State Alternative Fuels Plan Economic Analysis

California Energy Commission

October 9, 2007

According to AB 1007, the plan must…

- "Optimize the environmental and public health benefits of alternative fuels…in the most cost-effective manner possible"
- "Minimize the economic costs to the state"
- "Maximize the economic benefits of producing alternative fuels in the state"

Components of the Economic Analysis

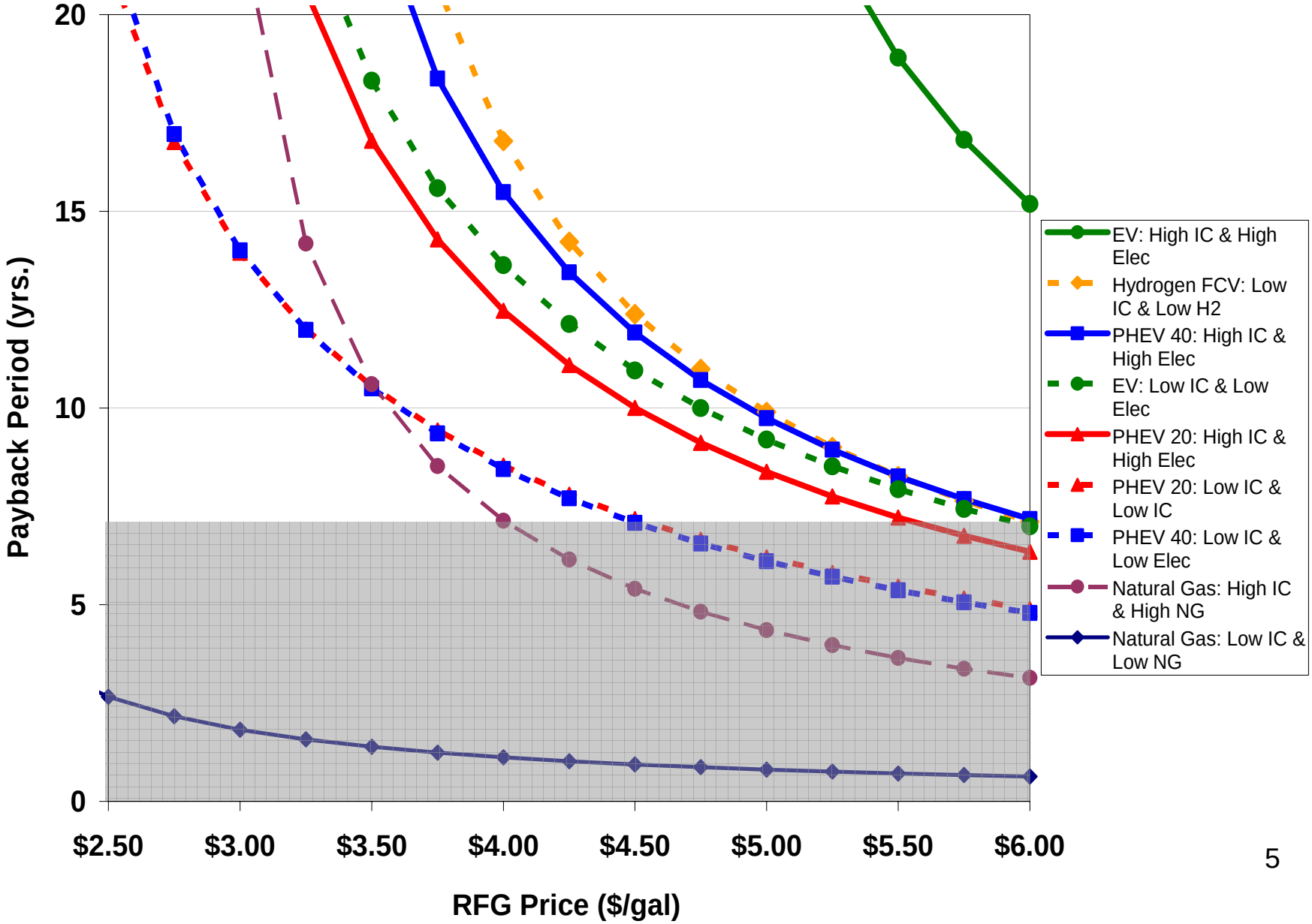
- Capital Cost Assessment
- Consumer Payback Period
- Societal Cost-Effectiveness Analysis
- Macroeconomic Analysis

Capital Cost Assessment

Alternative fuel capital costs for displacing the equivalent of 1 billion gallons of gasoline (billion 2007$):

	Production Facilities	Distribution Infrastructure	Fueling Stations	Vehicles (Incremental)	Vehicle/Fuel R&D
E85	3.3	1	0.4	0.3	0
Non-Alcohol Biofuel	4.5	0.3	0	0	1
Natural Gas	0	0	2.1	2.9	2
Propane	0	0	1.8	1.8	0
Electricity (PHEV)	0	0.5	0	20.7	2
Hydrogen	1.0	0.9	2.4	31.7	2

Consumer Payback Period (Light-Duty Vehicles)



Payback Period Assumptions

	Vehicle Incremental Price	Fuel Price
Natural gas (low)	$1,000	$1.33/GGE
Natural gas (high)	$3,900	$2.00/GGE
PHEV 20 (low)	$4,600	$0.055/kWh
PHEV 20 (high)	$5,300	$0.13/kWh
PHEV 40 (low)	$5,900	$0.055/kWh
PHEV 40 (high)	$7,400	$0.13/kWh
EV (low)	$10,350	$0.055/kWh
EV (high)	$15,300	$0.13/kWh
Hydrogen (low)	$9,000	$3.00/kg
Hydrogen (high)	$20,500	$4.00/kg

Discount rate = 8%

Payback Period Conclusions

- All alternative vehicles are more expensive than conventional vehicles, but the higher cost is paid back over time through fuel cost savings
- The higher the gasoline price, the shorter the payback period
- If consumers require a 7-year payback period, most alternative vehicles will be attractive at gasoline prices of $4-$6/gallon

Societal Cost-Effectiveness Analysis

Cost-Effectiveness of Petroleum Reduction =

(Costs – Benefits) / Avoided Petroleum Consumption

Cost-Effectiveness of GHG Emissions Reduction =

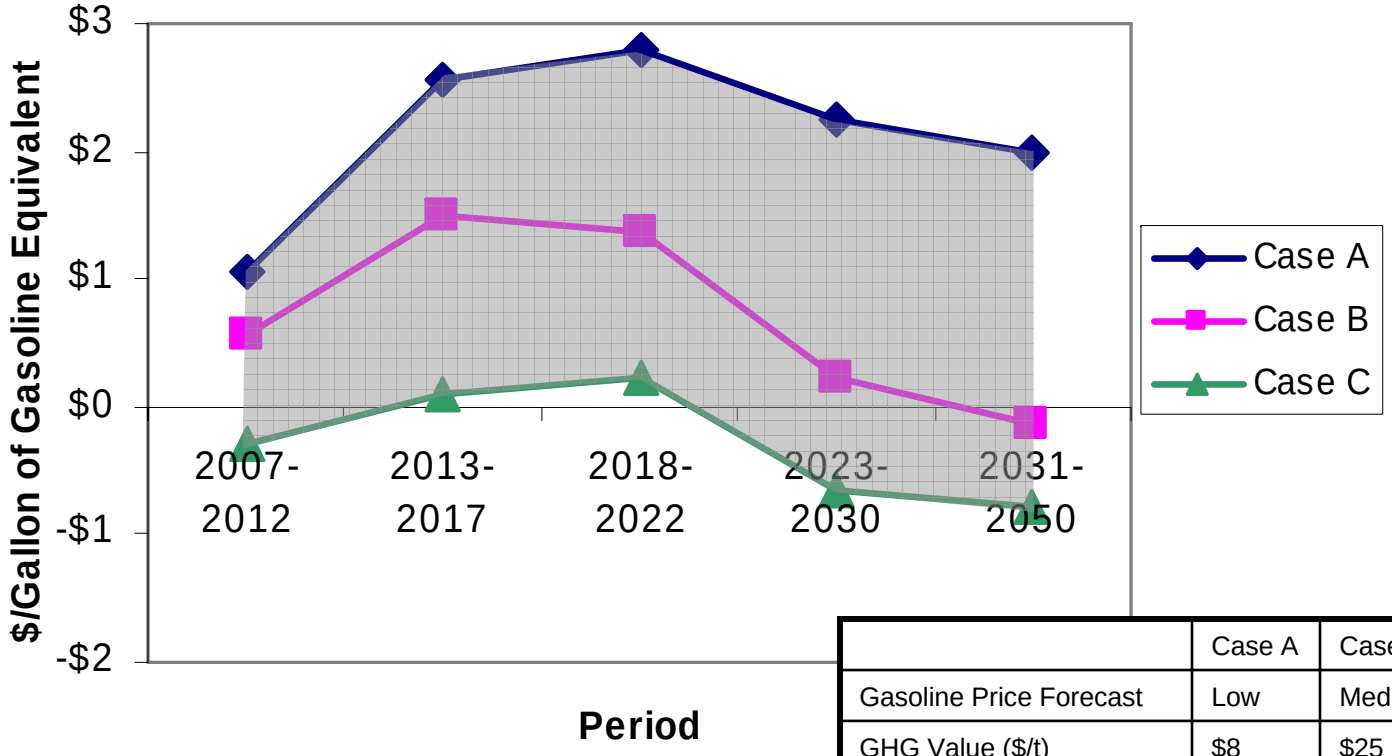
(Costs – Benefits) / GHG Emissions Avoided

Costs	**Benefits**
Alternative Fuel Cost	Avoided Cost of Conventional Fuel
Alternative Vehicle Cost	Avoided Cost of Conventional Vehicles
Infrastructure Cost*	Value of Avoided GHG Emissions**
R&D Cost*	Value of Avoided Criteria Pollution

* Only includes portion of infrastructure and R&D costs not recovered in fuel/vehicle prices

** Only included in the first cost-effectiveness formula

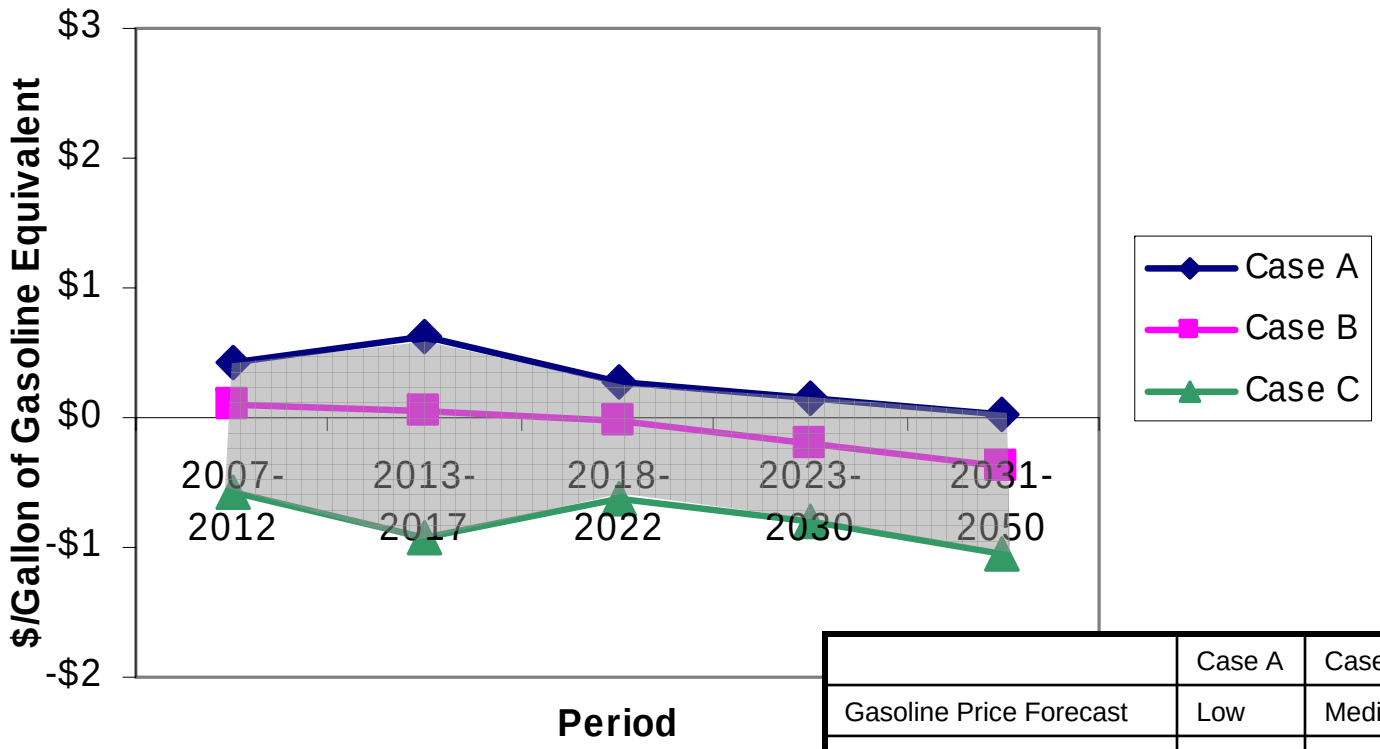
Cost-Effectiveness Range, Example 1 (Ethanol and Hydrogen)



	Case A	Case B	Case C
Gasoline Price Forecast	Low	Medium	High
GHG Value ($/t)	$8	$25	$50
Alternative Vehicle Prices	High	Medium	Low

Negative values represent net savings relative to gasoline/diesel

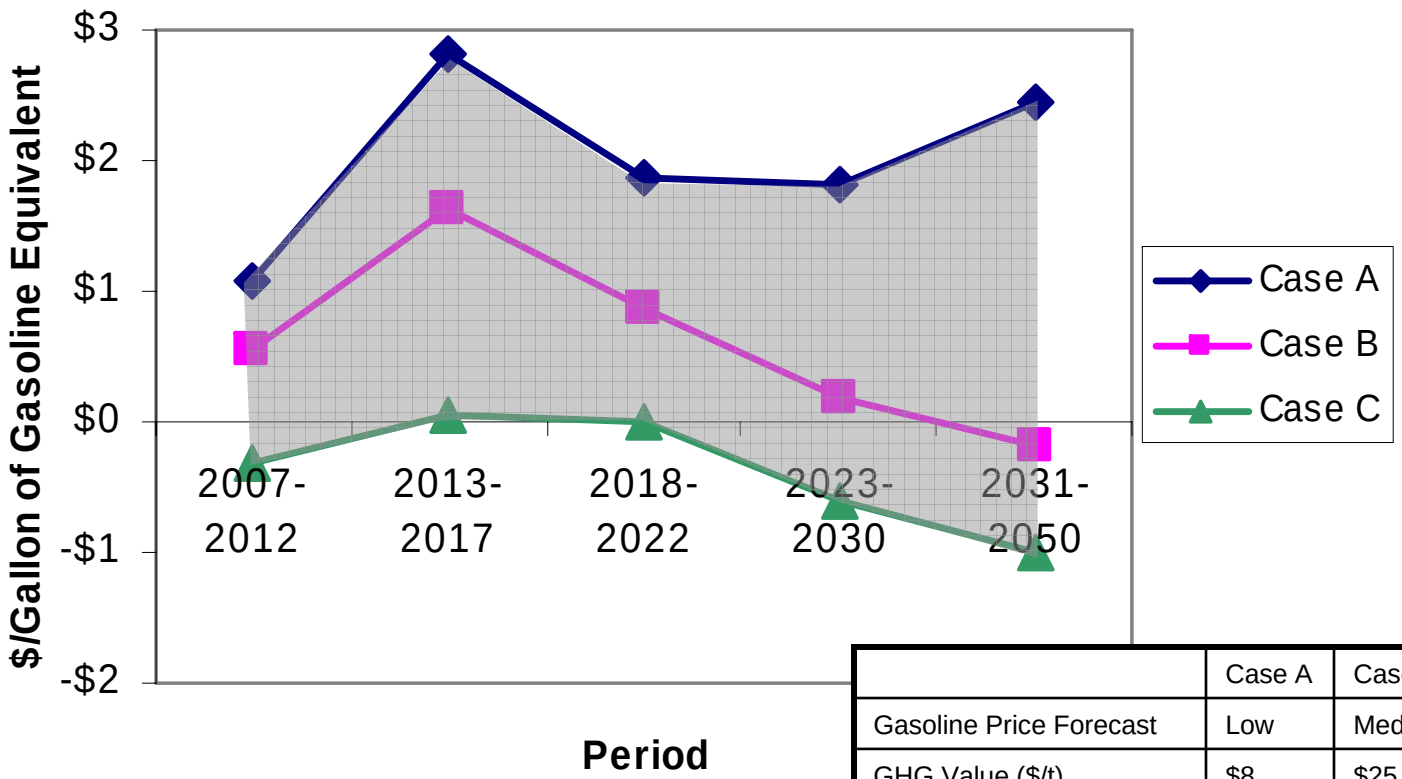
Cost-Effectiveness Range, Example 2 (Non-Alcohol Biofuel and PHEVs)



	Case A	Case B	Case C
Gasoline Price Forecast	Low	Medium	High
GHG Value ($/t)	$8	$25	$50
Alternative Vehicle Prices	High	Medium	Low

Negative values represent net savings relative to gasoline/diesel

Cost-Effectiveness Range, Example 3 (Non-Alcohol Biofuel and Hydrogen)

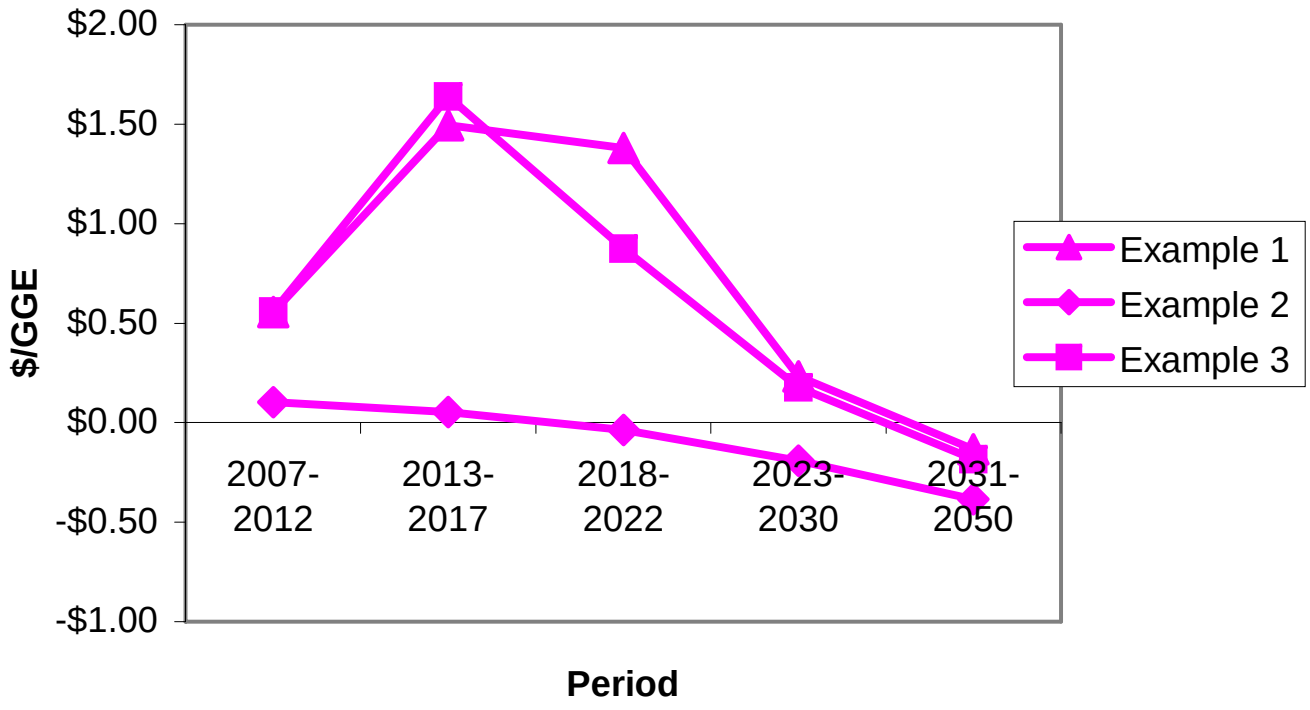


	Case A	Case B	Case C
Gasoline Price Forecast	Low	Medium	High
GHG Value ($/t)	$8	$25	$50
Alternative Vehicle Prices	High	Medium	Low

Negative values represent net savings relative to gasoline/diesel

Cost-Effectiveness Comparison of the Three Examples

Medium price assumptions (Case B)



Negative values represent net savings relative to gasoline/diesel

Cost-Effectiveness of Individual Fuels

Cost-Effectiveness of Petroleum Reduction ($/gallon of gasoline equivalent)

	2007-2012	2013-2017	2018-2022	2023-2030	2031-2050
Hydrogen	$13.00 to $35.00	$13.00 to $33.00	$10.00 to $28.00	$1.40 to $19.00	-$1.00 to $13.00
Electric Drive	$10.00 to $17.00	$1.80 to $9.00	-$0.22 to $5.90	-$1.80 to $3.50	-$2.90 to $1.40
Renewable Diesel	$1.60 to $2.00	$1.50 to $1.90	$1.40 to $1.90	$1.30 to $1.80	$1.00 to $1.50
Ethanol	$0.36 to $0.61	$0.32 to $0.62	$0.18 to $0.47	-$0.08 to $0.17	-$0.01 to $0.17
Propane	$0.14 to $0.29	-$0.01 to $0.33	-$0.03 to $0.32	-$0.04 to $0.30	$0.08 to $0.32
Natural Gas	-$2.20 to -$1.20	-$3.10 to -$1.20	-$3.30 to -$1.50	-$3.10 to -$1.40	-$2.50 to -$1.10
Non-Alcohol Biofuel			-$0.25 to $0.06	-$0.26 to $0.06	-$0.22 to $0.05

Cost-Effectiveness of GHG Emissions Reduction ($/metric ton CO_2 avoided)

	2007-2012	2013-2017	2018-2022	2023-2030	2031-2050
Hydrogen	$1,700 to $4,200	$1,600 to $3,900	$1,100 to $3,000	$190 to $1,900	-$66 to $1,300
Electric Drive	$1,400 to $2,300	$140 to $980	-$88 to $630	-$220 to $390	-$330 to $170
Renewable Diesel	$200 to $200	$170 to $170	$140 to $150	$130 to $130	$96 to $97
Ethanol	$160 to $200	$120 to $140	$85 to $110	$22 to $49	$33 to $60
Propane	$160 to $230	$64 to $260	$53 to $260	$45 to $240	$140 to $281
Natural Gas	-$500 to -$290	-$640 to -$250	-$680 to -$300	-$670 to -$300	-$560 to -$240
Non-Alcohol Biofuel			$13 to $23	$13 to $22	$11 to $19

Includes both light-duty and heavy-duty vehicle classes

Cost-Effectiveness Conclusions

- All three examples result in net savings to society in the long-term (beyond 2030) under medium cost assumptions
  - Example 2 results in net savings beginning in 2018
- Example 2 appears to be the most cost-effective in all years, but the potential cost-effectiveness ranges of the three examples overlap significantly
- Some alternative fueled vehicles are very costly in the near-term (even when the value of avoided emissions is taken into account), but large cost decreases are likely as technologies mature and achieve increased market penetration.

Macroeconomic Analysis

- Macroeconomic impacts evaluated by Peter Berck (UC Berkeley) using E-DRAM
- Effects on state output, personal income, and employment are small and positive in most years

Example	Indicator	2012	2017	2022	2030	2050
Example 1: Ethanol and Hydrogen	State Output	0.06%	0.03%	0.08%	0.02%	0.14%
	Personal Income	0.01%	0.05%	0.13%	0.16%	0.05%
	Employment	0.06%	0.08%	0.14%	0.16%	0.14%
Example 2: Biofuel and PHEV	State Output	0.06%	0.11%	-0.11%	-0.04%	-0.24%
	Personal Income	0.02%	0.09%	0.04%	0.12%	-0.09%
	Employment	0.05%	0.09%	0.15%	0.15%	0.00%
Example 3: Biofuel and Hydrogen	State Output	0.08%	0.11%	-0.11%	-0.04%	0.21%
	Personal Income	0.01%	0.09%	0.04%	0.14%	0.08%
	Employment	0.06%	0.09%	0.15%	0.16%	0.15%

Assumes that state alternative fuel expenditures are shifted from other transportation programs, and does not take into account the costs associated with reducing spending on those programs