Biomass Research Opportunities and Nutrition Management

Mark Coleman

IFTNC Annual Meeting

5 April 2011

University of Idaho

INTERMOUNTAIN FOREST TREE NUTRITION COOPERATIVE

Interest in bioenergy production

Renewable Fuel Standard

2007 Energy Independence and Security Act (EISA)

Targets 36 billion gallons by 2022 partially through advanced biofuels

Presidents *Blueprint for a Secure Energy Future*

March 30, 2011

"speed the development of 'drop-in' biofuels substitutes for diesel and jet fuel"

2011 Funding opportunities

Forest Service

- Woody Biomass, Bioenergy, and Bioproducts
  - 11 Feb 2011

Agriculture and Food Research Initiative (AFRI)

- Sustainable Bioenergy
- Climate Change

USDA/DOE Biomass R&D Initiative (BRDI)

- Feedstocks development
- Biofuels and biobased products development
- Biofuels development analysis

National funding for silviculture research is rare

- Can funding for bioenergy feedstock production achieve silviculture research objectives?
- How to accomplish forestry research through bioenergy funding calls?

- Dedicated energy production systems are unlikely in mountain west
- Harvest residues:
  - available at roadside
  - Require forest operations research to remove and process

Silviculture research for bioenergy

There is large feedstock supply in young overstocked stands

Hopes and Desires

- Compliment timber operations
  - Pay for intermediate treatments
  - Add value to residual stands
- Increase resistance to wildfire, drought, pests & disease
- Reduce slash, decrease emissions
- Pay for hazard fuel removal
- Pay for pre-commercial thinning

Manager incentives for biomass removal

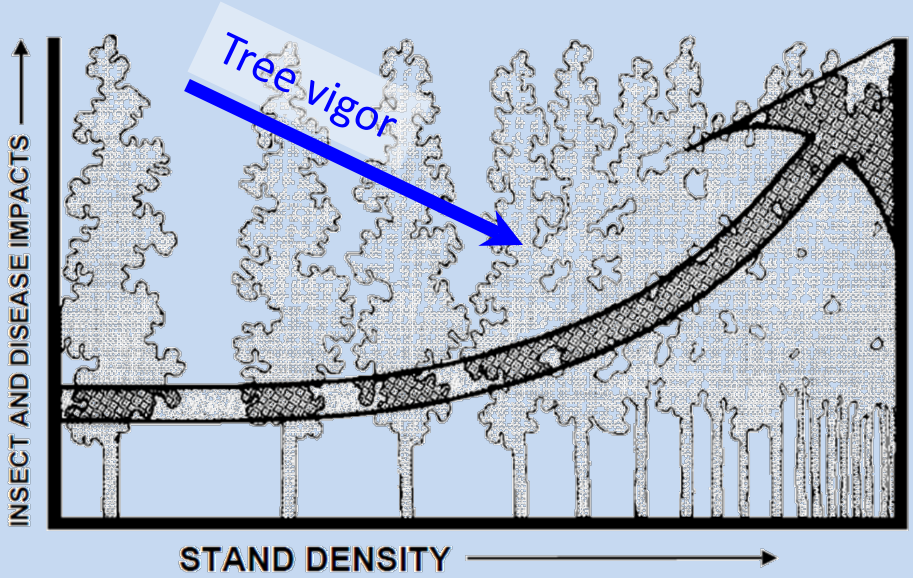
- Forest management
- Air quality management
- Other requirements

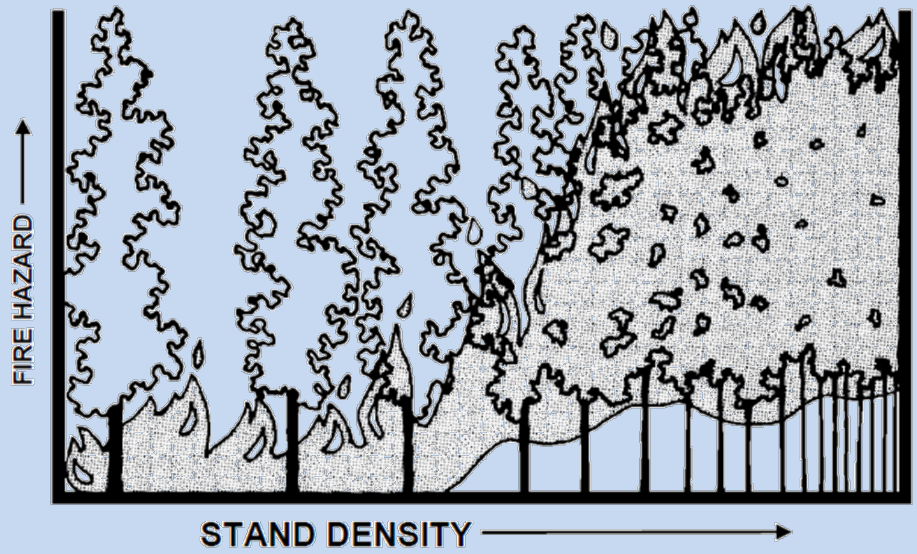
Manager incentives for biomass removal

Forest management

- Decrease fire risk
- Regulations requiring fuels removal
- Improve forest productivity
- Increased pests and disease resistance

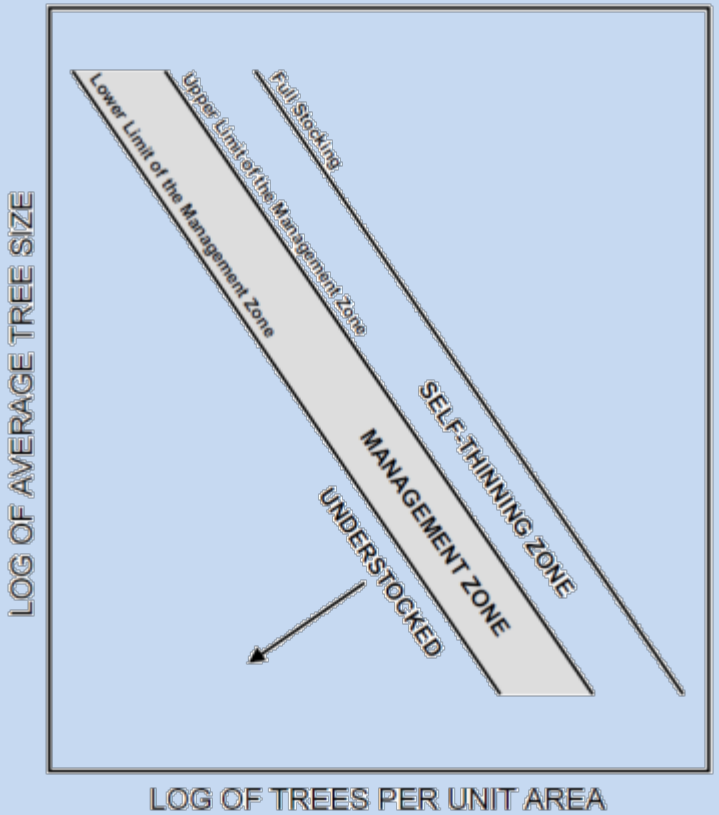
Mortality risk and fire hazard increases with stand density





Powell 1999 Suggested stocking ..

Proper stand management requires density control



Manager incentives for biomass management

Air quality management

- Decreased wildfires reduces emissions
- Burn window restrictions
- Agricultural burn bans extended to forestry
- Increased PM 2.5 monitoring?
- Carbon trading and reduced carbon dioxide emissions?

Harvest residue results from timber production

In 1997
Gan & Smith 2006

	Growing stock Recoverable	Growing stock and other sources Recoverable
	-------1000 dry ton	--------
Idaho	190	637
Montana	132	441
Intermountain	372	1251
Alaska	349	614
Oregon	346	705
Washington	345	699
PNW	692	1403

190,000 dry tons

- 19 MW power
- 0.4 million barrels of bio-oil

Imnt & PNW

- 70 MW
- 1.4 million barrels of bio-oil

There is 130 million acres of timberland in western US

USDA Forest Service 2005

	Land area (million acres)			Treatment opportunities (million acres)		
State	Total	Forestland	Timberland	Timberland	Class 2 + 3	Class 3
ID	53	21.6	16.8	12.1	8	3.3
MT	93.2	23.3	19.2	14.3	9.5	3.7
OR	61.4	29.7	23.8	16.9	12.2	5.6
WA	42.6	21.8	17.3	12.4	8.5	2.5
			77.1			15.1

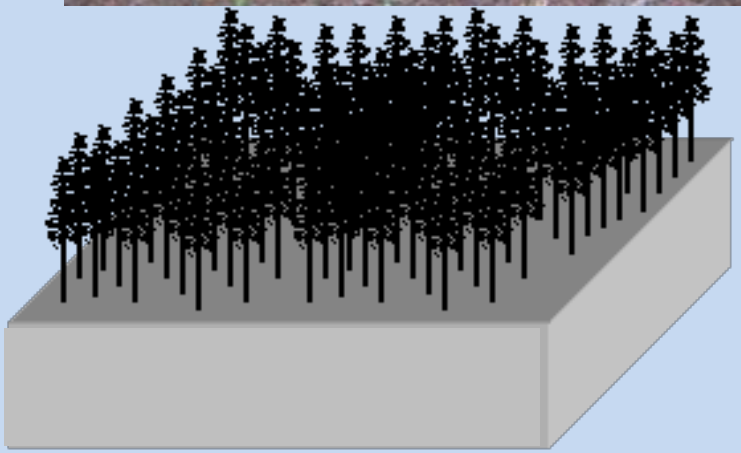
- 2/3 of timberland is in four neighboring states
- A fifth of that could be treated
- The 3.3 million acres in ID contains 80 million tons of biomass (8000 MW power, or 160 million barrels of bio-oil)
- The 15 million acres in four states contains 300 million tons (30 GW power, or 600 million barrels of bio-oil)

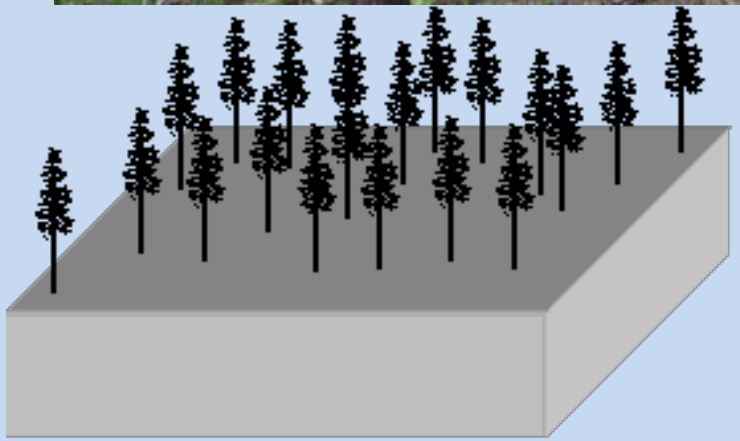
Sustainable Woody Biomass Production Systems

might involve:

Utilization of thinned material and

Enhancement of residual stand vigor





Biomass removal in the inland NW

What are the critical questions regarding biomass removal?

- Maintaining long-term productivity
- Growth and yield of residual stands
- Others?





Questions of maintaining long-term productivity

- Do carbon and nutrient removals degrade site quality?
- Can amendments mitigate impacts?
  - fertilizer, biochar
- Are thinning and biomass removal better tests of site vulnerability?
  - Stage of greatest nutrient demand
  - Short-term monitoring of retained forest
- How sensitive are low quality vs. high-quality sites?
- Will seasoning of slash mitigate impacts of slash removal?

Questions of growth and yield for residual stands

- What's the best timing for stand treatments?
- What are can be done to enhance residual stand productivity, resilience and timber value?
- Will fertilizer, herbicide, N-fixing understory improve thinning response?
- What are the economics of stand enhancement?
  - Will biomass removal to bioenergy pays for thinning or realizes profit?
  - Will residual stand reach harvest sooner and at higher value?

Proposed forest biomass and nutrition project to test for impacts and mitigating factors

100% FS	75% FS Remove	75% FS Retain	50% FS Remove	50% FS Retain
Low Ntrts	Low Ntrts	Low Ntrts	Low Ntrts	Low Ntrts
Fertilize	Fertilize	Fertilize	Fertilize	Fertilize
Fertilize & Veg Control	Fertilize & Veg Control	Fertilize & Veg Control	Fertilize & Veg Control	Fertilize & Veg Control

One of two replicate blocks

Two locations at two age class

15 yr	20 yr
15 yr	20 yr

Other factors:
Site quality
Seasoned slash

75% FS bio char	50% FS bio char
Low Ntrts	Low Ntrts
Fertilize	Fertilize
Fertilize & Veg Control	Fertilize & Veg Control

Additional plots @ select locations

30 -40 acre sites
3-5 acre thinning units
PCT units w/ & w/o biomass removal

Integrated bioenergy production system

- Forestry feedstocks as a component
- Forwarding operations
- Chipping and transport
- Mobile fast pyrolysis conversion to biofuel
- Rural refinery concept
- Modified petroleum refinery
- Life cycle analysis

ABRI 50 ton/day mobile fast pyrolysis unit

Forwarding operations

- Radio-controlled Forest Crawler I & II small
  - shear for felling (Crawler II)
  - grapple for skidding (Crawler I)
- Forwarding via All Season Vehicle with radio controlled Winch ASV RC-30
- PTO-driven tracked conveyor
- Grapple loader into Valmet tractor-drawn forwarder trailer.

Chipping and transport

- Rotochopper one-pass precision grinder
  - 1/8th diameter fibers
- Advanced Trailer agricultural drying van
  - Drying, transport and storage
  - Sized for forestry operations

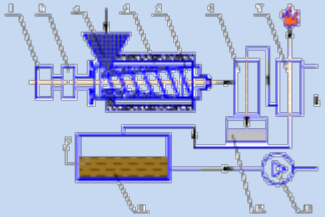
Rotochopper

Advanced Trailer

Mobile fast pyrolysis conversion to biofuel and biochar products

- **Small scale units**
  - In woods processing
  - Avoid long-haul biomass transport costs
- **Produces bio-oil**
  - substitutes for fuel oil
  - refined to high-value products
- **Bio-char byproduct**

Portable conversion technology

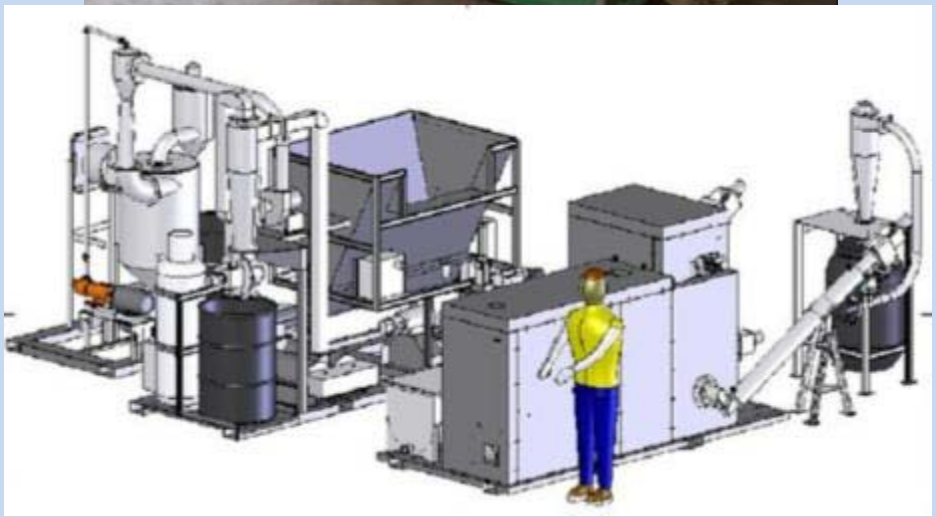


In-woods products

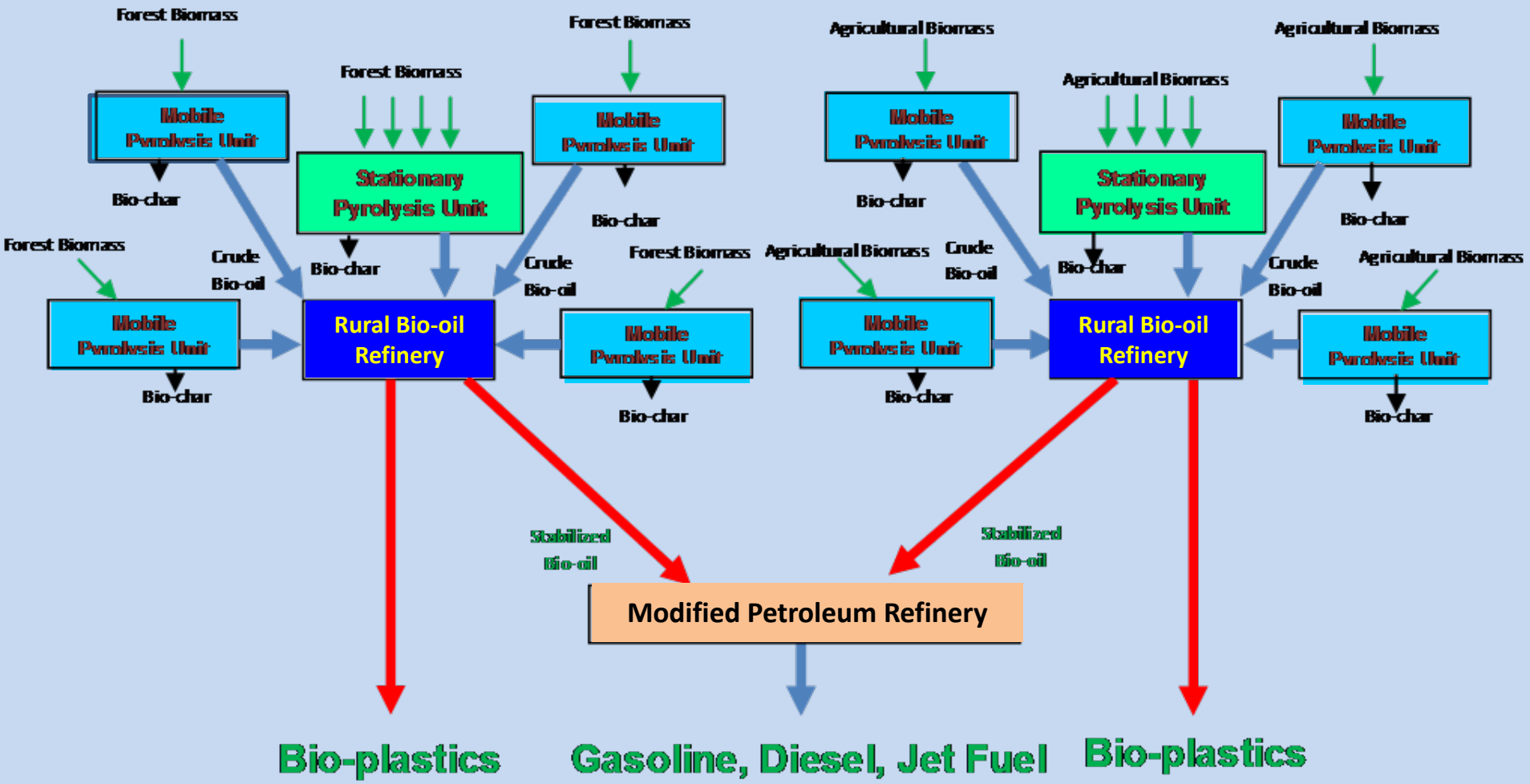
Bio-oil 60%

University of Idaho's Pilot pyrolysis unit

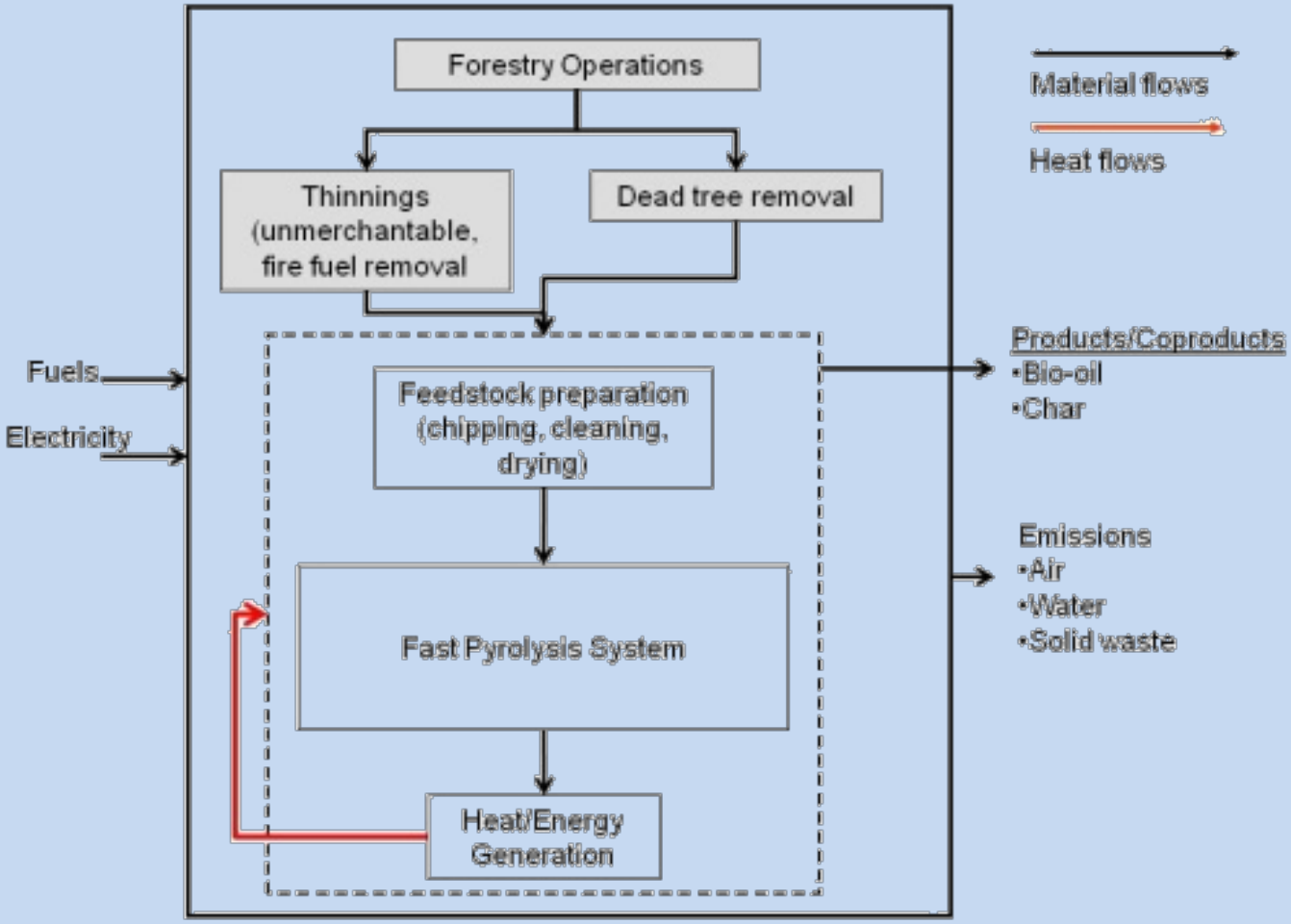
- ABRI half-ton pyrolysis unit
- Installed on a trailer as a mobile unit
- Determine mass & energy
- Prepare products from various feedstocks for analysis
- Produce biochar for field tests



Mobile pyrolysis rural refinery concept



Cradle to gate system boundary for bio-oil and bio-char production



Conclusions

- Abundant bioenergy research opportunities
- Largest potential feedstock is thinning young overstocked stands
- Develop new products with potential to pay for intermediate treatments
- Improve silviculture operations and expand management options
- Assure soil and sites are not degraded, investigate mitigation and improvement strategies
- Develop cost-effective methods for biomass extraction
- Forestry feedstocks must be integrated into a complete energy production system

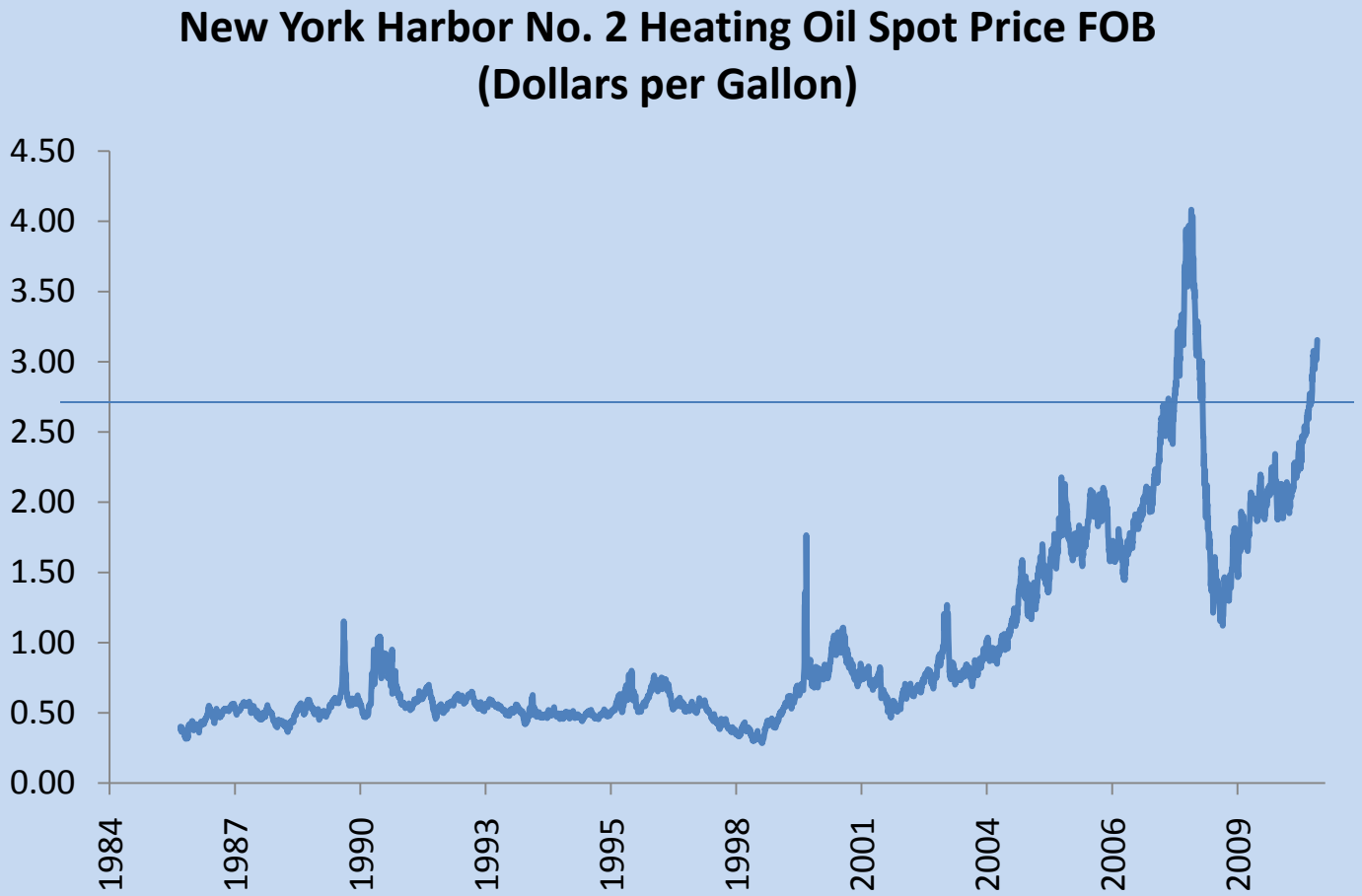
Financial Performance

Assumptions

- Unit will process 21.9 BDTPD (7127 BDTPY)
- Unit costs $3.46 million and has useful life of 10 years
- 60% capital borrowed @ 9% for 7 years
- Unit operated by two shifts of 3 on-site employees
- Output (% input weight): 57% bio-oil; 27% bio-char; 1% tar; 15% syngas
- 7% net of inflation discount rate

After tax returns (Federal and Oregon)

Prices			After tax returns		
#2 fuel oil ($/gal)	Bio-oil ($/gal)	Bio-char ($/ton)	NPV ($1000s)	Average annual cash flow ($1000s)	Pay-back period (years)
1.55	0.80	136	-2506	-261	>10
2.63	1.36	136	36	91	9
4.02	2.08	136	2146	392	4
2.63	1.36	200	526	160	8


New York Harbor No. 2 Heating Oil Spot Price FOB
(Dollars per Gallon)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
1984
1987
1990
1993
1995
1998
2001
2004
2006
2009