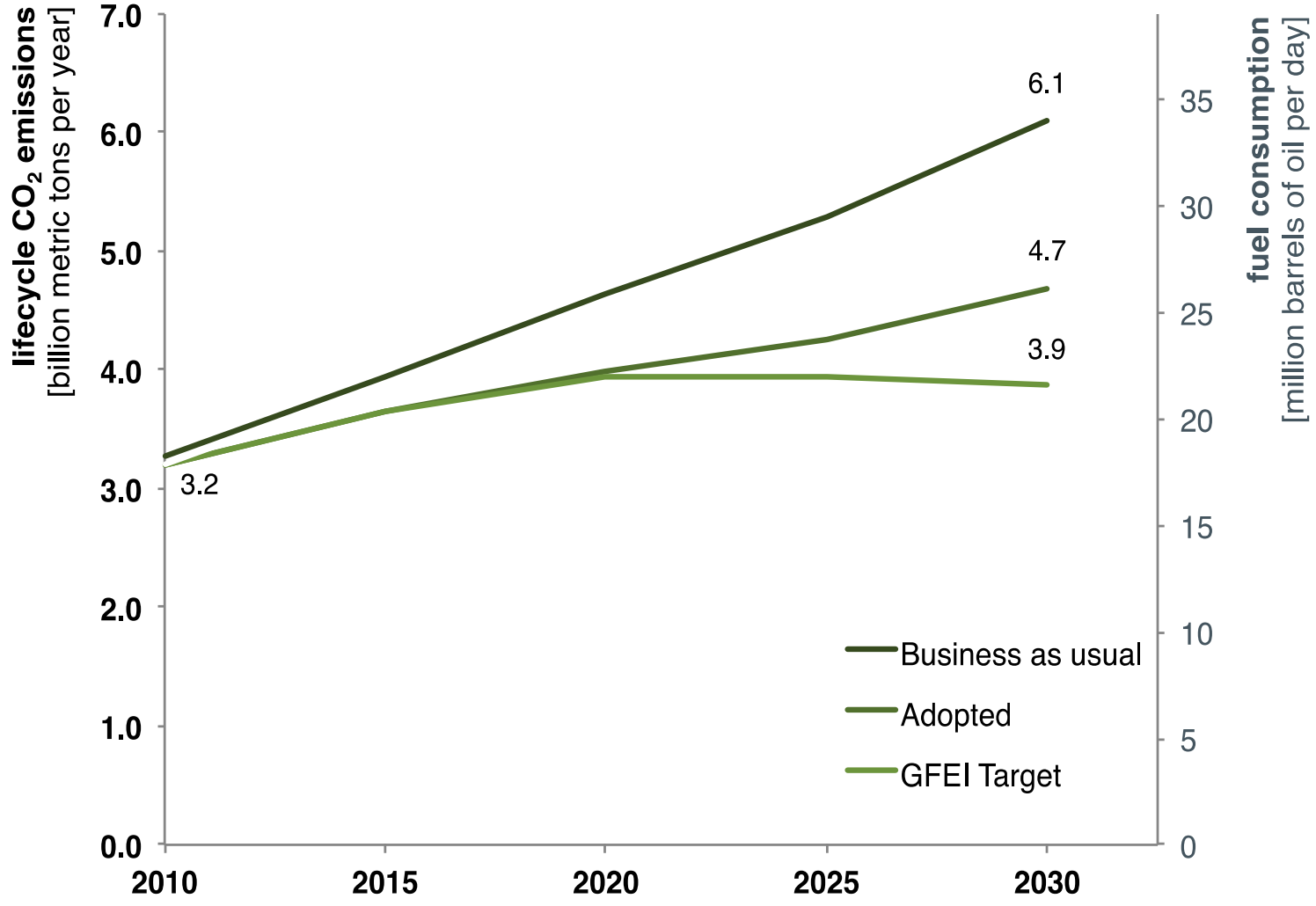


http://www.theicct.org/laboratory-road-2014-update

Take away on fuel economy labeling

- Mandatory requirement with wide scope (LDV/HDV, new/used, all fuel type)
- Label information (Fuel economy absolute value/rating, fuel cost/financial information, AFVs)
- Information online and through other media
- Market-base research
- Make sure test fuel economy represents real fuel economy
- Labeling program collects data and is enabler for fuel economy standards and fiscal measures

Meeting GFEI target will stabilized global CO_2 emissions in 2020



*Estimated using ICCT's Global Transportation Roadmap model (Facanha, et al., 2012). **Business as usual** = vehicle efficiency remains at 2005 levels. **Adopted** = currently adopted policies. **GFEI Target** = countries adopt standards that reduce average fuel consumption of new vehicles to 50% below 2005 levels by 2030 (GFEI, 2014).*

More information …

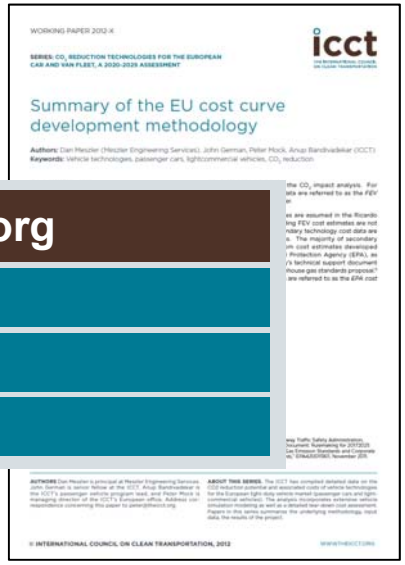
- ICCT Passenger Vehicles website: http://www.theicct.org/passenger-vehicles
- ICCT Staff blog: http://www.theicct.org/blogs/staff
- Global Passenger Vehicle Standards Update: http://www.theicct.org/global-passenger-vehicle-standards-update
- US CAFE Standards: http://www.theicct.org/policies/us-cafe-standards
- EU LDV CO_2 Regulation: http://www.theicct.org/policies/eu-light-duty-vehicle-co2-regulation
- Review and Comparative Analysis of Fiscal Policies to promote fuel economy: http://www.theicct.org/review-and-comparative-analysis-fiscal-policies
- CO_2 Standards: http://www.theicct.org/issues/co2-standards

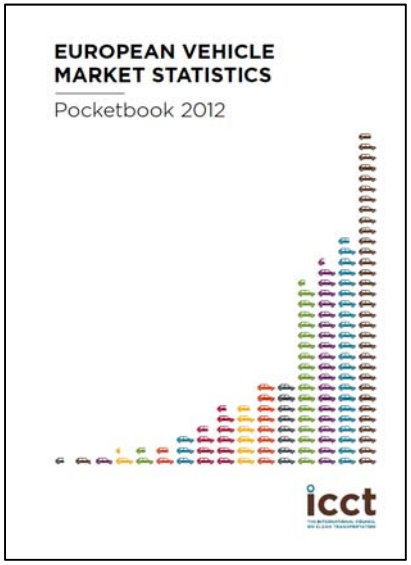
www.theicct.org

Detailed technical studies

Summary and briefing papers

Newsletter





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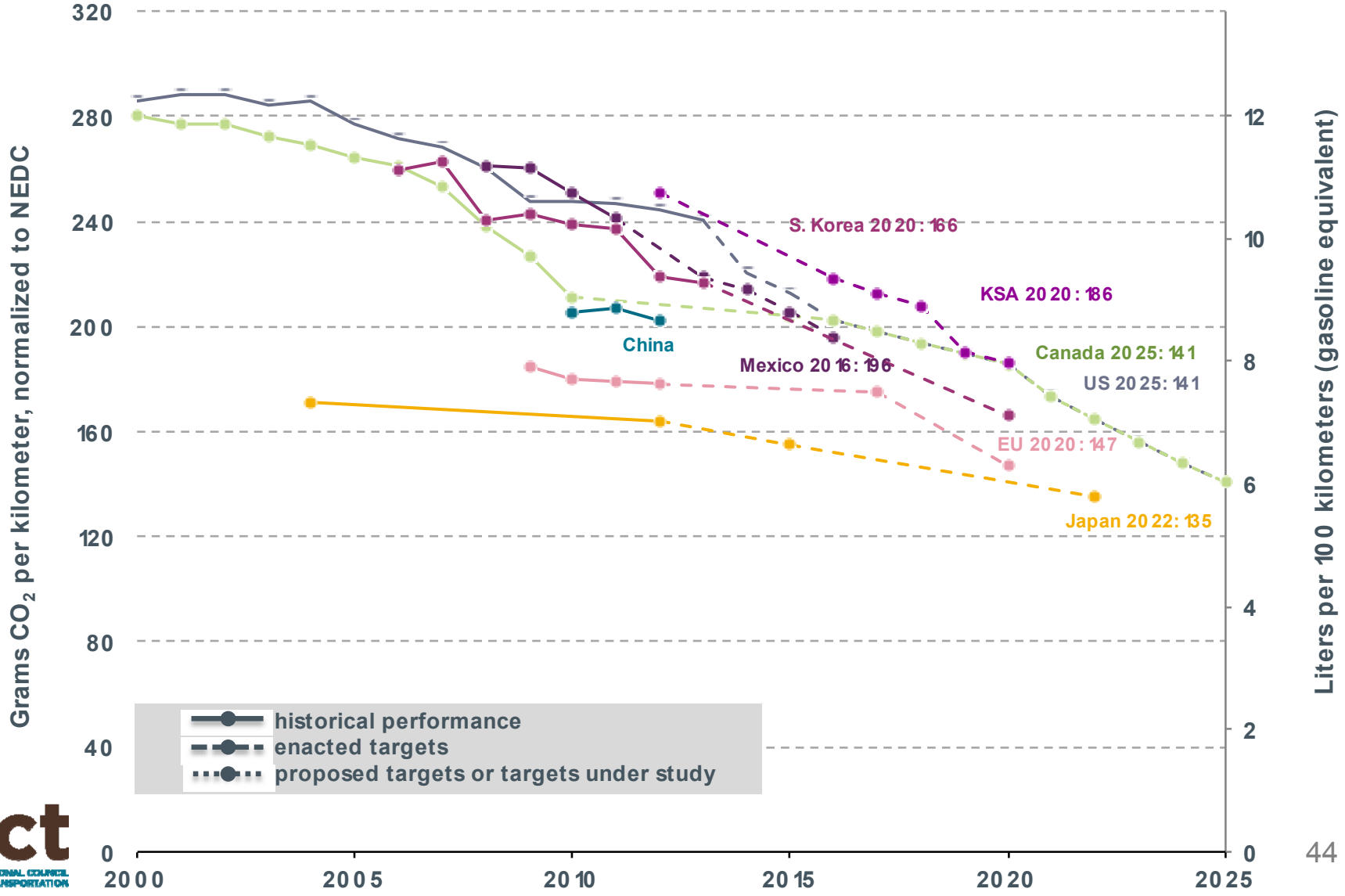
Backup slides

Light truck/light-commercial vehicle fuel economy standards globally



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Cost and payback by countries

Rule	Per-Vehicle Cost	Payback Period
US LDV 2017–2025	$1,800 (avg. 2025)	3.5 years
US LDV 2012–2016	$950 (avg. 2016)	3 years
Canada LDV 2017-2025	$707 (2021); $2,095 (2025)	2 to 5 years
Canada LDV 2011-2016	$89 (2011); $1,195 (2016)	1.5 years
European 95g CO2/km Standard 2020	€1,300	4-5 years
India LDV 2020	$478 to $637	2–3 years

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What are Green Freight Programs

- What is Green Freight?
  - “Green freight” refers to a collection of technologies and practices that improve the efficiency of the freight sector
- What are Green Freight programs?
  - Green freight programs promote these technologies and practices across the freight sector to help cut costs and benefit the environment.
- Currently there are approximately 15 established Green Freight programs worldwide
  - Wide variations between program elements (including transport mode, regional/national coverage, administrative structure)
- Key stakeholder groups
  - Private Sector (shippers, carriers, logistics companies), Government, Technology Manufacturers, Financing Institutions, Civil Society

Green Freight Programs and Initiatives