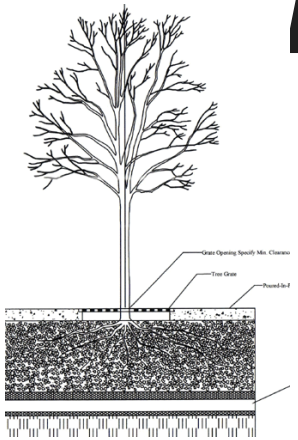
Emerging Biochar Markets

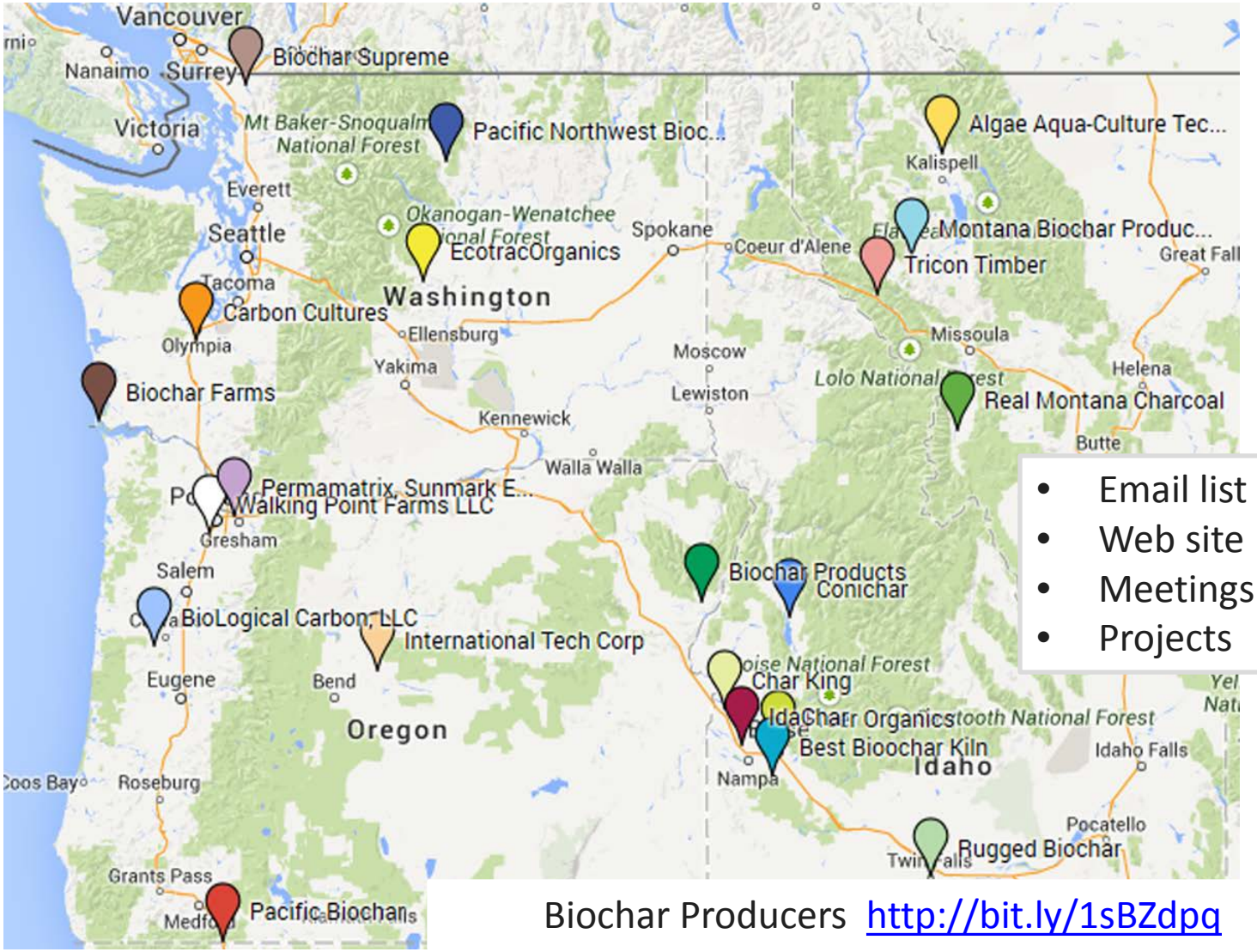


Tom Miles,
T.R. Miles Technical Consultants, Inc.
North West Biochar Working Group
www.nwbiochar.og

Black is the New Green
Biochar Expo
Roseburg, Oregon
October 18, 2014

NW Biochar Working Group

nwbiochar.org



- Email list
- Web site
- Meetings
- Projects

Biochar Producers http://bit.ly/1sBZdpq

Processed Biochars Have Different Qualities Than Do-It-Yourself Biochars

Biochar Supreme

photo: Biochar Supreme biocharsupreme.com

SELECT BIOCHARS TO SUIT SOILS AND CROP NEEDS

Biochar Helps Re-vegetation, Environmental Remediation, and Urban Farming

BIOCHAR IN HYDROSEEDING AND FILTERS

PermaMatrix

www.permamatrix.com

Biochar Can Improve Turf and Landscape Management for Parks and Recreation

- Use normal practices
- Use stable soil amendment
- Retain more water
- Replace non-sustainable materials
- Reduce chemical leaching and runoff
- Reduce chemical and fertilizer use
- Decrease saturated hydraulic conductivity
- Promote growth of microorganisms
- Sequester CO_2

(Sunmark Environmental)

(Sand-based turfgrass root-zone modification with biochar, Shane R. Brockhoff, Iowa State University)

Biochar + compost may resist Pythium blight

(Photo LP Tredway)

Biochar in Green Roof Media

Using 30% biochar in scoria roof media increased plant water availability by 16% .

Cao, C.T.N., C. Farrell, P.E. Kristiansenn, J.P. Rayner. 2014. Ecological Engineering 71: 368-374.

Photo: Ladybird Johnson Wildflower Center

Adding 7% Biochar to Scoria based media improved the effluent with 70% reduction in Nitrates, 40% reduction in Phosphates and 70% reduction of Organics than un-amended control.

Beck, D.A., G.R. Johnson and G.A. Spolek. 2011. Environmental Pollution 159: 2111-2118.

Biochar Improves Water Quality

LOW IMPACT DESIGN:RAIN GARDENS/STORM DRAINS

WSU Low Impact Development Center

DEMOS: 8 Cities

RESEARCH:

- **OSU – MS, MBA**
- **EPA Corvallis**
- **WSU Puyallup**
- **Stanford/CSM**

ROOF DRAINS

BIOCHAR IN COMPOST ROLLS AND BIO BAG FILTERS FOR SURFACE RUNOFF

Biochar in Sand and Biofilters for Industrial Stormwater Filtration

Port of Tacoma, West Hylebos Pier Log Yard

Photo: Kennedy Jenks, Port of Tacoma, West Hylebos Pier Log Yard

Up to 80% - 90% reduction in ISGP parameters: pH, Zinc, Copper, Turbidity, TSS & COD

Small Scale tests: 70% Sand + 30% Biochar to capture Copper and reduce Chemical Oxygen Demand (COD)

Biochar Improves Remediation

"This was the recycled nasty soil from the steel mill that still grew vegetation. There is a line of where we sprayed PermaMatrix and where it was not applied. The other vegetation died."
-- Drew Schaefer Sunmark Environmental www.sunmarkenvironmental.com

Biochar Filters Toxics & Organics

Peer reviewed research shows the following toxic organics are sorbed by biochar.

- **Heavy Metals:** Copper, Zinc, Lead, Cadmium, Chromium, Mercury
- **Explosives:** DNT, TNT, RDX
- **Herbicides:** Atrazine, Acetochlor, Clopyralid, Fipronil, Glyphosate, Simazine, 2,4D, Trifluralin, Diuron (DCMU)
- Benzonitrile, Phenathrene, trichloroethylene, Triazine
- **Hydrocarbons**
- **Poly chlorinated biphenyls** (PCB)
- **Pesticides & Fungicides:** Pyrimethanil, Hexachlorobenzene, Pentachlorophenol, Lindane, Isoproturon, Endosulfan, Chlorantraniliprole, Chlorpyrifos, Carbofuran
- ***Polycyclic Aromatic Hydrocarbons (PAH)*** >50% of 4-& 5- ring PAH, >40% of 2- & 3- PAH

Literature Search: sciencedirect.com

Biochar in Nurseries

Agronomic Benefits

SOIL STRUCTURE-
Vermiculite substitute

COMPOST AID -
Peat substitute = Compost + Biochar

PLANT HEALTH -
Inhibits root disease
Nutrient (P) carrier for poor soils

2008
Calforest
Nurseries

Ponderosa Pine in Soilless Media with Vermiculite (Left) and Biochar (Right)
2009

Biochar for Healthy Trees

No Treatment (right) 5% biochar + compost top dressing
Tree roots at 18 months in compacted soils.
Photo: Morton Arboretum Soil Science Laboratory

Biochar + Compost
Biochar + Mycorrhiza, Composted

- Increases disease & insect resistance
- Improves microbial activity and soil fertility
- Increases soil water retention, and available water to tree roots
- Stimulates tree growth
- Improves tree survival

Trenches with Biochar + Mycorrhiza can be used to rehabilitate diseased trees, like these examples from Japan ->

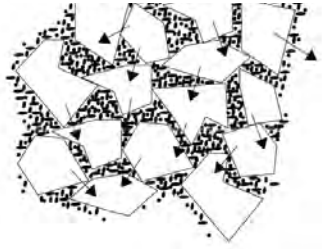
(Bartlett Tree Service & Dr. Makoto Ogawa)

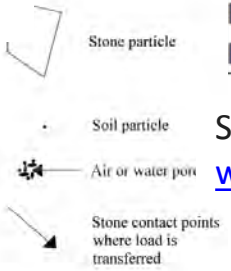
Biochar in Structural Soil

Parking Forest ParkingForest.org

Structural Soil under Permeable Pavement for larger canopy trees.

Parking forest PCC
(Maria Cahill)





Structural Soil, Cornell University
www.hort.cornell.edu

Biochar in Structural Soil

- Improves tree health, helps them resist disease
- Adsorbs oils/metals from the parking lot
- Filters rain water, keeps nutrients close to trees.
- Increases water available to street trees.

Biochar in Urban Gardening

Ghost Peppers and
Hot Chilis
Black Stuff Biochar

URBAN FARMING

GREEN ANCHORS
www.facebook.com/greenanchorspdx

Making Biochar

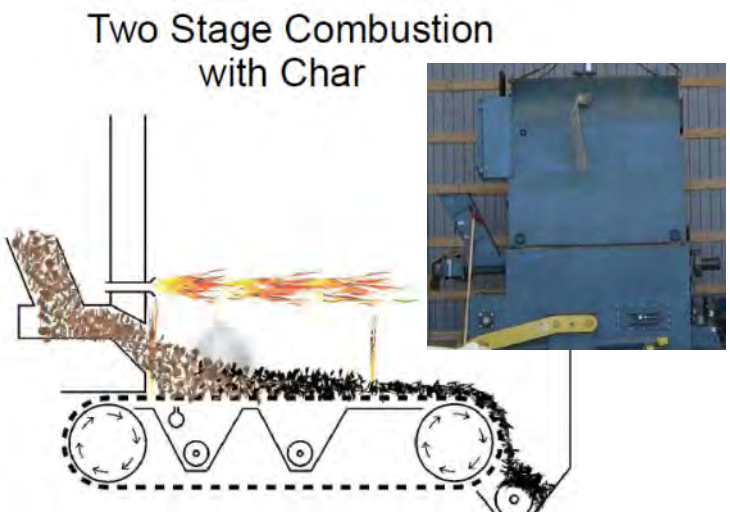
- **Dry Fuel** – Air Dried or Less than 20% MC
- **Temperatures** – 400°C, 600 °C, 800 °C
- **Industrial Scale**
  - High Carbon Flyash, 10 CY/day
  - ICM Biochar 400 CY/day
  - Earth Systems 10-20 CY/day
- **Farm Scale**
  - Adam Retort 1-2 CY/day
- **Small scale** –
  - Top Lit Burn Pile – >0.5CY/day
  - Small Ovens – <10 ft3/day, Firepit kiln, Jolly Roger, Gasifiers
  - Stoves, BBQ – <ft3/day

Biochar is Made at Small and Large Scales

BioChar TLUD Cook Stove
Seachar.org

Greenhouse scale heat and biochar NE Biochar 1 t/10h

Mobile Pyrolysis
Black is Green (BIG) AUS



Burt's Greenhouses
Ontario, CAN

Boiler 3 MMBtuh Hot Water
500 lb/h 25% Char

ICM Gasifier
4-8 tph

Small Scale Biochar Production

Firepit Cone Kiln

Gasifier

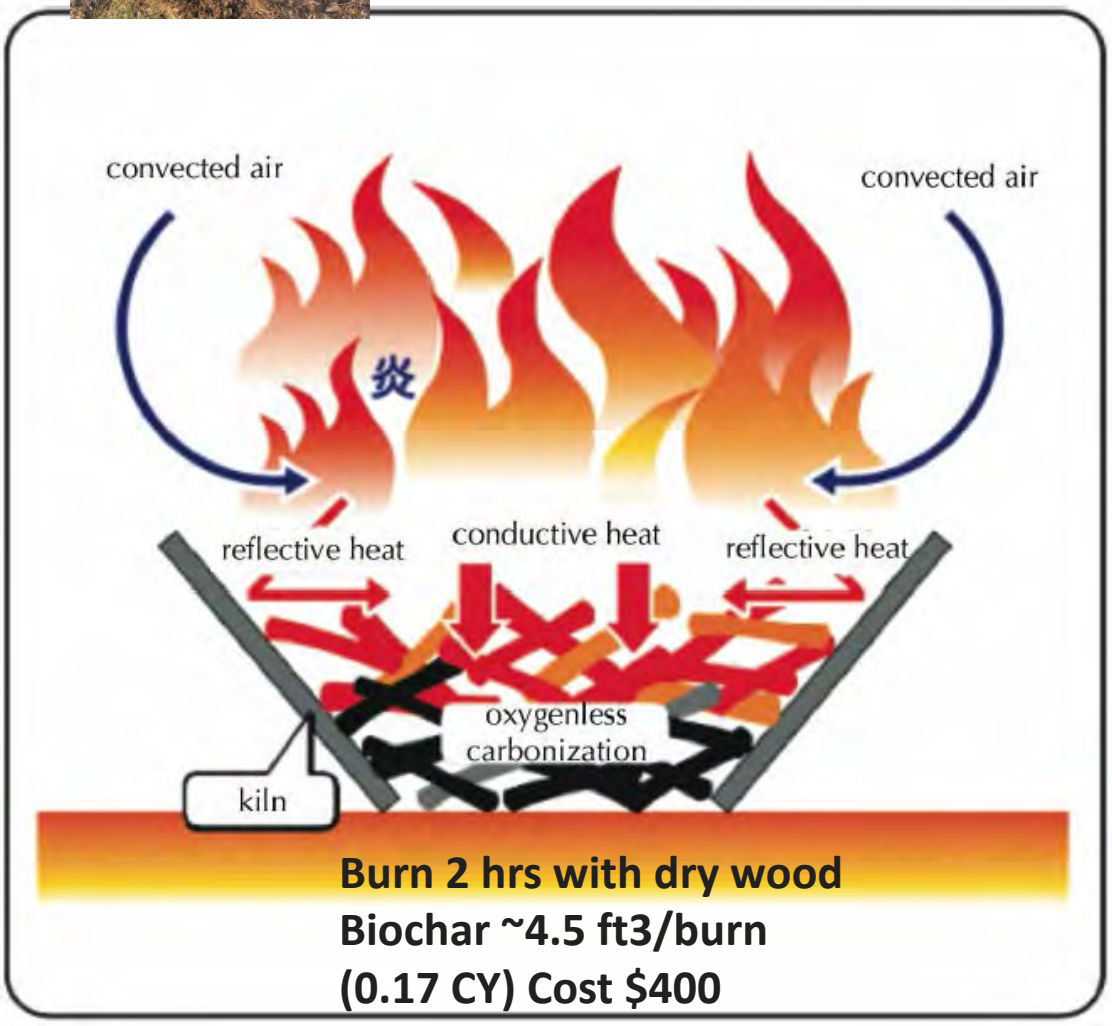
“J-RO” Jolly Roger Oven
Top Lit Gasifier + Barrel Oven

Top Lit Burn Pile

Top Lit TLUD Gasifying Cook Stove

Top Lit (Firepit) Cone Kiln

Makes Char by Limiting Oxygen at Base of Fire



Burn 2 hrs with dry wood
Biochar ~4.5 ft3/burn
(0.17 CY) Cost $400

Wilson Biomass Associates
www.wilsonbiochar.com
backyardbiochar.net

Bluesky Biochar http://youtu.be/bO9-RBaAq3U

Carbon Cultures Gasifier

Limits combustion air to make gas and char
Gas burns cleanly above kiln

Wood size max 3” diameter
Burn 3-5 hrs with dry wood
Biochar ~20 ft3/burn (0.75 CY)

- Prevents heat damage to soil organisms
- Reduces pollution from gas and particulate
- Recovers biochar

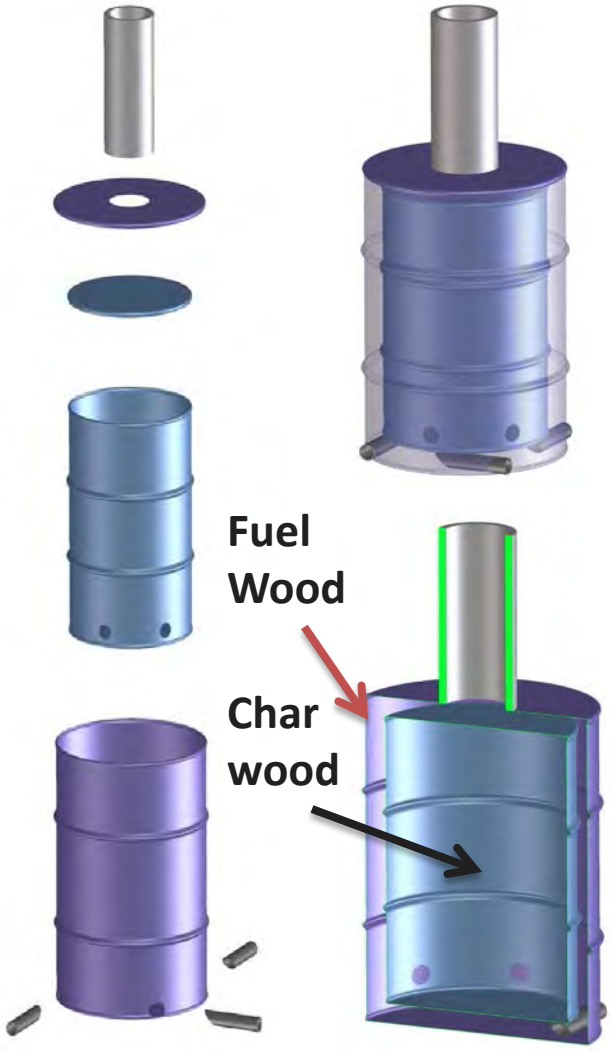
carboncultures.com


Carbon Cultures Glacier Kiln at Coffelt Farm March 7, 2014
GAS BURNER
AIR ADJUSTMENT
Carboncultures.com

Heating Wood to Make Char in a Barrel Oven

Max Henderson
Kelpie Wilson

SIMPLE CHAR KILN
Folke Gunther



30 Gal in 50 Gal Barrel
1.5 ft3/Burn

Wells Retort

Wood charred in rotating barrel by heat from an inner tube.

Amherst, MA

Fuel 5 lb/hr
Biochar 1.5 lb/hr

Rotate Barrel

Firebox

Single Chamber Top Lit (TLUD) Batch Ovens

David Yarrow 55 Gal TLUD
Barrel Burner 3 ft3/burn .2CY

www.dyarrow.org/CarbonSmart

Karl Frogner, Doug Clayton
55 Gal TLUD Ovens

www.youtube.com/watch?v=IGsdma-2CkQ

www.youtube.com/watch?v=Kg95KYrH8PI

Making Biochar in TLUD Ovens for Water Treatment in Burma

55-gal TLUD drum pyrolyzer design can be made using only a machete – no electricity or power tools required. (**Josh Kearns, Aqueous Solutions**)

Aqueous Solutions http://on.fb.me/1LuQWJh

Top Lit Up Draft (TLUD) Stoves Make Gas for Cooking and Char for the Garden

(micro gasification)

Champion TLUD

Estufa Finca

Planetstove Firepit BBQ

Flame consumes oxygen and carbonizes wood as it burns
Stop burning before the char is consumed ~ 20-24% of fuel.

Cost $100 Burn 1/2 hr with dry wood, Biochar ~0.05-0.25 ft3/burn

https://energypedia.info/wiki/File:Micro_Gasification_Cooking_with_gas_from_biomass.pdf

Cookstove Char From Top Lit Updraft Gasifiers

- **Batch load.**
- **Gases burn above fuel.char.**
- **Heat from flame and partial burning drives volatile gases from fuel.**
- ***Char* remains after volatiles burn**

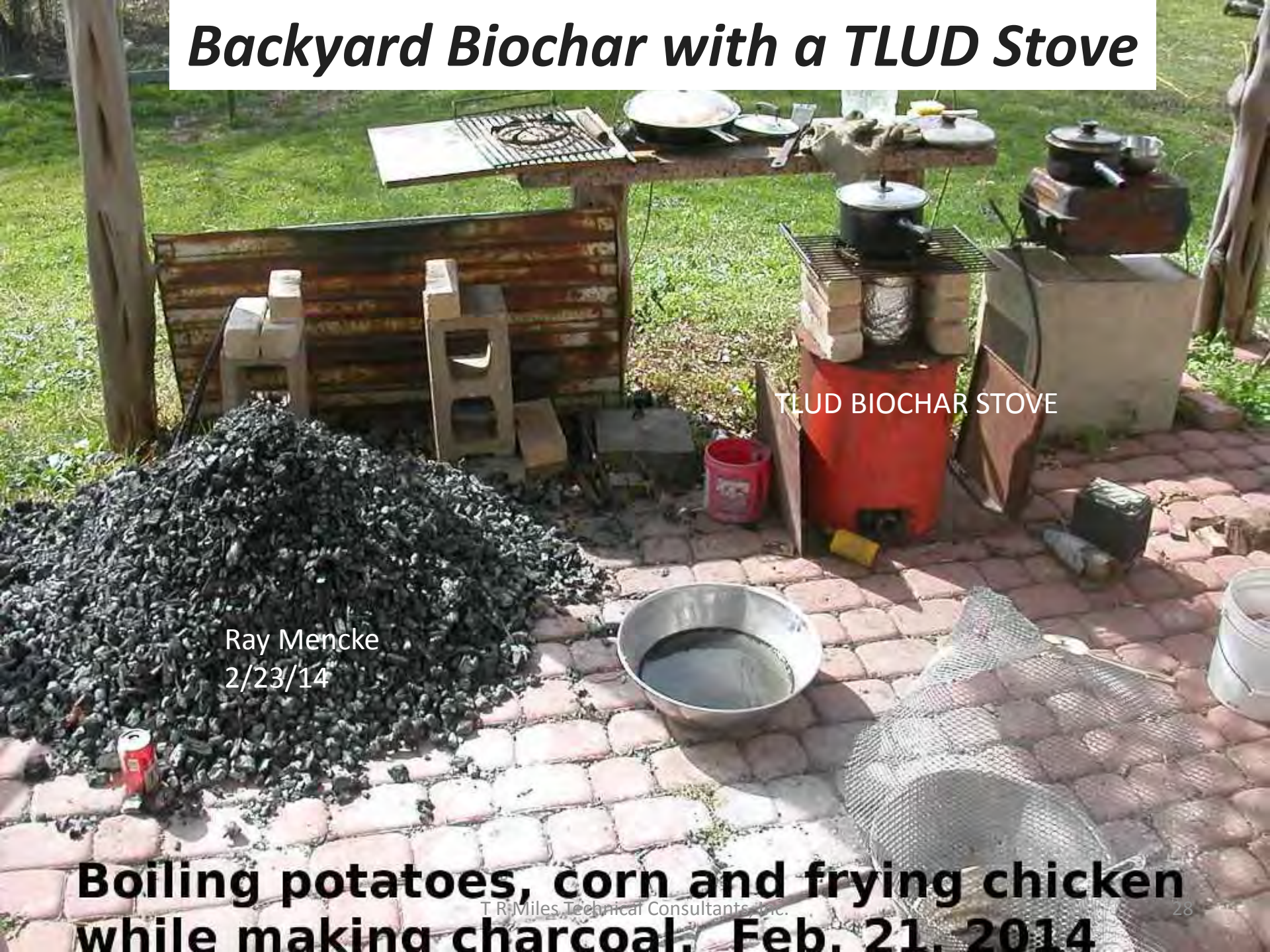
BioChar Cook Stove
Seachar.org

Cooking on the TLUD "Estufa Finca" in Costa Rica

Dr TLUD's Stoves For Developing Countries

Paul Anderson
www.drtlud.com

Backyard Biochar with a TLUD Stove



Boiling potatoes, corn and frying chicken while making charcoal. Feb. 21, 2014

Biogreen-Energy Demonstration Ames, IA 2010

www.biogreen-energy.com

Mobile Charmaker

20 CY/DAY

2 ton 10 CY/4 hours

Fully automated

Earth Systems (Aus)

USD $345,000

http://www.esenergy.com.au/services/charmaker/charmaker-techprocess

Mobile Char from Cordwood and Waste Wood

1 Cord (4 CY) wood /Batch
8 hr burn ->1-2 CY Biochar

Living Web Farm
www.biochar.bioenergylists.org/living-web-biochar-workshop-2013

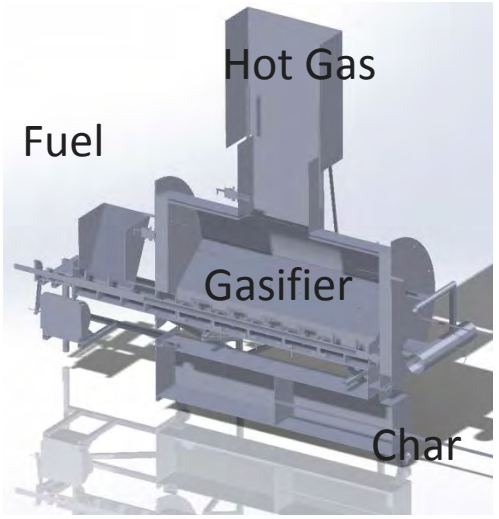
New England Biochar
www.newenglandbiochar.org

Stationary Retort with Greenhouse Heating

Sullivan Center for Sustainable Agriculture and CSA, NH
sullivancsa.com
New England Biochar
newenglandbiochar.org

1 Cord ~ 4 CY
8 hr burn 1-2 CY Biochar
+ 300,000 Btuh Hot Water

Trough Gasifier For Bark, Litter, Sawdust



Biomass 800-1500 lb/hr chips, litter
Heat 1.4 MMBtuh
Biochar 140 lb/hr 4-12 CY/Day
Cost $150,000

BES Australia Stephen Joseph 2014

Mobile, Batch and Continuous Kilns

Make Char Though Gasification Without Heat Recovery

Carbon Gold UK

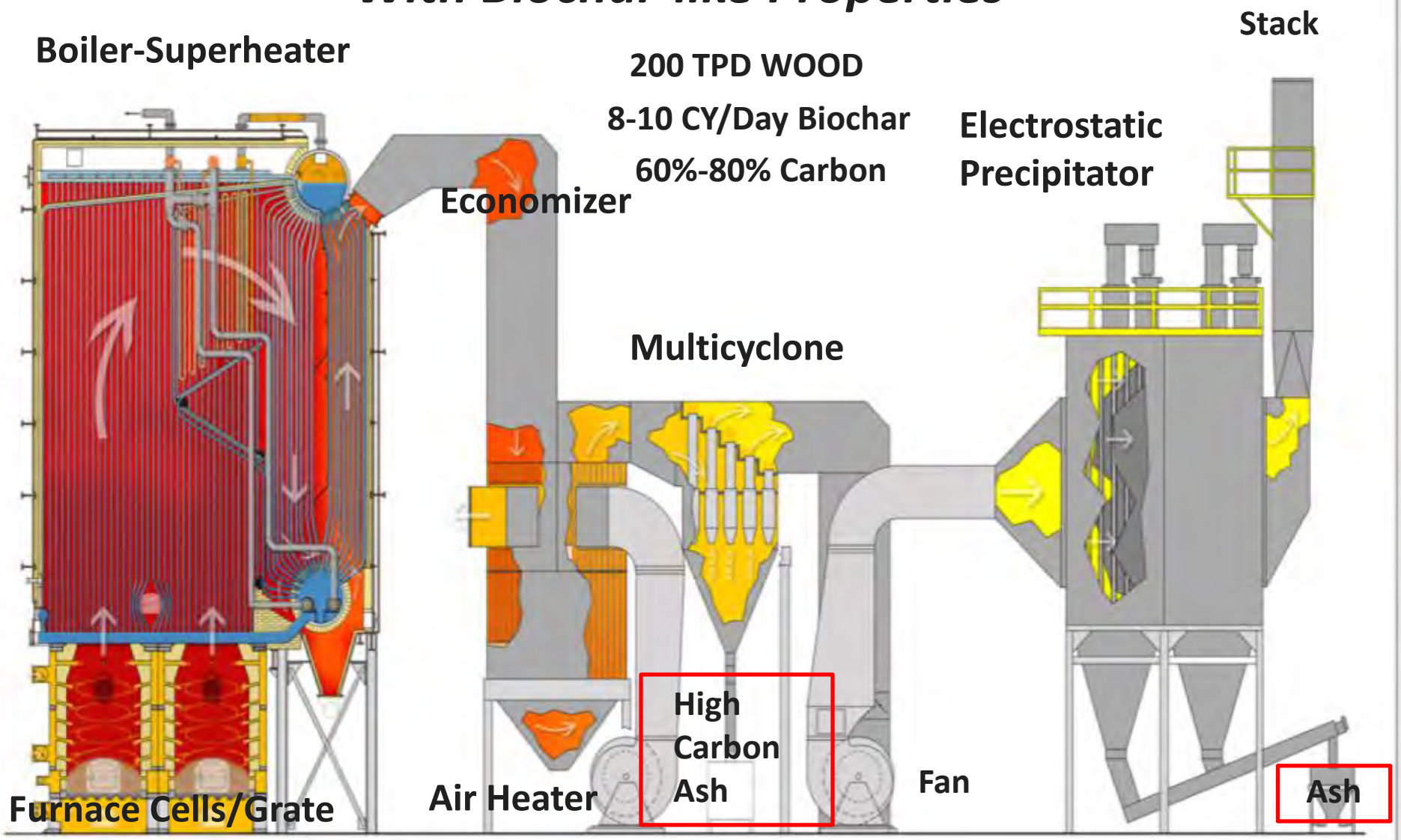
www.carbongold.com

BIGCHAR AUS

www.bigchar.com.au

Continuous Mobile Kilns $300k

Some Industrial Biomass Boilers Produce High Carbon Ash With Biochar-like Properties



Source: Wellons, Inc. www.wellonsusa.com

Industrial Systems Convert Wood/Straw to Heat, Power and Biochar

Makes 40 TPD 400 CY/Day BIOCHAR

ICM 200 tpd Gasifier
Wood, Straw, Stover
www.icminc.com

4-8 TPH Biomass 2-5 MWe
30-60,000 BDT/y

International Biochar Initiative Biochar-international.org

NW Biochar Working Group www.nwbiochar.org

Biochar Listserv www.biochar.bioenergylists.org

TR Miles Technical Consultants, Inc. 503-780-8185
tmiles@trmiles.com www.trmiles.com

Design and development of energy and environmental processes

Industries

- **Biomass energy**
- **Pollution control**
- **Materials handling**
- **Feed, Food and Fuels**