Bioeconomy Development Opportunity Zone Risk Rating

A

Barnwell County, SC Bioeconomy Development Opportunity Zone is rated "A". Long- term outlook on feedstock price and quantity of Forest & Sawmill Residuals is deemed stable. Key risks are likely addressable.

Rating Parameters

Quantity	Feedstock Type	Feedstock Price	BDO Zone Supply Basin
300,000 gt/yr	Forest & Sawmill Residuals	$25-35/gt FOB generator	75-mile drive

BDO Zone Assets

- **12.1 million green tons per year (gt/yr) of woody biomass is generated , including 6.8 million gt/yr of Sawmill Residuals and 5.3 million gt/yr of Forest Residues.**
- **There is a surplus of 6.7 million gt/yr of woody biomass in the Supply Basin. Most of this surplus is in the form of Forest Residue.**
- **Woody biomass supply chain is characterized by a large number of potential suppliers: 24 sawmills and 84 loggers/harvesters operating within the Supply Basin.**
- **The forestry labor market is healthy, and we do not anticipate labor or skill shortages.**

BDO Zone Liabilities

- **Year-to-year variation in Sawmill Residual generation. However, *softwood* Sawmill Residual generation is more stable.**
- **Suppliers are subjected to the same external factors: slow lumber markets can negatively affect Sawmill Residual and Forest Residue generation.**

BDO Zone Risk Rating

The Barnwell County Bioeconomy Development Opportunity Zone is rated "A", or *low risk*.

Risk Rating Grades are defined as follows: Aa (*very low*), A (*low*), Baa (*low-moderate*), Ba (*moderate*), B (*moderate-high*) or C (*high*).

In assessing the biomass supply chain risk for the Barnwell County, SC Bioeconomy Development Opportunity (BDO) Zone, 52 Risk Indicators from the *US National Biomass Supply Chain Risk Standards* were applied. These BDO Zone Risk Indicators are the subset of BSCR Risk Indicators applicable to gauging feedstock risk within a BDO Zone.

Feedstock quantity is expressed in green tons. Feedstock cost is expressed in US dollars, at the site of generation. Maximum transport distance is based on a 75-mile driving distance supply basin.

Scoring and Ratings Methodology

The BDO Zone rating is based on an aggregation of the scores assigned to each BDO Zone Risk Indicator (RI) assessed in this report. First, each BDO Zone Risk Indicator is given a **Raw RI** score based on the research and analysis conducted on the feedstock supply chain in the region. Raw RI Scores are scaled between 1 (*low risk*) and 10 (*high risk*).

Next, each Risk Indicator is discounted, or "notched", based on the degree to which the uncertainty drivers are deemed to be addressable, and whether there is a reasonable expectation that mitigation measures could be put into place within the price parameters for this rating. The **Notched Salience score** represents this, and corresponds to the likelihood of each Risk Indicators' described risk materializing given the implementation of reasonable mitigation measures. To arrive at the Notched Salience score, Raw RI scores are reduced based on the efficacy of the proposed mitigation measures. If applicable, notching occurs at one of 3 levels: 25%, 50% or 75%.

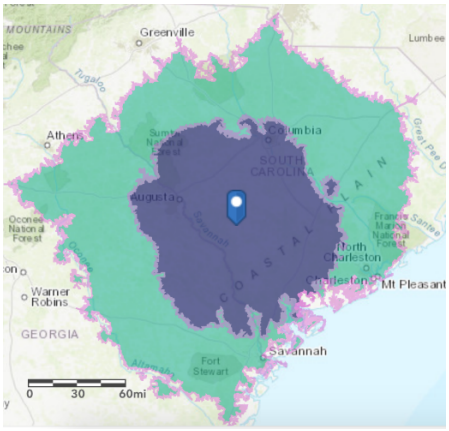
Finally, the potential impact of each Risk Indicator on the supply chain is assessed and scored on a 10-point **Impact Level** scale, as either *low (3.33), moderate (6.66), or high (9.99).* Impact level scores are based on the assumption that key measures were implemented to mitigate uncertainty drivers in the BDO Zone but failed to do so.

The **Loaded RI** score for each Risk Indicator is then calculated as the product of Notched Salience and Impact Level scores. For example, Risk Indicator '*Feedstock Supply Curve*' is

scored at 2.25 and Impact Level is deemed low (i.e., 3.33). The final Loaded RI score for this risk indicator is 2.25 x 3.33 = 7.49 (out of 100).

Loaded RI scores of 33.33 or less are deemed *low risk*; scores greater than 33.33 and less than 66.66 are deemed *moderate risk*; and those that score 66.66 to 100 are deemed *high risk*.

Barnwell, SC BDO ZONE



The total risk rating for the BDO Zone is the average of all Loaded RI scores. The BDO Zone score for Barnwell, SC is ***18.68 out of 100, resulting in an "A" designation.*** All scoring and rationale for each Risk Indicator is provided in Appendix B.

Analyst Notes

There is an abundance of woody biomass generated in the Supply Basin, defined by a 75-mile drive from the Barnwell BDO Zone. 12.1 million green tons per year (gt/yr) of woody biomass is generated, including 6.8 million gt/yr of Sawmill Residuals and 5.3 million gt/yr of Forest Residues.

We estimate that 5.4 million gt/yr of woody biomass generated in the Supply Basin are currently consumed by large facilities located in the Competition Zone, defined by 150-mile drive from the Barnwell BDO Zone. Therefore, there is a surplus of 6.7 million gt/yr of woody biomass in the Supply Basin. Most of this surplus is in the form of Forest Residue, which is currently not utilized and is left in the forest after harvesting. Some of this surplus is in the form of Sawmill Residuals, which are currently utilized internally by sawmills or go to smaller markets, such as animal bedding.

The forestry industry in the Barnwell BDO Zone is strong and has a long history of production and performance. In fact, forestry is the largest industry in South Carolina from the employment perspective. Therefore, the forestry labor market is healthy, and we do not anticipate labor or skill shortages.

The woody biomass supply chain is characterized by a large number of potential suppliers. There are 24 sawmills and 84 loggers/harvesters operating in the Supply Basin. This is a relatively large number of individual generators of woody biomass compared to other regions, providing for supply chain robustness.

Out of the 24 sawmills, nine indicated current availability of Sawmill Residuals (though did not provide quantities available) and nine currently commit all Residuals to existing markets (the remaining six did not respond to our inquiries). Our survey therefore suggests that approximately 50% of the 6.8 million gt/yr of Sawmill Residuals could be currently accessible to new buyers, assuming satisfactory pricing is offered.

The average current (Q1 2021) pricing of Sawmill Residuals in the Supply Basin is $32/gt FOB generator. Average Bark pricing is $19.22/gt; Sawdust - $21.28/gt; Shavings - $36.14/gt; and Chip - $51.25/gt. The average pricing of Forest Residue is $24.21/gt FOB generation site.

Historical pricing trends vary depending on biomass type. Chip and Shavings pricing remained relatively constant over the past decade, despite year-to-year variation. Bark prices increased slightly over the same period, from an average of $15.96/gt in 2010 to $18.15/gt in 2020. Sawdust average pricing increased significantly, from $12.85/gt in 2010 to $20.02/gt in 2020. Similarly, Forest Residue average pricing has been increasing steadily over the last decade, from $16.46/gt in 2011 to $23.56/gt in 2013. Pricing increases of Bark, Sawdust and Forest Residue, all lower-value feedstocks, can be partially explained by the higher demand from the pellet industry, which experienced significant growth in the last decade.

High Risk Indicators

Year-to-year variation in Sawmill Residual generation is significant. To estimate Sawmill Residual generation variation, we use roundwood production as proxy. Between 2011 and 2013, roundwood production decreased by 31%, while over the following two years, it increased by 63%. However, it is important to note that the variation in roundwood production is mainly due to changes in *hardwood* roundwood production. Softwood roundwood production tends to be stable, with the exception of 2015, when it increased

significantly. This is important because most sawmills process softwoods. Therefore, despite the fact that roundwood year-to-year production variation is significant, it is mitigated by fact that this variation is mainly due to hardwood production.

Suppliers are subject to the same external risk factors. Sawmills and loggers/harvesters are subject to the same risks related to the lumber market. If the lumber market declines, it can significantly influence the availability of Sawmill Residuals and Forest Residues. This risk, however, is mitigated by the large surplus of generated woody biomass discussed above.

Competitors' locations and geographical influence on the market poses a moderate risk. A total of 27 major competitors were identified within the 150-mile driving distance from the Barnwell BDO Zone. There are four categories of facilities consuming Sawmill Residuals and Forest Residue in significant quantities: biomass power plants, biomass cogeneration heat and power (CHP) plants, pellet mills, and pulp mills. Within the Competition Zone, there are six biomass power plants, four biomass CHP plants, six pellet mills and 11 pulp mills. In total, these facilities consume an estimated 10.8 million gt/yr of woody biomass. We estimate that approximately 50% of that total is sourced from the Supply Basin.

Infrastructure Asset Profile

Barnwell's infrastructure assets were scored on a scale of 0 - 10, with scores defined as follows: 0 (*insufficient*), 2 (*poor*), 4 (*fair*), 6 (*reasonable*), 8 (*good*), 10 (*very good*). 46% of all assets scored as either *good* or *very good*, and only 1 scored as *poor* or *insufficient*. Among the top rated assets are landfill access, sewage disposal trunk line, outdoor recreational activities, highway access, and land cost. Overall, Barnwell presents a profile of positively rated infrastructure assets, with an average score of **6.85**. This score supplements Barnwell's BDO Zone rating, and reinforces it's **A** (*low risk*) designation. The full infrastructure asset profile is detailed in *Table 2*. Documentation supporting infrastructure assessment is available upon request.

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Figure 1 - Risk Indicators (sorted by risk level)

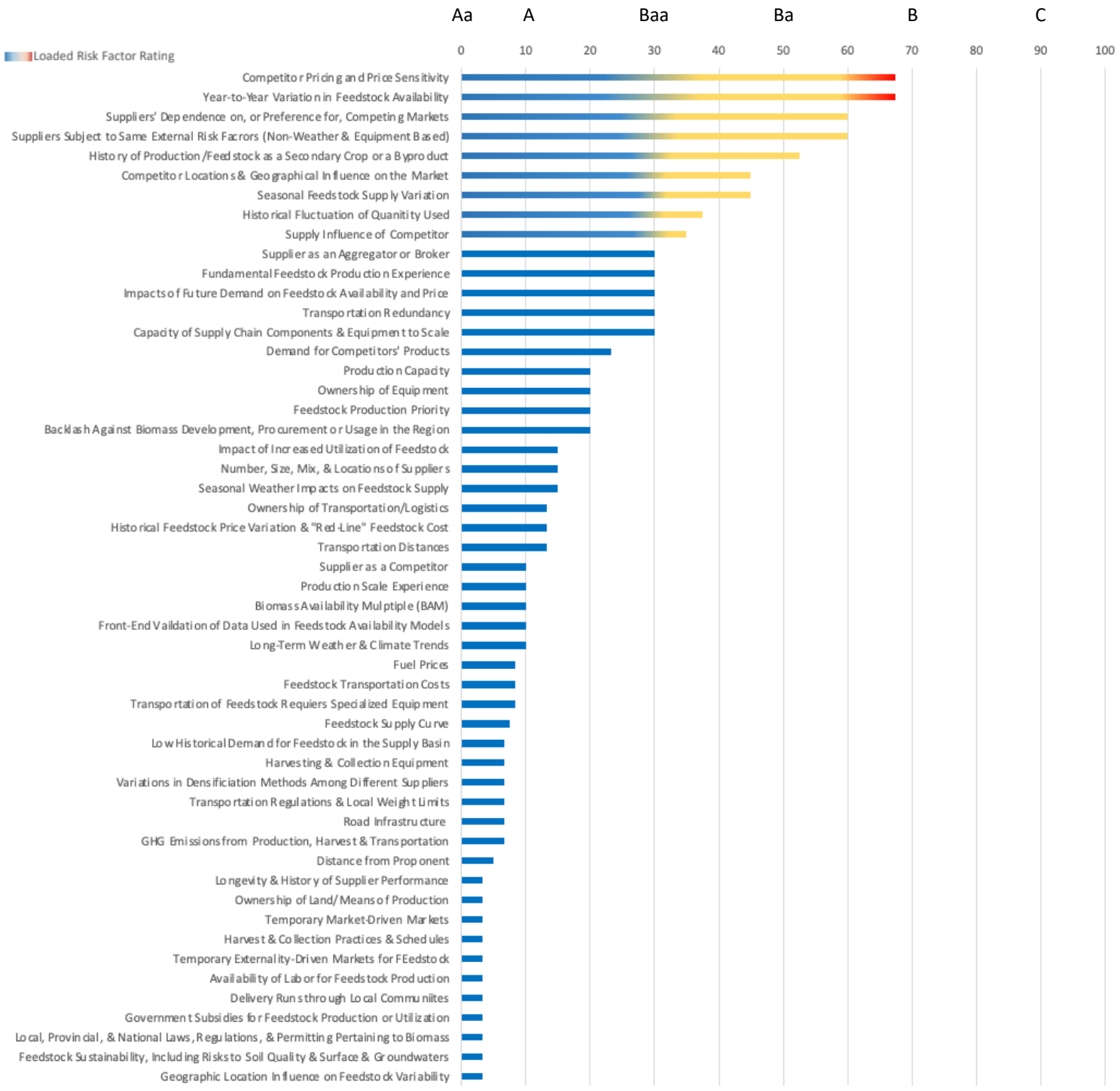


Table 1 - Risk Indicators

Feedstock Supply Chain Risk Indicators	Raw RI Score	Notched Salience	Impact Level	Loaded RI Score
Category 1: Supplier Risk				
Longevity & History of Supplier Performance	1	1	3.33	3.33
Production Capacity	2	2	9.99	19.98
Supplier's Dependence on, or Preference for, Competing Markets	6	6	9.99	59.94
Supplier as a Competitor	3	3	3.33	9.99
Ownership of Land/Means of Production	1	1	3.33	3.33
Ownership of Equipment	3	3	6.66	19.98
Ownership of Transportation/Logistics	4	2	6.66	13.32
Supplier as an Aggregator or Broker	4	3	9.99	29.97
Distance from Proponent	3	1.5	3.33	4.99
Fundamental Feedstock Production Experience	3	3	9.99	29.97
Production Scale Experience	4	3	3.33	9.99
Feedstock Production Priority	8	6	3.33	19.98
Category 2: Competitor Risk				
Competitor Locations & Geographical Influence on the Market	6	4.5	9.99	44.96
Historical Fluctuation of Quantity Used	5	3.75	9.99	37.46
Competitor Pricing & Price Sensitivity	9	6.75	9.99	67.43
Impacts of Future Demands on Feedstock Availability & Price	6	3	9.99	29.97
Supply Influence of Competitor	7	3.5	9.99	34.97
Temporary Market-Driven Markets	1	1	3.33	3.33
Demand for Competitors' Products	7	3.5	6.66	23.31
Category 3: Supply Chain Risk				
Biomass Availability Multiple (BAM)	1	1	9.99	9.99
Impact of Increased Utilization of Feedstock	3	2.25	6.66	14.99
Feedstock Supply Curve	3	2.25	3.33	7.49
Seasonal Feedstock Supply Variation	6	4.5	9.99	44.96
Year-to-Year Variation in Feedstock Availability	9	6.75	9.99	67.43
Front-End Validation of Data Used in Feedstock Availability Models	3	3	3.33	9.99
Historical Feedstock Price Variations & "Red-Line" Feedstock Cost	4	4	3.33	13.32
Low Historical Demand for Feedstock in the Supply Basin	1	1	6.66	6.66
History of Production/Feedstock is a Secondary Crop or a Biproduct	6	5.25	9.99	52.45
Fuel Prices	5	2.5	3.33	8.33
Harvest & Collection Practices & Schedules	1	1	3.33	3.33
Harvesting & Collection Equipment	1	1	6.66	6.66
Temporary Externality-Driven Markets for Feedstock	1	1	3.33	3.33
Variation in Densification Methods Among Different Suppliers	2	2	3.33	6.66
Availability of Labor for Feedstock Production	1	1	3.33	3.33
Feedstock Transportation Costs	5	2.5	3.33	8.33
Transportation Distances	4	4	3.33	13.32
Transportation of Feedstock Requires Specialized Equipment	5	1.25	6.66	8.33
Delivery Routes through Local Communities	1	1	3.33	3.33
Transportation Regulations & Local Weight Limits	1	1	6.66	6.66
Road Infrastructure	1	1	6.66	6.66
Transportation Redundancy	6	3	9.99	29.97
Number, Size, Mix, & Locations of Suppliers	3	2.25	6.66	14.99
Suppliers Subject to Same External Risk Factors (Non-Weather & Equipment Based)	8	6	9.99	59.94
Seasonal Weather Impacts on Feedstock Supply	3	1.5	9.99	14.99
Long-Term Weather & Climate Trends	2	1.5	6.66	9.99
Government Subsidies for Feedstock Production or Utilization	1	1	3.33	3.33
Local, Provincial, & National Laws, Regulations, & Permitting Pertaining to Biomass	1	1	3.33	3.33
Backlash Against Biomass Development, Procurement or Usage in the Region	2	2	9.99	19.98
Feedstock Sustainability, Including Risks to Soil Quality, & Surface & Groundwaters	1	1	3.33	3.33
GHG Emissions from Production, Harvest & Transport	2	2	3.33	6.66
Geographic Location Influence on Feedstock Variability	1	1	3.33	3.33
Capacity of Supply Chain Components & Equipment to Scale	6	3	9.99	29.97
		Risk Score		**18.68**

Table 2 - Asset Indicators

Infrastructure Assets	Overview	Score
Category 1: Physical Infrastructure		
1.1 Land Parcel	Various land parcels available for purchase at various sizes. Strong availability for a facility to purchase and be developed on.	8
1.2 Industrial Land Use Zone	Multiple industrial lands are available within a close driving distance of Downtown Barnwell. Commercial realtors in the area have industrial land as listed for sale.	8
1.3 Natural Gas Line	Natural gas line is available.	6
1.4 Electrical	2 Utility companies serve the 21,788-person population of Barnwell County, South Carolina. The county ranks 12 out of 46 in South Carolina for Utility companies per capita.	6
1.5 Fresh Water Supply Line	The City of Barnwell has the capacity to distribute 750,000 gallons of water. Water transported exceeds all federal and state standards.	8
1.6 Sewage Disposal Trunk Line	The City of Barnwell's wastewater treatment facilities are capable of processing 3 million gallons of wastewater per day.	10
1.7 Drainage	Drainage is connected by the City of Barnwell's wastewater system network. Disposal for commercial septic waste is also available.	6
1.8 Stormwater Management	The South Carolina Department of Health and Environmental Control has a detailed manual for how to efficiently manage stormwater and reduce sediment available.	6
1.9 Available ICT Services	Good. Fiber optics cabling is available and cabling installers are available.	8
1.10 Available Land	Good. Various plots of land are available in and near downtown Barnwell of various areas.	8
1.11 Cost of Land - Initial Cost	Land listed at competitive rates.	8
1.12 Cost of Land - Property Tax, Utilities	Property taxes must be paid by January 15 of each year.	6
1.13 Infrastructure - Landfill/waste disposal	Solid waste and wastewater treatment facilities are both available at nearby locations.	10
Category 2: Logistics		
2.1 Highway Access and Intersection	Ample Highway access for variety of locations within and outside of South Carolina.	8
2.2 Proximity to Major Markets	Good rail and road transportation. Major markets can be reached through a variety of routes in efficient, timely manners.	8
2.3 Accessibility to Airport	Fair. Regional Airport located in Barnwell County.	4
2.4 Railway Service	More than 2,300 miles of railroad track are lain and operating in the state of South Carolina.	6
2.5 Logistics - Construction Logistics	Reasonable. Various construction companies available in the region.	6
Category 3: Social Infrastructure		
3.1 Quality of Life	Family-friendly. Good outdoor activities with various parks, restaurants and hotels.	6
3.2 Education - Elementary & High School	Fair. Elementary, middle, and high schools available in Barnwell, as well as others in neighboring counties.	6
3.3 Education - Post Secondary	Fair. While there are no universities within Barnwell County, Clemson University, Medical University of South Carolina and the University of South Carolina are all situated nearby.	4
3.4 Local Retail	There is some local retail in Downtown Barnwell, adequate for the small population of the area.	8
3.5 Culture and Recreation	Strong selection of parks, outdoor recreational activities, springs, lakes and rivers.	10
3.6 Hospital and Doctors	Fair. Bamberg -Barnwell Emergency Medical Center serves the community.	6
3.7 Housing Availability	149 affordable and available apartments and houses are listed as for rent within Barnwell County.	6
3.8 Crime Rate	The crime rate in Barnwell is 69 per 1,000 residents, making the crime rate in the county one of the largest in the country, independent of community size.	2
	Total	***6.85***



Bioeconomy Development Opportunity Zone Program Advisory Committee:

Jordan Solomon, Ecostrat

Chris Tindal, CAAFI

Cole Dudley, South Carolina Research Authority

Tim Adams, South Carolina Forestry Commission

Enzo de Biase, Versalis

Scott Chabina, Chabina Energy Partners

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APPENDIX A: BACKGROUND RESEARCH

1. Introduction

This appendix provides background research conducted for the purposes of this BDO Zone designation. It sets out the context of the research and discusses results related to supply, demand, and pricing of woody biomass in the Barnwell BDO Zone.

1.1 Supply Basin, Competition Zone and Included Counties

A Supply Basin is an area from which woody biomass (feedstock) can be economically sourced. For the purposes of the BDO Zone designation, the Supply Basin is defined as an area within a 75-mile drive distance of Barnwell County. Supply analysis for this study was conducted on the state and county levels, when granular data was available. Counties included in the supply basin are summarized in Table 1. The distance column in Table 1 is from the center of Barnwell, South Carolina to the center of the respective county.

The Competition Zone is defined by a driving distance double that of the Supply Basin, or a 150-miles driving distance from Barnwell County, South Carolina. The Supply Basin is depicted in Map 1 in purple, and the competition zone in light green.

Map 1: Barnwell County BDO Zone Supply Basin, Competition Zone & Included Counties



Table 1: Counties within the Supply Basin

County Name	State	Distance from Barnwell (miles)	Approximate Percentage of County in Supply Basin
Aiken	South Carolina	33	100%
Allendale	South Carolina	17	100%
Bamberg	South Carolina	21	100%
Barnwell	South Carolina	0	100%
Bulloch	Georgia	73	50%
Burke	Georgia	58	90%
Calhoun	South Carolina	49	100%
Clarendon	South Carolina	75	10%
Colleton	South Carolina	56	80%
Columbia	Georgia	66	90%
Dorchester	South Carolina	52	75%
Edgefield	South Carolina	54	100%
Effingham	Georgia	74	80%
Greenwood	South Carolina	75	10%
Hampton	South Carolina	31	100%
Jasper	South Carolina	70	70%
Jefferson	Georgia	75	20%
Jenkins	Georgia	65	100%
Lexington	South Carolina	57	100%
McCormick	South Carolina	75	15%
McDuffie	Georgia	75	30%
Orangeburg	South Carolina	35	100%
Richland	South Carolina	68	85%
Richmond	Georgia	55	100%
Saluda	South Carolina	66	90%
Screven	Georgia	75	100%

1.2 Feedstock Definitions

This BDO Zone designation is conducted for woody biomass, which includes Forest Residues and Sawmill Residuals, defined below.

Note on feedstock type capitalization. Whenever specific feedstock types are referred to, as per the definition below, they are capitalized. For example, Forest Residues and Sawmill Residuals.

Forest Residues

Forest Residues are by-products of sawtimber and pulpwood harvesting[1]. Forest Residues include tree crowns, branches, stumps, and unmerchantable stems. Forest Residues are chipped or ground in the forest and delivered in either open-top van trailers or walking-floor trailers, depending on the market.

Ash content of Forest Residues can range between 1 and 5%, depending on composition. Where Forest Residues contain mainly unmerchantable stems, the ash content is low; where Forest Residues contain higher portions of branches, or

[1] Sawtimber is large diameter timber processed by sawmills into lumber, and pulpwood is small diameter timber processed by pulp mills into pulp and paper.

where the harvester is not incented to keep the fiber clean, the ash content is higher. Moisture content tends to be seasonal, ranging between 40 and 55%, but sometimes less.

Sawmill Residuals

Approximately 50% of the volume of every sawtimber log processed by a sawmill is converted into lumber. The rest of the log is waste material, composed of four main types: Chips, Sawdust, Shavings, and Bark (Hog Fuel). Note that these Sawmill Residual types are not always kept separate; if Chips are mixed with Sawdust, Shavings and/or Bark, they are referred to as Dirty Chip.

1.3 Methodology for Estimating Feedstock Generation

Sawmill Residual feedstock generation for both hardwood and softwood were modeled with data from the FIA's Timber Products Output (TPO) Toolkit and industry-appropriate transfer functions. Forest Residue generation was estimated using data from the FIA's EVALIDator tool. TPO data and EVALIDator data are from 2019. For unit consistency, it was assumed that all Forest Residues have a moisture content of 43.7%, loblolly pines' approximate moisture content[2]. This assumption was made due to loblolly pine being South Carolina's most common tree type[3]. See Appendix C for details and sources pertaining to generation estimates.

When an entire county did not land in the supply basin, it was assumed that the approximate percentage of the county within the supply basin was the percentage of that county's feedstock generation produced within the supply basin, and therefore counted towards the supply basin total. For example, approximately 50% of Bulloch County, Georgia, lies within the supply basin, so 50% of the estimated Residual generation within Bulloch County was counted towards the supply basin total. The percentage of a county in the supply basin was estimated using GIS modeling.

Where appropriate, outreach was performed to stakeholders, local experts, and other relevant individuals to anecdotally contextualize the numeric modeling outputs.

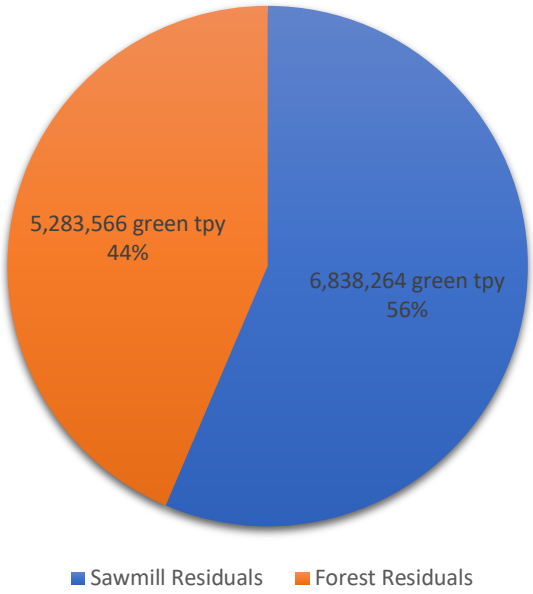
2. Supply

2.1 High-Level Supply: Feedstock Generation

An estimated 12,121,829 green tons per year (gt/yr) of feedstock are generated in the supply basin. Sawmill Residuals account for 6,838,264 gt/yr of feedstock generation (56%), while Forest Residues account for 5,283,566 gt/yr of feedstock generation (44%).

[2] Moisture Content and Specific Gravity of the Four Major Southern Pines Under the Same Age and Site Conditions: https://www.srs.fs.usda.gov/pubs/ja/ja_gibson002.pdf
[3] USDA Forest Service Southern Research Station: https://www.state.sc.us/forest/forestsofsc2011.pdf

Figure 1: Total Estimated Feedstock Generation in Supply Basin



2.2 Sawmill Residual Generation

An estimated 6,838,264 gt/yr of Sawmill Residues are generated in the supply basin. Softwood Sawmill Residuals account for an estimated 5,715,435 gt/yr of the total (84%). Hardwood Sawmill Residuals account for 1,122,829 gt/yr of estimated feedstock generation (16%) (Figure 2).

Sawmill Residual generation was also estimated on a county basis. The five largest generators of total Sawmill Residuals were Orangeburg (820,869 gt/yr), Colleton (699,944 gt/yr), Hampton (692,738 gt/yr), Aiken (425,531 gt/yr), and Screven (404,771 gt/yr) counties. Cumulatively, these five counties produce 45% of the total Sawmill Residual generation within the supply basin. Barnwell County generates an estimated 227,507 gt/yr of Sawmill Residuals, of which 200,519 gt/yr are softwood and 26,988 gt/yr are hardwood (Figure 3).

Figure 4 shows the Sawmill Residual generation curve, which indicates the quantity of Sawmill Residuals generated at each distance interval from Barnwell County. Within 15 miles of Barnwell, there is an estimated 377,262 gt/yr of Sawmill Residuals generated. Within 25 miles over 1 million gt/yr are generated. The generation of Sawmill Residuals increases exponentially with distance thereafter.

Of the total estimated 5,715,435 gt/yr of Softwood Sawmill Residuals, 3,528,046 gt/yr (62%) are Chips; 882,011 gt/yr (15%) is Sawdust; 781,210 gt/yr (14%) are Shavings; and 524,167 gt/yr (9%) is Bark (Figure 5). Of the total estimated 1,122,829 gt/yr of Hardwood Sawmill Residuals, 494,203 gt/yr (44%) are Chips; 276,734 gt/yr (25%) is Sawdust; 138,377 gt/yr (12%) are Shavings; and 213,496 gt/yr (19%) is Bark (Figure 6).

Figure 2: Estimated Sawmill Residual Generated in the Supply Basin

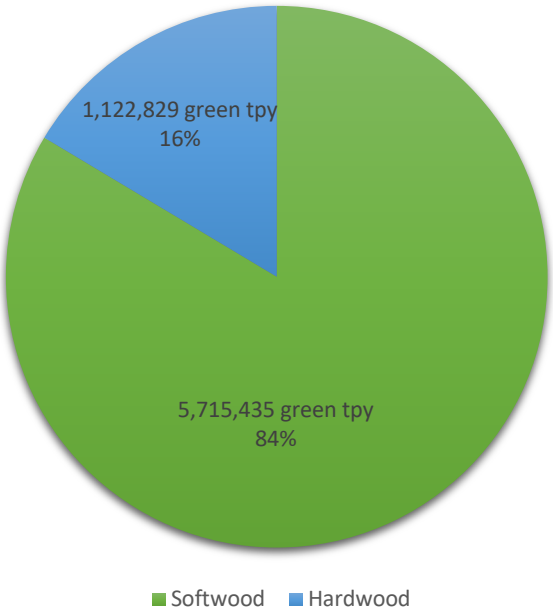


Figure 3: Estimated Sawmill Residual Generation in Supply Basin, by County

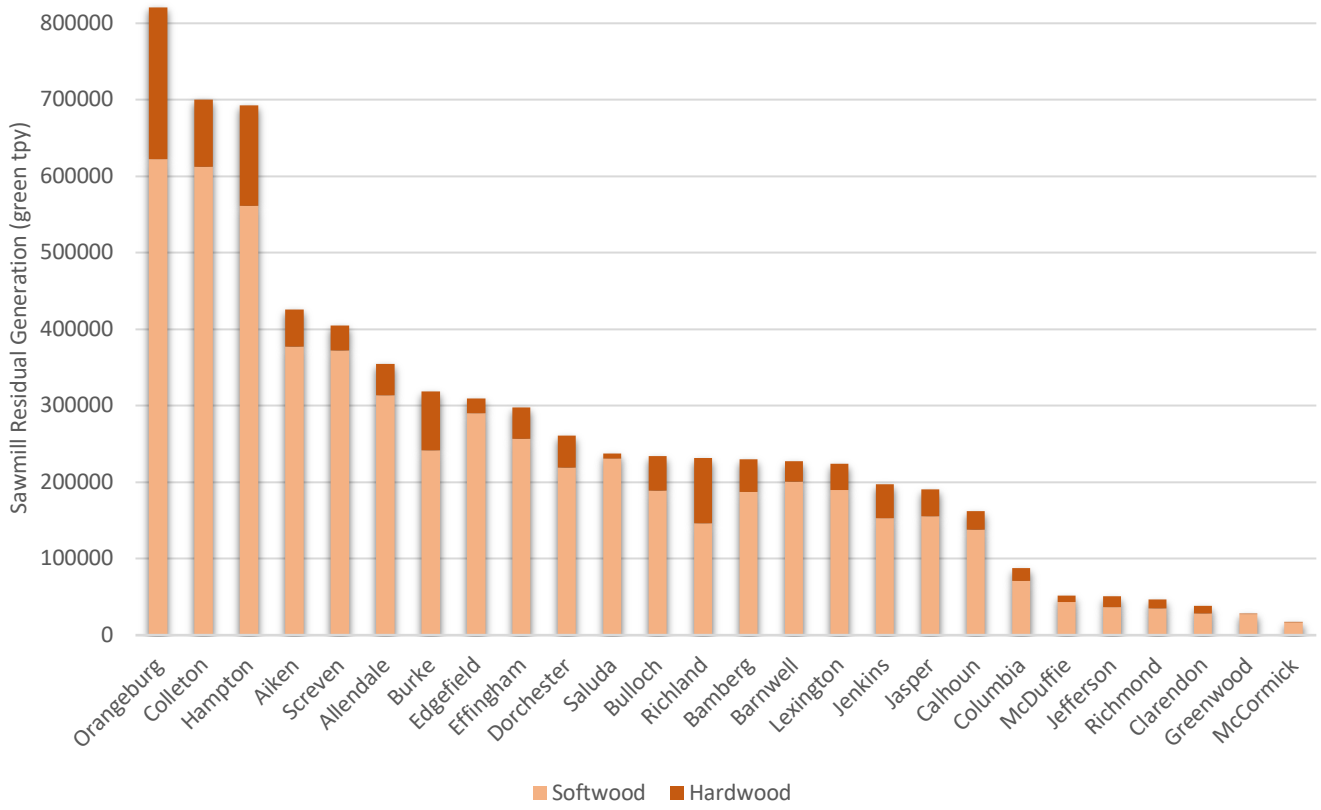


Figure 4: Sawmill Residual Generation Curve

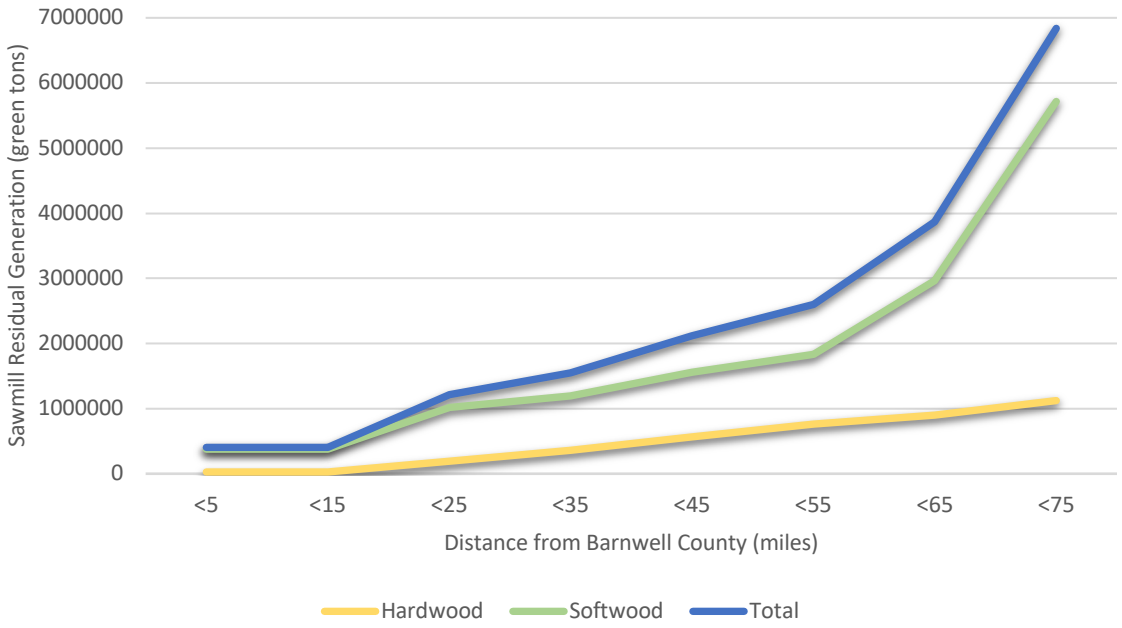


Figure 5: Total Estimated Softwood Sawmill Residual Generation, by Type

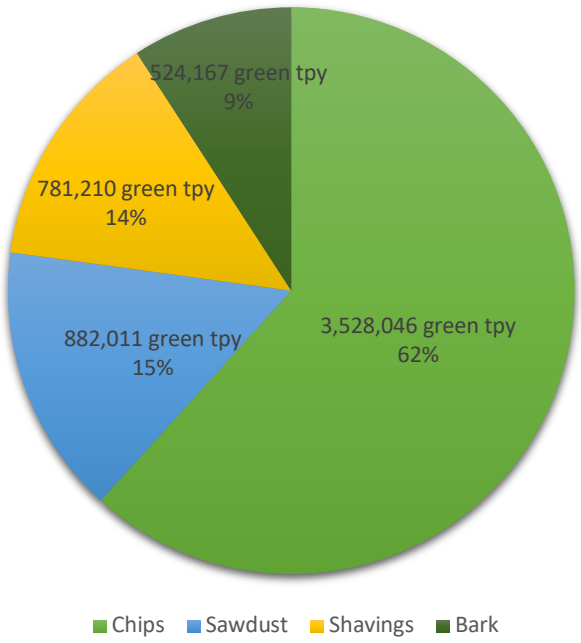
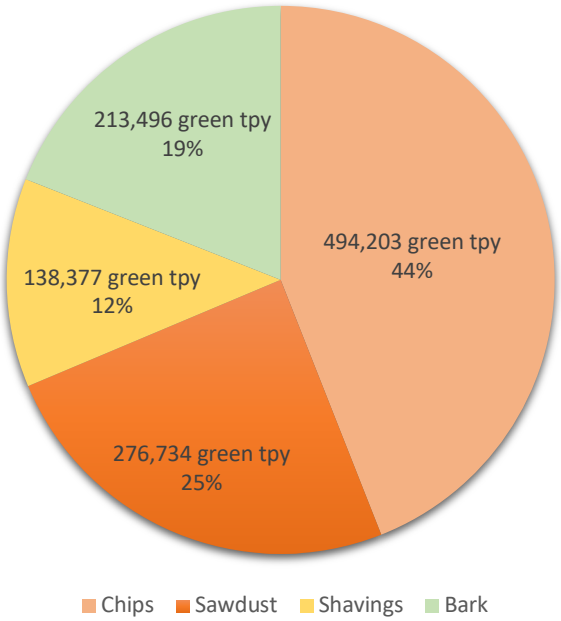


Figure 6: Total Estimated Hardwood Sawmill Residual Generation, by Type



2.3 Year-to-Year Generation Variation

Sawmill Residuals

Historical Sawmill Residual generation data were unavailable. To understand year-to-year variation in Sawmill Residual generation, we use roundwood production data as proxy[4]. As shown in Figure 7 and Table 2, the year-to-year variation in roundwood production in the Supply Basin is significant. For example, between 2011 and 2013, roundwood production decreased by 31%, while over the following two years it increased by 63%. However, it is important to note that the variation in roundwood production is mainly due to changes in *hardwood* roundwood production. Softwood roundwood production tends to be stable, with the exception of 2015, when it increased significantly (Figure 7).

[4] For chips, sawdust and shaving: Estimated Production, Consumption and Surplus Mill Wood Residuals in Canada - 2004 A National Report

Figure 7: Estimated Historical Roundwood Timber Production in Supply Basin

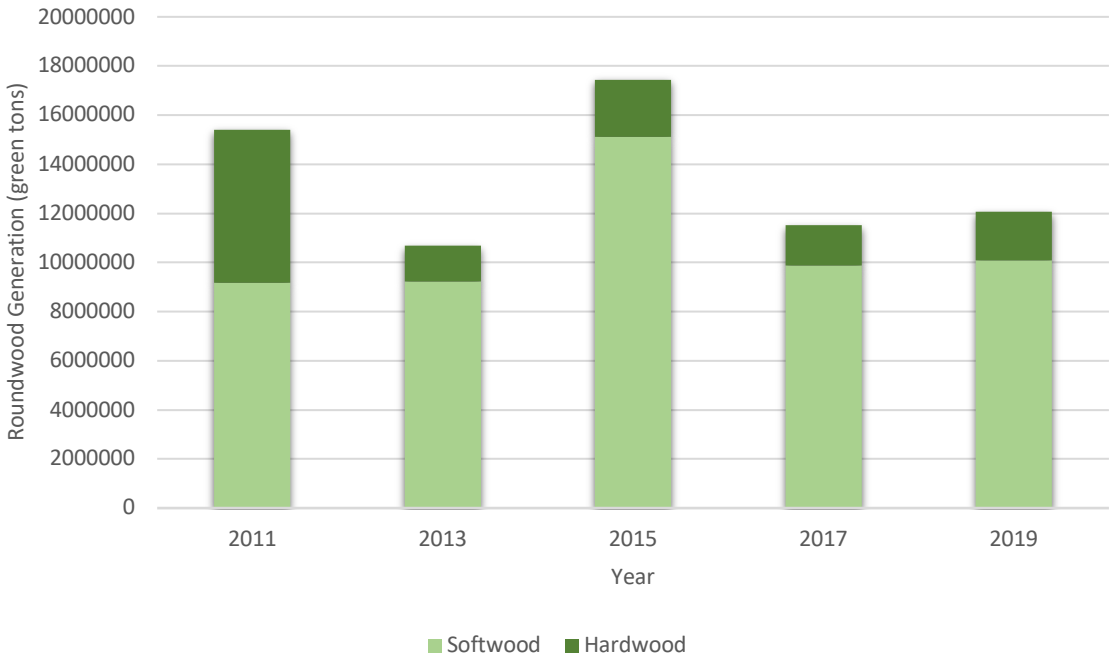


Table 2: Total Bi-annual Roundwood Timber Production in Supply Basin (gt/yr)

	Softwood	Hardwood	Total	%Change of Total
2011	9,160,708	6,238,135	15,398,872	-
2013	9,217,158	1,455,710	10,672,868	-31%
2015	15,103,549	2,319,188	17,422,737	63%
2017	9,876,707	1,652,339	11,529,047	-34%
2019	10,080,132	1,976,811	12,056,943	5%

Forest Residue

The variation in Forest Residue generation in the Supply Basin is relatively small (Figure 8, Table 3). The largest year-to-year change was an increase of 15% between 2015 and 2016. Otherwise, since 2014, the year-to-year variation was within 6% change.

It is worth noting that the general Forest Residue generation trend is upward: between 2014 and 2019, the Supply Basin experienced an 8% increase.

Figure 8: Estimated Historical Forest Residue Generation in the Supply Basin

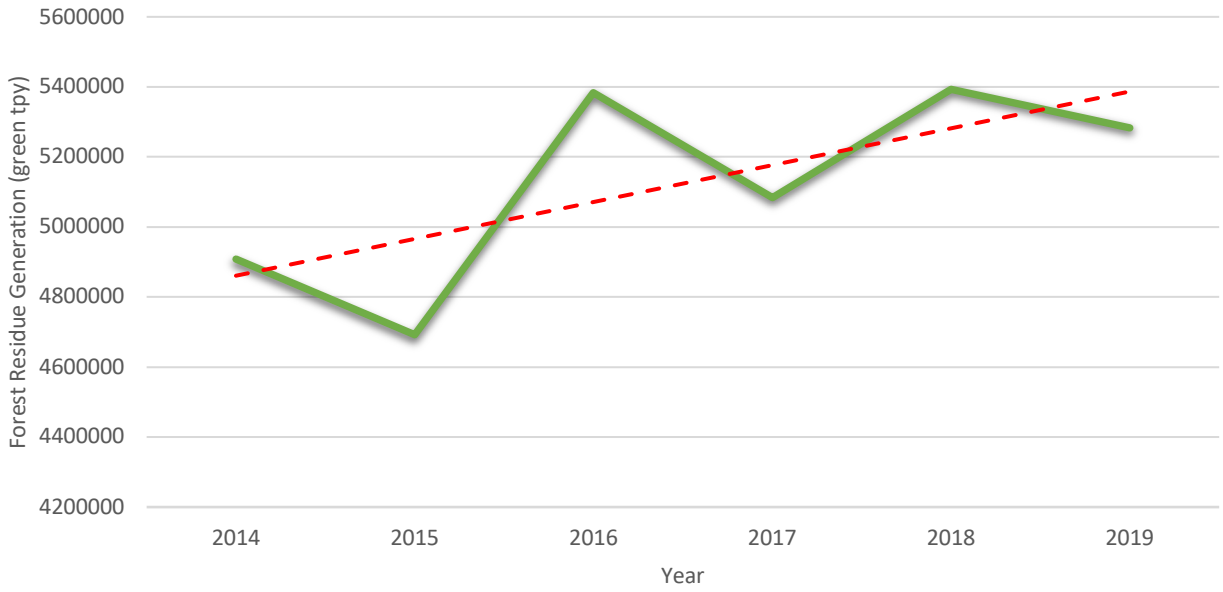


Table 3: Total Estimated Historical Forest Residue Generation in the Supply Basin

	Forest Residue Generation (gt/yr)	% Change
2014	4,907,566	-
2015	4,692,170	-4%
2016	5,383,275	15%
2017	5,083,352	-6%
2018	5,393,038	6%
2019	5,283,566	-2%

2.4 Suppliers

Sawmill Residuals

There are 24 relatively large sawmills located in the Supply Basin (Map 3, Table 4). Nine of the sawmills indicated interest in supplying Sawmill Residuals to a project in Barnwell. However, due to trade confidentiality reasons, none of the sawmills disclosed available quantities or prices. Nine of the 24 sawmills indicated that all Sawmill Residuals they generate are unavailable, being either under contract with other markets or utilized internally. The remaining six sawmills did not respond to our inquiries within the study timeframe.

Map 3: Sawmills in the Supply Basin

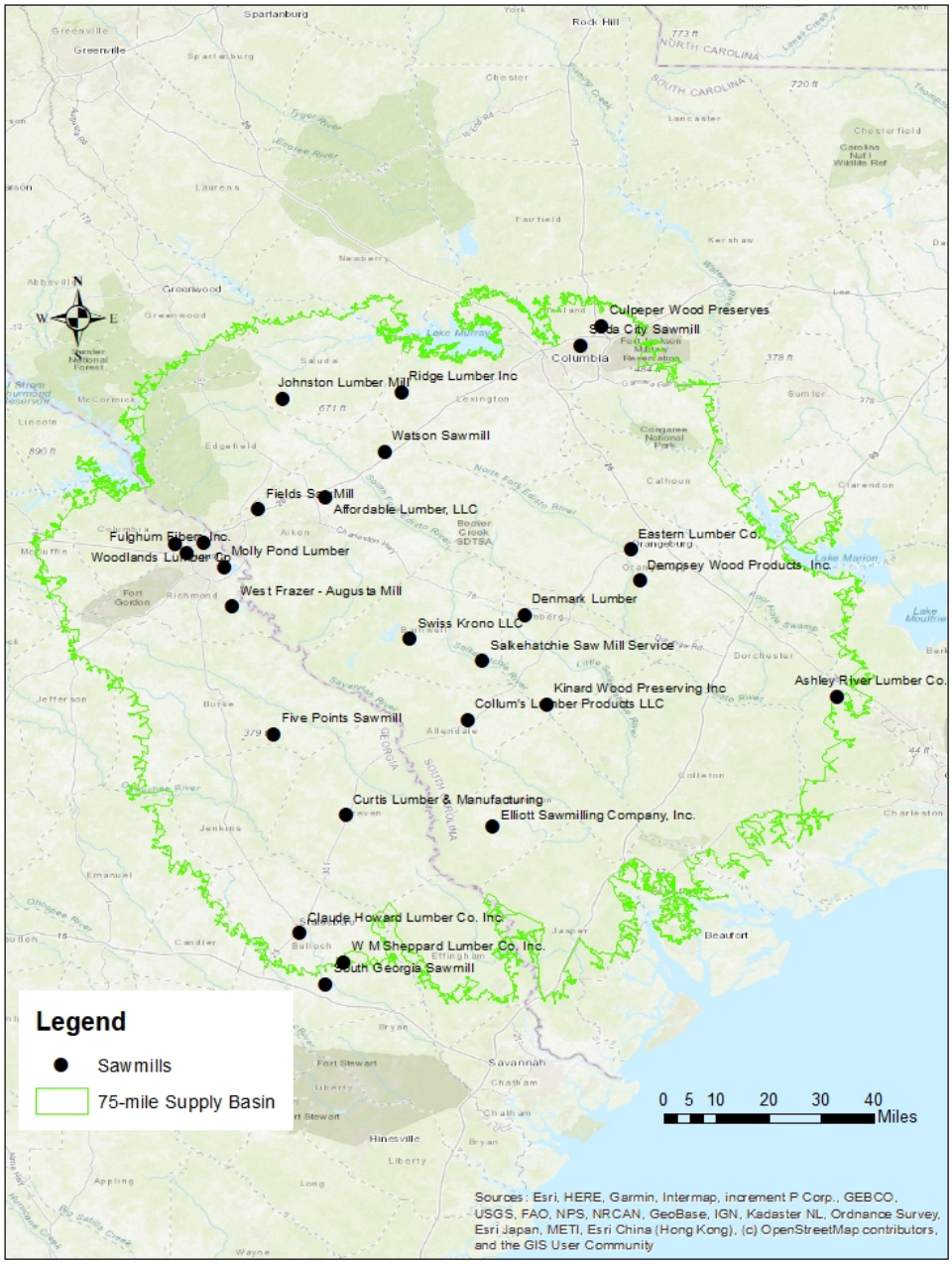


Table 4: Sawmills in the Supply Basin

Sawmill Name	Location	Interested in Supplying?	Phone Number	General Notes
Affordable Lumber, LLC	Aiken, SC	No	866.334.9923	Small mill, not much generation.
Ashley River Lumber Co.	Ridgeville, SC	Yes	803.707.5625	Residuals available – unwilling to disclose price without desired quantity.
Claude Howard Lumber Co. Inc.	Statesboro, GA	No	803.267.2712	All generation already contracted out.
Collum's Lumber Products LLC	Allendale, SC	No Response	404.482.1777	Contacts attempts unsuccessful.
Culpeper Wood Preserves	Columbia, SC	No	803.640.8493	All residuals used internally.
Curtis Lumber & Manufacturing	Sylvania, GA	Yes	803.687.0497	Large volume generated and available.
Dempsey Wood Products, Inc.	Rowesville, SC	Yes	912.564.9360	Large quantities of residual available.
Denmark Lumber	Denmark, SC	Yes	803.531.1887	Green residuals available.
Elliott Sawmilling Company, Inc.	Estill, SC	Yes	706.793.8753	Green residuals available.
Fields SawMill	Graniteville, SC	No Response	803.533.0158	Facility has a "mountain of waste" for which the facility owner is actively seeking more sustainable disposal methods.
Five Points Sawmill	Sardis, GA	No	706.860.7566	Mill temporarily closed due to medical reasons.
Fulghum Fibers Inc.	Augusta, GA	Yes	706.664.3530	All generation already contracted out.
Johnston Lumber Mill	Johnston, SC	Yes	803.532.2310	Green residuals generated, potentially available.
Kinard Wood Preserving Inc	Ehrhardt, SC	Yes	706.465.3506	Residuals available.
Molly Pond Lumber	Augusta, GA	No Response	912.764.5407	Contact attempts unsuccessful.
Ridge Lumber Inc	Leesville, SC	No Response	912.842.2197	Contact attempts unsuccessful.
Salkehatchie Saw Mill Service	Barnwell, SC	No	803.608.4460	All residuals used internally.
Soda City Sawmill	Columbia, SC	Yes	800.347.5033	Currently a small facility, but is growing rapidly. While selling residuals is a new business for the facility, they would be interested as operations continue to expand.
South Georgia Sawmill	Brooklet, GA	No Response	912.839.4279	Contact attempts unsuccessful.
Swiss Krono LLC	Barnwell, SC	No	803.932.2100	No sawdust or chips available.
W M Cramer Lumber Co.	Augusta, GA	No	912.839.4279	All residuals used internally.
W M Sheppard Lumber Co. Inc.	Brooklet, GA	No	864.456.3494	All generation already contracted out.
Watson Sawmill	Batesburg-Leesville, SC	No	803.924.9086	All residuals used internally.
West Frazer - Augusta Mill	Augusta, GA	No Response	864.575.2479	Contact attempts unsuccessful.

Forest Residues

There are at least 84 logging companies registered in the Supply Basin that could potentially process Forest Residue from their harvesting operations to supply a project in Barnwell (Table 5). Only a fraction of these logging companies currently operate an in-woods chipper or grinder; that is, only a fraction currently process Forest Residue. However, our experience in the industry, supported by verbal indications from surveyed companies, suggests that with additional demand for Forest Residue, logging companies will invest in processing equipment.

Table 5: List of Companies with Harvesting Operations Registered in the Supply Basin

Company Name	Company Type	Location
Affordable Lumber, LLC	Sawmill	Aiken, SC
Arcola Timber Co., L.L.C.	Logger	Barnwell, SC
Ashley River Lumber Co.	Sawmill	Ridgeville, SC
Austin Logging Inc	Logger	Lexington, SC
B. K. Roddenberry Timber, Inc.	Logger	Columbia, SC
Bbw Logging LLC	Logger	Grovetown, GA
Bedenbaugh Logging of Prosperity Inc	Logger	Prosperity, SC
Beech Island Timber and Construction, Inc.	Logger	Jackson, SC
Bobby Claxton Timber Harvesting, Inc.	Logger	Cameron, SC
Boddiford Timber Co Inc	Logger	Sylvania, GA
Bootle Logging Co LLC	Logger	Yemassee, SC
Bowers Timber Company	Logger	Varnville, SC
Brown Chappel Logging LLC	Logger	Early Branch, SC
Brown Timber & Logging, Inc	Logger	Summerville, SC
Brushy Creek Logging, LLC	Logger	Gaston, SC
Canal Wood LLC	Logger	Walterboro, SC
Carolina Timber Inc.	Logger	Hardeeville, SC
Carter Logging Inc	Logger	Walterboro, SC
Cason Logging Company	Logger	Lexington, SC
Charles Carter Logging LLC	Logger	Walterboro, SC
Charles Larry Cowart	Logger	Walterboro, SC
CL Logging, LLC	Logger	Bamberg, SC
Claude Howard Lumber Co. Inc.	Sawmill	Statesboro, GA
Clear Pond Logging, LLC	Logger	North, SC
Collum's Lumber Products LLC	Sawmill	Allendale, SC
Crosby Logging & Timber Inc	Logger	Edgefield, SC
Culpeper Wood Preserves	Sawmill	Columbia, SC
Curtis Lumber & Manufacturing	Sawmill	Sylvania, GA
Davis Swamp Logging LLC	Logger	Bamberg, SC
Deerwood Logging LLC	Logger	Salley, SC
Deloach Timber Harvesting Inc	Logger	Luray, SC
Dempsey Wood Products, Inc.	Sawmill	Rowesville, SC
Denmark Lumber	Sawmill	Denmark, SC
Douglas & Tracy Logging, Incorporated	Logger	Edgefield, SC
Dyson Logging Inc	Logger	Springfield, GA
Eastern Lumber Co.	Sawmill	Orangeburg, SC
Elliot Hutson Logging	Logger	Edgefield, SC
Elliott Sawmilling Company, Inc.	Sawmill	Estill, SC
Fields SawMill	Sawmill	Graniteville, SC
Five Points Sawmill	Sawmill	Sardis, GA
Forehand Logging Co Inc	Logger	Sylvania, GA

Forest Hills Logging Inc	Logger	Saluda, SC
Forest Seckinger Products Inc	Logger	Guyton, GA
Fulghum Fibers Inc.	Sawmill	Augusta, GA
Gary Neidlinger Logging, LLC	Logger	Springfield, GA
Gordon Logging Co Inc	Logger	Varnville, SC
Gordon's Logging	Logger	Columbia, SC
Groton Land Co Inc	Logger	Salley, SC
Gruber Wood Inc	Logger	Saint George, SC
Heyward Brown Logging	Logger	Springfield, GA
J D Burns & Sons Logging Inc	Logger	Newington, GA
Jerry L Burns Logging Inc	Logger	Newington, GA
Johnston Lumber Mill	Sawmill	Johnston, SC
Justin Logging	Logger	Orangeburg, SC
JWL Logging Company LLC	Logger	Ninety Six, SC
K. O. Logging, LLC	Logger	Barnwell, SC
Kc Logging Inc	Logger	Branchville, SC
Kinard Wood Preserving Inc	Sawmill	Ehrhardt, SC
Koppers Utility and Industrial Products Inc.	Logger	Orangeburg, SC
L & P Logging, Inc.	Logger	Springfield, GA
Leeway Ltd.	Logger	Norway, SC
Log Creek Thinning, Inc.	Logger	Edgefield, SC
Longhorn Logging LLC	Logger	Harleyville, SC
Martin Brothers Inc	Logger	Summerton, SC
Michael's Logging LLC	Logger	Ehrhardt, SC
Mill Creek Logging LLC	Logger	Leesville, SC
Molly Pond Lumber	Sawmill	Augusta, GA
Mountain View Farms Inc	Logger	Early Branch, SC
North Edisto Logging, Inc.	Logger	Leesville, SC
Owens Logging & Landclearing LLC	Logger	Statesboro, GA
PSCNC Logging	Logger	Evans, GA
Rango Williams Logging Inc	Logger	North, SC
Ridge Lumber Inc	Sawmill	Leesville, SC
Robert's Forestry Inc	Logger	Newberry, SC
Ronnie Atkinson Logging, LLC	Logger	Springfield, GA
Roy Eugene Bell	Logger	Estill, SC
Roy Williams Logging	Logger	Neeses, SC
S M Bodiford & Sons Inc	Logger	Norway, SC
Safe Logging, LLC	Logger	Hampton, SC
Salkehatchie Saw Mill Service	Sawmill	Barnwell, SC
Savannah Creek Logging LLC	Logger	Bamberg, SC
Shaw Logging, Inc	Logger	Yemassee, SC
Smith Logging Company of Grays, South Carolina, Inc.	Logger	Early Branch, SC
Smith Timber Inc	Logger	Gadsden, SC

Soda City Sawmill	Sawmill	Columbia, SC
South Carolina Pole and Piling, Inc	Logger	Leesville, SC
Southern Forest Products, LLC	Logger	Hampton, SC
Southern Pine Logging Inc	Logger	Saluda, SC
Swiss Krono LLC	Sawmill	Barnwell, SC
Thomas Neidlinger Logging, Inc.	Logger	Springfield, GA
Three Gen Inc	Logger	Yemassee, SC
Thurmond Logging Company, Inc	Logger	Clarks Hill, SC
Thurmond Logging Company, Inc.	Logger	Appling, GA
Timber Express L.L.C.	Logger	Pineland, SC
Tom E Boy Forest Products, LLC	Logger	Statesboro, GA
Tracy's Logging LLC	Logger	Leesville, SC
Travis' Logging LLC	Logger	Blythe, GA
V. P. Kiser Lumber Company, Inc.	Logger	Bowman, SC
W M Cramer Lumber Co.	Sawmill	Augusta, GA
W M Sheppard Lumber Co. Inc.	Sawmill	Brooklet, GA
W Lominick Logging	Logger	Edgefield, SC
W. Wright Logging	Logger	Aiken, SC
Walterboro Pole Company, LLC	Logger	Walterboro, SC
Washington Brothers Logging	Logger	Batesburg-Leesville, SC
Watson Sawmill	Sawmill	Batesburg-Leesville, SC
WCB Logging, Inc.	Logger	Walterboro, SC
West Frazer - Augusta Mill	Sawmill	Augusta, GA
William Danny Richardson	Logger	Springfield, GA
Woodlands Lumber Co	Sawmill	Martinez, GA

3. Demand

3.1 Competitors

There are four categories of facilities consuming Sawmill Residuals and Forest Residue in significant quantities: biomass power plants, biomass cogeneration heat and power (CHP) plants, pellet mills, and pulp mills. Within the 150-mile drive Competition Zone, there are six biomass power plants, four biomass CHP plants, six pellet mills and eleven pulp mills (Map 4, Table 5). Methodology for estimating competitor woody biomass consumption is provide in Appendix D.

In total, these facilities consume an estimated 10,782,276 gt/yr of woody biomass. Biomass power plants consume an estimated 1,146,000 gt/yr of woody biomass (11% in total); biomass CHP plants consume 1,543,000 gt/yr (14%); pellet mills consume 2,213,150 gt/yr (20%); and pulp mills consume 5,905,366 gt/yr (55%) (Figure 8).

Not all the 10.8 million gt/yr consumed by competitors is sourced from the Supply Basin. For example, competitors located at large distances from the BDO Zone source much of their feedstock from areas outside the Supply Basin. We estimate that approximately 50% of feedstock competitors consume is sourced outside of the Supply Basin. This is because of the presence of large pulp mills located at the northern edge of the Competition Zone (Map 4). Therefore, the estimated demand for woody biomass generated in the supply basin is 5.4 million gt/yr.

Map 4: Competitors within 150-mile Drive Distance

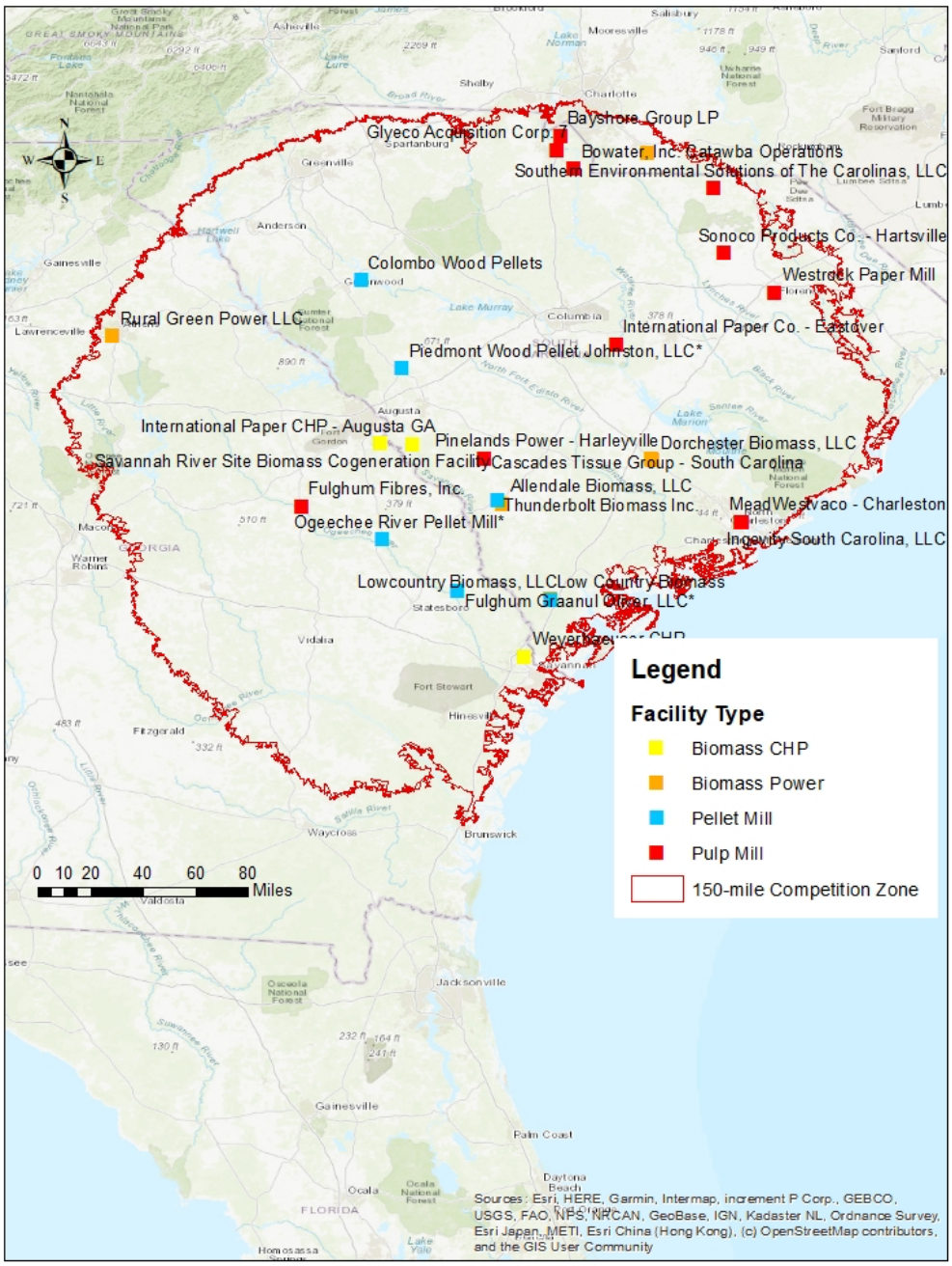
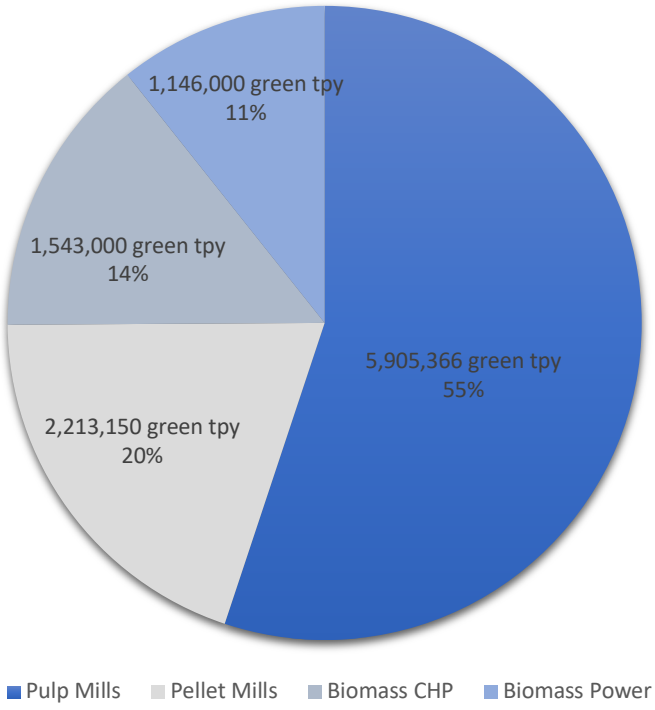


Table 6: Competitors within 150-mile Drive Distance

Facility Name	Facility Type	City	Estimated Feedstock Intake (green tons/year)
Cascades Tissue Group – South Carolina	Pulp Mill	Barnwell, SC	534,556
Thunderbolt Biomass Inc.	Pellet Mill	Allendale, SC	132,000
Allendale Biomass, LLC	Biomass Power	Fairfax, SC	200,000
Ameresco Savannah River CHP	Biomass CHP	Aiken SC	160,000
Savannah River Site Biomass Cogeneration Facility	Biomass CHP	Aiken SC	200,000
International Paper CHP – Augusta GA	Biomass CHP	Augusta, GA	793,000
Piedmont Wood Pellet Johnston, LLC[5]	Pellet Mill	Trenton, SC	450,000
Ogeechee River Pellet Mill[8]	Pellet Mill	Millen, GA	800,000
Fulghum Graanul Oliver, LLC[8]	Pellet Mill	Oliver, GA	180,000
Dorchester Biomass, LLC	Biomass Power	Harleyville, SC	200,000
Pinelands Power – Harleyville	Biomass Power	Harleyville, SC	356,000
International Paper Co. – Eastover	Pulp Mill	Eastover, SC	534,566
Lowcountry Biomass, LLC	Biomass Power	Ridgeland, SC	200,000
Lowcountry Biomass, LLC	Pellet Mill	Ridgeland, SC	100,000
Fulghum Fibres, Inc.	Pulp Mill	Louisville, SC	534,556
Enviva Pellets – Greenwood	Pellet Mill	Greenwood, SC	551,150
Weyerhaeuser CHP	Biomass CHP	Wentworth, GA	390,000
MeadWestvaco – Charleston	Pulp Mill	North Charleston, SC	534,556
Ingevity South Carolina, LLC	Pulp Mill	Charleston, SC	534,556
Bowater, Inc. – Catawba Operations	Pulp Mill	Catawba, SC	534,556
Glyeco Acquisition Corp. 7	Pulp Mill	Rock Hill SC	534,556
Sonoco Products Co. – Hartsville	Pulp Mill	Hartsville, SC	534,556
Bayshore Group LP	Pulp Mill	Fort Mill, SC	534,556
Westrock Paper Mill	Pulp Mill	Florence, SC	534,556
Southern Environmental Solutions of the Carolinas, LLC	Pulp Mill	Chesterfield, SC	534,556
Union County Green Energy Biogas Park, LLC	Biomass Power	Monroe, NC	80,000
Rural Green Power LLC	Biomass Power	Athens, GA	110,000

[5] Proposed Facility

Figure 8: Consumption of Woody Biomass by Competitor Type



3.2 Future Competitors

We identified two proposed pellet mills planned to be located within 150-mile drive from the Barnwell BDO Zone: Ogeechee River Pellet Mill and Piedmont Wood Pellet Johnston. Ogeechee River Pellet Mill, planned to be located in Millen, GA, has a proposed intake capacity of 800,000 gt/yr of woody biomass. The last time the project was discussed was in 2018[6], therefore it is possible that the pellet mill is no longer in development. Piedmont Wood Pellet Mill Johnston, to be located in Trenton, SC, has a planned intake capacity of 450,000 gt/yr of woody biomass.

4. Pricing

4.1 Current Pricing

As of Q1 2021, the average woody biomass pricing in the Supply Basin was as follows (all prices FOB generation site)[7]:

- Sawmill Residuals
  - Bark: $19.22/gt;
  - Sawdust: $21.28/gt;
  - Shavings: $36.14/gt;
  - Softwood Chip: $52.00/gt (as of 2017[8]);
  - Hardwood Chip: $50.50/gt (as of 2017).
- Forest Residues: $24.21/gt.

These data were corroborated by verbal indications from sawmills and harvesting companies.

[6] Source: https://www.southernenvironment.org/uploads/maps/SELC_WoodPelletExportMap_2018_0123+table.pdf
[7] Source: TimberMart South
[8] More recent data were unavailable.

4.2 Historical Pricing

Historical prices of Sawmill Residuals and Forest Residues are provided in Table 7 and shown on Figure 9.

Sawmill Residuals

Chips. Despite slight annual variation, the average prices of Softwood and Hardwood Chip remained relatively constant between 2010 and 2017. Although recent pricing data for Chips were unavailable, we expect that the prices remained relatively stable until 2021.

Sawdust. Sawdust average prices increased significantly over the past decade, from an average of $12.85/gt in 2010 to $20.02/gt in 2020. Notably, the most significant pricing jump was between 2013 and 2016, from $13.52/gt in 2013 to $19.61/gt in 2016. This increase in Sawdust prices coincided with wood pellet mill developments in the Southeast.

Shavings. Despite slight annual variation, Shavings prices remained relatively constant over the past decade. In 2010, the average Shavings price was $32.89/gt, and in 2020 it was $34.84/gt. Shavings prices are significantly higher than Sawdust prices due to their use in the animal bedding market. For this reason, the development of the pellet mills in the last decade did not affect Shavings prices significantly.

Bark. Bark prices increased slightly over the past decade, from an average of $15.96/gt in 2010 to $18.15/gt in 2020. Notably, average Bark prices were stable between 2016 and 2019, increasing slightly since.

Forest Residues

Forest Residues average prices have been increasing steadily from 2011. In 2011, the average price was $16.46/gt and in 2020 it was $24.21/gt.

As previously discussed, our experience in the industry, supported by verbal indications from surveyed companies, suggests that with additional demand for Forest Residue, logging companies will invest in processing equipment. Equipment capital expenses start at approximately $27,000 for an industrial woodchipper.

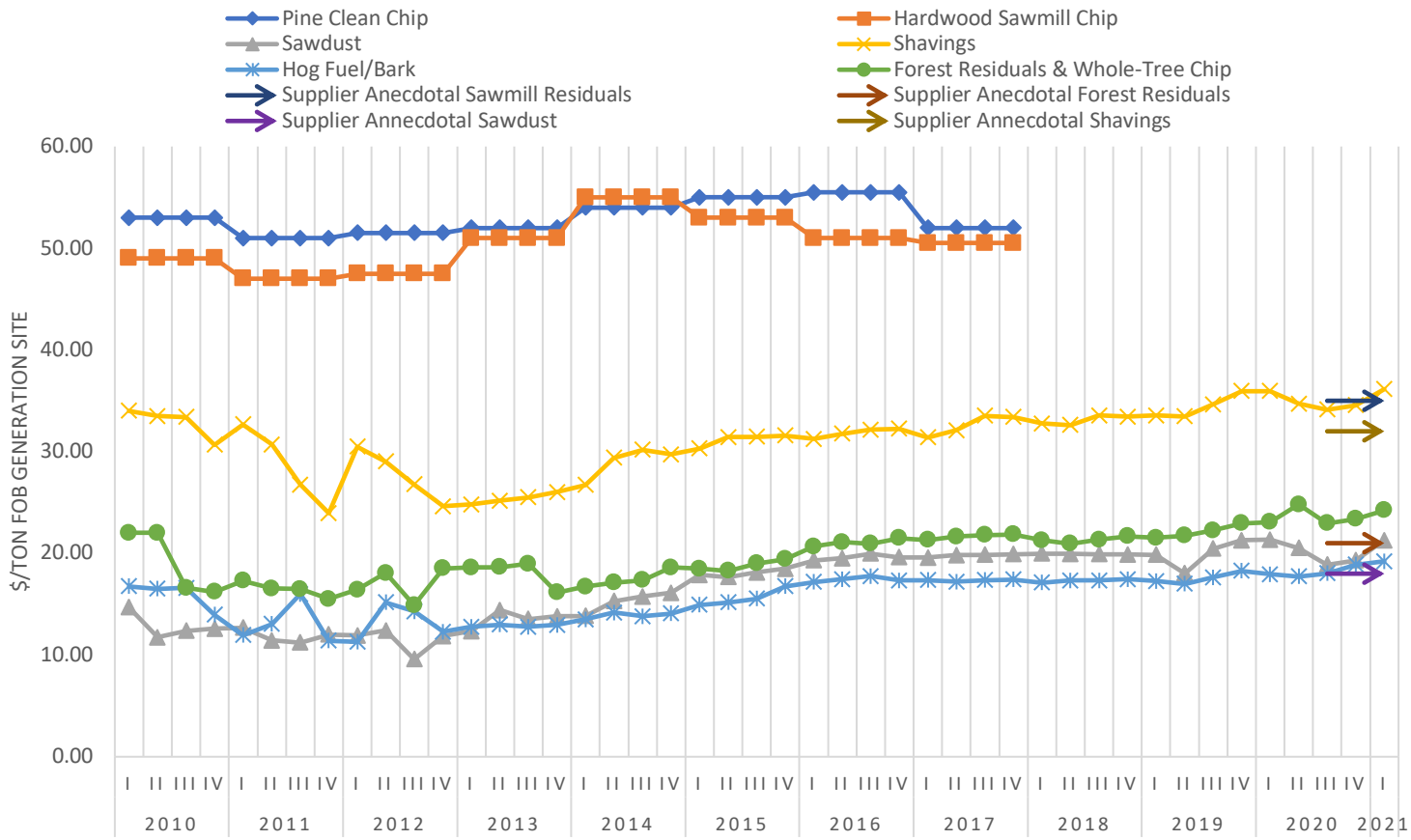
Table 7: Historical Average Annual Price by Woody Biomass Type, $/gt FOB Generation Site

	Softwood Chip	Hardwood Chip	Sawdust	Shavings	Bark	Forest Residue
2010	53.00	49.00	12.85	32.89	15.96	19.19
2011	51.00	47.00	11.84	28.52	13.10	16.46
2012	51.50	47.50	11.45	27.73	13.26	16.97
2013	52.00	51.00	13.52	25.38	12.88	18.10
2014	54.00	55.00	15.25	29.01	13.90	17.46
2015	55.00	53.00	18.04	31.19	15.60	18.79
2016	55.50	51.00	19.61	31.85	17.43	21.05
2017	52.00	50.50	19.78	32.60	17.34	21.65
2018	-	-	19.92	33.10	17.31	21.32

2019	-	-	19.90	34.40	17.55	22.12
2020	-	-	20.02	34.84	18.15	23.56
Q1 2021	-	-	21.28	36.14	19.22	24.21

Internal data from previous Ecostrat studies conducted in the region confirm that Clean Chip prices have increased in the short-term. Vendors in the region previously sold Clean Chip at $30/ton FOB generation site in August 2019, representing an 17% increase in price over 22 months to today's price of $35/ton FOB generation site.

Figure 9: Historical Average Annual Price by Woody Biomass Type, $/gt FOB Generation Site



5. Transportation

Sawmill Residuals and Forest Residues are transported in open-top or live-bottom trailers. Conversations with local stakeholders revealed that most Sawmill Residual and Forest Residuals are currently transported with standard open-top trailers. New bioprocessing facilities may have to design around this already-existent open-top trailer infrastructure or be prepared to invest significant capital to acquire more specialized equipment. Per a local industry expert, many chipping operations in the region also transport their chips via rail. Depending on a facility's preferred dominant feedstock, a new bioprocessing facility may want to consider rail location, access, and distribution in relation to chip transportation, should Clean or Dirty Chips be the preferential feedstock.

Sawmill Residuals

Transportation of Sawmill Residuals is most commonly done by sawmills; that is, sawmills own and operate trucks and trailers used for Sawmill Residual delivery. When sawmills do not have enough transportation equipment for required deliveries, transportation is outsourced to third-party hauling companies. We identified 50 trucking companies operating in the Supply Basin that could be potentially used for Sawmill Residual transportation.

Forest Residues

Transportation equipment used to transport Forest Residues is owned and operated either by logging/harvesting companies or by third-party trucking companies. We identified 84 logging/harvesting companies (Table 5) and 50 trucking companies (Appendix E) operating in the Supply Basin.

6. Infrastructure

6.1. Roads

The state of South Carolina boasts a stout infrastructure network that supports the forest industry. The state's highway system provides direct access to 60% of the US population within 1 day[12], a testament to the robust and well-maintained nature of the road infrastructure that can be utilized by any potential project looking to site in Barnwell County. Preliminary GIS analysis confirmed an effective, intersecting, and expansive network of roads and highways, in and out of Barnwell County. Anecdotally, the existing movement of millions of tons of woody biomass around, and out of, Barnwell is indicative of the existing infrastructure being effective for industry utilization. No bridges on the major highways in or out of Barnwell County that could produce weight-limit risks during transport of feedstock were identified.

6.2. Availability of Labor

The forestry industry in the state of South Carolina is strong, and has a long history of production and performance. Some impressive economic statistics pertaining to the forestry industry in the state, taken from the South Carolina Forestry Commission[9], include:

- 68% of the state's land area being forest/timberland;
- Stable forestland acreage since 1968;
- 88% of the forestland in the state is privately owned, and therefore can be auctioned off to loggers when ready for harvesting;
- Forestry is the top manufacturing industry in the state, employing more than 90,000 individuals;
- Forestry's annual payroll is $4.1 billion, again number one in the state;
- Forest products are the largest export by volume from the Charleston Port.

A 2019 publication from the South Carolina Forestry Commission's Resource Development Division[10] found that there was a 16.4% increase in total forestry employment within the state from 2017 to 2018. In 2018, forestry induced 23,060 new jobs. The study commented that the increased demand for timber products will continue to drive the state's economy, both through creating new forestry jobs and shifting already-existing jobs within subsections of the industry. The study explicitly mentioned the global biomass and biofuels economy as one of the forestry subsectors they expect to play a commanding role in shaping the overall industry's future and job creation. Therefore, the size of the industry makes it likely that there will be a consistent supply of available laborers to carry on feedstock procurement and management activities.

[9] South Carolina Forest Industry Facts. https://www.state.sc.us/forest/scfifacts.pdf
[10] South Carolina Forestry Commission. The Wave of Wood: Forestry's Economic Contribution to South Carolina's Economy in 2018. http://www.state.sc.us/forest/pubs/scfcimplaneconomicimpactstudy2018-web.pdf

7. Policy

7.1. Local, Federal & National Laws, Regulations and Permitting Pertaining to Biomass

No pertinent local or state laws or regulations pertaining to biomass were identified. Federally, a potential project could engage in the Renewable Identification Number (RIN) marketplace, should it utilize proper qualifying forest residue feedstocks.

APPENDIX B: RISK INDICATOR SCORING METRICS

Category 1: Supplier Risk

1.1. Longevity & History of Supplier Performance

Rationale. Number of years in business is a positive indicator of future solvency. Historical performance is an indicator of future performance.

Raw RI Score. The forest industry had been historically one of the most important industries in the Barnwell BDO Zone. The industry is healthy and growing[11]. Most sawmills located in the Supply Basin have been in operations for many decades. The average age of sawmills (of which years of operations could be determined) is 58 years. Two sawmills have been in operations for over 100 years. Due to the long history of forest industry in the Supply Basin coupled with longevity of the sawmills, risk related to longevity and history of supplier performance is deemed low. Raw RI score is 1 out of 10.	**Score 1**
Notched Salience. No adjustment.	**Score Unnotched**
Impact Level. RI Impact Level is deemed *low*.	**Score 3.33**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 3.33 out of 100.	**Score 3.33**

1.2. Production Capacity

Rationale. Supplier production capacity can be a strong indicator of long-term credit worthiness and future solvency. Higher production capacities can denote strength of operational elements, including cash flows, that are important to future solvency.

Raw RI Score. **Sawmill Residuals.** There are 24 sawmills generating an estimated 6,838,264 green tons per year (gt/yr) of Sawmill Residuals. Therefore, on average, each sawmill generates approximately 285,000 gt/yr. This shows that sawmills in the Supply Basin have comparatively large production capacities. For example, sawmills located in another healthy forest industry region, interior British Columbia, generate an average of 90,000 gt/yr of Sawmill Residuals. **Forest Residue.** There are 84 logging/harvesting companies generating an estimated 5,283,566 gt/yr of Forest Residue. Although we do not have data in other regions to compare this production to, the large quantity of Forest Residue generated coupled with a large number of logging/harvesting companies is favorable to new bio-projects.	**Score 2**

[11] Barnwell County, South Carolina | Timber Update: https://timberupdate.com/locations/barnwell-county-south-carolina/

Due to the two arguments above, the risk associated with supplier production capacity is deemed low. We do not assign it the lowest risk level, however, because we could not compare Forest Residue production capacity directly with other regions. Therefore, the raw RI score is 2 out of 10.

Notched Salience. No adjustment.	**Score** Unnotched
Impact Level. RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 19.98 out of 100.	**Score 19.98**

1.3. Suppliers' Dependence on, or Preference for, Competing Markets

Rationale. Supplier may have a vested interest or preference to supply to specific competitors for biomass feedstock. Preferences may be due to historical, long-term, or personal relationships, less stringent feedstock quality requirements, more flexible operating hours by competing markets, or supplier's dependences on competing markets to accept or purchase other products/by-products. During periods of feedstock shortage such suppliers may be more likely to allocate the scarce supply to a competitor resulting in supply disruptions for the Proponent.

Raw RI Score. **Sawmill Residuals.** Sawmills can be blocked by certain biomass consumers from supplying Sawmill Residuals to other consumers. For example, it is common to see pulp mills using their buying power to request that a sawmill commits 100% of its Sawmill Residuals to it; by not complying, pulp mills may threaten that no Sawmill Residuals will be bought from the sawmill at all. Since sawmills rely on pulp mills as Chip buyers, they are often willing to commit all their Residuals, including Bark, even at slightly lower prices than available in the market. Out of the 24 sawmills we contacted, nine indicated interest in supplying a new bio-project, while nine indicated that they do not have any additional availability. Therefore, we can assume that about 50% of sawmills are not under pressure from large biomass buyers to commit all Sawmill Residuals and will sell on the open market. **Forest Residues.** There is significantly more potential supply than demand for Forest Residues. Therefore, suppliers would deliver to any buyers with no inherent preference. Due to the fact that up to 50% of sawmills in the region may have preferences for existing markets but the remainder of Sawmill Residuals and Forest Residues should be available on the open market, we deem risks associated with supplier dependence on, or preference for, competition moderate to high. Therefore, the raw RI score is 6 out of 10.	**Score 6**
Notched Salience. No adjustments.	**Score** Unnotched
Impact Level. RI Impact Level is deemed *high*.	**Score 9.99**

Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 59.94 out of 100.	**Score 59.94**

1.4. Supplier as a Competitor

Rationale. The risks of feedstock costs going up and availability going down increase if a supplier is also a competitor to the Proponent. In times of feedstock shortage, the risk of supply commitments not being met increases.

Raw RI Score. **Sawmill Residuals.** It is common for sawmills to use Sawmill Residuals as fuel for internal operations, most often Sawdust and Bark. Most sawmills burn a fraction of Sawmill Residuals they generate, but some burn most of Sawdust and Bark. Most sawmills have an ability to switch between burning Sawmill Residuals and natural gas. The decision on whether to burn one or the other is based on economics. For example, with higher demand and prices for Sawmill Residuals, sawmills switch over to natural gas. For this reason, the impact exerted by sawmills' internal use of Sawmill Residuals on the broader market is limited. **Forest Residues.** In terms of Forest Residues, suppliers do not act as potential competitors. Due to the fact that some sawmills use Sawmill Residuals internally, the risks related to suppliers acting as competitors is deemed low-to-medium. Therefore, we assign the raw RI score of 3 out of 10.	**Score 3**
Notched Salience. A bio-project can approach sawmills asking for supply commitments/contracts. Given price agreement, it is likely that sawmills would consider committing to supply and substitute previously utilized Sawmill Residuals with natural gas. However, there may be future regulatory and carbon incentives for sawmills to utilize their own residuals instead of natural gas or may require purchasing natural gas at a higher cost. For this reason, we do not notch RI 1.4.	**Score Unnotched**
Impact Level. RI Impact Level is deemed *low*.	**Score 3.33**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 9.99 out of 100.	**Score 9.99**

1.5. Ownership of Land/Means of Production

Rationale. Suppliers that own land where feedstock is produced, or a production facility, tend to have better control of supply chains and present lower degrees of supply risk.

Raw RI Score.	**Score 1**

Sawmill Residuals. Sawmills own the means of production, therefore, there is no risk associated with this risk indicator from Sawmill Residual supply perspective.

Forest Residues. Despite the fact that loggers/harvesters do not typically own the land where they harvest, this does not pose a risk to the availability of Forest Residues. As historical data show, landowners make timber available for harvesting continually year-to-year.

Due to the arguments above, we deem risks related to ownership of land and means of production as low. Therefore, we assign the raw RI score of 1 out of 10.

Notched Salience. No adjustment.	**Score** **Unnotched**
Impact Level. RI Impact Level is deemed *low*.	**Score** **3.33**
Loaded RI Score. The Loaded RI Score (Notched Salience x Impact Level) is 3.33 out of 100.	**Score** **3.33**

1.6. Ownership of Equipment

Rationale. In most cases, suppliers which own or lease equipment for harvest, collection and processing feedstock are lower risk than those who do not. For example, third-party harvesting equipment may not be available when required. Short harvest windows may be missed if a farmer and contractor cannot schedule harvest times that are convenient and quantity shortages can result.

Raw RI Score. Surveyed loggers already own the equipment necessary to harvest and collect timber and other forest products, including Forest Residues, or expressed a willingness to acquire it. Conversations with local stakeholders revealed that sawmills also own the equipment required to collect and load Forest Residues to open-top trailers. For these reasons, we see no significant risk pathways through equipment ownership from sawmills, but some risk pathways from loggers who would have to invest in new equipment to supply to Forest Residue markets. Therefore, Raw RI score is 3 out of 10.	**Score** **3**
Notched Salience. No adjustment.	**Score** **Unnotched**
Impact Level. RI Impact Level is deemed *moderate*.	**Score** **6.66**
Loaded RI Score. The Loaded RI Score (Notched Salience x Impact Level) is 19.98 out of 100.	**Score** **19.98**

1.7. Ownership of Transportation/Logistics

Rationale. In most cases, suppliers that own or lease transportation equipment necessary to transport biomass from forest or field are lower risk than those who do not. However, in some circumstances, reliance on third-parties to transport biomass is common practice and does not contribute to risk.

Raw RI Score. Woody biomass transportation often requires open-top or live-bottom trailers. Transportation of Sawmill Residuals can likely be achieved through internal ownership and operation of necessary trailers, or through the contracting of a third-party hauling service. Conversations with local stakeholders revealed that logging companies typically handle Forest Residue transportation, through either their own hauling trucks or through a contracted third-party. In addition to loggers, at least 50 trucking companies were identified in Barnwell, though we note that many of these companies appear to operate a small number of trucks. If outsourced, transportation would likely have to be contracted to a small number of major trucking companies or a large number of smaller ones. For these reasons, risks associated with transportation/logistics are deemed to be moderate-low. Raw RI Score is 4 out of 10.	**Score 4**
Notched Salience. From conversations with local industry leaders, it is our understanding that much of the feedstock transportation, even when carried out by different trucking companies, is coordinated by Williams Brothers Trucking (WBT) International, located in Walterboro, South Carolina. Should third-party contracting be required for feedstock transportation, engaging in delivery contracts with companies such as WBT International could help a facility manage the risks associated with contracting small hauling services. As a result, the Raw RI Score is notched by 50%: Notched Salience is 2.	**Score 2**
Impact Level. RI Impact Level is deemed *moderate*.	**Score 6.66**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 13.32 out of 100.	**Score 13.32**

1.8. Supplier as an Aggregator or Broker

Rationale. Aggregators may effectively provide supply chain redundancy and eliminate risk and complexity of dealing with multiple sources of supply by combining supplies into a single master contact. Aggregators can add much needed stability into biomass supply basins by increasing offtake stability for both suppliers and markets. An aggregator can be a more reliable long-term offtake for suppliers by virtue of having multiple markets; and can be a more reliable long-term supplier for markets by virtue of having multiple suppliers. Further, when a single supplier breaches, the aggregator can source from another.	
Raw RI Score. Some major suppliers in the area, such as Corbett and Canal Wood, aggregate residuals and whole-tree chips from various sources. While we were not able to determine what percentage of the market these aggregators control, anecdotal evidence from suppliers in the region revealed that sellers are very eager and ready to engage in business dealings for Forest Residues. It is our understanding that aggregators are keen for new whole-tree chip markets. The presence, and willingness to engage with new markets, of these aggregators presents less	**Score 4**

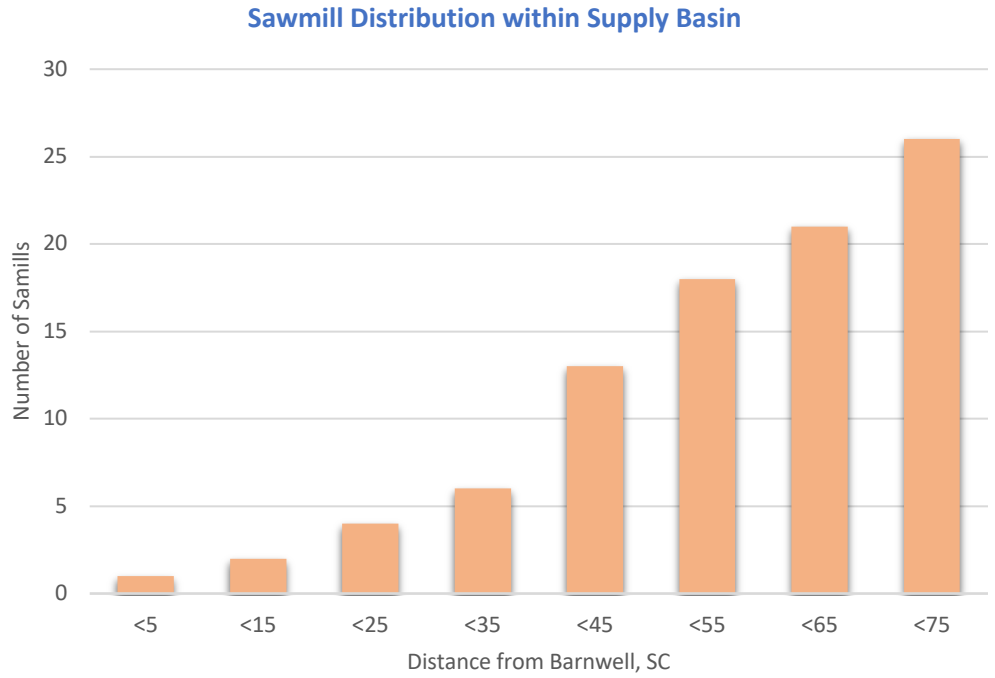
risk than would accompany a larger number of smaller suppliers. Risk associated with suppliers as aggregators or brokers is deemed moderate low. Raw RI Score is 4 out of 10.	
Notched Salience. A total of 110 potential suppliers were identified within the supply basin. Partial de-risking of RI 1.8 could be achieved by sourcing from a variety of suppliers of different sizes, lowering the dependence a project may have on any one supplier. As a result, the Raw RI Score is notched by 25%: Notched Salience is 3.	**Score 3**
Impact Level. RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 29.97 out of 100.	**Score 29.97**

1.9. Distance from Proponent

Rationale. The greater the distance from a supplier to a plant, the more exposure it has to weather and fuel cost risks, and the greater the competitive pressure (to breach) that a closer competitor can exert.	
Raw RI Score. Loggers' distance from Barnwell is largely irrelevant so long as they are located within the Supply Basin.	**Score 3**

Four sawmills were identified within 25 miles of Barnwell County; 18 within 55 miles; and a total of 24 sawmills within the 75-mile BDO Zone supply basin.

Raw RI Score is 3 out of 10.



Notched Salience. No adjustment.	**Score Unnotched**
Impact Level. RI Impact Level is deemed *low*.	**Score 3.33**
Loaded RI Score. Loaded RI Score (Raw RI x Impact Level) is 9.99 out of 100.	**Score 9.99**

1.10. Fundamental Feedstock Production Experience

Rationale. Risk is higher when a supplier has limited experience with planting/growing/harvesting/processing and/or collecting biomass. In cases where experience is lacking, Proponent should show that steps have been taken to ensure proper training, knowledge dissemination and monitoring.	
Raw RI Score. Average age of the sawmills whose years in operation could be determined was 58 years. While young mills are roughly a decade old, two mills have been in operation for more than 100 years. Sawmill Residuals are necessarily generated as a result of sawmill operations. Similarly, Forest Residues are a by-product of roundwood timber production. Loggers in the area have deep knowledge and experience generating this residual wood. However, since loggers may be required to acquire new equipment to generate Forest Residues, we see a pathway for a small amount of risk associated with Forest Residue feedstock production experience. Therefore, Raw RI Score is 3 out of 10.	**Score 3**
Notched Salience. No adjustment.	**Score Unnotched**
Impact Level. RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score. The Loaded RI Score (Notched Salience x Impact Level) is 29.97 out of 100.	**Score 29.97**

1.11 Production Scale Experience

Rationale. Scale-up entails risk. Risk is higher when a supplier has limited experience with the production of the quantity of feedstock required.	
Raw RI Score. Conversations with suppliers in the region expressed an eagerness to engage in a marketplace for in-woods whole-tree chips, indicating a capacity and desire to scale up Forest Residue production and sales. The state of South Carolina also reports that the state's forests are growing more wood than is being harvested, and that 88% of their forestry land is privately-owned[12]. This means that,	**Score 4**

[12] South Carolina Forest Industry Facts. https://www.state.sc.us/forest/scfifacts.pdf

should overall production need to scale to meet new or unexpected demand, the supply chain point source is well set-up to do so. While these factors bode in favor of production scale increase, production scale may require logging and transportation equipment and tools that some suppliers may not already have in the required quantities (such as live-bottom trailers). Acquiring this equipment would require loggers incur a materials-purchasing cost, which would then likely be passed on to a potential facility through an increase in feedstock prices. Taking all of these factors into consideration, risk associated with production scale experience is deemed low-moderate. Raw RI Score is 4 out of 10.	
Notched Salience. By engaging in supply contracts with potential suppliers, it is possible to partially moderate the prices a project would have to pay to acquire feedstock, mitigating some of the risk associated with the costs that production scale increase could create. Feedstocks that do not require new equipment, only additional time (such as in-woods whole-tree chips) could also be prioritized to reduce the risk associated with RI 1.11. As a result, Raw RI Score is notched by 25%: Notched Salience is 3.	**Score 3**
Impact Level. RI Impact Level is deemed *low*.	**Score 3.33**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 9.99 out of 100.	**Score 9.99**

1.12. Feedstock Production Priority

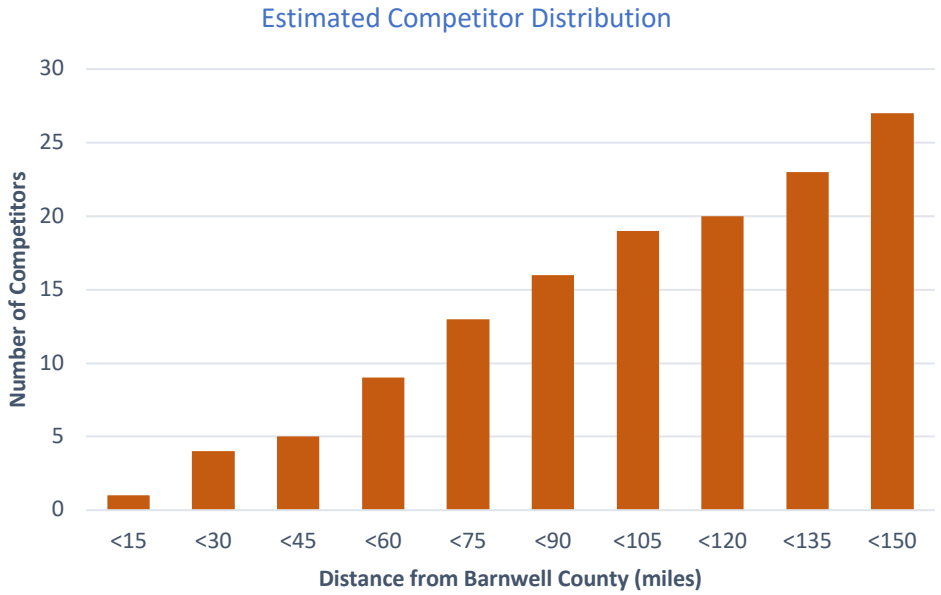
Rationale. When biomass feedstock is a secondary or non-core line of business, or when it is a by-product or a residual from a more valuable primary product, then suppliers may not put sufficient effort to consistently produce it. Risk of breach increases when production and/or delivery of feedstock compromises supplier's ability to make a primary product. When biomass feedstock is a by-product of another main higher margin or main product, such as corn stover (e.g., corn) or forest residues (e.g., pulpwood), supply may not be a top priority for a supplier.	
Raw RI Score. Sawmill Residuals are a necessary by-product of the timber processing industry. Though unavoidable to a certain degree, sawmills can aim to reduce their residual generation. Forest Residues are at present not a high priority for loggers, partially due to the smaller market demand. Loggers must spend more time in the forest, chipping or grinding the tree residuals produced from logging to generate Forest Residues. However, as trees are typically cut in the same fashion, creating a financial incentive – through the creation of a new market – for these logging residuals to be chipped/ground to then be sold would increase loggers' profits.	**Score 8**

Though unavoidable to a certain extent, feedstock production is at-present not a high priority for loggers or sawmills. Therefore, Raw RI Score is 8 out of 10.	
Notched Salience. By increasing competition in the market for woody biomass, a new bio-based facility would be inherently incentivizing residual generators to maintain their product. Particularly with Forest Residue, their waste would be converted to a commodity. Increased demand for Forest Residues, given current prices can be matched, will incentivize loggers to process larger quantities of logging waste into Forest Residue feedstock. As a result, Raw RI Score is notched by 25%: Notched Salience is 6.	**Score 6**
Impact Level. RI Impact Level is deemed *low*.	**Score 3.33**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 19.98 out of 100.	**Score 19.98**

Category 2: Competitor Risk

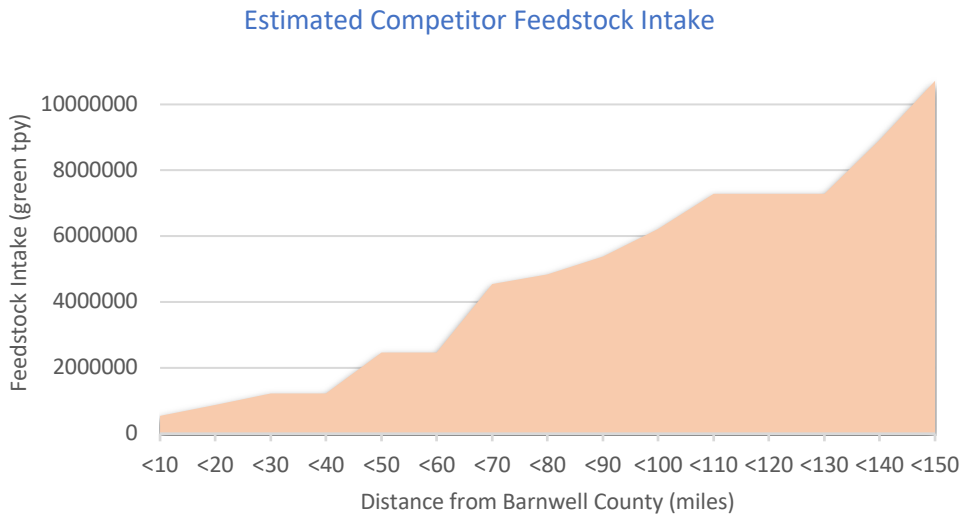
2.1. Competitor Locations and Geographical Influence on the Market

Rationale. Competitors' locations relative to a Proponent can affect the viability of procuring feedstock and the cost of that feedstock. Accurate and detailed competitor mapping provides an understanding of the geographical influence a competitor may have, including competitive advantages such as short-hauling.	
Raw RI Score. A total of 27 major competitors were identified within the 150-mile driving distance Competition Zone. Major competitors can be sorted into four categories: pulp mills, pellet mills, biomass power plants, and biomass cogeneration heat and power (CHP) plants. Most competitors are pulp mills (11 of them), followed by pellet mills and biomass power plants (6 each), and then biomass CHP (4). Table 6 in Appendix A.3.1 lists all identified competitors along with their estimated annual feedstock intakes.	**Score 6**



The estimated distribution of competitors splits almost evenly at the 75-mile driving distance mark, with 14 of the competitors lying within this driving distance and 13 lying at a driving distance greater than 75 miles. In total, large biomass consumers intake an estimated 10,807,516 gt/yr of woody biomass. We estimate that 50% of that is sourced from within the Supply Basin.

Within 30 miles of Barnwell County, competition is modest, with competition intake totaling 1,226,556 gt/yr within this radius (11% of total competition intake). At the 70-mile mark, competition consumption jumps by 84%, from 2,469,556 gt/yr within 60 miles to 4,540,112 gt/yr within 70 miles. Modeling shows no competition intake increase between radii of 110- and 130-miles from Barnwell, remaining at a constant 7,293,779 gt/yr. The Competition Zone's cumulative 10,716,366 gt/yr competitive intake is achieved at the 150-mile radius mark.



Though overall competitor consumption is more than 10 million gt/yr, the majority of the intake occurs at distances greater than 80 miles from Barnwell. In other words, though there is significant overall competition, the largest competitors are predominantly located farther away from Barnwell. For this reason, Raw RI Score 6 out of 10.

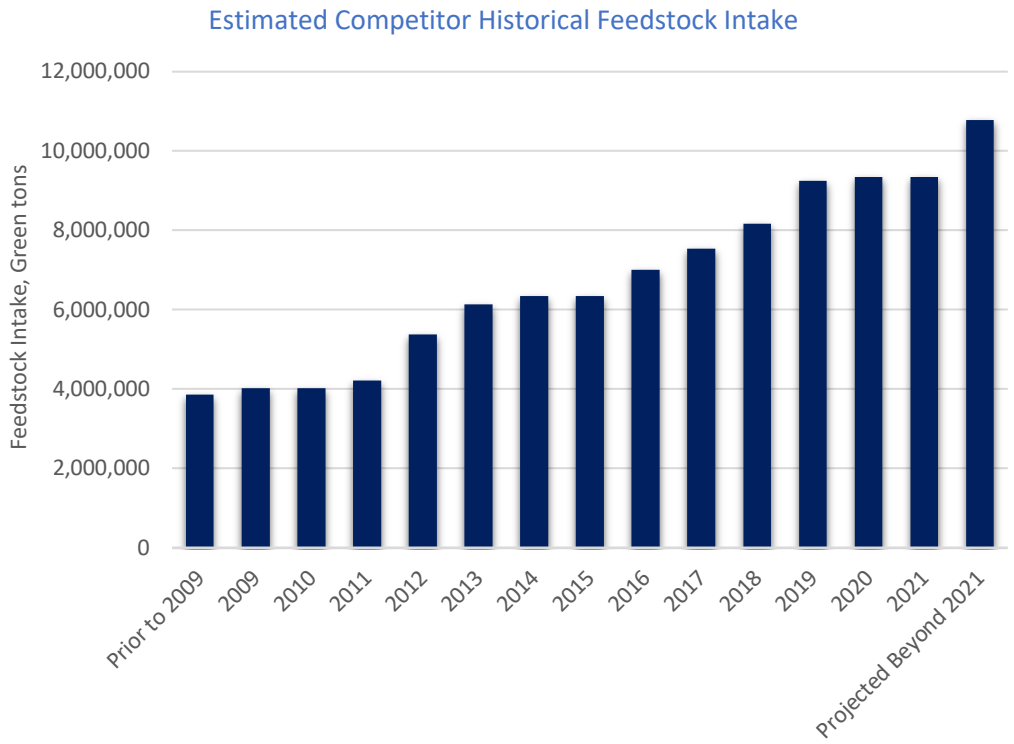
Notched Salience. The figure above illustrates that the majority of competitor consumption occurs farther away from Barnwell in the second half of the competition zone. From 0-75 miles from Barnwell, competition intakes an estimated 4,840,112 gt/yr of feedstock, vs 5,967,404 gt/yr from 75-150 miles. Excess generation in the first 75 miles is estimated as 7,281,717 gt/yr, while total excess across the competition zone is an estimated 1,314,313 gt/yr. By sourcing from within 75 miles of a facility located in Barnwell County, a potential facility could mitigate much of the risk associated with RI 2.1. As a result, the Raw RI Score is notched by 25%: Notched Salience is 4.5.	**Score 4.5**
Impact Level. RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 44.96 out of 100.	**Score 44.96**

2.2. Historical Fluctuation of Quantity Used

Rationale. Clear understanding of key competitors' consumption of each type of feedstock utilized by the Proponent is essential to quantifying the risks associated with each competitor. Understanding historical trends of feedstock utilization can provide valuable information about feedstock price elasticity during shortages, and insight into events that may impact future supply conditions. It can enable more accurate estimates of the sensitivity of feedstock availability to potential future consumption levels or to the impact of external events (e.g., weather events, structural economic changes, seasonality, or policy change).

Raw RI Score. Estimated historical competitor feedstock intake has been rising steadily since 2009, and in total has more than doubled since then. However, no year saw a drastic jump in consumption by competitors. All increases over the past 12 years have been incremental.

Score 5



For these reasons, Raw RI Score is 5 out of 10.

Notched Salience. A potential project could likely mitigate much of the risk associated with the historical fluctuation of quantity used by sourcing a portion of the facility intake from feedstock aggregators, as these facilities are more likely to be equipped with the feedstock and infrastructure to continue supply when/if there is an increase in demand.

Score 3.75

As a result, the Raw RI Score is notched by 25%: Notched Salience is 3.75.

Impact Level. RI Impact Level is deemed *high*.

Score 9.99

Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 9.99 out of 100.	**Score 37.46**

2.3. Competitor Pricing and Price Sensitivity

Rationale. Understanding how much competitors pay for different feedstock types is an essential step to determining competitiveness of Proponent.

Historical prices paid by competitors provide insight into their procurement behaviors and ability/willingness to pay premiums for feedstock and expert pressure on Proponent's suppliers during times of feedstock shortage. Competitors that have an ability to offer higher prices for feedstock during feedstock shortages can pose significant risks to Proponent.

Raw RI Score. Pulp mills represent the most ardent competition to a potential project for feedstock. Should a bidding war for feedstock commence, pulp mill pricing would outcompete whatever price a new bioprocessing facility could pay. The economics of biomass facilities also vary greatly, depending on scale and output product. Considering the variety in size and distribution of biomass facilities within the supply basin, the risk associated with these competitors price sensitivity is also high. Due to these reasons, and the fact that competitor price tolerance could not be determined, Raw RI Score of 9 out of 10.	**Score 9**
Notched Salience. The highest risk that would prove most difficult to overcome is the risk associated with pulp mills. These facilities are well-established and are able to tolerate higher prices temporarily. By removing itself from the pulpwood submarket, where pulp mills reside, a potential project could shield itself from much of the highest risk factors with respect to competitor pricing. As a result, the Raw RI Score is notched by 25%: Notched Salience is 6.75.	**Score 6.75**
Impact Level. RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 67.43 out of 100.	**Score 67.43**

2.4. Impacts of Future Demands on Feedstock Availability and Price

Rationale. Future competitors for feedstock, or expansion of feedstock demand by current competitors, can cause feedstock market disruption.

Raw RI Score. Three proposed pellet mills were identified within the Competition Zone. The largest of these is the Ogeechee River Pellet Mill, with a proposed intake of 800,000 gt/yr. No updates more recent than 2014 were found, when the project was announced and was seeking financing[13]. However, the Southern Environmental Law Center included it in its 2018	**Score 6**

[13] Biomass Magazine. http://biomassmagazine.com/articles/10205/geechee-energy-announces-georgia-pellet-project

Wood Pellet report[14], indicating the project could still be in development. The plant is slated to be located in Millen, GA. The next largest proposed pellet mill is Piedmont Wood Pellet Johnston, LLC in Trenton, South Carolina. This facility has a proposed intake capacity of 450,000 gt/yr. The facility will export its pellet through the Savannah port, though the year the facility will go online has yet to be determined[11]. The facility would be a subsidiary of Enova Energy Group, LLC. Conversations with local experts also revealed that many sawmills in the region are installing in-line kilns, which consume nearly all the sawdust generated by sawmills. Installation of these kilns leads to an increase in sawmill internal feedstock consumption. Facilities who choose to acquire these in the future will not have as much sawdust available as other residual types. The most recent database available from the South Carolina Energy Office (SCEO)[15] does not indicate any biomass power facilities that are either planned or under construction within the Competition Zone. SCEO's reporting runs through June 2020. No proposed biomass power facilities were identified within the Competition Zone in Georgia. The US Department of Energy Combined Heat and Power and Microgrid Installation Databases[16] also do not show any CHP facilities planned or under construction within the Barnwell competition zone. Due to these factors, Raw RI Score is 6 out of 10.	
Notched Salience. The highest risk that would prove most difficult to overcome is the risk associated with pulp mills. By removing itself from the pulpwood submarket, a potential project could shield itself from much of the highest risk factors with competition's future demand on feedstock availability and price, as these facilities are the ones most likely to outcompete a facility in regards to feedstock pricing. As a result, the Raw RI Score is notched by 50%: Notched Salience is 3.	**Score 3**
Impact Level. RI Impact Level is deemed *high.*	**Score 9.99**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 29.97 out of 100.	**Score 29.97**

2.5. Supply Influence of Competitor

Rationale. In some cases, competitors may be able to exert high degrees of pressure over local suppliers, effectively enabling them to control feedstock, especially during times of shortage. This control can derive from long previous relationships between suppliers and competitors. It can also result from verbal or "understood" agreements, or a competitor	

[14] Southern Environmental Law Center. https://www.southernenvironment.org/uploads/maps/SELC_WoodPelletExportMap_2018_0123+table.pdf
[15] SC Energy Data: Biomass. http://energy.sc.gov/node/3080
[16] USDOE Combined Heat and Power and Microgrid Installation Database: U.S. Department of Energy Combined Heat & Power and Microgrid Installation Databases (icfwebservices.com)

being able to assist suppliers in times of surplus by maintaining large inventories which enable suppliers to continue supplying when other markets impose quotas. Understanding and planning around such soft risk factors is important. If such relationships exist in the Proponent's procurement area, they may indicate increased risk of feedstock shortage or pricing changes.	
Raw RI Score. The closest seven competitors are all within 50 miles of Barnwell, SC. The Cascade Tissue Group facility is the closest competitor to Barnwell, approximately 3 miles away, and they likely exert notable influence on feedstock supply as their estimated feedstock intake is more than 534,000 gt/yr. The largest of the nearby competitors is the International Paper CHP in Augusta, GA, 47 miles away, with a reported feedstock intake of 793,000 gt/yr. The other 5 facilities within 50 miles have an average annual feedstock intake of 173,000 gt/yr. Due to the presence of several competitors in the immediate region, and the proximity of two major competing facilities, Raw RI Score is 7 out of 10.	**Score 7**
Notched Salience. The consumption of the largest nearby competitor, International Paper CHP, accounts for 13% of the total feedstock generation within 50 miles, and Cascade Tissue Group another 9%. Even with these two major competitors, estimated excess available biomass (total generation minus total competitor consumption) totals 3.41 million green tons within 50 miles of Barnwell. The closest competitor, a pulp mill, can be significantly mitigated by avoiding the pulpwood submarket. Much of the risk associated with the International Paper facility could be mitigated by sourcing feedstock from different suppliers who do not sell to this facility. As a result, the Raw RI Score is notched by 50%: Notched Salience is 3.5.	**Score 3.5**
Impact Level. RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 34.97 out of 100.	**Score 34.97**

2.6. Temporary Market-Driven Markets

Rationale. Alternative, non-traditional, market-driven competitors for feedstock can drive feedstock demand in unusual circumstances.	
Raw RI Score. No temporary market-driven markets for either Forest or Sawmill Residuals were identified. Competition in the competition zone is well-established and is not temporary. Therefore, Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience. No adjustment.	**Score Unnotched**
Impact Level. RI Impact Level is deemed *low.*	**Score 3.33**
Loaded RI Score. Loaded RI Score (Raw RI x Impact Level) is 3.33 out of 100.	**Score**

	3.33

2.7. Demand for Competitors' Products

Rationale. Increased demand for competitor's product can cause an increased demand for feedstock by the competitor, given the competitor can increase its production capacity easily. For example, an increased demand for biofuels due to a clean fuels policy can cause increased biofuel production by the competitor, thereby increasing demand for feedstock.	
Raw RI Score. One national trend to note is the increase in cardboard and packaging demand that has been observed with the growth of online shopping, accelerated by the COVID-19 crisis. The demand for packaging paper products reached their highest levels ever in 2020, and at least 3 of the 11 Pulp Mills within the competition zone produce these types of products. Sonoco Products in Hartsville produces containerboards, MeadWestvaco in Charleston produces packaging papers, and WestRock in Florence, South Carolina produces paper packaging materials. While there is no evidence these facilities are expanding operations at present, it is prudent to note this national trend in relation to the at least three facilities it could apply to. As demand for renewable energy increases domestically and abroad, the South Carolina Resource Development Division anticipates an increase in the demand for wood pellets as the fuel for biomass power[17], though exact values were not projected or quantified. This Development Division projection is supported by the on-the-ground data, with all of the identified proposed competitive facilities being Pellet Mills. See Appendix A.3.3 for a discussion of these proposed facilities. No proposed Biomass Power or CHP facilities were identified in the competition zone. Due to these shifting market dynamics, Raw RI Score is 7 out of 10.	**Score 7**
Notched Salience. None of the three proposed pellet mill facilities are in Barnwell's immediate vicinity, with their proposed locations being approximately 49, 61, and 62 miles away. By sourcing feedstock from suppliers closer to Barnwell than to these proposed facilities, a new bioprocessing plant sited in Barnwell, SC, could mitigate much of the risk associated with the new pellet mills. Another portion of the risk related to uncertainty in the Barnwell marketplace is due to the production of packaging paper products. By removing itself from the pulpwood market, a potential facility could mitigate much of this risk. As a result, the Raw RI Score is notched by 50%: Notched Salience is 3.5.	**Score 3.5**
Impact Level. RI Impact Leve is deemed *moderate.*	**Score 6.66**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 23.31 out of 100	**Score 23.31**

[17] South Carolina Forestry Commission. The Wave of Wood: Forestry's Economic Contribution to South Carolina's Economy in 2018. http://www.state.sc.us/forest/pubs/scfcimplaneconomicimpactstudy2018-web.pdf

Category 3: Supply Chain Risk

3.1. Biomass Availability Multiple (BAM)

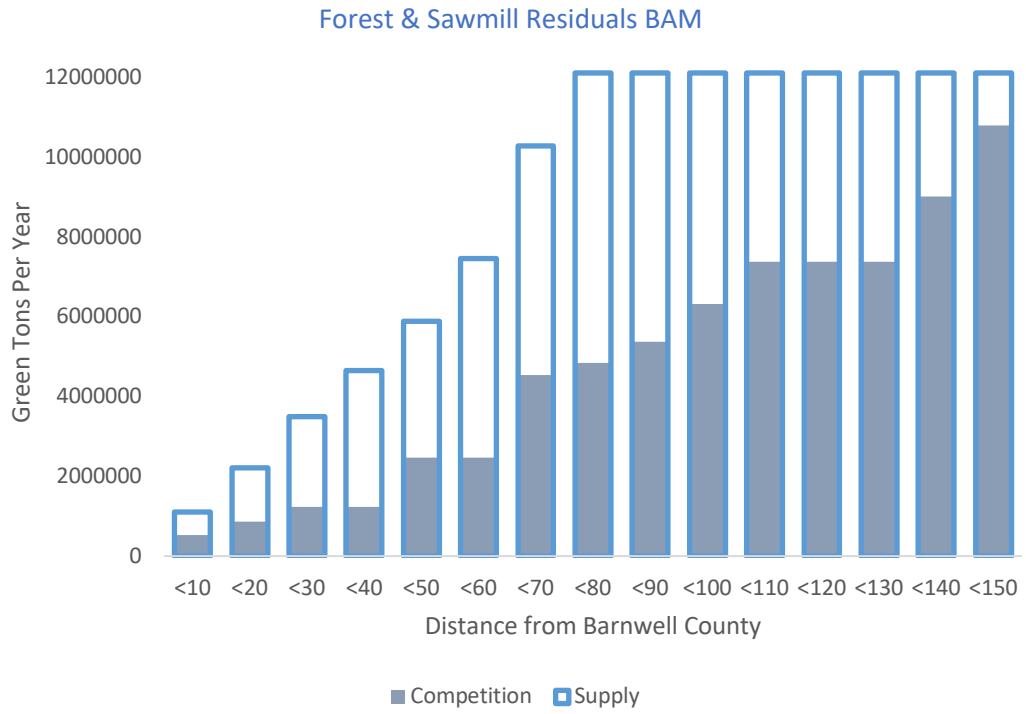
Rationale. Biomass Availability Multiple (BAM) indicates the degree of redundancy in a Proponent's supply chain. BAM is the ratio of biomass feedstock available to a project, at costs, timing, and in quality feasible for the Proponent, divided by the project's feedstock requirements. BAM is a strong indicator of supply chain resilience when stressed by supply shortage and/or supplier breach.

Raw RI Score. The Biomass Availability Multiple (BAM) indicates redundancy of available feedstock within the supply basin for a pre-defined project intake capacity. Forest Residuals and Sawmill Residuals constitute feedstock in this analysis. It was assumed that a potential Project would have a feedstock intake requirement of 300,000 gt/yr.

Score 1

Overall, the Barnwell County supply basin has a BAM of 4.38 for Forest Residuals and Sawmill Residuals. The figure below illustrates the spatial relationship between supply and demand for feedstock through the 150-mile competition zone. The strong BAM score of 4.38 indicates strong resiliency and opportunity for the feedstock supply chain in Barnwell County.

Due to Sawmill Residuals having a BAM of 4.38, and forest residuals historically being underutilized, the Raw RI Score is 1 out of 10.



Notched Salience. No adjustment. **Score Unnotched**

Impact Level. RI Impact Level is deemed *high*. **Score 9.99**

Loaded RI Score. Loaded RI Score (Raw RI x Impact Level) is 9.99 out of 100.	**Score 9.99**

3.2. Impact of Increased Utilization of Feedstock

Rationale. Feedstock utilization in a supply basin can change over time. Existing consumers of feedstock can expand operations or new facilities can enter the market. Increased utilization puts additional pressure on feedstock and can lead to higher prices, feedstock disruptions, shortages or supplier breach.	
Raw RI Score. With a Forest and Sawmill Residual BAM of 4.38, there is space in the market for increased feedstock utilization without risking oversaturation, particularly for Forest Residues, which constitute the majority of currently unutilized feedstock. Additionally, the pace of South Carolina's forest growth outpaces the rate of tree removal, so should the market become saturated, more trees could easily be harvested to meet the increasing demand. These lands are privately owned, and foresters could see the increase in demand as an opportunity to increase profits by selling rights to more land should the need arise. The increased utilization of Forest Residue would also likely not impact forest health, as only a small portion of residuals must be left behind for soil health purposes. The combination of these factors makes the Raw RI Score a 3 out of 10.	**Score 3**
Notched Salience. By sourcing from a combination of small suppliers and feedstock aggregators who contractually sell a certain volume at a set price, a potential project could be shielded from the impacts of increased feedstock utilization by competitors. As a result, the Raw RI Score is notched by 25%: Notched Salience is 2.25.	**Score 2.25**
Impact Level. RI Impact Level is deemed *moderate*.	**Score 6.66**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 14.99 out of 100.	**Score 14.99**

3.3. Feedstock Supply Curve

Rationale. The greater the feasible transport distance, the more feedstock is accessible to the Proponent, but at a higher delivered cost. The feedstock supply curve is a function of feedstock availability over its cost which is primarily, but not exclusively, a function of distance. The feedstock supply curve is used to determine the availability of redundant feedstock at various price points.	
Raw RI Score. An estimated 12,121,829 gt/yr of feedstock are generated in the Supply Basin. Total feedstock generation can be broken into Sawmill Residual feedstock generation and Forest Residue feedstock generation. Sawmill Residue account for 6,838,264 gt/yr of feedstock generation (56%), while Forest Residues account for 5,283,566 gt/yr of feedstock generation (44%).	**Score 3**

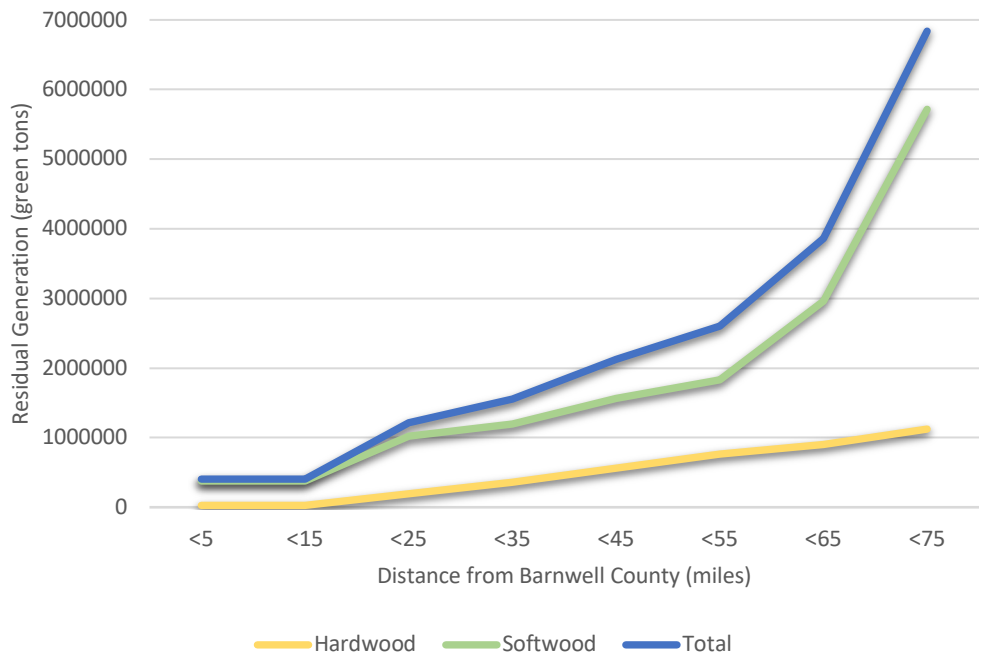
From 2014 – 2019, the most recent years for which complete supply basin data are available, an average of 5,123,828 green tons of Forest Residuals were generated per year. The dashed trend line in Figure 14 of Appendix A.2.4 shows that Forest Residue generation has been increasing since 2014, from 4,907,566 to 5,283,566 green tons in 2019, growth totaling 8%. Estimated annual Forest Residue generation in the Supply Basin are summarized in the table below.

Total Estimated Historical Forest Residuals Generation within Supply Basin

	Georgia	South Carolina	Total
2014	1,672,826	3,234,740	4,907,566
2015	1,277,177	3,414,993	4,692,170
2016	1,335,937	4,047,339	5,383,275
2017	1,368,201	3,715,151	5,083,352
2018	1,464,598	3,928,440	5,393,038
2019	1,432,994	3,850,572	5,283,566

Total estimated Sawmill Residual feedstock generation largely follows the trends of softwood Sawmill Residual feedstock generation, shifted up by the magnitude of hardwood Sawmill Residual feedstock generation. This relationship, as well as total Sawmill Residual generation as a function of distance, are illustrated in the figure below.

Sawmill Residual Feedstock Supply Curve



No "red-flags" are found when analyzing the relationship between supply and distance, but some uncertainty stems from the fact that Forest Residue cannot be mapped as accurately as Sawmill Residual generation, due to the manner Forest Residue data are reported. Therefore, Raw RI Score is 3 out of 10.	
Notched Salience. A potential project could de-risk the ambiguity present in the Forest Residue spatial data by reaching out directly to suppliers in the Supply Basin, once a facility size is determined. Knowing if/how much Forest Residue the facility would need to intake would allow future outreach to produce more granular results, that would then allow the facility to select an advantageous site within Barnwell County, and therefore mitigate some of the risk. As a result, the Raw RI Score is notched by 25%: Notched Salience is 2.25.	**Score 2.25**
Impact Level. RI Impact Level is deemed *low.*	**Score 3.33**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 7.49 out of 100.	**Score 7.49**

3.4. Seasonal Feedstock Supply Variation

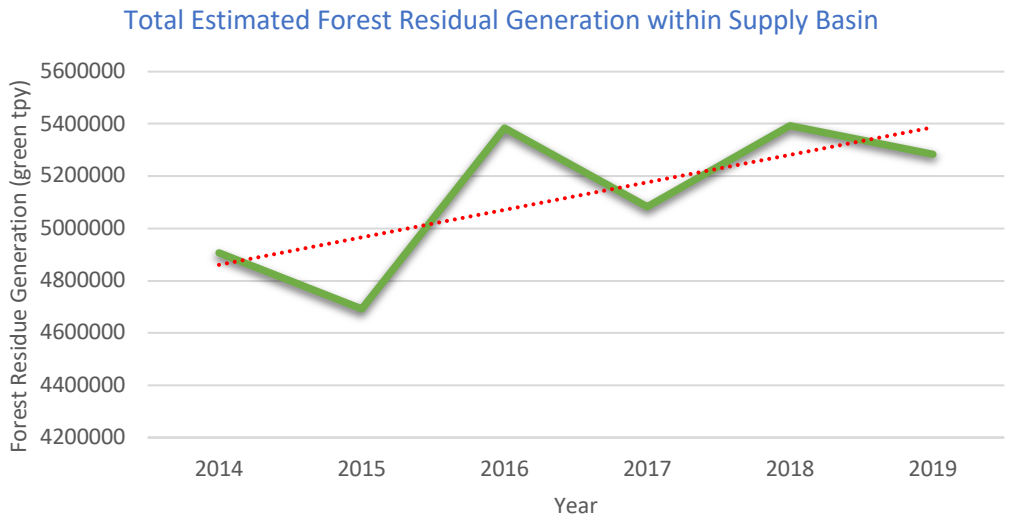
Rationale. Biomass supply can present significant seasonal supply variations. Seasonal supply variations combined with limitations associated with longer-distance transportation and storage can lead to regional biomass supply imbalances (Golecha & Gan 2016) and can manifest in shortages and higher costs for Proponents.	
Raw RI Score. Minor temporary delays in timber delivery to sawmills can occur during periods of heavy rainfall, when loggers are unable to clear trees from timberland and/or dirt roads are flooded. These delays can cause variations in both sawmill and Forest Residue feedstock production, but the delays (and therefore feedstock generation variations) typically do not last more than several days. Additionally, sawmills often have some amount of timber reserves on-site, and therefore could still produce Sawmill Residuals even if there is a delay in the delivery of new timber. While the COVID-19 crisis has been highly impactful on the lumber industry, the likelihood of such an event occurring again is fairly low. Additionally, few markets and industries remained unimpacted by the economic repercussions of the global pandemic. Thus, there is no added risk inherent to the supply chain from 100-year-events such as this. Sawmill Residual generation tracks linearly with roundwood generation. Though there is no seasonal variation in Sawmill Residual generation, overall roundwood production has been volatile since 2011. However, at no point in the available data did roundwood generation drop below 10,000,000 gt/yr, and roundwood production has been increasing since 2017. Due to there being no identified seasonal variation in Forest Residue generation, and significant Sawmill Residual generation variations being on the scale of years rather than seasons, the assigned raw RI score is 6 out of 10.	**Score 6**

Notched Salience. Potential facilities could mitigate the risk associated with feedstock shortages during period of heavy rainfall by having a small to moderate amount of feedstock reserves stored on site. These reserves would have to be sufficient to keep the facility operating for up to 1 – 2 weeks, to practice healthy caution. Should a facility maintain these reserves, much of the risk associated with the temporal delays in feedstock production brought on by rainfall could be mitigated. However, large-scale biomass facilities typically have storage on the scale of days to a week. Storing feedstock for timeframes longer than this could prove cost-intensive and could require a large area. As a result, the Raw RI Score is notched by 25%: Notched Salience is 4.5.	**Score 4.5**
Impact Level. RI Impact level is deemed *high.*	**Score 9.99**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 44.96 out of 100.	**Score 44.96**

3.5. Year-to-Year Variation in Feedstock Availability

Rationale. Biomass can have significant year-to-year supply variations due to variability in yield from biomass harvesting operations, particularly with agricultural biomass.

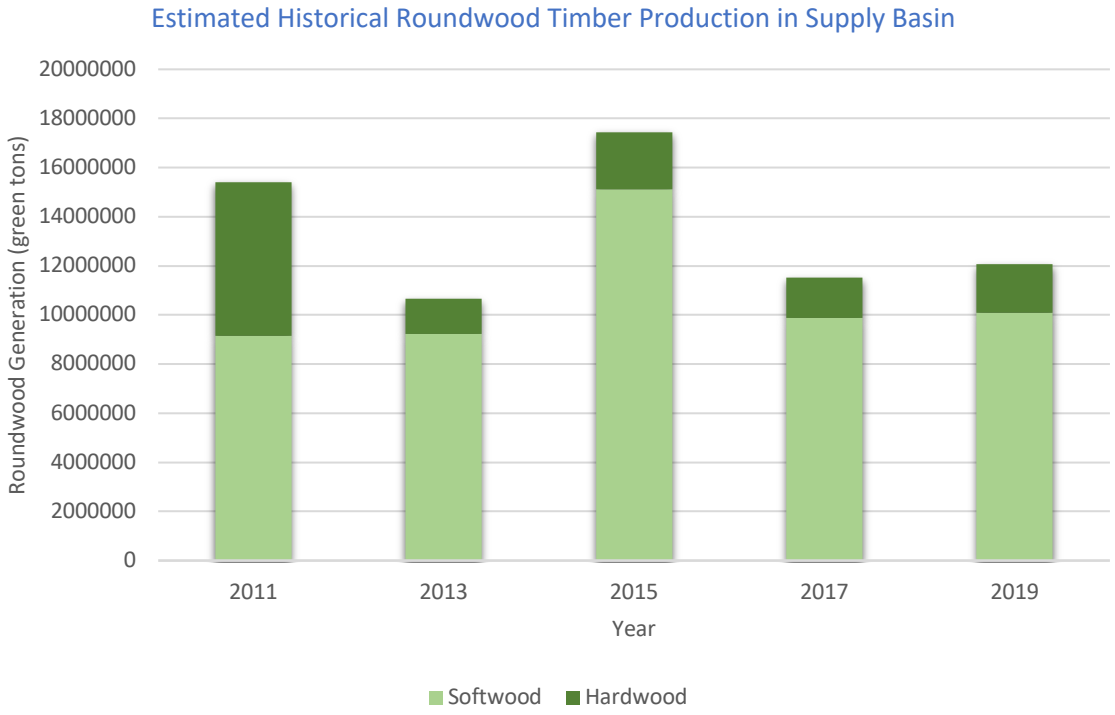
Raw RI Score. From 2014 – 2019, the most recent years for which complete supply basin data are available, an average of 5,123,828 gt/yr of Forest Residue were generated per year. The dashed trend line in the figure below shows that Forest Residue generation has been increasing since 2014, from 4,907,566 to 5,283,566 green tons in 2019, growth totaling 8%. Table 3 in Appendix A.2.4 summarizes estimated annual Forest Residue generation in the supply basin.	**Score 9**



Overall roundwood timber production has been volatile since 2011. However, at no point in the available data did roundwood generation drop below 10,000,000 green tons in a year, and roundwood production has been increasing since 2017.

Because Sawmill Residual feedstocks are by-products of the generation of other primary commodities (roundwood timber products), roundwood timber production was studied over time to understand year-to-year variations in Sawmill Residual feedstock generation. This assumption is justified since production of hardwood and softwood Sawmill Residuals both track linearly with roundwood timber generation.

The earliest data from 2011 show a total of 15,398,872 green tons of roundwood production within the Supply Basin. By 2013, total roundwood generation dropped to 69% of 2011 generation. Overall roundwood timber generation increased from 2013 to 2015 from 10,672,868 green tons to 17,422,737 green tons. Production has since decreased to 12,056,943 green tons in 2019. The figure below shows that timber production spikes and falls regularly, though in the available data, production never dropped below 10,000,000 green tons in a given year. Roundwood generation in the supply basin is historically strong, generating large magnitudes in all years with available data. While always large in magnitude, there are significant variations in total roundwood generation bi-annually.



Given the high unpredictability in roundwood timber generation, Raw RI Score is 9 out of 10.

Notched Salience. Forest regrowth outpaces forest harvesting in the state of South Carolina. With a new market for wood residuals and woody biomass, it is possible that loggers would be incentivized to clear the necessary timber to meet their increasing demand. This added incentive could help bring some level of stability, appropriate for a potential facility intake capacity, to the volatility observed in the date. Furthermore, a new market for Forest Residue – made from chipped	**Score 6.75**

wood typically left in the forest – could help offset reductions in roundwood generation during lower-production years.

As a result, Raw RI Score is notched by 25%: Notched Salience is 6.75.

Impact Level. RI Impact Level is deemed *high.*	**Score 9.99**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 67.43 out of 100.	**Score 67.43**

3.6. Front-End Validation of Data Used in Feedstock Availability Models

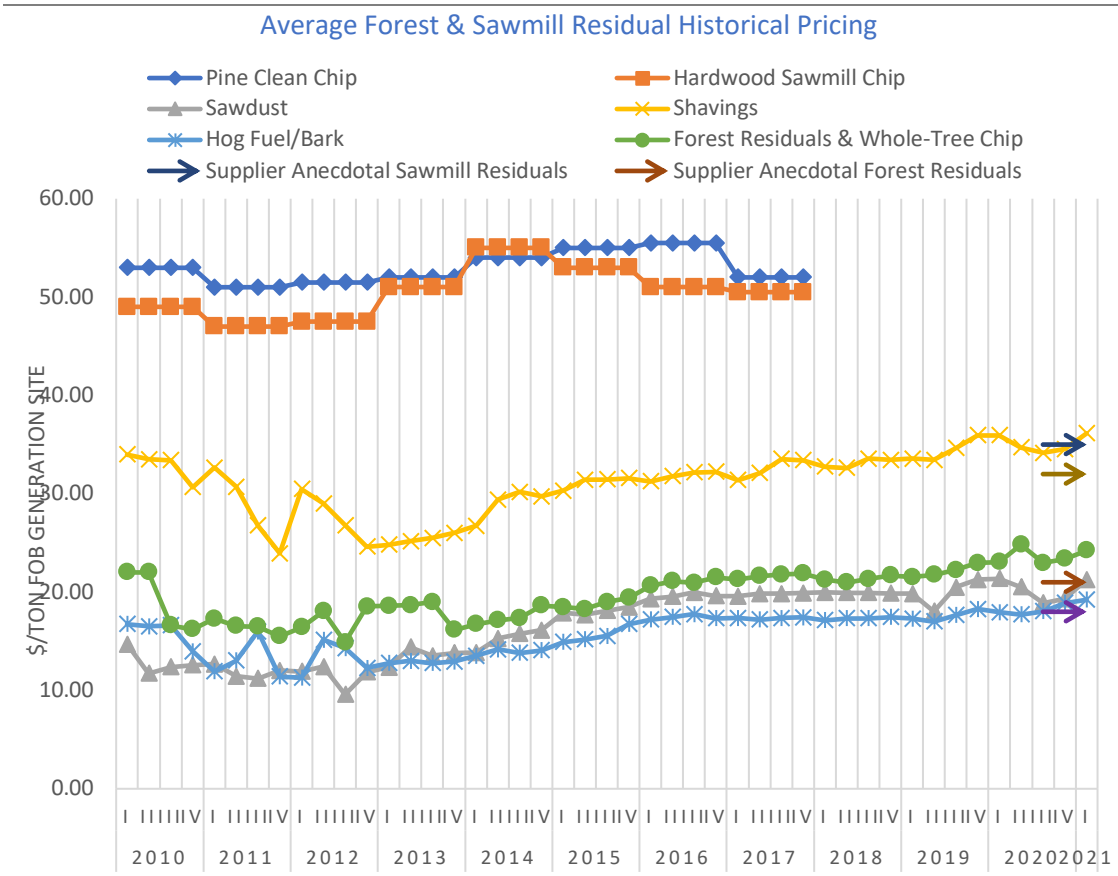
Rationale. Feedstock supply models can be complex. Lack of clarity about model assumptions and baseline data can result in confusion on the part of the capital markets and drive financing costs for biomass projects. The adequacy and credibility of assumptions and baseline data is paramount to credible model outputs.

Raw RI Score. All data used in modeling was sourced from the USDA's Forest Service Forest Inventory & Analysis (FIA)'s Timber Product Output Toolkit (for forest residuals), FIA's EVALIDator Tool (for sawmill residuals), and outreach to woody biomass dealers in the region. See Appendix C for a detailed discussion on modeling process. Due to all used data coming from the most recent US federal government data bases, Raw RI Score is 3 out of 10.	**Score 3**
Notched Salience. No adjustments.	**Score Unnotched**
Impact Level. RI Impact Level is deemed *low.*	**Score 3.33**
Loaded RI Score. Loaded RI Score (Raw RI x Impact Level) is 9.99 out of 100.	**Score 9.99**

3.7. Historical Feedstock Price Variations and "Red-Line" Feedstock Cost

Rationale. If volatility is shown in the historical feedstock price, then the risk of future price fluctuation is elevated. If feedstock prices have historically exceeded the price at which the Proponent would have to cease operations or breach a financial covenant (i.e., the "red-line" feedstock cost), then mitigation measures should be put in place.

Raw RI Score. Historical prices for whole-tree chips, Pine sawdust, shavings, and hog fuel/bark were acquired from TimberMart South. Quarterly prices for these commodities were collected for the past 10 years. Prices for Pine Clean Chip and Hardwood Chip Sawmill Residuals were acquired from the most recent Forest2Market report for the region, and run from 2010 to 2017. Forest2Market data are reported on an annual, rather than quarterly, basis. All historical prices are summarized in Table 7 of Appendix A.4.2 and presented graphically in the figure below.	**Score 4**



With the lone exception of Pine Clean Chips, prices for all residual types increased from the first quarter of 2010 through the end of the available data (Q4 2017 or Q1 2021). From 2010 to 2017, Pine Clean Chip prices dropped in price by roughly 2%, from $53 to $52 per ton FOB generation site. During the same time period, Hardwood Sawmill Chip prices experienced a 3% increase in price, from $49 to $50.50 per ton FOB generation site. Pine Clean Chip and Hardwood Chip prices were fairly constant through the available data.

Average Sawdust prices have increased by 66%, from $12.85/ton in 2010 to $21.28/ton FOB generation site in the first quarter of 2021. Whole-Tree Chips experienced a 26% increase in average price during that time span, from $19.19 to $24.21/ton FOB generation site. Hog Fuels saw a 20% increase in average price, from $15.19 to $19.22/ton FOB generation site. The 10% overall increase observed in Shaving's average cost is misleading. While these costs experienced a fairly small percent increase, from $32.89 to $36.14/ton FOB generation site, Shavings prices were the most volatile during the past decade. Particularly from 2011 to 2013, Shavings average prices spiked and fell regularly. They have been increasing fairly constantly since then.

Internal data from previous Ecostrat studies conducted in the region confirm that Clean Chip prices have increased in the short-term. Vendors in the region previously sold Clean Chip at $30/ton FOB generation site in August 2019, representing an 17% increase in price over 22 months to today's price of $35/ton FOB generation site.

To determine whether a feedstock price is below a "red-line" cost, a specific project would first need to be identified. To generally understand if a feedstock price is close to a red-line cost, $3.20 per running mile of transportation fees can be added to the feedstock price.

Forest and Sawmill Residual prices were generally more stable after 2015 than prior to 2015. Due to this fairly constant recent trend, Raw RI Score is 4 out of 10.

Notched Salience. No adjustment.	**Score Unnotched**
Impact Level. RI Impact Level is deemed *low.*	**Score 3.33**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level is 13.32 out of 100.	**Score 13.32**

3.8. Low Historical Demand for Feedstock in the Supply Basin

Rationale. If Proponent supply basin does not have history of developed, large-scale feedstock procurement, suppliers may not have sufficient expertise in feedstock production to ensure reliable supply, especially in early years.

Raw RI Score. A total of 27 major competitors were identified within the 150-mile driving distance Competition Zone. Major competitors can be sorted into 4 categories: Pulp Mills, Pellet Mills, Biomass Power facilities, and Biomass Cogeneration Heat and Power (CHP) facilities. The majority of competitors are Pulp Mills (11), followed by Pellet Mills and Biomass Power facilities (6 each), and then Biomass CHP (4). All identified major competitors are listed in Table 6 of Appendix A.3.1. An estimated total of 10,807,516 gt/yr of feedstock are consumed by competition. Pulp mills represent the largest competition for feedstock to a potential project in Barnwell County, with these facilities intaking an estimated 5,905,366 green tons of feedstock per year. The next largest competition category by volume is pellet mills, who intake an estimated 2,213,150 green tons of feedstock per year. Biomass CHPs consume an estimated 1,543,000 gt/yr. Finally, Biomass Power facilities consume an estimated 1,146,00 gt/yr, representing the smallest proportion of major competitors for feedstock in the competition zone. The variety and magnitude of competitor intake is a testament to the fact that feedstock collection practices are well-established and of low-risk. Therefore, Raw RI Score is 1 out of 10.	**Score 1**

Notched Salience. No adjustment.	**Score Unnotched**
Impact Level. RI Impact Level is deemed *moderate.*	**Score 6.66**
Loaded RI Score. Loaded RI Score (Raw RI x Impact Level) is 6.66 out of 100.	**Score 6.66**

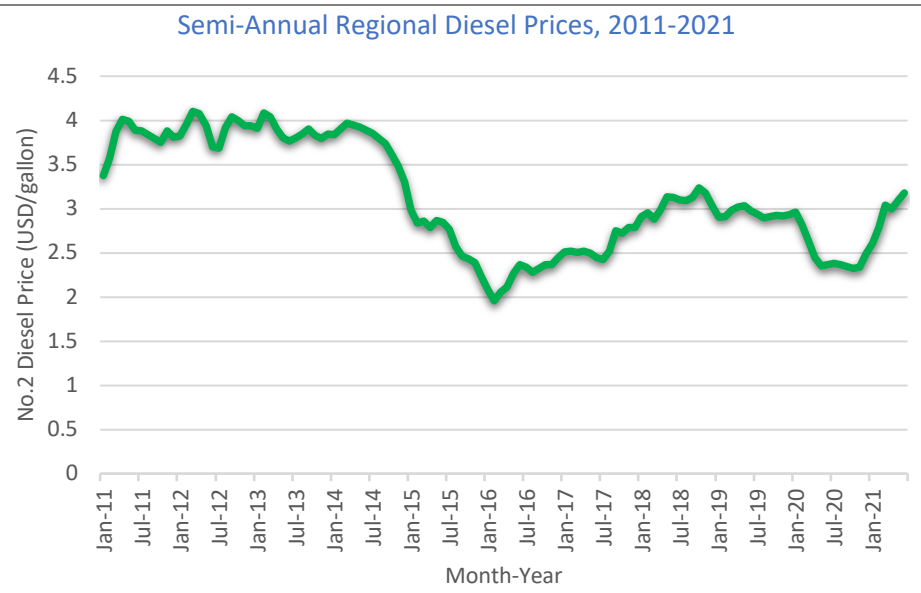
3.9. History of Production/Feedstock is a Secondary Crop or a Byproduct

Rationale. If feedstock is a new/secondary crop or a by-product, suppliers may either lack sufficient experience to mitigate risk, or be unable to react to such risk. Secondary crop or by-product producers may be less likely to prioritize production. If feedstock is a secondary crop, then production can be subject to variables beyond suppliers' control (e.g., changing primary crop prices).	
Raw RI Score. Both Forest and Sawmill Residuals are by-products of the forestry industry in the supply basin. While the forestry industry is the largest, in terms of economic impact and employment in the state of South Carolina, if there were a crash in the timber industry, feedstock price and generation would be dramatically impacted. Because of this, Raw RI Score is 7 out of 10.	**Score 7**
Notched Salience. The forestry industry in the region is the largest in the state of South Carolina, is the largest employer in the region, and dates back more than 100 years. While a timber market crash would indisputably impact the feedstock supply chain, a modest amount of resiliency can be assumed based on the size, strength and history of the industry. A facility being prepared to pay higher prices for feedstock temporarily could help address some of the risk associated with feedstocks being a by-product. Storing a moderate amount of reserve feedstock on-site could also help mitigate the risk of RI 3.9. As a result, Raw RI score is notched by 25%: Notched Salience is 5.25.	**Score 5.25**
Impact Level. RI Impact Level is deemed *high*.	**Score 9.99**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 52.45 out of 100.	**Score 52.45**

3.10. Diesel Prices

Rationale. Diesel, oil and PPI can impact feedstock cost of harvest and collection over time. Sensitivities to worst case scenarios should be run.	
Raw RI Score. Regional prices for No. 2 Diesel that include the Supply Basin both in South Carolina and Georgia were acquired from the U.S. Energy Information Administration's Diesel database[18]. Outreach to potential suppliers in the region was performed to understand what prices a potential project looking to site in Barnwell County could expect to pay for feedstock acquisition. Outreach to local suppliers indicated that current transportation costs are roughly $3.20 per running mile. Therefore, a facility could expect to pay the cost of feedstock per ton, plus $3.20 per running mile to assess total delivered feedstock cost.	**Score 5**

[18] EIA's Monthly Retail Gasoline and Diesel Prices:
https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMD_EPD2DXL0_PTE_R1Z_DPG&f=M



The graph above shows that diesel prices are, as expected, volatile and hard to predict. However, diesel prices have not risen back to their 2012/2013 peak costs, even though they have been rising since 2020. Because of these factors, Raw RI Score is 5 out of 10.

Notched Salience. Some of the risks associated with volatile fuel prices could be mitigated by a project engaging in contracts with suppliers who are located closer to Barnwell, reducing transportation costs, and unrelated to this RI, would have the added benefit of also reducing price pressure from larger and more abundant competition. As a result, the Raw RI Score is notched by 50%: Notched Salience is 2.5.	**Score 2.5**
Impact Level. RI Impact Level is deemed *low*.	**Score 3.33**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 8.33 out of 100.	**Score 8.33**

3.11. Harvest & Collection Practices & Schedules

Rationale. Differences in harvest timing and practices used can create risk to both the quantity and quality of feedstock. For example, feedstock harvested by different suppliers in different windows can undergo varying levels of exposure to sun, wind and moisture, leading to variations in delivered feedstock quality.	
Raw RI Score. Harvest and collection practices and schedules are well-established and robust in the supply chain. Foresters and loggers have routines for growing trees, auctioning them, and harvesting, collecting, and distributing timber and timber products. With these practices entrenched, Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience. No adjustment.	**Score Unnotched**

Impact Level. RI Impact level is deemed *low*.	**Score 3.33**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 3.33 out of 100.	**Score 3.33**

3.12. Harvesting & Collection Equipment

Rationale. Different types of harvesting and collection equipment used by suppliers can have a significant impact on the quality and availability of feedstock. Use of different types and combinations of harvesting, collection and processing equipment among suppliers can lead to non-homogeneous feedstock. Equipment that is not designed specifically for biomass cultivation, harvesting and collection, can increase feedstock quality risks. Relevant equipment should be specified for the sake of product consistency and risk reduction.	
Raw RI Score. It is industry standard that loggers own and operate all of their own harvesting and collection equipment. Outreach to loggers and aggregators in the Supply Basin confirmed ownership of the equipment required to harvest and collect feedstock. These factors lead to a Raw RI Score of 1 out of 10.	**Score 1**
Notched Salience. No adjustment.	**Score Unnotched**
Impact Level. RI Impact Level is deemed *moderate.*	**Score 6.66**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 6.66 out of 100.	**Score 6.66**

3.13. Temporary Externality-Driven Markets for Feedstock

Rationale. Alternative, non-traditional, externality-driven competitors for feedstock can drive feedstock demand (and cost) in unusual circumstances.	
Raw RI Score. No temporary externality-driven markets for Sawmill or Forest Residual feedstocks were identified. Therefore, Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience. De-risking measures are not necessary for risk indicators with raw RI Scores of 1, as they area already the lowest risk.	**Score Unnotched**
Impact Level. RI Impact Level is deemed *low.*	**Score 3.33**
Loaded RI Score. Loaded RI Score (Raw RI x Impact Level) is 3.33 out of 100.	**Score 3.33**

3.14. Variations in Densification Methods Among Different Suppliers

Rationale. The shape and density of the unit in which feedstock is supplied can impact feedstock cost and quality.	

Raw RI Score. Densification methods among different suppliers do not vary significantly. While the quality of the feedstock will vary depending on the wood source and stage in processing, chipping methods are typically industry standard. Therefore, Raw RI Score is 2 out of 10.	**Score 2**
Notched Salience. No adjustment.	**Score Unnotched**
Impact Level. RI Impact Level is deemed *low.*	**Score 3.33**
Loaded RI Score. Loaded RI Score (Raw RI x Impact Level) is 6.66 out of 100.	**Score 6.66**

3.15. Availability of Labor for Feedstock Production

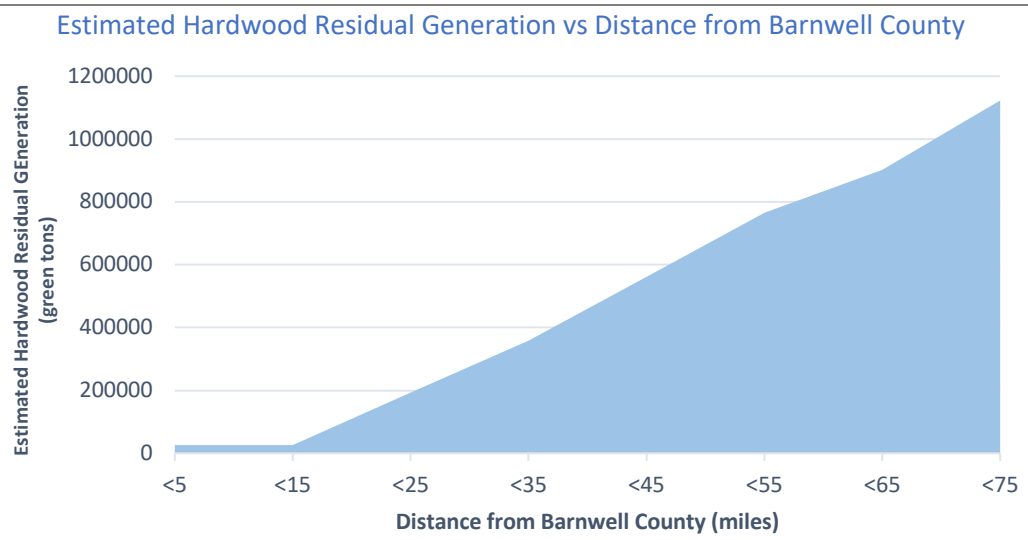
Rationale. Skilled labor shortages can be difficult to remedy in the short-term. Availability of suitable labor in an area can impact the ability to procure sufficient feedstock quantities on required schedules. Labor risks are higher for facilities where supply chains are not yet active; or for Proponent's for whom large feedstock requirements, or development of new (or expanded) supply chains, demand significant additions to the local labor force.	
Raw RI Score. A 2019 publication from the South Carolina Forestry Commission's Resource Development Division found that there was a 16.4% increase in total forestry employment within the state from 2017 to 2018. In 2018, forestry induced 23,060 new jobs. The study commented that the increased demand for timber products will continue to drive the state's economy, both through creating new forestry jobs and shifting already-existing jobs within subsections of the industry. The study explicitly mentioned the global biomass and biofuels economy as one of the forestry subsectors they expect to play a commanding role in shaping the overall industry's future. It should also be noted that the production of woody biomass in and of itself does not require much additional labor, beyond the additional drivers for increased residual transportation. Put together, there is no reason to believe that labor for feedstock acquisition will be unattainable. The size of the industry makes it likely that there will be a consistent supply of available laborers to carry on feedstock procurement and management activities. Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience. De-risking measures are not necessary for risk indicators with raw RI Scores of 1, as they area already the lowest risk.	**Score Unnotched**
Impact Level. RI Impact Level is deemed *low.*	**Score 3.33**
Loaded RI Score. Loaded RI Score (Raw RI x Impact Level) is 3.33 out of 100.	**Score 3.33**

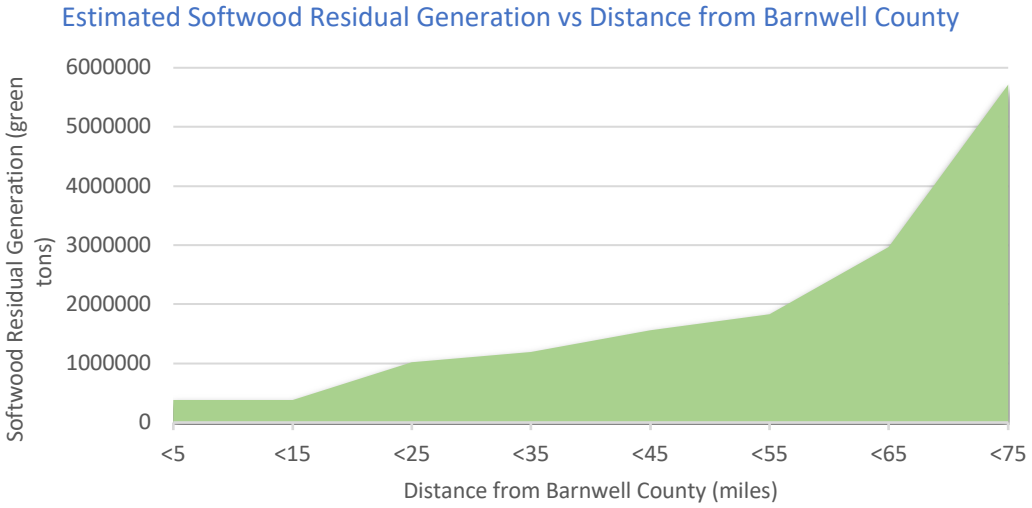
3.16. Feedstock Transportation Costs

Rationale. Transportation can be one of the most significant cost components of biomass supply chains. The average transport cost and percentage of total feedstock cost attributable to transport should be known.	
Raw RI Score. Transportation costs can be estimated as a function of the price of fuel per gallon per running mile. At present, transportation costs are estimated as $3.20 per running mile, though this price will follow the trends of the graph displayed in RI 3.10. For this reason, Raw RI Score is 5 out of 10.	**Score 5**
Notched Salience. Much of the risk associated with volatile fuel prices could be mitigated by a project engaging in supply deals with suppliers closer to the facility site. As a result, the Raw RI Score is notched by 50%: Notched Salience is 2.5.	**Score 2.5**
Impact Level. RI Impact Level is deemed *moderate.*	**Score 6.66**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 16.65 out of 100.	**Score 16.65**

3.17. Transportation Distances

Rationale. Transport distances of 50-75 miles for biomass feedstocks are typical but larger distances can be common. Where average transport distance from suppliers to Proponent is high, the supply chain is subject to greater sensitivities to risks, such as increases in diesel cost, weather impacts, mechanical breakdown, and by the demand for feedstock from competitors closer to the source. Understanding average transport distance can help flag higher-risk suppliers where transport distance materially exceeds the average.	
Raw RI Score. Analysis revealed very different relationships between softwood and hardwood Sawmill Residual generation with respect to distance from Barnwell County. Estimated hardwood Sawmill Residual generation increases almost entirely linearly with distance from Barnwell, as shown in the figure below. After minimal increases in generation when within 15 miles of Barnwell, generation grows at a rate of roughly 182,640 gt/yr for every 10 miles of driving-distance increase. Softwood Sawmill Residual generation does not follow this linear trend. The largest spikes in estimated generation occur at driving distances of 25-, 65-, and 75-miles. When driving distance radius is increased to 25 miles, softwood Sawmill Residual production jumps by a factor of 2.7, from 377,262 to 1,018,860 green tpy. At 65 miles, production increases from 1,833,749 to 2,963,837 green tpy. The aggregate total softwood Sawmill Residues generated within the supply basin reach its value of 5,715,435 green tpy at 75 miles.	**Score 4**





Forest Residue generation data were only available on a state – not county – level, making accurate spatial distribution modeling difficult.

Due to the majority of softwood Sawmill Residue being generated at distances greater than 35 miles, and the spatial distribution of Forest Residue generation being difficult to model precisely, Raw RI Score is 4 out of 10.

Notched Salience. No adjustment.	**Score** Unnotched
Impact Level. RI Impact Level is deemed to be *low.*	**Score 3.33**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 9.99 out of 100.	**Score 13.32**

3.18. Transportation of Feedstock Requires Specialized Equipment

Rationale. Requirements for specialized transport equipment can increase supply chain risk. Where there is low availability in required transportation equipment, equipment owners have increased leverage over transportation prices and supply chain resiliency can be lower.	
Raw RI Score. Transportation of feedstock does not inherently require specialized equipment. Conversations with local experts revealed that the majority of the feedstock presently moved within the Supply Basin is transported with traditional open-top trailers. Additionally, one logger and potential supplier in the region expressed the company has been transporting Forest Residue (in the form of in-woods whole-tree chips) without live bottom trailers, to date. Hauling services also exist in the area that would be able to transport feedstock from Forest Residue generation/aggregation sites and sawmills as necessary. Requirement of specialized equipment is predominantly predicated on the potential bioprocessing facility, and how its eventual infrastructure dictates what types of transportation vehicles can be used to deliver feedstock. Because of this, raw RI Score is 5 out of 10.	**Score 5**
Notched Salience. If a facility is designed to be able to accept offload from other kinds of transportation (that are not live-bottom trailers), the risk associated with the need for specialized equipment is mitigated significantly. Alternatively, should the feedstock quantity desired be sufficiently large, at least one supplier who does not already own live-bottom trailers expressed a willingness to explore options for acquiring them, though this would likely translate to an increase in feedstock cost to offset the purchasing of new equipment. As a result, Raw RI is notched by 75%: Notched Salience is 1.25.	**Score 1.25**
Impact Level. RI Impact Level is deemed *moderate.*	**Score 6.66**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 8.33 out of 100.	**Score 8.33**

3.19. Delivery Routes through Local Communities

Rationale. Transportation of biomass can become a nuisance to local communities, especially if a large number of trucks pass through residential and school areas. Local communities often have power to force regulations regarding truck transport, impeding a Proponent's ability to transport feedstock. This risk is greater in greenfield projects than operational ones.	
Raw RI Score. Preliminary GIS analysis confirmed an effective, intersecting, and expansive network of roads and highways, in and out of Barnwell County. Additionally, should a delivery route traverse through a local community, feedstocks do not carry unpleasant odors or visuals.	**Score 1**

For these reasons, Raw RI Score is 1 out of 10.	
Notched Salience. No adjustment.	**Score** Unnotched
Impact Level. RI Impact Level is deemed *low.*	**Score 3.33**
Loaded RI Score. Loaded RI Score (Raw RI x Impact Level) is 3.33 out of 100.	**Score 3.33**

3.20. Transportation Regulations & Local Weight Limits

Rationale. In many regions, transportation is regulated based on seasonal road conditions. These regulations (e.g., "frost laws") often take the form of weight restrictions or limits on the number of trucks allowed on roads. Such regulations can impede the project's ability to source sufficient feedstock or increase the cost of doing so at certain times of the year.	
Raw RI Score. Considering the quantity of timber that is currently transported in the supply basin, both in volume and mass, it is highly unlikely that transportation regulations could hinder feedstock acquisition or transportation. Max weight allowable for transportation are 80,000 pounds of gross vehicle weight for a multi-axle commercial vehicle[19]. When the weight of the semi-truck and trailer are accounted for[20], each truck shipment can be expected to transport 22-23 tons. For these reasons, Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience. No adjustment.	**Score** Unnotched
Impact Level. Impact Level is deemed *moderate.*	**Score 6.66**
Loaded RI Score. Loaded RI Score (Raw RI x Impact Level) is 6.66 out of 100.	**Score 6.66**

3.21. Road Infrastructure

Rationale. Feedstock cost and availability can be a function of road infrastructure, in particular the accessibility the infrastructure provides to feedstock. Issues with road networks will translate directly to risks to feedstock supply.	
Raw RI Score. The state of South Carolina boasts a stout infrastructure network that supports the forest industry. The state's railroad web operates 2,300 miles of track[21]. Additionally, the state's highway system provides direct access to 60% of the US population within 1 day[14], a testament to the robust and well-maintained nature of the road infrastructure that can be utilized by any potential project looking to site in Barnwell County.	**Score 1**

[19] From Oversize.io: https://oversize.io/regulations/axle-weight-calculator/south-carolina
[20] Hanna Law Firm: How Much Does A Semi Truck Weigh? | How Heavy Is A Semi Tractor? (hannalawfirm.com)
[21] South Carolina Forest Industry Facts. https://www.state.sc.us/forest/scfifacts.pdf

Preliminary GIS analysis confirmed an effective, intersecting, and expansive network of roads and highways, in and out of Barnwell County. Therefore, Raw RI Score is 1 out of 10.	
Notched Salience. No adjustment.	**Score** Unnotched
Impact Level. Impact Level is deemed *moderate.*	**Score 6.66**
Loaded RI Score. Loaded RI Score (Raw RI x Impact Level) is 6.66 out of 100.	**Score 6.66**

3.22. Transportation Redundancy

Rationale. Transport equipment redundancy is important for dealing with seasonally variable feedstock supplies as well as the risk of equipment breakdowns.	
Raw RI Score. Transportation of Sawmill Residuals can likely be achieved by a facility owning and operating its own trailers for transportation, or through a third-party contracted transportation company. Conversations with local stakeholders revealed that logging companies typically handle Forest Residue transportation, again through either their own hauling trucks or through a contracted third-party. In addition to loggers, another 50 trucking companies were identified in Barnwell, though it should be noted that many of these companies appear to operate a small number of hauling trucks only. If outsourced, transportation would likely have to be contracted to a small number of major trucking companies or a large number of smaller ones. Identified trucking services in Barnwell are listed in Table 9 of Appendix A.5.1. Due to the majority of identified trucking services being small-scale, and that the effectiveness of the already-built-in transportation redundancy in the supply chain could be significantly reduced if a new facility design requires live-bottom trailer delivery, Raw RI Score is 6 out of 10.	**Score 6**
Notched Salience. Local stakeholders revealed that much of the feedstock transportation, even when carried out by different trucking companies, is coordinated by Williams Brothers Trucking (WBT) International, located in Walterboro, South Carolina. Should third-party contracting be required for feedstock transportation, engaging in delivery contracts with companies such as WBT International could help a facility manage the risks associated with contracting small hauling services. Transportation redundancy could be built into the Forest Residue supply chain by exploring the options developed by Han et al. in their 2018 study for optimizing Forest Residue processing and transportation[22] in relation to local dynamics. To optimize the economics of Forest Residue transportation, their study proposes facilities consider 3 Forest Residue models: (i) chip Forest Residues at the site of generation and transport directly to a bioprocessing facility; (ii) collect all residues from across logging locations unchipped at a central location, and then chip them directly into chip vans for transportation; or (iii) collect	**Score 3**

[22] Han, H., Woodam, C., Wells, L., and Anderson, N. "Optimizing Biomass Feedstock Logistics for Forest Residue Processing and Transportation on a Tree-Shaped Road Network." Published in *Forests* Journal, 5 March 2018.

residues at nearby chipping facilities, and then transport those to their use-location at a bioprocessing facility. A potential facility could work with loggers on transportation logistics to determine how the above-listed methods can be optimized within the Barnwell context to strengthen feedstock's transportation logistics.

As a result, Raw RI Score is notched by 50%: Notched Salience is 3.

Impact Level. Impact Level is deemed *high.*	**Score 9.99**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 3.33 out of 100.	**Score 29.97**

3.23. Number, Size, Mix, & Locations of Suppliers

Rationale. In general, a supply portfolio involving multiple suppliers of various sizes is important for ensuring steady and uninterrupted feedstock supply with minimal price fluctuations. If a small number of large suppliers provides a high proportion of total feedstock, a disruption or supplier breach will have greater impact on the supply chain. In such cases the risk of disruption is lower but the impact of those disruptions is higher. Conversely, a large number of small suppliers are less likely to have the capacity to withstand internal disruptions and thus may be more likely to breach. Here, risk of disruption is higher but their likely impact is lower. The number of suppliers as well as the ratio of small to large suppliers should be optimized.

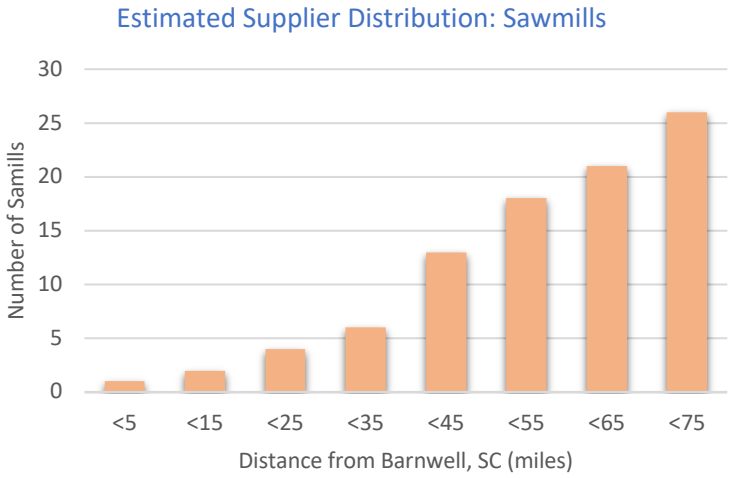
There is no pre-determined number or optimal ratio of suppliers, although having too many or too few can both pose higher degrees of risk.

Raw RI Score. A total of 110 potential suppliers were identified within the supply basin: 26 sawmills (who could supply Sawmill Residuals) and 84 loggers (who could supply Forest Residuals). Table 4 in Appendix A.2.5 summarizes all identified potential suppliers within the 75-mile supply basin. **Score 3**

It is important to note that only loggers with in-woods chippers or grinders produce whole-tree chips. Additionally, loggers' listed locations are largely home offices, and they will typically travel to wherever there is work. So long as they are located within the supply basin, loggers' distance from Barnwell County is largely irrelevant, and were thus not mapped. Map 3 in Appendix A.2.5 shows the spatial distribution of the 26 identified sawmills with respect to Barnwell.

Sawmill outreach results were likely seriously impacted by the COVID-19 crisis. With many employees working remotely during the course of this study, it proved difficult to reach administrative/reception assistants who could then forward inquiries to the appropriate individuals within the respective companies. Consequently, size mix of potential sawmill suppliers was not able to be determined.

Spatially, the density of competition to the west of Barnwell, north of Fort Gordon, contains the highest sawmill-to-competition-location ratio. Sourcing from these sawmills could potentially be advantageous due to reduced competition.



The number and mix of potential suppliers in the supply basin is advantageous for projects looking to site in Barnwell County. However, the fact that 76% of potential suppliers operate outside of a 35-mile driving distance introduces some risk factor. Therefore, Raw RI Score is 3 out of 10.

Notched Salience. By engaging in feedstock agreements with the closest sawmills or those to the west of Barnwell, some of the risk associated with RI 3.23 could be mitigated, as the risk is predominantly associated with distance. Risk could be further mitigated by prioritizing Forest Residues over Sawmill Residues intake, as there is substantially less competition for Forest Residues in the BDO Zone. As a result, Raw RI is notched by 25%: Notched Salience is 2.25.	**Score 2.25**
Impact Level. RI Impact Level is deemed *moderate.*	**Score 6.66**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 14.99 out of 100.	**Score 14.99**

3.24. Suppliers Subject to Same External Risk Factors (Non-Weather & Equipment Based)

Rationale. When a single risk event can impact the feedstock production ability of all (or most) suppliers, then feedstock risk is higher and supply chain resiliency is lower. Resilience is maximized when biomass supply chains exhibit diversity in spatial location (i.e., geography), production practices and other elements of supply chain structure such that the impact of single high-risk events have varying impacts on suppliers.	
Raw RI Score. Suppliers in Barnwell County are subject to the same external risk factors. Sawmills are subject to the same risks related to the lumber market. Additionally, the market in Barnwell is predominantly softwood (84% of total Sawmill Residual generation), meaning that the region is also largely subject to the same species-related risks. For this high risk inherent to the supply chain, Raw RI Score is 8 out of 10.	**Score 8**

Notched Salience. Should a potential facility source feedstock predominantly from aggregators or other major suppliers, it could likely shield itself from a portion of the risk. Larger feedstock generators' supply chains are less likely to be heavily impacted by temporal external risk factors, that could seriously hinder smaller suppliers' ability to produce desired feedstock quantities. By sourcing predominantly from major suppliers, and supplementing feedstock with deliveries from smaller suppliers, RI 3.24 could be partially mitigated. As a result, Raw RI Score is notched by 25%: Notched Salience is 6.	**Score 6**
Impact Level. Impact level is deemed *high.*	**Score 9.99**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is	**Score 59.94**

3.25. Seasonal Weather Impacts on Feedstock Supply

Rationale. Seasonal weather impacts are defined as those deriving from natural weather variations (i.e., spring thaws, rainy seasons or dry seasons – as opposed to from singular weather events like fires, droughts or hurricanes). Seasonal weather changes can be a significant risk factor affecting feedstock availability, quality and price.	
Raw RI Score. Temporary delays can occur during periods of heavy rainfall when loggers are unable to clear trees from timberland, or dirt roads are flooded. These delays cause variations in both Sawmill and Forest Residual feedstock production, but the delays (and therefore feedstock generation variations) typically do not last more than a few days. Sawmill Residuals generation track linearly with roundwood timber generation. Though there is no seasonal variation in Sawmill Residual generation, overall timber production has been volatile since 2011. However, at no point in the available data did roundwood generation drop below 10,000,000 green tons in a year, and roundwood production has been increasing since 2017. There is no additional seasonal variation in Sawmill Residual generation. Sawmill Residuals are less subject to seasonal weather impacts because sawmills tend to build up inventories, leading to a somewhat constant seasonal lumber (and Sawmill Residual) production. There can be some seasonal delays in Forest Residual generation, particularly in the spring, when in-woods chipping can be hindered by thawing. Combining these factors leads to a Raw RI score of 3 out of 10.	**Score 3**
Notched Salience. Several steps could be taken by a facility to mitigate the risk associated with RI 3.25. Since seasonal delays are typically on the order of days-to-weeks, having a modest-sized, but well-maintained, feedstock reserve on-site could help in significantly reducing the risk. Additionally, sourcing predominantly from larger suppliers, whose ability to deliver feedstock is less likely to be delayed by storms and other weather events, could help mitigate the risk.	**Score 1.5**

As a result, Raw RI is notched by 50%: Notched Salience is 1.5.

Impact Level. RI Impact Level is deemed *high.*	**Score 9.99**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 14.99 out of 100.	**Score 14.99**

3.26. Long-Term Weather and Climate Trends

Rationale. In certain regions, climatic trends and significant potential changes to future weather patterns can create feedstock risk.

Raw RI Score. As anthropogenic greenhouse gas (GHG) emissions continue to rise globally, one of the already-observed consequences is the increase in strength and size of Atlantic hurricanes. Situated in a hurricane-prone region of the United States' east coast, hurricane strength increases also increase the probability of a heavy disruption to the supply chain. Though these long-term weather and climate trends could significantly impact the supply chain on the order of days to weeks, from the biomass transportation perspective, increase in hurricane strength could be seen as an opportunity. Hurricanes tend to generate more biomass (although of lower quality) when the heavy rainfall and strong winds knock down trees. These fallen trees must then be chipped, making more Forest Residual feedstock available. However, it is possible that increased temperatures and heavier rainfalls could impact long-term forest health and production negatively. Due to the potential opportunity presented by the increased production and availability of Forest Residuals, Raw RI Score is 2 out of 10.	**Score 2**
Notched Salience. Hurricane season in South Carolina officially runs from June 1 to November 30, peaking around September 10[23]. By tracking storms during this period, a potential facility could increase its feedstock reserves and storage capabilities as necessary. As a result, Raw RI is notched by 25%: Notched Salience is 1.5.	**Score 1.5**
Impact Level. RI Impact Level is deemed *moderate.*	**Score 6.66**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 9.99 out of 100.	**Score 9.99**

3.27. Government Subsidies for Feedstock Production or Utilization

Rationale. Feedstock that is directly subsidized though government programs can pose greater long-term risk than feedstock that is not. Subsidies may be subject to amendment or repeal, sometimes with minimal notice.

[23] The Sun News: https://www.myrtlebeachonline.com/news/local/article251800153.html

NOTE: This risk indicator refers to direct feedstock subsides only; it does not apply to government subsidies that pertain indirectly to the operations of the Proponent such as Loan Guarantees or to the markets for products produced by the Proponent.

Raw RI Score. No government subsidies for feedstock production or utilization were identified. Federally, a potential project could engage in the Renewable Identification Number (RIN) marketplace, should it utilize proper qualifying forest residue feedstocks.	**Score 1**
Notched Salience. No adjustment.	**Score Unnotched**
Impact Level. RI Impact Level is deemed *low.*	**Score 3.33**
Loaded RI Score. Loaded RI Score (Raw RI x Impact Level) is 3.33 out of 100.	**Score 3.33**

3.28. Local, Provincial, & National Laws, Regulations, & Permitting Pertaining to Biomass

Rationale. Feedstock whose production is directly dependent on local, provincial or national laws or government regulations can pose greater long-term risk than feedstock that is not, since laws and regulations may be subject to amendment or repeal.

If utilization of biomass requires specific permits (i.e., percentage removal of forest residues or corn stover, allowable cut limits, air emission, storage permits, rights-of-way, overweight permits for trucks, cross-border permitting for shipment of biomass, chain of custody, or certification of sustainability) then likelihood of obtaining such permits and/or complying with permitting requirements should be examined.

Raw RI Score. No pertinent local or state laws or regulations pertaining to biomass were identified. Federally, a potential project could engage in the Renewable Identification Number (RIN) marketplace, should it utilize proper qualifying forest residue feedstocks. Though no exact policies have been enacted, President Biden's Executive Order on Tackling the Climate Crisis at Home and Abroad expressed a desire for expansive domestic investments in biofuels and biomass projects. Forthcoming US policies that stem from this stated administrative goal would likely be of benefit to any biomass facilities looking to site in Barnwell County, through tax credits or some other as-yet to be determined incentives. With these considerations in mind, Raw RI is 1 out of 10.	**Score 1**
Notched Salience. No adjustment.	**Score Unnotched**
Impact Level. RI Impact Level is deemed *low.*	**Score 3.33**
Loaded RI Score. Loaded RI Score (Raw RI x Impact Level) is 3.33 out of 100.	**Score 3.33**

3.29. Backlash Against Biomass Development, Procurement or Usage in the Region

Rationale. Public backlash against biomass development in the Proponent region can directly impact Proponent's ability to procure, transport, trans-load, store, or utilize feedstock by affecting local policies, regulations and Proponent's ability to obtain necessary permitting.

Raw RI Score. No past backlash against any of the already-existing Biomass Power or CHP facilities in the competition zone was identified. In fact, local opposition to a Pellet Mill in Ridgeland, SC was identified, due to the facility's harmful air pollution[24]. Potential backlash against other types of biomass development would have to be evaluated on a case-by-case basis, as there are no other case studies to draw insights from within the supply basin or competition zone. However, the Pellet Mill case study could be an indication that significant backlash can occur in response to unwanted odors, air and/or water pollutants. Due to no past backlash against biomass development being identified and backlash against competitor facilities being identified in at least one instance, Raw RI Score is 2 out of 10.	**Score 2**
Notched Salience. No adjustment.	**Score Unnotched**
Impact Level. RI Impact Level is deemed *high.*	**Score 9.99**
Loaded RI Score. Loaded RI Score (Raw RI x Impact Level) is 19.98 out of 100.	**Score 19.98**

3.30. Feedstock Sustainability, Including Risks to Soil Quality, & Surface & Groundwaters

Rationale. Public concerns about sustainability of feedstock production can jeopardize biomass feedstock operations. Sustainability certification schemes should be utilized where applicable to ensure that feedstock comes from sustainable sources.

Soil sustainability can be defined as management of soil in a way that does not exert any negative or irreparable effects either on the soil itself or any other systems. There is a diversity of approaches to soil sustainability in jurisdictional guidelines for biomass harvesting and production. For different feedstock types, there are also different thresholds at which feedstock removal causes significant negative consequences on soil.

Excessive nutrient runoff from biomass feedstock production can accumulate in surface waters and result in algal blooms and hypoxia which can lead to habitat loss for aquatic species higher up the food chain and alter aquatic ecosystem food webs. Damage to aquatic ecosystems can cause social and regulatory backlash. Water intake issues can also increase risk.

Raw RI Score. Feedstocks pose no risk to sustainability metrics. Raw RI Score is 1 out of 10.	**Score**

[24] Post and Courier: https://www.postandcourier.com/news/wood-pellet-mill-in-rural-sc-town-draws-air-pollution-complaints-threats-of-legal-action/article_88ff434a-025a-11eb-8fbf-fb945008256e.html

	1
Notched Salience. No adjustment.	**Score** **Unnotched**
Impact Level. RI Impact Level is deemed *low.*	**Score** **3.33**
Loaded RI Score. Loaded RI Score (Raw RI x Impact Level) is 3.33 out of 100.	**Score** **3.33**

3.31. GHG Emissions from Production, Harvest, & Transport

Rationale. Understanding a project's overall emissions and the carbon intensity throughout the feedstock supply chain is an essential part of reducing risks related to carbon pricing mechanisms and related regulations GHG emissions from production, harvest and transportation can be a significant challenge to Proponent claims of carbon neutrality for biomass projects. Carbon emissions from harvested soils, as well as emissions from harvesting machinery or delivery trucks, can make the achievement of net-zero GHG emissions difficult. If a Proponent's financial model relies on carbon neutrality/GHG regulatory pricing frameworks, then an investigation into the feedstock's carbon emission status is essential.	
Raw RI Score. Assuming that (i) transportation trucks average 6.5 miles per gallon[25]; (ii) all feedstock must be transported 75 miles; (iii) trucks can carry 22 tons per delivery; (iv) facility intake requirement is 300,000 tpy, and; (v) 19.64 pounds of CO_2 are emitted per gallon of fuel used[26], approximately 1,545 tons of CO_2 would be emitted per year in feedstock transport. However, average CO_2 carbon sequestration for pine trees is approximately 11 tons per acre of new tree growth[27], meaning that only 140 acres of new trees would have to be grown per year to sequester all the carbon emitted from feedstock transportation. Given the scale of the forestry industry in South Carolina, this tree growth is all but assured. GHG emissions stemming from feedstock production and harvest are more difficult to model. However, given the health of the forestry industry in South Carolina, and the fact that the industry is expected to continue growing in the near-term, it is possible that new tree growth in the supply basin could sequester most or all of the GHGs emitted during feedstock production and harvest. For these reasons, Raw RI Score is 2 out of 10.	**Score** **2**
Notched Salience. No adjustment.	**Score** **Unnotched**
Impact Level. RI Impact Level is deemed *low.*	**Score** **3.33**
Loaded RI Score. Loaded RI Score (Raw RI x Notched Salience) is 6.66 out of 100.	**Score** **6.66**

[25] Arrow Truck: https://www.arrowtruck.com/blog/2016/06/21/manage-your-semi-trucks-fuel-use-with-these-tips/
[26] US Energy Information Administration: http://www.patagoniaalliance.org/wp-content/uploads/2014/08/How-much-carbon-dioxide-is-produced-by-burning-gasoline-and-diesel-fuel-FAQ-U.S.-Energy-Information-Administration-EIA.pdf
[27] GoTree Quotes: https://www.gotreequotes.com/how-much-co2-do-trees-absorb/

3.32. Geographic Location Influence on Feedstock Variability

Rationale. Feedstock from different regions may differ in quality due to variations in soil quality, topography, harvest practices, weather, fertilizer applied, etc.	
Raw RI Score. Geographic location within the supply basin does not impact feedstock variability. Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience. No adjustment.	**Score Unnotched**
Impact Level. RI Impact Level is deemed *low.*	**Score 3.33**
Loaded RI Score. Loaded RI Score (Raw RI x Impact Level) is 3.33 out of 100.	**Score 3.33**

3.33. Capacity of Supply Chain Components & Equipment to Scale

Rationale. Scale-up risk increases if supply chain components, or underlying feedstock infrastructure necessary for these components, cannot scale to handle Proponent feedstock requirements and throughput capacity. Capacity to scale should be demonstrated.	
Raw RI Score. Supply chain equipment is cost-intensive, and scaling capacity would require large capital investments from potential suppliers, that would then be passed on to a potential facility through an increase in feedstock price. Raw RI is 6 out of 10.	**Score 6**
Notched Salience. Outreach to one potential major supplier revealed that suppliers are able and willing to acquire new equipment, should it be required for selling to a new market that would increase their bottom line. Engaging in Forest Residual contracts with potential suppliers could further incentivize suppliers to incur the capital cost of purchasing new equipment to increase profits with materials that would otherwise often be left behind in the forest. As a result, Raw RI is notched by 50%: Notched Salience is 3.	**Score 3**
Impact Level. RI Impact Level is deemed *high.*	**Score 9.99**
Loaded RI Score. Loaded RI Score (Notched Salience x Impact Level) is 29.97 out of 100.	**Score 29.97**

APPENDIX C: FEEDSTOCK GENERATION METHODOLOGY

1. Forest residual generation procedure and assumptions

1. Data on average annual removals of aboveground biomass of trees on timberland was obtained for each quadrant from FIA.
2. Data on average removals of merchantable bole biomass of trees on timberland was obtained through the same source.
3. Measurement unit was converted from dry short tons to green short tons using relevant conversion factors.
4. The following formula was used to estimate forest residual generation

$$FR = RAB - RMBB$$

Where:
FR - Forest residual (GMT/yr)
RAB - removals of aboveground biomass (GMT/yr)
RMBB - removals of merchantable bole biomass (GMT/yr)

2. Bone-Dry Ton to Green Ton Conversion

USDA data on forest residual generation are reported in bone-dry tons. For unit consistency, these reported data were converted to green tonnage with the following equation[28,29]:

$$MC = \frac{M_g - M_d}{M_d}$$

Where:
MC – Moisture Content
M_g – Weight in Green Tons
M_d – Bone-dry weight

3. Sawmill Residual Generation Procedure and Assumptions

1. County-level data on production of saw logs by major tree species group was obtained from the FIA's TPO (Timber Products Output) data tool[30].
2. Residual generation of chips, sawdust, shavings and bark was estimated in GMT/yr by applying residual yield ratios[31] by major tree species groups:
    - Residual ratios for softwood saw logs:
        - Chip generation, $RR_{SC} = 35\%$ of raw softwood timber input
        - Sawdust generation, $RR_{SD} = 8.75\%$ of raw softwood timber input
        - Shavings generation, $RR_{SS} = 7.75\%$ of raw softwood timber input
        - Bark generation, $RR_{SB} = 5.2\%$ of raw softwood timber input
    - For facilities in majority hardwood states:
        - Chip generation, $RR_{HC} = 25\%$ of raw hardwood timber input
        - Sawdust generation, $RR_{HD} = 14\%$ of raw hardwood timber input
        - Shavings generation, $RR_{HS} = 7\%$ of raw hardwood timber input
        - Bark generation, $RR_{HB} = 10.8\%$ of raw softwood timber input

[28] Glass & Zelinka: https://www.researchgate.net/publication/273459077_Moisture_Relations_and_Physical_Properties_of_Wood
[29] Professor Charles Ray, Penn State: https://extension.psu.edu/calculating-the-green-weight-of-wood-species
[30] FIA's Timber Products Output (TPO) Tool Kit: https://www.fia.fs.fed.us/tools-data/index.php
[31] For chips, sawdust and shaving: Estimated Production, Consumption and Surplus Mill Wood Residuals in Canada - 2004 A National Report
_ Residual yield ratio for bark was calculated by Ecostrat based on 2017-2018 TPO data for Arkansas

APPENDIX D: COMPETITION FEEDSTOCK CONSUMPTION MODELING

1. Pulp Mill Competition Estimation

Total Pulp Mill feedstock consumption was estimated using a Forest2Market conversion factor[32]. Since individual pulp mill intake could not be determined, the total pulp mill feedstock consumption, derived from the Forest2Market conversion factor, was assumed to be evenly distributed across all the identified mills in the supply basin.

2. Pellet Mill Competition Estimation

Pellet Mill intake volumes were gathered from the Southern Environmental Law Center[33], internal Ecostrat data, and the US Energy Information Administration's Monthly Densified Biomass Fuel Report[34].

3. Biomass CHP & Power Plants Competition Estimation

Biomass CHP intake volumes were taken from Wood2Energy[35]. When available, Biomass Power facilities intake volumes were also taken from Wood2Energy. For Biomass Power facilities whose feedstock intake could not be determined, their power production was studied as a proxy. For every MW of energy produced by the Biomass Power facility, it was assumed that 10,000 green tons of feedstock were consumed. For example, a 20 MW Biomass Power Facility was estimated to have a feedstock intake requirement of 200,000 green tpy.

4. Total Competition Historical Consumption Estimation

When generating historical competitor consumption estimates, the year each facility was brought online was determined. It was assumed that each facility has had their most recently reported or estimated feedstock intake capacity the entirety of its operation length. Estimated historical competition feedstock intake was then aggregated on an annual basis, based on the number of facilities that were brought online during that year.

[32] 2018 US Forest Harvest Utilization: https://www.fisheri.com/blog/pulp-paper-products-consume
[33] Southern Environmental Law Center: https://www.southernenvironment.org/uploads/maps/SELC_WoodPelletExportMap_2017_0707_map+table.pdf
[34] EIA Monthly Densified Biomass Fuel Report: https://www.eia.gov/biofuels/biomass/
[35] Wood2energy: https://www.wood2energy.org/

APPENDIX E: TRANSPORT COMPANIES OPERATING IN THE SUPPLY BASIN

Company Name	Address	Phone Number
NCT Trucking	6734 Hwy 278	803.300.9336
Ike's Trucking	315 N Clemson Dr	803.541.6553
Zorn Trucking	805 Wellington Rd	803.300.2427
T Express Co.	61 Satterthwaite Dr	803.541.0855
Hummingbird Trucking	406 Scuppernong Rd	803.541.6825
Marvins Trucking	490 Ball Park Rd	803.541.0304
Williston Transportation	61 Satterthwaite Dr	803.541.0855
Bengy's Trucking	34 Sapphire Lane	803.259.4545
Thunder Mountain Transport	680 S Toby Creek Rd	888.521.9553
Cave Transportation Services	820 Marble Lane	803.259.7917
William M Towne Trucking	170 Duncan Lane	803.259.5702
Still Trucking	545 Still Rd	803.259.5699
Towne Trucking Co	20 Swift Lane	803.259.5975
B&T Express Co	13626 Hwy 64	803.571.5759
Amber Logistics LLC	2883 Highway 300	865.992.2745
Wiggins Trucking	1703 Ninth St	803.259.7096
Big Country Trucking LLC	171 Sapling Rd	803.571.1895
Camp Eight Trucking LLC	5865 US Highway 278	803.571.1907
Chappell Transport	166 Boiling Springs Rd	803.584.2565
D&C Express LLC	268 Red Oak Rd	803.571.5699
G Oberry Trucking LLC	2441 Black River Rd	803.709.0504
G&S Trucking	395 Sweetwater Circle	803.571.5835
Cave Xpress	2894 Red Oak Rd	803.308.5858
Hartzog's Trucking LLC	59 Wingo Estates Rd	803.671.6773
Helping Hands Transportation LLC	111 Pine Hvn	803.686.2170
Innovative Express Transport LLC	871 Fairway Ln	803.541.6677
J Riley LLC	45 Willow St	803.514.4599
Kendall McDonald Trucking LLC	4401 Galilee Rd	803.300.0954
Buckmon Transportation	371 Sweetwater Circle	803.300.2052
Kirby Transport LLC	40 Marble Rd	803.672.7282
LMT Trucking LLC	2434 Black River Rd	803.571.1951
Lone Wolf Trucking LLC	542 Huckleberry Bay Rd	803.226.2031
Hammond Transport	173 Debbie Ln	803.679.0232
Moors Trucking	63 Oak Rd	803.671.4711
Palmetto Truck & Trailer Service	5585 Highway 70	803.259.5636
Ralph's Trucking Company Inc	3217 Galilee Rd	706.447.4133
Robert Collins Company LLC	9881 Marlboro Ave	803.259.3583
Shatzer Trucking	2682 Patterson Mill Rd.	803.259.1347
Davis Swamp Logging LLC	462 Cedar Run Rd	803.671.2673
Twitty's Tree Service Inc	812 Black River Rd	803.259.9252

SRA Track LLC	14812 Dunbarton Blvd	803.259.1292
Safe Transport Logistics LLC	1810 Clinton St Apt 13	843.305.1804
SKN Transport LLC	41 Debbie Ln	803.645.7390
SOS Transporting Services	137 Ashley Lane	803.259.2117
Spring Valley Transport LLC	223 Walnut Ave	717.587.8251
Tiger Paw Logging	286 Jackson Street	803.541.2738
Trendsetta Transit LLC	73 Lyndhurst Rd	803.671.1050
TTQ Enterprises LLC	5310 Seven Pines Rd	803.259.3005
Yellow Dog Trucking LLC	271 Kings Ave	443.624.0427