Giant King Grass
An Energy Crop for Cellulosic Biofuels & Electric Power Plants

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Biofuels and Jatropha Markets Asia
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VIASPACE
Company Background

- Founded in 1998 as a spin out from the NASA/Caltech Jet Propulsion Laboratory (JPL)
- Became a public company in 2005. Traded on the U.S. OTC bulletin board with stock symbol VSPC

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VIASPACE Focus

- **Renewable Energy--Giant King Grass**
  - Non-food feedstock for low carbon, liquid biofuels for transportation including cellulosic ethanol
  - Low carbon biomass replacement for coal in electric power plants
  - Feedstock for bio-methane production
- **Alternative Energy--Fuel Cell Cartridges**
  - Disposable methanol fuel cartridges for fuel cell powered portable electronics-- notebook computers and mobile phones

Worldwide Trend to Cellulosic Biofuels

- China has made renewable biofuels a national priority and banned biofuels made from food crops
- The Obama administration has called for U.S. national low- carbon fuel standard
- The State of California has passed the world's first low-carbon fuel standard that favors biofuels made from grass and other non-food materials
- BP plans to build a cellulosic ethanol plant in Florida using grass as feedstock
- Toyota’s new hybrid vehicles can be “even greener” using cellulosic biofuels

Nonfood Biofuels-- From Which Feedstock?

- Liquid biofuels for transportation
  - Gasoline replacement from nonfood cellulosic feedstocks including dedicated energy crops such as fast-growing grasses and agricultural waste like bagasse, corn stalks, wheat straw and wood chips
  - Bio-diesel from Jatropha, palm oil, algae, grass, etc.
- Biomass for direct combustion in an electric power plant
  - Agricultural waste
  - Dedicated, fast-growing energy crops such as grass or trees

Advantages of Giant King Grass

- Supports China's national priorities
  - Renewable and locally produced non-food energy
  - Cleaner environment with reduced carbon emissions
  - Improved agriculture to feed the population
- Fast growth produces much higher yield per hectare of land
  - Much higher productivity than switchgrass or miscanthus or food crops
  - Land can support both food and fuel needs
  - Can grow on marginal lands as well
- Provides multiple opportunities-- feedstock for liquid biofuels, as coal replacement for electricity generation, renewable methane & animal feed

Giant King Grass

- Rapid growth to 4 m height
- Very high productivity
  - Up to 350 tonnes/hectare (wet)
- Perennial grass with 7 year life
- Best in tropical and subtropical areas.
  - 4 or more harvests per year possible
  - Little growth below 10 C, frost will kill tops, roots can survive
- Originally developed as feed for cows, sheep, pigs, fowl and fish
  - Suitable as fresh grass, silage or dried and processed into meal

Giant King Grass

- Natural hybrid of Pennisetum Purpureum (also known as elephant grass or Napier grass) with another grass
  - Not genetically modified
- Widely adaptive and stress resistant
- Modest need for fertilizer
- No pesticide needed in most cases

Giant King Grass

- Suitable for wide range of soils including acidic red loam and mildly saline soil
- Can be planted on drylands, paddy fields, hillsides, plains
- Needs >100 days of sunshine per year, 800mm rain or irrigation
- Propagated by division or seedlings

Grassoline

- Grassoline—a new term for renewable, low carbon liquid biofuels made from grass
- Examples
  - Cellulosic ethanol, methanol and green gasoline
- Does not use food crops such as corn for its production
  - Does not cause high food prices and resulting world hunger
- Note: In 2008 one third of the US corn crop was used to make ethanol

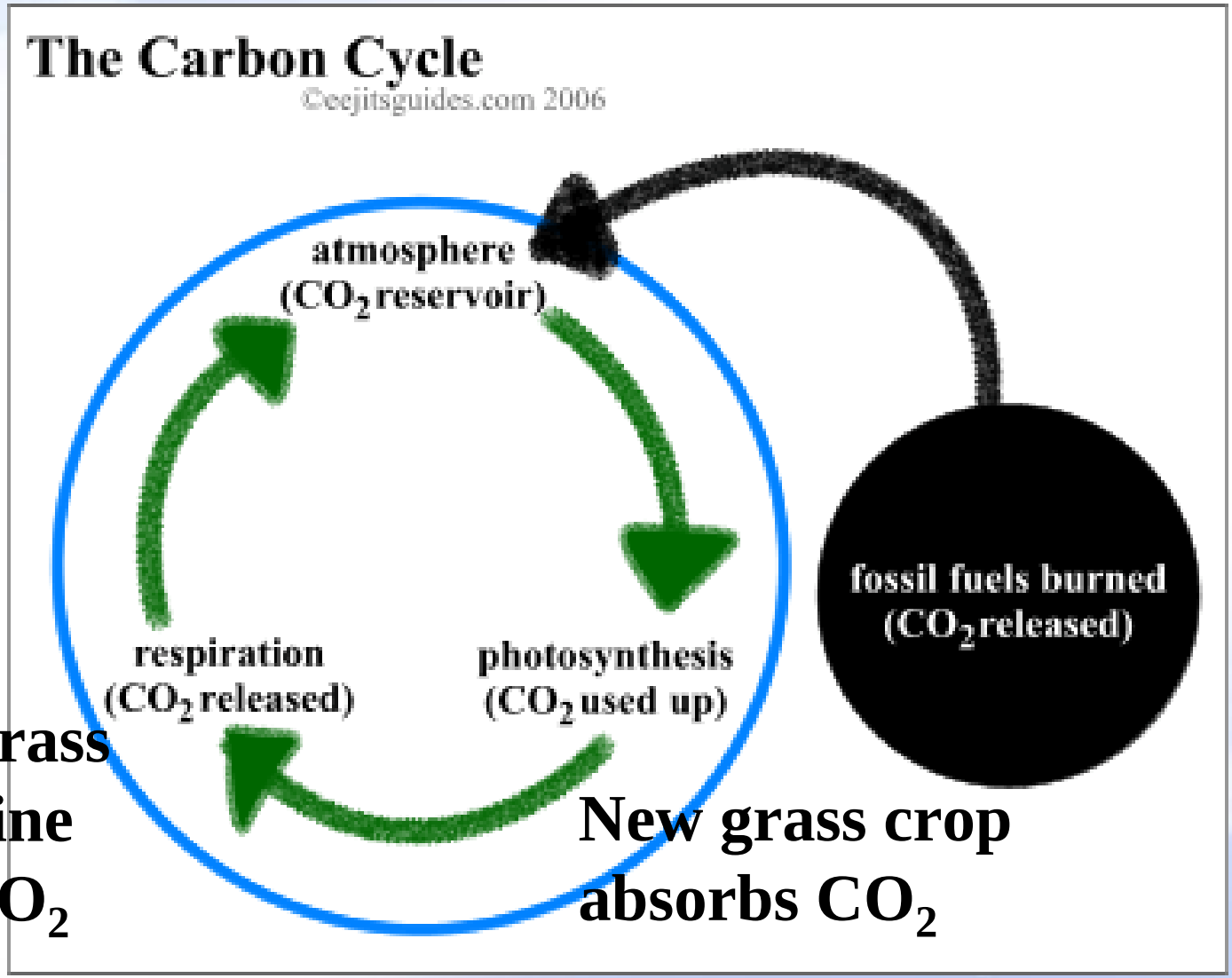
Scientific American July 2009--Highlights

- Cellulosic biofuels offer the most environmentally attractive and technologically feasible near-term alternative to oil
- Grassoline will come from agricultural waste and dedicated energy crops such as fast-growing grasses
- The US can grow enough of these feedstocks to replace about one half the country's total consumption of oil without affecting food supplies

Scientific American July 2009--Highlights

- Most energy crops can grow on marginal lands that would not otherwise be used as farmland
- Cellulosic biomass can be converted into any type of fuel – ethanol, ordinary gasoline, diesel and even jet fuel
- A plant producing 34,000 barrels/day of Grassoline would require 5,000 tons of biomass every day
- The move toward Grassoline can fundamentally change the world

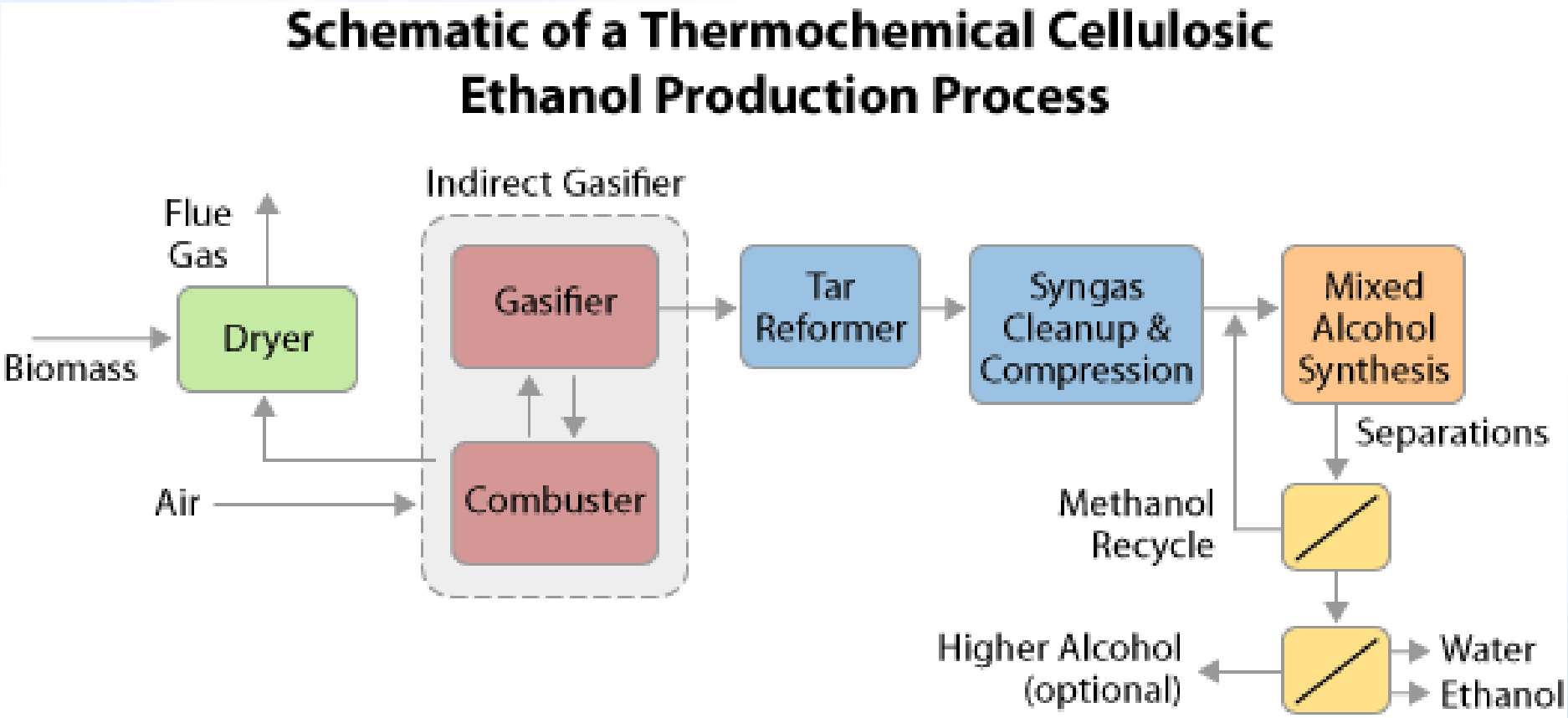
Grassoline Can Be Low Carbon



Burning grass or grassoline releases CO_2

New grass crop absorbs CO_2

Grass to Ethanol by Gasification



Grass to Ethanol by Fermentation

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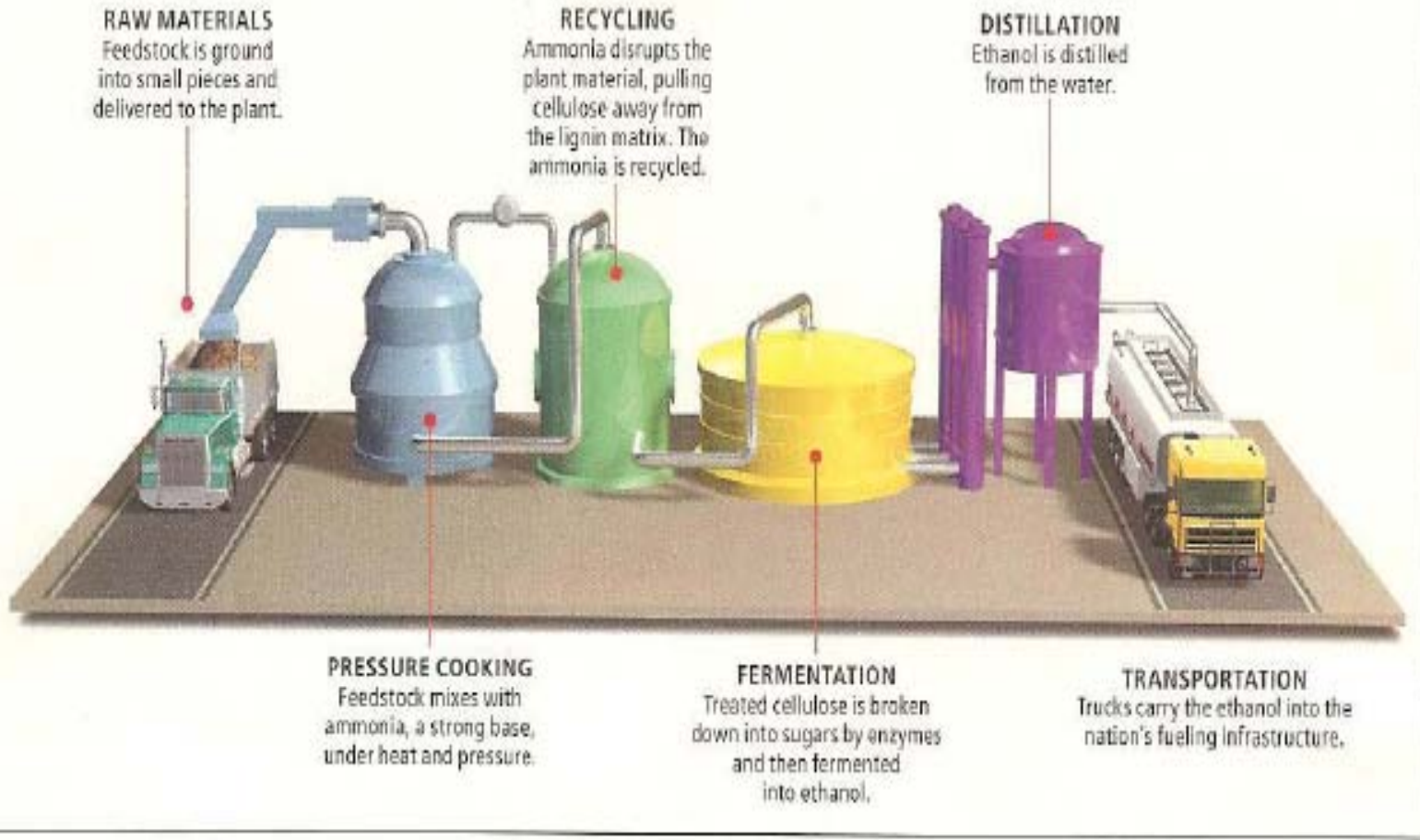
BREAKING DOWN CELLULOSE WITH AMMONIA

Although there are many possible ways to pretreat plant fibers to get at the cellulose—acids and heat are most commonly mentioned—the ammonia fiber expansion (AFEX) process offers a unique combination of low energy requirements, low costs and high efficiency.



Co-firing Coal and Biomass

- An existing coal-fired electrical power plant can be modified to burn biomass instead of coal for up to 30% of its fuel
  - Grass, wood or other agricultural products
- Carbon dioxide smokestack emissions are the same as 100% coal, but the next crop of grass absorbs the carbon dioxide emitted from the burned grass as it grows
- Simplest and fastest way to partially clean up coal power plants and introduce renewable biomass fuels on a large scale
  - Converting existing coal power plants, compared to building new plants

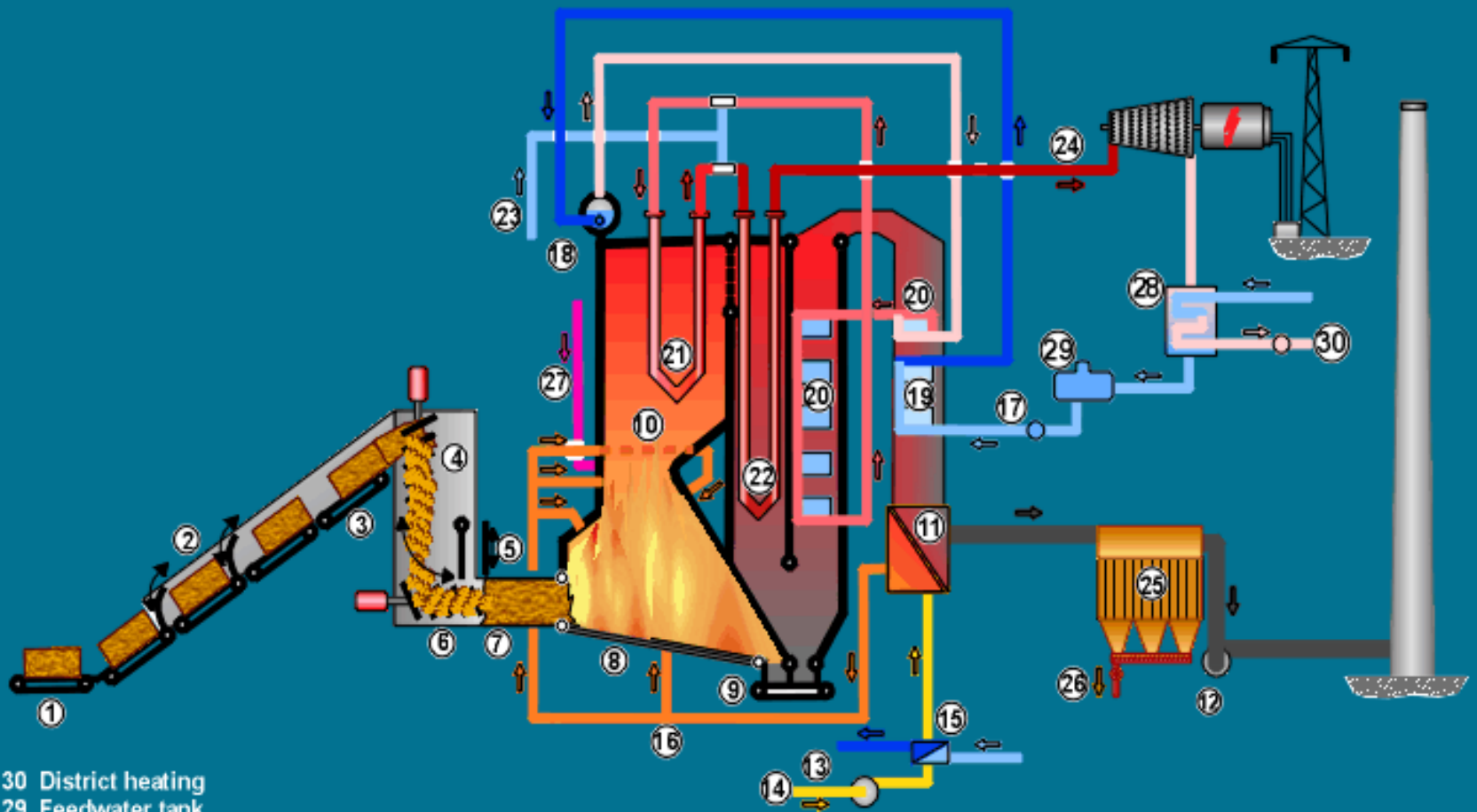
Trend to 100% Biomass Power Plants

- FirstEnergy in Ohio, USA is converting an old coal-fired power plant to 100% biomass
  - Preferable to upgrading the emissions controls of the coal plant or converting to natural gas
- Dragon Power in China has built and operates 19--100% biomass power plants
  - 12 to 30 MW, operating on agricultural waste
  - Benefits from China's substantial subsidies for biomass generated electricity
- Biomass power plants encouraged in India
- Biomass can provide electricity 24 hours a day
  - Solar only when sunny, wind only when windy

100% Biomass Power Plants

- Agricultural waste such as corn straw, wheat straw and wood chips is currently used for fuel
  - However quantity and quality of agricultural waste varies with season
- Dedicated energy crops are desired for 50% or more of power plant fuel requirements
  - Reliable with consistent quality

Straw fired boiler



30 District heating
29 Feedwater tank
28 Condenser
27 Natural gas
26 Ash handling
25 Fabric filter
24 High pressure steam to turbine
23 Water for atemperators
22 Superheater 3
21 Superheater 2
20 Superheater 1
19 Economiser
18 Steam drum
17 Feedwater
16 Preheated combustion air
15 Air preheater
14 Combustion air intake
13 Forced draught fan
12 Induced draught fan
11 Air preheater
10 Combustion chamber
9 Slag conveyor
8 Vibrating grate
7 Water cooled duct
6 Stoker
5 Fire dampers
4 Scarifier
3 Dosing unit
2 Seal gates
1 Chain conveyor

Giant King Grass as Dedicated Energy Crop

- 30 MW grass-fired electricity generating plant needs 460 tonnes of grass every day
- Average household in Shanghai uses 1200 kWh/year or average power of 0.14 kW
  - Average household in US uses 11,200 kWh/year—1.3 kW
- 30 MW plant can supply 214,000 Chinese households
- 30 MW power plant requires 1000-2200 hectares of land (using Giant King grass with yield of 350 tonnes/hectare wet and 75-175 dry)
- One hectare can provide electricity for 98-214 Chinese households

Renewable Methane (Natural Gas)

- Biomethanation (anerobic digestion) is source of renewable energy because it produces methane gas that can be burned to generate electricity and heat
- Microorganisms break down biodegradable material in the absence of oxygen
  - Widely used today to treat wastewater sludges and organic waste because it reduces volume of the waste destined for landfills
- Identified by United Nations Development Program as a decentralized energy source
- Giant King Grass is a candidate feedstock

Giant King Grass Status

- Land leased in Guangdong province in southern China
- First crop of 1.2 million seedlings planted in October 2008
  - Propagated to 3M seedlings
  - Another propagation in 2009
- In discussions to grow grass in other regions in China and other countries
  - Tropical and subtropical areas with adequate rainfall or irrigation

New Planting in China

Additional Land in China

Role of Biomass for Energy-Summary

- Waste from current agriculture should be utilized for energy production, but not enough waste available for large scale use
- Dedicated energy crops required
  - Highly productive crops
    - Without negative side effects such as soil depletion or invasive species
  - Prefer crops that can grow on marginal land
- Displacing food crops will not be allowed

Role of Biomass for Energy-Summary

- Analysis shows that there is enough land on Earth to grow for food and fuel as well if the crop has high productivity (yield)
  - For use in liquid biofuels and for direct combustion
- Direct combustion of biomass allows 24 hour electricity generation
  - Solar energy only when the sun shines
  - Wind energy only when the wind blows
- Biomass together with solar, wind and ocean power can make a big contribution
  - All alternative fuels are currently more expensive than coal or oil and need government subsidies

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Business Strategy

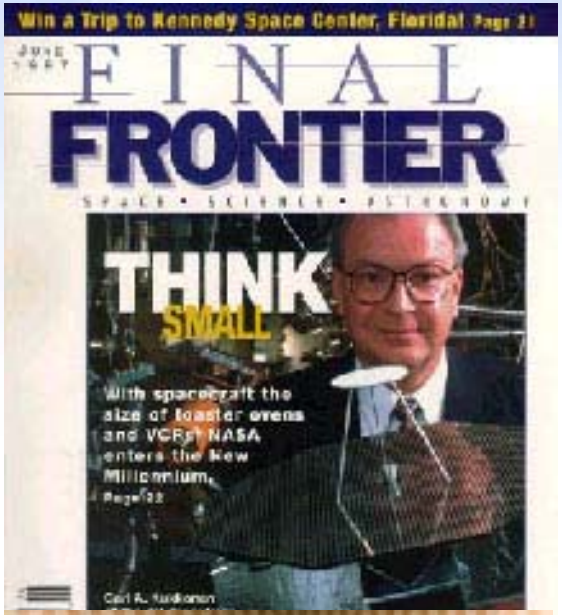
- Focus on growing and supplying feedstock for biofuels & fuel for electric power plants
- Expand land under cultivation
  - Grow seedlings to enable rapid expansion
- Sell grass initially as animal feed
  - Generate early revenue
- Seek strategic partnerships with biofuel producers and biomass power plants
  - Long-term grass supply contracts

Business & Financial Opportunities

- Business opportunities
  - Joint venture with VIASPACE for Giant King Grass cultivation in other regions
  - Supply contract for Giant King Grass from VIASPACE for biofuels, biomass or animal feed
- Financial opportunities
  - Purchase VIASPACE stock listed on the OTC bulletin board--symbol VSPC in the open market as an investment in renewable energy
  - Direct investment in the company to speed expansion

Backup Slides

CEO Background



Kukkonen with Al Gore

Dr. Carl Kukkonen

2005 – present — **VIASPACE Inc. CEO**
-Publicly traded on the OTC BB symbol VSPC

1998-2005 — **ViaSpace Technologies (incubator)**
- Founded and led 7 startup companies

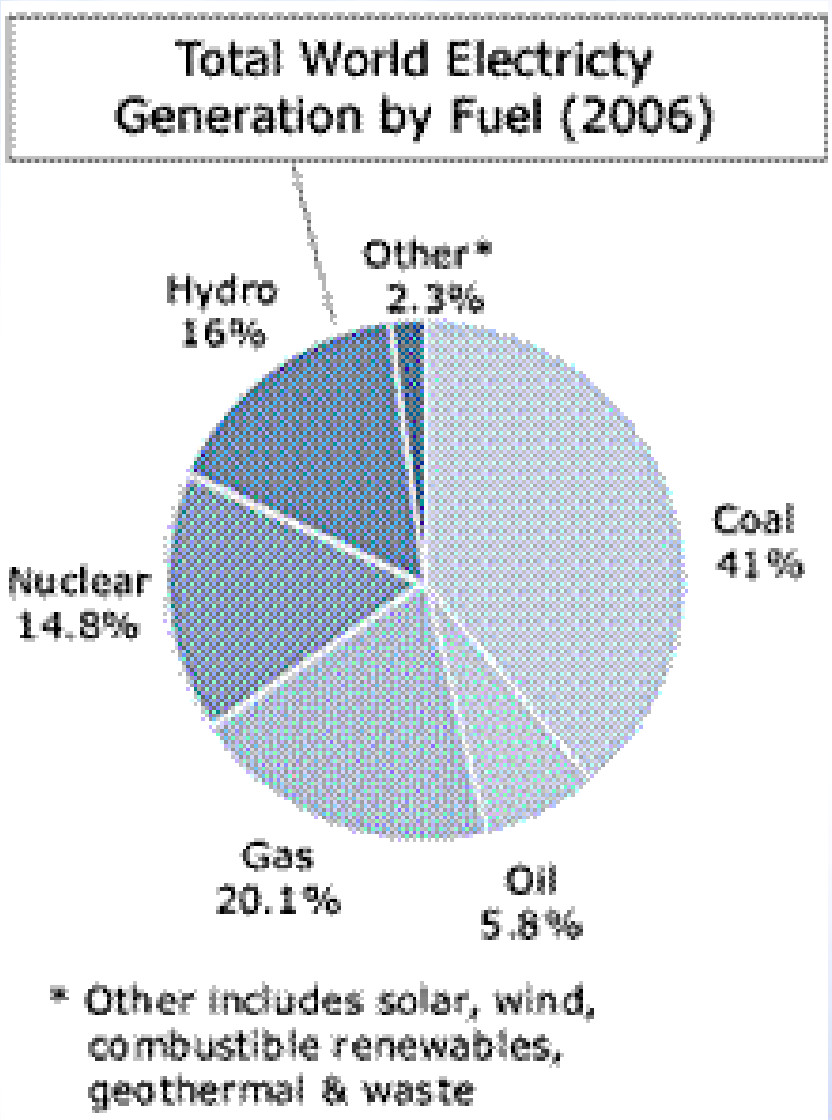
1984-1998 — **NASA/Caltech Jet Propulsion Laboratory**
Director, Center for Space Microelectronics & Manager of Supercomputing
- Led staff of 250 with annual budget of $70M
- On review boards of 14 leading universities

1977-1984 — **Ford Motor Company,**
Principal Research Scientist and Engineer
- Ford's expert on hydrogen as an alternative motor fuel
- Developed new direct injection diesel engine

1975-1977 — **Purdue University**
Postdoctoral Research Fellow

1975 — **Cornell University**
PhD, Physics

Is There Enough Land for Energy Crops?



- **Is there enough land to grow biomass to provide 41% of global electricity and replace coal?**
- World electricity use 0.72 x 10^{20} joules
  - Priority is to replace coal which is most polluting
  - Photovoltaics and wind will also contribute
- Total world land 13 billion hectares
- Total cropland 1.5 billion hectares
  - 11.5% of total world land

Is There Enough Land for Energy Crops?

- Energy crop yield depend on climate, rainfall, fertilizer and crop type
- Biomass yield can range from 5 to 350 tonnes/hectare/year
- Biomass energy content typically 10,000-20,000 joules/kg vs coal 26,000 j/kg
  - Use 15,600 for calculations
- Biomass power plant efficiency 31%

There is Enough Land for High Yield Crops

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- Calculation of additional land needed to grow enough biomass to replace all coal used globally to produce electricity

% Increase in World Cropland = 4.4/Yield x 100%

- Probably cannot expand cropland by more than 10% due to climate, soil, deforestation and other issues
- Yields > 44 tonnes/hectare/yr are desired
- Giant King Grass yield is up to 175
  - Switchgrass is up to 25

High Yield Biomass Has Large Potential

- Can replace all coal used to generate electricity worldwide by planting **new land (not using existing cropland)** with the area equal to:
  - 18% of today's world cropland using switch grass
    - May be difficult or impossible to find that much new land
  - **Only 3-6% using Giant King Grass**
    - **Land probably available**
- Liquid biofuel plants and biomass power plants likely to be smaller than conventional plants and located near the sources of the biomass
- Supplying biomass is a recurring business for the 50 year life of the biofuel or power plants

Compare Feedstock

Coal US	27GJ /mt	$50 /mt	**$1.85 /GJ**
Coal Max.	27GJ /mt	$100 /mt	**$3.70 /GJ**
Oil	6.1GJ /barrel	$70 /barrel	**$11.48 /GJ**
Nat. Gas		$5.00 /Mbtu	**$5.27 /GJ**
Bio-mass	15.6GJ/mt	$36 /mt	**$2.31 /GJ**

- Coal is cheapest
  - Most electricity is from coal
  - But most carbon dioxide and other pollutants
- Natural gas is next
  - Cleanest fossil fuel
  - Much electricity from natural gas
- Oil is most expensive
  - Little electricity from oil
- Biomass needs subsidy to compete with coal
- Biomass has least net carbon dioxide emissions

Biomass vs Corn to Ethanol—Land Use

- **Is it a more efficient use of land to grow corn or biomass for biofuels?**
- Biomass with yields above 25 tonnes/hectare/year exceed the land productivity of corn to produce ethanol
  - Switchgrass can be as high as 25 tonnes/hectare/year
  - Giant King Grass exceeds 75
- High yield is key

Feed-stock	Yield	Ethanol GJ/hectare
Corn US	472 bu /hectare	100
Biomass	11.2 mt/ha	44
Biomass	25 mt/ha	98
Biomass	75 mt/ha	293

GIANT KING GRASS FOR FISH FOOD

Grass carp are fed exclusively Giant King Grass
Not necessary to process the grass