

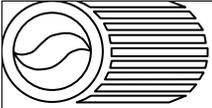
Low Carbon Fuel Standard Workshop: Economic Analysis

January 30, 2009

California Environmental Protection Agency

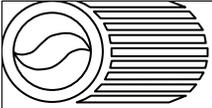


Air Resources Board



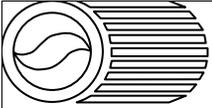
Methodology

- Estimate Production Costs of Gasoline and Diesel
- Estimate Production Costs of Lower-Carbon-Intensity (CI) Fuels
- Apply Costs to Eight Compliance Scenarios
- Estimate Cost Effectiveness (\$/metric ton CO₂ reduced)



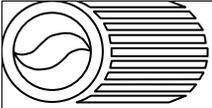
Methodology (Cont.)

- Estimate Cost to Businesses
- Estimate Cost to Government
- Cost to Consumers
- Assess Impact of Federal RFS2 on LCFS



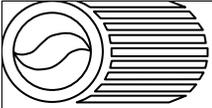
Cost of Alternative Fuels

- Used Antares Paper for Western Governors Association for Most Fuels
- Acquired Primary References
- Adjusted Cost Estimates to Reflect
 - Scaled plants to 50 million gallons per year (MGY)
 - Updated feedstock costs and co-product values
 - Updated to 2007 dollars



Capital Costs

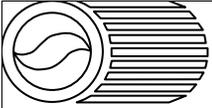
- ASPEN PLUS Model to Build Virtual Plants
 - Identify equipment (reactors, tanks, etc.)
 - Scale to size of plant
- Equipment Cost Estimates from Vendors or Default Values



Production Costs

- ASPEN PLUS Includes Production Costs
 - Fixed: Labor, Maintenance, Taxes, Insurance
 - Variable: Utilities, Non-Feedstock Materials, Waste Disposal

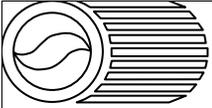
- Staff Adjusted Costs for Crude Price Increases
 - Fuel-related costs: denaturant, diesel, electricity
 - Accounts for 15 - 20 percent of production costs



Feedstock Costs

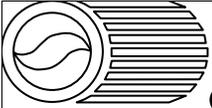
- Values Used in Analysis
 - Corn: \$3.94/bu
 - Corn stover: \$40/ton
 - Wood chips: \$30/ton
 - Soybean oil: \$0.36/lb
 - Yellow grease: \$0.11/lb
 - MSW (green): \$0.00/ton

- Staff Adjusted Costs for Crude Price Increases
 - Fuel-related costs: growing/harvesting and transport
 - Accounts for 20 - 35 percent of production costs



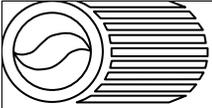
Co-Product Credits

- **Corn**
 - Dry mill: distillers grain
 - Wet mill: corn gluten, corn gluten meal, corn oil
- **Cellulosic Fermentation**
 - Waste solids: fuel for process, generate steam or electricity
- **Fischer-Tropsch Diesel**
 - Electricity and naphtha
- **Other**
 - FAME biodiesel: glycerin
 - FAHC diesel: light hydrocarbons



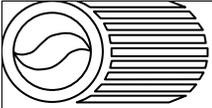
Storage, Transport, and Distribution Costs

- 2007 EPA RFS1 Analysis for Ethanol
 - Ethanol freight cost = \$0.21/gal
 - Additional infrastructure capital cost = \$0.02/gal
 - On a GGE basis, total = \$0.34/gal
- Staff Assumes Similar Numbers for Alternative Diesel Fuels
- Costs Only from Production Facility to Station



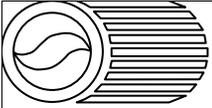
Example Alternative Fuel Costs

Fuel	Feedstock	Total Cost
Ethanol	Corn (dry)	\$2.78*
Ethanol	Wood chips	\$2.52*
Ethanol	Green MSW	\$2.13*
Biodiesel	Soybean oil	\$3.13
F-T Diesel	Wood chips	\$3.43
FAHC Diesel	Yellow grease	\$1.53
CNG	Natural gas	\$1.81**
Electricity	LSE tariffs	\$1.17**
Hydrogen	Natural gas	\$1.26**
* Per GGE		** Per GGE, EER adjusted



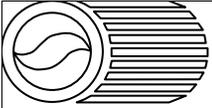
Fuel Dispensing Costs (Per Facility)

- E85
 - Tank, dispenser, auxiliaries, installation
 - \$172,000
- Hydrogen
 - 1,000 kg H₂/day liquid delivery system
 - \$2.7 million
- CNG
 - Dispenser, hoses, compressor, and drier
 - \$373,000



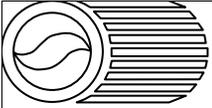
Federal Fuel Tax Incentives

- Ethanol
 - \$0.45/gal credit to blenders
 - \$1.01/gal credit to cellulosic producers
 - Another \$0.10/gal credit for small producers
- Biodiesel
 - \$1.00/gal credit to blenders
 - Only \$0.50/gal for waste grease
- CNG
 - \$0.50/GGE sold



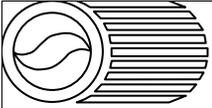
Gasoline Scenarios

- Five Scenarios to Date
 - Varied ZEV deployment and ethanol compositions
 - Compared scenarios to base case
 - Included E85 and electricity dispensing costs
- Results
 - See first significant economic impact in 2014
 - Scenarios resulted in overall savings
 - CE range was $-\$30/\text{MT CO}_2$ to $-\$115/\text{MT CO}_2$



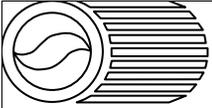
Gasoline Scenarios (Cont.)

- Scenario #1
 - Corn ethanol gradually replaced with lower-CI ethanol
 - E85 arrives in 2015 for additional ethanol needs
- Scenario #2
 - Sugarcane ethanol displaces some corn ethanol
 - More FFVs = more E85



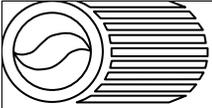
Gasoline Scenarios (Cont.)

- Scenario #3
 - Number of ZEVs nearly doubles to one million in scenario and base case
 - Less ethanol in fuel blend
- Scenario #4
 - Number of ZEVs doubles again to two million in scenario and base case
 - More corn ethanol, less advanced renewable



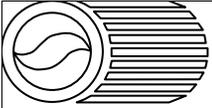
Gasoline Scenarios (Cont.)

- Scenario #5
 - Number of ZEVs at one million in scenario and base case (Similar to #3)
 - More advanced renewable ethanol than #3
 - More total ethanol than #3



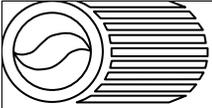
Diesel Scenarios

- Three Scenarios to Date
 - Varied LC diesel compositions, CNG and electric vehicle deployment
 - Compared scenarios to base case
 - Included CNG and electricity dispensing costs
- Results
 - 2012 modest impacts, 2015+ more noticeable
 - Scenarios resulted in overall savings
 - CE range was $-\$70/\text{MT CO}_2$ to $-\$90/\text{MT CO}_2$



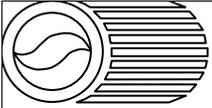
Diesel Scenarios (Cont.)

- Scenario #1
 - Lower-CI diesel substitution (~15% in 2020)
- Scenario #2
 - CNG with two percent penetration
 - Additional savings
- Scenario #3
 - More CNG
 - Heavy duty plug-in hybrids
 - Additional savings



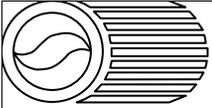
RFS2 Impacts on LCFS

- RFS2 Will Bring Biofuels to California
- Average Carbon Intensity Not Sufficient for LCFS
- RFS2 May Achieve About Half of LCFS Target
- RFS2 Could Be Assigned Infrastructure Costs
- Staff Still Quantifying



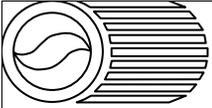
Cost to Businesses

- **Blenders**
 - Additional storage tanks
 - Operational revisions?
- **Refineries**
 - Less CARFG sold
 - Throughputs unchanged
- **Dispensing Stations**
 - Infrastructure costs
 - Not mandated to install at any one station
- **Costs Attributable to RFS2?**



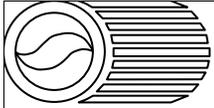
Impacts on Government

- Federal
 - More volume = more excise tax
 - But tax credits reduce revenue
- State
 - More volume \neq more excise tax
 - Excise tax \$0.09/gal for E85, not \$0.18/gal
- Local
 - Sales Tax: More volume of less expensive E85



Work to Do

- Get Updated Crude and Fuel Prices from CEC
- Run Additional Scenarios
- Conduct Sensitivity Analyses (Crude Price, Feedstock Costs)
- Estimate RFS2 Impact on Cost Effectiveness
- Continue to Estimate Costs to Businesses
- Consider Socioeconomic Impacts of LCFS
- Convene a Working Group Meeting in mid-February



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