TRANSPORTATION POLICIES TO PROTECT THE DRCOG REGION FROM THE ECONOMIC SHOCKS OF RISING FUEL PRICES.

Support for TIP Funding of RAQC Vehicle Technologies Program

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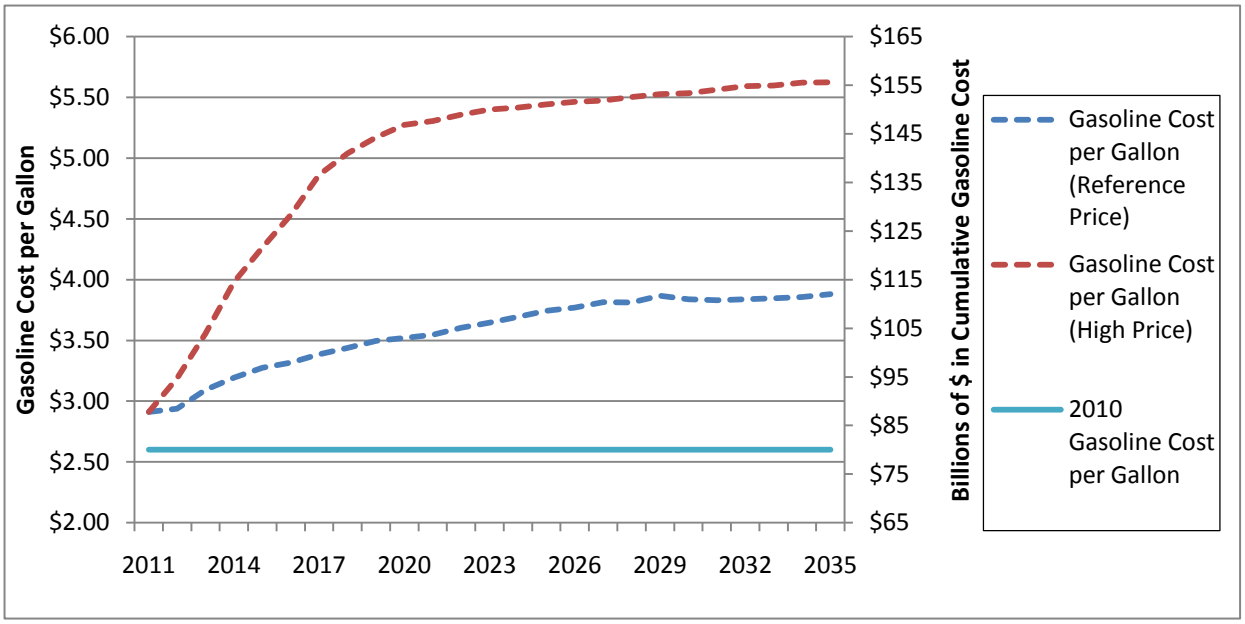
Introduction.

At its March 2011 meeting, the DRCOG board voted to remove the Vehicle Technology Program submitted by the Regional Air Quality Council ("RAQC"), but agreed to consider a proposal to place the RAQC program first in the queue for any additional funding that becomes available to DRCOG. SWEEP testified during the public comment period urging the Board not to remove the RAQC Program from the TIP because of the value to the region of the fuel savings that would be achieved by accelerating the conversion of the light duty vehicles in the region from petroleum fuels to electricity. The RAQC's program includes support for the advancement of electric vehicles. SWEEP announced that it would provide a detailed analysis to the DRCOG board regarding the benefits of vehicle electrification in time for consideration of the proposal to give the RAQC program priority for the programming of any additional funds that become available to DRCOG. This is the promised analysis for your consideration.

Rising Petroleum Fuel Prices Will Have Significant Adverse Impact on the Local Economy.

In Colorado, the average retail gasoline price has risen by 30%, from $2.60 per gallon in early December 2010 to $3.38 per gallon in late March 2011. Under the federal Energy Information Administration's (EIA) High Oil Price Scenario, prices are expected to increase 103% to $5.27 per gallon in 2020 and 116% to $5.62 by 2035. At these prices, the annual cost of gasoline to the economy of the DRCOG region will rise from $3.5 billion in 2011, to between $5.2 and $7.2 billion (constant 2009 dollars) in 2035 depending on the price of gasoline. Assuming the EIA price scenarios, cumulative gasoline costs for the region would range between $114 and $156 billion for the period from 2011 and 2035. This is compared to a cumulative cost of $83 billion if gasoline prices were to remain at 2010 levels. Doubling the cost of transportation fuels compared to recent prices will impose a significant negative impact on the Region's economy. But some of this impact can be avoided by accelerating the electrification of light duty vehicles.

EIA Estimated Gasoline Price per Gallon and Cumulative Fuel Costs
For Denver Metropolitan Region: 2011-2035



This increase in the cost of driving will have a significant economic impact on the region as an increasing share of household disposable income will be required to pay for transportation. In 2009, fuel costs accounted for 3.17% of total personal income in Colorado. Under the reference gasoline price scenario this percentage would increase to 3.44% by 2035 and to 4.86% in the high gasoline price scenario. In response to these higher transportation costs, households will reduce spending on other goods and services, and reduce the discretionary miles they drive. Together, less disposable income and less willingness to drive will have a negative impact on economic activity in the region.

Petroleum prices are determined by global market forces that can no longer be controlled by the United States. Economic growth in developing nations has increased global demand for personal vehicles and petroleum fuels. In 2009, China replaced the U.S. as the largest market for motor vehicles. In China 20 of every 1000 people own a vehicle, and in India ownership is 8 per 1000, compared to nearly 800 vehicles/1000 in the U.S. Almost all vehicles purchased in Asia are adding more vehicles to the highway that drive up demand for petroleum fuels, whereas in the U.S. 19 of 20 new vehicles are replacing existing vehicles. These long-term factors are driving both higher demand and prices for petroleum fuels. But the economies of U.S. metropolitan areas need not be victimized by global forces if actions are taken to buffer these impacts by reducing dependence on petroleum fuels.

DRCOG Can Buffer Regional Economy from Impacts of Petroleum Fuel Price Shocks.

Metropolitan regions that promote alternatives to petroleum powered transport will develop an economic advantage over areas that remain primarily dependent on oil for their transportation needs. By investing today in alternative modes of travel and locally produced domestic sources of energy for motor vehicles, decision makers will lay the groundwork for substantial economic benefits over the next

25 years. Metropolitan areas that make these investments will buffer the regional economy from the adverse economic shocks of expected increases in the global price of petroleum fuels.

Two general strategies are available to metropolitan areas to reduce a region's reliance on petroleum fuels:

1) replace existing gasoline vehicles with vehicles powered by in-State-generated electric power (or other highly efficient alternative domestic fuels), and
2) provide alternative modes of travel that offer cost-effective mobility choices that will be more affordable compared to the expected future costs of driving.

The DRCOG 2035 Regional Transportation Plan's commitment to build out FasTracks and the new TIP policies aimed at encouraging new development in urban centers served by regional transit is designed to achieve the fuel cost savings available to the Region from shifting travel to alternative modes. SWEEP presented an analysis to the Board in November 2009 demonstrating that land use and pricing strategies designed to shift travel to transit and reduce VMT could net the Region $4.4 billion in fuel cost savings by 2035. The updated 2035 Plan does not, however, include policies designed to achieve the regional economic benefits that are available from converting the light duty vehicle fleet to domestically produced electricity.

These comments focus on quantifying the potential economic benefits that can be achieved by electrification of light duty VMT in the DRCOG region.[1]

Economic Benefits of Electrification of Light Duty Vehicles.

By adopting policies that accelerate the conversion of light duty vehicles to electric power, Colorado and the DRCOG region will benefit economically by retaining greater financial resources in the state's economy. Currently, Colorado produces enough oil to satisfy only one-quarter of its consumption, but the state is a net exporter of natural gas and coal, its main sources of electricity generation.[2] By shifting

[1] SWEEP recognizes that conversion of light duty vehicles to compressed natural gas (CNG) could also achieve some of the benefits achievable with electric vehicles. SWEEP performed this benefits analysis only for electrification of light duty vehicles for a number of reasons. First, only one original equipment manufacturer (Honda) offers a CNG model for sale in the United States, compared to more than a dozen EV models being readied for sale between now and 2013. See Attachment 1. Second, the fuel for electric vehicles is widely available at home and can easily be supplied at public locations at modest costs, whereas CNG fueling stations are not conveniently accessible and will not become ubiquitous without major capital investments. Third, a comparison of ozone precursor and GHG emissions from CNG and EVs prepared for the Regional Air Quality Council demonstrates that CO2 emissions from a regional fleet of CNG vehicles will rise back to 2005 levels along with VMT growth after the initial conversion from gasoline, but that EVs offer the potential for continuing to reduce CO2 emissions despite VMT growth if electric power generation continues to be converted from coal to natural gas, and then to renewable energy sources. See, "Ozone Precursor and GHG Emissions from Light Duty Vehicles--Comparing Electricity and Natural Gas as Transportation Fuels" (SWEEP, April 2011). CNG would therefore defeat the targeted reduction in GHG emissions adopted as one of DRCOG's sustainability objectives in the 2035 Vision Plan.

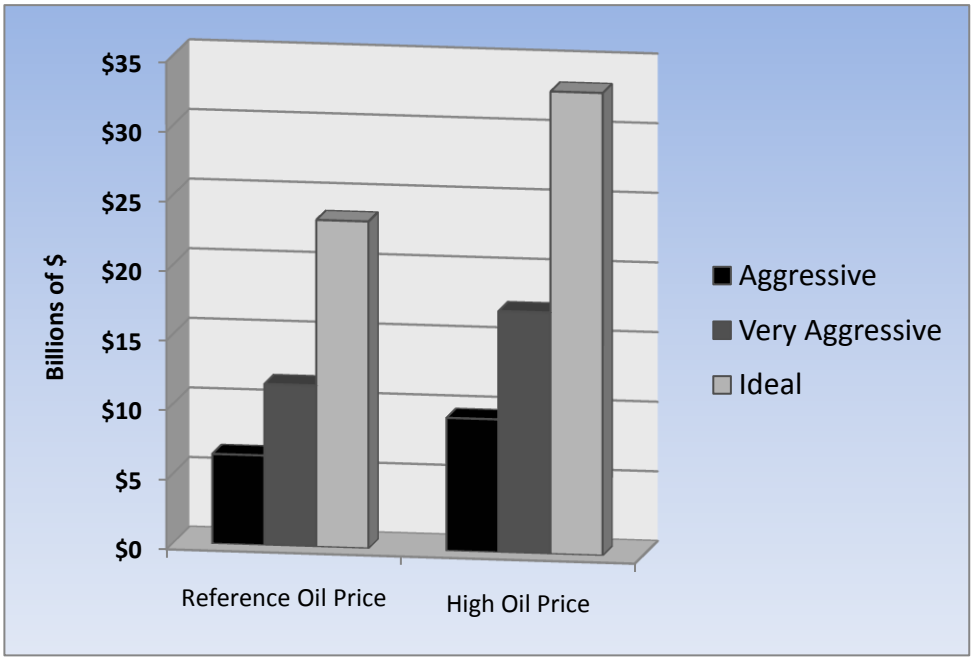
[2] In 2009, Colorado produced 1,499,070 million cubic feet of natural gas and consumed 520,206 million cubic feet. It produced 28,267 thousand short tons of coal and consumed 17,674 thousand short tons. See http://www.eia.doe.gov/state/state-energy-profiles-data.cfm?sid=CO.

vehicles to fuels that are produced and generated in Colorado, less money will be spent on imported fuel and more money will remain in the state's economy. Funds not spent on importing fuel are likely to remain in the local economy to be spent on food, housing, entertainment, education and other goods and services which will in turn generate employment opportunities. Reducing oil consumption for transportation will also reduce the United States' dependence on imported petroleum, and strengthen our national energy security.

Electric vehicles' electric motors use energy more efficiently than gasoline-powered internal combustion engines. Electric powered vehicles can cover the same distance as gasoline powered vehicles using between 35% and 60% less energy (measured in BTUs), depending on the efficiency of the source generating the electricity.

Electric vehicles will both reduce gasoline consumption and will provide significant savings to drivers by reducing fuel costs and overall lifecycle vehicle costs. Compared to an average new gasoline vehicle, an EV driver will spend $0.65 on electricity to travel the same distance covered by a gallon of gasoline. At current electricity and gasoline prices, an electric vehicle driver travelling 12,000 miles/year (the average for light duty vehicles in the DRCOG region) would save over $1,500 annually in fuel costs. As gasoline prices are expected to increase at much greater rates than electricity prices, electric vehicles will achieve a significantly greater fuel price advantage even as new gasoline powered light duty vehicles become more efficient due to the federal fuel efficiency standard fully in effect by 2016.

Cumulative (2011-2035) $ Fuel Savings from Different Electrification Scenarios



The following table shows the billions of dollars that the region could be expected to save in fuel costs under three different scenarios for the market penetration of EVs during the planning horizon for the current regional transportation plan. The three Electric Vehicle Market Penetration Scenarios are described in the Methodology section (below). Future fuel price estimates are from the U.S. DOE, Energy Information Agency, as described in the Methodology section.

Cumulative Net Fuel Savings (Billions of $), 2011 - 2035

	Reference Fuel Price	High Fuel Price
Aggressive	6.4	9.5
Very Aggressive	11.6	17.3
Ideal	23.5	33.2

Even if the estimated incremental vehicle cost of Plug-in Electric vehicles (PEVs) is deducted from the fuel savings, every scenario would still see a net economic benefit to the region. See the Methodologies section for a detailed explanation of the estimated incremental capital costs of PEVs.

Cumulative Net Fuel Savings Less the Estimated Incremental Plug-in Electric Vehicle Cost (Billions of $), 2011-2035

	Reference Fuel Price	High Fuel Price
Aggressive	2.7	5.8
Very Aggressive	5.1	10.8
Ideal	13.4	23.1

Electric vehicles also provide important air quality and public health benefits in the areas where they are adopted. The following table shows the percentage reduction of the ozone precursors Nitrogen Oxides (NOx) and Volatile Organic Compounds (VOC) achieved by replacing gasoline powered vehicles with PEVs.

Ozone Precursor Reductions Compared to Baseline Emissions[3]

	2035
NOx	
Aggressive	4.8%
Very Aggressive	8.5%
Ideal	12.5%
VOC	
Aggressive	2.6%
Very Aggressive	5.1%
Ideal	7.1%

[3] Baseline emissions from the light duty fleet were estimated for 2035 in the conformity determination prepared for the latest update of the Regional Transportation Plan. *See,* Denver Regional Council of Governments and North Front Range MPO (2010, January 20): *2009 Amendment Cycle 2 Denver-North Front Range Joint Interim 8-Hour Ozone Conformity Determination*. Retrieved from http://www.drcog.org/documents/FINAL-Cycle%202%202009%20Joint%20Ozone%208-hour%20Conformity.pdf. Please see the Methodologies section for a description of how NOx and VOC emissions reductions were estimated.

The next table shows the percentage reduction in CO_2 emissions that would be expected due to the electrification of the light duty fleet, assuming that the electric grid becomes 40% less carbon intensive by 2035 (compared to 2005 levels). Because Colorado currently requires that 30% of electric power be generated from renewable sources (i.e., solar, wind, geothermal and hydro) by 2020, it is reasonable to assume that at least another 10% will be generated from renewable sources between 2020 and 2035. These reductions could contribute significantly to the region meeting the Metro Vision sustainability goal of reducing greenhouse gas emissions by 60% below 2005 levels by 2035. Electrification of light duty vehicles makes it possible to reduce CO_2 emissions from these vehicles by more than 80% if electric power is generated from renewable sources (i.e., wind, solar, hydro and geothermal), and 75% of VMT is operated by batteries powered from the grid or roof-top collectors.

CO_2 Emission Reduction Compared to Reference Case Gasoline Consumption[4]

	2035	
	Reference Fuel Price	High Fuel Price
Aggressive	11.4%	10.6%
Very Aggressive	19.5%	18.1%
Ideal	46.9%	45.8%

Regional Plan and TIP Policies to Support Electrification of Light Duty Vehicles.

Electrification of light duty vehicles will provide several benefits to the area including: reduced dependence on imported fuel, greater use of local energy sources that contribute to regional job growth, more efficient use of energy in the transportation sector, significant fuel cost savings that are retained in the regional economy, improved air quality and reduced greenhouse gas emissions.

SWEEP submits these comments to urge the Denver Regional Council of Governments to invest regional resources in the infrastructure needed to support the public acceptance, purchase and operation of plug-in electric and hybrid electric vehicles. These vehicles are coming to market now (see Attachment 1 for list of electric vehicles coming to market by 2013). House bill 1331 (2009) provides a state income tax credit of 75% for the incremental cost of electric vehicles to promote their sale. Promoting their purchase and use will preserve economic activity in the region that will otherwise be suppressed by the adverse economic impacts of higher fuel prices on a petroleum-dependent transport sector.

Policy options for the region to implement are discussed in the attached report: "**What can Cities and Counties do to Promote the Deployment of Electric Vehicles?**" (SWEEP, March 2011, prepared with funding and support from the U.S. DOE). SWEEP encourages DRCOG to fund the RAQC Vehicle Technology Program, and to consider adding policies to the Regional Plan and TIP criteria that provide incentives to local jurisdictions to adopt zoning, permitting and other policies designed to support the development of infrastructure designed to facilitate the operation of electric vehicles.

[4] CO_2 reductions are lower in the high price scenario because higher fuel prices are expected to lead to consumer decisions to purchase vehicles with slightly higher average fuel economy which will reduce the amount of fuel consumed and CO_2 emitted compared to the baseline scenario.

Methodologies

Electric Vehicle Market Penetration Scenarios

Three electrification scenarios (aggressive, very aggressive and ideal) were analyzed by SWEEP to reflect the uncertainty in the potential for electric vehicles to achieve significant market penetration over the next 25 years.

The first two electrification scenarios were adopted by the U.S. EPA in their analysis of strategies for reducing GHG emissions from the transportation sector.[5] EPA considers these scenarios to be technologically feasible if supportive policies are in place or market conditions stimulate greater consumer demand. The first scenario, described as 'aggressive', assumes that by 2030, PEVs would make up 14% of the light duty fleet (one third battery-only electric vehicles (BEVs) and two-thirds plug-in hybrid electric vehicles (PHEVs)), with sales of PHEVs making up 17% of new sales and BEVs 13%. The second scenario, described as 'very aggressive' assumes that by 2030, PEVs would make up 21% of the light duty fleet by 2030 (two thirds BEVs and one-third PHEVs), with sales of BEVs making up 30% of new vehicle sales and PHEVs 19% of new vehicles sales by 2030. The final 'ideal' scenario (created by SWEEP) assumes that by 2030 PEVs make up 71% of new vehicle sales and 37% of the light duty fleet. These estimates were projected backwards to determine percentage of vehicle sales and stock for 2011 to 2030 and then projected forward along the same trend line until 2035. These percentages for each year are then multiplied by the estimated number of annual light duty vehicle sales for the DRCOG region to determine estimates of the number of PHEVs and BEVs purchased in the metropolitan area annually. It is also assumed that 50% of miles traveled by PHEVs are battery powered.

Fuel Price Scenarios.

Two scenarios for gasoline prices were considered based on the EIA's estimates of future gasoline prices in the Mountain region, their reference scenario and high oil price scenario. The reference case scenario is based on the assumption that "current practices, politics and levels of access will continue in the near to mid-term, whereas long-term developments will be determined largely by economics."[6] In this scenario gasoline prices reach $3.88 per gallon by 2035. The high oil price scenario assumes that major producing countries "use quotas, fiscal regimes, and varying degrees of nationalization to further increase revenues from oil production, and the consuming countries turn to domestic production of high-cost unconventional liquids to satisfy demand."[7] In this scenario gasoline prices reach $5.62 per gallon by 2035. Both of these scenarios underestimate the price of gasoline in 2011, placing it at $2.91 per gallon compared to the current state average of $3.35 per gallon. Prices rise to reach the current price by 2017 in the reference scenario and by 2013 in the high price scenario. This underestimation of

[5] Environmental Protection Agency (2010, February 10). EPA Analysis of the Transportation Sector. Available from http://www.epa.gov/oms/climate/GHGtransportation-analysis03-18-2010.pdf.

[6] Energy Information Administration. (2010, May 11). *Annual Energy Outlook 2010*. World Oil Prices and Production Trends in AEO2010. Retrieved from http://www.eia.doe.gov/oiaf/archive/aeo10/woprices.html

[7] Energy Information Administration. (2010, May 11). *Annual Energy Outlook 2010*. World Oil Prices and Production Trends in AEO2010. Retrieved from http://www.eia.doe.gov/oiaf/archive/aeo10/woprices.html

current prices suggests that the high price scenario is a more realistic assumption for future gasoline prices.

The future estimated price of electricity was taken from the EIA's estimate of prices for the Mountain region.[8]

Plug-in Electric Vehicles' Incremental Costs

Estimates of the future cost of PEVs are heavily dependent on assumptions about the cost of the batteries. Battery costs per kWh have fallen significantly from over $650 per kWh in 2009 to around $450 per kWh in 2011, which is much faster than was assumed in most analyses of future battery costs. In response to this decrease in prices, Deutsche Bank recently revised their estimate for future battery costs to $250 per kWh in 2020.[9] Future estimates of the incremental costs for electric powered vehicles are given in the table below. The original figures were taken from the U.S. DOT's report on greenhouse gas emissions from the transportation sector[10] but have been accelerated by ten years as the DOT report had estimated battery costs reaching $250 per kWh by 2030. Given the rapid decrease in prices over the last two years as battery and vehicle production has come online it seems that further cost reductions are likely and the estimates below may be conservative.

Projected Incremental Cost for Electric Powered Vehicles

	2011	2030
PHEV 10	$4,600	$3,000
PHEV 40	$20,000	$5,700
BEV	$12,000	$5,600

The amount of the federal and state tax credit has been subtracted from the incremental cost of electric powered vehicles sold between 2011 and 2015 at which point consumers would bear the entire incremental cost of these vehicles.

Criteria Pollutant Reductions.

DRCOG's latest ozone conformity determination was used as the baseline for expected NOx and VOC emissions for future years.[11] For 2035, DRCOG estimates that on-road vehicles will emit 37.6 tons per day of NOx and 69.0 tons per day of VOCs. To estimate the potential reduction from electric vehicles,

[8] Energy Information Administration. (2010, December 16). Annual Energy Outlook 2011. Energy Prices by Sector and Source, table 18. Retrieved from http://www.eia.doe.gov/forecasts/aeo/tables_ref.cfm

[9] Deutsche Bank. (2010, December 22). The End of the Oil Age 2011 and Beyond: A Reality Check. Retrieved from http://bioage.typepad.com/files/1223fm-05.pdf

[10] U.S. Department of Transportation. (2010, April). *Transportation's Role in Reducing U. S. Greenhouse Gas Emissions*. Retrieved from http://ntl.bts.gov/lib/32000/32700/32779/DOT_Climate_Change_Report_-_April_2010_-_Volume_1_and_2.pdf

[11] Denver Regional Council of Governments and North Front Range MPO (2010, January 20): *2009 Amendment Cycle 2 Denver-North Front Range Joint Interim 8-Hour Ozone Conformity Determination*. Retrieved from http://www.drcog.org/documents/FINAL-Cycle%202%202009%20Joint%20Ozone%208-hour%20Conformity.pdf.

the total stock of battery electric vehicles was multiplied by the average VMT for light duty vehicles and then multiplied by the average emission rate for new vehicles (0.07 grams per mile for NOx and 0.09 grams per mile for VOCs). This gives the tailpipe emissions (in grams per year, which was then converted to tons per day) avoided by all electric vehicles that had been purchased rather than an ICE gasoline powered vehicle. To estimate emissions from plug-in hybrid electric vehicles, half of the VMT is assumed to operate on the battery. The total stock of plug-in hybrid vehicles was multiplied by 0.05 (for NOx) and 0.035 (for VOCs), which is half of the EPA-tested emission rates of the Chevy Volt's current gasoline engine. This would give the total emissions removed from battery powered VMT for plug-in electric vehicles. These total tons were then divided by the inventory figures provided by DRCOG to determine the percentage of these pollutants reduced in 2035. Current federal tailpipe emission standards are assumed to remain unchanged through 2035.

Attachment 1. Planned EV and PHEV Releases with Target Dates for Sale in US Market

Make/Model	EV or PHEV	Battery Size (kwh)	Electric Range (miles)	Target Intro in US	Estimated Price
Audi A1 Sportback	PHEV	20		2011	
BMW ActiveE	EV	125	100	Field trial in 2011	
BYD E6	EV	75-200	Up to 200	2010	
BYD F3DM	PHEV		60	2010	$22,000
Coda Sedan	EV		90-120	2010	$45,000
Daimler Smart ED	EV		90+	2012	
Fisker Karma	PHEV		50	2010	$87,900
Ford Escape	PHEV	10	40	2012	
Ford Focus	EV		100	2011	
Chevy Volt	PHEV	16	40		$41,000
Hyundai Blue Will	PHEV		38	2012	
Hyundai i10	EV		100	2012	
Mitsubishi iMiEV	PHEV	16	50	2010 (limited)	$47,500
Fiat Micro-Vett e500	EV		75	2012	
Nissan Leaf	EV	24	100	2010 (limited)	$32,780
Tesla Model S	EV		150-300	2011	$57,400
Tesla Roadster	EV		220	2010	$109,000
Think City	EV		80	2010	
Toyota Prius	PHEV		10-18	2010- 2012	$27,550
Volkswagen Twin Drive	PHEV		30	2013	
Volvo V70	PHEV		31	2012	