Appendix C

ECONOMIC ANALYSIS INPUTS

APPENDIX C
Economic Analysis Inputs

The following appendix provides additional information on the assumptions used in the staff's economic analysis, found in the Zero Emission Vehicle (ZEV) Initial Statement of Reasons (ISOR). Additional information is provided regarding electricity and hydrogen fuel prices, electric charging equipment costs, purchase incentives, and gasoline fuel tax revenue losses.

Impact to Manufacturers - Infrastructure Inputs

Electricity Rates

Assumed electricity rates for battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV) were used for determining consumer payback periods in Table 5.4, Section 5.4. A number of factors will have impacts on future electricity rates, some of which are vehicle owner specific depending on how and when they charge. These factors include increased power production costs due to the state's 33-percent Renewable Portfolio Standard (RPS) by 2020, time-of-use (TOU) rates that offer low super-off-peak rates coupled with high on-peak rates, increased local distribution costs as more electric vehicles charge from the grid, and infrequent fast charging at a premium price. Table C.1 below summarizes various electric rate programs and projections for reference purposes.

Table C.1: Sample electric rate programs or projections (2009$)
(California except where noted)

	$/kWh
Average residential retail rate in California (2010)	0.127
Projected residential retail rate under 33% RPS (2020)[1]	0.17
AEO 2010-2035 reference electric rate	0.10
Ave. transportation electric rate (CEC IEPR 2011 fuel prices)	0.126
Experimental EV TOU for SDG&E (super off-peak /off-peak /on-peak)[2]	0.08/0.18/0.29

kWh: kilowatt hour
AEO: Annual Energy Outlook
CEC IEPR: California Energy Commission Integrated Energy Policy Report
SDG&E: San Diego Gas and Electric

For this analysis, a fixed electric rate of $0.15/kWh was assumed for 2017 and beyond. This simplified scenario value is a balance between potential rate increases from carbon and renewables policies, but also expected off-peak charging with lower TOU rates. Estimating a more accurate average electric rate for BEV and PHEV drivers is not realistic, given the number of uncertainties that could have large effects on the price. Future driver charging trends will be important to study, which will affect average electric rates depending on the time of day charging occurs, and whether it is a residential or public charge location. Additionally, the future use of sub (or separate) meters for

[1] E3, 2010. Energy & Environmental Economics (E3), prepared for CPUC, October 2010. "Greenhouse Gas Modeling of California's Electricity Sector to 2020: Updated results of the GHG Calculator."
[2] CPUC, 2010. California Public Utilities Commission. June 24, 2010. Resolution E-4334.

residential dedicated charging circuits will have a large impact on the price. In California household, electricity rates increase with electricity use. The addition of an electric car to the household electricity load will push the usage into the highest tiers, raising the rates to the maximum level. So, if a separate meter and account is allowed, the car can be disassociated with the house and the household is not penalized for including the car in the household load.

Electric Vehicle Service Equipment (EVSE) Equipment

The purchase and installation of residential electric vehicle chargers, commonly referred to as electric vehicle service equipment (EVSE), was included in the incremental vehicle prices for BEVs and PHEVs (Table 5.1, ZEV ISOR).[3,4] However, the following tables provide details of these assumptions. Table C.2 below provides details of the residential EVSE level assumed for the varying technology types. Generally, advanced vehicles with smaller battery packs (e.g. PHEV with 20 miles electric range) can be accommodated with Level 1 (L1) home charging, whereas BEVs will need to more heavily rely on home Level 2 (L2) charging.

Table C.2: Charging type by vehicle technology and class

	PHEV20	**PHEV40**	**BEV75**	**BEV100**	**BEV150**
Subcompact	100% L1	25% L1, 75% L2	100% L2	100% L2	100% L2
Compact	100% L1	10% L1, 90% L2	100% L2	100% L2	100% L2
Midsize	100% L1	100% L2	100% L2	100% L2	100% L2
Small truck	100% L1	100% L2	100% L2	100% L2	100% L2

Table C.3 below shows the cost assumptions used in this analysis, drawn from the joint analysis with the Environmental Protection Agency (EPA) and National Highway Traffic Safety Administration (NHTSA). The costs below account for charging technology cost reductions over time, fixed labor rates for electrical contractors, and a varying level of home installations depending on how large the battery pack is in the vehicle. Level 1 residential chargers were assumed to be $30 in 2025, and Level 2 chargers were assumed to be $202 in 2025.

[3] DOE, 2011a. United States Department of Energy. Fact Sheet. 2011. "*Electric Vehicle Charging Equipment Permitting*"

[4] DOE, 2011b. United States Department of Energy Clean Cities. Fact Sheet. April 2011. "*Plug-in Electric Vehicle Fact Sheet*"

Table C.3: Residential EVSE Cost Assumptions, 2009$

Cost type	Technology	Vehicle Class	2020	2025
Direct manufacturing cost (DMC)	PHEV20 charger	All	38	30
	PHEV40 charger	Subcompact	199	159
		Compact	231	185
		Midsize, small truck	252	202
	BEV charger	All	252	202
Indirect costs (IC)	PHEV20 charger	All	18	10
	PHEV40 charger	Subcompact	92	55
		Compact	107	64
		Midsize, small truck	117	70
	BEV charger	All	117	70
Total costs	PHEV20 charger	All	55	41
	PHEV40 charger	Subcompact	291	214
		Compact	338	249
		Midsize, small truck	369	272
	BEV charger	All	369	272
Labor	All	All	1009	1009

Although electric sub-meters are not required for homeowners to charge a BEV or a PHEV, and costs for such were not considered in this analysis, they will be necessary for homeowners to take advantage of electric vehicle-specific TOU electric rates in the future. Additionally, future vehicles may have this sub-meter capability built into the vehicle's computer and communication with electric utilities. With today's homeowner costs for sub-meters, the cost break-even period could be substantial as the electric vehicle specific TOU rate may not be much lower than the whole house TOU rate.

Hydrogen Pricing

Assumed hydrogen prices for fuel cell vehicles (FCV) were used for determining consumer payback periods in Table 5.6, Section 5.3.1. It is difficult to project the price of hydrogen for transportation, particularly in the next few years when a network of distribution stations is first being formed. Academic and federal national laboratory analysis largely focuses on relatively large stations operating at high throughput utilization. A supporting factor that will contain costs for early networks, however, is that hydrogen production will predominantly come from existing centralized industrial facilities. In order to perform the economic analyses for the Low Emission Vehicle (LEV), the ZEV, and the Clean Fuels Outlet (CFO) regulations, staff assumed a linear decreasing price scenario as shown in Table C.4. For further details on how staff estimated the hydrogen fuel price, refer to the CFO ISOR, Section 5 and Appendix E.

Table C.4. Delivered Hydrogen Price Scenario by Year - (2009 $)

Year	2018	2019	2020	2021	2022	2023	2024	2025
Price, $/kg	$13	$12	$11	$10	$9	$8	$7	$6

Although the information in Table C.4 was developed for the economic analyses, it is by no means intended to serve as a pricing schedule for retail hydrogen.

In addition to electricity and hydrogen fuel prices, detailed estimates of future gasoline prices were assumed. Table C.5 below shows a sample of gasoline prices used to calculate the impact to the consumer.

Table C.5. Select Retail Gasoline Fuel Prices (2009 dollars per gallon)*

Year	Price
2011	$3.68
2015	$4.06
2020	$4.06
2025	$4.02
2030	$4.17

Average of high and low cases, converted from 2010 dollars using Consumer Price Index adjustment factor.

*CEC, 2011. California Energy Commission. Draft Staff Report, August 2011. “Transportation Energy Forecasts and Analyses for the 2011 Integrated Energy Policy Report” http://www.energy.ca.gov/2011publications/CEC-600-2011-007/CEC-600-2011-007-SD.pdf

Details of these values, and their information sources, can be found in the LEV III ISOR Section VII-B.

Impacts to Individuals – Incentive Considerations

As referred to in Section 5.3, Potential Impacts to Individuals, vehicle and equipment purchase incentives can have a positive impact on consumers’ purchase decisions for advanced vehicles and fuels. Although this incentive information was not directly included in the staff analysis, as incentives are expected to have expired soon after 2015, it is provided here as background information.

Many advanced vehicles have temporary government incentives designed to help increase demand and use. Table C.6 shows the most relevant federal and state incentives that exist for purchasing electric vehicles. There are a number of additional incentives at the state and local level, primarily for charging equipment subsidies, but are too numerous to list here. The California Energy Commission’s Assembly Bill 118 program funds are partly used for residential vehicle charging equipment, and the South Coast and Bay Area Air Quality Management Districts have substantial regional funds available.

Table C.6: Current Incentive Programs at the Federal and State Level

Incentive Program	Description	Yrs Effective
Federal vehicle tax credit, PEVs	$7,500 for BEVs; $4,500 - $7500 for PHEVs; Max 200,000 vehicles per manufacturer	2009 -
Federal vehicle tax credit, FCVs	$4,000 for FCVs	2009 - 2014
California vehicle rebate	$2,500 for ZEVs (BEV or FCV); $2,000 for PHEV	2010 - 2015

A list of all the incentive programs, with cross-references by technology and/or fuel type, can be found at www.DriveClean.ca.gov. By 2015, the majority of existing incentives will not be available. Net consumer calculations shown here did not assume any incentives in the 2020 through 2025 period.

Impacts to Local and State Agencies – Fuel Tax Revenue Considerations

As noted in Section 5.6, gasoline tax revenues will be impacted by vehicle fleets that become more efficient and transition to non-gasoline or diesel fuels. Gasoline tax revenue has not been rising with increased transportation infrastructure costs, and as a result, revenue generation is no longer keeping pace with expenditures. The primary reason is the existing tax rates have not changed for many years and are not indexed to inflation. However, a secondary reason is the vehicle fleet is becoming more efficient. The new national fleet standard will compound this challenge. A third issue with the current tax structure, though minor in scale, is that hydrogen and transportation electricity are not taxed for these transportation infrastructure costs.

Although this challenge is not a result of the LEV III and ZEV regulations, the scale of the problem is large enough to warrant highlighting in this analysis. Table C.7 below shows the fuel tax losses over the years of the LEV III regulation (2017-2025) given today's taxation structure (Federal and California).

Table C.7: Lost fuel tax revenue from entire LEV III fleet displacing gasoline usage in California (2017-2025, 2009$)[1, 2]

Gasoline displaced (million gallons)	5,960
Total tax revenue loss ($ millions)	**$ 3,980**

1. Gasoline taxation includes three components:
   - $0.184 /gallon federal fuel tax
   - $0.357 /gallon state excise tax
   - Variable state sales tax. This includes $0.055 prepaid sales tax/gallon + 2.25% sales tax on the retail (untaxed) price of fuel.
2. References:
   i. API, 2011. American Petroleum Institute, as published on CaliforniaGasPrices.com. Webpage. "USA Tax Map" May 2011 http://www.californiagasprices.com/USA_Tax_Map.aspx. Accessed November 7, 2011.
   ii. BOE, 2011. State of California Board of Equalization. Website. Fuel Tax Swap Frequently Asked Questions (FAQ) http://www.boe.ca.gov/sutax/gasswapfaq.htm#1 Accessed November 7, 2011.

This loss in fuel tax revenue directly affects budgets for transportation infrastructure and system improvements, including road improvements, subsidies for mass transit, and non-vehicle modes (bicycle routes, etc). The estimates in Table C.7 assume all federal fuel taxes collected from California fuel sales ultimately return to California through the state dispersements. Historically, California has not received its proportional share (less than 100% returned).

REFERENCES
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