Pyrolysis Blanket:
A Low-Cost in-Forest Processing Technology

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Premise: To have impact, in-forest processing needs low capital costs and operations suitable for current burn crews.

Blanket idea from an interdisciplinary grad project

- Tribal Partnerships: Specialized grad students go into the field
- Engineers and resource scientist get to explore the triple bottom line of a renewable-based product or service
- Refining the idea of "Community-Based Engineering"
  - Integration of technology at the landscape-scale
  - Technology primarily to meet economic, ecologic, and community goals

NSF

USDA

IGERT
Integrative Graduate Education and Research Traineeship

CORPS
NSF Innovation Corps

NARA
Northwest Advanced Renewables Alliance

Technology needs are motivated by experiences with the Yakama Nation and Confederated Salish & Kootenai Tribes

- Forest residue economics and supply reasonable for 15 MW biopower facility at Yakama Forest Products mills

  J.J. Richardson et. al, Biomass Bioenergy (2011).

- No economic outlets were available for forest residues on CSKT reservation; other renewables made more sense.

  L. James et. al, Forestry Chron (2012).

CSKT project surveyed several emerging technologies

Fast and slow pyrolysis technologies

- Can be mobile, transportable, or centralized (economy of scales)
- Mobile is targeting up to ~ 20 BDT/day per unit
- PacNW disposes roughly ~ 5.8MM BDT/year of waste wood

Biochar Solutions (6 BDT/day, slow pyr)

Agri-Therm (5 BDT/day, fast pyr)

High capital and operating costs; operators need expertise

Mobile slow pyrolysis can be capital-free!

Labor intensive production of charcoal (biochar) on the Yucatan Peninsula, 2011

Issues

- High emissions
- Quality control & throughput
- Deforestation

Blanket pyrolysis v.1.0 shows promise

- ++ Dramatic (>10x) reduction in labor
- \+ Low initial capital investment
- \- Poor materials durability

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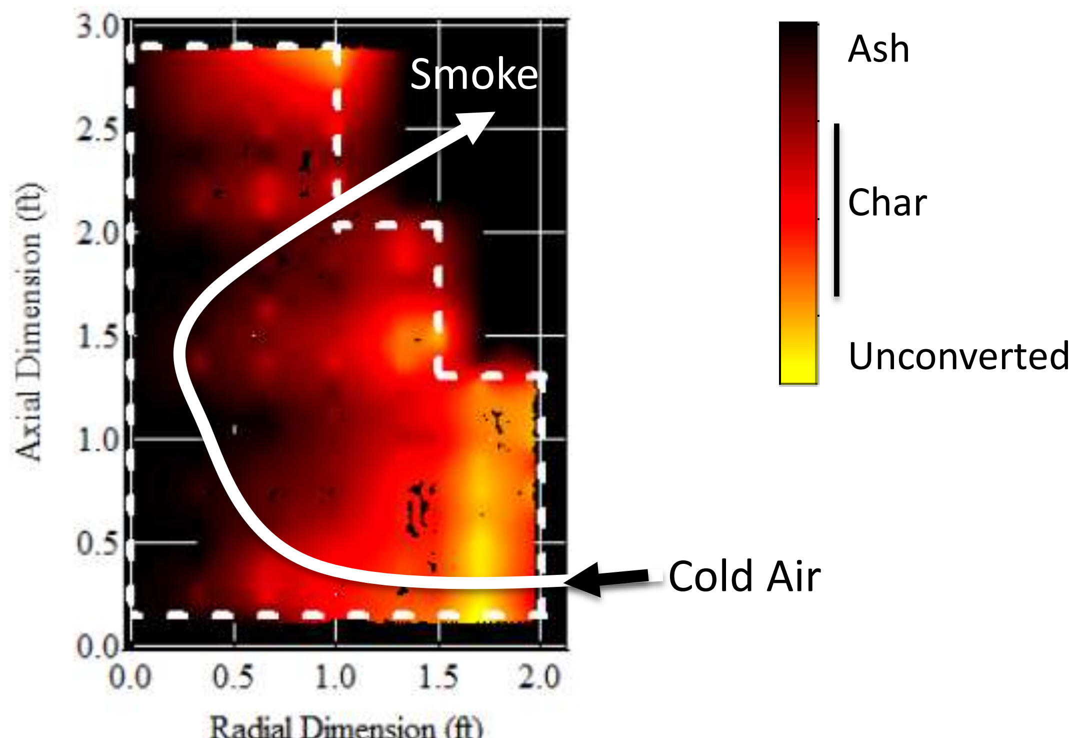
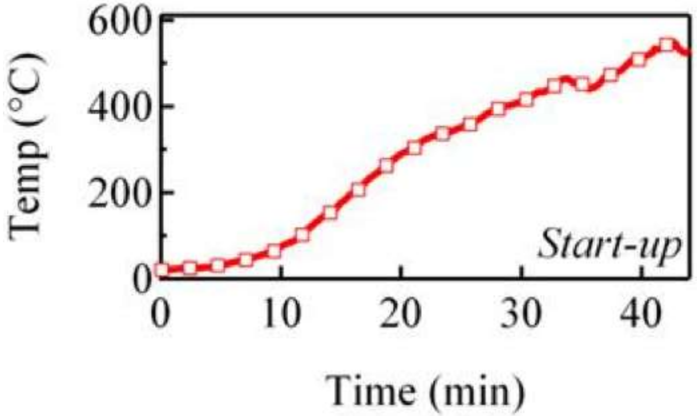
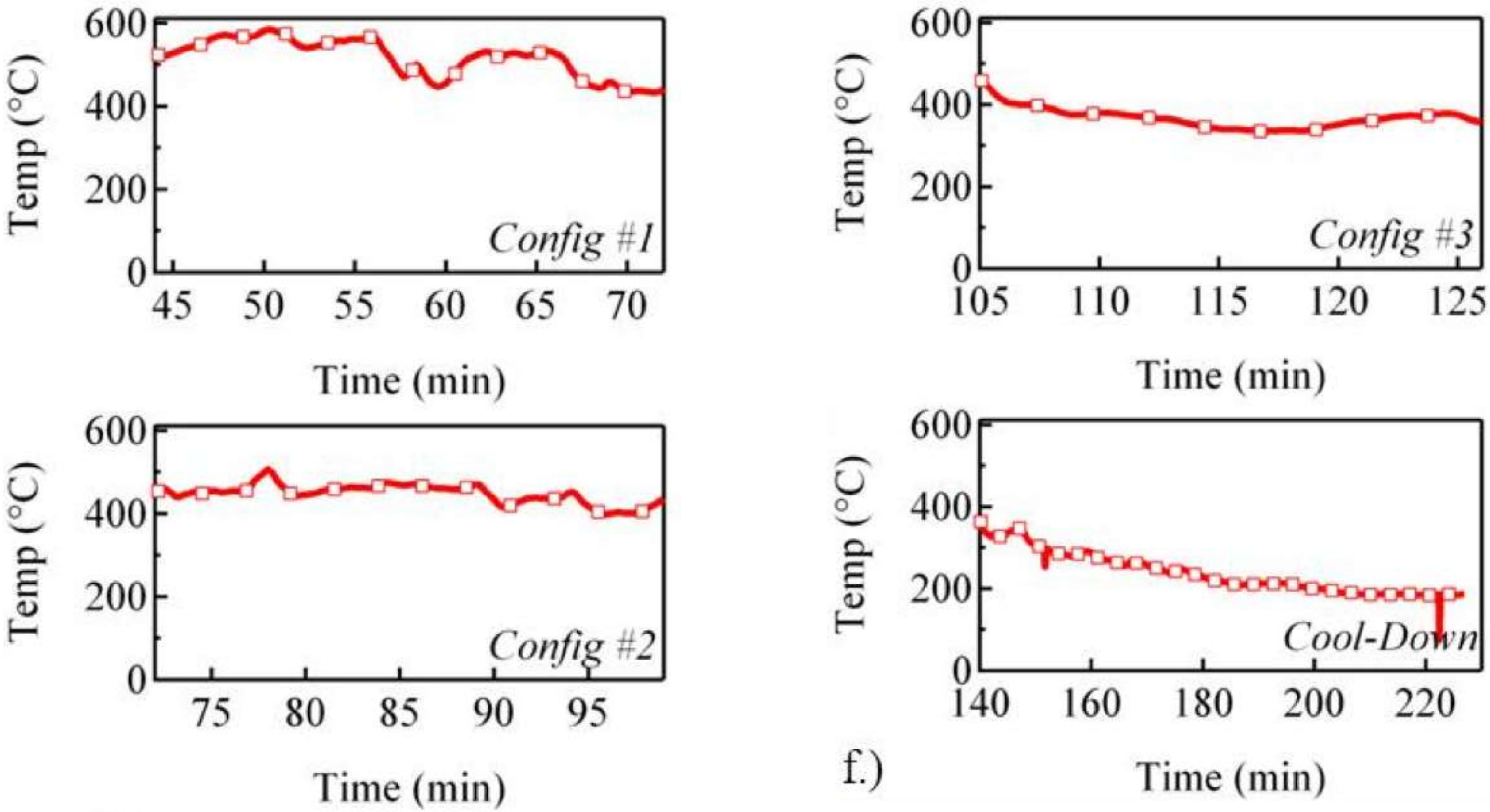
\+ Low initial capital investment
\- Poor materials durability
\- Vent design and base sealing
\- - Emissions & product uniformity



Blanket pyrolysis v.1.0 shows effect of vent configuration, base sealing

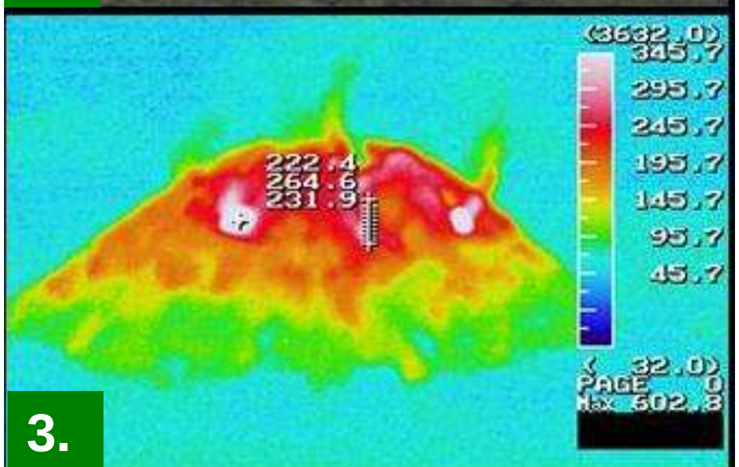




f.)

Blanket pyrolysis v.1.0 makes product.

TGA used to get char proximate composition.



Blanket pyrolysis v.2.0

- *more durable material design*
- *more easily reconfigured vents*
- *US patent filed 05/11, “Blanket for biomass pyrolysis & drying”*

Basic Materials Design

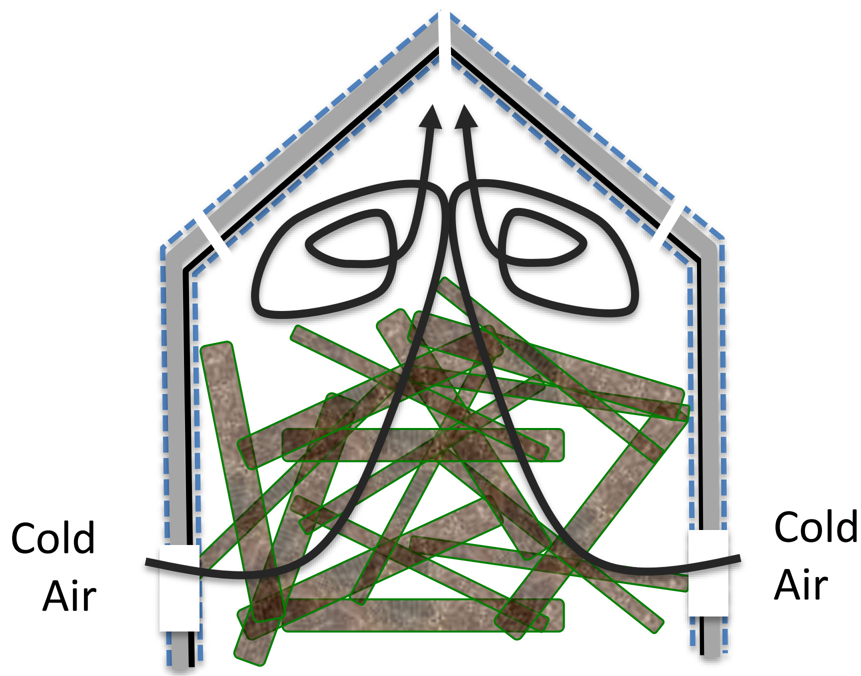
3 or 4-ply laminate with

- 1 or 2 layers for durability
- 1 gas impermeable layer
- 1 insulating layer

Blanket pyrolysis v.4.0

- *panels unfold and interconnect to aid deployment*
- *"tent" shape set by stiff panel interconnects*
- *controlled shape = controlled 2nd burn in "canopy"*

noticeably reduced smoke



Need partner to help <u>quantify</u> emission factors

Blanket pyrolysis v.4.0

- *operational domain and product reproducibility testing*

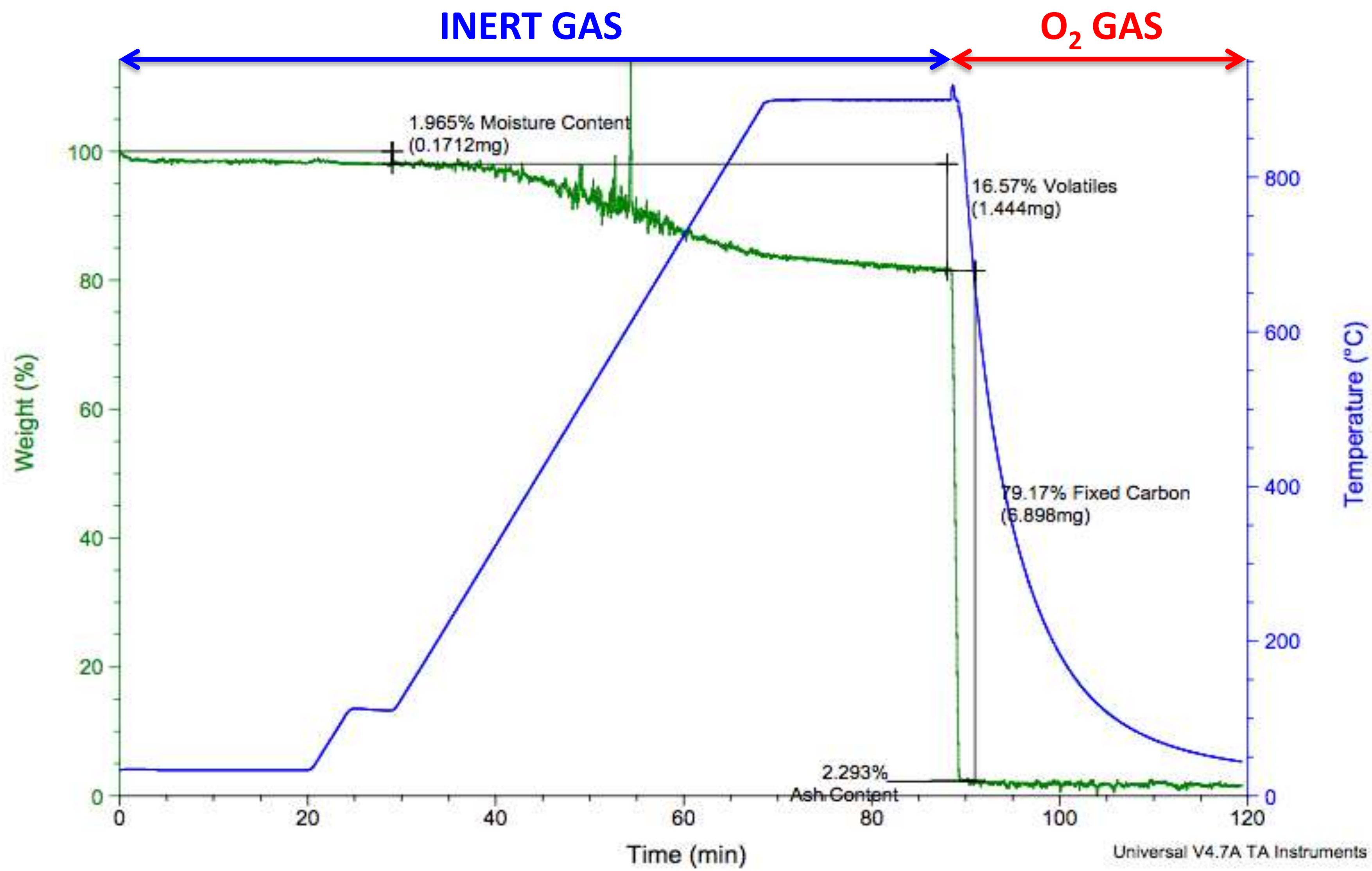
Species	Pieces (diam)*	Gross Mass (kg)**	Ave. Temp (˚C)	Process TIme (min)	% Biochar Yield***
Ponderosa	Mixed (1.5-4 in)	154	560	80	**33%**
Ponderosa	Uniform (3 in)	93	550	70	**43%**
Alder	Mixed (1.5-4 in)	175	616	75	**34%**
Alder	Mixed (1.5-4 in)	162	425	85	**32%**

*expected relationship: process time ~ $(\text{diam})^2$

**all wood was seasoned with approximately 10% initial moisture

***yield only includes completely converted pieces based on friability test.

Example TGA results from alder biochar



TGA results from two comparable alder pyrolysis runs are consistent

	Moisture (%)	Volatiles (%)	Fixed C (%)	Ash (%)
Alder 1	2.0	16.6	79.2	2.3
Alder 2	1.1	16.9	79.7	2.5

- Biochar composition (proximate and ultimate) matters for soil amending, combustion, cooking, etc.

- Species, temp, piece size, process time, initial moisture should affect product traits (not all mapped out).

Carbon Cultures

Healthy Forests, Healthy Soils, Healthy People

Seattle Business

Bright Idea: A Blanket Endorsement

Carbon Cultures uses $50,000 grant to create reusable pyrolysis blanket.

FINNIAN DURKAN | APRIL 2012 | FROM THE PRINT EDITION

We've raised about $120k to get company started

Public demo in Kerby, OR last week

BioChar Technology Showcase Event!

November 6, 7, 8, 9

Carbon Cultures patented biochar producing technology

Science, engineering and commercialization questions remain

- Life-cycle impact depends on emission factors…
  must measure and ensure robustly controlled

- Blanket scale-up and logistical details…
  biggest test to date: 0.5 tons with v.2 blanket

- Design and operation for optimal product uniformity…
  CFD may be able to support in silico *design*

- Low volume biochar soil amendment market…
  widespread field testing and demos needed