

# Giant King Grass as an Energy Crop in the United States



Clean Energy for a  
Cleaner Tomorrow



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- VIASPACE is a publicly traded company on the US OTC Bulletin Board
  - VIASPACE stock symbol VSPC.OB

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# Dr. Carl Kukkonen

## CEO Biography



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**1998-PRESENT VIASPACE Inc. CEO**

**1984-1998 NASA/Caltech Jet Propulsion Laboratory (JPL)**

**Director Center for Space  
Microelectronics Technology  
& Manager of Supercomputing**

- Led staff of 250 with \$70 million annual budget
- On review boards of 14 leading universities
- NASA Exceptional Achievement Award 1992
- Space Technology Hall of Fame 2001

**1977-1984 Ford Motor Company**

- Developed direct injection diesel engine
- Ford's expert on hydrogen as an automotive fuel
- Research in Physics Department



**1975-1977 Purdue University postdoctoral fellow**

**1968-1975 Cornell University MS & PhD in theoretical physics**

**1966-1968 University of California Davis BS physics**



**See Giant King Grass  
At Booth 734**

**Giant King Grass growing in California**

# Giant King™ Grass



- Highest yield, perennial grass-dedicated energy crop
  - Plant once, harvest for 7-10 years
- Electricity generation
  - Direct combustion
  - Anaerobic digestion
  - Gasification
- Pellets
- Cellulosic biofuels, biochemicals and
- bio plastics
- Tropical and subtropical grass
  - Does not survive a long freeze
- Natural hybrid, not genetically modified
- Not invasive species



**Giant King Grass is approved by USDA APHIS  
for distribution in the US**



**Giant King Grass growing in California  
We cut plants to gather data, provide nodes  
for propagation and measure regrowth**









HOLD

lb

44LB x 0.02LB



**Cut area provides yield data, nodes for propagation  
and test area for regrowth after cutting**





**Manual planting**

# Drip tape irrigation





**1 Week  
New growth**



**2 weeks  
New growth**



**5 weeks  
New growth**

# Regrowth is faster because roots already in place

A photograph showing a vast field of tall, green grass. In the center, a man wearing an orange shirt and dark pants stands looking towards the camera. The grass in the foreground is bright green and dense, while the grass behind him is tall and yellowish-brown, indicating regrowth after a cut. The sky is clear and blue.

**5 weeks  
Regrowth**



**11 weeks  
New Growth**



**11 weeks  
Regrowth**



**5 ½ months  
New Growth**

**5  $\frac{1}{2}$  months  
Regrowth**





**6  $\frac{1}{2}$  months  
New Growth**



**6 ½ months  
Regrowth**

# Giant King Grass

- 14 + feet tall in 6 months
- Harvest twice a year
- Growing in
  - US
  - St. Croix, US Virgin Islands
  - Central America
  - Myanmar
  - Thailand
  - South Africa



# Manual Harvesting



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**Mechanical harvesting**



**Preparing Giant King Grass propagation nodes**

# Refrigerated container of Giant King Grass nodes sent to St. Croix



# GIANT KING GRASS

*is coming!*

[www.TIBBARENERGY.com](http://www.TIBBARENERGY.com)

Biomass to Energy

St. Croix US Virgin Islands



# Energy *crop*

Company growing Giant King Grass  
to produce renewable power on STX



**Front-page story in St. Croix Avis**



**St. Croix US Virgin Islands**

# DEPARTMENT OF AGRICULTURE STATE OF HAWAII PLANT QUARANTINE



## Biomass Electricity

**Low Cost, Renewable, Low Carbon  
Option That Provides Jobs for Farmers**

# Closed Loop Biomass Power Plant



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- Power plant co-located with Giant King Grass (or other biomass) plantation
- Water and sunshine in—clean, low carbon electricity out



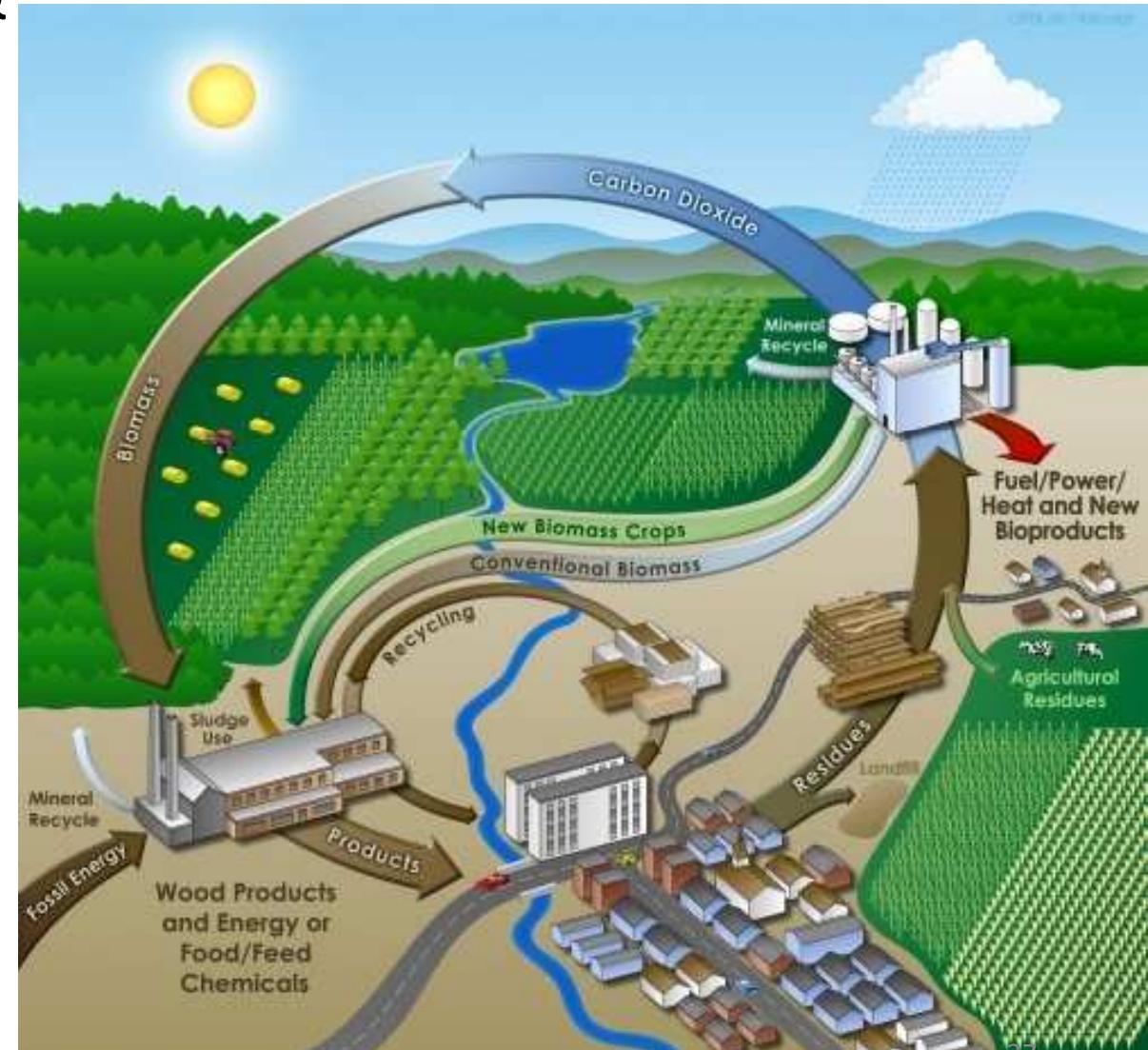
**VIASPACE ← Power Plant Partner → EPC → Customer**

# Biomass is Low Carbon Fuel Plants Breathe Carbon Dioxide



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- Plants use sunlight & CO<sub>2</sub> to grow. Carbon is stored in the plant
- Burning biomass or biofuels simply recycles the CO<sub>2</sub> stored in the plant
  - Time can be 6 mos - grass to 20 yrs-trees
- Biomass is carbon neutral except from
  - Fertilizer, harvesting, & delivery



# Giant King Grass Has Been Extensively Tested With Consistent Results



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Proximate Analysis	Unit	Sun Dried As Received	Giant King Grass Bone Dry
<b>Total Moisture</b>	%	<b>14</b>	<b>0</b>
<b>Volatile Matter</b>	%	<b>65.68</b>	<b>76.37</b>
<b>Ash</b>	%	<b>3.59</b>	<b>4.17</b>
<b>Fixed Carbon</b>	%	<b>16.74</b>	<b>19.46</b>
<b>Total Sulfur</b>	%	<b>0.11</b>	<b>0.13</b>
<b>HHV</b>	MJ/Kg	<b>15.85</b>	<b>18.43</b>
<b>LHV</b>	MJ/Kg	<b>14.52</b>	-

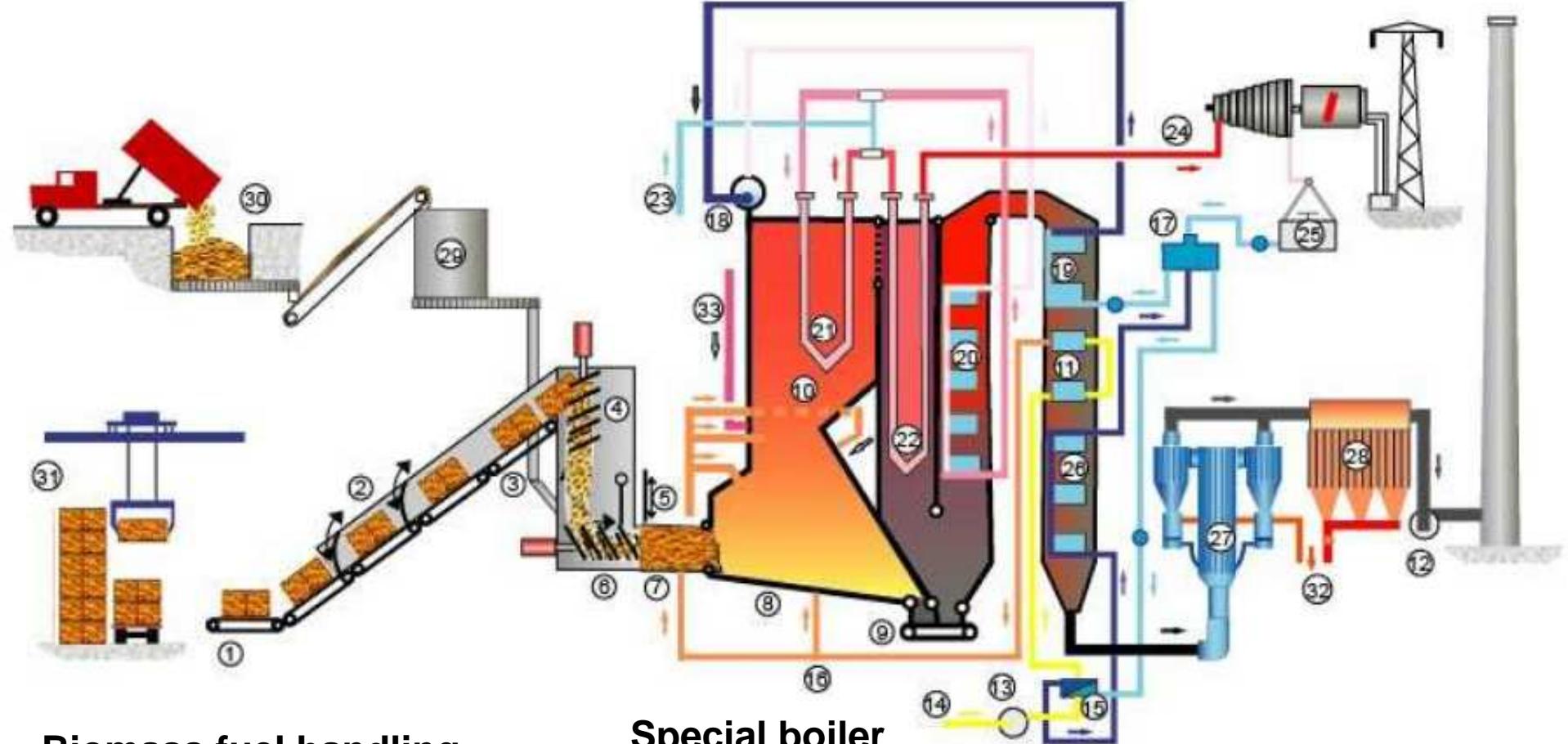


**30 MW power plant in China uses corn straw & rice husk. Giant King Grass is same as corn straw**

# Direct Combustion Biomass Power Plant



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Biomass fuel handling

Special boiler  
burns biomass  
to create steam

High pressure steam  
turbine turns generator  
to make electricity



**Baled corn straw**



**Baled corn straw**





**Power plant accepts loose biomass as well as bales**



**Corn straw is de-baled before entering boiler**





**30 MW biomass power plant control room**



**Steam turbine and generator**



# Biogas from Giant King Grass



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*Biogas plant generating 1 MW of electricity and 1 MW of heat plus organic fertilizer*



*Giant King Grass is cut every 30-45 days at 3-5 feet tall for biogas*

- Biogas is produced when Giant King Grass decomposes without oxygen (anaerobic digestion)
- Biogas is composed of methane (55%) and carbon dioxide and used to generate electricity and heat
  - Organic fertilizer is the byproduct
- Giant King Grass has been independently tested for biogas yield and the results are excellent

# Giant King Grass Pellets as Coal Replacement



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- Giant King Grass pellets can replace up to 20% of coal in an existing coal-fired power plant
  - Burning coal and biomass together is called cofiring
  - Requires small modification
- Preserves large capital investment in existing power plant with 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
- Large global demand
  - Particularly in Europe
  - Korea, China, Japan emerging



# Test Data on Giant King Grass



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## Composition Determination

Parameter	Amount (a.r.)	Amount (o.d.)
Total Moisture	8,81	
Moisture Airdry		
Ash	4,66	5,11
Volatile matter incl. moisture.		
Volatile matter	70,34	77,14
Fixed Carbon	16,18	17,75
Gross Calorific Value	4055,2	4446,9
	16,978	18,618
Nett Calorific Value (cV)	3742,1	
	15,667	
	6735,7	
Nett Calorific Value (cP)	15,592	



国家煤炭质量监督检验中心  
China National Coal Quality Supervision  
and Testing Center



# Biofuels, Biochemicals and Biomaterials

# Cellulosic Biofuels, Biochemicals & Bio Plastics



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- 1<sup>st</sup> generation bio ethanol is made from sugar cane, corn or recently cassava
  - Making fuel from food is being restricted or prohibited
- 2<sup>nd</sup> generation is cellulosic ethanol made from
  - corn straw— not the corn grain
  - Sugar cane bagasse—after the sugar is removed
  - Dedicated energy crops such as Giant King Grass
- 2<sup>nd</sup> generation processes utilize the polymeric sugars trapped in the stalks and leaves
  - Requires pretreatment and enzymatic hydrolysis
  - Currently more expensive and not yet commercial

# Giant King Grass for Fermentation-Based Biorefinery



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

Notes and references:

Giant King Grass: average of samples cut at 4 m tall

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 tests by 3 independent companies.**

**Giant King Grass has essentially the same composition as corn Stover and miscanthus per dry ton**

# Compare Giant King Grass Yield to Corn & Miscanthus



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Yield Dry Matter	Giant King Grass	Corn Stover	Miscanthus
US ton/acre	44	3.5-4.7	14-18
Metric ton/ha	100	8.6-11.6	30-40

**Yield:** The yield comparison amongst Giant King Grass, corn Stover and Miscanthus is not an exact apples-to-apples comparison.

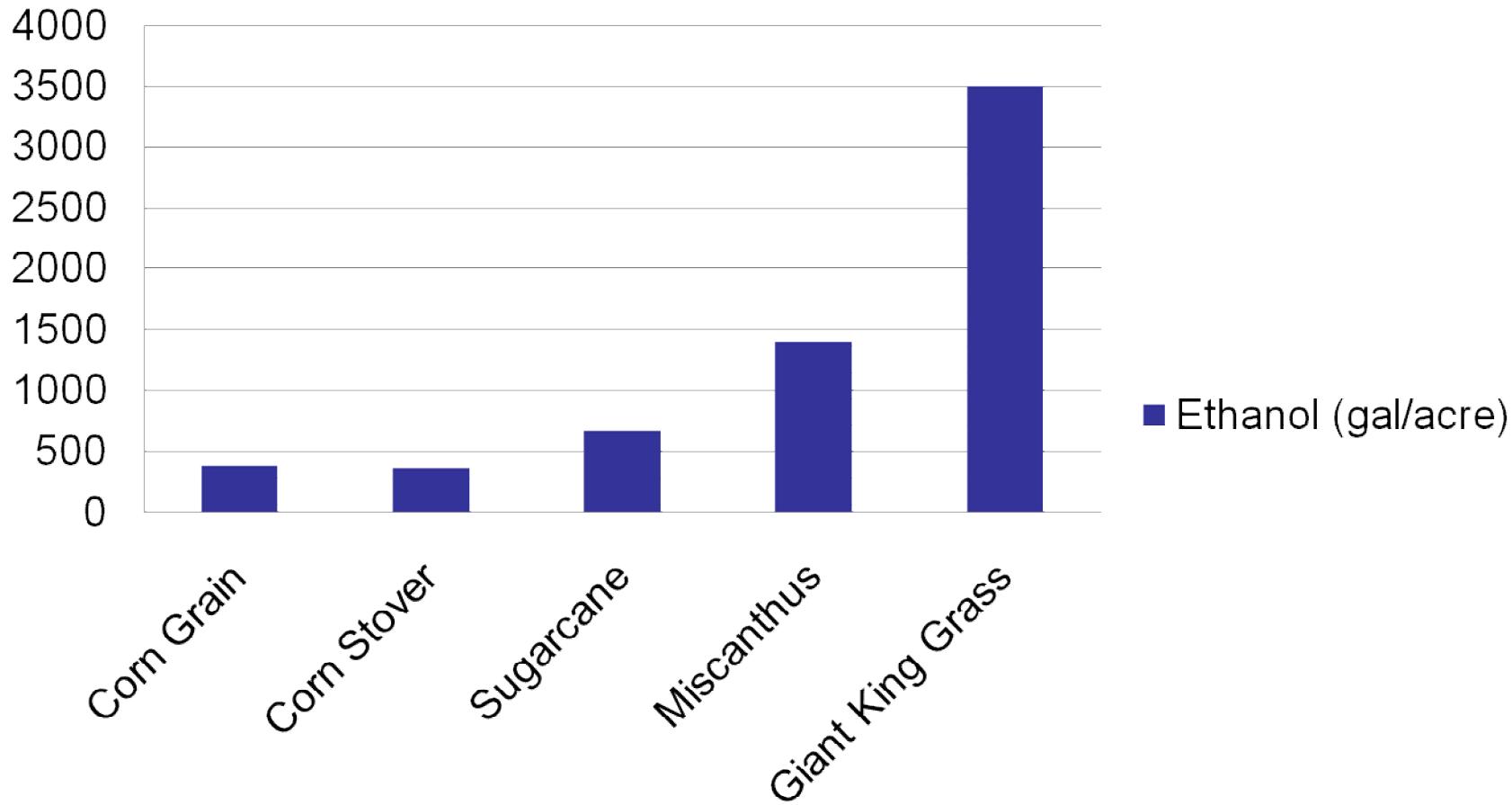
- Corn will grow in cold areas, whereas Giant King Grass cannot tolerate freezing temperatures
- Corn is an annual crop and must be planted every year which causes additional expense. The annual planting also has issues for soil erosion, soil organic matter and some of the corn and wheat must be left on the field for nutrient recycling and to mitigate soil erosion, etc.
- Giant King Grass and Miscanthus are both perennial grasses. Giant King Grass requires tropical and subtropical regions and can be harvested several times a year for many years. Miscanthus will grow in cold areas.

# Land-Use Efficiency



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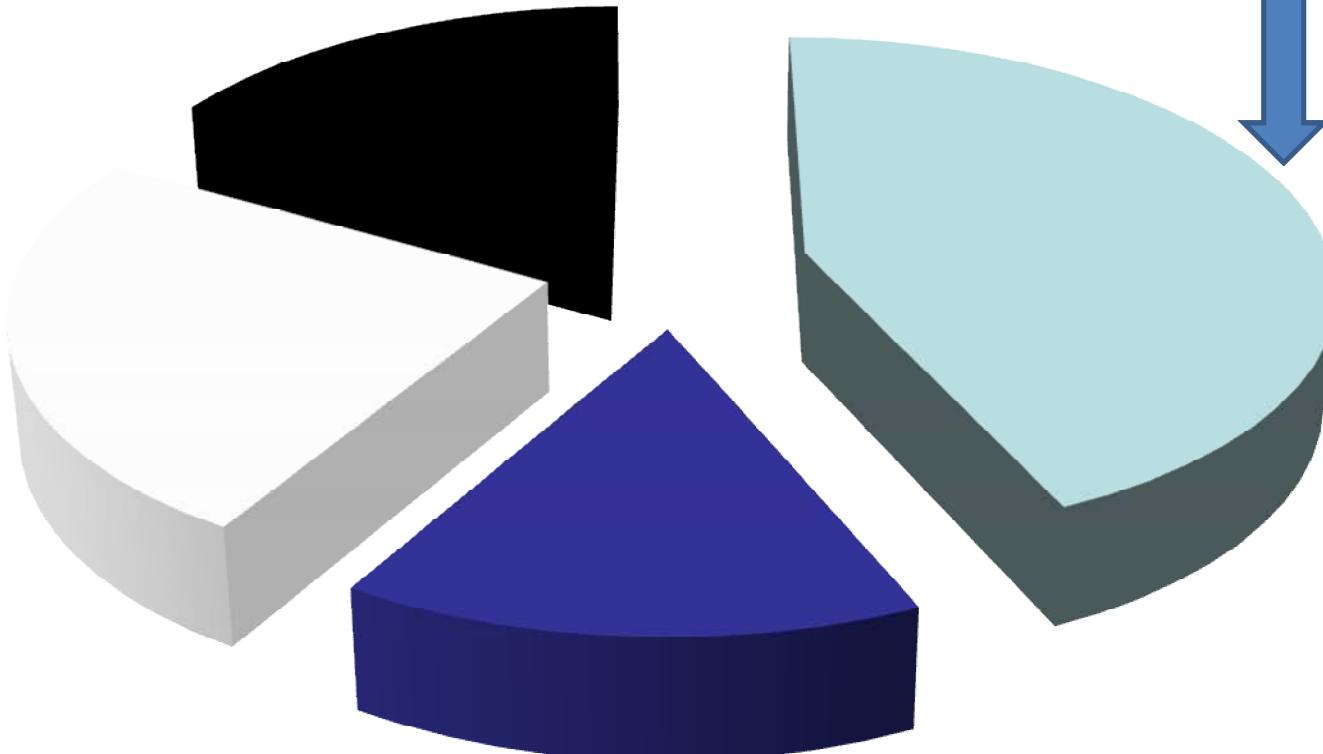
## Ethanol (gal/acre)



# Feedstock is the Largest Cost of Cellulosic Ethanol



**Giant King Grass and co-location can reduce feedstock cost by 40-50% making cellulosic ethanol profitable**



- Feedstock
- Enzymes
- Other
- Capital

# Advantages of Giant King Grass



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- “Platform” energy crop for many bioenergy applications
  - Electricity, pellets, biofuels, biochemicals & bio plastics
- Lowest cost--Can meet cost targets for energy & biofuels applications because of high yield of Giant King Grass
  - Less expensive than agricultural waste
  - Can be used in combination w/ agricultural waste
- Perennial crop
  - Do not have to plant every year, just harvest
  - Short rotation—first harvested in 6.5 months
- Provides reliable, well documented, consistent quality fuel or feedstock with predictable, affordable price
  - Fuel supply reliability required for project financing

- VIASPACE works on integrated plantation and bioenergy, pellet or biorefinery projects
- VIASPACE is seeking quality project opportunities
- VIASPACE will work with partners, project developers or act as project developer
- Potential R&D collaborations
- Giant King Grass samples available

# Thank You



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# Applications of Giant King Grass



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

Applications that are commercial today with agricultural & forestry waste that can use Giant King Grass instead

*Low cost of Giant King Grass will allow commercial applications in future*

# Biomass Options to Produce Clean Electricity



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- Direct combustion--Burn Giant King Grass in a boiler to produce high pressure steam which turns a generator to make electricity
  - Sizes from 10 – 35 MW
- Anaerobic Bio digestion of Giant King Grass to produce biogas which is burned in an engine or turbine which turns a generator
  - Typical sizes from 0.5 – 3.0 MW
- High temperature gasification to syngas
- Co-fire pellets in existing coal power plant to reduce carbon dioxide emissions

# Giant King Grass Dedicated Energy Crop



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- Very high yield
  - 100 dry mt/ha/year (44 US t/acre)
- Sustainably grown, not a food crop, grows on marginal land
- Perennial grass, harvest 2x/year
- Not genetically modified
- Not an invasive species
- Needs sunshine, warm weather & rain or irrigation
  - no freezing or standing water
- Fertilizer use is modest
- No pesticide

