PROTECTING ARIZONA FROM THE ECONOMIC SHOCKS OF RISING FUEL PRICES

Southwest Energy Efficiency Project

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Rising Petroleum Fuel Prices Will Have Significant Adverse Impact on Arizona's Economy.

In Arizona, the average nominal retail gasoline price has risen by 38% in eight months, from $2.60 per gallon in early October 2010 to $3.60 per gallon in early June 2011 (in real 2009 dollars). According to the federal Energy Information Administration's (EIA) High Oil Price Scenario, prices will increase by nearly 100% to $5.10 per gallon in 2020 and 112% to $5.52 in 2030, compared to $3.83 in the EIA's Reference Case Scenario (see red and blue dashed lines on following chart).[1] Given that 2011 prices are now close to the EIA's reference case estimate for 2020, the High Price scenario may be a more realistic estimate.

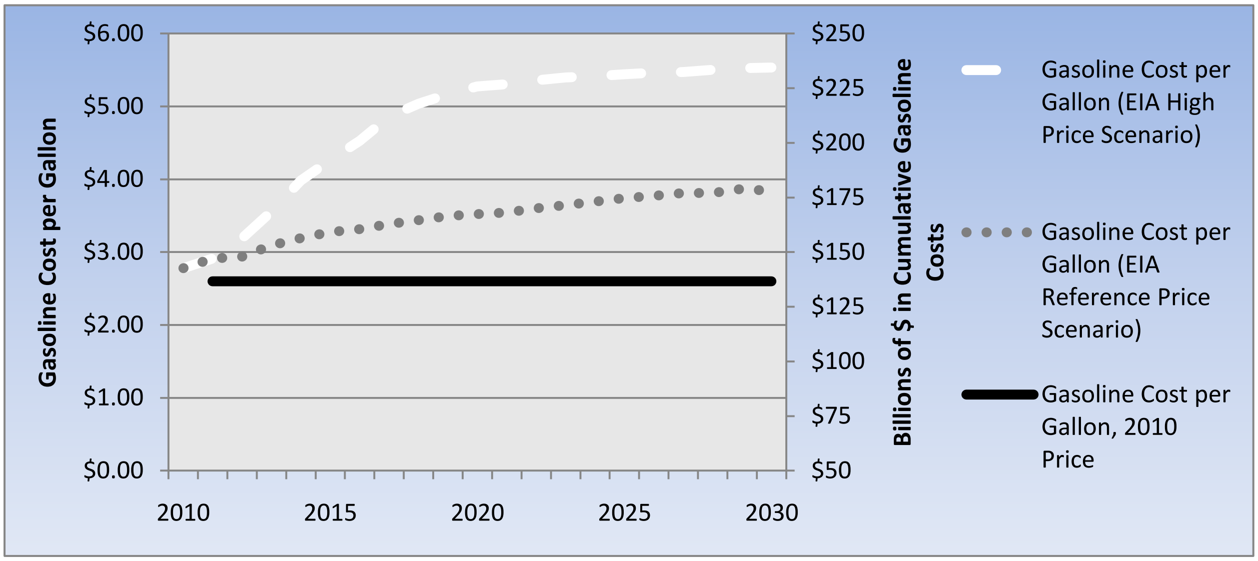
At these prices, the annual cost of gasoline to the regional economy of Maricopa, Pima and Pinal Counties will rise from $6.1 billion in 2011, to between $10.4 and $14.4 billion (in real 2009 dollars) in 2030 depending on the price of gasoline.[2] Assuming the EIA price scenarios, cumulative gasoline costs for the state are expected to range between $174 and $239 billion for the period from 2011 and 2030. This is compared to a cumulative fuel cost of $128 billion over the same period if gasoline prices were to remain at 2010 levels. This projected near doubling of the cost of transportation fuels will impose a significant negative impact on the State's economy.

Figure 1 (below) shows both the expected increase in gasoline prices over the next 20 years and the expected cumulative cost of gasoline to the 3 county region over this time period. The three lines represent three different scenarios for the price of gasoline (left side axis) which show how much would be spent cumulatively in each scenario (right side axis).

[1] The EIA provides a reference price and a high price scenario for gasoline costs. The current gasoline price, $3.60 per gallon, is near the high price scenario for 2012 and the reference price scenario for 2022, indicating that the high price scenario for gasoline is a more likely estimation of the future price of gasoline.

[2] Estimated fuel consumption in 2030 assumes 1) that population grows at rates forecast by the Arizona Commerce Authority, 2) that annual VMT per vehicle increases from 8,100 in 2011 to 11,300 in 2030, and 3) that fuel efficiency for gasoline vehicles will remain at the level required for 2016 model vehicles. If population does not grow, and VMT per vehicle is held constant at 2011 level, annual gasoline expenditures in 2030 would be $8.5 billion under the high price gasoline scenario.

Figure 1. EIA Estimated Gasoline Price per Gallon and Cumulative Fuel Costs For 3 County Region (constant 2009 $): 2012-2030



As a result of the anticipated rise in driving costs, families will be required to pay an increasing share of household income for transportation. 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 negatively impact economic activity in the State. In addition, the economic resources spent on motor fuels will mostly leave the State and not contribute significantly to economic activity in the State because Arizona is not a major producer of petroleum fuels. A report by Next 10 found that fuel savings are spent on local goods and services and have a strong multiplier effect, creating more jobs than are displaced.[3]

Arizona Can Buffer its Economy from Impacts of Petroleum Fuel Price Shocks by Promoting Alternatives to Petroleum-Powered Transportation.

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. Vehicle sales in China alone are expected to exceed 20 million units in 2011, nearly double expected U.S. sales. In China 20 of every 1000 people own a vehicle, and in India ownership is 8 per 1000, compared to nearly 800 vehicles per 1000 people in the U.S. Almost all vehicles purchased in Asia are replacing bicycles and mopeds, adding more vehicles to the highway and driving up global demand for petroleum fuels. In the U.S. 19 of 20 new vehicles are replacing existing vehicles. Because of more stringent national fuel

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[3] Roland-Holst, D. (2011, May) How Fuel Economy and Emissions Standards Will Impact Economic Growth and Job Creation. Retrieved from http://next10.org/next10/publications/vehicle_efficiency.html

efficiency standards, new vehicles sold in the U.S. use less fuel than the vehicles they replace. U.S. demand for petroleum fuels has stabilized. But global long-term factors are driving both higher demand and prices for petroleum fuels.

The economies of U.S. States and metropolitan areas need not be victimized by global forces if actions are taken to buffer these impacts by reducing dependence on petroleum fuels.

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 20 years. States and metropolitan regions that make these investments will buffer their economies from the adverse economic shocks of expected increases in the global price of petroleum fuels. In 2010, the average Arizona resident was estimated to spend 4.7% of his/her annual income ($1,637) on gasoline.[4] The percentage share which would be expected to increase as fuel prices rise faster than the inflation rate for all goods and services.

By adopting policies that reduce petroleum consumption, the region will benefit economically by retaining greater financial resources in the State's economy. Currently, Arizona produces enough oil to satisfy less than one tenth of one percent (<0.1%) of its consumption.[5] By replacing petroleum consumption with local sources of energy less money will be spent on imported fuel and more money will remain in the state's economy both to produce the energy locally, and because the cost of locally produced fuel is less. Most funds not spent on importing fuel are expected 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.

Replacement of Gasoline Vehicles with Electric Vehicles is the Most Available Option for Reducing Petroleum Dependence.

SWEEP considered three options for reducing petroleum dependence in Arizona: 1) electric vehicles (EVs), 2) natural gas vehicles, and 3) increased domestic petroleum production. EVs are the only available option for a number of reasons.

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[4] Natural Resources Defense Council. (2011). Fighting Oil Addiction: Ranking States' Gasoline Price Vulnerability and Solutions for Change. Retrieved from http://www.nrdc.org/energy/states/files/Oil_Vulnerability_May_2011.pdf

[5] In 2009, Arizona produced 46,000 barrels of oil and consumed 99,900,000 barrels. See http://www.eia.doe.gov/state/state-energy-profiles-data.cfm?sid=AZ

First, the state is not a petroleum producer, and cannot protect its economy by expanding local petroleum production. Second, even if the U.S. were to expand domestic petroleum production by 20% (a very aggressive target), these additional 2 million barrels/day would not be enough to offset demand growth in developing economies, and would have little impact on oil price in a global market where 88 million barrels/day are now consumed. Thus increased domestic production will not protect U.S. consumers from future global market price shocks.

Third, only one natural gas light duty vehicle is being offered by an original equipment manufacturer in the U.S.,[6] whereas as many as 55 models of EVs and hybrid EVs are expected on the market by 2015.[7] In addition, Arizona has already adopted Clean Car Standards as part of its air pollution control planning that includes a requirement that original equipment manufacturers offer "zero emission vehicles" (ZEVs) for sale in Arizona. This program matches the California ZEV program which is also in effect in ten other states in addition to Arizona. Together with California, these states comprise nearly one-third of the U.S. vehicle market. All major vehicle manufacturers are offering EVs or hybrid EVs for sale to meet ZEV sales targets in these states.

In addition, consumers are reluctant to invest in natural gas vehicles because few fueling stations exist, and access to fuel is not convenient. By comparison, virtually every home has access to the power grid, and charging stations are easy to install for most homeowners.

For these reasons, SWEEP limited its analysis to the fuel cost savings and capital costs of owning and operating EVs compared to gasoline.

Economic Benefits of Replacing Gasoline Vehicles with EVs.

The net economic benefits of increasing the share of light duty vehicles that operate on batteries powered from the grid are large. Taking into account both the savings that result from using locally generated electricity instead of petroleum as the energy source, and the incremental capital cost of purchasing a battery operated vehicle, the net benefits to the three county region will range from $500 million to $5.2 billion between now and 2030, depending on the price of gasoline and the penetration rate of electric powered vehicles.

Fuel Cost Savings.

Electric vehicles' achieve significant reductions in fuel costs both because electric motors use less energy, and because the electricity used to power a vehicle costs nearly 2/3 less than petroleum fuels.

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

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[6] Honda Civic.

[7] Citi. (2011, February 23). Electric Vehicles: Perspectives on a Growing Investment Theme. Retrieved from http://www.ceres.org/resources/reports/electric-vehicles-report

60% less energy (measured in BTUs), depending on the efficiency of the source generating the electricity.

Pure electric vehicles operate entirely on power from the grid. Hybrid EVs operate on battery power until the battery is empty, and then switch to liquid fuel. Both types of EVs 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 in the urban counties of central Arizona 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 10,000 miles/year would save over $1,000 annually in fuel costs. During the 15 year life of an average vehicle, these savings will more than offset the additional cost of a battery powered vehicle. As gasoline prices are expected to increase at much greater rates than electricity prices, electric vehicles will achieve a significantly greater fuel price advantage in future years even as new gasoline powered light duty vehicles become more efficient due to the federal fuel efficiency standard that will be fully in effect by 2016.

The following graph and table show 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 over the next 20 years. The three Electric Vehicle Market Penetration Scenarios are

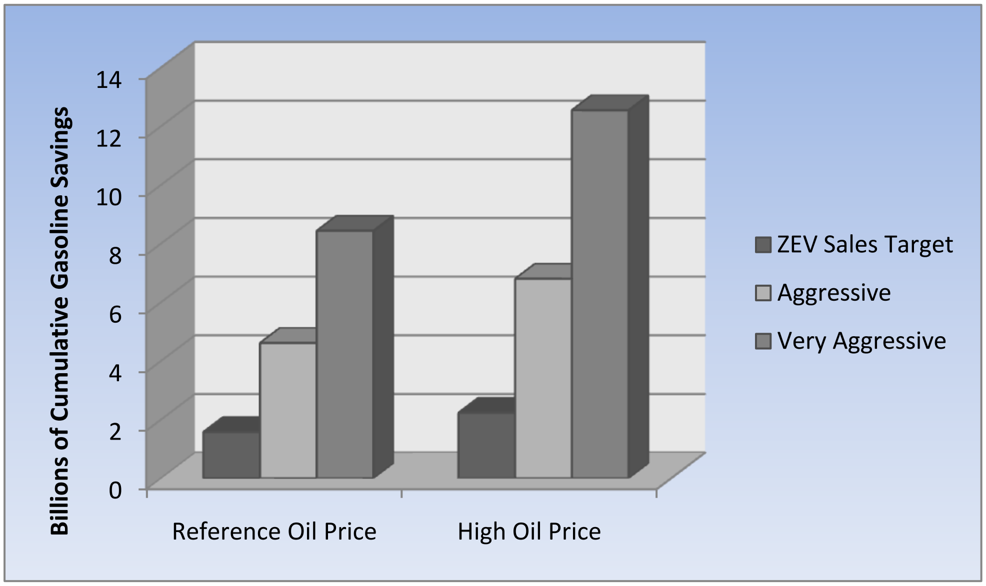
1) the minimum number of EVs that would be expected from meeting the sales targets for zero-emission vehicles (ZEVs) in Arizona's Clean Car Standards;
2) the minimum number of EVs that would be expected to be sold under markets influenced by aggressive marketing strategies undertaken by motor vehicle manufacturers; and
3) the number of EVs that would be expected to be sold if aggressive manufacturer marketing strategies were supported by public policies designed to provide direct market incentives such as tax credits and fee-bate programs, along with user benefits such as free or preferential parking at high traffic destinations (e.g., airports, sporting venues, commercial facilities), access to HOV lanes, etc.

Assumptions for each Scenario are described in more detail in the Methodology section (below). Future fuel price estimates are from the U.S. DOE, Energy Information Agency, as described in the Methodology section.

Table 1. Cumulative Net Fuel Savings (Billions of $), 2012 - 2030

	Reference Fuel Price	**High Fuel Price**
Aggressive Marketing	4.6	6.8
Very Aggressive Marketing with Market Incentives and User Benefits	8.4	12.5
ZEV Sales Target	1.6	2.2

Figure 2. Cumulative (2012-2030) $ Fuel Savings from Different Electrification Scenarios



Cumulative Net Fuel Savings Less the Estimated Incremental Cost of Plug-in Electric Vehicle.
The fuel cost savings more than pay for the incremental capital cost of purchasing electric vehicles. When the estimated incremental vehicle cost of Plug-in Electric vehicles (PEVs) is deducted from the fuel savings, each scenario would still achieve a significant net economic benefit to the region.[8] See the Methodologies section for a detailed explanation of the estimated incremental capital costs of PEVs.

Table 2. Net Fuel Savings After Deducting Incremental Capital Cost (Billions of $), 2012-2030.

	Reference Fuel Price	**High Fuel Price**
Aggressive Marketing	0.5	2.7
Very Aggressive Marketing And User Benefits	1.1	5.2
ZEV Sales Target	1.1	1.8

Air Quality, Greenhouse Gas Reduction and Public Health Benefits.

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

[8] The expected cost of electric vehicle charging infrastructure is not estimated in this analysis because there are a number of unknown variables which make it difficult to accurately estimate. While the incremental purchase price of PEVs is expected to be borne by market participants (either the individual purchaser pays the incremental cost or all new car purchasers share the capital cost if fee-bates are offered, or the public shares the cost if tax credits), and the cost of electric power will be paid by users, it is unclear who will pay the initial capital cost (EV owners, utilities seeking to expand power sales, power retailers, employers, or governments) for the provision of electric vehicle charging infrastructure. The amount of charging infrastructure needed to support a significant penetration of PEVs is also unknown. Once a better understanding of who will bear the costs and a reasonable estimate of costs becomes available, SWEEP will develop estimates of electric vehicle charging infrastructure costs.

(NOx) and Volatile Organic Compounds (VOC) achieved by replacing gasoline powered vehicles with PEVs in Maricopa County where the Maricopa Association of Governments has estimated future emissions of ozone precursors from motor vehicles.

Table 3. Ozone Precursor Reductions (Maricopa County only) Compared to Baseline Emissions[9]

2025		
	NOx	**VOC**
Aggressive	1.3%	2.4%
Very Aggressive	1.3%	2.7%
ZEV target	0.5%	0.6%

SWEEP has reviewed the "Calculation and Analysis of Emission Reduction Benefits of Adopting California LEVII Program in Arizona" (Air Quality Division, ADEQ, September 2009). This report concludes that by 2020 the adoption of the California LEV II standards will achieve greater reductions that the federal motor vehicle emission control program for each of the primary ozone precursors: 3.24% less NOx, and 2.32% less NMOG. However, the report does not explain whether any portion of the VMT estimated for 2020 was assigned to zero-emission vehicles, or whether the VMT assigned to such vehicles took account of the percent of sales required by the California rule to be ZEVs. If ZEVs were included in the analysis, then the NOx and VOC reductions shown in Table 3 are included in the ADEQ analysis; if not then the reductions shown in Table 3 are in addition to those estimated in the ADEQ analysis.

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 20% less carbon intensive by 2030 (compared to 2005 levels). Because Arizona currently requires that 15% of electric power be generated from renewable sources (i.e., solar, wind, geothermal and hydro) by 2025, it is reasonable to assume that at least another 5% will be generated from renewable sources between 2025 and 2030. 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.

[9] Baseline emissions from the light duty fleet were estimated for 2025 in the conformity determination prepared for the latest update of the Regional Transportation Plan. *See, Conformity Analysis for the FY 2011-2015 Transportation Improvement Program and the Regional Transportation Plan 2010 Update*. Retrieved from http://www.azmag.gov/Documents/EP_2010-08-30_Conformity-Analysis-for-the-TIP-and-RTP-Update-Final_.pdf. Please see the Methodologies section for a description of how NOx and VOC emissions reductions were estimated.

Table 4. CO_2 Emission Reduction Compared to Reference Case Gasoline Consumption[10]

	2030	
	Reference Fuel Price	High Fuel Price
Aggressive Marketing	6.2%	5.9%
Very Aggressive Marketing with User Benefits	10.9%	10.5%
ZEV Sales Target	1.8%	1.7%

Recommendations.

The early investments in electric vehicle charging infrastructure being made by the EV Project and the federal government are placing Arizona in a strong position to reduce petroleum consumption by accelerating the penetration of electric vehicles. The EV Project is supplying electric vehicle owners with electric vehicle charging equipment for their homes and is setting up public charging stations across the Phoenix and Tucson metropolitan areas.

Implementing strategies designed to increase the sale and use of EVs will maximize the return on this investment in recharging infrastructure. The economic benefits to the region of increasing EV use far exceed the additional capital costs of EVs and charging infrastructure.

To determine how best to proceed, Arizona should carefully analyze the legal, administrative and regulatory options available for achieving the economic and air quality benefits of the three strategies presented in this report. The current ZEV sales targets in the Clean Air Standards clearly achieve significant economic and air quality benefits that will not be achieved by reverting to the federal motor vehicle emission standards. Those benefits should not be abandoned by revoking the State's Clean Car Standards unless –

1) it is clear that the region will not need the ozone precursor emission reductions to attain the revised ozone NAAQS scheduled to be promulgated by EPA on July 31,2011; and
2) greater economic and air quality benefits will be achieved from the implementation of economic incentives and user benefits designed to stimulate the ownership and use of EVs.

At a minimum, the State should defer action on the proposed revocation of the Clean Car Standards until the level of the revised Ozone NAAQS is known, and modeling has been conducted to assess whether the reductions in precursor emissions achieved by the Clean Car Standards will be needed to attain the NAAQS.

In addition, before abandoning the current Clean Car Standards, the State should a) undertake discussions with motor vehicle emission manufacturers to request commitments to undertake

[10] 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.

aggressive marketing campaigns designed to achieve greater sales of EVs than is required to meet current ZEV targets, and b) assess the feasibility and public acceptance of the tax incentives, fee-bate, parking, HOV access and other strategies that will be needed to accelerate consumer adoption of electric vehicles and use of electric vehicle charging infrastructure. Some policy options for the region to implement are discussed in the 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 [available at swenergy.org]).

Unless the State obtains commitments from manufacturers to voluntarily undertake more aggressive marketing campaigns than would be needed to meet the ZEV sales targets, and the State is committed to implement the economic incentives and user benefits that will stimulate greater EV ownership than the ZEV sales targets, ADEQ should not abandon the Clean Car Standards.

Methodologies and Assumptions

Electric Vehicle Market Penetration Scenarios

Three electrification scenarios (aggressive, very aggressive and the ZEV mandate) were analyzed by SWEEP to reflect the uncertainty in the potential for electric vehicles to achieve significant market penetration over the next 20 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.[11] 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. These estimates were projected backwards to determine percentage of vehicle sales and stock for 2012 to 2030. The ZEV sales target requires the following percentages of ZEV to be sold in Arizona in these years: 2012-2014: 0.2% BEV and 0.3% PHEV ; 2015-2017: 0.9% BEV and 1.1% PHEV; 2018 and subsequent: 1.6% BEV and 2.0% PHEV. These percentages for each year are then multiplied by the estimated number of annual light duty vehicle sales for the three county region (determined on a per capita basis from EIA's projections for vehicles sales in the Mountain 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."[12] In this scenario gasoline prices reach $3.83 per gallon by 2030. 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."[13] In this scenario gasoline prices reach $5.52 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 $3.60 per gallon. Prices rise to reach the current

[11] Environmental Protection Agency (2010, February 10). EPA Analysis of the Transportation Sector. Retrieved from http://www.epa.gov/oms/climate/GHGtransportation-analysis03-18-2010.pdf.
[12] 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
[13] 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

price by 2020 in the reference scenario and by 2012 in the high price scenario. This underestimation of 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.[14]

Plug-in Electric Vehicles' Incremental Costs

Estimates of the future cost of PEVs are heavily dependent on assumptions about the cost of 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 greater than was assumed in most earlier 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.[15] 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,[16] 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 is likely that further cost reductions will be achieved. The cost 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 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.

Tailpipe Criteria Pollutant Reductions.

Because only the Maricopa Association of Governments (MAG) provides forecasts for ozone precursor pollutants, only Maricopa's reductions for NOx and VOC are considered. MAG's latest ozone conformity determination was used as the baseline for expected NOx and VOC emissions for future years.[17] For

[14] 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

[15] 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

[16] 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

[17] *Conformity Analysis for the FY 2011-2015 Transportation Improvement Program and the Regional Transportation Plan 2010 Update*. Retrieved from http://www.azmag.gov/Documents/EP_2010-08-30_Conformity-Analysis-for-the-TIP-and-RTP-Update-Final_.pdf.

2025, MAG uses emission factors from EPA's MOBILE6.2 model to estimate that on-road vehicles will emit 39.5 tons per day of NOx and 37.8 tons per day of VOCs. MOBILE does not include emission factors for the Arizona Clean Car Standards which are based on the California LEV II standards. To estimate the potential reduction from electric vehicles, 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 MAG to determine the percentage of these pollutants reduced in 2025. Current federal tailpipe emission standards are assumed to remain unchanged through 2025.