EPA Decision Document: Mercedes-Benz Off-cycle Credits for MYs 2012-2016

United States
Environmental Protection
Agency

EPA Decision Document: Mercedes-Benz Off-cycle Credits for MYs 2012-2016

Compliance Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

United States Environmental Protection Agency

EPA-420-R-14-025
September 2014

EPA Decision Document: Mercedes-Benz Off-cycle Credits for MYs 2012-2016

I. Introduction

EPA's light-duty vehicle greenhouse gas (GHG) rules include an opportunity for manufacturers to generate CO_2 credits for technologies that provide CO_2 reductions not captured by the 2-cycle emissions test. Pursuant to those rules, Mercedes-Benz (Mercedes) submitted an application requesting off-cycle credits for model years (MYs) 2012-2016 for four technologies: engine stop-start, high efficiency exterior lighting, infrared glazing, and active seat ventilation. EPA published a notice in the *Federal Register* on October 1, 2013 announcing a 30 day public comment period for the Mercedes application.[1] EPA received several comments focusing mostly on credits requested by Mercedes for the engine stop-start technology.

EPA is approving the credit methodology for Mercedes high efficiency exterior lighting, infrared glazing, and active seat ventilation consistent with Mercedes' initial application. For the Mercedes engine stop-start technology, EPA is approving a methodology based on conservative inputs that will result in a significantly reduced level of credits compared to the level originally requested by Mercedes. The Agency has taken this approach because the stop-start demonstration is based on only a relatively small set of actual driving data. Where there is increased uncertainty regarding in-use performance due to a limited dataset, EPA believes it is appropriate to take steps to ensure that it can conclude with high confidence that the credits awarded through an off-cycle demonstration will be met or exceeded by the actual in-use performance. The conservative inputs applied in this final decision give us high confidence that the in-use performance will be at least as good as implied by the credits being awarded.

Section II of this document provides background on EPA's off-cycle credits program and the Mercedes credits application. Section III provides EPA's decision including a summary and analysis of comments on the Mercedes engine stop-start system credits methodology. Section IV covers EPA's decision for high efficiency exterior lighting, infrared glazing, and active seat ventilation. EPA did not receive substantive comments on these technologies. This decision document applies only to the Mercedes application.

[1] 78 FR 60275, October 1, 2013. https://www.federalregister.gov/articles/2013/10/01

II. Background

A. EPA's Off-cycle Credits Program

In the model year (MY) 2012-2016 light-duty vehicle greenhouse gas (GHG) rule, EPA established an option for manufacturers to generate credits by employing technologies that achieve carbon dioxide (CO_2) reductions in the real world but are not captured on the 2-cycle test procedures used to determine compliance with the fleet average standards (i.e., "off-cycle" credits). EPA adopted the off-cycle credit option to encourage the introduction of these types of technologies, believing that demonstrated off-cycle CO_2 reductions should be considered in determining a manufacturer's fleet average, and that a credit mechanism is an effective way to achieve this goal.

The MY 2012-2016 rule provides two ways for manufacturers to demonstrate the off-cycle emissions reduction capabilities of a technology and thereby generate off-cycle credits: either through 5-cycle testing (which captures elements of real-world driving not captured by the 2-cycle compliance tests, including high speeds, rapid accelerations, and cold as well as hot temperature operation), or through an alternative demonstration methodology developed by the manufacturer and approved by EPA.[2] The alternative methodology approach allows manufacturers to demonstrate off-cycle emissions reduction technology using an alternative methodology developed by the manufacturer in cases where the real world benefit of the technology cannot be adequately demonstrated using the 5-cycle test procedures.[3] The regulations regarding the alternative methodology specify the data and information needed to support a manufacturer's off-cycle credit application.[4] The alternative methodology proposed by the manufacturer must be approved by EPA prior to the manufacturer generating credits. Also, as part of the EPA review, the alternative methodology must be made available for public comment.[5]

In the MY 2017-2025 rule, EPA adopted a list of pre-approved off-cycle technologies and credits (also referred to as a "menu" of credits) that manufacturers can use beginning in MY 2014.[6] This option was included in the MY 2017-2025 rule because certain types of off-cycle credits are amenable to quantification without further demonstration, and EPA's specification of these credits therefore significantly streamlines the off-cycle credits program and reduces the testing and data burden that the program otherwise entails. To qualify for credits, manufacturers using the pre-approved list only need to provide EPA at the time of certification information demonstrating that their technology meets applicable definitions; there are no testing or other requirements for demonstrating emissions reductions. Manufacturers may, however, either demonstrate that their technology achieves greater off-cycle emissions reductions than are provided by the pre-defined list, or seek credits for technologies that are not on the list, by using the 5-cycle or alternative methodology pathways.

---

[2] 75 FR 25438-25440, May 7, 2010.
[3] 40 CFR 86.1869-12(d).
[4] 40 CFR 86.1869-12(d) and (e).
[5] 40 CFR 86.1869-12(d)(2).
[6] 40 CFR 86.1869-12(a).

B. Mercedes-Benz Off-cycle Credits Application

Mercedes applied for off-cycle credits for the 2012 through 2016 model year vehicles equipped with the following technologies: engine stop-start, high efficiency exterior lighting, infrared glazing, and active seat ventilation. Mercedes applied for off-cycle credits using the alternative methodology approach since: these technologies cannot be adequately demonstrated over the 5-cycle test; the credits are for vehicles in model years prior to MY 2014; and the credits are in excess of the credits on the pre-approved list. EPA published a notice in the *Federal Register* on October 1, 2013 announcing a 30 day public comment period for the Mercedes application. The *Federal Register* notice provides additional background on EPA's off-cycle program as well as an overview of the Mercedes application. The Mercedes application was placed in docket EPA-HQ-OAR-2013-0643 and also on EPA's web site at http://www.epa.gov/otaq/regs/ld-hwy/greenhouse/ldghg.htm. EPA received eight public comments (see Table 1) on the Mercedes credits application and Mercedes submitted a rebuttal and a supplemental rebuttal to the comments for EPA's consideration.[7] These documents are also available in the docket.

Table 1: Commenters

Alliance of Automobile Manufacturers	Honda
American Council for and Energy-Efficient Economy (ACEEE)	International Council on Clean Transportation (ICCT)
California Air Resources Board (CARB)	Natural Resources Defense Council (NRDC)
Global Automakers	Union of Concerned Scientists (UCS)

EPA has considered the public comments and the Mercedes reply thereto. EPA did not receive adverse comments on the methodologies for high efficiency exterior lighting, infrared glazing, and active seat ventilation technology credits. EPA agrees those methodologies are appropriate (see rationale stated in the October 1, 2013 notice), and is therefore approving the credits methodologies for these technologies consistent with Mercedes' initial request.

On the other hand, many commenters raised concerns that the Mercedes stop-start credits request was not supported by sufficient real-world data to demonstrate the credit levels requested by Mercedes. EPA has considered these comments and is approving a more conservative methodology for determining credits for the Mercedes stop-start system for MYs 2012-2016 that will result in fewer credits than requested. The Mercedes off-cycle credits application, the public comments, Mercedes' rebuttal of the comments, and EPA's decision are discussed in detail below.

[7] The regulations provide an opportunity for manufacturer rebuttal of comments. See §86.1869-12(d)(3)(iii).

III. Mercedes Stop-Start System

A. Overview

Mercedes applied for engine idle stop-start credit covering all of their MY 2012-2016 U.S. model product range (e.g., small/mid-size/large cars and light-duty trucks) (See Section II-III of Mercedes-Benz Application). Mercedes followed a similar methodology to the one EPA described in the Technical Support Document (TSD) for the MY2017-2025 rule, but with unique inputs for idle time and stop-start system effectiveness, which includes parameters related specifically to the Mercedes' control strategy for its stop-start system. [8]

The basic methodology used by Mercedes entailed the following steps: estimate or measure the total idle fraction as a percentage of all vehicle operation in the real-world; estimate or measure the percentage of idle fraction that the stop-start system is enabled out of all the available idle time (i.e., eligible stop-start percentage or stop-start system effectiveness); determine the benefit of the stop-start system in grams per mile based on A-B emissions testing (i.e., technology on and off); and multiply the eligible real world stop-start time (relative to the 2-cycle eligible time) by the stop-start system benefit to estimate the engine idle stop-start credit. The Mercedes system includes a button on the dashboard allowing the driver to disable the stop-start system, and so the frequency of driver disablement also must be considered in determining appropriate credit levels.

Mercedes submitted data to demonstrate a real-world idle time, and an engineering analysis to demonstrate their stop-start system effectiveness (i.e., how often the system would turn off the engine). The Mercedes analysis resulted in requested credit levels of 9.1 to 19.0 g/mile compared to the pre-approved list credit values of 2.5 to 4.4 g/mile. Mercedes provided technical information on system architecture and function but did not submit data on the real-world effectiveness of the system. In addition, Mercedes referenced a future comprehensive study that they felt would support their real-world idle time demonstration and engineering analysis. Commenters raised several concerns regarding the approach used by Mercedes and the lack of real-world, customer vehicle data for estimating real-world effectiveness, discussed in detail below.

In response to comments, Mercedes conducted limited on-road testing under conditions designed to inform a conservative assessment of system effectiveness in the real-world. Mercedes used these test results to derive a level of credits for EPA to consider on an interim basis until Mercedes could conduct a full-scale real-world test program. As discussed in detail below, EPA considered this approach and is approving the calculation methodology on an interim basis (MYs 2012-2016) that includes even more conservative inputs for real-world system effectiveness than suggested by Mercedes based on the limited Mercedes' data. This approach will result in credits well below the levels contained in the original Mercedes request and in the Mercedes rebuttal, as shown in the table below. Therefore, it is possible that system effectiveness as determined from the expected full-scale testing will be higher than

[8] MY2017-2025 Technical Support Document, Chapter 5, Section 5.2.8.1.

the conservative values EPA is approving. Further, it gives us high confidence that the in-use performance for these vehicles in aggregate will not be less than the performance level implied by the credits being awarded here.

Table 2: Off-cycle Credits (g/mile) for Mercedes-Benz Stop-Start System

	Small Car	Mid Car	Large Car	Light Truck
EPA "menu" credits	2.5	2.5	2.5	4.4
Mercedes application	11.0	9.1	19.0	17.1
Mercedes rebuttal	8.72	6.92	8.46	7.56
Approved methodology with conservative inputs*	4.3	3.7	3.7	3.6

* Illustrative based on initial A-B testing. Actual credits will be based on model specific A-B testing

The credits in the table above are based on the emissions A-B test results (with and without the stop-start system active) from just a few representative vehicles presented in the Mercedes application and are illustrative of the relative credit levels. The final credits will be based on emissions from specific vehicle models as measured in A-B testing, and may vary from the credits shown in the table. Accordingly, Mercedes retains the option to use the pre-defined list credits for MY 2014 and later without EPA's additional approval rather than conducting A-B testing and submitting data.

The following is a discussion of the specific parameters used in the calculation to develop the approved off-cycle credits in Table 2. As discussed above, off-cycle credits are meant to provide credits for emissions reductions not captured on the 2-cycle test. For stop-start, the credit is based on how much the engine is estimated to idle in the real-world compared to the 2-cycle test and the fraction of that additional idle time where the engine will turn off. In addition to vehicle A-B test data, the methodology for calculating credits includes three key inputs: 1) real-world idle time, 2) stop-start system effectiveness, and 3) driver system disablement. Each factor is discussed in detail below followed by a discussion of the credits calculation methodology being approved.

EPA is approving the methodology using conservative inputs on an interim basis for MYs 2012-2016. A full demonstration of system effectiveness including driver disablement based on instrumented real-world driving data will be required for MYs 2017 and later, along with other requirements under 40 CFR 86.1869-12(d), for Mercedes to generate credits beyond the pre-approved table values in the MY 2017-2025 regulations. Also, additional retroactive credits may be granted for MYs 2012-2016 if supported by actual, real-world, customer vehicle data. An application for MY 2017 and later (and additional retroactive credits for MY 2012-2016, if appropriate) will be considered by EPA to be a new application by Mercedes and EPA will provide a new opportunity for public comment as part of EPA's review process.

B. Real World Idle Time

In lieu of the EPA default idle time estimate employed for the pre-approved list analysis, Mercedes proposed to apply its own measured, fleet-specific idle time to its vehicles. Mercedes measured idle time in a field study conducted from January 2010 to June 2011 that included 29 instrumented customer vehicles (not equipped with stop-start technology), randomly selected from the Mercedes-Benz customer base. Based on this study, Mercedes estimated that its vehicles have a 23.83% total idle fraction as a percentage of all vehicle operation. To provide further support for its idle fraction estimate, Mercedes acquired independent data from Progressive Insurance. Progressive Insurance provided data to Mercedes from about 1.4 million vehicles in its "Snapshot" Program covering 44 states collected over a six month period in calendar years 2008, when the program was initiated, through 2013. In the Progressive data set, there are 17,484 Mercedes vehicles which are represented in proportion to current industry sales shares. Based on the Progressive data set, Mercedes estimated its vehicles have an idle fraction of 23.9%. This is consistent with the 23.83% idle fraction found in the Mercedes study discussed above and used by Mercedes in its analysis.

In its analysis of stop-start idle time for the MY 2017-2025 rulemaking, EPA used a real world idle fraction of 13.76% derived from the MOVES model. The additional idle time estimated by Mercedes for its vehicles accounted for the large majority of additional credits above the EPA table values originally requested by Mercedes in its application. Several commenters raised concerns regarding allowing a manufacturer to generate credits based on unique driving behavior (such as manufacturer-specific idle times) rather than differences in technology. Commenters were concerned about a proliferation of idle time values across manufacturers and the potential negative impacts of varying credit levels on market competition and fairness. Commenters recommended that EPA establish a single value for idle time representative of the U.S. fleet for all manufacturers to use rather than allowing manufacturers to use unique values. Using a single value would reward incremental improvements in technology (e.g., systems that trigger the engine to shut off quicker and stay shut off longer) rather than idiosyncratic driving behavior.

EPA understands these concerns and agrees that the off-cycle program is intended to encourage more energy efficient technologies, not to provide credits on the basis of driver-specific or customer-specific driving behavior. In its rebuttal to the comments, Mercedes noted that Progressive data for the entire U.S. fleet indicates that the real world idle times for all manufacturers are higher than EPA's estimated real world idle time. A review of Progressive second-by-second vehicle speed data collected in 2008-2013 on more than 1.2 million vehicles, accounting for a total of 1.25 billion trips and 8.3 billion miles of driving experience, indicates that 22.7% of trip time is spent idling (at 0 mph). Progressive's fleet average idle time for the U.S. is close to the average idle time observed in Mercedes vehicles (23.8%) and significantly higher than EPA's estimate (13.76%) based on earlier studies.

EPA has reviewed the Progressive dataset. This is a very large dataset of 1.2 million vehicles that includes most manufacturers and a very large portion of the U.S. However, the EPA has some concerns about the general representativeness of the activity data. The Progressive data is a "snapshot" of a driver in time, and the data is used for the purposes of discounting insurance premiums. It is thus possible that the some of the drivers sampled have changed their driving behavior for the short period of time that they were monitored due to the perceived financial incentive to do so. However, while the drivers may change the speed or aggressiveness of their driving, the EPA does not believe that drivers will significantly change the fraction of time that they spend in idle (where speed is zero). Table 3 below shows the idle fractions from the Progressive dataset based on different categorizations within the dataset.

Table 3: Progressive Real world Idle Fraction: Category Averages versus Overall Idle Time

Category	Idle Time (%)
Model Year	22.962
State	22.559
Original Equipment Manufacturer (OEM)	22.493
Overall (All model years, OEMs and states)	22.656

This table shows the consistency in the estimated idle time regardless of category. As a result, although EPA continues to collect the best in-use real-world activity data, EPA believes that the Progressive data is appropriate to serve as the basis for an estimate of the U.S. fleet idle fraction for the purposes of calculating stop-start credits for MYs 2012-2016 until a higher quality dataset is collected. EPA is thus approving the use of the 22.7% idle fraction based on the Progressive data for purposes of the interim Mercedes credits for MY 2012-2016. Although the idle time is significantly higher than that used by EPA in the TSD analysis, it is supported by a large amount of data and is likely more representative of the current U.S. fleet than the idle time of 13.76% used by EPA in the TSD. EPA will continue to review the Progressive and other datasets and may consider revising the fleet idle time for any future stop-start credit applications as needed based on new data.

Table 4: Real world Idle Fraction

	% real-world idle fraction	Source
EPA TSD	13.76%	U.S. Fleet average based on MOVES
Mercedes Application – Mercedes Customer Study	23.83%	- Mercedes specific idle fraction based on Mercedes 29 vehicle study
Mercedes Application – Mercedes Vehicles in Progressive Data	23.9%	- Progressive data: 1.2 million vehicles across 44 states representing 1.25 billion trips - 17,484 Mercedes vehicles in Progressive data (1.457%)
Approved Method for Mercedes start-stop technology credits for MY 2012-2016	22.7%	U.S. fleet average based on Progressive data (1.2 million vehicles across 44 states representing 1.25 billion trips)

C. System Effectiveness

How often a stop-start system actually turns the engine off during real world idling is a key input in determining an appropriate level of credits for a stop-start system since systems vary widely in design and calibration. The algorithms that control the system can be very complex, taking into account many different operating parameters. For the MY 2017-2025 final rule TSD analysis, EPA made simplifying assumptions that did not attempt to, and could not, account for many of the manufacturer-specific variables that may impact the operation of a system. EPA used a system effectiveness of 87.75% which was based on an adjusted full vehicle simulation and excluded engine-off operation for engine warm-up, extended idle and ambient temperature effects such as air conditioner use during hot ambient conditions and some heater operation during extremely cold ambient conditions. EPA has learned more regarding the design and complexity of stop-start systems since the final rule and it appears thus far that the effectiveness used in the EPA analysis may be higher than the real world system effectiveness for some manufacturer's systems. However, this higher system effectiveness was offset by the conservative estimate of real world idle time discussed above. Therefore, EPA believes that taken as a whole, the pre-approved menu values remain reasonable conservative baseline off-cycle credits for "typical" stop-start systems and EPA is not proposing to modify the idle fractions or the menu credit values at this time.

In their application, Mercedes provided an engineering analysis of system effectiveness similar to that used by EPA in the final rule TSD. Mercedes' stop-start system has several design features that Mercedes took into account in analyzing its system performance, as described in Section III of the Mercedes application. First, the Mercedes stop-start system includes an electric heater circulation pump that maintains cabin heating in cold temperatures, and thus enables stop-start capability when heat is demanded for a period of time (dependent on a number of factors). Second, the Mercedes system has a supplemental 12 volt battery system that supplies power for all the electrical components and accessories. This allows the main battery to support electric accessory loads, restarting, and also enables continued cooling of the cabin via air re-circulation in hot ambient conditions where the cabin vent fans remain on even though the A/C compressor has discontinued spinning along with the engine. Mercedes also made an adjustment to account for on-board diagnostics (OBD) and stop-start interactions, which limits the availability of stop-start during the first 170 seconds of vehicle operation. These adjustments resulted in a Mercedes estimated fraction of effectiveness (i.e., when the system is active) of about 91.32%, compared to EPA's estimate used in the rulemaking of 87.75%.

Several commenters noted that Mercedes did not provide real-world data on system effectiveness to support the level of credits initially requested, as required by the regulations. ICCT and NRDC commented that Mercedes must be required to provide their best engineering estimate of their stop-start system operation and then validate it with actual in-use data instead of using the methodology EPA used. The commenters suggested revising credit levels retroactively based on real in-use operating data. CARB also commented that Mercedes provided no real-world testing to determine when the engine would actually shut off.

In their supplemental rebuttal to comments, Mercedes provided a limited amount of on-road data with the intent of supporting a more conservative interim level of credits while they collect necessary real-world data to potentially justify higher credit levels. The driving parameters and route chosen by Mercedes were not designed to represent average U.S. driving, but more conservative conditions. Mercedes conducted on-road testing of vehicles with over 50 tests in two test programs from January through March 2014 and again in April 2014 in cold and moderate ambient temperatures. As described in the Mercedes rebuttal, the test program included three different vehicle models equipped with the stop-start system: CLA 250 4MATIC (small car; April 2014 testing only), E350 (mid-size car), and S550 4MATIC (large car). There were no sport utility vehicles (SUVs) or large trucks (e.g., pick-ups)[9] included in the test program.

The testing included:

- Varied time of day to account for different traffic patterns;
- Use of different drivers including independent contract drivers not aware of the technology being tested;
- 5-10 mile routes including city and rural/highway operation;
- Cold, mid, and warm engine temperatures at the beginning of the testing;
- Climate control settings to automatic (target interior temperature set to 72 degrees Fahrenheit)
- Maximum accessory turned on during the test to add load to the electrical system.

The April 2014 testing reflected improvements to the January-March 2014 testing recommended by EPA to evaluate shorter trip lengths, ensure worst case accessory loading, and visually documenting the route for understanding operational conditions (e.g., traffic patterns, driver behaviors, stopping patterns and durations. Mercedes analyzed this set of 39 tests run in April 2014 in Ann Arbor, Michigan over a 5 mile primarily city route and a 10 mile route that included city and rural driving. The testing included runs in both cold ambient (<40° F) and mid ambient (40-80° F) temperature zones, with all but three of the tests starting with cold engine conditions. Mercedes derived effectiveness estimates for each vehicle type for the cold and mid temperature zones by averaging the effectiveness results in those temperature zones over the 10 mile (city and rural) tests. Mercedes assumed a 20% effectiveness in the hot ambient (>80° F) temperature zone versus the EPA assumption of 0% effectiveness in the MY2017-2025 rule but did not provide on-road data in this temperature zone due to the time of year the testing was conducted. The Mercedes analysis resulted in weighted average effectiveness estimates of 60-65%.

EPA also analyzed the data collected by Mercedes in the April 2014 period, taking a more conservative approach. First, EPA included only on-road tests that began with a cold engine, excluding mid and warm

[9] Mercedes does not currently manufacture or sell any large, truck-based models (e.g., pick-ups) domestically or globally. However, they do offer a wide range of compact through full size SUVs that would fall into the "truck" category.

engine starts. This is considered more conservative because the stop-start system is less likely to operate while the engine is warming up. Second, EPA included only the first 5 miles of each trip to capture more impact due to engine warm up which prevents the stop-start system operation (5 miles is close to the average trip length of 4.5 miles estimated by MOVES) and longer trips include warmer engine operation which would improve overall average system effectiveness. Third, EPA included primarily city driving, excluding higher speed, rural and highway operation. Slower speed city operation is more likely to result in slower engine warm up and electrical system state of charge depletion preventing stop-start system operation. In contrast, higher speed operation provides an opportunity for the engine to warm up and the battery that supports the stop-start system to recharge. Finally, EPA assumed an effectiveness of 0% for the hot temperature zone. Mercedes did not provide any on-road data for the hot temperature zone and the effectiveness of the stop-start system in this temperature zone is uncertain due to the loads placed on the system by the operation of the vehicle air conditioning system. An assumption of 0% effectiveness in the hot temperature zone is consistent with EPA's approach taken in the TSD analysis. This likely is a very conservative assumption in the case of the Mercedes system given that the Mercedes system includes an additional battery that should enable some ability to re-circulate cooled air in the cabin at high ambient temperatures as mentioned above.

In addition to the April 2014 dataset, EPA considered the January - March 2014 test data provided by Mercedes. The earlier January-March 2014 data was also collected in Ann Arbor and included additional cold and mid ambient tests but over a longer test route conducted with city-highway and highway-city sequencing. However, for conservative analysis purposes, EPA only included tests that met the criteria outlined above (e.g., cold engine, 5 mile city route). EPA averaged the cold ambient results and mid ambient results to estimate the effectiveness for each temperature zone and used 0% effectiveness in the hot ambient temperature zone. This conservative approach to the data analysis resulted in a weighted average effectiveness estimate of 54%.

Further, EPA took an additional step of applying a 1x standard deviation of the mean to the average cold ambient and mid ambient effectiveness values resulting in a reduced weighted average effectiveness of 52%. EPA only applied a 1x standard deviation of the mean rather than a 2x or 3x standard deviation of the mean because of the other conservative steps used in the data analysis. EPA believes that collectively these steps result in a very conservative estimate of system effectiveness that will help ensure that the system effectiveness used for the credit calculations is well within the actual average real world effectiveness of the Mercedes system. In the absence of real world data from instrumented vehicles driven by consumers, EPA believes this approach is appropriate for use in an interim methodology for calculating credits. EPA is including this more conservative value of 52% as the effectiveness input in the credits calculation methodology being approved for Mercedes. The 52% effectiveness value is significantly lower than the 91.32% in the Mercedes application and also lower than the 60-65% in used in the Mercedes rebuttal credit calculations.

Table 5: Effectiveness Estimates

	Cold (<40°F)	Mid (40-80°F)	Hot (>80°F)	Weighted
EPA 2017-2025 Rule TSD	86.65%	100%	0%	87.75%
Mercedes Application	82%	94%	88%	91.32%
Mercedes Rebuttal	44-56%	71-74%	20%	60-65%
EPA Conservative Estimate	34%	65%	0%	52%
VMT Temperature Weightings (EPA TSD)	20.92%	68.75%	9.70%	100%

D. Driver Disablement (Eco Button)

The Mercedes stop-start system may be disabled by the driver and therefore the frequency of driver disablement must be factored into credit estimates. The Mercedes system is enabled as the default mode at every key start so that it is automatically on at the beginning of each trip, and the system cannot be permanently disabled. To consistently disable the system, the driver must press the button at each start (or at some other point in the trip). In its initial application, Mercedes provided European survey data that showed that respondents disabled the system less than 1% of the time.

Commenters raised the lack of data regarding driver disablement in the U.S. as a serious shortcoming with the Mercedes application. ICCT commented that the preliminary data from a small sample of vehicles in Europe is highly unlikely to be representative of U.S. market. UCS commented that 9 of the 22 vehicles in the European study are not even sold in the U.S. NRDC recommended assuming a 50% rate of driver disablement given the lack of data.

In its rebuttal to comments, Mercedes provided internal and JD Powers U.S. consumer survey data on stop-start equipped Mercedes vehicles showing much less than 1% of owners with stop-start complained about the operation of the system. In its internal survey of vehicle owners, 142 respondents expressed questions or concerns regarding stop-start out of 65,000 respondents with stop-start systems. This represents 0.002% of respondents with stop-start. For the JD Powers data, 19 out of 1,158 respondents with stop-start responded to a stop-start system question negatively. Mercedes notes that this is less than 0.00001% of all stop-start vehicles sales for MY 2013-2014. Mercedes in their supplemental rebuttal analysis added 10% to the original 1% estimate, for a total of 11% driver disablement, which they considered a high end conservative value in the credit calculations.

EPA agrees that using 11% disablement is reasonably conservative when coupled with the conservative approach used for effectiveness as discussed above and the U.S. consumer data indicating minimal customer dissatisfaction with the Mercedes stop-start system. EPA believes that widespread consumer dissatisfaction with the system that would result in frequent deactivation would likely have appeared in the survey results. Therefore, EPA believes that Mercedes' suggested 11% disablement is a reasonable assumption for purposes of interim credit values for MYs 2012-2016. As a result, EPA is approving the use of 11% for disablement as part of the interim methodology for MYs 2012-2016. If Mercedes applies for additional credits beyond the pre-approve list values for MYs 2017 and later and/or additional retroactive credits for MYs 2012-2016, Mercedes will need consumer data from instrumented vehicles that demonstrates how often the system is disabled in actual driving. As discussed above, this will be considered a new application and EPA decision process which will include an opportunity for public comment. Together, the 11% adjustment for driver disablement and the 52% effectiveness results in an adjusted overall system effectiveness of 46%.

E. A-B Testing

The regulations require model-type testing unless the manufacturer can demonstrate that model specific data is not necessary.[10] EPA received several comments that model specific A-B testing is needed and agrees with these comments. Stop-start credits generally must be based on model specific 2-cycle A-B testing, with and without the system activated. Mercedes included A-B testing for some models sold by Mercedes in MYs 2012-2013 and we can calculate the credit levels for those models, as discussed below. For other models, Mercedes will need to conduct A-B testing which will result in differing credit levels. Mercedes has indicated that they plan to conduct model type A-B testing as part of their annual credits calculations. Mercedes retains the option to use the pre-defined list credits for MY 2014 and later without EPA's additional approval rather than conducting A-B testing and submitting data.

F. Interim Stop-Start Credit Methodology for MYs 2012-2016

Mercedes has provided detailed information on the design of their stop-start system and an engineering analysis of system operation but has not provided comprehensive real-world data on system effectiveness and driver disablement needed to support the level of credits originally requested. Mercedes is planning to collect real-world data from stop-start equipped vehicles to support higher credit levels. In their rebuttal of comments, Mercedes has suggested a more conservative interim level of credits compared to their application, based on limited on-road test data.

As discussed in Section II.C., EPA has further analyzed the data provided by Mercedes, deriving a more conservative input for system effectiveness. EPA is approving the calculation methodology submitted by Mercedes for MYs 2012-2016, using the more conservative effectiveness input derived by EPA. As discussed in Section II.B., EPA is also approving the use of a real world idle time estimate of 22.7% based on a fleet-wide average rather than a Mercedes-specific fleet estimate. The calculation methodology using these inputs is shown below. Overall, the resulting credit levels will be significantly lower than those requested by Mercedes both in their application and in their rebuttal. EPA acknowledges that the interim methodology is not based on comprehensive real-world effectiveness data. However, EPA believes that using the more conservative approach discussed above results in credit levels that are very

[10] §86.1869-12(d)(1)(iv).

likely underestimating the overall system effectiveness. The approved approach provides certainty that the credits provided to Mercedes on an interim basis represent real-world emissions reductions beyond those captured by the 2-cycle test.

Equation 1: Mercedes-Benz stop-start credit methodology

$$Offcycle\ Credit\ = Oncycle\ CO2\ Improvement \times \frac{Real\ world\ engine\ off\ ratio}{Oncycle\ engine\ off\ ratio} \times (1 - driver\ disablement) - Oncycle\ CO2\ Improvement$$

Where:

On cycle CO2 Improvement = System on-cycle benefit (g/mile) = Model-specific 2-cycle A-B test results without the stop-start system activated minus the A-B 2-cycle test results with the system activated

Real world engine off ratio = weighted average system effectiveness multiplied by the estimated real world idle fraction = 52% x 22.7% = 11.8%

On cycle engine off ratio = on-cycle system effectiveness (based on A-B test results) multiplied by the on-cycle idle fraction (10.7%)

Driver disablement = frequency of driver disabling the system = 11% (0.11)

Mercedes provided A-B test results for some vehicle models in their application. A summary of the EPA approved inputs, the A-B test results provided by Mercedes, and an example calculation using Mercedes A-B test results for the mid-size car testing, are shown below.

Table 6: Off-cycle Inputs and Example Credits (g/mile) for Mercedes-Benz Stop-Start System

	Small Car	**Mid Car**	**Large Car**	**Light Truck**
EPA Approved Inputs				
On-cycle idle fraction	10.7%	10.7%	10.7%	10.7%
Real world effectiveness	52%	52%	52%	52%
Driver disablement	11%	11%	11%	11%
Real world idle fraction	22.7%	22.7%	22.7%	22.7%
A-B Testing				
A-B test results (g/mi)	9.8	8.1	16.9	15.2
On-cycle effectiveness	68.20%	67.30%	80.4%	79.40%
Credits*	4.3	3.7	3.7	3.6

* Illustrative based on initial A-B testing. Actual credits based on model specific A-B testing

Example Off-cycle Credit Calculation for Mid-size Car

$$Offcycle\ Credit\ = 8.1\ g/mi \times \frac{(52\% \times 22.7\%)}{(10.7\% \times 67.30\%)} \times (1 -\ 0.11)\ - 8.1\ g/mi = 3.7\ g/mi$$

ACEEE commented that a time-based, weighted average of 74 percent city and 26 percent highway should be used to calculate the 2-Cycle idle time rather than the current, traditional distance-based, weighted average of 55 percent city and 45 percent highway. While this argument has some merit, this would create an inconsistency between the gram per mile CO2 standards in the 2017-25 GHG Rule generated from the 2-Cycle Tests, since they also use the distance-based weighted average of 55 percent city and 45 percent highway, and the credit values in the off-cycle program. Therefore, we did not incorporate this comment in the calculations nor consider this comment in the decision on the Mercedes application.

Mercedes may apply for additional credits for MY 2012-2016 vehicles if those credits are supported by comprehensive real-world data (i.e., data collected using instrumented vehicles driven by vehicle owners over a variety of ambient and roadway conditions and types). This approach fits within the context of the provisions in 40 CFR §86.1865(k)(8)(i) that allow a manufacturer to apply credits to three model years prior to the model year in which they are earned, in effect allowing manufacturers to carry a credit deficit if necessary.[11] The approach also fits with the provisions in 40 CFR §86.1865(k)(6)(ii) that allow credits generated in MYs 2010-2016 to be used through MY 2021. Although any additional credits would be tied to the model year of the vehicle generating the credits, the credits would be able to be used through MY 2021. EPA anticipates that the instrumented vehicle testing will provide a robust dataset on which to base much more precise real-world effectiveness and driver disablement estimates. Such data will also be necessary if Mercedes chooses to apply for additional stop-start credits beyond the pre-approved list credits for MYs 2017 and later. A future application for additional stop-start credits will be made available for public comment as part of the EPA review process per the regulations prior to EPA making a decision on the application.

IV. High efficiency exterior lighting, infrared glazing, and active seat ventilation

A. High Efficiency Exterior Lighting

Mercedes-Benz applied for off-cycle credits for high efficiency exterior lighting for their MY 2012-2016 U.S. model product range equipped with the following lighting elements: low beam head lights, high beam head lights, parking/position, front turn signal, front side marker, tail lights, rear turn signal, and

[11] Also see 49 U.S.C. 32903.

license plate (See Section IV of the Mercedes-Benz application). This list of lighting elements is consistent with that specified by EPA for the pre-approved list in the MY 2017-2025 rule. [12]

To calculate the high efficiency exterior lighting credits, Mercedes-Benz used the EPA methodology set forth in the TSD for the MY2017-2025 rule.[13] Specifically, Mercedes-Benz used the MY 2017-2025 rule baseline wattage values for each lighting element listed above and the time of day (e.g., day time, night time) usage rates from a study performed by Schoettle et al[14] and inserted the wattage values from the Mercedes-Benz high efficiency exterior lighting to determine the wattage savings for each lighting element. In most cases, the Mercedes-Benz wattage savings for each lighting element exceeded the wattage savings projected in the MY 2017-2025 rule (exceptions: parking/position lights at 70% savings versus 78% in the MY 2017-2025 rule; license plate light at 86% versus 90% in the MY 2017-2025 rule).

For the final credit amounts, Mercedes-Benz multiplied the wattage savings times the usage rates and a constant of 0.032 g/mi CO2 /watt (based on data showing a 100 watt savings equates to 3.2 g/mi CO2 savings) for a credit of 1.1 g/mi CO2 total for all the high-efficiency exterior lighting elements used over the range of Mercedes-Benz models. In comparison, the default credit value for high efficiency exterior lighting in the MY2017-2025 rule is 1.0 g/mi CO2.

EPA did not receive any adverse comments on the Mercedes approach and credit levels requested for high efficiency exterior lighting, with the comments from the Alliance, Global Automakers, and Honda supportive of the Mercedes methodology and granting the requested credit levels. EPA has independently evaluated the application, and agrees with the rationale there provided. Therefore, EPA is granting Mercedes the requested credits of 1.1 g/mi CO2 for high efficiency exterior lighting in MY 2012-2016.

B. Infrared Glazing

Mercedes-Benz applied for off-cycle credits for infrared glazing for the S-Class, ML-Class and GL-Class vehicles that utilize infrared glazing technology (See Section IV of Mercedes-Benz's application). The infrared glazing technology absorbs and/or reflects a percentage of the infrared solar energy emitted from the sun and reduces the amount of solar heat load transmitted into the cabin; this is termed "total solar transmittance" or "Tts." The Tts is usually expressed as a percentage and defined as the amount of solar energy that passes through the glazing, including energy absorbed and subsequently re-radiated to the interior, to the amount of solar energy imparted on the surface of glazing.[15] The higher this number, the more solar energy is allowed to penetrate into the passenger cabin. Therefore, a lower Tts number

[12] 40 CFR §86.1869-12(a)(ii).

[13] MY2017-2025 Technical Support Document, Chapter 5, Section 5.2.3.

[14] Schoettle, B., et al., "LEDS and Power Consumption of Exterior Automotive Lighting: Implications for Gasoline and Electric Vehicles," University of Michigan Transportation Research Institute, October, 2008. For the MY2017-2025 Rule, the high efficiency exterior lighting wattage for one lighting element, low beam head lights, was revised based on manufacturer comment.

[15] Title 17 California Code of Regulations §95600-95605: "Cool Car Standards and Test Procedures – 2012 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles."; Air Resources Board; May 8, 2009 (see:http://www.arb.ca.gov/regact/2009/coolcars09/coolcarsappa.pdf).

is better since less solar energy will penetrate the passenger cabin and, consequently, the interior cabin temperature is reduced. Infrared glazing technologies improve passenger comfort, reducing the need for air conditioning (A/C) usage, which in turn, reduces vehicle fuel consumption. EPA's analysis relied on a study performed by the National Renewable Energy Laboratory (NREL) demonstrating that a one degree centigrade reduction in cabin air temperature results in a 2.2% reduction in CO_2 emissions resulting from a reduction in passenger compartment temperature and reduced A/C usage.[16]

To calculate the infrared glazing credits, Mercedes-Benz used the methods set forth in Chapter 5 of the TSD for the MY 2017-2025 rule.[17] This method utilizes the International Organization for Standardization's (ISO) standard #13837 for measuring the solar transmittance of infrared glazing[18] and a formula for estimating the effect of the solar performance of glazing technologies developed by EPA and California Air Resources Board with input from the National Renewable Energy Laboratory (NREL) and the Enhanced Performance Glass Automotive Association (EPGAA). Specifically, the contribution of each glass/glazing location to the overall interior temperature reduction is estimated using its measured Tts, relative to a baseline level, and the area of the glass/glazing location relative to the overall glass area.[19]

The infrared glazing used by Mercedes-Benz has the same Tts performance levels as the baseline Tts levels specified in the MY2017-2025 rule: 62% for all glazing locations, except for rooflites and rear side glazing of crossovers, SUVs, and minivans, which have a baseline Tts of 40%. Based on the Tts levels for Mercedes Benz's infrared glazing and the formula described above, Mercedes-Benz calculated a credit of 0.8 to 1.7 g/mi CO_2 for the infrared glazing used over the range of Mercedes-Benz models. In comparison, the default credit values for infrared glazing in the MY2017-2025 rule are scalable depending on such factors as the amount of glass in the vehicle and the performance of the glazing, up to a maximum of 2.9 g/mi CO_2 for cars and 3.9 g/mi CO_2 for trucks.

EPA did not receive any adverse comments on the Mercedes approach and credit levels requested for infrared glazing, with the comments from the Alliance, Global Automakers, and Honda supportive of the Mercedes methodology and granting the requested credit levels. EPA has independently evaluated the application, and agrees with the rationale there provided. Therefore, EPA is granting Mercedes the requested credits of 0.8 to 1.7 g/mi CO_2 for infrared glazing in MY 2012-2013. Mercedes retains the option to use the pre-defined list credits for MY 2014 and later without EPA's additional approval rather than conducting A-B testing and submitting data.

[16] Rugh, J., Farrington, R. "Vehicle Ancillary Load Reduction Project Close-Out Report," National Renewable Energy Laboratory Technical Report NREL/TP-540-42454, January, 2008.

[17] MY2017-2025 Technical Support Document, Chapter 5, Section 5.2.10.

[18] International Organization for Standardization's (ISO) 13837: "Road vehicles -- Safety glazing materials -- Method for the determination of solar transmittance," April 15, 2008.

[19] 40 CFR 86.1869-12(b)(1)(viii)(A).

C. Active Seat Ventilation

Mercedes-Benz applied for off-cycle credits for applicable vehicles that have active seat ventilation on both the front row' driver and passenger seats (See Section IV of Mercedes-Benz's application). [20] The Mercedes-Benz active seat ventilation technology has the capability to both pull air away from and push air to the seating surface that helps to maintain passenger comfort and lower overall air conditioning usage; consequently lowering vehicle fuel consumption and CO_2 emissions.

To calculate the active seat ventilation credits, Mercedes-Benz used the methods set forth in Chapter 5 of the MY 2017-2025 TSD.[21] Based on the NREL study mentioned above, a 7.5% reduction in air conditioning (A/C) related emissions could be achieved by lowering the surface temperature of the vehicle seats and drawing heat away from the seated driver/passenger. [22]

Based on the seat location criteria, capability, and the methodology described above, Mercedes-Benz estimated a credit of 1.0 g/mi CO_2 for cars and 1.3 g/mi CO_2 for trucks for the active seat ventilation technology used over the range of Mercedes-Benz models. These values are identical to the default values in the pre-approved off-cycle credit list in the MY 2017-2025 rule. Therefore, Mercedes-Benz concludes that its active seat ventilation system achieves equivalent performance to that assumed in the MY 2017-2025 rule. Mercedes-Benz could use the pre-approved list to claim these credits beginning in MY 2014, but since they are seeking credits to begin in MY 2012, and because these technologies are not measurable through the 5-cycle testing pathway, Mercedes-Benz is applying for these credits through this alternative technology pathway.

EPA did not receive any adverse comments on the Mercedes approach and credit levels requested for active seat ventilation, with the comments from the Alliance, Global Automakers, and Honda supportive of the Mercedes methodology and granting the requested credit levels. EPA has independently evaluated the application, and agrees with the rationale there provided. Therefore, EPA is granting Mercedes the requested credit of 1.0 g/mi CO_2 for cars and 1.3 g/mi CO_2 for trucks for active seat ventilation in MY 2012-2013. Mercedes retains the option to use the pre-defined list credits for MY 2014 and later without EPA's additional approval rather than conducting A-B testing and submitting data.

[20] 40 CFR 86.1869-12(b)(4)(viii).
[21] MY2017-2025 Technical Support Document, Chapter 5, Section 5.2.11.
[22] Ibid 12.