

Greenhouse Gas Emissions Performance for the 2020 Model Year Light-Duty Vehicle Fleet

In relation to the *Passenger Automobile and Light Truck
Greenhouse Gas Emission Regulations* under the *Canadian
Environmental Protection Act, 1999*



Environment and
Climate Change Canada

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List of acronyms

AC – Air conditioner

ATV – Advanced technology vehicle

CAFE – Corporate average fuel economy

CEPA – Canadian Environmental Protection Act, 1999

CO – Carbon monoxide

CO₂ – Carbon dioxide

CO₂e – Carbon dioxide equivalent

CREE – Carbon related exhaust emissions

CWF – Carbon weight fraction

EPA – Environmental Protection Agency

FCEV – Fuel cell electric vehicle

FTP – Federal test procedure

GHG – Greenhouse gas

g/mi – grams per mile

HC – Hydrocarbons

HFET – Highway fuel economy test

LT – Light truck

NO_x – Oxides of nitrogen

N₂O – Nitrous oxide

PA – Passenger automobile

PM – Particulate matter

TOF – Temporary optional fleet

VKT – Vehicle kilometres travelled

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Executive summary

The *Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations* (hereinafter referred to as the “regulations”) establish greenhouse gas (GHG) emission standards for new 2011 and later model year light-duty on-road vehicles offered for sale in Canada. These regulations require importers and manufacturers of new vehicles to meet fleet average emission standards for greenhouse gases. The Regulations also establish annual compliance reporting requirements. This report summarizes the fleet average greenhouse gas emission performance of the fleets of light-duty vehicles. It also provides a compliance summary for each of the obligated companies including their individual fleet average carbon dioxide equivalent (CO₂e)¹ emissions value (referred to as the “compliance value”) and the status of their emission credits.

The CO₂e emission standards are company-unique as they are a function of the footprint and the quantity of vehicles offered for sale in a given model year. These footprint-based target values are aligned with those of the United States Environmental Protection Agency (EPA) and are progressively more stringent over the 2012 through 2026 model years². Since the Canadian greenhouse gas standards were introduced prior to the U.S. EPA program, the 2011 model year target values in Canada were instead based on the U.S. Corporate Average Fuel Economy (CAFE) levels. Since the introduction of the regulations, the fleet average standards for passenger automobiles and for light trucks have become more stringent by 36.4% and 25.9% respectively.

A company’s performance relative to its standard is determined through its sales weighted fleet average emissions performance for the given model year for its new passenger automobile and light truck offerings, expressed in grams per mile of CO₂e based on standardized emissions tests simulating city and highway driving cycles. The emissions measured during these test procedures include CO₂ and other carbon related combustion products, namely carbon monoxide (CO) and hydrocarbons (HC). This ensures that all carbon containing exhaust emissions are also recognized. These regulations also set limits for the release of other greenhouse gases such as methane (CH₄) and nitrous oxide (N₂O). A number of mechanisms are incorporated into the regulations which provide companies with a series of options to achieve the applicable greenhouse gas standards while incentivizing the deployment of new greenhouse gas reducing technologies. These mechanisms include allowances for vehicle improvements and complementary innovative technologies that contribute to the reduction of greenhouse gas emissions in ways that are not directly measured during standard tailpipe emissions testing. Flexibility mechanisms include recognition of the emission benefits of dual-fuel capability, electrification and other technologies that contribute to improved greenhouse gas performance. The regulations also include an emission credit system that allows companies to generate emission credits if their fleet average performance is superior to the standard. Emission credits can be accumulated for future use to offset emission deficits (a deficit is incurred if a company’s fleet performance is above their applicable standard). This allows companies

¹ CO₂e is used throughout this report as a common unit to standardize the environmental impacts of different greenhouse gases (such as N₂O & CH₄) in terms of an equivalent amount of CO₂.

² In December 2021, the U.S. EPA published its Final Rule which increased the stringency of GHG standards for model years 2023 to 2026.

to maintain regulatory compliance as their product mix and demands change year to year and through product cycles which may result in fleet average performance above the standard. Companies that generate emission credits may transfer those credits to other companies. Emission credits generated for performance superior to the standard have a lifespan which is determined based on the model year in which they were generated, whereas deficits generated for performance worse than the standard must be offset within 3 years from the model year in which the deficit was incurred. Compliance to the regulations and the corresponding tracking of credits is monitored, in part, through the annual reports and companies are required to maintain all relevant records relating to their vehicle greenhouse gas emissions performance.

The regulations have been instrumental in influencing companies to make progressive improvements to the efficiency and GHG reductions of their new light duty vehicle fleets available in Canada since the 2011 model year. These regulations have pushed companies to meet these engineering challenges through the introduction of a wide variety of new and innovative technologies. To meet the regulatory standards, companies have not only continued to improve upon conventional internal combustion engine technologies but have incorporated an array of innovative approaches such as active aerodynamics, advanced materials for light-weighting, solar reflective paint, high efficiency lighting and more. Companies have also been driven to increase the availability of advanced technology vehicles with lower to zero GHG emissions, which consist of battery electric vehicles (BEV), plug-in hybrid electric vehicles (PHEV), and fuel cell electric vehicles (FCEV), collectively as zero emission vehicles (ZEVs), and natural gas vehicles (NGVs) to meet the regulatory targets. In fact, since the introduction of the regulation the production volume of ZEVs reached 4.0% for the 2020 model year. Specifically, battery electric vehicles has increased from 198 to 38 455 representing 1.4% of the total fleet in 2020, and the production volume of plug-in hybrid electric vehicles has increased from zero to 20 381 representing 2.6% of the total fleet in 2020. The sum of these developments within the Canadian vehicle fleets have resulted in measureable improvements to GHG emissions performance, and ZEVs are expected to continue to gain market share as standards continue to increase in stringency.

Results from regulatory reports indicate that companies continue to be in compliance through the 2020 model year. The average compliance value for the fleet of new passenger automobiles has decreased from 255 g/mi to 178 g/mi since the introduction of the regulation, representing a 30.2% reduction. The compliance value for light trucks decreased by 20.3%, from 349 g/mi to 278 g/mi since the introduction of the regulation. All companies remained in compliance with the regulations by either meeting their applicable standard, through the use of their own accumulated emission credits or by purchasing credits from other companies. To date, companies have generated a total of approximately 93.1 million credits, of which, approximately 27.4 million remain available for future use. A total of 27.9 million credits have been used to offset emission deficits by individual companies over the 2011 to 2020 model years, of which 3.6 million credits were used to offset deficits accrued in the 2020 model year. The remaining 37.8 million credits have expired.

1. Purpose of the report

The purpose of this report is to provide company specific results of the fleet average greenhouse gas emission performance of the Canadian fleets of passenger automobiles (PA) and of light trucks (LT)³. Building on the previous GHG emissions performance report for the 2019 model year, this report focuses on the GHG emissions performance of the last 4 model years. The results presented herein are based on data submitted by companies in their annual regulatory compliance reports, pursuant to the *Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations*, which have undergone a thorough review by Environment and Climate Change Canada (ECCC). The report assists with identifying trends in the Canadian automotive industry including the adoption and emergence of technologies that have the potential to reduce GHG emissions. It also serves to describe emission credit trading under the regulations.

2. Overview of the regulations

In October 2010, the Government of Canada published the *Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations*⁴ (regulations) under CEPA. This was the first Government of Canada regulation targeting GHG's, and was a major milestone for ECCC towards addressing GHG emissions from the Canadian transportation sector. The regulations and the subsequent amendments introduced progressively more stringent GHG emission targets for new light-duty vehicles of model years 2011 to 2026 in alignment with the U.S. national standards, thereby establishing a common North American approach.

The department monitors compliance with the fleet average requirements through annual reports submitted pursuant to the regulations. These reports are used to establish each company's fleet average GHG performance and the applicable standard for both its passenger automobile and light truck fleets⁵. As part of the regulatory compliance mechanism, companies may accrue emission credits or deficits, depending on their fleet performance relative to the standard. These reports also enable the department to track emission credit balances and transfers. There are in excess of 10 000 data elements collected each reporting cycle. ECCC has a process to review and validate company data and the results may be subject to change should new information become available.

Companies that submitted a report pursuant to the regulations during 2017 to 2020 model years are listed in Table 1.

Table 1: model year report submission status

Manufacturer	Common Name	2017	2018	2019	2020
Aston Martin Lagonda Ltd.	Aston Martin	LVM ^a	LVM ^a	LVM ^a	LVM ^a
BMW Canada Inc.	BMW	*	*	*	*
BYD Canada Company Limited	BYD	--	--	--	*

³ The department has released 6 [reports](#) documenting the overall fleet performance from earlier model years.

⁴ [The regulations, along with amendments, and the accompanying regulatory impact analysis statement](#)

⁵ Definitions of passenger automobile and light truck can be found in the Regulations

FCA Canada Inc.	FCA	*	*	*	*
Ferrari North America Inc.	Ferrari	LVM ^a	LVM ^a	LVM ^a	LVM ^a
Ford Motor Company of Canada Ltd.	Ford	*	*	*	*
General Motors of Canada Company	GM	*	*	*	*
Honda Canada Inc.	Honda	*	*	*	*
Hyundai Auto Canada Corp.	Hyundai	*	*	*	*
Jaguar Land Rover Canada ULC	JLR	*	*	*	*
Kia Canada Inc.	Kia	*	*	*	*
Lotus Cars Ltd.	Lotus	LVM ^a	LVM ^a	LVM ^a	LVM ^a
Maserati North America Inc.	Maserati	LVM ^a	LVM ^a	*	*
Mazda Canada Inc.	Mazda	*	*	*	*
McLaren Automotive Limited	McLaren	LVM ^a	LVM ^a	LVM ^a	LVM ^a
Mercedes-Benz Canada Inc.	Mercedes	*	*	*	*
Mitsubishi Motor Sales of Canada, Inc.	Mitsubishi	*	*	*	*
Nissan Canada Inc.	Nissan	*	*	*	*
Pagani Automobili SPA, Italy	Pagani	LVM ^a	LVM ^a	LVM ^a	LVM ^a
Porsche Cars Canada, Ltd.	Porsche	*	*	*	*
Subaru Canada Inc.	Subaru	*	*	*	*
Tesla Motors, Inc.	Tesla	*	*	*	*
Toyota Canada, Inc.	Toyota	*	*	*	*
Volkswagen Group Canada, Inc.	Volkswagen	*	*	*	*
Volvo Cars of Canada Corp.	Volvo	*	*	*	*
<p>*Indicates that a report has been submitted</p> <p>^a Beginning with the 2012 model year, low volume manufacturers (LVM) may elect to exempt themselves from CO₂e standards. This exemption does not have a noticeable impact on fleet-wide performance given the small volume of vehicles.</p>					

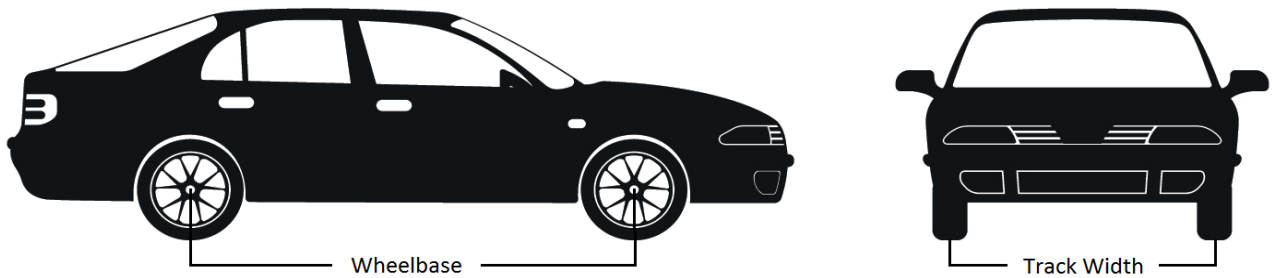
2.1. CO₂e emission standards

The applicable standards for a given model year are based on prescribed carbon dioxide (CO₂e) emission “target values” that are a function of the “footprint” (Figure 1) and quantity of the vehicles in each company’s fleet of passenger automobiles and light trucks offered for sale⁶ to the first retail purchaser⁷. These standards are performance-based in that they establish a maximum amount of CO₂e on a gram per mile basis. This progressively more stringent approach allows companies to choose from an ever changing array of the most cost-effective technologies to achieve compliance and reduce emissions, rather than requiring a particular technology.

⁶ The terms “sold”, “offered for sale” and “production volume” are used interchangeably in this report to designate the quantity of vehicles manufactured or imported in Canada for the purpose of first retail sale.

⁷ The regulations exclude “used vehicles” imported into Canada, new vehicles exported from Canada, emergency vehicles, and vehicles imported on a temporary basis for the purposes of exhibition, demonstration, evaluation and testing.

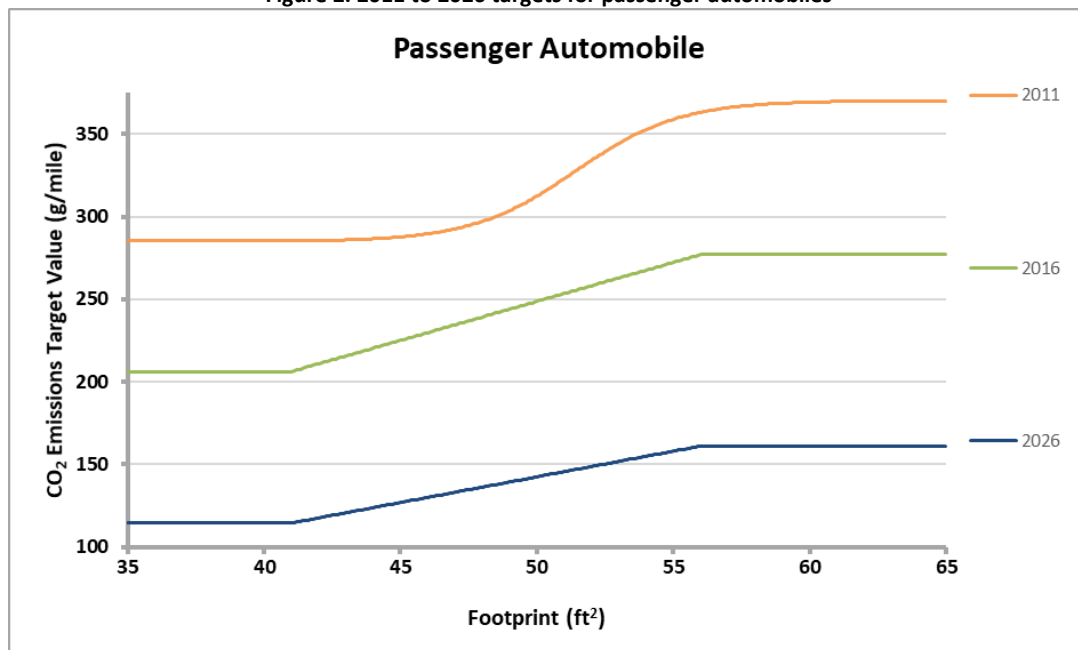
Figure 1. vehicle footprint



$$Footprint = \frac{front\ track\ width + rear\ track\ width}{2} \times wheelbase$$

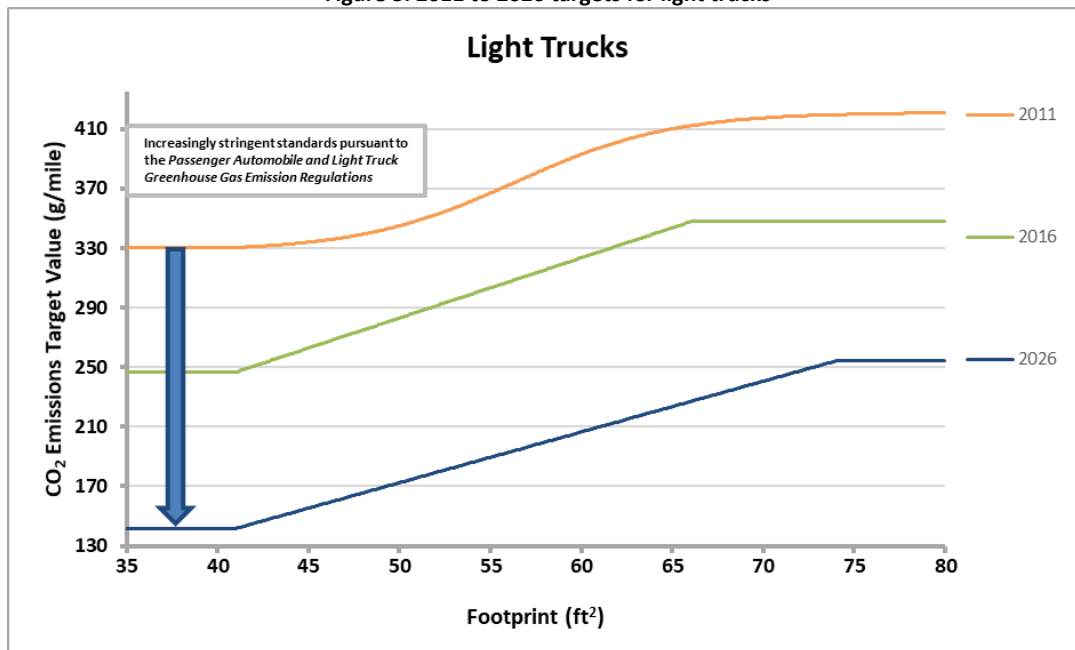
The regulations prescribe progressively more stringent target values for a given footprint size over the 2011 through 2026 model years⁸. Figures 2 and 3 illustrate the target values for passenger automobiles and light trucks, respectively.

Figure 2. 2011 to 2026 targets for passenger automobiles



⁸ See footnote 2

Figure 3. 2011 to 2026 targets for light trucks



As depicted in Figures 2 and 3, the targets for the 2011 model year are unique in that they follow a smooth curve. This is because the 2011 target values were introduced 1 year prior to the U.S. Environmental Protection Agency (EPA) program, and were instead based on the U.S. Corporate Average Fuel Economy (CAFE) levels. Accordingly, the regulations considered the consumption of fuel as the basis to establish reasonable approximations of GHG performance for the 2011 model year⁹. The CO₂e standard was derived using a conversion factor of 8 887 grams of CO₂/gallon of gasoline¹⁰ for the 2011 model year only.

For the 2012 and later model years, the CO₂e emissions target values are aligned with the U.S. EPA target values.

The overall passenger automobile and light truck fleet average standard that a company must meet is ultimately determined by calculating the sales weighted average of all of the target values using the following formula:

⁹ The fuel economy target values that apply to vehicles of the 2011 model year are calculated using the following formula:

$$T = 1 / ((1/a) + (1/b) - (1/a) * ((e^{(x-c)/d}) / (1 + e^{(x-c)/d})))$$

Where: x is the footprint for the vehicle in question, a = 31.20, b = 24.00, c = 51.41, d = 1.91 for PA's

and a = 27.10, b = 21.10, c = 56.41, d = 4.28 for LT's

¹⁰ Although the conversion factor 8 887 is specific to gasoline, it was applied fleet-wide since the proportion of vehicles using other fuel types is very low.

$$\text{Fleet Average Standard} = \frac{\Sigma (A \times B)}{C}$$

where

A is the CO₂e emission target value for each group of passenger automobiles or light trucks having the same emission target;

B is the number of passenger automobiles or light trucks in the group in question; and

C is the total number of passenger automobiles or light trucks in the fleet.

The final company-unique fleet average CO₂e standards for the 2017 to 2020 model years are presented in Table 2. These represent the regulatory values that a company's fleets of passenger automobiles and light trucks must meet.

Table 2. fleet average CO₂e standard (g/mi)

Manufacturer	2017 PA	2018 PA	2019 PA	2020 PA	2017 LT	2018 LT	2019 LT	2020 LT
BMW	216	208	196	188	283	274	270	262
BYD	--	--	--	194	--	--	--	--
FCA	234	228	218	206	312	295	301	290
Ford	220	209	202	193	308	310	303	296
GM	218	204	192	181	320	310	298	293
Honda	214	204	193	184	274	261	258	245
Hyundai	216	206	196	184	278	266	258	269
JLR	244	242	219	203	286	286	278	267
Kia	216	204	195	183	277	267	263	253
Maserati	--	--	231	218	--	--	278	269
Mazda	212	202	189	183	267	256	249	238
Mercedes	225	213	205	195	287	274	263	263
Mitsubishi	203	195	183	176	253	242	234	226
Nissan	216	205	191	190	282	273	261	245
Porsche	215	224	194	198	285	284	277	266
Subaru	210	199	189	180	257	245	241	235
Tesla	254	226	211	202	--	292	284	275
Toyota	212	201	192	183	286	273	265	261
Volkswagen	211	201	190	183	273	269	264	246
Volvo	242	245	222	212	288	291	274	263
Fleet Average	216	205	194	185	298	288	282	272

A company's average footprint (Table 3) is one of the factors in establishing their CO₂e standards. Companies are responsible for meeting their own unique fleet average CO₂e standard based on the size of vehicles they produce. However, the regulations provide additional compliance flexibilities for intermediate sized companies to make use of an alternative schedule of annual emission standards for the 2017 to 2020 model years (discussed in section 2.3.7.).

Table 3. average footprint for the 2017 to 2020 model years (sq. ft.)

Manufacturer	2017 PA	2018 PA	2019 PA	2020 PA	2017 LT	2018 LT	2019 LT	2020 LT
BMW	45.6	46.3	45.9	46.3	50.4	50.8	51.9	52
BYD	--	--	--	47.9	--	--	--	--
FCA	49.3	50.9	51.2	50.9	57.8	56.1	59.0	58.3
Ford	46.7	46.6	47.4	47.7	58.3	61.3	60.7	60.2
GM	45.8	45.2	44.3	43.5	60.9	60.2	59.7	60.1
Honda	45.1	45.4	45.2	45.2	48.6	48.2	49.2	48.3
Hyundai	45.8	45.9	45.9	45.5	49.2	49.2	49.2	53.5
JLR	48.9	48.7	48.8	47.8	50.8	50.7	51.7	51.0
Kia	45.7	45.3	45.7	45.3	49.2	49.3	50.3	50.0
Maserati	--	--	54.3	53.8	--	--	53.4	53.4
Mazda	44.8	44.8	44.2	45	47.0	47.3	47.3	46.8
Mercedes	47.4	47.2	48.0	48.1	51.3	50.9	50.3	52.1
Mitsubishi	41.8	42.3	41.7	42.7	44.0	44.2	44.1	44.2
Nissan	45.4	45.5	44.6	45.8	50.4	50.8	49.9	48.2
Porsche	42.3	44.4	42.8	46.6	50.5	50.3	51.6	51.0
Subaru	44.5	44.4	44.4	44.4	44.8	44.9	45.7	46.1
Tesla	54.2	50.4	49.6	49.8	--	54.8	54.8	54.8
Toyota	44.8	44.7	44.9	45.1	51.7	51.1	50.9	51.7
Volkswagen	44.5	44.7	44.6	45.1	48.4	50.0	50.4	48.5
Volvo	48.7	49.2	49.7	49.9	51.2	52.1	50.9	50.4
Fleet Average	45.5	45.5	45.3	45.6	54.9	54.8	55.1	54.5

2.2. Carbon related exhaust emissions

The fleet average carbon-related exhaust emission (CREE) value is the sales-weighted average performance of a company in a given model year for its passenger automobile and light truck fleets, expressed in grams of CO₂e per mile. The CREE value is a single number that represents the average carbon exhaust emissions from a company's total fleets of passenger automobiles and light trucks. The emission values to calculate a CREE value are measured using 2 emissions test procedures; the Federal Test Procedure (FTP) and the Highway Fuel Economy Test (HFET). The FTP and HFET tests are more commonly referred to as the city and highway tests. These 2 tests ensure that the CREE is measured in a manner that is consistent across the automobile industry. During these tests, manufacturers measure the carbon-related combustion products including carbon dioxide (CO₂), carbon monoxide (CO), and hydrocarbons (HC). This ensures that all carbon-containing exhaust emissions that ultimately contribute to the formation of CO₂ are recognized.

The CREE for each vehicle model type is calculated based on actual emission constituents (such as CO₂, HC, and CO) from that model over the city and highway tests. The 2 test results are then combined based on a 55% city and 45% highway driving distribution. A company's final CREE value is based on the sales weighted average of the combined test results for each model, and the number of vehicles manufactured or imported into Canada for the purpose of sale.

The calculated fleet average CREE values achieved by companies over the 2017 to 2020 model years are presented in Table 4.

Table 4. fleet average carbon related exhaust emissions (g/mi)

Manufacturer	2017 PA	2018 PA	2019 PA	2020 PA	2017 LT	2018 LT	2019 LT	2020 LT
BMW	249	259	250	249	309	300	292	295
BYD	--	--	--	0	--	--	--	--
FCA	310	314	311	324	373	360	368	357
Ford	260	241	249	204	349	347	341	325
GM	209	191	179	152	362	349	349	339
Honda	205	202	207	207	267	255	264	257
Hyundai	246	241	222	211	340	337	342	325
JLR	299	277	330	291	338	316	304	315
Kia	233	223	203	176	322	322	315	310
Maserati	--	--	376	370	--	--	421	410
Mazda	217	215	223	226	266	259	266	260
Mercedes	275	264	275	269	329	316	320	308
Mitsubishi	213	151	162	155	271	264	261	261
Nissan	236	204	202	214	293	294	288	265
Porsche	294	291	322	147	319	318	317	320
Subaru	251	254	243	250	248	242	241	235
Tesla ¹¹	0	0	0	0	--	0	0	0
Toyota	216	205	200	176	315	315	290	289
Volkswagen	237	255	221	193	321	296	292	300
Volvo	265	257	262	241	267	267	272	267
Fleet Average	232	221	211	195	334	323	320	309

2.3. Compliance flexibilities

The regulations provide various compliance flexibilities that reduce the compliance burden on low and intermediate volume companies, to encourage the introduction of advanced technologies which reduce GHG emissions, and to account for innovative technologies whose impacts are not easily measured during standard emissions tests. The regulations also recognize the GHG reduction potential of vehicles capable of operating on fuels produced from renewable sources (such as ethanol). The aforementioned compliance flexibilities are discussed in the following sub-sections.

2.3.1. Allowances for reduction in refrigerant leakage (E)

Refrigerants currently used by air conditioner (AC) systems have a global warming potential¹² (GWP) that is much higher than CO₂. Consequently, the release of these refrigerants into the environment has a more significant impact on the formation of greenhouse gases than an equal amount of CO₂. The regulations include provisions which recognize the reduced GHG emissions from improved AC systems designed to minimize refrigerant leakage into the environment. Based on the performance of the AC system components, manufacturers can calculate a total annual refrigerant leakage rate for an AC system which, in combination with the type of refrigerant, determines the CO₂e leakage reduction in grams per mile (g/mi) for each of their air conditioning systems. The maximum allowance value that can be generated for an improved air conditioning system in a passenger automobile is 12.6 g/mi for systems using traditional HFC-134a refrigerant, and 13.8 g/mi for systems using refrigerant with a lower GWP. These

¹¹ Tesla and BYD only produce battery electric vehicles and use the 0 g/mi incentive for their CREE as described in section 2.3.5.

¹² Additional information relating to GWP's can be found on [Canada's action on climate change website](#).

maximum allowance values for air conditioning systems equipped in light trucks is 15.6 g/mi and 17.2 g/mi, respectively.

The total fleet average allowance for reduction in AC refrigerant leakage is calculated using the following formula:

$$E = \frac{\Sigma (A \times B)}{C}$$

where

A is the CO₂e leakage reduction for each of the air conditioning systems in the fleet that incorporates those technologies;

B is the total number of vehicles in the fleet equipped with the air conditioning system; and

C is the total number of vehicles in the fleet.

Table 5 shows the leakage allowances in g/mi for the 2017 to 2020 model years.

Table 5. allowance for reduction in AC refrigerant leakage (g/mi)

Manufacturer	2017 PA	2018 PA	2019 PA	2020 PA	2017 LT	2018 LT	2019 LT	2020 LT
BMW	13.7	13.6	13.5	13.6	16.9	16.9	17.2	17.2
BYD	--	--	--	0.0	--	--	--	--
FCA	13.6	13.8	13.7	13.8	14.8	15.8	15.6	15.7
Ford	11.7	12.8	12.8	13.6	14.4	15.5	16.3	17.1
GM	8.5	12.3	12.3	12.9	15.1	16.7	16.4	16.7
Honda	9.7	11.6	12.7	12.8	13.5	15.6	16.5	16.5
Hyundai	2.8	5.4	10.6	9.0	1.6	2.2	1.7	4.3
JLR	13.8	13.8	13.7	13.8	17.2	17.2	17.2	17.2
Kia	5.4	8.2	12.7	13.3	8.6	7.9	15.4	16.3
Maserati	--	--	5.9	13.8	--	--	7.7	17.2
Mazda	0.0	2.7	1.5	1.9	0.0	4.3	5.0	5.0
Mercedes	5.8	5.9	6.2	6.2	7.2	7.6	7.4	8.4
Mitsubishi	2.7	9.8	7.8	13.5	6.1	13.1	13.5	16.7
Nissan	4.2	6.2	8.6	--	6.8	6.9	7.4	--
Porsche	13.7	13.5	12.6	--	12.1	14.4	6.5	--
Subaru	1.9	1.4	1.4	7.9	5.8	4.5	9.1	14.9
Tesla	0.0	5.7	12.7	13.7	--	5.2	11.2	15.4
Toyota	3.3	5.2	8.1	10.8	6.5	7.5	11.1	12.8
Volkswagen	4.7	12.3	13.2	10.5	7.1	15.6	15.7	13.0
Volvo	5.3	5.1	4.9	13.2	6.5	6.9	7.4	16.6
Fleet Average	6.0	8.4	10.3	9.7	12.0	13.3	14.2	14.3

2.3.2. Allowances for improvements in air conditioning efficiency (F)

Improvements to the efficiency of vehicle air conditioning systems can result in significant reductions in CO₂e emissions that are not directly measurable during standard emissions test procedures. Implementing specific technologies (for example, more efficient compressors, motors, fans etc.) can reduce the amount of engine power required to operate the air conditioning system which, in turn,

reduces the quantity of fuel that is consumed and converted into CO₂. The regulations contain provisions which recognize the reduced GHG emissions from AC systems with improved efficiency. Manufacturers can claim these allowances by either submitting proof of U.S. EPA approval for the efficiency-improving technology, or by selecting, during reporting, the applicable technologies from a pre-approved menu (Appendix A-2) that have an assigned value. These allowance values are aligned with those established by the U.S. EPA and may be applied cumulatively to an AC system. For the 2017 and later model years, the maximum allowance value for improvements in air conditioning efficiency is 5.0 g/mi for passenger automobiles and 7.2 g/mi for light trucks.

Once the air conditioning efficiency allowances are determined for each AC system, the overall allowance applicable to a company's fleet of vehicles is determined with the following formula:

$$F = \frac{\Sigma (A \times B)}{C}$$

where

A is the air conditioning efficiency allowance for each of the air conditioning systems in the fleet that incorporate those technologies

B is the total number of vehicles in the fleet equipped with the air conditioning system; and

C is the total number of vehicles in the fleet.

Table 6 shows the fleet average allowance values in g/mi for the 2017 to 2020 model years.

Table 6. allowance for improvements in AC system efficiency (g/mi)

Manufacturer	2017 PA	2018 PA	2019 PA	2020 PA	2017 LT	2018 LT	2019 LT	2020 LT
BMW	4.8	4.9	4.9	4.9	5.5	6.3	7.0	7.0
BYD	--	--	--	0.0	--	--	--	--
FCA	4.8	4.7	4.7	4.8	5.6	5.9	5.8	6.2
Ford	3.4	4.0	4.3	4.6	6.1	6.8	6.7	6.6
GM	3.9	4.3	4.0	3.9	6.6	6.9	6.7	6.7
Honda	3.3	3.6	3.7	3.6	5.5	5.8	6.3	5.2
Hyundai	3.3	3.4	3.5	3.1	5.4	5.2	5.4	4.0
JLR	5.0	5.0	5.0	5.0	7.2	7.2	7.2	7.2
Kia	3.1	3.2	3.6	3.3	5.2	5.2	5.4	4.2
Maserati	--	--	4.9	5.0	--	--	7.2	7.2
Mazda	0.0	0.0	0.0	1.4	0.0	0.0	0.0	1.1
Mercedes	4.9	5.0	5.0	5.0	7.1	7.1	5.8	7.1
Mitsubishi	0.4	2.2	1.9	4.6	2.9	3.0	3.0	6.0
Nissan	3.2	3.9	4.0	--	3.4	4.0	4.2	--
Porsche	5.0	5.0	5.0	--	7.2	7.2	7.2	--
Subaru	3.0	3.1	3.0	3.6	4.5	4.6	5.8	6.6
Tesla	5.0	5.0	5.0	5.0	--	7.2	7.2	7.2
Toyota	4.4	4.2	4.6	4.7	6.9	6.0	6.4	6.3
Volkswagen	4.1	4.8	4.9	3.8	5.9	7.1	7.1	5.5
Volvo	4.2	4.0	4.8	4.7	5.4	6.2	6.2	6.3
Fleet Average	3.5	3.7	3.9	3.4	5.7	6.1	6.0	5.8

2.3.3. Allowances for the use of innovative technologies (G)

The regulations recognize that a variety of innovative technologies that have the potential to reduce CO₂e emissions cannot be measured during standard emissions test procedures. Innovative technologies can range from advanced thermal controls that reduce operator reliance on engine driven heating/cooling systems, to solar panels which can charge the battery of an electrified vehicle. Starting with the 2014 model year, companies were given the option to select applicable technologies from a menu of pre-set allowance values. This menu includes allowances for the following systems:

- waste heat recovery
- high efficiency exterior lights
- solar panels
- active aerodynamic improvements
- engine idle start-stop
- active transmission warm-up
- active engine warm-up
- thermal control technologies

Companies can report any combination of innovative technologies from this menu; however, the total allowance value for a fleet of passenger automobiles or light trucks is capped at 10 g/mi.

The total fleet average allowance for the use of innovative technologies is calculated using the following formula:

$$G = \frac{\Sigma (A \times B)}{C}$$

where

A is the allowance for each of those innovative technologies incorporated into the fleet;

B is the total number of vehicles in the fleet equipped with the innovative technology; and

C is the total number of vehicles in the fleet.

Table 7 summarizes the total innovative technology allowances reported by companies for model years 2017 to 2020.

Table 7. allowance for the use of innovative technologies (g/mi)								
Manufacturer	2017 PA	2018 PA	2019 PA	2020 PA	2017 LT	2018 LT	2019 LT	2020 LT
BMW	3.2	3.6	4.4	7.3	6.7	8.1	10.8	13.3
BYD	--	--	--	0.0	--	--	--	--
FCA	3.7	4.3	4.8	5.2	8.1	10.4	11.6	10.6
Ford	5.3	5.5	6.3	7.1	11.4	13.4	14.9	16.2
GM	5.4	7.1	6.0	6.0	7.8	8.9	10.0	12.1
Honda	3.9	4.1	4.1	4.4	8.3	8.5	9.4	12.7

Hyundai	1.5	2.4	2.1	4.0	5.6	5.7	5.3	8.5
JLR	4.2	6.9	5.5	6.8	7.4	12.4	12.2	12.9
Kia	1.9	2.0	2.9	4.7	3.4	4.5	4.7	7.5
Maserati	--	--	6.0	7.0	--	--	13.1	13.8
Mazda	0.0	1.4	1.9	2.4	0.0	4.6	5.1	6.6
Mercedes	1.0	3.9	1.5	1.4	2.1	3.3	2.5	2.9
Mitsubishi	0.0	2.4	1.7	3.2	0.0	1.4	1.4	4.9
Nissan	2.0	2.2	2.0	--	5.1	6.0	5.9	--
Porsche	2.7	3.2	2.0	--	3.5	3.1	9.8	--
Subaru	0.8	2.0	2.1	2.3	0.7	4.9	6.2	8.5
Tesla	0.0	4.8	4.6	4.6	--	8.3	8.3	8.3
Toyota	3.7	4.1	4.4	5.0	7.1	6.8	8.4	8.6
Volkswagen	3.8	4.7	5.1	5.6	6.6	10.6	11.6	11.9
Volvo	3.6	6.7	4.7	5.0	5.7	11.4	8.4	8.5
Fleet Average	3.0	3.2	3.6	4.1	7.6	9.2	10.2	10.7

2.3.4. Allowance for certain full-size pick-up trucks

The 2017 model year introduced additional allowances which companies may elect to claim in respect of their full-sized pick-up trucks. These new flexibilities recognize both the hybridization and emission reduction of vehicles that can serve some utility function in the Canadian marketplace.

2.3.4.1. Allowance for the use of hybrid technologies on full-size pick-up trucks

Companies may elect to calculate an allowance associated with the presence of hybrid technology on full-size pick-up trucks if that technology is present on the prescribed percentage of that company's fleet of full-size pick-up trucks for that model year. The penetration rate depends on the model year in question and whether the vehicles employ "mild" or "strong" hybrid electric technology. "Mild hybrid electric technology" means a technology that has start/stop capability and regenerative braking capability, where the recaptured braking energy is between 15% and 65% of the total braking energy. "Strong hybrid electric technology" means a technology that has start/stop capability and regenerative braking capability, where the recaptured braking energy is more than 65% of the total braking energy.

2.3.4.2. Allowance for full-size pick-up trucks that achieve a significant emission reduction below the applicable target

Companies may claim an allowance for the models of full-size pick-up trucks that have a CREE that is between 80% and 85% of its CO₂e emission target value and comprise a prescribed percentage of the fleet. The regulations also allow companies to claim an allowance for full-size pick-up trucks that have a CREE that is less than or equal to 80% of its CO₂e target value and comprise at least 10% of that company's full-size pick-up truck fleet for model years 2017 to 2025.

A company can only use one of the allowances for full-size pick-up trucks for a given vehicle.

The total fleet average allowance for certain full-size pick-up trucks is calculated using the following formula:

$$H = \frac{\Sigma (A_H \times B_H) + \Sigma (A_R \times B_R)}{C}$$

where

A_H is the allowance for the use of hybrid electric technologies;

B_H is the number of full-size pick-up trucks in the fleet that are equipped with hybrid electric technologies;

A_R is the allowance for full-size pick-up trucks that achieve a certain carbon-related exhaust emission value;

B_R is the number of full-size pick-up trucks in the fleet that achieve a certain carbon-related exhaust emission value; and

C is the total number of vehicles in the fleet.

As of the 2020 model year no companies made use of the allowance for certain full-size pick-up trucks.

2.3.5. Advanced technology vehicles

The regulations offer a number of additional provisions to encourage the deployment of “advanced technology vehicles” (ATVs) which consist of battery electric vehicles (BEV), plug-in hybrid electric vehicles (PHEV), fuel cell electric vehicles (FCEV) and natural gas vehicles. BEVs are completely powered by electrical energy stored in a battery, and hence produce no tailpipe emissions. PHEVs incorporate an electrical powertrain which enables them to be charged with electricity to operate solely on electrical power, but also contain an internal combustion engine to extend the operating range of the vehicle. FCEVs are propelled solely by an electric motor where the energy for the motor is supplied by an electrochemical cell that produces electricity without combustion. When calculating a CREE, the regulations allow companies to report 0 g/mi for electric vehicles (for example, BEVs), fuel cell vehicles, and the electric portion of plug-in hybrids (when PHEVs operate as electric vehicles). Additionally, companies may multiply the number of ATVs in their fleet by a specified factor to increase the impact that they have on a company’s overall fleet average. The applicable multiplying factors and the associated model years can be found in Table 8.

Table 8. multiplying factors for advanced technology vehicles

Model year	BEV and FCEV multiplier	PHEV multiplier	Natural gas
2011 to 2016	1.2	1.2	1.2
2017	2.5	2.1	1.6
2018	2.5	2.1	1.6
2019	2.5	2.1	1.6
2020	2.25	1.95	1.45
2021	2.0	1.8	1.3
2022 to 2025	1.5	1.3	1.0

The production volumes of BEVs and PHEVs sold by model year are presented in Tables 9 and 10.

Table 9. production volumes of BEVs by model year

Manufacturer	2017 PA	2018 PA	2019 PA	2020 PA	2017 LT	2018 LT	2019 LT	2020 LT
BMW	96	70	69	158	--	--	--	--

BYD	--	--	--	25	--	--	--	--
FCA	--	--	--	--	--	--	--	--
Ford	522	682	--	--	--	--	--	--
GM	2 133	1 474	5 445	5 236	--	--	--	--
Honda	--	--	--	--	--	--	--	--
Hyundai	655	394	4 584	5 573	--	--	--	--
JLR	--	--	365	--	--	--	365	139
Kia	477	964	1 186	3 677	--	--	--	--
Mazda	--	--	--	--	--	--	--	--
Mercedes	106	442	141	--	--	--	--	--
Mitsubishi	85	--	--	--	--	--	--	--
Nissan	884	4 440	4 340	1 848	--	--	--	--
Porsche	--	--	--	1 039	--	--	--	--
Subaru	--	--	--	--	--	--	--	--
Tesla	3 483	8 511	12 502	18 483	--	450	862	328
Toyota	--	50	196	22	--	--	--	--
Volkswagen	705	808	1 024	1 929	--	--	918	23
Volvo	--	--	--	--	--	--	--	--
Total	9 146	17 835	29 487	37 990	0	450	2145	490

Table 10. production volumes of PHEVs by model year

Manufacturer	2017 PA	2018 PA	2019 PA	2020 PA	2017 LT	2018 LT	2019 LT	2020 LT
BMW	528	481	656	277	184	566	--	46
BYD	--	--	--	--	--	--	--	--
FCA	--	--	--	--	739	1 578	600	1 026
Ford	1 991	2 106	1 513	1 906	--	--	--	208
GM	5 728	5 400	2 675	--	--	--	--	--
Honda	--	850	910	747	--	--	--	--
Hyundai	128	1 024	1 622	1 396	--	--	--	--
JLR	--	--	--	--	--	--	--	207
Kia	110	45	1 150	1 361	--	--	--	--
Mazda	--	--	--	--	--	--	--	--
Mercedes	31	330	--	9	45	--	147	59
Mitsubishi	--	5 380	2 088	2 456	--	--	--	--
Nissan	--	--	--	--	--	--	--	--
Porsche	--	344	90	73	417	348	325	320
Subaru	--	--	--	413	--	--	--	--
Tesla	--	--	--	--	--	--	--	--
Toyota	1 164	3 606	1 600	8 659	--	--	--	--
Volkswagen	483	609	--	--	--	--	--	444
Volvo	--	41	3	86	615	497	541	688
Total	10 163	20 216	12 317	16 970	2 000	2 989	1 613	3 411

2.3.6. Provisions for small volume companies for 2012 and later model years

The regulations include provisions enabling smaller companies that may have limited product offerings to opt out of complying with the CO₂e standards (non application of the standards respecting CO₂ equivalent emissions¹³) for 2012 and subsequent model years. This exemption is available to companies that:

¹³ This exemption does not have a noticeable impact on fleet-wide performance given the small volume of vehicles.

- a. have manufactured or imported less than 750 passenger automobiles and light trucks for either the 2008 or 2009 model years
- b. have manufactured or imported for sale a running average of less than 750 vehicles for the 3 model years prior to the model year being exempted
- c. submit a small volume declaration to ECCC.

A small volume company must submit an annual report to obtain credits. These companies are still required to comply with the standards for nitrous oxide and methane (refer to section 2.5 for further details).

Table 11 summarizes the production volumes reported by small volume companies. This flexibility was claimed by 6 small volume companies for the 2012 and later model years.

Table 11. production volumes for small volume manufacturers by model year

Manufacturer	2017	2018	2019	2020
Aston Martin	82	44	148	741
Ferrari	275	247	364	370
Maserati	1 369	1 000	--	--
McLaren	112	220	195	157
Lotus	13	12	0	15
Pagani	0	0	0	
Total	1 851	1 523	707	1283

2.3.7. Flexibilities for intermediate sized companies

The regulations included an option for intermediate sized companies¹⁴ to meet an alternative less stringent standard between the 2012 to 2016 model years inclusive. This provision was intended to provide intermediate sized companies that have a less varied product line additional time to transition to the more stringent standards.

Starting with the 2017 model year, eligible intermediate volume companies are allowed to follow an alternative schedule of annual emission standards for model years 2017 to 2020, as shown in Table 12. As of model year 2021, these companies will have to comply with the prescribed emission standards for the applicable model year. Any company that elects to use the alternative schedule will not be permitted to sell any emission credits obtained against these standards to any other regulated company.

Table 12. alternative schedule of fleet average CO₂e emission standards for eligible intermediate volume companies

Model Year	Applicable Fleet Average CO ₂ e Emission Standard
2017	2016
2018	2016
2019	2018
2020	2019

¹⁴ Companies that manufactured or imported in total 750 or more, but fewer than 7 500, passenger automobiles and light trucks of the 2009 model year for sale in Canada.

Over the 2017 to 2020 model years, JLR, Porsche, and Volvo made use of the alternative schedule of fleet average emission standards.

2.4. Standards for nitrous oxide and methane

The regulations also limit the release of other GHG's, such as emissions of methane (CH₄) and nitrous oxide (N₂O). Starting with the 2012 model year, the regulations set standards for N₂O and CH₄ at 0.01 g/mi and 0.03 g/mi respectively. These standards are intended to cap vehicle N₂O and CH₄ emissions at levels that are attainable by existing technologies and ensure that levels do not increase with future vehicles. Companies have 3 methods by which they can conform to the standards for N₂O and CH₄.

The first method allows companies to certify that the N₂O and CH₄ emissions for all its vehicles of a given model year are below the cap-based standards. This method does not impact the calculation of a company's CREE.

The second method allows companies to quantify the emissions of N₂O and CH₄ as an equivalent amount of CO₂ and include this in the determination of their overall CREE. Companies using this method must incorporate N₂O and CH₄ test data into the CREE calculation, while factoring in the higher global warming potential of these 2 gases. This method is not as commonly used as it counts N₂O and CH₄ emissions even for the portion of a company's fleet that does not exceed the standard.

The third method allows companies to certify vehicles to alternative N₂O and CH₄ emissions standards. This method generally offers the greatest flexibility to companies as they are left to establish alternative standards that apply only to those vehicles that would not meet the cap-based value as opposed to impacting the entire fleet. Additionally, companies using this method can comply with standards of N₂O and CH₄ separately by setting alternative standards for either emission as needed. The g/mi difference between the alternative standard and the cap-based standard that would otherwise apply is used to determine a deficit which must be offset with conventional CO₂e emissions credits. The total deficits incurred by the companies that used this method are summarized in Tables 13 and 14.

Table 13. N₂O emissions deficits by company for the 2017 to 2020 model years (Mg CO₂e)

Manufacturer	2017 PA	2018 PA	2019 PA	2020 PA	2017 LT	2018 LT	2019 LT	2020 LT
BMW	-1 215	-2 284	--	--	-3 276	-3 920	--	--
FCA	--	--	--	-49	-10 957	-23 275	-6 269	-10 333
Ford	-2 124	-715	-847	-10	-47 486	-17 047	-10 562	-713
GM	-645	-1 166	-236	--	-3 114	-6 146	-4 501	-35 225
Hyundai	--	-331	-999	-917	--	--	--	--
JLR	-1 379	-1 999	-62	--	-2 830	-9 638	-3 935	-1 322
Kia	--	-2 211	-1 447	-1 104	--	--	--	--
Mazda	-807	-1 449	-360	-179	-5 436	-4 324	-12 750	-3 439
Nissan	-930	-414	--	--	--	--	--	--
Toyota	-2 219	-1 306	-1 466	-1 267	-3 599	-2 289	-3 490	-8 913
Volkswagen	--	--	--	--	--	--	-300	-120
Fleet Total	-9 319	-11 875	-5 417	-3 526	-76 698	-66 639	-41 807	-60 065

Table 14. CH₄ emissions deficits by company for the 2017 to 2020 model years (Mg CO₂e)

Manufacturer	2017 PA	2018 PA	2019 PA	2020 PA	2017 LT	2018 LT	2019 LT	2020 LT
BMW	-153	-288	--	--	-412	-493	--	--
FCA	-7	-3	-3	-37	-1 296	-3 215	-3 001	-186
Ford	-532	-152	-155	-240	-8 296	-18 801	-13 041	-10 361
GM	-81	-357	-137	-64	-1 791	-1 969	-762	-310
Mazda	-136	-340	-474	-122	-475	-121	-401	0
Volkswagen	-85	-74	-15	-51	--	--	--	--
Fleet Total	-994	-1 214	-784	-514	-12 270	-24 599	-17 205	-10 857

2.5. CO₂e emissions value

The fleet average CO₂e emissions value, referred to as the “compliance value” is the final average CO₂e performance of a company’s fleets of passenger automobiles and of light trucks, reported as CREE, after being adjusted for all available compliance flexibilities, using the following equation:

$$\text{Compliance value} = D - E - F - G - H$$

where

D is the fleet average carbon-related exhaust emission value for each fleet (section 2.2);

E is the allowance for reduction of air conditioning refrigerant leakage (section 2.3.1);

F is the allowance for improving air conditioning system efficiency (section 2.3.2); and

G is the allowance for the use of innovative technologies that have a measurable CO₂e emission reduction (section 2.3.3);

H is the allowance for certain full-size pick-up trucks (section 2.3.4).

A company’s compliance value for its fleet of passenger automobiles and light trucks is what is ultimately compared to its CO₂e standard for both aforementioned categories to determine compliance and to establish a company’s emission credit balance. Tables 15 and 16 show both the companies’ compliance and standard values for the passenger automobiles and light truck fleets across the 2017 to 2020 model years.

Table 15. PA compliance and standard values over the 2017 to 2020 model years (g/mi)

Manufacturer	2017 Compliance	2018 Compliance	2019 Compliance	2020 Compliance	2017 Std.	2018 Std.	2019 Std.	2020 Std.
BMW	227	237	227	223	216	208	196	188
BYD	--	--	--	0	--	--	--	194
FCA	288	291	288	300	234	228	218	206
Ford	240	219	226	179	220	209	202	193
GM	191	167	157	129	218	204	192	181
Honda	188	183	187	186	214	204	193	184
Hyundai	238	230	206	195	216	206	196	184
JLR	276	251	306	265	244	242	219	203
Kia	223	210	184	155	216	204	195	183
Maserati	--	--	359	344	--	--	231	218
Mazda	217	211	220	220	212	202	189	183
Mercedes	263	249	262	256	225	213	205	195

Mitsubishi	210	137	151	134	203	195	183	176
Nissan	227	192	187	214	216	205	191	190
Porsche	273	269	302	147	215	224	194	198
Subaru	245	248	237	236	210	199	189	180
Tesla ¹⁵	-5	-16	-22	-23	254	226	211	202
Toyota	205	192	183	156	212	201	192	183
Volkswagen	224	233	198	173	211	201	190	183
Volvo	252	241	248	218	242	245	222	212
Fleet Average	220	205	193	178	216	205	194	185

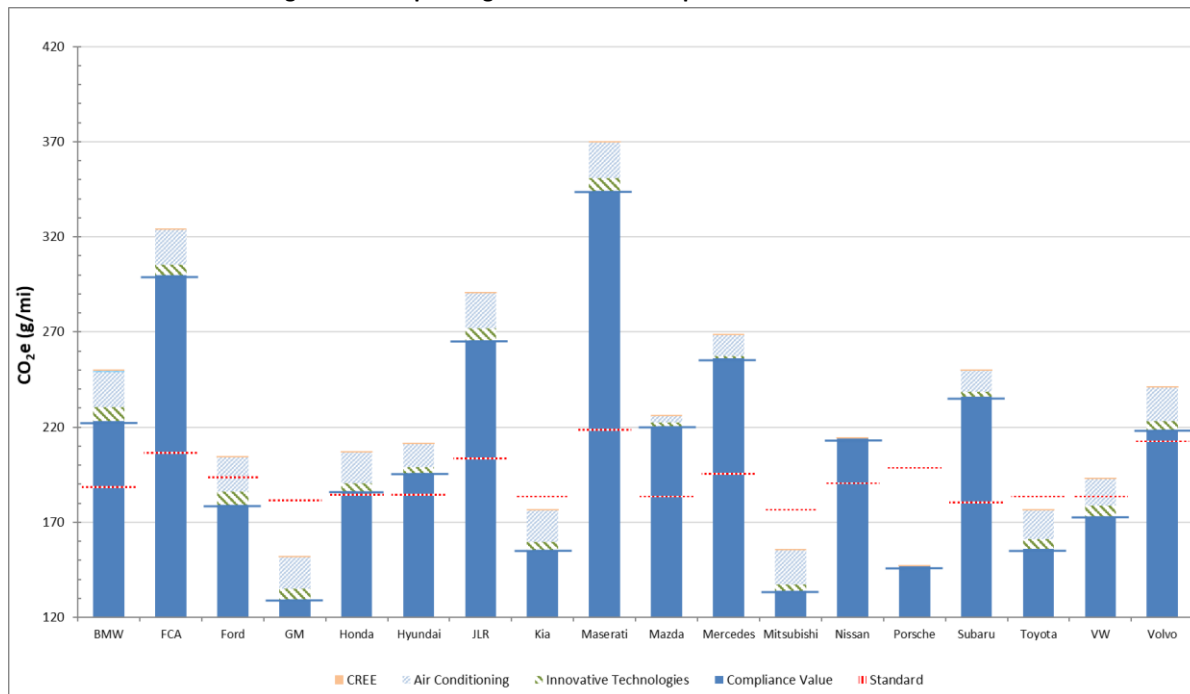
Table 16. LT compliance and standard values over the 2017 to 2020 model years (g/mi)

Manufacturer	2017 Compliance	2018 Compliance	2019 Compliance	2020 Compliance	2017 Std.	2018 Std.	2019 Std.	2020 Std.
BMW	280	269	257	258	283	274	270	262
BYD	--	--	--	--	--	--	--	--
FCA	345	328	335	325	312	295	301	290
Ford	317	311	303	285	308	310	303	296
GM	333	317	316	304	320	310	298	293
Honda	240	225	232	223	274	261	258	245
Hyundai	327	324	330	308	278	266	258	269
JLR	306	279	267	278	286	286	278	267
Kia	305	304	290	282	277	267	263	253
Maserati	--	--	393	372	--	--	278	269
Mazda	266	250	256	247	267	256	249	238
Mercedes	313	298	304	290	287	274	263	263
Mitsubishi	262	247	243	233	253	242	234	226
Nissan	278	277	271	265	282	273	261	245
Porsche	296	293	294	320	285	284	277	266
Subaru	237	228	220	205	257	245	241	235
Tesla ¹⁵	--	-21	-27	-31	--	292	284	275
Toyota	295	295	264	261	286	273	265	261
Volkswagen	301	263	258	270	273	269	264	246
Volvo	249	243	250	236	288	291	274	263
Fleet Average	309	294	290	278	298	288	282	272

Figures 4 and 5 provide a graphical representation of the role that compliance flexibilities play in arriving at a company's overall compliance status for their 2020 model year passenger automobile and light truck fleets. The orange line on the top of the bar indicates a company's fleet average CREE. The wide red line represents the fleet average standard and the wide dark blue line represents the fleet average compliance value (accounting for compliance flexibilities). The bars show the extent to which companies incorporate the previously described compliance flexibilities into their products to achieve their fleet average compliance value. Figures showing this information for prior model years are located in the appendix.

¹⁵ Tesla only produces electric vehicles, and is able to use the 0 g/mi incentive for its entire fleet. The compliance value is negative once its AC allowances have been factored in.

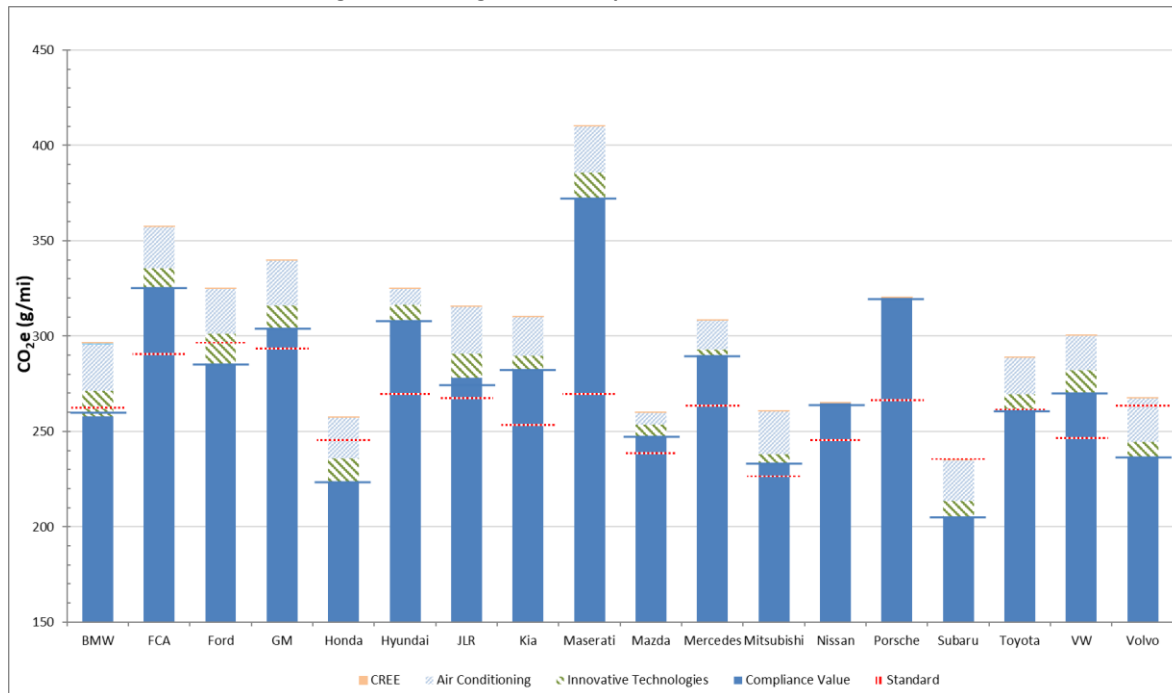
Figure 4. 2020 passenger automobile compliance status with offsets



Notes:

1. The final compliance value may be lower than the CREE through the application of compliance flexibilities
2. Tesla has a fleet average standard of 202 g/mi and fleet average compliance value of -23 g/mi. Tesla's compliance value falls outside of the range of this graph.
3. BYD has a fleet average standard of 194 g/mi and fleet average compliance value of 0 g/mi. BYD's compliance value falls outside of the range of this graph.

Figure 5. 2020 light truck compliance status with offsets



Notes:

1. The final compliance value may be lower than the CREE through the application of compliance flexibilities
2. Tesla has a fleet average standard of 275 g/mi and fleet average compliance value of -31 g/mi. Tesla's compliance value falls outside of the range of this graph.

2.6. Technological advancements and penetration rates

As fleet average emission standards have become more stringent, automobile manufacturers have developed a variety of technologies to reduce their CO₂e emissions. Some of these technologies seek to reduce or eliminate the use of conventional fuels by introducing electrical powertrain components (BEVs, PHEVs etc.). There also exists a wide range of technologies used by companies to improve the efficiency of transmissions and conventional engines and reduce emissions. Some examples include turbocharged engines, cylinder deactivation, and continuously variable transmissions.

This section, while not an exhaustive list, describes some of the commonly used technology types, along with their corresponding penetration rates in the Canadian new vehicle fleet in given model years.

Turbocharging

Turbochargers improve the power and efficiency of an internal combustion engine by extracting some of the waste heat energy otherwise lost through the exhaust pipe. These exhaust gases are used to drive a turbine that is connected to a compressor which provides greater amounts of air into the combustion chamber (forced induction). This results in greater power than a naturally aspirated engine of similar displacement, and greater efficiency than a naturally aspirated engine of the same power and torque. This permits the use of smaller displacement, lighter engines that can produce the same power as larger, heavier engines without turbocharging. For this reason, it is becoming increasingly common to see turbochargers incorporated into vehicles with smaller engines in order to decrease the overall vehicle weight and improve fuel efficiency by as much as 8%.

Variable valve timing & lift

Engine intake and exhaust valves are responsible for letting air into the cylinders and exhaust gases out. This is an important function since optimal engine performance requires precise “breathing” of the engine. In most conventional engines, the timing and lift of the valves is fixed, and not optimized across all engine speeds. Variable valve timing (VVT) and variable valve lift (VVL) systems adjust the timing, duration and amount that the intake and exhaust valves open based on the engine speed. This optimization of the engines ‘breathing’ improves engine efficiency resulting in reduced fuel consumption and emissions. Variable valve timing and lift technologies can result in efficiency improvements of 3-4%.

Higher geared transmissions (>6 speeds)

Fuel efficiency, and by extension, CO₂e emissions coming from a vehicle are dependent on the efficient operation of all of the elements that make up a vehicle. An engine that is operating at speeds outside its most efficient range will result in increased fuel consumption and CO₂e emissions. Transmissions with more gear ratios (or speeds), allows the engine to operate at a more efficient speed more frequently. It is becoming increasingly common for vehicles to be equipped with transmissions that have more than 6 gears to keep the engine running at its most efficient operating point and thereby reduce CO₂e emissions.

Continuously variable transmissions

Continuously variable transmissions (CVT) are transmissions that, unlike conventional transmission configurations, do not have a fixed number of gears. Because CVT's do not have a discrete number of

shift points, they can operate variably across an infinite number of driving situations to provide the optimal speed ratio between the engine and the wheels. This ensures that the engine is able to operate as efficiently as possible and consume only as much fuel as is required, thereby lowering CO₂e emissions. Typically CVT's can improve fuel efficiency by as much as 4%.

Cylinder deactivation system

Cylinder deactivation systems (CDS) shut off cylinders of a 6 or 8 cylinder engine when only partial power is required (for example, travelling at constant speed, decelerating etc.). The CDS works by deactivating the intake and exhaust valves for a particular set of cylinders in the engine. A CDS can reduce CO₂e emissions by improving the overall fuel consumption of the vehicle by 4 to 10%¹⁶.

Gasoline direct injection

A proper air-fuel mixture is critical to the performance of any conventional internal combustion engine and has direct impacts on the resulting emissions. Over the past several decades, the most common mechanism for preparing the air-fuel mixture has been “port fuel injection”. In port fuel injection systems, the air and fuel are mixed in the intake manifold and are subsequently drawn into the combustion chamber. By contrast, gasoline direct injection (GDI) systems spray fuel directly into the combustion chamber resulting in a slightly cooler air-fuel mixture allowing for higher compression ratios and improved fuel consumption. GDI systems are also better at precisely timing and metering the fuel delivered to the cylinder, which results in more efficient combustion.

Diesel

Diesel engines provide greater low-end torque and fuel efficiency than a comparably sized gasoline engine. Diesel fuel contains more energy per unit volume than an equivalent amount of gasoline. As a result diesel vehicles can travel, on average, 20 – 35% further per litre of fuel than a gasoline based equivalent¹⁷ which translates into measurable reductions in CO₂e emissions.

The fleet-wide penetration rates of the above described technologies have been provided in Table 17, while data pertaining to company specific usage can be found in Appendices A-3 to A-10.

Table 17. penetration rates of drivetrain technologies in the Canadian fleet

Technology	2017	2018	2019	2020
Turbocharging	27.7%	33.8%	33.2%	32.7%
VVT	96.5%	94.7%	95.4%	94.2%
VVL	16.5%	17.9%	18.2%	18.0%
Higher Geared Transmission	26.9%	39.4%	54.9%	57.4%
CVT	19.9%	20.9%	21.0%	28.4%
Cylinder Deactivation	14.2%	12.5%	16.3%	13.7%
GDI	38.0%	45.6%	42.0%	48.0%
Diesel	0.6%	1.2%	0.5%	0.7%

¹⁶ [Natural Resources Canada](#)

¹⁷ [US EPA website](#)

3. Emission credits

The regulations include a system of emission credits to help meet overall environmental objectives in a manner that provides the regulated industry with compliance flexibility. A company must calculate emission credits and deficits in units of megagrams (Mg) of CO₂e for each of its passenger automobile and light truck fleets of a given model year. Credits are weighted based on VKT to account for the greater number of kilometres travelled by light trucks over their lifetime than by passenger automobiles. Using the mathematical formula below, a company will generate credits in a given model year if the result of the calculation is positive or better than the GHG emission standard. If the result of the calculation is negative or below the applicable standard, the company will incur a deficit. A company that incurs an emissions deficit must offset it with an equivalent number of emission credits from past model years or within the subsequent 3 model years.

The total credit balance is determined according to the following formula¹⁸:

$$\text{Credits} = \frac{(A - B) \times C \times D}{1\,000\,000}$$

Where

A is the fleet average standard for passenger automobiles or light trucks;

B is the fleet average compliance value for passenger automobiles or light trucks;

C is the total number of passenger automobiles or light trucks in the fleet; and

D is the total assumed mileage of the vehicles in question, namely,

(a) 195 264 miles for a fleet of passenger automobiles, or

(b) 225 865 miles for a fleet of light trucks.

The credits represent the emission reductions that manufacturers have achieved in excess of those required by the regulations. The ability to accumulate credits allows manufacturers to plan and implement an orderly phase-in of emissions control technology through product cycle planning to meet future, more stringent emission standards.

The regulations initially established that credits could be banked to offset a future deficit for up to 5 model years after the year in which the credits were obtained (the credits had a 5-year lifespan). The regulations were amended to extend the lifespan of credits earned during the 2010 to 2016 model years to 2021. Emission credits that can be used to offset a deficit incurred in the 2022 and later model years can only be generated beginning with the 2017 model year and have a 5-year lifespan.

3.1. Credit transfers

Table 18 summarizes transactions by company and the model year in which the credits were generated. There have been more than 15 million credits transferred between companies for either immediate use

¹⁸ In October 2021, the Department published an [Interim Order](#) to correct the multiplier formula used to determine carbon dioxide (CO₂) equivalent emission credits for advanced technology vehicles.

to offset a deficit or in anticipation of a possible future deficit, including those purchased from the Receiver General. It should be noted that the model year is not necessarily indicative of when a credit transfer occurred. For example, it is possible to transfer credits for the 2012 model year during the 2017 calendar year. As well, the total quantity transferred in or out from a company for a given model year may be the result of multiple transactions.

Table 18. credit transactions (transferred out) by model year (Mg CO₂e)

Manufacturer	Early Action	2011 to 2016	2017	2018	2019	2020	Total
FCA	0	11 974	--	--	--	--	11 974
Honda	2 138 563	3 069 910	--	--	--	--	5 208 473
Mitsubishi	63 349	--	--	--	--	--	63 349
Nissan	822 292	402 728	--	--	--	--	1 225 020
Suzuki	123 345	30 431	--	--	--	--	153 776
Tesla	2 292	352 079	176 147	433 130	615 273	1 748 770	3 327 691
Toyota	2 623 142	2 680 598	--	--	--	--	5 303 740
Receiver General	--	6 906	--	--	--	--	6 906

Table 18. credit transactions (transferred in) by model year (Mg CO₂e)

Manufacturer	Early Action	2011 to 2016	2017	2018	2019	2020	Total
Aston Martin	--	2 626	--	--	--	--	2 626
BMW	--	1 000 000	--	--	--	--	1 000 000
FCA	4 775 129	3 333 018	176 147	433 130	465 273	1 648 770	10 831 467
Ferrari	8 473	--	--	--	--	--	8 473
Ford	342 272	257 728	--	--	--	--	600 000
JLR	143 369	--	--	--	--	--	143 369
Lotus	--	139	--	--	--	--	139
Mercedes	--	1 745 000	--	--	--	--	1 745 000
Maserati	3 740	11 974	--	--	--	--	15 714
Porsche	--	4 141	--	--	150 000	100 000	254 141
Subaru	--	300 000	--	--	--	--	300 000
Volkswagen	500 000	--	--	--	--	--	500 000

3.2. Total credits generated and final status

Table 19 shows the credits earned (or deficits incurred) by all companies over the 2020 model year. This table also shows the total number of credits remaining in each company's bank, taking into account the credits that have expired, been transferred, or used to offset a deficit.

Since the regulations came into force, companies have generated approximately 93.1 million emission credits (including early action credits and TOF credits), of which approximately 27.4 million credits remain for future use. A total of 27.9 million credits have been used to offset deficits and 37.8 million credits have expired.

Table 19. net credits by model year and current credit balance (Mg CO₂e)

Manufacturers	Generated Credit/Deficit in 2020	Current Balance ¹⁹
BMW	-111 239	651 582
BYD	2121	2121
FCA	-1 138 386	4 353 184
Ford	464 898	1 415 360
GM	-37 430	3 322 554
Honda	337 831	5 504 364
Hyundai	-336 026	1 594 791
JLR	-42 691	--
Kia	77 346	307 449
Maserati	-6 332	--
Mazda	-183 370	2 869 902
Mercedes	-321 720	262 208
Mitsubishi	30 695	784 583
Nissan	-464 865	633 100
Porsche	-8 708	84 423
Subaru	121 948	990 440
Tesla	1 880 526	1 968 642
Toyota	559 334	2 205 754
Volkswagen	-129 343	648 206
Volvo	61 183	282 957
Total	755 772	27 449 553

4. Overall industry performance

The overall fleet average compliance information for passenger automobiles and light trucks is summarized in Tables 20 and 21. Additionally, Figures 6 and 7 illustrate the year over year performance for both passenger automobile and for light truck fleets. These trend lines depict the average standard applicable to the overall fleet (dotted line) and the compliance value (solid line) for each fleet.

Because each manufacturer's fleet is unique, the data presented in the tables and graphs are based on the sales weighted values for all companies, and are intended to depict the average results.

Table 20. passenger automobile compliance summary for the 2011 to 2020 model years (g/mi)

Model Year	CREE	Innovative Technologies	AC Refrigerant Leakage Reduction	AC Efficiency Improvements	Compliance value	Standard	Compliance margin
2011	258	0.2	2.0	1.3	255	291	36
2012	247	0.5	2.9	2.0	242	263	21
2013	244	0.4	3.0	2.4	238	256	18
2014	241	1.5	3.5	2.6	233	248	15
2015	238	1.8	4.0	2.9	230	238	8
2016	238	2.0	4.7	3.4	228	227	-1
2017	232	3.0	6.0	3.5	220	216	-4
2018	221	3.3	8.4	3.7	205	205	0
2019	211	3.1	10.3	3.9	193	194	1
2020	195	4.1	9.7	3.4	178	185	7

¹⁹ The current balance accounts for any expired credits, remaining early action credits, transactions, and offsets.

Figure 6. average GHG emissions performance - passenger automobiles

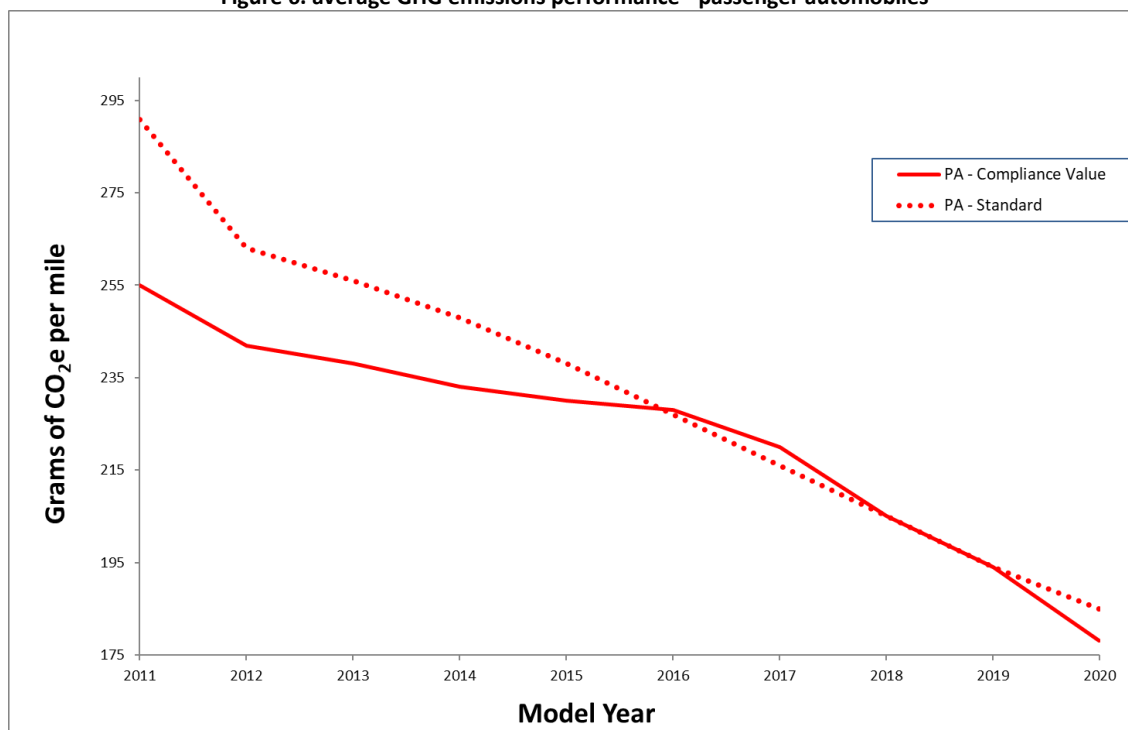
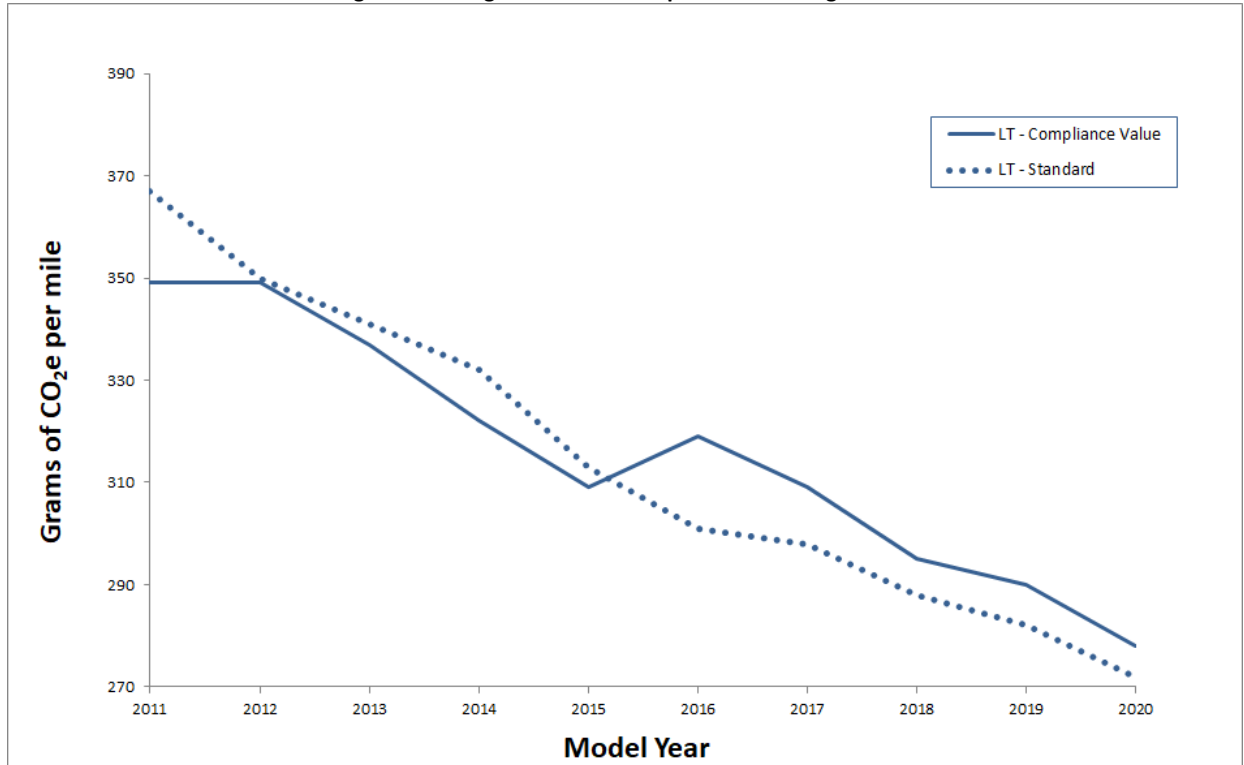


Table 21. light truck compliance summary for the 2011 to 2020 model years (g/mi)

Model Year	CREE	Innovative Technologies	AC Refrigerant Leakage Reduction	AC Efficiency Improvements	Compliance value	Standard	Compliance margin
2011	356	0.7	5.5	1.3	349	367	18
2012	357	1.2	5.8	1.5	349	350	1
2013	347	1.3	6.2	2.2	337	341	4
2014	337	4.3	6.8	3.1	322	332	10
2015	326	5.2	7.6	3.6	309	313	4
2016	337	5.9	8.5	3.7	319	301	-18
2017	334	7.5	12.0	5.7	309	298	-11
2018	323	8.5	13.3	6.1	295	288	-7
2019	320	9.7	14.2	6.0	290	282	-8
2020	309	10.7	14.3	5.8	278	272	-6

Figure 7. average GHG emissions performance - light trucks



As depicted in Figures 6 and 7, the 2020 model year saw the overall compliance value for passenger automobiles decrease to 178 g/mi, and the overall compliance value for light trucks decrease to 278 g/mi. This has resulted in an overall net improvement of 30.2% and 20.3% relative to the 2011 model year for passenger automobiles and light trucks respectively.

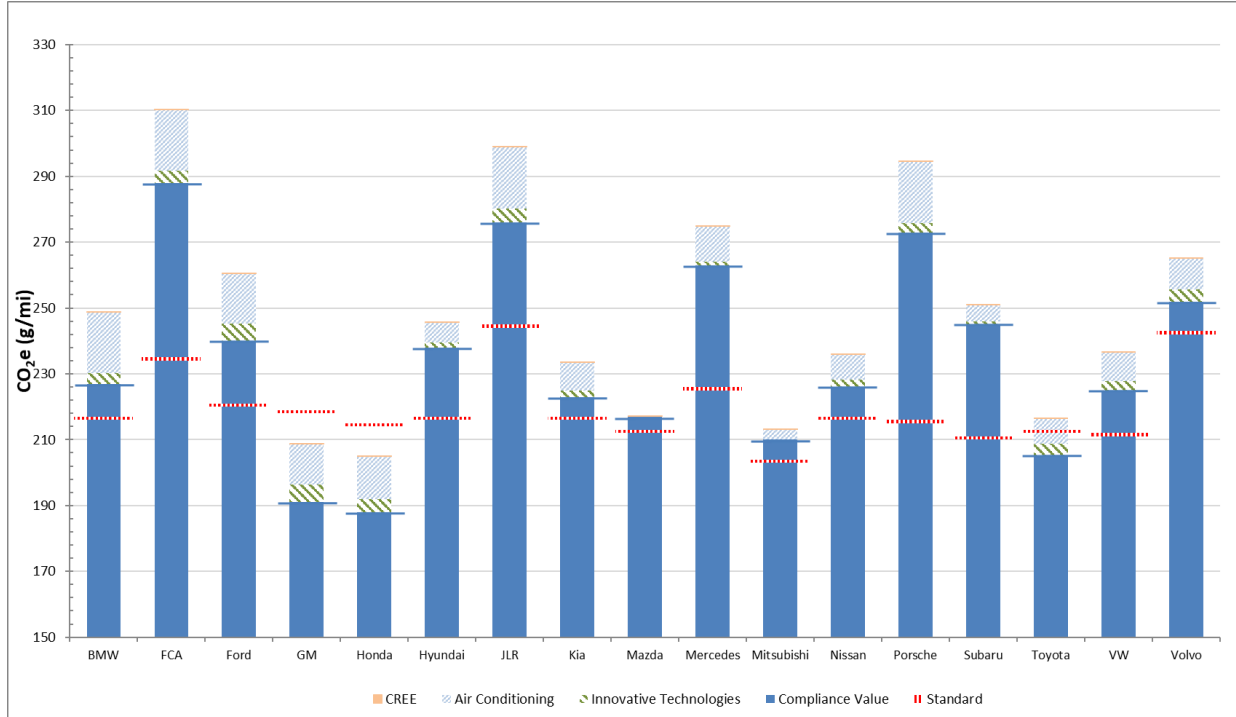
All companies remained in compliance with the regulations through the use of their own accumulated emission credits or by purchasing credits from other companies. Results to date indicate that all companies continue to meet their vehicle GHG regulatory obligations for the 2020 model year.

Appendix

Table A-1. production volumes by company

Manufacturer	2017 PA	2017 LT	2017 All	2018 PA	2018 LT	2018 All	2019 PA	2019 LT	2019 All	2020 PA	2020 LT	2020 All
Aston Martin	82	0	82	44	0	44	148	0	148	741	0	741
BMW	25 882	17 059	42 941	34 831	17 207	52 038	23 245	18 585	41 830	18 188	13 506	31 694
BYD	--	--	--	--	--	--	--	--	--	25	0	25
FCA	20 591	242 874	263 465	15 144	170 242	185 386	11 522	221 797	233 319	2 936	137 799	140 735
Ferrari	275	0	275	247	0	247	364	0	364	370	0	370
Ford	72 230	205 393	277 623	41 855	233 897	275 752	27 203	200 523	227 726	15 349	172 413	187 762
GM	96 569	173 949	270 518	81 077	188 187	269 264	60 593	186 381	246 974	24 622	128 565	153 187
Honda	112 783	81 780	194 563	110 320	81 930	192 250	102 062	102 252	204 314	80 531	73 611	154 142
Hyundai	161 646	11 171	172 817	117 473	6 050	123 523	111 853	3 900	115 753	122 929	8 298	131 227
JLR	2 345	11 870	14 215	1 654	11 646	13 300	567	11 678	12 245	423	14 985	15 408
Kia	42 768	25 637	68 405	55 202	22 719	77 921	42 547	28 680	71 227	47 977	33 467	81 444
Lotus	13	0	13	12	0	12	0	0	0	15	0	15
Maserati	--	--	0	--	--	0	172	291	463	77	191	268
Mazda	35 910	23 202	59 112	55 953	26 762	82 715	39 613	30 779	70 392	18 368	21 827	40 195
McLaren	112	0	112	220	0	220	195	0	195	157	0	157
Mercedes	22 371	22 371	44 742	25 562	29 596	55 158	17 214	19 918	37 132	13 543	26 523	40 066
Mitsubishi	13 686	11 301	24 987	9 004	15 434	24 438	5 158	13 252	18 410	4 151	14 435	18 586
Nissan	87 293	62 006	149 299	82 124	57 229	139 353	88 662	52 623	141 285	56 966	43 810	100 776
Pagani	0	0	0	0	0	0	0	0	0	0	0	0
Porsche	2 357	6 829	9 186	3 589	7 837	11 426	2 130	5 723	7 853	2 944	4 856	7 800
Subaru	17 744	33 502	51 246	16 574	42 019	58 593	16 350	49 803	66 153	12 845	38 408	51 253
Tesla	3 483	--	3 483	8 511	450	8 961	13 101	263	13 364	18 483	328	18 811
Toyota	107 989	121 998	229 987	112 328	121 236	233 564	90 548	113 360	203 908	99 295	118 030	217 325
Volkswagen	72 212	26 667	98 879	61 658	68 060	129 718	78 118	50 314	128 432	22 059	32 233	54 292
Volvo	1 331	5 008	6 339	1 256	6 691	7 947	1 762	10 116	11 878	953	9 061	10 014
Fleet Total	899 672	1 082 617	1 982 289	834 638	1 107 192	1 941 830	733 127	1 120 238	1 853 365	563 947	892 346	1 456 293

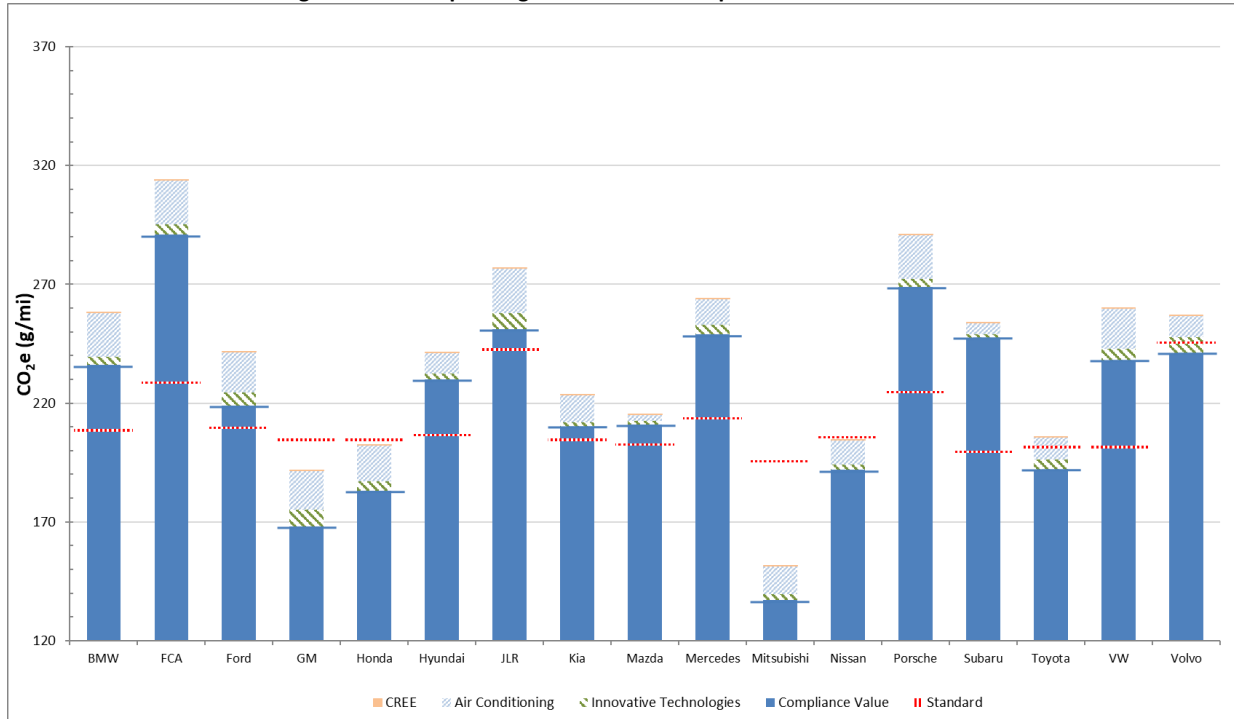
Figure A-1. 2017 passenger automobile compliance status with offsets



Notes:

1. The final compliance value may be lower than the CREE through the application of compliance flexibilities
2. Tesla has a fleet average standard of 254 g/mi and fleet average compliance value of -5 g/mi. Tesla's compliance value falls outside of the range of this graph

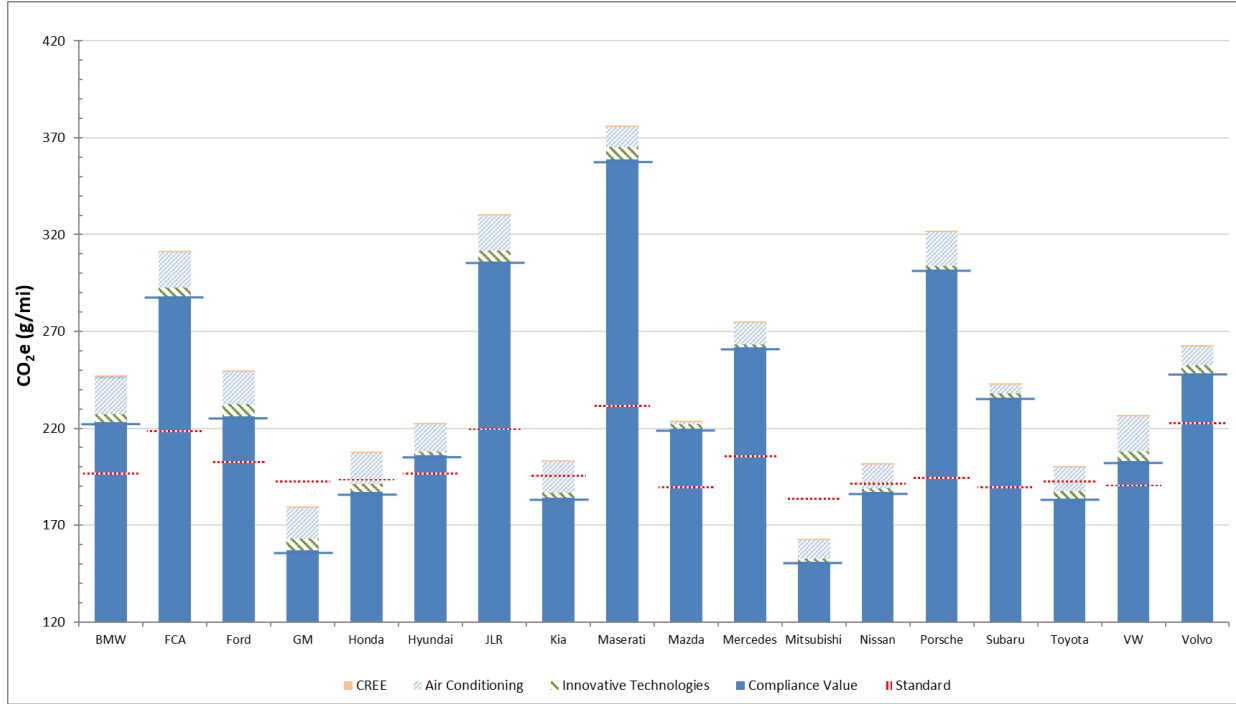
Figure A-2. 2018 passenger automobile compliance status with offsets



Notes:

1. The final compliance value may be lower than the CREE through the application of compliance flexibilities
2. Tesla has a fleet average standard of 226 g/mi and fleet average compliance value of -16 g/mi. Tesla's compliance value falls outside of the range of this graph.

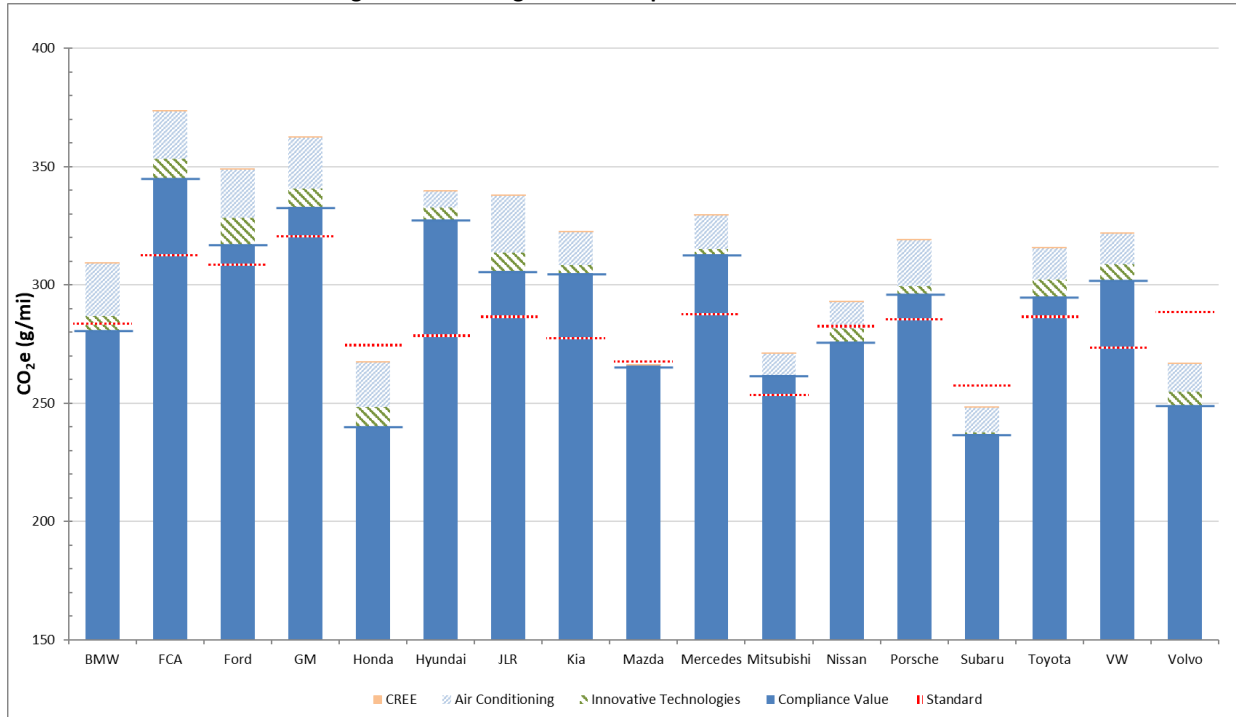
Figure A-3. 2019 passenger automobile compliance status with offsets



Notes:

1. The final compliance value may be lower than the CREE through the application of compliance flexibilities
2. Tesla has a fleet average standard of 211 g/mi and fleet average compliance value of -22 g/mi. Tesla's compliance value falls outside of the range of this graph.

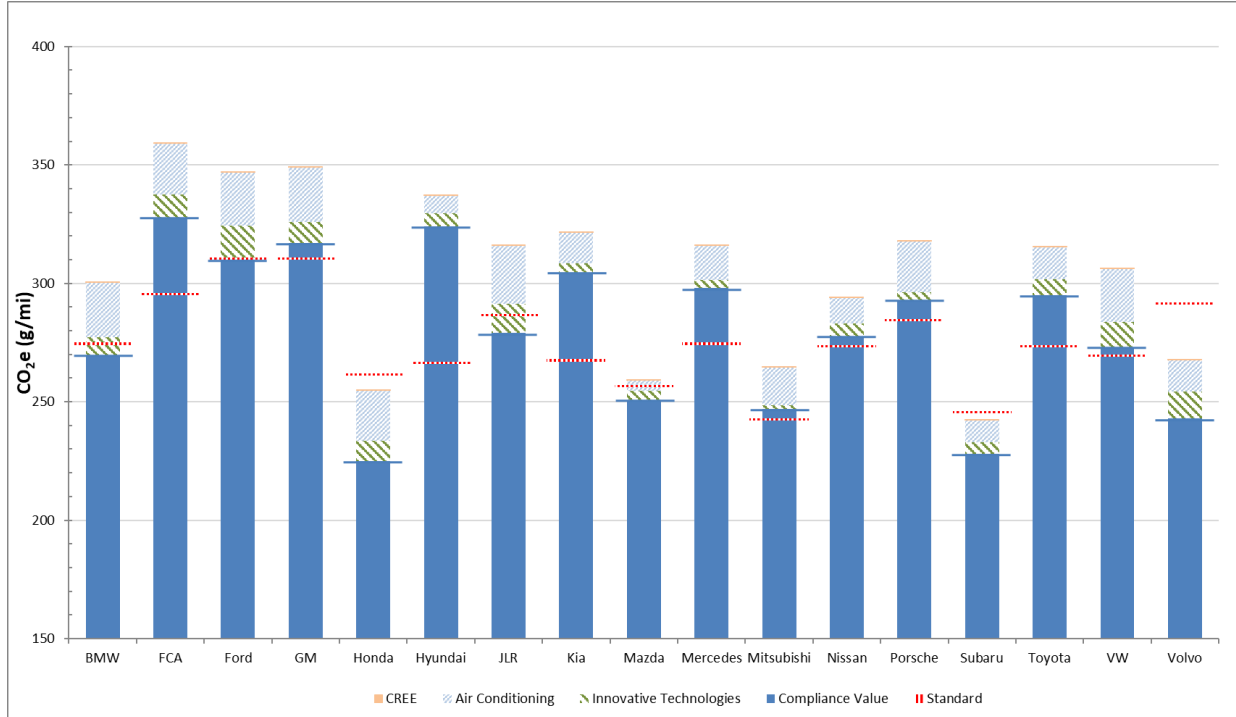
Figure A-4. 2017 light truck compliance status with offsets



Notes:

1. The final compliance value may be lower than the CREE through the application of compliance flexibilities

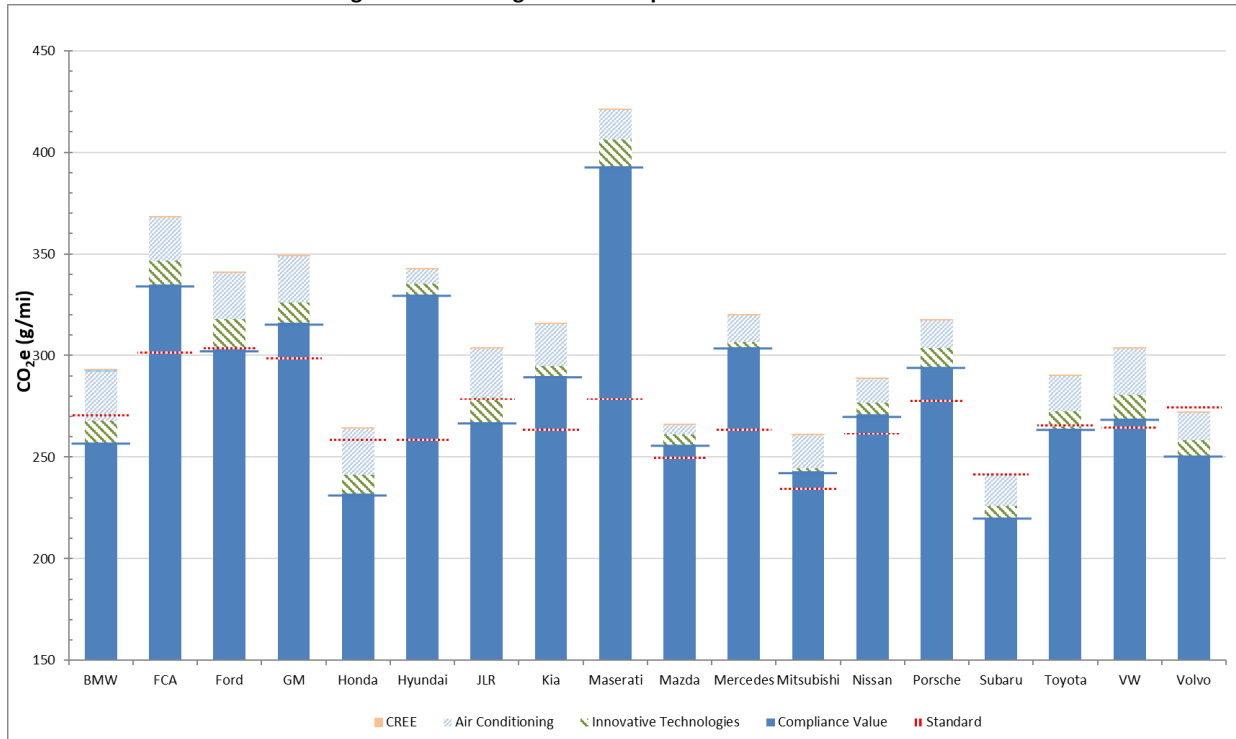
Figure A-5. 2018 light truck compliance status with offsets



Notes:

1. The final compliance value may be lower than the CREE through the application of compliance flexibilities
2. Tesla has a fleet average standard of 292 g/mi and fleet average compliance value of -21 g/mi. Tesla's compliance value falls outside of the range of this graph.

Figure A-6. 2019 light truck compliance status with offsets



Notes:

1. The final compliance value may be lower than the CREE through the application of compliance flexibilities
2. Tesla has a fleet average standard of 284 g/mi and fleet average compliance value of -27 g/mi. Tesla's compliance value falls outside of the range of this graph.

Table A-2. preapproved menu of efficiency improving technologies for AC systems

Technology	Allowance value (g/mi)
Reduced reheat, with externally-controlled, variable-displacement compressor (for example, a compressor that controls displacement based on temperature set point and/or cooling demand of the air conditioning system control settings inside the passenger compartment).	1.7
Reduced reheat, with externally-controlled, fixed-displacement or pneumatic variable displacement compressor (for example, a compressor that controls displacement based on conditions within, or internal to, the air conditioning system, such as head pressure, suction pressure, or evaporator outlet temperature).	1.1
Default to recirculated air with closed-loop control of the air supply (sensor feedback to control interior air quality) whenever the ambient temperature is 75 °F or higher: Air conditioning systems that operated with closed-loop control of the air supply at different temperatures may receive credits by submitting an engineering analysis to the Administrator for approval.	1.7
Default to recirculated air with open-loop control air supply (no sensor feedback) whenever the ambient temperature is 75 °F or higher. Air conditioning systems that operate with open-loop control of the air supply at different temperatures may receive credits by submitting an engineering analysis to the Administrator for approval.	1.1
Blower motor controls which limit wasted electrical energy (for example, pulse width modulated power controller).	0.9
Internal heat exchanger (for example, a device that transfers heat from the high-pressure, liquid-phase refrigerant entering the evaporator to the low-pressure, gas-phase refrigerant exiting the evaporator).	1.1
Improved condensers and/or evaporators with system analysis on the component(s) indicating a coefficient of performance improvement for the system of greater than 10% when compared to previous industry standard designs).	1.1
Oil separator. The manufacturer must submit an engineering analysis demonstrating the increased improvement of the system relative to the baseline design, where the baseline component for comparison is the version which a manufacturer most recently had in production on the same vehicle design or in a similar or related vehicle model. The characteristics of the baseline component shall be compared to the new component to demonstrate the improvement.	0.6

Table A-3. production volume of vehicles with turbocharging

Manufacturer	2017	2018	2019	2020
BMW	42 508	51 729	41 633	31 481
BYD	--	--	--	0
FCA	6 412	13 340	10 693	14 687
Ford	164 219	164 992	161 201	132 368
GM	62 935	102 272	82 820	56 807
Honda	72 053	92 935	92 538	76 355
Hyundai	18 680	15 002	17 376	16 152
JLR	6 904	7 665	6 080	12 771
Kia	6 772	6 740	2 301	2 675
Maserati	--	--	452	268
Mazda	3 351	5 943	12 735	5 416
Mercedes	44 636	54 716	36 991	40 066
Mitsubishi	0	3 051	3 848	4 173
Nissan	8 776	4 013	8 486	3 365
Porsche	8 086	102 06	7 401	6 354
Subaru	6 969	7 540	8 696	12 249
Toyota	7 756	4 969	6 884	7 444
Volkswagen	88 174	108 768	111 198	50 140
Volvo	2 299	2 088	3 192	3 549
Total	550 530	655 969	614 525	476 320

Table A-4. production volume of vehicles with variable valve timing

Manufacturer	2017	2018	2019	2020
BMW	40 874	49 292	41 633	31 481
BYD	--	--	--	0
FCA	256 770	174 949	222 283	135 261
Ford	236 387	216 872	191 796	159 409
GM	265 518	262 223	238 873	142 300
Honda	194 563	189 280	204 314	154 142
Hyundai	172 162	123 129	111 169	125 654
JLR	11 321	10 833	9 817	14 287
Kia	67 928	76 957	70 041	77 767
Maserati	--	--	463	268
Mazda	59 112	82 715	70 208	40 195
Mercedes	44 636	54 716	36 991	40 066
Mitsubishi	21 579	24 438	18 410	18 586
Nissan	148 415	134 913	136 945	98 928
Porsche	9 186	11 426	7 853	6 761
Subaru	51 246	58 593	66 153	51 253
Toyota	229 987	233 514	203 712	217 303
Volkswagen	98 759	128 910	126 490	49 087
Volvo	6 339	7 947	11 878	10 014
Total	1 914 782	1 840 707	1 769 029	1 372 762

Table A-5. production volume of vehicles with variable valve lift

Manufacturer	2017	2018	2019	2020
BMW	40 250	49 292	41 633	31 481
FCA	3 390	20 691	12 547	8 156
GM	5 318	3 940	62	4 933
Honda	194 563	132 525	131 803	95 409
JLR	11 321	10 833	9 817	14 287
Mercedes	0	0	9 587	18 149
Mitsubishi	6 600	6 425	4 862	5 545
Nissan	12 249	8 325	4 394	1 903

Porsche	9 186	11 426	7 853	6 761
Toyota	6 012	13 514	9 804	39 288
Volkswagen	39 030	91 365	105 248	36 835
Total	327 919	348 336	337 610	262 747

Table A-6. production volume of vehicles with higher geared transmissions

Manufacturer	2017	2018	2019	2020
BMW	36 967	48 365	36 184	30 975
FCA	140 612	124 854	184 880	116 342
Ford	32 228	142 121	153 389	165 213
GM	57 092	79 811	124 530	101 414
Honda	38 550	45 711	77 951	60 188
Hyundai	8 284	8 757	25 507	33 571
JLR	14 192	13 294	11 873	15 269
Kia	1 162	2 440	20 537	21 058
Maserati	--	--	452	268
Mercedes	44 346	54 716	36 991	40 066
Mitsubishi	0	3 051	3 848	4 173
Nissan	43 356	30 409	47 354	30 762
Porsche	9 030	10 935	7 607	6 317
Subaru	10 924	33 738	56 211	45 076
Toyota	63 640	68 806	115 112	106 374
Volkswagen	28 174	90 782	104 054	49 028
Volvo	6 339	7 947	11 878	10 014
Total	534 896	765 737	1 018 358	836 108

Table A-7. production volume of vehicles with continuously variable transmissions

Manufacturer	2017	2018	2019	2020
FCA	178	0	600	1 026
Ford	3 173	2 860	5 390	11 772
GM	12 217	10 944	22 050	12 178
Honda	131 295	141 280	137 294	109 601
Hyundai	0	0	0	46 969
Kia	0	0	12 300	31 660
Mitsubishi	19 002	15 846	14 497	14 333
Nissan	114 907	112 790	114 857	95 193
Subaru	43 218	49 919	59 598	45 489
Toyota	71 042	73 312	23 416	45 664
Total	395 032	406 951	390 002	413 885

Table A-8. production volume of vehicles with cylinder deactivation

Manufacturer	2017	2018	2019	2020
FCA	98 158	48 374	96 115	52 737
Ford	0	0	0	16 696
GM	137 599	137 688	131 428	83 485
Honda	44 490	33 245	42 749	23 086
Mazda	0	23 102	28 751	20 472
Mercedes	0	0	2 142	1 817
Volkswagen	1 682	1 044	569	778
Total	281 929	243 453	301 754	199 071

Table A-9. production volume of vehicles with gasoline direct injection

Manufacturer	2017	2018	2019	2020
BMW	40 874	49 292	41 633	31 481

FCA	886	3257	7 744	11 126
Ford	0	102 948	22 051	77 783
GM	244 125	240 931	211 556	129 927
Honda	120 523	125 220	142 381	103 952
Hyundai	113 544	73 000	74 035	58 513
JLR	11 321	10 833	9 817	14 287
Kia	59 381	65 121	56 952	44 780
Maserati	--	--	452	268
Mazda	56 102	82 715	70 208	40 195
Mercedes	44 636	54 687	36 966	40 059
Nissan	41 163	41 087	40 129	32 920
Subaru	14 903	29 505	52 667	49 459
Toyota	676	434	317	2 655
Volkswagen	0	0	0	52 340
Volvo	6 339	7 947	11 878	10 014
Total	754 473	886 977	778 786	699 759

Table A-10. production volume of diesel vehicles

Manufacturer	2017	2018	2019	2020
BMW	1 643	2 437	0	0
FCA	4 174	9 880	2 661	3 489
Ford	0	3 030	1 913	265
GM	2 867	5 567	2 656	5 651
JLR	2 894	2 467	2 063	982
Mazda	0	0	184	0
Total	11 578	23 381	9 477	10 387