Reviewing EPA's FuelEconomy.Gov PlugIn Emissions

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2012 Toyota Prius

2012 Chevrolet Volt

2012 Nissan Leaf

March 2012

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Introduction

Several of the white papers on this website have analyzed electric car fuel economy information on car window stickers. These papers have noted that important information is missing from the window sticker. For some time I have been following the Environmental Protection Agency (EPA) fueleconomy.gov website waiting for promised new functionality to make comparing vehicle MPG and CO_2 emissions easier. [1] I was very interested in this new information since the past data provided by the EPA, the Department of Energy (DOE) and the Department of Transportation (DOT) was sometimes inaccurate and often incomplete. The new functions on fueleconomy.gov are now available and I have used them to compare 2012 models of the Toyota Prius, the Chevrolet Volt and the Nissan Leaf. I assumed I could now get an "apples to apples" comparison and settle some long standing doubts about the accuracy of Miles per Gallon equivalent (MPGe) and CO_2 grams per mile for plug-in cars.

Fueleconomy.gov is also referred to on the new window sticker that becomes effective with the 2013 car models. Thus it is the main source of information for the details I was seeking. Doing this analysis left me with two conclusions. First it is difficult to find the information and the new functions do not give clear straightforward explanations. Furthermore, there are contradictions about MPG and CO_2 on the website; in one place it says certain information is not available and in another place the information can be found. Secondly, the information presented on the website is far more voluminous than on the label, causing some information overload. This contributes to the difficulty of obtaining clear and complete data. Hopefully the EPA will do a better job of integrating the website with the new 2013 window sticker. At the same time the organization could address the sticker errors and omissions that I have previously pointed out.

Fueleconomy.gov Graphics

I will show the details of the EPA's website by stepping through the sequence I used to obtain MPG and CO_2 information. I captured the resulting website screens, placed them in this paper, and then analyzed the components. From fueleconomy.gov I picked the "Find and Compare Cars" option on the lower left of the home page. At the next prompt I was presented with a "Browse by Model" option with three selection choices for Year, Make and Model. I first entered 2012, then Toyota, and then Prius. Results appeared with an option to "Add a Vehicle". I selected this and added the Volt and the Leaf, following the process of picking the year, the company and the model. I then selected "Compare". The results are shown in Figure 1 and Figure 2 (There was more data than could be captured in a single figure).

Fuel Economy | Energy and Environment | Safety | Specs

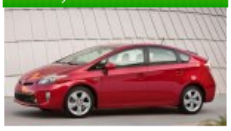
	2012 Toyota Prius	2012 Chevrolet Volt	2012 Nissan Leaf
Personalize	Hybrid Vehicle	Plug-in Hybrid	Electric Vehicle
			
	1.8 L, 4 cyl, Automatic (variable gear ratios)	1.4 L, 4 cyl, Auto (AV) MSRP: $39,145	Automatic (A1)
EPA Fuel Economy			
Miles per Gallon	Regular Gasoline: 50 Combined; 51 City, 48 Highway	Premium Gas: 37 Combined; 35 City, 40 Highway	
Miles per Gallon Equivalent 1 gallon of gasoline=33.7 kw-hr		Electricity: 94 Combined; 95 City, 93 Highway	Electricity: 99 Combined; 106 City, 92 Highway
kw-hrs/100 miles		Electricity: 36 Combined; 36 City, 37 Highway	Electricity: 34 Combined; 32 City, 37 Highway

Figure 1: Fuel Economy (MPG) for Prius, Leaf and Volt (all 2012)

MPG Estimates from Drivers Like You			
Learn more about "Your MPG"	User MPG estimates are not yet available for this vehicle	Average based on 2 vehicles: 38.9 (39 Lo – 39 Hi)	User MPG estimates are not yet available for this vehicle
		View Individual Estimates	
Fuel Economics ⓘ			
Cost to Drive 25 Miles	Gas: $1.72	Prem only: $2.51	Elec: $1.02
		Elec only: $1.08	
Fuel to Drive 25 Miles	Gas: 0.50 gallons	Prem only: 0.68 gallons	Elec: 8.50 kw-hrs
		Elec only: 9.00 kw-hrs	
Cost to Fill the Tank	-	Prem: $31	-
Miles on a Tank	-	Prem: 310 miles	-
Tank Size	-	9.3 gallons	-
Annual Fuel Cost*	Gas: $1,032	Prem only: $1,508	Elec: $612
		Elec only: $648	

*Based on 45% highway, 55% city driving, 15,000 annual miles and current fuel prices. Personalize.
MSRP and tank size data provided by Edmunds.com, Inc.

Figure 2: Other Fuel Economics for Prius, Leaf and Volt (all 2012)

Note that although the information in Figure 2 could be useful, it is cumbersome and based on erroneous Miles per Gallon equivalent (MPGe) information in Figure 1. I may analyze this in the future, but will not do so in this paper.

In Figure 1 there are four tabs - Fuel Economy, Energy and Environment, Safety, and Specs. Selecting the Energy and Environment option gives the graphic shown in Figure 3. This displays Annual Petroleum Consumption in barrels of oil along with a statement that 1 barrel = 42 gallons. It then shows barrels used under Energy Impact Score rather than gallons, requiring calculations to reach the more common gallon measure. Greenhouse Gas Emissions show horizontal bars with a pointer which indicates some non-numerical comparison of all cars in a specific class. The bar graphs add little to the data shown here, as the important information is the numeric values above the bars – 178 grams per mile for the Prius, 240 grams per mile for the Volt, and 0 for the Leaf.

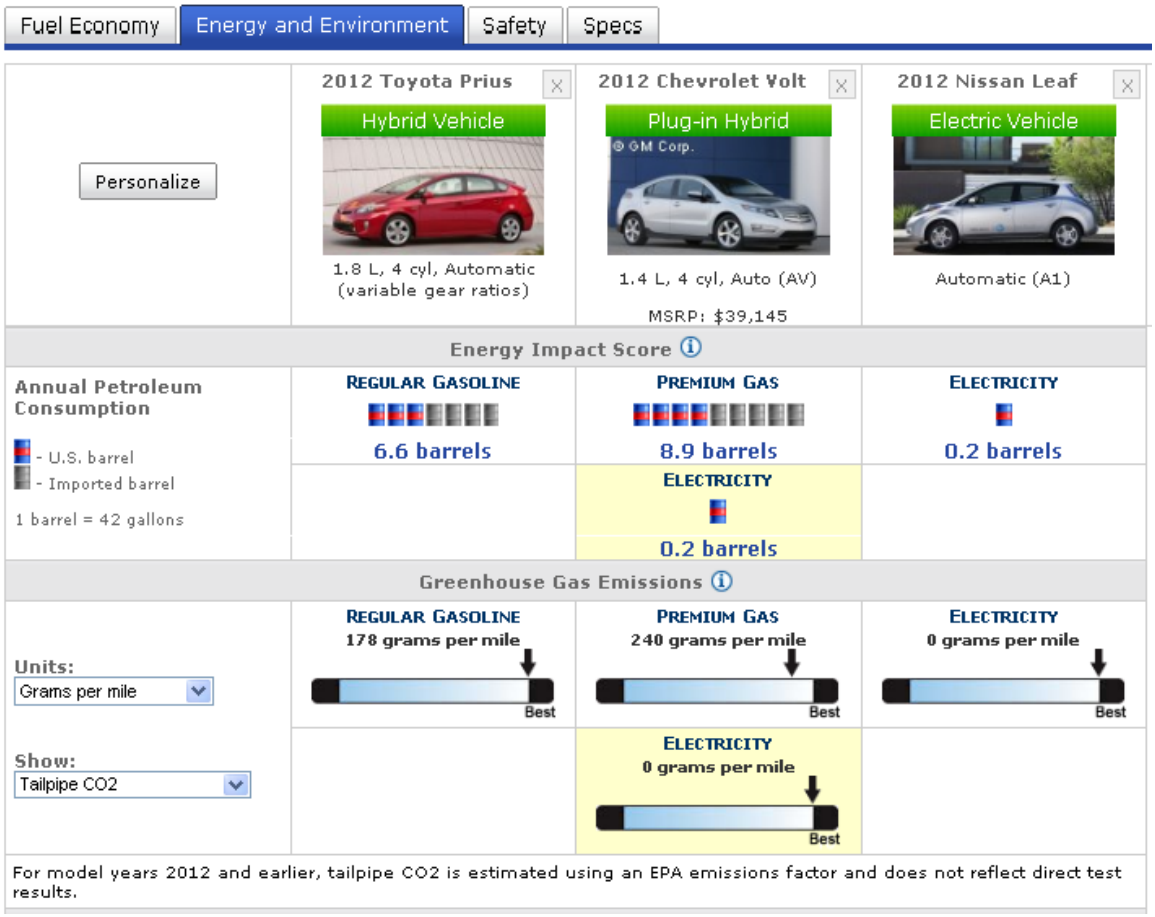


Figure 3: Energy & Environment (tailpipe only) – CO_2 for Prius, Volt and Leaf (2012)

There is a field labeled Show in the lower left of Figure 3 that allows the selection of "Tailpipe CO_2" or "Tailpipe and Upstream GHG". Selecting this second option provides the graphic in Figure 4 with new Greenhouse Gas Emissions values. However, the upstream CO_2 emissions of electric vehicles are not given; only the CO_2 for gasoline vehicles is provided. This is unfortunate since one cannot get a full picture of the Energy and Environment data without this information.

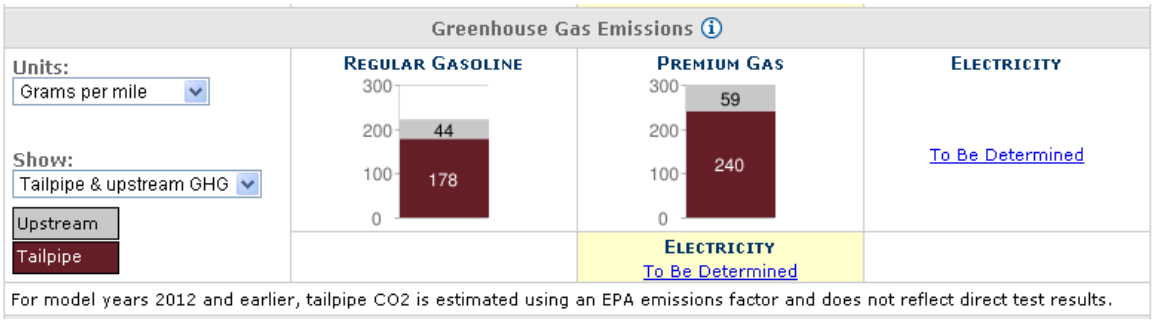


Figure 4: CO_2 for Prius, Volt and Leaf – Energy & Environment (tailpipe & upstream)

Note that 44 grams have been added to the original Prius' 178 grams per mile and 59 grams have been added to the Volts' 240 grams per mile. The change in format from a horizontal bar to a vertical column shows an inconsistency in the presentation. There is such a small amount of additional information that a more complete presentation could have been used from the start.

But the important information relative to CO_2 emissions from electricity used to charge the plug-in batteries is missing. Instead two "To Be Determined" entries under the heading "Electricity" are highlighted, one for the Volt and one for the Leaf. Clicking on either option results in this caveat:

> Electric vehicles (EVs) themselves emit no greenhouse gases (GHGs), but substantial emissions can be produced "upstream" at the electric power plant. Upstream emissions for any particular EV will vary greatly depending on where and when the vehicle is charged. Upstream emissions will be higher in areas where electricity is generated primarily from burning coal, lower when natural gas is used, and near zero when it is produced from nuclear, hydro-electric, wind, or solar power. Many areas get power from several sources, and the percentage of electricity produced from "clean" power can vary by season and even by time of day. *EPA is in the process of developing a method for calculating a useful and meaningful estimate of upstream greenhouse gas emissions for consumers. We will provide these estimates on fueleconomy.gov as soon as they become available*. (Italics mine)

I was certain the EPA knew how to calculate the appropriate numbers and had hoped the new functionality on the EPA website would provide the data. I found that following an alternate path from the main page does show the desired information. It is accessed from the home page of fueleconomy.gov, by clicking on "New Window Stickers" and then "Beyond Tailpipe Emissions". This provides a way to find the CO_2 emissions information for the Leaf and the Volt. After selecting "Beyond Tailpipe Emissions" and entering my zip code, results for the Volt (Figure 5) and the Leaf (Figure 6) were displayed.

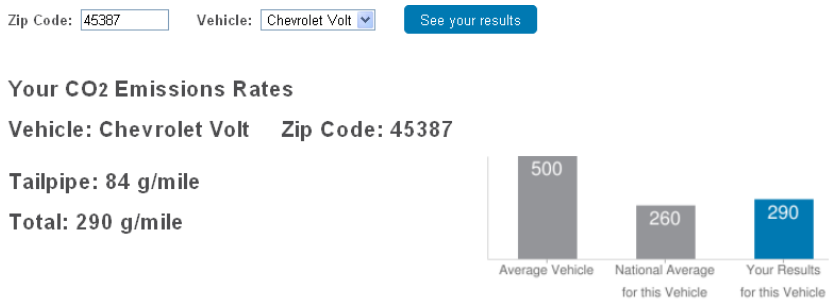


Figure 5: CO_2 Emissions for Plug In Hybrid Volt

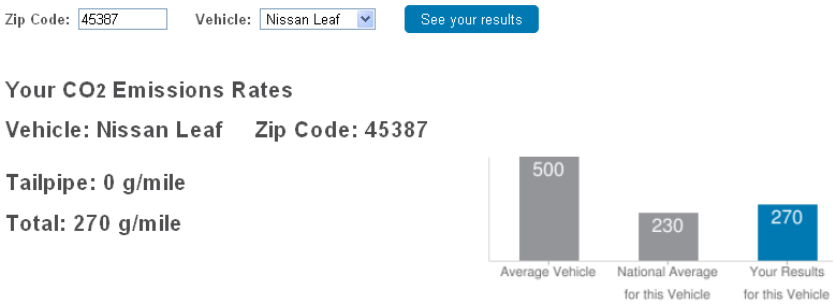


Figure 6: CO_2 Emissions for All Electric Leaf

This makes it clear that the power plant fuel mix and the CO_2 generated for any place in the country is known by the EPA. Other government agencies also have the data as shown in Figure 7, which is a DOE map showing the distribution of energy for each state, the Net Electricity Generation by State, and the Fuel Source.

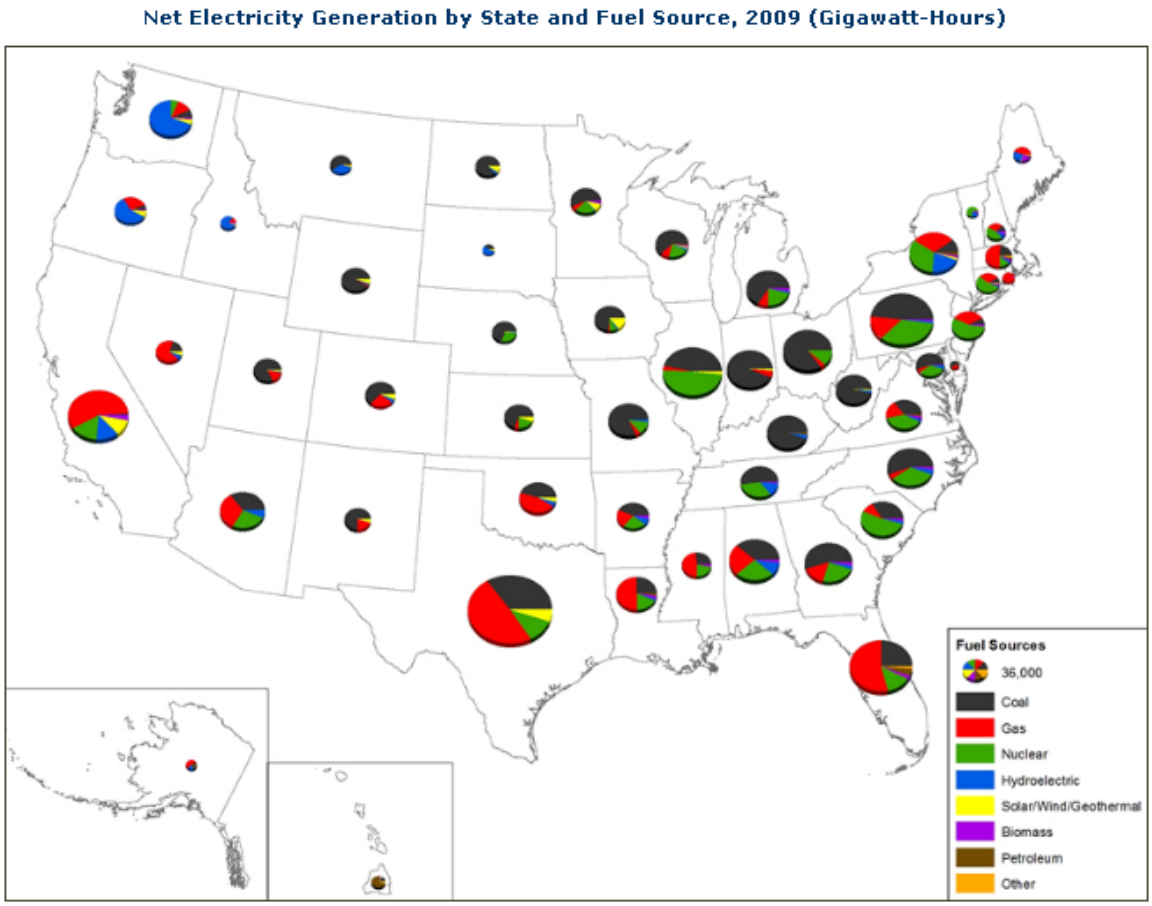


Figure 7: Map of US with Fuel Mix for Electricity [2]

The EPA could easily connect the "Energy and Environment" results with the "Beyond Tailpipe Emissions" information on their website. To not provide grams per mile of CO_2 for either the Leaf or the Volt when operating on electricity under "Find and Compare Cars" is either an oversight or deliberate. The grams per mile for gasoline operation includes an upstream component for refining and transportation of 20%, showing that the actual CO_2 generated from gasoline cars when operating is 80% of the total (Figure 4). Another energy specialist source uses 17% for upstream CO_2 which is the value I have used in other white papers on this website. [3]

Summarizing the Information

In analyzing information from the EPA website, it can be useful to separate the vital numerical data from the graphics that accompany it since the graphical elements often make it harder to understand the numerical information. Sometimes two different formats are used for the same information in different parts of the website. The graphics are relatively large with small text print, making it hard to clearly perceive the numerical data. In this section of this paper I have provided the essential rating data and terms, dropping the pictures of barrels of oil and bars with markers. In some cases I have also simplified the presentation. For example the website presents MPG in a triad format with combined mileage higher and centered relative to city and highway mileage. I list them in a simple column. Table 1 is a summary of the numerical information from Figure 1 that does not contain "upstream" energy use. Regular and premium gas designations are ignored.

	2012 Toyota Prius	2012 Chevrolet Volt	2012 Nissan Leaf
GASOLINE			
Miles Per Gallon	50 Combined 51 City 48 Highway	37 Combined 35 City 40 Highway	
ELECTRICITY			
Miles per Gallon Equivalent – 1 gallon of gasoline=33.7 kw-h		94 Combined 95 City 93 Highway	99 Combined 106 City 92 Highway
Kw-hrs/100 miles		36 Combined 36 City 37 Highway	34 Combined 32 City 37 Highway

Table 1: Fuel Economy – MPG for Prius, Leaf and Volt (all 2012)
Summary of Figure 1

Note that this part of the website does not contain all relevant information. For example the equivalent to kWh/100 miles would be "gallons per 100 miles" but this is not shown for the Prius even though "gallons per 100 miles" is on the 2013 window sticker.

Table 2 summarizes the information from Figure 2.

Fuel Economics	Prius	Volt	Leaf
Cost to Drive 25 Miles	Gas $1.72	Gas 2.51 Elec. $1.08	Elec. $1.02
Fuel to Drive 25 miles	0.5 gallons	0.68 gallons Elec. 9 kw-hrs	Elec 8.5 kw-hrs
Cost to Fill the Tank		$31	
Miles on a Tank		310 miles	
Tank Size		9.3 gallons	
Annual Fuel Cost	Gas $1,032	Gas $1,508 Elec: $648	Elec: $612

Table 2: Cost Economics – Summary of Figure 2 Information

In Table 3 I have summarized the information from Figure 3 (tailpipe only) and Figure 4 (tailpipe and upstream). I converted the cumbersome "barrels of petroleum" to gallons of gasoline and kWh, the actual energies used to move the car. The code "tbd" in Table 3 is an abbreviation for the phrase "to be determined" listed in two places in Figure 4.

	2012 Prius	2012 Volt	2012 Leaf
Annual Consumption			
Gasoline (gallons)	277	374	
Electricity (gallons equiv.)		0.8	0.8
CO2 Grams per mile gasoline			
Upstream	44	59	tbd
Tailpipe	178	240	
CO2 Grams per mile electricity			
Upstream		tbd	tbd
Tailpipe			

Table 3: CO_2 for Prius, Volt and Leaf (2012) – Energy and Environment Option
Summary from Figures 3 and 4

With some work, the CO_2 emissions from electric cars can be derived from information on the EPA website. In Table 4 I have added the data from Figure 5 and Figure 6 to the information in Table 3. The EPA website calculator that provided the Leaf and Volt CO_2 numbers for Figure 5 and 6 provided the national average which I use here. Upstream and tailpipe emissions could easily be shown on a single chart. In fact, it is hard to understand why someone would want to see tailpipe only emissions separately.

	2012 Prius	2012 Volt	2012 Leaf
Annual Consumption			
Gasoline (gallons)	277	374	
Electricity (gallons equiv.)		0.8	0.8
Total	277	374.8	0.8
CO2 Grams per mile gasoline			
Upstream	44	59	0
Tailpipe	178	240	0
Total	222	299	0
CO2 Grams per mile electricity			
Upstream		84	0
Tailpipe		206	270
Total		290	270

Table 4: CO_2 for Prius, Volt and Leaf – Energy and Environment (tailpipe & upstream)
Summary from Figures 3 and 4

If one wishes to, the CO_2 numbers can also be calculated directly from the EPA window sticker or the fueleconomy.gov comparisons shown in Figure 1. Both the window sticker

and the website provide a “kw-hrs / 100 miles” number. The value for the Volt is 36 kWh / 100 miles and the value for the Leaf is 34 kWh / 100 miles.

There are 260 grams of CO_2 generated from burning a gallon of gasoline. Multiplying the kWh / 100 miles by 2.6 and then dividing by the correction factor of 0.36 (discussed in other white papers on this site) gives 260 g/mile for the Volt and 245 g/mile for the Leaf, fairly close to the CO_2 values in Figures 5 and 6 of 290 g/mile for the Volt and 270 g/mile for the Leaf obtained from EPA website calculator. More information as to how the EPA does these calculations would be useful.

Eliminating the superfluous information provides the basic results desired by the typical consumer. Table 5 is an example of a much simpler and much more accurate representation of MPG and MPGe as well as CO_2 in grams per mile.

	Prius	Volt	Leaf
MPG and MPGe combined	50	35	36
CO_2 (grams per mile) combined	222	290	270

Table 5 Simple Version

Conclusion

The EPA has claimed it was sorting out the issue of upstream CO_2 emissions for some time. In my white paper on the BEV[4] I quoted a statement the EPA made in August, 2009.[5]

> EPA has not tested a Chevy Volt and therefore cannot confirm the fuel economy values claimed by GM. EPA does applaud GM’s commitment to designing and building the car of the future—an American-made car that will save families money, significantly reduce our dependence on foreign oil and create good-paying American jobs. We’re proud to see American companies and American workers leading the world in the clean energy innovations that will shape the 21st century economy.

Obviously the EPA has been working on this problem for at least three years. Their interim window sticker of November 2010 and the final 2013 window sticker published in May 2011 contain essentially the same information, which I elaborated on in my BEV white paper. [6] Since one EPA website page says they are trying to figure it out and another says they have figured it out, some form of stonewalling may be taking place. It may well be an effort to protect the campaign pledge of President Obama that committed the nation to subsidize one million 150 MPGe plug-in hybrid cars (later changed to all plug-ins of any type) at the original rate of $7,500 per car and a new rate of $10,000 per car. It would be embarrassing to find the President, or his advisors, did not understand the difference between source and site energy as well as source and site CO_2, in EPA terminology, Upstream and Tailpipe Only.

Previous white papers of mine have discussed electric vehicle history in great detail, pointing out the invalid high MPGe numbers. Using an appropriate calculation involving upstream to tailpipe only ratios will give more accurate MPG (or MPGe) and more accurate CO_2 emissions. The issue seems to be more political than technical. In my previous white paper entitled "The EPA's Flawed 2013 Window Sticker" on this website I called for the EPA to provide new labels that are accurate and disclose information fully before the 2013 model year. Clearly they have the information but so far this has not happened.

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[1] Fueleconomy.gov http://www.fueleconomy.gov/

[2] Net Electricity Generation by State and Fuel Source, 2009 (Gigawatt-Hours) http://explore.data.gov/Energy-and-Utilities/Electricity-Generation-by-State-by-Type-of-Produce/rhyi-ndfk Accessed January 24, 2012

[3] Fuel Economy Numbers for Electric Vehicles, Prepared by: MIT Electric Vehicle Team, March 2008, http://mit.edu/evt/summary_mpgge.pdf Accessed Sep 1, 2011

[4] History and Status of the Battery Electric Vehicle (BEV), Section entitled "A Question of Credibility", http://www.pluginscam.org/

[5] EPA Applauds GM Effort, but Says It Cannot Confirm Volt's Claimed 230 MPG By Scott Doggett, August 11, 2009 http://www.autoobserver.com//2009/08/epa-applauds-gm-effort-but-says-it-cannot-confirm-volts-claimed-230-mpg.html, Accessed January 24, 2011

[6] History and Status of the Battery Electric Vehicle (BEV), Section entitled "CO_2 Emissions of Electric Vehicles: Inaccurate and Accurate Calculations", http://www.pluginscam.org/