California Energy

Biomass to Liquids: California and North America

Second Annual BTL Congress
Berlin, Germany
October 13, 2006

James D. Boyd
Vice-Chair and Commissioner
California Energy Commission

California Energy

Presentation Outline

- Why Biomass to Liquids?
- Current State of Biofuel Industry in the US and California
- Strategic Value of Biomass Resources
- Governor's Executive Orders on Biomass and Climate Change
- Bioenergy Interagency Working Group
- State Legislative Initiatives affecting Biofuels
- Biomass as a Source of Transportation Fuels

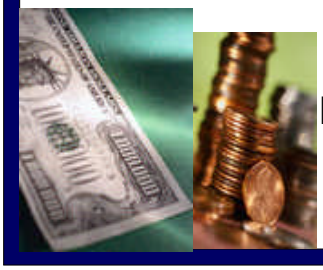
California Energy

Why Biomass to Liquids?

Energy Security

Environment

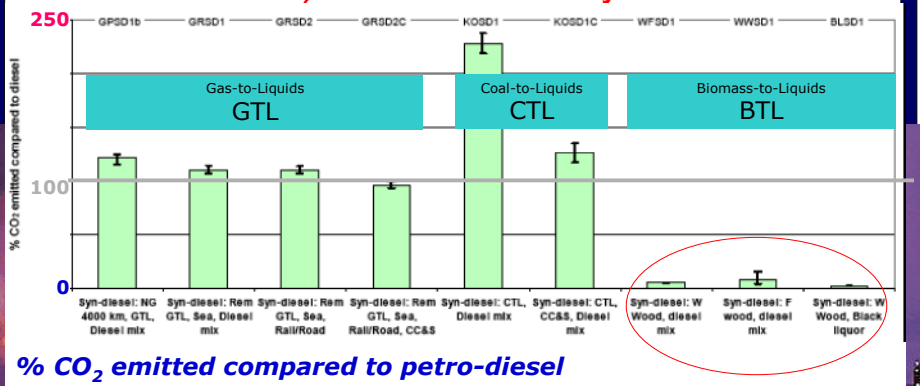
Economy



- Rural Economy
- Balance of Trade
- National Debt

California Energy

Net CO_2 Emissions for Syndiesels



% CO_2 emitted compared to petro-diesel

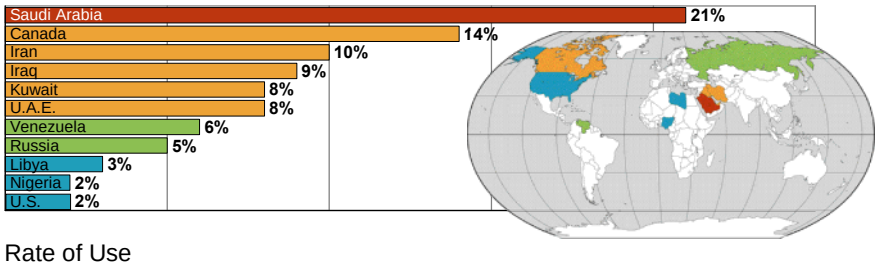
WELL-TO-WHEELS ANALYSIS OF FUTURE AUTOMOTIVE FUELS AND POWERTRAINS IN THE EUROPEAN CONTEXT (May, 2006)

Image: http://www.fischer-tropsch.org/

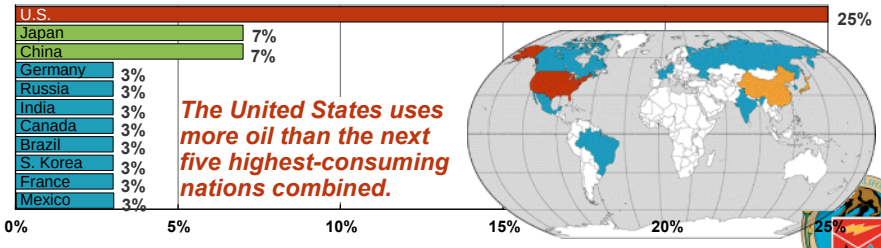
California Energy

U.S. Dependence on Foreign Oil

Oil Reserves



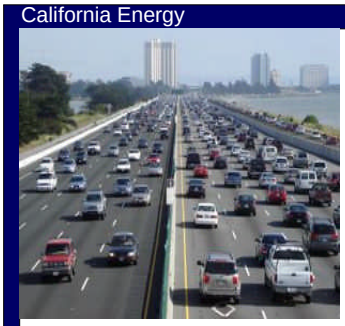
Rate of Use



The United States uses more oil than the next five highest-consuming nations combined.

Updated July 2005. Source: International Energy Annual 2003 (EIA), Tables 1.2 and 8.1-O&GJ. Canada's reserves include tar sands.

California Energy



2005 U.S. Fossil Transportation Fuel Consumption (gallons)

Gasoline	140,000,000,000
Diesel	40,000,000,000

Current petroleum imports: 12 million barrels/day

At mid-July peak of $78.26/barrel, annual oil import bill is $342 Billion

On September 27, @ $61.54/barrel, annual bill is $269 Billion

President's State of the Union Address

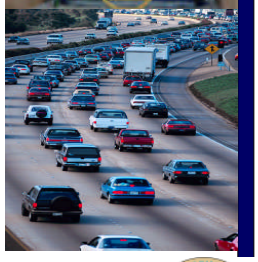
●*Keeping America competitive requires **affordable energy.** And here we have a serious problem: America is **addicted to oil,** which is often imported from unstable parts of the world.*

●*The best way to break this addiction is through **technology….** and we are **on the threshold of incredible advances**…*

●*So tonight I announce…push for breakthroughs in two vital areas…**change how we power our homes and offices**,…**change how we power our automobiles**.*

January 31, 2006
STATE OF THE UNION ADDRESS BY THE PRESIDENT
United States Capitol
Washington, D.C.

Current State of the Biofuels Industry In the U.S. (as of 9/15/06)



- Most ethanol available today in the U.S. is corn, or grain, based ethanol.
- U.S. ethanol production is increasing annually from 1.1 bgy 1996 to 4.9 bgy 2006 with an additional 0.5byg to come on line before the end of the year.
- Total Number of U.S. E85 Fueling Stations: 841
- Estimated number of FFVs in service in 2006 is 6.2 million, up from approximately 0.5 million in 1999.

Data: Renewable Fuels Association, Alternative Fuels Data Center

California Energy

Biofuels in California Transportation

California is about 95 percent petroleum dependent.

California consumers over 900 million gallons per year of ethanol and over 11 million gallons of biodiesel fuel.

There are multiple pathways to convert biomass residues to transportation fuels.

California's biomass resources can support 2 billion gallons per year and up to 3 billion gallons per year by 2020.

Biomass-based fuels can contribute to reducing our state's petroleum dependence, while decreasing air pollution and greenhouse gases.

California Energy

Strategic Value of Bioenergy

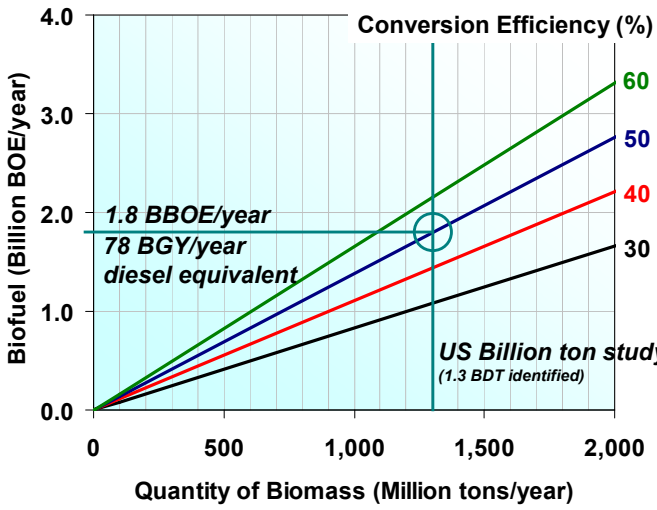
The U.S. has large, diverse and untapped biomass resources which can support greater use in electric power, fuels and chemicals.
U.S. Potential = 1.3 billion tons
California = 80 million tons

Biomass is an energy resource capable of achieving state petroleum reduction, climate change, renewable energy and environmental goals.

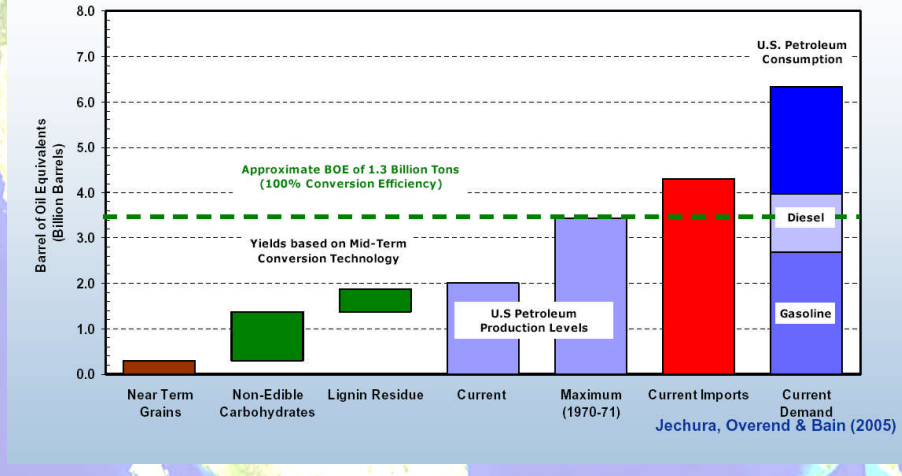
Use of biomass for energy production can address the U.S. and California's waste disposal and environmental problems, while creating local jobs.

Other public benefits include improving forest health and human and animal health, while avoiding catastrophic wildfires.

U.S. Biofuel Potential



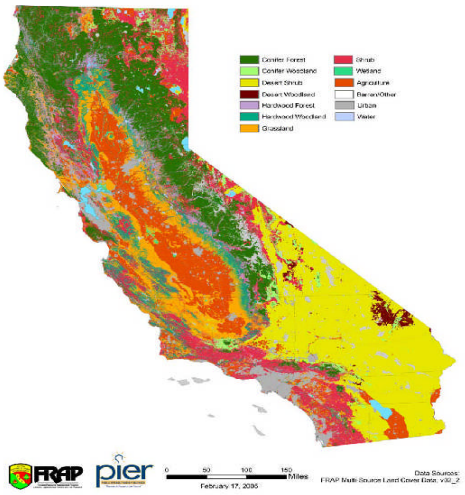
Biofuel Potential in US Transportation



source: Bain, 2005

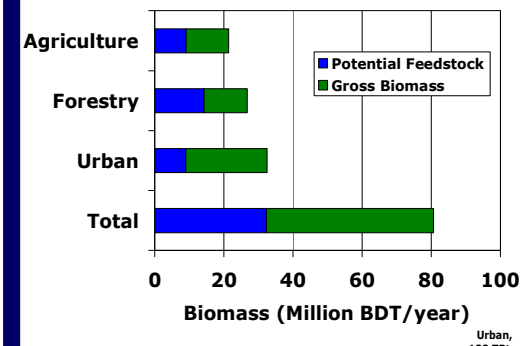
California Energy

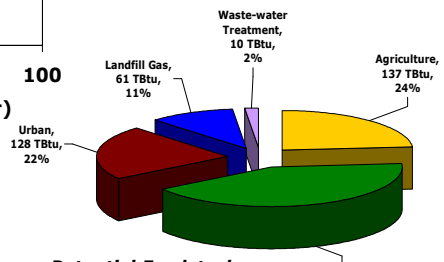
California's Vast, Untapped Biomass Resources



California Energy

California Biomass Technical Potential





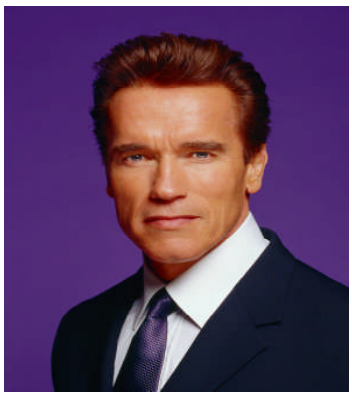
Potential Feedstock Energy in Biomass 507 Trillion Btu/year

Governor Directs State Agencies to Expand Biofuels to Fight High Gasoline Prices

"It is critical that we do everything we can to reduce our dependence on petroleum based fuels. "

"Turning waste products into energy is good for the economy, local job creation and our environment."

---Governor Schwarzenegger
Sacramento, California
April 25, 2006



Governor's Executive Order S-06-06

Established targets to increase in-state production and use of bioenergy, including ethanol and bio-diesel fuels made from renewable resources:

- **For biofuels**, the state shall produce a minimum of 20 percent of its biofuels within California by 2010, 40 percent by 2020, and 75 percent by 2050.
- **For biomass for electricity**, the state meet a 20 percent target within the established state goals for renewable generation for 2010 and 2020.

California Energy

Governor's Executive Order S-06-06

Directed the California Resources Agency and the Energy Commission to coordinate work among state agencies to promote the use of biomass resources:

- Continue the work of the Bioenergy Interagency Working Group, chaired by the Energy Commission.
- Identify and secure federal and state funding for research, development and demonstration projects.
- Advance the use of biomass resources for electricity generation and biofuels for transportation.

California Energy

Governor's Executive Order S-06-06

The Energy Commission shall report biannually to the Governor and the Legislature through its *Integrated Energy Policy Report* on progress made in achieving sustainable biomass development in California.

The California Air Resources Board is urged to consider the most flexible use of biofuels in its *Rulemaking to Update the Predictive Model and Specifications for Reformulated Gasoline.*

The California Public Utilities Commission is requested to initiate a new proceeding or build upon an existing proceeding to encourage the use of biomass and other renewable resources.

Bioenergy Interagency Working Group

- **Goals:**
  - Identify opportunities to advance biopower, biogas and biofuels;
  - Address regulatory and institutional barriers and propose solutions;
  - Create synergy and consistency through joint, state level efforts.
- **Membership**: California Energy Commission (Chair), California Public Utilities Commission, Department of Food and Agriculture, Air Resources Board, Department of Forestry and Fire Protection, State Water Resources Control Board and the California Integrated Waste Management Board.
- **Timing**: The Working Group began meeting regularly in May 2005; the Draft Consultant Report, *Recommendations for a Bioenergy Plan for California,* was the subject of a public workshop on March 9, 2006. The Working Group meets regularly to comply with E. O. S-06-06.

California Energy

State Action Plan Objectives

1. Establish California as a market leader in technology innovation, sustainable biomass development, and market development for bio-based products.
2. Coordinate research, development, demonstration, and commercialization efforts across federal and state agencies.
3. Align existing regulatory requirements to encourage production and use of California's biomass resources.
4. Facilitate market entry for new applications of bioenergy including electricity, biogas, and biofuels.
5. Maximize the contributions of bioenergy toward achieving the state's petroleum reduction, climate change, renewable energy, and environmental goals.

Bioenergy Action Plan Status

The Bioenergy Interagency Working Group continues to meet to comply with the Governor's Executive Order.

The Governor's Executive Order on Biomass and the final report, *Recommendations for a Bioenergy Plan for California,* is available on our web page at:
www.energy.ca.gov/bioenergy_action_plan

The Energy Commission will complete the State Alternative Fuels Plan by June 30, 2007, in partnership with the Air Resources Board.

The Energy Commission will report on our progress in our *2007 Integrated Energy Policy Report.*

California Energy

State Legislative Direction

The Governor signed Assembly Bill 1007 (Pavley, Chapter 371, Statutes of 2005) on September 29, 2005, requiring the Energy Commission to:

- Develop and adopt a State Plan to Increase the Use of Alternative Fuels no later than June 30, 2007.
- Work in partnership with the Air Resources Board and affected state agencies.
- The Energy Commission has a proceeding underway to complete the Plan.

AB 1007 Process

State plan to increase the use of alternative transportation fuels—the AB 1007 Alternative Fuels Plan

- Energy Commission will prepare a plan to reduce petroleum use
- Plan does not pick technology "winners" and "losers."
- Plan will "provides a comprehensive framework for the state to ensure that all fuel and technology options are given an opportunity to compete in the California transportation market."

Plan Scope:

- Evaluate fuels on full fuel-cycle assessment of emissions
- Set goals for 2012, 2017, 2022 for increased use of alternative fuels
- Recommend policies to ensure alternative fuel goals are attained, including:
  - Fuel and vehicle standards
  - Requirements and incentives to ensure vehicles use alternative fuels
  - Requirements and incentives to ensure fueling stations are available
  - Incentives and other encouragement for alternative fuel-capable vehicles, including Research, Development and Demonstration projects.

California Energy

Global Warming Solutions Act of 2006

On September 27, 2006, the Governor signed Assembly Bill 32, the Global Warming Solutions Act of 2006, authored by Assembly Speaker Fabian Nunez.

California's initiative to limit greenhouse gas emissions will favor low-carbon technologies, including the increased use of alternative fuels, such as biofuels.

This landmark legislation, gives the California Air Resources Board new responsibilities to:

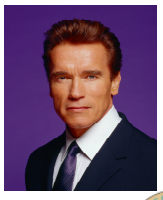
- Adopt a statewide greenhouse gas (GHG) emissions limit;
- Adopt regulations to achieve "maximum feasible and cost-effective GHG reductions;
- Adopt market mechanisms, such as cap-and-trade programs;
- Establish mandatory reporting of GHG emissions by large emitting sectors and industries.

California Energy

Climate Change Initiative

"I say the debate is over. We know the science. We see the threat. And we know the time for action is now."

-- Governor Schwarzenegger
June 1, 2005
World Environment Day



California Energy

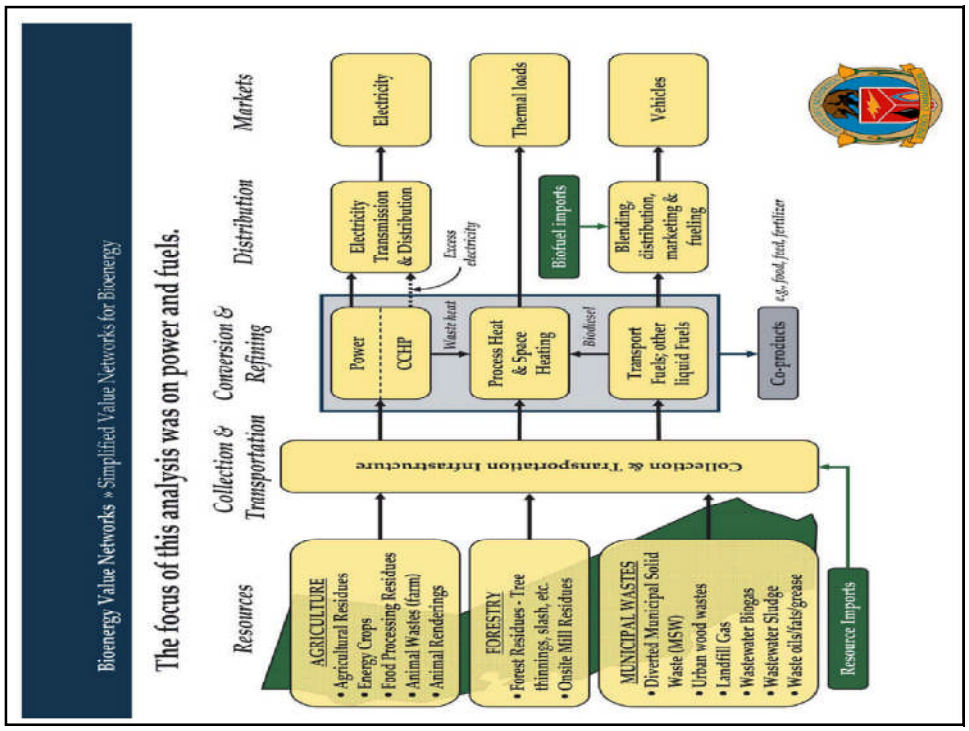
Governor's Executive Order on Climate Change

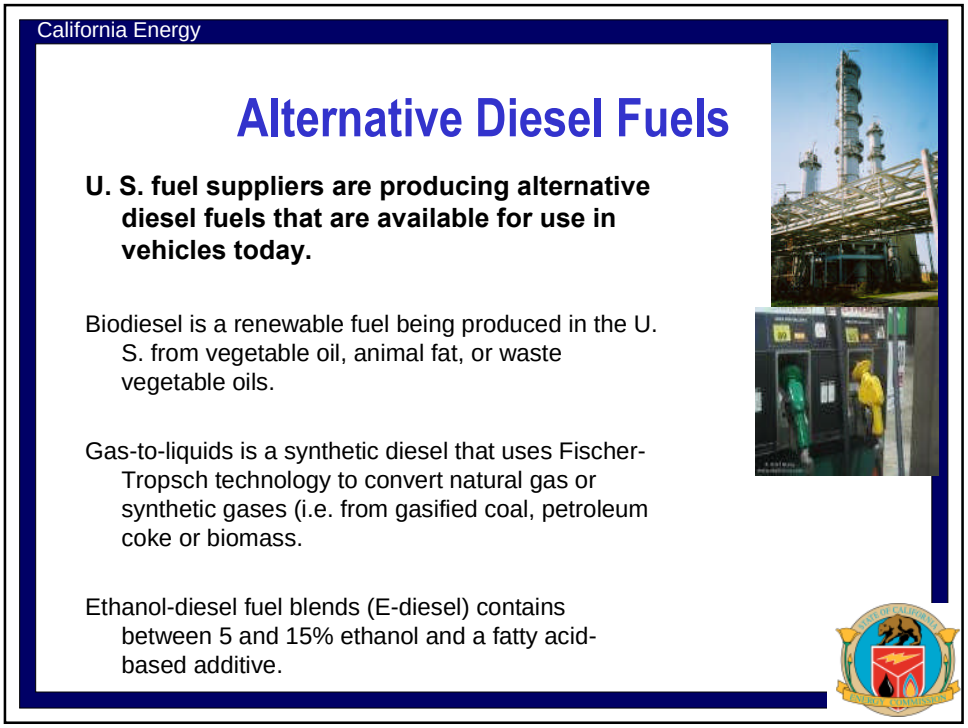
On July 1, 2005, the Governor signed Executive Order S-3-05, establishing the following greenhouse gas (GHG) emission reduction targets:

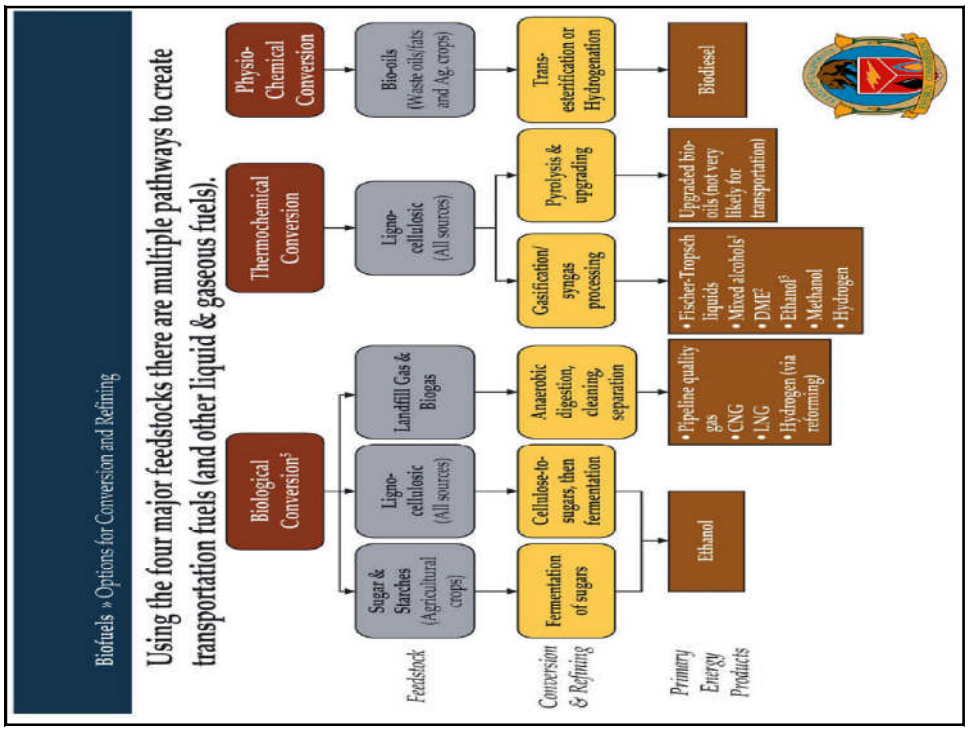
- **By 2010,** Reduce to 2000 Emission Levels
- **By 2020,** Reduce to 1990 Emission Levels
- **By 2050,** Reduce to 80% Below 1990 Levels

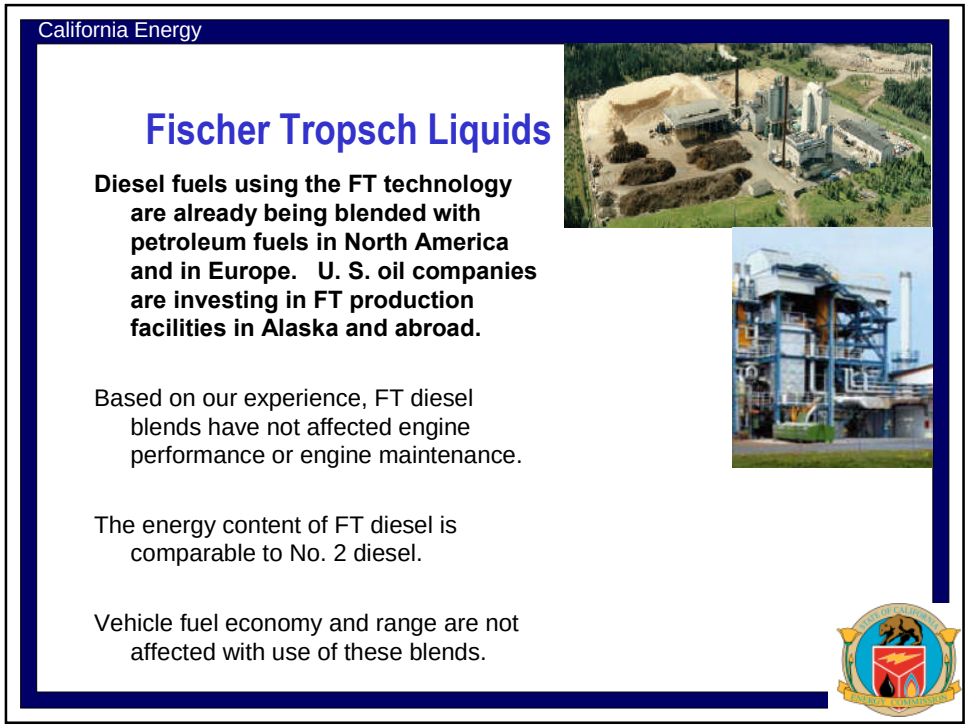
To meet the targets, the Governor directed the California Environmental Protection Agency to coordinate state agency activities and established a high-level Climate Action Team.

Emission reductions from over 40 measures are needed to reach these statewide targets. Use of biofuels can play a role.


Bioenergy Value Networks » Simplified Value Networks for Bioenergy
The focus of this analysis was on power and fuels.
Resources
Collection & Transportation
Conversion & Refining
Distribution
Markets
AGRICULTURE
• Agricultural Residues
• Energy Crops
• Food Processing Residues
• Animal Wastes (farm)
• Animal Renderings
FORESTRY
• Forest Residues - Tree thinnings, slash, etc.
• Onsite Mill Residues
MUNICIPAL WASTES
• Diverted Municipal Solid Waste (MSW)
• Urban wood wastes
• Landfill Gas
• Wastewater Biogas
• Wastewater Sludge
• Waste oils/fats/grease
Resource Imports
Collection & Transportation Infrastructure
Power
CCHP
Waste heat
Process Heat & Space Heating
Biodiesel
Transport Fuels; other liquid Fuels
Co-products
e.g., food, feed, fertilizer
Electricity Transmission & Distribution
Excess electricity
Biofuel imports
Blending, distribution, marketing & fueling
Electricity
Thermal loads
Vehicles


California Energy
Alternative Diesel Fuels
U. S. fuel suppliers are producing alternative diesel fuels that are available for use in vehicles today.
Biodiesel is a renewable fuel being produced in the U. S. from vegetable oil, animal fat, or waste vegetable oils.
Gas-to-liquids is a synthetic diesel that uses Fischer-Tropsch technology to convert natural gas or synthetic gases (i.e. from gasified coal, petroleum coke or biomass.
Ethanol-diesel fuel blends (E-diesel) contains between 5 and 15% ethanol and a fatty acid-based additive.


Biofuels » Options for Conversion and Refining
Using the four major feedstocks there are multiple pathways to create transportation fuels (and other liquid & gaseous fuels).
Physio-Chemical Conversion
Thermochemical Conversion
Biological Conversion[3]
Bio-oils (Waste oils/fats and Ag. crops)
Ligno-cellulosic (All sources)
Sugar & Starches (Agricultural crops)
Ligno-cellulosic (All sources)
Landfill Gas & Biogas
Trans-esterification or Hydrogenation
Pyrolysis & upgrading
Gasification/ syngas processing
Cellulose-to-sugars, then fermentation
Fermentation of sugars
Anaerobic digestion, cleaning, separation
Biodiesel
Upgraded bio-oils (not very likely for transportation)
• Fischer-Tropsch liquids
• Mixed alcohols[4]
• DME[5]
• Ethanol[6]
• Methanol
• Hydrogen
Ethanol
• Pipeline quality gas
• CNG
• LNG
• Hydrogen (via reforming)
Feedstock
Conversion & Refining
Primary Energy Products


California Energy
Fischer Tropsch Liquids
Diesel fuels using the FT technology are already being blended with petroleum fuels in North America and in Europe. U. S. oil companies are investing in FT production facilities in Alaska and abroad.
Based on our experience, FT diesel blends have not affected engine performance or engine maintenance.
The energy content of FT diesel is comparable to No. 2 diesel.
Vehicle fuel economy and range are not affected with use of these blends.

E-Diesel

E-diesel blends of up to 15 percent ethanol can be used in most (but not all) vehicles.

Similar to biodiesel blends, E-diesel acts as a solvent and can release deposits from the vehicle fuel system.

For safety reasons, and to prevent vapor explosions, vehicle fuel tanks may need to be retrofitted with a flame arrester.

Limiting use of E-diesel to centrally fueled fleets is recommended.

E-diesel use also reduces emissions of particulates (PM) and carbon monoxide (CO), and insignificantly affects oxide of nitrogen (NOx) emissions.

California Energy

Biodiesel

Biodiesel production in California is growing, reached 11.6 million gallons in 2006.

Biodiesel blends of up to 20 percent (B-20) are allowed under state fuel specifications set by the California Air Resources Board.

Today, most vehicles can accept up to 5 percent biodiesel (B-5), using existing diesel engines.

Biodiesel qualifies as an “alternative fuel” which can meet federal fleet requirements under EPACT.

Pure biodiesel (B-100) can be used in some engines without modification, although B-5, B-10 and B-20 blends are more common.

Ethanol

In California and other U. S. States, ethanol is blended into gasoline as E-5.7 for use as both an oxygenate and an octane enhancer.

Over 900 million gallons were blended into California gasoline in 2005 by the state's refiners, marketers, and wholesalers.

California has large yet untapped potential to produce ethanol from cellulosic biomass (urban green waste, agricultural and forestry residues).

About 90 percent of the ethanol is imported to California from the Mid-West and is produced from corn.

California Energy

Ethanol (continued)

Ethanol produced from biomass can reduce our state's petroleum dependence and decrease greenhouse gas emissions, when compared to corn-based ethanol.

Conversion technology to use cellulosic biomass is still under development.

Ethanol in diesel (E-diesel) is also being actively pursued by some fuel suppliers as an experimental fuel.

California Energy

Other Renewable Transportation Fuels

Hydrogen can be produced from biomass, using a process called "reformation" to transform natural gas or landfill gas to hydrogen.

Biomass-to-liquid fuels are being pursued by some oil companies and fuel producers to convert biomass to a synthetic diesel-like fuel.

Methane is being converted from landfill wastes as a source of "biogas" needed for compressed or liquefied natural gas or pipeline quality natural gas.

California Energy

Other Biofuels-Related Work Underway

The Energy Commission through the Biomass Collaborative has drafted a roadmap for biomass development in California that includes comprehensive RD&D for biofuels conversion technologies.

The Energy Commission is undertaking a special study of Biofuel Technology Development options. Using grant funding of $100,000 from the Western Governor's Association, we will complete an in-depth evaluation of biomass conversion technologies by mid-2007.

The Energy Commission through the Public Interest Energy Research Program will release a competitive grant solicitation by the end of October 2006 with the intent of accelerating research, development and demonstration of biofuel technologies and refineries.

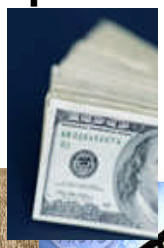
Results of this study and the Biofuels Solicitation will be made available on our Web Page.

California Energy

What Must Happen For Biomass to Liquids To Become Commercialized?

Biomass To Liquids must be competitive

Biofuel Cost
- Feedstock
- Conversion
- Delivery



Fossil Fuel Cost
(Internalize the externalities)
- Security
- Environment
- Economy

RD&D Breakthroughs

Policy

Permitting

California Energy

Additional information

The Energy Commission's web site has extensive information on the ongoing bioenergy work in California at:

http://www.energy.ca.gov/bioenergy_action_plan

http://www.energy.ca.gov/2005_energypolicy/