THE NECESSITY OF APPLYING THE ECONOMY OF HARM AND BENEFIT OF EXPLOITATION OF ELECTRIC VEHICLES.

Nada Kosanovic[326]
Danijela Rakic[327]

DOI: https://doi.org/10.31410/eraz.2018.692

Abstract: *Ecological benefit from electric vehicles is being taken as an understandable fact and it is not so rare, coming from the benefit, that countries approve a series of subsidies for the purchase of electric vehicles. However, more detailed analysis shows that the assessment of the environmental damage of electric vehicles is not at all simple, and that they are not as nearly "ecologically clean" as it is believed to be. When assessing the degree of damage to the exploitation of electric vehicles, specific factors related to a specific location must also be taken into account. Primarily, the method of electricity generation and flows of its distribution through a distribution network, is necessary to estimate the specific local policies for electric vehicles. The real danger of setting up local policies is to make environmental damage to maximum exports to other countries. It could potentially create interstate problems and political tensions. It is, therefore, important to evaluate the benefits and damages of electric vehicles, approaching all the complexity of the factors involved in their production and exploitation with respect.*

Key words: *ecology, economy, renewable energy, state subsidies, regulatory analysis*

It is, without a doubt, not uncommon to take the benefits of electric vehicles as self-explanatory. It is not contraversal that benefits are there, most of what is claimed in apologetic texts about e-Vehicles is quite right. The problem is not in what has been said, but in what is often held out in such "analyzes", which are harmful factors, not obvious at first glance. There is more to those factors, from ecological pollution caused by the production of parts, especially battery, through pollution caused by the exploitation of batteries, to the pollution that comes from charging batteries. Batteries are filled with "pure" electricity. But how is this energy being produced? In some countries, electricity is produced mainly by combustion of fossil fuels, which is a mode of production that has a very high impact on environmental pollution. Furthermore, as analyzes show, the use of electric vehicles may also have a negative political impact because it can happen that energy is consumed in one state, and that most of the pollution generated by that consumption is broadcasted in another country, which is possible thanks to the distributive nature of the electrical network.

The history of apologetic displays of benefits from electric vehicles, begins almost since the existance of such vehicles. One of the advocates of such vehicles wrote back in 1977: „Civilized is the word for the electric car, not only because it is environmentally clean, but also because it conveys the impression of friendliness and serenity. They offer efficient transportation, yet still they proceed with civility and show compassion for lovers, joggers, bicyclists and walkers.“ That time, it was taken as an axiom that electric vehicles do not pollute the environment. When we consider the production of electricity for battery charge, this could be true only if they are

[326] Research associate, Institute of applied science in agriculture, Belgrade, Republic of Serbia
[327] PHD student at the Faculty of Culture and Media, Department of Culture. University "Megatrend", Serbia

filled from ecologically clean electricity sources, such as solar power plants or wind farms. However, in that case, production and disposal of spent batteries will be polluting the environment.The degree of that pollution would depend on how much the recycling capacities of discharged battery cells would have been developed.

It is estimated that about half of buyers of electric vehicles decide on them because of the extensive network of subsidies. Bearing in mind that a large part of these subsidies are granted by the state, there is an impression that state policy continues to be self-explanatory and that electric vehicles are significantly less harmful than other types of vehicles and therefore it makes sense to subsidize their purchase. Subsidies, depending on the level at which they are granted, are being approved for various reasons. Manufacturers, of course, want to sell the electric cars they produce, but the state subsidies are primarily based on the fact that the use of electric cars is environmentally beneficial, but also because it wants to reduce the dependence on imported oil. Before we consider the justification of these subsidies, in the part concerning the preservation of the environment, let's take a look at what subsidies for electric vehicles exist in the United States.

State Incentive Programs

- Alabama-Low-interest loans for alternative fuel vehicle (AFV) projects.
- Arizona-State income tax deduction of 25 percent on the purchase cost of AFVs; a lower license tax than that applied to conventional vehicles-$4 for every $100 assessed value; Honda Civic Hybrid, Honda Insight and Toyota Prius may use the HOV lane; up to $75tax credit for home recharging unit installations; EV recharging-station parking is reserved for EVs; all others are fined a minimum of $350.

5. Arkansas-A 50 percent tax credit for any Arkansas taxpayer who constructs a facility in the state that will manufacture EVs, fuel cells or photovoltaic cells.

- California-Up to $5,000 in rebates on the purchase or lease cost of EVs, ZEVs (battery electric and hydrogen fuel cell), plug-ins, and AFVs until March 31, 2009, and a $1,000tax incentive for NGVs. Free meter parking for alternative fuel and hybrid electric vehicles. The vehicles must display a California Clean Air decal and then may park free for the maximum time limit indicated on the meter.
- Colorado-A credit is available to both new and converted vehicles based on computation of credit. Amounts vary according to the model and year of the auto, and the type of fuel used. It averages between $2,500 and $4,000. Percentages decreased beginning in June 2009. The credit applies to nonprofit and government agencies, the private sector, and individuals. Up to 50 percent rebate on the cost of AFVs. Credit for alternative fuel refueling stations was added in 2006 and extends through 2010. This credit may extend to 70 percent if the fuel being dispensed is from a renewable energy source.
- Florida-Between 2006 and 2010, sales and use tax exemptions for hydrogen and bio-fuel vehicles.
- Georgia-Tax incentive for the construction of alternate fuel production facilities. Facilities must use biomass such as agricultural products or animal fats.
- Kansas-Up to 50 percent tax credit on the cost of converting a vehicle to AFV that uses biomass. Up to $750 or five percent of cost for purchasing a new vehicle (original owner only).
- Kentucky-Beginning in 2008, up to $1 per gallon tax credit (total allowed, $5 million) for qualified ethanol producers. Must be corn - or cellulosic-based ethanol that meets ASTM (American Society for Testing and Materials) standard D 4806. Unused credits may not be carried forward and applied to a future tax return. However, unused ethanol

credits from one ethanol-based cap, such as corn, may be applied to another ethanol-based cap, such as cellulosic, in the same taxable year.

- Louisiana-Zero-interest loans for fleet conversions to CNG or LNG vehicles. Up to 20 per-cent for the purchase or conversion of an AFV or the building of a refueling station for AFVs.
- Maryland-A tax credit of up to $2,000 for EVs, $500 to $1,000 for hybrid electrics based on their energy efficiency, and $125 to $500 for their ability to regenerate through breaking. Hybrids are exempt from emissions testing for the first three years if they meet 50mpg EPA rating.
- Minnesota-Excludes the sale of propane or natural gas for vehicles from the motor fuel tax. Offers tax incentive (up to $0.20 per gal.) for producing ethanol; payments are limited to $3 million per producer and end in 2010.
- Montana-A 50 percent tax deduction for the purchase cost of an AFV. Up to $500 tax credit to defray costs for converting vehicles to alternative fuels. Ethanol producers and distributors have a credit of $0.20 per gallon if at least 20 percent of the ethanol is made from Montana products.
- Nebraska-Low cost loans (5 percent) toward the purchase or conversion of fleets to AFVs. Investors in Nebraska biodiesel production facilities (must be at least 51 percent owned by Nebraskans) producing B100 biodiesel may receive a tax credit for 30 percent (not to exceed $250,000) for the first three years.
- North Carolina-State and local government credit unions offer green vehicle loans for new AFVs and HEVs. The loans are offered at a one percent interest rate discount.
- New York-Rebates up to 80 percent of the cost of converting vehicles to CNG. Tax credits equal to 50 percent of the cost for installation of a refueling structure for alternative fuels (natural gas, liquefied petroleum gas, hydrogen, electricity, and any other fuel that is a least 85 percent ethanol or other alcohol.) This credit does not apply after December 31, 2010.
- Ohio-A ten percent tax credit for vehicles using ethanol. Retailers who sold E85 or biodiesel are eligible for a tax credit of $0.15 per gallon of E85 or biodiesel fuel sold using a metered pump at a fueling station in 2007, and $0.13 per gallon of E85 or biodiesel fuel sold in 2008.
- Oklahoma-A ten percent tax credit for the cost of AFV conversions and for electric vehicles or hybrids. Until 2010, tax credit of 50 percent for the cost of installing alternative fuel refueling infrastructure (CNG, LPG, LNG, methanol, electricity).
- Oregon-A 35 percent tax credit for AFV projects. Up to a total of $1,500 may be claimed if the homeowner has both an alternate fuel vehicle and a home refueling station. Up to $10,000 to install or convert fueling equipment at retail gasoline stations and fleet fueling sites to B20 or higher biodiesel blends and E85 ethanol blends.
- Rhode Island-A 50 percent tax credit was offered to businesses for constructing EV recharging stations effective January 1, 1998 through January 1, 2003. A tax credit of 25 percent of the federal credit for electric vehicles.
- Texas-A $2,000 rebate for CNG conversions. Blended diesel/biodiesel is exempt from diesel fuel tax. Austin set aside $1 million for plug-in hybrid rebates.
- Utah-A tax credit for up to 50 percent of the cost of a new EV to a maximum of $2,000per vehicle. As of 2008, hybrids were no longer exempt. In 2009, alternative fuel credit changed to 35 percent.
- Virginia-No local motor vehicle license fees for AFVs. Beginning in 2008, a tax credit of $0.01 for biodiesel producers up to $5,000 and available the first three years.
- Wisconsin-Taxis may be reimbursed for the amount of Wisconsin fuel tax paid. A minimum 100 gallons of alternative fuel must have been used in that year.

The following form of subsidies are *Federal Incentive Programs*, which were established in 2001 since *Securing America Energy Act*. was brought. The aim of this program is to reduce the dependence on imported energy sources from 56% to 45%. As summarized by Anderson and Anderson, the most important points of this program concerning electric vehicles are:

Battery Electric Vehicles (BEV)

- A 10 percent tax credit for low-speed BEVs (up to $4,000).
- A $4,000 tax credit for passenger vehicles and light-duty trucks with a driving range of at least seventy miles on one charge.

Fuel Cell Electric Vehicles (FCEV)

- A $4,000 tax credit for light-duty FCEVs.
- An additional tax credit of $1,000–$4,000 for vehicles that show a 150–300 percent increase in fuel mileage over that of fiscal year 2000.

Hybrid Electric Vehicles (HEVs)

A $250–$1,000 tax credit for HEVs less than 8,500 pounds gross vehicle weight.

An additional tax credit of $1,000–$3,500 for HEVs that show a 125–250 percent increase in fuel economy over that of fiscal year 2000.

Hydrogen research and design—Authorizes $250 million for hydrogen research for fiscal years 2002–2006.

Fuel cell research—Authorizes $84 million for a three-year research program. Fleets—Requires the federal fleet program to increase acquisitions of alternative fuel vehicles by five percent by fiscal year 2005.

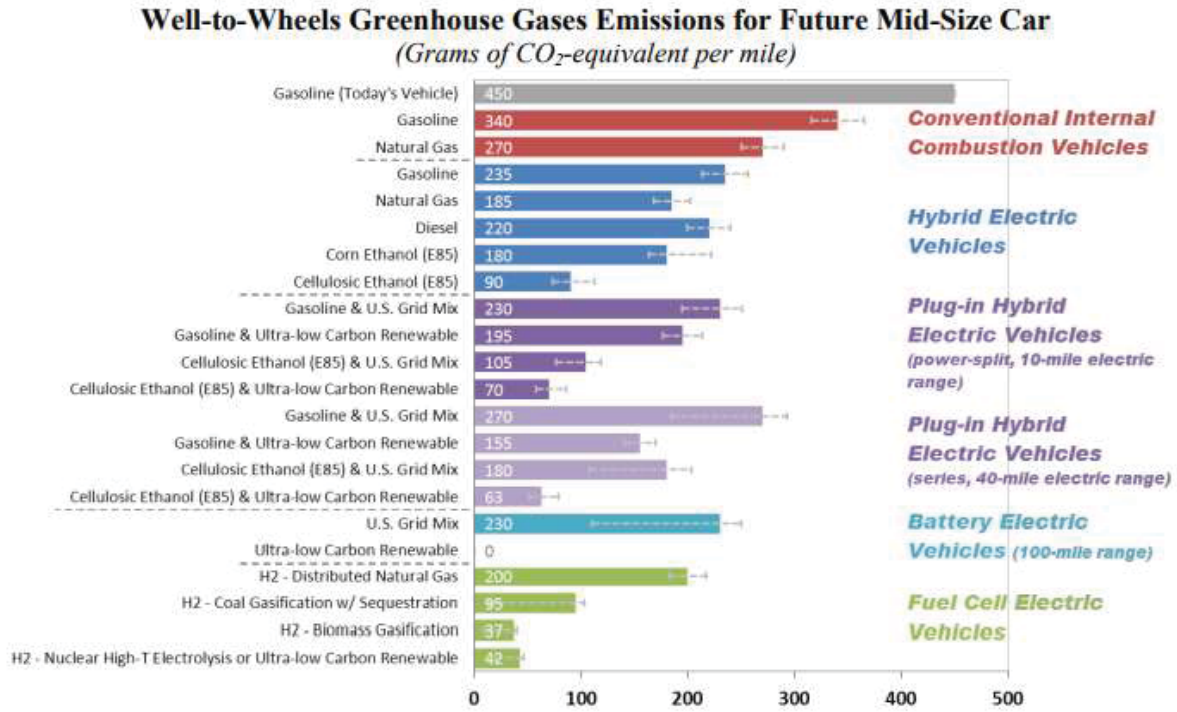
In addition to these programs, there are support programs for building a filling station for electric vehicles. They are *Utility Incentive Programs*. Some of the examples of these programs are:

- Colorado-Financial assistance for CNG fueling stations.
- Connecticut-Financial assistance for NGV purchases.
- Florida-$300 free CNG for private fleets. None in 2008.
- Illinois-Tax rebate of $1,500 on the purchase cost of a NGV. Private consulting firm offers feasibility studies for CNG refueling stations on a case-by-case basis.
- Maryland-$1,500 tax credit for hybrids. None in 2008.
- Mississippi-special rates for natural gas purchased as vehicle fuel.
- Montana-Ten percent tax credit on the purchase of an EV. None in 2008.
- North Carolina-Discounted charging rates for EVs. None in 2008.
- Oregon-A 35 percent tax buy-back credit on the purchase of an EV. None in 2008.
- Washington-A partner in the Seattle Clean Cities program offers assistance and refueling for natural gas vehicles.
- Wyoming-Ten percent tax credit on the purchase cost of an NGV. Assistance in converting vehicles to NGV and consulting services for alternate fuel comparisons.

In addition to the subsidies we have listed, there are city subsidies, and the manufacturers themselves approve various forms of subsidies to make their vehicles as attractive as possible

on the market.

When it comes to pollution produced by electric vehicles, earlier research was concentrated only on carbon dioxide (CO2). Here's how to estimate CO2 emissions from electric and other types of vehicles:



The same document provides serious reductions in pollution by electric vehicles which will be produced in the future. However, pollution by CO2 emissions is not the only type of pollution which produces electric vehicles. Furthermore, the data from the chart above are direct emission data (most types of batteries for electric vehicles emit CO2). What needs to be taken into account, whether we really want to estimate the degree of environmental pollution, are also other types of pollution, and in particular pollution generated by the production of electricity used to charge batteries on electric vehicles.

If we, hypothetically, take two states and call them state A and state B, and if in state A electric cars are filled with electricity produced from wind farms, and in state B they are charged with electricity produced in coal-fired power plants, then the same electric vehicles in state A will not produce any pollution of the external type by filling, while in state B it will produce significant pollution from external sources. In other words, pollution produced by electric vehicles depends not only on the type and technology of the vehicle, but largely depends on external factors, and the most important is exactly the way in which the electricity is being filled.

The situation in reality can be even more complexed. Although, state A does not have pollution caused by the production of electricity, in case that state A and state B are neighbors, it can happen that pollution generated by electricity production in State B has a negative impact on the environment in the State A.

We took an example with wind farms because, at first glance, it seems to be the easiest way to

establish the differences between states A and B. However, in reality, the problem is even more complicated. What kind of energy is consumed during the production of windmills and what kind of pollution is caused by their production technology? According to Anderson and Anderson: „There is much disagreement among environmental factions on how power might be generated, and whether private automobile ownership is in the public's best interest. The objections are varied. Hydroelectric power plants cover Indian ruins in Arizona, deplete salmon runs in the Pacific Northwest and generally disrupt the flow of wild rivers. The whirling blades of windmills can kill birds and bats, including protected species. Solar energy takes up too much land space. Geothermal sites are mostly in protected areas like Yellowstone and have a limited nonrenewable capacity. Coal-fired and natural gas plants are air polluters. Nuclear plants have the problem of waste product storage 29 and must over-come consumers' fear of reactor malfunctions, as occurred at Chernobyl and Three Mile Island, to be considered a viable choice."

It is obvious that a realistic estimate of the level of pollution caused by electric vehicles requires, taking into account, a large number of factors, and only when those factors are taken into account, it can be realistically estimated how justified the subsidies for electric vehicles are. That was precisely the aim of the research whose results were published under the title „Are There Environmental Benefits from Driving Electric Vehicles? The Importance of Local Factors".

As the authors themselves summarize their work: „We combine a theoretical discrete-choice model of vehicle purchases, an econometric analysis of electricity emissions, and the AP2 air pollution model to estimate the geographic variation in the environmental benefits from driving electric vehicles. The second-best electric vehicle purchase subsidy ranges from $2,785 in California to −$4,964 in North Dakota, with a mean of −$1,095. Ninety percent of local environmental externalities from driving electric vehicles in one state are exported to others, implying they may be subsidized locally, even when the environmental benefits are negative overall. Geographically differentiated subsidies can reduce deadweight loss, but only modestly. "The authors of this study emphasize that their analysis is motivated by three main reasons.

The first reason is the already mentioned fact that the previous studies of electric vehicles focused on pollution testing through CO2 emissions, thereby, as they emphasize, these studies did not have a conceptual framework for the analysis of subsidies for electric vehicles. Instead of focusing only on pollution by CO2 emissions, this study is: „We consider damages from five pollutants: CO 2 , SO 2 , NO x , PM 2.5 , and VOCs. These pollutants account for the majority of global and local air pollution damages and have been a major focus of public policy. "In spite of that, the authors also analyze the model of vehicle selection, because they believe that the choice should be motivated by the difference between environmental pollution during the lifetime of two different vehicles that are compared. Besides that, authors believe that their theoretical framework allows them to deal with different policies for different levels of jurisdiction and to assess the environmental benefits that one measure gives in comparison to the other.

The second reason is the fact that, despite that, regulators treat electric vehicles as zero-emission gases, they do not emit harmful gases themselves, or they are being broadcasted to a small extent, but it also does not mean that electricity production does not pollute the environment. Noting that almost 70% of electricity in the United States is produced by combustion of coal and natural gas, the authors also point out the significant fact that pollution cannot be easily assessed on the basis of how the country is producing electricity, because the flows of electricity

distribution are not equal to the electricity production flows. In other words, it is possible that energy from environmentally friendly sources is produced in one country, and trough transmission lines transferred to another (which produces electricity in a "dirty" way), where it is used to charge electric vehicles, and vice versa.

The third reason is the fact that there are significant physical differences between the emissions of gases produced by combustion of gasoline and emissions produced by the use of electric vehicles. These differences are due to the distributive nature of the electricity network, the level at which the harmful emissions and the specificity of the combustion chemistry. The result of these factors can be that emission of harmful substances and its rates can be spatially different in comparison to the place where the vehicles are used.

This study is, as the authors point out, the first one to systematically deal with geographical differences in the pollution of harmful gas emission from electric vehicles, and thus can contribute to solving the issue of political economy and fiscal federalism.

The study itself has shown that the evaluation of the harmful or beneficial effects of electric vehicles vary greatly from country to country: „Our first set of results documents the considerable heterogeneity in the environmental benefits of an electric vehicle relative to a gasoline vehicle. These benefits can be large and positive, large and negative, or negligible, depending on the location. For example, California has relatively large damages from gasoline vehicles and a relatively clean electric grid, which implies large positive environmental benefits of an electric vehicle. These conditions are reversed in North Dakota. The variation in the sign of the environmental benefits stems almost entirely from local air pollution. If we account only for greenhouse gases, then electric vehicles are superior to gasoline vehicles almost everywhere“.

The results of this study are particularly surprising in the part where it deals with assessment of "damage export" to other countries. It was shown that in the case of gasoline vehicles, in only 19% of cases environmental damage caused by a ride in one state, manifests itself in another. However, in case of electric vehicles, this damage is transferred to other countries in as much as 91% of cases. The authors emphasize that this fact could indicate local regulatory bodies to favor technologies that are most likely to be exported to other countries.

Since the authors took the county as the "measure unit", and the results are shown for individual districts. The following chart will show how differences in environmental harmfulness are different from the location:

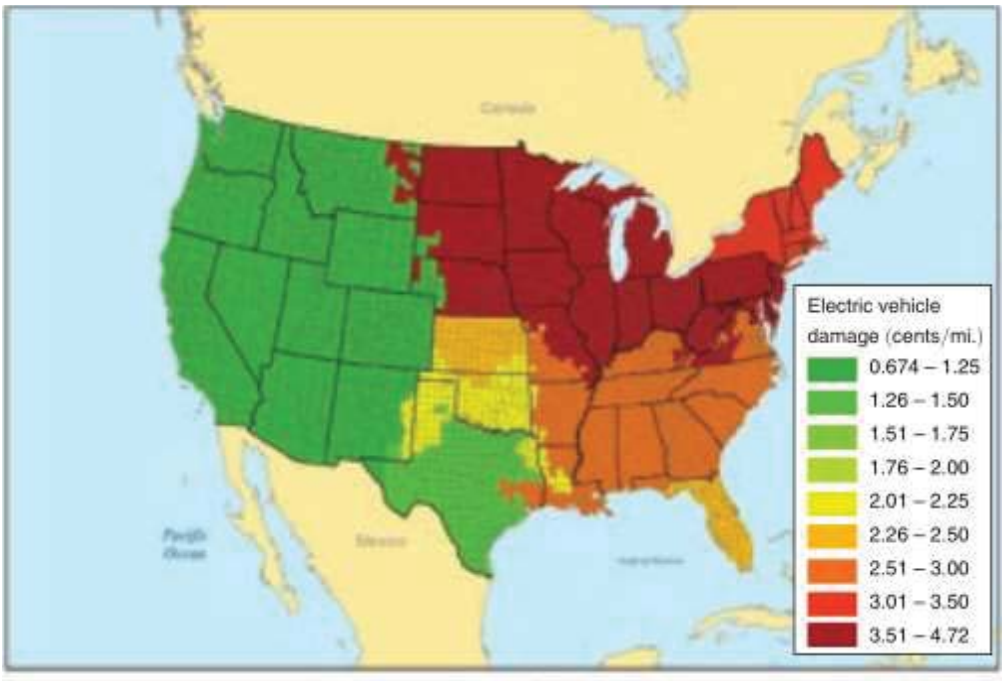


FIGURE 1. MARGINAL DAMAGES FOR GAS AND ELECTRIC VEHICLES BY COUNTY

Summarizing their results, the authors say „our main results show that the subsidy for electric vehicles is not justified by environmental benefits“. However, they emphasize that there are other potential benefits of using electric vehicles, such as the reduction in dependence on oil imports.

The conclusion from these analyzes is undoubtedly that the assessment of the ecological harmfulness of electric vehicles is not simple, and that they are not as nearly "ecologically pure" as it is often propagated. In order to make the assessment degree of damage to the exploitation of electric vehicles to make sense, a number of specific factors related to a particular location must be taken into account. First of all, these are the ways of electricity generation and flows of its distribution through a distribution network. The assessment of different policies for electric vehicles is even more complex, because they take into account other factors, such as the reduction in dependence on oil imports. The risk of local policy making so that environmental damage is maximally exported to other countries could, potentially, create interstate problems and political tensions. This shows the exceptional importance of both, studies and future complex research on this topic.

Literature

1. Anderson, C.D. and Anderson J., *Electric and hybrid cars: a history*, 2nd ed., McFarland & Company, Inc., Publishers, Jefferson, 2010.
2. *Benefits of electric vehicles*, Ergon Energy Network, https://www.ergon.com.au/network/smarter-energy/electric-vehicles/benefits-of-electric-vehicles, retr. 26.6.2018.
3. Davis L.W. and Knittel C.R., *Are Fuel Economy Standards Regressive?*, National Bureau Of Economic Research, Cambridge, MA 02138, 2016.
4. Graff Zivin, J.S. *et al*, *Spatial and Temporal Heterogeneity of Marginal Emissions: Implications for Electric Cars and Other Electricity-Shifting Policies*, National Bureau Of Economic Research, Cambridge, MA 02138, 2012.

5. Holland, S.P. *et al*, *Are There Environmental Benefits from Driving Electric Vehicles? The Importance of Local Factors*, American Economic Review 2016, 106(12).
6. *Well-to-Wheels Greenhouse Gas Emissions and Petroleum Use for Mid-Size Light-Duty Vehicles*, US Department Of Energy, 2010.