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Mr. Wehrly:

Request for GHG Credit for High Efficiency Alternator Technology

Pursuant to the provisions of 40 CFR § 86.1869-12(d), General Motors requests off-cycle greenhouse gas credit for the use of high efficiency alternator technologies. Based on the analysis provided in this petition, General Motors requests credits equal to 0.16 grams CO_2 per mile for each 1% improvement in the VDA efficiency rating of the alternators that GM used over a baseline efficiency of 67% VDA. These credits would be applied to 2010 to 2016 model General Motors vehicles sold in the U.S. with alternators exceeding 67% VDA efficiency, as shown in Appendix A. If EPA approves the current request for credits for 2010-2016 model vehicles using the proposed methodology, our intention would be to also use this methodology for off-cycle credits for future high efficiency alternators. We would also plan to submit similar credit requests to NHTSA for off-cycle CAFE credits for the appropriate model years.

The conservative credit formula in this request is based on the low end of the range of a series of simulation results using the EPA Alpha model. In addition, as described below, this credit formula is also supported by many other analyses. Collectively, this extensive accumulation of evaluations shows the proposed credit methodology to be robust to specific vehicle implementation issues, as well as conservative in comparison to the actual real world fuel savings and emissions reductions that can be expected from this technology. Specifically, we compare Alpha model results to the EU eco-innovation methodology for efficient alternator credits, to the EU methodology adjusted for actual North American Willan’s numbers for engine efficiency, and to simulations using the GM Unified Model.

In order to accelerate the rate of improvement in alternator efficiency while minimizing the costs of data collection and analysis, we urge EPA to approve the off-cycle credits in this petition calculated with this methodology, and to also endorse this simple and conservative off-cycle credit methodology as a common template for the industry.

Technology Description

Automotive alternators convert mechanical energy from an internal combustion engine to electrical energy to be used by the vehicle's electrical systems. The additional mechanical load on the engine from the alternator results in the increased consumption of fuel and CO_2 emissions. A variety of mechanical and electrical losses are inevitable in this energy conversion process, and high efficiency alternators use new technologies to reduce these loses, thereby reducing the alternator load on the engine and resulting in better fuel economy and lower CO_2 emissions.

The efficiency of the alternator is the ratio of the alternator output power to the power supplied to the alternator. The Verband der Automobilindustirie (VDA) efficiency test procedure is the accepted industry standard for measuring alternator efficiency. The VDA efficiency rating is the weighted average of the efficiencies measured in component bench tests at four different alternator speeds. The weighting is 25% @ 1,800 rpm, 40% @ 3,000 rpm, 25% @ 6,000 rpm and 10% @ 10,000 rpm, each measured at 50% of maximum current charge. Although various designs may be used to increase efficiency, for the purposes of this credit petition a high efficiency alternator is defined as any alternator that exceeds a baseline VDA efficiency rating of 67%.

Off-Cycle Condition and Alternative Methodology Requirement

EPA created the off-cycle credit program to incentivize the implementation of technologies which reduce greenhouse gas emissions in the real world by a greater amount than would be captured in the two-cycle test program. The EPA's two-cycle test program for city and high way drive schedules is conducted with most electrical accessories switched off. This includes electrical accessories used due to either hot-weather or cold-weather conditions, such as HVAC blowers and (potentially) electric air conditioner compressors or electric heater circulation pumps. Also, the city and highway cycles do not include high-speed driving, even though powertrain-related electrical loads are higher at high vehicle speeds in order to power more work by electrical devices such as spark ignition systems, fuel injection systems, fuel pumps and (potentially) electric oil or coolant pumps. Clearly, vehicle electrical loads and the associated fuel consumption to power these electrical loads are higher in real world driving than on the two-cycle fuel economy tests.

EPA's five-cycle test program also would not adequately measure the real-world greenhouse gas reduction benefits of high efficiency alternators. While electrical loads for HVAC and powertrain systems are included in the five-cycle tests, other accessory systems which use electrical power are still never activated, such as exterior and interior lights, wipers, power windows, rear window defrosters, radios and other entertainment systems, communications systems, comfort features, etc. As a result, the five-cycle test program cannot be used to adequately evaluate the off-cycle benefit of high efficiency alternator technologies, and an alternative methodology must be used instead.

Background

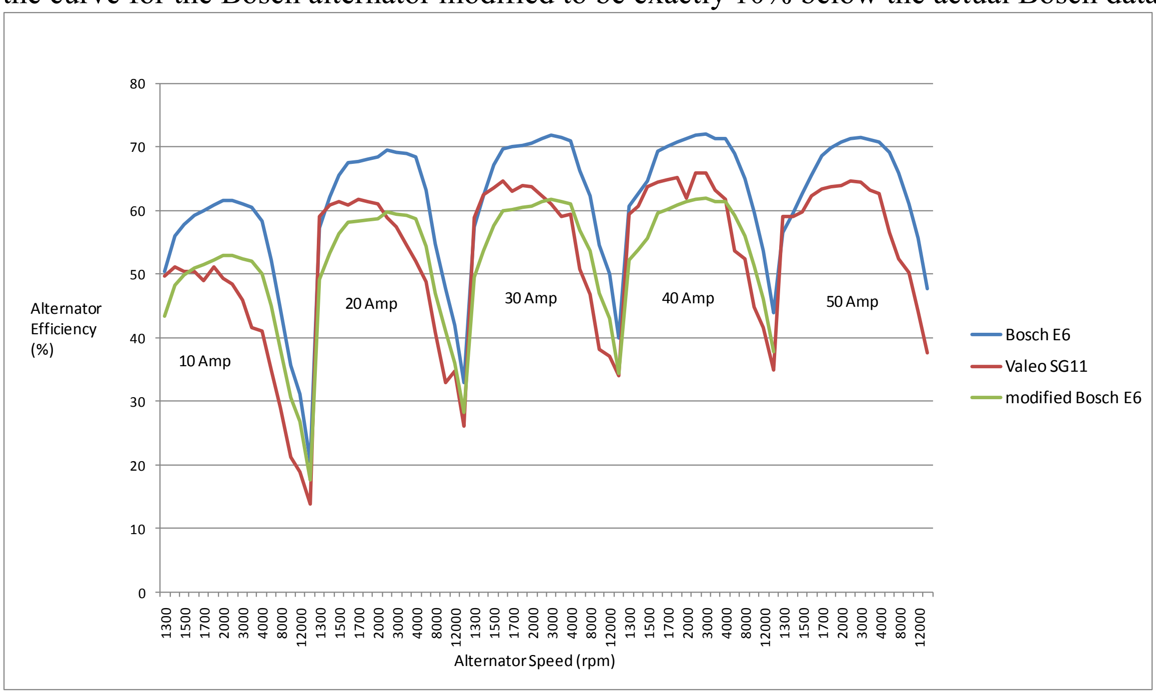
An extensive background has been established over the past six years that supports granting greenhouse gas reduction credits for high efficiency alternators. They were first mentioned by EPA/NHTSA as a possible candidate for off-cycle credit in the Supplemental Notice of Intent published in August 2011 to start the process of creating 2017-2025 greenhouse gas standards. However, they were not included in the subsequent Notice of Proposed Rulemaking's (NPRM's) list of pre-defined and pre-approved off-cycle credits.

The Alliance of Automobile Manufacturers filed comments to this NPRM proposing several technologies that could be added to the pre-defined and pre-approved list. Off-cycle credits for high efficiency alternators were one of those proposals (Alliance comments, Appendix 2, p. 10). The Association of Global Automakers and alternator suppliers such as Denso and Robert Bosch also filed comments supporting the addition of high efficiency alternators to the pre-approved off-cycle credit list. Denso submitted an analysis showing an on-cycle electrical load of 240 Watts, a real-world load of 750 Watts, and a resulting simulated reduction of 2.8 grams CO_2 per mile when alternator efficiency was raised from 65% to 75% (Response to Comments, p. 7-36 through 7-41). This analysis would support an off-cycle credit of 0.28 grams CO_2 per mile for each 1% improvement in the alternator efficiency rating.

The Alliance of Automobile Manufacturers comments included an analysis by General Motors using the GM Unified Model simulation tool. This analysis used a “conservative” assumption of an on-cycle 20 amp electrical load and an additional 20 amps real-world electrical load. It proposed establishing a credit for high efficiency alternators with VDA efficiency ratings of 68% or higher (which EPA/NHTSA deemed in their Response to Comments an “appropriate” definition for high efficiency). GM ran simulations of three different alternators on a range of four different vehicles using the NEDC drive cycle. The alternators were the Valeo SG11 (61% VDA), Bosch E6 (69% VDA) and Denso DSO (70% VDA). Note that this analysis included actual alternator maps throughout their complete range of operation, and was not solely based on the VDA efficiency rating.

Each of these alternators was simulated using the GM Unified Models for the Cadillac SRX, Chevrolet Sonic, Chevrolet Cruze, and Cadillac ATS. Actual performance curves for each of the alternators were used for one set of simulations. Another set of simulations was done for the high efficiency Bosch and Denso alternators, wherein the actual performance curves were compared to alternator performance curves set to be exactly 10% lower than the actual curves. Also, a very simple set of simulations was done to compare a flat 70% efficiency alternator to a 60% efficiency alternator.

The following chart shows the efficiency curves for the Bosch and Valeo alternators, and also shows the curve for the Bosch alternator modified to be exactly 10% below the actual Bosch data:



Using this approach, the following CO_2 savings were estimated for the extra 20 amps typical of real-world driving, compared to the 2-cycle test's 20 amp load:

Vehicle	Alternator Comparison	Savings with High Efficiency Alternator (grams CO_2 per mile)
SRX	Valeo (61% VDA) vs Bosch (69% VDA)	0.1
Sonic	Valeo (61% VDA) vs Bosch (69% DA)	1.1
ATS	Valeo (61% VDA) vs Bosch (69% VDA)	0.8
Cruze	Valeo (61% VDA) vs Bosch (69% VDA)	0.7
SRX	Constant 60% vs 70%	1.3
Sonic	Constant 60% vs 70%	2.0
ATS	Constant 60% vs 70%	1.0
Cruze	Constant 60% vs 70%	1.5
SRX	Bosch mod (61% VDA) vs Bosch (69% VDA)	1.3
Sonic	Bosch mod (61% VDA) vs Bosch (69% VDA)	1.8
ATS	Bosch mod (61% VDA) vs Bosch (69% VDA)	1.1
Cruze	Bosch mod (61% VDA) vs Bosch (69% VDA)	1.1
SRX	Valeo (61% VDA) vs Denso (70% VDA)	-0.4
Sonic	Valeo (61% VDA) vs Denso (70% VDA)	1.2
ATS	Valeo (61% VDA) vs Denso (70% VDA)	0.7
Cruze	Valeo (61% VDA) vs Denso (70% VDA)	0.7
SRX	Denso mod (61% VDA) vs Denso (70% VDA)	0.8
Sonic	Denso mod (61% VDA) vs Denso (70% VDA)	1.6
ATS	Denso mod (61% VDA) vs Denso (70% VDA)	0.9
Cruze	Denso mod (61% VDA) vs Denso (70% VDA)	0.9

As would be expected, the complexity of vehicle operations results in a spread in results from this exercise. However, the overall average improvement across all 20 comparisons in this analysis is 0.168 grams CO_2 per mile for each 1% improvement in the alternator's VDA efficiency rating.

In response, EPA/NHTSA agreed that off-cycle credits for high efficiency alternators were attractive, but asked for case-by-case applications for credits in view of the difficulties in establishing a default credit value for the pre-defined and pre-approved list (Final Rule, Federal Register Vol. 77, No. 199, p. 62730). In particular, EPA/NHTSA stated they wished to review more analyses for midsize cars, large cars and large trucks before they could begin to establish a default credit value. We have therefore included analyses for these vehicle segments in this petition.

Subsequently, in August 2015, the American Automotive Policy Council (AAPC) requested from EPA and NHTSA an off-cycle greenhouse gas credit for high efficiency alternators in comments filed relating to the Phase 2 Heavy Duty truck greenhouse gas/fuel efficiency regulation. AAPC reviewed the previous work on a high efficiency alternator credit for light-duty vehicles and the EU Eco Innovation template for credits, and also presented a new analysis by General Motors involving a series of simulations for two actual alternators using the GM Unified Model for a 6.2 liter V8 engine on the GMC Sierra heavy-duty pickup (AAPC comments, p. 38-45).

On its 2015 heavy-duty pickups, General Motors upgraded its alternators to 72% VDA efficiency, compared to a 68% alternator used in previous years. Simulations for the GM heavy-duty gasoline pickup were performed using data for these two actual alternators, using a baseline on-cycle electrical load of 280 Watts (based on actual vehicle tests) and an assumed real-world load of 750 Watts, as used in the European eco-innovation system. This analysis supported on off-cycle credit of 1.9 grams CO_2 per mile, based on the fuel savings above those experienced in the two-cycle tests. Because the alternator efficiency was improved 4 points on the VDA scale, the 1.9 grams CO_2 per mile off cycle benefit equated to a benefit of approximately 0.5 grams CO_2 per mile for each 1% improvement in the VDA efficiency rating of the alternator on this large pickup truck. That is a significantly higher benefit than measured on smaller vehicles during the light-duty vehicle rulemaking process (0.168 grams CO_2 per mile per 1% VDA increase), and is a strong indicator that high efficiency alternator technology will generally provide a bigger real-world benefit on larger vehicles.

EU Eco-Innovation

On July 25, 2011, the EU published a regulation (Commission Regulation (EU) No. 725/2011) and a technical guideline document to establish type approval procedures for eco-innovation greenhouse gas credits. The technical guideline document describes the high efficiency alternator as one of the technologies that qualifies for eco-innovation credits, and establishes the credit calculation methodology for such alternators. Since then, the EU has approved at least eight applications for eco-innovation greenhouse gas reduction credits for high efficiency alternators from Denso, Mitsubishi Electric, Valeo and Robert Bosch, all using the same template for calculating the credit.

The EU eco-innovation credit methodology for high efficiency alternators is described in the following tables. Using this EU methodology, the relationship of grams CO_2 per mile credits as a function of alternator efficiency is not perfectly linear. However, for perspective, in the range of an alternator improvement from 67% to 77% efficiency, this methodology gives credits for gasoline engines of 0.23 grams CO_2 per mile per 1% VDA alternator improvement, 0.24 grams CO_2 per mile for turbo gasoline engines, and 0.22 grams CO_2 per mile for diesel engines. However, these quantities reflect the average test cycle speed on the EU test cycle of 33.58 kilometers per hour. If this is adjusted to the higher average speed on the U.S. city-highway test of 54.2 kph, the EU methodology yields relationships for gasoline engines of 0.142 grams CO_2 per mile per 1% VDA alternator improvement, 0.150 grams CO_2 per mile for turbo gasoline engines, and 0.134 grams CO_2 per mile for diesel engines. These are the numbers which can best be compared to the 0.16 grams CO_2 credit per 1% VDA improvement that is in this request.

One key input set by the EU Joint Research Centre is the factor for engine fuel consumption per unit of effective power, which is set at 0.264 liters per kWh for gasoline naturally aspirated engines, 0.28 for gasoline turbo engines, and 0.22 for diesel engines. This methodology is described as using the Willan's approach, and these key factors for the engine's marginal efficiency are called Willan's numbers. The Willan's number describes the engine efficiency in terms of the amount of positive work from the engine per liter of fuel consumption.

Data for EU Eco Innovation Credit Calculation:

P_{RW} Vehicle's total electric power requirement under "real-world" conditions: 750 W

P_{TA} Vehicle's total electric power requirement under type-approval conditions: 350 W

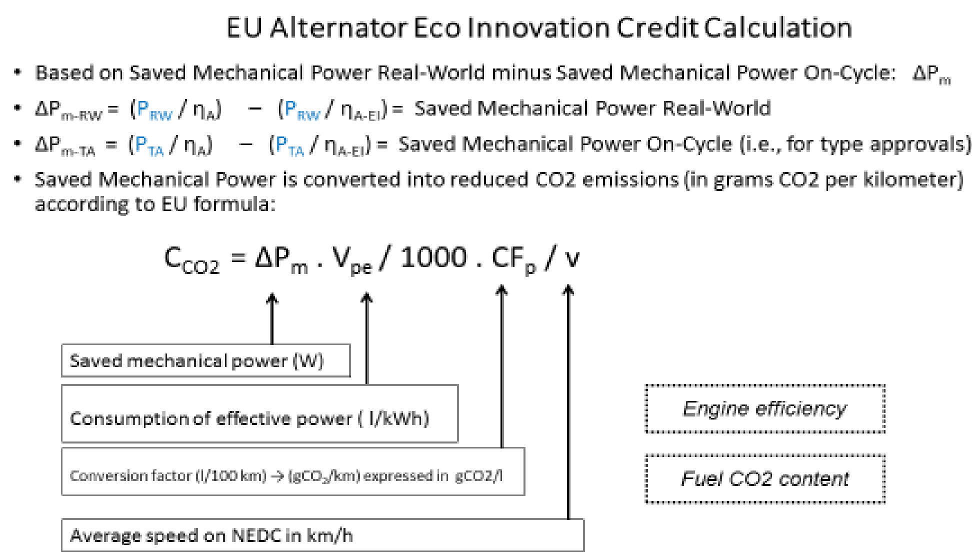
v Mean NEDC drive speed: 33.58 km/hr

η_a Baseline alternator VDA efficiency: 67% for new type approvals

η_{a-El} High efficiency alternator VDA efficiency: Must be tested

V_{Pe} Consumption of effective power:
0.264 l/kWh gasoline, 0.28 l/kWh turbo gasoline, 0.22 l/kWh diesel

CF Conversion Factor: 2330 grams CO_2 / liter gasoline, 2640 grams CO_2 / liter diesel



As discussed later, the Willan's factors in the EU eco-innovation template represent highly efficient engines, which results in lowered CO_2 credit amounts from efficient alternators, compared to the use of Willan's factors for actual engines currently being produced and sold in the U.S., or planned for the near future.

<u>Baseline Efficiency</u>

The EU Eco-Innovation Technical Guidelines created by the EU Joint Research Centre recommend a baseline VDA of 67% for calculating the eco-innovation credit for high efficiency alternators on new vehicles types. In comparison, EPA/NHTSA used a baseline alternator efficiency of 65% in its Joint Technical Support Document for the 2017-2025 GHG regulation, based on a 2008 Delco-Remy Alternator. As previously mentioned, in the discussion of high efficiency alternator off-cycle credits in the Federal Register Final Rule for 2017-2025 EPA indicated that 68% VDA would be an appropriate threshold to begin awarding high efficiency alternator off-cycle credits:

"The 68% VDA number stated by the Alliance of Automobile Manufacturers seems to be appropriate starting point given current technology…" (Final Rule, Federal Register Vol. 77, No. 199, p. 62731)

Based on this input combined with a review of GM's typical alternator efficiencies on North America prior to 2010, we propose using 67% VDA efficiency as the baseline for credit calculations (the same as the EU), thereby affording some credit to any alternator with an efficiency of 68% or higher.

Real-World Electrical Load

In the EU Eco-Innovation Technical Guidelines the electrical load under NEDC testing conditions is defined as 350 Watts and the real-world driving electric power requirement is defined as 750 Watts. This results in a real-world off-cycle load of 400 Watts above the electrical load required for fuel economy test conditions.

A sampling of recent GM vehicles shows that on-cycle average electrical loads are below the 350 Watts used in the EU template. GM on-cycle average electrical loads appear to be approximately 250 Watts, and this value was used for the on-cycle load in the following GM Unified Model analysis of the Denso SC0, Valeo FG15 and Valeo EG15 alternators.

Average On-Cycle Total Electrical Power Loads
(Watts)

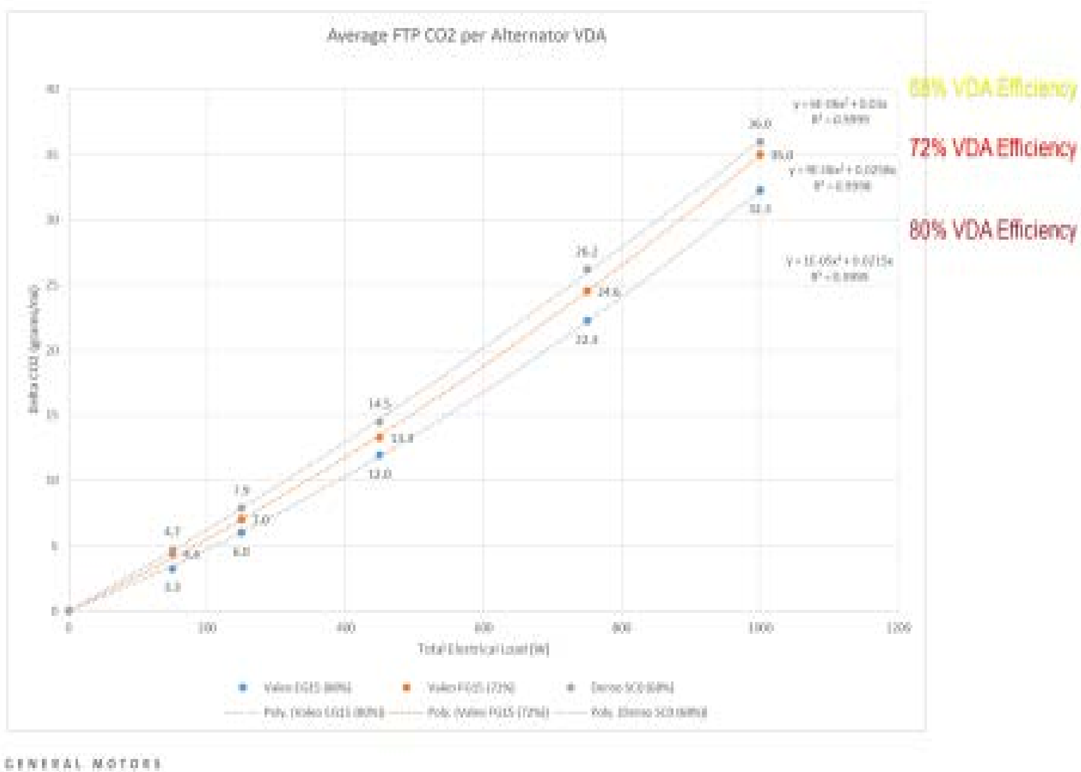
	Average	2016 Impala	2017 Savana	2014 Acadia	2015 Sierra	2015 Sierra	2014 ATS
		2.5L gas	2.8L TD	3.6L gas	6.6L TD	6.2L gas	2.0L turbo
City	246	233	315	187	205	319	216
Highway	264	280	281	291	185	255	291

GM Unified Model

Three actual alternators were used in simulations using the GM Unified Model. These were the Denso SC0 with 68% VDA efficiency, the Valeo FG15 with 72% efficiency, and the Valeo EG15 with 80% efficiency. These three alternators were each simulated on seven vehicle configurations: the Opel Mokka with 1.2L and 1.35L turbo gasoline engines (sold in the U.S. as the Chevrolet Traxx), the Cadillac XT5 with a 2.0L gasoline turbo, the Buick Regal with 1.8L and 2.0L turbo gasoline engines, and the Opel Insignia with 1.5L turbodiesel and 2.0L turbodiesel engines. These results thus represent a small SUV/crossover vehicle, a midsize SUV/crossover vehicle, and two midsize passenger cars. Note that the engines are all highly efficient small turbocharged engines with nine-speed transmissions, which are representative of future powertrains, but which result in smaller off-cycle credits for efficient alternators than would be the case if the analysis used more typical current engines and transmissions.

The summary table and graph shown below are averages using these seven GM configurations, showing the CO_2 usage on standard test cycles attributable to the alternator at a range of total electrical loads, and the improvements from more efficient alternators:

	CO_2 @250W	CO_2 @750W	Off Cycle Electric Load	Improvement Versus Baseline	CO_2 Reduction Per 1%VDA
	(gCO_2/mile)	(gCO_2/mile)	(gCO_2/mile)	(gCO_2/mile)	(gCO_2/mile)
Denso 68%	7.9	26.2	18.3	baseline	
Valeo 72%	7.0	24.6	17.6	0.7	0.175
Valeo 80%	6.0	22.3	16.3	2.0	0.167



This analysis shows that, within the range of real-world off-cycle electrical loads, the more efficient alternators would deliver CO_2 reductions at a rate of 0.175 grams CO_2 per 1% VDA improvement for the Valeo FG15 (with 72% VDA efficiency) and at a rate of 0.167 grams CO_2 per 1% VDA improvement for the Valeo EG15 (with 80% VDA efficiency). These rates of improvement are both higher than the 0.16 grams of off-cycle credit per percent of VDA efficiency improvement in the current credit request.

<u>Truck Study</u>

A range of eight truck configurations was analyzed using the GM Unified Model over the combined city/highway drive cycles, using an off-cycle electrical load of 400 Watts. These included very large SUVs such as the Chevrolet Suburban XL as well as large pickup trucks. Simulations were performed for improvements in alternator efficiency of 4% and 8%. The average CO_2 reduction from these eight models was a rate of 0.18 grams CO_2 per mile for each 1% VDA efficiency improvement. As expected based on prior studies, the rate of improvement was on average greater than on passenger cars, and the rate of improvement was generally highest on the largest, least fuel efficient vehicles. Based on this truck analysis, the requested off cycle credit of 0.16 grams CO_2 per mile for each 1% VDA efficiency improvement is conservative.

Model	Alternator Off-Cycle Credit (grams CO_2 per mile per 1% VDA)
Suburban 5.3L 10-speed RWD	0.1529
Suburban 6.2L 10-speed RWD	0.2043
Suburban XL 6.2L 10-speed AWD	0.1634
Silverado 4.3L V6 6-speed RWD 5000lbs.	0.1820
Silverado 5.3L V8 8-speed RWD 5250 lbs.	0.1658
Silverado 5.3L V8 8-speed AWD 5250lbs.	0.1686
Silverado 5.3L V8 8-speed AWD 5500lbs.	0.2000
Silverado 5.3L V8 HD 8-speed AWD 5250lbs.	0.1914
Average	0.1786

EU Methodology with Adjusted Engine Efficiency

This analysis with the GM Unified Model was then compared to the EU eco-innovation credit methodology. While the EU credit methodology specifies Willan's numbers of 0.264 for gasoline engines and 0.28 for turbocharged gasoline engines, a review of GM test data for current engines shows that 0.3055 is the best value encountered for an actual production gasoline engine. The GM Unified Model gives similar results to the EU eco-innovation methodology when the EU methodology uses a realistic Willan's number. Using a Willan's number of 0.31, and the U.S. test cycle average speed of 54 kilometers per hour, the EU eco-innovation formula yields a credit of 0.188 grams CO2 per mile for a 1% improvement in the VDA efficiency rating of the alternator.

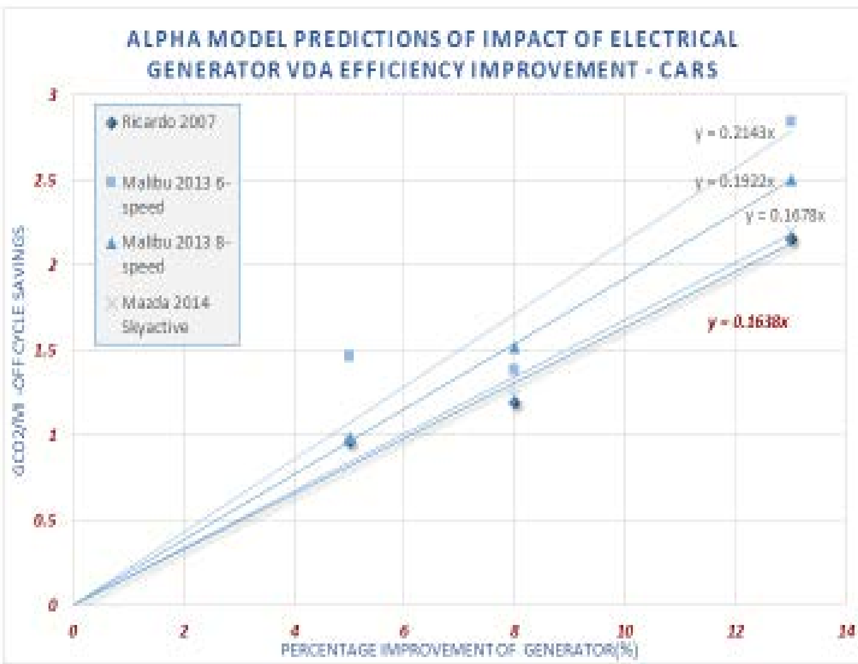
Credit Methodology

The Version 2.0 EPA ALPHA model was used to simulate the off-cycle fuel and CO_2 savings from alternator efficiency improvements, based on assumed electrical loads of 350 Watts on-cycle and 750 Watts in the real world. Version 2.0 was used since it was the latest version compatible with the Matlab software that was available to the GM engineering group performing this analysis. Four vehicle configurations available in this version of Alpha were used. These were small and midsize cars, which should generally yield relatively small off-cycle credits for alternator efficiency improvements, since these are relatively fuel efficient vehicles compared to industry averages.

As the following tables show, the credits calculated range from a low of 0.16 grams CO_2 per mile per 1% alternator VDA efficiency improvement, up to a high of 0.21 grams CO_2 per mile.

ALPHA CONFIGURATIONS REVIEWED

	2007_standard_car_ricardo_NA	2013_chevy_malibu_2p5l	2013_chevy_malibu_2p5l2	2014_mazda_skyactiv_US_20l_93AKI_v2
Engine Vintage	past	present	present	present
Transmission	transmission_2008_estimated_5AT	transmission_2013_GM_6T40_matrix	transmission_2014_FCA_8AT_FWD	transmission_2013_GM_6T40_matrix
Transmission Gears	5	6	8	6
RL A lbf	29.797529	29.797529	29.797529	29.797529
RL B lbf/mph	0.172102	0.172102	0.172102	0.172102
RL C lbf/mph^2	0.0186	0.0186	0.0186	0.0186
Combined FE - MPG	31.49	34.31	37.7	36.33
Combined GHG - gCO2/mi	282.2	259	235.7	244.6
gCO2/mi per %VDA Improvement	***0.16***	***0.21***	***0.19***	***0.17***



Summary of Analyses

The following table summarizes the analyses discussed in this petition:

Analysis	Description	Off Cycle Credit per 1% VDA Improvement (grams CO_2 per mile)
2011 GM Unified Model	Avg. of 20 Simulations, Small and Midsize Car and SUV	0.168
2011 Denso		0.28
2015 GM Unified Model	Heavy Duty pickup	0.5
2017 GM Unified Model	Valeo 72% on 7 Small and Midsize Vehicles	0.175
2017 GM Unified Model	Valeo 80% on 7 Small and Midsize Vehicles	0.167
2017 GM Unified Model	8 Large Trucks	0.18
EPA Alpha 2.0 Model	2007 Ricardo Standard Car	0.16
EPA Alpha 2.0 Model	2013 Malibu 6-speed	0.21
EPA Alpha 2.0 Model	2013 Malibu 8-speed	0.19
EPA Alpha 2.0 Model	2014 Mazda SkyActiv	0.17
EU Eco-Innovation	Gasoline	0.142
EU Eco-Innovation	Gasoline Turbo	0.15
EU Eco-Innovation	Diesel	0.134
EU Eco-Innovation	Adjust Willan's to 0.31	0.188

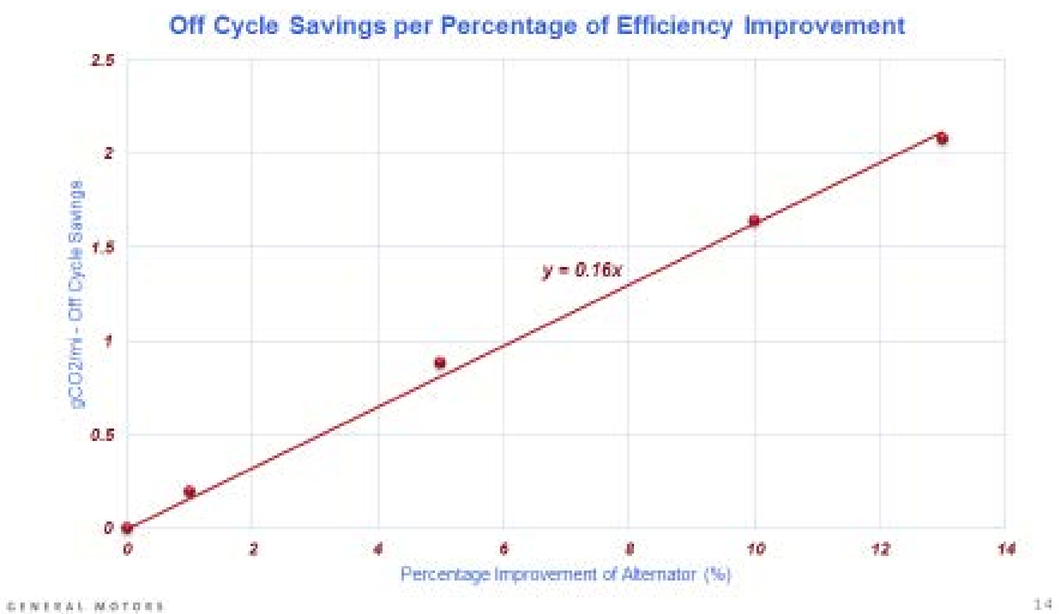
As can be seen from this table, 0.16 grams CO_2 per mile per 1% VDA improvement would be a conservative factor to use to calculate off-cycle credits for all light-duty vehicles. It represents the low end of the range of simulations performed using the EPA Alpha model, and it is also at the low end of the range of simulations performed using the GM Unified Model. These simulations include the full range of vehicles from small cars to the largest light-duty pickup trucks and SUV's. Although the EU eco-innovation credit methodology yields a slightly smaller credit amount when adjusted to the average speed of the U.S. test cycle, the EU methodology rises to give larger credits (0.188 grams CO_2 per mile per 1% VDA) if the Winan's number is adjusted to more accurately reflect the best vehicles in the North American market.

Based on this review of a wide range of analyses performed over the past six years, GM proposes the use of a scalable off-cycle credit value as calculated by the following formula for all vehicle categories:

$$Credit\ \left(\frac{g}{mi}\right) = 0.16\frac{g}{mi}\times\left(\eta_{alt} - \eta_{avg}\right)$$

Where:
Credit = the off-cycle credit in grams per mile for the high efficiency alternator
η_{alt}= the alternator efficiency based on the VDA test procedure
η_{avg} = the industry average baseline alternator efficiency

GM also recommends the use of 67% VDA as the industry average baseline alternator efficiency for the credit calculation, therefore using the value 0.67 for the variable η_{avg} in this credit calculation.



Durability
Durability of alternators used in GM products has been thoroughly tested to meet General Motors specifications. Durability specifications for General Motors alternators are included in Attachment B. These specifications include generator efficiency requirements defined by both the VDA and GMNA test procedures (Appendix B, GM specifications, p. 7). Reliability and durability requirements are set through 150,000 miles (Appendix B, GM specifications, p. 9). It must be demonstrated that each alternator design can maintain acceptable performance to these standards by passing a series of at least 18 validation tests, including a thermal excursion test, high speed endurance test, maximum speed endurance test, mechanical shock test, vibration durability test, connector/terminal retention test, environmental exposure test, contamination tests (humidity, dust and muddy water spray), corrosion test, salt spray test, thermal cycle life validation test, noise tests, electromagnetic compatibility test, load dump transient test, over-voltage protection test and reverse

voltage protection test (Appendix B, GM specifications, p. 14-19). General Motors only uses alternators which successfully pass all durability testing.

One objective of these durability evaluations is to determine the performance level that effectively represents GM alternators in actual use over the full useful life of candidate in-use vehicles of each vehicle design, including predicting any expected in-use deterioration. Based on these tests, GM is willing to attest that the alternators covered in this petition are expected to meet EPA requirements for in-use durability over the complete vehicle lifetime of at least ten years for cars and eleven years for trucks, and no reduction has been applied for in-use degradation of the benefits of these high efficiency alternators.

Conclusion

Based on the analysis presented in this petition, General Motors hereby requests that EPA approve an off-cycle greenhouse gas credit of 0.16 grams CO_2 per mile for each 1% VDA efficiency improvement above a 67% VDA efficiency baseline rating. The current request would apply this credit formula to the list of vehicles contained in Appendix A. If this request is approved, we anticipate making further claims for credits using the same methodology for future vehicles in 2017 and subsequent model years. This credit calculation methodology conservatively estimates the fuel savings that can be expected from this technology in actual real-world usage in U.S. national average conditions, and the conservatism of this methodology should result in the real-world fuel savings exceeding the credited amounts. We therefore also request that EPA endorse this simple and conservative off-cycle credit methodology as a common template for the industry. The relevant 2010-2016 models and their sales volumes and credits are listed in Attachment A.

Thank you for your consideration of this application for off cycle greenhouse gas credits.

Fredrick S. Sciance
Manager, Environment, Energy and Safety Policy
General Motors Public Policy Center

Attachments:

Attachment A: Confidential Listing of 2010-2016 GM Vehicles with High Efficiency Alternators, Sales Volumes and Credits

Attachment B: Confidential General Motors Engineering Standards for Alternators

c: Roberts French
David Wright
James Tamm
Barbara Kiss
Scott Simon