Integrated Energy Crop Plantation & Biomass Power Plant

VIASPACE Clean Energy for a Cleaner Tomorrow

Giant King Grass: A Dedicated Energy Crop

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Biomass Power Session:
"Cultivating Electricity: Growing the Fuels That Feed Our Power Plants"

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

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Closed Loop Biomass Power Plant

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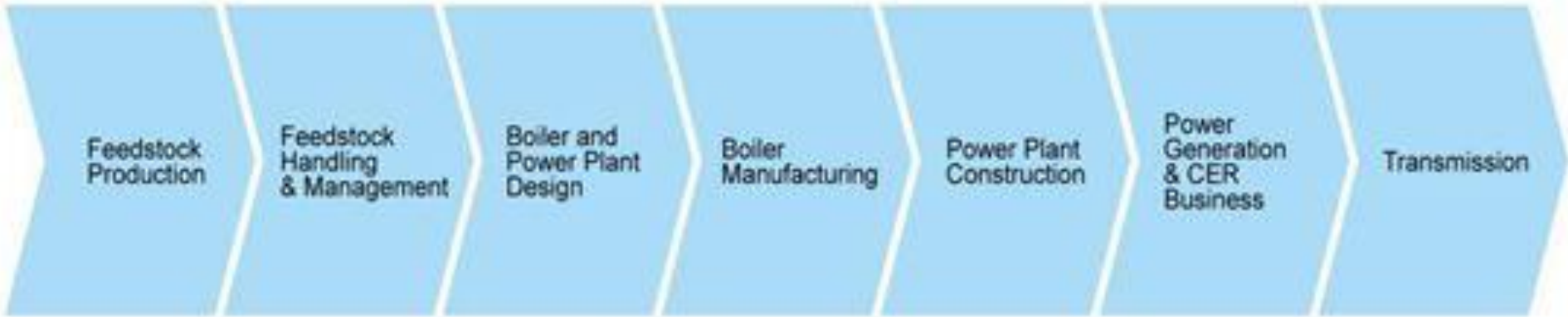
- Power plant co-located with Giant King Grass (or other biomass) plantation
- Water and sunshine in–clean, low carbon electricity out



VIASPACE ⟵ Power Plant Partner ⟶ EPC ⟶ Customer

Biomass Electricity

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- Wood or agricultural products as the fuel?
  - Wood is a better boiler fuel with higher calorific value, lower ash, higher melting temperature ash and lower chlorine compared to corn straw, wheat straw or grass
  - But wood has other higher value uses than fuel
    - Lumber, pulp and paper
  - Trees take 4-20 years to grow which means that it takes 4-20 years to get cash flow, and up to 20 years to recycle the CO_2 which may be too late
  - Much of the wood in the world is spoken for and it takes a long time to grow more

Agricultural Waste or Dedicated Energy Crops

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- Agricultural waste is initially free or low-cost, but price rises quickly when there is a demand
  - This is the experience in China, Thailand, India
- Agricultural waste only available on spot market, and banks and investors will not finance a power plant project without a long-term fuel supply contract
- Dedicated agricultural energy crops such as perennial grasses are very attractive
  - Short rotation (harvest annually or more often) means quick cash flow and rapid recycling of carbon dioxide
  - High yield means low cost. Long-term contracts available
  - Can grow on marginal land
  - Can be used for anerobic digestion as well as combustion

Yield Comparison of Perennial Grasses

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Perennial Grass (Genus-Species)	Dry Mass (US ton/acre/year, mt/ha/yr))	
Phalaris-- Reed Canary Grass	2.0 – 3.6	4.5-8.1
Panicum-- Switchgrass	5-9	11-20
Miscanthus--Miscanthus x Giganteus	13-21	29-47
Pennisetum-- Pennisetum Purpureum	24 –27	54-61
Giant King Grass	44	100

Notes: data taken from the literature. Sources are available upon request

- Reed Canary Grass data from US state of Michigan and Ontario Canada
- Switchgrass data from trials by the University of Illinois in the state of Illinois
- Miscanthus data from trials by the University of Illinois in the state of Illinois
- Pennisetum Purpureum data from trials at the University of Florida in the state of Florida

Important factors to consider in interpreting the data.

- Phalaris and Panicum are cold weather grasses that can tolerate a long freeze. The growing season is relatively short in the cold areas
- Miscanthus can tolerate moderate but not deep freezes. Cold weather induces senescence
- Pennisetum Purpureum and Giant King Grass are tropical and subtropical grasses. The do not survive a long freeze. The growing season can be 12 months and these crops can be harvested more than once a year

Agricultural Waste is Disbursed And Seasonal

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Off-site storage of dried, baled seasonal feedstock

30 MW power plant

100 km collection for agricultural waste

Dedicated Giant King Grass Plantation & Power Plant Could Fit in Center Square

Advantages of High Yield & Co-location

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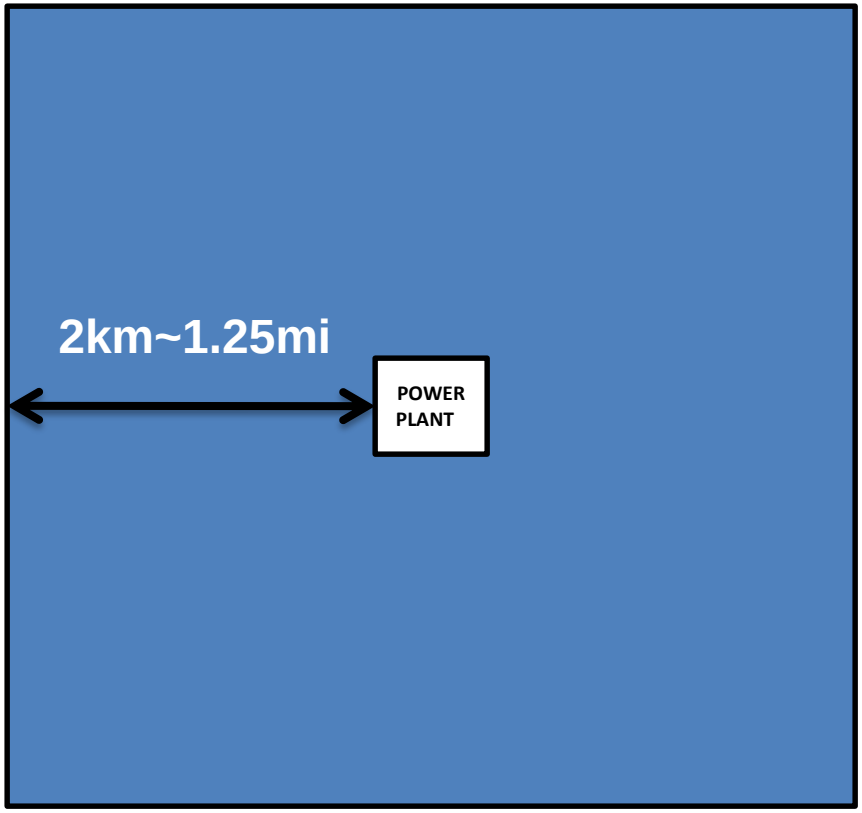
- 30 MW power plant can be fueled by Giant King Grass grown on 1600 ha (4000 acres)
- High yield and co-location short distances means low cost fuel
  - Less expensive than agricultural waste

- Maximum transport distance is 2 km (1.25mi)



VIASPACE Giant King Grass

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Giant King Grass
Highest Yield=Lowest Cost

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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
- Fertilizer use is modest
- No pesticide
- Extensive bioenergy test data

Giant King Grass
Test plot
6 ½ months after planting
Cutting, measuring & propagating


200 inches tall (5m)plant
Weighs 36.7 pounds (16.6 kg)


36.7
HOLD
lb

Composite picture because 17 ft plant is too tall to get in a single picture

Corner cleared for regrowth test

,test plot with drip irrigation

One week

Two weeks

Two weeks

New Growth & Regrowth at Four weeks

Germination rate 95- 98%

Above: growth and regrowth at five weeks

Right: regrowth at 7 ½ weeks

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

30 MW Biomass Power Plant Uses Agricultural Waste Today

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Biomass Power Plant

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Combustion Issues
100% Grass/Straw Boilers

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- Grass and straw have higher ash, lower melting temperature ash, and higher chlorine compared to wood
- Many boilers designed for wood cannot use straw

Slag on superheater →

- Water cooled grate, special boiler design, staged air & materials to control slag & and corrosion, and flue gas cleaning to meet air emissions standards
- Power plants suitable for grass and straw are available

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
Total Moisture	**%**	**14**	**0**
Volatile Matter	**%**	**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**	**-**

Giant King Grass & Waste Straws Have Same Properties

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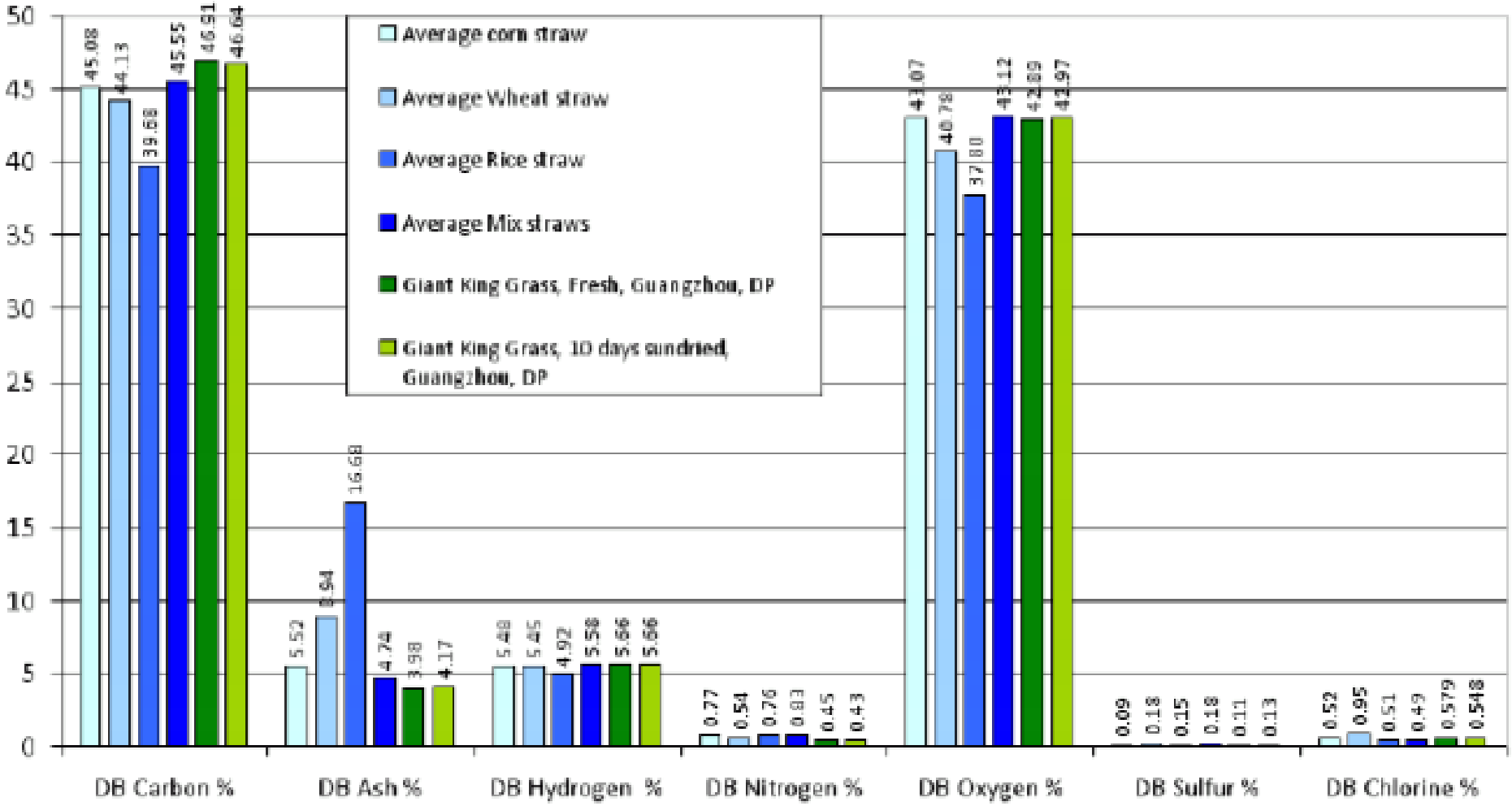

Giant King Grass Pellets as Coal Replacement

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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

Giant King Grass Pellets-- Tested by Many Independent Laboratories

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Compositional Analysis: Proximate/Ultimate Analysis

Parameter	As-Received	Oven Dry
Total Moisture (%)	7.62	
Ash (%)	2.42	2.61
Volatiles (%)	72.60	78.59
Fixed Carbon (%)	17.28	18.71
Gross Calorific Value (GJ/Tonne)	18.38	19.90
Net Calorific Value (cV)(GJ/Tonne)	17.20	18.81
Net Calorific Value (cP)(GJ/Tonne)	17.13	18.74
Carbon	44.63	48.31
Hydrogen	4.88	5.28
Nitrogen	0.69	0.75
Sulfur	0.09	0.09
Oxygen	39.69	42.96
Chlorine	1140	1234

BEL BIOMASS ENERGY LAB

Biomass Energy Lab, a JV of Timber Products Inspection & Control Union is only US lab accredited for European biomass fuel quality testing

KFRI 국립산림과학원 KOREA FOREST RESEARCH INSTITUTE

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	

TLR international laboratories

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

SGS

Giant King Grass and Factory

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110 ha (270 acre) test 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

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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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

Cellulosic Biofuels, Biochemicals & Bio Plastics

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- 1st generation bio ethanol is made from sugar cane, corn or recently cassava
  - Making fuel from food is being restricted or prohibited
- 2nd 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
- 2nd 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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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

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

Sugar Data & Projected Ethanol Yield (gal/ton)

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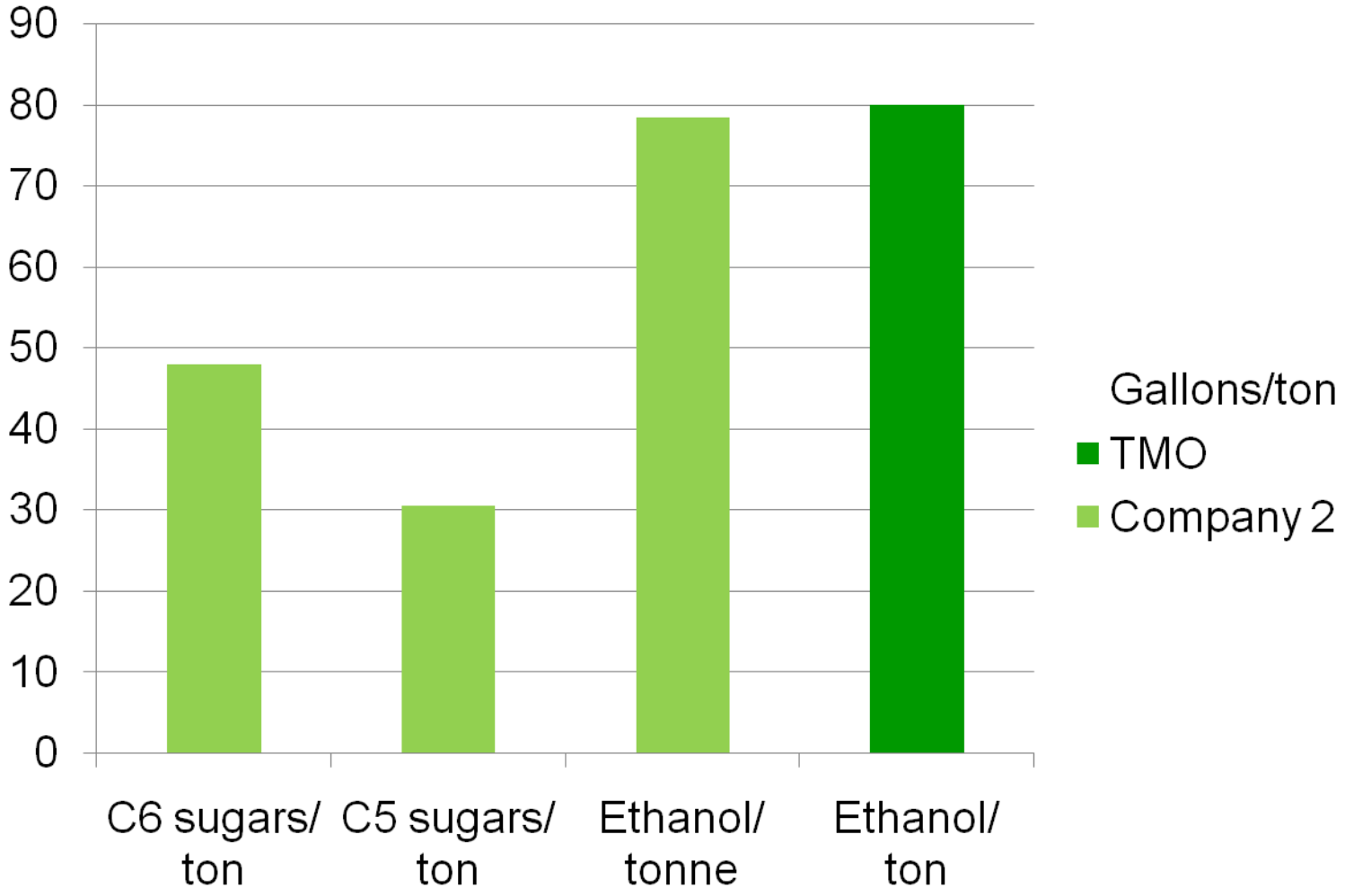

Compare Giant King Grass Yield to Corn & Miscanthus

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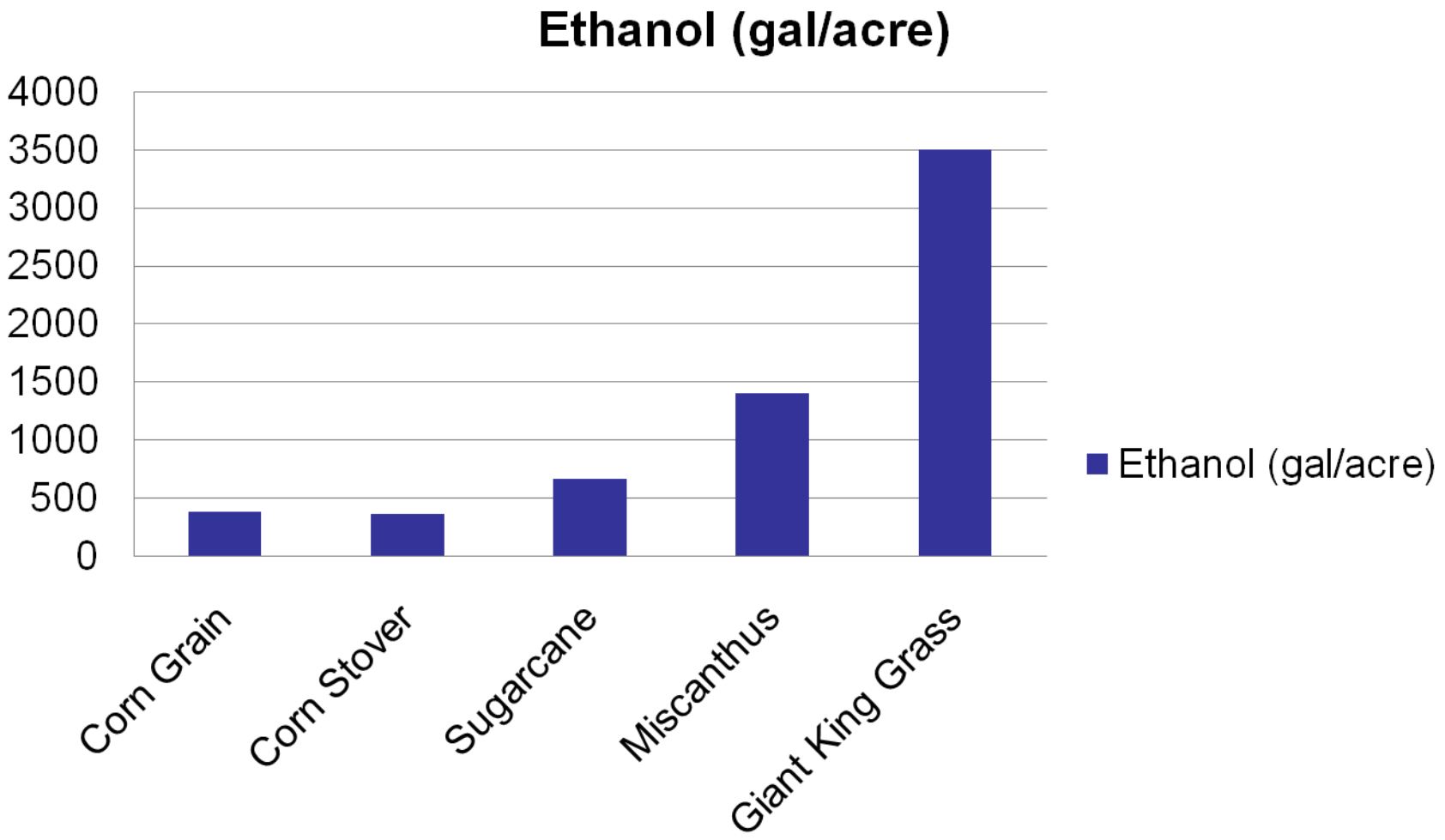
Yield Dry Matter	Giant King Grass	Corn Stover	Miscanthus
US ton/acre	44	3.5-4.7	14-18
Metric ton/ha	100	8.6-11.6	30-40

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



Feedstock is the Largest Cost of Cellulosic Ethanol

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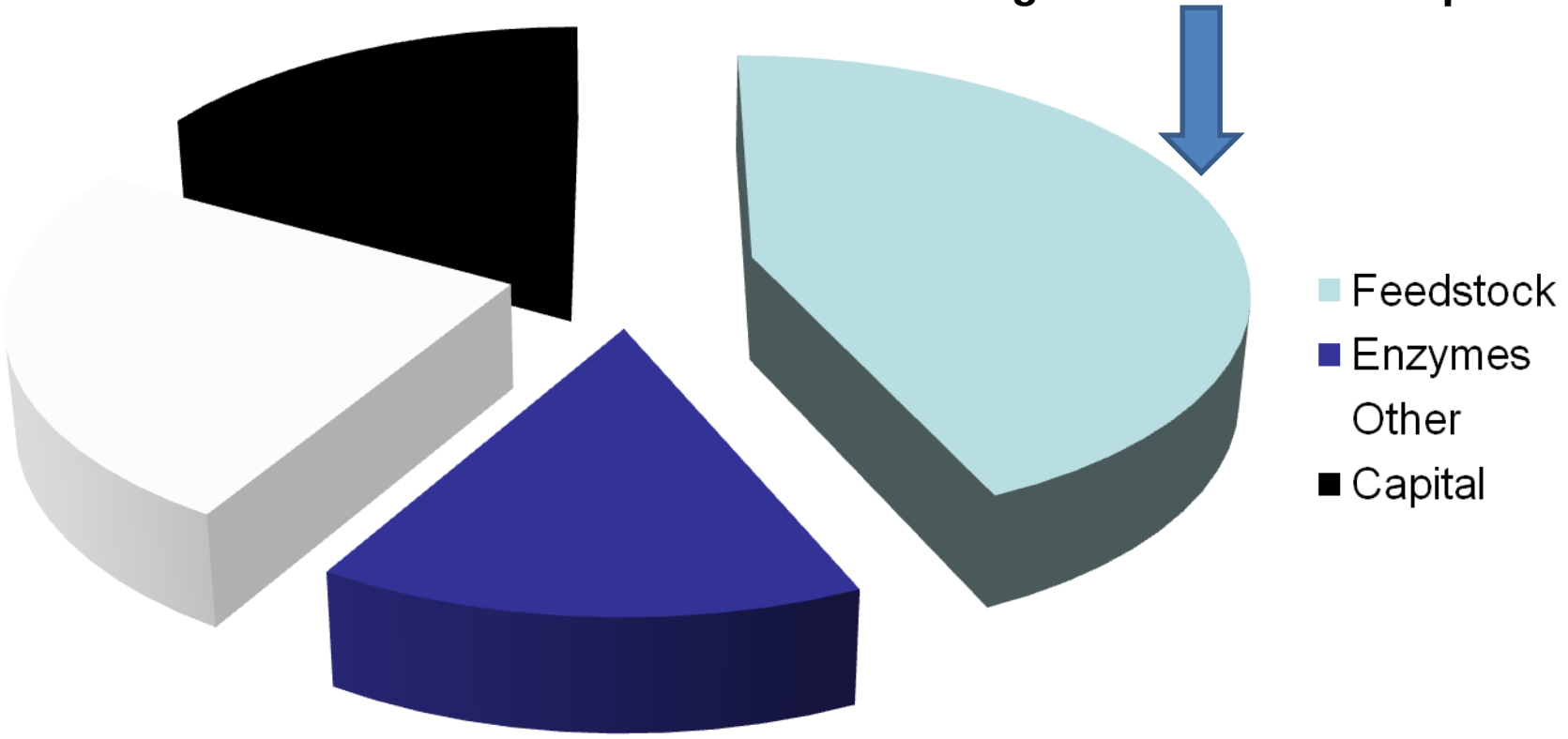
Giant King Grass and co-location can reduce feedstock cost by 40-50% making cellulosic ethanol profitable



Advantages of Giant King Grass

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- "Platform" energy crop for many bioenergy applications
  - Electricity, pellets, biofuels, biochemicals & bio plastics
- Low cost--Can meet cost targets for energy & biofuels applications because of high yield
  - 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 Business

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- 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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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

Biomass is Low Carbon Fuel
Plants Breathe Carbon Dioxide

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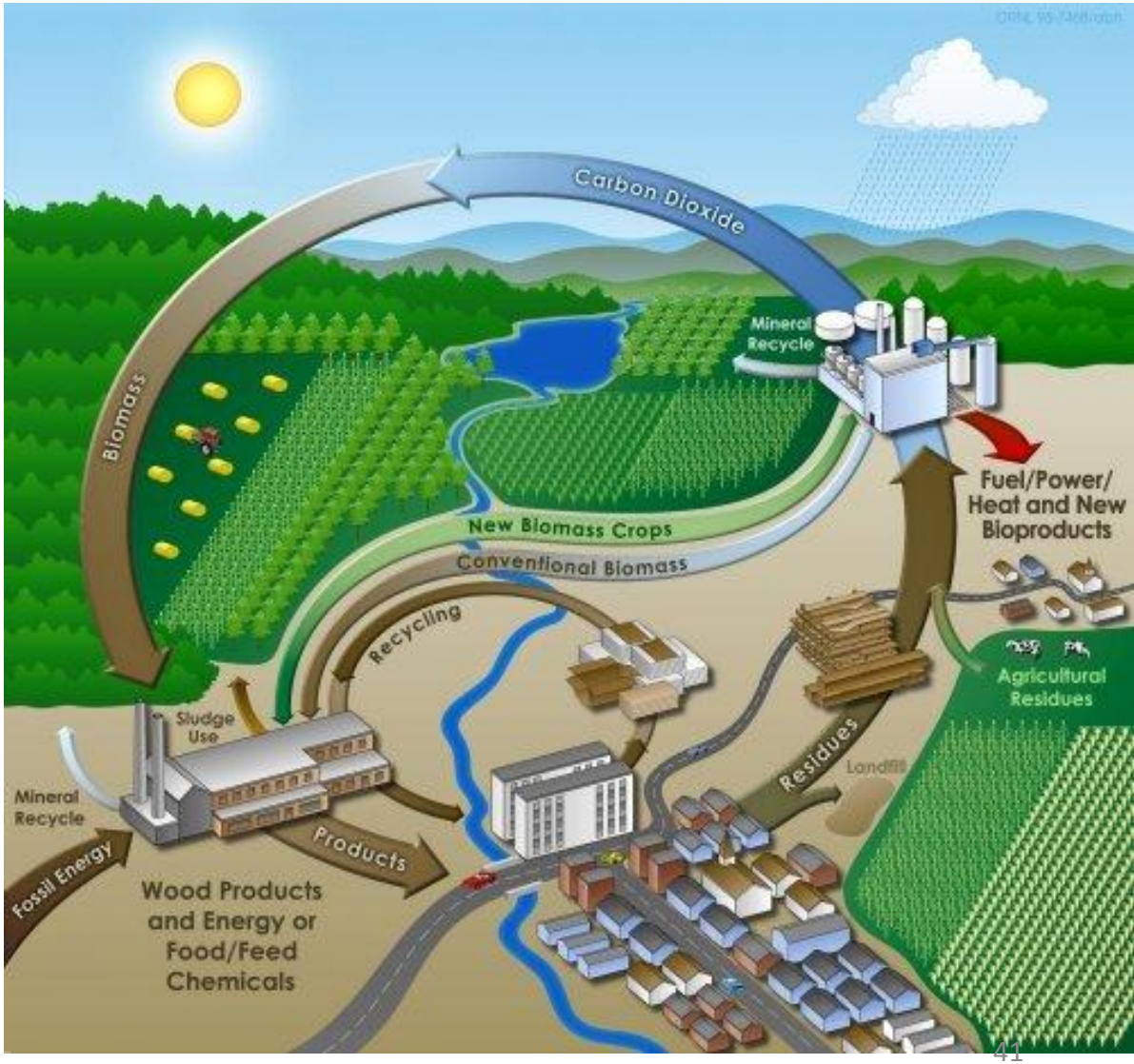
- Plants use sunlight & CO_2 to grow. Carbon is stored in the plant
- Burning biomass or biofuels simply recycles the CO_2 stored in the plant
  - Time can be 6 mos - grass to 20 yrs-trees
- Biomass is carbon neutral except from
  - Fertilizer, harvesting, & delivery



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 /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

Direct Combustion Biomass Power Plant

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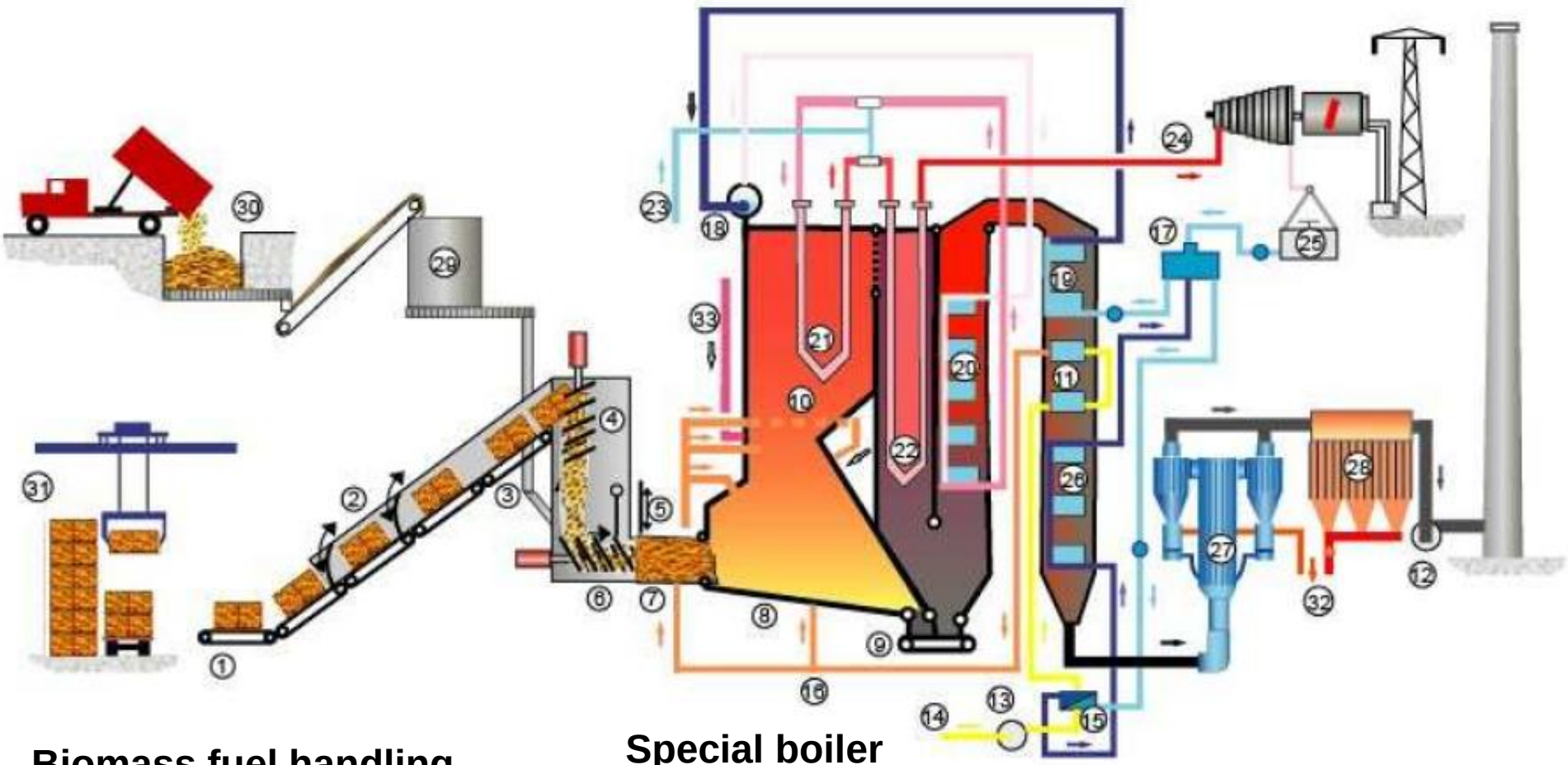

Biomass fuel handling

Special boiler burns biomass to create steam

High pressure steam turbine turns generator to make electricity

Biogas to Electricity

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- Sizes of Biogas power plants are 0.5 to 3 MW
- 70 hectare Giant King Grass per 1 MW power
- Provides 24/7 electricity for remote area, factory or to the grid
- Biogas power plant and plantation should be co-located to minimize fuel transportation costs
- Waste heat and organic fertilizer have value

Giant King Grass has both higher biogas yield per kilogram and higher kilogram yield per hectare than competing biomass

- Lower cost feedstock and electricity & higher profit

1.5 MW biogas engine generator set

Bio-Methane Yield/ Hectare of Land

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- Biogas production uses fresh Giant King Grass with yield of 375 mt/ha
- Measured biogas yields are 160-190 cubic meters of biogas/tonne of fresh grass
  - Methane content is 57% of biogas
- Bio-methane yield is 94 -111 m3/ha/day
- Giant King Grass bio-methane yield is 3.4 - 4.0 million BTU per hectare per day
- 1 MW of electricity requires 70 ha

Giant King Grass--Scalable & Sustainable Development

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- Giant King Grass plantation co-located with a power plant, pellet mill, bio-methane facility or biorefinery
  - Scalable, integrated, clean energy module that can be replicated throughout the world
- Provides local employment for farmers and power or processing plant operators
- Provides clean electricity
- Provides energy security & independence
- Money stays in country rather than sent overseas to purchase fuel