



# ***Biochar: Applications for Climate Resilient Communities***

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Northwest Biochar Working Group

**Biocycle West Coast Conference**  
Building Climate Resilient Communities  
Portland, Oregon  
April 13-16, 2015



***What is biochar?***

***Who buys it?***



***How can biochar help communities?***



# Biochar is charcoal made for use in the soil

- Carbon enriched (for lost C)
- Carbon smart (C Credits)
- Safe for use in soil



- $\geq 10\%$  Carbon
- H:Corg ratio  $< 0.7$  (longevity)
- Non toxic
- Sustainable

International Biochar Initiative Std. Ver 2.0  
[Biochar-international.org](http://Biochar-international.org)

Material*	Ash %	Organic Carbon %	H:Corg	Toxic e.g. As mg/kg	pH
BBQ Charcoal	$\leq 6\%$				
IBI Biochar Standard		10% Min Class 1: $\geq 60\%$ Class 2: $\geq 30\%$ Class 3: $\geq 10\%$	$< 0.7$	$< 13$	
Pyrolysis (Hardwood)	5.2 %	83.8%	0.68	1.2	7.5
Gasification (Softwood tops)	18.3%	74.3	0.41	0.7	12.0
Boiler Flyash (Softwood hog fuel)	98.5	1.6	8.68	5.7	12.8
Boiler – High Carbon Fly Ash (Softwood hog fuel)	8.4	75.8	0.48	9.8	9.5

\*Source: T R Miles Technical Consultants Inc.

Ash components are important to uses.

# ***Biochar and Charcoal: Different Forms and Qualities For Different Applications***



Charred Branches



Char in Soil – Terra Preta 3,500 yrs



Charred Chips



6 mm Chips



Biochar Pellets



Biochar+ Fiber+Micro  
Biotic Soil Amendment



Prills



Extruded Charcoal

# Biochar Production is Diverse

- **Dry Fuel** – Air Dried or Less than 20% MC, pure or blended
- **Temperatures** – 400°C, 600 °C, 800 °C
- **Industrial Scale**
  - High Carbon Flyash, 10-20 CY/day
  - Karr/Earth Systems 10-20 CY/day
  - Energy and Biochar, 50 CY/Day
  - ICM Biochar 400 CY/day
- **Farm Scale**
  - Adam Retort 1-2 CY/day
- **Small scale** –
  - Top Lit Burn Pile – >0.5CY/day
  - Small Ovens – <10 ft<sup>3</sup>/day, Firepit kiln, Jolly Roger, Gasifiers
  - Stoves, BBQ – <ft<sup>3</sup>/day



# *Opportunities to Make Biochar from Urban Residues*

- **Make high carbon flyash in existing boiler**
- **Install large industrial pyrolyzer to make biochar and heat/power**
- **Install a modular carbonizer to make biochar, BBQ charcoal, and heat.**



# *Biochar Made From Urban/Ag Feedstocks*



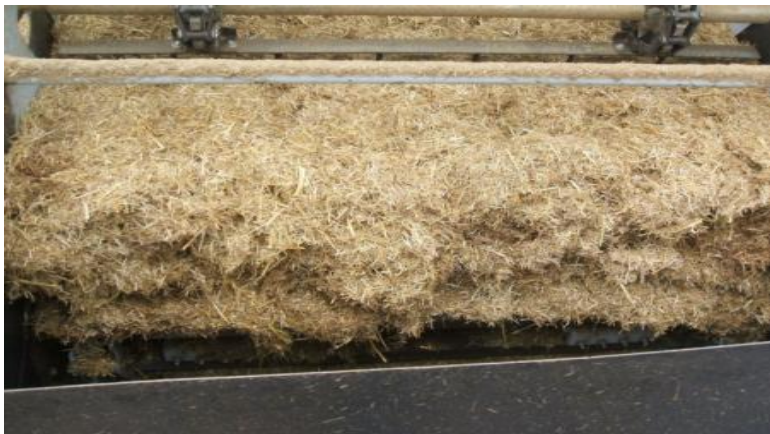
**Urban Wood**



**ICM GASIFIER**



**Wood Char**



**Wheat Straw or Corn Stover**



**Straw Char**

[www.icminc.com/services/gasifiers](http://www.icminc.com/services/gasifiers)

# Recover Heat, Power, and Biochar From Urban Residues



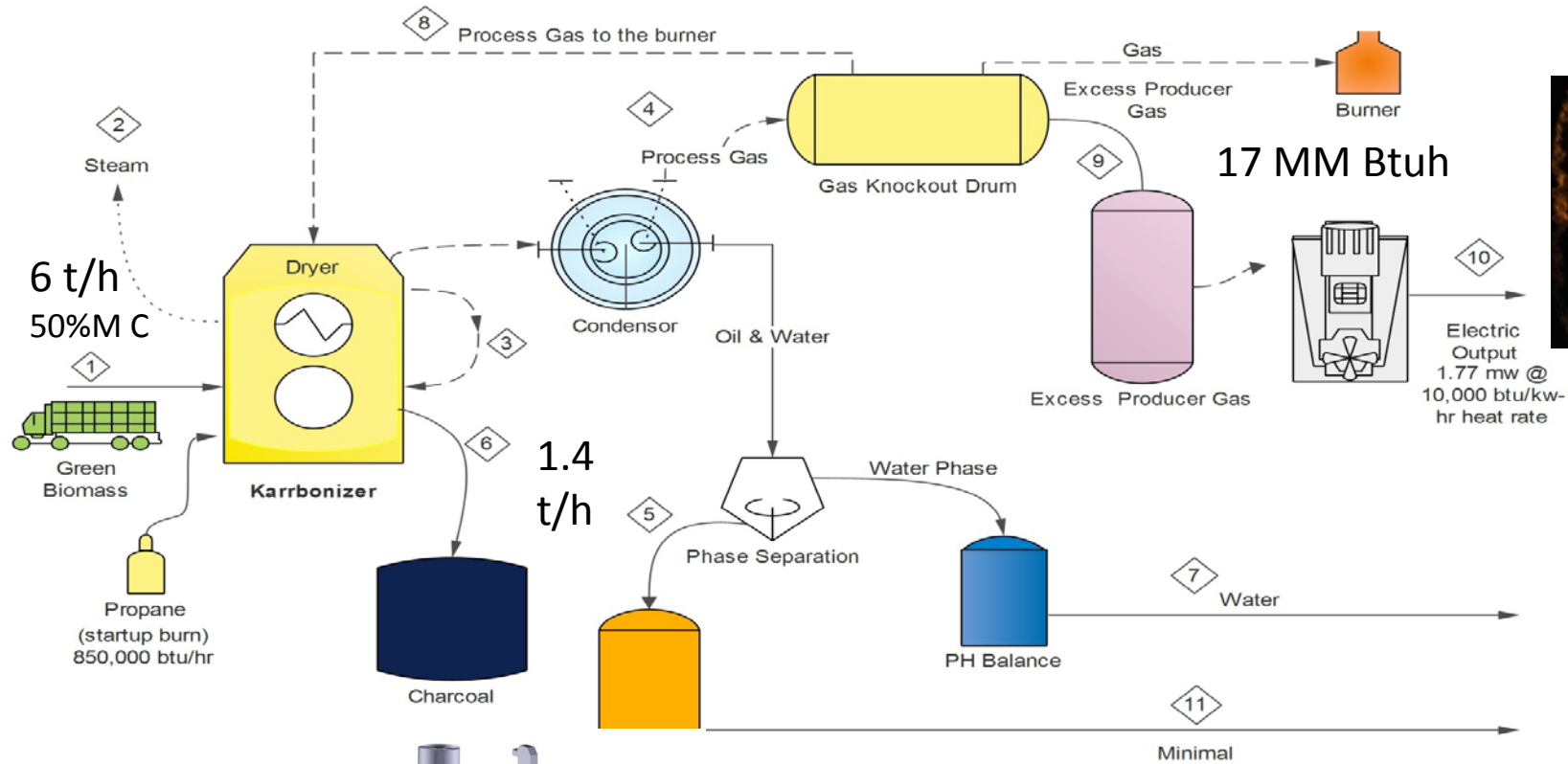
Wet Sawdust



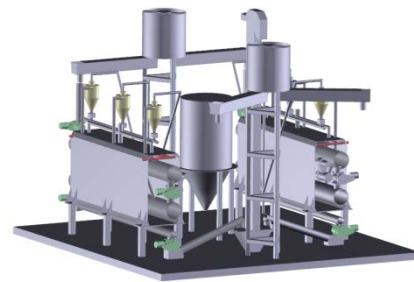
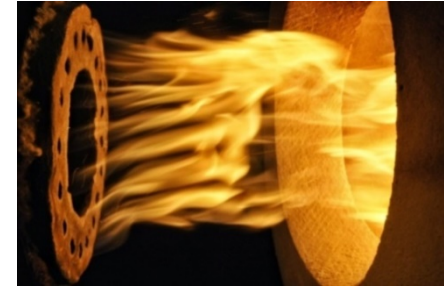
Bark



Urban Waste



Heat to Boiler or Dryer



karrgroupco.com



Biochar





# Biochar Products in Different Packages



[www.biocharm.com](http://www.biocharm.com)



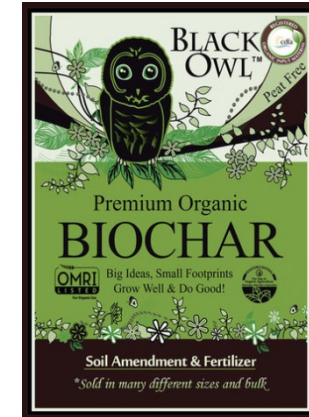
[www.permamatrix.com](http://www.permamatrix.com)



[walkingpointfarms.com](http://walkingpointfarms.com)



[www.ecotrorganics.net](http://www.ecotrorganics.net)



[www.biocharsupreme.com](http://www.biocharsupreme.com)



[www.confluenceenergy.com](http://www.confluenceenergy.com)



[www.soilreef.com](http://www.soilreef.com)



[www.coolplanet.com](http://www.coolplanet.com)

# *Who Buys Biochar? Emerging Markets.*

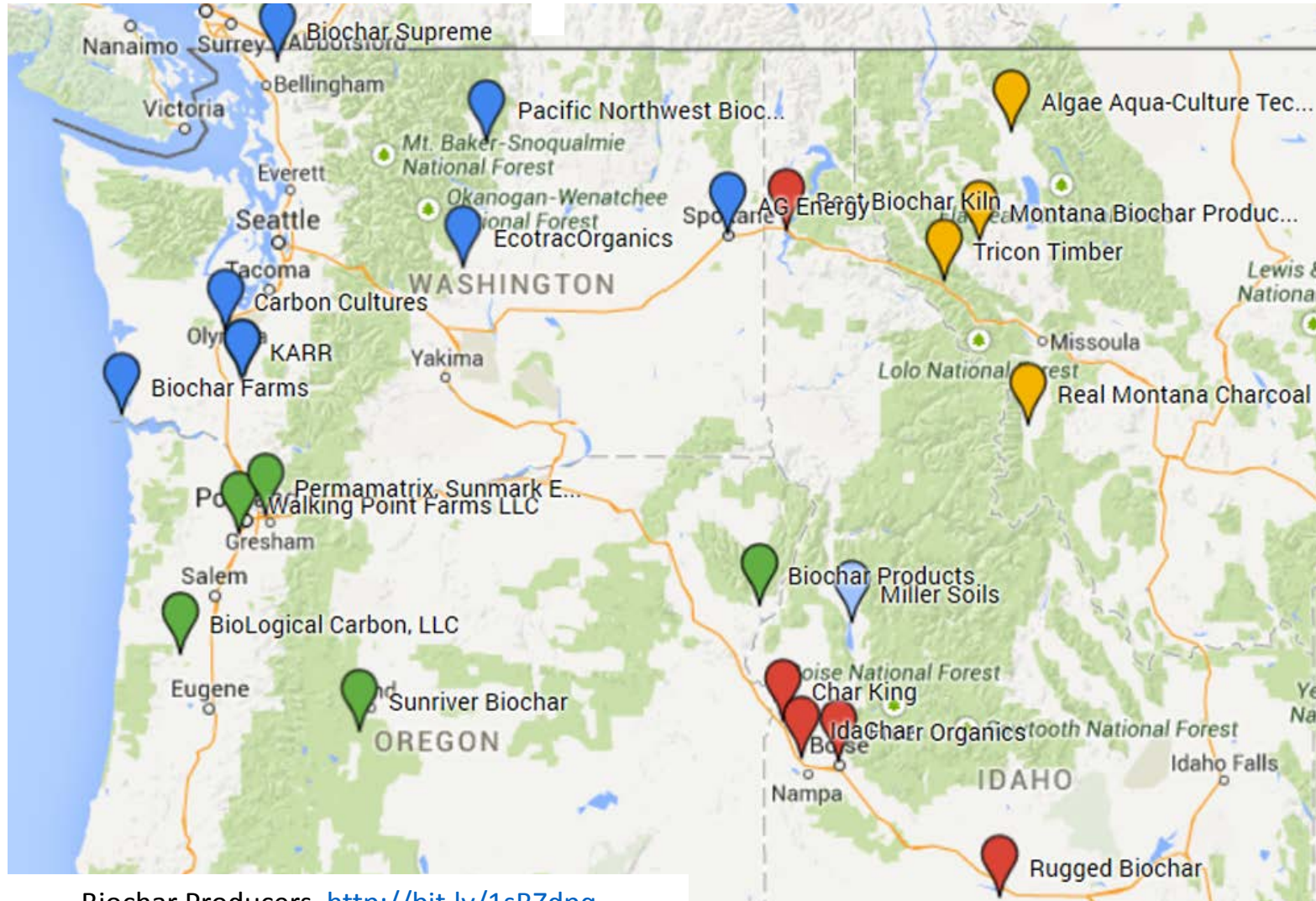
- **Retail Garden and Landscaping**
  - Packaged consumer products
    - Biochar, Compost and biochar
    - Biotic Soil Amendments(biochar + organics minerals and biologicals)
- **Wholesale to**
  - Landscape services – tree service
  - Specialty Crops, Horticulture, and Turf
- **Bulk Char to Remediation, Erosion Control**
  - Stormwater filtration
  - Granulated products for hydro-seeding
  - Oilfield remediation, Filtration
  - Mine reclamation



# ***Biochar Products are Diverse and Improved***

- Designer Biochars and Product Differentiation
- Increased Biochar testing and characterization
  - IBI testing protocols
  - Internal quality control procedures
- Product Expansion
  - Formulated products – nutrient enhancement
  - Processed products – feedstock prep, activation, blending
- Creative Production and Delivery Systems for Agriculture
  - Delivery via Irrigation and Spraying systems
  - No till injection to buffer aluminum toxicity
- Growing Product Awareness in the Market
  - Not “What is Biochar?” but how much, what kind and what benefit
  - What products will soils and crops professionals specify?

# Biochar Producers and Distributors in PNW Cooperate to Develop Biochar Markets and Uses



NW Biochar Working Group  
[nwbiochar.org](http://nwbiochar.org)

- Email list
- Web site
- Meetings
- Projects

**150 Members:  
20 Producers +  
Suppliers, Support**

Biochar Producers <http://bit.ly/1sBZdpg>

# North American Regional Biochar Organizations



# Early Adopters: Abundant Crops Grow on Enriched Soils



No Char  
Ferralsol  
Hi Iron  
pH 3.6



Char Only  
Terra Mulata  
pH 4.4



Char + Waste  
Terra Preta de Indio  
pH 5.3-5.7



Papaya  
Biochar+ Fertilizer



Cacao Pod and Bean



Cupuaçu  
Biochar Applications



Manioc (Cassava) root

EMBRAPA Caldeirão, Amazonas, BR  
4/15/2015

# Terra Preta: Charcoal and Nutrients Enriched Poor Tropical Soils

- Composted fish bones, food waste, excrement, soil with charcoal from burning vegetation.
- Anthropogenic soil: 30 in (75 cm) pH 5-6; P 100-300x; Zn 10 x; high base sat; low Fe sat

[www.ibi2010.org/field-trip-to-the-amazonexcursao-tecnica-para-a-amazonia](http://www.ibi2010.org/field-trip-to-the-amazonexcursao-tecnica-para-a-amazonia)



Costa Laranjal, Amazonas, BR



# ***There are Many Contemporary Uses for Biochar***

- Stormwater and Water Quality
- Erosion Control and Soil Remediation
- Trees and Landscaping, Structural Soil
- Turf Maintenance
- Nurseries, peat moss
- Seed coating, prills and agglomerates
- Green roofs
- Urban Farms and Gardens
- Bedding, kitty litter
- Agriculture:
  - Specialized or strategic use in agriculture
  - Traditional horticulture, hydroponics, poultry farms
  - Forest re-vegetation



# ***Biochar in Bioretention Filter Media for Stormwater***

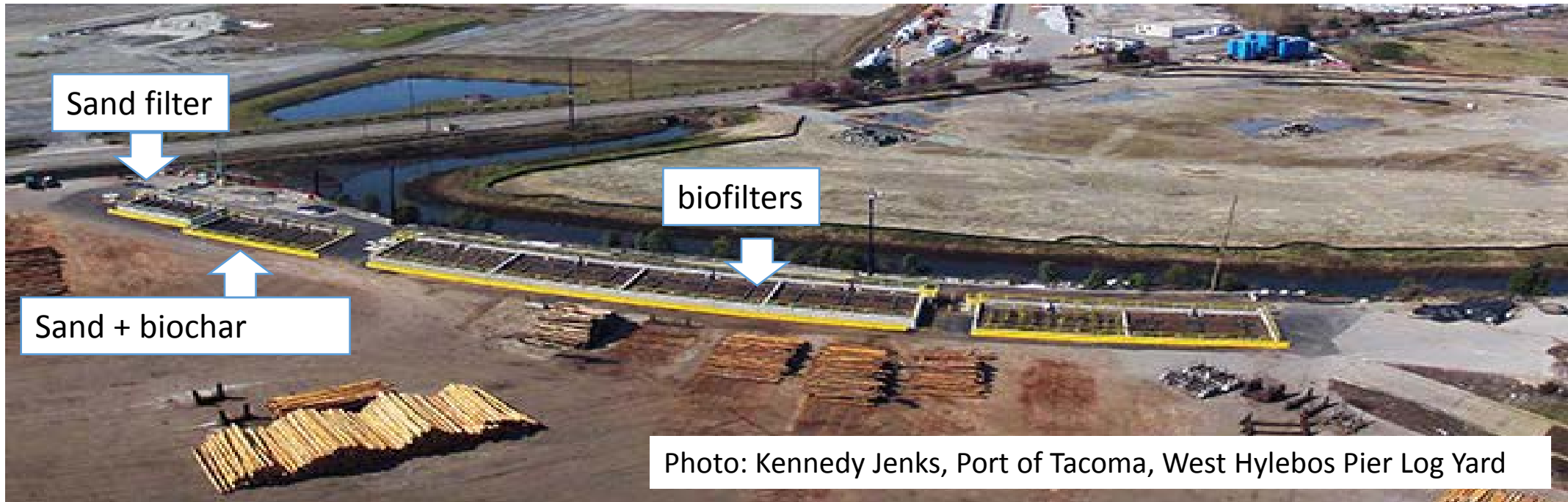


The bioretention soil mix included **15% Black Owl Biochar's Environmental Ultra** in addition to compost and sand. Biochar Supreme offers custom [Stormwater Mix](#)

[www.biocharsupreme.com](http://www.biocharsupreme.com)

# Biochar in Industrial Stormwater Filters

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)

# ***Promising Research for Toxics & Organics Filtered by Biochar Demonstrations Needed***

Peer reviewed research show beneficial impact of biochar with the following toxics

- **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](http://sciencedirect.com)

# Biochar Can Improve Water Quality



**LOW IMPACT DESIGN:RAIN GARDENS/STORM DRAINS**



DEMOS: 8 Cities  
RESEARCH:

- OSU
- EPA Corvallis
- WSU
- Gonzaga
- Stanford -CSM



**ROOF DRAINS**

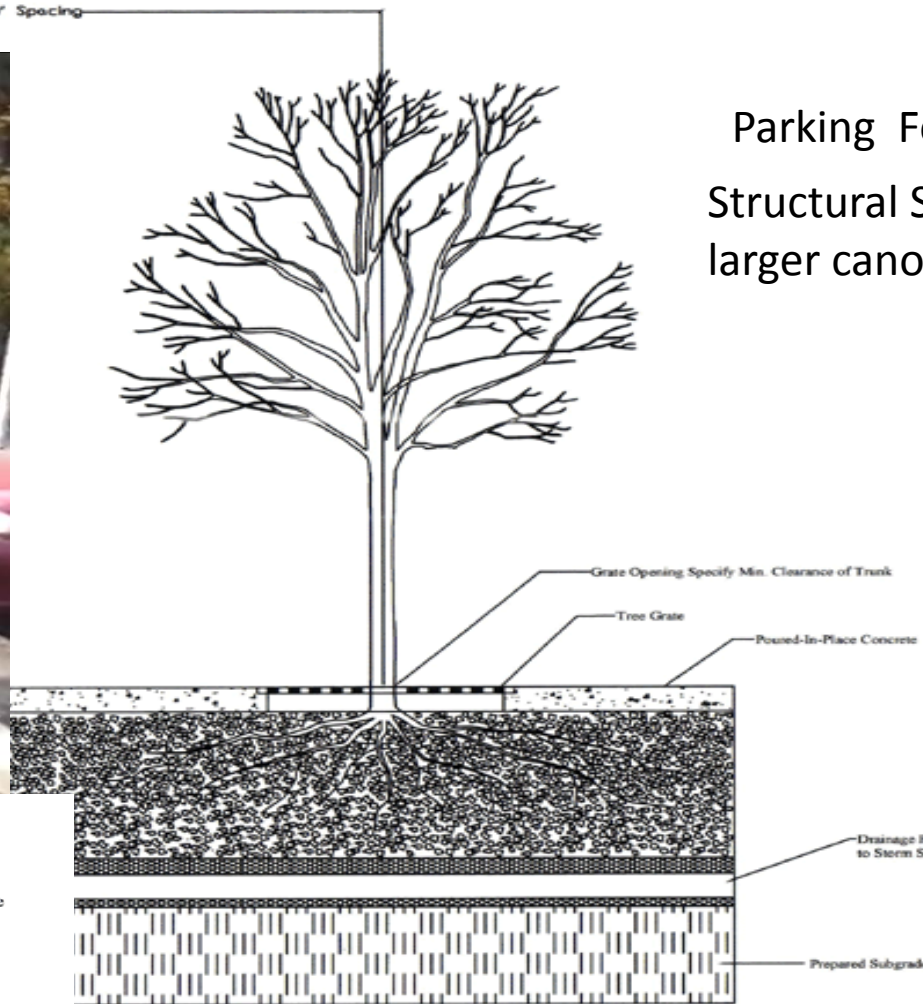


**BIOCHAR IN COMPOST ROLLS AND BIO BAG FILTERS FOR SURFACE RUNOFF**

# Biochar Potential in Structural Soil



Loading or Compaction Effort

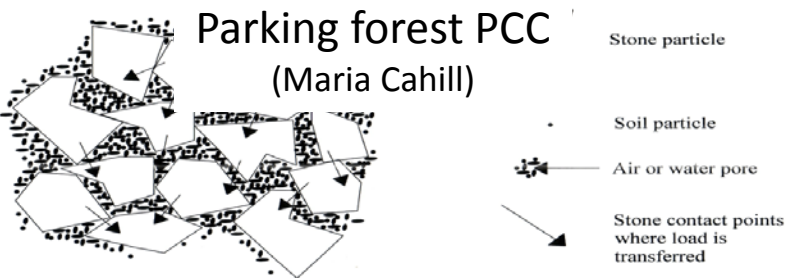


Parking Forest [ParkingForest.org](http://ParkingForest.org)

Structural Soil under Permeable Pavement for larger canopy trees.

## 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.



Structural Soil, Cornell University  
[www.hort.cornell.edu](http://www.hort.cornell.edu)

# *Biochar Helps Re-vegetation, Environmental Remediation.*



[www.permamatrix.com](http://www.permamatrix.com)

**BIOCHAR IN HYDROSEEDING AND FILTERS**

# ***Biochar Products 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<sub>2</sub>

(Permatatrix)

(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 Nurseries With Bark, Peat, or Peat Substitutes***

**“A means of putting biology back into  
growing media”**

**SOIL STRUCTURE-**

**Vermiculite substitute**

**COMPOST AID -**

**Vermiculite-Peat substitute = Composted Biochar**

**PLANT HEALTH -**

**Inhibits root disease**

**Nutrient (P) carrier for poor soils**



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

**Calforest  
Nurseries**



# Biochar Used 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.](#)

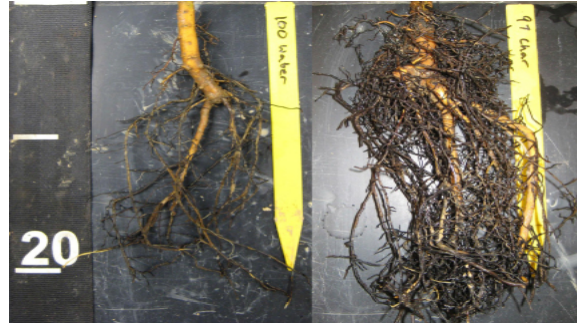


Illustrative Photo: Ladybird Johnson Wildflower Center

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 Tree Health



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



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

(Dr. Makoto Ogawa)

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

Bartlett Tree Service  
[www.bartlett.com/tips/Biochar.cfm](http://www.bartlett.com/tips/Biochar.cfm)

# Biochar Media in Urban Farms and Gardens



Ghost Peppers and Hot Chilis



GREEN ANCHORS

[www.facebook.com/greenanchorspdx](http://www.facebook.com/greenanchorspdx)

URBAN FARMING



West Seattle Herald

Carbon Garden Project at South Seattle Community College  
[Seachar.org](http://Seachar.org)

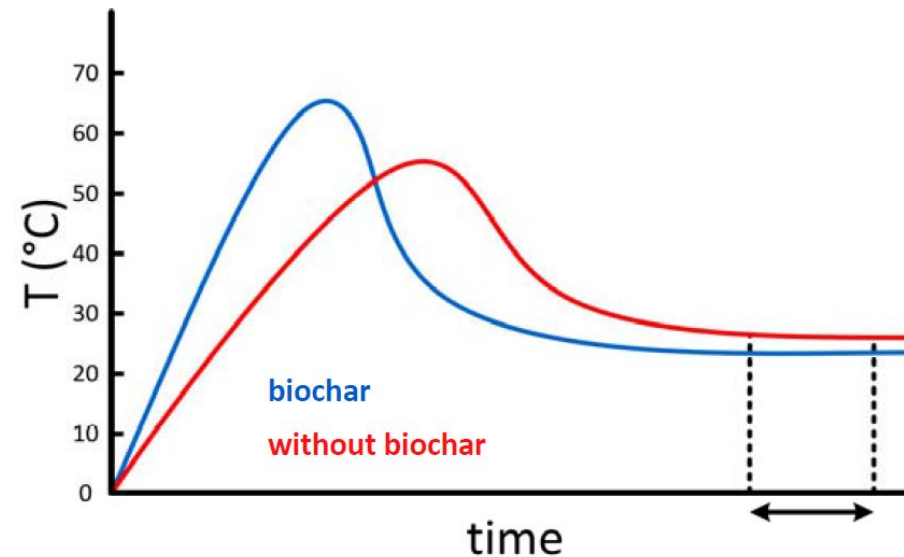


# The Use of Biochar in Composting

By Marta Camps, Massey University; and Thayer Tomlinson, International Biochar Initiative  
February 2015; for more information, please see [www.biochar-international.org](http://www.biochar-international.org)

## Adding biochar can enhance the composting process through:

- Accelerating the composting process
- Reducing GHG emissions
- Reducing ammonia loss
- Serving as a bulking agent for the compost
- Reducing odor



Oversize compost screenings can be carbonized and composted with organics.

# ***Biochar Price and Value are not established for most markets***

## ***Apparent Market Values \$0.10-\$1.00/lb***

1. Activated Carbon \$1.00+/lb, \$300+/CY
2. Partially Activated Biochar – environmental, stormwater
3. Nutrient Management \$0.50/lb, \$150/CY
4. Carrier for Bio-fertilizers
5. Soil blends for Moisture Management \$0.40, \$120/CY
6. Pet products: food and bedding
7. Soil Amendment \$0.30/lb, \$90/CY
8. Compost, Odor Control, \$0.10, \$30/CY

Value is greater when biochar is used as a component in a product suited for specific applications.

# Low Cost Chars and Feedstocks Will Drive US Biochar Production

- **Industrial Char Residuals (>70,000 CY/yr)**
  - Combustion char
  - Gasifier char
- **Biochar Co-products of Activated Carbon (<4,000 CY/yr)**
- **Wood Industry Residuals (<4,000 CY/yr)**
  - Dry wood trim
  - Chipped wood waste, sawdust
- **Harvested Cordwood (<20,000 CY/yr)**
- **Small scale wood residuals (<4,000 CY/yr)**
- **Future Feedstocks From**
  - *Organics recycling: landscape and tree service prunings, recycled urban wood*
  - High ash crop residues and manures
  - Forest residues from restoration forestry and stewardship contracts
  - Residuals (lignin) of biobased fuels (ethanol, butanol, acetic acid, furfurals, diesel) and chemicals production (xylitol)



# *Summary*

- Biochar – carbonized biomass- is becoming an established product to improve soil fertility, increase food production, reduce pollution, improve water quality and sequester carbon.
- Communities can converting part of their urban residues to biochar and energy.
- Commercial systems are available to convert residues that are not suitable for higher value uses.
- **Biochar** can help build **green** infrastructure.

**NW Biochar Working Group** [www.NWBiochar.org](http://www.NWBiochar.org)

**Biochar Listserv** [www.biochar.bioenergylists.org](http://www.biochar.bioenergylists.org)

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**Design and development of energy and environmental processes**

**Industries**

**Biomass energy**

**Pollution control**

**Materials handling**

**Feed, Food and Fuels**

