

# *Financial feasibility of fast pyrolysis plants in SW Oregon using forest residues as feedstock*

Colin B. Sorenson

The University of Montana  
Bureau of Business and Economic Research  
colin.sorenson@business.umt.edu

*Western Forest Economists meeting – May 11, 2011*



# *Overview*

- Motivation
- Background
- Assumptions
- Financial Analysis Method
- Financial Performance & Sensitivity
- Conclusions

# Forest biomass – waste product or energy feedstock?



Photo: RMRS

# Handling options

- Pile and burn or seek value-added end uses
- Open burning – emissions concerns and no value recovered
- Renewable energy feedstock – carbon neutral/negative, displaces fossil fuels
- Must be **financially feasible**



Pile and burn  
disposal

OR



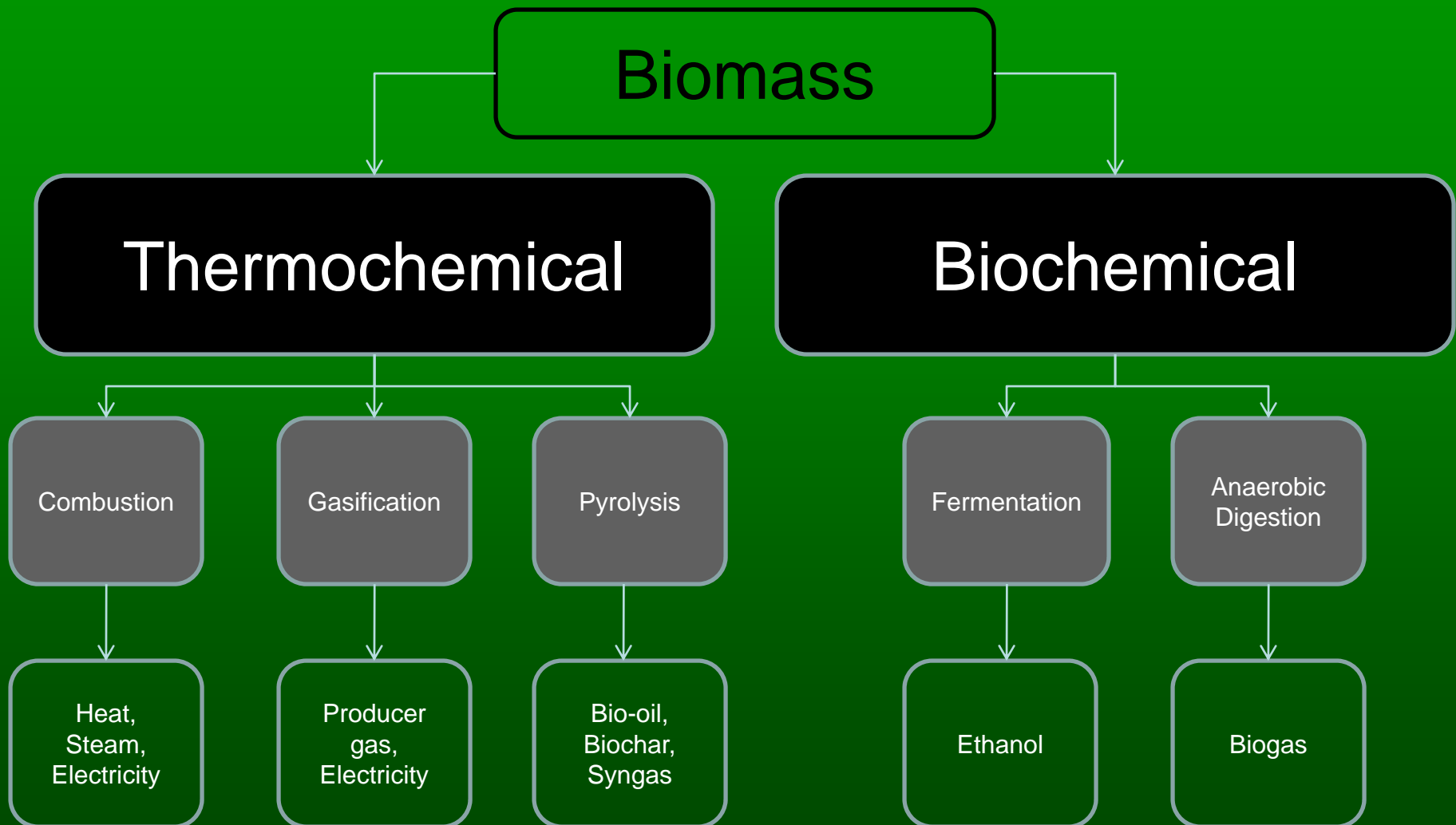
In-woods handling, transport

&



Energy conversion

# Bioenergy Conversion Methods



# Fast Pyrolysis

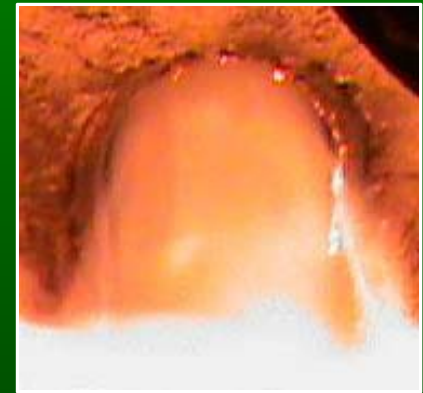
Rapid thermal degradation of biomass in the absence of oxygen



Bio-oil

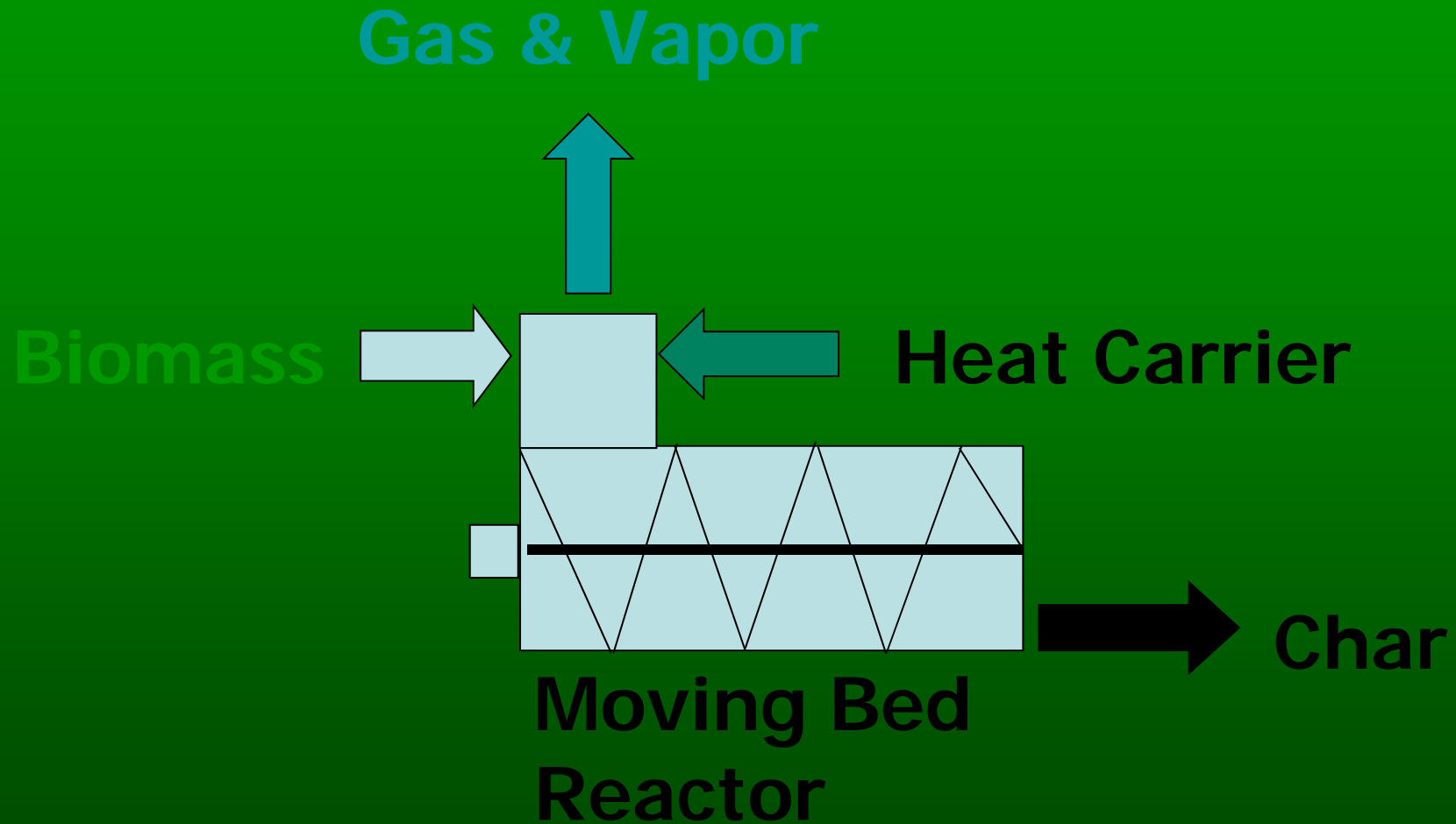


Biochar

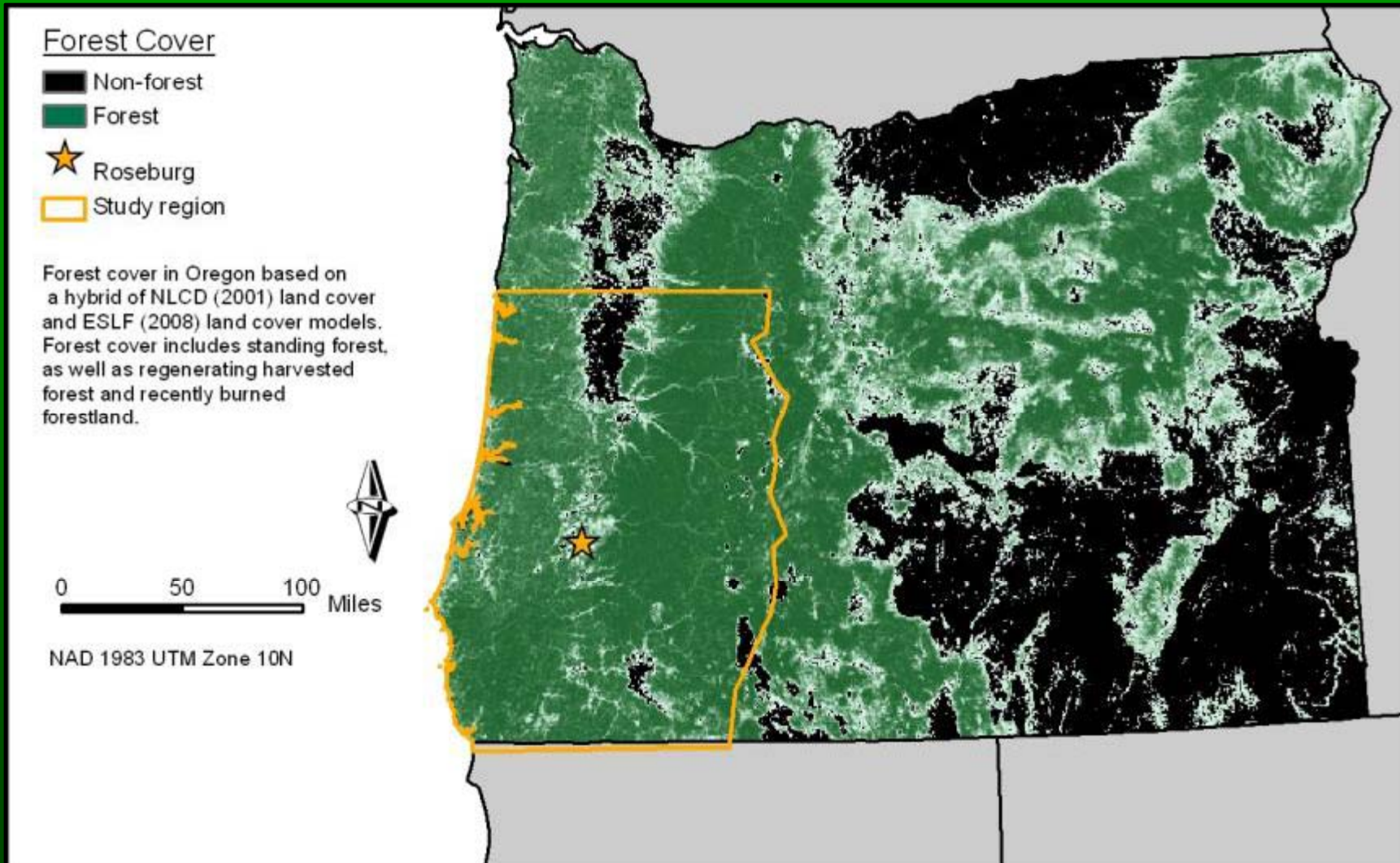


Syngas

# Renewable Oil International® LLC Fast Pyrolysis Process



# Study region for mobile and fixed pyrolysis





# Assumptions for both plants

- Products: 57% bio-oil, 27% biochar, 15% syngas, 1% tar
- 75% of thermal process energy supplied by syngas
- 60% capital investment borrowed @ 9% for 7 years
- Straight line depreciation
- Standard federal income taxes and Oregon excise taxes
- Energy content of #2 fuel oil = 0.139 MMBtu/gal
- Energy content of bio-oil = 0.08 MMBtu/gal
- Price #2 fuel oil = \$2.64/gal (2-yr avg price Sep07-Aug09)
  - (Latest available weekly price from EIA = \$3.09 as of Mar 2011)
- **Price bio-oil (incl. 10% discount) = \$1.36/gal**
- **Price bio-char = \$136/ton**

# Contrasting assumptions

## Mobile 50 BDTPD

- \$3.46 million initial capital investment
- Operates 12 hours per day
- 87.5% utilization rate
- 6 FTE employees
- Delivered feedstock \$20/BDT
- Consumes 7,128 BDT/yr
- Annual Production
  - 780,642 gallons bio-oil
  - 2,138 tons biochar
  - 79 tons tar
- All electrical process energy supplied by bio-oil
- Unit moves 2 times per year

## Fixed 200 BDTPD

- \$24.26 million initial capital investment
- 24-hour continuous operation
- 90% utilization rate
- 17.5 FTE employees
- Delivered feedstock \$45/BDT
- Consumes 65,700 BDT/yr
- Annual Production
  - 8.32 million gallons bio-oil
  - 19,710 tons biochar
  - 730 tons tar
- All electrical process energy purchased from grid

# Financial analysis method

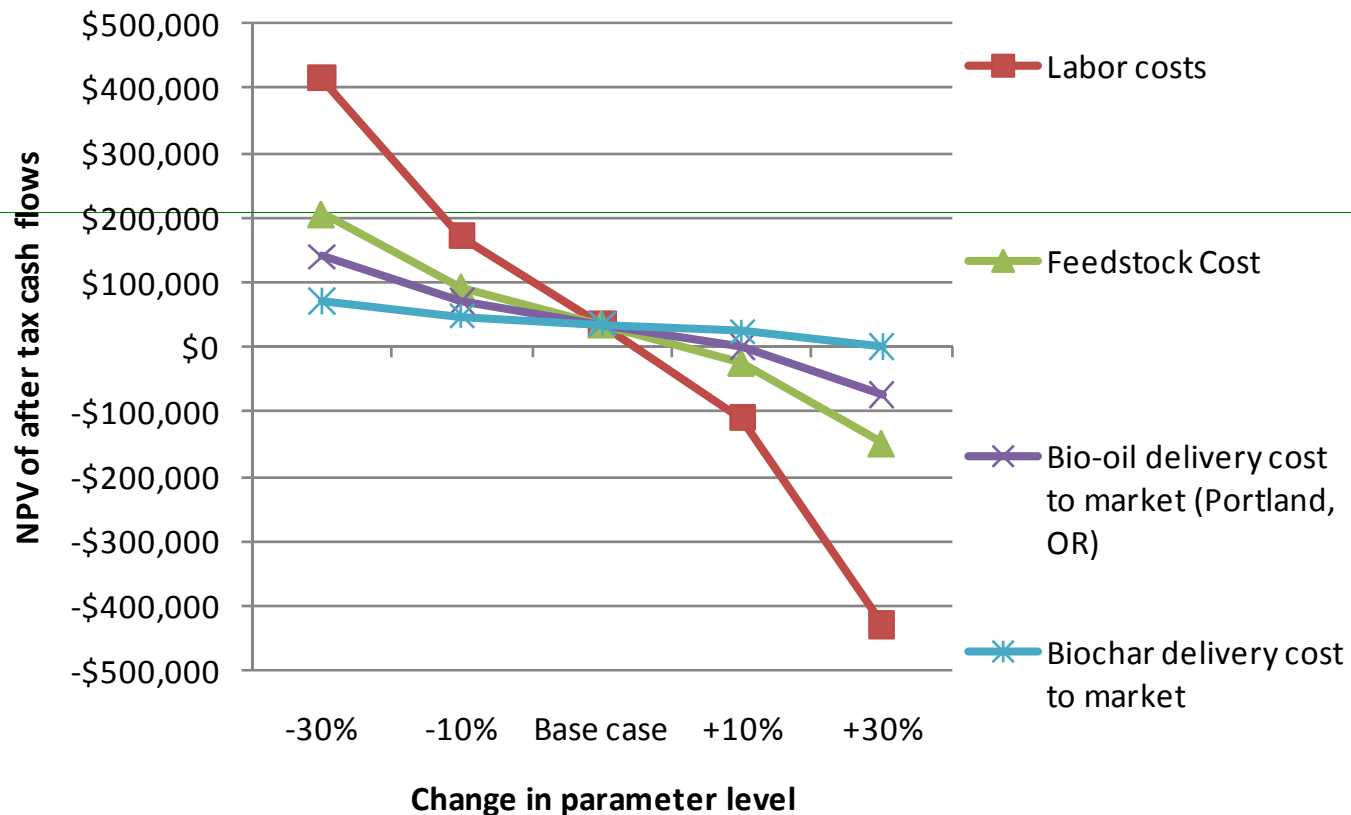
- Discounted cash flow analysis
  - 7% real (net of inflation) discount rate
  - NPV of after tax cash flow and IRR determined for each plant
  - Sensitivity analyses for multiple cost and revenue parameters
  - Compare tradeoffs between mobile and fixed

# Baseline Financial Performance

	<b>Mobile</b>	<b>Fixed</b>
NPV (\$1000s)	36	9,681
IRR (%)	7.4	20.9

# Financial Performance Sensitivity Analysis

Mobile plant sensitivity to selected variable cost parameters

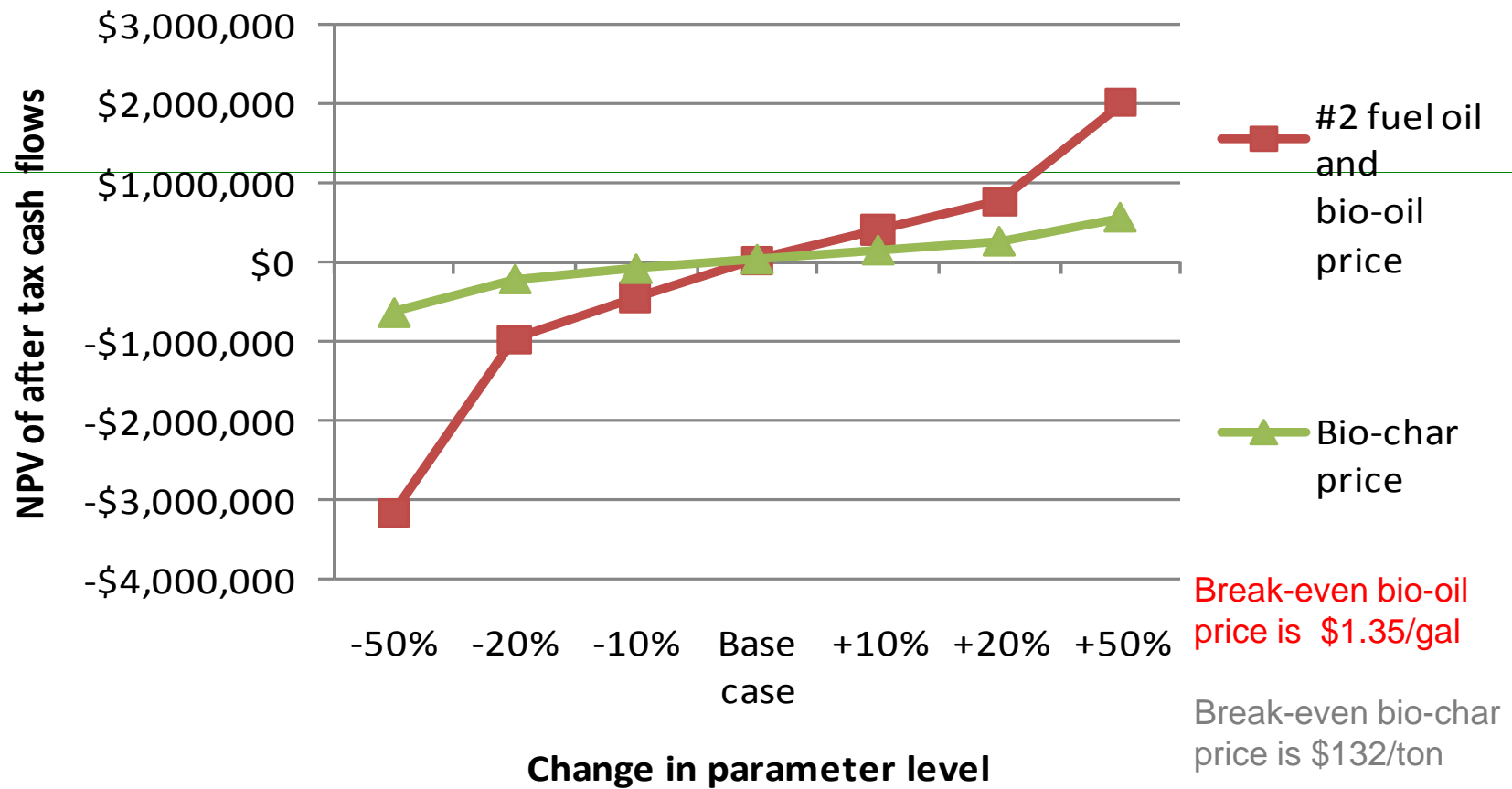


Breakeven labor cost is \$29.84/hr/emp.

Breakeven feedstock cost is \$21.43/BDT

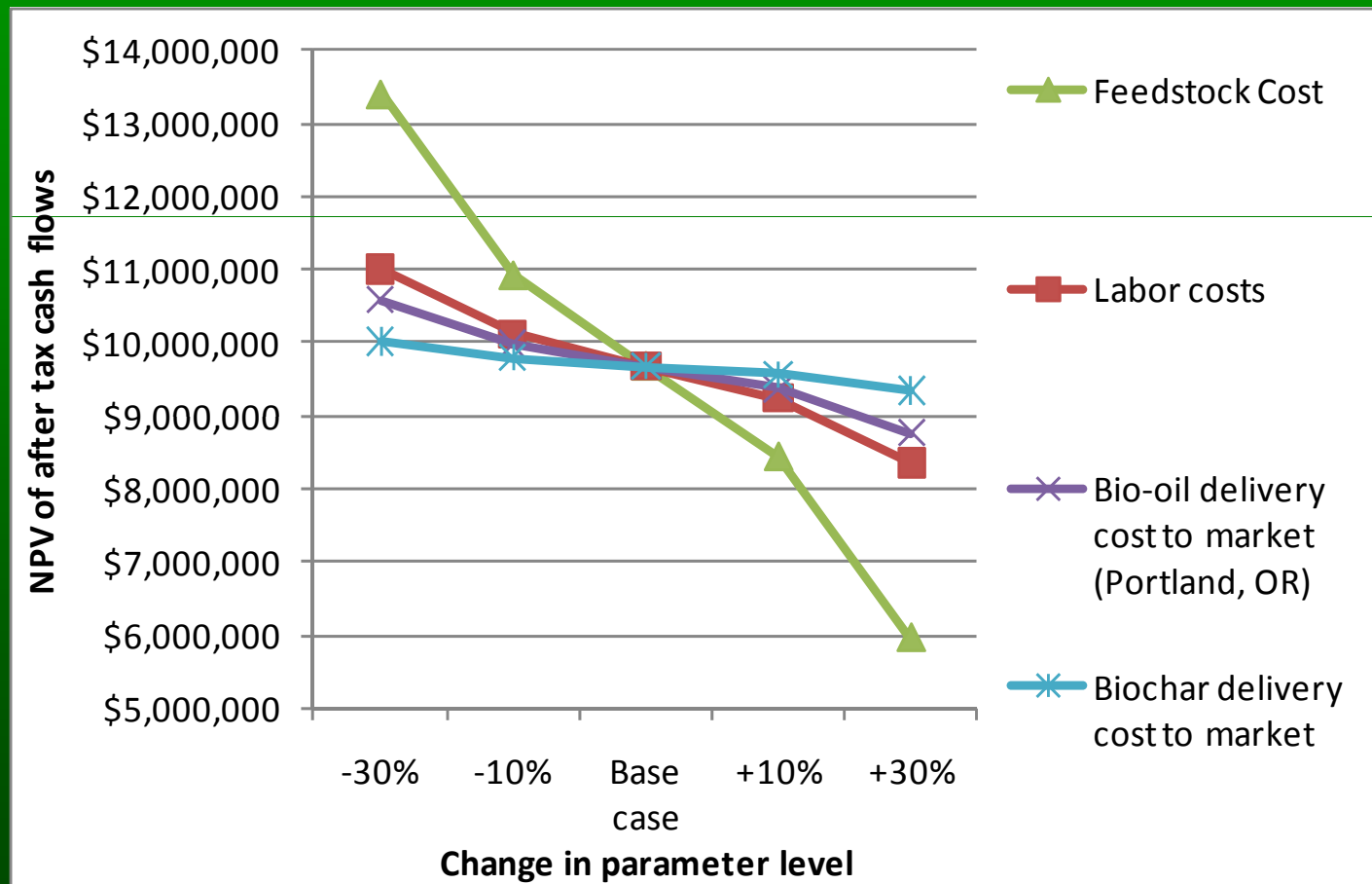
# Financial Performance Sensitivity Analysis

Mobile plant sensitivity to bio-oil and biochar prices



# Financial Performance Sensitivity Analysis

Fixed plant sensitivity to selected variable cost parameters

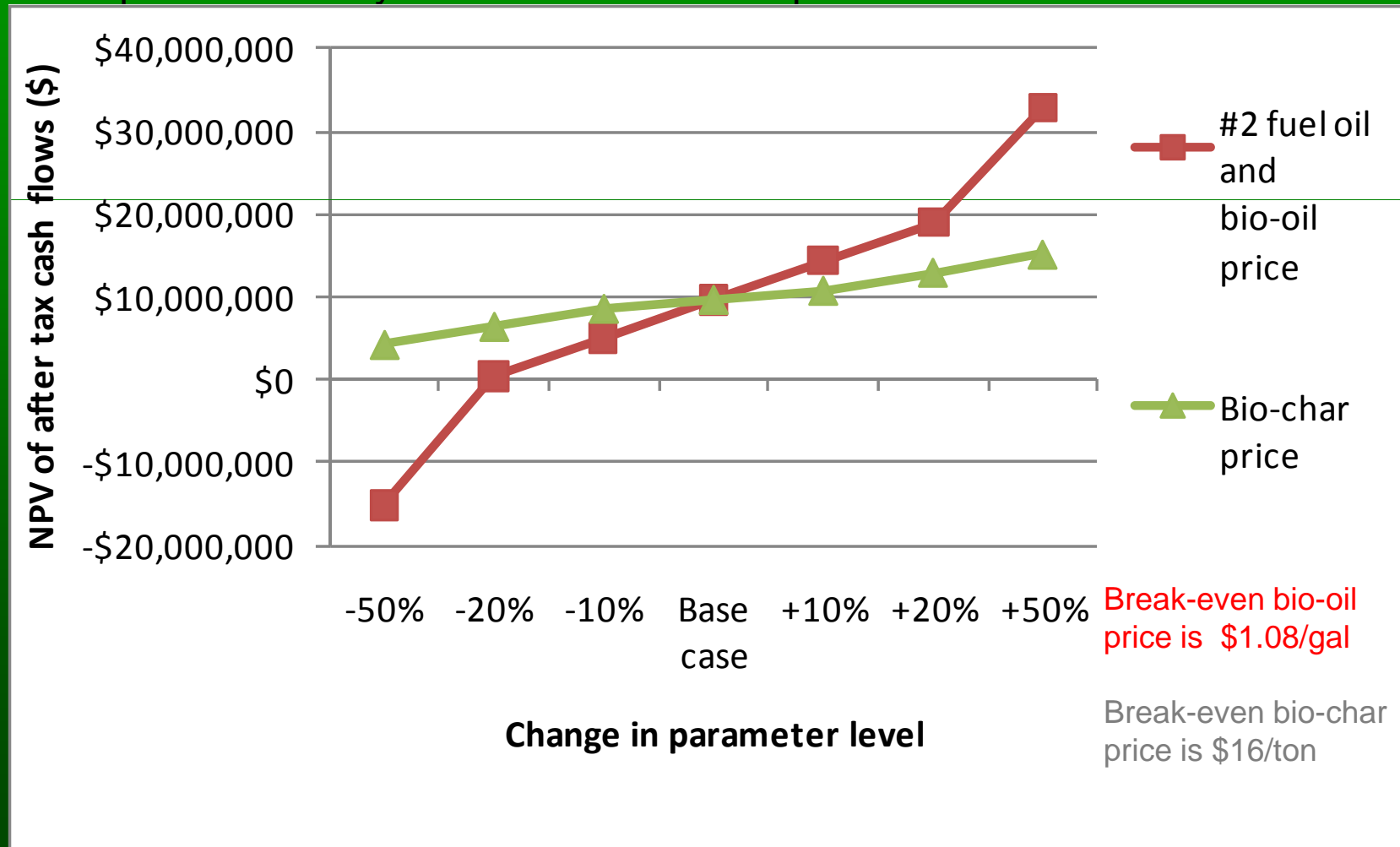


Breakeven labor cost is \$92.93/hr/emp.

Breakeven feedstock cost is \$80.69/BDT

# Financial Performance Sensitivity Analysis

Fixed plant sensitivity to bio-oil and biochar prices





# Additional breakeven levels

	<b>Mobile</b>	<b>Fixed</b>
Scheduled operating days	322	223
Utilization rate (%)	86.8	55.0
Initial capital investment (\$millions)	3.51	47.23

# Conclusions

- Both mobile and fixed pyrolysis can be profitable
- Fixed plant exhibits superior returns under each financial performance measure
- Tradeoffs
  - Mobile plant has lower feedstock cost and ability to operate off-grid
  - Fixed plant exhibits economies of scale, especially with respect to labor costs
  - Both plants depend on developed markets for both bio-oil and biochar to be profitable

# Contact Information

Colin Sorenson

The University of Montana

Bureau of Business and Economic Research

406-243-5113

[colin.sorenson@business.umt.edu](mailto:colin.sorenson@business.umt.edu)

[www.bber.umt.edu](http://www.bber.umt.edu)

