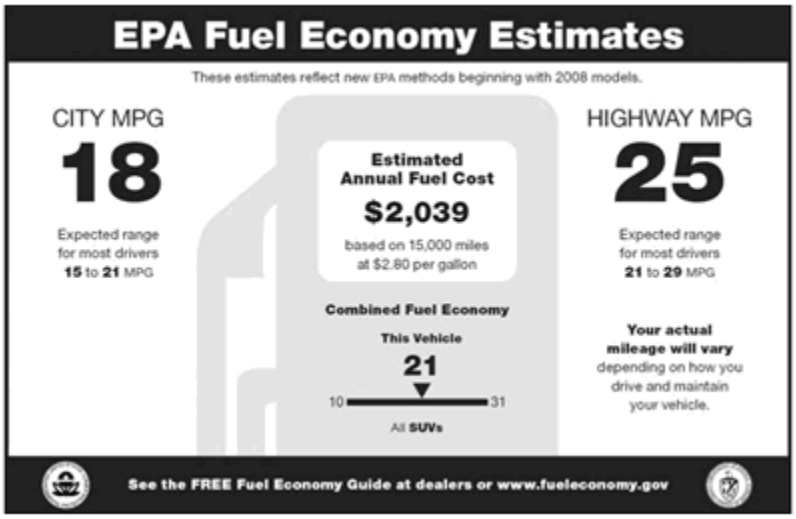
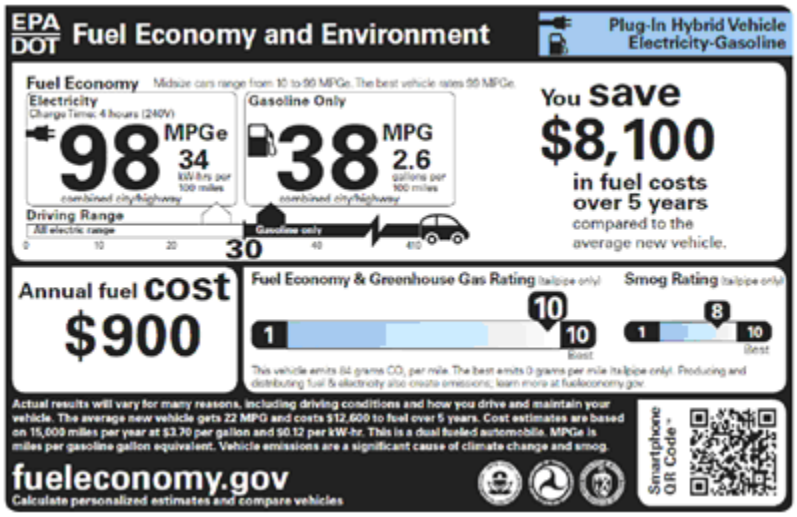
# The EPA's Flawed 2013 Window Sticker

## Supporting Vehicle Electrification by Misrepresenting MPG Equivalency

**By Pat Murphy, Plan Curtail**




**Accurate Simple Window Sticker**




**Inaccurate Complicated Window Sticker**

**February 2012**

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## Introduction

Automobile “window stickers” provide relevant information about new automobiles (Figure 1). They are affixed to every new car in every car showroom in the U.S. The window sticker is specified and designed by the Environmental Protection Agency (EPA) with support from the Department of Energy (DOE) and Department of Transportation (DOT); the logos of all three organizations are on the most recent sticker. The EPA and related agencies set the standards for car fuel economy testing but do not do the actual testing of cars; this is done by the car manufacturers. Automakers are required to test one representative vehicle – typically a preproduction prototype – for each combination of loaded vehicle weight class, transmission class, and basic engine. EPA reviews the results and verifies a small number of the cars tested using their own tests at the National Vehicles and Fuel Emissions Laboratory.

Figure 1: EPA and DOE Heads Reviewing a New Window Sticker

The information on the window sticker reflects government policies. For decades, the most significant information has been the miles per gallon (MPG) ratings. The window sticker also includes the car classification, organized by size and type, such as subcompact, compact, mid size, full size, sports car, etc. The highest and lowest MPG rating for all cars in a particular class is included on the sticker. An Annual Estimated Fuel Cost for each car is also included.

The window stickers changed very little for three decades. In 2008 an even simpler version of the original sticker was provided, eliminating some of the original data. In 2011 a very substantial change was made to the sticker which will become official in 2013. The amount of information on the sticker has more or less doubled as measured by word count. The changes in the sticker reflect changes in government policy. More emphasis has been placed on the five year financial savings of a particular car compared to the average car. The word count for this part of the sticker increased from 5 words on the 1977 sticker to 13 words on the 2008 sticker to 47 words on the 2011 sticker. $CO_2$ emissions information was added for the first time to the 2011 sticker,

including the $CO_2$ generated, measured in grams per mile, as well as where this car fits on a $CO_2$ scale of 1 to 10 within its class. This new complexity is illustrated by comparing the density of information on the 2008 window sticker (on the left) and the 2011 sticker (on the right) in Figure 2.


Figure 2: Complexity and Density of 2008 and 2011 (2013) Window Stickers

A very significant addition to the most recent window sticker is Miles per Gallon Equivalent (MPGe) for battery electric vehicles (BEVs) and Plug-In Hybrid Vehicles (PHEVs). This reflects the high priority the Obama administration has set for electric cars, allocating billions of dollars for battery and EV manufacturing programs.

The issue of government required labels on products is controversial. One well known example is the government food label, famous for its confusion and frequent updating and redesigning. It is extremely difficult to put a complex topic like nutrition in a few square inches. The same situation could occur with cars although the relevant car information is much more limited and the number of square inches of space for information is much greater on car stickers than food labels. However, the information on either can be used to educate or to obfuscate. For example, the accuracy and completeness of the most recent version of the window sticker relative to accurate fuel economy and $CO_2$ emissions information is questionable. The influence of car manufacturers as well as energy companies and utilities on the design and information content on the window stickers cannot be overemphasized.

The white papers on this website are gathered under the overall rubric of “Plug-in Scam”. The term “scam” is used because a group of government agencies, non profits, utilities, automakers, and lobbyists are deliberately manipulating consumers to buy electric vehicles. They are doing this by misrepresenting the physics and mathematics of miles per gallon equivalency (MPGe) between electricity and gasoline. Window sticker designs ignore the fact that energy is consumed and $CO_2$ generated when creating electricity at a power plant. This is a violation of basic physical laws. This could be a fatal strategic flaw that may result in a backlash which could challenge both the integrity of the newest window sticker and its significantly increased complexity.

**Window Sticker History – 1975 to 2010**

The Energy Policy and Conservation Act of 1975 required that a car window sticker[1] must contain the fuel economy of the automobile, the estimated annual fuel cost, the fuel economy range of comparable sized automobiles, and a statement that a Fuel Economy Guide would be available at all car dealers. Other related information could be incorporated into the “Monroney” label required by the 1958 Automobile Information Disclosure Act. A.S. "Mike" Monroney, a longtime Oklahoma congressman, introduced the Automobile Information Disclosure Act. [2] This law required a label be affixed on all new vehicles which must included the make, model, serial or identification numbers, the final assembly point, the name and location of the dealer, the method of transportation used in delivering the automobile, the Manufacturer's Suggested Retail Price (MSRP or "sticker price") of the base vehicle, the price of optional equipment installed on the base vehicle, and the transportation charges for delivery of the vehicle to the dealer from the manufacturer. Window stickers resulting from the 1975 law first became available in 1977.

For many years the window stickers concerning fuel economy were simple and contained the minimal MPG information required by law. Figure 3 shows the sticker from a 1993 Toyota Camry that is representative of window stickers from 1977 to the mid 2000s.[3]

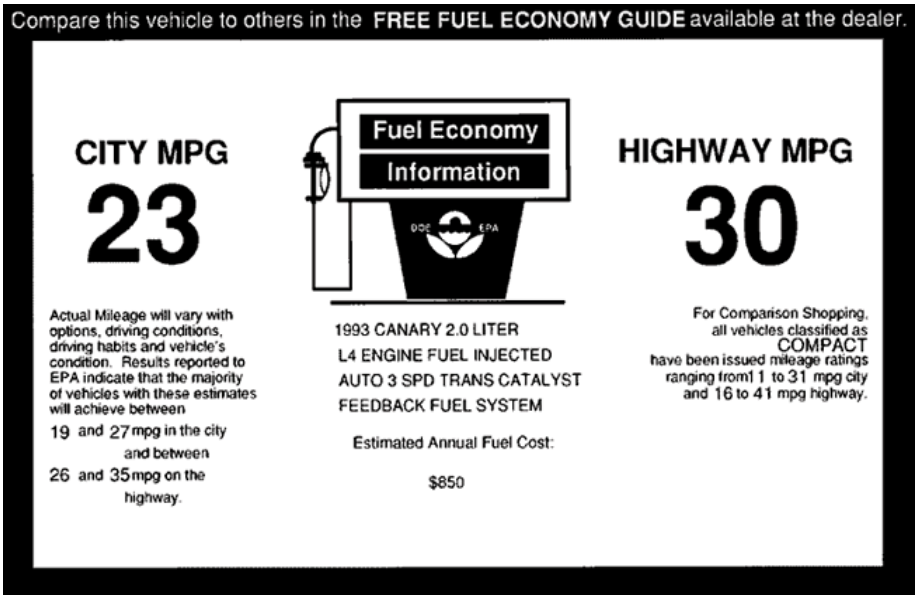


Figure 3: 1993 EPA Window Sticker Example

The most important items on the sticker were the MPG ratings, which historically included different values for city and highway. In addition to the two MPG ratings a range of MPG values were given that reflected the fuel economy of all vehicles in a particular class. The EPA logo was placed on the lower part of the gasoline pump graphic under the title Fuel Economy Information. It was somewhat obscure and in many cases the connection to the EPA was not made by consumers. The top of the sticker noted that more comparative information was available in a Free Fuel Economy Guide that auto

dealers had to make available on request (There was no Internet access at that time). There are approximately 115 words and unique numbers in this sticker.

In 2006 the EPA revised the fuel economy window sticker to be effective in the 2008 model year. This is illustrated in figure 4.[4]

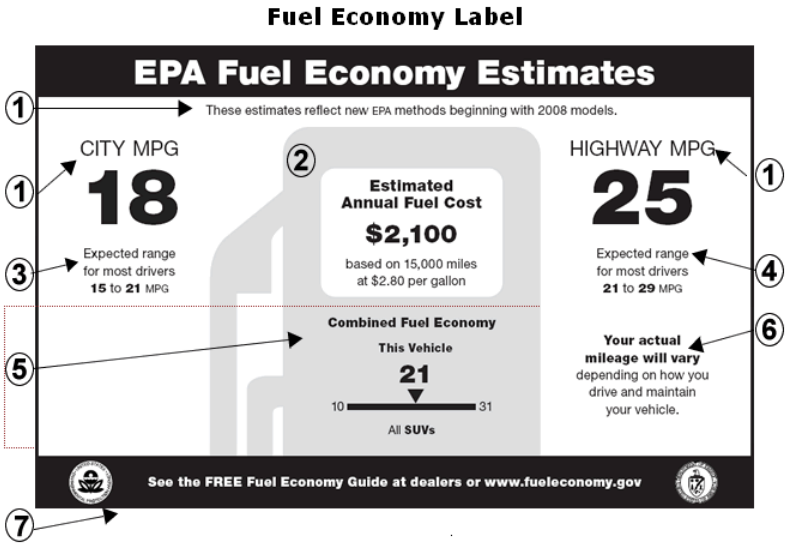


Figure 4: Model Year 2008 Fuel Economy Window Sticker [5]

There are several differences between this sticker and the one from the late 1970s (Figure 3). The differences include changing the sticker title “Fuel Economy Information” to “EPA Fuel Economy Estimates” and relocating it to the top of the sticker. The fuel economy range (lower right on the older sticker) was divided into two parts and moved under the city and highway MPG. A new Combined Fuel Economy was added, located in the lower middle part of the sticker. In figure 4 the range is from 10 to 31 for the class of All SUVs. The “Combined Fuel Economy – This Vehicle” implies 21 MPG rather than stating it specifically. This sticker contains 85 words and unique numbers.

Below is a summary of the changes to the window sticker.

1. Updated Presentation Methods – The sticker shows the estimated city MPG at the top left, and highway MPG at the top right.
2. Estimated Annual Fuel Costs – The center of the sticker provides estimated annual fuel costs based on a given number of miles and a particular fuel price, also listed on the sticker. The annual miles driven and the cost of fuel have been added.
3. Expected City Range – Expected city MPG range appears at the top left, under the main city MPG estimated number.
4. Expected Highway Range – Expected highway MPG range appears at the top right, under the main highway MPG estimated number.
5. Compare to Other Vehicles in this Class – The lower center of the sticker gives a combined city/highway estimate for that vehicle, and shows where that value falls on a bar scale. The bar scale gives the highest and lowest fuel

economy of all other vehicles in its class (e.g. SUVs, minivans, compact cars, etc).

6. "Your Actual Mileage Will Vary" Statement – The sticker includes a reminder that there are many reasons why your actual fuel economy may vary from the estimates.

7. Free Fuel Economy Guides and Website – Consumers are reminded about additional sources of information.

The new sticker is somewhat easier to read than the former one. However, information from the original version that described the power train of the car was unfortunately dropped.

**The 2011 (2013) Window Sticker**

The first window sticker was used for 31 years – from model year 1977 through model year 2007. The current sticker has been used for five years – from model year 2008 through model year 2012. As stated earlier, a new window sticker was approved in 2011 and will become official with the 2013 model year. In this document the new sticker will be referenced as a 2011 (2013) sticker to show the year the window sticker was approved as well as the car model year in which it will be first applied.

Figure 5 shows the new sticker along with numerical indicators in circles for various features. These are described below. There are about 180 words and numbers in this sticker example, twice the information on the 2008 sticker shown in figure 4.

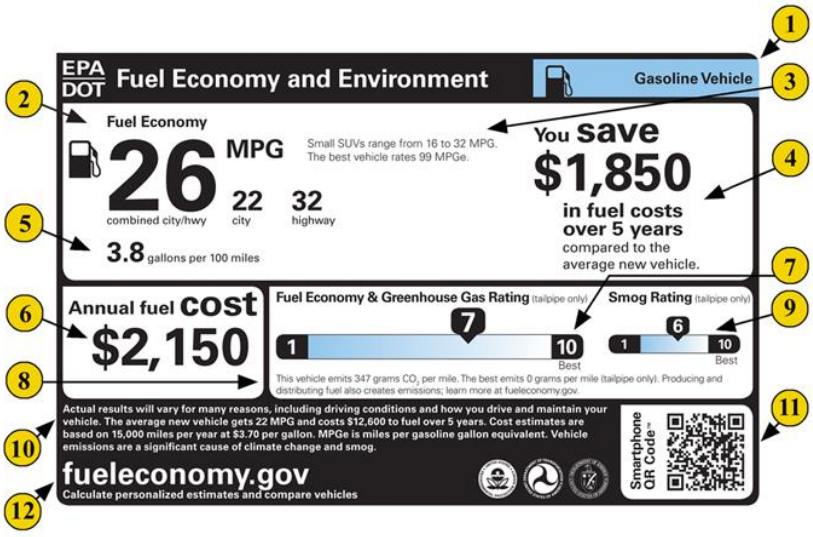


Figure 5: 2011 (2013) EPA Window Sticker [6]

The following list is matched to the window sticker example in figure 5 with each number corresponding to the numbers in circles on the left and right side of the sticker.[7]

1. Vehicle Technology & Fuel – The upper right corner of the sticker displays text and a related icon to identify it as a vehicle that is powered by gasoline. Note that hybrid gasoline-electric vehicles that do not have plug-in capability are classified as gasoline vehicles.

2. Fuel Economy – The sticker shows City, Highway, and Combined MPG (miles per gallon) values, with the Combined MPG value more prominent. Combined fuel economy is a weighted average of City (55%) and Highway MPG (45%).
3. Comparing Fuel Economy to Other Vehicles – This text indicates the class category of the vehicle (e.g., Small SUV, Station Wagon, Pickup Truck, etc.) and the best and worst MPG within that class category for the given model year. There are nine car categories, six truck categories, and a "special purpose vehicle" category.
4. You Save/Spend More over 5 Years Compared to Average New Vehicle – This gives the estimated fuel cost savings for a five-year period for the vehicle compared to the average new vehicle (which is shown in the small print at the bottom of the sticker to get 22 MPG). These estimates are based on driving 15,000 miles per year for five years, with a projected fuel price of $3.70 per gallon of gasoline.
5. Fuel Consumption Rate – Miles per gallon (MPG) estimate, historically described as Fuel Economy, has appeared on the sticker for several decades. A new metric has been added which expresses fuel efficiency in terms of Fuel Consumption (e.g., gallons per 100 miles) rather than in terms of fuel economy (MPG). The revised sticker now includes both, although fuel consumption is given only for combined MPG.
6. Estimated Annual Fuel Cost – This shows the annual fuel cost for the vehicle is based on two assumptions: an annual mileage of 15,000 miles and a projected gasoline price of $3.70 per gallon.
7. Fuel Economy and Greenhouse Gas Rating – The new sticker assigns each vehicle a rating from 1 (worst) to 10 (best) for Fuel Economy and Greenhouse Gas Ratings. The rating is listed on a bar graph for both.
8. $CO_2$ Emissions Information – This very small text provides three pieces of information:

Combined city/highway $CO_2$ tailpipe emissions – The rate of $CO_2$ emissions is displayed in grams per mile. Note this is only for tailpipe emissions and does not include power plant emissions.

Vehicle with lowest $CO_2$ emissions – The sticker identifies the lowest tailpipe $CO_2$ emissions of available vehicles.

$CO_2$ from producing energy – The sticker notes that producing energy generates $CO_2$. It does not give any data on the sticker.

9. Smog Rating – This is a rating for vehicle tailpipe emissions of those pollutants that cause smog and other local air pollution. This information, listed as "Smog" on the stickers, is displayed on a horizontal bar with a scale of 1 (worst) to 10 (best).
10. Details in Fine Print – This part of the sticker includes a reminder that your fuel economy and emissions may be different due to a number of factors, such as how you drive and maintain your vehicle, how much you use air conditioning and other accessories, the weather, road conditions, how much the vehicle is loaded, and other factors. It also details the assumptions that are used to determine the estimated annual fuel cost and the value used to compare 5-year costs to the average vehicle. EPA assumes average annual mileage of 15,000 miles.
11. QR Code® – You will be able to scan the QR Code® on the new sticker using your Smartphone, which will link you to additional information about the vehicle.

12. www.fueleconomy.gov – The sticker directs you to a website where you can compare vehicles and enter personalized information (e.g., local gas prices and individual driving habits) to get best possible cost and energy-use estimates.

The 2011 (2013) sticker includes several different versions to cover a variety of new vehicle types besides gasoline vehicles (shown in figure 5). These types include electric vehicles, natural gas vehicles, and flex fuel cars. One of the versions provides fuel economy information for a new unique power train, the Pluggable Hybrid Electric Vehicle or PHEV (Figure 6).[8] It is the most complex of the new stickers with a total word and number count of about 220.

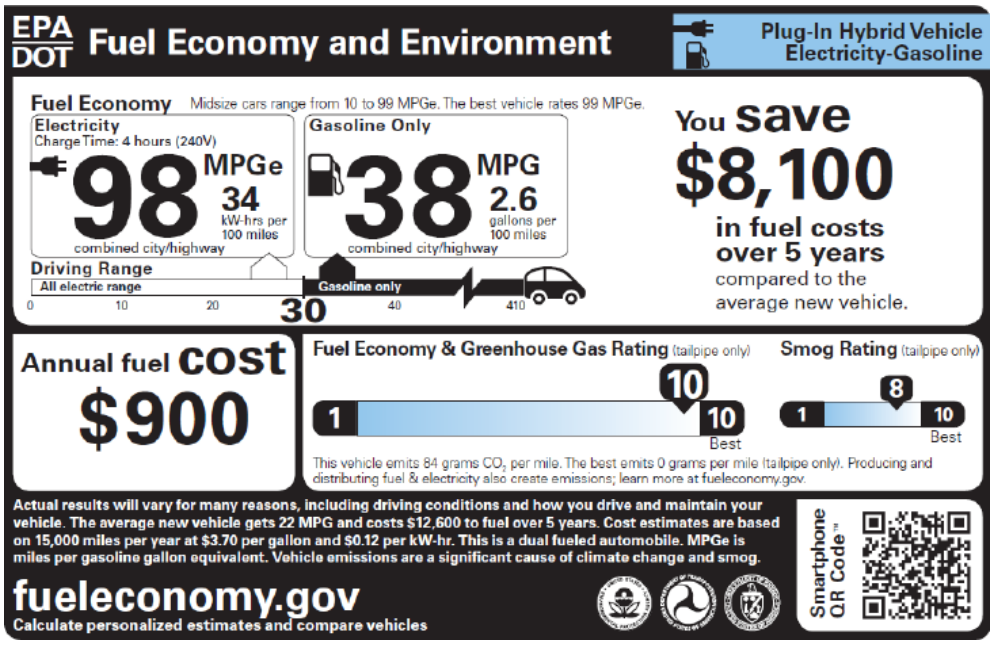


Figure 6: Plug-In Hybrid Vehicle (PHEV) Fuel Economy Window Sticker

Table 1 shows the increasing complexity of the window stickers by the combined counts for words and numbers.

| Window Sticker Year | Word/Number Count |
|---|---|
| 1977 | 115 |
| 2008 | 85 |
| 2011 General | 200 |
| 2011 PHEV | 220 |

Table 1: Increase in Amount of Sticker Information Over Time

The increased information has led to some tradeoffs. For example, PHEV stickers no longer have city and highway fuel economy ratings but only combined city/highway MPG.

**Comparing Historical Sticker Changes From 1977 to 2011 (2013)**

This section analyzes the differences in the various sticker versions by comparing the text information without reference to formats and graphic elements. Analyzing the text separate from the font size, bolding or other characteristics provides a new perspective. The window stickers provide a limited number of types of information, including:

A Name on the Sticker – normally at the top
MPG – combined, city and highway
Driving Habits Warning – about personal driving and car maintenance
Vehicle Class and Rating – identifying the range of MPG in vehicle's class
Vehicle Description – (removed in later versions)
Fuel Consumption – based on gallons or kWh per 100 miles in 2013 sticker

The text for each of the four window stickers illustrated in Figure 3 through Figure 6 is summarized below.

1977 window sticker (figure 3)

*1. Name of Sticker* – Fuel Economy Information.
*2. MPG on Sticker* – City MPG 23, Highway MPG 30.
*3. Driving Habits Warning* – Actual mileage will vary with options, driving conditions, driving habits and vehicle's condition.
*4. Driver Range* – Results reported to EPA indicate that the majority of vehicles with these estimates will achieved between 19 and 27 MPG in the city and between 26 and 35 MPG on the highway.
*5. Vehicle Class and Rating* – For Comparison Shopping all vehicles classified as COMPACT have been issued mileage ratings ranging from 1 to 31 MPG city and 16 to 41 MPG highway.
*6. Vehicle Description* – 1993 CAMRY 2.0 LiiTer L$ ENGINE FUEL INJEXTE ATUO 3 SPD TRANS CATALYST FEEDBACK FUEL SYSTEM.
*7. Annual Cost:* Estimated Annual Fuel Cost: $850.

2008 window sticker (Figure 4)

*1. Name of Sticker – EPA* Fuel Economy Estimates. These estimates reflect new EPA methods beginning with 2008 models.
*2. MPG on Sticker* – City MPG 18, Highway MPG 25, Combined Fuel Economy This Vehicle 21.
*3. Driving Habits Warning* – Your actual mileage will vary depending on how you drive and maintain your vehicle.
*4. Driver Range* – Expected range for most drivers (for city) 15 to 21 MPG. Expected range for most drivers (for highway) 21 to 29 MPG.
*5. Vehicle Class and Rating* – All SUVs range from10 to 31.
*6. Vehicle Description* – None.
*7. Annual Fuel Cost* – Estimated Annual Fuel Cost: $2,100 based on 15,000 miles at $2.80 per gallon.

2011 (2013) window sticker – Conventional car (Figure 5)

*1. Name of Sticker* – EPA/DOT Fuel Economy and Environment, Gasoline Vehicle.
*2. MPG on Sticker* – Combined 26 MPG combined city/hwy. 22 City, 32 Highway.

*3. Driving Habits Warning* – Actual results will vary for many reasons, including driving conditions and how you drive and maintain your vehicle.
*4. Driver Range:* None.
*5. Vehicle Class and Rating* – Small SUVs range from 16 to 32 MPG. The best vehicle rates 99 MPGe. MPGe stands for miles per gasoline gallon equivalent.
*6. Vehicle Description* – None.
*7. Annual Fuel Cost* – Annual Fuel Cost $2,150*.* Cost estimates are based on $15,000 miles per year at $3.70 per gallon.

2011 (2013) window sticker – PHEV car (Figure 6)

*1. Name of Sticker* – EPA/DOT Fuel Economy and Environment, PHEV Vehicle.
*2. MPG on Sticker* – Combined 38 MPG, Combined electricity 98 MPGe.
*3. Driving Habits Warning* – Actual results will vary for many reasons, including driving conditions, and how you drive and maintain your vehicle.
*4. Driver Range* – None.
*5. Vehicle Class and Rating* – Midsize cars range from 10 to 99 MPGe. The best vehicle rates 99 MPGe. MPGe is miles per gasoline gallon equivalent.
*6. Vehicle Description* – None.
*7. Annual Fuel Cost* – Annual fuel cost $900*.* Cost estimates are based on $15,000 miles per year at $3.70 per gallon and $0.12 per kW-hr.

Over a three decade period, there is some rewording but essentially not much change. For example, the first window sticker Annual Cost wording was “Estimated Annual Fuel Cost: $850”, in the second window sticker it was “Estimated Annual Fuel Cost: $2,100 based on 15,000 miles at $2.80 per gallon” and the 2011 (2013) version is “Annual Fuel Cost $2,150*.* Cost estimates are based on $15,000 miles per year at $3.70 per gallon”.

The PHEV car window sticker looks similar to the others but includes a new term MPGe which stands for Miles Per Gallon Equivalent. It has two values for MPG, one the MPG for the gasoline engine and one the MPGe for the electric engine.

**New Additions to the 2011 (2013) Window Sticker**

New classes of information have been added to the 2011 (2013) sticker. This new information for the gasoline vehicle shown in Figure 5 is:

*1. Five Year Cost Savings* – You save (or spend) $1,850 in fuel costs over 5 years compared to the average new vehicle. The average new vehicle gets 22 MPG and costs $12,600 to fuel over 5 years.
*2. Fuel Consumption* – 3.8 gallons per 100 miles.
*3.* $CO_2$ – This vehicle emits 347 grams $CO_2$ per mile. The best emits 0 grams per mile tailpipe only. Producing and distributing fuel also creates emissions. Vehicle emissions are a significant cause of climate change and smog. For the PHEV car the emissions are 86 grams $CO_2$ per mile.
*4. Fuel Economy and Green Gas Rating* – This car is rated seven on a scale of 1 to 10.
*5. Smog Rating* – This car is rated 6 on a scale of 1 to 10.
*6. Car type* – This is a dual fueled automobile.

The amount of new information is somewhat significant as shown in Table 1. Five year savings (or spending) costs have been added which requires describing the characteristics of the average new vehicle so they can be compared against the vehicle being considered. This requires adding two sentences. Fuel economy (MPG) has been the basis for comparison for 33 years but now a new Fuel Consumption number has been added, which is the inverse of fuel economy. It is arguable if this is needed. The literature implies that it was done because it is standard in Europe.

Most of the additional information deals with fuel economy, green house gas ratings, smog and $CO_2$. The $CO_2$ text as shown above is particularly wordy, possibly because it does not have a single number but rather a number that is not representative of the actual $CO_2$ from all sources, including the $CO_2$ created at the power plant. For plug-ins the $CO_2$ numbers have a "tailpipe only" designation, acknowledging that power plant emissions are not included.

The major addition to the window sticker is the MPGe rating. This is an attempt to find a value comparable to the long-standing MPG rating for gasoline vehicles. For PHEVs the window sticker must now measure the car fuel economy for both its gasoline only mode and its electric only mode. This is difficult and label space is limited. For example, the 2011 (2013) sticker for PHEVs shown in figure 6 only contains combined MPG, with the familiar city and highway MPG missing. Electric cars add kWh as a source of energy but rather than developing this, for example by adding "Miles per kWh", an awkward conversion to MPGe is made. There is a comment in small print saying "MPGe is miles per gasoline gallons equivalent" which may mean nothing to the average consumer. The use of MPGe is not well understood and may prove to have been a mistake.

**The 2011 (2013) Window Sticker Format**

As already shown window sticker changes from the 2008 window sticker to the 2011 (2013) window sticker were significant. Consider the fact that the number of words almost doubled as shown in Table 1, making the 2011 (2013) sticker harder to read. The sticker uses a very small font in places which obscures important information. Questionable graphics take a lot of space, such as the figures of a gasoline pump and an electric plug. The MPG size is larger than on earlier labels while the other text is now smaller.

Figure 7 shows the precise specification for the window sticker. This graphic comes from a 419 page document describing the sticker in detail along with its history. It is a formidable document showing the complexity of creating a window sticker format. [9]

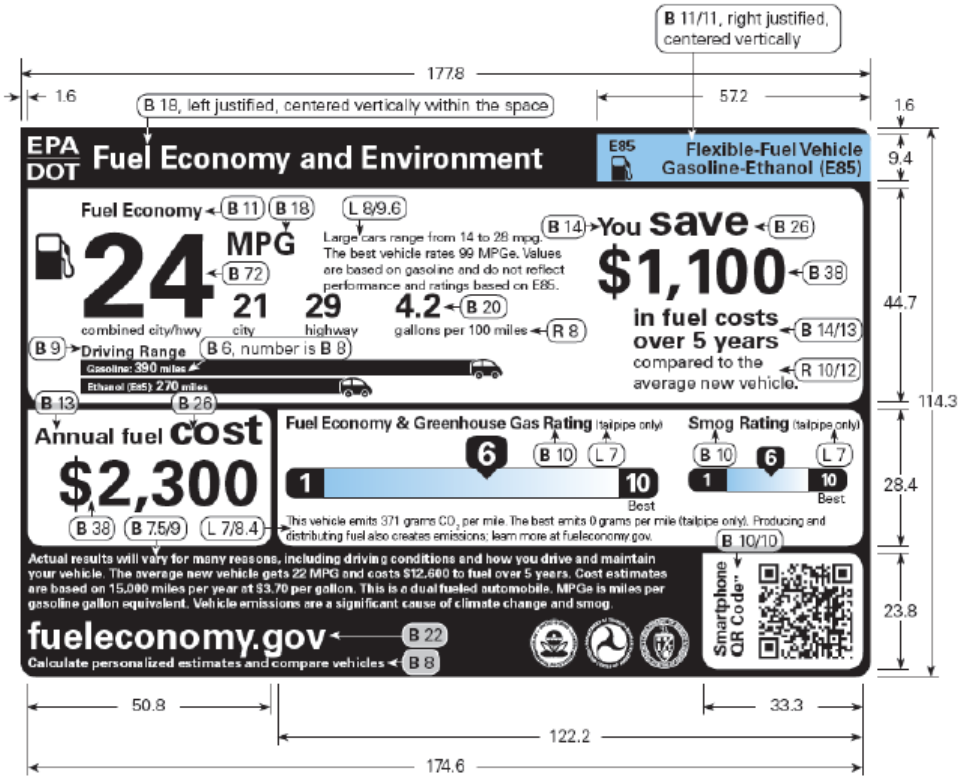


Figure 7: Formatting Rules for 2011 Window Sticker

There are a total of 15 font sizes - 6, 7, 7.5, 8, 8.4, 9, 9.6, 10, 12, 13, 14, 18, 22, 26 and 38. The limitation of size is very apparent in the area at the bottom which is very difficult to read both because of the small font size and the use of reverse black and white formatting. This reflects marketing and promotional strategies.

An EPA report that discussed the parameters for designing the 2008 sticker (figure 4) emphasized that people distrust small print.[10] It noted that fine print adds unnecessary or unclear information. According to the report, many people stated that fine print would not get read and that it implied something that is to be hidden. “If you want me to read it, make it bigger” was the recommendation of people who contributed to the report. In the 2011 (2013) sticker the philosophy seems to have shifted. Fine print is everywhere.

**Confusing Sticker Formatting – Fuel Costs**

One way to analyze the effectiveness of the sticker is to study a subset of the total sticker content, such as fuel costs, which I will do for a gasoline vehicle. Figure 8 (same as figure 5) shows a 2011 (2013) sticker for a gasoline vehicle.

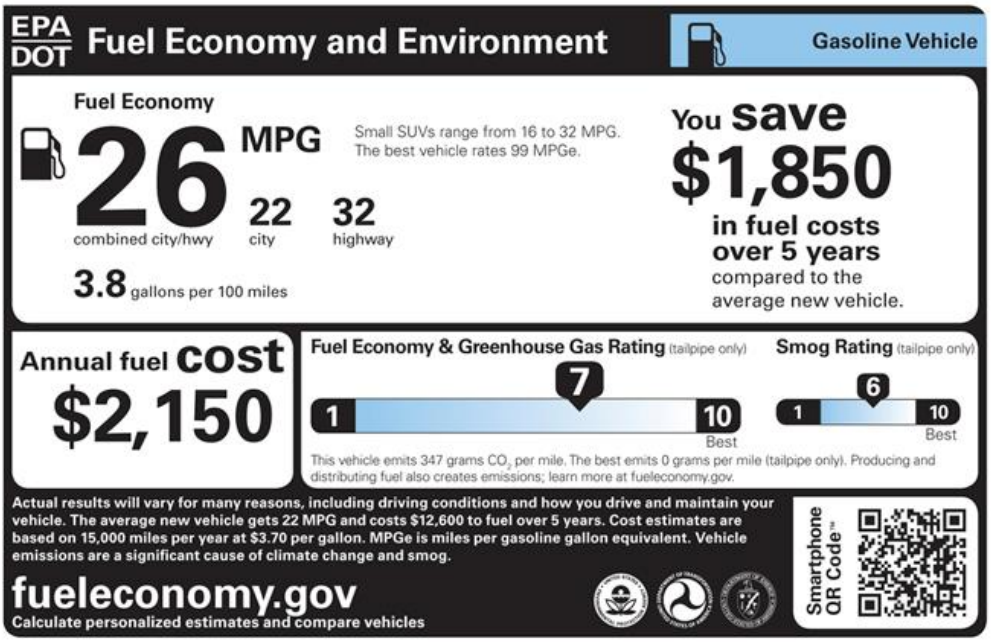


Figure 8: 2011 (2013) Gasoline Vehicle Sticker

The information relative to fuel costs are in three different places on the window sticker. The first is the savings in the upper right. The second is the annual fuel cost in the lower left. The third is near the bottom in the “fine print” section of the sticker.

In figure 9 I show only these three parts of fuel cost by removing all information except for the cost sections. The fuel cost savings (upper right) is calculated by using the annual fuel cost in the lower left and comparing it to the cost information from the average new car available in the lower fine print part of the sticker. Thus the information dealing with a single theme is shown to be in three different places on the sticker using many different type sizes and styles. The term “type” refers to different type faces, such as Helvetica or Arial. In this example there are many size and styles (bold, small, white on black, etc.)


Figure 9: Three sections of 2011 (2013) Sticker Addressing Fuel Costs

Formatting is a key component. Figure 10 shows the relevant words from the three areas in Figure 9 that deal with costs. Note that the first sentence uses five font sizes for fifteen words and numbers. The second sentence uses three font sizes for four words and numbers. The remaining 28 words and numbers are white on a black background.

**You save $1,850 in fuel costs over 5 years** compared to the average new vehicle. **Annual fuel cost $2,150**

The average new vehicle gets 22 MPG and costs $12,600 to fuel over 5 years. Cost estimates are based on 15,000 miles per year at $3.70 per gallon

Figure 10: Example of Extreme Formatting

When these are shown alone, the misleading effects become clear. For clarity, this information should be in one place, not three, and written in a consistent manner for the consumer. Figure 11 simplifies the information. This is important as we are educating and providing information to the consumer, not attempting to convince him or her to buy.

You save $1,850 in fuel costs over 5 years compared to the average new vehicle that gets 22 MPG and costs $12,600 to fuel over 5 years. Annual fuel cost is $2,150 based on driving 15,000 miles annually with a gasoline cost of $3.70 per gallon.

Figure 11: Example of Simple Formatting

It is important that the sticker should educate rather than obfuscate. Once the messages are clear, good design can be used to make them easy to understand. The space needed to do this will probably be smaller. Using mixed extremely large and small fonts is an emotional approach used for marketing reasons rather than an approach for clear understanding. Such an emotional approach focuses the eye on one set of particulars and ignores others.

**Government Priorities as Measured by Format Differences**

The use of sticker formatting to affect consumer behavior should not be overlooked. Figure 12 is derived from the same 2011 (2013) sticker (figure 8) and is an example of the government's priority relative to $CO_2$ emissions versus MPG. The $CO_2$ emission value is in the smallest lightest lettering on the sticker. In this example, (size scaled up for readability) the 72 point font for MPG is bold for the number 26 while the 9 point font for the number 347 (amount of CO2 generated per mile) number in the lower right hand corner is very small and light.

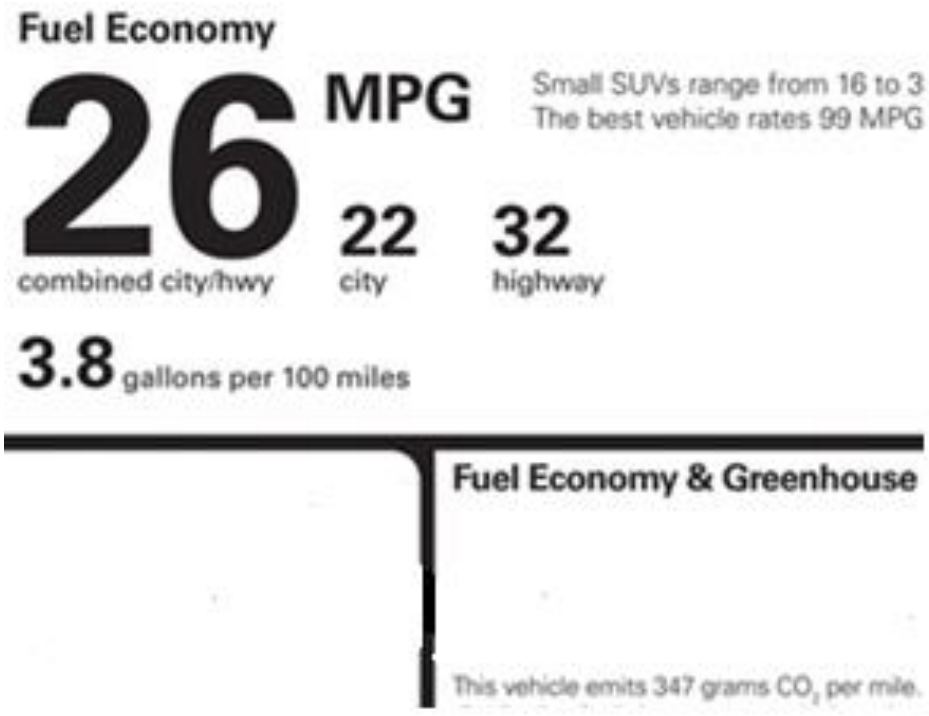


Figure 12: Font size and Highlighting Comparisons for 2011 (2013) Sticker

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The current approach to labeling is not impartial. One can tell a lot about government priorities and intentions by the complexity of the sticker and the emphasis placed by graphical design elements on the different categories. The EPA and other government agencies are not completely neutral. In this case, they have chosen to deemphasize $CO_2$ emissions.

**Two Failures of the 2011 (2013) Sticker**

There are two major failures of the 2011 (2013) window sticker. First is the misrepresentation of MPGe for electrification. Second is the understatement of $CO_2$ emissions. The first will be apparent to some when they see the term MPGe rather than MPG in the fuel economy section. The second is obvious from the words “tailpipe only” and “the best emits 0 grams per mile.” These phrases distort the information from the window stickers to the extent that it may be useless. Essentially “tailpipe only” and “MPGe” are not explained and their derivation is both misleading and inaccurate.

It is important to understand that the terms “tailpipe only” and MPGe misrepresent the energy and emissions of electric vehicles. As I have explained previously, the 2011 (2013) sticker ignores the energy costs of refining and transportation of oil and gasoline as well as the energy costs of creating electricity. The energy cost penalty is 17% for gasoline vehicles and 67% for electric vehicles. The quandary for the government is that including this information will result in a reduction of MPG for gasoline cars and a dramatic reduction of MPGe for electric cars. However, it would make clear that plug-in cars do not significantly reduce $CO_2$.

As the nation begins to face up to its climate and energy crises, we must take on the task of educating people. References to fueleconomy.org might help but consumers would have to decide to go there first. Misleading information should be removed from the 2011 (2013) sticker before the newer cars come on to the market. Alternatives are not difficult to develop. Standards should be set that reflect the energy cost of creating both gas and electricity. A caveat for gasoline might be a statement such as:

> Fuel economy estimates do not include energy used and $CO_2$ emissions created from refining oil into gasoline or transporting oil to the refinery and gasoline to service stations. If these were included MPG would be 17% less than the number shown. (42 words)

For electricity a similar statement is needed such as:

> Fuel economy estimates do not include energy used and $CO_2$ emissions created in generating electricity from fossil fuels and in transmitting electricity to the consumer. If these were included MPGe would be 67% less than the number shown. (38 words)

The EPA changed all mileage numbers in 2008 on the fueleconomy.gov website. This resulted in lower MPG numbers and reflected better information that had become available. The same thing could be done again, changing all MPG numbers for gasoline to reflect the energy expended to refine and transport gasoline. Plug-in cars would have

MPGe numbers that reflected the creation and transportation of electricity. Then people can use the numbers for comparison and evaluation.

**Understanding Source Energy versus Site Energy**

We need to understand the difference between energy in its original form and energy in its final form after some kind of transformation. This includes the gasoline obtained from refining oil and the electricity obtained from burning coal, natural gas and other fuels. This understanding can also be used to determine the fossil fuel energy inputs for corn that is later refined into ethanol which is added to gasoline. The terms for using energy to make a different form of energy (oil to gasoline, coal to electricity, natural gas used in corn fertilizers to grow corn to make ethanol) is "source" and "site" energy. The gasoline in your car or the electricity at an outlet in your house is the site energy. The EPA has a good explanation on the subject of source and site energy in reference to buildings. [11]

> The difference between site and source energy - Most building managers (*Author's note – and homeowners*) are familiar with *site energy*, the amount of heat and electricity consumed by a building as reflected in utility bills. Site energy may be delivered to a facility in one of two forms: primary and/or secondary energy. *Primary energy* is the *raw fuel* that is burned to create heat and electricity, such as natural gas or fuel oil used in on site generation. *Secondary energy* is the energy product (heat or electricity) created from a raw fuel, such as electricity purchased from the grid or heat received from a district steam system. A unit of primary and a unit of secondary energy consumed at the site are not directly comparable because one represents a raw fuel while the other represents a converted fuel. Therefore, in order to assess the relative efficiencies of buildings with varying proportions of primary and secondary energy consumption, it is necessary to convert these two types of energy into equivalent units of raw fuel consumed to generate that one unit of energy consumed on-site. To achieve this equivalency, EPA uses the convention of source energy.
>
> When primary energy is consumed on site, the conversion to source energy must account for losses that are incurred in the storage, transport and delivery of fuel to the building. When secondary energy is consumed on site, the conversion must account for losses incurred in the production, transmission, and delivery to the site. The factors used to restate primary and secondary energy in terms of the total equivalent source energy units are called the *source-site ratios*.
>
> The use of national conversion factors - The efficiency of secondary energy (e.g. electricity) production depends on the types of primary fuels that are being consumed and the specific equipment that is used. These characteristics are unique to specific power plants and differ across regions of the country. For example, some states have a higher percentage of hydroelectric power, while others consume greater quantities of coal. Because ENERGY STAR is a national program for protecting the environment through energy efficiency, EPA has determined that it is most equitable to employ national-level source-site ratios. As such, there is only one source-site ratio for each of the primary and secondary fuels in Portfolio Manager, including electricity. (*Authors note* -

*Portfolio Manager is an interactive energy management tool for tracking and assessing energy consumption for a group of buildings*.) The use of national source-site ratios ensures that no specific building will be credited (or penalized) for the relative efficiency of its utility provider. (*Authors note – The same methodology can be used for Plug-in Vehicles).* ……..For more detailed information on source energy, refer to "ENERGY STAR Performance Ratings, Methodology for Incorporating Source Energy Use." [12] This complete technical document provides detail on the distinction between site and source energy and the value of performing source energy comparisons.

Quoting the information does not imply that this description should be used just as it is for cars. Rather it is to point out that a terminology and methodology exists relative to accounting for the source energy used to create electricity from fossil fuels that could be modified slightly to apply to cars. This kind of understanding needs to be part of the education of consumers. It is not a difficult concept and could be the beginning of an attempt to educate rather than promote. Understanding that a plug-in car is a big mobile appliance that is plugged into the home electricity system will help change our perspective. It is conceptually simple and not arithmetically challenging.

**Suggested Content for a New Sticker**

Consumers don't need a picture of a gas pump, a plug, a tiny car or horizontal bars without numerical scales. Nor is it helpful to have 16 different type sizes for a document that contains about 200 words. The original justification for the window sticker was to provide numeric information so that comparisons could be made between different cars. No one wants to struggle to read fine print nor do we react positively to it, assuming something is being deliberately hidden. If the information is important, it should be made easily readable. Consider the ease of reading the 2008 window sticker compared to the 2011(2013) version (Figure 2).

The priority of information is also important. I think most Americans view the window sticker principally as a way to provide comparative miles per gallon (MPG). Thus Fuel Economy is the single most important factor. These were the principle numbers on the first window sticker from the 1970s (See Figure 3). The 2008 sticker added Combined Fuel Economy MPG to the city MPG and highway MPG. It also expanded Fuel Cost by giving the basis for its calculation, that is, miles driven yearly and price per gallon of gasoline.

The 2011 (2013) sticker added Fuel Consumption information written in the form of Gallons per 100 miles. I am not sure of its usefulness as I noted earlier. Apparently it is justified by the fact that European car companies provide this information. Whatever the case, it doesn't take much space to provide it. The latest sticker also included $CO_2$ emissions measured in grams generated per mile.

The following table shows how easily the information above could be expressed. This uses about 50 words and numbers, 25% of the approximately 200 words and numbers used for recent sticker text. This table uses the Prius 2012 statistics. (The term "tbd" in the following tables stands for "to be determined" and is used to show where eventual values are to be placed.). Calculations cannot be made yet since the EPA has not

provided a consistent way of accessing the information I need about these topics on its website.

| | City | Highway | Combined |
|---|---|---|---|
| Miles per Gallon (MPG) – site | 51 | 48 | 50 |
| Miles per Gallon (MPG) – source | 42 | 40 | 41 |
| Miles per Gallon (MPG) – lost | 9 | 8 | 9 |
| Gallons per 100 miles – site | 4.5 | 3.1 | 3.8 |
| $CO_2$ grams per mile – source | tbd | tbd | 210 |

Table 2: Proposed Window Sticker Measurements – Hybrid Gasoline Car

A battery vehicle such as the Nissan Leaf would have a similar representation as shown in Table 3, which uses about 60 words and numbers.

| | City | Highway | Combined |
|---|---|---|---|
| Miles Per Gal eqv. (MPGe) – site | 106 | 92 | 99 |
| Miles Per Gal eqv. (MPGe) – source | 35 | 33 | 30 |
| Miles Per Gal eqv. (MPGe) – lost | 71 | 59 | 69 |
| Miles per kWh | 3.1 | 2.7 | 2.9 |
| KWh per 100 miles – site | 32 | 37 | 34 |
| $CO_2$ grams per mile – source | tbd | tbd | 230 |

Table 3: Proposed Window Sticker Measurements – Electric Car

Certain assumptions are required to provide backup information for the two preceding tables. As discussed earlier most of this information is scattered randomly around the sticker. The assumptions cover Fuel Economy and Fuel Costs along with the addition of Source and Site $CO_2$ information. Table 4 summarizes these and uses about 70 words and numbers.

| |
|---|
| Fuel Economy Assumptions |
| Source energy MPG of gasoline is 17% less than Site Energy MPG. |
| Source energy MPGe for electric drive is 67% less than Site Energy MPGe. |
| Fuel Costs Assumptions |
| Yearly cost for 15,000 miles at $3.70 /gal is $2,000. |
| Yearly cost for average 22 MPG car (depends on car) |
| Yearly savings (depends on car) |
| Source $CO_2$ emissions |
| National $CO_2$ emissions are 230 grams/mile. Regional $CO_2$ emissions will differ. |

Table 4: Assumptions for a Window Sticker for a PHEV

This rough proposal provides the basic information that could both inform and educate. Graphic formatting should only be to make the information easier to understand. It is not exact but intended to set a direction of fully disclosing source and site MPG, MPGe and

$CO_2$ emissions, with the same priority as measured by the type size and bolding used for MPG.

## Conclusion

The most important requirement for a government imposed label such as an automobile window sticker is that it be credible. Full transparency (the truth, the whole truth, and nothing but the truth) must be paramount. People count on their government to both assist them and protect them from marketers. In my opinion, the 2011 (2013) sticker is not credible. The numbers for electric vehicles (battery or plug-in) and for $CO_2$ emissions from such vehicles are deliberately misrepresented. Ignoring the source energy used to generate and transmit electricity, as well as the $CO_2$ created and released in that process, is a failure on the part of government agencies.

The window sticker must also be clear and understandable. The information needed by the consumer is numeric in nature e.g. MPG, $CO_2$ created (grams per mile), etc. Putting pictures of plugs and gasoline pumps on the sticker, using many different sized fonts, and drawing horizontal bars with no scales is simply confusing and unnecessary. Numbers are needed, not graphics.

As more and more information has been added over the years, the window sticker has become somewhat obscure and less comprehensive. One must now visit a website to understand its implications. However, going to the website could be even more confusing since space limitation is not a consideration and explanatory documents are very large.

The concept of “Source vs. Site” or “Primary vs. Secondary” or “Pre vs. Post” energy needs to be emphasized strongly to the consumer. In recent additions to the EPA website the terminology seems to be “Tailpipe Only” and “Tailpipe and Upstream GHG”, al least for emissions. This is a matter of providing education on a topic which is becoming ever more important for people to understand. It could be that this is the single most important new concept that the American people need to absorb.

Finally, it is vital that the government face up to its responsibilities and correct the existing misleading stickers before late 2012 at which point the 2013 car models will begin to appear and when the latest sticker rules go into effect. It would be a tragedy to educate the public erroneously. Full transparency and clarity are critical to developing long range solutions to energy limitations and the need to reduce $CO_2$ emissions. After the financial crisis and other government fiascos of recent years, people do not need another scandal in such an important area of their lives.

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