8-20-2017

Can biochar link forest restoration with commercial agriculture?

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Economic Evaluation of a Forest-to-Farm Biochar Paradigm

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Agricultural Research Service

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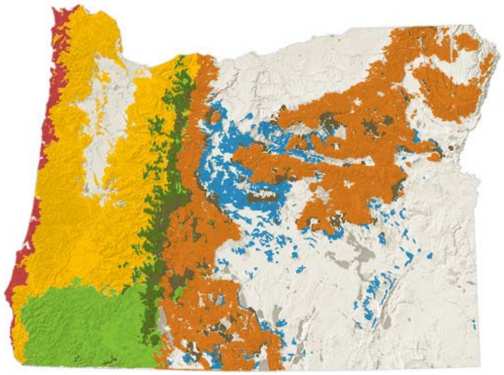
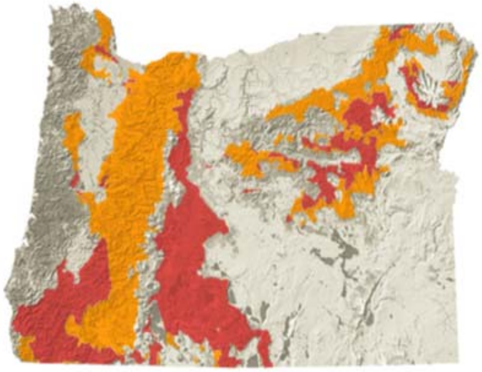
College of Forestry

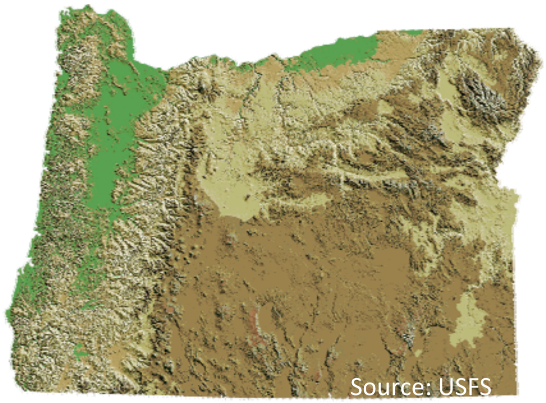
Catastrophic fire threatens Oregon's forests

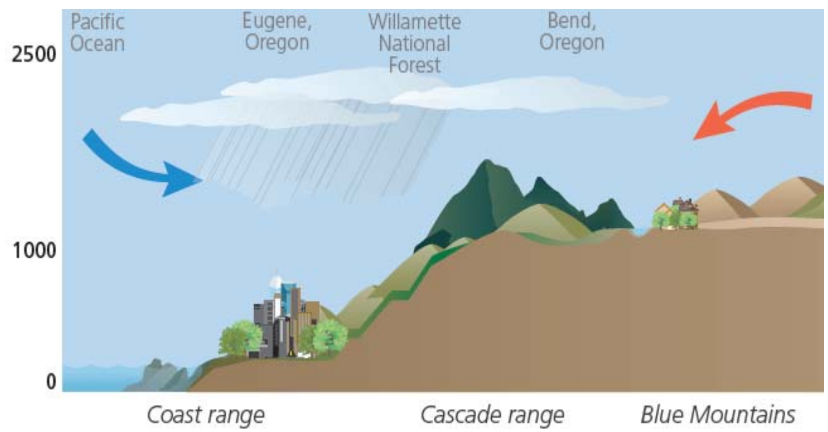


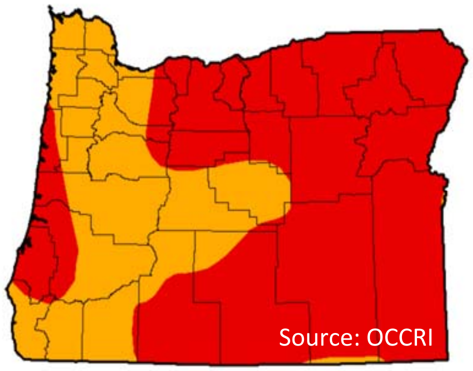


- 4 million ha. are at high risk of wildfire in Oregon
- Most of the risk is due to decades of fire suppression and a lack of funds to support fuel reduction treatments
- Limited demand for forest harvest residues restricts the ability of foresters to fund restoration projects.

Drought threatens Oregon's crops

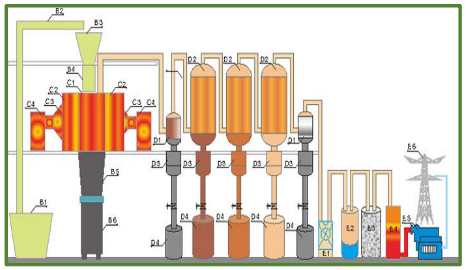


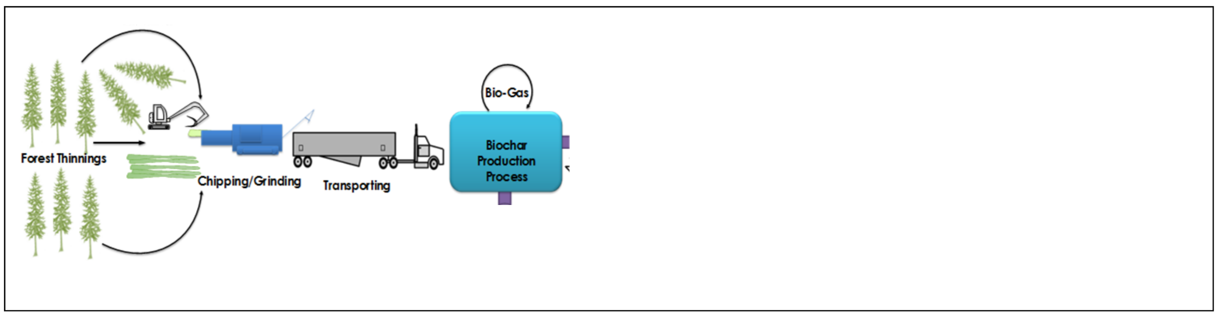




- In 2015 drought resulted in over >$1.2 billion in crop losses
- Biochar has the potential to improve water availability in agricultural soils, but limited supplies means costs are high.
- **Does a forest-origin biochar strategy pair these reciprocal needs of forest restoration and agricultural productivity?**

Does a forest-to-farm biochar paradigm pair the needs of forest restoration and agriculture?





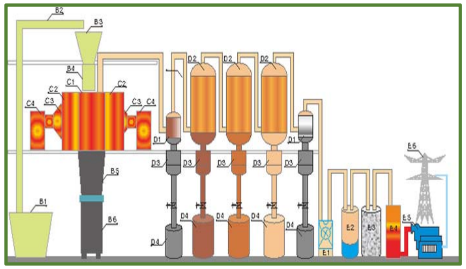
Char Properties

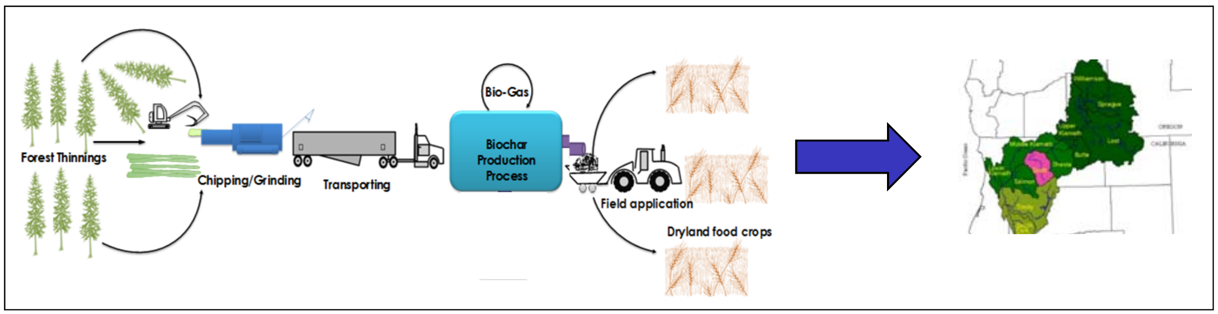
	Chemical Characteristics		
	pH	CEC cmol-C/kg	Bulk Density
Microwave	8.23	7.34	0.25
Thermal	9.34	6.05	0.27

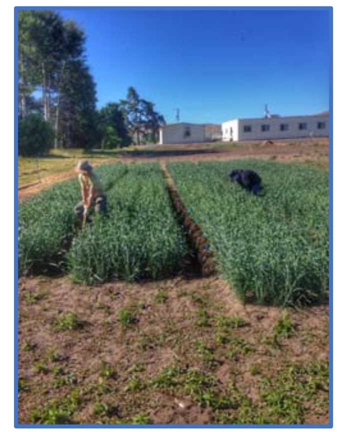
	Proximate			Ultimate				
	Volatile	Fixed C	Ash	C	H	N	O	S
	%	%	%	%	%	%	%	%
Microwave	13	82	5	88	2	0.5	5	0.089
Thermal	14	73	12	83	2	0.5	5	<0.005

	VOCs									Semi-volatiles		
	Acetone	2-Butanone	Benzene	Toluene	Ethylbenzene	m,p-Xylenes	o-Xylene	4-Isopropyltoluene	Naphthalene	Naphthalene	2-Methylnapthalene	Phenanthrene
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Microwave	62	21	8.8	11	2	4.4	2.6	5.7	BMDL	2.6	BMDL	BMDL
Thermal	38	BMDL	2.6	1.8	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL	BMDL

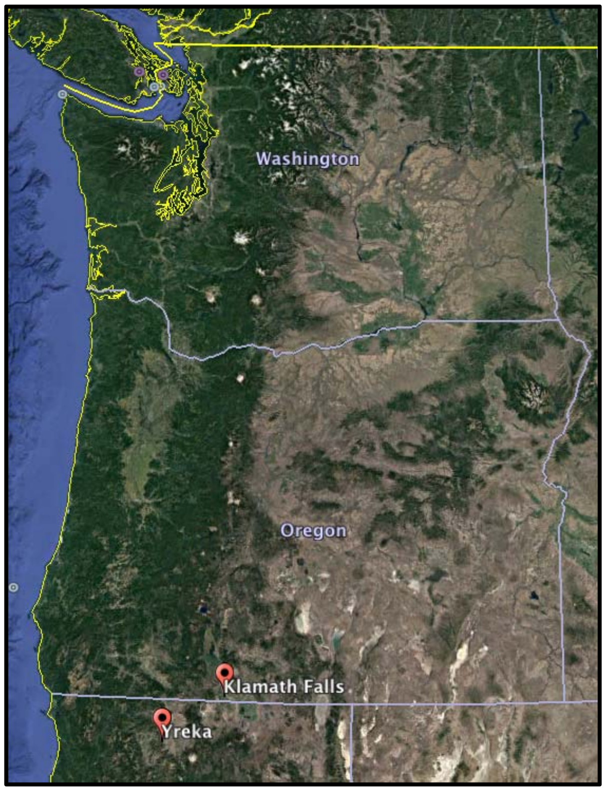
Does a forest-to-farm biochar paradigm pair the needs of forest restoration and agriculture?

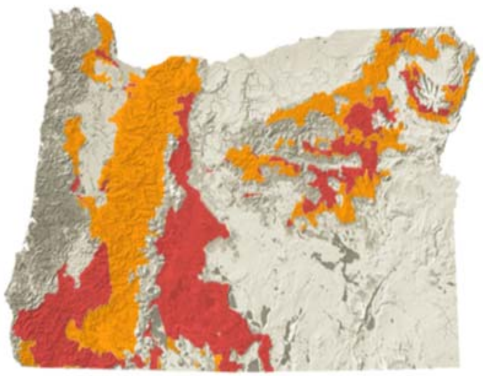


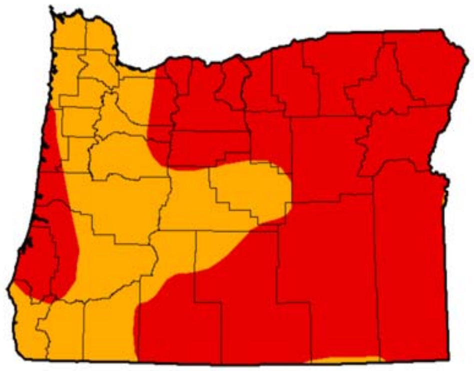


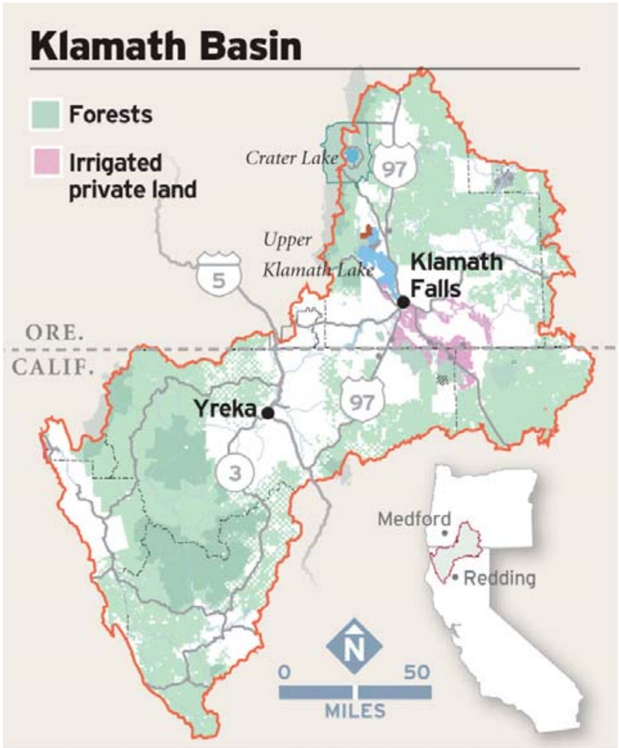


Klamath Basin of Oregon: where irrigated cropping systems, water scarcity, and high fire-hazard forests share the same landscape









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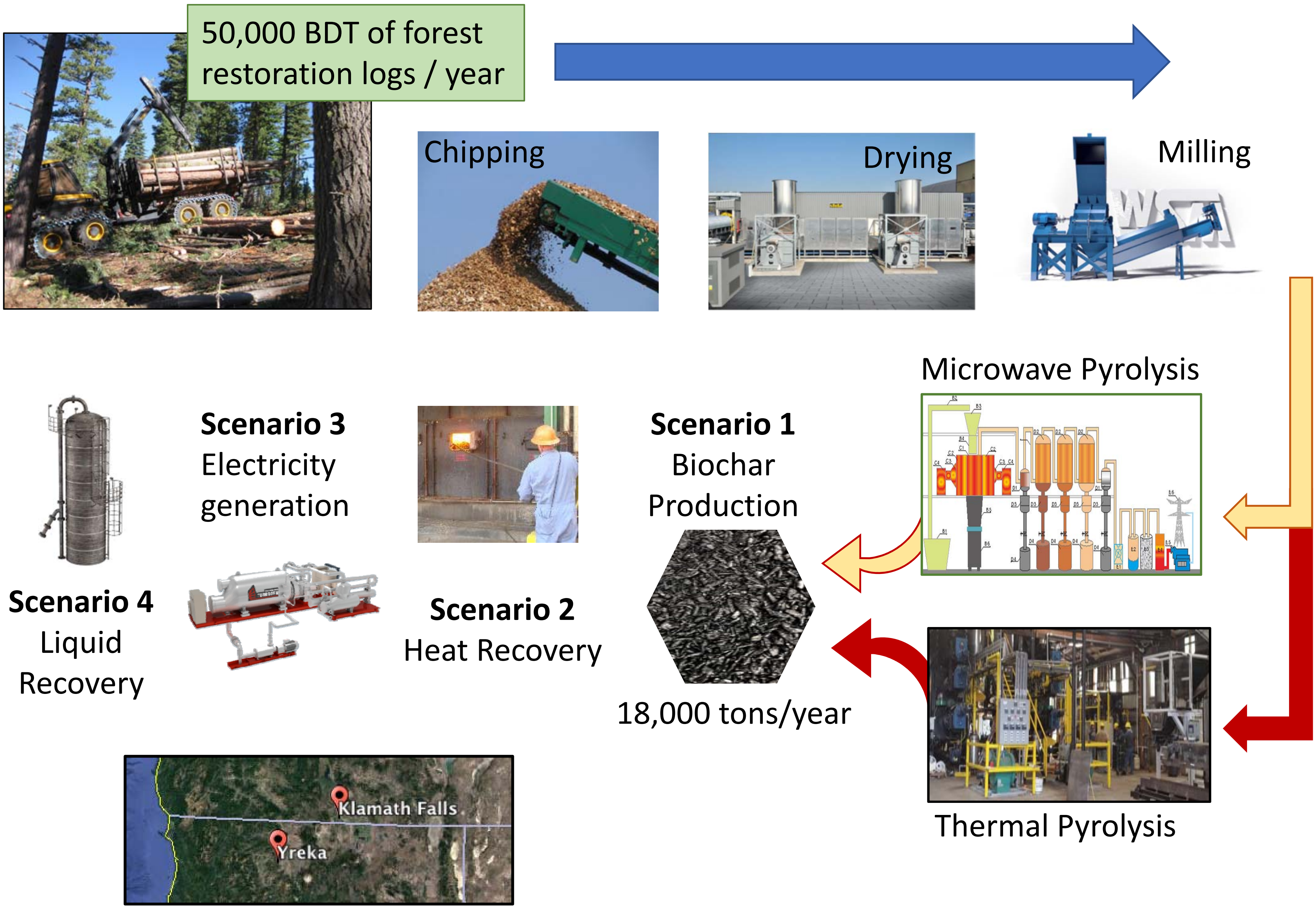
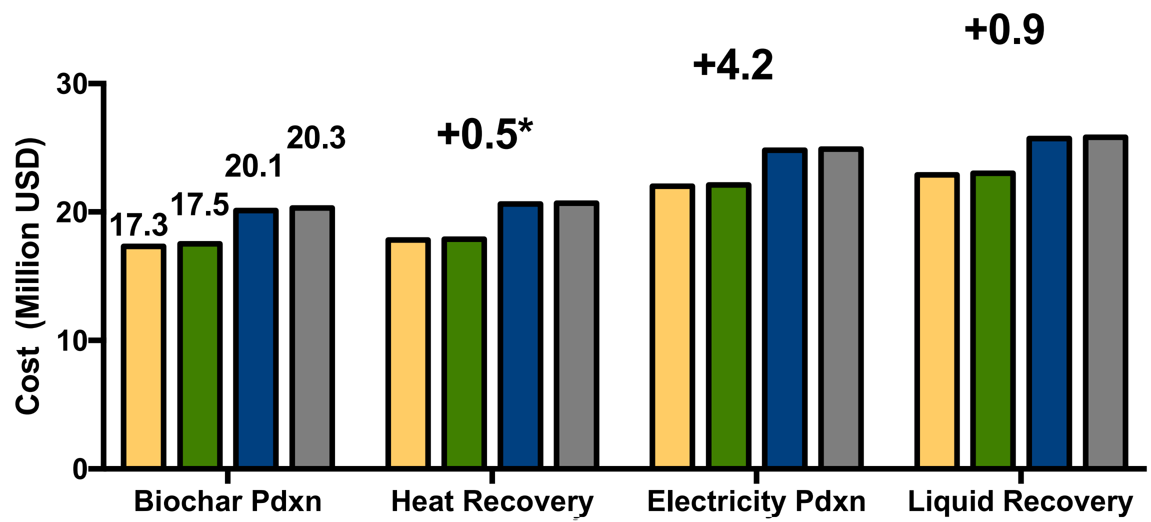
BIOCHAR PRODUCTION PROCESS

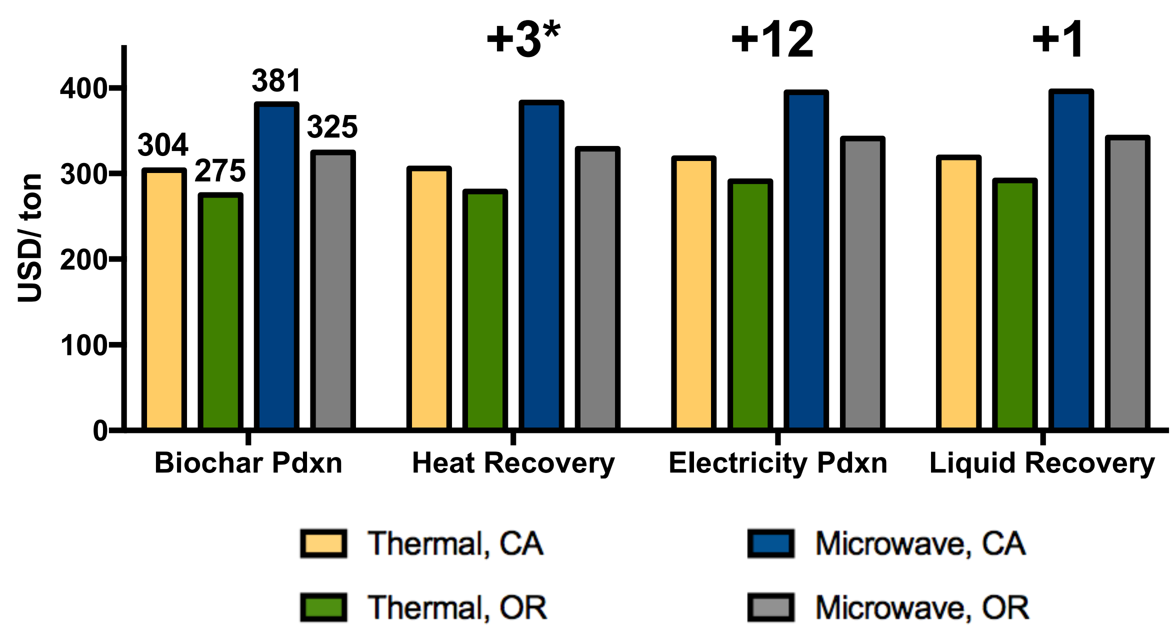


Preliminary Cost Estimates

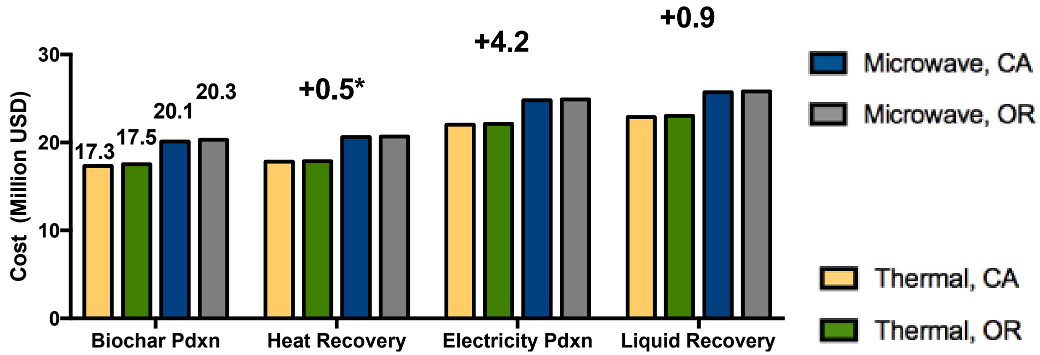
Preliminary Capital Costs

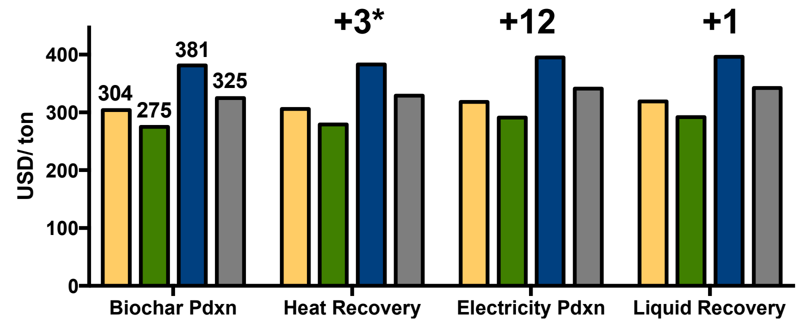


Preliminary Biochar Production Cost



Critical Economic Factors





- Plant location
  - Influences delivered log costs
- Electricity rates
  - Higher in California than Oregon
  - Higher usage for microwave technology
- Plant Complexity
  - Recovery of energy and condensable liquids adds capital and operating costs
- Seasonality
  - Influences raw material and finished product inventory
  - Log deliveries limited to summer months
  - Product sales limited to spring and fall months
  - Plant operates year round to maximize asset utilization

Summary

- Biochar-based products utilize low-value biomass from forest restoration projects. Simultaneously, biochar can:
  - Prolong the storage of soil water
  - Sequester carbon in soils
  - Improve plant productivity
- **Our economic analysis determined that:**
  - **Microwave pyrolysis is more costly than thermal pyrolysis**
  - **Electrical generation from this process adds a significant cost**
- Further analyses will determine if these extra costs can be offset.

Acknowledgments

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Collaborators: Karr Group; BSEI Inc.; Green Diamond, Miller Timber Services

USDA United States Department of Agriculture Agricultural Research Service

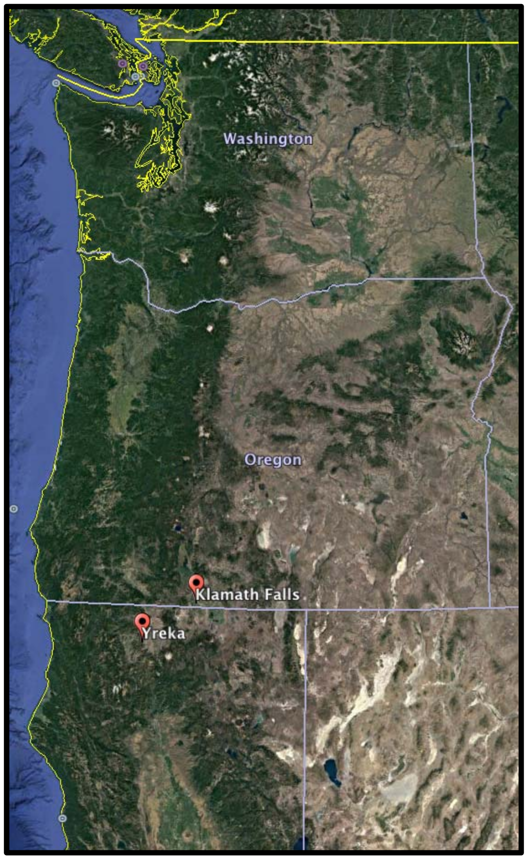
Oregon State University College of Forestry

- A shift level productivity study using steep slope harvesting technology was used to develop a model of tethered harvest.
- Used decision support models to optimize treatments and transport from forest to plant.
- The cost of tethered machines on tethered operations (TT) and untethered operations (TU), and the cost of untethered machines on untethered operations (UT) were estimated.

Courtesy of J. Sessions

	No Firewatch			With Firewatch		
Cost per	TT	TU	UT	TT	TU	TT
green ton	$26.84	$23.63	$21.38	$27.04	$23.80	$21.55

Biochar Plant Design Assumptions



- Log supply:
  - 50,000 bdt/year
  - Low-grade logs from restoration treatments on National Forests
- Plant Location
  - Existing wood processing sites in Oregon and California
- Primary Technology
  - Thermal and Microwave pyrolysis reactors from commercial suppliers
- Other Technology
  - Size reduction and material handling systems from commercial suppliers