Giant King® Grass Biomass Power Projects in Caribbean & Central America

Giant King Grass Dedicated Energy Crop

Example Biomass Power Plant Under Construction

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• VIASPACE is a publicly traded company
  – Fully reporting to SEC and audited
  – VIASPACE stock symbol VSPC
• Giant King® is a registered trademark of VIASPACE Inc.
• Giant King® Grass is proprietary to VIASPACE

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Mature 6 month old Giant King Grass ready to harvest
Biomass is Renewable & Low Carbon
Plants Breathe Carbon Dioxide

- Plants use sunlight & CO₂ to grow. Carbon is stored in the plant
- Burning biomass or biofuels simply recycles the CO₂ stored in the plant
  - Time can be 6 months - grass to 20 years - trees
- Biomass is carbon neutral except from
  - Fertilizer, harvesting, & delivery
Sources of Biomass for Energy

- **Wood and wood waste**
  - Best fuel, but limited availability and there are many other uses in addition to construction and furniture that have higher value
    - Pulp and paper
    - Sawdust for particle board (MDF)
- **Sugarcane bagasse** is already used by sugar mills to produce heat and electricity
  - Only available for 6-9 month crushing season
- **Agricultural residues** such as corn, wheat or rice straw and rice husk
  - Seasonal availability with uncertain pricing, and no long term contracts available
- **Dedicated energy crops** such as fast growing trees and perennial grasses
- **Giant King Grass** has highest yield by far which means lowest cost
Generate Electricity from Biomass

• Direct combustion
  – Burn 100% biomass in power plant for zero carbon emissions
  – Co-fire with coal to reduce carbon emissions

• Proven technology

• Harvest Giant King Grass twice per year at 15 – 18 feet tall
  – Dry and chop for local power plant
  – Make pellets for export

• Reliable 24/7 base electricity
Generate Electricity from Biomass

- **Anaerobic digestion**
  - Biological process that mimics a cow stomach to make bio methane (biogas)
  - Organic fertilizer is a byproduct
- Biogas is used in engine which turns a generator
- Reliable 24/7 base electricity
  - 10,000 operational in Europe
- Giant King Grass is harvested 4-5 times per year at 8-12 feet tall
- Chop only, drying not necessary
  - Can be stored as silage
- Co-digestion with other organic matter such as manure or food processing waste

Biogas is 57% methane and 43% carbon dioxide and fuels an engine that turns a generator to make electricity
Other Renewables--Wind Energy

- Fuel is free and no carbon dioxide emissions
- Intermittent energy
  - Wind speed varies greatly
  - Average is 34% of rated
- Fast responding backup generator fueled by gas or oil needed to provide constant electrical output
  - 1 MW of when requires 1 MW of backup
- Wind turbine and backup required to make system work
- Wind blows often at night when demand is low
Other Renewables--Solar Power

- Fuel is free and no carbon emissions
- Need backup for night and cloudy days
- 1 megawatt of backup for one MW of solar
- Solar peak is at time of high demand
Electricity Cost Comparison--
Fuel Contribution

Portion of Electricity Cost from Fuel (US$/kwh)

Fuel costs are zero for hydro, wind & solar

Oil and gas electricity prices assumes 36% overall net efficiency
Electricity Cost Comparison--Portion from Capital Expense

Crude Estimate* of Portion of Electricity Cost from CAPEX (US$/kwh)

*CAPEX/electricity produced in 10 years & LCOE from EIA

Capital costs are not zero for hydro, wind and solar
Estimated Cost of New Electricity in 2016-19 and Carbon Dioxide Emissions

- **Coal**: $1050/mwh, CO2 99 kg/mwh
- **US Diesel**: $778/mwh, CO2 151 kg/mwh
- **Heavy oil**: $778/mwh, CO2 91 kg/mwh
- **US Natural gas**: $443/mwh, CO2 58 kg/mwh
- **LNG**: $163/mwh, CO2 163 kg/mwh
- **Biomass**: $103/mwh, CO2 35 kg/mwh
- **Hydro**: $85/mwh, CO2 13 kg/mwh
- **Wind**: $80/mwh, CO2 10 kg/mwh
- **Solar PV**: $130/mwh, CO2 32 kg/mwh
- **Solar Thermal**: $243/mwh, CO2 13 kg/mwh


Best options have both Low cost electricity and Low carbon emissions

Sales price 20+% higher

Require oil or gas backup which adds cost
Long Term Fuel Cost

- Power plant investment is for 25+ years
- How long will oil price stay low?
- Lifetime fuel costs are much larger than power plant cost
- Giant King Grass provides predictable fuel price for lifetime of power plant
- Money stays in country, instead of going overseas to pay for oil

<table>
<thead>
<tr>
<th>Base Power fuel</th>
<th>CAPEX per MW</th>
<th>Price ($46 &amp; $100/bbl oil)</th>
<th>Price/kwh electricity</th>
<th>25 year fuel cost/MW</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel</td>
<td>$1.3M</td>
<td>$1.64/gallon</td>
<td>$0.109/kwh</td>
<td>$23M</td>
<td>Likely to increase</td>
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<tr>
<td></td>
<td></td>
<td>$2.95/gallon</td>
<td>$0.217/kwh</td>
<td>$45M</td>
<td>volatile</td>
</tr>
<tr>
<td>Heavy fuel oil</td>
<td>$1.3M</td>
<td>$265/mt</td>
<td>$0.061/kwh</td>
<td>$13M</td>
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<td></td>
<td></td>
<td>$611/mt</td>
<td>$0.141/kwh</td>
<td>$29M</td>
<td>volatile</td>
</tr>
</tbody>
</table>
| Giant King® Grass | $2.5M     | $45/mt                      | $0.04/kwh             | $8M                  | fixed cost  
                      |             |                             |                       | No volatility |
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
Giant King® 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
• Provides reliable, low cost fuel or feedstock for 24/7 operations 365 days/year
Giant King Grass is NOT for Everyone

- Needs warm weather, sunshine and water
  - No freezing weather
- Need land availability (70 ha/MW)
- Need sufficient rainfall or source of water for irrigation
  - California has little rain, but rivers for irrigation
  - Nicaragua has rain, but a dry season with a lake for irrigation
  - Guyana has sufficient rain. No irrigation used
  - Islands may not have the water
Giant King® Grass Growth Cycle

Perennial Crop--Plant Once, Harvest Many Times
Mature 6 month old Giant King Grass ready to harvest
Surface or subsurface drip tape irrigation, row & furrow or flood irrigation can be used.
Giant King® Grass
March 27 – Regrowth in 10 days

Giant King Grass in the left rear is 18 feet tall
Giant King® Grass
April 18 – One Month Old
Giant King® Grass
May 13 – Two Months Old

Ready for harvest for animal feed (14.9% crude protein)
For reference VIASPACE CEO Dr. Carl Kukkonen is 6’1” (185 cm) tall
Giant King® Grass
May 30 – 2 ½ Months Old

Perfect for anaerobic digestion
Giant King® Grass
July 2 – 3 ½ Months Old
Giant King® Grass
July 31 – 4 ½ Months Old
Giant King® Grass
August 28 – 5 ½ Months Old

Ready for propagation or harvest
Giant King® Grass
September 29 – 6 ½ Months Old

Strong growth—ready for harvest or propagation
For reference VIASPACE CEO is 6’1” (185 cm) tall
Nicaragua Project Overview
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
- Giant King Grass growing on AGRICORP plantation since 2012
- 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
Tropical Weather is Suitable

With sufficient rainfall or irrigation, Giant King Grass can be harvested twice per year.
Energía Reino Verde Nicaragua Power Plant

- 12 MW gross electrical production
- High efficiency, 32% LHV of the fuel to electricity
  - 11% internal use
  - 90+% utilization--7884 hours/year
  - Lifetime 25 years
- 84 GWh saleable electricity
- Giant King Grass requirement
  - 9 dry equivalent metric tons/hour
- Operating costs/kWh
  - Fuel $0.04, Total $0.06
- Debt 70%
- 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
Feasibility Study Summary and Conclusions

• The proposed integrated Energía Reino Verde 12 MW biomass power plant and 925 ha Giant King Grass plantation project is technically feasible and financeable.
• Validated costs and financial projections for the project.
• Strong support team for the project including:
  – Agricorp—one of the largest companies in Nicaragua
    • annual revenues exceeding $150 million
  – IC Power (2nd largest IPP in Nicaragua)
  – Pro Nicaragua, the government investment promotion agency.
• Giant King Grass plantation is very similar to a sugarcane plantation:
  – Will utilize best practices from the sugarcane industry.
Feasibility Study Summary and Conclusions

• The Giant King Grass plantation will be located on the 4,200 ha (10,387 acre) Miramontes plantation that is currently growing rice on 2,800 ha.
  – Irrigation from Lake Nicaragua is available
  – Plantation and power plant workers available in the region.

• In addition to Giant King Grass, the power plant will be fueled by rice husk as a secondary fuel (5-8%)

• Rice straw from the plantation is available as a backup fuel
Giant King Grass Growing Well at Miramontes

aerial view of 12 ha test plot and nursery

two agronomists assigned to Giant King Grass

VIASPACE CEO
Dr. Carl Kukkonen

www.pelicansa.com
AGRICORP Has Infrastructure and Experience

Irrigation available

Farm equipment and knowhow
Feasibility Study Summary and Conclusions

- Co-location of power plant and plantation is a major advantage
- Average distance of field to power plant is 3 km
- Reduces transport costs
- Simplifies logistics
Power Plant Operations

- An experienced team will operate the power plant.
- A candidate operator is IC Power Nicaragua
  - Large independent power producer in Nicaragua with 185 MW installed from bunker oil and wind
  - Previous experience in sugarcane bagasse power plant

51 MW bunker oil power plant 63 MW of wind power
Feasibility Study Summary and Conclusions

- The biomass power plant is located 9 km from a grid connection point
  - Reasonable expense for the proposed size of the project.

Surveyed route shown in red
Project status

- Feasibility study completed
- SPV company established
- EPCs interviewed
- Initial presentations to investors (debt and equity)
- Provisional generation license, power purchase agreement, permits and other contracting tasks in progress
- PPA discussions underway
- Financial closure
- Construction and commissioning in 18-24 months
• Provides renewable, low carbon, base electricity
  – Reliable 24 hours/day
  – Not intermittent like wind and solar
  – Complements hydro
• Lower cost than heavy fuel oil at ~$60/barrel
• Plantation and power plant provide jobs
  – Construction employment
  – Ongoing rural employment—skilled and farmworkers
• Pays municipal and national taxes
• 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 sending money overseas for oil
Tibbar Energy USVI is developing an anaerobic digestion biogas power plant on St. Croix, US Virgin Islands.

Primary feedstock is Giant King Grass, which will be grown on a 1500 plus acres.

Biogas used to power engine generator set 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.
Tibbar Energy St. Croix Project Status

- Required permits will be in place by February 2015
- Giant King® Grass from its nurseries on St. Croix is ready for the production fields
- Completing financing
- Construction is scheduled to begin in second quarter of 2015
Giant King Grass in Guyana

- Customer plans to make energy pellets for export to Europe
- Giant King Grass planted on savannah with only rainfall—no irrigation
  - Growing well
- Vast areas available
Giant King Grass in Guyana

• Also plan to use Giant King Grass to produce small-scale electricity for remote areas using anaerobic digestion to produce biogas
  – 0.5-3 MW
• Guyanese team is seeking partner
Giant King Grass in Jamaica

- Customer plans to use biogas from anaerobic digestion to produce low carbon liquid fuels
- Planted initial trial without irrigation. Drought in Jamaica negatively affected yield
- Plans to use irrigated former sugarcane land
Giant King Grass Is Growing Well in Hawaii

Water availability can be an issue on islands. Irrigation is used in Hawaii.
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
## Composition Determination

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Amount (a.r.)</th>
<th>Amount (o.d.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Moisture</td>
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<td></td>
</tr>
<tr>
<td>Moisture Airdry</td>
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<td></td>
</tr>
<tr>
<td>Ash</td>
<td>4.66</td>
<td>5.11</td>
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<tr>
<td>Volatile matter incl. moisture</td>
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<td></td>
</tr>
<tr>
<td>Volatile matter</td>
<td>70.34</td>
<td>77.14</td>
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<tr>
<td>Fixed Carbon</td>
<td>16.18</td>
<td>17.75</td>
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<tr>
<td>Gross Calorific Value</td>
<td>4055.2</td>
<td>4446.9</td>
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<tr>
<td></td>
<td>16.978</td>
<td>18.618</td>
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<tr>
<td>Nett Calorific Value (cV)</td>
<td>3742.1</td>
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<tr>
<td></td>
<td>15.667</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6735.7</td>
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</tr>
<tr>
<td>Nett Calorific Value (cP)</td>
<td>15.592</td>
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</tr>
</tbody>
</table>
GKG is Good Feed for Dairy Cows, Cattle, Camels, Goats, Sheep & Horses

- Cut at 5-7 ft tall at 45-60 days
- Cut & carry, or potentially intensive grazing
- Fresh, silage, hay, Meal or pellets

Part of diet for pigs, rabbits & fish
Giant King Grass Nutrition

- Excellent nutrition--ideal for ruminants-cattle, sheep, goats & camels
- Also for horses, pigs, rabbits and some fish
- Better than oat hay
- High yield means low cost
- Reduces need for expensive alfalfa, grains and concentrates in a mixed ration feed
- Can be used as fresh chop, silage, hay, meal or pellets
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

<table>
<thead>
<tr>
<th>Composition</th>
<th>Giant King Grass</th>
<th>Corn Stover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucan</td>
<td>43.0</td>
<td>37.4</td>
</tr>
<tr>
<td>Xylan</td>
<td>22.3</td>
<td>21.1</td>
</tr>
<tr>
<td>Arabinan</td>
<td>2.9</td>
<td>2.9</td>
</tr>
<tr>
<td>Lignin</td>
<td>17.4</td>
<td>18.0</td>
</tr>
<tr>
<td>Ash</td>
<td>4.5</td>
<td>5.2</td>
</tr>
</tbody>
</table>

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

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

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

<table>
<thead>
<tr>
<th>Yield Dry Matter</th>
<th>Giant King Grass</th>
<th>Corn Stover</th>
</tr>
</thead>
<tbody>
<tr>
<td>US ton/acre</td>
<td>44</td>
<td>3.5-4.7</td>
</tr>
<tr>
<td>Metric ton/ha</td>
<td>100</td>
<td>8.6-11.6</td>
</tr>
</tbody>
</table>

Giant King Grass has much higher yield per acre than corn Stover
High Yield of Giant King Grass Means High Ethanol Production

Ethanol Production gallons per acre

- Corn Grain
- Corn Stover
- Sugarcane
- Giant King Grass

Giant King Grass has significantly higher ethanol production compared to other crops.
Bioenergy Applications of Giant King Grass

- 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
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?

• VIASPACE intends to pursue additional projects in the region

• Need local partners in each country
Thank You
1998-PRESENT  VIA SPACE Inc. CEO—Originally products came “VIA” the “SPACE” program
   VIA SPACE now focuses on renewable energy and animal feed using its proprietary
   Giant King Grass

1984-1998  NASA/Caltech Jet Propulsion Laboratory (JPL)
   Director, Center for Space Microelectronics Technology
   and 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
Giant King Grass
Very High Yield

• 15 + feet tall in 6 months
• Harvest tall 2 times a year
• Growing in
  – US—California, Hawaii
  – St. Croix, US Virgin Islands
  – Nicaragua
  – Myanmar
  – South Africa
  – China
  – Pakistan
  – Guyana
  – Jamaica
  – Philippines
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
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
Nicaragua 12 MW Power Plant

- 12 MW biomass power plant
  - 84 GWh of saleable 24/7 renewable, low carbon base electricity
  - High pressure / high temperature biomass boiler
    - High efficiency 32%
    - Well proven--many in operation
    - >90% availability (year-round)
    - Connected to Nicaragua transmission network

- Fueled by Giant King Grass dedicated energy crop grown on 925 ha (2300 acre) plantation
  - 834 ha planted plus roads, canals, power plant
    - Co-located with power plant on 4200 ha rice plantation
    - High yield, low cost crop
    - Can provide >100% of fuel needed
    - Excess used as animal feed
  - Irrigation from Lake Nicaragua for reliability
  - Cultivation similar to sugarcane
  - Rice husk and rice straw as secondary/back-up fuel