Biochar Production, Economics and Policy Implications for the Forest Sector

Harvesting woody biomass in Idaho to fuel cogeneration of heat and power.

Tucker RNG biomass gasification system developed in partnership with USFS.

Chips and biochar produced from biomass harvested from White River National Forest.

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FCWG Knowledge Transfer: Biochar
January 12, 2021

Photos: Anderson

What’s ahead?

- Background
  - Biochar systems
  - Bioproducts supply chains
  - Focus on forest biomass
- Economics
  - Investment risk
  - De-risking biochar ventures
- Policy connections
- Take home messages
- Discussion

A commercial biochar operation co-located with a sawmill in Colorado.

Photos: Anderson

Acknowledgements

- USDA National Institute of Food and Agriculture (NIFA)
  - RMRS-BRDI (2011-10006-30357)
  - BANR (2013-68005-21298)
  - UM-BRDI (2016-10008-25636)
  - MASBio (2020-68012-31881)
- USDA Forest Service
- University partners, faculty, staff, postdocs and graduate students
- Industry and NGO partners

Photos: Anderson; J.Field/BANR (center)

Biochar Systems

- Soil benefits
- Waste management
- Renewable energy
- Carbon sequestration

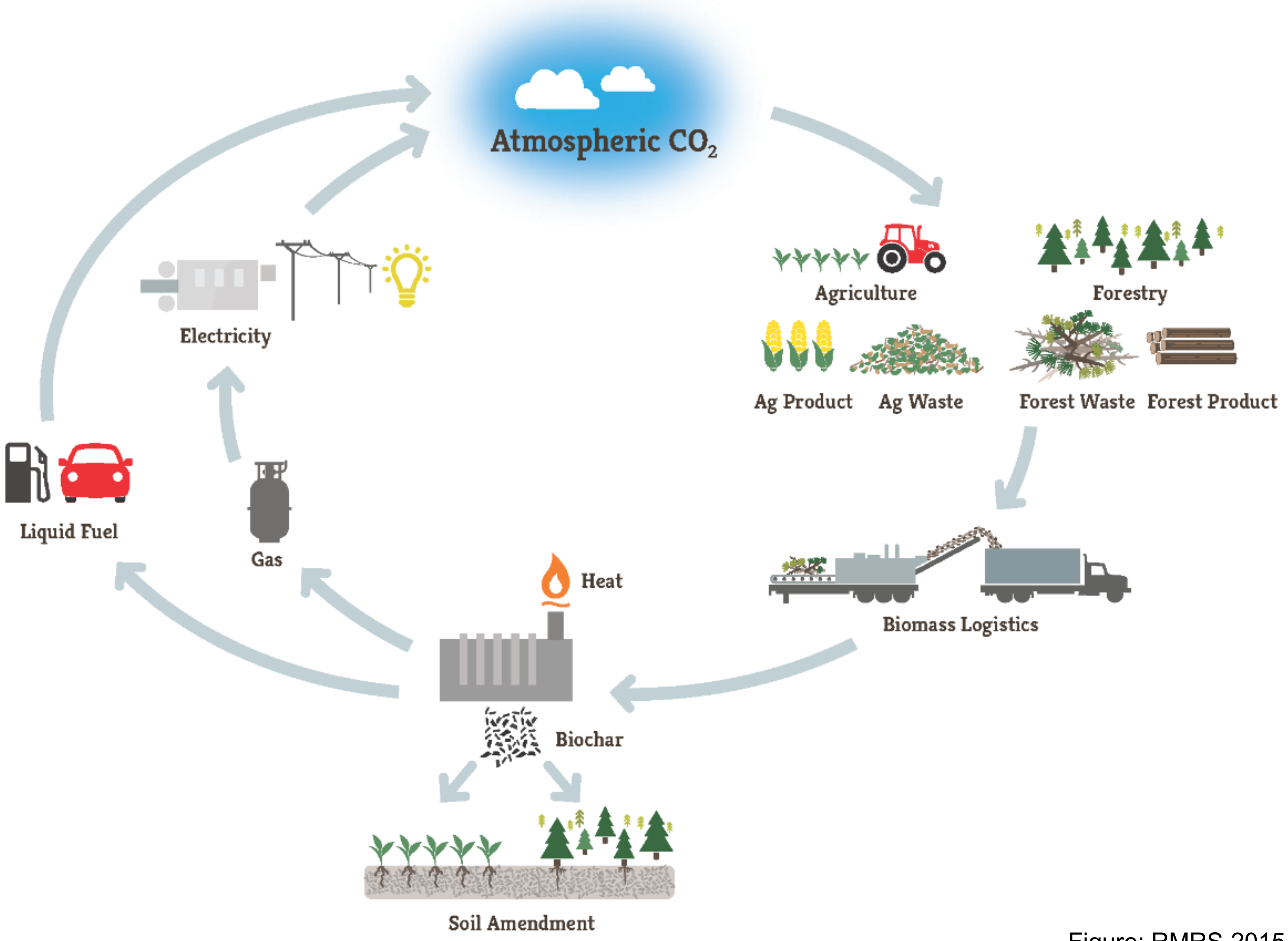
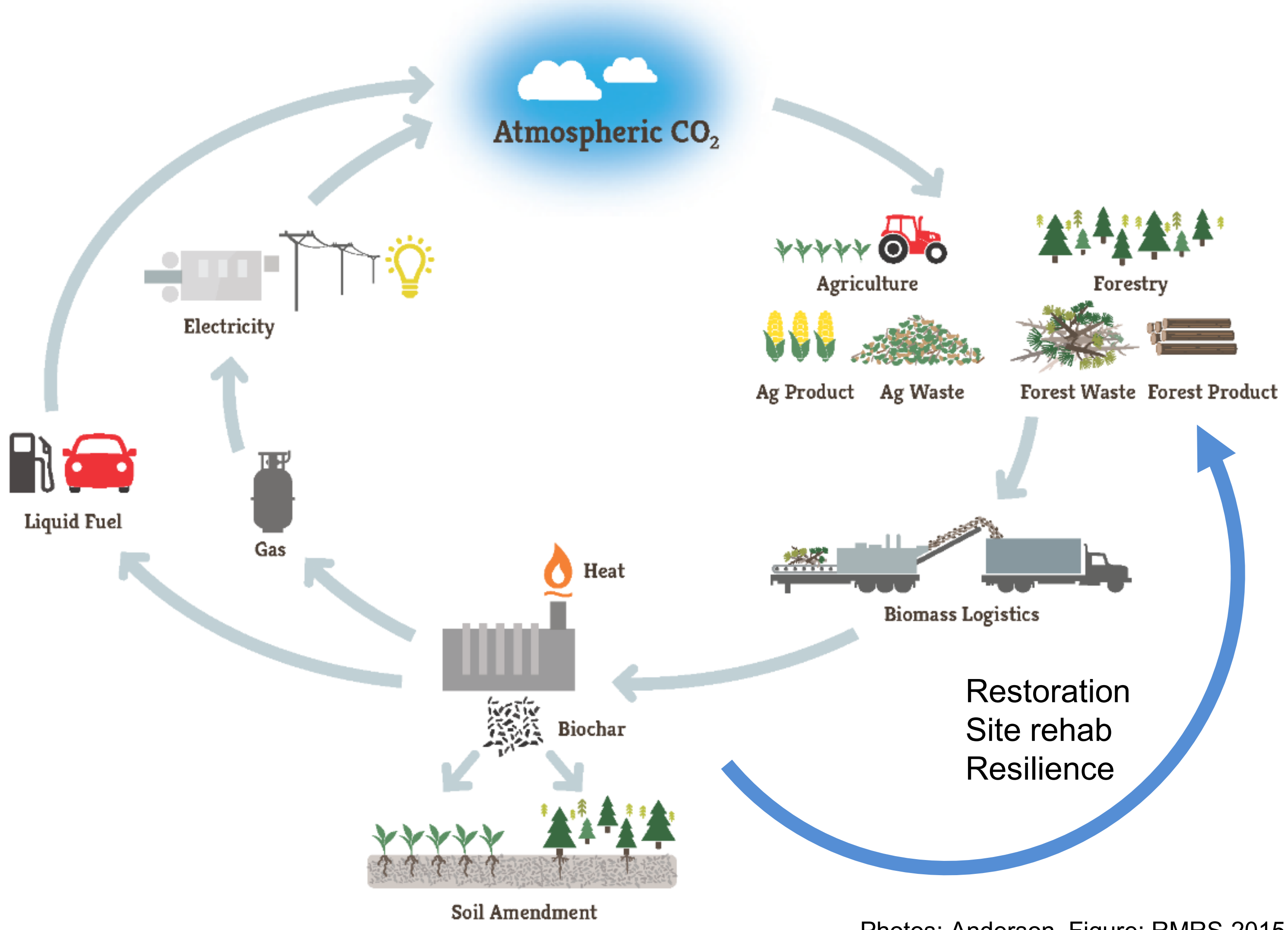


Figure: RMRS 2015

Biochar Systems

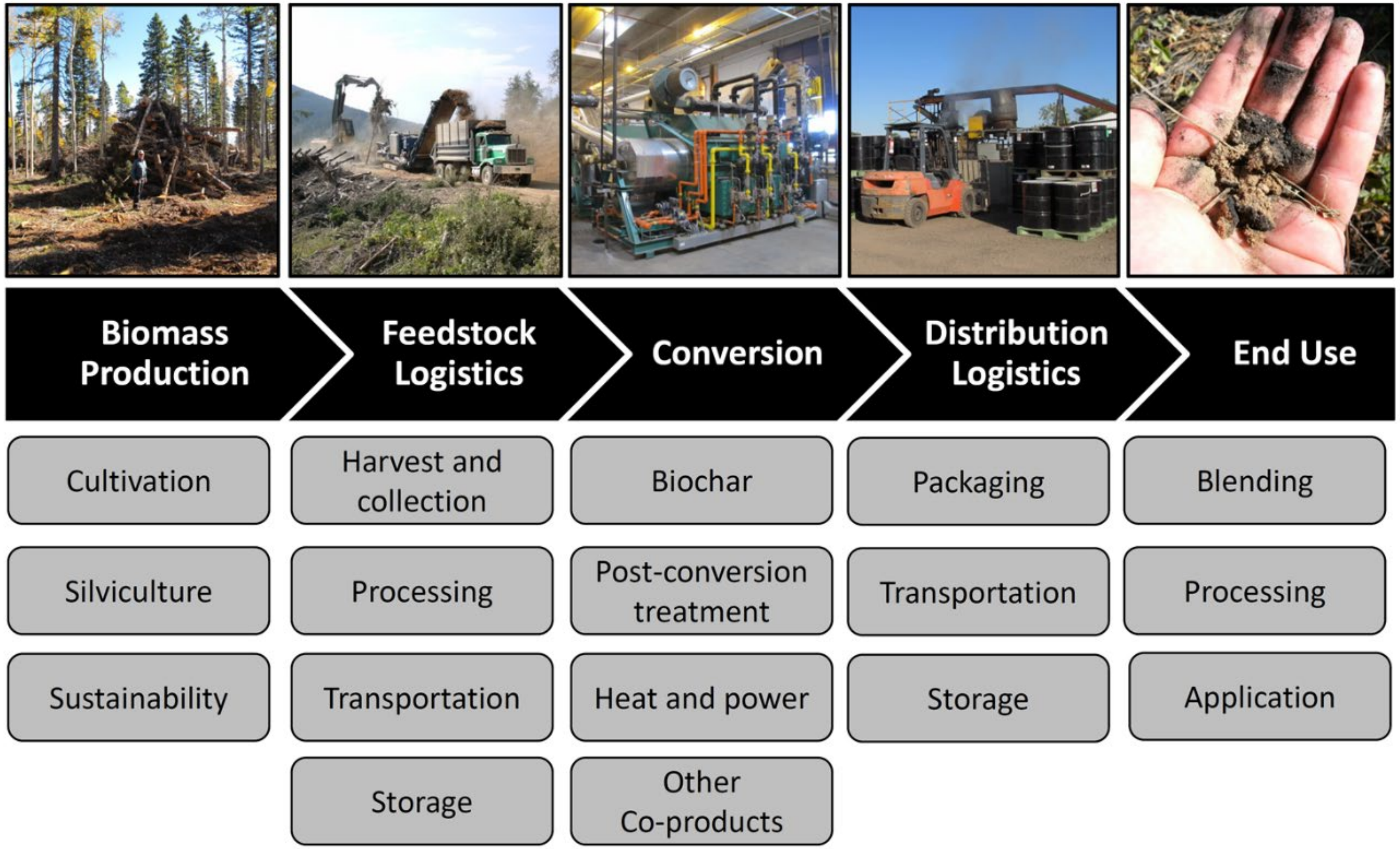
Forests providing sustainable biomass for biochar production and biochar providing rehabilitation and restoration benefits on National Forests.



Photos: Anderson. Figure: RMRS 2015

The Bioproducts Supply Chain

- Bioproducts supply chain
  - Production
  - Feedstock logistics
  - Conversion
  - Distribution logistics
  - End use
- Flows of:
  - Material & carbon
  - Capital ($)
  - Information



Anderson et al. 2017. Chapter 2 in *Biochar: A Regional Supply Chain Approach in View of Climate Change Mitigation*, Cambridge University Press. (Photos: Anderson)

Competitive Advantages of Forest Biomass


Logging residues


Aspen logs


Mill residues


Fuel Treatment


Beetle kill salvage


Mill residues


Fuel Treatment

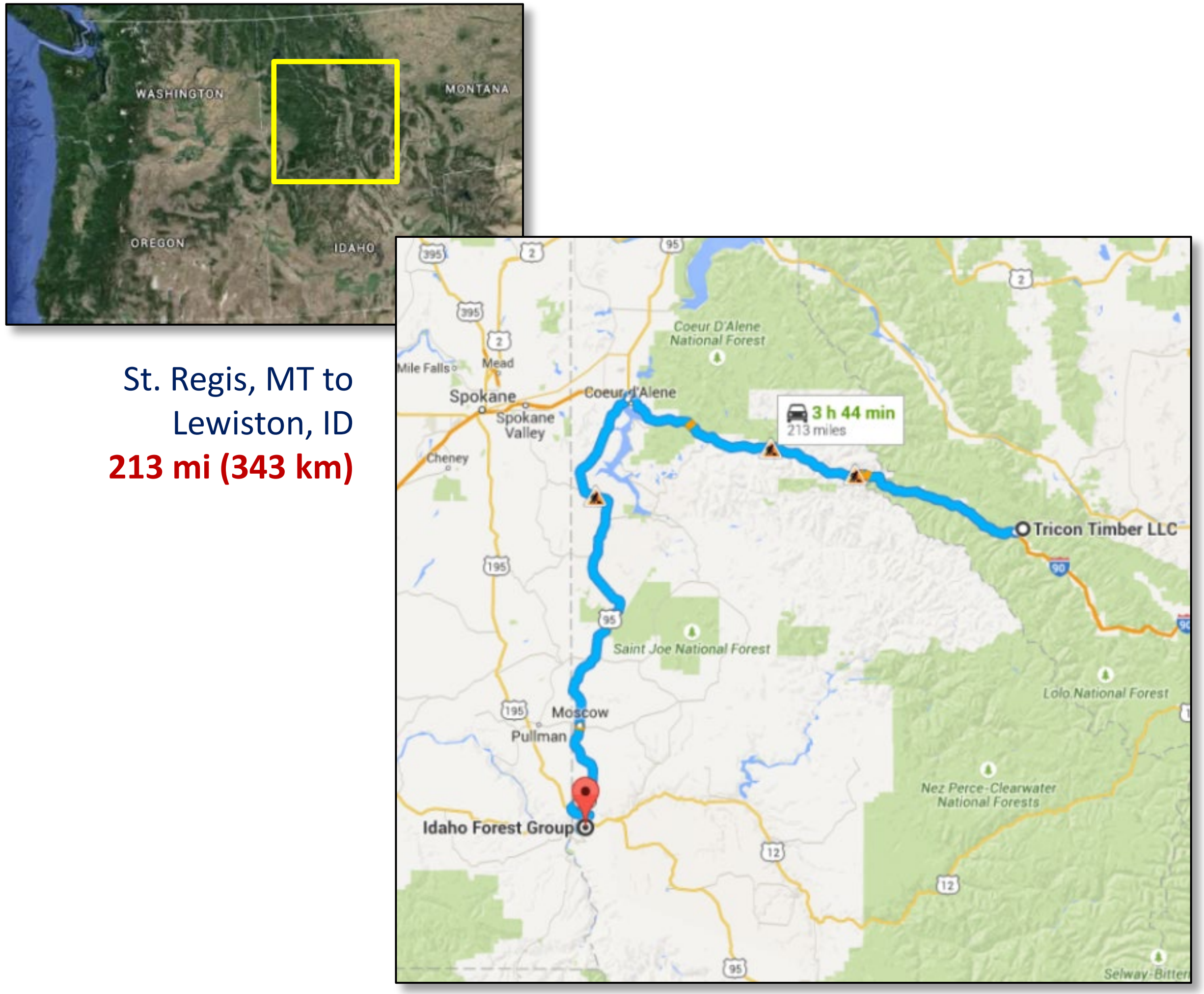

Hardwood cull


Hogged slash

- Large volumes as waste or byproduct
- Options for material quality and cost
- Low, zero or negative stumpage cost
- Co-location with existing industry
- Generally good carbon balance and sustainability, depending on land use
- Tied to non-market benefits like:
  - Forest restoration and forest health
  - Reduced wildfire and smoke risk
  - Diverse ecosystem services including carbon sequestration, recreation, water, biodiversity and others

Photos: Anderson and Loeffler (bottom left)

Competitive Disadvantages of Forest Biomass



St. Regis, MT to
Lewiston, ID
213 mi (343 km)

Images: Google Maps

- Difficult terrain with dispersed access
- Long transportation distances
- Costly logistics
- Heterogeneous feedstock characteristics
- Spotty, episodic salvage availability
- Tied to timber and land management goals
- Seasonality and storage challenges

Expand Markets for Forest Biomass with New Enterprises

Biomass Power

Photo: Dodson

Sawmill w/Cogen

Biochar only

Photo: Pacific Biochar

Biofuel with biochar

Photo: CPES

Heat & Power Cogen

Photo: CPR News

Pellet Mill

Co-located biochar

Post & Pole

Institutional Heat

Photo: Campbell

Pellet Mill w/biochar

Biopower w/biochar

Commercial firewood

Photo: SCNF

Photos: Anderson except where noted.

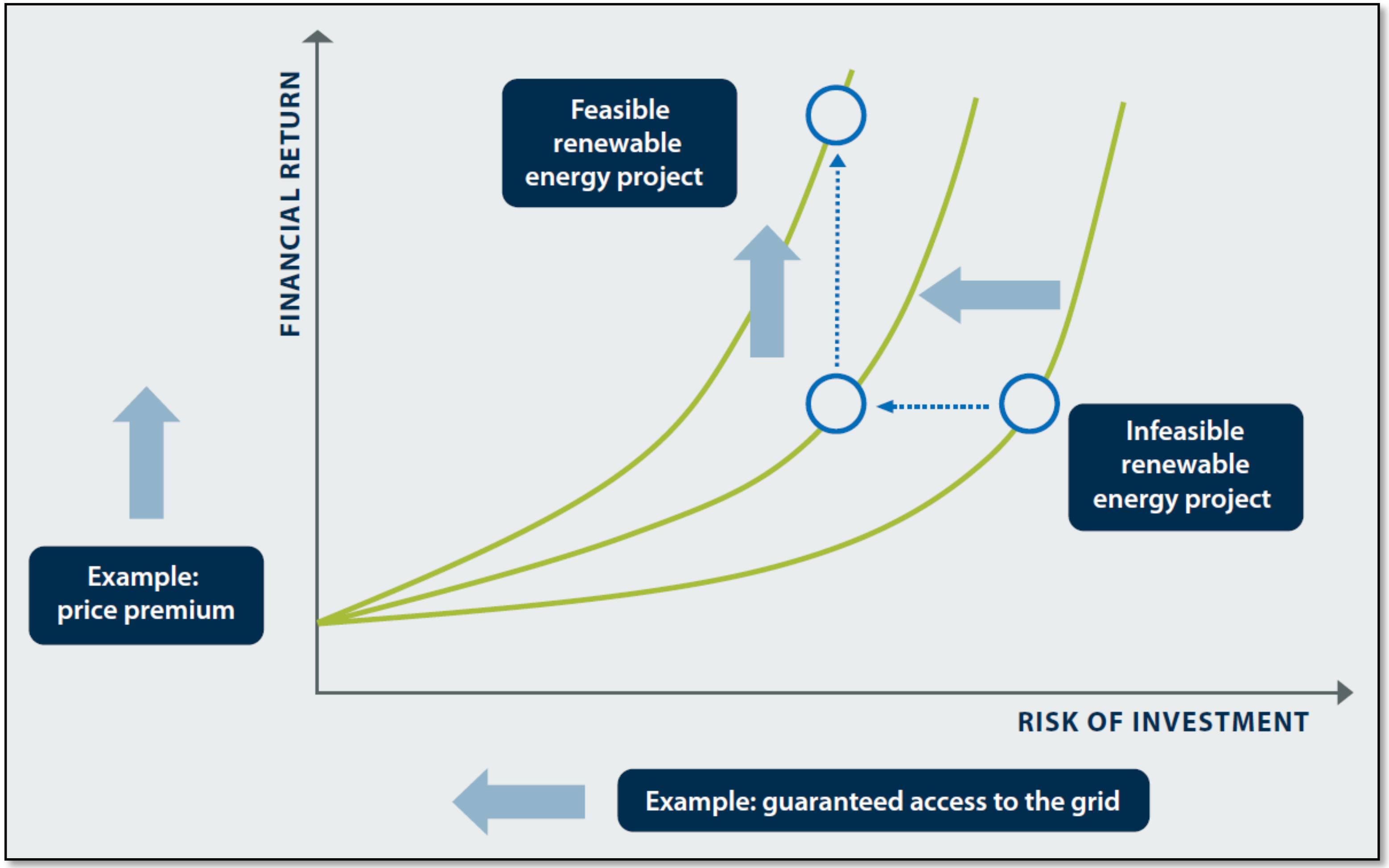
Drivers and Barriers to Success

Critical Factor	Considerations
Integration	Integration within and across sectors (e.g., forestry, agriculture, energy) Horizontal integration with other forest industry and manufacturing Vertical integration along the supply chain
Scale	Economies of scale in production; benefits of clustering Appropriate scale for feedstock supply and markets
Competition	Barriers to entry; Substitutability, price competitiveness, return on investment; Pressure to innovate, lower costs, increase productivity, improve quality
Public policy	Policies that favor or disfavor bioenergy and bioproducts Regulations, R&D funding, subsidies, taxes, information, carbon price Trade organizations, lobbying
Local policy and support	Local project support, public acceptance Knowledge and awareness about bioenergy and bioproducts

Adapted from Roos, A., et al. 1999. Critical factors to bioenergy implementation. Biomass and Bioenergy 17: 113-126.

De-risking Investment

- Increase financial returns on investment
- Reduce risk
  - Uncertainty
  - Stochastic outcomes
  - Impact

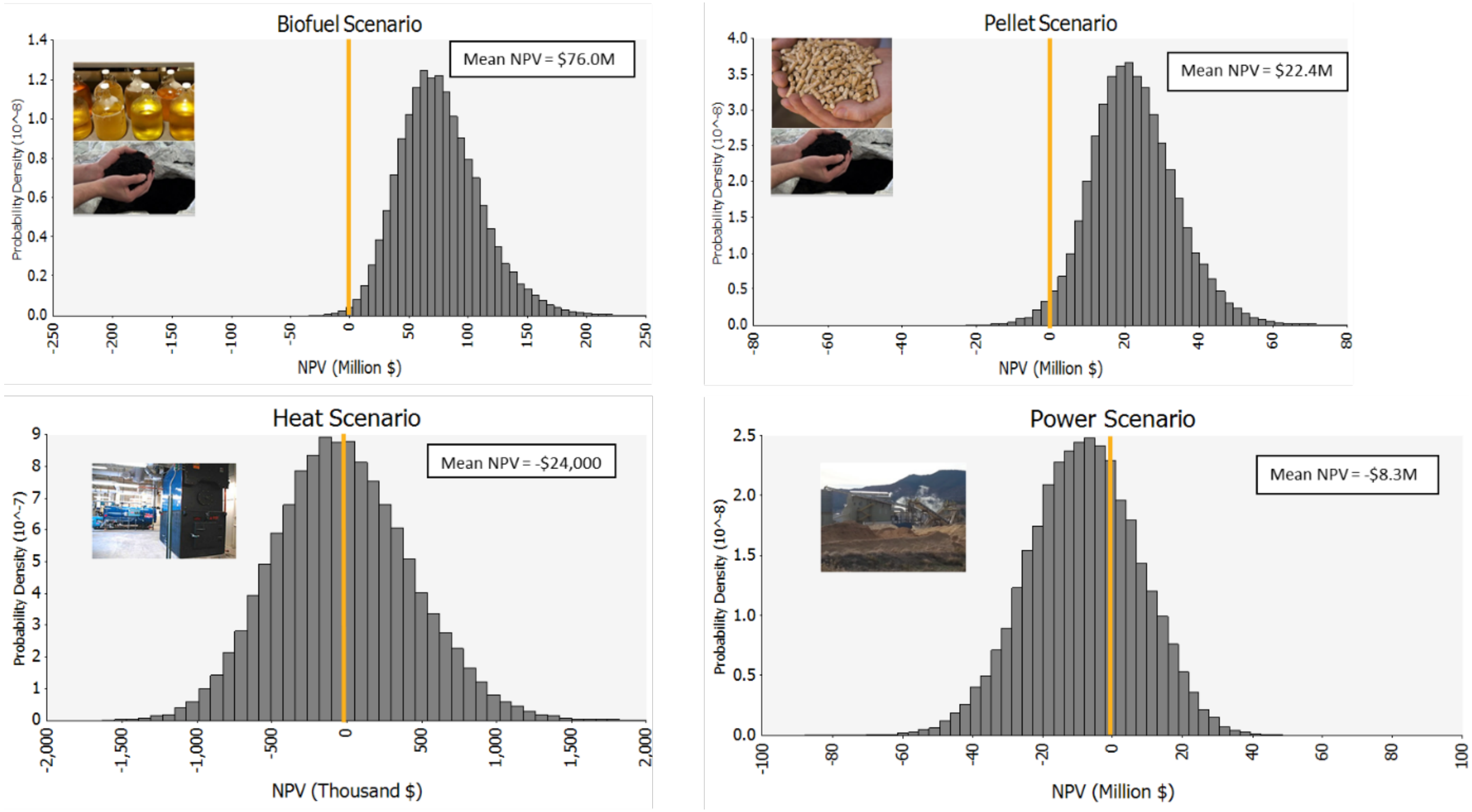


Shifting the reward-risk profile of project investment.

Waissbein, O., et al. 2013. Derisking Renewable Energy Investment. New York: UNDP and Glemarec, Y. 2011. Catalysing Climate Finance. New York: UNDP.

Technoeconomic Analysis

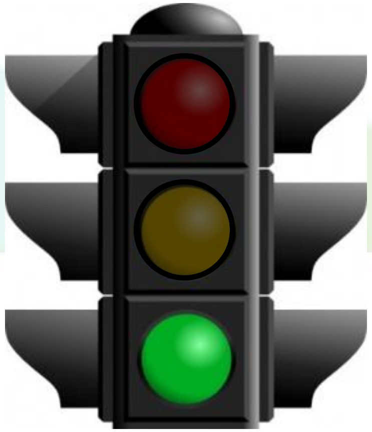
- Combine:
  - Engineering specs
  - Benefit-cost analysis
- Compare:
  - Project options
  - Technologies
  - Business conditions
  - Assumptions
  - Other variables



NPV distributions over a 20-year project period based on simulations for four project scenarios

Campbell, R.; Anderson, N.; Daugaard, D.; Naughton, H. 2018. Technoeconomic and Policy Drivers of Project Performance for Bioenergy Alternatives Using Biomass from Beetle-Killed Trees. Energies 11: 293-313.

Biochar Investment Risk



Likely Profitability

- ✓ Waste feedstock (i.e., “tipping fee”)
- ✓ Proven mature technology (“nth plant”)
- ✓ Multi-product supply chain
  - – Co-products, heat and power
  - – Value added products (e.g., sorbents, etc.)
- ✓ Monetized non-market benefits
  - – Carbon credits, tax incentives, etc.
- ✓ Price covers production cost and profit
- ✓ Offtake agreements or supply contracts

From top left: dry microchips, pulp chips, raw biochar, biochar pellets, activated carbon from biochar, and wood pellets.

Photo: Anderson

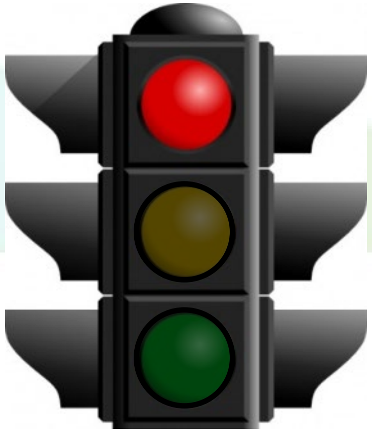
Biochar Investment Risk

<u>Potential Profitability</u>

- ✓ “Free” or low-cost feedstock
- ✓ New but tested technology (alpha unit)
- ✓ Primary products with process heat or power
- ✓ Non-market benefits as a marketing asset
  - Carbon sequestration, renewables, etc.
- ✓ Price uncertain, but based on evidence
- ✓ Spot-market transactions with repeat customers

Biochar packaged & ready for shipping.

Biochar Investment Risk



<u>Unlikely Profitability</u>

X Costly feedstock

X Unproven technology (prototype or pilot)

X Single low-value product

X Uncertain non-market benefits

X Unknown current and future prices

X Fuzzy competitive markets

X High risk investment

Emissions problems with a mobile pyrolysis unit processing wood waste.

Other Factors

- Scale (feedstock, production, markets)
- High or low capital expenditure (CAPEX)
- High or low operating expenses (OPEX)
- Mobile, modular or centralized
- Simple or complex conversion technology
- Low price or high price for outputs
- Benefits that accrue to the customer

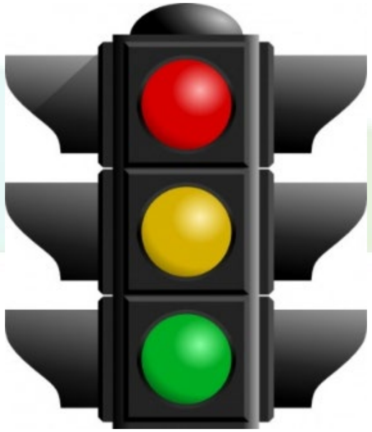
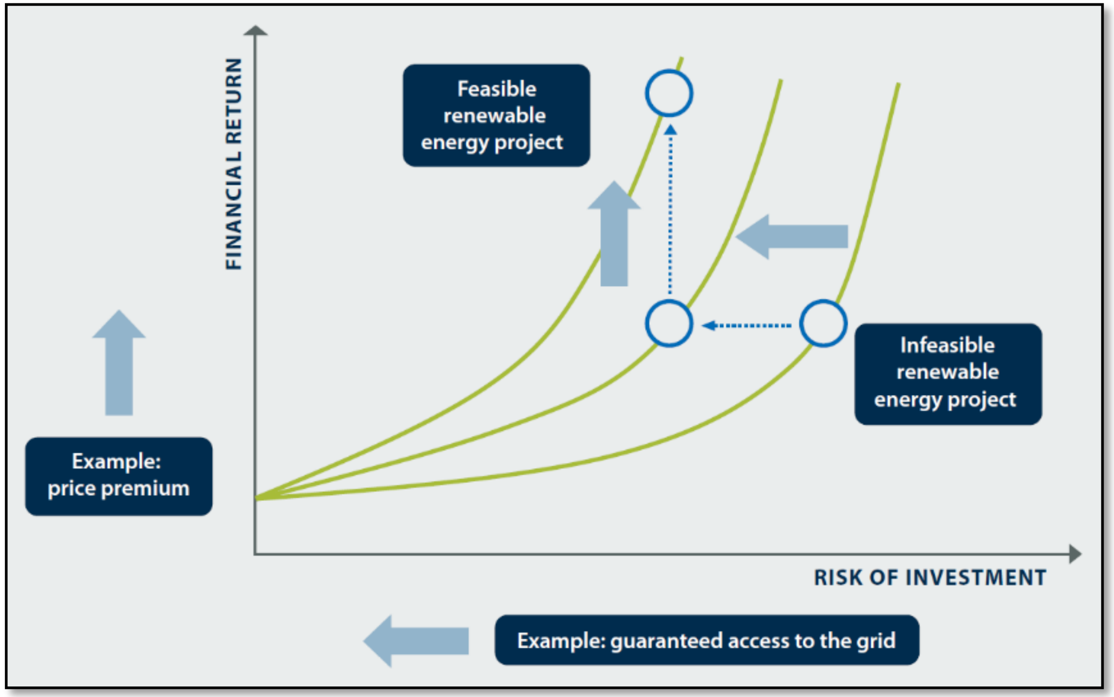


Photo: Pacific Biochar

Photos: Pacific Biochar; Anderson; Anderson

Policy Connections



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Transfer investment risks to public actors to incentivize public benefits:

- Direct incentives: premiums, subsidies, tax credits, carbon offsets, etc.
- Grants, loan guarantees, public-private co-investment, partnerships
- Feed-in tariffs, supply and offtake agreements
- Payments for ecosystem services (PES), political risk insurance (PRI), etc.
- Research, development and Extension

Campbell, R.; Anderson, N.; Daugaard, D.; Naughton, H. 2018. Financial viability of biofuel and biochar production from forest biomass in the face of market price volatility and uncertainty. Applied Energy 230, pp.330-343.

Take Home Messages

- There are opportunities for biochar production and use in the forest sector
- There are risks associated with investment
- We can de-risk bioproducts supply chains
- Research and decision tools can help

The Tucker RNG System

Biochar water quench.

Biochar from southern yellow pine.

Photos: Anderson

For More Information

Anderson, N.; Bergman, R.; Page-Dumroese, D. 2017. A supply chain approach to biochar systems. Chapter 2 in: *Biochar: A Regional Supply Chain Approach in View of Climate Change Mitigation.* Cambridge, UK: Cambridge University Press. p. 25-45.

Campbell, R.; Anderson, N. 2019. Comprehensive economic evaluation of woody biomass energy from silvicultural fuel treatments. *Journal of Environmental Management* 250: 109422, 12 pp.

Campbell, R.; Anderson, N.; Daugaard, D.; Naughton, H. 2018. Technoeconomic and policy drivers of project performance for bioenergy alternatives using biomass from beetle-killed trees. *Energies* 11(2): 293, 20 pp.

Campbell, R.; Anderson, N.; Daugaard, D.; Naughton, H. 2018. Financial viability of biofuel and biochar production from forest biomass in the face of market price volatility and uncertainty. *Applied Energy* 230, pp. 330-343.

Kim, D.; Anderson, N.; Chung, W. 2015. Financial performance of a mobile pyrolysis system used to produce biochar from sawmill residues. *Forest Products Journal* 65(5/6): 189-197.

Contact Information

Thanks!

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Photo: W. Chung