LOUISIANA'S BIOENERGY RESOURCES

Presentation to

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Green Business Energy Summit
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Baton Rouge, Louisiana

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Louisiana's Bioenergy Resources

PRESENTATION OUTLINE

- Introduction – Convergence of Factors
- Louisiana's Renewable Energy Resources
- Louisiana's Bioenergy Resources
- Bioenergy Drivers
- Bioenergy Challenges
- National Prognosis for Bioenergy
- Louisiana's Bioenergy Future
- Conclusions

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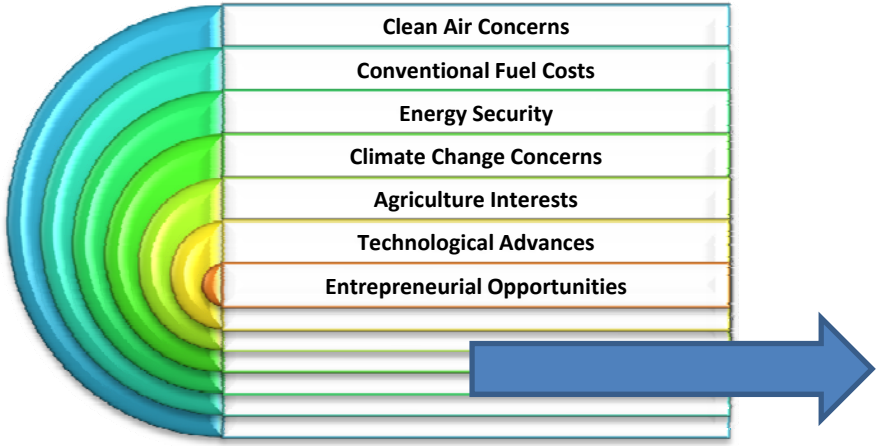
Introduction – Convergence of Factors



Energy Future

- ✓Domestic
- ✓Clean
- ✓Affordable
- ✓Renewable
- ✓Sustainable

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Louisiana's Renewable Energy Resources

- Hydroelectric (Sabine River Authority, Louisiana Hydroelectric)
- Hydrokinetic (Mississippi River possibilities)
- Wave
- Tide
- Ocean Thermal Energy Conversion (OTEC) – Some GOM potential
- Geothermal – some potential for direct heat along AR and TX borders
- Geopressured-Geothermal (Good potential LA and TX)
- Solar – some potential (2007 LA solar tax credit bill)
- Wind – some potential along coast (LA authorizes lease of state-owned lands for wind power production)
- Biomass – good potential (forest residues, mill residues, agricultural residues, urban wood wastes, e.g. bark, wood chips, bagasse, rice hulls)
- Biogas – landfills, anaerobic digestors
- Biofuels – good potential (grain/sugar ethanol, biodiesel, cellulosic ethanol, green diesel and gasoline, butanol, diesel/jet fuel from algae, pyrolysis liquids, syngas liquids)

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Louisiana's Bioenergy Resources

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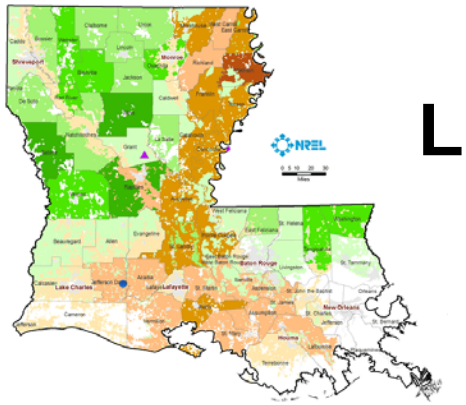

Louisiana's Bioenergy Advantages

- Mild climate – extended growing season
- Fertile soils
- Good solar radiation
- Plentiful rainfall
- Strong agricultural heritage/infrastructure
- Chemical manufacturing prowess
- Energy/fuels experience and distribution infrastructure

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Louisiana's Bioenergy Resources

BIOMASS FEEDSTOCKS	UNITS	LOUISIANA	U.S. TOTAL
Agricultural Residues			
Plant based (crop residues)	thousand dry tons	4,335	157,194
Animal based (methane from manure)	thousand tons	6	2,189
Wood Residues			
Forest residues	thousand dry tons	3,384	56,612
Primary mill residues	thousand dry tons	3,577	77,125
Secondary mill residues	thousand dry tons	33	2,615
Urban wood residues	thousand dry tons	474	30,902
Municipal Discards			
Methane from landfills	thousand tons	166	12,380
Methane from wastewater treatment	thousand tons	7	465
Dedicated Energy Crops Case Studies			
Conservation Reserve Program land			
-Switchgrass	thousand dry tons/yr	1,072	83,572
-Willow or Hybrid Poplar	thousand dry tons/yr	903	61,323

Data source: Milbrant, 2005

Louisiana's Bioenergy Resources

BIOMASS SOURCE	WET TONS	NET MILLION Btu	MILLION kWh
Residue Wood			
Sawdust, trimmings, bark	134,323	1,244,665	73
Logging slash	8,432,792	71,678,733	4,216
Soybeans			
Straw	1,501,071	8,916,364	524
Sugarcane			
Bagasse (dry wt.)	122,702	895,725	53
Rice			
Hulls (dry wt.)	85,100	766,751	45
Straw	2,180,694	11,928,397	702
Sweet Potatoes			
Vines	60,288	253,000	15
Corn			
Stalks, roots, husks	350,043	1,470,000	86
Wheat			
Straw	320,064	2,010,000	118
Grain Sorghum (milo)			
Residue	52,544	221,000	13
Cotton			
Gin trash	57,553	327,000	19
Peanuts			
Vines	1,435	6,700	0.39
Oats			
Straw	267,670	1,670,000	98
Animal Wastes			
Cattle manure/biogas	9,881,919,000 cf	5,930,000	395
Poultry manure	944,150	4,437,505	261
TOTAL		111,755,839	6,620

Approximately 98% of the wood milling residues (bark, sawdust, etc.), 96% of the sugarcane bagasse, and 54% of the rice hulls are already being used for energy and other purposes and are not included in these numbers.

Data source:
LSU AgCenter, 2006

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Louisiana's Bioenergy Resources

Louisiana Biofuel Production Potential (McGee and Crouch, 2007)

Using 2005 production data, McGee and Crouch estimated the amount of biofuel that could be produced from crops and waste products currently being produced in the state.

- They estimated that a little over *367 million gallons of ethanol* could be produced annually from sugarcane and grains (corn, grain sorghum, oats, and wheat) assuming the entire resource was used for biofuel production.
- Their estimate for *ethanol production* from biomass other than sugarcane and grains (e.g. forest residues, urban wood wastes, energy crops such as switch grass, bagasse, municipal wastes) was about *513 million gallons/year.*
- They estimated a production potential of around *64 million gallons/year of biodiesel* from oil crops and waste cooking oil/grease.
- Based on these estimates and some feedstock utilization assumptions, they concluded that *Louisiana could produce 18.7% of its transportation energy needs*.

Bioenergy Drivers

- An Obama administration placing high priority on green energy and addressing global warming
- Two high profile bills in Congress that contain aggressive goals for renewable energy
- The $787 billion American Reinvestment and Recovery Act (ARRA)

  * LDNR State Energy Program will receive $71 million from DOE; $9.8 million will be available for renewable energy projects through competitive grants.
- Federal Biomass Policy – Federal Legislation
  - Energy Policy Act of 1992 (EPAct)
  - The Biomass Research and Development Act of 2000 (revised by EPAct 2005)
  - Farm Bill 2002 Title IX
  - The Health Forests Restoration Act of 2003
  - Energy Policy Act of 2005 (EPAct 2005)
  - Energy Independence and Security Act of 2007 (EISA)
- Federal Renewable Fuels Standard Program (EPAct, EISA)
- Federal biofuel incentives
- State incentives/initiatives (e.g. RFS, Adv. Biofuel Ind. Dev. Init, Exec Order)
- Special Interests, national trade groups, environmental organizations, and volunteer organizations

Bioenergy Drivers

Renewable Fuel Volume Requirements for RFS2 (billion gallons)

YEAR	CONVENTIONAL RENEWABLE FUELS	ADVANCED BIOFUELS				TOTAL RENEWABLE FUELS
		CELLULOSIC	BIOMASS-BASED DIESEL	OTHER ADVANCED BIOFUELS	SUBTOTAL	
2006	4.00					4.00
2007	4.70					4.70
2008	9.00					9.00
2009	10.50		0.50	0.10	0.60	11.10
2010	12.00	0.10	0.65	0.20	0.95	12.95
2011	12.60	0.25	0.80	0.30	1.35	13.95
2012	13.20	0.50	1.00	0.50	2.00	15.20
2013	13.80	1.00	a	0.75	2.75	16.55
2014	14.40	1.75	a	1.00	3.75	18.15
2015	15.00	3.00	a	1.50	5.50	20.50
2016	15.00	4.25	a	2.00	7.25	22.25
2017	15.00	5.50	a	2.50	9.00	24.00
2018	15.00	7.00	a	3.00	11.00	26.00
2019	15.00	8.50	a	3.50	13.00	28.00
2020	15.00	10.50	a	3.50	15.00	30.00
2021	15.00	13.50	a	3.50	18.00	33.00
2022	15.00	16.00	a	4.00	21.00	36.00
2023+	b	b	b	b	b	b

[a] To be determined by EPA through a future rulemaking, but no less than 1.0 billion gallons.

[b] To be determined by EPA through a future rulemaking.

Bioenergy Drivers

Federal Biofuel Incentives

- VEETC – volumetric ethanol excise tax credit or "blenders tax credit" currently provides a tax break of 45 cents to registered blenders for every gallon of pure ethanol blended into gasoline in a effort to keep ethanol priced competitively with gasoline. Currently effective through 2010.

- A related tax credit is the small ethanol producer credit of 10 cents per gallon for facilities that produce less than 60 million gallons per year.

- The cellulosic biofuel tax credit (effective through 2012) allows producers to claim up to $1.01 per gallon of qualified ethanol.

- Biodiesel receives similar incentives, including a biodiesel tax credit which is now set at $1 per gallon through 2009.

- In addition to these tax credits, the U.S. biofuel industry benefits from a 54-cent per gallon tariff on imported ethanol that is currently in place through 2010.

Source: Early and McKeown (2009)

Bioenergy Challenges

- Competition With Conventional Fossil Fuels
- Competition With Other Renewable Energy Sources
- State of Technology
- State of the Economy
- Intrinsic Bioenegy Challenges
  - The food versus fuel controversy
  - Environmental impacts
  - Feedstock logistics
  - Industry fragmentation

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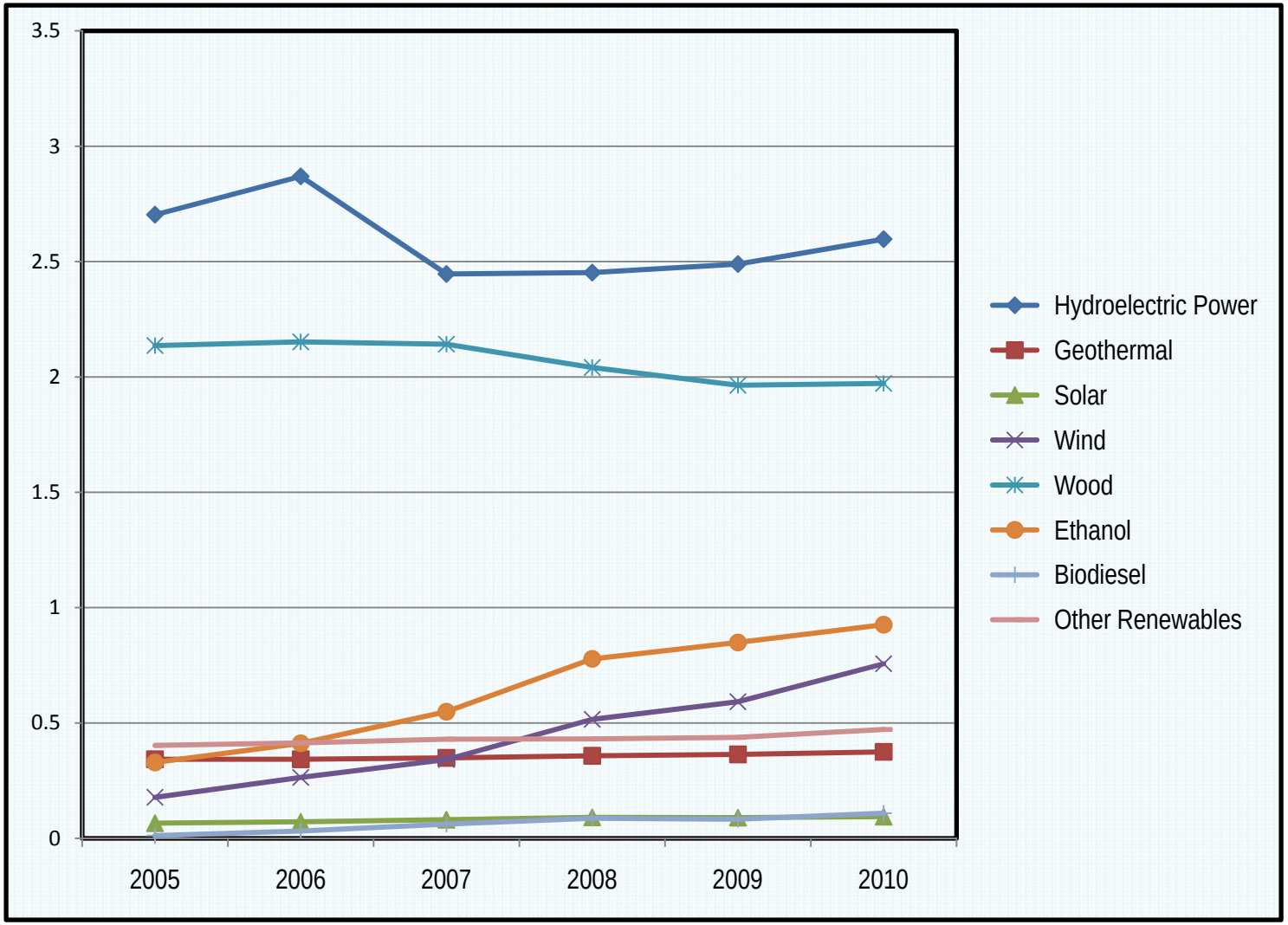
Bioenergy Challenges

Intrinsic Bioenegy Challenges:

- *Food Versus Fuel Controversy*
  - A number of studies produced widely differing results
  - CBO (2009) estimated that the increased use of ethanol for fuel accounted for about 10% to 15% of the rise in food prices between April 2007 and April 2008. Rising demand for corn also increased the demand for cropland and the price of animal feed.
- *Environmental Impacts*
  - Increased soil erosion, and runoff of nutrients and pesticides
  - Greater irrigation demands, pollution of groundwater
  - Loss of wildlife habitat and diversity
  - Land conversion for planting causes a long-term "carbon debt"
- *Feedstock Logistics* - With its areal distribution and low energy density, biomass is relatively expensive to collect and transport. Because of these traits, most bioenergy projects are limited to collection radii of about 50 mi.
- *Industry Fragmentation* – Industry is composed of fuel providers (farmers, foresters, agricultural processors, and urban waste operators), fuel producers (companies that collect, process, and transport biomass residues to end users), and fuel users (power plant operators, liquid fuel manufacturers). Difficult for industry to address common issues.

National Prognosis for Bioenergy

U.S. Renewable Energy Supply (Quardrillion Btu)



Source: EIA, 2009

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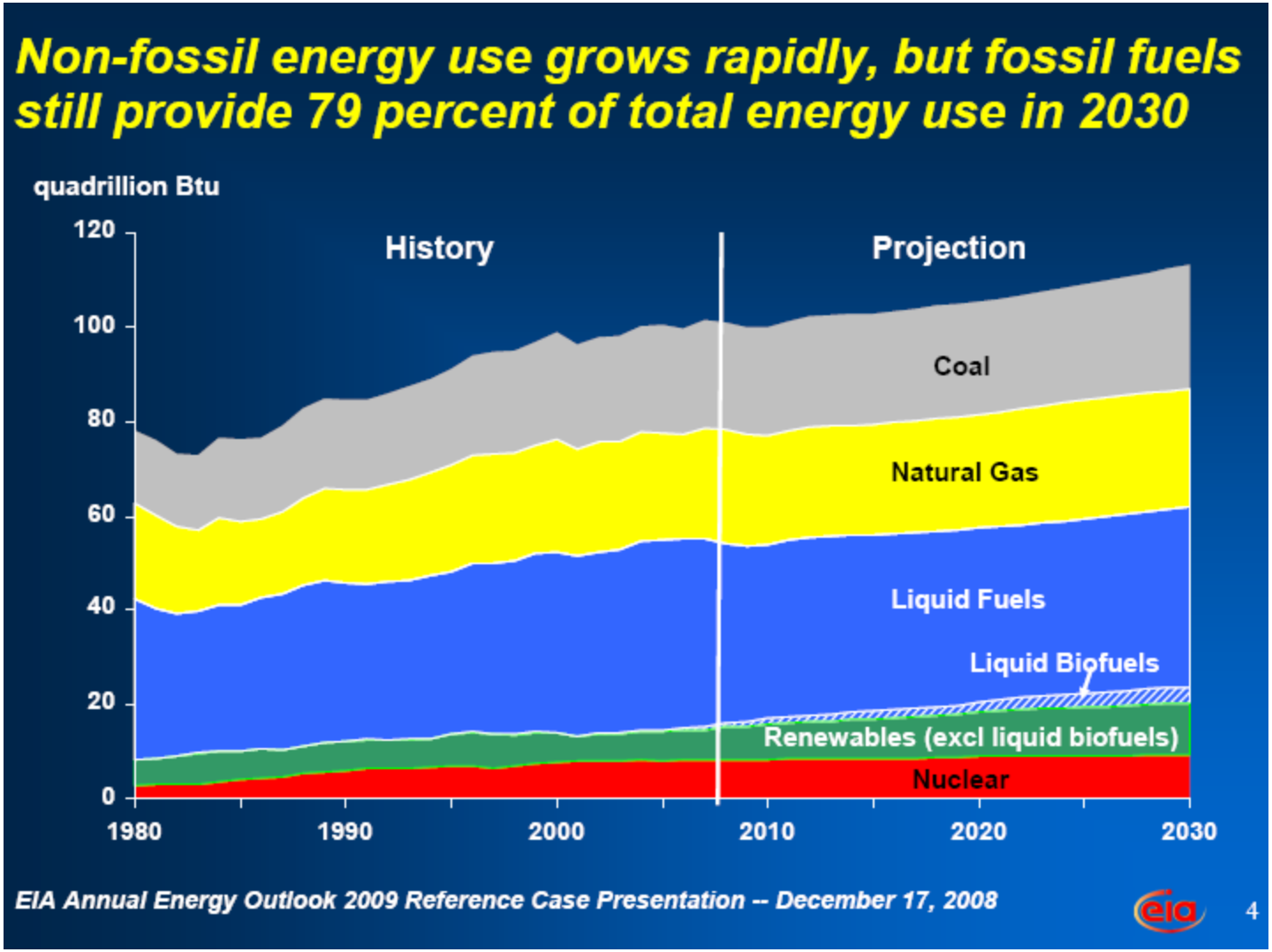
National Prognosis for Bioenergy



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Louisiana's Bioenergy Future

Near-Term

Given current circumstances both nationally and locally, the near-term outlook does not look promising for bioenergy production in Louisiana, especially for 1st generation biofuels such as corn ethanol and soy biodiesel.

Intermediate to Longer-Term

Efforts made now to research, promote, and establish capabilities for production of 2nd generation and/or advanced biofuels could substantially benefit the state's long-term economic development. Some examples of promising 2nd generation/advanced biofuels are:

- Cellulosic Biofuels
- Bio-based Biodiesel
- Woody Biomass Fuels
- Biogas – Anaerobic Digestion
- Thermochemical Conversion Technologies

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Louisiana's Bioenergy Future

Current Status of Biofuel Facilities in Louisiana

Company	Location	Product	Feedstock	Capacity million gpy	Status
Aspen Biofuels New Orleans LLC	New Orleans	Biodiesel	Soy/palm oil & tallow	80	Construction not begun
Bionol Lake Providence LLC	Lake Providence	Ethanol	Corn	108	Construction on hold
Bossier City BioEnergy Partners LLC	Bossier City	Ethanol	Ethanol transfer only	84	Construction not begun
Dynamic Fuels LLC	Geismar	Renewable diesel	Animal fat	75	Under construction
Greater Baton Rouge Ethanol LLC	Port Allen	Ethanol	Corn	100	Cancelled
Green Earth Fuels of New Orleans LLC	Harvey	Biodiesel	Undecided	86	Cancelled
Louisiana Green Fuels LLC	Lacassine	Ethanol	Sugarcane, sweet sorghum	22	Under construction
Renewable Energy Group Inc.	St. Rose	Biodiesel	Soybean Oil	60	Construction on hold
South Louisiana Ethanol LLC	Belle Chase	Ethanol	Corn	65	Construction on hold
Tiger State Ethanol LLC	Convent	Ethanol	Corn	110	Construction not begun
Tiger State Ethanol LLC	Lake Providence	Ethanol	Corn	110	Construction not begun
Tiger State Ethanol LLC	Paulina	Ethanol	Corn	110	Cancelled
Vanguard Synfuels LLC	Pollock	Biodiesel	Soybean oil	15	Inactive
Verenium Corporation	Jennings	Ethanol	Biomass	Pilot scale	Operating
Verenium Corporation	Jennings	Ethanol	Bagasse, energy cane	1.4	Operating

Louisiana's Bioenergy Future

Cellulosic Biofuels

Biofuels derived from cellulosic feedstock offer many advantages over those derived from cultivated food crops such as corn and soybeans:

- Louisiana has substantial feedstock resources in wood and agricultural residuals.
- The state has good potential for producing specific energy crops such as high-fiber sugarcane, sweet sorghum, switchgrass and miscanthus.
- Louisiana's extended growing season allows for the possibility of producing a much wider variety of feedstock crops.
- Life-cycle greenhouse gas emissions are much lower than conventional fossil fuels and corn-based ethanol and easily qualify for meeting EPA renewable fuel standards.
- Not as susceptible to food-versus-fuel controversy.

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Louisiana's Bioenergy Future

Bio-based Biodiesel

While the soybean-based biodiesel industry is currently struggling because of economic factors, the potential for biodiesel produced from other feedstocks such as animal fats, non-traditional crops, and algae looks promising for our state. As examples:

- Dynamic Fuels, a joint venture of Tyson Foods and Syntroleum Corporation, is building a new facility in Geismar that will convert animal fats and greases provided by Tyson into ultraclean renewable diesel and jet fuel.
- A recent report commissioned by Louisiana Economic Development concludes that high yield potential and low impact on existing agriculture make algae a strong candidate for renewable fuel production.
- There is considerable interest in bio-based biodiesel in the aviation industry. Recent test results show that a jatropha and algae oil biofuel blend used in a Continental Airlines January 7 biofuel demonstration flight proved approximately 1.1% more efficient that traditional jet fuel and reduced life cycle GHG emissions by an estimated 60-80%. The Defense Advanced Research Projects Agency (DARPA) is funding research to accelerate the development of surrogates for military-grade jet fuel (JP-8), of which DOD consumes nearly 3 billion gal/yr.
- On July 14th, ExxonMobil announced plans for a $600 million investment in producing liquid transportation fuels from algae.

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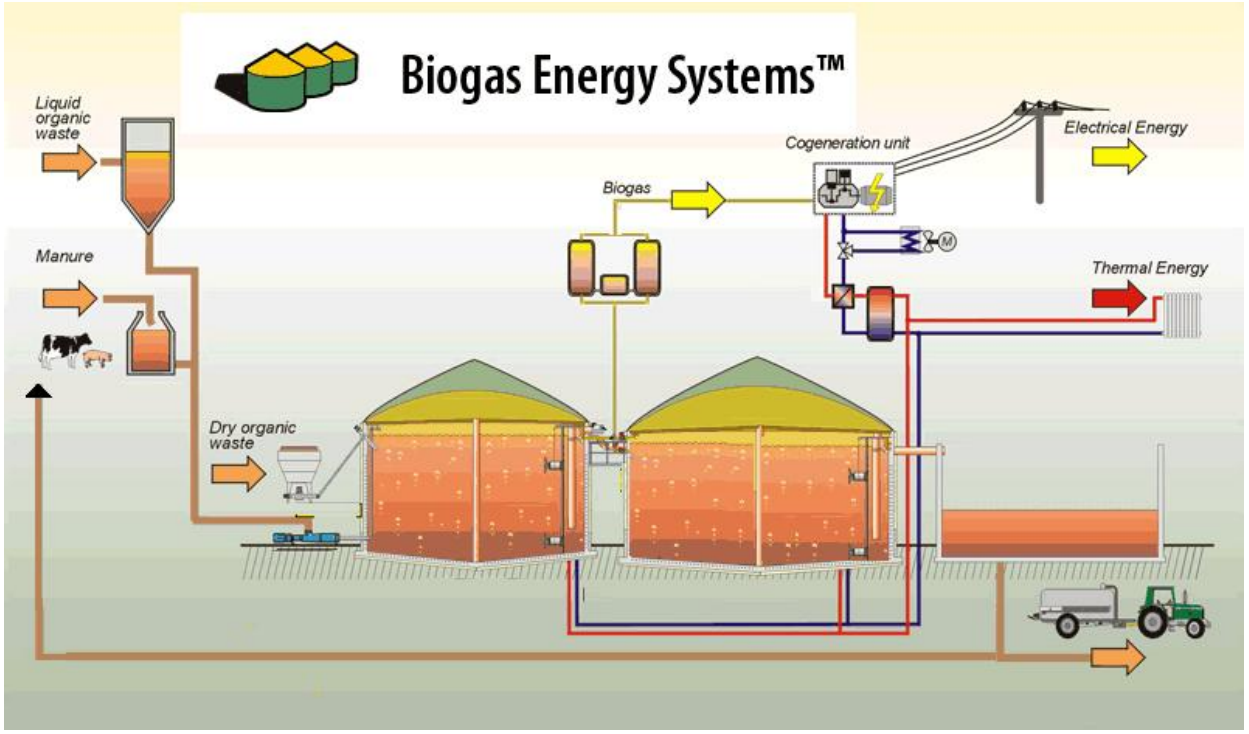
Biogas – Anaerobic Digestion



•DOE (1998) found that it is feasible to capture and use over a third of biogas potential from landfills, animal waste, and sewage or about 1.25 quadrillion Btu (about 6% of all natural gas used in the U.S).
•In Sweden, biogas from organic wastes fuels city buses, garbage trucks, taxi cabs, even a train.
•Over 4,000 anaerobic digesters have been built in Germany.
•A new generation of AD has been developed in the UK to help solve the problem of shortage of landfill sites.

Biogas offers a number of advantages as a bioenergy resource:

- It relies on mature technologies.
- It is a renewable energy source with low lifecycle GHG emissions.
- It can be distributed through existing natural gas infrastructure.
- It can reduce the amount of organic wastes going to landfills.
- Residuals can be used to enrich soils.
- Used for treating livestock wastes on farms, it can reduce water pollution.

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Woody Biomass Fuels – Fuel Pellets

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Woody Biomass Fuels – Fuel Pellets

- Wood pellets as a heating fuel actually originated in the U.S. in the 70's in response to high energy prices and is now an increasingly popular co-fire and stand-alone feedstock for commercial and utility renewable energy applications, especially in Europe.
- The EU requires member countries to generate 20% of their electricity from renewable resources by 2020. Although wood pellets are a bit pricier than coal, burning them is a less-expensive way to generate electricity than using wind or solar energy. Europe imported about $93 million of pellets and other wood-based fuels in the first three months of 2009, up 62% from the same period a year ago. Europe presently consumes about 8 million tons of wood pellets annually.
- Until recently, there were about 40 pellet factories in the U.S., which produced about 900,000 tons per year, mostly for heating homes in the Northeast and Northwest. Since May, 2008 there have been a number of large capacity (500,000 tons/yr) plants opened or announced (e.g. Cottondale, FL; Selma, AL; Camden, AR; Corinth ME).
- In March, 2009 plans to build a $100 million wood pellet-making plant at the Port of Greater Baton Rouge were announced, with the pellets to be sold as fuel overseas.
- There are currently two high-profile bills in the U.S. Congress that would require a renewable energy standard (RES) for electrical generation similar to that in Europe, and it appears likely there will be a federal RES within the next year or two. This will greatly increase interest in wood pellets in the U.S.
- American Electric has conducted biomass co-firing tests at several of its U.S. plants.
- Electric utilities in Georgia and Texas have recently announced they will build several biomass-fueled generating plants by 2015.

Louisiana's Bioenergy Future

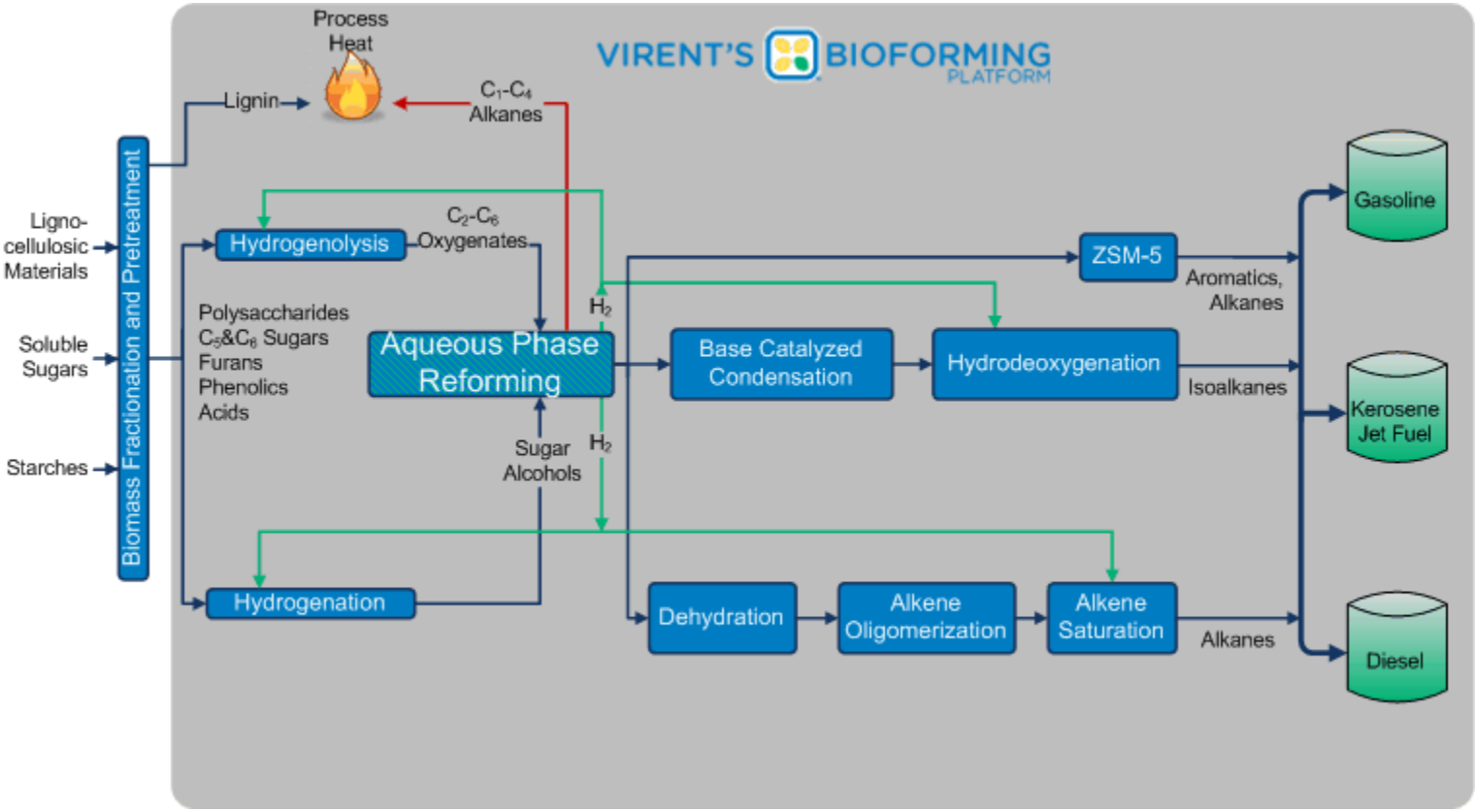
Themochemical Conversion

- Thermochemical conversion technologies (TCT) convert biomass to fuels, chemicals, and power using gasification and pyrolysis techniques. The TCT route for biofuel production is largely based on existing technologies that have been in operation for a number of decades.
- Gasification involves heating biomass with about one-third of the oxygen necessary for complete combustion to produce a mixture of carbon monoxide and hydrogen, known as syngas.
- A typical biomass-to-liquids (BTL) process would involve the production of a syngas which is cleaned before being passed through the Fischer-Tropsch process to create a range of liquid fuels suitable for aviation and marine applications, but mainly synthetic diesel.
- Pyrolysis involves heating the biomass in the absence of oxygen to produce a liquid pyrolysis oil that can be refined to produce various fuels and chemicals.
- A principle advantage of TCT is the wide variety of feedstocks that can be used to produce any number of specific fuels or chemicals.
- A principle disadvantage is cost.

Louisiana's Bioenergy Future

Thermochemical Conversion

Chemical Bioforming



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Conclusions

- National concerns for energy security, environmental pollution, and global warming have significantly raised interest in clean, domestic, renewable sources of energy.
- Louisiana's natural setting, agricultural heritage, chemical manufacturing prowess, and fuels distribution infrastructure make it particularly well-suited for the development of its abundant bioenergy resources.
- Development of these resources will depend on economic factors as well as federal, state, and local rules and policies.
- There are presently many sentiments, incentives, and regulatory drivers directed toward development of renewable energy resources. However, there are also a number of challenges facing the development of these resources including cost, technology, and environmental impact concerns.
- Given current national and state circumstances, the near-term outlook for bioenergy in Louisiana is not promising. *However, efforts made now to research, promote, and establish capabilities for production of advanced biofuels could substantially benefit the state's long-term economic development.*