Renewable Diesel Scenario Analysis

Algae
Biodiesel
Biomass-to-Diesel
Non Esterified Renewable Diesel

Gary Yowell
May 31, 2007
Key Issues

- Diesel Demand
- Crude Oil Price
- Renewable Diesel Supply (volume and timing)
  - Imports (serving Biodiesel and NERD)
  - Domestics (serving Biodiesel and NERD)
  - Unconventional (Algae, BTL, Thermal Depolymerization – with unconventional feeds)
- Projected Response to Incentives/Mandates
  - 0.50-$2.00/gallon
California’s Fuel Demand is Strong and Steady

100-year Trend and Forecast of California’s Gasoline & Diesel Demand 1950 - 2050

- Historic (Gasoline EIA)
- Historic (Diesel EIA)
- Historic (Diesel Ca Board of Equalization)
- Forecast (Diesel 2005 IEPR GHG Case) (5/24/07)
- Historic (Gasoline Ca Board of Equalization)
- Diesel Demand Pavley (off and on-road added)
- Linear (Historic (Gasoline Ca Board of Equalization))
- Linear (Historic (Diesel Ca Board of Equalization))
Diesel Demand

100-year Trend and Forecast of California’s Diesel Demand
1950 - 2050

- Historic (Diesel EIA)
- Historic (Diesel Ca Board of Equalization)
- Forecast (Diesel 2005 IEPR GHG Case) (5/24/07)
- Diesel Demand Pavley (off and on-road added)
- Total Diesel On-, Off-Road, & Max Diesel Cars
- Linear (Historic (Diesel Ca Board of Equalization))

Fuel Demand (billion gallons) vs. Years

- Y-axis: Fuel Demand (billion gallons)
- X-axis: Years (1950-2050)

The chart shows the trend and forecast of California’s diesel demand from 1950 to 2050, including various data sources and projections.
Opportunity for Alternative Fuels to Displace 60% Before Impacting Current Levels

100-year Trend and Forecast of California's Diesel Demand
1950 - 2050

- Historic (Diesel EIA)
- Historic (Diesel Ca Board of Equalization)
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- Total Diesel On-, Off-Road, & Max Diesel Cars
- Linear (Historic (Diesel Ca Board of Equalization))

50% Displacement by 2030
### Three Crude Oil Price Scenario

<table>
<thead>
<tr>
<th>Crude Oil Price Scenario</th>
<th>2007</th>
<th>2012</th>
<th>2017</th>
<th>2022</th>
<th>2030</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>63</td>
<td>70</td>
<td>83</td>
<td>90</td>
<td>99</td>
<td>121</td>
</tr>
<tr>
<td>Reference</td>
<td>63</td>
<td>49</td>
<td>48</td>
<td>51</td>
<td>55</td>
<td>64</td>
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<tr>
<td>Low</td>
<td>63</td>
<td>37</td>
<td>31</td>
<td>31</td>
<td>31</td>
<td>31</td>
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</tbody>
</table>

Prices are dollars per barrel, in constant 2007 dollars
Staff Linear Extrapolated EIA values to 2050

Source: 2007 EIA AEO
Retail Diesel Price Scenarios

U.S. Diesel Prices Since 1918 to Present and AB 1007 Retail Price Scenarios Considered to 2050

- Nominal Price
- Real Price (2003$)
- CEC High Forecast (2007 Real Dollars)
- CEC Reference Forecast (2007 Real Dollars)
- CEC Low Forecast (2007 Real Dollars)
Average Gasoline Prices over the last 12-months

Retail Regular Gasoline (AAA and EIA)

$/Gallon (AAA)

Cents/Gallon (EIA)
High and Middle Case Gasoline Price Forecasts
Annual Average Prices for Regular-Grade in Constant & Nominal Terms

[Assumes inflation of about 2%/yr]
Supply Context

2005/06 World Production of major oilseeds
387 million metric tons


This production is serving food, cosmetic and other markets.
Palm production @ 9 billion gallons and growing

![Graph showing historical development of global oil palm production from 1970 to 2004.](image)

- This production is serving food, cosmetics and other markets.
- Growing 5% annually.

*Figure 1. Historical development of the global palm oil production 1970-2004*
Supply - Biodiesel Production Trends
(In Million Gallons)

Sources: European Biodiesel Board, National Biodiesel Board, Commission Staff Phone Survey of Biodiesel Production,
Greenhouse Gas Emissions

- Biodiesel 50% GHG Reduction
- RenDiesel 70-85% GHG Reduction
- BTL 70-85% GHG Reduction

- Low Carbon Fuel Standard:
  - B20 Biodiesel Blends
  - RD15 NERD Blends
Scenario Analysis – Baseline

- Less than 4-6% of Ca demand is met with Renewable Diesel
  - Existing Federal Incentive Remains
  - No additional Research to advanced Algae, or BTL Plants
- Low Carbon Fuel Standard Baseline
  - 15% NERD & Biodiesel blends
  - Biodiesel is generally use up to B5 although B20 should be feasible with a B20 ASTM adoption
Alternative Scenarios

- State production incentives/or mandated cost of: 50, 1.00, 1.50, $2.00/gallon
- $50 & $500 R&D for unconventional feedstock processes (Algae, BTL)
- 10-year off-take contracts for “unconventional” plants (non-esterified Plants, Algae, BTL, Thermal Conversion)
- Favorable tax credits for in-state renewable plants
- Facilitate siting petroleum infrastructure port facilities, & bulk storage
  - Pulls Renewables into Ca market
  - Accelerate plants, and volume.
# Market Supply Responses to Incentives or Mandates

Table 2. Maximum Renewable Diesel Penetrations after 20-30 years in Response to Varying Incentives or Mandated Cost

<table>
<thead>
<tr>
<th>Existing Federal Incentive ($ / gallon)</th>
<th>Additional Incentive ($ / gallon)</th>
<th>Total Incentive ($ / gallon)</th>
<th>Low</th>
<th>Reference</th>
<th>High</th>
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</thead>
<tbody>
<tr>
<td>$1.00</td>
<td>0</td>
<td>$1.00</td>
<td>4%</td>
<td>5%</td>
<td>6%</td>
</tr>
<tr>
<td>$1.00</td>
<td>60¢</td>
<td>$1.60</td>
<td>8%</td>
<td>11%</td>
<td>14%</td>
</tr>
<tr>
<td>$1.00</td>
<td>$1.00</td>
<td>$2.00</td>
<td>14%</td>
<td>20%</td>
<td>24%</td>
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<tr>
<td>$1.00</td>
<td>$1.50</td>
<td>$2.50</td>
<td>22%</td>
<td>31%</td>
<td>38%</td>
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<tr>
<td>$1.00</td>
<td>$2.00</td>
<td>$3.00</td>
<td>30%</td>
<td>44%</td>
<td>52%</td>
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</tbody>
</table>

% of Ca Demand
Fig 5 Renewable Diesel Volumes
Scenario Model Analytics

- Constructed for AB 1007 Criteria
- XTL and Renewable Diesels use same backbone - projected diesel demand vs. % displacement
- Percent of XTL supply – Incentives
- \( \sum \) Cost (Consumer, Gov, Fuel Prices, Fuel energy impacts)
- Emissions, Petroleum Reduction Cost effectiveness is quantified to 2050
Cost Effectiveness Results

@ 20% Renewable Diesel Blend
with $1.00 additional cost/gallon

<table>
<thead>
<tr>
<th>Cumulative Years</th>
<th>Consumers Incremental Expense (billion $)</th>
<th>Gov't Tax Revenue Expense (billion $)</th>
<th>Gov' t Incentives Expense (billion $)</th>
<th>Total Gov' t Expense (billion $)</th>
<th>Petroleum Reduction (billions)</th>
<th>Alt Fuels Demand (billions)</th>
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<tbody>
<tr>
<td>2007 to 2012</td>
<td>0.00</td>
<td>0.00</td>
<td>0.97</td>
<td>0.97</td>
<td>0.49</td>
<td>0.21</td>
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<tr>
<td>2007 to 2017</td>
<td>0.00</td>
<td>0.00</td>
<td>7.22</td>
<td>7.22</td>
<td>3.61</td>
<td>0.89</td>
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<tr>
<td>2007 to 2022</td>
<td>0.00</td>
<td>0.00</td>
<td>18.22</td>
<td>18.22</td>
<td>9.11</td>
<td>1.21</td>
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<tr>
<td>2007 to 2030</td>
<td>0.00</td>
<td>0.00</td>
<td>41.63</td>
<td>41.63</td>
<td>20.82</td>
<td>1.67</td>
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<td>2007 to 2050</td>
<td>0.00</td>
<td>0.00</td>
<td>125.20</td>
<td>125.20</td>
<td>62.60</td>
<td>2.44</td>
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</table>

**NOTE:** Positive Numbers are Reductions, Negative Numbers are Increases

Cost Effectiveness Analysis ($s per ton reduction)

<table>
<thead>
<tr>
<th>Cumulative Years</th>
<th>Petroleum Reduction</th>
<th>NOx</th>
<th>CO</th>
<th>NMOG</th>
<th>Toxics</th>
<th>Particulate Matter</th>
<th>GHGs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007 to 2012</td>
<td>2.000</td>
<td>-2,925,230</td>
<td>268,173</td>
<td>-9,317,599</td>
<td>-1,845,561,967</td>
<td>3,424,927</td>
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<tr>
<td>2007 to 2017</td>
<td>2.000</td>
<td>-51,598,929</td>
<td>2,003,386</td>
<td>-64,008,689</td>
<td>-1,880,942,645</td>
<td>24,263,768</td>
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<tr>
<td>2007 to 2022</td>
<td>2.000</td>
<td>91,503,140</td>
<td>5,112,691</td>
<td>-142,774,934</td>
<td>-1,884,337,897</td>
<td>56,673,938</td>
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<tr>
<td>2007 to 2050</td>
<td>2.000</td>
<td>35,826,152</td>
<td>39,237,628</td>
<td>-459,910,342</td>
<td>-1,886,245,838</td>
<td>225,346,201</td>
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# Emissions & Petroleum Reduction

Based on 2005 IEPR Emission Analysis To Be Updated ASAP

15% Renewable Diesel Blend

<table>
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<tr>
<th>Single Year</th>
<th>NOx</th>
<th>CO</th>
<th>NMOG</th>
<th>Toxics</th>
<th>Particulate Matter</th>
<th>GHGs</th>
<th>Petroleum Reduction (billion gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>10</td>
<td>-1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1,733,854</td>
<td>0.159</td>
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<tr>
<td>2017</td>
<td>41</td>
<td>-5</td>
<td>-2</td>
<td>-1</td>
<td>3</td>
<td>7,293,559</td>
<td>0.668</td>
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<tr>
<td>2022</td>
<td>56</td>
<td>-6</td>
<td>-2</td>
<td>-1</td>
<td>4</td>
<td>9,888,819</td>
<td>0.905</td>
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<tr>
<td>2030</td>
<td>77</td>
<td>-9</td>
<td>-3</td>
<td>-1</td>
<td>5</td>
<td>13,662,852</td>
<td>1.251</td>
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<tr>
<td>2050</td>
<td>113</td>
<td>-13</td>
<td>-5</td>
<td>-2</td>
<td>8</td>
<td>20,006,245</td>
<td>1.832</td>
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Results Petroleum Reduction

Potential Petroleum Reductions per Incentive per Fuel Price Scenario
2012-2050
GHG Reductions 80% GHG Benefit Assumed

Potential Greenhouse Gas Reductions per Incentive per Fuel Price Scenario

2012-2050

- GHG Reductions During High Crude Oil Prices
- GHG Reductions During Reference Crude Oil Prices
- GHG Reduction During Low Crude Oil Prices

GHG Reductions (US Tons/year/incentive in $)

<table>
<thead>
<tr>
<th>Year</th>
<th>2012</th>
<th>2017</th>
<th>2022</th>
<th>2030</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$1.00</td>
<td>$1.50</td>
<td>$2.00</td>
<td>$2.50</td>
<td>$3.00</td>
</tr>
<tr>
<td>GHG Reductions</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
</tr>
</tbody>
</table>
Staff Recommended Actions

- Lack of bulk storage sufficient to receive Renewable Diesel shipments (and XTL diesel) from abroad and keep bulk segregated
  - Improved Permitting Process,
  - Legislature empower the Energy Commission to oversee and facilitate the permitting process (at ports and inland)

- Limited Market Demand for Renewable Diesels
  - Low Carbon Fuel Standard – implementing the standard in a way that pulls Renewable diesels into market.
  - Need a 5% mandate to get infrastructure established
  - Use Incentives to move beyond 5%
Continued Staff Recommendations

• Limited In-State Renewable diesel Production.
  □ The State Legislature should establish “Floor” price protection up to 25 cents per gallon excise tax exemption for Renewable diesel fuels
  □ Floor is indexed on a composite of palm, canola and soy oil and Diesel Rack prices
  □ Subsidy cost funded via a 0.1 cent per gallon tax per diesel gallon sold
  □ Must require that the fuel be sold in California
Continued Staff Recommendations

- Now is the time to develop sustainable Biofuel production policy (guidelines) for in-state and foreign Biofuel supplies

  - Will the Low Carbon Fuel Process result in a GHG Certification?
  - Welcome comments and suggested language that staff could include into our staff recommendations.
Current Storage

Westway Terminal

- Port of LA
- 25MM gal
  - 6MM+ dedicated to biodiesel
  - 1MM+ gallons of Ethanol Storage
  - could be expanded to support more an/or higher percentage of renewable diesel and ethanol storage
  - Close proximity to major oil refineries and Kindermorgan Carson facility
- City of LA closing down to make way for park within 18 months
- Losing this storage would make it more difficult for the state to achieve its biofuel objectives for the next 3 years
- Industry recommends delaying closing 3-5 years until replacement facility is built

QuickTime™ and a TIFF (LZW) decompressor are needed to see this picture.
New Storage

- Targets to meet renewable diesel growth
  - Expect 6-8 turns year for the storage
  - Takes 3-4 years to build with permitting
  - To support 1B gallons within 5 years, CA needs at least 150MM gals to 200MM gals of new storage

- What the market needs
  - Developers of storage need to fast track permitting process to help cut one year off process
  - Storage needs to be planned now to get ahead of the demand curve as proposed
  - Storage needs to be near pipelines with rail, truck and ship (at least 30k MT dead tonnage)
Comments - Suggestions