U.S. Department of Energy
Ethanol Workshop Series

Hawaii

WELCOME

Ethanol Fuel: Coming Soon to a Car Near You

SPONSORED BY:

U.S. Department Of Energy, Office of Fuels Development
Pacific Regional Biomass Energy Program
City and County of Honolulu
Hawaii Department of Agriculture
Hawaii Department of Business, Economic Development & Tourism
Hawaii Department of Health
Hawaii Natural Energy Institute
JN Automotive Group
Honolulu Clean Cities

RECEPTION SPONSORED BY:

ED & F Man Alcohol, Inc.
Hawaiian Commercial & Sugar Company

Ala Moana Hotel
Honolulu, Hawaii

November 14, 2002
8:00 a.m. – 4:30 p.m.

Hawaii

Ala Moana Hotel
Honolulu, Hawaii

November 14, 2002

Agenda

8:00 AM **REGISTRATION & COFFEE**

8:30 AM **WELCOME & INTRODUCTION**

Eileen Yoshinaka - Pacific Liaison, United States Department of Energy (USDOE)
The USDOE-Seattle Regional Office provides funding for a wide variety of biomass energy programs in the Pacific Northwest, Alaska, and Hawaii. This is the first fuel ethanol workshop they are sponsoring in Hawaii.

- **National Energy and Fuels Policy**

Maurice Kaya, P.E. - Administrator, State of Hawaii, Energy, Resources & Technology Division
The Energy, Resources, and Technology Division of the State of Hawaii Department of Business, Economic Development, and Tourism is the state agency responsible for developing plans and recommendations for Hawaii's energy future. It's also the agency through which federal funding under the State Energy Program comes to Hawaii.

- **Workshop Purpose and Objective**

9:00 AM **ETHANOL OVERVIEW**

Doug Durante - Executive Director, Clean Fuels Development Coalition
The Clean Fuels Development Coalition is a national not-for-profit organization based in Washington, D.C., that actively supports the development and production of fuels that can reduce air pollution and lessen America's dependence on imported oil.

- **Energy Sources, Uses, and Concerns**
- **Fuel Supplies - domestic and foreign, existing and projected**
- **Environmental Issues**

Gary Herwick, Director - Transportation Fuels, General Motors Corporation- ***Presented by Doug Durante***

- **Ethanol as a Vehicle Fuel**

Larry Schafer - Legislative Counsel, Renewable Fuels Association
The Renewable Fuels Association works in tandem with state governments, agriculture, environment, and public interest groups, and ethanol advocates nationwide.

- **Ethanol Fuel and the Economy**
- **Renewable Fuels Standard**
- **Costs – past, present, future**
- **Federal incentives**

10:00 AM **BREAK**

10:30 AM **FUEL ETHANOL AND HAWAII'S ECONOMY**

Mark Yancey - Director of Consulting Services, BBI International
BBI International performs ethanol impact studies for a variety of clients, including private companies, financial institutions, and state governments. Following his presentation of BBI's preliminary review of the situation in Hawaii, there will be opportunity for discussion, suggestions, and comment.

- **Potential for ethanol production in Hawaii**
- **Costs, benefits, and other effects - short and long-term**
- **Bottom line**

Discussion

11:00 AM **FUEL ETHANOL FOR HAWAII: PAST & PRESENT**

Warren Hall - Hawaii Manager, EA Engineering, Science, and Technology, Inc.
EA Engineering, Science, and Technology is a national energy and environmental consulting firm recognized for its work in the alternative fuel vehicle and energy efficiency arena.

- **Ethanol Use in Hawaii: Historical Perspective**

Maurice Kaya - Energy Program Administrator, Hawaii State Energy Office
The State Energy Office works collaboratively with Hawaii companies and organizations to develop projects and partnerships that further Hawaii's energy objectives.

- **State Energy Policy, Incentives, & Mandates**

Discussion

11:45 AM **LUNCH**
Topic Tables: Experts in different subject areas will be seated at designated tables to allow small group discussion of various topics

1:15 PM **FUEL ETHANOL PRODUCTION**

Moderated by Sue Conroe, BBI International

Rick Elander –Team Leader for Biomass Pretreatment R&D, *National Renewable Energy Laboratory (NREL)*
NREL is the U.S. Department of Energy's premier laboratory for renewable energy and energy efficiency research & development

- **Ethanol from cellulosic materials**

Jayant Godbole – Regional Director of the Americas, Praj International
Praj is the world's single largest supplier of cane molasses-based ethanol production facilities.

- **Ethanol from molasses**

Bob Shleser – President, The 'Aina Institute
Dr. Shleser, author of the 1994 report for the State of Hawaii on "Processes, Feedstocks, and Current Economic Feasibility of Fuel-Grade Ethanol Production in Hawaii" is actively involved in further economic analysis and project feasibility assessments in Hawaii.

- **Ethanol from wastes, sugarcane**

Larry Johnson –Business Development Manager, Delta-T Corporation
Delta-T combines technological innovation with environmental stewardship in the energy and chemical processing industries to contribute to cleaner air and water around the world.

- **Steps to building an ethanol plant**

2:15 PM **FUEL ETHANOL DISTRIBUTION**

Moderated by William Maloney, ED&F Man Alcohol, Inc.

Barry Duffin - Quality Control Specialist, ConocoPhillips (Tosco "76" Brand)
ConocoPhillips is one of the largest ethanol blenders in the U. S. Recently, 100% of their California system was converted to ethanol.

Mike Allen - President, Allen Oil Company
Allen Oil Company is a family owned business engaged primarily in the wholesale distribution of petroleum products, ethanol, and biodiesel throughout Montana.

3:00 PM **BREAK**

3:15 PM **FUEL ETHANOL USE**

Moderated by George Nitta, Nitta's Auto Repair and Hawaiian Automotive 101 radio show

Larry Johnson – Business Development Manager, Delta-T Corporation
Minnesota's "Ethanol Answerman" answers your questions about the use of ethanol blended fuels in cars, trucks, boats, lawnmowers, etc.

- **Your car can use ethanol**

Joe Collette - Certified Automotive Technician, Bob's Auto Repair
This motorcycle racing mechanic can explain a thing or two about engines and high performance fuels to motorheads and non-motorheads alike.

- **Ethanol in racing engines**

Larry Schafer - Legislative Counsel, Renewable Fuels Association
Tomorrow's fuels, tomorrow's vehicles, and tomorrow's fueling stations: What might they look like? How do we get from here to there? Does ethanol fit in with a transition to the "Hydrogen future?"

- **Ethanol for fuel cells**

Doug Vind - President & Chief Operating Officer, Western Ethanol Company, LLC, & Regent International
Diesel engines: Can ethanol be used there too? What engine modifications are required? Doug Vind will explain at least two approaches.

- **Ethanol in diesel engines (oxydiesel and biodiesel)**

4:30 PM **SUMMARY & CLOSE**

5:00 PM **RECEPTION – Sponsored by ED & F Man Alcohol, Inc. and Hawaiian Commercial & Sugar Company**

U.S. Department of Energy - Ethanol Workshop Series
Ala Moana Hotel – Honolulu, Hawaii
November 14, 2002

Speaker Biographies

MICHAEL W. ALLEN - President, Allen's Inc., Allen Oil Company

Mike Allen has been president of Allen Oil Company and Allen's Inc. since 1994, and it's general manager before that. Mike has 22 years in the fuel marketing business. He has been instrumental in promoting and marketing ethanol and other renewables in Helena and throughout Montana. He is active in EPAC (Ethanol Producers and Consumers) as a board member and is the winner of the 1999 ACE (American Coalition for Ethanol) Grass Roots Award.

Community and industry minded, Mike has served as President of the Montana Petroleum Marketers Association and on the Board of Directors of the WPMA (Western Petroleum Marketers Association). Mike has a BS degree in Education with a double major in business and physical education from Northern Montana College (now MSU-Northern). He resides in the capital city of Helena, Montana.

JOE COLLETTE – Certified Automotive Technician, Bob's Auto Repair

Joe Collette is a certified automotive technician at Bob's Auto Repair. He has been drag racing motorcycles since 1995 and using ethanol as a race fuel since 1999. He attended General Motor's automotive service excellence program at Cerritos College. Joe is ASE certified in all fields with the exception of transmission. Joe has been an automotive technician since 1992. He served on board USS Michigan (SSBN 727 Gold) from 1986-1989 as a machinist mate repairing hydraulics, pneumatics, and atmosphere control equipment. He served on board USS Proteus (AS-19) from 1989-1992 in the field of nuclear repair.

SUE CONROE – Assistant to the President, BBI International

Sue works for BBI International -- a biofuels consulting firm based in Colorado. Last year Sue worked with eight different states to plan and conduct Department of Energy Ethanol Workshops similar to this one today. Sue also helped with a series of renewable diesel workshops conducted last year by the National Renewable Energy Laboratory and DOE.

BARRY A. DUFFIN - Quality Control Specialist, ConocoPhillips

Barry Duffin is the Quality Control Specialist at ConocoPhillips. Barry was instrumental in the development of a tactical implementation plan for the removal of MTBE and introduction of Ethanol blending at ConocoPhillips locations in California. He has 21 years in the downstream petroleum industry with broad experience in product quality. Barry Duffin began his career in the petroleum industry at Unocal's Science and Technology Center where he gained experience in process and product development, engine testing and knock laboratory management along with ASTM, SAE, STLE, NLGI, API & OEM requirements. He carried this experience to several key positions in Refining, Marketing and Transportation, which allowed him to obtain a diverse background in the industry. Barry Duffin has been responsible for laboratory operations, internal audit programs, training, SPC programs, supplier and subcontractor evaluations, and for the successful development of Quality Management Systems to meet ISO 9000 requirements. Two of his facilities achieved Freightliner's Masters of Quality Award**.** He is an RAB Quality Systems Auditor and Accredited Safety Auditor as well as a member of ASTM, ASQ and SEMA. Mr. Duffin oversees the quality of products at 25 terminals located in 11 western states for ConocoPhillips.

DOUGLAS A. DURANTE - Executive Director, Clean Fuels Development Coalition

Douglas Durante serves as the Executive Director and Washington Representative of the Clean Fuels Development Coalition (CFDC), a non-profit organization he assisted in forming in 1987. The CFDC works in support of renewable alcohols and ethers and has a broad-based membership including automotive, agricultural, and other alternative energy interests.

Doug has been working in the fields of energy, transportation, and the environment since 1977. He was the Director of Public Affairs for the National Alcohol Fuels Commission and also served as a Special Assistant in the Office of Alcohol Fuels at the U.S. Department of Energy. He has been involved in the development of several ethanol projects throughout the U.S. Doug has served on numerous state and federal advisory committees, including Chair of the Fuels Subcommittee of the Federal Biomass Advisory Committee.

Doug holds a B.A. degree in English and Journalism from Elon University (North Carolina) and has completed a number of graduate courses and programs in business and government affairs. He served on the U.S. Environmental Protection Agency's Clean Fuels Advisory Committee, and the Department of Energy's Business Roundtable Advisory Group.

RICHARD ELANDER – Team Leader for Biomass Pretreatment R&D, National Renewable Energy Laboratory (NREL)

Rick joined NREL in 1991 as a process engineer and is currently the Team Leader for Biomass Pretreatment Research and Development in the Biotechnology Division for Fuels and Chemicals. He has expertise in biomass conversion processes, including biomass pretreatment and thermochemical hydrolysis, enzymatic hydrolysis and fermentation, equipment design, pilot-scale engineering and operations, and process economic analysis. He has also been involved in several industrial collaboration projects, including New Energy Company of Indiana that was the recipient of a prestigious *R&D 100* Award in 1993. Rick will be the NREL technical leader of a recently-awarded $38MM, 4 year collaborative project involving DuPont, Diversa Corporation, John Deere, Michigan State University, and NREL to develop an integrated corn-based biorefinery.

Prior to joining NREL, Rick was a process development engineer at Genencor International Inc. At Genencor, Rick worked on processes for the production and recovery of several industrial enzymes, including cellulase. Rick holds a B.S. degree in Chemical Engineering from the University of Pennsylvania and a M.S. degree in Chemical Engineering from Colorado.

JAYANT GODBOLE – Regional Director, Americas, Praj Industries Limited

Jayant Godbole is the Regional Director for the Americas at Praj Industries Limited. He has worked with Chemical Engineering Companies including Alfa Laval in India before joining PRAJ. He started and headed the international business division of PRAJ from 1994 to 1998. He has developed and successfully secured several international projects in Indonesia, Philippines, Sri Lanka, Nepal, South Africa, Peru, and Colombia. In 1999 he established PRAJ 's regional office for Latin America & the Caribbean's at Bogotà, Colombia. He has worked closely with sugar factory & distillery clients in Colombia, Peru, Venezuela, Guatemala, El Salvador, Nicaragua, Dominican Republic, Trinidad, Barbados, and Jamaica. He speaks both English and Spanish. He heads the operations in Latin America and Caribbean's for PRAJ.

Jayant is a graduate of the University Department of Chemical Engineering, Mumbai, India. He has a postgraduate diploma in International Business.

WARREN HALL – Manager, Hawaii Operations, EA Engineering, Science, and Technology, Inc.

Warren Hall is the Manager of Hawaii Operations for EA Engineering, Science, and Technology, Inc., a national environmental engineering and energy consulting firm based in Hunt Valley, Maryland with unique capabilities in the alternative fuels arena. Warren has worked for various federal and private clients in Hawaii and the Pacific Basin on various environmental, energy use, and alternative fuels issues. He has provided consulting services to private fleets related to alternative fuel vehicle use and infrastructure requirements and is an active member of the Honolulu Clean Cities organization.

LARRY JOHNSON – Business Development Manager; Delta-T Corporation

Larry Johnson is the Business Development Manager at Delta-T Corporation. For 15 years, Larry managed his own consulting company called Ethanol Marketing and Management Services. He became known as the “Ethanol Answerman” for his work with engine mechanics, fuel distributors and consumers, while developing the Minnesota ethanol market and organizing more than a dozen farmer-owned cooperatives.

On January 1, 2000, he took the position of U.S. Business Development Manager with Delta-T Corporation of Williamsburg, Virginia. Delta-T is a leading design/engineering firm with more than 60 ethanol installations around the world. His primary role today is the development of new ethanol projects. Mr. Johnson now combines his 20 years of experience in ethanol marketing and project development with the technology, engineering, financing and project development resources of Delta-T Corporation. This combination of resources can provide any feasible project with the most experienced and comprehensive project support and development services available today.

MAURICE H. KAYA – Administrator, State of Hawaii-Energy, Resources & Technology Division

Maurice Kaya is the Administrator for the State of Hawaii Energy, Resources & Technology Division. Maurice has 30 years experience in energy and environmental engineering in the State of Hawaii in both the public and private sectors. He currently administers statewide energy programs for the State of Hawaii. He is responsible for the planning and execution of energy policy in three major areas: statewide energy emergency preparedness, energy conservation programs, and development of renewable energy projects.

As director of Hawaii’s Energy program, Maurice has lead efforts to implement renewable energy and energy efficiency programs in the state, including the successful development of a Model Energy Code, performance contracting programs, and widespread adoption of statewide utility demand-side management programs. These efforts have resulted in national recognition for Hawaii’s energy code, Million Solar Roofs Partnership, Rebuild America program, and numerous other innovations.

The U.S. Energy Secretary appointed Maurice to a two-year term as Chair of the federal State Energy Advisory Board (STEAB). He serves on the Advisory Board of the Natural Energy Laboratory of Hawaii (NELHA); Hawaii Natural Energy Institute, University of Hawaii; and is current Chair of the Emerging Energy Technologies technical committee, Energy Division, American Society of Civil Engineers. He holds a B.S. in Civil Engineering and a M.S. in Environmental Engineering from the University of Hawaii.

WILLIAM MALONEY – Director of Business Development, ED & F Man Alcohol, Inc.

Since 1998, William has been serving in a consulting role in the capacity of Director of Business Development to ED & F Man Alcohols, one the world's largest alcohol trading companies. In this position he has been responsible for the marketing of fuel ethanol in the United States as well as project development in the US and Central America.

Prior to joining ED & F Man, William was the principal owner and director of Caribbean Pacific Alcohol Company, a twelve million gallon per annum ethanol plant in Kingston, Jamaica. He was concurrently Managing Director of Tropicana Holdings Ltd., a 7,000-acre sugar estate and sugar factory located in St. Thomas, Jamaica. Under his direction the company increased its annual sugar production from less than 7,000 tons per annum to more than 15,000 tons. Mr. Maloney also served as a director of the Sugar Manufacturing Corporation of Jamaica, and on the Board of Management of the sugar producer's federation.

From 1984-1990 Mr. Maloney was the General Manager and then President (1990-1992) of Tropicana International Ltd., owner and operator of a 25 million gallon per annum ethanol facility in Kingston, Jamaica. Mr. Maloney guided the company from inception to production.

Mr. Maloney received a Bachelor of Arts degree with honors from the University of San Diego majoring in Economics and History.

GEORGE NITTA – Host, Hawaiian Automotive 101 Radio Talk Show & Owner, Nitta's Auto Repair

George Nitta hosts the Hawaiian Automotive 101 Radio Talk Show, and is the owner of Nitta's Auto Repair. He began working on cars as a teenager. In 1961, George began working as a mechanic for Servco Pacific's Motor Imports. Soon, his love of cars found him at the local racetrack. George would go on to become a fixture at the track for the next twenty years, racing for major sponsors like Autolite, Fram, Pennzoil, Crane Cams, Hurst Shifters, and Goodyear Tires. He founded the 50th State Pro Gas Association in the late 70's, which continues today.

In 1965, while working at Import Motors, George started a part-time auto repair business, Nitta's Auto Repair. Two years later, he quit the dealership and has been in business for himself ever since. In the mid 70's, George founded the Kaka'ako Business Association, later serving as Chairman; and he served two terms on the Ala Moana/Kaka'ako Neighborhood Board, also as Chairman. He has taught many classes including a course called Practical Auto at the University of Hawaii at Manoa. In 1995, he began his radio call-in show, Automotive 101. Major companies have also noticed his expertise in cars. Honda America and Chrysler have drawn on George's knowledge in courtroom cases, as have several large insurance companies. Their manufacturers have adopted some of George's product improvements.

LARRY H. SCHAFER – Legislative Counsel, Renewable Fuels Association

Mr. Schafer is the Legislative Counsel for the Renewable Fuels Association (RFA). He specializes in the political tax arena and serves as RFA's lead lobbyist before the tax and trade writing U. S. House of Representative Ways and Means Committee, the U.S. Senate Finance Committee, the U.S. Department of Treasury, and the Internal Revenue Service.

Prior to coming to RFA, Mr. Schafer served as Vice President of Legal, Tax & Accounting (LTA) Policy with the National Council of Farmer Cooperatives (NCFC). Where he was the policy director and lead lobbyist on legal, tax and accounting issues.

Prior to joining NCFC, Mr. Schafer served as Legislative Counsel to U.S. Congressman Earl Pomeroy (D-ND), where he provided legal and legislative analysis concerning agriculture, trade and other important issues. Mr. Schafer is a native of Mandan, North Dakota. He received his law degree from the University of North Dakota School of Law, and holds a B.S. in Business Administration with a concentration in accounting from Valley City State University in North Dakota.

ROBERT SHLESER, Ph.D. – President, The ‘Aina Institute

Bob Shleser is the President of The ‘Aina Institute, a Non-Profit Organization established to conduct research development and technology transfer on methods of recapturing value from biomass. He has been a resident of Hawaii for 26 years. Bob has worked on projects and activities that have contributed to the foundation for Biomass Energy Opportunities in Hawaii.

In 1991, Bob and others formed the ‘Aina Institute. He became directly involved with evaluation of technologies for production of ethanol from biomass in 1993 when he was consultant to Department of Business Economic Development and Tourism (DBEDT) of the State of Hawaii to evaluate the technical and economic performance of seven emerging technologies for conversion of lignocellulosic biomass to ethanol.

He is author of the 1994 report “Ethanol Production in Hawaii”. During the period 1994-96, he was the Manager of the Sustainable Biomass Energy Program at the Pacific International Center for High Technology Research (PICHTR). He developed programs to evaluate technologies that might contribute to the economic performance of sugar production in Hawaii.

He holds a B.S., Agriculture, Purdue University, M.S., Genetics, Purdue University, and a Ph.D. Biophysics/ Molecular Genetics, Purdue University.

DOUGLAS B. VIND – President and Chief Operating Officer, Western Ethanol Company, LLC & Regent International

Douglas Vind is President and Chief Operating Officer of Western Ethanol Company LLC, (“WEC”), and Regent International. Doug has been working in the fuel and fuel-alcohol manufacturing and distribution business since 1982.

WEC is both a manufacturer and distributor of fuel grade ethanol throughout the Western United States. WEC dehydrates alcohol and distributes finished fuel grade ethanol through bulk storage and terminal facilities in the United States. In addition to its own proprietary production, WEC also maintains significant purchase, distribution and exchange agreements with domestic ethanol producers.

Regent International focuses on niche market opportunities and new fuel related technologies involving the use of ethanol. Regent was involved as an early participant in the operation and fueling infrastructure of E-85 vehicles. Regent has since focused on “emerging” ethanol demonstration projects including E-diesel, and ethanol used in electrical power generation in turbines and portable generators.

Doug is also directly involved in the adoption of fuel and alternative fuel legislative and regulatory activities in his capacity as Chairman of the California Renewable Fuels Council. He also serves as a member of the Washington, D.C. based Renewable Fuels Association, and has sponsored regulations and legislation promoting the alternative fuels industry throughout the United States.

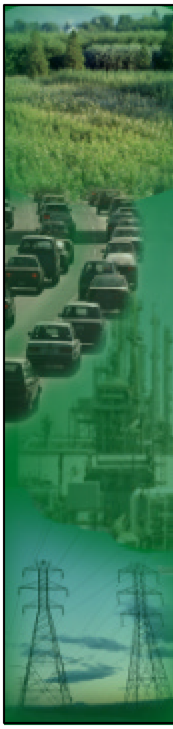
MARK YANCEY – Director of Consulting Services, BBI International

Mark Yancey is the Director of Consulting Services for BBI International – a biofuels consulting firm based in Colorado. Mark provides feasibility studies, business plans, project development advice and economic impact analyses for both national and international clients. Mark has twenty-three years of experience in the fields of renewable energy and bioengineering and holds a B.S. in Chemical Engineering from Stanford University.

EILEEN YOSHINAKA - Pacific Liaison, Seattle Regional Office, U.S. Department of Energy

Eileen is the Pacific Liaison for the U.S. Department of Energy (DOE) Seattle Regional Office. Eileen is responsible for oversight, technical/field management, coordination and implementation of DOE's programs and projects administered in the Pacific Insular Area comprised of the State of Hawaii, Territory of American Samoa, Territory of Guam, Commonwealth of the Northern Mariana Islands and the Republic of Palau.

Eileen was born in Hawaii. Graduated from San Francisco State University with a degree in Business Administration.



Office of Biomass Programs

Hawaii Ethanol Workshop

Honolulu, Hawaii

November 14, 2002

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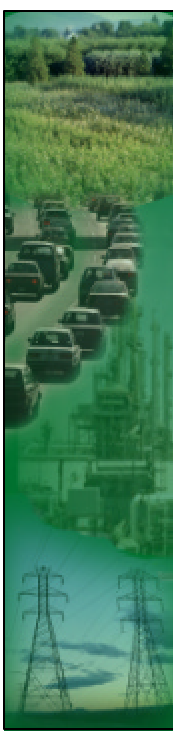

Topics

- Background
- Program Mission and Goals
- Office of Biomass Programs R&D Focus Areas
- Opportunities

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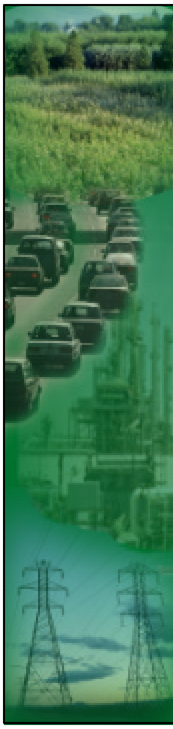

Background
Petroleum Production – 2001

- Net crude imports totaled 9.3 Mil. Bbl/day
  - 4.8 Mil. Bbl/day imported from OPEC nations
- Net U.S. Production totaled 5.8 Mil. Bbl/day

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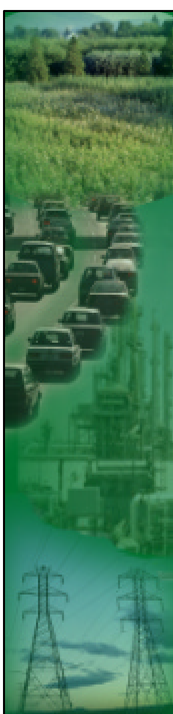

Background (cont.)
Petroleum Consumption – 2001

- Imports are a large and growing share of U.S. petroleum consumption
  - 19.6 Mil. Bbl/day consumption
  - 10.9 Mil. Bbl/day net imports
    - 25% of these imports come from OPEC nations
- Petroleum product consumption in the transportation sector was approx. 14.9 Mil. Bbl/day
  - Motor gasoline: 8.61 Mil. Bbl/day

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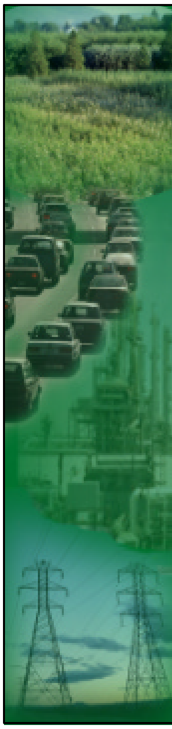

Background (cont.)
Ethanol Production - 2001

- 1.77 billion gallons of ethanol were produced in the U.S.
- 2002 estimates exceed 2 billion gallons
- 90% ethanol produced from the starch portion of the corn kernal

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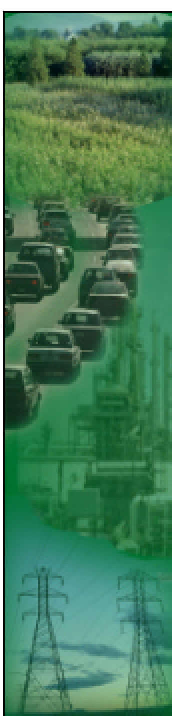

Program Goals

Goals

- Reduce U.S. dependence upon foreign sources of petroleum
- Support development of Industrial Biorefinery

The term 'biorefinery' means equipment and processes that:

- Convert biomass into fuels and chemicals; and
- May produce electricity

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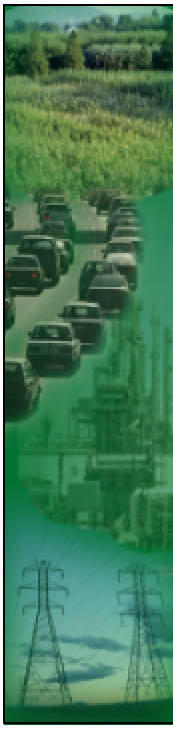

Program Mission

Mission

- To foster research and development on advanced technologies to transform our abundant biomass resources into clean, affordable, and domestically-produced biofuels, biopower, and high-value bioproducts for improving the economic development and enhancing the energy supply options of the U.S.

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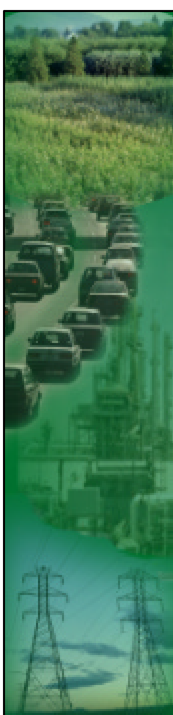

Biomass R&D is a National Priority

- The Biomass R&D Act of 2000 directs DOE and USDA to enhance and coordinate biomass R&D efforts.
- The Energy Title (Title IX) of the new Farm Bill provides supports for increased use of biomass energy and products and for R&D.
- Various pieces of legislation debated in Congress to provide energy tax incentives, funding for R&D, and other forms of tax relief

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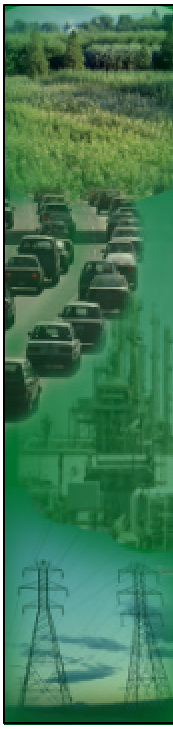

Opportunities

- On the horizon
  - Develop and integrate bioproducts to enable deployment of biofuels
  - Develop strong partnerships with industry leaders committed to technology deployment
  - Coordinate with USDA
  - Provide Americans with a stronger economy, healthier environment, and more secure future

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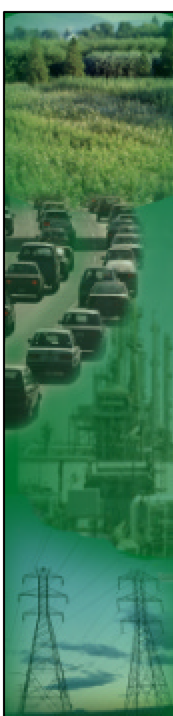

- More Information:

www.ott.doe.gov/biofuels

www.afdc.doe.gov

www.ccities.doe.gov

www.eren.doe.gov

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Hawaii Fuel Ethanol Workshop

For Sustainable Transportation Biofuels

WELCOME

Maurice H. Kaya, Administrator

State of Hawaii - Department of Business, Economic Development & Tourism - Energy, Resources, and Technology Division
www.state.hi.us/dbedt/ert

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Sponsors

- U.S. Department of Energy, Office of Fuels Development
- Pacific Regional Biomass Energy Program
- City and County of Honolulu
- ED&F Man Alcohols
- Hawaii Department of Agriculture
- Hawaii Department of Business, Economic Development & Tourism
- Hawaii Department of Health
- Hawaii Natural Energy Institute
- Hawaiian Commercial and Sugar Company
- Honolulu Clean Cities
- JN Automotive Group

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Working Group

Mr.	Richard	Akana	Akana Petroleum Inc.
Mr.	Barry	Ching	State Department of Health
Mr.	Wayne	Condit	Shell Oil Products US
Mr.	Eric	Darmstaedter	WEG-Kauai LLC
Mr.	Douglas	Durante	Clean Fuels Development Coalition
Mr.	Michael	Edwards	Sustainable Kauai
Ms.	Beverly	Harbin	Chamber of Commerce of Hawaii
Mr.	Mark	Hepburn	ChevronTexaco Corporation
Mr.	Steve	Holaday	Hawaiian Commercial and Sugar
Ms.	Sabra	Kauka	Garden Island RC&D
Mr.	David	Keith	Aloha Petroleum, Ltd.
Mr.	Daniel	Kenknight	Oahu Ethanol Corporation
Mr.	Alan	Kennett	Gay and Robinson
Mr.	Kal	Kobayashi	County of Maui Energy Office
Ms.	Susan	Kusunoki	Tesoro Hawaii Corporation
Mr.	Calvin	Lee	State Department of Agriculture
Mr.	Ray	Levinson	U.S. Postal Service Pacific Area Operations
Mr.	William	Maloney	ED & F Man Alcohol Inc.
Mr.	Brad	Nicolai	JN Automotive
Mr.	William	Pierpont	State Department of Agriculture
Mr.	Robert	Primiano	Honolulu Clean Cities
Dr.	Richard	Rocheleau	Hawaii Natural Energy Institute
Mr.	Ralph	Saito	Leeward Petroleum Inc.
Mr.	Glenn	Sato	County of Kauai
Dr.	Bob	Shleser	The 'Aina Institute
Mr.	Robert	Tam	State Department of Health
Ms.	Stephanie	Whalen	Hawaii Agriculture Research Center
Mr.	Gordon	Wong	Tesoro Hawaii Corporation
Mr.	Gordon	Yorke	Hawaiian Commercial and Sugar

3

Workshop Purpose and Objective

- Provide context
- Present information on current status of fuel ethanol nationally
- Present information on potential for production and use of fuel ethanol in Hawaii
- Provide an opportunity for community input
- Build a foundation for future discussion, work and collaboration in this area

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Why Fuel Ethanol?

- Cars can use it.
- Consumers will benefit.
- Our economy will be stronger.
- Our air will be cleaner.

5

Ethanol Fuel: Coming Soon to a Car Near You

U.S. Department of Energy

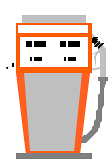
Ethanol Workshop

Honolulu, Hawaii

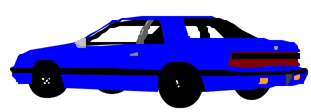
November 14, 2002

Douglas A. Durante
Executive Director
Clean Fuels Development Coalition
Washington, DC

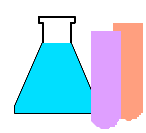
Clean Fuels Development Coalition Constituency



Alternative Fuel Providers



Automobile Manufacturers



Clean Fuel Technology Developers

and the . . .

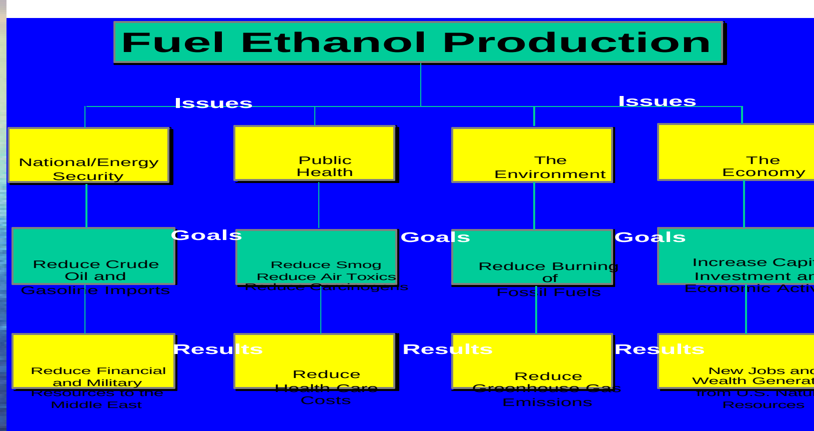
Federal and State Governments, Public and Private Organizations that Support Their Advancement

Ethanol has a Long History of Bipartisan Support

- Energy Security Act of 1978
- Energy Tax Act of 1980
- Alternative Motor Fuels Act of 1988
- Clean Air Act of 1990
- Energy Policy Act of 1992
- Energy Act of 2002??

All Identify Ethanol as a Way to Achieve a Variety of Public Policy Goals

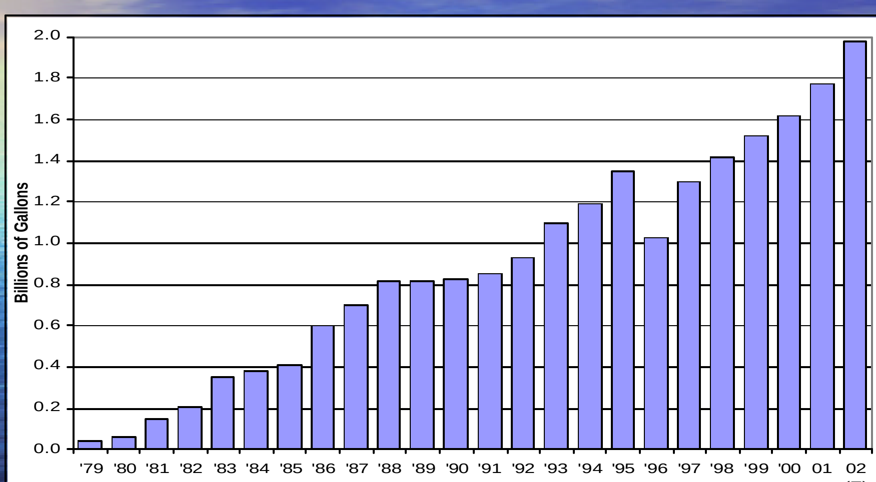
Ethanol is Moving the Nation in the Right Direction



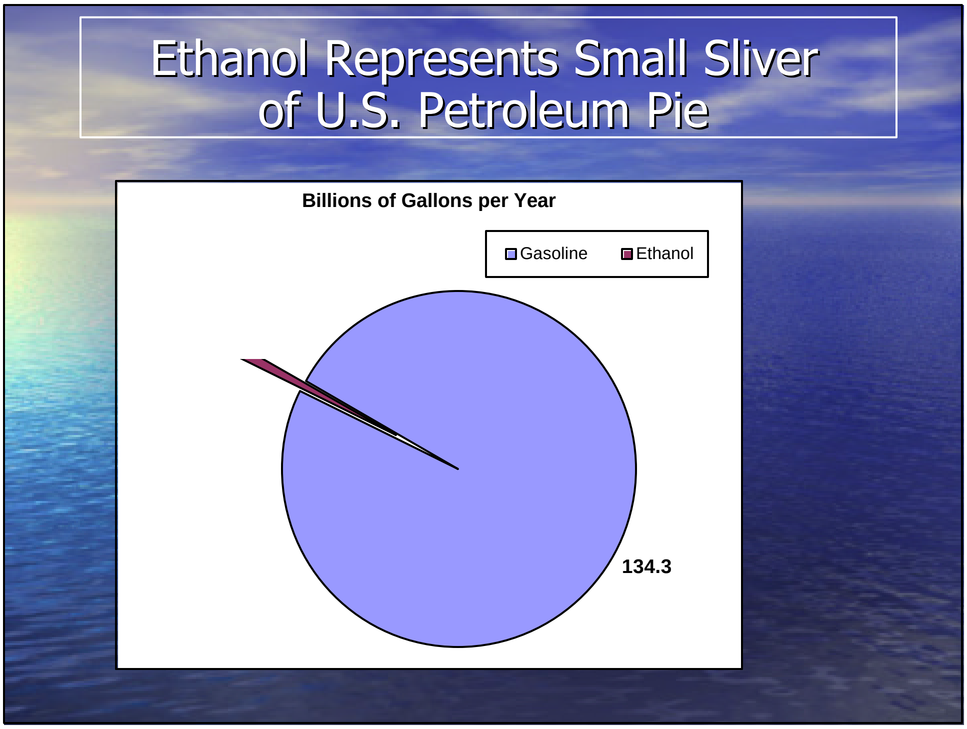
Ethanol Supported by a Variety of Federal and State Programs

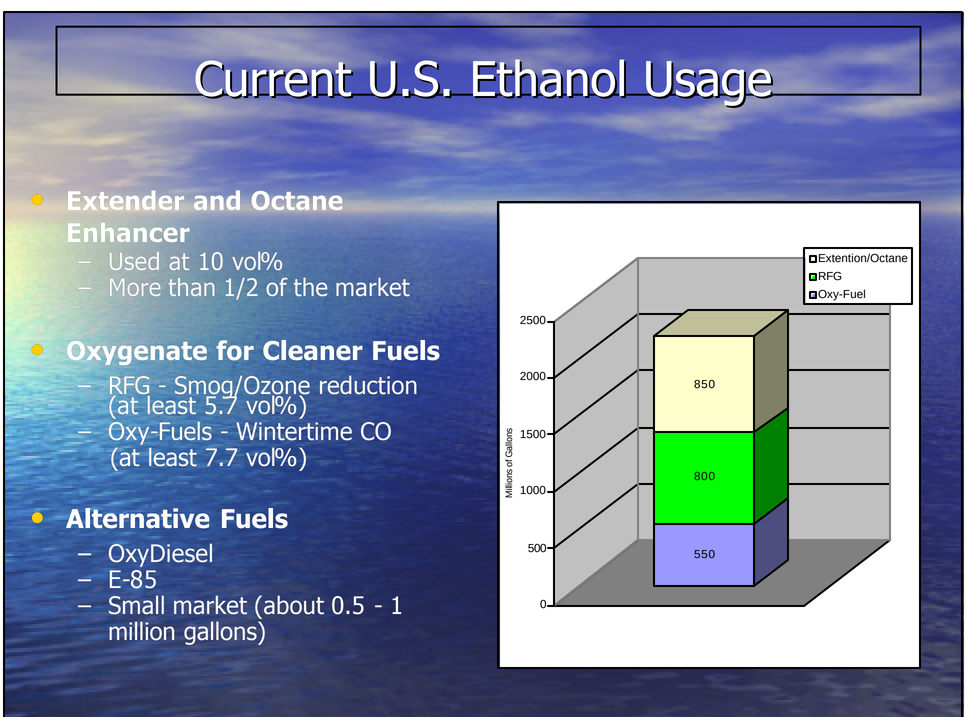
- Increasing Ethanol Use:
  - Federal Tax Incentives
  - Clean Air & Control of Fuel Properties
  - Fleet Requirements
  - E-85 and Alt Fuel Credit Program
- Increasing Ethanol Production:
  - Financial Assistance
  - Commodity Programs
  - State and Local Incentives

U.S. Fuel Ethanol Production



(E) = 2002 ethanol production estimated based on year-to-date production from U.S. EIA

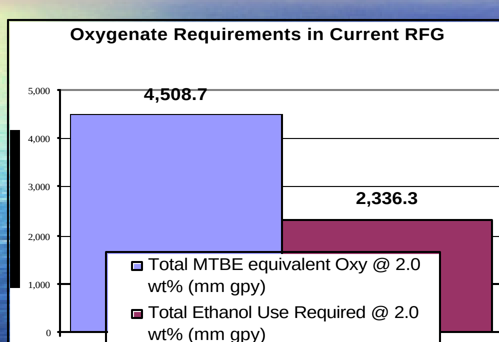

Ethanol Represents Small Sliver of U.S. Petroleum Pie
Billions of Gallons per Year
Gasoline
Ethanol
134.3


Current U.S. Ethanol Usage
Extender and Octane Enhancer
– Used at 10 vol%
– More than 1/2 of the market
Oxygenate for Cleaner Fuels
– RFG - Smog/Ozone reduction (at least 5.7 vol%)
– Oxy-Fuels - Wintertime CO (at least 7.7 vol%)
Alternative Fuels
– OxyDiesel
– E-85
– Small market (about 0.5 - 1 million gallons)
Extention/Octane
RFG
Oxy-Fuel
Millions of Gallons
2500
2000
1500
1000
500
0
850
800
550

Key U.S. Clean Gasoline Programs

- Carbon Monoxide Control
  - 39 Cities in violation of standard.
  - Required to use gasoline containing 2.7% (wt) oxygen during winter months.
  - Extremely effective -- nearly 2/3 have come into compliance -- 20-30% reduction.
- Ozone -- Reformulated Gasoline
  - 9 U.S. cities by law -- a dozen more by choice
  - Vapor pressure controls & oxygen -- 2% (wt)
  - Key emission categories affected:
    - VOCs (exhaust and evaps)
    - Toxics (benzene
    - NOx

Current RFG & Oxygenate Requirements



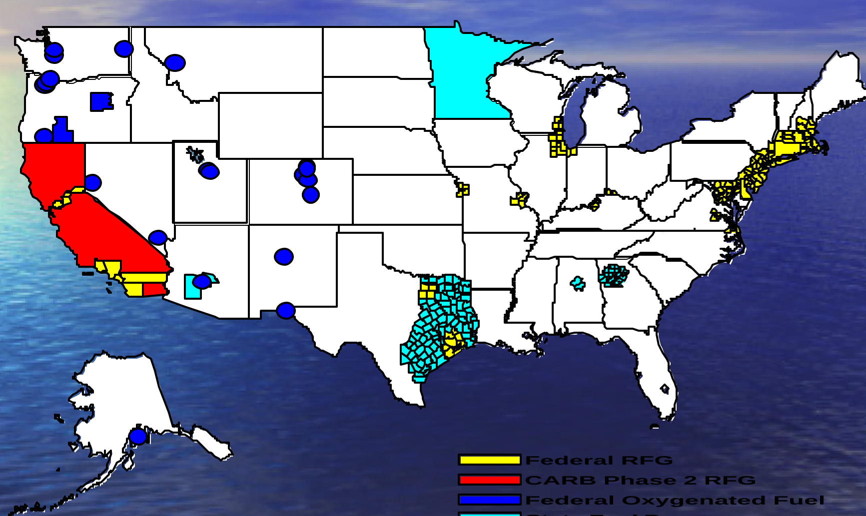
Source: Clean Fuels Development Coalition
Gasoline Demand: U.S. EIA

- The Federal RFG Program currently covers about 41 billion gallons of gasoline in the U.S., according to the U.S. DOE's Energy Information Administration's 1998 Petroleum Marketing Annual.
- Meeting the oxygenate requirement for this fuel with MTBE would require just over 4.5 billion gallons, with ethanol, just over 2.3 billion gallons would be needed.

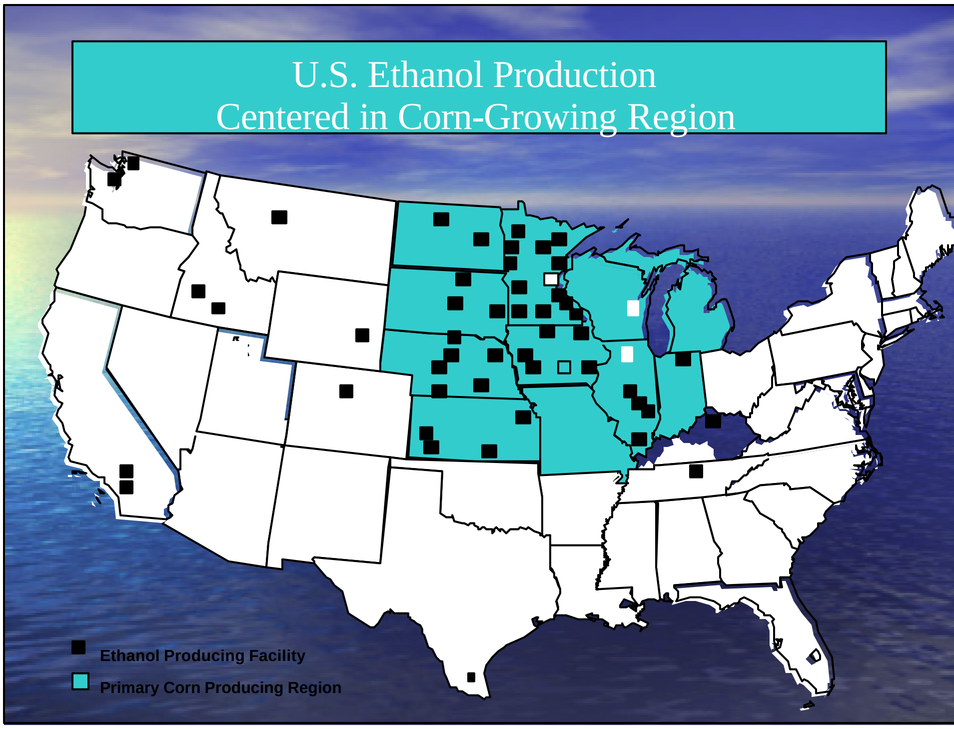
Possible Banning of MTBE

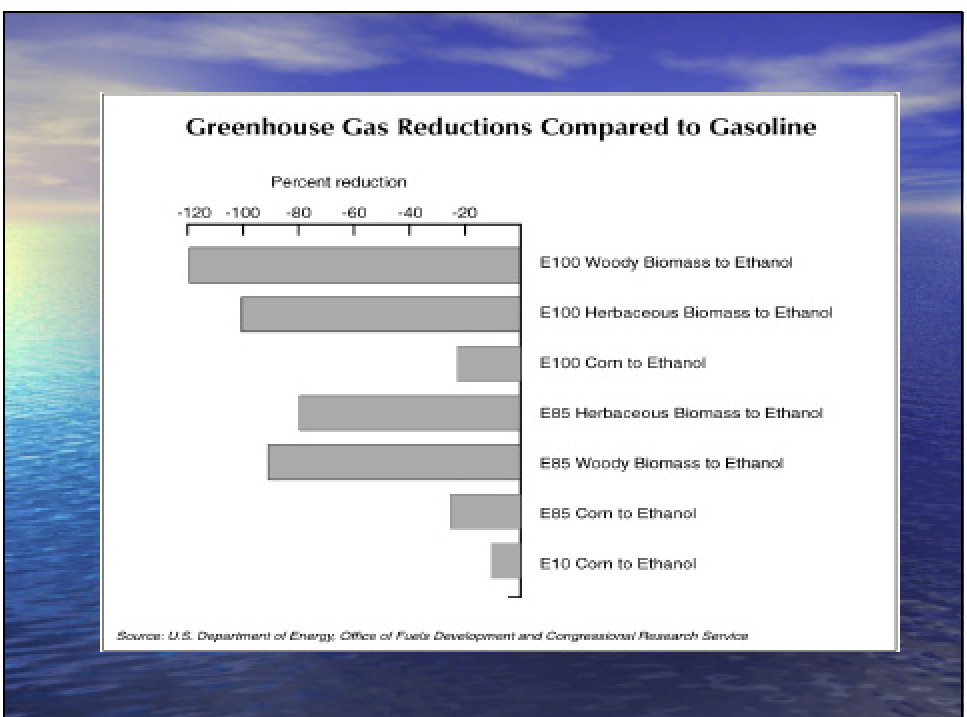
- **4.5 billion gallons used in the U.S.**
- **Proposed to be banned Nationwide**
- **California**
  - Scheduled for elimination in 2004
  - Most refiners already moving away from MTBE
- **Other States are also Banning**
  - Arizona (2003)
  - Connecticut (2003)
  - Maine (no date)
  - Minnesota (2005)
  - Nebraska (use limited)
  - New York (2004)
  - South Dakota (use limited)
- **More to follow when state legislatures begin work in January**

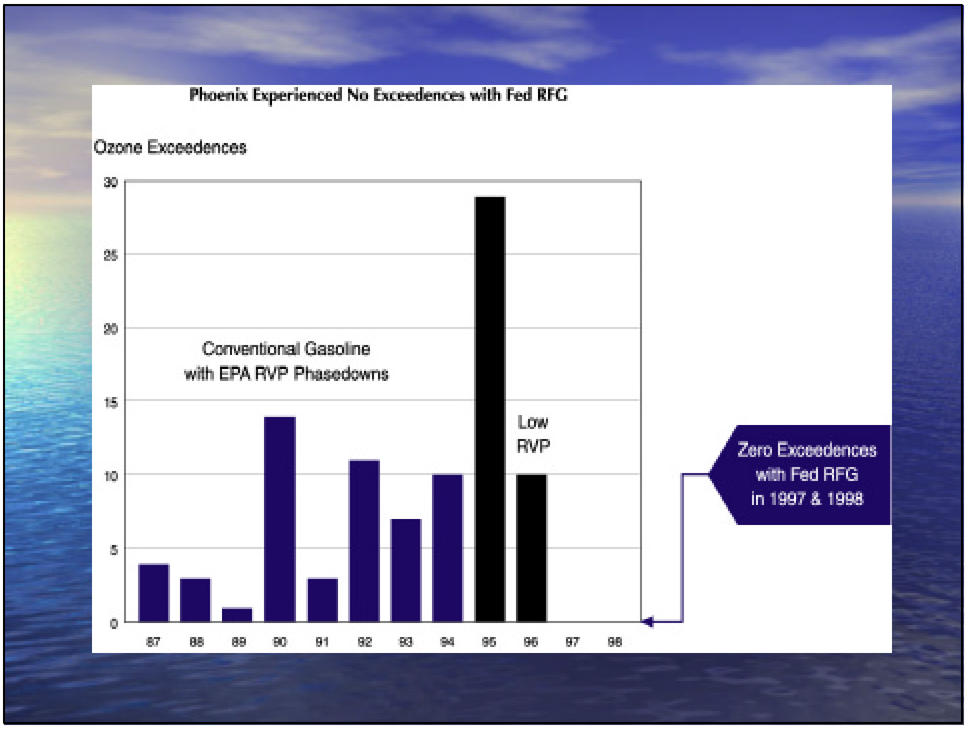
U.S. Clean Fuel Requirements



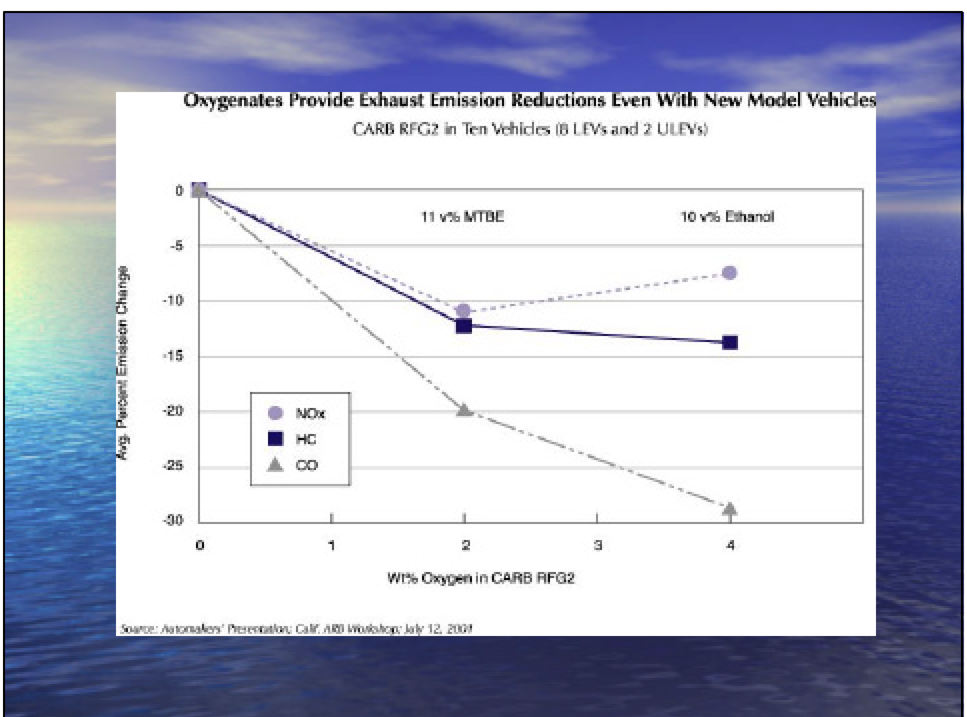
Source: Clean Fuels Development Coalition


U.S. Ethanol Production
Centered in Corn-Growing Region
Ethanol Producing Facility
Primary Corn Producing Region


Greenhouse Gas Reductions Compared to Gasoline
Percent reduction
-120
-100
-80
-60
-40
-20
E100 Woody Biomass to Ethanol
E100 Herbaceous Biomass to Ethanol
E100 Corn to Ethanol
E85 Herbaceous Biomass to Ethanol
E85 Woody Biomass to Ethanol
E85 Corn to Ethanol
E10 Corn to Ethanol
Source: U.S. Department of Energy, Office of Fuels Development and Congressional Research Service



Phoenix Experienced No Exceedences with Fed RFG
Ozone Exceedences
30
25
20
15
10
5
0
Conventional Gasoline
with EPA RVP Phasedowns
Low
RVP
Zero Exceedences
with Fed RFG
in 1997 & 1998
87
88
89
90
91
92
93
94
95
96
97
98



Oxygenates Provide Exhaust Emission Reductions Even With New Model Vehicles
CARB RFG2 in Ten Vehicles (8 LEVs and 2 ULEVs)
Avg. Percent Emission Change
0
-5
-10
-15
-20
-25
-30
11 v% MTBE
10 v% Ethanol
NOx
HC
CO
0
1
2
3
4
Wt% Oxygen in CARB RFG2

Birth of the RFS: A Solution to Significant Problems

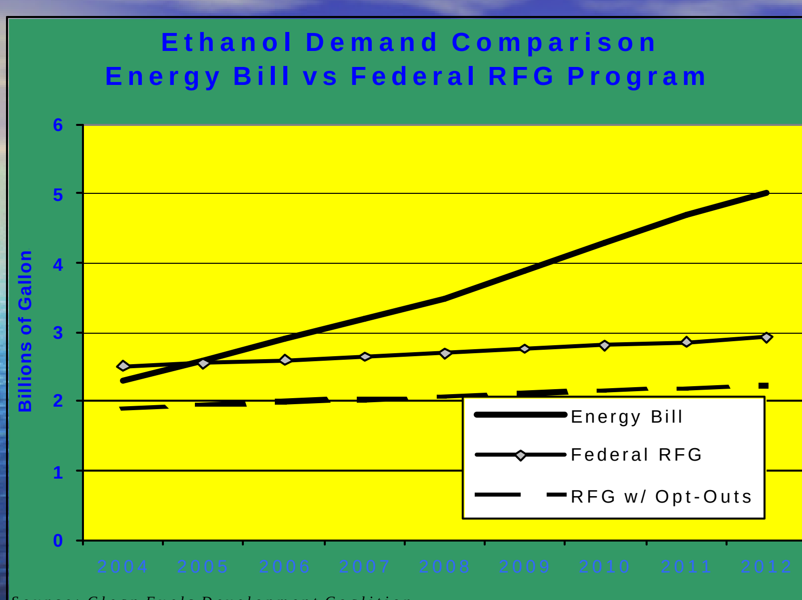
- MTBE In Water
  - Bans MTBE in Four Years
  - Provides Transition and Remediation Assistance
- Limited and Declining Oxygenate Market
  - Replaces Oxygen with Renewable for Demand Pull, Creating More than a Doubling of Market
- Environmental Concerns over Use of Ethanol (Evaporative Emissions)
  - Relieves Urban Areas of Oxygen Requirement
  - Allows for Continued Use in Areas of Success
- Extreme Opposition of Oil Industry to Ethanol Only Program
  - Addresses Difficulties in Meeting Vapor Pressure Restrictions
  - Provides Flexibility in Manner and Geography of Usage

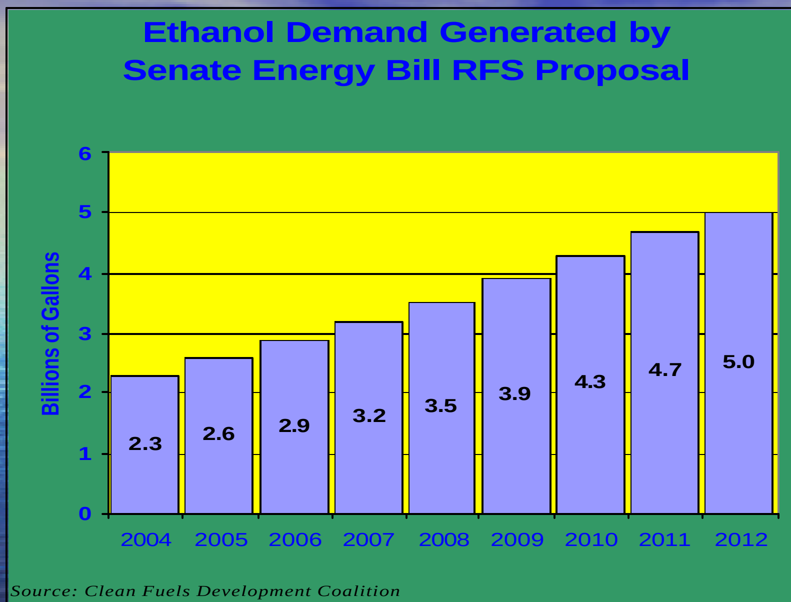
FACT SHEET ON FUEL PROVISIONS OF S.517

- Establishment of a renewable fuels standard requiring 2.3 billion gallons of either ethanol or biodiesel in 2004 and increasing to 5 billion gallons by 2012;
- Decisive vote in U.S. Senate 69-31, currently in Conference Committee
- Allows Refiners to meet requirement through a credits and trading program;
- Banning of MTBE in 4 years (from enactment);
- Repeal of the oxygen content of federal reformulated gasoline;
- Streamlining the process by which Governors can control vapor pressure;
- Authorizes funds for underground tank cleanup;
- Provides assistance for MTBE producers to convert to other, safer additives;
- Promotes development of biomass ethanol through some preferential treatment in the credits program;
- Treats biodiesel and ethanol as equal thus helping both industries.

WIDESPREAD SUPPORT FOR RFS

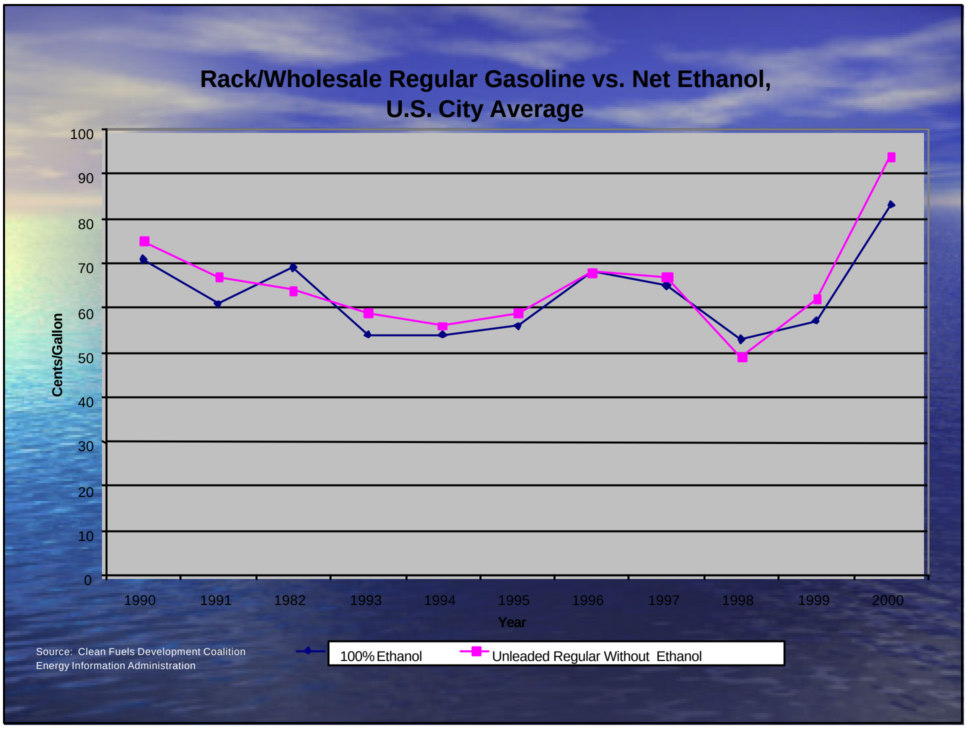
- Ethanol and Agriculture Communities Unified -- RFS Coalition
- U.S. Senate
- Bush Administration -- "…urges adoption of RFS that will improve the Nation's Energy Security, farm economy, and environment, " 6-27-02 Letter from DOE Secretary to Conferees
- Governors' Ethanol Coalition
- Key Environmental and Air Quality Organizations
- American Petroleum Institute
- Previous House Support of Oxygenates Likely to Translate to RFS Support

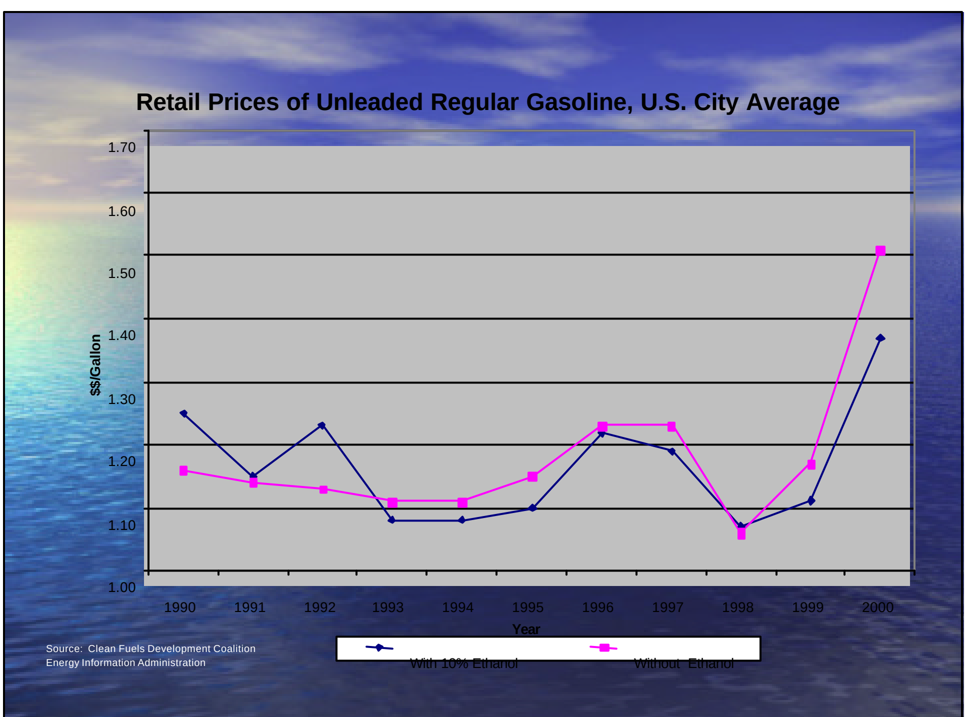




ONGOING ISSUES AND CONCERNS

- Cost and Price:
  - No Basis for Claims of Higher Gasoline Costs
  - CFDC Analysis of US and Nebraska Supports Lower Cost of Ethanol
  - Petroleum Industry Historically Identifies Supply Shortages/Disruptions as Source of Price Spikes
  - Adding Product Addresses Shortages and Holds Down Prices
- Supply Issues:
  - Meeting Production Goals
  - Drought
  - Capital Investment
  - MTBE Volume Loss
- Energy Balance
- “Food vs. Fuel”
- Boutique Fuels
- Concerns over Consolidation of the Industry
- Ethanol Plant Emissions


Rack/Wholesale Regular Gasoline vs. Net Ethanol,
U.S. City Average
Cents/Gallon
100
90
80
70
60
50
40
30
20
10
0
1990
1991
1982
1993
1994
1995
1996
1997
1998
1999
2000
Year
Source: Clean Fuels Development Coalition
Energy Information Administration
100% Ethanol
Unleaded Regular Without Ethanol


Retail Prices of Unleaded Regular Gasoline, U.S. City Average
$$/Gallon
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Year
Source: Clean Fuels Development Coalition
Energy Information Administration
With 10% Ethanol
Without Ethanol

ENERGY SECURITY

Ethanol is Homegrown for the Homeland -- Capitalize on Strengths

- Imported Oil Remains a Key Issue:
  - 2001 U.S. Consumed 18 mmbd,
  - Transportation Sector Uses 68% of Total
  - 57% Imported, or 9.1 mmbd – 1/3 US Trade Imbalance
  - 2.5 mmbd, or 27% comes from Saudi Arabia and Iraq
  - New Estimates of 28 mmbd by 2020
- Last Week EIA Research Reveals Quarterly Increase in Demand Up One Percent from 2001 While Domestic Production down 3%!
  - Difference Met By Imports!
- Stationary Source Power Remains Critical -- Secretary Abraham Calls for One New Power Plant Per Week for Next 20 Years!
- New Technologies (e.g., gasification) Can Allow Ethanol Plants To Become Generators of Food, Fuel, and Power!

SUMMARY

The ethanol industry is growing throughout the United States.

Ethanol offers a tremendous opportunity for Hawaii

- Value added to sugar industry
- Employment and economic development
- Increased supply of motor fuels
- Opportunity to become the first state to have all gasoline blended with 10% ethanol
- E-85 and Oxydiesel offer even more displacement

Go for it!!

Ethanol: An Important Role in Global Transportation Fuels

Hawaii – U.S. DOE Ethanol Workshop

Honolulu, Hawaii

November 14, 2002

Gary Herwick

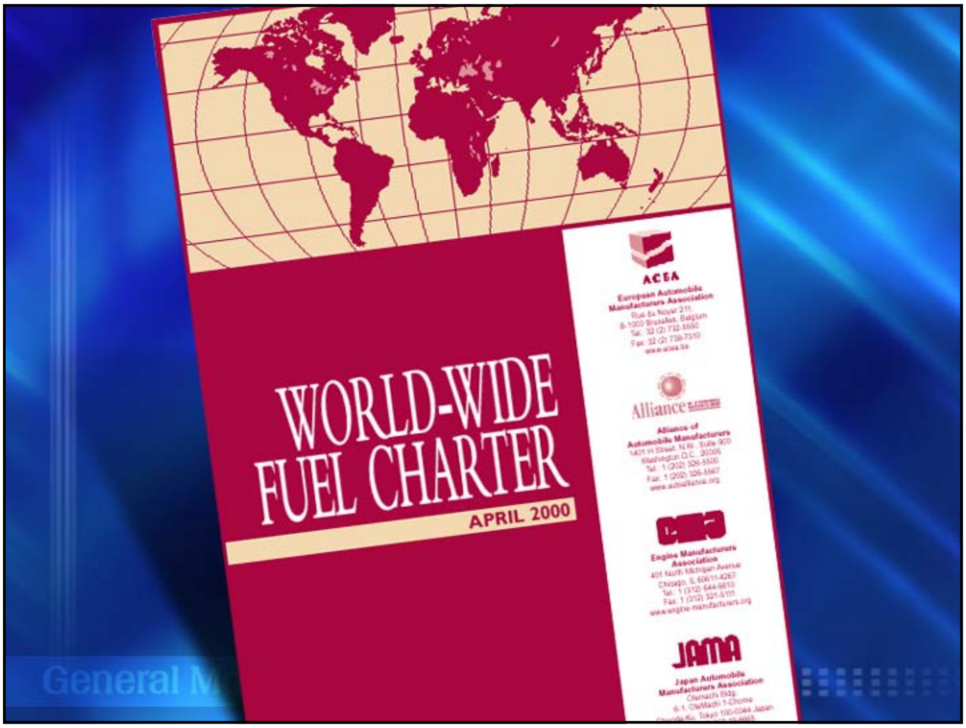
General Motors Corporation

General Motors

Transportation Fuel Quality

- **Fuel quality affects emissions, fuel economy, durability, driveability**
- **Vehicles and fuels must be considered a "system"**
- **Ability to meet stringent global emission requirements increasingly dependent on fuel quality**
  - Insure lowest emissions
  - Enable emission control technology
- **World-Wide Fuel Charter Category 4 (Tier 2/LEV II/Euro IV)**
  - <10 ppm sulfur
  - 1200 DI max
  - Ethanol blends up to 10%, comply with all specifications
- **Address energy use and greenhouse gas emissions concerns**

General Motors



General Motors Promotes the Use of Ethanol in Transportation Fuel

- **Approved the use of 10% ethanol blended gasoline in all GM products for 20 years**
- **Owners manuals *recommend* the use of clean fuels containing oxygenates**
- **Largest producer of E85 Flexible Fuel vehicles**
  - Tahoe, Suburban, Yukon, Yukon XL SUV
  - S10, Sonoma, Silverado, Sierra Pickup
- **Strategic transportation fuels initiative**

General Motors

GM E85 Vehicles

General Motors

The Benefits of Ethanol

- **Clean burning fuel**
  - Ethanol blends reduce sulfur and aromatic hydrocarbons for improved exhaust emission performance
  - Evaporative emissions are increased, but are less reactive in forming ozone
- **Renewable fuel**
- **Domestically produced**
- **Ethanol made from corn reduces greenhouse gas emissions**
- **Longer-term, ethanol made from cellulose has the potential to virtually eliminate greenhouse gas emissions from automobiles**

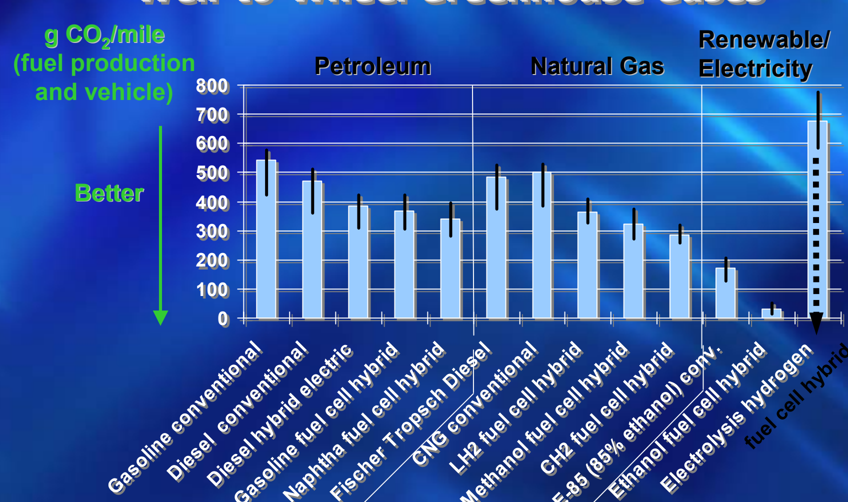
General Motors

Strategic Initiative

- **Promote the use of E85 as a renewable alternative fuel, and as a means of addressing CO2 emission concerns. Support the development of ethanol from cellulose.**
- **GM commissioned Well-to-Wheels life cycle analysis of energy use and greenhouse gas emissions**
  - Compares 15 propulsion technologies and 75 different fuel "pathways"
  - Ethanol (E85) reduces greenhouse gas emissions more than any other alternative fuel
- **"The alternative fuel that makes sense."**

General Motors

Well-to-Wheel Greenhouse Gases



General Motors

Ethanol and Emissions

- **More stringent emission requirements**
  - Zero evaporative emissions
  - Control of warm-up emissions = ability to meet standard
- **Fuel system permeation**
  - Swelling of fuel system elastomer materials
  - Increased evaporative emissions
- **Exhaust emissions**
  - Higher heat of vaporization contributes to incomplete vaporization during engine cold start and warm-up
  - Increased exhaust HC emissions
- **CRC test programs will quantify effects on LEV vehicles**
- **Mitigation strategies are needed**

Gasoline DI Limit

- **A DI limit enhances the opportunity for ethanol blended fuels**
- **DI limit applies to the HC blendstock**
- **Mitigates impact of ethanol on cold start HC emissions**
- **Renewable Fuel Standard and a DI limit go together**

Ongoing GM Support

- **Research on the development of ethanol from bio-mass**
- **Development of E85 fueling infrastructure**
  - Partnership with BP to provide E85 fueling capability for GM company vehicle fleet in Southeast Michigan
  - Additional infrastructure and education project plans
- **Membership in CFDC, NEVC**

General Motors

BP (Amoco) E85 Station

Rochester Hills, MI

General Motors

Summary

- Transportation fuels must address energy use and greenhouse gas emissions concerns.
- General Motors has supported the use of ethanol in transportation fuels for many years.
- GM is the largest producer of E85 Flexible Fuel vehicles.
- GM will continue to support increased use of ethanol through research and infrastructure development.
- A DI limit on US gasoline enhances the opportunity for ethanol, mitigates emissions impact of ethanol.

General Motors

Biofuels for Sustainable Transportation

Hawaii

Larry Schafer
Legislative Counsel
Renewable Fuels Association

RFA
Renewable Fuels Association

Overview

- **The Ethanol Industry Today**
- **Current Markets for Ethanol**
- **Expectations for Industry Growth**
- **The "Renewable Fuels Standard"**
- **New Market Opportunities**
- **USDA Programs – Starting an Ethanol Facility**

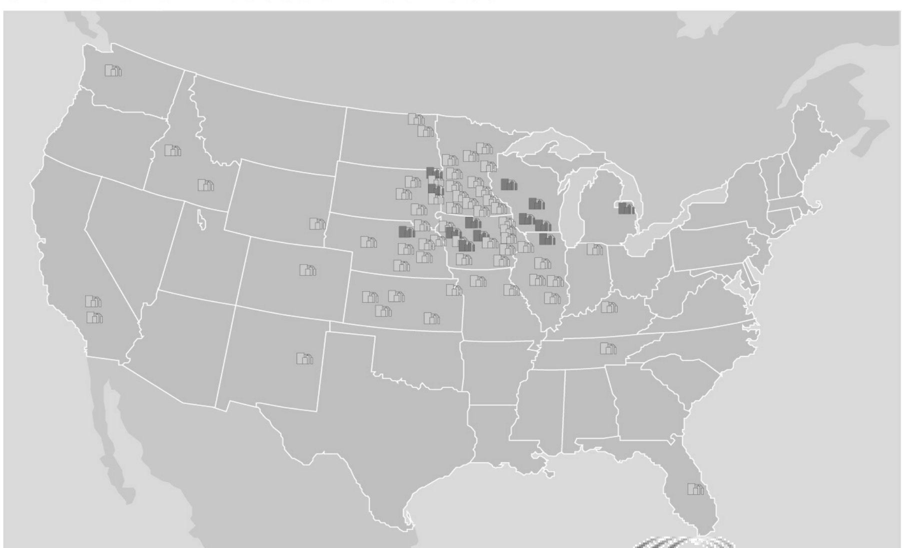
RFA
Renewable Fuels Association

U.S. Ethanol Industry Today

- Annual production record in 2001 of 1.77 bgy
- 2.4 bgy capacity today
- 65 facilities in 20 states
- 12 plants under construction (>400 mgy) will increase capacity to 2.7 bgy by end of year
- Expansions to existing facilities underway
- Dozens of additional plants in various stages of development

RFA Renewable Fuels Association

U.S. Ethanol Production Facilities



Ethanol Production Facility
Under Construction

RFA Renewable Fuels Association

Current U.S. Markets

▪ Octane/Extender ~	830 mgy
▪ Winter Oxyfuel Program ~	250 mgy
▪ Reformulated gasoline ~	450 mgy
▪ Minnesota oxygen program~	250 mgy
▪ Total	1.78 bgy

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Renewable Fuels Association

What's Leading Industry Growth?

- Concerns about MTBE contamination
- California market opportunity
  - California Switching to Ethanol
    - BP / Shell / Phillips / Exxon-Mobil
    - 56% of California Market
    - 400 – 500 mgy
- Need to expand U.S. fuel supply
- Energy and homeland security agenda

RFA
Renewable Fuels Association

Senate Energy Bill Fuels Agreement

- Phases out MTBE use in 4 years
- Eliminates 2% RFG oxygen standard from the Clean Air Act
- Maintains current air quality gains of RFG program
- Creates Nationwide Transportation Fuels Program
- Creates Renewable Fuels Standard (RFS)

RFA
Renewable Fuels Association

Renewable Fuels Standard in S. 517 (HR 4)

- **Requires gradual and increasing percentage of renewable fuels, including ethanol and biodiesel, growing to 5 bgy in 2012**
- **Credit Trading and Banking**
- **DOE can adjust % upward or downward, depending on supply**
- **Temporary Waivers**
- **Small Refiner Exemption**

RFA
Renewable Fuels Association

Economic Impact of RFS

- **Provide a one-time boost of $142 million to the local economy during construction.**
- **Expand the local economic base of the community by $110.2 million each year through the direct spending of $56 million.**
- **Create 41 full-time jobs at the plant and a total of 694 jobs throughout the entire economy.**
- **Increase the local price of corn by an average of 5-10 cents a bushel, adding significantly to farm income in the general area surrounding the plant.**

RFA
Renewable Fuels Association

Economic Impact of RFS

- **Increase household income for the community by $19.6 million annually.**
- **Boost state and local sales tax receipts by an average of $1.2 million (varies depending on local rates).**
- **Provide an average 13.3 percent annual return on investment over ten years to a farmer who invests $20,000 in an ethanol production facility.**

RFA
Renewable Fuels Association

Senate Energy Bill Fuels Agreement

- Supported by:
  - American Petroleum Institute
  - Northeast States for Coordinated Air Use Management (NESCAUM)
  - American Lung Association
  - Renewable Fuels Association
  - Renewable Energy Action Project
  - Others

RFA
Renewable Fuels Association

New Market Opportunities

- **E-Diesel fuel blends**
- **Fuel Source for Fuel Cells**
- **Research underway to identify new uses and high-value co-products**
- **Worldwide demand for renewable fuels growing as means to reduce GHG and develop new agricultural markets**

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Renewable Fuels Association

USDA Programs – Starting an Ethanol Facility

On the federal level, the U.S. Department of Agriculture (USDA) Rural Development Office provides financial assistance in the form of grants and loans to improve the economy and quality of life in rural America. Technical assistance and information resources are also available. These programs can assist entities seeking to develop and build an ethanol production facility.

RFA Renewable Fuels Association

USDA Programs – Starting an Ethanol Facility

USDA provides two types of Programs:

Business Programs
&
Cooperative Services.

RFA Renewable Fuels Association

USDA Business Programs

USDA through its "Rural Business-Cooperative Service" program creates partnerships with commercial lending institutions, the Farm Credit System, Farmer Mac, and other supplemental sources of funding to provide financing for qualified rural business enterprises.

Business Programs are available to businesses in areas outside the boundary of urban areas with populations under 50,000.

Recipients may include any legally organized entity, including cooperatives, corporations, partnerships, trusts, profit and nonprofit organizations, Indian tribes, private companies, municipalities, counties or individuals.

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USDA Business Programs

Business and Industry (B&I) Guaranteed Loan Program: Provides financial backing for rural businesses to help create jobs and stimulate rural economies. Provides guarantees up to 90% of a loan made by a commercial lender. Loan proceeds may be used for working capital, machinery and equipment, buildings and real estate, and certain types of debt financing. The maximum loan amount to any one borrower is $25 million.

Cooperative Stock Purchase Program: Farmers can use B&I loan guarantees to help pay for stock in a start-up cooperative that processes an agricultural commodity into a value-added product. The cooperative must be a new venture. The cooperative (not the farmer) must make a written request to its USDA Rural Development State Office for determination of eligibility.

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USDA Business Programs

Rural Business Opportunity Grants: Designed to promote economic development in rural communities by making grants to pay the costs of providing economic planning, technical assistance, or training. Applicants must be a public body, nonprofit corporation, Indian tribe, or cooperative with members that are primarily rural residents. Applicants must have expertise in the activities proposed and be able to demonstrate that funding will result in rural economic development. A maximum of $1.5 million is available for the program, with most grants of $50,000 or less.

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USDA Business Programs

Rural Business Enterprise Grants: The Rural Business-Cooperative Service makes grants to facilitate development of small and emerging business enterprises in rural areas. Use of grant funds may include acquisition and development of land and the construction of buildings, plants, equipment, access roads, parking areas, and utility extensions; refinancing; fees; technical assistance and training; loans to third parties; production of television programs to provide information to rural residents; and distance learning networks.

RFA Renewable Fuels Association

USDA Business Programs

Intermediary Relending Program: The purpose of the Intermediary Relending Program (IRP) is to finance business facilities and community development projects in rural areas. This is achieved through loans made by the Rural Business-Cooperative Service (RBS) to intermediaries. Intermediaries re-lend funds to ultimate recipients for business facilities or community development. Intermediaries establish revolving loan funds so collections from loans made to ultimate recipients in excess of necessary operating expenses and debt payments will be used for more loans to ultimate recipients.

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Renewable Fuels Association

USDA Business Programs

Rural Economic Development Loans: Provides zero-interest loans to electric and telephone utilities financed by the Rural Utilities Service (RUS), an agency of the United States Department of Agriculture, to promote sustainable rural economic development and job creation projects.

RUS Electric Program: Makes insured loans and guarantees of loans to nonprofit and cooperative associations, public bodies, and other utilities. Insured loans primarily finance the construction of facilities for the distribution of electric power in rural areas. The guaranteed loan program has been expanded and is now available to finance generation, transmission, and distribution facilities in rural areas.

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Renewable Fuels Association

USDA Cooperative Service Programs

Promotes understanding and use of the cooperative as a viable organizational option for marketing and distributing agricultural products. Helps rural residents form new cooperative businesses and improve the operations of existing cooperatives.

Value-Added Agricultural Product Market Development Grants - Independent Producers: This grant program seeks to encourage independent agricultural producers to further refine their products for value-added benefits. These grants will facilitate greater participation by farmers in markets for value-added agricultural commodities and facilitate the opening of new markets for value-added products. The proposed project must change the form of an agricultural product, such as processing grain into ethanol, wheat into flour, etc.

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Renewable Fuels Association

USDA Cooperative Service Programs

Cooperative Development Technical Assistance: Provides assistance for those interested in forming a new cooperative, from an initial feasibility study to the creation and implementation of a business plan.

Technical Assistance: Could include helping a cooperative develop a strategic marketing plan, determine whether to merge or form a joint venture with other coops, or find a way to turn raw products into value-added products. Assistance often includes an analysis of operations or assessing the economic feasibility of new facilities or adding new products or services.

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Renewable Fuels Association

USDA Cooperative Service Programs

Cooperative Services also conducts research, provides education and information, and collects historical data and statistics. For further information or assistance for cooperatives, contact:

USDA Rural Development/Cooperative Services
Stop 3250
Washington, DC 20250-3250
(202) 720-7558 FAX: (202) 720-4641
email: coopinfo@rurdev.usda.gov

RFA Renewable Fuels Association

USDA Special Initiatives

Commodity Credit Corporation (CCC) Bioenergy Program: Under the program, the CCC has made up to $150 million available annually in incentive cash payments to bioenergy (ethanol and biodiesel) producers in the U.S. that increase their purchases of agricultural commodities over the previous fiscal year's purchases and convert that commodity into increased bioenergy production.

RFA Renewable Fuels Association

USDA Special Initiatives

Rural Cooperative Development Grants: USDA grants are available for establishing and operating centers for cooperative development to improve rural economies through the development of new cooperatives and to improve the operations of existing coops.

Biobased Products and Bioenergy Program: This program seeks to promote national economic interests through the conversion of renewable farm and forestry resources to affordable fuel (i.e. ethanol and biodiesel), chemicals, electricity, pharmaceuticals, and other materials in cost- competitive manner. Loans are eligible for financing under the Business and Industry Guaranteed and Direct Loan Programs (see above).

RFA
Renewable Fuels Association

Contact Information:

Renewable Fuels Association
(202) 289-3835
Web site: www.ethanolRFA.org
Email: Info@ethanolrfa.org

Economic Impact Assessment for Ethanol Production and Use in Hawaii: An Interim Report

Hawaii Ethanol Workshop
sponsored by DOE and DBEDT
November 14, 2002

BBI International
Mark Yancey
602 Park Point Drive, Suite 250
Golden, Colorado 80401
(303) 526-5655 mark@bbiethanol.com

BBI INTERNATIONAL CONSULTING

BBI International

- Bryan & Bryan, Inc. founded in 1995 by Mike and Kathy Bryan
- 18 full-time employees
- 80+ years ethanol and biofuels experience
- Services:
  - Ethanol and Bioenergy Project Development
  - International Conferences and Workshops
  - Ethanol Producer Magazine
- An independent source of information and data for owners, lenders and policy makers

Presentation Overview

- Economic impact assessments
- Resources for ethanol production on Hawaii
- Ethanol market potential
- Ethanol production scenario
- Capital and operating cost estimates for ethanol production in Hawaii
- Economic impact results

Economic Impact Assessments

- Determine the impact of new economic activity on jobs, income, total spending and taxes for a specific region or area
- Determine the direct impacts and then use "multipliers" to determine indirect and induced impacts
- Not a feasibility study

Hawaii's Resources for Ethanol Production

- Ethanol is typically produce by fermentation of sugars by yeast
- All plants contain sugar, starch or cellulose – all can be used to make ethanol
- Hawaii has sugar and cellulose feedstocks and few starch crops
- MSW (garbage) can also be used

Feedstock Assessment

- There are only two crops grown in Hawaii at the scale required for production of ethanol:
  - Sugarcane and molasses
  - Pineapples (too expensive)
- Agricultural residues
- MSW and food waste
- Energy crops

Ethanol Potential

Feedstock Resource	Supply (dry tons)	Ethanol Yield (gal/ton)	Ethanol Potential (MMGY)
Sugar-based crops			
Raw sugar	300,000	150	45
Molasses	100,000	72	7
Food Waste	40,500	62	3
Organics in MSW	620,000	60	37
Lignocellulosics			
Pineapple residues	181,000	80	14
Sugarcane residues	535,000	75	40
State Total	**1,776,500**	**83**	**148**

Based on 2001 crop production data

Ethanol Market Potential

- Hawaii's transportation market is dependant on imported oil
- Present annual consumption of gasoline by the ground sector in Hawaii is on the order of 400 MMGY
- At 10% ethanol blend by volume = 40 million gallons of ethanol per year

Ethanol Production Scenario

- There are many possible scenarios for ethanol production in Hawaii
- After considering many different scenarios, BBI selected:
  - 15 MMGY on Oahu from MSW
  - 15 MMGY on Maui from Molasses
  - 10 MMGY on Kauai from Molasses

Oahu Ethanol Plant

- 15 million gallon per year capacity
- Assume that at this size the operation of the H-Power facility will not be affected
- Would utilize lignocellulosic biomass to ethanol technology (not commercial)
- An option for future consideration is to integrate an organic recycling program focused on generating biogas from food wastes to fuel the ethanol plant

Maui Ethanol Plant

- 15 million gallon per year capacity
- The Maui plant would utilize molasses from current sugar operations, supplemented with sugar from existing operations or from new sugarcane production

Kauai Ethanol Plant

- 15 million gallon per year capacity
- The Kauai plant would utilize molasses from current sugar operations, supplemented with sugar from existing operations or from new sugarcane production

Capital Cost Estimates

Ethanol Plant Site	Oahu	Maui	Kauai
Ethanol Production (Gal/Year)	**15,000,000**	**15,000,000**	**10,000,000**
Project Costs			
Ethanol Plant Cost per Gallon	$2.67	$1.94	$2.17
Engineering & Construction	$39,981,000	$29,143,000	$21,714,000
Inventory - Biomass	$136,000	$240,000	$160,000
Inventory - Chemicals/Denaturant	$66,000	$67,000	$45,000
Inventory - Ethanol & Lignin	$453,000	$435,000	$290,000
Spare Parts	$300,000	$300,000	$200,000
Startup Costs	$700,000	$700,000	$500,000
Land	$300,000	$300,000	$200,000
Administration Building & Furnishing	$200,000	$200,000	$200,000
Site Development Costs	$500,000	$500,000	$500,000
Tools and Laboratory Equipment	$200,000	$200,000	$200,000
Organizational Costs	$700,000	$700,000	$500,000
Capitalized Fees and Interest	$1,079,000	$787,000	$586,000
Working Capital	$400,000	$291,000	$217,000
Estimated Total Project Cost	**$45,015,000**	**$33,863,000**	**$25,312,000**

Operating Cost Estimates

Ethanol Plant Site	Oahu	Maui	Kauai
Production & Operating Expenses			
Feedstocks	$4,809,524	$8,487,395	$5,658,263
Purchased Cellulase Enzymes	$1,454,400	$0	$0
Other Chemicals	$1,115,329	$1,154,286	$769,524
Fuel Oil	$2,980,950	$2,833,333	$1,888,889
Electricity	$2,040,000	$1,165,714	$777,143
Denaturants	$655,714	$655,714	$437,143
Other costs	$484,757	$196,856	$137,585
Direct Labor & Benefits	$1,059,537	$1,059,537	$753,729
Total Production Costs	$14,600,211	$15,552,836	$10,422,275
Administrative Expenses	$2,777,196	$2,387,153	$1,910,661
Principal & Interest - Debt	$4,044,757	$3,010,711	$2,259,877
Annual Operating Expense	**$21,422,164**	**$20,950,700**	**$14,592,813**
Number of Employees	**31**	**31**	**22**

Economic Impacts

- The expenditures of the ethanol plants will become the income of other businesses or individuals, which in turn is re-spent in the economy to provide income for others
- The initial economic activity has a multiplier effect that ripples through the economy
- Economic impact analysis is an analytical method that provides a measure of the economic effects of an activity within a specified region

Economic Impact Results

Construction Phase Impacts	Oahu	Maui	Kauai
Ethanol Plant Capital Cost (millions)	$45.0	$33.9	$25.3
Final Demand Impact (millions)	$109.2	$82.2	$61.4
Earnings Impact (millions)	$35.5	$26.7	$19.9
Employment Impacts (indirect jobs)	1,108	833	623

Operations Phase Impacts	Oahu	Maui	Kauai
Operating Expenditures (millions)	$21.3	$20.8	$14.5
Final Demand Impact (millions)	$42.0	$41.1	$28.6
Earnings Impact (millions)	$7.5	$7.3	$5.1
Employment Impacts (direct jobs)	31	31	22
Employment Impacts (indirect jobs)	226	221	154
Total Jobs	257	252	176

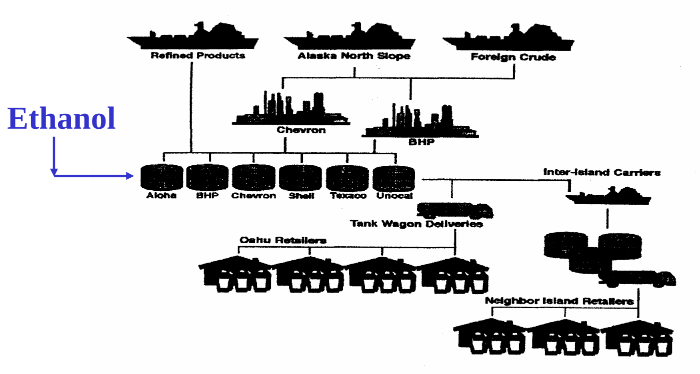
Tax Impacts

Impact of State Producer Payment	Oahu	Maui	Kauai
Ethanol Plant Average Pre-Tax Income (millions)	$3.6	$4.1	$2.0
Hawaii & Federal Corporate Income Tax Revenu	$1.5	$1.7	$0.8
Hawaii Personal Income Tax on Earnings	$0.6	$0.6	$0.4
Total Tax Revenue (millions)	$2.1	$2.3	$1.3
State Producer Payment (millions)	$4.2	$4.2	$2.7
Annual Return to State (millions)	($2.1)	($1.9)	($1.4)

Impacts to Fuel Refining and Distribution Systems

- Dr. Joseph Masin conducted a study to determine the capital and operating cost impacts of blending fuel grade ethanol with gasoline in Hawaii
- Ethanol is assumed to be manufactured in Hawaii and blended with gasoline at 10% by volume

Hawaii's Gasoline Distribution System



Source: The Energy Division, State of Hawaii Department of Business, Economic Development & Tourism

Note: Most Hawaii gasoline and diesel starts out as crude oil brought in by tankers. Two local refineries process the crude oil into the products sold by various companies to gas stations.

Ethanol Blending

- Petroleum refiners will need to remove light gasoline components, like butanes and pentanes, from current blend recipes in order to accommodate the relatively high vapor pressure that results when ethanol is blended with gasoline at 5 to 10 percent by volume ethanol
- This may require modification of distillation and storage facilities, as well as finding markets for the removed components

Ethanol Blending Scenarios

Component	Volume 10^6 gal/yr	RVP psi	Octane RM/2	Weight 10^3 T/yr	LHV 10^9Btu/yr
Case 1	Existing Blend				
Butane	24	51.5	92	58	-2295
LVN	16	12.0	61	43	-1685
Other Gasoline Base	360	8.8	89	1206	-45828
Total	400	11.5	88.2	1308	-49807
Content per gallon (# or Btu)				6.54	-124518
Case 2	Add ethanol, waive RVP limit				
Ethanol	44	18.0	113	145	-3454
Butane	24	51.5	92	58	-2295
LVN	14	12.0	61	38	-1464
Other Gasoline Base	360	8.8	89	1206	-45828
Total	442	12.1	90.8	1447	-53041
Content per gallon (# or Btu)				6.55	-120027
Case 3	Add ethanol, keep RVP limit				
Ethanol	43	18.0	113	141	-3375
Butane	18	51.5	92	43	-1675
LVN	14	12.0	61	38	-1469
Other Gasoline Base	360	8.8	89	1206	-45828
Total	434	11.5	90.7	1428	-52348
Content per gallon (# or Btu)				6.57	-120485
Case 4	Replace lights with Ethanol, keep RVP				
Ethanol	41	18.0	113	135	-3211
Butane	8	51.5	92	19	-765
LVN	0	12.0	61	0	0
Other Gasoline Base	360	8.8	89	1206	-45828
Total	409	10.6	91.6	1360	-49803
Content per gallon (# or Btu)				6.65	-121799

Summary of Refinery and Fuel Distribution Impacts

Ethanol Blending	Case 2	Case 3	Case 4
Description	Waive RVP Limit	Keep RVP Limit	Replace Lights with Ethanol
Vapor Pressure (psi) *	12.1	11.5	10.6
Refiner's Capital Costs ($MM)	$3.00	$4.30	$5.70
Additional Labor (FTE)	8.90	8.80	8.60
Net Refiner Revenue ($/gal)	$0.07	$0.06	$0.02
Net Decrease in Energy ($/gal)	($0.05)	($0.05)	($0.03)
Net Savings with Ethanol ($/gal)	$0.02	$0.01	($0.01)

* Vapor pressure limit for gasoline in Hawaii is 11.5 psi

Conclusions for Ethanol Production Impacts

- These results are preliminary! Refinery side impacts are not incorporated
- Sugar and starch feedstocks are in short supply due to declining sugarcane acreage
- Lignocellulosic feedstocks are plentiful, but the corresponding ethanol technology is not yet commercial
- The potential ethanol market on Hawaii is 40 MMGY and growing

Conclusions

- Ethanol production brings significant positive economic impacts:
  - Total constructions costs = $104 million
  - The resulting total economic impact during construction is estimated to be $253 million
  - Total jobs created during construction are approximately 2,564 with an increase in personal income of $82 million
  - Combined annual operating costs = $57 MM
  - Creating $112 million in total annual economic activity and 686 new jobs

Fuel Ethanol In Hawaii:
A Historical Perspective

Prepared for:
U.S. Department of Energy
Ethanol Workshop

Ethanol Fuel:
Coming Soon to a Car Near You

Honolulu, Hawaii
November 14, 2002

Historical Perspective

- Early ethanol fuel use
- Notable non-fuel uses
- Chronology of ethanol fuel use
- Past problems experienced in Hawaii
- Typical types of problems reported
- Possible causes and solutions
- Simple steps to eliminate problems

Early Ethanol Fuel Use

- Maui Agriculture Co. (Paia mill) built the first distillery in U.S. to produce ethanol from molasses for fuel use in 1917!
- Ethanol used to operate cars, trucks, and camp stoves during WWI.
- Continued to use ethanol fuel until 1922(?) when gasoline and kerosene supplies became cheaper and more consistent.

Notable Non-Fuel Uses

- Seagram's constructs a distillery at HC&S Puunene (Maui) to produce rum in 1963. Rum is sold under the Leilani brand.
- Distillery closes in 1969.
- A&B acquires distillery in 1976.
- A&B sells facility to Maui Distillers in 1980 to produce "Hana Bay" and "Whaler's" brand rum.
- Closed in 1986.
- Hawaiian brand rums still exist today.

Chronology of Ethanol Fuel Use

- Worldwide oil shortages causes gasoline prices to skyrocket in 1970s.
- Midwestern farmers focus on using corn to produce ethanol as a gasoline “extender.”
- Various studies in Hawaii focus on using ethanol from molasses to accomplish same thing.
- Local sugar industry is optimistic and invests heavily into research in this area.
- HSPA (now HARC) studies indicate profitability of producing ethanol from molasses will rely heavily on government incentives.

Chronology of Ethanol Fuel Use

- Aloha Petroleum imports ethanol to blend with gasoline and begins marketing “gasohol” in 1979.
  - *Hawaii is a national leader by being one of the first locations to offer gasohol to the general public.*
  - *Customer problems attributed to gasohol arise immediately. (Discussed in more detail later)*
- In 1979, A&B and Maui Distillers agree to reopen Maui distillery to produce ethanol for both fuel and alcoholic beverages.

Chronology of Ethanol Fuel Use

- In 1980, the legislature contemplates a $0.06 per gallon tax to underwrite construction of a $40 million fuel ethanol plant. Proposal goes nowhere.
- C. Brewer (now BEI) completes a feasibility study in March 1981 to build an 11.4 million gallon per year molasses to ethanol plant on Big Island. Plans to build the facility continue to move ahead.
- Nationally, average retail gasoline prices peak at $1.94 per gallon in 1981.

DBEDT

Chronology of Ethanol Fuel Use

- State demonstrates a 10% ethanol blend in DAGS fleet in early 1981.
  - *Conducted between February and May 1981*
  - *Involved 127 vehicles (1972 to 1980 model years)*
  - *Over 348,000 miles*
  - *No unusual problems noted*
- Average national gasoline prices begin to drop in 1982.

DBEDT

Chronology of Ethanol Fuel Use

- Aloha Petroleum discontinues their 2.5 year-old gasohol program in 1982.
  - *Weak demand and less overall interest spur decision.*
  - *Overall program was not doing well financially.*
- By 1984, the average national gasoline price had dropped over 22% from the 1981 peak.
- C. Brewer decides to cancel plans to build Big Island ethanol plant in 1984.
  - *Unable to finalize long-term ethanol purchase agreement with local refineries*
  - *Unable to justify investment since they do not directly market gasoline*

DBEDT

Chronology of Ethanol Fuel Use

- Pacific Ethanol Products builds a small ethanol production facility on Oahu in 1985.
  - *Molasses obtained from Oahu Sugar.*
  - *Completed by end of 1985 to obtain federal tax credits.*
- Nationally, U.S. EPA mandated phase-down of lead levels in gasoline reaches 0.1 gram per gallon. Alternative octane enhancers, including ethanol, gain favor.
- In 1986, Aloha Petroleum imports ethanol to blend and market an “ethanol-enhanced” unleaded fuel.

DBEDT

Chronology of Ethanol Fuel Use

- State again demonstrates a 10% ethanol blend in the DAGS fleet in late 1986.
  - *Uses only Hawaii-produced, molasses-derived ethanol from Pacific Ethanol Products.*
  - *Problems with vapor lock on about 1% of fleet every week.*
  - *Vapor pressure of blend was found to be excessive. Can be corrected with proper blending.*
- By 1987, national average gasoline price had dropped to $1.10 per gallon.

DBEDT

Chronology of Ethanol Fuel Use

- By the late 1980s, Pacific Ethanol Products was the only entity offering ethanol for fuel blending in state.
- Many of the economic incentives driving the production of ethanol in Hawaii were gone.
- Due to naturally clean air, Hawaii was not mandated to reduce CO emissions through use of oxygenates (e.g., ethanol, MTBE)
- National average gasoline price was under $1.06 per gallon by 1993.

DBEDT

Past Problems Experienced in Hawaii

- There were problems reported by automotive service technicians believed to be related to the use of gasoline blended with ethanol.
- Mostly anecdotal.
- Controlled studies showed few of these same problems (e.g., State DAGS fleet, 1981).
- Very few problems ever reported regarding engine power, mileage, or performance.
- Similar problems were initially seen in other U.S. mainland locations and have been overcome.

DBEDT

Typical Types of Problems Reported

- Deterioration of rubber components in carburetors, fuel lines, and fuel pumps.
- Fuel filter plugged with debris.
- Vapor lock.
- Water in fuel line.

DBEDT

Possible Causes and Solutions

- Deterioration of rubber components in carburetors, fuel lines, and fuel pumps.
  - *Appeared to only affect certain makes and models of vehicles.*
  - *Components in newer vehicles have been updated and are fully compatible.*
  - *All vehicle warranties now cover use of ethanol blended fuel.*
  - *Most older cars have already had these parts replaced with newer materials.*

Possible Causes and Solutions

- Fuel filter plugged with debris.
  - *No evidence that ethanol contained debris.*
  - *Ethanol has inherent solvent and detergent qualities. If any system is dirty (i.e., vehicle fuel system, UST at dispensing location, transport truck, etc.), the addition of ethanol may loosen and suspend this debris.*
  - *Fuel systems on newer vehicles very clean.*
  - *More detergents being used in gasoline now than previously.*
  - *Filter is doing its job.*

Possible Causes and Solutions

- Vapor lock.
  - *Can be caused by high vapor pressure or a high vapor/liquid ratio of the fuel.*
  - *Ethanol has a high vapor pressure and raises the vapor pressure of the blended fuel.*
  - *Current formulation of gasoline refined in Hawaii has a vapor pressure too high to allow direct blending with ethanol without exceeding the U.S. EPA maximum vapor pressure parameter.*
  - *Blending ethanol with gasoline refined in Hawaii would necessitate refiners to reformulate the vapor pressure or their gasoline.*

DBEDT

Possible Causes and Solutions

- Water in vehicle fuel line
  - *Water may have come from vehicle's fuel tank or the gasoline UST.*
  - *Water in vehicle's fuel tank*
    - *Extremely rare to have water in fuel system in newer vehicle.*
    - *If older vehicle has water in fuel tank, addition of ethanol may move water into fuel line.*

DBEDT

Possible Causes and Solutions

- Water in vehicle fuel line (continued)
  - *Water in gasoline UST*
    - *Older gasoline USTs may have contained water. This water may have mixed with the ethanol and caused water to be transferred to vehicle.*
    - *Hawaii Department of Health UST program became operational in 1986. UST operations are now regulated to a much higher degree than before.*
    - *Critical that USTs must be free of water before ethanol blends are added. However, once UST is free of water, ethanol blend will keep UST water free.*
    - *Normal practice now to place a filter on dispensing pump to prevent transfer of any free water in UST to vehicle. This was not a common practice previously.*

DBEDT

Simple Steps to Eliminate Problems

- Be certain that gasoline USTs are free of any free water before being used for ethanol blends.
- Work with refiners to obtain gasoline with the correct vapor pressure so that ethanol can be blended without exceeding U.S. EPA maximums.
- Install filters on dispensing pumps to remove free water.
- Be prepared to replace some rubber seals, etc. on older and vintage vehicles.

DBEDT

Ethanol Fuel for Hawaii: State Policy, Incentives, and Mandate

State of Hawaii
Department of Business, Economic Development & Tourism
Energy, Resources, and Technology Division
www.state.hi.us/dbedt/ert

Maurice H. Kaya, Administrator

1

State Laws Supporting Fuel Ethanol

- Ethanol production credit
- Exemption from 4% state excise tax on retail sales
- Reduced highway taxes on E85
- Ethanol content requirement

2

State Tax Credit for Investment in Ethanol Production Facilities

- Equivalent to 30 cents per gallon of fuel-grade ethanol produced
- Credit for up to 15 million gallons / year / facility
- Available up to 8 years if investment was less than $50 million; up to 10 years for investment greater than $50 million
- Facility must be in Hawaii and in production before January 1, 2012.
- www.state.hi.us/dbedt/ert/ethanol-incentive.html

3

Exemption from 4% state excise tax on retail sales for alcohol fuels

- Fuel mixture consisting of at least 10% biomass-derived alcohol
- Applies to E10 and E85
- Exemption terminates on December 31, 2006
- www.capitol.hawaii.gov
  (find Hawaii Revised Statutes section 237-27.1)

4

Reduced Rate of State Highway Tax

- Alternative fuels are subject to one-half the effective state highway tax rate of diesel fuel
- Applies to E85
- Does not apply to E10 or oxydiesel
- www.state.hi.us/dbedt/ert/fueltax-act143.html

State plus County taxes for on-highway use of alternative fuels:				
	Honolulu	Maui	Hawaii	Kauai
Ethanol (E100)	$ 0.094	$ 0.084	$ 0.072	$ 0.084
Gasoline	$ 0.325	$ 0.290	$ 0.248	$ 0.290

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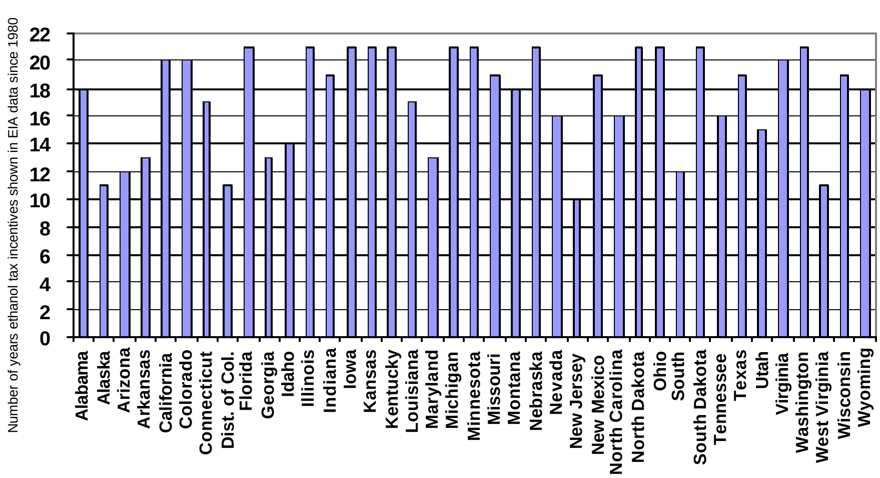
States with 10 or more years of fuel ethanol use



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Fuel ethanol on the Mainland

- On the Mainland, "independent" gasoline stations were the first to offer E10.
- Adding 10% ethanol to gasoline:
  - raises octane 3 points
  - raises vapor pressure (RVP) 1 pound / sq. in. (psi)
- EPA imposed summertime volatility limits of 7.0-9.0 psi in all areas of the U.S. – except Alaska and Hawaii
- EPA allows a 1.0 psi "volatility waiver" for gasoline ethanol blends - but it does not apply in Hawaii

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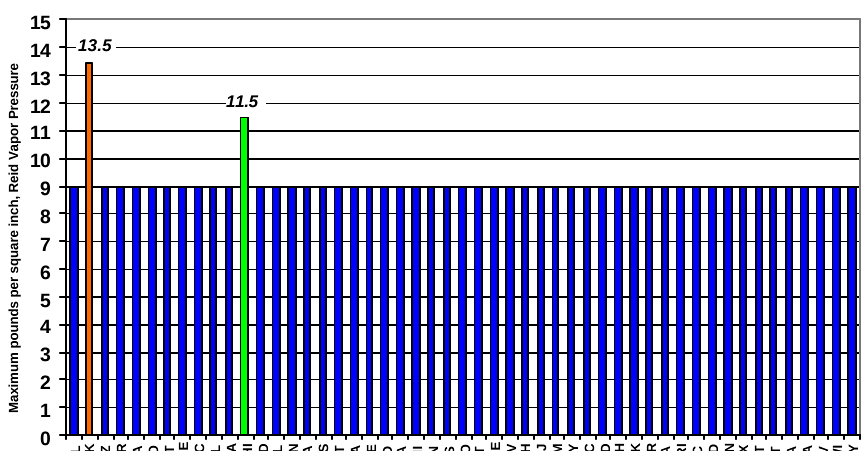
Summertime vapor pressure limits*



(maximums; some areas subject to limits as low as 7 psi). Areas subject to EPA's 9 psi limit, but without serious air quality problems, are allowed a 1 psi waiver for gasoline ethanol blends.

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Why no fuel ethanol in Hawaii?

- According to ASTM specification D4814, Hawaii is volatility class “C” all year: gasoline may not have a RVP (Reid vapor pressure) greater than 11.5 pounds per sq.in.
- Gasoline testing report in 1989 showed that vapor pressures ranged from 9.7 to 11.4 psi.
- Adding ethanol to gasoline near the 11.5 psi limit would result in out-of-spec fuel
- To blend ethanol in Hawaii, refiners would have to produce a suitable blendstock
- Bottom line: in Hawaii, refiner participation is necessary.

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Hawaii Ethanol History (abridged)

1984 **C. Brewer cancels plans to construct an ethanol plant on the Big Island.** According to their press release, " ... we cannot invest $15 million in capital to produce a product we cannot be assured of marketing ..."

1991 "Ethanol blending letter" sent to refiners & gasoline retailers asking: "for ethanol/gasoline blends to be cost-competitive, ethanol would have to be available for $_____?“ Responses indicated a lack of interest.

1992 Meeting of energy & agriculture people to see if there are ethanol & electricity opportunities at Hamakua.

1994 Numerous articles on “ethanol will (or won’t) help save sugar.”

1994 **Ethanol Content Requirement** signed into law. The law states: “DBEDT shall adopt rules ... to require that gasoline ... contain 10% ethanol... “

1995 National Energy Policy Act requires centrally-fueled State fleets on Oahu to purchase **alternative fuel vehicles**.

1995 “Transportation Energy Strategy” completed. Various approaches considered. E10 recommended as cost-effective approach.

1995 Oil company representatives say “we’re energy companies,” will blend ethanol if the price is right, mandate is not necessary.

2000 **Ethanol production incentive** signed into law. Incentive is 30 cents per gallon of fuel grade ethanol.

2002 Several ethanol producers are **ready to start construction of ethanol production facilities in Hawaii.** Ethanol production expected in 2004.

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§486J-10 (a) - Ethanol Content Requirement

- The commissioner shall adopt rules ... to require that gasoline sold in the State for use in motor vehicles contain ten per cent ethanol by volume.
- The amounts of gasoline sold in the State containing ten per cent ethanol shall be in accordance with rules as the commissioner may deem appropriate.
- The commissioner may authorize the sale of gasoline that does not meet these requirements as provided in subsection (d).

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§486J-10 (b) and (c)

(b) Gasoline blended with an ethanol-based product, such as ethyl tertiary butyl ether, shall be considered to be in conformance with this section if the quantity of ethanol used in the manufacture of the ethanol-based product represents ten per cent, by volume, of the finished motor fuel.

(c) Ethanol used in the manufacture of ethanol-based gasoline additives, such as ethyl tertiary butyl ether, may be considered to contribute to the distributor's conformance with this section; provided that the total quantity of ethanol used by the distributor is an amount equal to or greater than the amount of ethanol required under this section.

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§486J-10 (d) - Ethanol Content Requirement

(d) The commissioner may authorize the sale of gasoline that does not meet the provisions of this section:

(1) To the extent that sufficient quantities of competitively-priced ethanol are not available to meet the minimum requirements of this section; or

(2) In the event of any other circumstances for which the commissioner determines compliance with this section would cause undue hardship.

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§486J-10 (e) - Ethanol Content Requirement

(e) Each distributor, at such reporting dates as the commissioner may establish, shall file with the commissioner, on forms prescribed, prepared, and furnished by the commissioner, a certified statement showing:

(1) The price and amount of ethanol available;

(2) The amount of ethanol-blended fuel sold by the distributor;

(3) The amount of non-ethanol-blended gasoline sold by the distributor; and

(4) Any other information the commissioner shall require for the purposes of compliance with this section.

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§486J-10 (f), (g) and (h)

(f) Provisions with respect to confidentiality of information shall be the same as provided in section 486J-7.

(g) Any distributor or any other person violating the requirements of this section shall be subject to a fine of not less than $2 per gallon of nonconforming fuel, up to a maximum of $10,000 per infraction.

(h) The commissioner, in accordance with chapter 91, shall adopt rules for the administration and enforcement of this section.

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§486J-1 - Definitions

"Competitively priced" means fuel-grade ethanol for which the wholesale price, minus the value of all applicable federal, state, and county tax credits and exemptions, is not more than the average posted rack price of unleaded gasoline of comparable grade published in the State.

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§486J-1 - Definitions

"Distributor" means and includes:

(1) Every person who refines, manufactures, produces, or compounds fuel in the State, and sells it at wholesale or at retail, or who utilizes it directly in the manufacture of products or for the generation of power;

(2) Every person who imports or causes to be imported into the State or exports or causes to be exported from the State, any fuel; and

(3) Every person who acquires fuel through exchanges with another distributor.

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§486J-1 - Definitions

"Petroleum commissioner" or "commissioner" means the administrator of the energy, resources, and technology division of the department of business, economic development, and tourism.

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Ethanol Content Requirement

- Rules have not been finalized.
- Rulemaking takes several months.
- There is an opportunity for public input.
- If private companies can reach agreements that result in local production and availability of fuel ethanol, regulation may not be necessary.

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Summary

- Incentives and mandates are in place to support the local production and use of fuel ethanol.
- Fuel ethanol is not currently available in Hawaii.
- We expect it to be available in 2004.
- Working together, we can make it happen.
- Thank you

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Websites with More Information

- Hawaii State Energy Office: www.hawaii.gov/dbedt/ert
- Hawaii State Department of Taxation: www.hawaii.gov/tax
- Hawaii State Legislature: www.capitol.hawaii.gov

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Ethanol From Cellulosic Materials

Rick Elander
Pretreatment R&D Team Leader
Biotechnology Division for Fuels and Chemicals
National Renewable Energy Laboratory
Golden, CO

U.S. DOE Fuel Ethanol Workshop
Honolulu, HI
November 14, 2002

NREL

Operated for the U.S. Department of Energy by Midwest Research Institute • Battelle • Bechtel

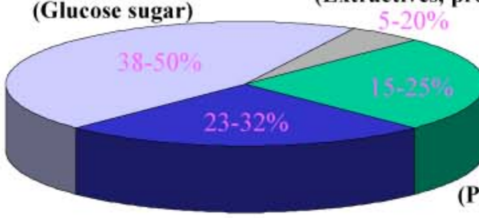
Lignocellulosic Biomass


Corn Stover


Bagasse


Hardwood

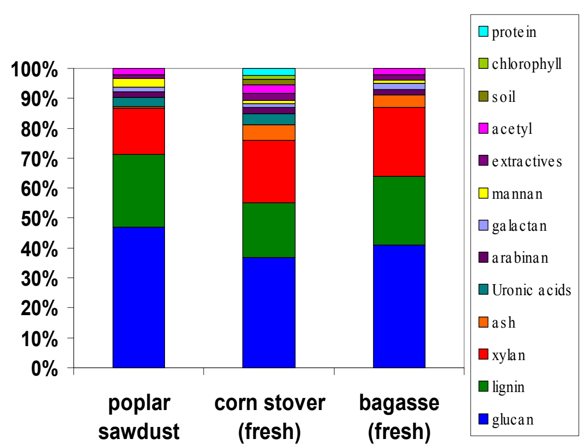

Softwood



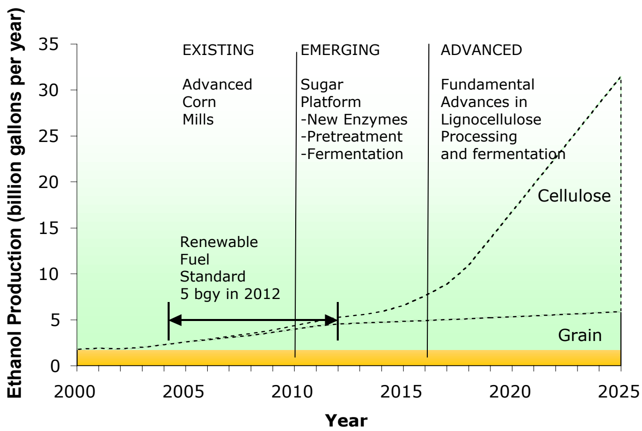

Corn Stover—the "hot" feedstock

- Up to 60 MM dry tons per year available from the 10 leading corn production states can be collected in a sustainable manner
  - -erosion control
  - -soil carbon levels
- Enough to produce over 4 billion gallons of ethanol per year

Stover and Bagasse—Many Similarities

Ethanol from Starch and Lignocellulose



Existing and emerging technology supports targets of a renewable fuel standard

Advanced technology provides the leap to substantial oil displacement

Government role in high risk R&D

Industry role is to commercialize

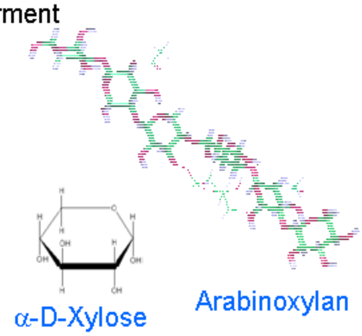
Lignocellulose Conversion Processes

- Concentrated acid hydrolysis (sulfuric or hydrochloric acid)
  - Thermochemical hydrolysis of cellulose and hemicellulose
  - Relatively low temperature, requires acid recovery and recycle
- Dilute acid hydrolysis (sulfuric or hydrochloric acid)
  - Thermochemical hydrolysis of cellulose and hemicellulose
  - Relatively high temperature, no acid recovery
  - Difficult to achieve high glucose yields without complex reactor configurations
- Pretreatment/enzymatic hydrolysis
  - Partial to complete thermochemical hydrolysis of hemicellulose
    - Various pretreatment approaches available
  - Enzymatic hydrolysis of cellulose and any remaining hemicellulose
    - Enzymes are currently too costly

Challenges for Lignocellulosic Ethanol

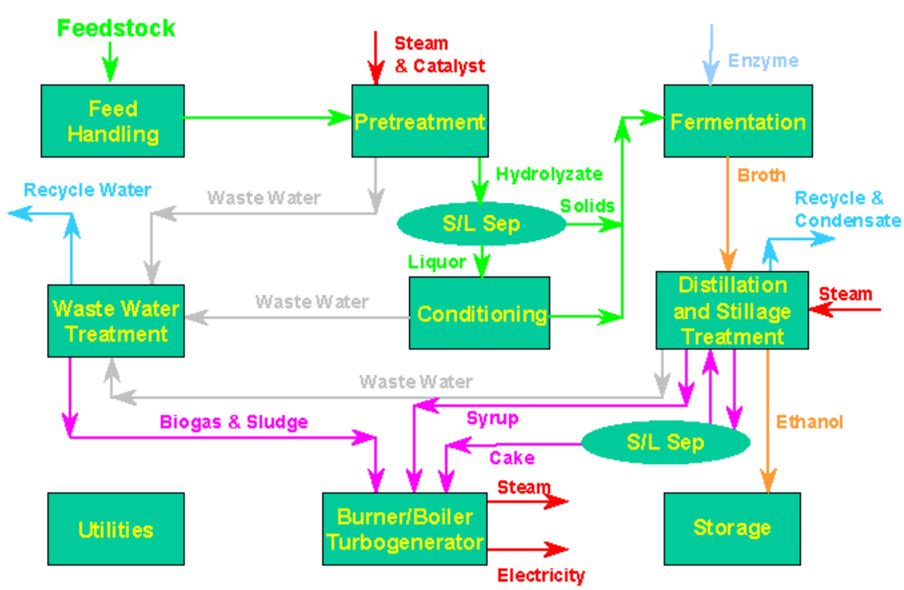
Cellulose is much more recalcitrant than starch

Hemicellulose largely consists of pentose sugars—more difficult to ferment

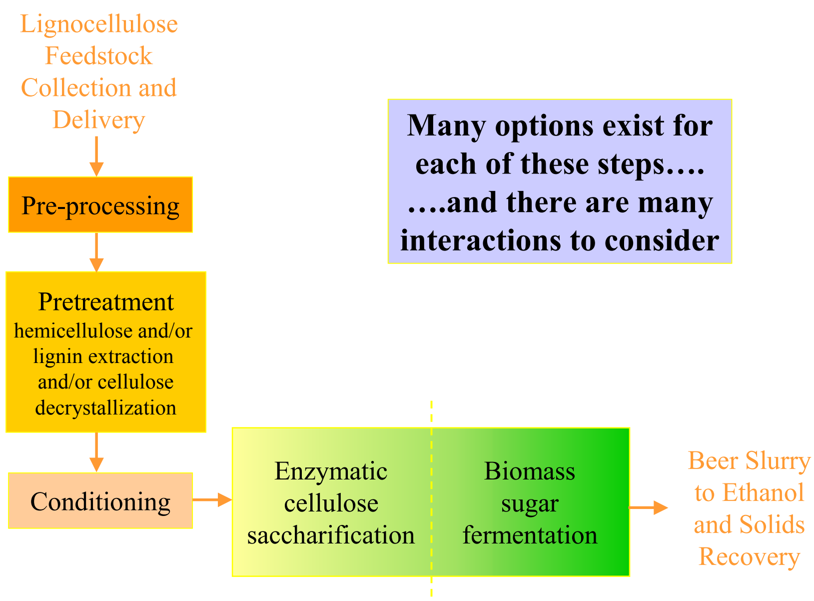


Lignin—a highly aromatic, refractory heteropolymer

Generic Bioethanol Process Flow

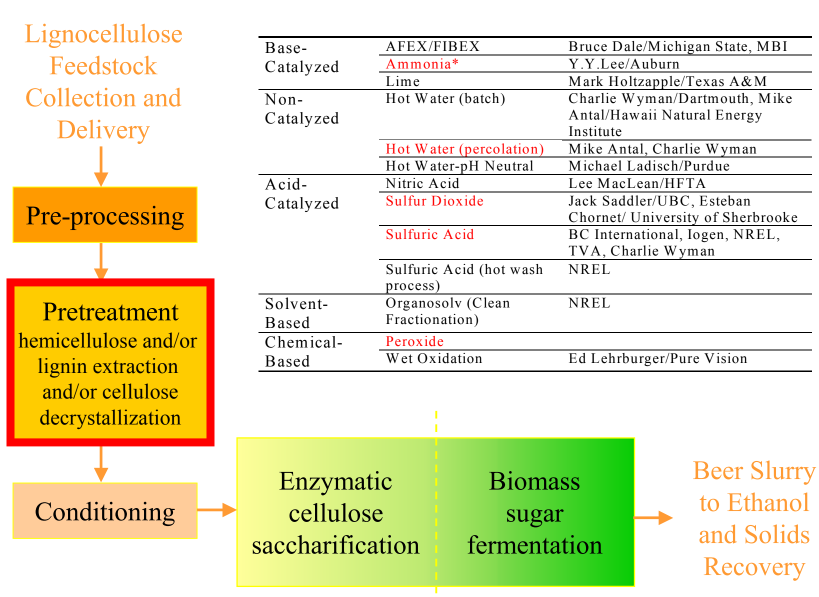


The Key Steps



Pretreatment

Base-Catalyzed	AFEX/FIBEX	Bruce Dale/Michigan State, MBI
	Ammonia*	Y.Y.Lee/Auburn
	Lime	Mark Holtzapple/Texas A&M
Non-Catalyzed	Hot Water (batch)	Charlie Wyman/Dartmouth, Mike Antal/Hawaii Natural Energy Institute
	Hot Water (percolation)	Mike Antal, Charlie Wyman
	Hot Water-pH Neutral	Michael Ladisch/Purdue
Acid-Catalyzed	Nitric Acid	Lee MacLean/HFTA
	Sulfur Dioxide	Jack Saddler/UBC, Esteban Chornet/ University of Sherbrooke
	Sulfuric Acid	BC International, Iogen, NREL, TVA, Charlie Wyman
	Sulfuric Acid (hot wash process)	NREL
Solvent-Based	Organosolv (Clean Fractionation)	NREL
Chemical-Based	Peroxide	
	Wet Oxidation	Ed Lehrburger/Pure Vision



Pretreatment

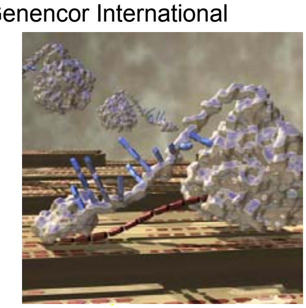
Lignocellulose Feedstock Collection and Delivery → Pre-processing → Pretreatment (hemicellulose and/or lignin extraction and/or cellulose decrystallization) → Conditioning → Enzymatic cellulose saccharification | Biomass sugar fermentation → Beer Slurry to Ethanol and Solids Recovery

- The Biomass Refining Consortium for Applied Fundamentals and Innovation (CAFI)
  - Auburn University
  - Dartmouth College
  - Michigan State University
  - NREL
  - Purdue University
  - Texas A&M University
- Development of comparative pretreatment data using common feedstock, analytical methods, data reporting methodology, and process economic evaluation

Saccharification and Fermentation

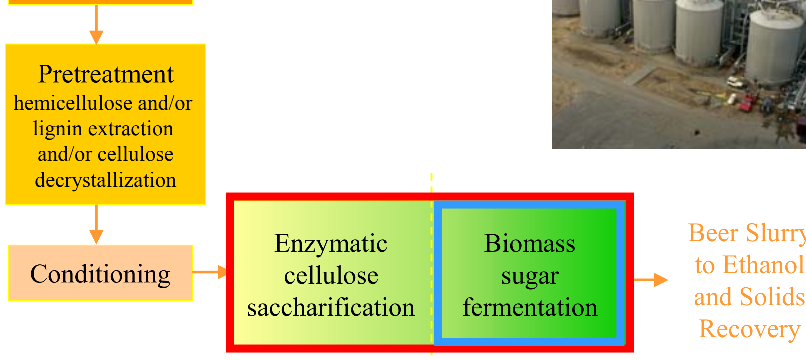
Lignocellulose Feedstock Collection and Delivery → Pre-processing → Pretreatment (hemicellulose and/or lignin extraction and/or cellulose decrystallization) → Conditioning → Enzymatic cellulose saccharification | Biomass sugar fermentation → Beer Slurry to Ethanol and Solids Recovery

- Subcontracts with the two largest enzyme producers to reduce the costs of cellulase enzymes ten-fold
  - Novozymes
  - Genencor International

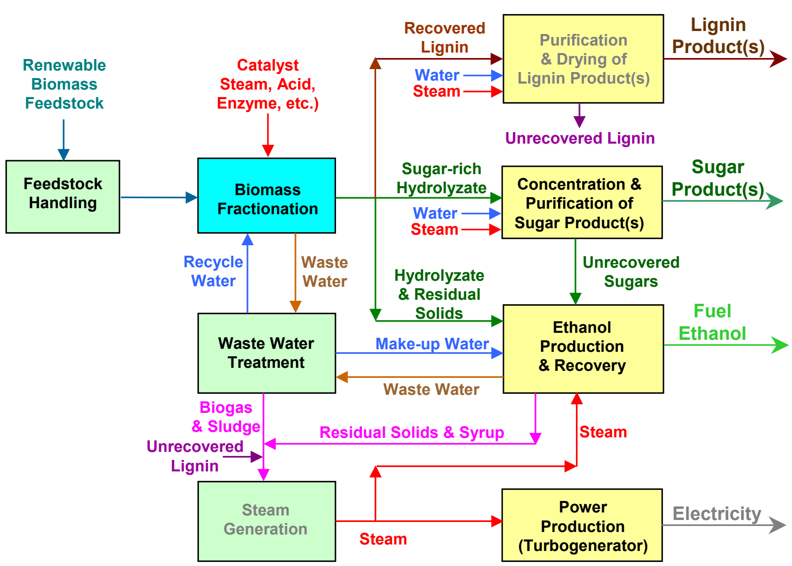


Saccharification and Fermentation

- Robust, co-fermenting organisms need further development
  - •Yeast (recombinant)
  - •Bacteria (recombinant)



Sugar and Lignin Platform Biorefinery



The Biotechnology Division for Fuels and Chemicals at NREL

http://www.nrel.gov/biotechnology/

http://www.ott.doe.gov/biofuels/

Acknowledgements

- U.S. Department of Energy, Office of Biomass Programs
- State of Hawaii; Department of Business, Economic Development & Tourism; Energy, Resources, and Technology Division
- BBI International

Ethanol from Cane Molasses

Jayant Godbole
PRAJ INDUSTRIES LTD.
PUNE, INDIA

DOE+BBI Hawaii Ethanol Workshop, November 14, 2002
Honolulu, Hawaii.

PRAJ - Background

- Over 250 customers around the world.
- Over 60 distilleries attached to sugar mills.
- Fermentation process using cane molasses , syrup of sugarcane juice or mixture, grains, cassava etc.
- Has mapped molasses characteristics by analyzing more than 1500 cane molasses samples across the world.

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PRAJ - Infrastructure & Strengths

- Established knowledge based company with expertise in Fermentation,Distillation and in value added options for vinasse treatment & disposal.
- *MATRIX* - Technology Development Center with Analytical Laboratory & Pilot Plant Facilities.
- Central Technology and Engineering Facility with over 200 Experts for Design, Engineering, Project Management, Manufacture ,Installation & Commissioning of Alcohol Plants.
- Manufacturing facility for stainless steel, copper titanium etc.with ISO 9002 and ASME-U & H.

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PRAJ - Customers

- Seagram India.
- Allied Domeque.
- PT Molindo Raya, Indonesia.
- La Tondena, Philippines.
- Destilerias Unidas, Peru.
- Sucromiles, Colombia
- Destileria Brugal, Dominican Republic.
- West Indies Rum, Barbados.
- Thai Alcohol Company.
- McDowell & Company.
- Shaw Wallace.

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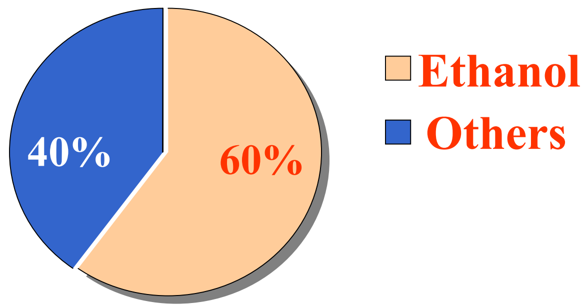
Utilization of Molasses
…..An overview



Ethanol Production from Cane Molasses is Over 20 billions Litres per Annum.

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Availability of Molasses

- Tropical Climatic Conditions Influence Many Technical Aspects of Molasses to Ethanol Fermentation.
- Majority of Molasses to Ethanol Plants are Concentrated in Tropical & Sub-tropical Regions.
- India has more than 200 distilleries using cane molasses. Other major producers od ethanol from cane molasses are Thailand, Indonesia, Philippines, Brazil, Guatemala, Mexico etc.

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Factors Affecting Composition of Molasses

- Variety of cane
- Composition of soil
- Climatic conditions
- Harvesting practices
- Sugar manufacturing process
- Handling and storage

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Typical Composition of Molasses

• Total Solids	: 75 to 88 % Wt.
• Total reducing sugars	: 44 to 60 % Wt.
• Unfermentable Sugars	: 4 to 5 % Wt.
• Fermentable Sugars	: 40 to 55 % Wt.
•Total Inorganics	: 8 to 12 % Wt.
• Settlable dry sludge	: < 3.5% Wt.
• Specific Gravity	: 1.38 to 1.52
• Titrable volatile acidity	: 3000-20,000 ppm
• pH at 40 deg. Diluion	: 4.5 to 5.6
• Caramel(OD)	: 0.2 to 0.6

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Mapping Characteristics of Cane Molasses

	Analytical Parameter	SOUTH AMERICA	AFRICA	SOUTH EAST ASIA	CARRABIAN
A	**Chemical Analysis**				
1	Brix (Degree Brix) At ambient temp.	87- 93	83 - 91	78 - 85	84 - 93
2	Total Solids (% w/w)	81 - 86	82 - 85	78 - 85	74 - 79
3	Total sugars as reducing matter (% w/w)	49 - 54	48 - 55	50 - 60	52 - 56
4	Un-fermentable sugars as reducing matter (% w/w)	2.5 - 5.2	2.3-5.4	3.7-4.9	3.5 - 4.5
5	Fermentable sugars (% w/w)	43.5 - 50	43- 49.5	45 - 60	47.5 -52
6	F:N Ratio	1.0 - 1.6	1.0 - 1.5	1.2 - 2.8	1.7- 2.8
7	Total inorganic matter (% w/w)	7.8 - 14	6.5 - 8.5	4 - 5	9 - 12
8	Calcium as CaO (% w/w)	1.3 - 3.9	2 - 3	1.9 - 2.5	1.8 - 2.6
9	Total Settlable dry sludge at pH 4.5 and 40 Brix dilution (% w/w of raw molasses)	0.7- 4.5	0.5 - 3.0	0.5 -1.0	1 - 1.5
10	Total settlable sludge at pH 4.5 – 4 Hr settling (by Vol. %)	15 - 26	5 - 20	1- 6	0 - 12
11	Specific Gravity(at ambient temperature)	1.46 - 1.50	1.43 - 1.51	1.40 - 1.45	1.44 - 1.49
12	Titrable volatile acidity in terms of acetic acid and acetate salts (PPM)	5500 - 22500 Average 12000	6500-12500	5500-11500	4000 - 5500
13	PH at 40 Brix dilution	5-5.5	4.8-5.5	4.6-5.3	4.8 - 5.4
14	Dry suspended particles (> 100 μ) (% w/w)	ND	ND	ND	ND
15	Colour in terms of optical density (OD) at 375 nm with 0.1 % w/v dilution.	0.2- 0.32	0.3 - 0.49	0.2 - 0.55	0.35 - 0.4
B.	**Microbiological Analysis**				
1	Total Viable count cfu/gm	100 – 20000	100-600	3000-40000	1000-4000
C	**Instrumental (GC) analysis of Individual Free Volatile fatty acids (By-products of bacterial metabolism).**				
1	Acetic Acid (PPM)	4000-22000	2000-3000	5000-7000	4000-5000
2	Propionic Acid (PPM)	30-250	30-50	80-90	35-40
3	Isobutyric acid (PPM)	300-600	10-20	40-60	20-40
4	Butyric acid (PPM)	100-220	60-70	40-60	300-355
5	Isovaleric acid (PPM)	10-50	200-230	100-114	400-430
6	Valeric acid (PPM)	10-40	5-10	5-10	5-10
7	Total Acids by GC (PPM)	4450- 23200	2300-3400	5300- 7350	4700- 5900

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General observations about Cane Molasses

- South American molasses is generally high in fermentable sugars, high in calcium, inorganic ash and volatile acidity.
- Caribbean molasses is normal in calcium and volatile acidity & high in fermentable sugars.
- Molasses in Central America has moderate fermentables, medium VA & high in caramel
- African molasses is high in fermentable sugar low calcium & sludge content and normal VA.
- South East Asian molasses is high in fermentable sugars, high volatile acidity & higher in caramel.
- Molasses in northern & southern India has low fermentable sugars, higher VA & caramel.

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Fermentation of Molasses to Ethanol

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What is Fermentation ?

Fermentation of Sugar.

Fermentable sugar gets converted in to ethanol with yeast as catalyst.

Reaction:

Di-saccharide ---------------> Mono-saccharide

Mono-saccharide -----------> Ethanol + CO_2
Yeast

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Factors in Molasses Influencing Fermentation

- **Fermentable Sugars**

Yeast uses fermentable sugar for ethanol production

- **Inorganic Salts**

Salts inhibits yeast activity due to Osmotic pressure.

- **Volatile Acidity**

Volatile acids reduce yeast growth and ethanol formation.

- **Hygienic Conditions**

Hygienic condition controls contamination.

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Composition of Molasses & Effects on Fermentation Kinetics

- F:N ratio < 0.9 retards fermentation rate by average 15 - 20 %
- Ash content above 10 % can retard the rate of fermentation by 5 - 10 %.
- Extent of caramelization : (Measured as color in OD units at 375 nm of 0.1 % molasses solution)> 0.40 OD retards fermentation rate by 20-25%.Reaction ceases beyond 0.65.
- Volatile acids in mash > 2500 ppm reduce the rate of fermentation and yeast growth.
  Volatile acids in mash > 5000 ppm reduce fermentation rate by 30 - 40 %.
  Volatile acids in mash > 7000 ppm can kill the yeast reducing viability up to 40-50 %.

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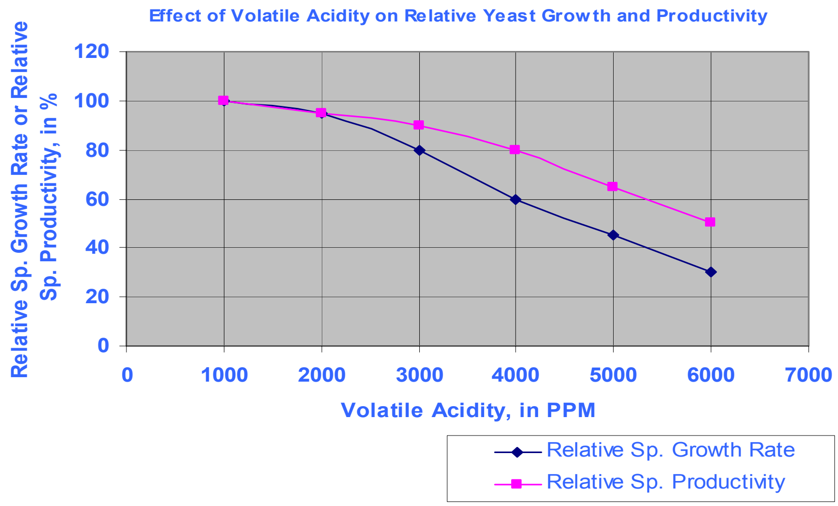

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Parameters For Fermentation

- Alcohol concentration in Mash.
- Sugar & Yeast Concentration in Mash.
- Temperature & pH of Mash.
- Volatile acidity in Mash.
- Residence Time In Fermentors.
- Fermentation Efficiency.

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Fermentation Plant

- **Main Sections:**
  - Yeast Propagation.
  - Fermentation.
  - Yeast Separation and Recycle.
  - Sludge Separation.
- **Auxiliary Sections:**
  - Handling & distribution of Inputs.
  - Cooling System.
  - Acid, Nutrients, Antifoam Supply.
  - Cleaning in Place System.

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Continuous Fermentation….

- More than 100 distilleries in Asia & India use continuous fermentation on cane molasses.
- Easier to operate with 2-4 fermentors , consistent quality & no need to propagate yeast daily.
- Higher efficiency of 89-90 % instead of 80-84 % in a batch process.
- Alcohol yield of 270-274 Lit of 99.5 % v/v Ethanol/ MT molasses with 48 % Fermentable Sugars (64-65 gallon/short ton).
- Alcohol concentration increases from 5-6 % in the 1st fermentor to 8-9.5 % in the last one.

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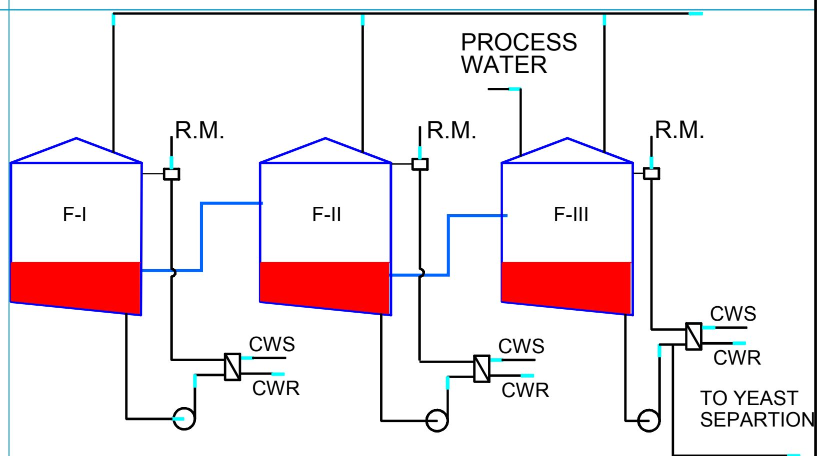
Continuous Fermentation



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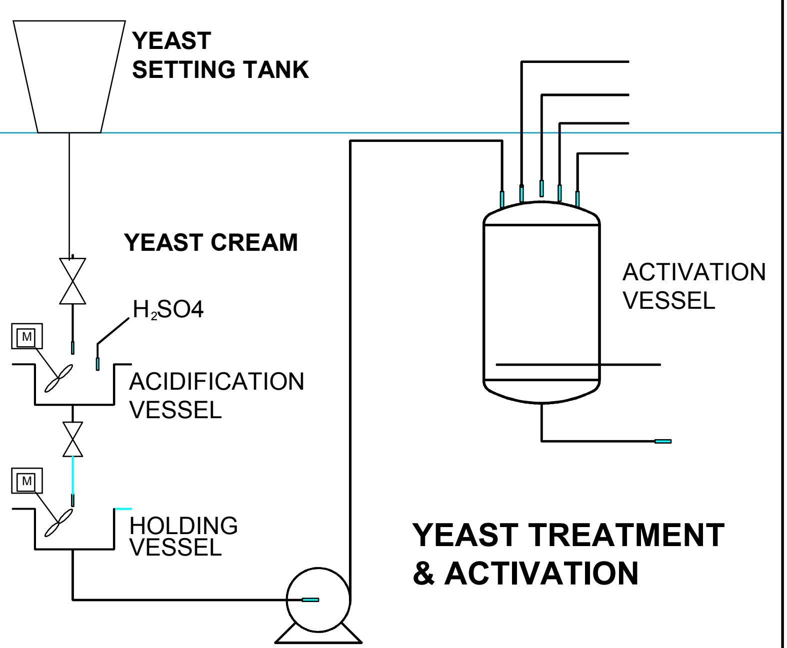

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Ethanol Distillation

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What is Distillation ?

Separation of Liquid Mixture(s)
of Different Components
into a Number of Fractions of
Different Compositions
OR
into its Pure Components.

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Objective of Distillation

- Stripping of alcohol from Fermented Mash.
- Concentration of stripped alcohol to 95 - 96.5%v/v for industrial alcohol & further concentration to 99.5 - 99.8%v/v in dehydration plant for ethanol.
- Concentration of stripped Ethanol to 96 - 96.5 %v/v for Potable application. Separation of impurities become prime importance. Achieved by controlling-
  - Dilution & Extraction
  - Temperature.

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Parameters for Distillation.

- Number of distillation columns depend on required product composition.
- Selection of parameters like pressure & temperature
- Energy conservation by -
  Heat Recovery, Thermal Integration.
- Automation for consistency in quality.
- Plant Design to Take Care Fouling Nature of Mash.

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Distillation Scheme Selection

- Energy cost being a significant potion of operating cost, configuration is designed to minimize energy.
- Use of re-boilers to minimize volume of effluent.
- Using cascading pressure for integration of heat & saving in energy.
- Automation to get consistent quality product.

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Multi-pressure Vacuum Distillation

- Lower consumption of steam
- Multi-pressure vacuum configuration eliminates problems of scaling in mash column
- Consistently high quality of product
- Higher degree of instrumentation and automation

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Effluent Treatment

AN OVERVIEW OF

TECHNOLOGIES FOR TREATMENT OF
VINASSE FROM
CANE MOLASSDES DISTILLERIES

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Characteristics of Effluent

Effluent generated by molasses based distilleries has following characteristics:

Volume**:** 9 to 12 KL per KL of alcohol produced.

B.O.D.**:** 40,000 to 60,000 mg./ lit or ppm.

C.O.D.**:** 80,000 to 120,000 mg./lit or ppm.

Total solids**:** 7 to 12 % w/w.

Organic solids**:** 4 to 8 % w/w

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Objective For Effluent Treatment

- To ensure safe treatment of the organic part of the effluent
- To ensure safe and proper disposal of the treated effluent.

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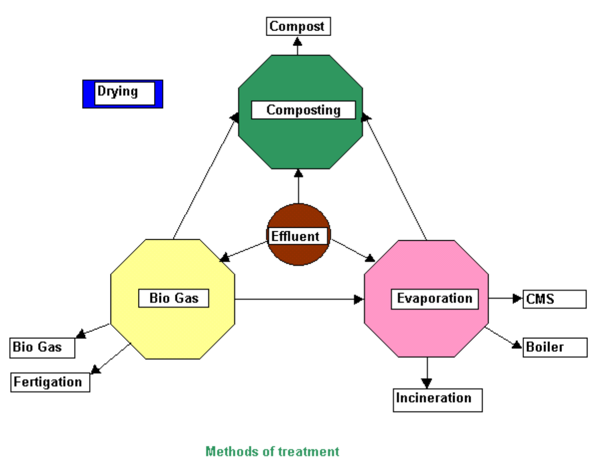
Options of Treatment of Vinasse



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Options / Schemes

- Anaerobic Bio-Methanation followed by aerobic, activated sludge treatment: almost 80 % of the energy requirement can be derived from vinasse.
- Aerobic, Biological Composting.
- Concentration and usage in Animal Feed (CMS).
- Concentration and Incineration, with and without Steam Generation.
- Ferti - Irrigation with bio-methanated or with partially evaporated vinasse.
- Disposal in water bodies like river,lake or sea.

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Recycle of Vinasse

- When using cane molasses or juice syrup, up to 50 % of vinasse can be recycled.
- Vinasse gets concentrated to 25-30 % solids.
- Careful process design required to avoid excessive build-up of bacterial contamination.
- Aspects like content of calcium & inorganic ash and content of bacteria & volatile acids need to be considered carefully.

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Evaporation of Vinasse - *'FLUBEX'* . . . . .

- Deposition and scaling in falling film evaporators due to presence of calcium salts in vinasse is the major problem in evaporation of vinasse.
- Self-cleaning fluidized bed *FLUBEX* evaporators of PRAJ employs metal wire-bits which get fluidized in the exchanger and gently scour the tube-walls
- *FLUBEX* enables use of vinasse evaporator for a longer duration of 30-90 days without cleaning.

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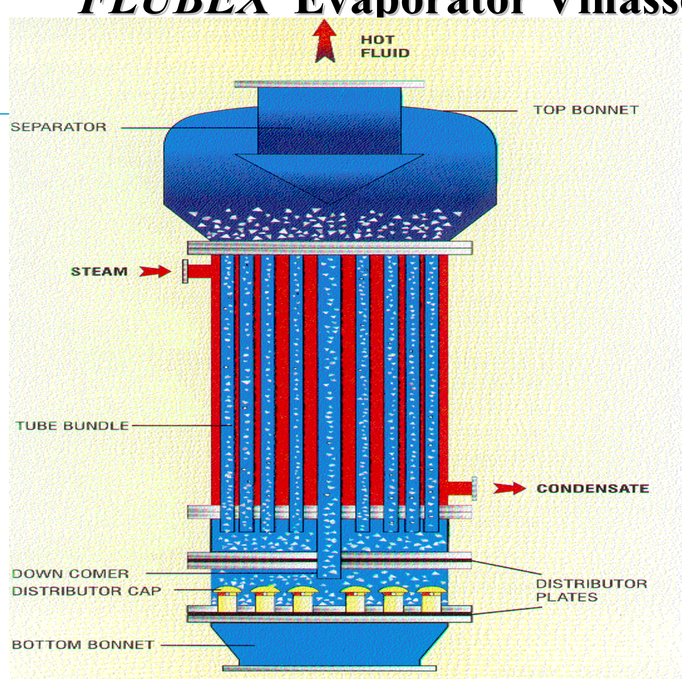
FLUBEX Evaporator Vinasse



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Integration of *FLUBEX* Evaporator with Distillation

- Evaporation of Mash before distillation to produce high wine
- Vinasse gets concentrated to 50 % solids
- Use of vapors from Rectifier column under high pressure to heat the evaporator
- Steam consumption of < 3.7 kg/lit (31 lb/gallon) of alcohol for evaporation + distillation
- System eliminates use of Mash column and thus avoids related problems of scaling.

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FLUBEX Mash/Vinasse Evaporator

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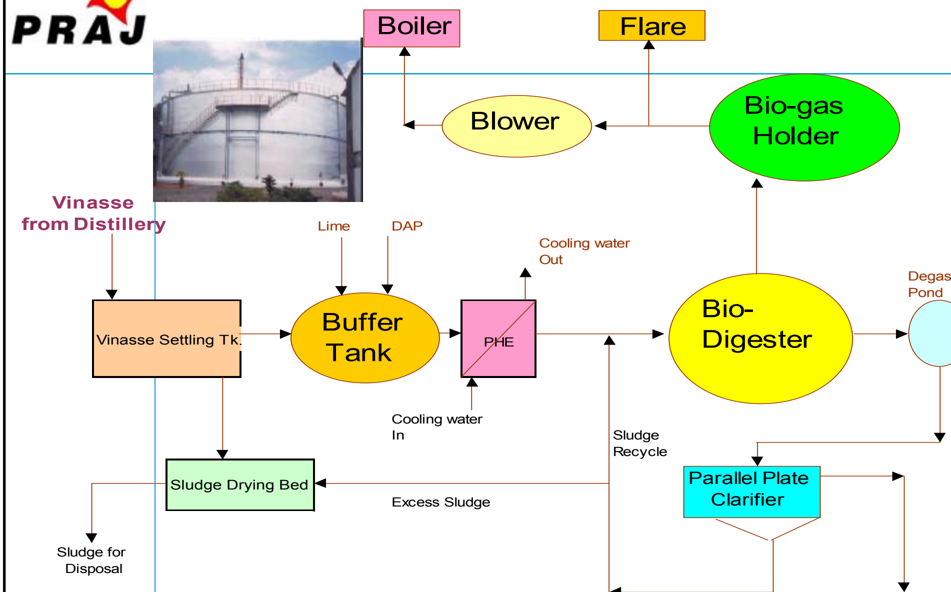
Bio-methanation of Vinasse



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Aerobic Open Wind-Row Bio-Composting of Vinasse

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Conclusions

- Appropriate technologies at affordable project investment are available for production of ethanol from cane molasses.
- Valuable energy and organic soil conditioner compost can be produced by treatment of vinasse.
- Variable cost of production will is between US Cents 75-95/gallon, depending upon factors like cost of molasses, technology used and the choice of vinasse treatment.

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PRAJ INDUSTRIES

Thanks Indeed !

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THE 'AINA INSTITUTE
FOR BIOCONVERSION TECHNOLOGY

- The 'Aina Institute is a 501 (C) (3) Non-Profit Organization
- Established in 1991
- **GOAL**
- Developing sustainable technology in food production and energy production.
  - Education ,
  - Research,
  - Demonstration ,
  - Technology Transfer
  - Development,

Activities include the application of bioconversion technologies to meet local needs for food, water and energy while maintaining or improving the quality of the environment.

This is a discussion about:

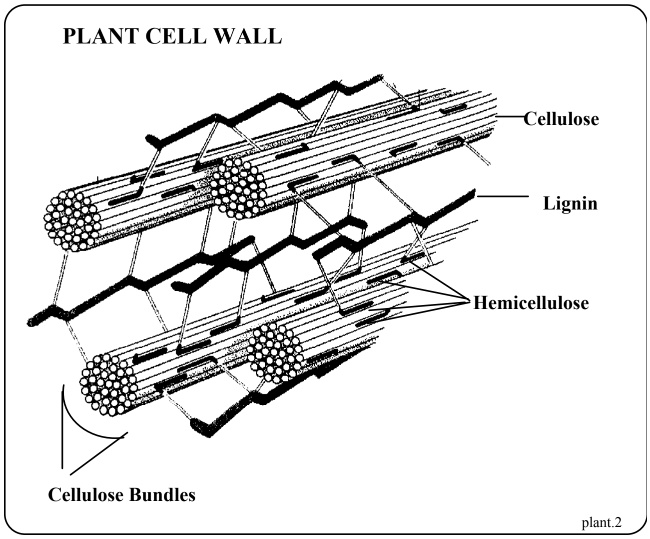
ETHANOL TECHNOLOGY

&

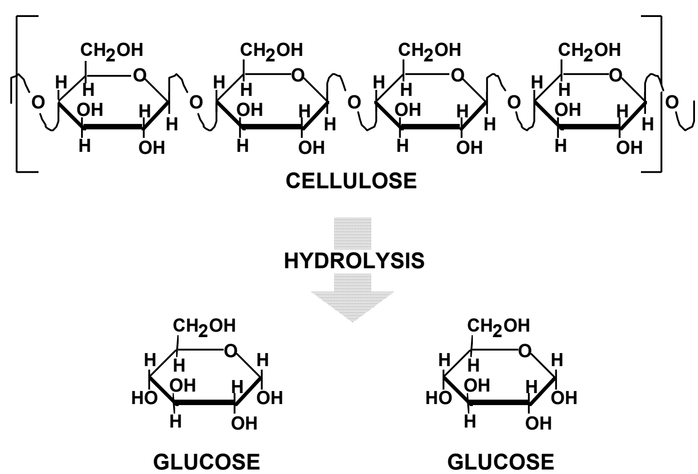
“Waste Our Most Sustainable Resource”

Wasting Waste is Wasteful !

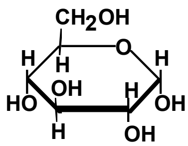
BIOMASS – ETHANOL BACKGROUND



BIOMASS – ETHANOL BACKGROUND

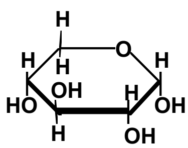


Sugar Fermentation



—fermentation→ $CH_3\ CH_2\ OH$ + CO_2
$CH_3\ CH_2\ OH$ + CO_2

(1) GLUCOSE —fermentation→ (2) ETHANOL + (2) CARBON DIOXIDE



—fermentation→ $CH_3\ CH_2\ OH$ + CO_2 + H_2O

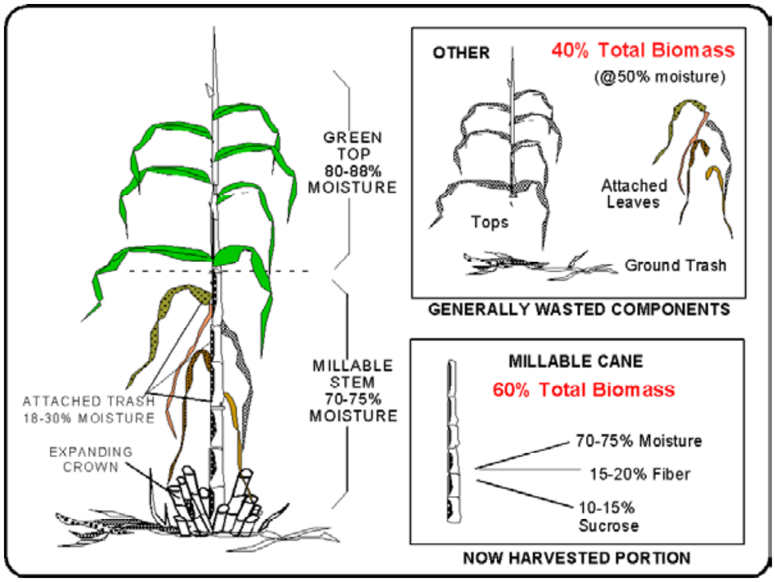
XYLOSE —fermentation→ ETHANOL + CARBON DIOXIDE + WATER

BIOMASS COMPOSITION

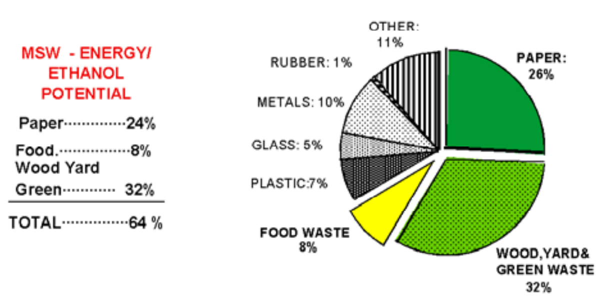
(% by dry-weight)

Biomass Source	Sugars	Cellulose	Hemicellulose	Lignin	Other
Bagasse	3	38	27	**20**	**12**
Sugarcane ("prepared" cane)	43	22	15	**11**	**9**
Sugarcane leaves	--	36	21	**16**	**27**
Sugarcane (whole plant)	33	25	17	**12**	**13**
Napier grass	--	32	20	**9**	**39**
Sweet sorghum	34	36	16	**10**	**3**
Eucalyptus grandis	--	38	13	**37**	**12**
Eucalyptus saligna	--	45	12	**25**	**18**
Leucaena leucocephala	--	43	14	**25**	**18**
Municipal Solid Waste	--	33	9	**17**	**41**
Newspaper	--	62	16	**21**	**1**

Sugar Crop Biomass



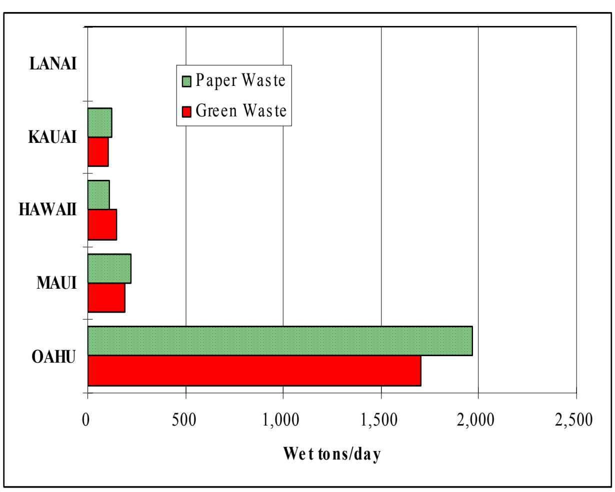
HAWAII MSW COMPOSITION



There are major opportunities to produce biomass from waste

- Producing Ethanol from sugar limits opportunities
- Producing Ethanol from corn seed alone limits opportunities
- Substantial research has focused on producing ethanol from biomass and wastes
  - **CO_2 loss in fermentation reduces yields**
  - **Enzyme cost and performance must be considered**.
- Process costs and reliability are still major issues

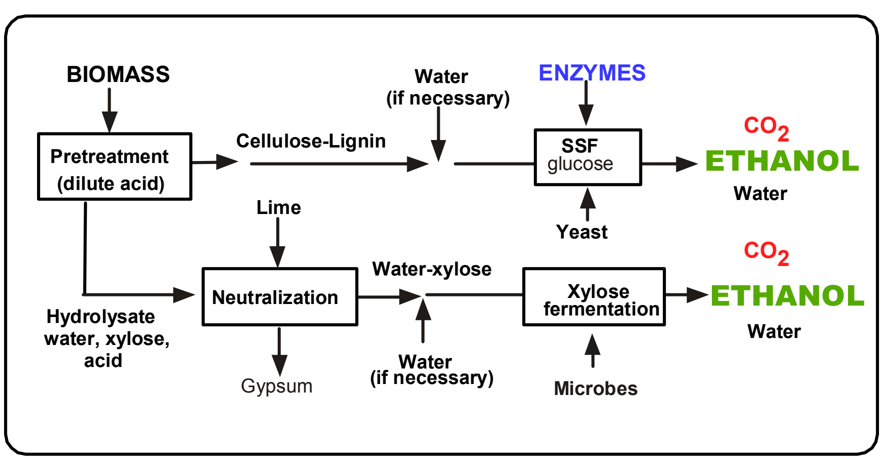
Hawaii Paper &Green Waste

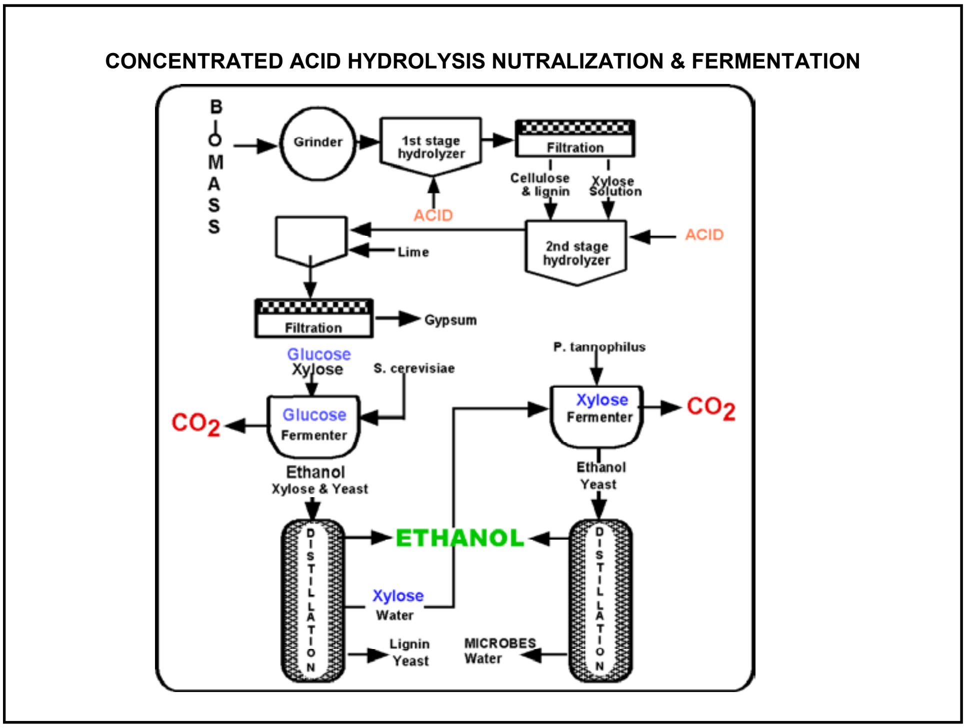


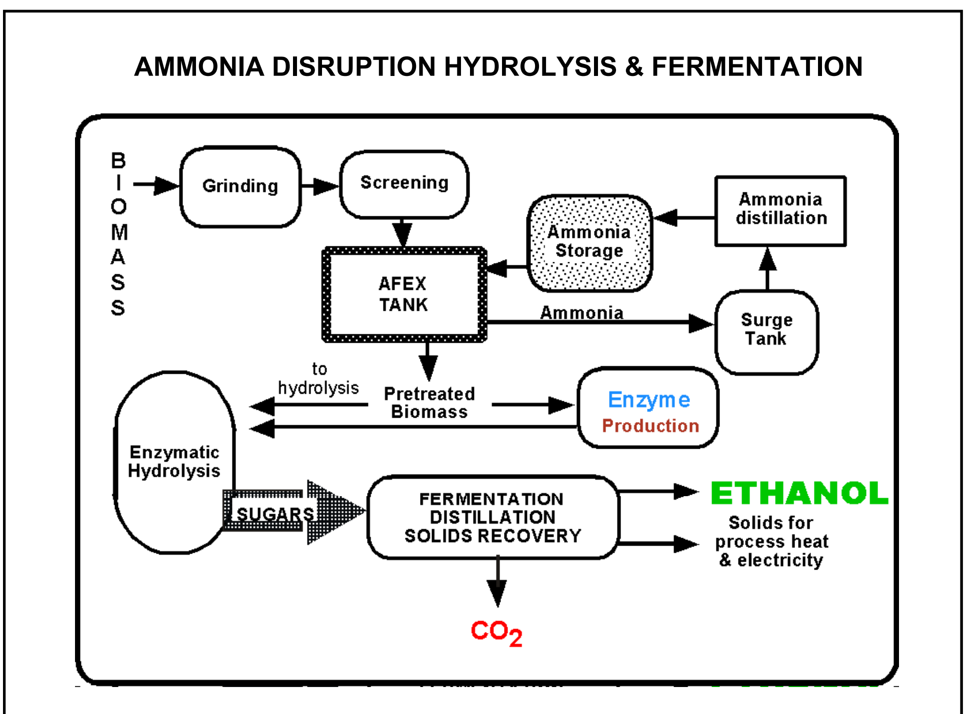
TECHNOLOGY REVIEW

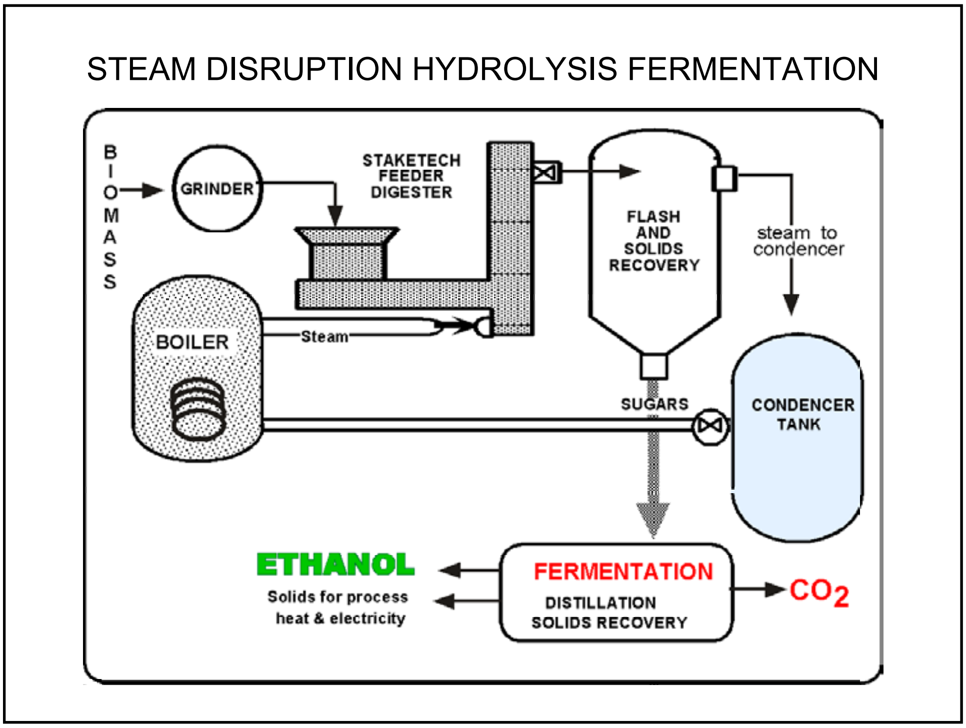
- A Brief Survey of Biomass-Ethanol Technologies
- A Look at Present and Future Opportunities

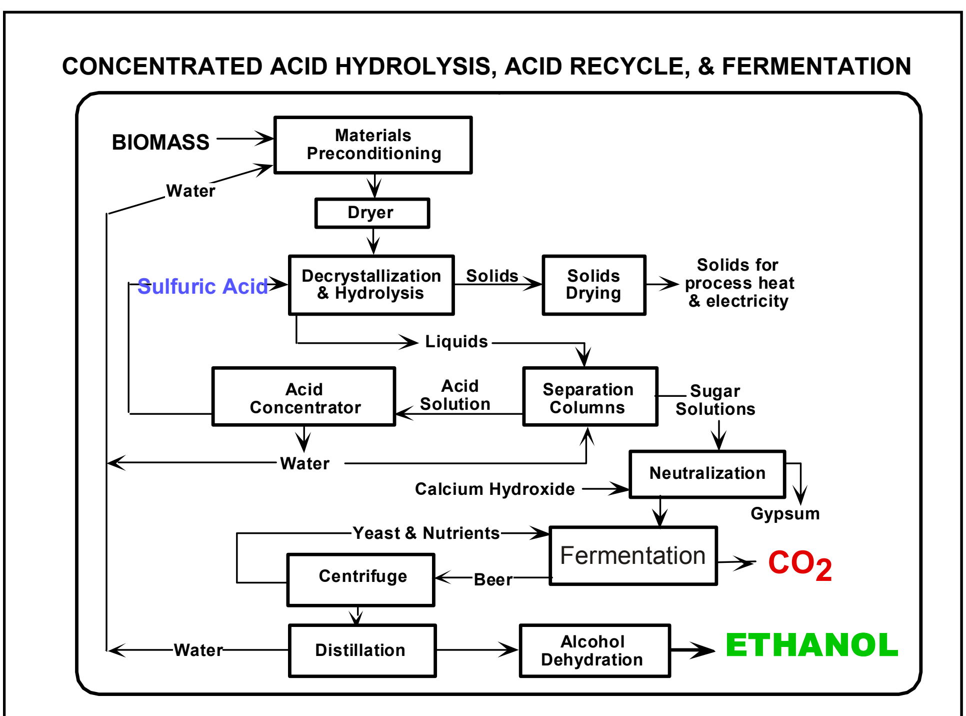
SIMULTANEOUS SACCHARIFICATION and FERMENTATION

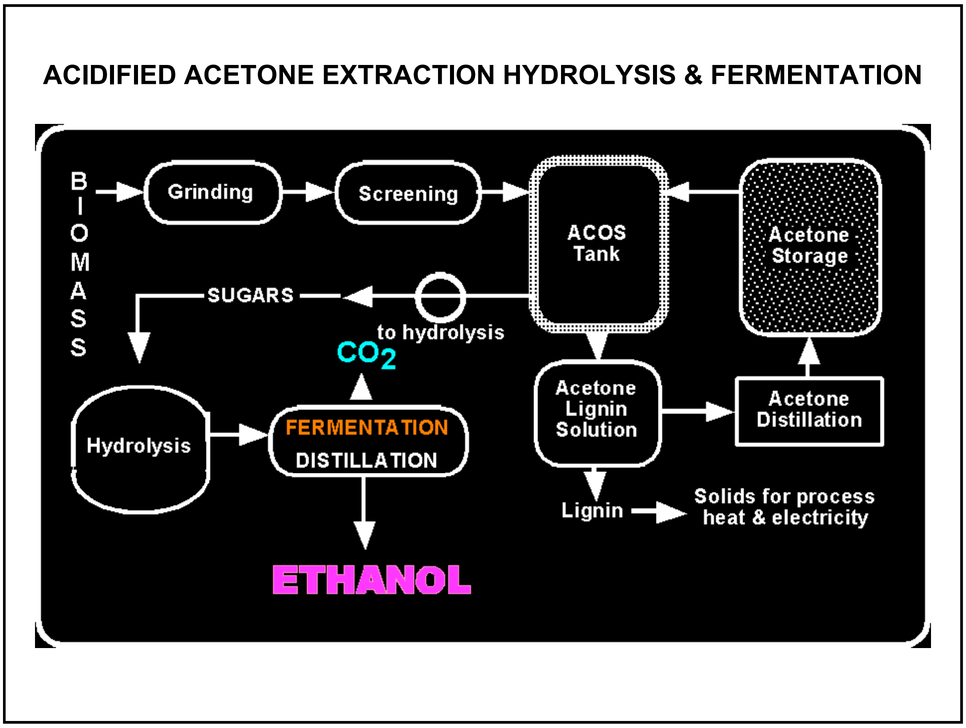


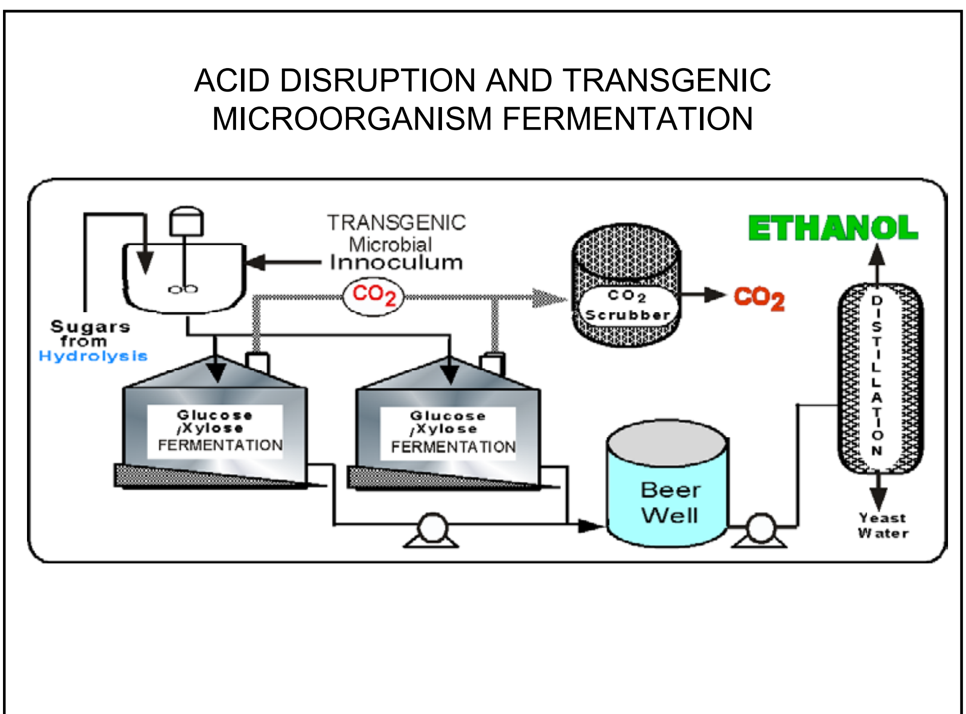

CONCENTRATED ACID HYDROLYSIS NUTRALIZATION & FERMENTATION
BIOMASS
Grinder
1st stage hydrolyzer
Filtration
Cellulose & lignin
Xylose Solution
ACID
Lime
2nd stage hydrolyzer
ACID
Filtration
Gypsum
Glucose
Xylose
S. cerevisiae
P. tannophilus
CO_2
Glucose Fermenter
Xylose Fermenter
CO_2
Ethanol
Xylose & Yeast
Ethanol
Yeast
DISTILLATION
ETHANOL
DISTILLATION
Xylose
Water
Lignin
Yeast
MICROBES
Water


AMMONIA DISRUPTION HYDROLYSIS & FERMENTATION
BIOMASS
Grinding
Screening
Ammonia Storage
Ammonia distillation
AFEX TANK
Ammonia
Surge Tank
to hydrolysis
Pretreated Biomass
Enzyme Production
Enzymatic Hydrolysis
SUGARS
FERMENTATION DISTILLATION SOLIDS RECOVERY
ETHANOL
Solids for process heat & electricity
CO_2

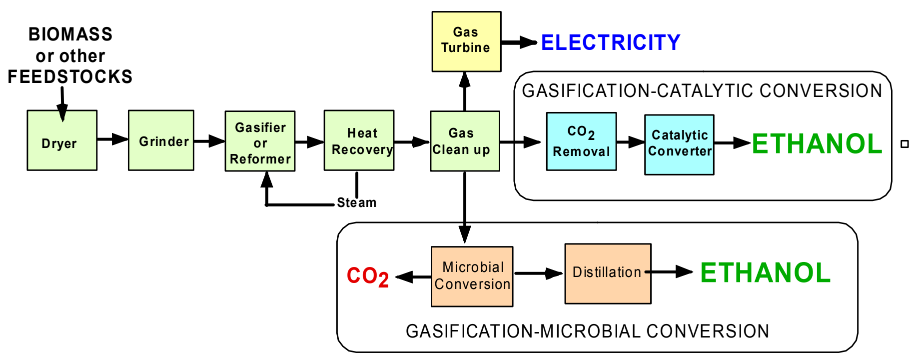

STEAM DISRUPTION HYDROLYSIS FERMENTATION
BIOMASS
GRINDER
STAKETECH FEEDER DIGESTER
FLASH AND SOLIDS RECOVERY
steam to condencer
BOILER
Steam
SUGARS
CONDENCER TANK
ETHANOL
Solids for process heat & electricity
FERMENTATION
DISTILLATION
SOLIDS RECOVERY
CO2


CONCENTRATED ACID HYDROLYSIS, ACID RECYCLE, & FERMENTATION
BIOMASS
Materials Preconditioning
Water
Dryer
Sulfuric Acid
Decrystallization & Hydrolysis
Solids
Solids Drying
Solids for process heat & electricity
Liquids
Acid Concentrator
Acid Solution
Separation Columns
Sugar Solutions
Water
Neutralization
Calcium Hydroxide
Gypsum
Yeast & Nutrients
Fermentation
CO2
Centrifuge
Beer
Water
Distillation
Alcohol Dehydration
ETHANOL


ACIDIFIED ACETONE EXTRACTION HYDROLYSIS & FERMENTATION
BIOMASS
Grinding
Screening
ACOS Tank
Acetone Storage
SUGARS
to hydrolysis
CO_2
Hydrolysis
FERMENTATION
DISTILLATION
Acetone Lignin Solution
Acetone Distillation
Lignin
Solids for process heat & electricity
ETHANOL


ACID DISRUPTION AND TRANSGENIC MICROORGANISM FERMENTATION
TRANSGENIC Microbial Innoculum
CO_2
CO_2 Scrubber
CO_2
ETHANOL
Sugars from Hydrolysis
Glucose /Xylose FERMENTATION
Glucose /Xylose FERMENTATION
Beer Well
DISTILLATION
Yeast Water

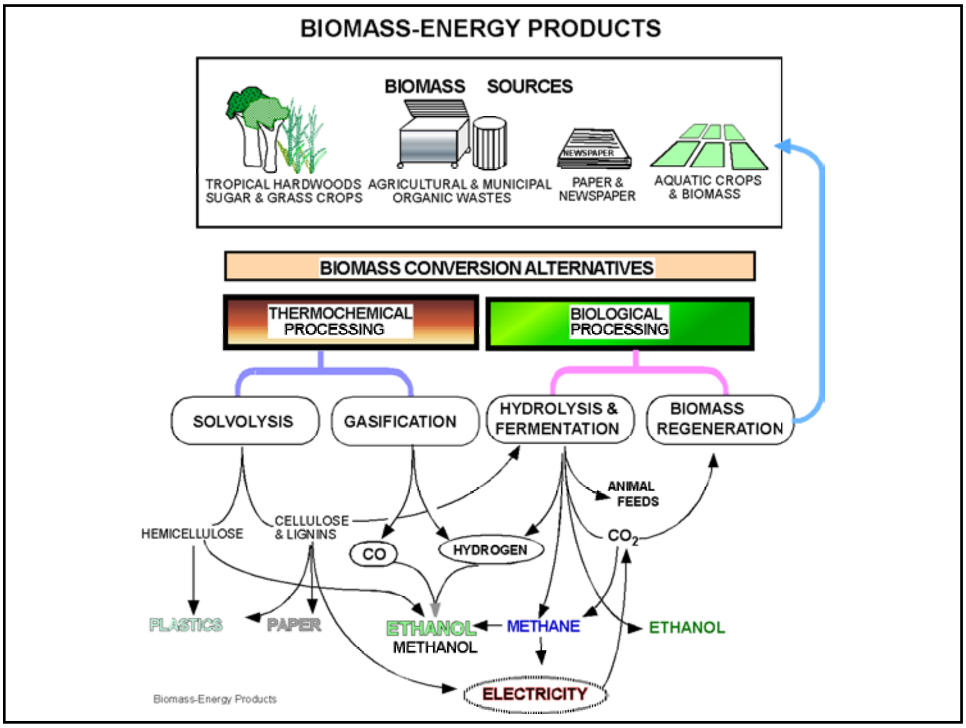
GASIFICATION - ETHANOL TECHNOLOGY

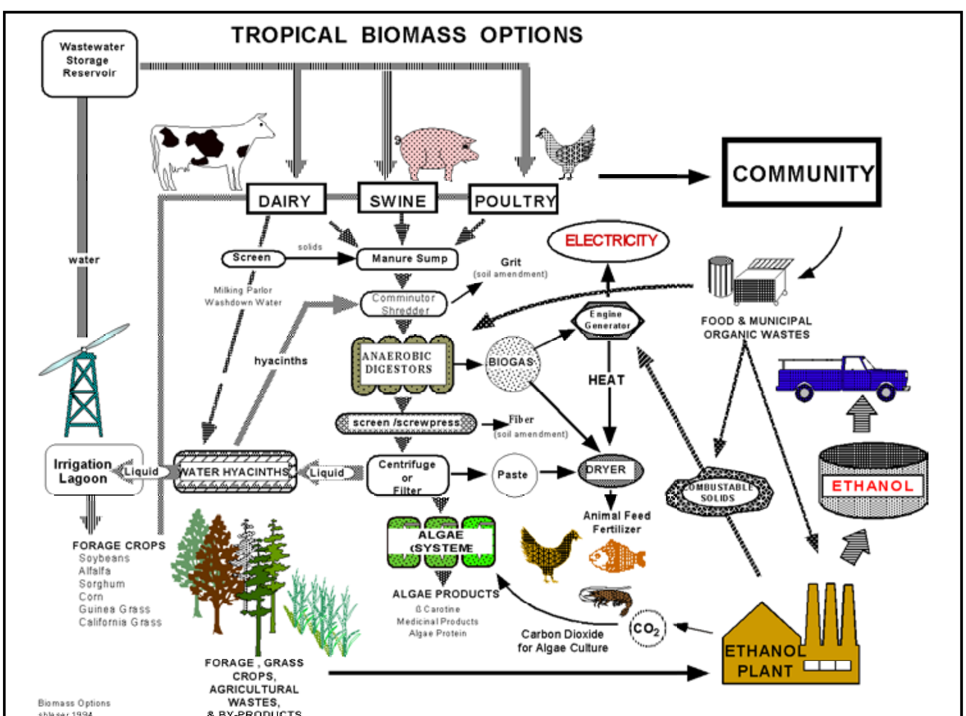


ETHANOL PROCESSES COMPARISONS

STATUS OF ETHANOL PRODUCTION TECHNOLOGY

METHOD	PRODUCTS	ADVANTAGES	DISADVANTAGES	COMMENTS	YIELD (gal./ dry ton)
Molasses > Fermentation> Ethanol	Ethanol , Carbon Dioxide, Concentrated Molasses solids	Simple traditional yeast fermentation method	Limited supply- Half sugar becomes carbon dioxide, residue is concentrated molasses solids / may have disposal problem	Depends on Molasses from sugar indstry Lack of efficiency, Only 50% of sugars converted to ethanol	70-80
Corn> Processing > **Fermentation** > Ethanol	Ethanol Distillers dried grains Carbon Dioxide	Good for corn industry	Not applicable to Hawaii at this time	Lack of efficiency, only 50% of sugars are converted to ethanol	110-120
Fiber treatment by acid, ammonia, steam, or solvents to release sugars that can be fermented to produce ethanol	Ethanol, Carbon Dioxide, Lignin (SSF-BCI)	Converts any fiber source including paper and yard waste to ethanol	Half sugar becomes carbon dioxide, residue may have disposal problem	Lack of efficiency, only 50% of sugars are converted to ethanol	50 - 90
Wood fiber and Carbon containing molecules>gasification> carbon monoxide>with **bioconversion>ethanol**	Ethanol ,Water microbes	Can use most carbon containing materials that can be gasified to produce carbon monoxide and hydrogen	Depends on performance of microorganisms concerns about stability -reliability of culture	Technologies are not yet demonstrated commercially	80-100
Wood fiber and Carbon containing molecules>gasification> carbon monoxide/ hydrogen> **catalytic conversion >ethanol**	Ethanol Butanol Propanol	Can use most carbon containing materials that can be gasified to produce carbon monoxide and hydrogen. Ethanol is produced as a gas	Sensitive to performance of catalyst	Technology not demonstrated commercially	180 +


BIOMASS-ENERGY PRODUCTS
BIOMASS SOURCES
TROPICAL HARDWOODS SUGAR & GRASS CROPS
AGRICULTURAL & MUNICIPAL ORGANIC WASTES
PAPER & NEWSPAPER
AQUATIC CROPS & BIOMASS
BIOMASS CONVERSION ALTERNATIVES
THERMOCHEMICAL PROCESSING
BIOLOGICAL PROCESSING
SOLVOLYSIS
GASIFICATION
HYDROLYSIS & FERMENTATION
BIOMASS REGENERATION
ANIMAL FEEDS
HEMICELLULOSE
CELLULOSE & LIGNINS
CO
HYDROGEN
CO_2
PLASTICS
PAPER
ETHANOL
METHANOL
METHANE
ETHANOL
ELECTRICITY
Biomass-Energy Products


TROPICAL BIOMASS OPTIONS
Wastewater Storage Reservoir
water
DAIRY
SWINE
POULTRY
COMMUNITY
ELECTRICITY
Screen
solids
Manure Sump
Grit (soil amendment)
Milking Parlor Washdown Water
Comminutor Shredder
Engine Generator
FOOD & MUNICIPAL ORGANIC WASTES
hyacinths
ANAEROBIC DIGESTORS
BIOGAS
HEAT
screen /screwpress
Fiber (soil amendment)
Irrigation Lagoon
Liquid
WATER HYACINTHS
Liquid
Centrifuge or Filter
Paste
DRYER
COMBUSTABLE SOLIDS
ETHANOL
Animal Feed Fertilizer
ALGAE SYSTEM
FORAGE CROPS
Soybeans
Alfalfa
Sorghum
Corn
Guinea Grass
California Grass
ALGAE PRODUCTS
ß Carotine
Medicinal Products
Algae Protein
Carbon Dioxide for Algae Culture
CO_2
ETHANOL PLANT
FORAGE, GRASS CROPS, AGRICULTURAL WASTES, & BY-PRODUCTS
Biomass Options shleser 1994

THE 'AINA INSTITUTE
FOR BIOCONVERSION TECHNOLOGY

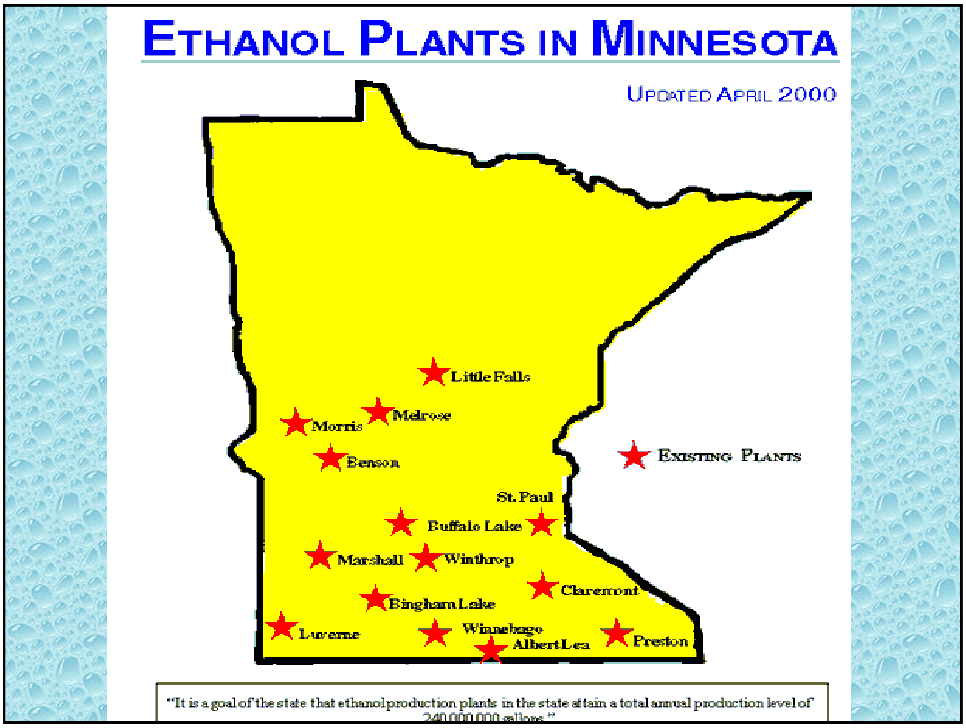
WASTING
WASTE
IS
WASTEFUL !

Delta-T

Unconventional solutions, unrivaled results.

Larry Johnson

- **25 years Production Agriculture.**
- **15 years Ethanol Consultant**
- **3 years Delta-T Corporation**
  Business Development Manager



FROM GROUND BREAKING TO FULL PRODUCTION IN 12 MONTHS.


Chippewa Valley Ethanol, Benson, Minnesota

ACE Ethanol

ACE Ethanol

WHAT'S DRIVING ETHANOL DEMAND?

- World energy demand and high crude oil prices
- The Clean Air Act Amendments of 1990
- Unprecedented U.S. gasoline demand
- The phase-out of MTBE from U.S. gasoline
- Continued demand for gasoline octane
- U.S. oil refineries are operating at capacity
- A general movement toward renewable energy

WHAT MISTAKES WERE MADE PREVIOUSLY BY ETHANOL PLANTS?

- Inadequate Technology
- Inefficient Plant Design
- Inaccessible Markets
- Under Capitalization
- Poor Management

Ethanol Plant Requirements

1. SITE QUALIFICATIONS
2. BUSINESS ECONOMICS
3. PROJECT FINANCING

1. Site Qualifications

- Rail
- Roads
- Water
- Boiler Fuel
- Electricity
- Permits
- Community Acceptance

2. Business Economics

- **Feedstocks**
- **Markets**
- **Costs and Efficiencies**
- **Livestock**

3. Project Financing

- **Grants**
- **In-Kind**
- **Investor Equity**
- **Debt Finance**

Intangibles

- **Leadership**
- **Timing**
- **Image**
- **Dedication and Hard Work**

In Summary...

THE OVERRIDING AND MOST IMPORTANT ISSUE IS,

PROFIT!

and...

The Most Important Profit Factor Is...

THE RELATIONSHIP BETWEEN THE FEEDSTOCK PRICE AND THE PRICE OF ETHANOL.

What Level Profitability??

- **Ethanol will Definitely Add Value!**
- **Energy up? Agriculture Down?**
- **Agriculture up? Energy Down?**

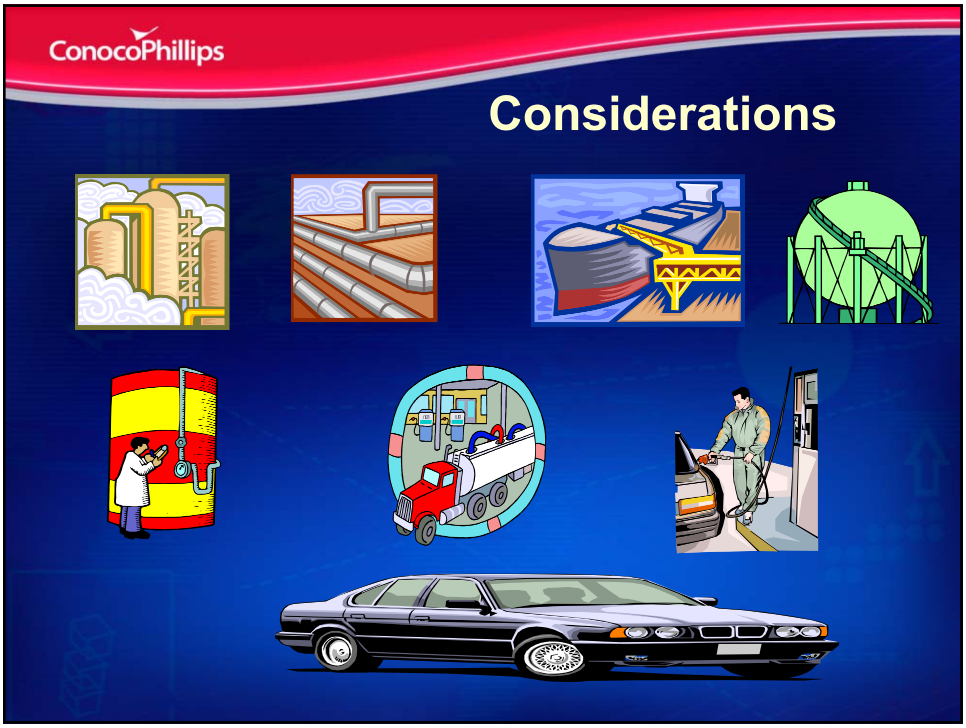
The Correct Decision Will Require Accurate Information, Good Planning, a Little Luck and Dedication...

Hawaii Specific Considerations

- Maintaining the Unique Island Character
- Enhancing and Diversifying State Economy
- Promoting Desirable Land Use
- Maintaining Clean Environment
- Providing a High Performance Fuel
- Considering Future Technology
- Insuring Energy Security
- Creating a Workable Public Policy Environment
- Serving the Hawaiian Citizens


ConocoPhillips
CALIFORNIA ETHANOL Project Overview
Ethanol Conversion
Barry Duffin


ConocoPhillips
Project Goals
• Eliminate MTBE in California Gasoline
• Introduce Ethanol through oxygenate blending at terminal load racks
• Maintain consistent supply and quality of California Gasoline at all retail outlets.



ConocoPhillips

Scope Description

- Project Planning and Management
- Refinery Blend Slate vs. Ethanol Specifications
- Refinery and Terminal MTBE Phase out and CARBOB Conversion
- Ethanol compatibility with Terminal and Retail equipment
- Terminal load rack preparation for ethanol blending
- Retail UST preparation for Ethanol Blended gasoline conversion
- Ethanol Supply, Logistics and Storage
- Quality Oversight of Ethanol Inventory and Blending

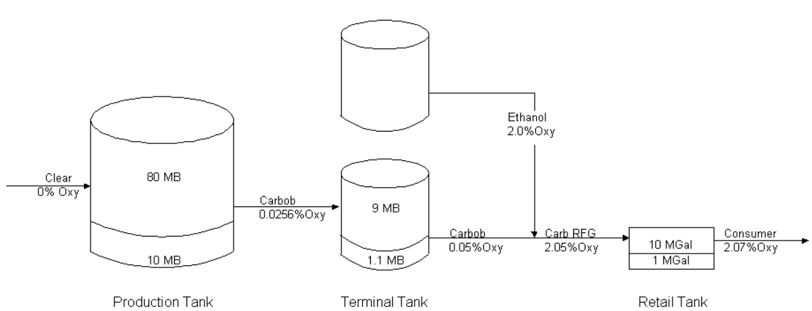
ConocoPhillips

Refinery and Terminal Preparation

- Refineries (2 Internal)
  - Blend Slate / RVP / Octane / Specifications
  - Ethanol Storage / Tank realignment
  - Blend certification
- Terminals (4 Internal)
  - Ethanol storage tank preparation
  - Ethanol receipt and shipping modes
  - Blending, load rack piping, blend meter calibration (VCFs)
  - Blending oversight (sequential vs. ratio)
  - Ethanol fire fighting foam

ConocoPhillips

Tank Transition Schematic - 2nd Blend Into Production Tank

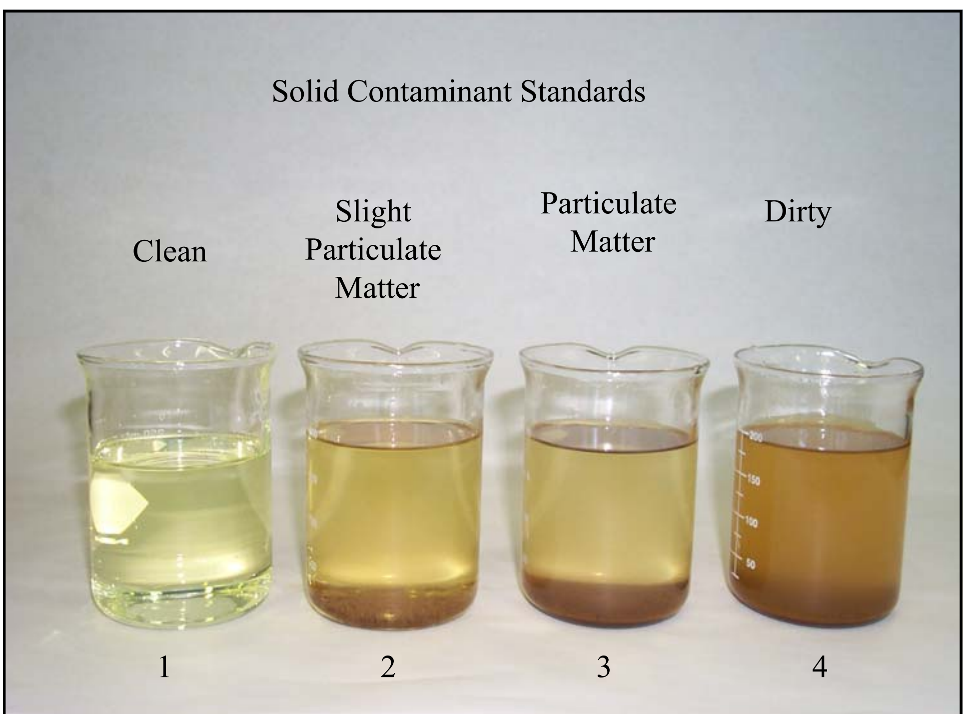


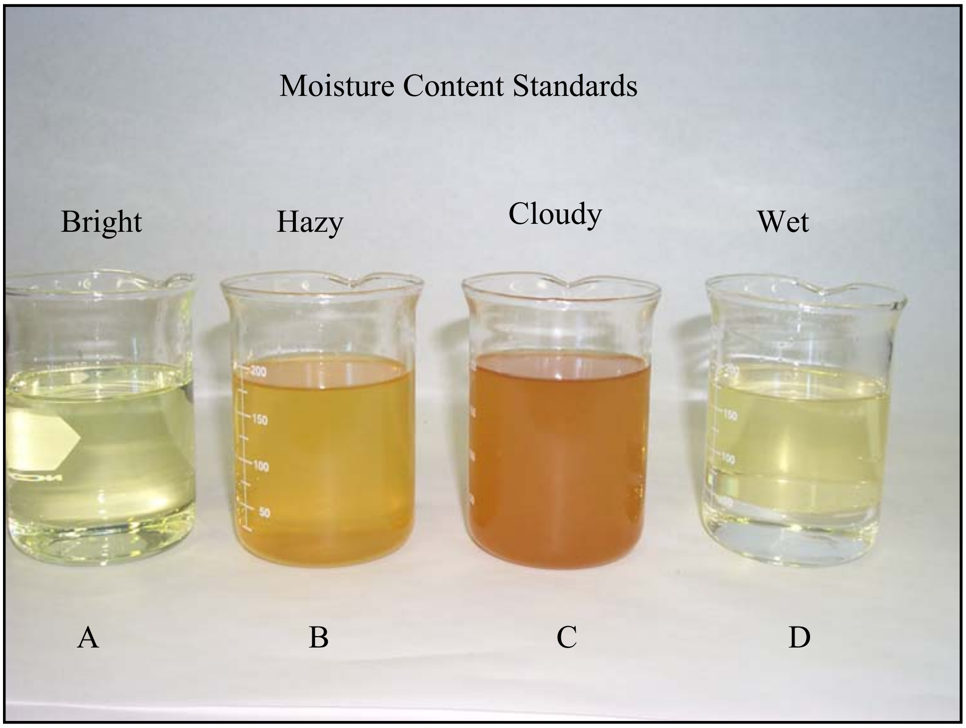
Notes:
1) % Oxy is Weight %
2) Production Tank Heel "Starts" at 0.23%
3) Terminal Tank Heel "Starts" at 0.25%
4) Retail Tank Heel "Starts" at 2.24%

ConocoPhillips

Retail Preparation

- Resources
  - 4 Managers
  - Special Training
  - Special Procedures
  - 5 Contractors
  - 120 Days
- 3000 USTs
  - 2600+ Inspected
  - 185 Cleaned (7%)
- Compatibility
  - Filters,
  - Pumps
  - Labels
  - Ethanol Water Paste




Moisture Content Standards
Bright
Hazy
Cloudy
Wet
A
B
C
D


E
Surfactants

ConocoPhillips

Ethanol Supply Issues

- Lack of consistent Volumetric Measurement
- Inconsistent Quality Certifications
  - Test results seldom include all ASTM D-4806 requirements
  - Product Identification and Traceability needs improvement

ConocoPhillips

Specification

Denatured Fuel Ethanol (1)

Basic Requirements

On each occasion that Ethanol is supplied, the following shall apply:

Suppliers shall provide a Certificate of Conformance identifying the test results which show that the denatured ethanol complies with ASTM D4806 and the specifications below.

The only denaturants shall be natural gasoline, gasoline components, or unleaded gasoline.

Specification Requirements

Specification	**Test Method**	**Value**		**Notes**
		Min	**Max**	
Fuel Ethanol	ASTM D5501	95.0		(6)
Neat Ethanol Vol%	ASTM D5501	92.1		(7)
Methanol Vol%			0.5	
Denaturant Content, vol.%,		1.96	4.76	
Existent Gum, mg/100ml	ASTM D-381		5.0	
Water Content, vol%	ASTM E203 or E1064		1.0	
Inorganic Chloride Content, ppm, (mg/L)	ASTM D512, Proc. C (modified)		40 (32)	(4)
Copper Content, mg/kg	ASTM D1688, Proc. D (modified)		0.1	(4)
Acidity (as acetic acid), wt%, (mg/L)	ASTM D1613		0.007 (56)	(5)
Phe	ASTM D 6423	6.5	9.0	
Appearance	ASTM D4806	C&B		(2)
Sulfur	ASTM D2622	Report		
Corrosion Inhibitor XXX	XXX	20	40	(3)
Reid Vapor Pressure Psi	ASTM D5191		4.5	
Nace Rust	TM-01-73	Report		

ConocoPhillips

Lessons Learned

- Have a Tactical Implementation Plan
  - Monitor progress on a scheduled basis
- Volumetric measurement of ethanol should be performed using API Table 6C in place of Table 6B
- Require inspection and removal of any water bottoms from third party terminal tanks
- Inspect as many Retail outlet USTs as possible
- Train retail operators on proper housekeeping
- Plug overfill drains at retail outlets


Ethanol
Michael W. Allen, Presenter
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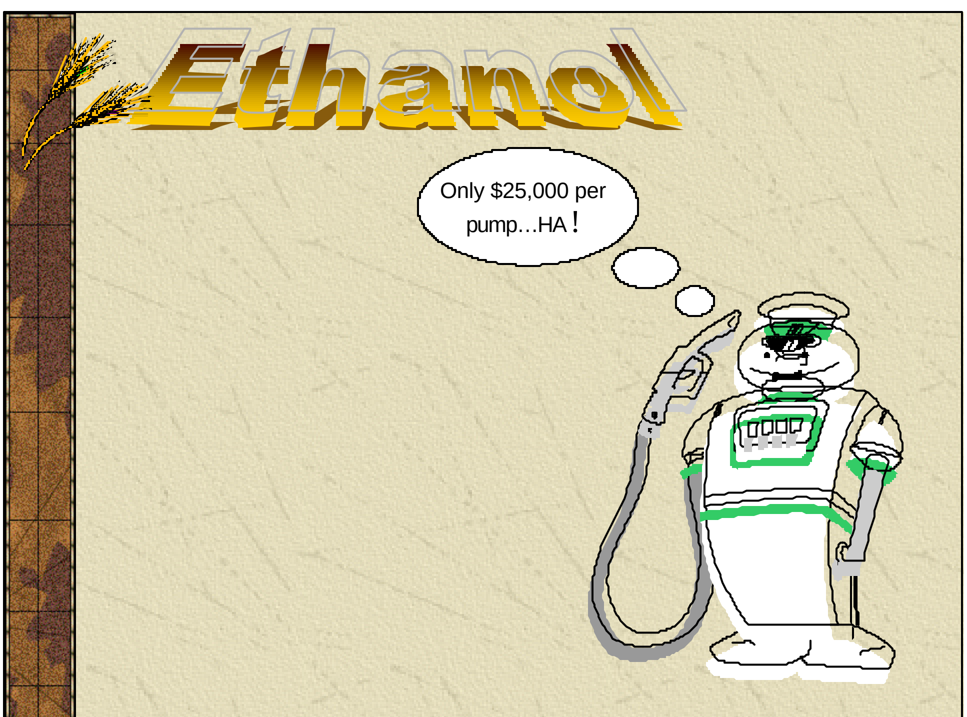
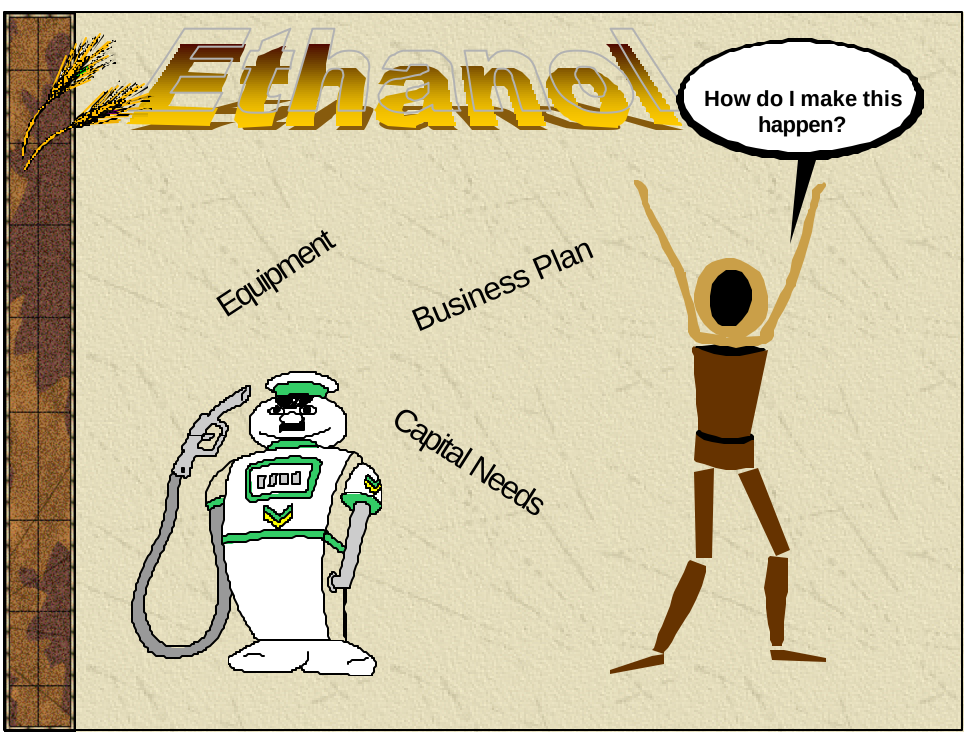
Mikea@AllenOilCompany.com


Ethanol
Only $25,000 per pump…HA!


Ethanol
I Like this stuff!!!
Ethanol…
◆Made from grain
◆Clean burning
◆Benefits local farmer
◆Competitive Priced


Ethanol
Yellowstone National Park
I LIKE IT!
Information provided by Howard Haines , State of Montana, Department of Environmental Quality
☞ E-10 Blends Reduces CO Emissions by 11-25% Over Traditional Gasoline
☞ E-10 Blends Reduces Hydro-carbon Emissions by 36% Over Traditional Gasoline.
☞ E-10 Blends Reduce Particulate Matter Over Traditional Gasoline by 25%.


Ethanol
•Good for the environment
•Good for the agricultural community
•Good for my customer….
•Good for my business

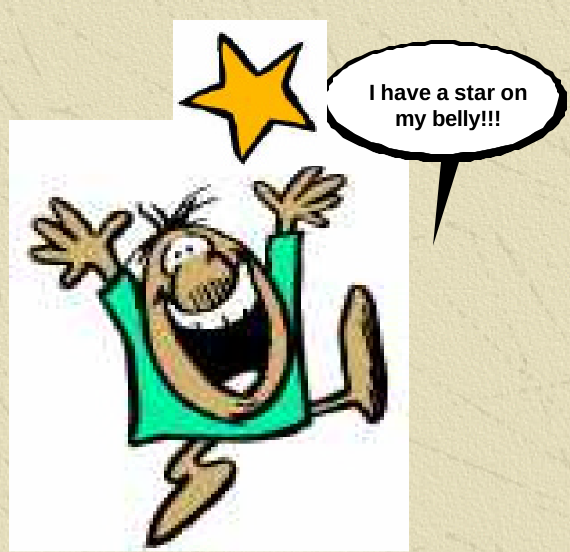

Ethanol
How do I make this happen?
Equipment
Business Plan
Capital Needs

Ethanol

Gasoline Spill = 

Ethanol Spill = 

Ethanol



Ethanol

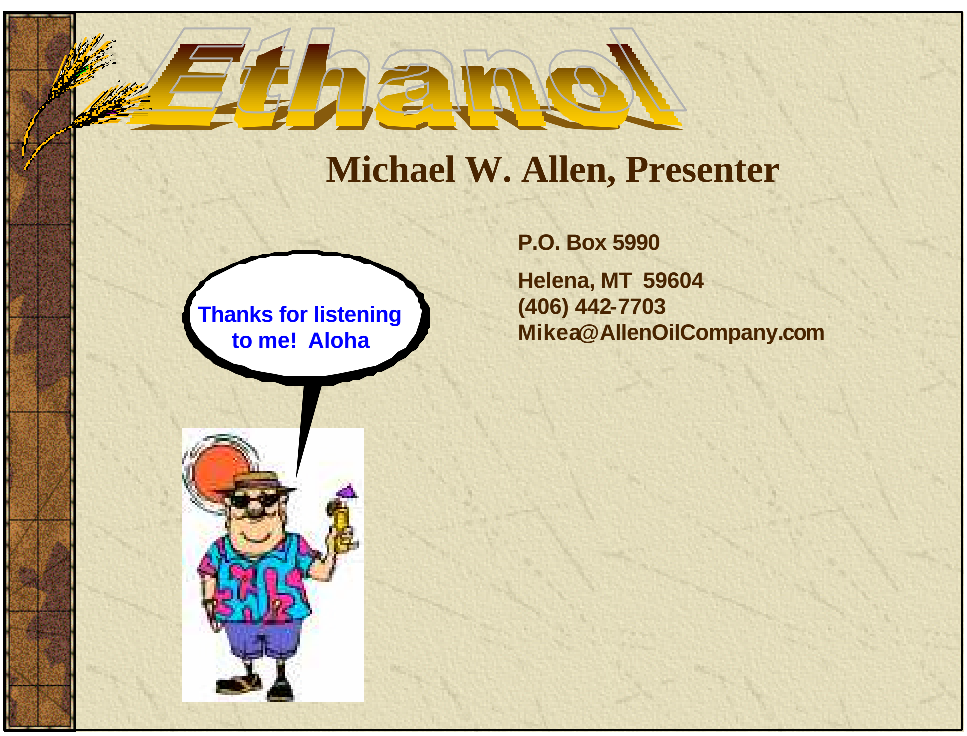
Yellow Dime Promotion

Ethanol

PROMOTION…PROMOTION!

- Yellow Dime Give-A-Ways
- Join one of the non-profit trade associations (EPAC, ACE, RFA)
- Flyers and brochures on your store counters
- Local News
- WORD OF MOUTH!!!
- Educate your employees…they must be informed.


Ethanol
It will work!!!


Ethanol
Michael W. Allen, Presenter
P.O. Box 5990
Helena, MT 59604
(406) 442-7703
Mikea@AllenOilCompany.com
Thanks for listening to me! Aloha


Ethanol
Come On, Son….let’s go swimming!

Delta-T

Unconventional solutions, unrivaled results.

Larry Johnson

Delta-T 25 years Production Ag.

15 years Ethanol Consultant

3 years Delta-T Corporation

Holiday Label

Super America Label

PDQ Label

Why Ethanol – The Discussion Agenda and History

Initially Politically Driven – Today also Market Driven

➢ **Agriculture – Historic**	**1900s and 1930s**
➢ **Energy – Iranian Revolution**	**1979**
➢ **Octane – CAA Lead Phase-out**	**1985**
➢ **Energy – Gulf War**	**1991**
➢ **Air Quality – CAAA Oxy and RFG**	**1992**
➢ **Refinery Demand – At Capacity**	**2000**
➢ **Renewable Energy – All of the Above**	**TODAY**

Mechanical and Performance Issues

- Octane
- Volatility
- Distillation
- Deposits
- Materials Compatibility
- Enleanment
- Mileage
- Phase Separation

Standard Corrected Data for 29.92 inches Hg. 60 F dry air Test# 13

Test: 300 RPM/Sec Acceleration Fuel Spec. Grav.: .716 Air Sensor: 9.C
Vapor Pressure: .19 Barometric Pres.: 27.34 Ratio: 1.00 TO
Engine Type: 4-Cycle Spark Engine displacement: 355.0 Stroke: 3.480

RPM	CBT Lb-Ft	CBHP	FHP	VE%	ME%	FA+FB Lb/Hr	A1 scfm	A/F	BSFC	CAT F	OIL Out	WAT Out	BS
4100	399.4	311.8	53.9	94.1	83.7	142.0	358.3	11.6	.51	62	143	167	5.
4200	399.5	319.5	56.3	93.3	83.5	143.7	364.8	11.7	.51	61	143	167	5.
4300	408.2	334.2	58.7	93.9	83.5	146.3	376.0	11.8	.49	61	143	167	5.
4400	414.2	347.0	61.2	94.7	83.5	150.3	387.9	11.9	.49	61	144	167	5.
4500	421.4	361.1	63.6	96.7	83.5	153.4	404.8	12.1	.48	61	144	167	5.
4600	428.0	374.9	66.1	98.1	83.5	156.4	420.1	12.3	.47	61	144	167	5.
4700	430.8	385.5	68.6	99.3	83.3	159.5	434.7	12.5	.46	61	144	167	5.
4800	434.1	396.7	71.2	100.4	83.2	166.4	450.2	12.4	.47	59	144	166	5.
4900	436.1	406.9	73.9	101.5	83.1	173.8	464.4	12.3	.48	59	145	166	5.
5000	437.2	416.2	76.5	101.8	82.9	176.1	474.2	12.4	.48	60	145	166	5.
5100	439.7	427.0	79.2	103.0	82.7	183.9	488.6	12.2	.48	61	145	166	5.
5200	439.7	435.3	82.1	103.4	82.5	185.0	499.4	12.4	.48	62	145	166	5.
5300	438.1	442.1	84.9	103.4	82.2	190.2	508.2	12.3	.49	63	145	166	5
5400	435.6	447.9	87.7	103.4	81.9	192.9	517.7	12.3	.49	63	146	167	5.
5500	431.4	451.8	90.7	102.7	81.5	197.4	523.3	12.2	.49	63	146	167	6
5600	427.8	456.1	93.6	102.0	81.2	201.3	529.2	12.1	.50	63	146	167	6
5700	426.3	462.7	96.7	102.2	80.9	204.5	539.8	12.1	.50	63	146	168	6
5800	422.6	466.7	99.7	102.9	80.5	206.7	553.1	12.3	.50	63	146	168	6
5900	421.7	473.7	102.8	103.4	80.3	209.6	565.6	12.4	.50	63	147	168	6
6000	415.7	474.9	106.0	103.3	79.9	208.3	575.8	12.7	.50	62	147	168	6
6100	411.0	477.4	109.6	103.2	79.4	208.1	584.7	12.9	.49	62	147	168	6
6200	405.3	478.5	113.7	102.9	78.8	207.8	593.7	13.1	.49	61	147	168	6
6300	402.3	482.6	117.7	102.5	78.4	211.3	601.2	13.1	.50	61	147	168	6
6400	397.7	484.6	121.9	102.3	77.8	215.8	609.5	13.0	.50	61	148	169	6
6500	393.6	487.1	126.0	102.2	77.3	216.3	618.3	13.1	.50	61	148	169	6
6600	388.3	488.0	130.3	101.8	76.8	216.9	624.9	13.2	.50	61	149	169	6
6700	379.9	484.6	134.6	100.9	76.0	223.2	629.0	12.9	.52	61	149	169	6
6800	372.5	482.3	139.1	99.9	75.3	235.6	632.3	12.3	.56	61	149	169	6
6900	365.6	480.3	143.5	99.1	74.6	242.0	635.0	12.0	.57	62	149	169	6
7000	362.7	483.4	148.9	98.3	74.0	247.4	639.1	11.9	.58	62	150	169	6

100% 110 oct. RACE fuel

Standard Corrected Data for 29.92 inches Hg. 60 F dry air Test# 11

Test: 300 RPM/Sec Acceleration Fuel Spec. Grav.: .736 Air Sensor: 9.(
Vapor Pressure: .19 Barometric Pres.: 27.35 Ratio: 1.00 TO
Engine Type: 4-Cycle Spark Engine displacement: 355.0 Stroke: 3.480

RPM	CBT Lb-Ft	CBHP	FHP	VE%	ME%	FA+FB Lb/Hr	A1 scfm	A/F	BSFC	CAT F	OIL Out	WAT Out	BS
4000	418.9	319.0	51.6	97.1	84.6	148.1	360.8	11.2	.52	62	184	164	5.
4100	411.8	321.5	53.9	94.9	84.1	147.5	361.5	11.3	.52	62	184	164	5.
4200	410.3	328.1	56.3	93.9	83.8	143.2	365.7	11.7	.49	63	184	164	5.
4300	420.4	344.2	58.7	94.7	83.9	121.9	377.5	14.2	.40	63	184	163	5.
4400	425.4	356.4	61.2	95.5	83.8	105.4	389.6	17.0	.33	63	183	163	5.
4500	432.8	370.8	63.6	96.7	83.8	112.6	403.6	16.5	.34	63	183	164	5.
4600	437.2	382.9	66.1	97.8	83.7	125.3	417.5	15.3	.37	63	183	164	5.
4700	443.4	396.8	68.6	99.9	83.7	127.9	435.9	15.6	.36	62	183	164	5.
4800	445.2	406.9	71.2	101.0	83.6	137.6	450.3	15.0	.38	62	183	164	5.
4900	446.6	416.7	73.9	101.2	83.4	140.6	460.7	15.0	.38	62	183	164	5.
5000	451.1	429.5	76.5	102.9	83.3	161.5	477.9	13.6	.42	62	183	164	5.
5100	452.0	438.9	79.2	103.5	83.1	197.6	490.3	11.4	.51	62	183	165	5.
5200	450.2	445.7	82.1	103.5	82.8	198.1	500.0	11.6	.50	62	183	165	5.
5300	449.0	453.1	84.9	103.7	82.6	173.4	510.1	13.5	.43	62	182	165	5.
5400	447.8	460.4	87.7	103.7	82.3	171.8	519.5	13.9	.42	63	183	166	5.
5500	444.4	465.4	90.7	103.1	82.0	170.5	526.0	14.2	.41	63	183	164	5.
5600	441.3	470.5	93.6	102.8	81.7	167.0	533.3	14.7	.40	63	183	165	5.
5700	438.5	475.9	96.7	102.8	81.4	165.9	543.7	15.0	.39	62	183	165	5.
5800	434.0	479.3	99.7	103.1	81.0	165.2	555.0	15.4	.39	62	183	165	6.
5900	431.5	484.7	102.8	103.2	80.7	166.6	565.6	15.6	.39	62	183	165	6.
6000	430.7	492.0	106.0	103.0	80.4	165.9	573.7	15.9	.38	62	184	166	6.
6100	425.6	494.3	109.6	103.1	80.0	161.0	585.6	16.7	.37	60	184	166	6.
6200	419.2	494.9	113.7	102.9	79.4	157.0	595.5	17.4	.36	59	184	166	6.
6300	413.9	496.5	117.7	102.5	78.9	149.5	601.5	18.5	.34	60	184	166	6
6400	411.7	501.7	121.9	103.2	78.4	148.7	615.0	19.0	.34	61	184	167	6.
6500	407.7	504.6	126.0	102.5	77.9	153.2	619.2	18.6	.34	62	184	167	6
6600	402.8	506.2	130.3	102.0	77.4	164.7	625.2	17.4	.37	62	184	167	6
6700	396.5	505.8	134.6	101.3	76.8	115.5	630.6	25.1	.26	62	184	167	6
6800	387.8	502.1	139.1	100.6	76.1	112.7	636.5	25.9	.25	61	184	168	6
6900	381.7	501.5	143.5	99.7	75.5	114.2	641.0	25.8	.26	60	184	168	6
7000	375.9	501.0	148.9	99.4	74.7	79.1	648.0	37.6	.18	61	184	168	6

20% ETHANOl
80% 110 OCT. RACE fuel

Standard Corrected Data for 29.92 inches Hg. 60 F dry air Test# 29

Test: 300 RPM/Sec Acceleration Fuel Spec. Grav.: .793 Air Sensor: 9.0
Vapor Pressure: .20 Barometric Pres.: 27.74 Ratio: 1.00 TO 1
Engine Type: 4-Cycle Spark Engine displacement: 357.0 Stroke: 3.480

RPM	CBT Lb-Ft	CBHP	FHP	VE%	ME%	FA+FB Lb/Hr	A1 scfm	A/F	BSFC	CAT F	OIL Out	WAT Out	BSAC
4600	436.2	382.0	66.5	95.8	83.8	242.2	413.5	7.8	.71	67	158	164	5.53
4700	437.1	391.2	69.0	95.2	83.6	242.9	419.5	7.9	.69	67	158	165	5.48
4800	439.9	402.0	71.7	95.8	83.5	246.8	431.6	8.0	.68	67	158	165	5.48
4900	445.6	415.7	74.3	96.0	83.4	245.8	441.2	8.2	.66	67	158	166	5.42
5000	448.2	426.7	77.0	97.0	83.3	247.6	454.8	8.4	.65	67	158	166	5.44
5100	447.2	434.3	79.7	97.2	83.0	252.8	465.2	8.5	.65	67	159	166	5.47
5200	447.8	443.4	82.5	98.0	82.8	261.8	478.1	8.4	.66	67	159	166	5.51
5300	448.7	452.8	85.4	98.5	82.6	269.9	489.6	8.3	.66	67	160	167	5.53
5400	448.1	460.7	88.2	98.6	82.4	272.5	499.1	8.4	.66	67	160	167	5.54
5500	449.3	470.5	91.2	99.3	82.2	280.3	512.3	8.4	.66	67	160	167	5.57
5600	448.3	478.0	94.2	99.0	82.0	283.9	520.2	8.4	.66	67	160	167	5.57
5700	450.3	488.7	97.2	100.0	81.8	291.9	534.4	8.4	.67	67	160	167	5.60
5800	445.0	491.4	100.3	99.6	81.5	293.5	541.5	8.5	.67	67	160	167	5.64
5900	446.0	501.0	103.4	100.3	81.3	304.9	555.3	8.4	.68	67	160	167	5.68
6000	444.5	507.8	106.6	100.9	81.0	321.4	567.4	8.1	.71	67	160	167	5.72
6100	441.7	513.0	110.2	100.9	80.7	328.8	577.3	8.1	.72	67	160	167	5.77
6200	440.0	519.4	114.3	100.7	80.3	331.7	585.5	8.1	.71	67	160	167	5.78
6300	437.6	524.9	118.4	100.9	79.9	338.8	596.3	8.1	.72	67	160	167	5.83
6400	433.7	528.5	122.5	100.0	79.4	330.6	600.4	8.3	.70	67	160	167	5.83
6500	429.6	531.7	126.7	99.3	78.9	345.8	605.7	8.0	.73	67	161	167	5.85
6600	427.1	536.7	131.1	99.0	78.5	359.1	611.4	7.8	.75	68	161	167	5.86
6700	421.3	537.5	135.4	98.2	78.0	360.3	614.3	7.8	.75	69	161	167	5.89
6800	416.4	539.1	139.8	97.8	77.4	354.4	620.8	8.0	.74	69	161	167	5.94
6900	409.8	538.4	144.4	97.1	76.8	353.5	625.7	8.1	.74	69	161	167	6.00
7000	406.1	541.3	149.7	96.9	76.3	357.7	633.4	8.1	.74	69	161	168	6.05
7100	398.9	539.3	155.2	96.4	75.5	358.6	639.9	8.2	.75	68	161	168	6.13
7200	390.4	535.2	160.8	95.7	74.7	362.7	646.5	8.2	.76	67	161	168	6.24
7300	385.2	535.4	166.5	95.3	74.0	382.0	650.7	7.8	.81	68	161	169	6.29
7400	380.4	536.0	172.3	94.7	73.4	390.4	656.1	7.7	.82	68	161	169	6.35
7500	373.9	533.9	178.2	94.2	72.6	399.3	660.7	7.6	.85	68	161	169	6.42

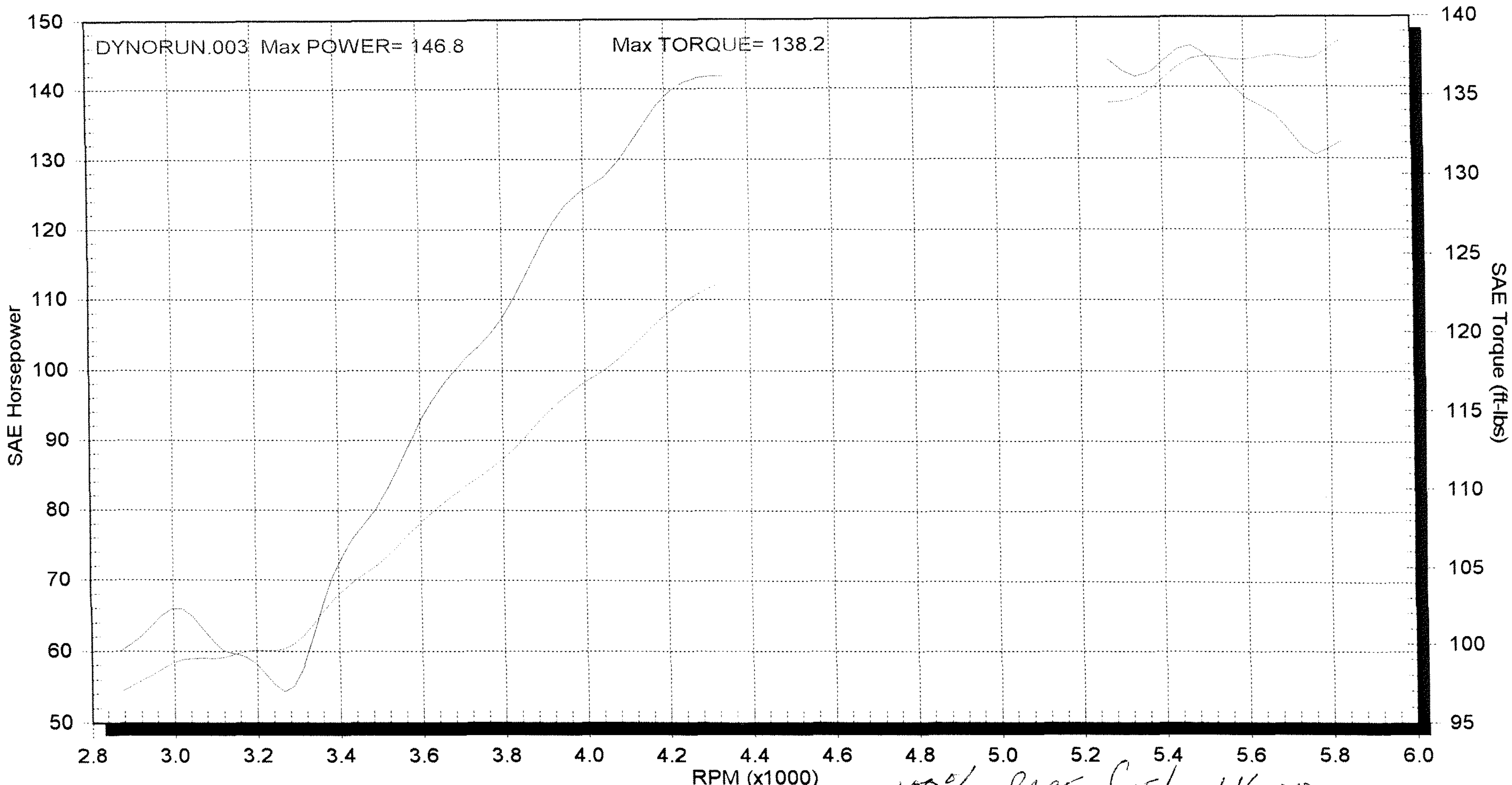
97
40°
2" open
1.6 Ex. Rocker

100% ETHANOL

WinPEP **DYNOJET Performance Evaluation Program**

DYNORUN.003 BASELINERO 11/7/02 6:09:20 PM

CYCLE NUTS & BOLTS HARLEY- DAVIDSON



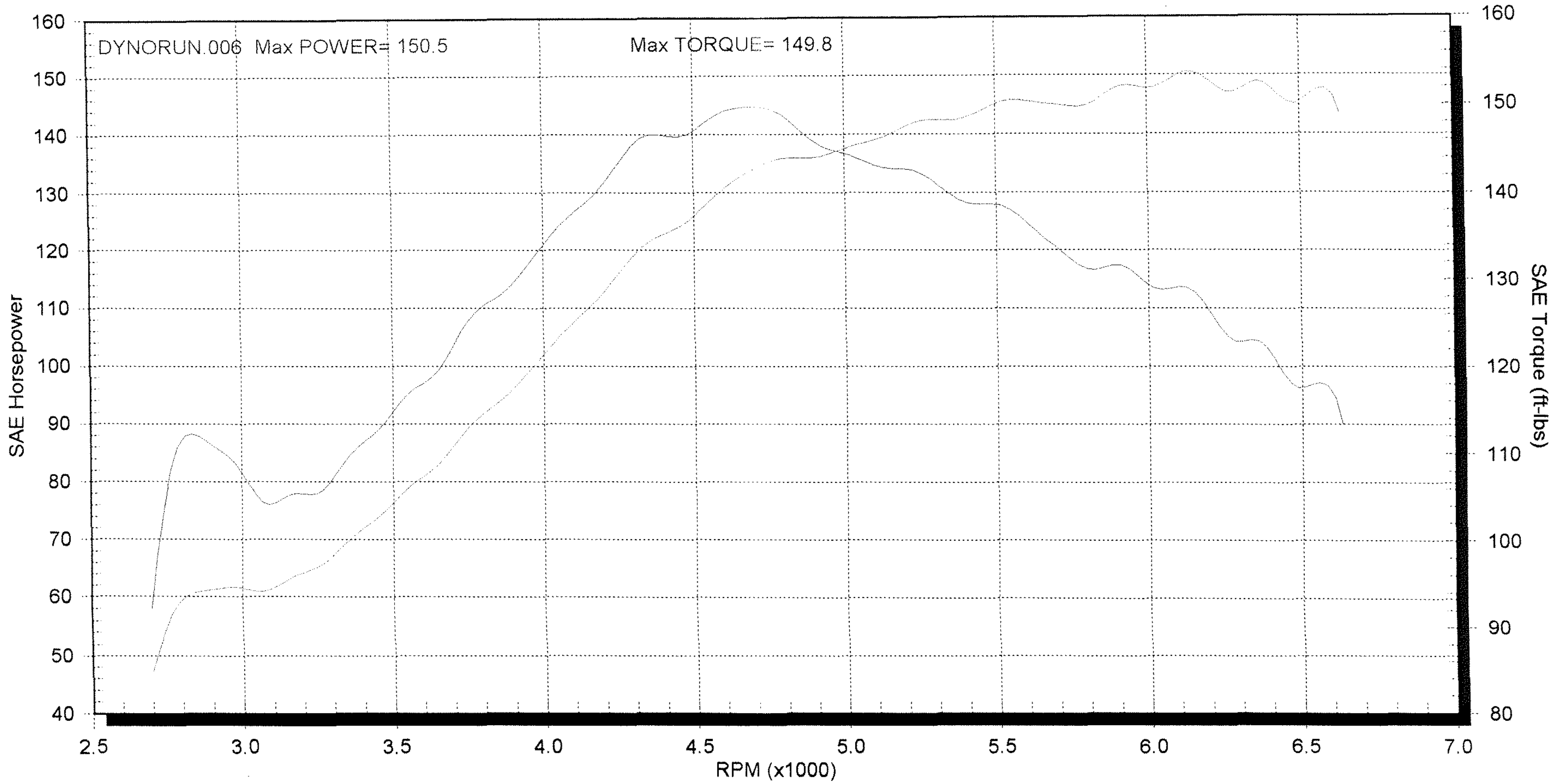
100% RACE fuel 116 oct.

DYNORUN.003 BASELINE RO 11/7/02 6:09:20 PM

DYNOJET Performance Evaluation Program

DYNORUN.006 25% 110 GASRO 11/7/02 6:32:08 PM

CYCLE NUTS & BOLTS HARLEY- DAVIDSON

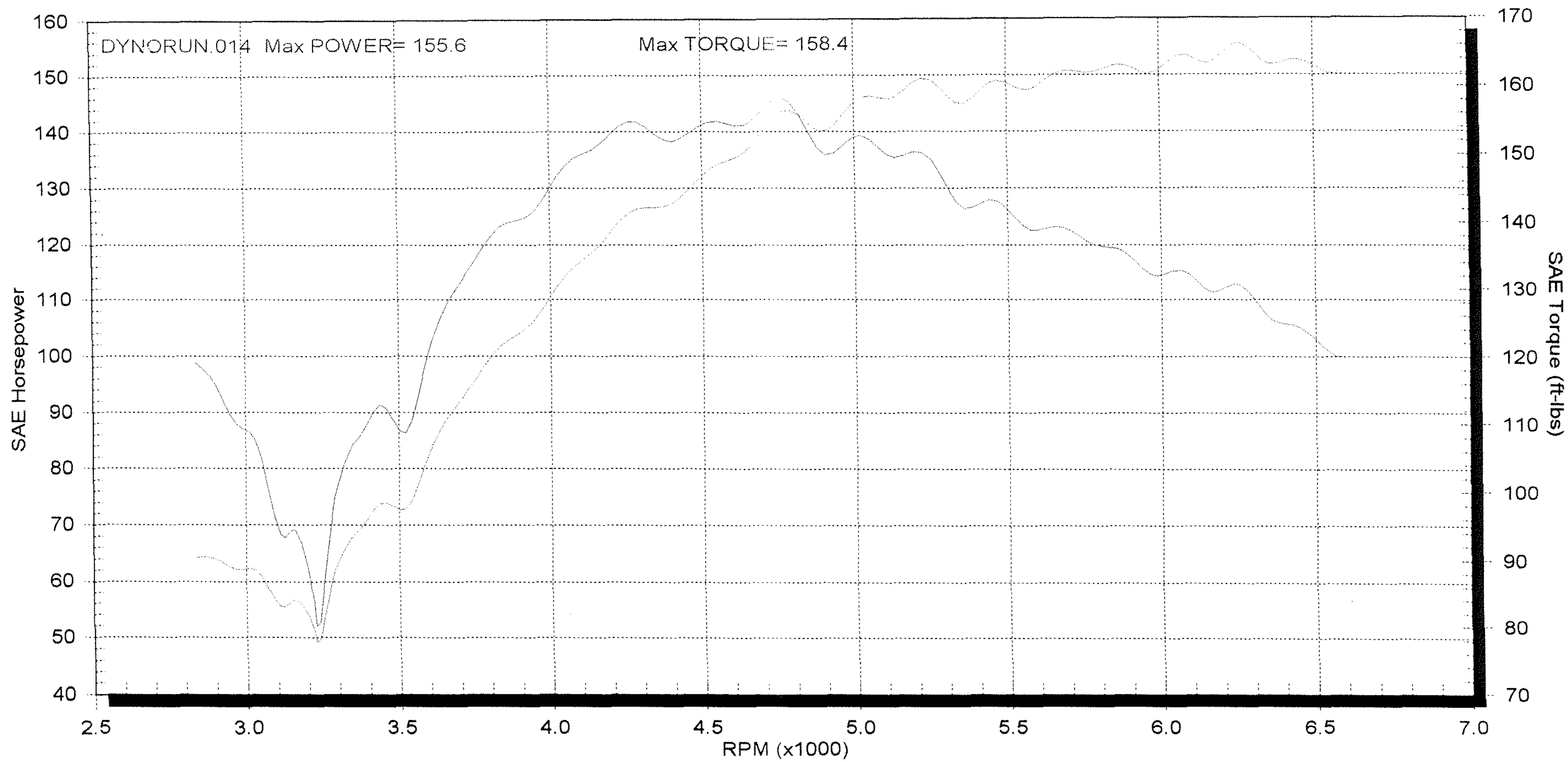


DYNORUN.006 25% 110 GAS RO 11/7/02 6:32:08 PM
86 MAIN JET

WinPEP DYNOJET Performance Evaluation Program

DYNORUN.014 50%A 110 GASRO 11/7/02 8:42:54 PM

CYCLE NUTS & BOLTS HARLEY- DAVIDSON



DYNORUN.014 50%A 110 GAS RO 11/7/02 8:42:54 PM
110 MAIN 40 INTER
WENT FROM 76 TO 80 AIR BLEED ON MAIN

Biofuels for Sustainable Transportation

Ethanol and Fuel Cells
The Future is Now!

November 14, 2002 - Honolulu, HI

What is a Fuel Cell?

Fuel cells work by combining hydrogen and oxygen in a chemical reaction to create electricity, without the noise and pollution of conventional engines.

In principle, a fuel cell works like a battery.

Unlike a battery, however, a fuel cell does not run down or require recharging.

It will produce energy in the form of electricity as long as fuel is supplied.

Ethanol C_2H_5OH

Why does ethanol have a future as the fuel source for fuel cells?

Ethanol is a hydrogen-rich liquid, which overcomes both the storage and infrastructure challenges of hydrogen for fuel cell applications.

Why Ethanol?

- **Ethanol promotes fuel flexibility/diversity**
  - Coexists with Gasoline, Natural Gas
- **Ethanol will leverage existing investments**
  - Ethanol production/distribution infrastructure
  - Fuel Cell R&D- Government and Commercial
- **3 market areas- with different timing**
    - Stationary power
    - Ethanol-Hydrogen refueling stations
    - Ethanol/Gasoline fuel cell vehicles
- **Ethanol will continue to receive government focus because of it's high societal benefits**
  - Economic, Energy Security, Environmental.

Societal Benefits are High

- **Improved air quality,**
- **Increased energy security,**
- **Economic opportunities for farmers and fuel distributors.**
- **Production from cellulosic biomass feedstocks, such as corn stover, rice straw, and forestry residues.**
- **Spills or leaks will not pollute groundwater**

The Societal Benefits of Ethanol are High

Ethanol and fuel cells together create significant synergy, reaching markets and bringing benefits that are *not* achievable with any other fuel or with any other power technology**.**

Ethanol is a renewable resource *that is playing an increasingly important role in assuring the nation's air quality, improving the economic security of America's farming communities, and addressing the challenges of homeland energy security***.**

Ethanol & Fuel Cells – The Power of 2™

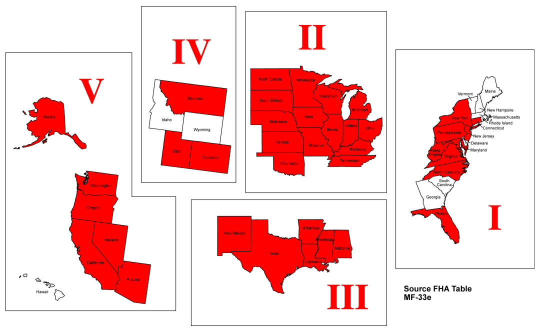
- Ethanol blends seamlessly with gasoline fuels to create an improved, fuel cell fuel that is easily stored and dispensed. These blends can be varied over time, providing fuel source flexibility.
- Ethanol, a renewable fuel, used in fuel cell vehicles or for stationary power plants generates far fewer greenhouse gases than conventional fuels such as gasoline or natural gas.
- Fuel cells are extremely efficient powerplants, reducing the importance of fuel cost and leveling the playing field vs. fossil fuels.
- Ethanol's distribution infrastructure is complete to the terminal level, meaning that only very limited investment in local distribution could enable ethanol to power fuel cells for remote residences and cell towers far from the electric grid.
- Unlike other fuel cell alternative fuels like hydrogen or methanol, ethanol has a very positive environmental, health, and safety footprint with no major uncertainties or hazards.
- The technology to use ethanol in fuel cells already exists and has been demonstrated. Only minor changes are required to existing systems to introduce ethanol as a fuel cell fuel.

Driving On Ethanol

- **An ethanol fuel cell vehicle (FCV) will emit about 13% of the tailpipe pollutants compared with a gasoline vehicle and less than half the pollutants of even a gasoline hybrid vehicle.**
- **Greenhouse gas emissions from an ethanol FCV would be substantially less than even an advanced vehicle using a gasoline internal combustion engine. The ethanol FCV contributions to greenhouse gases could be close to zero if cellulosic biomass is used for the ethanol feedstock.**
- **Unlike hydrogen and methanol, ethanol poses no unique or potentially "show-stopping"health and safety hazards.**
- **Unlike other fuel cell alternative fuels like hydrogen or methanol, ethanol has a very positive environmental, health, and safety footprint with no major uncertainties or hazards.**

Source: Based on 2001 California Fuel Cell Partnership Study

Ethanol is Already Widely Available



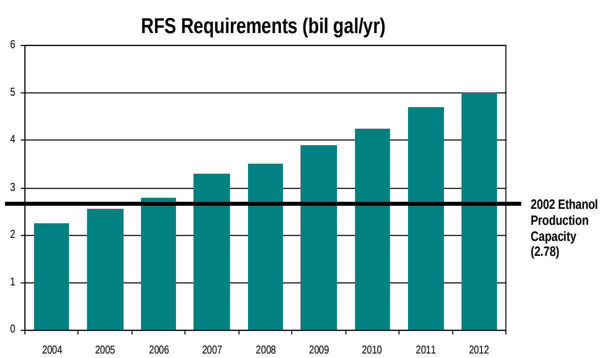
"The outlook for ethanol has never been brighter. Demand for clean-burning, domestic, renewable fuels is at an all-time high, and the US ethanol industry is rising to the challenge."

Bob Dinneen
President & CEO
Renewable Fuels Association

Source: FHA Table MF-33e

The ethanol infrastructure is second only to gasoline as a passenger car fuel.

Ethanol Use Will Grow



Source: Downstream Alternatives, Inc.

The Renewable Fuels Standard (RFS) would gradually increase the use of renewable fuels such as ethanol by 0.3 to 0.4 billion gallons per year (bgy), reaching 5.0 bgy by 2012. This increase in demand will require a substantial investment in new ethanol production facilities – an investment that largely will be made in the nation's rural communities.

Benefits of an RFS

An RFS that grows to 5 billion gallons of ethanol by 2012 would have a significant impact on both the farm and overall economy over the next decade:

- Reduce crude oil imports by 1.6 billion barrels.
- Reduce the US trade deficit by $34 billion.
- Create 214,000 new American jobs.
- Increase US household income by $51.7 billion.
- Create $5.3 billion in new investment in renewable fuel production facilities.
- Increase demand for grain (mainly corn) an average of 1.4 billion bushels and soybeans 144 million bushels.

Source: AUS Consultants, Inc.

California Fuel Cell Partnership
Conclusions about Ethanol

The fuels assessment study released by the Partnership in October 2001 presented the following conclusions about ethanol as a fuel for fuel cell vehicles:

- A ***"major advantage"*** of ethanol is its compatibility with gasoline reformer technology and its flexibility to be used neat (i.e., only ethanol) or in a range of gasoline/ethanol blends.

- Flexibility, combined with ethanol's compatibility with the gasoline infrastructure, means that ethanol can be optimized regionally and according to ethanol economics and availability vs. gasoline. This is the only proposed fuel cell vehicle fueling strategy that does not require the commitment of major infrastructure investments to a single fuel.

- An ethanol reformer could be simpler, more reliable, and less costly than a gasoline/multifuel reformer, increasing ethanol's attractiveness as a neat fuel for fuel cell vehicles

3 Market Areas

Hydrogen Fueling Stations- Ethanol converted to hydrogen at a service station site. Would support early vehicle demonstrations.

Stationary Power- Ethanol can be used to make power locally. Cost competitiveness depends on:

- FC cost & efficiency improvements
- Ethanol pricing vs. propane and natural gas
- State/federal incentives for renewables

Fuel Cell Vehicle Fuel- Ethanol (or blend) used in "gasoline" fuel cell vehicles.

Stationary Power Demonstration

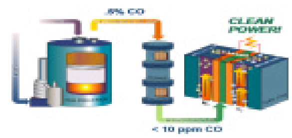
NUVERA CATERPILLAR Williams

Program Partnership

NUVERA
- PEM Fuel Cell and Reformer
- Fuel Cell Control
- System Testing and Key System Variables Data Acquisition
  - Fuel Processor, Fuel Cell, Byproduct Management
  - Fuel Cell Control, System Control Interface

CATERPILLAR
- Program Management
- System Control
- System Testing and Data Acquisition
  - Inverter, Supporting Electronics
  - Electrical Power System Components

WILLIAMS BIO-ENERGY
- Ethanol Fuel Source
- System Test Facility
- System Test Monitoring
  - Installation & Integration
  - Facility Monitoring



Homeland Security & Energy Independence

"America cannot have homeland security without energy independence."

President George W. Bush

"73 percent of Americans believe the US should develop new energy sources to diminish its dependence on Mideast oil supplies."

Newsweek Poll, November 2001

Ethanol Around The World

Brazil-Volkswagen plans to produce 100,000 ethanol-fueled cars in Brazil, exchanging the finance for Kyoto carbon credits with the Brazilian government.

India- August 14 2002 The Indian government ordered the compulsory sale of ethanol-blended gasoline from January 2003 in 13 of the country's states and territories.

China- In November 2001 started to construct its first ethanol plant in Jilin province.

France- bio-ethanol is "a boon to… Agriculture! Bio-Fuels produce some unsuspecting benefits for the environment. Notably in agriculture where once fallow fields are again in use, and jobs are created in rural areas. Even better, increased plant growth reduces CO2 in the air, as the growing plants "trap" it by photosynthesis." -*Oxygen*, Peugeot Citroen Magazine

Near Term Actions Awareness and Engagement

1. Raise stakeholder awareness
   - Economic analyses to define competitive markets
   - Ethanol supply, and infrastructure development status
   - Conference presentations
2. Identify Fuel Cell companies willing to include ethanol in market development.
3. Evaluate technical and economic feasibility of building an ethanol-hydrogen fueling station.
4. Engage the automotive industry to gain further acceptance of ethanol
5. Work with the DOE to tailor existing technology programs to the use of ethanol.
6. Work with state and local governments to define ethanol role in renewable power programs.

The RFA Fuel Cell Task Force

Mission

The Renewable Fuels Association's Fuel Cell Task Force, seeks to promote the advantages of renewable ethanol as a fuel source for fuel cells, which offer significant promise in reducing fossil fuel use and increasing energy efficiency. In doing so, we also seek to advance ethanol fuel cells in all practical applications including mobile and stationary power.

The RFA is an active member of the U.S. Fuel Cell Council.

Fuel Cell Task Force Members

- Jeff Oestmann, Cargill Inc.
- Randall Doyal, Al-Corn Clean Fuel
- Charles Corr, Archer Daniels Midland
- Jacki Fee, Cargill Inc.
- Robert Reynolds, Downstream Alternatives Inc.
- Glenn Kenreck, GE Betz
- Jeff Roskam, ICM, Inc.
- Philip Shane, Illinois Corn Growers Association
- David Loos, Illinois Department of Commerce and Community Affairs
- Neil Koehler, Kinergy, LLC
- Duane Adams, Minnesota Corn Growers Association
- Jon Doggett, National Corn Growers Association
- Todd Allsop, New Energy Corp.
- Gary Welch, Williams Bio-Energy
- Mary Giglio, Renewable Fuels Association

"E-Diesel and Biodiesel: A Status Report to the Industry"

U.S. Department of Energy Fuel Ethanol Workshop

Presented by

Douglas Vind
Western Ethanol Company LLC
Regent International

Honolulu, Hawaii

November 14, 2002

Introduction

AAE TECHNOLOGIES, INC.

- Established in 1997, holder of numerous worldwide patents for fuel additive technologies
- O²Diesel™ efforts in U.S. underway since 1998 – focused on cost-effective, commercially viable products

OCTEL STARREON, LLC

- Over 60 years as a leading world fuel additive supplier
- Leading manufacturer and supplier of diesel additives
- North American sales and distribution network for Performance & Petroleum Specialty Chemicals

AAE TECHNOLOGIES

Introduction (continued)

Western Ethanol Company LLC
Regent International

- 20 years as an ethanol producer and distributor, both domestic and international.
- Detailed experience in shipping, storing, and delivering fuel ethanol throughout Europe and North America.
- Committed to identifying and developing new uses and markets for ethanol fuels.

AAE TECHNOLOGIES

Diesel Market Overview

- Diesel emissions under scrutiny on a global level
- Global policies challenge operators, refiners and marketers
- Targeted emissions from diesel: NOx, CO, PM and air toxics
- Other solutions such as CNG, catalysts & DPFs are costly, some still untested, and many require major infrastructure changes
- Fleets affected include: urban transit vehicles, delivery & service fleets, construction and other off-road equipment
- U.S. market: ~50 <u>billion</u> gallons and growing (highly segmented)

What is E-Diesel?

A diesel fuel containing conventional diesel blendstock(s) with:

- Up to 15 vol% Anhydrous Ethanol
- Stabilized with ~1.0 – 5.0 vol% proprietary additive(s), and
- Cetane enhancement where required

The AAE-Octel Starreon *Octimax™ 4931* (includes cetane improver) makes commercially viable O^2Diesel™ at <1.0 vol% additive treat rate

- Premium Diesel performance – lubricity, stability, conductivity
- Little or no infrastructure or engine changes required
- Can be used in heavy-duty on- & off-road CI engines now!

What is E-Diesel? (continued)

Why Ethanol is an Ideal Diesel Oxygenate

- Benefits:
  - Renewable, domestic replacement for imported petroleum
  - No significant environmental side-effects
  - Widely proven as a gasoline oxygenate in world markets including USA, Canada & Brazil
  - Supply & infrastructure already exists in key global markets
  - Greenhouse gas reduction impacts

However, historically unable to 'blend' ethanol with diesel largely due to ethanol's hygroscopic nature -- *UNTIL NOW!*

Emissions Benefits

"Typical" E-Diesel Emissions Test Results

Colorado School of Mines: Nov. '99 – Dec. '00

EPA No.2 Diesel vs. No.2 O^{2}Diesel™ (7.7vol% ethanol)

CO	NOx	PM	BHP
▼	▼	▼	▼▲
20-28%	2-6%	34-40%	-1/+2%

EPA 13-mode Transient Cycle Engine Tests (1991 DDC Series 60)

Summary: O^{2}Diesel™ Fleet Testing

- Ease of logistics, distribution, and handling
- "Drop-in" clean fuel solution
- Little or no infrastructure or engine changes
- Excellent cold weather operability
- Visible and measurable emission benefits

- Good engine performance and driveability
- Fuel is fully fungible with regular diesel
- No reported mileage demerits (urban fleets)
- Economics better than alternative technologies
- No significant capital investment required

AAE TECHNOLOGIES

Summary: O^{2}Diesel™ Fleet Testing

- Nevada Ready Mix (Las Vegas, NV): Feb. 2000 – July 2001 (quarry trucks)
- Lincoln StarTran (Lincoln, NE): August, 2000 – current (urban buses)
- Pepsi-Cola (The Bronx, NY): Nov. 2000 – current (>200 delivery trucks)
- Zachry Const. (San Antonio, TX): Mar. 2001 – current (const. equipment)
- Pearl City Co-op (Pearl City, IL): June 2000 – current (fuel delivery trucks)
- Winnipeg Transit (Winnipeg, Manitoba): Oct. 2001– Aug. 2002 (20 buses)
- Citizen Area Transit (Las Vegas, NV): Started Nov. 2002 (17 urban buses)

Also:

- OCTranspo (Ottawa, Ontario): Starts 1st Qtr. 2003 (20 urban buses)
- 5 Municipalities (So. Calif.): Starts 1st Qtr. 2003 (120 diesel engines)

AAE TECHNOLOGIES

E-Diesel Technical Agenda: 2002

- "Ethanol-Blended Diesel Fuel Handbook" -- initiated Summer, 2001 and to be completed Fall, 2002 (Argonne Nat'l. Labs)
- Uniform Safety and Handling procedures -- Evaluation underway in 2001/02 at Southwest Research Institute
- Greenhouse gas impact analysis -- initiated Summer, 2001 by Argonne Nat'l. Labs (Michael Wang, et al)
- Health effects testing req'd. per Section 211(b) of the Clean Air Act
- John Deere cooperative test program (>$2 million + 2 years)

E-Diesel Consortium: Organization

- Draft Consortium Charter approved Dec. 4, 2001
- Established under the Renewable Fuels Foundation
- Consortium began work in early 2002
- Significant technical & regulatory agenda (2002 – 03)
- Broad industry/government participation anticipated

E-Diesel Consortium: Participants

- State of Illinois “Core Group” (original E-Diesel Task Force)
- Additive Suppliers (AAE Technologies/Octel Starreon, Akzo Nobel, GE/Betz, Lubrizol, Pure Energy Corp., etc.)
- Engine Manufacturers (John Deere, etc.)
- US Dept. of Energy (including NREL, Argonne National Lab)
- Renewable Fuels Association (U.S. and Canada)
- National Corn Growers Association (and state chapters)
- State and local, public & private groups (e.g., Nebaska Ethanol Board)

E-Diesel Consortium: Technical Issues

- Managing flash point & flammability
- Determining materials compatibility & durability
- Establishing storage & handling requirements
- Meeting ASTM/CGSB fuel standards & acceptability (“Fill & Go”)
- Completing EPA health effects testing
- Obtaining additional emissions benefits
- Complying with federal, state & local laws & regulations

Conclusions

Challenges:

- E-Diesel faces a substantial technical & regulatory agenda
- Tax incentive issues must be addressed for full commercialization
- Meaningful public & private support for E-Diesel needed
- Major competition from other new diesel fuels & technologies expected
- OEM skepticism will be significant for a while to come

But E-Diesel has *Momentum*.........

- E-Diesel Consortium is now in place to address all outstanding issues
- E-Diesel will be “ready for prime time” well before 2006 – 07!

AAE TECHNOLOGIES

Biodiesel Overview

- What is Biodiesel?
- How is Biodiesel made?
- Biodiesel market
- Benefits of Biodiesel
- Biodiesel Challenges
- Ethanol and Biodiesel

AAE TECHNOLOGIES

What is Biodiesel?

- Biodiesel (fatty acid alkyl esters) is a cleaner-burning diesel replacement fuel.
- Made from natural, renewable sources such as new & recycled vegetable oils and animal fats.
- Just like petroleum diesel, biodiesel operates in combustion-ignition engines.
- Blends of up to 20vol% biodiesel + 80vol% petroleum diesel fuels (B20) can be used in nearly all diesel equipment and are compatible with most storage and distribution equipment.
- Higher blends, even neat biodiesel (B100), can be used in many engines built since 1994 with little or no modification.

AAE TECHNOLOGIES

How is Biodiesel Made?

- Biodiesel fuel can be made from “virgin” or recycled vegetable oils and animal fats, which are non-toxic, biodegradable, renewable resources.
- Fats and oils are chemically reacted with an alcohol (typically methanol, but ethanol is also used) and a catalyst to produce fatty acid methyl (or ethyl) esters and glycerine co-products.
- Biodiesel can be produced by a variety of esterification technologies.
- Approximately 50% of the U.S. biodiesel industry can use any fat or oil feedstock, including recycled cooking grease. The other half is limited to vegetable oils, the least expensive of which is soybean oil.

AAE TECHNOLOGIES

Biodiesel Fuel Market

- The use of biodiesel has grown dramatically in the United State during the last few years. (Currently about 25 mil. gallons per year).
- The Energy Policy Act (EPACT) was amended in 1998 to include biodiesel fuel use as a way for federal, state, and public utility fleets to meet requirements for using alternative fuels.
- Biodiesel users include the U.S. Postal Service and the U.S. Departments of Energy and Agriculture. In addition, many school districts, transit authorities, national parks, public utility companies, and garbage and recycling companies also use the fuel.
- With sufficient government incentives, biodiesel sales could reach about 2 billion gallons per year, or about 8% of highway diesel consumption.

Benefits of Biodiesel

- Every gallon of biodiesel displaces 0.95 gallons of petroleum-based diesel over its life cycle.
- Biodiesel reduces the amount of carbon dioxide (CO2) being released into the atmosphere.
- Biodiesel is nontoxic and biodegradable.
- Biodiesel can provide substantial lubricity benefits to premium diesel fuels.
- Biodiesel is an oxygenated fuel, so it contributes to a more complete fuel burn and a greatly improved emissions profile.
- Biodiesel reduces air toxics that are associated with petroleum diesel exhaust and are suspected of causing cancer and other human health problems.

Challenges for Biodiesel

- Biodiesel currently costs between $1 and $2 per gallon to produce.
- Fats and greases cost less and produce less expensive biodiesel but feedstock costs alone are at least $1.50 per gallon of soybean oil-based biodiesel.
- According to the National Renewable Energy Laboratory (NREL), there is only enough U.S. feedstock to supply 1.9 billion gals. of biodiesel.
- Biodiesel's fuel economy, torque, and power are somewhat less than diesel (8% to 15%) because of its lower energy content.
- Biodiesel derived from some feedstocks tends to increase NOx emissions.
- In colder weather, tank heaters or agitators may be required.

AAE TECHNOLOGIES

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Ethanol and Biodiesel

- Ethanol can be utilized to produce an *ethyl ester* (instead of a methyl ester derived from using methanol).
- Ethyl esters can have lower smoke opacity, exhaust temperatures and pour point temperatures than methyl esters.
- Ethyl esters meet the same ASTM standard specification for biodiesel as methyl esters (D6751)
- Ethanol is a preferred process alcohol compared to methanol because it is renewable and more environmentally benign.
- In Hawaii, recycled vegetable oils & ethanol represent the most promising biodiesel (ethyl ester) feedstocks due to their <u>availability</u>.
- For more Biodiesel information contact the National Renewable Energy Laboratory (NREL)

AAE TECHNOLOGIES

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U.S. ETHANOL PRODUCTION CAPACITY

Source: BBI International

November 8, 2002

COMPANY	LOCATION		FEEDSTOCK	CAPACITY (mmgy)**
A.E. Staley	Loudon	TN	Corn	60
ACE Ethanol*	Stanley	WI	Corn	15
Adkins Energy*	Lena	IL	Corn	40
Ag Processing, Inc.*	Hastings	NE	Corn	52
Agri-Energy, LLC*	Luverne	MN	Corn	20
Alchem LLP	Grafton	ND	Corn	10.5
Al-Corn Clean Fuel*	Claremont	MN	Corn	30
Archer Daniels Midland	Decatur	IL	Corn	1,118
Archer Daniels Midland	Peoria	IL	Corn	"
Archer Daniels Midland	Cedar Rapids	IA	Corn	"
Archer Daniels Midland	Clinton	IA	Corn	"
Archer Daniels Midland	Walhalla	ND	Corn	"
Archer Daniels Midland	Columbus	NE	Corn	"
Archer Daniels Midland	Marshall	MN	Corn	"
Badger State Ethanol*	Monroe	WI	Corn	40
Broin Enterprises	Scotland	SD	Corn	8
Cargill, Inc.	Blair	NE	Corn	75
Cargill, Inc.	Eddyville	IA	Corn	35
Central Minnesota Ethanol Co-op*	Little Falls	MN	Corn	19
Chief Ethanol	Hastings	NE	Corn	62
Chippewa Valley Ethanol*	Benson	MN	Corn	21
Corn Plus*	Winnebago	MN	Corn	44
Dakota Ethanol LLC*	Wentworth	SD	Corn	45
DENCO, LLC.*	Morris	MN	Corn	20
ESE Alcohol	Leoti	KS	Seed Corn	1.5
Ethanol2000*	Bingham Lake	MN	Corn	28
EXOL, Inc.*	Albert Lea	MN	Corn	38
Glacial Lakes Energy LLC*	Watertown	SD	Corn	40
Golden Cheese Co of California	Corona	CA	Cheese Whey	5
Golden Triangle*	Craig	MO	Corn	20
Gopher State Ethanol	St. Paul	MN	Corn	15
Grain Processing Corp.	Muscatine	IA	Corn	10
Heartland Corn Products*	Winthrop	MN	Corn	35
Heartland Grain Fuels LP*	Aberdeen	SD	Corn	8
Heartland Grain Fuels LP*	Huron	SD	Corn	14
High Plains Corporation	York	NE	Corn	50
High Plains Corporation	Colwich	KS	Milo / Corn	20
High Plains Corporation	Portales	NM	Milo	15
J.R. Simplot Company	Caldwell	ID	Potato Waste	3
J.R. Simplot Company	Burley	ID	Potato Waste	3
Land O' Lakes*	Melrose	MN	Cheese Whey	2.5
Manildra Ethanol Corporation	Hamburg	IA	Corn / Wheat Starch	8
Merrick/Coors	Golden	CO	Waste Beer	1.5
MGP Ingredients, Inc.	Pekin	IL	Corn / Wheat Starch	65
MGP Ingredients, Inc.	Atchison	KS	Corn / Wheat Starch	25
Michigan Ethanol LLC*	Caro	MI	Corn	40
Miller Brewing	Olympia	WA	Brewery Waste	0.7
Minnesota Energy*	Buffalo Lake	MN	Corn	18
New Energy Corp.	South Bend	IN	Corn	85

U.S. ETHANOL PRODUCTION CAPACITY

Source: BBI International

November 8, 2002

COMPANY	LOCATION		FEEDSTOCK	CAPACITY (mmgy)**
Northeast Missouri Grain, LLC*	Macon	MO	Corn	21
Northern Lights Ethanol, LLC*	Big Stone City	SD	Corn	40
Permeate Refining, Inc.	Hopkinton	IA	Sugars & Starches	1.5
Plover Ethanol	Plover	WI	Seed Corn / Whey / Potato Waste	3
Pro-Corn LLC*	Preston	MN	Corn	40
Quad-County Corn Processors*	Galva	IA	Corn	18
Reeve Agri-Energy	Garden City	KS	Corn / Milo	12
Siouxland Energy & Livestock Coop*	Sioux Center	IA	Corn	14
Sunrise Energy*	Blairstown	IA	Corn	7
Sutherland Associates, LLC	Sutherland	NE	Corn	15
Tall Corn Ethanol LLC*	Coon Rapids	IA	Corn	40
Tri-State Ethanol Company*	Rosholt	SD	Corn	15
U.S. Energy Partners LLC	Russell	KS	Milo / Wheat Starch	40
U.S. Liquids	Louisville	KY	Beverage Waste	4
U.S. Liquids	Bartow	FL	Beverage Waste	4
U.S. Liquids	R. Cucamonga	CA	Beverage Waste	4
Williams Bio-Energy	Pekin	IL	Corn	100
Nebraska Energy (Williams Energy)	Aurora	NE	Corn	35
Wyoming Ethanol	Torrington	WY	Corn	5
Total Capacity				**2,684**
Total Plants				**68**

* farmer-owned cooperative

** million gallons per year

U.S. ETHANOL PLANTS UNDER CONSTRUCTION

Source: BBI International

November 8, 2002

COMPANY	LOCATION		FEEDSTOCK	CAPACITY (mmgy)**
Algoma Ethanol, LLC	Utica	WI	Corn	20
Great Plains Ethanol LLC	Chancellor	SD	Corn	40
Husker Ag Processing LLC*	Plainview	NE	Corn	20
James Valley Ethanol, LLC	Groton	SD	Corn	45
KAAPA Ethanol, LLC*	Axtell	NE	Corn	40
Little Sioux Corn Processors*	Marcus	IA	Corn	40
Midwest Grain Processors*	Lakota	IA	Corn	45
Northeast Iowa Grain Processors*	Earlville	IA	Corn	15
Pine Lake Ethanol*	Steamboat Rocks	IA	Corn	20
Verasun Energy	Aurora	SD	Corn	100
Total Capacity				**385**
Total Plants				**10**

* farmer-owned cooperative

** million gallons per year

As of 11/20/2002

DOE Ethanol Workshop Series Final Registration Information
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DOE Ethanol Workshop Series Final Registration Information

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*** End of Report ***