Supply Chain Management of Multiple Biomass Utilization for Bioenergy and Bioproducts

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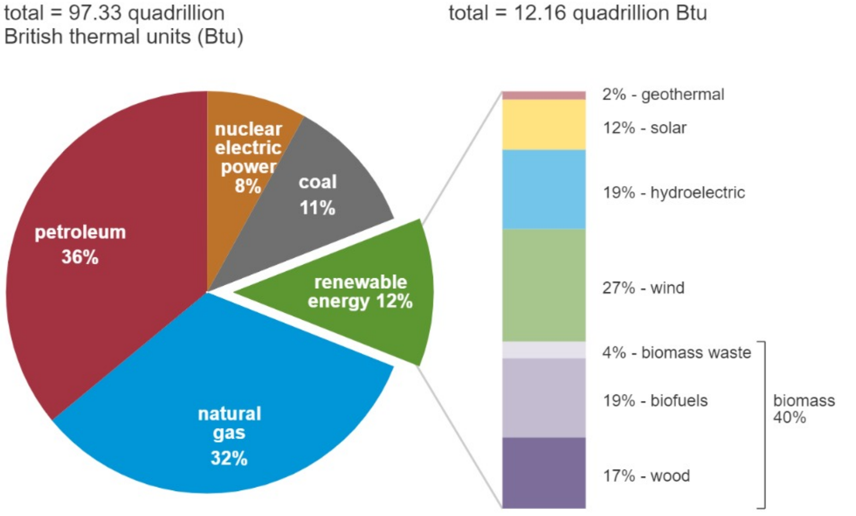
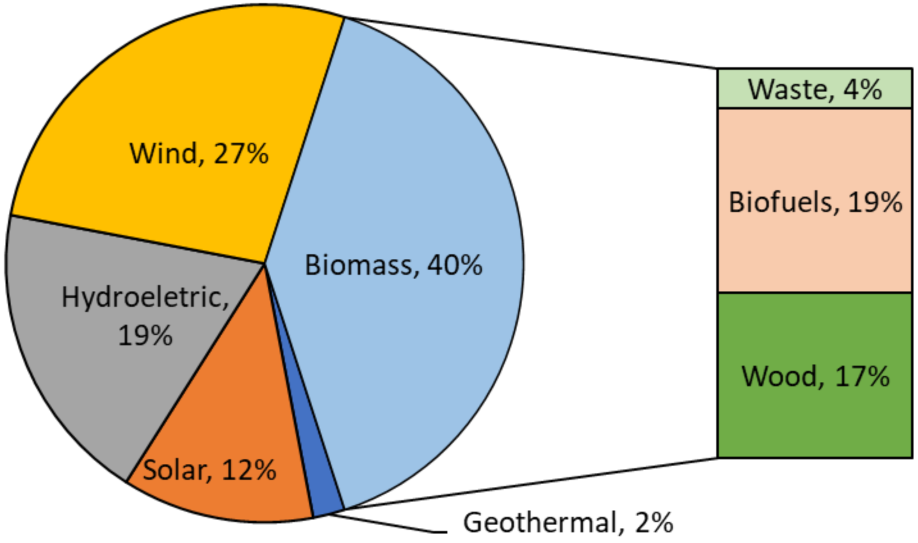
Biomass Energy in the U.S.

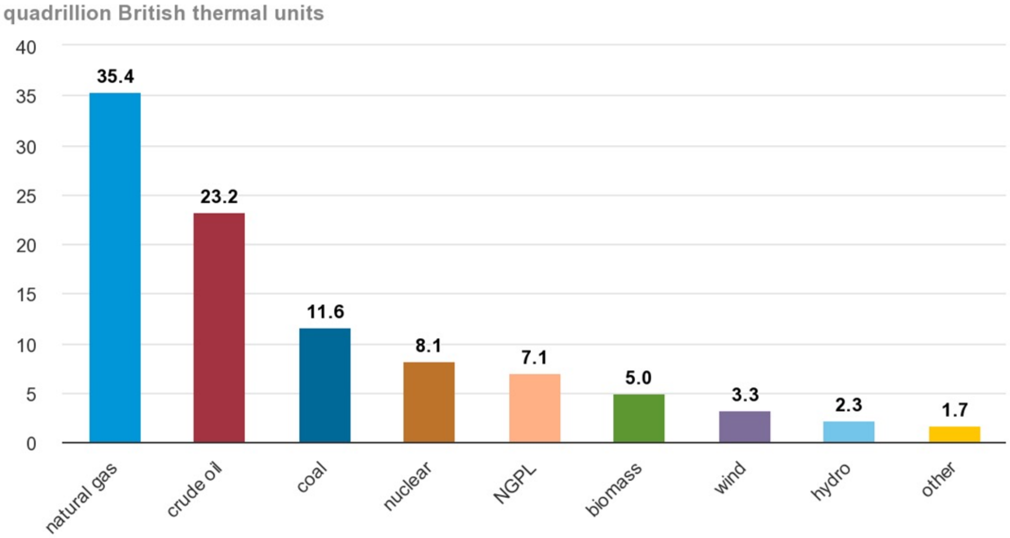
U.S. primary energy consumption by energy source, 2021



Data source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 and 10.1 April 2022, preliminary data
Note: Sum of components may not equal 100% because of independent rounding.



U.S. primary energy production by major sources, 2021



Data source: U.S. Energy Information Administration, *Monthly Energy Review*, April 2022, preliminary data
Note: NGPL is natural gas plant liquids; other is geothermal and solar; hydro is conventional hydroelectric.

Biomass and Forest Biomass?

Forest carbon neutral?

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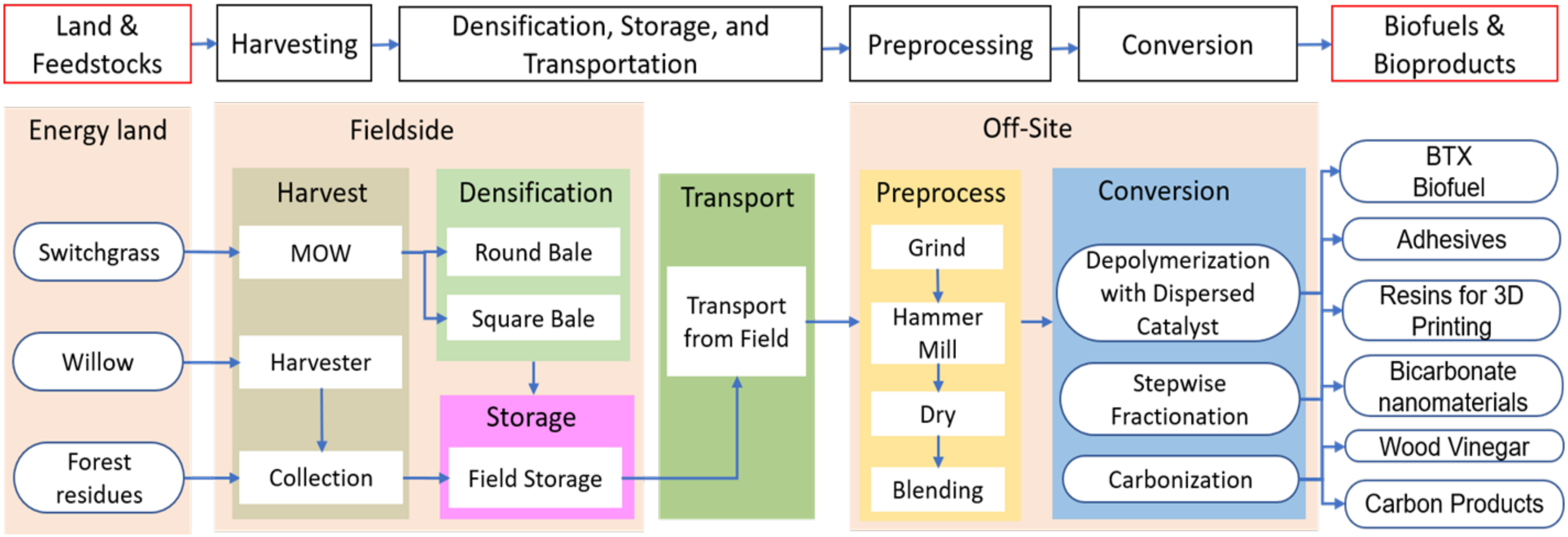
Supply Chains

- Clean alternative to fossil fuels
- Waste reduction in wood related industries
- Rural economic development
- Valuable commodity in-state and beyond



Land & Feedstocks → Harvesting → Densification, Storage, and Transportation → Preprocessing → Conversion → Biofuels & Bioproducts

Energy land

Switchgrass

Willow

Forest residues

Fieldside

Harvest

MOW

Harvester

Collection

Densification

Round Bale

Square Bale

Storage

Field Storage

Transport

Transport from Field

Off-Site

Preprocess

Grind

Hammer Mill

Dry

Blending

Conversion

Depolymerization with Dispersed Catalyst

Stepwise Fractionation

Carbonization

BTX Biofuel

Adhesives

Resins for 3D Printing

Bicarbonate nanomaterials

Wood Vinegar

Carbon Products

Wang, J. 2022. Forest and Biomass Harvest and Logistics. Springer Nature. Cham, Switzerland. 386 pp.

Harvest and Logistics

- Harvest and logistics, traditional systems for specific timber type and terrain vs. SRWC harvester
- Land and water uses
- Technologies
- Market
- Workforce
- Policies
- Uncertainties

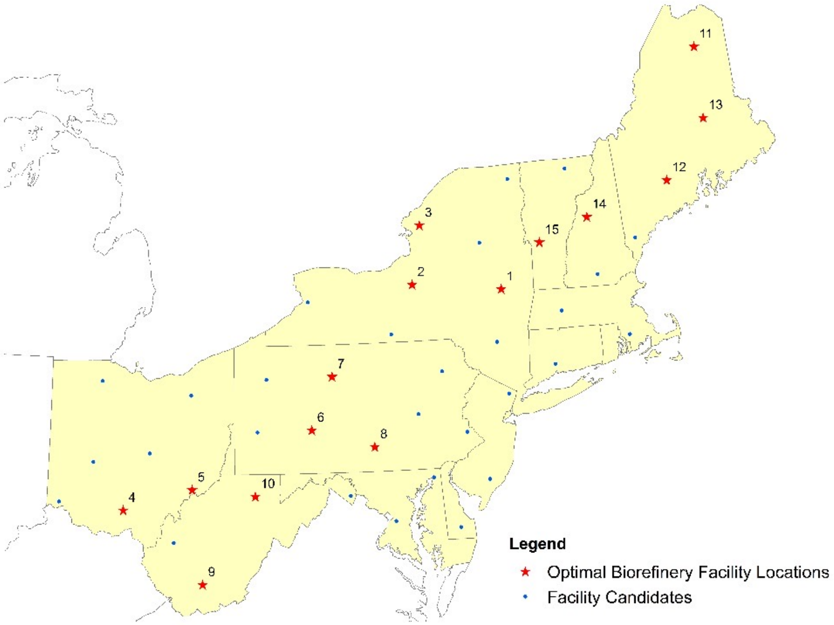
Biomass Harvest and Logistics

- One of the first dedicated harvesters for SRWC.
- By Case New Holland with SUNY ESF
- Max material size: 6”
- Chip length 0.4-1.8’’
- 3 to 5 ac per hour

Photo courtesy of Mark Eisenbies and Tim Volk, SUNY ESF

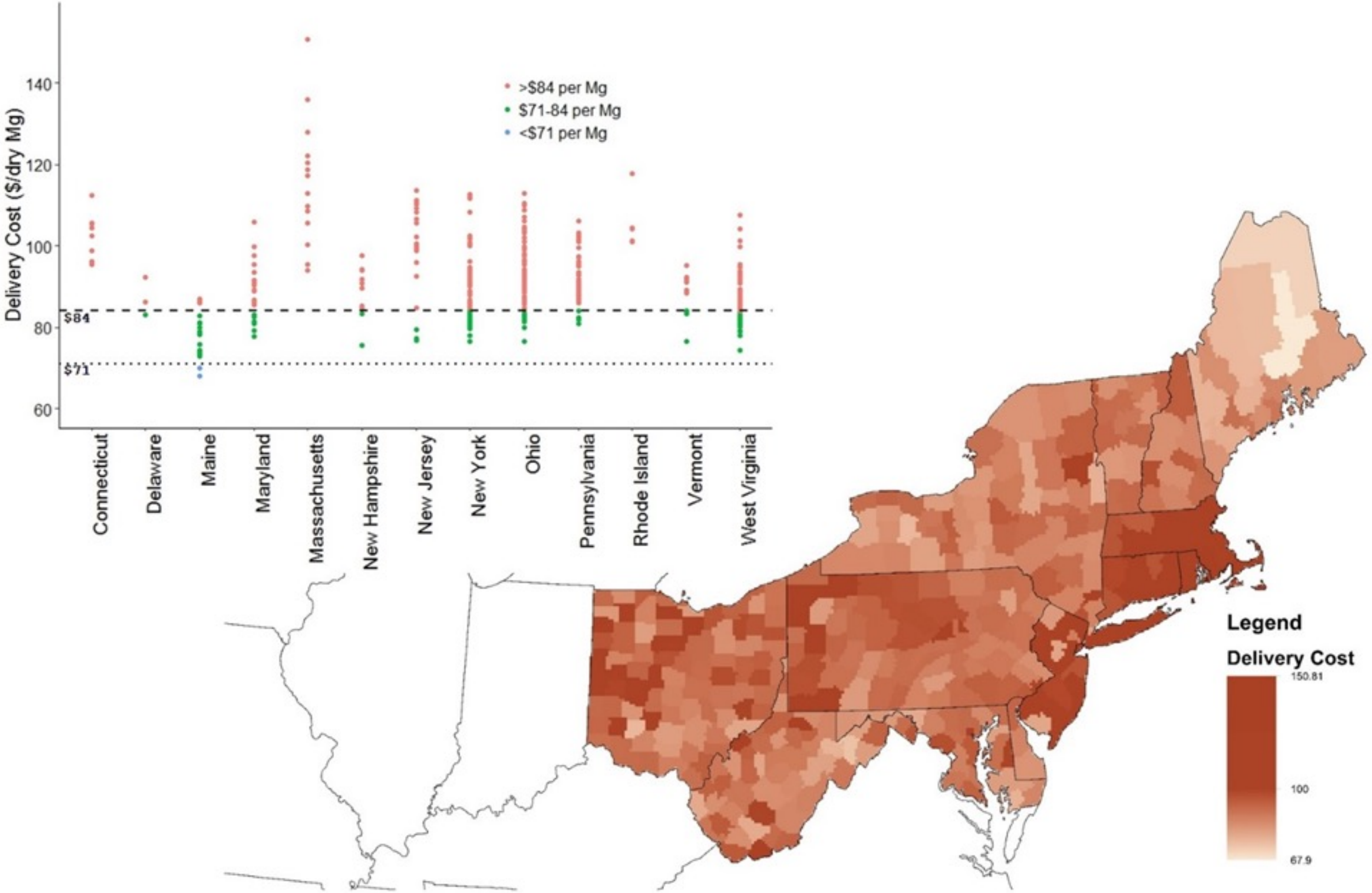
Biomass Procurement – Base Case

ID	Facility Locations	Min Transport Distance (km)	Average Transport Distance (km)	Max Transport Distance (km)	Average Total cost $/dry Mg
1	Schenectady	11.41	57.77	107.07	81.75
2	Onondaga	20.62	62.24	180.39	82.51
3	Jefferson	17.49	59.16	204.95	83.40
4	Pike	34.36	64.75	155.78	86.13
5	Washington	15.38	75.2	201.44	86.97
6	Cambria	9.43	42.05	127.49	81.76
7	Cameron	13.48	62.56	154.36	83.88
8	Cumberland	3.6	45.62	181.59	81.67
9	Raleigh	5.23	57.96	129.43	82.57
10	Taylor	5.32	65.65	192.33	83.81
11	Aroostook	2.34	28.11	85.63	71.96
12	Kennebec	5.62	35.62	88.54	78.76
13	Penobscot	2.17	22.04	89.22	67.90
14	Grafton	8.17	38.11	99.78	76.56
15	Rutland	7.93	46.15	108.92	77.48



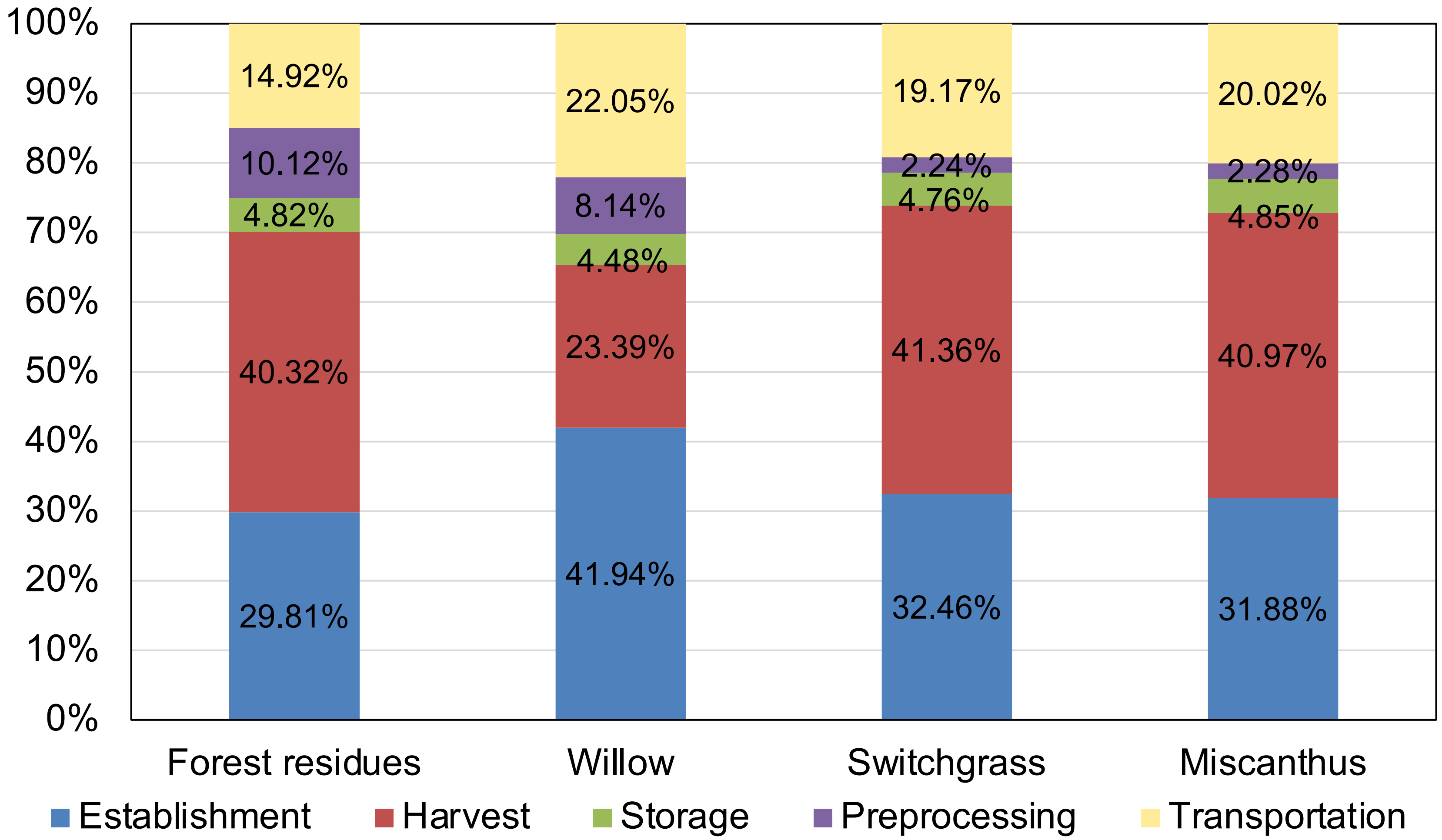
Optimization results ($/dry Mg)	
Total delivery cost	**80.47**
Establishment cost	27.29
Harvest cost	32.45
Transportation cost	9.34
Storage cost	4.47
Preprocessing cost	7.28

Spatial Distribution of Delivered Cost



Wang, Y., J. Wang, J. Schuler, D. Hartley, T. Volk, and M. Eisenbies. 2020. Optimization of harvest and logistics for multiple lignocellulosic biomass feedstocks in the Northeastern United States. Energy. https://doi.org/10.1016/j.energy.2020.117260.

Cost Composition by Feedstock



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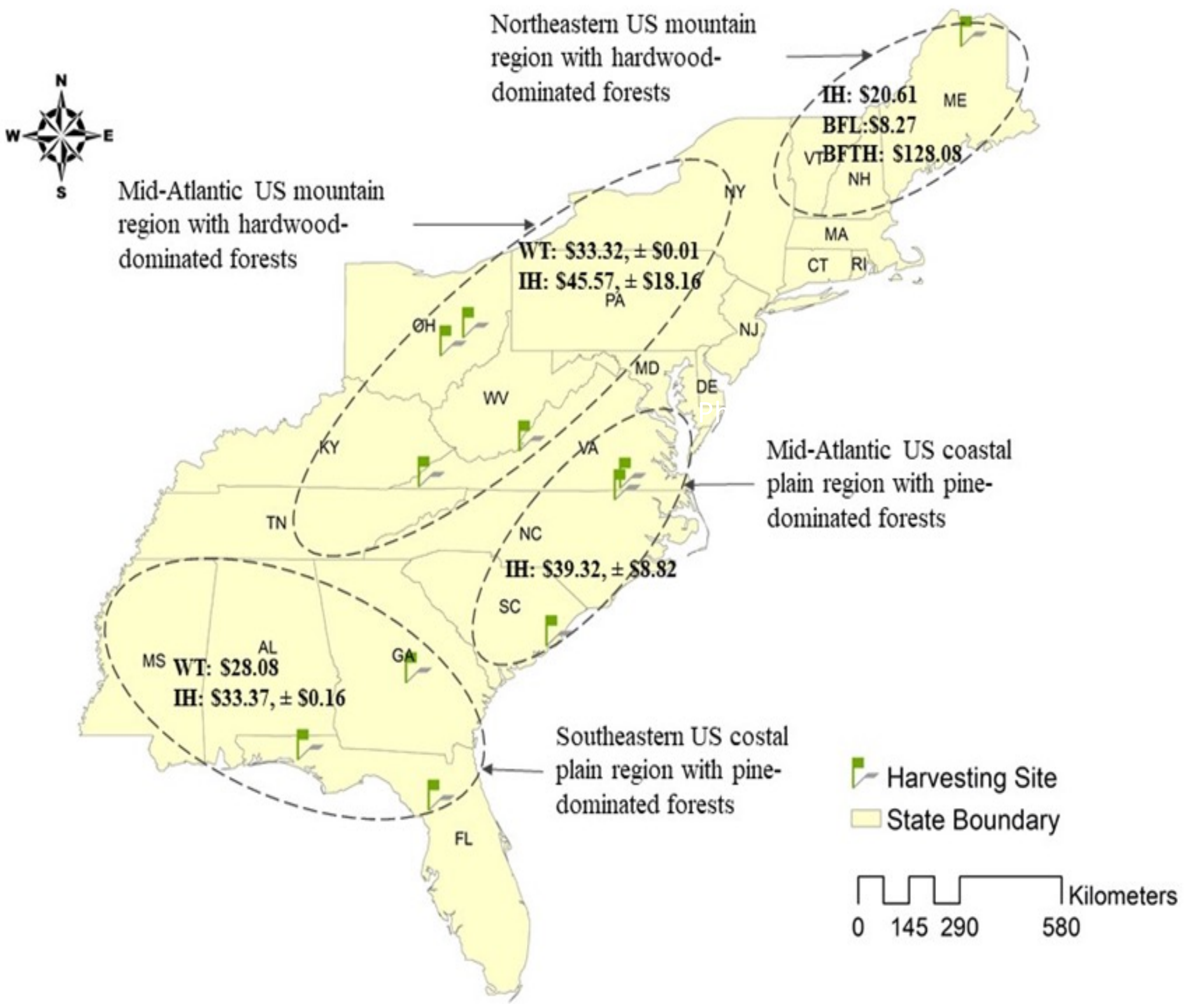
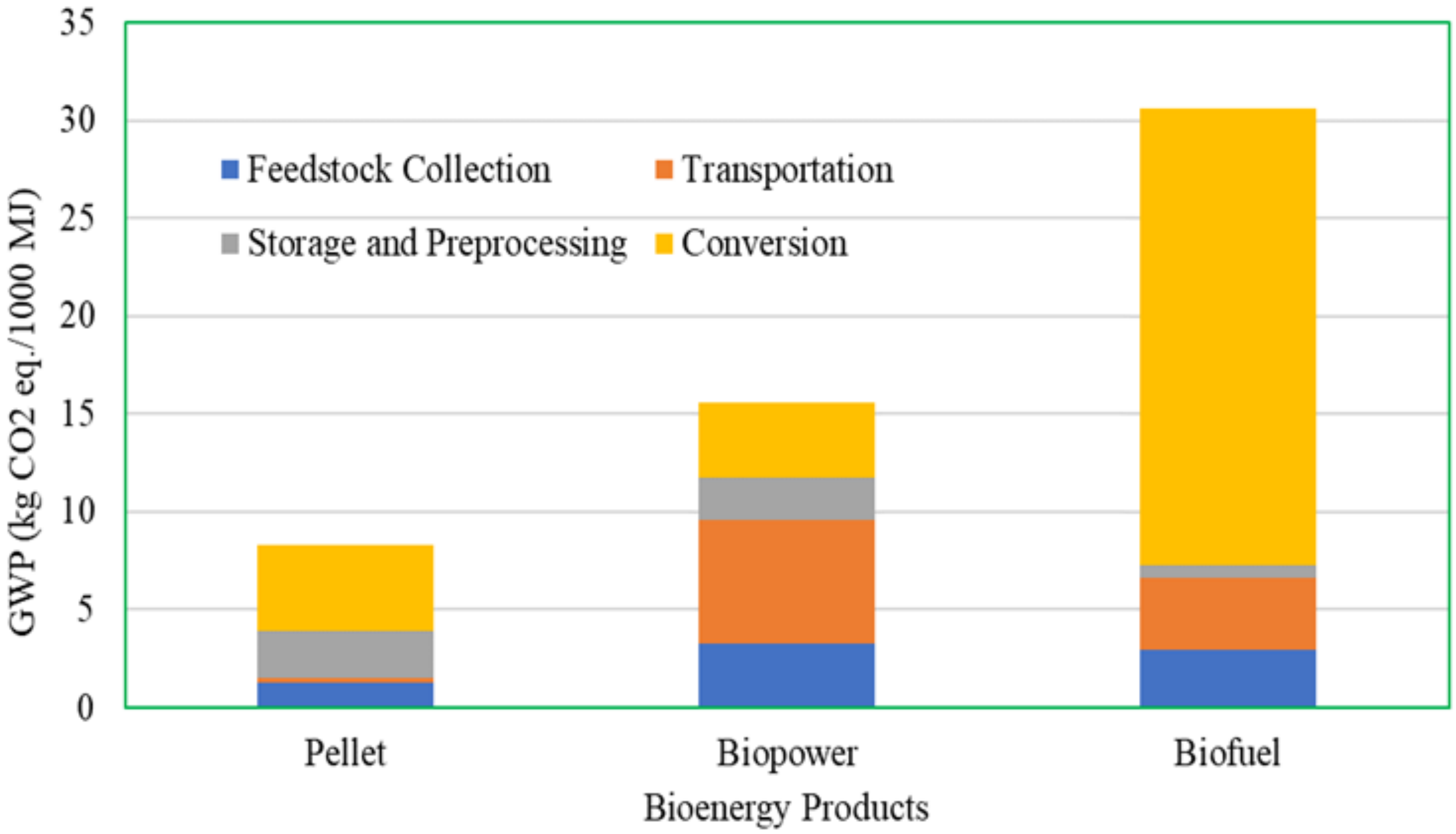
Biomass Harvest Costs



Zhang, X., Wang, J., & Strager, M. P. 2022. Industrial Development and Economic Impacts of Forest Biomass for Bioenergy: A Data-Driven Holistic Analysis Framework. Resources, Conservation and Recycling, 182, 106296.

Life Cycle Impacts

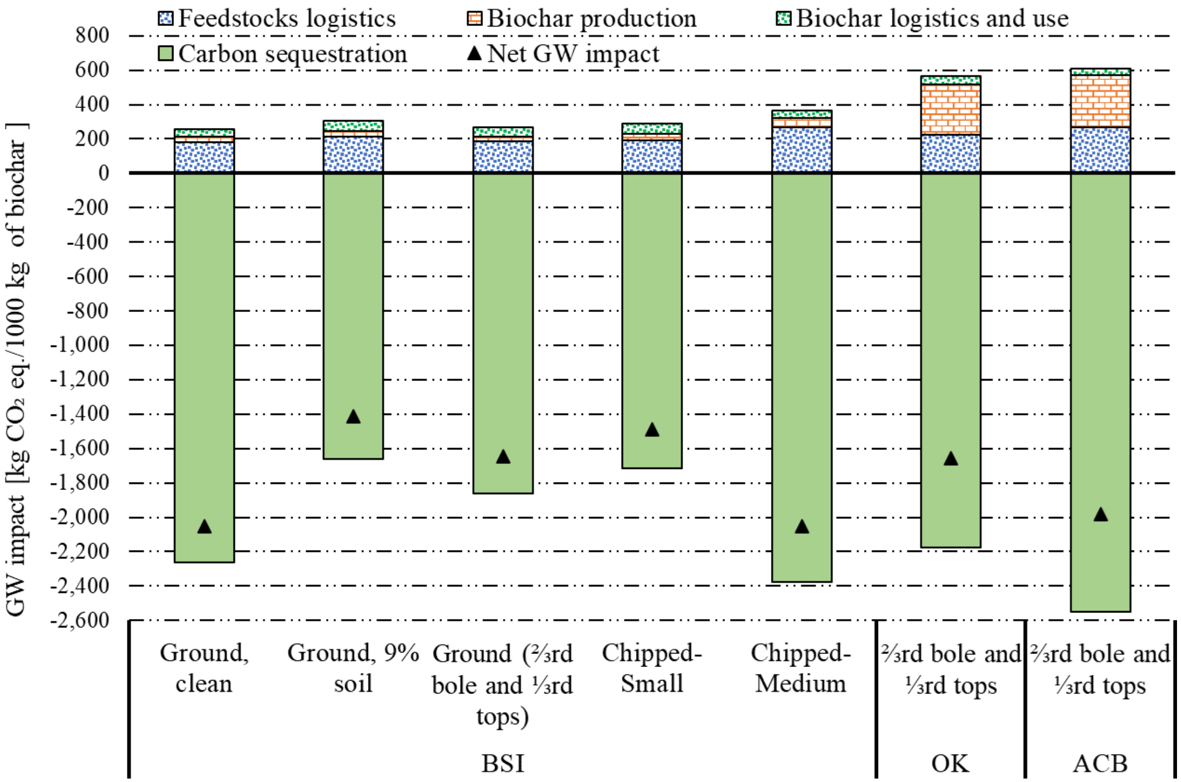


Wang, Y., J. Wang, X. Zhang, and S. Grushecky. 2020. Environmental and Economic Assessments and Uncertainties of Multiple Lignocellulosic Biomass Utilization for Bioenergy Products: Case Studies. Energies 2020, 13, 6277; doi:10.3390/en13236277. Impact Factor 2.702

Life Cycle Impacts

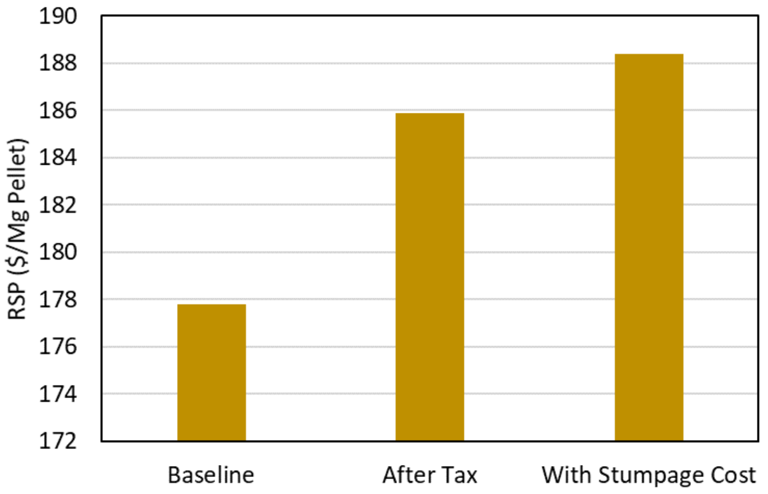
The results illustrated that the global warming (GW) impact of biochar production through BSI, OK, and ACB were **0.25–0.39**, **0.55**, and **0.61** Mg CO_2eq/Mg biochar applied to the field

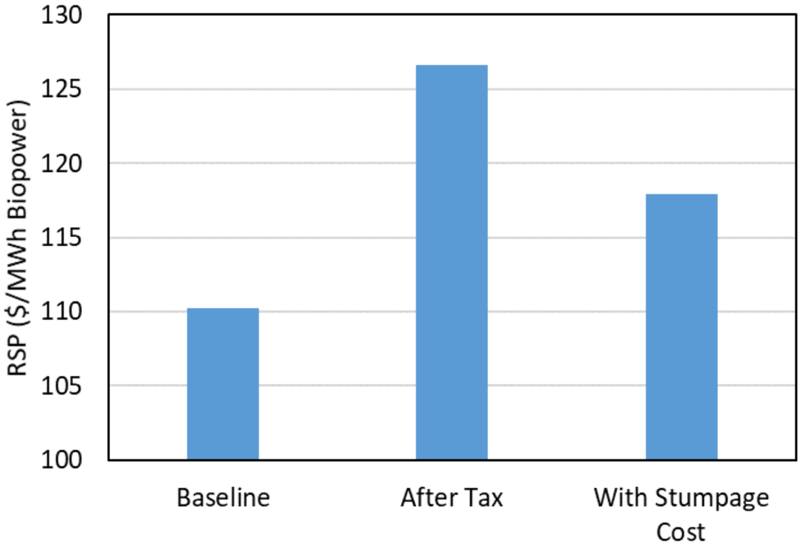
[Biochar Solutions Incorporated (BSI), Oregon Kiln (OK), and Air Curtain Burner (ACB)]

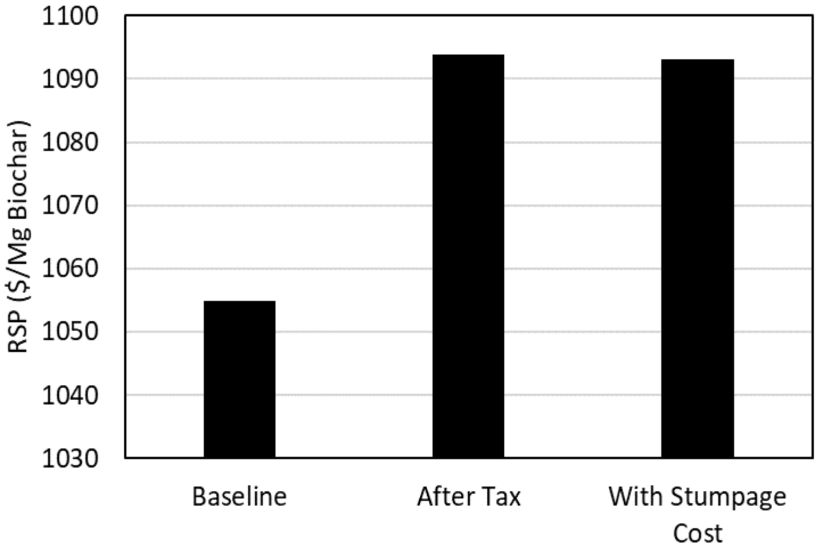


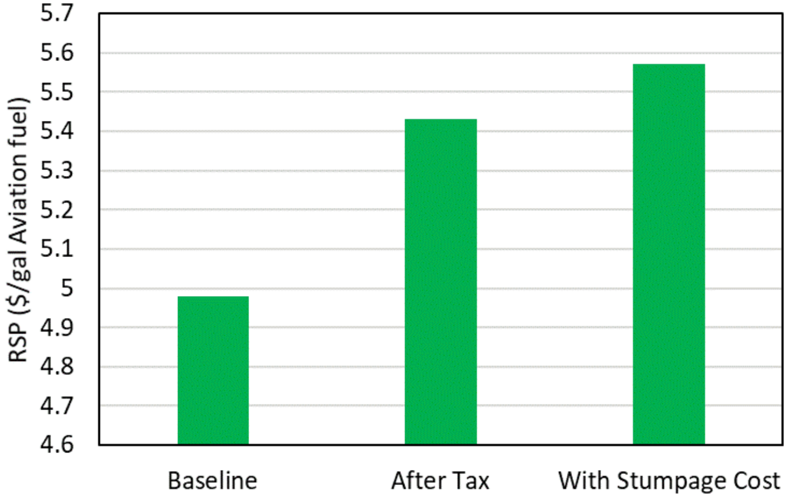
Sahoo K. et al. 2021. Life-cycle assessment and techno-economic analysis of biochar produced from forest residues using portable systems. The International Journal of Life Cycle Assessment. 26(1): 189-213. https://doi.org/10.1007/s11367-020-01830-9.

Techno-economic Impacts









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Future…

- Efficient biomass harvest and logistics systems with consideration of feedstock quality and decarbonization
- Value-added bioproducts or biochemicals to promote the rural economies
- Future biomass supply chain assessments using robust and consistent data analytics and tools
- Integrated production of bioenergy and bioproducts to improve the economics of the entire supply chain
- Engagement with stakeholders for bioeconomic development
- Workforce development
- …

Contact Us

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