Direct Combustion, Anaerobic Digestion, Cellulosic Biofuels, Biochemicals, Animal Feed

Six-month-old Giant King Grass in California

Giant King® Grass Overview

Characteristics	Cost	Range
Very high yield proprietary hybrid (non-GMO), harvested twice a year at 15+ feet Composition like Corn Stover and Miscanthus	Projected lowest cost delivered to the power plant or bio refinery **10x** the yield of Corn Stover and **3x** the yield of Miscanthus per acre	Warm weather climates –tropical regions including Southern U.S., Hawaii, Puerto Rico, Virgin Islands, Guam) Grows on marginal land

High potential "platform" energy crop for biopower, biofuels, biochemicals and other bioproducts

GKG Characteristics: Fast Growing Perennial Grass

After Cutting

2 Months Animal Feed

3 Months Biogas Production

6 Months Biofuels & Biopower

Cost: GKG Advantaged in Key Cost Categories

Costs	Key Drivers	Performance
Growth	Land Use	✓ Highest yield per acre of land
	Water Use	✓ Highest yield per acre-foot of water
	Land Quality	✓ Grows well on marginal land
	Land Amendments	✓ Perennial crop improves land over time through the addition of organic matter.
Harvesting / Logistics	Harvesting	✓ Can use standard equipment
	Transportation	✓ Co-location of biorefinery or power plant and plantation reduces transportation distances and costs
	Storage	✓ Just-In-Time, year-round harvesting reduces or eliminates need for significant storage

VIASPACE Develops Projects in Addition to Being a Feedstock Supplier

10-35 MW Direct Combustion Power Plant
1-10 MW Anaerobic Digestion Power Plant

VIASPACE can provide

- **Agricultural support**
- **Business plan development**
- **Financial models**
- **Prefeasibility studies**
- **Bankable feasibility studies**

VIASPACE partners provide technology & EPC contracting

GKG Projects in Development: Nicaragua Biopower

12 MW biomass direct combustion power plant
- 84 GWh of salable baseload electricity
- Well proven technology
- connected to the Nicaraguan grid

Fueled by 2,100 acre Giant King Grass plantation
- Co-located with power plant
- Irrigation from Lake Nicaragua for reliability
- Cultivation similar to sugarcane

VIASPACE partner is AGRICORP, a large agribusiness company in Nicaragua
- Land and expertise for plantation operations

EPC contract signed, debt financing letter of intent from IDB and FMO, local utility will operate

Giant King Grass growing well on part of 10,000 acre rice plantation not suitable for rice

GKG Projects in Development: AD Plant on St. Croix, US Virgin Islands

Tibbar Energy USVI is developing an anaerobic digestion (AD) biogas power plant on St. Croix, US Virgin Islands

Primary feedstock is Giant King Grass, which will be grown on 1,500+ acres

Biogas used to power generator to produce 7MW of base-load renewable electricity.

Tibbar will be the only base-load renewable energy project independent of fossil fuel in the USVI

Giant King Grass is harvested 4-5 times a year at 8-10 feet tall for anaerobic digestion

Giant King Grass on St. Croix

Typical Anaerobic Digestion Plant

Giant King Grass Nursery: San Diego County, California

- Primary nursery facility is in San Diego County, California and source of propagation material
- Giant King Grass is vegetatively propagated like sugarcane, but at a higher ratio for improved scalability
- Shipments and exports inspected and approved by USDA

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
PLANT PROTECTION AND QUARANTINE

PHYTOSANITARY CERTIFICATE

TO: THE PLANT PROTECTION ORGANIZATION(S) OF

FOR OFFICIAL USE ONLY

PLACE OF ISSUE
San Diego, California

NO. **F-C-06073-04005380-7-N**

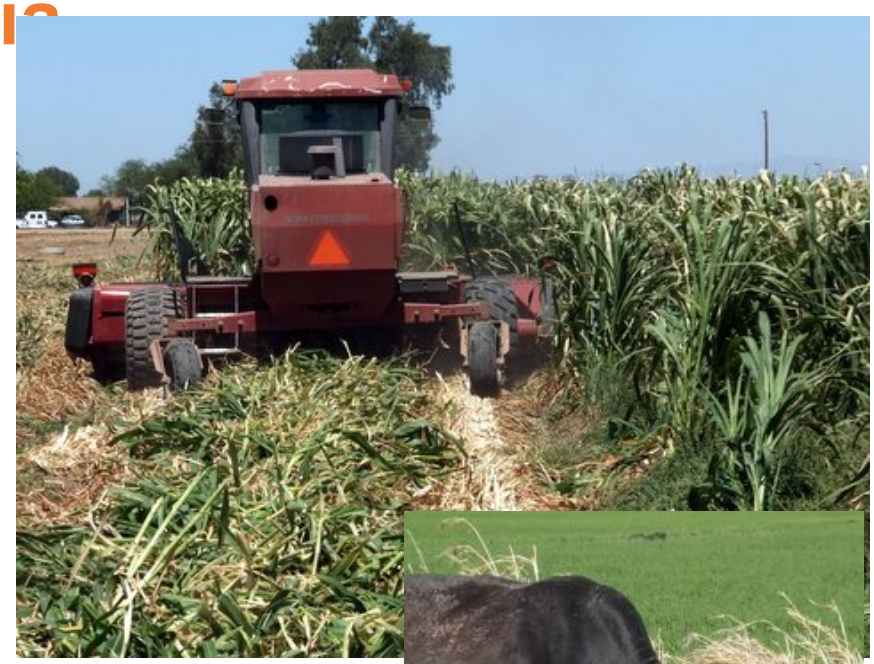
DATE INSPECTED

USDA

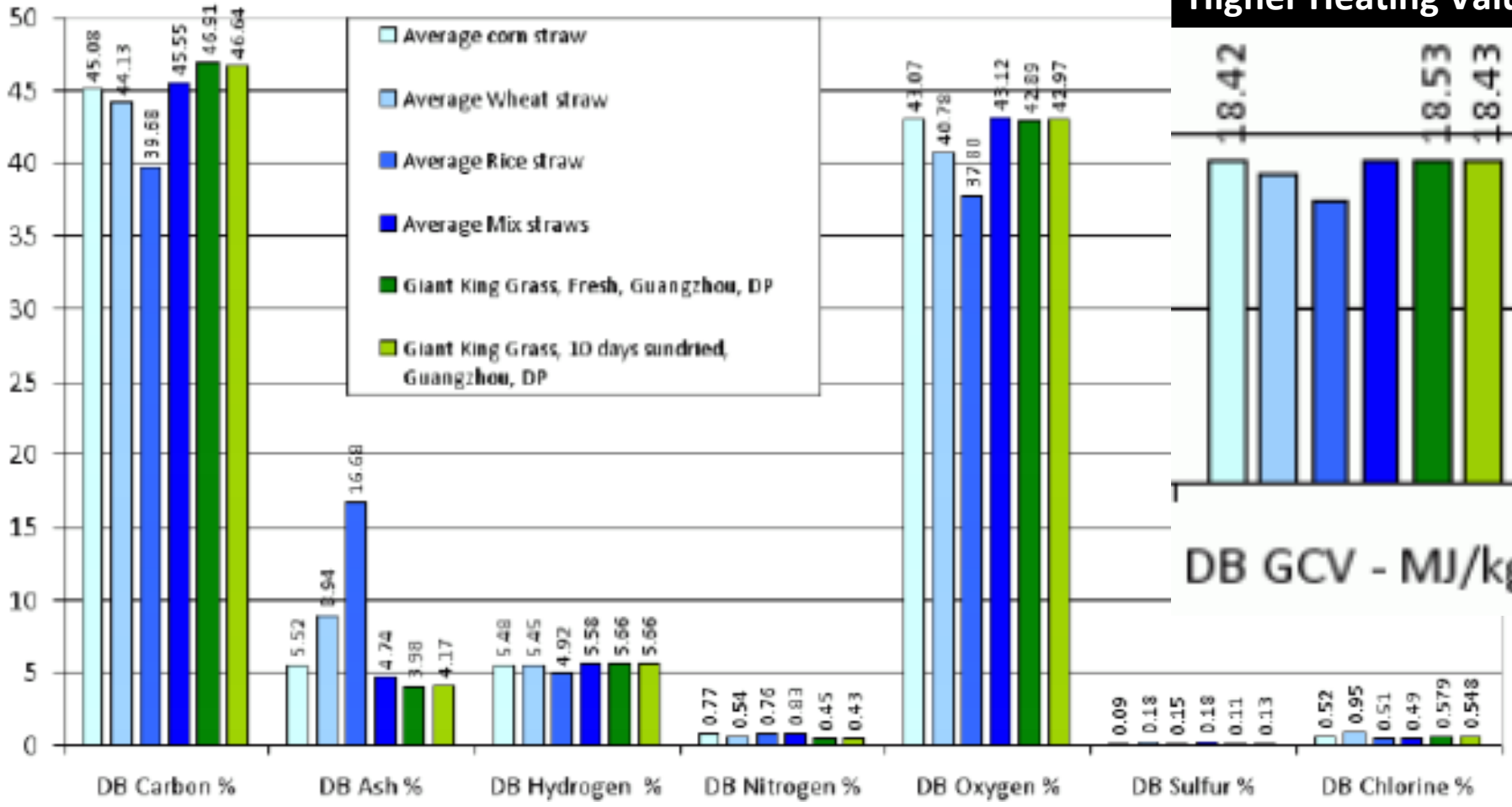
Giant King Grass in Hawaii
Second VIASPACE Nursery

GKG Research: Imperial Valley California

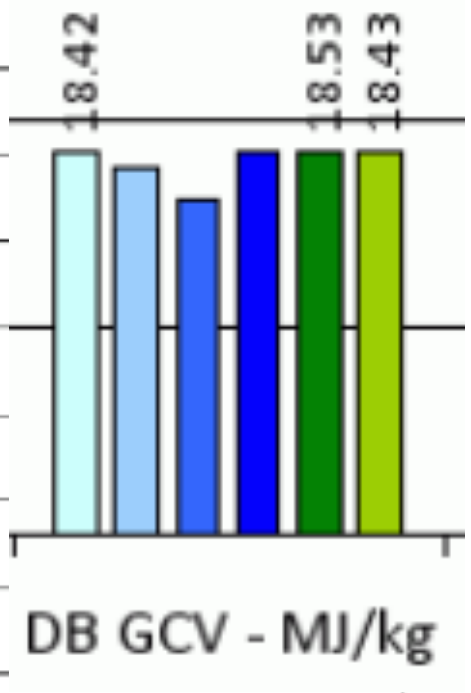
- University Of California Desert Research Center
- Growth in high temperature desert conditions
- 6 month harvest for bioenergy
- 2 month harvest for animal feed
  - High protein 14-17%
  - High Yield



Giant King Grass & Agricultural Waste



Higher Heating Value



Biomethane Production from GKG

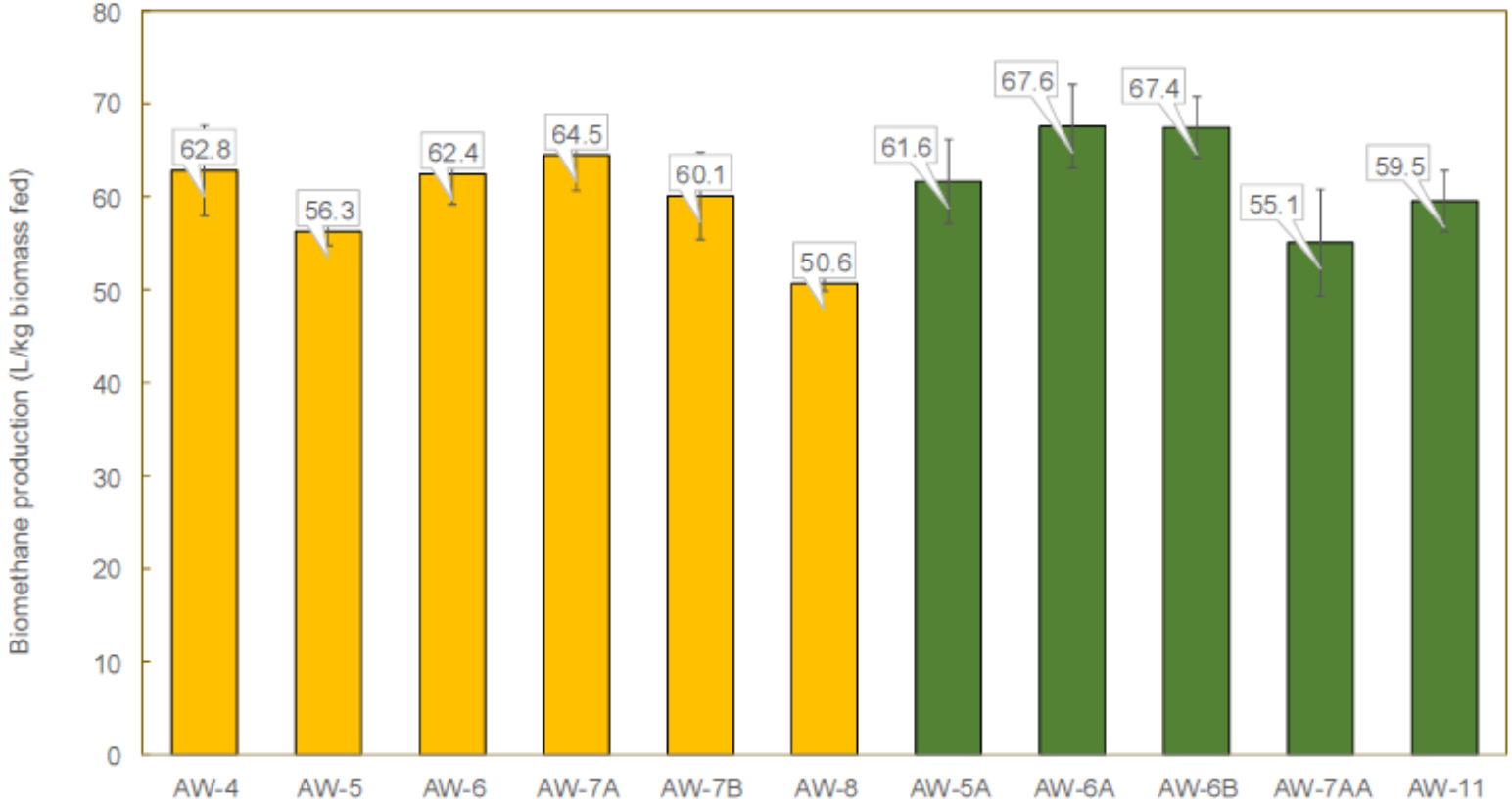


Figure 1. Overall biomethane production (@ STP) normalized by total biomass fed for the six GKG samples assessed in Batch #1 (yellow columns) and five in Batch #2 (green columns); callouts show the overall values; error bars represent the standard deviation obtained from replicates (three independent bioreactors).

GKG Composition for Biofuels & Biochemicals

Giant King Grass analysis by 3 independent companies:

Composition Dry Weight %	Giant King Grass	Corn Stover	Miscanthus
Glucan	43.0	37.4	44
Xylan	22.3	21.1	22
Arabinan	2.9	2.9	2
Lignin	17.4	18.0	17
Ash	4.5	5.2	2.5-4

Sugars used for biofuels and bioproducts

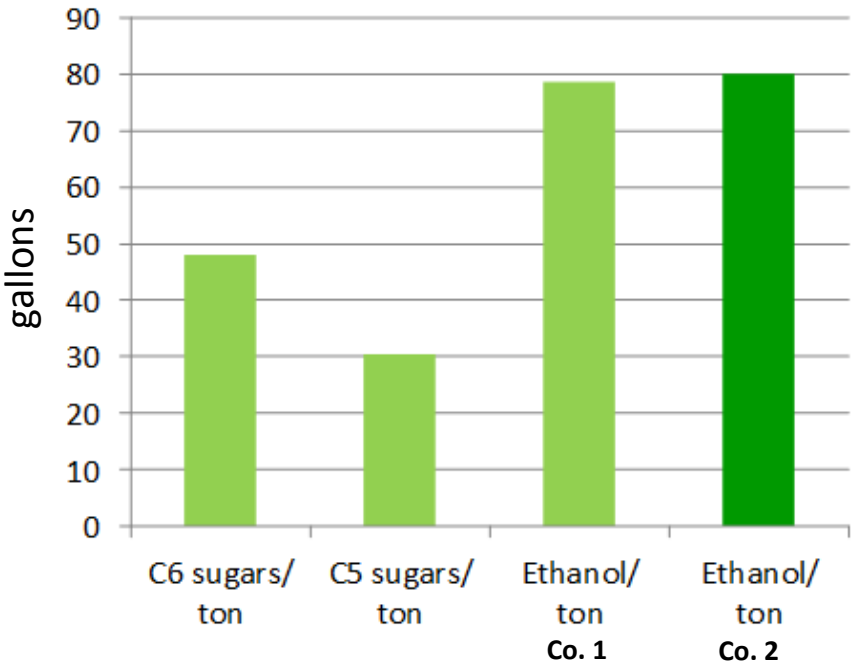
Byproducts

Notes and references:
Giant King Grass: average of samples cut at 4 m tall; **Data from Novozymes, POET, TMO**
Corn Stover: Aden et al. NREL/TP-510-32438, 2002
Miscanthus: Murnen et al. Biotechnology Progress 23, 4, 846-850, 2007 and other sources

Giant King Grass composition is equivalent or slightly better than Corn Stover and Miscanthus for biofuels and bioproducts

Independent Pretreatment & Enzymatic Hydrolysis Testing

Sugar (meas.) and Ethanol Yields (est.)



"Giant King Grass ethanol production is very similar to corn straw and Giant King Grass is probably easier to process"
– POET scientist

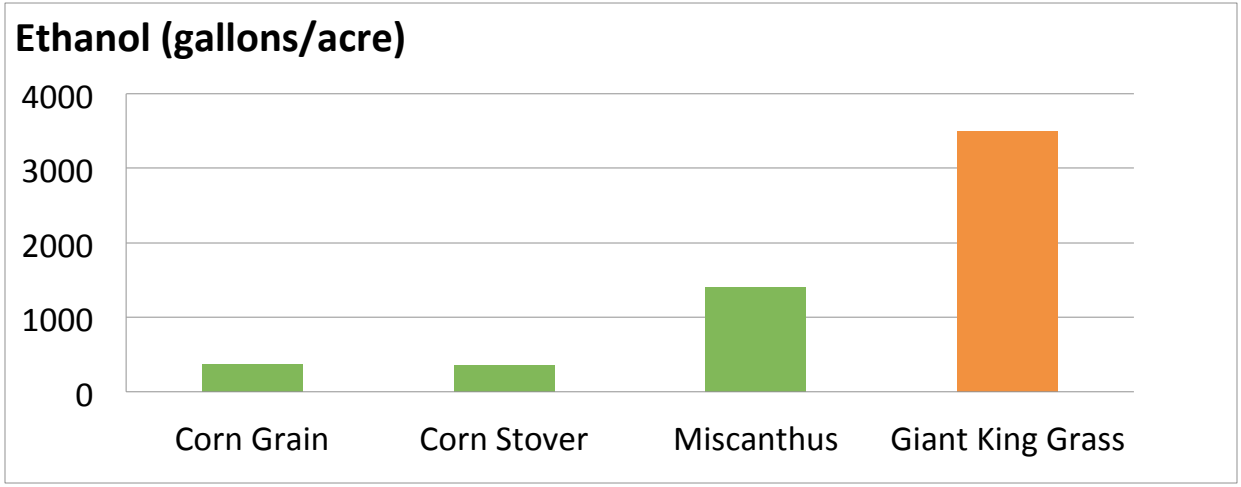
- Conversion of hemicellulose (xylan) to xylose >90%
- Conversion of cellulose (glucan) to glucose > 85%

High Land Use Productivity

Highest land use efficiency...

Yield Dry Matter	Giant King Grass	Corn Stover	Miscanthus
US ton/acre	**42**	**3.5-4.7**	**14-18**
Metric ton/ha	**94**	**8.6-11.6**	**31-40**

... results in highest productivity per acre.



Giant King Grass yields two harvests per year in warm climates compared with one harvest per year for corn and miscanthus.

Giant King Grass Pellets as Coal Replacement

- Giant King Grass pellets can replace up to 20% of coal in an existing coal-fired power plant
- Preserves large capital investment in existing power plant w/30 year additional life
- Meets carbon reduction targets
- 16M tons of pellets used globally today, 46M tons by 2020
- Grass is grown, dried and pressed into pellets and shipped in bulk like shipping grain

Composition Determination

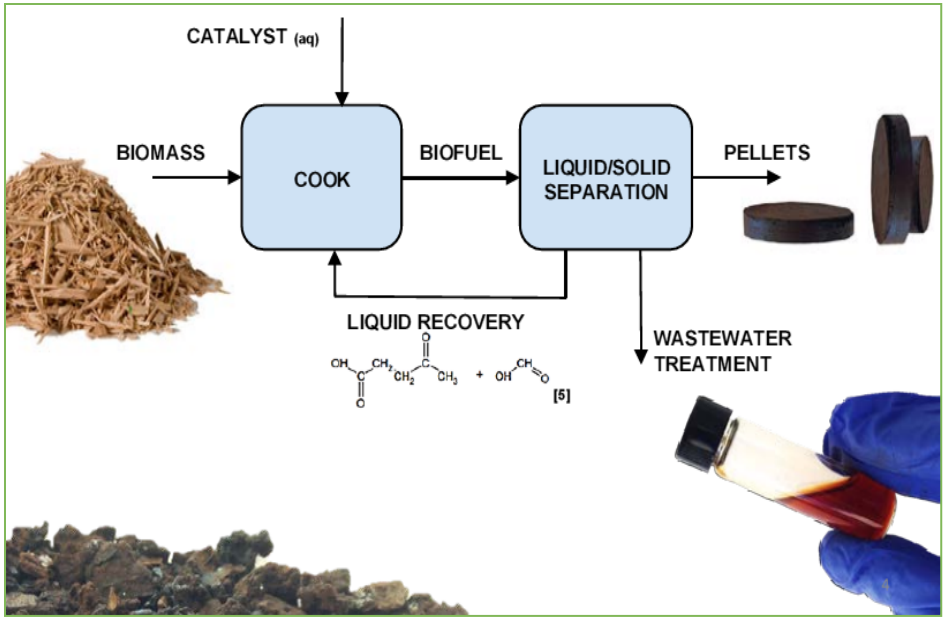
Parameter	Amount (a.r.)
Total Moisture	8 81
Moisture Airdry	
Ash	4 66
Volatile matter incl. moisture.	
Volatile matter	70,34
Fixed Carbon	16,18
Gross Calorific Value	4055 2
	16,978

Hydrothermal Process Conversion of Giant King Grass to Bio-coal

Partnered with PCS Biofuels, Inc. to convert GKG to drop-in coal replacement using its patented Polymer Carbon Solid (PCS) thermal catalytic process.

Results for PCS GKG biofuel:

- Same energy density as metallurgical coal (~24MJ/Kg)
- Burns cleanly without generating sulfur, mercury or other emissions found in coal
- Hydrophobic and can be stored outdoors like coal and pulverized in the same machines as coal.
- Ash content is similar to that of a good coal
- High melting point, above 950°C; no co-firing problems expected



Giant King Grass – Platform Crop

Multiple Applications

- Cellulosic liquid biofuels--ethanol/butanol
- Pyrolysis to bio oil
- Catalytic conversion to bio diesel
- Biochemicals and bio plastics
- High-temperature gasification
- Direct combustion for electric power/heat/ steam
- Pellets for co-firing with coal
- Briquettes for boilers
- Torrefaction/hydrothermal processing to bio coal
- Biogas /anaerobic digestion
- Pulp for paper and textiles
- Animal feed

Independent Testing Data

- Proximate & Ultimate analyses
- Trace metals
- Ash composition & melting temperature
- Biomethane production
- Cellulosic sugar composition
- Pretreatment and enzymatic hydrolysis
    - C5 and C6 sugars
- Bio coal analysis
- Animal feed nutrition

Energy content HHV: 18.4 MJ/dry kg= 4400 kcal/kg=7900 BTU/ lb
Biogas production: 539-758 liters/dry kg; 51-57% methane
Biofuels analysis: Glucan 43%; Xylan 22%; Arabinan 3% Lignin 17%
Cellulosic ethanol projection: 80 gallons per US ton)
Cellulosic ethanol yield projection: 3,500 gallons per acre
Biocoal: 24 MJ/kg HHV

Summary: Giant King® Grass

Advantages

- High yield dedicated energy crop producing 21 dry tons per acre per harvest when harvested for biofuels and biopower twice a year at 14+ feet tall
- Perennial crop, cut and regrow for 7 – 10 years
  - No need to plow & replant every year
  - Promotes strong subsoil environment
- Natural proprietary grass, not genetically modified
- Will grow on marginal land, does not displace food crops
- Well suited for bioenergy applications
- Provides reliable, low cost fuel or feedstock for 24/7 operations 365 days/year

Limitations

- Tropical and subtropical grass requiring non-freezing areas for perennial growth
- Giant King Grass has high water use efficiency and is drought tolerant, but needs consistent rainfall or irrigation for optimum production

Giant King Grass

Lowest Cost Feedstock Because of High Yield

High Energy Content

Composition like Corn Straw

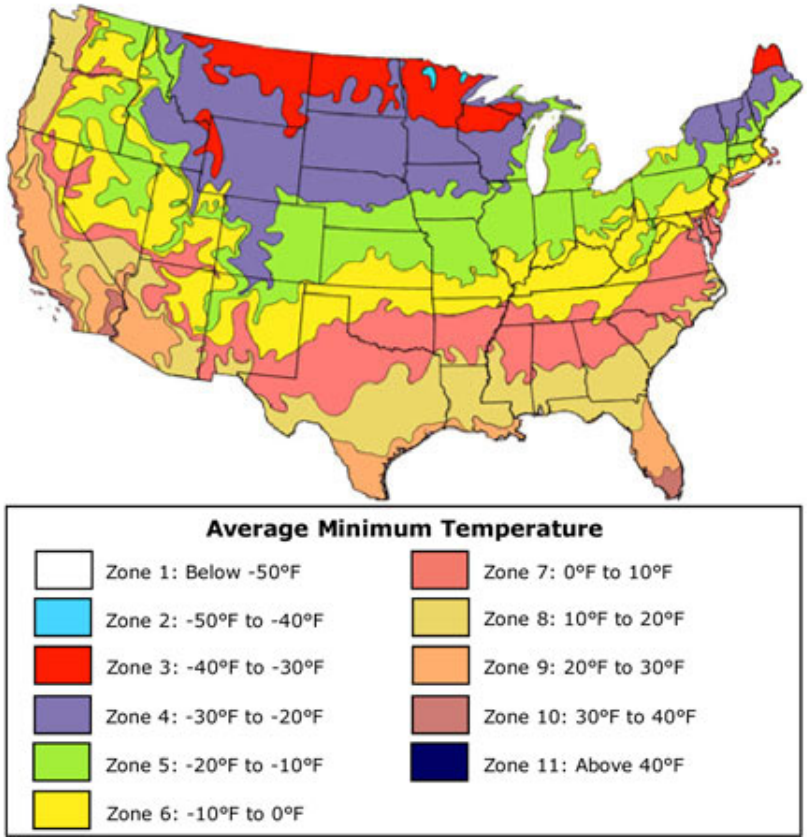
THANK YOU!

Giant King Grass U.S. Range

Giant King Grass is a tropical and subtropical grass suitable for Southern U.S. (zones 8+ on map), Hawaii, Puerto Rico, Virgin Islands, Guam, American Samoa

Giant King Grass will survive a short freeze – the roots survive and plant re-grows when the weather warms – but not an extended period of freezing weather

Giant King Grass requires warm weather, sunshine and sufficient rainfall or irrigation.



VIASPACE Background

- VIASPACE is a publicly traded company: Symbol VSPC
  - Fully reporting to SEC and audited
  - Headquartered in California, USA
- Originally founded in 1998 as an incubator to commercialize technology from Caltech/NASA Jet Propulsion Laboratory (JPL)
  - Dr. Carl Kukkonen, founder, directed a JPL research center
  - Original products came “via” the “space” program
- VIASPACE now focused on biomass for biofuels, bioproducts and bioenergy
- Giant King® Grass is a proprietary high-yield, dedicated energy crop currently being grown in California, Hawaii, St. Croix (US Virgin Islands), and other countries in Africa, Asia, Central and South America
- Experienced management and technical team