





### The Economics of Biochar Production



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T R Miles Technical Consultants

### T R Miles Technical Consultants, Inc.

- Design and development of energy and environmental processes.
  - Industries Biomass energy Pollution control Materials handling Feed, Food and Fuels









# Topics

- Product Definition
  - What is Biochar? What is Biochar Worth?
- Biochar, Sources and Markets, Competing Uses
- Examples of companies making Biochar
  - Biochar
  - Torrified wood, charcoal and power
  - Charcoal , heat, pellets
- What it will take to make Biochar?
  - Technology, process
  - Products
  - End user markets / prices
- Economics of biochar TR Miles Technical Consultants, Inc.

### Product Definition: What is Biochar?

Biochar is a fine-grained, highly porous charcoal that helps soils retain nutrients and water. IBI



IBI



**EPRIDA** 





#### COLLINS

#### LEHMANN

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### Product Value: What is Biochar Worth?

### **Agronomic Benefits**



#### FERTILITY

### **Environmental Benefits**







#### SOIL STRUCTURE



NUTRIENT RETENTION IBI

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# **Biomass Sources and Markets**

- Sources
  - Unused Straw grain and grass seed
  - Forest Residues slash, fuel reduction
  - Agricultural and Forest Industry Residues
  - Urban Wood Waste
- Markets
  - Soil remediation and storm water nutrient management
  - Horticulture, nursery and urban landscaping
  - Crops and soil amendment, e.g. biochar + digested solids, composting

# Competing Uses for Biomass 200,000 wet tpy – 20 tph

Product	Capacity	Qty Tpy	\$	\$/ton biomass	
Power	20 MWe	200,000	0.10/kWh	\$100	1MWh/ton
Pellets/Brick	20 TPH	100,000	\$150/ton	\$150/ton	0.5 ton/ton
Heat	160 MMBtuh	200,000	\$10/MMBtu		70% eff
Torrefaction	20 TPH	70,000 tpy	\$120/ton	\$100/ton	\$10/MMBtu
Charcoal	20 TPH	40,000 tpy	\$400/ton	\$100/ton	40% eff
Biochar	20 TPH	30,000 tpy	\$200/ton		
		30,000 tpy			
Soil	2 t/acre		\$40/cu yd	\$40/ton	

#### **Biomass Flows in the U.S. Economy**





### **Making Biochar**



http://www.holon.se/folke/carbon/simplechar/simplechar.shtml

**BARREL KILN** 

http://terrapreta.bioenergylists.org/taxonomy/term/674

### Making char in a Downdraft Gasifier: Air for Oxidation is Supplied Through a Manifold to Nozzles





- A manifold feeds nozzles that supply air to the oxidation zone.
- A cap is removed to light the hearth and observe oxidation and fuel movement.
- Gas exits in pipe below hearth.
- Gas is cleaned and burned for greenhouse heat or to run an engine to generate power (30 kWe).

FLUIDYNE GASIFICATION www.fluidynenz.250x.com

### Incoming Fuel Oxidizes Producing Heat to Convert Wood to Charcoal and Gas



- Gases evolve from the heated wood and burn between the wood particles.
- Air from the nozzles scours the charred surface of the burning wood particles.
- Combustion takes place between the char particles converting the gases to CO2 and producing heat.

### Incoming Fuel Oxidizes to Produce Heat to Convert Wood to Charcoal and Gas

- Combustion of the volatiles leaves "oxidation char."
- The char is light weight and has a bright sheen to the surface.
- Carbonization breaks the blocks of fuel apart according to the structure of the wood.



# **Biochar Engineering**

- Top Fed Carbonizer
- Wood Chips 100 kg/hr
- Char 50 kg/hr
- Gas recycle in Afterburner
- Temperature ControlField designs
- •BLM Field Tests Colorado Slash 2009
- •1TPH in Development
- •Prior experience:
  - Down Draft gasifiersEPRIDA



#### www.biocharengineering.com



#### TR Miles Technical Consultants, Inc.

www.bestenergies.com





### Alterna Energy Continuous Kiln

Alterna Energy www.alternaenergy.ca

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### Small Industrial: 2 TPH Carbonizer 3,000 Hrs/yr Sawmill or Urban Wood Waste

Receiving

2 dry ton/hr, 48 ton/day, 3000 hrs/yr

6,000 tons/yr dry

Processing

Shred, Fill, Dry, Carbonize, Cool, Screen, Grind, Bag, Ship

Continuous Kiln

1 process lines; 2-2.7 t/hr

1-70' x 100' process area, 2 operators

Capital: \$500,000-\$1,000,000 Installation: 18 months Products:

Biochar 2,000 tons per year

Excess Gas 10.6 MMBtu ~ 31,000 MMBtu/yr

### Products and Markets Sawmill or Urban Wood Waste Only

- Gas or Heat
  - 10.6 MMBth
  - \$10/MMBtu
- Biochar 2,000 tpy
  - Additive to compost (25%)
  - Soil amendment
  - Commercial Fertilizer/Garden Wholesaler
  - Wholesale \$200/ton in bulk bag 600 lb/bag
  - Retail packaging \$250/ton
- Voluntary Green Credit \$0.6 million/yr
  - 2,000 tC x 3t CO2/tC = 6,000 tCO2 @ \$10/tCO2

### Economics

#### Sawmill or Urban Wood Waste Only

Product	Quantit	y Pr	ice/unit	Rev	venue	
Biochar	2 <i>,</i> 000 o	dt/y	\$200/ton	\$ 4	400,000	
Heat	32,000 MN	/lbtu	\$10/MMBtu	\$ 3	320,000	
Green Credit*	6,000	tCO2	\$10/tCO2	\$	60,000	
Total				\$	780,000	
Expenses per dry ton logyard waste			Exp	oenses		
Wood waste	6,00	Ot/y	\$30/ton	\$	180,000	
0&M						
2 empl/shift	6,00	Ot/y	\$70/ton	\$	420,000	
Capital	6,00	Ot/y	\$10/ton	\$	60,000	
Total			\$110/ton	\$	660,000	
Income				\$	120,000	
				Ş	120,000	

3 tCO2/tC

### Small Industrial: 2 TPH Carbonizer 8,000 Hrs/yr Full Capacity 1 Line

Receiving

2.5 dry ton/hr, 48 ton/day, 8000 hrs/yr

20,000 tons/yr dry

Processing

Shred, Fill, Dry, Carbonize, Cool, Screen, Grind, Bag, Ship

Continuous Kiln

1 process line; 2-2.7 t/hr

1-70' x 100' process area, 2 operators

Capital: \$500,000 Installation: 18 months Products:

Biochar 6,600 tons per year

Excess Gas 13.2 MMBtu ~ 105,600 MMBtu/yr

### Products and Markets Full Capacity 1 Line

- Gas or Heat
  - 13.6 MMBth
  - \$10/MBtu
- Biochar 6,600 tpy
  - Additive to compost (25%)
  - Soil amendment
  - Commercial Fertilizer/Garden Wholesaler
  - Wholesale \$200/ton in bulk bag 1000 lb/bag
  - Retail packaging \$250/ton
- Voluntary Green Credit \$1.8 million/yr
  - 6,600 tC x 3t CO2/tC = 19,800 tCO2 @ \$10/tCO2

### Economics

#### Full Capacity : 1 Line

Product	Q	uantity	Price/unit	Revenue
Biochar		6,600 odt/y	\$200/ton	\$ 1,320,000
Heat	105	5,600 MMbtu	\$10/MMBtu	\$ 1,056,000
Green Credit*		19,800 tCO2	\$10/tCO2	<u>\$ 198,000</u>
Total				\$ 2,464,000
Expenses per dry ton logyard waste				Expenses
Area woodwaste		20,000 t/y	\$30/ton	\$ 600,000
0&M				
2 empl/shift		20,000t/y	\$30/ton	\$ 600,000
Capital		20,000t/y	\$3/ton	<u>\$ 60,000</u>
Total			\$63/ton	\$ 1,260,000
Income				\$ 1,204,000

\* 3 tCO2/tC

### Large industrial: 11 TPH Carbonizer 8,000 Hrs/yr Full Capacity Five Lines

Receiving

11 dry ton/hr, 270 ton/day; 56 cu yd/hr, 1345 cu yd/day 90,000 tons/yr dry; 448,000 cu yd/yr

Processing

Shred, Fill, Dry, Carbonize, Cool, Screen, Grind, Bag, Ship Continuous Kiln

5 process lines; 2.7 t/hr/ea, 11 cu yd/hr /ea

2 -70' x 100' bldgs, 2 operators

Capital: \$7 million Installation: 18 months Products:

Biochar 30,000 tons per year

Excess Gas 475,000 MMBtu ~ 30,000 Mwhe

### Products and Markets Full Capacity 5 Lines

- Gas or Heat
  - 60 MMBth ~ 4.5 Mwhe
    - 60 MMBtuh/15 Mmbtu/Mwe 32,000 MWhe
  - \$10/MMBtu
- Biochar 30,000 tpy
  - Additive to compost (25%)
  - Soil amendment
  - Commercial Fertilizer/Garden Wholesaler
  - Wholesale \$200/ton in bulk bag 1000 lb/bag
  - Retail packaging \$250/ton
- Voluntary Green Credit \$1.8 million/yr
  - 30,000 tC x 3t CO2/tC = 90,000 tCO2 @ \$10/tCO2

### Economics 11 TPH 8,000 hrs/yr

Product	Q	uantity	Price/unit	Revenue
Biochar		30,000 odt/y	\$200/ton	\$ 6,000,000
Heat	475,000 MMbtu		\$10/MMBtu	\$ 4,750,000
Green Credit*	90,000 tCO2		\$10/tCO2	<u>\$ 900,000</u>
Total				\$ 11,650,000
Expenses per dry ton biomass				Expenses
Shredded Biomass		90,000 t/y	\$30/ton	\$ 2,700,000
O&M				
2 empl/shift		90,000t/y	\$20/ton	\$ 1,800,000
Capital		90,000t/y	\$10/ton	<u>\$ 900,000</u>
Total			\$60/ton	\$ 5,400,000
Income				\$ 6,150,000
* 3 tCO2/tC				

# Summary

- Biochar is in development
- More plant trials are needed to establish the agronomic and market values of biochar.
- Small scale biochar technologies are under development.
- Returns look good if biochar can be sold for \$200/ton and there is a value (market) for the gas.
- Carbon credits will help make small plants viable.
- Large production facilities are planned but not yet in operation.

# Links

- Biochar for Environmental Management: Science and Technology <u>www.biochar-</u> <u>international.org/projectsandprograms/biocharbook2009.html</u>
- Pacific Northwest Biochar

www.pnwbiochar.org http://groups.google.com/group/pnw-biochar?hl=en

- International Biochar Initiative
  <u>www.biochar-international.org</u>
- Terra Preta @ Bioenergylists.org <u>www.biochar.bioenergylists.org</u>
- T R Miles, Technical Consultants, Inc. <u>www.trmiles.com</u>



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