California Renewable Diesel Multimedia Evaluation
Tier I Report

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Biodiesel Workshop

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Renewable Diesel Tier I Elements

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- Study Approach—Life Cycle and Multimedia
- Release Scenarios
- Renewable Diesel Production, Storage, Distribution and Use
- Renewable Diesel Toxicity
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- Tier I Conclusions

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Background

• Currently the majority of biological-source diesel fuels are fatty-acid methyl esters (FAME)
• Renewable diesel is different and now entering the market
• According to the Low-Carbon Fuel Standard (LCFS)

“... a motor vehicle fuel or fuel additive which is all the following:

(A) Registered as a motor vehicle fuel or fuel additive under 40 CFR part 79; A-9
(B) Not a mono-alkyl ester;
(C) Intended for use in engines that are designed to run on conventional diesel fuel; and
(D) Derived from nonpetroleum renewable resources.”
Biofuels Options

Fats and Oils
- Renewable Diesel
- Cracking
- Biodiesel (Fatty Acid methyl Ester or FAME)

Starches and Sugars
- Ethanol
- Higher Alcohols
- Sugar to Hydrocarbon

Biomass
- Cellulosic Ethanol
- Digestion
- Pyrolysis
- Hydrothermal
- Biomass to liquid (BTL)
Study Approach

• Life-cycle approach to impacts
  - Human health
  - Ecological risk
  - Resource stress and damage

• Identify key uncertainties and data gaps

• Address multimedia impacts
  - Air quality
  - Water resources
  - Soil
  - Infrastructure

• Excludes indirect environmental, ecological, and health impacts from biomass production (i.e. climate disruption)
Life-Cycle Stages

Demands

- Energy
  - Feedstock production, extraction
  - Transport
  - Fuel Production
  - Transport

- Resources

Impacts

- Air Emissions
- Water Emissions
- Wastes (contained)

Without containment

Environment, human health, resources (water)
Key LCA Studies Review

- **US EPA Life Cycle Assessment of Renewable Fuels**
  - As part of its RFS2 rulemaking, EPA made a life cycle assessment of alternative and petroleum transportation fuels
  - EPA reported fuel use and production emissions

  - Life-cycle damage per vehicle-mile traveled (VMT)
  - Different combinations of fuels and vehicle technologies
  - VMT damages were remarkably similar
  - NRC urged caution interpreting small differences between fuel/vehicle combinations
Release Scenarios

• Normal releases
  - Production emissions (in addition to refinery operation)
    - Hexane or CO₂ released to the air during seed extraction,
    - Odors associated with waste biomass
    - Used process water discharges (pH and trace-chemicals)
  - Use-phase (combustion) emissions
    - Tailpipe emissions
    - Marine engine water releases

• Off-normal releases—effectively the same as ULSD
  - Spills and leaks during production, distribution, and storage
    - Above- or below-ground storage tank & associated piping,
    - Liquid-transportation vehicles--rail tank car, tanker truck, tanker ship
    - Bulk-fuel transport pipeline
Production, Distribution, Storage and Use

• Approaches to producing renewable diesel (RD)
  - Hydrotreating vegetable oils or animal fats to make Hydrogenation Derived Renewable Diesel (HDRD)
  - Partially combusting a biomass to get CO/H₂ (syngas) utilizing the Fischer-Tropsch reaction to produce complex hydrocarbons
  - Emerging approaches based on synthesis of hydrocarbons through enzymatic reactions

• Producing HDRD
  - Co-processing in a conventional petroleum production stream
  - Dedicated HDRD (or R100) production with distribution, direct use or dilution

• Specifications for additives to RD expected to be similar to ULSD
Production, Distribution, Storage and Use

• Combustion emissions studies are ongoing

• Preliminary results suggest Renewable Diesel (RD) emissions & impacts that are within the range of ULSD emissions & impacts
  
  ➢ Absence of sulfur and aromatic compounds in pure RD
  
  ➢ Pure HDRD fuel showed significant emission benefits for CO, HC, NOx and PM—Secondary PM not yet addressed
    Below 10% RD, blends can result in CO and HC reductions, but not PM, NOx
  
  ➢ Volumetric fuel consumption is 5% higher because of lower HDRD density
  
  ➢ HDRD fuels avoid some biodiesel issues (oxidation, hygroscopicity, fouling, catalyst deactivation, etc).
Toxicity

• Key challenge
  – RD is not a defined chemical formulation or a defined mixture of components

• Limited tests indicate that RD has low relative toxicity
  – Major differences in health and ecological impact between existing diesel and RD blends are more likely to be associated with additives than with the hydrocarbon mix
  – Chemical comparison to conventional diesel is important for determining whether or how much additional toxicity tests are required
Transport and Fate

- The fate and transport of a fuel and its component chemicals in the environment depend on the multimedia transport properties of its constituent chemicals.
- Based on similarities in chemical composition, the multimedia environmental behavior of renewable diesel should be similar to ULSD.
- Impact of additives to fate and transport need to be evaluated.
Tier I Conclusions

- Renewable diesel (RD) is chemically similar to the ultra-low sulfur diesel (ULSD) fuel already in wide use in California.
- RD is compatible with existing refining and distribution infrastructure and can be used in current diesel engines without modification.
- Pure renewable diesel has reduced aromatic hydrocarbon content.
- Limited toxicity testing on rats reveals that pure RD has limited inherent toxicity and unlikely to exceed the inherent toxicity or mutagenicity of standard diesel.
- Life-cycle health impacts of renewable diesel blends are not likely to differ significantly from those of petroleum diesel.
Tier I Conclusions

- Knowledge gaps include
  - Additive impacts
  - Production, storage and distribution releases (off-normal)
  - Air emissions toxicity testing
  - Priority list of renewable diesel fuel formulations