

JAPAN 2030 FUEL ECONOMY STANDARDS

ICCT POLICY UPDATES

SUMMARIZE
REGULATORY
AND OTHER
DEVELOPMENTS
RELATED TO CLEAN
TRANSPORTATION
WORLDWIDE.

OVERVIEW OF THE STANDARDS

On June 3, 2019, Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and Ministry of Economy, Trade and Industry (METI) issued new fuel economy standards for passenger vehicles starting in model year 2030.¹ It has been 10 years since the issuance of the 2020 passenger car fuel economy standards in 2009, and the 11-year lead time for these new standards reflects the Japanese government's desire to give industry sufficient time for model upgrades. The standards require an average fleet gasoline-equivalent fuel economy of 25.4 kilometers (km) per liter (l) by 2030, which is a 32.4% improvement over the fleet average for fiscal year 2016.

THE "TOP-RUNNER" METHODOLOGY

The 2030 standards follow the same top-runner concept as the 2020 standards. The top runners, defined as the top 5% most-efficient vehicles on the JC08 test cycle for each 200 kilogram (kg) weight bin, vehicle type (minicar or standard vehicle), drivetrain (conventional or hybrid), and power source (fuel or electricity), were identified from the fiscal year 2016 fleet. These vehicles were then measured under the Worldwide Harmonized Light Vehicle Test Procedure (WLTP) and a linear regression line was generated for fuel consumption against vehicle weight. The most-efficient vehicle in relation to this straight line was determined to be the top-runner car for each vehicle category and weight category.

Government staff then interviewed manufacturers about fuel efficiency technologies under development and their potential for efficiency improvements. From this, the government estimated the potential for additional fuel efficiency improvement above and beyond the current top-runner car. The standard line subsequently created for the 2030 standards is the linear regression of the reciprocal of fuel economy with respect to the vehicle weight for each vehicle category. The standard line is converted into a curve of fuel economy (in km/l) versus vehicle weight (kg) in the regulation.

¹ New mileage standard values for passenger cars have been finalized at the Council and are available at http://www.mlit.go.jp/report/press/jidosha10_hh_000215.html. Additionally, the eighth car fuel efficiency standard subcommittee distribution document is available at https://www.mlit.go.jp/policy/shingikai/jidosha10_sg_000065.html

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CHANGES FROM 2020 STANDARDS

Compared with the 2020 standards, the 2030 standards include several revisions and improvements in design:

- » **The scope is expanded to electric vehicles (EVs).** The 2020 standards cover gasoline, diesel, and liquefied petroleum gas (LPG) vehicles only. The 2030 standards are expanded to cover battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). According to METI's EV-development target, it is estimated that the combined market penetration of BEVs and PHEVs will be 20% by 2030.² Fuel cell electric vehicles are expected to be a minor share of the market by 2030.
- » **The test cycle has changed.** The 2020 targets were set on the JC08 test cycle and the 2030 standards will be measured under the WLTP. The extra-high-speed phase is excluded from the WLTP to reflect slower driving on Japan's more congested roads.
- » **Comparative upstream energy efficiency is considered.** The 2020 standards only take account of tank-to-wheel (TTW) fuel consumption. Since EVs are included for the first time, the 2030 standards are well-to-wheel (WTW) and take account of the domestic upstream energy consumption of all fuel sources.
- » **Bin-based targets are replaced with a linear curve.** In the 2020 standards, fuel economy targets are set for different vehicle weight bins, which creates step function energy efficiency improvements by bin. The 2030 standards define fuel consumption targets with respect to vehicle weight as a continuous curve with a minimum fuel economy floor for the heaviest vehicles.
- » **The layout of the fuel economy label is updated.** The 2030 standards require manufacturers to display not only the composite fuel economy under the WLTP, but also the individual values from the cycle—i.e., from the low, medium, and high phases. BEVs and PHEVs are required to show the driving range and energy consumption in watt hours per kilometer (Wh/km) in charge-depleting mode. PHEVs are required to display the fuel economy in charge-sustaining mode.

TARGET VALUES

The corporate average fuel economy targets under WLTP are shown in Figure 1. For comparison, Figure 1 also presents some car models that were tested on the WLTP in 2018. Note that the target curve becomes flat when the curb weight of the vehicle exceeds 2,759 kg.

2 METI. (2018). 自動車新時代戦略会議（第1回）資料. Available at https://www.meti.go.jp/shingikai/mono_info_service/jidosha_shinjidai/pdf/001_01_00.pdf

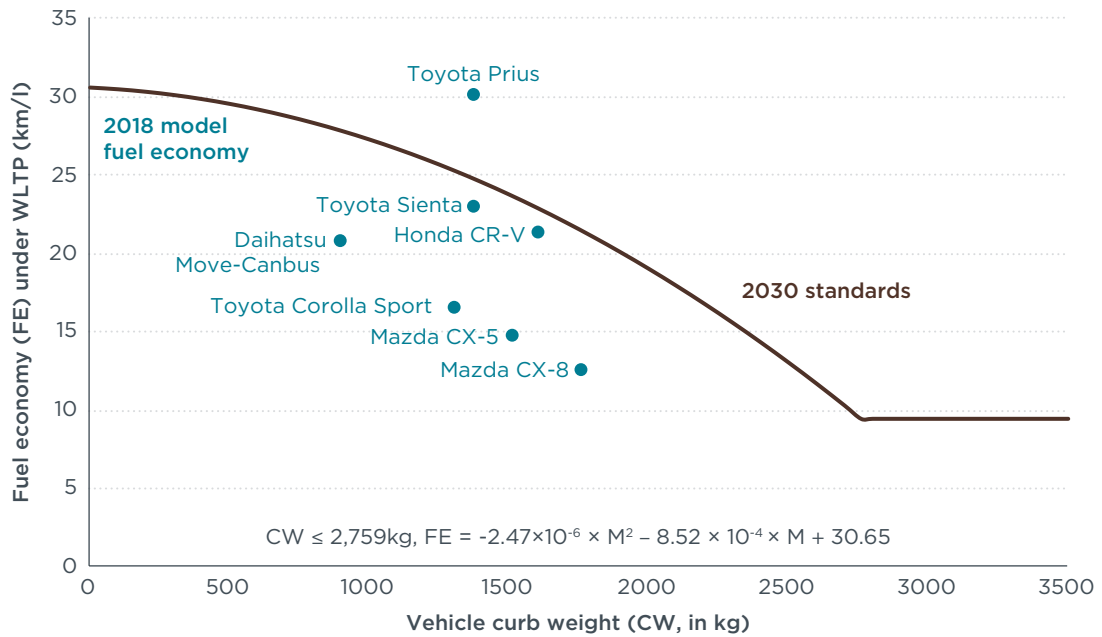


Figure 1. Japan’s 2030 corporate average fuel economy targets under WLTP. Note: The Toyota Prius uses an estimate value under WLTP.

COMPLIANCE

Manufacturers are required to meet the 2030 standards as a corporate average fuel economy (CAFE) and off-cycle credits are not currently provided. The determination of CAFE compliance is:

$$CAFE_{performance} = \left(\sum N_i \right) / \left(\frac{N_i}{FE_i} \right) \geq CAFE_{target} = \left(\sum N_i \right) / \left(\frac{N_i}{FE_{targeti}} \right)$$

$CAFE_{performance}$ is the corporate average fuel economy performance

$CAFE_{target}$ is the corporate average fuel economy target in 2030

N_i is number of sales of model i

FE_i is the fuel economy of model i

$FE_{targeti}$ is the fuel economy target of model i

The TTW fuel economy of vehicles powered by diesel, LPG, and electricity is first converted to gasoline-equivalent fuel economy. This is done by considering the energy density and then taking account of upstream efficiency and adjusting the domestic upstream efficiency ratio of each energy source to gasoline.³ This approach is different from the method used in the United States, where the climate impact of different energy types is compared. Tables 1 to 3 detail the assumptions for Japan’s WTW calculations.

3 Total FE = gasoline equivalent TTW FE * (upstream efficiency_{fuel}/upstream efficiency_{gasoline})

Table 1 Assumptions and calculation of the gasoline-equivalent TTW fuel economy for different fuel sources

	Lower heating value (megajoule/l)	Conversion to gasoline equivalent fuel economy (FE)
Gasoline	31.3	$31.3/31.3 * FE_G = FE_G$
Diesel	35.8	$31.3/35.8 * FE_D = 0.87 * FE_D$
LPG	24.7	$31.3/24.7 * FE_{LPG} = 1.27 * FE_{LPG}$
Electric		$31.3 * 10^6 / 3,600 / EC = 8,700 / EC$

Note: Unit of FE is km/l, unit of energy consumption (EC) is Wh/km

Table 2 Assumptions and calculation of well-to-tank (WTT) efficiency of fossil fuels

	Refining	Distributing	Refueling	Total upstream efficiency
Gasoline	92.9%	99.5%	99.5%	92%
Diesel	93.9%	99.5%	99.5%	93%
LPG	97.4%	99.5%	100%	97%

Table 3 Assumptions and calculation of the WTT efficiency of electricity

	Refining	Generation efficiency	Electric generation fraction	Distributing	Total upstream efficiency
Electric	99.8%	44.3%	56%	90.4%	71.4%

Note: Refinery and thermal efficiency of electricity is the average value of electric powerplants using fossil fuels including coal, natural gas, and oil. Total WTT efficiency is: $99.8% * 44.3% / 56% * 90.4% = 71.4%$

The fuel economy of PHEVs is determined the same way it is in Europe for the WLTP cycle—an average utility factor (UF) weighted fuel consumption of charge-depleting mode and charge-sustaining mode.⁴ The UF is a variable weighting factor that describes the ratio of driving in charge-depleting mode and charge-sustaining mode as a function of the electric range. Because the UF is highly dependent on how a PHEV is driven in practice, UFs are defined differently in Japan and Europe. Japan’s calculations of total fuel economy are detailed in Table 4.

4 Iddo Riemersma, Peter Mock, *Too low to be true? How to measure fuel consumption and CO₂ emissions of plug-in hybrid vehicles, today and in the future* (ICCT: Washington, D.C., 2017), <https://www.theicct.org/publications/too-low-to-be-true-how-to-measure-fuel-consumption-and-co2-emissions-plug-hybrid-vehicles>

Table 4 Calculation of total WTW fuel economy

Vehicle type	Total gasoline equivalent fuel economy (km/l)
Gasoline vehicle	FE_G
Diesel vehicle	$FE_D/1.1$
LPG vehicle	$FE_{LPG}/0.74$
BEV	6,750/energy consumption in Wh/km
PHEV	$\frac{1}{UF \times \left(\frac{1}{FE_{CD}} + \frac{1}{6.75 \times \frac{R_{CD}}{E_1}} \right) + \frac{1 - UF}{FE_{CS}}}$ $UF(R_{CD}) = 1 - e^{(29.1 \times \left(\frac{R_{CD}}{400}\right)^6 - 98.9 \times \left(\frac{R_{CD}}{400}\right)^5 + 134 \times \left(\frac{R_{CD}}{400}\right)^4 - 89.5 \times \left(\frac{R_{CD}}{400}\right)^3 - 32.5 \times \left(\frac{R_{CD}}{400}\right)^2 - 11.8 \times \left(\frac{R_{CD}}{400}\right)}$

Note: CD=charging depleting; CS=charging sustaining; R_{CD} =driving range (km); E_1 =battery capacity (kWh).

If manufacturers are found to not be in compliance with the standards, the name of the company will be publicized, and it will be charged a nominal fine of one million yen (currently approximately \$9,273 in U.S. dollars) or less per offense.

LABEL REQUIREMENTS

The 2030 standards require manufacturers to display more information on the vehicle’s fuel economy label than was required by prior standards. Table 5 specifies the information required on the label and Figure 2 presents examples of new labels.

Table 5 Fuel economy label requirement

		Unit	WLTC			
			Average	Low	Medium	High
Conventional vehicles	Fuel economy	km/l	✓	✓	✓	✓
	BEV	Energy consumption	Wh/km	✓		
	Driving range	km	✓			
PHEV	Hybrid fuel economy (charge-sustaining mode)	km/l	✓	✓	✓	✓
	Electric driving range	km	✓			
	Energy consumption (charge-depleting mode)	Wh/km	✓			

Note: ✓ in red are newly required information on the label.



Figure 2. Fuel economy requirements under 2030 standards in Japan. The left label is for conventional vehicles and the right label is for BEVs.

IMPACT OF EV PENETRATION

In the 2030 standards, the fleet average target for fuel economy is 32.4% higher than the 2016 baseline level, but this will be met through a combination of incremental improvements to conventional vehicles and expanded sales of EVs. The MLIT regulatory document assumes a 20% penetration of EVs. If we assume this 20% is evenly split between BEVs and PHEVs, the fleet average fuel economy that conventional vehicles need to achieve by 2030 is 23.6 km/l, a 22.8% improvement compared with the 2016 level. Thus, the high penetration of EVs in 2030 will significantly reduce the efficiency improvement burden on conventional vehicles.

Table 6 Impact of EV uptake on conventional vehicle efficiency improvement requirements

Scenario	Fuel economy (WLTP)	Improvement of conventional vehicles
2016 baseline	19.2 km/l	—
2030 target without EV penetration	25.4 km/l	32.4%
2030 conventional vehicle target with 20% EV penetration	23.6 km/l	22.8%

Note: EV penetration assumes 10% BEV (e.g., Nissan Leaf) and 10% PHEV (e.g., Prius Plug-in Hybrid)

GLOBAL COMPARISON

Figure 3 compares Japan’s newest standards with existing passenger car fuel economy requirements in other countries by converting to a common metric and test cycle.⁵ The conversion is done using test cycle conversion factors generated by the ICCT.⁶ As shown, the European Union and Japan have adopted the world’s most progressive fuel economy standards, both in terms of stringency and timeframe (2030). Japan’s standards are less stringent than Europe’s, but they are ahead of the other major vehicle markets, including the United States, Canada, and China.

5 “Chart library: Passenger vehicle fuel economy,” International Council on Clean Transportation, accessed September 9, 2019, <https://theicct.org/chart-library-passenger-vehicle-fuel-economy>
 6 Jörg Kühlwein, John German, Anup Bandivadekar, *Development of test cycle conversion factors among worldwide light-duty vehicle CO₂ emission standards* (ICCT: Washington, D.C., 2014), <https://theicct.org/publications/development-test-cycle-conversion-factors-among-worldwide-light-duty-vehicle-co2>

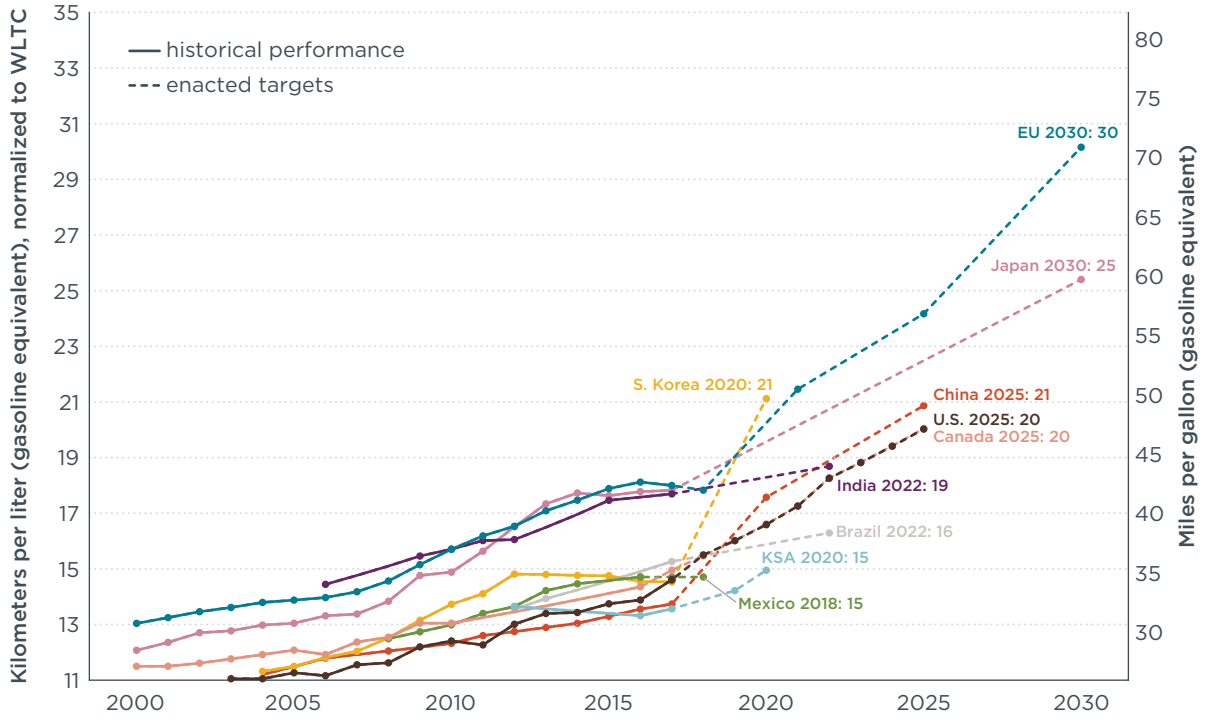


Figure 3. Comparison of fuel economy standards in key vehicle markets