An Opportunity To Revolutionize Transportation Fuel Production Domestically Using Existing Biomass

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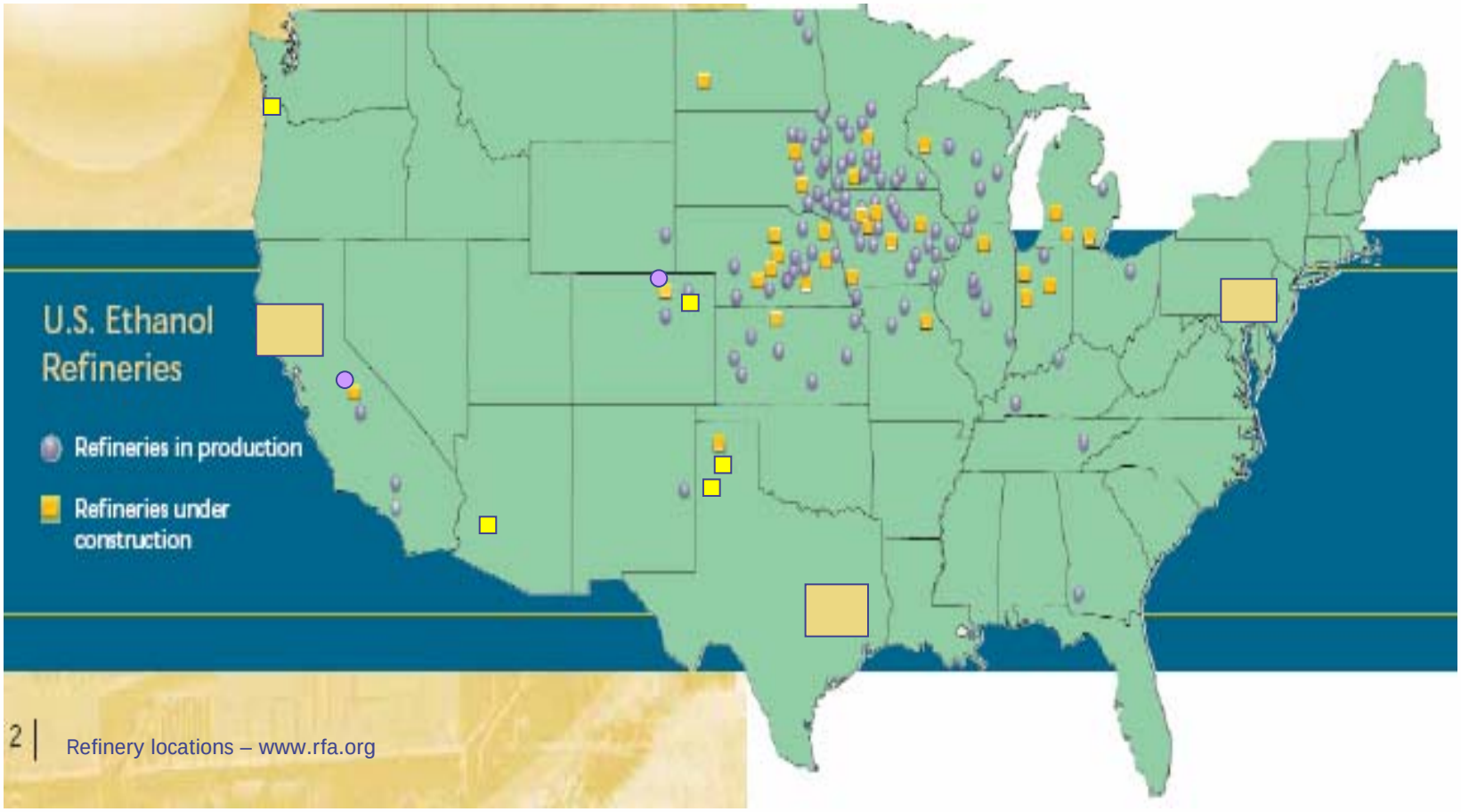
Problem Statements

- Need to reduce foreign oil imports and oil dependency
  - 65% of U.S. oil consumption is imported (of 21 million barrels per day consumption in 2005)
  - About 2.3 million barrels a day of US imports (a 17 percent share) came from the Persian Gulf in 2005, or about 11 percent of total US consumption
  - Oil imports is the largest single element of U.S. trade deficit.
  - We rely on fossil fuels for 95+% of our transportation needs
- Need to have solid waste management strategy
  - For growing urban areas
  - Alternatives to open-field burning
  - Improve forest health
- Must address Global Climate Concerns and preservation of natural resources
  - Transportation accounts for a significant portion of our annual greenhouse gas emissions

Bring ethanol production closer to ethanol demand
Create geographic diversity in ethanol production



RFG areas

Ethanol Industry

- U.S. Gasoline Market -140 billion gallons (2005)
- U.S. Ethanol Market – about 3% of US gasoline market
  - 115 ethanol plants (RFA)
  - Production capacity of 5.7BGPY (RFA)
- Renewable Fuel Standard will increase to 7.5 billion by 2012 - still only 5% of gasoline market

Federal and State Policies Forming to Create Renewable Fuels Market

- Federal
  - Renewable Fuel Standard calls for 7.5BGPY by 2012 – Credit for cellulose is 2.5:1 compared to other raw materials.
  - President Bush calls for Increasing RFS to require 35 billion gallons of renewable and alternative fuels by 2017 – nearly five times the 2012 target now in law. In 2017, this would displace 15 percent of projected annual gasoline use.
  - White House calls for reduction in foreign imports – 75% reduction by 2025
  - Cellulose to Ethanol deployment is necessary
- California
  - Governor Executive Order call for 20% renewable fuels production by 2010 and 40% by 2020
  - California's Low Carbon Fuel Standard is the first greenhouse gas emissions standard for transportation fuels in the world
    - Transportation accounts for 40% of CA GHG emissions
    - LCFS requires 10% GHG reduction in transportation fuels by 2020
- Misssissippi
  - 20 cents per gallon ethanol production incentive

Cellulose to Ethanol EPAct Incentives

- The Energy Policy Act of 2005 (H.R. 6), signed into law in August 2005, contains a number of incentives designed to spur cellulosic ethanol production:
  - Creates a credit-trading program where 1 gallon of cellulosic biomass ethanol or waste derived ethanol is equal to 2.5 gallons of renewable fuel
  - Creates a cellulosic biomass program of 250 million gallons in 2013
  - Creates a Loan Guarantee Program of $250 million per facility
  - Creates a $650 million Grant Program for cellulosic ethanol
  - Creates an Advanced Biofuels Technologies Program of $550 million.
  - Targets Biomass Research and Development
  - Establishes program of production incentives to deliver the first billion gallons of annual cellulosic ethanol production
- Next Step – fund and create programs

Cellulose Ethanol is The Future Of Ethanol

- Gain significant progress in meeting energy security goals
- Most promising near term solution to GHG reduction goals - Cellulose ethanol provides nearly 90% reduction.
  - Location within landfills create even greater GHG benefits from use of landfill gas and diversion of waste from decomposition avoiding methane production
- Create geographic diversity in ethanol production.
  - Bring ethanol closer to transportation fuel markets
- Contribute to waste management goals
  - Diversion of cellulosic wastes from landfills extends landfill space
  - More beneficial use of agricultural and forest residues
- New industry for our Nation's urban and rural communities

Means of Producing Ethanol from Biomass & other Wastes

Thermochemical			Hydrolysis		
Technology	Pros	Cons	Technology	Pros	Cons
Gasification – Catalytic	Lower capital cost, feedstock flexibility, high yield per ton of feed	Tar production, requires gas cleanup, catalyst poisoning, catalyst disposal, production of mixture of low alcohols (I.e., impure product)	Dilute Acid Hydrolysis	Low capital cost, low acid consumption, public domain technology	Lower conversion efficiency, co-factor/toxin production
Gasification – Bioreactor	Lower capital cost, feedstock flexibility, high yield per ton of feed	Tar production, requires gas cleanup - bioreactor poisoning with real feedstocks.	Strong Acid Hydrolysis	Medium-high capital cost, low acid consumption	Low conversion efficiency, co-factor production
Fractionization - Mechanical	Recovery of pure components	Moderate capital cost, high energy cost	Concentrated Acid Hydrolysis	95% recycling of acid, high conversion efficiency, near zero liquid discharge	Moderately-high capital cost
Fractionization – Solvents	Recovery of pure components	Moderate capital cost, high energy cost	Enzymatic Hydrolysis	Enzyme cost reduced recently	NOT Suitable for MSW and Greenwastes
			Hybrid – Dilute Acid/Enzymatic Hydrolysis	Enzyme cost reduced recently	Co-factor production

BlueFire Ethanol, Inc.

- Publicly traded on OTCC: Pinksheets – BFRE
- Exclusive licensee of Arkenol's concentrated acid hydrolysis process for North America
- Headquartered in California – Staff and majority shareholders have been involved in technology development since 1992 as Arkenol
- Experienced developer of energy projects as ARK Energy and Arkenol, Inc.
- Cellulose to ethanol pilot facility operated in California in late 1990s
- Process reviewed by federal, state and local agencies resulting in permits issued
- Technology demonstrated by JGC Corporation (major Japanese engineering and construction company)
- Strategic alliances with qualified parties for deployment of production facilities
- Initial Production facilities will be fully integrated in existing landfills across North America

BlueFire Basic Technology Description

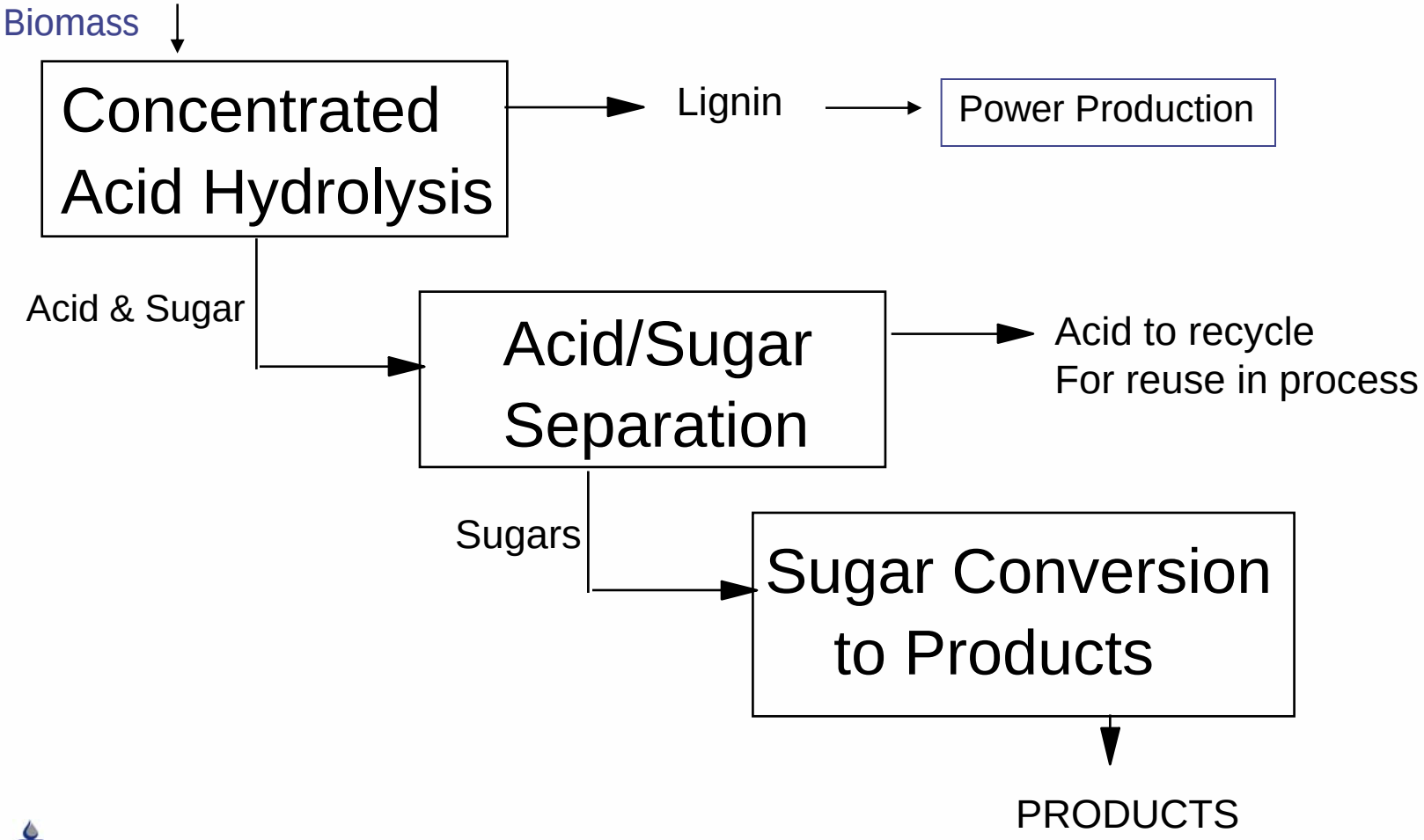
- Technology Category
  - Concentrated Acid Hydrolysis
    - No pretreatment required
    - Does not use enzymes
    - Proven concept in mid 1900s
- Feedstocks
  - Any cellulosic material – from forest to agricultural residues to post-sorted urban waste.
    - Flexibility in using mixed waste streams.
- Products
  - Ethanol
  - Lignin
  - Gypsum

Concentrated Acid Hydrolysis -a Demonstrated Technology

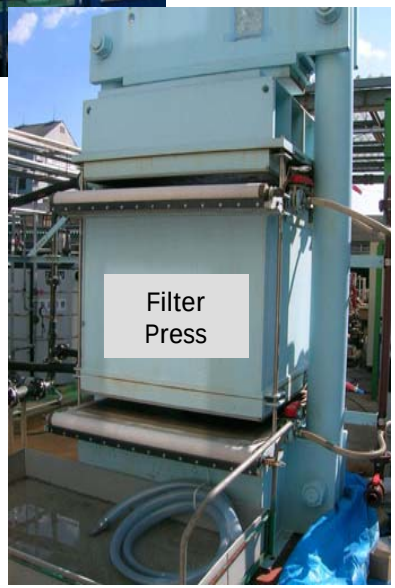
- Commercialized in the past, particularly in the former Soviet Union.
  - However, these processes were only successful during times of national crisis, when economic competitiveness of ethanol production could be ignored.
  - They cannot be economical because of the high volumes of acid required.
- TVA, with assistance from Mississippi State University (MSU), built a 4-ton-per-day concentrated acid hydrolysis experimental facility at Muscle Shoals, Alabama in 1985.
  - In this concentrated acid process, cellulose and hemicellulose from hardwoods were reduced by sulfuric acid to xylose and glucose sugars.
  - Unused acid was removed from the sugars by lime precipitation. The sugars were then fermented to ethanol. Process concepts were demonstrated and high hemicellulose and cellulose conversion efficiencies were achieved.
- However, process economics were poor as a result of two major problems:
  - (1) the acid was continuously consumed, elevating operating costs, and
  - (2) equipment costs were too high for a favorable investment return.

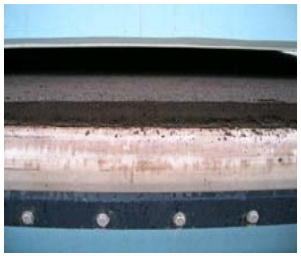
Proven Technology

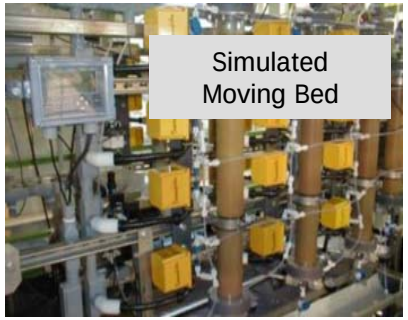
- Patents are improvements to proven concentrated acid hydrolysis technology
- Technology has been successfully licensed & used by third party – JGC Corporation of Japan
- Testing on a vast array of potential feedstock in Arkenol pilot plant in CA and JGC in Japan



Concentrated Acid Hydrolysis for Cellulose to Ethanol Production







IZUMI, JAPAN FACILITY

Operated by JGC Corp for NEDO

Project Maturity Schedule

- Research – DONE
- Pilot Plant - DONE
  - City of Orange, California
    - Used to test various equipment
    - Test feedstock from U.S. and overseas – ag, MRF residual, wood, greenwaste, RDF
    - Financed by Arkenol and ARK Energy, Inc.
    - Operated for 5 years
  - Izumi, Japan
    - Operated by JGC Corporation
    - Located adjacent to existing ethanol plant
    - Funded by JGC and NEDO (New Energy Development Organization)
    - Integrated system operated since 2002
    - Third party validation of Arkenol Technology
- Commercial Facility

BlueFire Cellulose to Ethanol Process Advantages

- Demonstrated by third party over 4 years of operation
- Higher sugar concentration and more efficient acid recovery means lower operations cost
- Use of common, less toxic sulfuric acid under mild conditions minimizes health and workplace hazards.
- No requirement for high pressure/temperature vessels means lower capital costs
- Does not require energy intensive grinding to small particle size compared to enzymatic means less energy, less capital required
- Higher sugar concentration means less energy required.
- Smaller waste stream.
- No enzyme risks (e.g., cost, health, workplace).
- No need to re-design process for each feedstock type creates feedstock flexibility

BlueFire Deployment Plan for Cellulose to Ethanol Projects

- Access reliable sources of input raw materials
  - These "biorefineries" will convert widely available, inexpensive, organic materials such as agricultural residues, high-content biomass crops, wood residues, and cellulose in municipal solid wastes into ethanol.
- Locate facilities to optimize synergies with strategic partners, reduce costs, maximize environmental benefits
  - Landfill locations
  - Landfill diversion facilities (MRFs) – residuals now going to landfills rich in cellulose
  - Biomass power plant
  - Anchor for eco-industrial parks
- Embark on projects with expansion or replication potential
- Rapid deployment of multiple facilities through strategic partnerships

Landfills are Our New Energy Source

- **Extended life – build air space**
  - **beneficial use of waste materials**
- **Co-location of ethanol biorefinery provides closer access to urban transportation fuel markets**
- **Economic source of landfill gas to generate power and steam for ethanol biorefinery**
- **Existing landfill regulatory oversight might simplify permitting process for ethanol biorefinery**
- **Generate GHG credits from ethanol production, use of landfill gas and diversion of waste from decomposition**

Cellulose to Ethanol
Opportunities in Mississippi and SE USA

- Landfills
- Forest-based industries
  - Beneficial use of under utilized from forests
  - Wood residues from wood products industry
- Other agricultural residues
- Potential Benefits
  - Healthier forests – less susceptible to insects, disease and fire
  - Revitalization of forestry and wood products industries
  - Domestic fuel production, economic development

BFRE Milestones Completed: July 2006 to date

- July — Began trading on the pink sheets as BFRE
- July — Completed Heads of Agreement with **JGC Corporation** for Process Design for North America Projects
- August — Identified Southern California Landfill for development under DOE Grant Application in cooperation with **Waste Management Inc. (WMI)**
- August — Announced LOI with **Petro-Diamond, a Mitsubishi Subsidiary**
- Sept — Congressional Briefing on Status of Cellulosic Ethanol Commercialization with Other Industry Leaders
- Nov — So California Landfill Project Short-listed for DOE Grant
- Dec — Selected **MECS (formerly Monsanto)** as lead EPC Contractor
- Dec — Filed Form 10 SB to Become Fully Reporting Company
- Jan — Identified Co-location of biorefinery with biomass power plant under DOE loan guarantee application
- Feb — Won **U.S. Department Of Energy** Grant for So Cal Landfill Project
- March — Selected for **California Energy Commission** Funding
- April — Commence Permitting, development and engineering for first plant

BlueFire's Southern California Biorefinery Project

- Selected as award recipient under U.S. Department of Energy Biorefinery Commercial Demonstration Program under EPAct 2005

Amount -	$40 million (40% cost share of total project costs)
Location -	Southern California Landfill
Output -	Approx 18.6 million gpy ethanol
Feedstock -	700 dry tpd green and wood waste
Site advantages-	Landfill gas, electricity, infrastructure
Timing -	Engineering and permitting efforts started
Construction -	Q2 2008 subject to regulatory process
Operation -	Q4 2009
Participants -	Waste Management, Inc., Petro-Diamond (Mistubishi subsidiary), JGC Corporation, MECS (formerly Monsanto), Colmac Energy

Summary

- Ethanol is a viable and immediate Renewable Fuel Solution
- Cellulose ethanol is the future of ethanol
- As a Nation we must make commercialization of cellulose to ethanol an imperative strategy
  - Increase Production of Cellulosic Ethanol
  - Increase flexibility to blend higher levels of ethanol in reformulated gasoline
  - Expand E85 refueling infrastructure
  - Incentives for increasing flexible fuel vehicles production
  - Develop policies that support greater access to forest biomass, create mechanisms for cost-effective use
- The Reward
  - Consumers gain fuel flexibility
  - Pricing related to demand
  - Break addiction to oil without being dependent on ethanol interests