Wood or Agricultural Pellets
Pluses & Minuses

VIASPACE Clean Energy for a Cleaner Tomorrow

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  - VIASPACE stock symbol VSPC.OB
- VIASPACE headquarters in the US with activities in China and other countries

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VIASPACE Giant King Grass

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- Giant King Grass is a high yield, fast growing dedicated and sustainable energy crop

Biomass is Low Carbon Fuel

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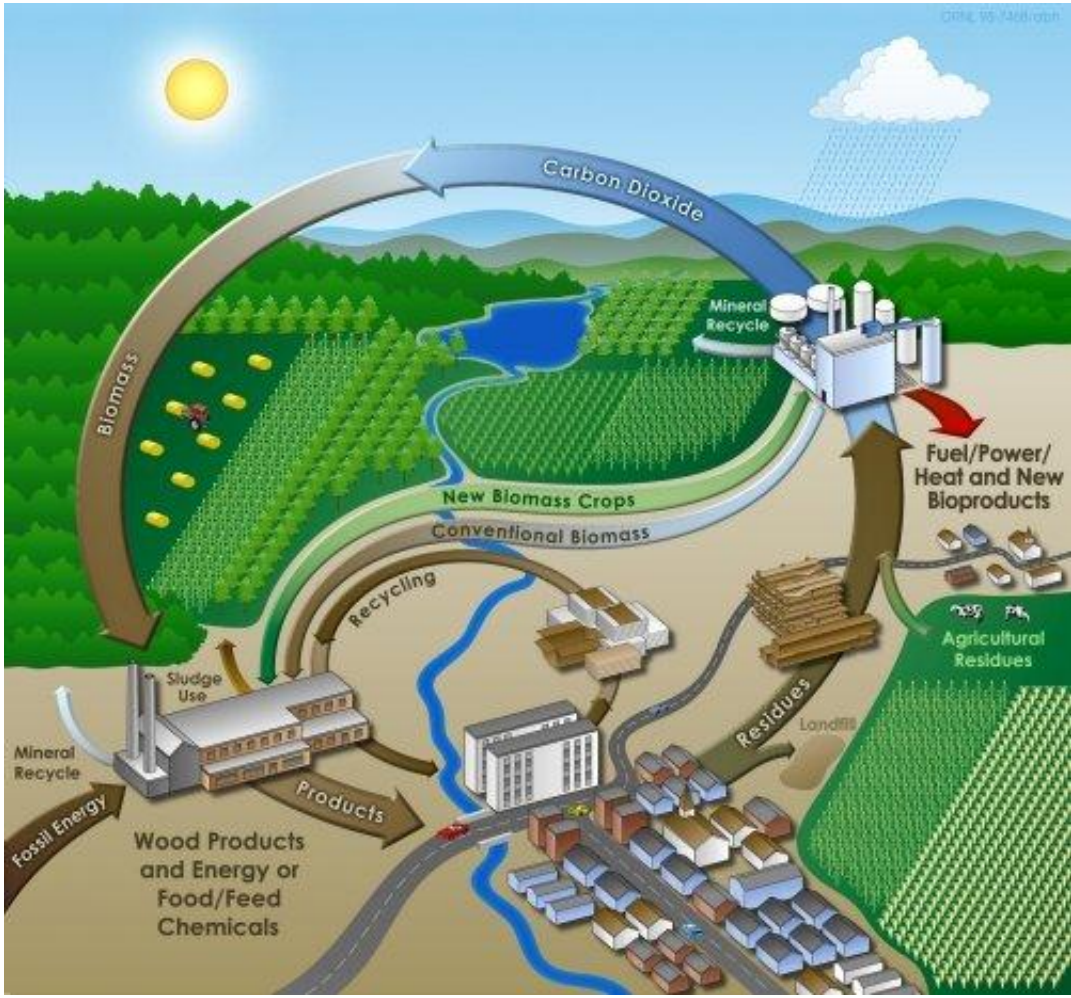
- Biomass energy is solar energy & CO_2 captured in plants by photosynthesis
- Burning biomass or biofuels simply recycles the CO_2 stored by the plant
- Carbon neutral except
  - Fertilizer, harvesting, & delivery contribute some carbon dioxide



Why Biomass Pellets ?

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- Biomass is renewable, sustainable & carbon neutral
  - much lower CO_2 emissions compared to coal
- However biomass is very bulky and difficult to ship over long distances– think of a bale of hay
- Pellets are densified biomass
  - Dried, ground into a powder and squeezed into a pellet, which is easy to ship in bulk--like grain
- Most importantly, biomass pellets can be substituted for up to 20% of coal in existing power plants (with only minor modifications) thus reducing emissions while preserving the hundreds of millions of dollars in power plant capital investment

Wood or Agricultural Pellets

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- Wood pellets are dominant today
  - 16 M mt/year
  - Made from sawdust and forestry waste
  - Small residential and commercial boilers can use 100% pellets
  - Replace 20% of coal in existing power plants
    - Minor modification to expensive power plant
  - Dedicated energy forests are being planted
- Agricultural pellets are emerging
  - Most wood waste is already committed for pressed wood products & pellets
  - Pellet market is growing to 46M mt/year by 2020
    - Need more supply
  - Do not cut down rain forests
  - Today made from waste e.g. corn or wheat straw
  - Dedicated , sustainable energy crops are attractive

Agricultural Biomass for Electricity Generation/Pellets

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- Agricultural waste (examples)
  - Corn, wheat, rice straws
  - Rice husk, corn cob
  - Sugarcane bagasse
- Dedicated energy crops (examples)
  - Perennial grasses
    - Switchgrass --temperate areas
    - Miscanthus--temperate areas
    - Elephant grass– tropical and subtropical areas
    - Giant King Grass--tropical and subtropical areas

This presentation focuses on straws & grasses because they are most widely available. Unpelleted bagasse is used today to generate heat/electricity at the sugar mill

Pellets to Replace Coal

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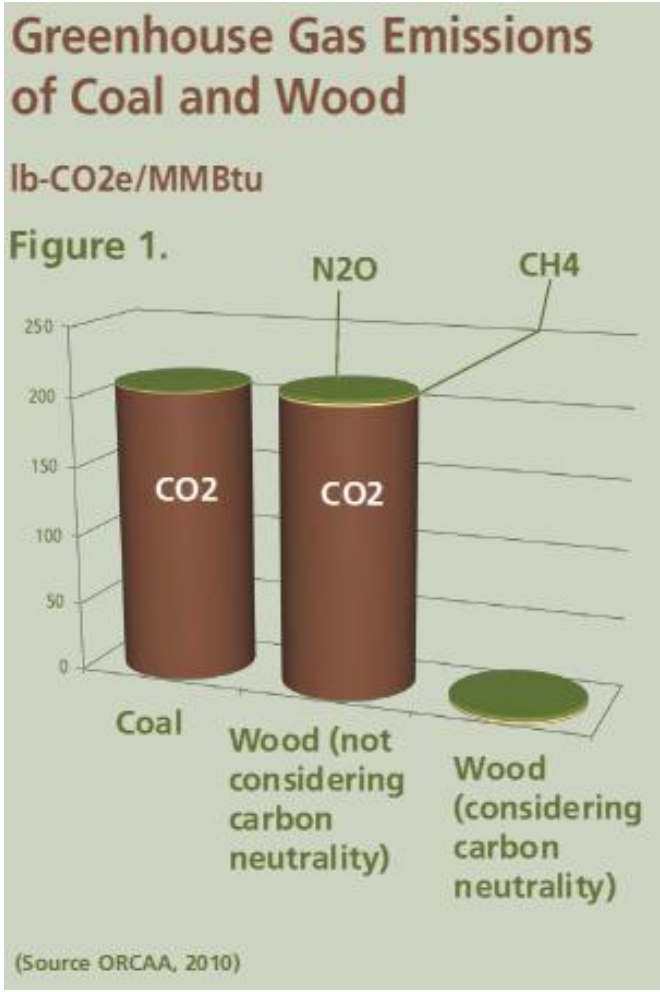
- Biomass has much lower CO_2 emissions and lower NOX, SO_2, HCL, Hg and As emissions



Forest Biomass and Air Emissions

Uncontrolled Emissions Comparison

Pollutant	WOOD LB pollutant/ LB/MMBtu	COAL LB/MMBtu	NATURAL GAS combined cycle turbine LB/MMBtu
NOX	0.220	0.510	0.0371
CO	0.600	0.025	0.0075
SO2	0.025	0.890 (coal sulfur content varies)	0.0028
VOC	0.017	0.003	0.0043
PM	0.570	0.460	0.0083
CO2	206.94	214.04	116.97
HCl	1.900E-02	6.100E-02	None
Hg	3.500E-06	1.600E-05	None
Mn	1.600E-03	1.200E-03	None

Source: ORCAA Assessment 2/3/2010, Ecology 2/24/2010

Coal Compared to Wood & Agricultural Pellets

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	Density kg/m3	Moisture % wet basis	LHV (NCV) MJ/kg	Ash % dry matter
Coal	850	10 – 15	24	12
Wood pellets	650	<10	17.3	0.5
Straw pellets	600	<10	15	5.2
Giant King Grass pellets	600	8.8	15.6	5.1

	Nitrogen % dry matter	Sulfur	Chlorine
Coal	1.3	0.35	0.01
Wood pellets	0.22	0.03	0.02
Giant King Grass pellets	0.79	0.20	0.13

Data shows that wood pellets have higher energy density and lower nitrogen, sulfur and chlorine content than straw or Giant King Grass pellets

Why Agricultural Pellets?

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- Both wood pellets and agricultural pellets are more environmentally friendly than coal
- Wood pellets are technically superior, but there is not enough wood to meet demand
- Agricultural pellets are the best alternative
- Dedicated sustainably grown energy crop pellets such as Giant King Grass have significant advantages
  - Will use Giant King Grass as an example. Physical properties are very similar to miscanthus etc.

Agricultural Waste or Dedicated Energy Crops

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- Agricultural waste pellets are made from corn straw, wheat straw or rice straw
  - Wastes from food crops are seasonal and generally not available on long-term contracts
    - Spot market only- price and availability is unpredictable
- Dedicated energy crops are grown entirely for energy use and not tied to a food harvest
  - Sustainably grown
  - Long-term contracts available
  - Reliable source of consistent quality pellets

Why Giant King Grass?

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- Dedicated energy crop, sustainably grown
- Can be harvested 6 ½ months after planting and every 5 months thereafter
  - Wood crops are 4-20 year harvest cycle
- Very high yield means lowest cost pellets
  - Generally lower cost than agricultural waste
- Single cultivar means consistent quality
- Can harvest all year long in tropical area
- Simple logistics if pellet mill is co-located with plantation and both are near a port

Giant King Grass & Waste Straws Have Same Properties

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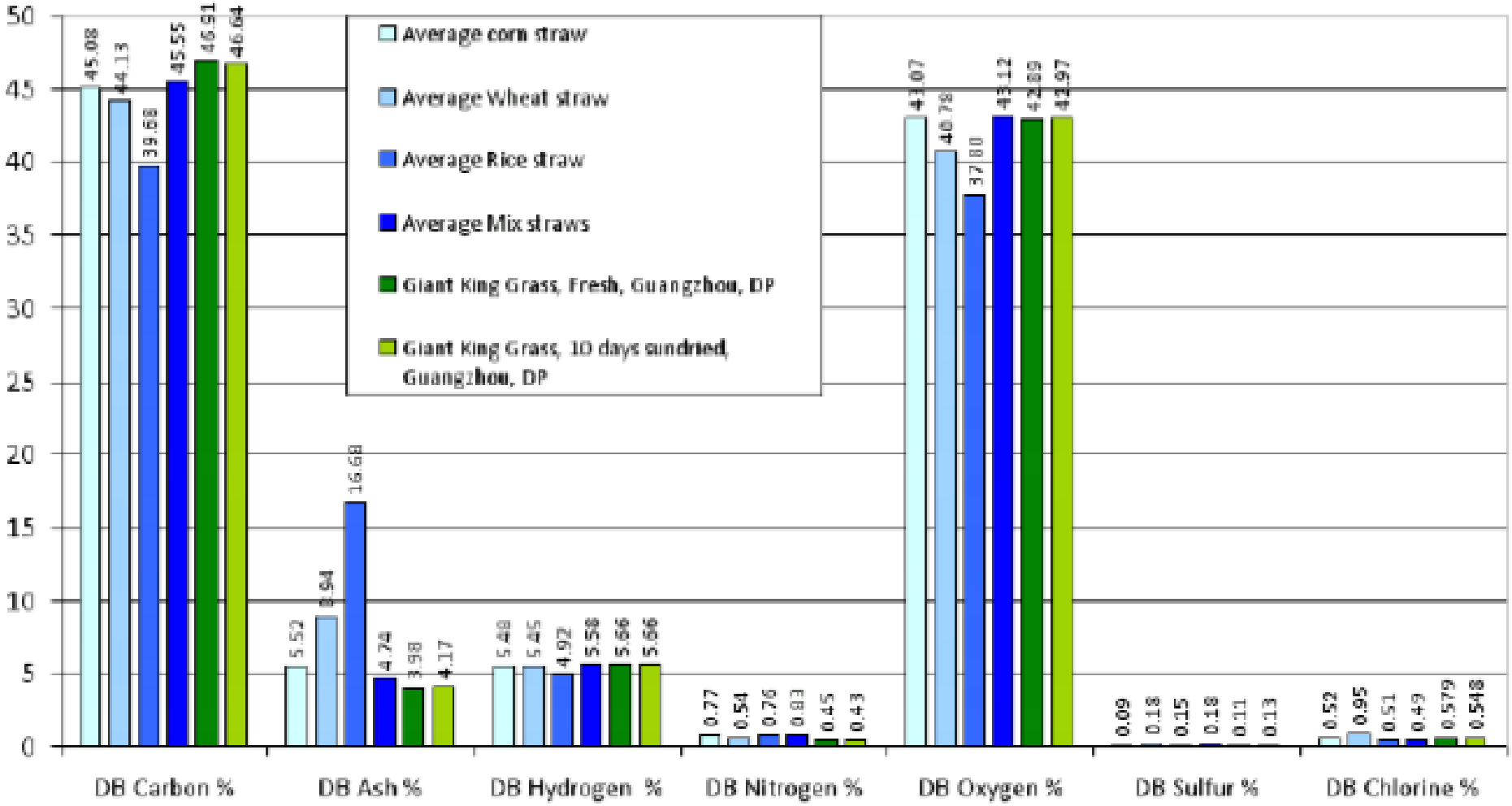

Test Data on Giant King Grass

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- Giant King Grass pellets have been tested by several independent laboratories

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	

SGS

Test Data on Giant King Grass Pellets

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Test Method : Korea Forest Research Institute Notice No. 2009-02

Products	Size (mm)		Sulfur (%)	Nitrogen (%)	Clorine (%)
	length	diameter			
Pellet	38	8	0.01	0.2	0.00

Products	Moisture content (%)	Ash content (%)	Calorific value (kcal/kg)
Pellet	7.3	5.2	4453 KFRI retest

KFRI
국립산림과학원
KOREA FOREST RESEARCH INSTITUTE

국립산림과학원장

Giant King Grass

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- Versatile, very high yield, non-food dedicated energy crop
  - Perennial in tropical and subtropical regions—no long freeze
  - Grows on marginal land
  - Harvest 2-3 times/year
- High yield translates into high land use efficiency and low cost
- Fuel for electricity generation
  - Burn directly or pelletize for co-firing
- Feedstock for cellulosic biofuels, biochemicals & bioplastics

Applications of Giant King Grass

- Direct combustion in electric power plant
- Pellets for co-firing with coal
- Briquettes for process steam and heat
- Biogas production/anerobic digestion
- Cellulosic liquid biofuels--ethanol/butanol
- Biochemicals and bio plastics
- Pulp for paper and cellulosic textiles
- High-temperature gasification
- Torrefaction to bio coal & pyrolysis to bio oil
- Catalytic processes to bio diesel

Applications that are commercial today with other feedstock

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

Extensive Independent Testing, But Not Yet in Production

Giant King Grass

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- Very high yield
  - 44 dry US tons/acre/year
  - 100 dry MT/ha/year
- Not genetically modified
- Not an invasive species
- Productive in first year
- Needs sunshine, warm weather & rain or irrigation
- Fertilizer use is modest
- Can be grown in acidic or mildly saline soil

Giant King Grass and Factory

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110 ha (270 acre) site provides
-seedlings for large energy projects
-demonstration of production
-sample quantities for customers

Note CEO standing at lower right . Giant King Grass is 4 m tall

Giant King Grass After Harvest

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Field dried grass and regrowth 10 days after harvest

Field Dried Grass & Regrowth

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Field Dried Grass Transported to Nearby Factory

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Co-location of plantation and factory means grass does not need to be baled

Chipper ,Rotary Dryer and Hammermill

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Green Log Machine

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Most Green Log processes are common to a pellet mill

-Growing
-Harvesting
-Chipping
-Drying
-Hammer mill

Stack of Green Logs

Combustion Issues
Residential & Small Applications

- Current small stoves & boilers for residential and small commercial applications are designed to burn 100% wood pellets
  - They may have problems with the increased quantity of ash with agricultural pellets and with the lower ash melting temperature which can cause slagging and deposits
  - They may also have a problem with corrosion from the higher level of chlorine
- Wood pellets are best for small applications

Combustion Issues
Large r 100% Biomass Boilers

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- Companies such as DP CleanTech using Danish technology have built many power plants that are fueled 100% with straw
- Watercooled grate, boiler design, staged air & materials to control slag & corrosion, and flue gas cleaning to meet air emissions standards

- Note that these power plants can operate on loose biomass and do not require pellets
- Many boilers designed for wood cannot use straw as the fuel

Slag on superheater

Co-firing Biomass Pellets with Coal

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- This is the most important industrial application of pellets
- Many existing large coal plants can replace up to 20% of coal with biomass thus reducing their carbon dioxide emissions by 20%
- Coal plants already handle large quantities of ash and have emissions control equipment.
  - Both wood pellets and agricultural pellets have less ash and lower sulfur and nitrogen than coal.

Co-firing Biomass Pellets with Coal

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- Coal contains aluminum silicates and sulfur that prevent corrosive alkali chlorides from forming
- Co-firing also reduces slagging
- All boiler types can co-fire biomass with coal
- Both wood pellets and agricultural pellets are suitable for co-firing

Cost of Replacing Coal w/ Pellets

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- Coal cost delivered to Europe , Korea or Japan is about $125 per metric ton
  - Energy content is 24 GJ/mt (LHV=NCV)
  - Delivered coal cost is $5.21/GJ
    - Less expensive than oil or natural gas
    - US price is about one half of this
- Carbon credits to offset coal burning are approximately $40 per ton of coal
  - Net cost of coal in Europe is $165/mt or $6.87/GJ including cost of carbon

Pellet Costs

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- Feedstock cost
  - Cost of wood waste or agricultural waste
  - Cost to grow dedicated energy crop
- Pelletizing cost
  - Capital equipment to build pellet mill
  - Electricity cost– largest single cost
  - Labor
- Transportation to port & port charges
  - Pellet mill should be close to port, but similar cost to coal
- Ocean transport
  - Expensive, but similar to coal
  - Cost depends on distance

Wood Pellet Price

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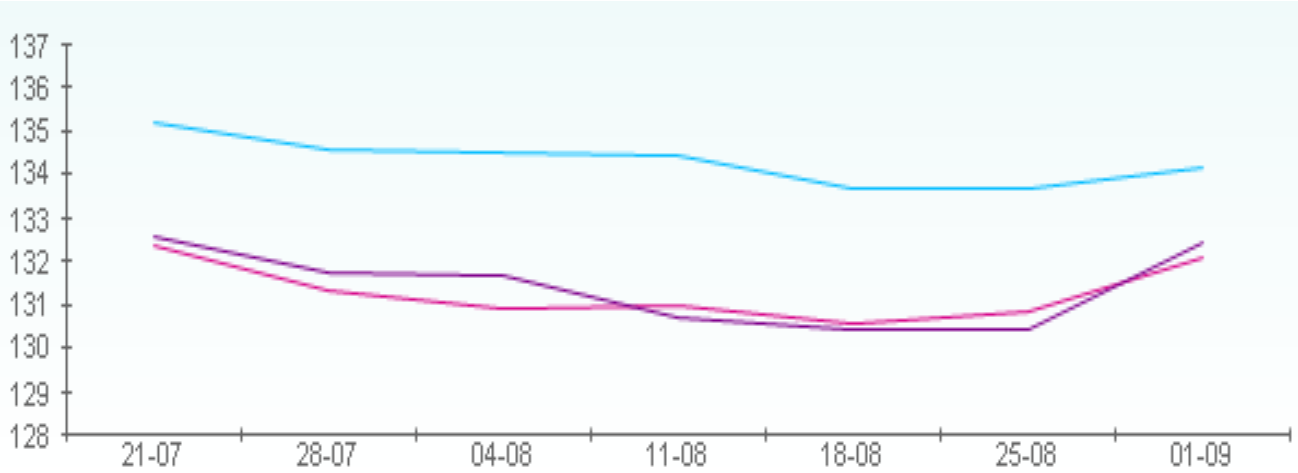
- **ENDEX INDUSTRIAL WOOD PELLETS PRICING**



- Wood pellet price is €132/mt =$186/mt delivered at Rotterdam October 2011
- Energy basis €7.6/GJ=$10.75/GJ @17.3GJ/mt
- Wood pellet price is much higher than the price of coal plus carbon ($6.87/GJ)

Giant King Grass/Straw Pellets

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- Giant King Grass and other straw pellets have about 10% less energy/mt and on this basis would sell for less than wood pellets
- UK currently gives an extra subsidy over wood for dedicated energy crops to encourage sustainably grown renewable crops
  - Policy is currently under review
- Poland has an increasing mandate for biomass to replace coal with a limitation on wood which encourages agricultural pellets

Giant King Grass -4m tall

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Summary

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- Wood pellets have about 10% higher energy density compared to agricultural pellets
  - Not an issue. Price is based on energy content
- Agricultural pellets have more ash than wood
  - Not an issue if replacing coal which has even more ash, but can be a problem with residential stoves that were designed for wood pellets
- Agricultural ash has a lower melting temperature than wood ash
  - Not an issue in industrial applications with 20% cofiring with coal. Slagging and deposits may occur in certain high temperature boilers that use 100% agricultural biomass. Proper combustor and boiler design solves this problem.

Summary

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- Agricultural straw pellets have higher chlorine
  - This is not an issue when cofiring with coal because the aluminum silicates in coal neutralize the effect of the chlorine. Chlorine related corrosion is an issue with simple substitution for wood in existing boilers. Proper boiler design solves this issue.
- Straw pellets have higher nitrogen and sulfur emissions than wood but both are lower than coal and meet European emission standards

Conclusions

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- Pellet demand is rising quickly
- Wood pellets are the best alternative to coal, but supply is limited
- When the global economy recovers, the demand for wood waste for construction materials will increase and wood pellet prices will rise
- As pellet demand increases, agricultural pellets, especially pellets from dedicated, sustainably grown energy crops will be in great demand

Conclusions

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- Long-term contracts for dedicated energy crop pellets will be attractive for customers
- Giant King Grass pellets will be the lowest cost because of high yield, year round production and simple logistics due to co-location
- VIASPACE and JV partner are developing 400,000 mt/y Giant King Grass plantation and pellet mill in Dominican Republic for European market
- VIASPACE is examining opportunities to grow & pelletize in Southeast Asia for Asian market

Thank You

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I have used public and private sources for the information in this presentation. I thank the people who have published or shared their data. Any errors are entirely my fault.