Advanced Biofuels A Truly Sustainable Renewable Future

For the Biotechnology Department, Chandigarh University October 12, 2020

Joanne Ivancic, Executive Director for Advanced Biofuels USA



Advanced Biofuels USA www.AdvancedBiofuelsUSA.org 301-644-1395



Advanced Biofuels USA

501(c)3 Nonprofit Educational Organization

Founded April 2008

Website:

www.AdvancedBiofuelsUSA.org

Advocates for the adoption of advanced biofuels as an

- energy security,
- military flexibility,
- economic development
- climate change mitigation
- pollution control

solution.

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Dollar

Advanced Biofuels USA: promoting the understanding, development and use of advanced biofuels around the world.

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A PLUG-IN FLEX FUEL HYBRID FOR THE NATION

by Timothy Jv Rudnicki (Minnesota Bio Fuels Association) What would it take to cut petroleum use by at least 85 Copyright 2020 Advanced Biofuels USA WEBINAR: Workshop 1: Ongoing Developments in EU Member States and the Role of REDII --- October 5, 2020 --- ONLINE

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TAGS



Advanced Biofuels USA, a nonprofit educational organization, advocates for the adoption of advanced biofuels as an energy security, economic development, military flexibility and climate change mitigation/pollution control solution.

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- ... Action Plan for a Sustainable Advanced Biofuel Economy
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Methanol Blend on Cards, India May Trim Oil Import Bill by Rs 5k Crore

by Yogima Seth Sharma and Nishtha Saluja (Economic Times) Gadkari writes to petroleum minister to ensure availability of methanol-blended fuel, which will help cut the consumer's fuel expenses by 10%. – The government is looking at introducing methanol-blended fuel pan India – a move that can potentially reduce one's fuel

December 24, 2019 🦘 Read Full Article

Contribution of Advanced Renewable Transport Fuels to the Decarbonisation of Transport in 2030 and beyond

(Netzwerk Biotreibstoffe) The workshop presented the findings of a project that was set up jointly by two Technology Collaboration Programmes of the International Energy Agency, namely the IEA Bioenergy TCP and the Advanced Motor Fuels TCP (AMF Annex 58). The project focuses on country-specific analysis of Germany, Finland, Sweden, USA,

December 20, 2019 🦘 Read Full Article

When Negative Is Good – Carbon Negative: The Digest's 2019 Multi-Slide Guide to Gevo's Biojet Fuel

by Jim Lane (Biofuels Digest) Noone wants to be negative...unless they are talking about carbon negative of course. The aviation industry has been all abuzz about lowering their carbon footprints for years, then carbon neutral, now carbon negative. According to Gevo's Timothy Cesarek, EVP & Chief Commercial Officer, the carbon footprint

December 14, 2019 🦘 Read Full Article

Hinduja Group Chairman Meets Capt Amarinder, Offers Transport & Tech Solutions to Address Stubble Burning

(Directorate of Information and Public Relations, Punjab, India) The Hinduja Group on Wednesday offered to help Punjab in addressing the stubble burning problem by lifting all the paddy straw from the fields for use in ethanol plants. The offer came during a meeting between Chairman of Hinduja Group, Prakash Hinduja, with

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Spurious Biodiesel Racket across Gujarat Unearthed

(Times of India) Gujarat Pollution Control Board (GPCB) and state goods and state goods and services tax (SGST) department, on Wednesday conducted joint raids at manufacturing units that make duplicate biodiesel. ... 60 units were raided. READ MORE Illegal biodiesel sale spurs GST into action (Ahmedabad Mirror) Excerpt from

October 2, 2020 🛛 🦘 Read Full Article

Green Fuels to Receive €86,000 Grant in Support of COVID-19-Related Work

(Biofuels International) ... Green Fuels was chosen ... for the meaningful work. .. with the waste management sector in Mumbai, India, to develop safe, reliable collection systems for food waste, suitable for use in developing countries COVID-19 lockdown. Green Fuels CEO James Hygate said: "This project is important because existing

October 1, 2020 🦘 Read Full Article

BIO Recognises Dr Pramod Chaudhari by George Washington Carver Award 2020

(Agro Spectrum) Dr Chaudhari becomes the first Indian chosen for the honor for his contribution towards building a bio-based economy. – Washington D.C.- based Biotechnology Innovation Organization (BIO) announced that Dr. Pramod Chaudhari, founder and executive chairman, Praj Industries, is selected for the prestigious 2020 George Washington Carver Award for Innovation

September 28, 2020 🦷 🐂 Read Full Article

Identified Tourism Sites Can Be Turned into Green Zones with Use of Only Biofuels: Petroleum Minister

Identified Tourism Sites Can Be Turned into Green Zones with Use of Only Biofuels: Petroleum Minister

(Economic Times) Speaking at a virtual event organised by the tourism ministry on the occasion of 'World Tourism Day 2020', Pradhan, Minister of petroleum and natural gas, and steel, said the project's aim will be to turn such sites of tourist importance into completely green energy driven areas. Union cabinet

September 28, 2020 🛛 🗢 Read Full Article

Making Biodiesel with Green Solvents

by David Bradley (Inderscience/Phys.Org) Green solvents for making biodiesel would reduce the environmental impact of such fuels still further. Writing in the World Review of Science, Technology and Sustainable Development, a team from India discussed the potential of ionic liquids in this field. ... There is, however, a need for volatile

September 23, 2020 🦘 Read Full Article

R&D Advances Abound LanzaTech's India Contract, NovoNutrients' Food & Feed from CO2, Industrial Microbes' New Methane Related Patent

by Helena Tavares Kennedy (Biofuels Digest) LanzaTech's 2G Ethanol India contract, NovoNutrients' food & feed from CO2, Industrial Microbes' new methane related patent — In just the last 24 hours or so there has been a flurry of R&D news. LanzaTech was awarded a contract to commence basic engineering for

September 17, 2020 🦘 Read Full Article

Advanced Biofuel Facility Gets Green Light in India

(Lanza Tech) Distributed Approach Enables Local Production of Ethanol from Agricultural Residues – Mangalore Refinery and Petrochemicals Limited (MRPL), a leading Indian Refining company based in Mangalore, is planning to install a second generation (2G) ethanol facility in the State of Karnataka, India. MRPL has awarded LanzaTech the

Before we start:

What do you think of when you hear *"bioenergy"*?

Does it include energy for transportation?



What do you think of when you hear "biofuel"?

- Corn-based Ethanol?
- Biodiesel from used cooking oil, canola/rapeseed?
- Ethanol from sugar cane, cassava, sugar beets?
- Renewable jet fuel?

Your answer might depend on where you live.

What are they? What are they used for? How are they made? Why are they important? Jobs/Careers throughout



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What are they? What are they used for? How are they made? Why are they important?



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Ethanol is a biofuel, not the only biofuel.

Biodiesel **Renewable Diesel** Sustainable Aviation Fuel (SAF) **Bio-isobutanol Renewable Natural Gas** rDME Drop-in hydrocarbons Marine/Maritime Fuel





"First Generation" Biofuel

Corn-based ethanol, sugarcane ethanol (nearly 200 proof moonshine or 100% ethanol)

One of the **few currently commercially available** biofuels you can buy for vehicles today. Blends of 10%, 15%, 85%

Replaces MTBE, provides octane.

- And the ethanol molecule is part of many other things too.
 - Wine
 - Beer
 - Whiskey











What are they? What are they used for? How are they made? Why are they important?



What Are Advanced Biofuels Used For? Today

- Fueling Cars and Trucks
 - Replace MTBE
 - Octane
 - Ultra Low Sulfur
- Fueling Aircraft







(15 ppm Sulfur Maximum)

Required for use in all highway diesel vehicles and engines. Recommended for use in all diesel vehicles and engines.

UP TO 5% BIODIESEL

What Are Advanced Biofuels Used For? Today



Ethanol Cook Stoves Project Gaia: Nigeria Ethiopia Haiti Brazil

Tanzania





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What Are Advanced Biofuels Used For? Today?

 Military Aviation Fuels

 Military Marine Fuels





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What Are Advanced Biofuels Used For? **Today**?

• Maritime/Marine Fuels

BIOFUELS USA



What Are Advanced Biofuels Used For? Today

• Green Racing: E85 in Indy Cars



• Formula 1

• Green Racing: Le Mans series used to use E85; now E20





What Are Advanced Biofuels Used For? Today Cumulative C02 Reductions (million tons)

SOURCE: Califorina Energy Commission, Low Carbon Fuel Standard Dashboard



What Will Fuel Ethanol Be Used For? Tomorrow Fuels for high performance





Fuels for high performance vehicles



What Will Advanced Biofuels Be Used For? Tomorrow

- Optimized Flex-Fuel Vehicles
 - E85
 - E30





- Drop-In Petroleum Fuel Replacements
 - The Rest of the Gallon





What Will Advanced Biofuels Be Used For? Tomorrow

Missile Fuel: DARPA High Density JP-10 (BR-1)

Rocket Fuel: Resupply Missions to the International Space Station

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HYDRAULIC ROD WARHEAD PUMP PILOT FUEL MAIN FUEL INJECTORS INJECTORS ELECTRONICS AIR TURBINE COMPARTMENT PILOT FUEL PUMP FLAME BURNER TANK HOLDER Copyright 2009 Phillip R Have

AIR TURBINE



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How are they made? Feedstock Logistics Technology



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Agriculture and Forestry **The Foundations** of the Bioeconomy

along with Waste Management for the Circular Economy



Some Feedstocks:

- Sugars, Starches
- Oil seed crops
- Grasses
- Trees and Forest Waste
- Agricultural Residues
- Algae
- Food/Animal Processing Residues
- Energy Crops
- Thin Air





Sweet Sorghum





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Sunflower or Jerusalem Artichoke







Grasses



Phragmites



Miscanthus

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Arundo or Giant Reed And many others



Switchgrass















Sugar Cane

Sugar Cane Bagasse







Sugar Beet/Sugar Beet Pulp

Energy Beets















Jatropha

Moringa

Pongamia

Castor Bean

Jojoba


Examples of potential crops/plants which can be used for production of biofuels



Cashew Apple

Sisal Bole





Agave



Examples of potential crops/plants which can be used for production of biofuels

Hemp and Cannabis Residues

Kenaf







Examples of potential crops/plants which can be used for production of biofuels





Cotton Seed and Hulls



Rice Hulls, Husk

Rice or Wheat Straw





Nut Shells

Examples of potential crops/plants which can be used for production of biofuels

Woody Biomass

Forest Waste and Residues





Examples of potential crops/plants which can be used for production of biofue

Short Rotation Coppice Willow Poplar









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		Duckweed/Lemna
Algae		
	Concopyright 2020 Advanced Biofuels USA	42 42

ADVANCED





Flue Gas





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Sorted Municipal Solid Waste or Food Waste

Brewers and Distillers Waste





Used Cooking Oils and Fats and Grease, Recycled Oil



Power to Fuel



Water for Renewable Hydrogen



Renewable Hydrogen plus Carbon Dioxide to Methanol

More Examples of Potential Feedstocks or Energy Crops

- Algae
- Agave
- Corn stover
- Corn cobs
- Energy cane
- Sorghum
- Forestry waste
- Municipal waste
- Sawdust
- Chicken manure
- Agricultural residues



- Grasses such as
 - Switchgrass
 - Miscanthus
- Sugar beets
- Coffee grounds
- Jatropha
- Camelina
- Paper/pulp mill waste
- Halophytes...







A Few Types of Jobs Available in Advanced Biofuels Feedstock Development and Production

- Agronomists
- Farmers
- Farm workers
- Farm equipment designers
- Biologists
- Biologists specializing in genetic research
- Biologists specializing in plant cells
- Chemists
- Chemical engineers
- Researchers into bioenergy crop development
- Agriculture/horticulture experts

- Freight railroad operators, engineers, loaders, unloaders
- Equipment operators, technicians
- Farm product purchasers/traders
- Agricultural and Forestry Supervisors
- Agriculture Economists
- Agricultural Inspectors
- Computer Software Engineers
- Commodity Traders
- Others?



What Are Advanced Biofuels?





Processes

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ced Biofuels

Biochemical

Thermochemical

Thermochemical

conversion of sugars

Gasification

Plasma arc

gasification

Pyrolysis

10

- Fermentation
- Plant extraction
- Transesterification
- Hydrolysis
- Enzymatic Catalysis

5. *

Overcoming the Technical Roadblocks to Low-Cost Advanced Biofuel Production

-- Make **all components of biomass** available for biofuel and coproduct production (*Use the appropriate parts of specific plants*)

-- Improve the **efficiency** of biomass to biofuel **conversion** (*Do it faster, cheaper, sustainably*)

-- Minimize the cost of biomass transportation (Move more for less)



"Why aren't we there yet?" Biomass Recalcitrance





• Lignin

("You can make anything you want from lignin except money")

- Cellulose
- Hemicellulose
- Pectin

Making Plant Biomass Available for Biofuel Production Sugar Availability in Plant Cell Walls



Additional "simple" sugars are available in **plant and tree cell walls**, but are in more **complex forms** that are not readily available for biofuel production

Plant cell walls are composed primarily of three components: **cellulose, hemicellulose, and pectin**



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Making Plant Biomass Available for Biofuel Production Sugar Availability in Plant Cell Walls



Wood Microscopic Structure

Tree and grass cell walls have an additional component, **lignin**.

This is the "woody" material that gives trees great tensile strength

Cellulose, hemicellulose, and pectin are composed of monosaccharides strung together, they are called polysaccharides

Lignin is composed of **polysaccharides** and alcohols



Making Plant Biomass Available for Biofuel Production Biomass Recalcitrance

- Cellulose, hemicellulose, pectin, & lignin intertwine to create **complex cell wall** matrices
- This complex structure protects plants and trees from disease, moves nutrients, and provides for growth
- These complex structures also **restrict access to the "simple sugar" components**
- Current technologies to break up biomass: acid, ammonia, steam, or pressure are energy





Making Plant Biomass Available for Biofuel Production Overcoming Biomass Recalcitrance

Researchers are pursuing at least **four different approaches** to overcome biomass recalcitrance

 Reverse engineer plant cell wall genetics to discover enzymes that will "deconstruct" cell wall matrices

2. Adapt microbial "rotting" enzymes to dissolve cell wall sugars





Making Plant Biomass Available for Biofuel Production Overcoming Biomass Recalcitrance

3. Breed plants and trees with cell wall structures more amenable to chemical or enzyme solubility

4. Reduce costs and energy requirements of chemical processes







Making Plant Biomass Available for Biofuel Production Overcoming Biomass Recalcitrance

Discover enzymes that will "deconstruct" cell wall matrices

Examples: Leaf Cutter Ants, Termites, Horse or Panda Feces.







Future Biorefineries: More Co-Products; Renewable Chemicals and Materials



Lallemand Biofuels & Distilled Spirits combines yeast and enzymes

INTRODUCTION

The Convergence platform: Yeast "and" Enzymes



CONVERGENCE

- Enabled by the development of new technology that expresses much higher levels of GA in yeast than previously possible.
- LBDS provides 100% of the GA required in a corn ethanol fermentation by the customer by using yeast with a small quantity of exogenous enzyme.
- The two worlds of yeast and enzymes are "combining or converging" into a new approach to fermentation.



TRANSFERM CV5 / ALCOLASE 146 SUMMARY

TRANSFERM

- TransFerm CV5 is a robust yeast with optimized GA and trehalase expression providing high ethanol yields via glycerol reduction
 - o Faster-fermenting, robust host strain
 - Optimized GA expression for significant enzyme activity production while maintaining strong fermentation performance under stress conditions
 - Incorporates yeast-expressed trehalase activity
 - Glycerol reduction for higher ethanol yields
- Alcolase 146 is a high-performance glucoamylase blend
 - Developed to maximize the fermentation performance of TransFerm CV5
 - Provides optimal results at significantly lower dose than other commercial enzyme blends

& DISTILLED SPIRITS

Virent's BioForming Platform

Recent announcement of working with Cargill to use dextrose from corn ethanol production as feedstock https://advancedbiofuelsusa.info/cargill-virent-collaborate-on-biobased-fuels-and-chemicals/



CLARIANT

BUT that is not all: sunliquid[®]- the ideal platform for highly sustainable bio-based products



Clariant ferments straw/stover/grasses/bagasse via enzymes and microorganisms to multiple products

sunliquid[®]: fully integrated & carbon negative process

15 Public Poolo Cervo, Business Line Biofaels & Derivatives, og 07,2024 CLARIANT

Areal view sunliquid® pre-commercial plant in Straubing, Germany

Extensive know-how in blocatalysis, strain optimization and heterogenous catalysis Specifications can be adjusted to the need of the added downstream processing





Process Path: Biomass-to-Fuels and Products



Graphic by Zina Deretsky, National Science Foundation



Recycling Carbon

Waste Carbon Streams as a Resource for Gas Fermentation





Recycling Plastics

Annellotech catalytic process

Producing recycled PET and PP plastics from waste packaging

Anellotech Plas-TCat Technology helps brand owners meet recycled plastic content goals



Anellotech

Aviation Fuel Processes/Pathways Alcohol to Jet (ATJ) Catalytic Conversion of Oil to Jet (CCOTJ) Catalytic Conversion of Sugar to Jet (CCSTJ) Catalytic Hydrothermolysis, Hydroprocessing to Jet (CH-HRJ) **Direct Fermentation of Sugar to Jet (DFSTJ) Fischer-Tropsch Synthesized Paraffinic Kerosene (FT-SPK)** Hydrotreated Depolymerized Cellulosic Jet (HDCJ) Hydroprocessed Esters & Fatty Acids (HEFA) Synthesized Iso-Paraffinic Fuel (SIP)

Conversion Processes: Turning biomass and renewables into building blocks for fuels, chemicals and products





A Few Types of Jobs Available in Advanced Biofuels Production

- Biologists
- Biologists specializing in genetic research
- Biologists specializing in plant cells
- Chemists
- Chemical engineers
- Mechanical Engineers
- Systems engineers
- Research assistants
- Lab technicians
- Industrial engineers
- Industrial architects

- Construction workers, Managers
- Truck drivers
- Plant operations managers
- Equipment operators, technicians
- Computer Software Engineers
- Refinery Equipment
 Manufacturers
- Welders
- Boilermakers
- Pipe Fitters
- Others?

What Are Advanced Biofuels?

How are they made? What are they used for? Why are they important? Policy Considerations Markets



Why replacing fossil fuel is important



Why replacing fossil fuel is important

What We Could Have ANT ALLER AND A
Why replacing fossil fuel is important



Windmills and solar can produce electricity but cannot power jet airplanes.

Virtually no oil is used to produce electricity in the US.





Why replacing fossil fuel is intervented by the second sec





Why replacing fossil fuel is important



BIDELLELS LISA

Before oil runs out, it becomes more difficult and dangerous to extract.





Why Replacing Fossil Fuel is Important Solutions to Problems

- Reduce carbon footprints
- Erosion control
- Waste water treatment
- Remediation of contaminated soil
- Nutrient management
- Carbon sequestration
- Alternative to carcinogens / Air Quality
- Overflowing landfill relief/plastic recycling
- Burning agricultural waste in fields
- Grease (fatbergs) in sewers
- Contaminated black market used cooking oil











A Few Types of Jobs in Communicating Importance of Advanced Biofuels

USA

- Public Relations
- Economic Development
- Marketing/Sales
- Elected Official
- Federal Agency Staff
- State Agency Staff
- County/Local Administrative Staff
- Journalists
- Writers
- Photographers
- Broadcast Media Professionals
 Others?
 Others?

- Teachers
- Teaching Assistants
- Nonprofit Organization Staff
- Advocates
- Lawyers
- Office Administrative Staff
- Book Publishers
- Event Organizers
- Fundraisers
- Celebrities

Barriers and Challenges Not as easy as we hoped!

TECHNICAL CHALLENGES, Biomass Recalcitrance, Enzyme Recycling, ...

FINANCING "New" & "Never Been Done Before" Technologies ...

POLICY ISSUES / CONTROVERSIES: Feedstock Cost Reductions, Efficient Land Use, Sustainability ...





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Frederick, MD

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Frederick, MD

Advanced Biofuels for a Truly Sustainable Renewable Future

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