Nicaragua 12 MW Biomass Power Plant with 840 Ha Energy Crop Plantation





**Giant King Grass Dedicated Energy Crop** 

**Example Biomass Power Plant In Development-- NOT BUILT YET** 

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Private Power in Central America Panama City, Panama June 12 – 13, 2014



- 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



1998-PRESENT VIASPACE Inc. CEO—Originally products "VIA" the "SPACE" program 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



1968-1975 Cornell University MS & PhD in theoretical physics

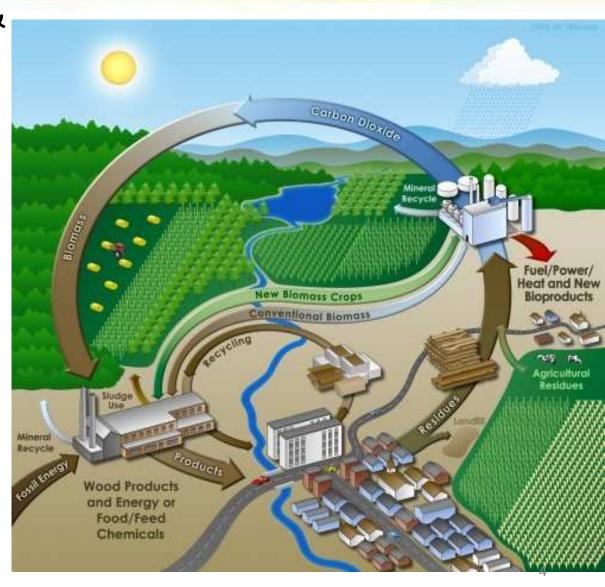
1966-1968 University of California Davis BS physics



### Biomass is Renewable & Low Carbon Plants Breathe Carbon Dioxide



- 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





#### Nicaragua Project Overview

#### Nicaragua Renewable Biomass Energy Project Overview



- 12 MW biomass power plant designed for grass, straw & rice husk as fuel
  - Proven technology
  - Provides clean, reliable 24/7
     base electricity
    - Dispatchable base power
- Fueled by Giant King Grass
  - Dedicated energy crop
  - Sustainably grown
  - Irrigation and rainfall
  - Rice husk as additional fuel



#### Project status



- ✓ Pre-feasibility study
- ✓ SPV company established
- ✓ Initial presentations to investors (debt and equity)
- Feasibility study in progress
  - Complete September 2014
- Provisional generation license, power purchase agreement, permits and other contracting tasks in progress
- Financial closure

#### Biomass Power Plant Financing VIASPACE



- First question from banker for biomass power plant is "show me your fuel supply agreement."
  - We are "growing our own electricity"
- Power Purchase Agreement (PPA) from a creditworthy counterparty
- Proven technology
- Qualified EPC contractor that will guarantee cost, schedule and performance
- Management/operations team

#### Nicaragua



- Largest country in Central America (in area)
- Large agriculture sector
- 5M people
- Now safest country in region
- Poorest country in region
- Tropical climate
  - Rainy & dry seasons
- Bunker oil provides base load for the electrical generation and about 50% of energy
  - Other 50%: hydro, wind, biomass and geothermal



#### Nicaragua



- Needs more electricity
- Policy is 97% renewables by 2030
  - Will use any renewable with lower cost than oil
- But hydro is seasonal and wind intermittent
  - Grid cannot handle any more intermittent
- 7 year tax break & no import duty on renewable equipment
- Nicaragua has low labor costs and industry wants to move there
  - But needs competitive and reliable electricity
- Can sell electricity to grid and private industry delivered by grid

#### **AGRICORP** is Partner



- Agro-industrial company in Nicaragua
- Mills, distributes and grows rice
- Has more than 50% of the rice market in Nicaragua



- AGRICORP investors and VIASPACE have formed a special purpose company for the 12 MW power plant and Giant King Grass plantation
  - In development—not built
- "Energia Reino Verde"—Green Kingdom Energy



#### Rice as Far as You Can See





#### Giant King<sup>TM</sup> Grass



- High yield dedicated energy crop
- Harvested twice a year at 4 m tall
- Perennial crop, cut and regrow for 7 − 10 years
- A natural proprietary hybrid, not genetically modified
- Sterile and noninvasive
- Propagated vegetatively like sugarcane
- Will grow on marginal land
- Tropical and subtropical grass
  - Will survive a frost, but not freezing weather
- Needs warm weather, sunshine and rainfall or irrigation

### Giant King Grass Plantation at AGRICORP Rice Plantation



- Located on 10,000 acre AGRICORP farm at Miramontes
  - 6,000 acres planted in rice
  - 2,100 acres of Giant King Grass to fuel initial 12 MW power plant
  - Giant King Grass already growing well there
- Irrigation from Lake Nicaragua in place
- Will leverage existing farm staff and infrastructure to lower costs
- Purchase special harvesting and transporting equipment for Giant King Grass
- Maximum distance to power plant is 5 km assuring simple logistics
- Reliable, low-cost, renewable fuel



# Giant King Grass Grown in Nicaragua for 18 months





## Expanded Giant King Grass Plantation





### Planting by Hand





#### Irrigate Right after Planting





## 10 Week Old Giant King Grass in Nicaragua







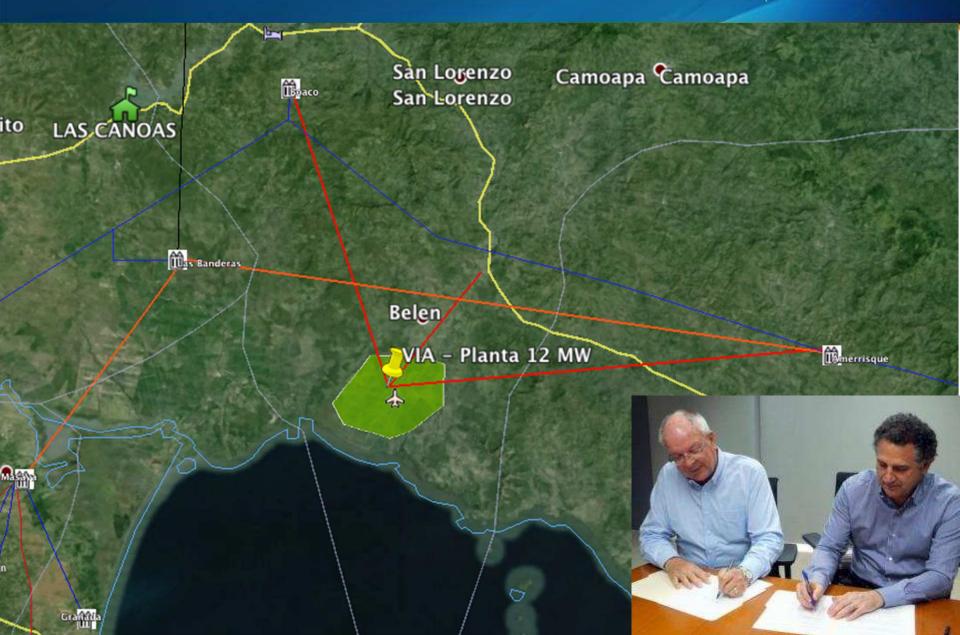
## Mature Giant King Grass Harvested Every Six Months





#### Plantation on Lake Nicaragua





#### 12 MW Power Plant Nicaragua



- 12 MW gross
- Efficiency
  - 32% lower heating value of the fuel to electricity
- 11% internal use
- 7884 hours/year
- 84 GWh saleable electricity
- 9 dry equivalent metric tons/hour fuel use
- Lifetime 25 years

- Operating costs/kWh
  - Fuel \$0.038
  - Labor \$0.008
  - Other \$0.006
  - Total \$0.052
- Debt 70%
  - 8.5%, 12 years
- Equity 30%
- Power plant ~\$2M/MW
- All-in capital ~\$3M/MW
  - EPC, civil works, short grid connection, legal, financing, plantation establishment on leased land, farm equipment

### 12 MW Giant King Grass Power Plant in Nicaragua



- Provides renewable, low carbon, base electricity
  - Reliable 24 hours/day
  - Not intermittent like wind and solar
  - Complements hydro
- Lower cost than oil
- Plantation and power plant provide jobs
- Electricity infrastructure for people and industry
- Utilizes the natural resources of Nicaragua– sunshine, warm weather and water
- Sustainable agriculture
- Money stays in Nicaragua rather than spending money for oil overseas



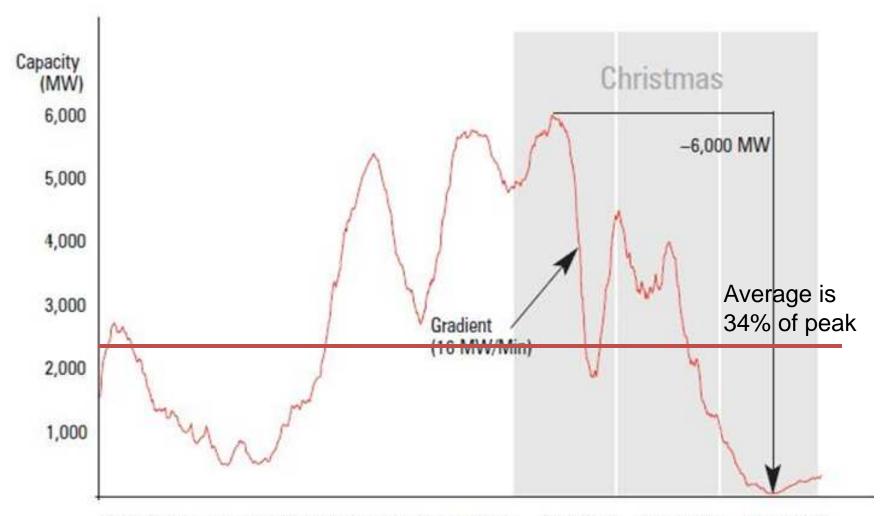
# Compare Wind, Solar and Giant King Grass Electricity

#### Wind Energy Has No Fuel Cost VIASPACE Clean Energy for a and No Carbon Dioxide Emissions



### Wind Energy is Intermittent Average Electricity is 34% of Peak Clean Energy for a Clean

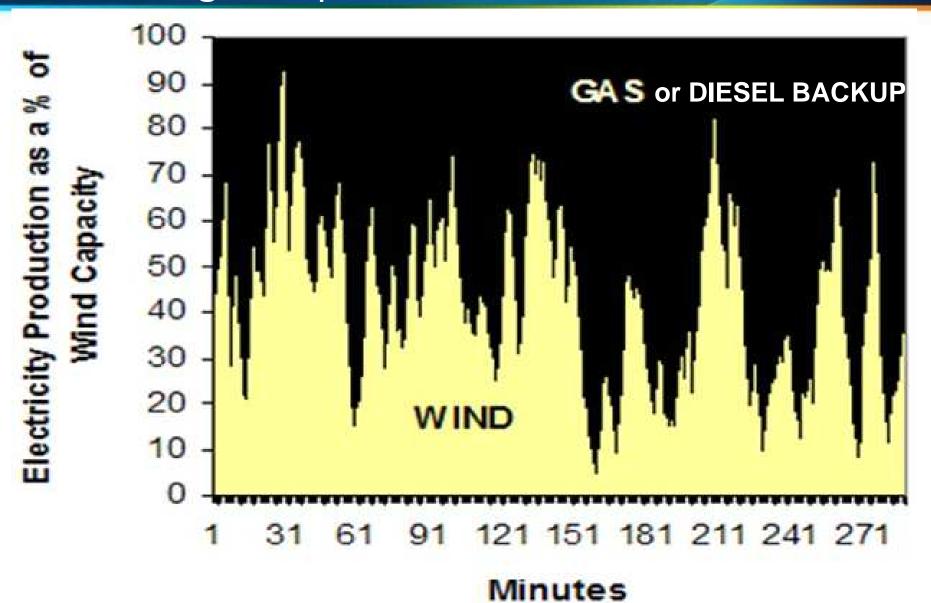
Figure 6: 2004 Christmas Wind Power Variability, Germany



Mon, 20.12. Tues, 21.12. Wed, 22.12. Thurs, 23.12. Fri, 24.12. Sat, 25.12. Sun, 26.12.

#### Intermittent Wind Electricity Needs Fast Reacting Backup Generator





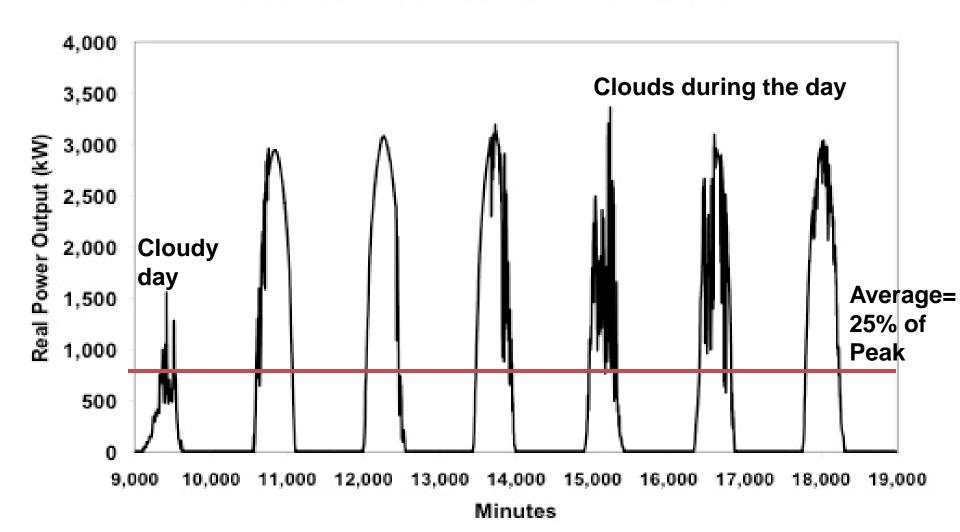
### Solar Photovoltaic—Fuel Is Free & No Carbon Dioxide Emissions





# Solar Electricity Output for 7 days in Arizona— note Effect of Clouds Clean Energy for a Clean Energy for a

Springerville, AZ 7 days at 1 minute resolution



#### Managing the Electrical Grid



- Wind and solar require fast responding backup power that is provided by oil and gas
  - there is no way to store electricity except by pumping water back up a dam
- 1 MW of wind or solar generation requires approximately 1 MW of backup generation from oil or gas
  - Have to build two power plants-one wind or solar plus one backup oil or gas power plant
  - The backup power plant must be kept spinning so it can react quickly and must be maintained
    - These are costs that must be paid even if it is not generating electricity—capacity charge

### Constant Electrical Power Output VIASPACE Clean Energy for a Clean E

Electricity Source	Cost per kilowatt hour <sup>1</sup>	Availability factor (24hr) <sup>2</sup>	Oil backup needed (24 hr)	Constant 24 hour power output cost /kwh³	Relative carbon dioxide emissions
Bunker oil	\$.20	1.00	0	\$.200	100%
Wind	\$.09 - \$.12	0.34	0.66	\$.176	66%
Solar PV	\$.12 - \$.16	0.25	0.75	\$.193	75%
Giant King Grass Biomass	\$.12 – \$.14	1.00	0	\$.140	0%

- 1 Total cost at power plant gate including fuel, operations, substation, capital equipment costs, finance charges and profit
- 2 Global averages of wind and solar availability over 24 hours
- 3 Uses \$.11 for wind, \$.15 for solar, \$.14 for Giant King Grass biomass, and \$.02/kWh for the spinning reserve required to back up solar and wind

Wind calculation (\$.11+\$.02) x 0.34+\$.20 x 0.66=\$.176/kWh averaged over 24 hours Solar calculation (\$.15+\$.02) x 0.25+\$.20 x 0.75=\$.193/kWh averaged over 24 hours



#### **Giant King Grass Overview**

### Giant King Grass Very High Yield

- 15 + feet tall in 6 months
- Harvest tall 2 times a year
- Growing in
  - US-California, Texas, Arizona,
     Hawaii
  - St. Croix, US Virgin Islands
  - Nicaragua
  - Myanmar
  - South Africa
  - China
  - Pakistan
  - Guyana



## Giant King Grass Approved by US Department of Agriculture



- US Department of Agriculture has grown Giant King Grass and found it to be free of disease and pests
- Approved for distribution in US and for export
- USDA will inspect Giant King Grass and issue phytosanitary certificate for export

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

PHYTOSANITARY CERTIFICATE

FOR OFFICIAL USE ONLY

PLACE OF ISSUE
San Diego, California

NO.
F-C-06073-03379890-7-N

DATE INSPECTED
September 03, 2013

CERTIFICATION

This is to certify that the plants, plant product or other regulated articles described herein have been inspected and/or tested according to appropriate official procedures and are considered to be free from the quarantine pests, specified by the importing contracting party and to conform with the current phytosanitary requirements of the importing contracting party including those for regulated non-quarantine pests.

#### Compare Energy Crops



- Giant King Grass
  - Very high yield
  - Non-invasive
  - Easy propagation—like sugarcane
  - Well characterized
  - Consistent quality
  - Used for energy & animal feed
- Arundo Donax
  - High yield
  - Listed as invasive
  - Difficult to propagate
  - Not animal feed

- Elephant grass
  - Pennisetum purpureum
  - Called King grass in region
  - 200 different types
    - Some have high yield
    - Some are good animal feed
  - Most not well characterized
- Miscanthus
  - Medium yield
  - Difficult to propagate
  - Not a tropical grass
- Switchgrass
  - Low medium yield
  - Easily planted from seed
  - Not a tropical grass

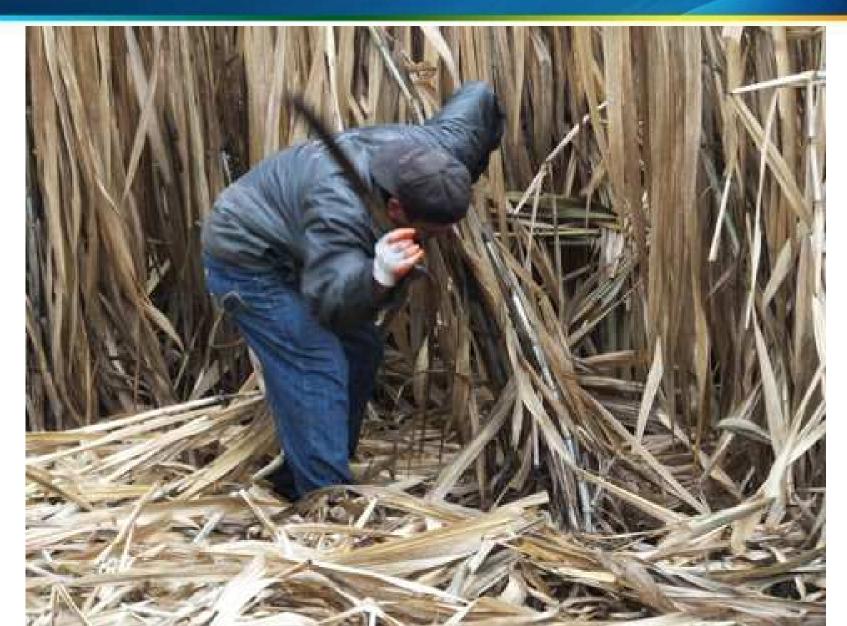
# Mechanical Planting of Giant King Grass





#### Harvest with Machete





# Manual Harvesting with Gas Powered Cutter









### **Giant King Grass Growth Cycle**

**Perennial Crop--Plant Once, Harvest Many Times** 



Mature 6 mo. old Giant King Grass ready to harvest

### Giant King <sup>TM</sup> Grass March 17, 2013– Just Harvested





Surface or subsurface drip tape irrigation, row & furrow or flood irrigation can be used.

### Giant King <sup>TM</sup> Grass March 27– Regrowth in 10 days





Giant King Grass in the left rear is 18 feet tall

### Giant King <sup>TM</sup> Grass April 18, 2013– One Month Old





### Giant King <sup>TM</sup> Grass May 13, 2013– Two Months Old





Ready for harvest for animal feed (14.9% crude protein) or anaerobic digestion For reference VIASPACE CEO Dr. Carl Kukkonen is 6'1" (185 cm) tall

### Giant King <sup>TM</sup> Grass May 30, 2013–2½ Months Old





### Giant King <sup>TM</sup> Grass July 2, 2013–3 ½ Months Old





### Giant King <sup>TM</sup> Grass July 31, 2013–4½ Months Old





# Giant King TM Grass August 28, 2013–5½ Months Old Clean Energy for a Cleaner Tomorrow



Ready for propagation or harvest

# Giant King <sup>TM</sup> Grass September 29, 2013–6½ Months Old Clean Energy for a Clean Energy fo



Strong growth— ready for harvest or propagation For reference VIASPACE CEO is 6'1" (185 cm) tall



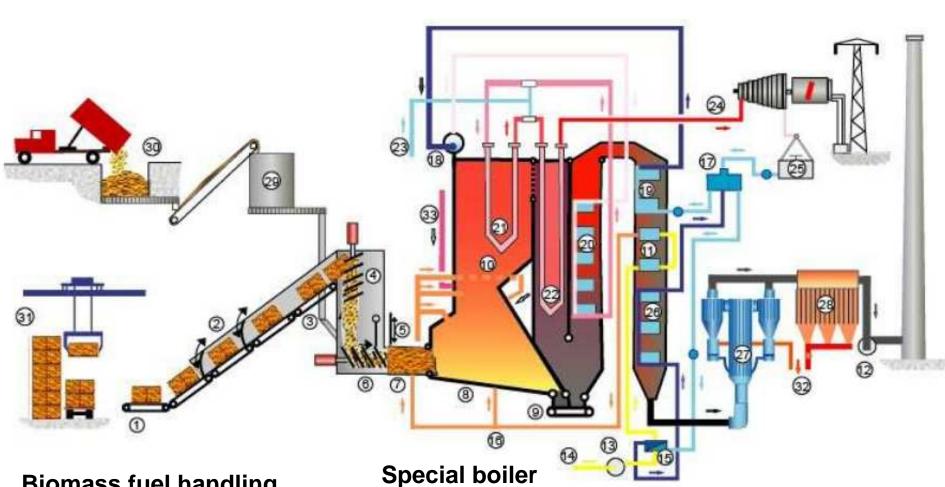
### Direct Combustion Power Plant Proven Technology



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

### **Direct Combustion Biomass Power Plant**





**Biomass fuel handling** 

burns biomass to create steam

High pressure steam turbine turns generator to make electricity

### Giant King Grass Has Been Extensively Tested With Consistent Results Clean Energy for a Clean Energy for a

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

#### Grass & Straw Boilers Are Tricky VIASPACE



- Most biomass boilers are designed for wood or sugarcane bagasse
- Wood is an excellent fuel with low ash, high melting temperature ash and low chlorine.
- Corn straw, wheat straw, rice straw, rice husk and grasses have higher ash, low melting temperature ash and higher chlorine
- These will destroy a wood or sugarcane boiler due to slagging and corrosion
- Must have a special boiler design

### Power Plant Technology Is Well Proven

VIASPACE Clean Energy for a Cleaner Tomorrow

- Special high temperature, high pressure boiler with 30% efficiency overcomes slagging & corrosion issues with straw as fuel
  - Straw has low melting temperature ash & high chlorine content
- Water cooled vibrating grate
- Proprietary primary & secondary air control
- Materials for corrosion
- Can also use wood, bagasse & other biomass
- Long life, high availability, low maintenance





### Agricultural Fuels Can Cause Slagging & Corrosion



- Low melting temp ash causes slagging
- High chlorine corrosion
- Must have proper boiler design





Low cost 10 MW biomass power plant with manual operations and inexpensive boiler requires high maintenance due to slagging on super heaters and boiler surfaces





# Additional Giant King Grass Applications

### 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
  - 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 **Shows Consistency of Product**



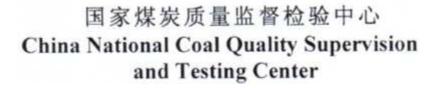
Compos	ition	Determ	ination
The state of the state of the state of			

Nett Calorific Value (cP)

omposition 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	18,61
Nett Calorific Value (cV)	3742,1	
	15,667	
	6735.7	





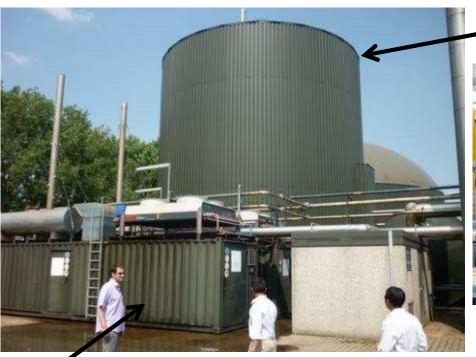


15,592



### Biogas Power Plant is Option Thousands Operating in Europe





**Completely stirred anaerobic digester** 



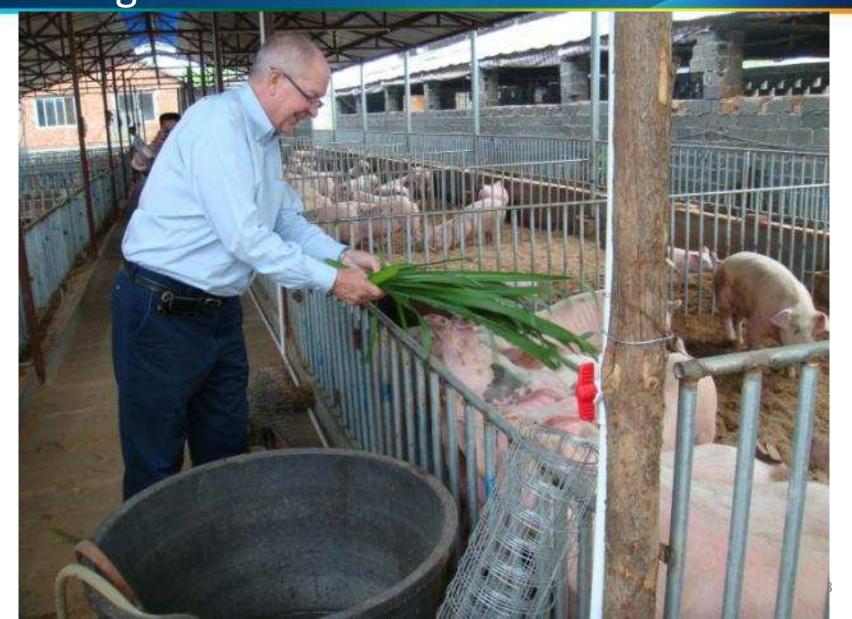
engine generator set

1 MW engine generator set in container

Waste engine heat used to heat greenhouses



# When Cut at 5-7 Feet Tall Giant King Grass Is Excellent Animal Feed Clean Energy for a Clean Energy for a



### Feeding Cattle





FORAGE TESTIN DAIRY ONE, IN 730 WARREN RO ITHACA, NEW Y	IC. DAD		Sample Description  FR GRASS FORAGE	1	1203	19216470
		607-257-1350)	· 1			į
			Analysis			
Sampled   Re	cvd  P	rinted  ST CO				
105/	15/13 0	5/16/13	Components			
			1			
B3			% Moisture	1	85.0	
CARL KUKHONEN	1		% Dry Matter	1	15.0	1000 N 120
33841 MERCATO	R ISLE		% Crude Protein	- 1	2.2	14.9
DANA POINT, C	CA 52629		% Available Protein	- 1	2.2	14.5
			% ADICP	- 1	. 1	.4
			% Adjusted Crude Protei	n	2.2	14.9
			Soluble Protein % CP	1		43
ENERGY TA	ABLE - N	RC 2001	Degradable Protein%CP	1		l 70 l
			% NDICP	1	. 5	3.5
N	Mcal/Lb	Mcal/Kg	% Acid Detergent Fiber	1	5.5	36.7
<del>-</del>			% Neutral Detergent Fib	er	10.0	66.6
DE, 1X	1.14	2.52	% Lignin	- 1	. 6	3.8
ME, 1X	0.95	2.10	% NFC	1	1.2	7.8
NEL, 3X	0.53	1.17	% Starch	- 1	<0.1	.2
NEM, 3X	0.55	1.22	% WSC (Water Sol. Carbs	.)	1.1	7.4
NEG, 3X	0.30	0.65	% ESC (Simple Sugars)	1	. 9	6.3
			% Crude Fat	ı	. 3	2.3
TDN1X, %	55		% Ash	1	1.79	11.92
			% TDN	1	9	60 65 I



# Giant King Grass Can Be Used As Feedstock for Biofuels, Biochemicals and Biomaterials

### Giant King Grass is the Same as Corn Stover w/ Much Higher Yield Clean Energy for a Cle

Composition Dry Weight %	Giant King Grass	Corn Stover
Glucan	43.0	37.4
Xylan	22.3	21.1
Arabinan	2.9	2.9
Lignin	17.4	18.0
Ash	4.5	5.2

Composition- Glucan Xylan & Arabinan are sugars for cellulosic ethanol. Lignin & ash are byproducts

Notes and references:

Giant King Grass: average of samples cut at 4 m tall Corn Stover: Aden et al. NREL/TP-510-32438, 2002

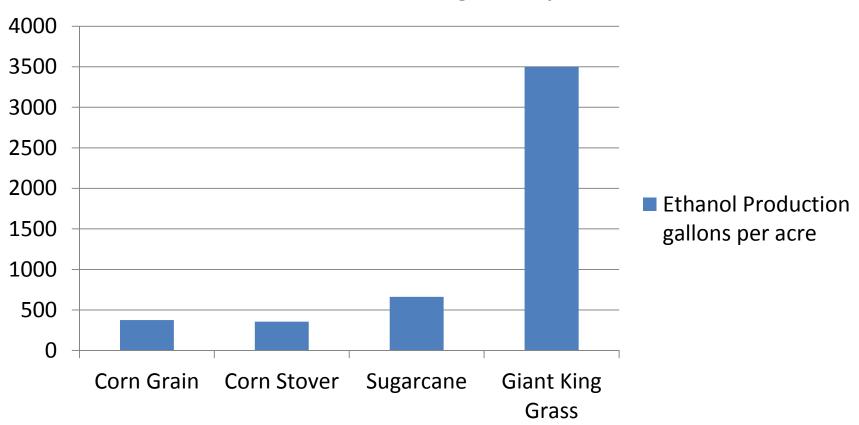
One dry ton of Giant King Grass is slightly better than corn Stover for cellulosic ethanol

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

### High Yield of Giant King Grass Means High Ethanol Production



#### **Ethanol Production gallons per acre**



## Bioenergy Applications of Giant King Grass



- Direct combustion in electric power/ heat/steam plant
- Pellets for co-firing with coal
- Briquettes for boilers
- Biogas /anerobic digestion
- Cellulosic liquid biofuels-ethanol/butanol
- Biochemicals and bio plastics
- Pyrolysis to bio oil
- Catalytic coversion 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

### Advantages of Giant King Grass



- "Platform" energy crop for many bioenergy applications
  - Electricity, pellets, biofuels, biochemicals & bio plastics
- Excellent animal feed with high protein
- Lowest cost--Can meet cost targets for energy & biofuels applications because of high yield of Giant King Grass
  - Less expensive than 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

#### What Are We Looking for?



- Nicaragua project
  - Majority of equity will be provided by Nicaraguan partners
  - Minority equity position available to investors who interested in this and future similar VIASPACE projects
  - Debt financing
    - Interest has been shown, but not settled yet
  - Interviewing EPC contractors

#### What Are We Looking For?



- VIASPACE intends to pursue additional projects in the region
- Need local partners in each country

### Thank You

