



# California Green Summit

## Future Fuels and Feedstocks

Alexander “Lex” Mitchell

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# Alternative Fuels in California

- Cap-and-Trade Program
  - Eligible biofuels have no compliance obligation
  - Most recent auction settlement price was \$12.73



# Alternative Fuels in California (Cont.)

- Low Carbon Fuel Standard
  - Fuels are scored by carbon intensity, lower carbon fuels generate higher credits
  - Credits = one tonne of CO<sub>2</sub>e, ~\$120



# Alternative Fuels in California (Cont.)

- Zero Emissions Vehicle (ZEV)



- Short-Lived Climate Pollutants (SLCP)



- Very Low Carbon Fuel Incentive

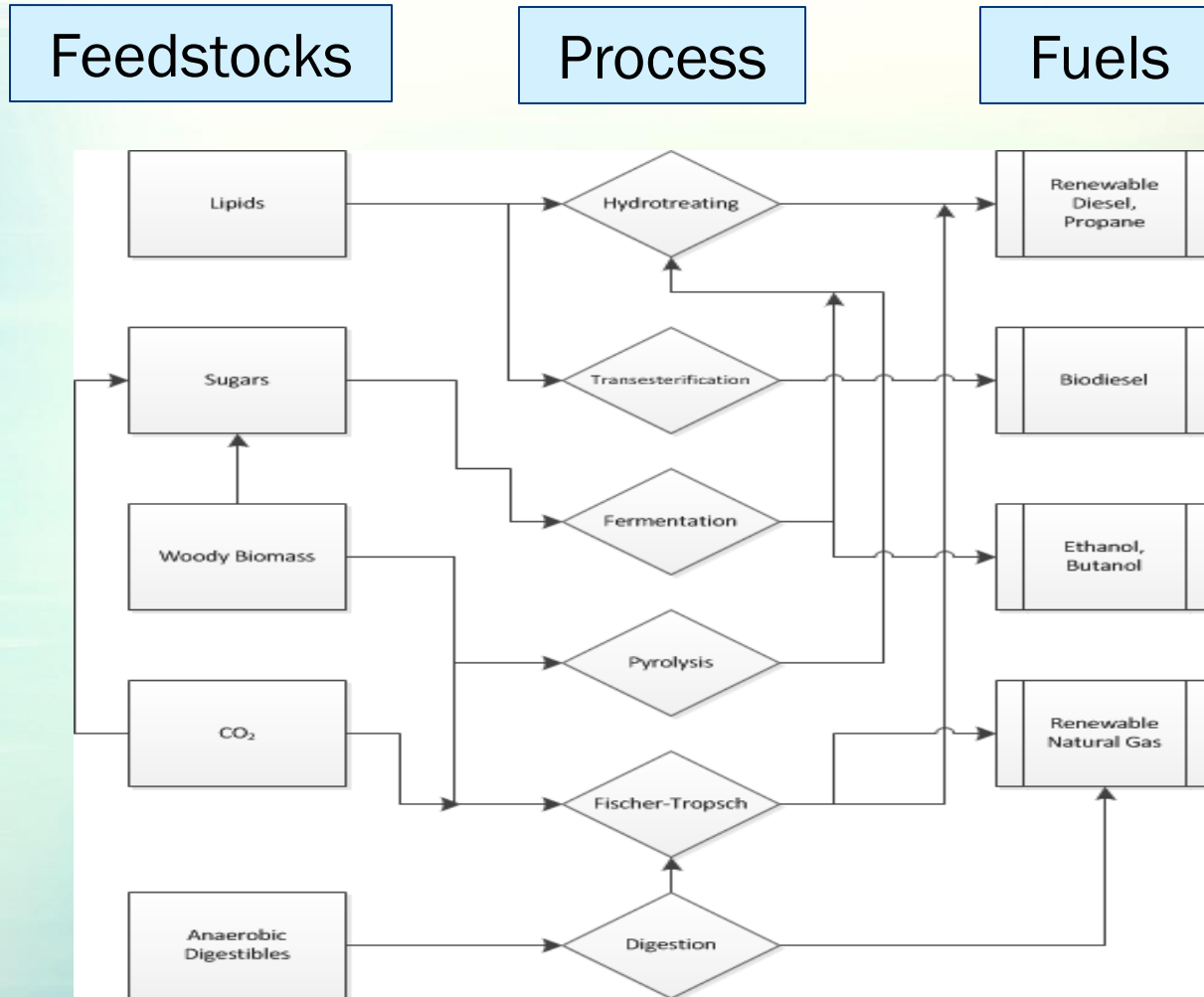


# Feedstock Drives Fuel Carbon Intensity

- Bio feedstocks generally reduce carbon
  - Corn ethanol CI ~ 76 gCO<sub>2</sub>e/MJ
  - Soy biodiesel CI ~ 53 gCO<sub>2</sub>e/MJ
- Waste or residue feedstocks can go lower
  - Landfill RNG CI ~ 23 gCO<sub>2</sub>e/MJ
  - Used Cooking Oil Biodiesel CI ~ 19 gCO<sub>2</sub>e/MJ
  - Anaerobic Wastewater RNG CI ~ 8 gCO<sub>2</sub>e/MJ



# Feedstocks Can Often be Used for Different Fuels



# Feedstocks for Alternative Fuels

- Lipids
- Sugars/starches
- Woody/herbaceous biomass
- Anaerobic digestibles
- CO<sub>2</sub>



# Feedstock: **Lipids**

- Includes animal fats, vegetable oil, and algae oil
- Fuels
  - Biodiesel (transesterification)
  - Renewable diesel (hydrotreating)
  - Propane (renewable diesel by-product)





# Feedstock: **Sugars/Starches**

- Can be derived from sugar/starch bearing plants (corn, cane) or cellulosic hydrolysis
- Fuels
  - Ethanol, or butanol (direct fermentation)
  - Renewable diesel  
(fermentation then hydrotreating)



# Feedstock:

## Woody/herbaceous biomass

- Includes energy crops such as miscanthus, willow, grass, or forest residue
- Fuels
  - Ethanol (hydrolysis and fermentation)
  - Renewable diesel (Fischer-Tropsch)
  - Renewable gasoline (pyrolysis and co-processing)



# Feedstock:

## Anaerobic digestibles

- Includes Landfill gas, municipal wastewater, dairy manure
- Fuels
  - Renewable natural gas (anaerobic digestion)
  - Renewable diesel (digestion and Fischer-Tropsch)



# Feedstock: CO<sub>2</sub>

- Can come from electrical power plants, any number of industrial sources, or from the atmosphere
- Generally research stage
- Can be used to produce a number of other feedstocks or fuels including sugars, renewable diesel, and renewable natural gas



# Contact Info

Alexander “Lex” Mitchell  
Manager, Emerging Technology Section  
Oil and Gas and GHG Mitigation Branch  
California Air Resources Board  
Phone: (916) 327-1513  
[Alexander.Mitchell@arb.ca.gov](mailto:Alexander.Mitchell@arb.ca.gov)

