Comparison of Automobile Fuel Efficiency and GHG Emission Standards around the World

- based on work for commissioned by Pew Center on Global Climate Change

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IEA/UNEP Workshop on
Automobile CO_2 Reduction and Fuel Economy Improvement Policies
13 October, 2004
Shanghai, China

Outline

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- Overview of Countries and Regions that have Vehicle Fuel Efficiency and GHG Standards
- Issues and Methodologies of Comparing Vehicle Standards Around the World
- Comparison of Vehicle Standards around the World
- Conclusions

Measures to promoting fuel-efficient vehicles around the world

A variety of approaches to reduce automobile fuel consumptions have been introduced in different parts of the world.

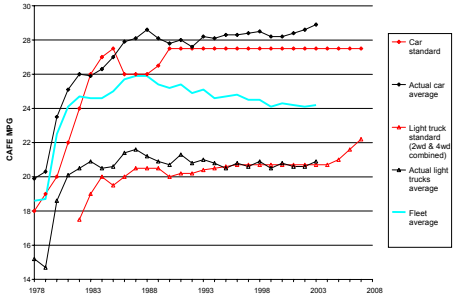
	Measures/forms	*Countries/regions*
Fuel efficiency std.	Numeric std. in MPG, km/L or L/100km	US, Japan, Canada, Australia, China, Taiwan, South Korea
GHG emission std.	grams/km or grams/mile	EU, California
High fuel taxes	Fuel taxes are 50% or higher of crude oil base price	EU, Japan
Fiscal Incentives	Tax relief based on engine size, efficiency and CO_2 emission also, incentives for particular technologies and alternative fuels	EU, Japan
Economic penalty	Gas guzzler tax	US
Technology mandates	Sales requirement for zero emission vehicles (ZEVs) or AFVs	California
Traffic control measures	HOV lanes for hybrids in California, banning SUVs in Paris	California, Paris

Overview of Countries and Regions that have Vehicle Fuel Efficiency and GHG Standards

At-least nine countries and regions have established or proposed motor vehicle fuel efficiency or GHG emission policies. Due to various historic, cultural and political reasons, different countries and regions chose to adopt different fuel efficiency or GHG standards

Countries/regions	*Types*	*Measures*	*Structures*	*Test Methods*
The United States	Fuel	MPG	Cars and Trucks	US CAFE
European Union	CO_2	g/km	Overall fleet	EU NEDC
Japan	Fuel	km/L	Weight-based	Japan 10-15
China	Fuel	L/100-km	Weight-based	EU NEDC
California	CO_2	g/mile	Car/LDT1 and LDT2	US CAFE
Canada	Fuel	L/100-km	Cars and Trucks	US CAFE
Australia	Fuel	L/100-km	Overall fleet	EU NEDC
Taiwan, Korea	Fuel	Km/L	Engine size	US CAFE

US Corporate Average Fuel Economy (CAFE) Standards - continuous decline since mid 80s



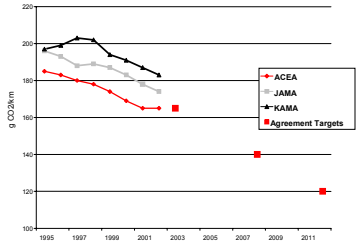
California proposed standards as of August 2004

		CO_2 emission standard (g/mi)		CAFE-equivalent (mpg)	
	Year	PC/LDT1	LDT2	PC/LDT1	LDT2
Near-term	2009	323	439	27.6	20.3
	2010	301	420	29.6	21.2
	2011	267	390	33.3	22.8
	2012	233	361	38.2	24.7
Medium-term	2013	227	355	39.2	25.1
	2014	222	350	40.1	25.4
	2015	213	341	41.8	26.1
	2016	205	332	43.4	26.8

Car/light-duty truck 1 (PC/LDT1) category includes all passenger vehicles regardless of weight and light-duty trucks weighing less than 3,750 lbs equivalent test weight (ETW). Light-duty truck 2 (LDT2) for light trucks weighing between 3,751 lbs ETW – 8,500 lbs gross vehicle weight (GVW), and vehicles 8,500 to 10,000 lbs GVW that are classified as medium-duty passenger vehicles.

EU - Progress and Targets under the ACEA Agreement

The agreement establishes industry wide targets to reach 140 grams of CO_2 per kilometer by 2008, with the possibility of extending the agreement to 120 gCO_2/km by 2012.



Japanese weight class fuel economy standards for gasoline passenger vehicles

Maximum vehicle curb weight		Fuel economy target	
kg	lbs	km/L	MPG (CAFE)
> 702	> 1548	21.2	49.8
709 – 827	1550 – 1824	18.8	44.2
828 – 1015	1826 – 2238	17.9	42.1
1016 – 1265	2240 – 2789	16.0	37.6
1266 – 1515	2791 – 3341	13.0	30.6
1516 – 1765	3343 – 3892	10.5	24.7
1766 – 2015	3894 – 4443	8.9	20.9
2016 – 2265	4445 – 4994	7.8	18.3
< 2266	< 4997	6.4	15.0

The Japanese government is currently considering revising the fuel economy standards to be more stringent, however details are not known at this time.

China's new automotive fuel efficiency standards

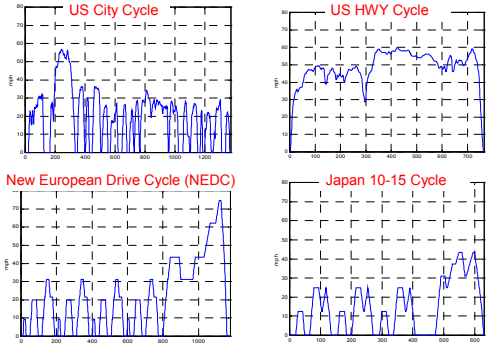
- Maximum Limits for Fuel Consumption (L/100-km), or Minimum CAFE-equivalent MPG Limits, for Passenger Vehicles in China

	Based on NEDC cycle, L/100-km				US CAFE-equivalent MPG			
	Phase I		Phase II		Phase I		Phase II	
Weight (kg)	manual	auto/SUV	manual	auto/SUV	manual	auto/SUV	manual	auto/SUV
CM≤750	7.2	7.6	6.2	6.6	36.9	35.0	42.9	40.3
750<CM≤865	7.2	7.6	6.5	6.9	36.9	35.0	40.9	38.5
865<CM≤980	7.7	8.2	7.0	7.4	34.5	32.4	38.0	35.9
980<CM≤1090	8.3	8.8	7.5	8.0	32.0	30.2	35.4	33.2
1090<CM≤1205	8.9	9.4	8.1	8.6	29.9	28.3	32.8	30.9
1205<CM≤1320	9.5	10.1	8.6	9.1	28.0	26.3	30.9	29.2
1320<CM≤1430	10.1	10.7	9.2	9.8	26.3	24.8	28.9	27.1
1430<CM≤1540	10.7	11.3	9.7	10.3	24.8	23.5	27.4	25.8
1540<CM≤1660	11.3	12.0	10.2	10.8	23.5	22.2	26.1	24.6
1660<CM≤1770	11.9	12.6	10.7	11.3	22.3	21.1	24.8	23.5
1770<CM≤1880	12.4	13.1	11.1	11.8	21.4	20.3	23.9	22.5
1880<CM≤2000	12.8	13.6	11.5	12.2	20.8	19.5	23.1	21.8
2000<CM≤2110	13.2	14.0	11.9	12.6	20.1	19.0	22.3	21.1
2110<CM≤2280	13.7	14.5	12.3	13.0	19.4	18.3	21.6	20.4
2280<CM≤2510	14.6	15.5	13.1	13.9	18.2	17.1	20.3	19.1
2510<CM	15.5	16.4	13.9	14.7	17.1	16.2	19.1	18.1

Issues of Comparing Vehicle Standards around the World

- Differences in test driving cycles
- Fuel economy vs. fuel consumption vs. CO_2 emissions
- Regulatory vs. voluntary
- Corporate fleet averages vs. minimum requirements
- Differences in vehicle categories and weight-classes

Differences in test driving cycles

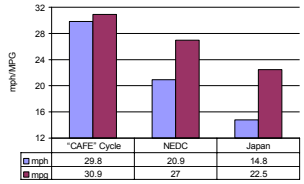


Methodology to Compare Vehicle Standards around the World

1. Select reference measures and test methods. In this analysis, we chose to use:
   - US CAFE test cycle in gasoline-equivalent MPG; and
   - EU's NEDC test cycle in CO_2 g/km.
2. Create conversion factors/tables from country/region-specific measures to reference measures
3. Convert country/region standards into reference measures using established conversion factors.
4. Estimate current vehicle mixes based on new vehicle sales figures.
5. Establish fleet average baseline (MY 2002) levels
6. Create future new-vehicle sale fleet averages for each country/region based current vehicle mixes and stated future targets.
7. Tabulate and graphically present the comparison results

Comparisons of US, EU and Japan Test Drive Cycles

	Average speed (mph)	A sample vehicle (Focus) MPG rating	Average adjustment to match CAFE	Countries applied
US Combined "CAFE" Cycle	29.8	30.9	1.00	US, Canada, Taiwan, California, South Korea (city only)
NEDC	20.9	27.0	1.13	EU, China, Australia
Japan	14.8	22.5	1.35	Japan



Many factors affect fuel economy ratings. However, there is a general positive correlation between average speed and fuel economy rating

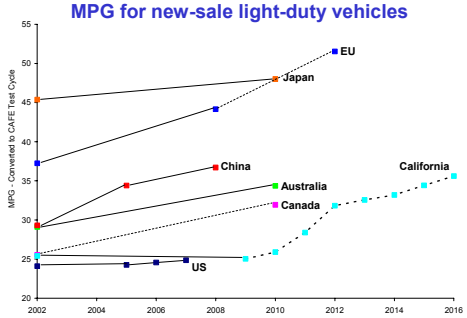
Conversion factors to CAFE-equivalent MPG and EU-equivalent CO_2 emission rate of g/km

Countries	Cycle	Type	Measures (Y)	Converted to CAFE-equivalent MPG		Converted to EU-equivalent CO_2 (g/km)		Converted to CA-equivalent CO_2 (g/mi)	
US	US CAFE	Fuel	MPG	Y *	1.00	1/(Y) *	6,180	1/(Y) *	8,900
Taiwan, Korea	US CAFE	Fuel	Km/L	Y *	2.35	1/(Y) *	2,627	1/(Y) *	3,783
Canada	US CAFE	Fuel	L/100-km	1/(Y) *	235.8	Y *	26.2	Y *	37.7
California	US CAFE	CO_2	g/mile	1/(Y) *	8,900	Y *	0.69	Y *	1.00
EU (gasoline)	NEDC	CO_2	g/km	1/(Y) *	6,180	Y *	1.00	Y *	1.44
EU (diesel)	NEDC	CO_2	g/km	1/(Y) *	7,259	Y *	0.85	Y *	1.23
Japan	Japan	Fuel	km/L	Y*	3.18	1/(Y) *	1,946	1/(Y) *	2,803
China, Australia	NEDC	Fuel	L/100-km	1/(Y) *	266.5	Y *	23.2	Y *	33.4

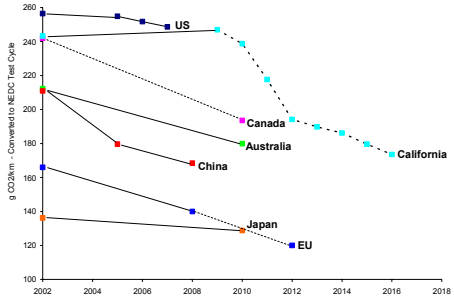
Fleet average Fuel economy and GHG standards around the world

Region	Fuel economy in mpg (CAFE test cycle)		CO2 emissions in gCO2/km (EU test cycle)		% change from current	Assumptions
	2002	Future	2002	Future		
United States	24.1	24.3 by 2005	256	255 by 2005	1%	Vehicle fleet remains 50% cars and 50% light trucks
		24.6 by 2006		252 by 2006	2%	
		24.9 by 2007		249 by 2007	3%	
California	25.4	25.0 by 2009	243	247 by 2009	-1%	Vehicle fleet remains 55% PC/LDT1
		25.9 by 2010		239 by 2010	2%	
		28.4 by 2011		218 by 2011	12%	
		31.8 by 2012		194 by 2012	25%	
		32.6 by 2013		190 by 2013	28%	
		33.2 by 2014		186 by 2014	31%	
		34.4 by 2015		180 by 2015	35%	
		35.6 by 2016		174 by 2016	40%	
Canada	25.6	*32.0 by 2010 proposed*	241	*193 by 2010 proposed*	25%	A 2002 baseline year is assumed for the 25% increase proposed for 2010.
European Union	37.2	44.2 by 2008	166	140 by 2008	19%	Converted to gasoline equivalent mpg
		51.5 by 2012 proposed		*120 by 2012 proposed*	28%	
Australia	29.1	34.4 by 2010	212	180 by 2010	18%	
Japan	45.4	48.0 by 2010	136	129 by 2010	6%	Fleet composition remains constant
China	29.3	34.4 by 2005	212	180 by 2005	17%	2002 baseline data based on CATARC's assessment. Future values based on WRI dataset.
		36.7 by 2008		168 by 2008	25%	

Comparison of fleet average fuel economy and GHG emission standards standardized by CAFE-converted MPG for new-sale light-duty vehicles



Comparison of fleet average fuel economy and GHG emission standards standardized by NEDC-converted gCO_2/km for new-sale light-duty vehicles



Conclusions

Our analysis shows that if all future standards are successfully implemented:

- EU and Japan have highest vehicle standards
- In the next 10 years or so, EU, China, Canada and California all would have fleet average fuel economy improvement greater than 25% over the 2002 baseline case.
- In contrast, the US standards not only have the lowest absolute fuel economy rating, but also have the lowest percentage gains in the foreseeable future.
- The California CO_2 standards, if realized, could close some gaps between US and EU standards, but in absolute terms, they are still far behind that of EU's.
- Japan has already made significant improvement in its fleet average fuel economy between 1995 and 2002. It's in a process of proposing higher fuel efficiency standards.
- If nothing else happens, the United States' 3% MPG improvement target by 2007 would almost guarantee that US would further fall behind the other counties in terms of fleet average vehicle efficiency among the group of countries analyzed here.