

The Integrated Biomass Energy System

Co-location of Biomethane and Biochar production Systems

From Waste Streams
To
Energy Flow and Nutrient Cycling
through design science and engineering

Pacific Northwest Biochar Working Group
LaSells Stewart Center
Oregon State University, Corvallis, Oregon

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John Miedema
BioLogical Carbon, LLC

Dean Foor, PE
Essential Consulting Oregon, LLC

My pathway to Biochar and Biomethane

- Sitting on the back of a boat thinking about food production and global warming in 1990
- Began investigation of on farm Biomethane production-- making energy from a waste stream while controlling and concentrating nutrients could lead to a robust and resilient agricultural system and environment
- Inefficiencies made the economics of the system difficult to overcome— ammonia build up, too much water in digestate for efficient distribution... so I pondered and read...

Timely Ingenuities

“I am enthusiastic over humanity’s extraordinary and sometimes very timely ingenuities. If you are in a shipwreck and all the boats are gone, a piano top buoyant enough to keep you afloat ...makes a fortuitous life preserver. But this is not to say that the best way to design a life preserver is in the form of a piano top. I think we are clinging to a great many piano tops in accepting yesterday’s fortuitous contriving as constituting the only means for solving a given problem.”

- Buckminster Fuller,
- Operation Manual For Spaceship Earth

- Comprehensive Anticipatory Design Science
- General Systems Theory
- Resilience** of the **integrated** and the **instability** of the **specialist**

Reorientation

“The economics of permanence implies a profound reorientation of science and technology, which have to open their doors to wisdom and, in fact, have to incorporate wisdom into their very structure..... Wisdom demands a new orientation of science and technology towards the organic, the gentle, the non-violent, the elegant and beautiful....”

- EF Schumacher
- Small is Beautiful

Biochar Professionals

- “Every profession bears the responsibility to understand the circumstances that enable its existence.”

-Robert Gutman

Resilient Sustainable Community Development requires

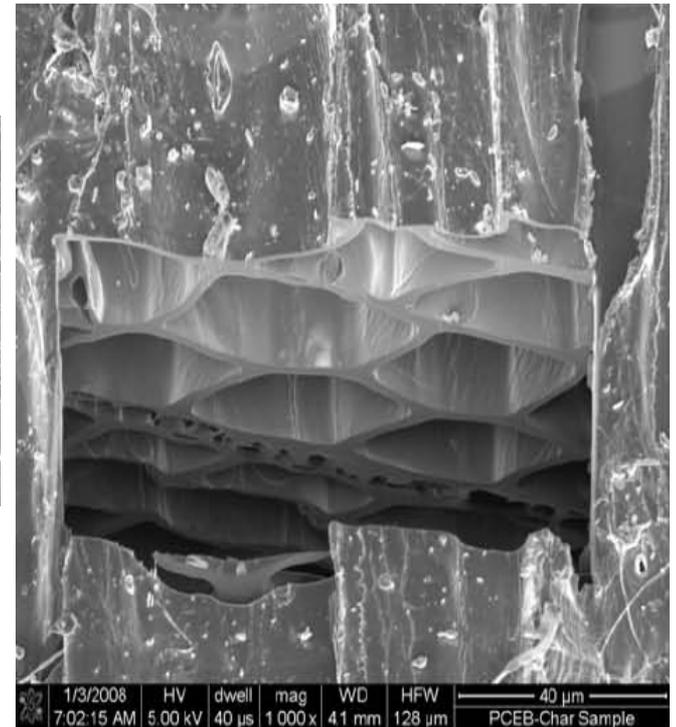
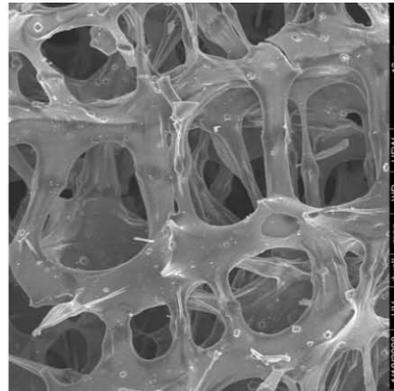
- Local Food-Local Energy-Local Employment—Local PEOPLE
- **A Technological Revolution**
- Creating **new pathways** in resource management
- Moving away from treating **Natural Capital** as Income to be spent in ruthless exploitation of finite resources for short term gain.
- **Requires New inventions** machines and methodologies which can reverse the destructive trends that current economic methodologies have brought about.
- **Turning Wastes into Resources**, continually looking to improve the use efficiency of energy and materials
- **A shift** in the economic emphasis of continual growth to an emphasis on the Economics of Permanence ---

Encountered the concept of Biochar 2006

Is produced by the thermal cracking of biomass in an oxygen controlled environment.

Results In:

- Stable compounds of single and condensing ring aromatic carbon
- High surface area
- Nutrient retention and capture (NH₄⁺, K⁺, Ca²⁺, Mg²⁺, P etc.)
- High ion exchange capacities (CEC and AEC)
- Increased pH
- Changes in physical properties
 - water retention
 - reduced soil density
 - increased porosity/aeration



Corn Cob and Pine Wood Char
Courtesy of J. Amonette

General Philosophy

The potential benefits Of Co-location of Biomethane and Biochar production Systems:

Food Security

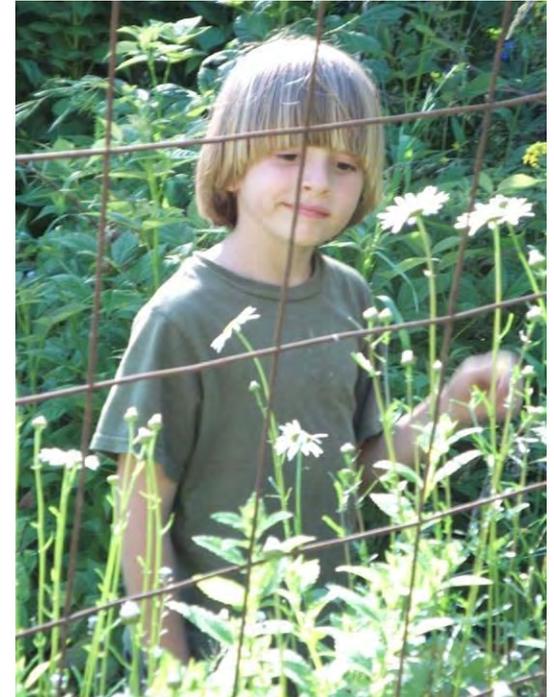
Energy Security

Job Creation

Water Clean-up

Environmental Revitalization

Carbon Sequestration



are so great, we would be remiss for not engaging wholly in rigorous study of the entire biochar system, to scientifically prove or disprove the validity of the system... **and an ounce of practice is worth more than a ton of theory ---“IT IS ALL IN THE DO”**

Research Philosophy: Specific

- 1.) Produce **energy from biomass**, ensuring that no additional carbon is released into the atmosphere
- 2.) **Remove CO₂ from the atmosphere** by converting part of the feedstock not into energy, but into a “stable” form (= char) from which it will not return to the atmosphere for a long time
- 3.) **Improve soil** by taking advantage of the unique physicochemical properties of artfully prepared chars to enhance fertility, modify physical properties, decontaminate soil and water resources

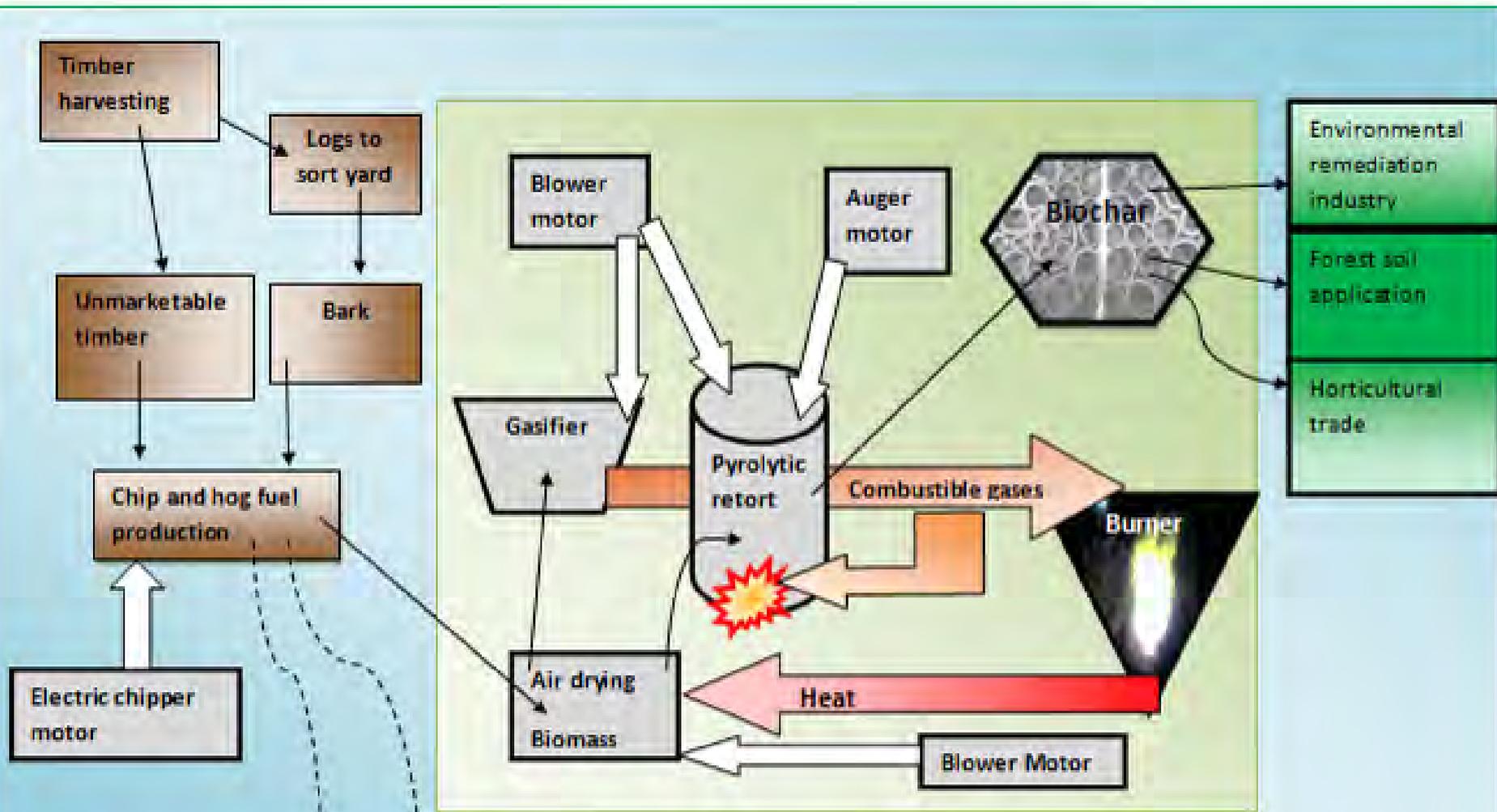


Figure 1. Project diagram, solid line arrows indicate flows of material (logs, chips, biochar). Block arrows indicate flows of energy (diesel fuel, electricity for system motors, or combustion gases). Dashed lines indicate current product uses for the wood waste.

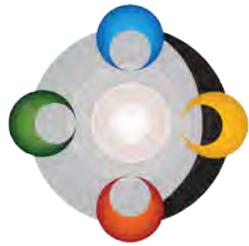
Industrial Lego's



SAM—Sustainability Advancement Machine

Would give me the ability to make chars under controlled conditions so we could investigate the efficacy of multiple types use





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Cultivating Renewable Energy Solutions



JC-Biomethane, LLC The Pacific Northwest's First Merchant Biogas Plant

Presented to: Biochar Workshop at 2013 Harvest Clean Energy

Date: 28 January 2013

Presented by: Dean Foor, PE
Project Engineer
Essential Consulting Oregon, LLC



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JC-Biomethane Project



Substrate / Feedstock

- Commercial Organics
- Agricultural Residues

Anaerobic Digestion

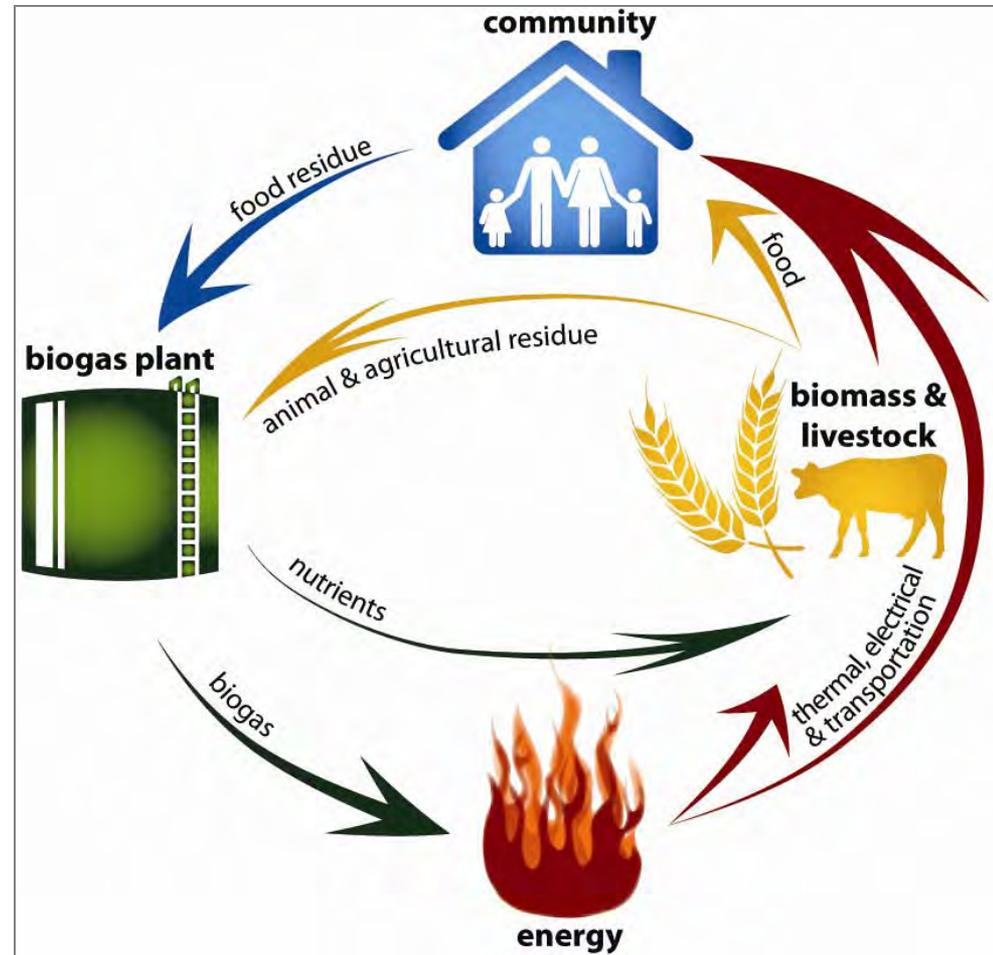
- Continuous Stir Tank Reactor
- (40 °C / 104 °F)

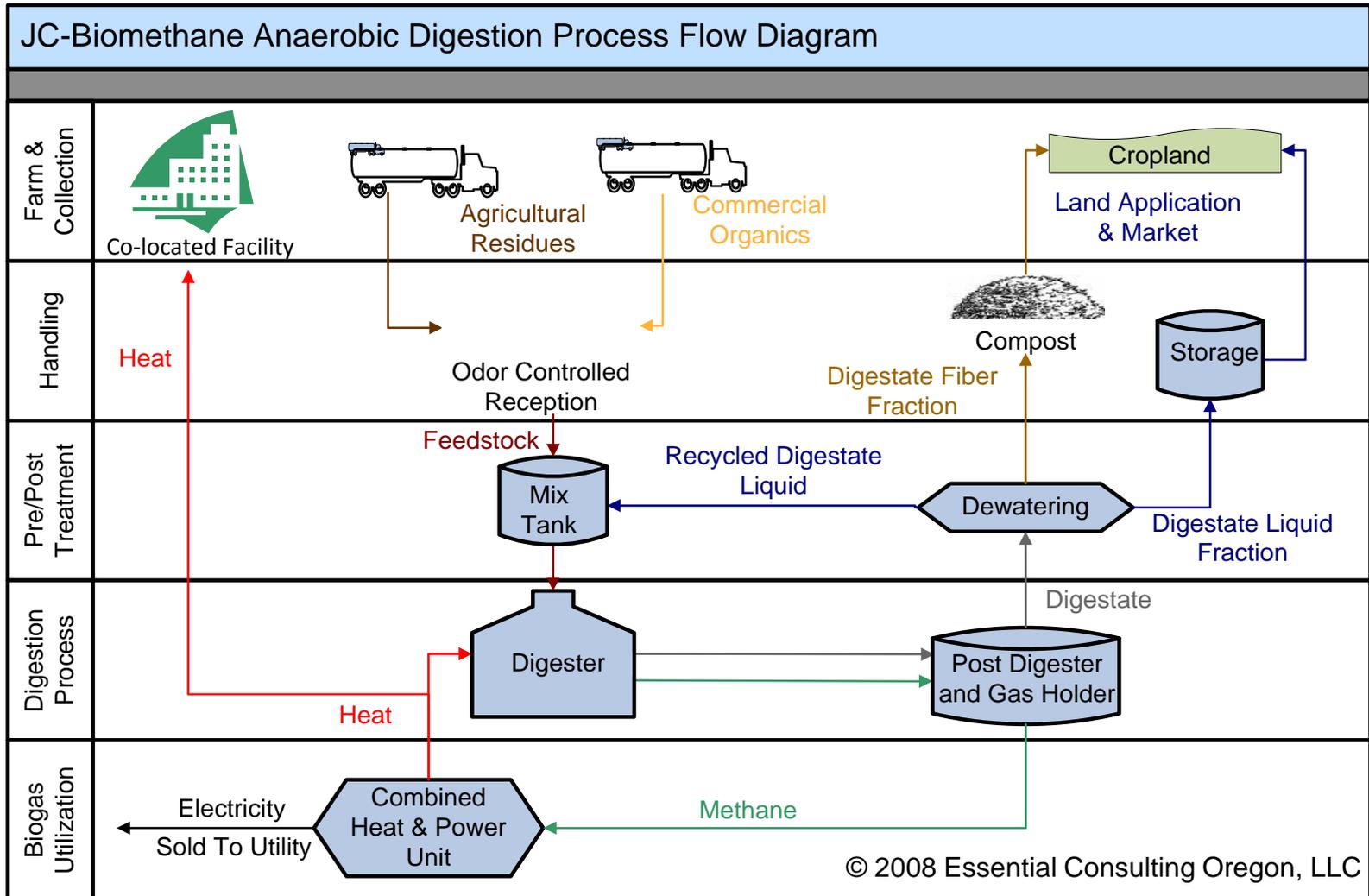
Biogas Energy

- 1.55 MW_{electrical}
- 1.80 MW_{thermal}

Nutrients

- Digestate Fiber Nutrients
- Digestate Liquid Nutrients





Rarely Found Synergies

- Substrate availability
- Co-product markets
- Broad-scale Agriculture

Secured Incentives before Sunset Provisions

- ARRA Grant
- Federal ITC 1603 Grant
- Oregon BETC

Power Sales

- Energy Trust of Oregon
- PPA prior to recent reduction



Site Synergies



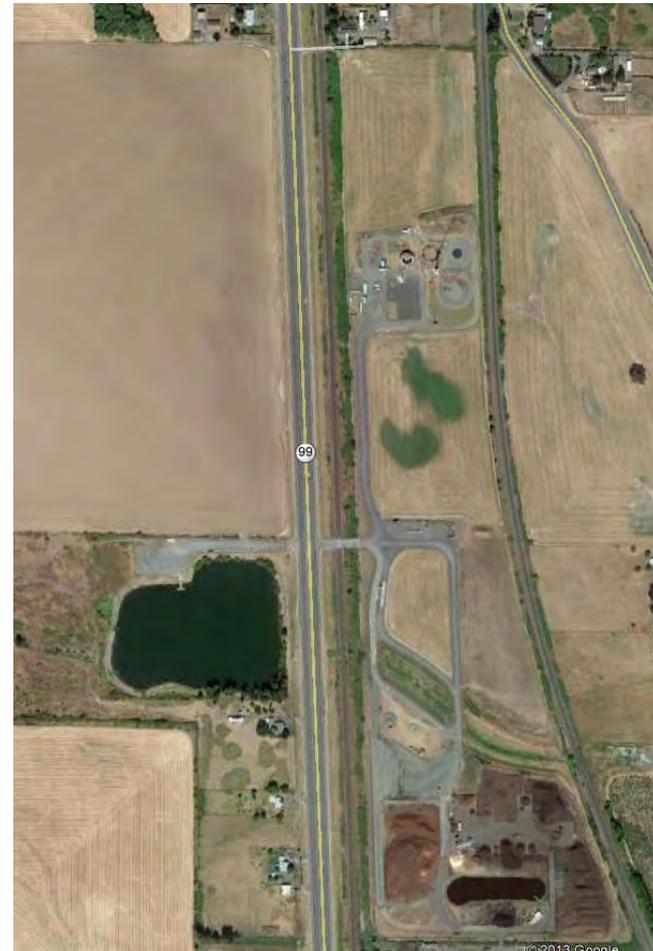
Industrial Zoning

Road and Railroad Access

Environmental Permits

Access to Raw Material

Proximity to Agriculture



Process Synergies



**Thermal Energy –
Drying Applications**

**Electrical and Thermal –
Renewable Energy Sources**

**Digester Fiber Nutrients –
dry / blend / pellet / char**

**Digester Liquid Nutrients –
potentially bind on biochar**

Operations Staff



Designer Biochar Synergies



- **Availability of various products** - wood, bark, bark fiber, compost, soils, nutrients and minerals
- Allows for engineering and manufacture of Dynamic and Intentional **Organic Mineral Complexes**

- Metal and non metal atoms entrained into carbon lattice.
 - Ionic and electrostatic bonding of metals oxides, carbonates, chlorides and phosphates around the organic lattice. (amorphous and crystalline) as separate phases
 - oxides and sulphide minerals offer dynamic functional sorption sites-
 - Some of these mineral phases are conductors, some semiconductors, or insulators.
- Silicates offer permanently negatively charged sites (basal surface and internal galleries) for bonding of metals
- Functionalized aromatic molecules (carboxyl, phenols, etc.) also exhibit amphoteric and dynamic sorption behaviors

S. Joseph, J. Amonette

Integrated Bio-Refinery



--- **inherently Local** because of low energy density of the feedstock---
inherently small 1.5MW-5MW

- **Local Waste Streams**

Food waste, manure, forest thinning, bark, crop residues clean urban wood waste (e.g. roadside clearing, pallets, sorted construction debris, yard waste)

- **Local Energy Supply**

- Electricity, Heat, Liquid fuels, chemical building blocks

- **Local Nutrient Supply**

- Control, distribution, cycling

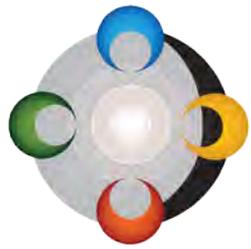
- **Local Solutions**

- **Local Food production**

- **Local Environmental Remediation**

- **Local Jobs**

- Regional resilience through Comprehensive design strategies



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Cultivating Renewable Energy Solutions

Contact



Dean Foor
Essential Consulting Oregon, LLC
ecoregon.com
(541) 485-9095
dean@ecoregon.com



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Core Competency

Essential Consulting Oregon

EC Oregon, based in Eugene, was founded in 2005 to provide energy analysis services to the agricultural and business community with an emphasis on anaerobic digestion of organic waste and biogas production.

Consulting Services

- Feasibility Studies
- Feedstock Assessment
- Financial Modeling
- Business Plan Development
- Vendor Evaluation
- Valuation of Environmental Credits
- Project Scheduling

Project Management

- Project Controls and Execution Plan
- Incentives and Tax Credit Applications
- Permitting
- Utility Interconnection
- Assembly of Development Team
- Funding Packages
- Development of Commissioning Plans

Further Information and Contacts

John Miedema
BioLogical Carbon, LLC
Philomath Oregon
541-619-0007
jmiedema@peak.org

Dean Foor
Essential Consulting Oregon, LLC
ecoregon.com
(541) 485-9095
dean@ecoregon.com

Markus Kleber
Professor, Crop and Soil Science
Department
Oregon State University
Markus.Kleber@oregonstate.edu