Sustaining Mobility & Cities:
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Presented By:

Tom Durbin, Ph.D.
Emission and Fuels Research Group
University of California, Riverside
Bourns College of Engineering -
Center for Environmental Research and Technology (CE-CERT)

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Introduction

• **Alternative/Renewable Transportation Fuels**
  – Replacement for traditional petroleum-based fuels
  – Made from materials that can be replaced as fast as it is used

• **Benefits**
  – Reduce petroleum dependence
  – Reduce greenhouse gas emissions
  – Potential improvements in “smog” emissions

Focus of this presentation: CE-CERT’s research in renewable fuels and how this work facilitates implementation of governmental policies
Alternative Fuel Technologies

- Conventional Alcohols like ethanol
- Conventional Biodiesel
- Cellulosic Biochemical/enzymatic Alcohols
- Thermochemical or high temperature processes
- Algae-based Fuels
- Hydrotreated Renewable Diesel and Jet Fuels
- Natural Gas, LPG, and DME
- Hydrogen
- Other Advanced Technologies
Federal Alternative Fuels Legislation

• Energy Policy Act
  – Renewable Fuels Standard
  – Biofuels Research and Development
    Target
  – Increasing renewable fuel use from 9 bill gal in 2009 to 36 bill gal by 2022
  – Specifies that 21 bill gal of the 2022 total must be derived from “Advanced Biofuels”:
    • non-cornstarch ethanol
    • 16 of 21 must be cellulosic biofuel
  – Conventional Fuels Consumption
    – 138 billion gallons of gasoline (2010)
    – 43 billion gallons diesel (2005)
California Alternative Fuels Legislation

• Low Carbon Fuel Standard (LCFS)
Reduce 10% carbon intensity of California's transport fuels by 2020.

• AB 32 – Global Warming Solutions Act
Reduce GHG to 1990 levels by 2020; 80%<1990 by 2050

• Bioenergy Action Plan
Maximize the contributions of bioenergy toward achieving the state’s petroleum reduction, climate change, renewable energy, and environmental goals.

• AB 1007 – Alternative Fuels Plan
Increasing the use of alternative fuels throughout the state

• AB 118 – Alternative and Renewable Fuel and Vehicle Technology Program
Develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies
• Hybrid electric vehicles (HEVs) begin sales 2010
• Plug-in hybrids (PHEVs) begin sales 2020
• Battery electric vehicles (BEVs) and fuel cell vehicles (FCVs) begin sales 2020
• Conventional vehicles – sales steadily decline 2010 to 2030
• Liquid fuels predominant in California for at least 20-30 years
UC Riverside CE-CERT:

College of Engineering-
Center for Environmental Research and Technology

- Established in 1992 as a research center in association with UCR’s College of Engineering
- 40 full-time faculty and staff plus 80 graduate and undergraduate students
- Contracts and grant activity at approximately $8-10 M per year
- CE-CERT has 5 main research areas
  - Emissions and Fuels, Production of Alternative Fuels
  - Atmospheric Chemistry, Solar Energy, Transportation Systems
CE-CERT Laboratories

Emissions and Fuels Research
Emissions measurement/analysis, fuel effects, new instrumentation/methods, after-treatment

Transportation Systems Research
ITS, vehicle activity, energy/emissions modeling

Atmospheric Processes Research
Secondary pollutant formation, mitigation methods

Southern California Research Initiative for Solar Energy (SC-RISE)
Research, education, and applications in solar energy technology

Sustainable Energy Research
cellulosic ethanol, gasification, synthetic diesel fuel

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Biodiesel as an Example

• Second most prominent alternative transportation fuel
  – 700 million gallons in 2008, 2 million gallons in 2000
  – Total feedstock ~1.7 billion gallons of biodiesel, offset 5% diesel market

• Biodiesel reduces many emissions components
  – For B20, PM -10%, HC -21%, CO -11%, but NO$_x$ +2%

• Primary concern is potential negative NO$_x$ impact
  – Oils can also be petroleum processed (hydrocracking)
    • Very clean fuel, commercial in Europe, jet fuel

• UC Riverside & California Air Resources Board (CARB) conducted largest study of biodiesel emissions to date
Biodiesel Mitigation Study Results
Ethanol

Status of Technology Development

– Most prominent alternative fuel in US
– Ethanol production via fermentation: mature
  • Corn ethanol capacity exceeded 13 billion gals./year in US
  • In 2009, 1/3 of corn crop went to 8% of US gasoline use.

Issues with Ethanol

– Supply limitations - all corn crop = 24 vol. % of gasoline pool
  • Need to use cellulosic materials or non-food crops
– Utilization issues
  • Use limited to 10 to 15% in conventional gasoline vehicles
  • Midwest corn provides no greenhouse gas benefits in California
  • Pipeline incompatibility
  • Low energy density – reduces fuel economy
Renewable Fuels Research at UC Riverside

Alternative Transportation Fuels Research Center
- Study impact of higher ethanol/butanol blends on modern gasoline and flexible fuel vehicles
- ~$1.4 million program to study currently underway
- Research guidance document for California Energy Commission

Production of Fuels from Cellulosic Feedstocks
- Biochemical/enzymatic production of fuels (ethanol)
  - Looking at breaking down cellulosic materials with DOE funding
- High temperature gasification process
  - UCR has hydrogasification process – with wet feedstocks
- SC-RISE (So. Cal. Research Initiative for Solar Energy)
  - Solar thermal materials (salt-like materials),
  - PV materials (nanostructures – organics/polymers)
  - multi-layer solar cells (high efficiency 36-38% vs. 8-10% reg.)
Summary

• Renewable Transportation fuels critical to addressing resource, environmental, and regulatory challenge
  – Big changes the next 1 or 2 decades

• CE-CERT has developed a strong research program in the areas of developing and assessing new transportation fuels
  – Large scale emissions programs for biodiesel and alcohol-based fuels
  – Development of research plans for various agencies
  – Enzymatic production of alcohols and other fuels
  – Gasification processes for synthetic diesel and gasoline
  – New program in Solar area
Thank you