

# U.S. BIOCHAR INITIATIVE ANNUAL CONFERENCE

August 23, 2016

## Engineered and Designed Biochar

**"CHAIN OF CUSTODY" FOR BIOCHAR PRODUCTION/DISTRIBUTION/USE**

# INFORMATION ONLY

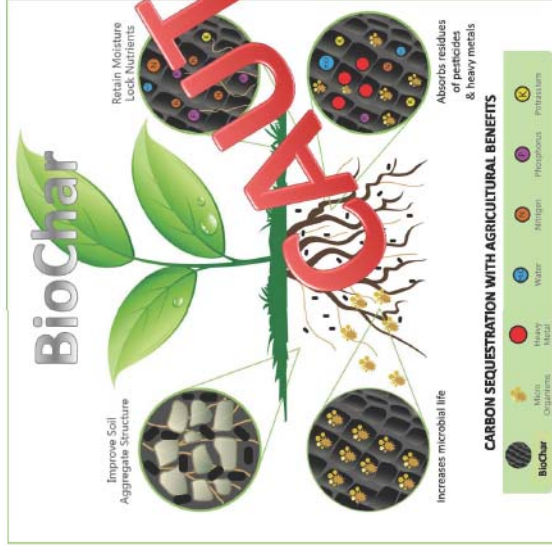
By:  
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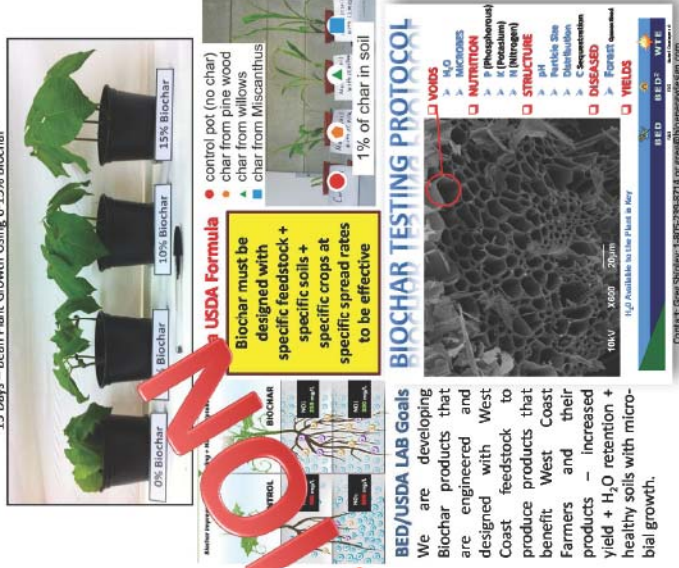
## “NOT ALL BIOCHAR IS CREATED EQUAL”

Dr. Jeff Novak – USDA-ARS Biochar Expert

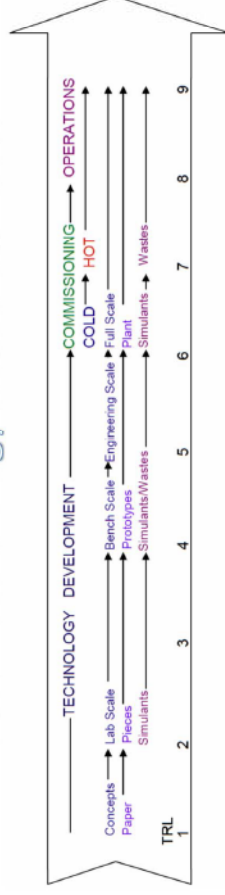


## BIOCHAR FOR AG

15 Days – Bean Plant Growth Using 0-15% Biochar



## DOE – Technology Readiness Level



### System Operations

**TRL 9** Actual system operated over the full range of expected conditions. The technology is in its final form and operated under the full range of operating conditions. Examples include using the actual system with the full range of wastes in hot operations.

**TRL 8** Actual system completed and qualified through test and demonstration. The technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental testing and evaluation of the system with actual waste in hot commissioning. Supporting information includes operational procedures that are virtually complete. An ORR has been successfully completed prior to the start of hot testing.

## TRU Pyrolysis Process and System is a TRL # 9



### TRU MODEL PYROLYSIS COMMERCIAL VALIDATION PLANT 5<sup>th</sup> Generation Patent Position



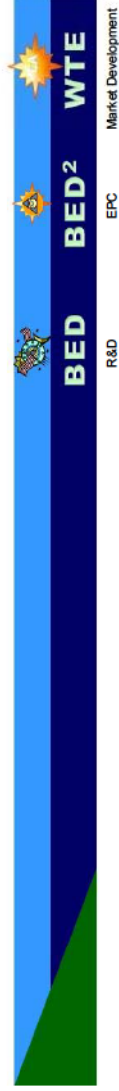
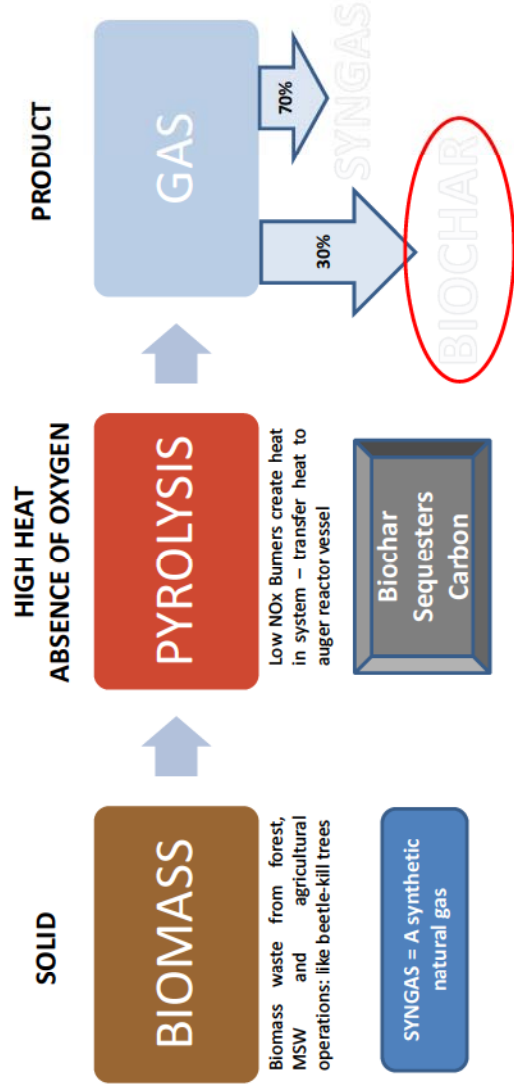
Partners: R&R Technology, Inc. and Cascade Carbon, LLC



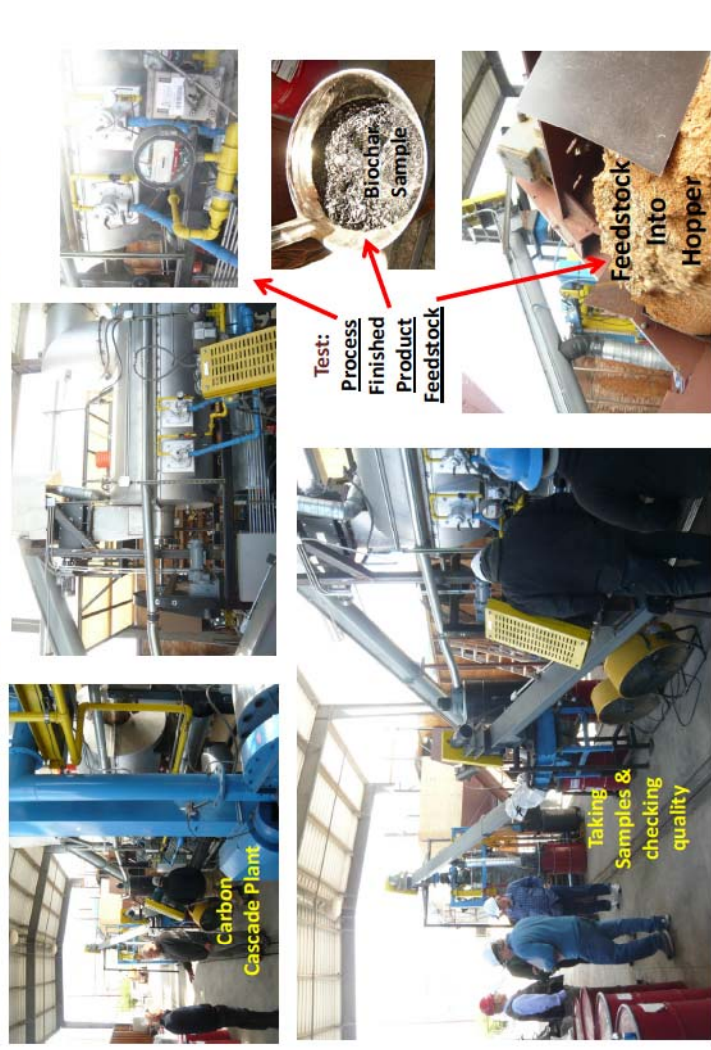


# SUBLIMATION PROCESS

An endothermic reaction – transferring heat to energy (exothermic)



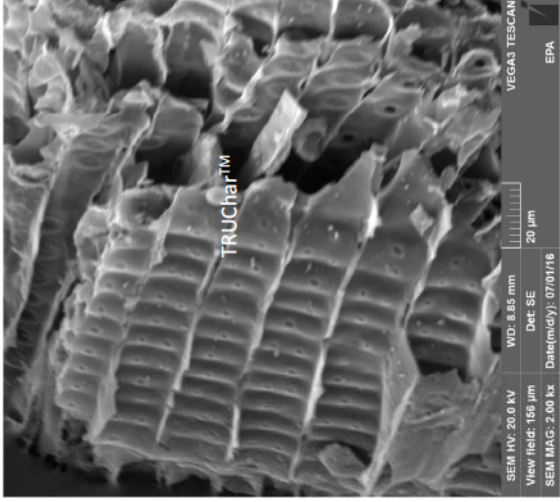
## Commercial Run – TRU Pyrolysis Process – 2016



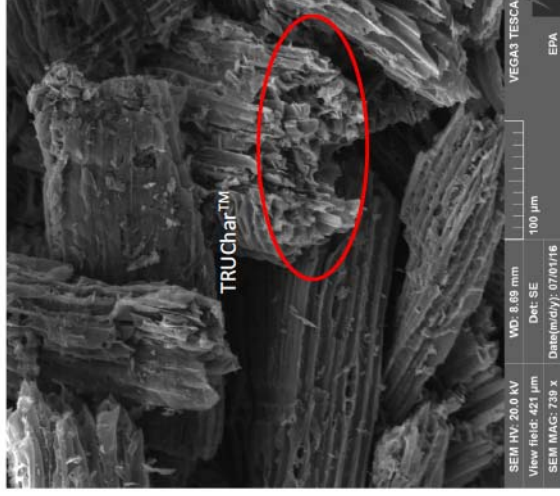
# TRU Pyrolysis Process Biochar

Electron Microscope Pictures: Courtesy of Dr. Mark Johnson – EPA Labs

Course Juniper Biochar



Fine Juniper Biochar



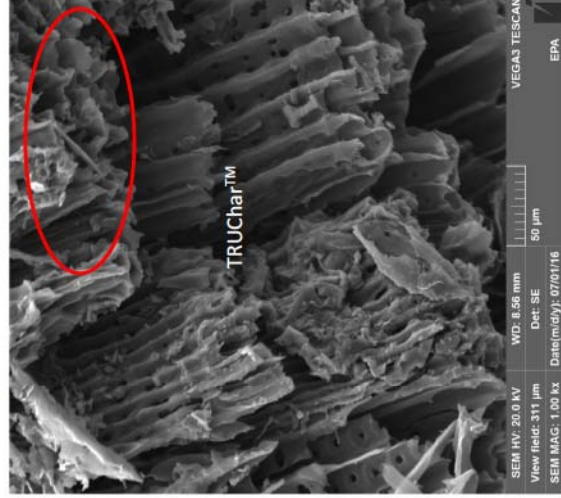
Samples Run: Prineville, OR Commercial Validation Plant – May 19, 2016



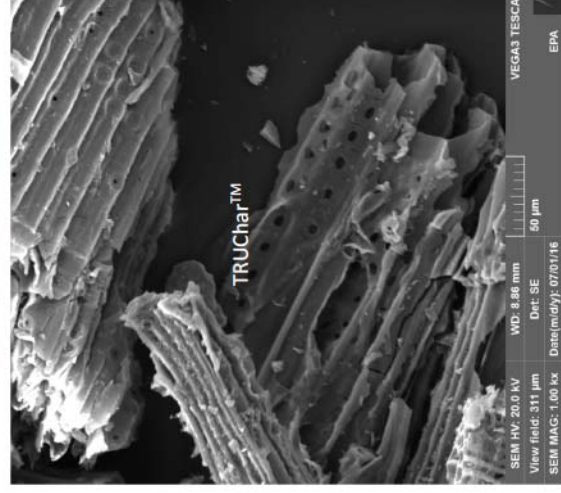
# TRU Pyrolysis Process Biochar

Electron Microscope Pictures: Courtesy of Dr. Mark Johnson – EPA Labs

Course Ponderosa Biochar



Fine Ponderosa Biochar



Samples Run: Prineville, OR Commercial Validation Plant – May 19, 2016






# USDA-ARS Lab Work

Photo of TRUChar™; Courtesy of Dr. Jeff Novak – USDA-ARS Labs



TRU Pyrolysis Biochar Samples - 2016

Elemental Analysis of biochar – for each shipment is essential





**BED**   **BED<sup>2</sup>**   **WTE**

R&D   EPC   Market Development

# BIOCHAR TEST RESULTS

## Biochar IBI Characteristics

### International BioChar Initiative (IBI) Laboratory Tests for Certification Program

Parameter	Units	Method
Moisture (wet weight analysis)	% wet wt.	ASTM D1702 (Loss on Drying)
Bulk Density	lb/cu ft	
Organic Carbon	% of total mass	Dry Combustion ASTM D 4373
Hydrogen/Carbon (H/C)	Molar Ratio	H-dry combustion (C/above)
Total Ash	% of total mass	ASTM D 1702-03
Total Nitrogen	% of total mass	Dry Combustion
pH value	units	4.11USCC-dil. Rajkovich
Electrical Conductivity (EC20 w/w)	dS/m	4.10USCC-dil. Rajkovich
Liming (net. Value as-CaCO3)	%CaCO3	ADAC 955.01
Carbonates (as-CaCO3)	%CaCO3	ASTM D 4373
Butane Act.	g/100g dry	ASTM D 1702-03
Surface Area Correlation	m <sup>2</sup> /g dry	G
Particle Size Distribution	Results	Units
Asenic (As)	ND	8.0 percent
Cadmium (Cd)	ND	44.0 percent
Chromium (Cr)	7.0	36.5 percent
Cobalt (Co)	ND	9.6 percent
Copper (Cu)	7.4	1.1 percent
Lead (Pb)	0.3	0.0 percent
Molybdenum (Mo)	2.0	0.0 percent
Nickel (Ni)	ND	0.0 percent
Selenium (Se)	ND	0.0 percent
Zinc (Zn)	28.1	0.0 percent
Boron (B)	ND	1237 mg/kg
Chlorine (Cl)	38.7	67 mg/kg
Sodium (Na)	ND	5.6 mg/kg
Iron (Fe)	1092	0.3 mg/kg
Manganese (Mn)	82	4254 mg/kg
Volatiles Matter	88.38 percent	Calc. D

\*"ND" stands for "not detected" which means the result is below the reporting limit.

Method A: Raymond & Higginson  
 B: Enders & Lehmann  
 C: Wang after Rajan  
 D: ASTM D1762-04  
 E: EPA3050B/EPA 8010  
 F: ASTM D 2862 Granular  
 G: Butane Activity Surface Area Correlation Based on McLaughlin, Shields, Jagello, & Thiele's 2012 paper: Analytical Options for Biochar Adsorption and Surface Area





**BIOCHAR RESOURCE**   **BED**   **BED<sup>2</sup>**   **WTE**

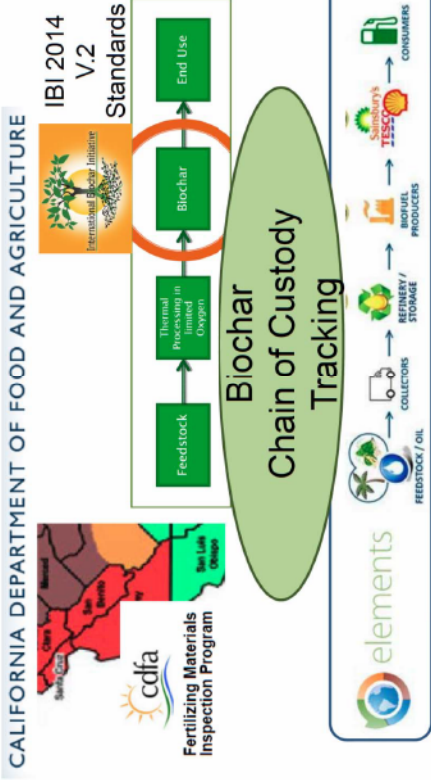
R&D   EPC   Market Development



# BIG DATA BIG DATA

BIOREFINERIES REQUIRE COMPLETE LABS  
& FULL CHAIN OF CUSTODY CAPABILITIES

**Compliant with:** Food Safety Modernization Act - 2015 &  
**Required to meet:** Roundtable on Sustainable Materials



Source to Use – for ALL Biomaterials



## QUESTIONS

**Customized Engineering to Support BED Technologies**  
**COMPLETE ENGINEERING SERVICES AND FEES**

- **Process Engineering**
  - Process Control Strategy
  - Process Flow Diagrams
  - PFDs & Equipment Sizing
  - Utility Requirements
  - Environmental Impacts
  - Permitting Issues
- **Process Design**
  - Feed & Heat Balances
  - Process Flow Diagrams
  - Equipment Sizing
  - Utility Requirements
  - Environmental Impacts
  - Permitting Issues
- **Process R&D**
  - Feasibility Studies
  - Technology Assessment
  - Process Flow Diagrams
  - Utility Requirements
  - Environmental Impacts
  - Permitting Issues
- **Process Construction**
  - Equipment Layout
  - Structural Steel Design
  - Piping & Instrumentation Diagrams
  - Construction Methods
  - Construction Schedule
  - Equipment Foundations
- **Process Operations/Maintenance**
  - Start-up
  - Startup & Shutdown
  - Normal Operations & Maintenance
  - Troubleshooting
  - Performance Analysis

**BED<sup>2</sup> Assures Accuracy**

- Complete Audit Trail
- Largest Database to support operations/R&D/Costs
- Complete documentation for all permitting processes. All changes of pages of engineering docs & designs are made throughout thousands of simulations, finite element analysis, and other design critiques

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