BD BIOECONOMY DEVELOPMENT
OZ OPPORTUNITY ZONE INITIATIVE

National Workshop Agreement for Bioeconomy Development Opportunity (BDO) Zone Ratings



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GOT FEEDSTOCK RISK? GET ECOSTRAT.



Introduction

03/17/2023

The Standards Council of Canada (SCC) has tasked Ecostrat Inc. with development of a systematic, standardized framework for assessing and rating biomass feedstock and infrastructure attributes with respect to regional development potential of new biofuel, renewable chemical, biogas or bioproduct manufacturing plants.

These new Bioeconomy Development Opportunity (BDO) Zone Workshop Agreement represents the current state-of-the-science in terms of quantification of regional biomass supply chain and infrastructure risk. They are a normative assessment protocol designed to enable the project developers, capital markets, governments and sector stakeholders to more accurately quantify regional bio-project development risk and reduce levels of uncertainty and inefficiency that are currently significant barriers to bio-based project development.

BDO Zone ratings help local regions and communities that want to attract new biobased development and participate in the growing global bioeconomy by enabling them to demonstrate the maturity of local biomass supply chains and infrastructure. Specifically, whether they are developed enough to support bio-based manufacturing without excessive risk.

They enable vastly improved assessment accuracy of biomass feedstock and infrastructure attributes of a region with respect to its development potential for new biofuel, renewable chemical, biogas or bioproduct manufacturing plants. Ultimately, they empower regions to leverage local biomass assets to attract new bio-based manufacturing plants and create jobs.

The impact of this BDO Zone Workshop Agreement is accretive and immediately transferable across the full spectrum of bio-based industries, supporting development of new plants that produce bioenergy, renewable chemicals, renewable natural gas (RNG), bio-based heat and power, clean hydrogen, and biomaterials. By filling the current gap for community-based economic development tools that help promote, de-risk and accelerate biobased project development and competitiveness, the BDO Zone Workshop Agreement can help to shift the national energy balance more rapidly towards net zero.

This BDO Zone Workshop Agreement is based on Canada's national *Standards for Biomass Supply Chain Risk (BSCR) (*CSA W209:21). While the BSCR Standards were designed to improve quantification of project-based supply chain risk for investors and were designed primarily as a due diligence tool for capital markets to facilitate the flow of capital to bio-based projects. The BDO Zone Workshop Agreement is designed primarily to improve quantification of regional biomass supply chain and infrastructure risk. They are meant to be used as economic development tools to facilitate and accelerate the flow of bio-based projects to regions that are best able to support them and where such projects are most likely to succeed.

For Canada, using forestry residues, agricultural crops, farm and food wastes, and MSW to manufacture clean fuels, chemicals and materials represents tremendous and largely untapped economic potential. Standards-based tools such as BDO Zone Ratings can help attract new bio-based manufacturing to Canada,

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create new clean energy jobs and generate new revenue streams for our agriculture, forestry and manufacturing sectors.

BDO Zone ratings also support Canadian federal GHG reduction and biobased economic development agendas by promoting and accelerating bio-based project development, innovation, and regional competitiveness, driving efficiencies around the use of sustainable and renewable feedstocks for biobased manufacturing and preparing regions for growth and success in the worldwide clean economy.

It is our intention and goal that this *BDO Zone Workshop Agreement* be integrated into the range of economic development tools, de-risking strategies, and policies used by regional economic development bodies, project development companies, investors, capital markets and governments who want to move towards net zero by participating in the rapidly growing global bioeconomy.

Best,



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In January 2023, three workshops were held to solicit input on the Risk Categories, Risk Factor and Risk Indicators in the BDO Zone Workshop Agreement. The authors are grateful to the participants in the Workshop for their feedback.

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The views expressed in this document are not necessarily supported in their entirety by all workshop participants. This document has benefited from the input of the workshop participants but does not represent the views or positions of the businesses and stakeholders for whom these participants work. The material in this publication may be quoted and used for non-commercial purposes provided there is proper attribution.

This document is being circulated to stimulate timely discussion and critical feedback, and to influence ongoing debate on the relevant topics.

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Overview

BDO Zone Ratings Address a Key Barrier to Development of the Canadian Bioeconomy

Clean energy markets are growing at an unprecedented pace, and communities need new tools to keep up on a competitive global stage and participate in the world bioeconomy. Many communities across Canada wish to participate in the rapidly growing bioeconomy by leveraging local biomass surpluses and other infrastructure-based advantages to attract new clean fuels projects, drive new biobased economic development, and create jobs.

However, they typically do not have the platform, credibility or budget to effectively promote these biomass supply chain advantages to biobased investors and developers around the world – and if they do, their communications are conflicted, not independent, and therefore not credible to project developers and investors. They constitute "noise" rather than "signal" and, as a result, fail to achieve the desired result of driving bio-based economic development.

It is vitally important for new bio-based manufacturing plants to locate where biomass supply chain risk is lowest. It's important that regions that possess these strategic bio-based assets have the tools that enable them to effectively and credibly communicate supply chain information to global investors and developers. So that bio-project development decisions can be made quickly and with minimal risk.

Unfortunately, the current system for communicating information regarding biomass supply chain risk is highly inefficient: it relies on an informal system of connection, collaboration where developers and investors interact with federal, provincial, and local economic development bodies, industry associations, and consultants to "search and find" optimal areas to locate new plants. This dynamic makes the economic development process expensive and time-consuming, often leading to plants located in sub-optimal areas, resulting in project failure.

In short, the current process for biobased economic development is highly inefficient, difficult to scale, and entails high risk, expense, and exposure for governments, economic development agencies, project developers, feedstock suppliers, investors and capital markets. The lack of a means to effectively "signal" regional feedstock risk to clean energy stakeholders in a transparent, credible and efficient manner constitutes a major barrier to local bio-based development and to Canada's national decarbonization objectives.

Addressing this barrier is essential to unlocking and accelerating investment in the bioenergy sector and to attracting new biofuel, renewable chemical, biogas, clean heat and power and bio-material plants to rural Canadian communities—and to achieving Canada's national decarbonization objectives.

BDO Zone ratings help address these barriers to powerfully leverage local biomass assets for clean fuels development. 'AA' and 'A' rated BDO Zone designations fill a critical need for more credible financial tools that empower rural regions to gain attention at the international level to attract new biomass-based clean fuel projects, decarbonize, and create jobs.

BDO Zone Ratings: Overview

The BDO Zone Initiative is a certification and regional biomass supply chain rating program that accelerates biobased project development in rural communities. A BDO Zone rating is a standards-based technical risk assessment of biomass feedstock, supply chain, and infrastructure attributes of a region

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with respect to the feasibility and development potential of new biofuel, renewable chemical, biogas or bioproduct manufacturing plants.

BDO Zones undergo rigorous and extensive due diligence using a framework of over 100 standardized, transparent and validated risk factors and indicators based on industry promulgated standards. 'AA' or 'A' BDO Zone Ratings put an internationally recognized, credible "bulls-eye" on the best areas in the country for low-risk bioeconomy project development.

BDO Zone ratings drive bio-based economic development by enabling 'AA' and 'A' rated communities to credibly signal and promote key local biomass supply chain "success" characteristics to biobased developers and investors around the world. This enables communities to connect more effectively with hundreds of biobased developers looking to develop new plants.

Bio-based development in BDO Zone-rated communities is actively supported by the *BDO Zone Investment Coalition,* made up of Goldman Sachs, Citibank, and Desjardins (and 17 others), which allocated $1B of capital for investment in BDO Zones in 2021. Economic development in BDO Zones is further supported by *Global Affairs' Invest-In-Canada*, which promotes BDO Zone Ratings through its offices worldwide.

As of Feb 2023, in North America there are 20 BDO Zone ratings either issued or in progress. Most recent ratings issues and press releases and press on for Bon Wier, TX, and Libby, MT, can be found here (*www.bdozone.org; https://www.canadianbiomassmagazine.ca/bon-wier-texas-receives-aa-rating-from-bdo-zone-initiative/; https://www.canadianbiomassmagazine.ca/libby-montana-awarded-bdo-zone-a-rating-for-woody-biomass/*)

Development of a Workshop Agreement for BDO Zone Ratings

The development of this Workshop Agreement within the framework of Canada's *Standards for Biomass Supply Chain Risk (CSA W209:21*) will help drive credibility, effectiveness and market-uptake of BDO Zone Ratings, support the goal of creating a national network of 100 'AA' and 'A'-rated BDO Zones. That will function to attract more bioenergy production facilities utilizing innovative, green technologies from around the world.

Standards for BDO Zone Ratings supports Canada's role in IEA Bioenergy Task 43

Canada is one of 17 countries participating in the research activities of the International Energy Agency (IEA) Bioenergy. A key IEA mission is improving the cooperation and sharing of information between countries with national research programs focusing on bioenergy development and deployment. Canada is involved in nine bioenergy tasks, *including IEA Bioenergy Task 43, Biomass Feedstocks for Energy Markets*.

"The goal of Task 43 is to promote sound bioenergy development through well-informed decisions by businesses, government, and other sectors. The aim of IEA Bioenergy participants in this task is to support decision-making by providing timely and topical analyses, syntheses, and general data on all fields related

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to biomass feedstock, including biomass markets and the socioeconomic and environmental consequences of feedstock production."[1]

A Workshop Agreement for BDO Zone Ratings strongly support IEA Task 43 for the following reasons:

- ✓ BDO Zone Ratings use internationally recognized standards, risk metrics and datasets to credibly quantify and signal key biomass feedstock and infrastructure "success" characteristics valued by biobased developers and investors globally.
- ✓ BDO Zone Ratings support community decision-making around bio-based project development.
- ✓ BDO Zone Ratings help develop new markets for biomass in the places where biomass feedstock supply chains are strongest and where those markets are most likely to succeed.

[1] https://www.nrcan.gc.ca/our-natural-resources/forests/industry-and-trade/forest-bioeconomy-bioenergy-bioproducts/bioenergy-biomass/13323

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Category 1.0: Supplier Risk

1.1 Risk Factor: Credit-Worthiness/Future Solvency of Suppliers

1.1.1 LONGEVITY AND 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.**
Reporting	**Reporting Requirements** 1. Issuer shall demonstrate understanding of number of years in business, historical feedstock supply performance and reputation for at least 3 significant suppliers in the Zone.
Guidance	**Guidance for Reporting Requirement 1** Local procurement professionals with developed relationships in the BDO Zone may have valuable insights about supplier's historical performance (Lewandowski 2018). Supplier's historical feedstock supply, performance and reputation in the market are positive predictors of likelihood of breach at some point in the future (Solomon 2018). Anecdotal feedback from competitors or other market players can be used as supporting evidence for supplier performance. Corroborating anecdotal data points from at least three independent third parties are preferred. Local members of relevant associations (i.e., local logging associations), government bodies often have insights about supplier's historical performance and reputation in the market.
Guidance Source	Bloomfield (2017, interview); Carollo (2017, interview); Crummett (2017, interview); Passmore (2017, interview); Solomon (2018, interview)

1.2 Risk Factor: Conflicts of Interest/Vested Interest with Competing Market(s)

1.2.1 SUPPLIERS DEPENDENCE ON, OR PREFERENCE FOR, COMPETING MARKETS

Rationale	**Suppliers 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 Issuer.**
Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of: 1. Knowledge of competing markets including, at minimum; approximate quantities, percentage of total supplier feedstock production and competing market's demand, and length of time supplied if supplier provides feedstock to competing markets. 2. Knowledge of the quantity and relevance of the risk of leverage a competing market could exert on supplier if supplier provides feedstock and any other products or by-products to such competing markets. **Reporting Recommendations** 1. Issuer should demonstrate understanding of supplier's relationship with competing markets, if possible.
Guidance	**Guidance for Reporting Requirement 1** Relationships between traditional markets such as pulp and paper companies, and suppliers such as forestry producers or sawmills can be personal and span several generations. If for example, a sawmill produces both chips and bark as by-products and has traditionally provided both to a local papermill, and if it has contracted part of its chip supply to the Issuer, then in times of chip shortage, the papermill may be able to compel deliveries of chips by threatening to refuse to take supplier's bark, thereby leveraging supplier to breach obligations to Issuer.

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	Anecdotal feedback from local experts can serve as adequate validation of vested interests. **Guidance for Reporting Recommendation 2** Anecdotal feedback from local experts can serve as adequate validation of vested interests.
Guidance Source	Hladik (2017, comment)

1.3 Risk Factor: Supplier Control Over Production and Transportation

1.3.1 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.**
Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of: 1. Supplier's land/facility ownership 2. Suitable control measures in cases where the supplier does not own/lease land/facility where feedstock is produced.
Guidance	**Guidance for Reporting Requirements 1-2** Many forestry companies do not own the land on which they harvest. In such cases, strong agreements are essential. Attributes of concern include biodiversity-enhancing management and biomass income generated from the land. Understanding these various factors, and clearly communicating the goals for the land within the agreement will benefit harvesting operations that do not occur on supplier owned lands (Rabotyagov & Lin 2013). In general, suppliers that own all means of production and transportation are more reliable than ones that do not.
Guidance Source	Rabotyagov & Lin (2013)

1.3.2 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 are 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. However, in some circumstances reliance on third-party equipment to harvest or produce feedstock can decrease supply chain risk. For example, when harvesting agricultural residues such as corn stover, the use of a third-party company with standard equipment specializing in harvesting, collection and transportation may decrease quality variations (e.g., ash content) of final feedstock.**
Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of: 1. Supplier's equipment ownership 2. The risk of using a third-party's equipment in cases where the supplier does not own/lease equipment. **Requirements Recommendations** 1. Issuer should demonstrate precedent for the use of a third-party's harvesting, collection, and transportation services.
Guidance	**Guidance for Reporting Recommendations 1-2** For example, a supply chain where a large number of suppliers have historically utilized third parties with success may demonstrate lower risk.
Guidance Source	Brechbill et al. (2011); Hladik (2017, interview); Solomon (2018, interview)

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1.3.3 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.**
Reporting	**Reporting Requirements** 1. Issuer shall demonstrate understanding of the risk of using third parties, both in cases where supplier provides transportation, but does not own/lease mean of transportation, and in cases where transportation is provided by Issuer (or contracted to a third-party by Issuer). **Reporting Recommendations** 1. Issuer should demonstrate precedent for the use of a third-party's transportation services.
Guidance	**Guidance for Reporting Requirement 1** This should include an understanding of any scheduling issues with transportation company and supplier. **Guidance for Reporting Recommendation 1** For example, a supply chain where a large number of suppliers have historically utilized third parties with success may demonstrate lower risk.
Guidance Source	Brechbill et al. (2011); Hladik (2017, interview); Solomon (2018, interview)

1.3.4 FEEDSTOCK AS A SECONDARY TRANSFORMATION

Rationale	**A secondary transformation dependent upon the production of primary products, e.g., forest residues, corn stover, bark, or sawmill chips (unless from a dedicated chip mill) are all secondary transformations of a primary product.** **Risks are higher if feedstock is a secondary transformation of a primary, more valuable product. It may not be economical for suppliers to produce biomass on its own, in the absence of markets for the primary product. For example, a supplier may produce dimensional lumber as its primary product and wood chips as a by-product, therefore relying on the health of the housing market for production levels. If the demand for dimensional lumber drops, so can the availability of sawmill residues.** **In case of agricultural feedstocks such as corn stover, the feedstock is a by-product of a primary crop. Since the primary crop is significantly more lucrative than the residue, it will be a priority for the producer. If production of the primary crop requires resources to be taken away from the production of secondary crop (e.g., in case of shorter harvesting windows due to weather), the secondary feedstock supply will suffer. In times of stretched resources, suppliers may also perceive harvesting and collection of the feedstock as a nuisance, potentially decreasing production levels.** **Understanding the economic drivers for suppliers' primary product can help gauge risk levels for secondary transformation biomass products.**
Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of: 1. Relationship between the primary product and the secondary transformation 2. Historical and projected market demand for supplier's primary product 3. The sensitivity of biomass feedstock production to demand fluctuations of the primary product.
Guidance	**Guidance for Reporting Requirement 1** Note how increases or decreases in production of the primary product affect the production levels of the secondary product. **Guidance for Reporting Requirements 2 and 3** In order to understand future biomass production levels, the demand for the primary product needs to be forecasted. Create a market analysis of the primary product determining the volatility of the production throughout different times of the year. Sensitivities to changes in demand should be modeled. If forecasts indicate an unstable demand for the primary product, long-term risk of biomass supply may be high. Finally, look for opportunities to increase the efficiency of the production of the secondary product (Kizha & Han 2016).

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	Chip production levels in a sawmill are proportional, and therefore highly sensitive to, lumber production levels. For example, recent softwood tariffs imposed by the US government caused significant reduction in supply of lumber (and sawmills residues) in many Canadian mills. Similarly, agricultural by-products may be dependent on demand for a particular commodity, as agricultural commodities are typically replaced with others when market demand changes (e.g., wheat is replaced by rye). Create a market analysis of the primary product determining the volatility of the production throughout different times of the year. Contrast this analysis with a sensitivity analysis of the secondary product (biomass) to the primary product.
Guidance Source	Bloomfield (2017, interview); Krigstin (2017, interview); Kizha & Han 2016; Nguyen (2018, comment); O'Leary (2017, interview); Rainey (2017, interview); Rob (2017, interview); Solomon (2018, interview)

1.4 Risk Factor: Supplier Experience

1.4.1 FUNDAMENTAL FEEDSTOCK PRODUCTION EXPERIENCE

Rationale	**Risk is higher when suppliers have limited experience with planting/growing/harvesting/processing and/or collecting biomass. Limited experience may be common for stover or forest residue supply chains where farmers or forestry producers may have no previous experience.**
Reporting	**Reporting Requirements** Issuer shall determine the experience in years that key suppliers in the area have in producing the rated category of biomass. **Reporting Recommendations** If possible, issuer shall evaluate key suppliers' delivery and quality performance in order to assess reliability and quality especially with regard to delivery to existing markets for biomass in the BDO zone
Guidance	**Guidance for Reporting Requirement 1** Anecdotal feedback from competitors in the BDO zone may be used to supplement and inform scoring. **Guidance for Reporting Recommendation 1** None
Guidance Source	Mitchell (2017, interview)

1.4.2 PRODUCTION SCALE EXPERIENCE

Rationale	**Scale-up entails risk. Risk is higher when suppliers has limited experience with the production of the quantity of feedstock required.**
Reporting	**Reporting Requirements** 1. Issuer shall demonstrate understanding of whether supplier commitments exceed current outputs and if so, whether such commitments exceed capacity to produce with current equipment, manpower and supply/customer base.
Guidance	**Guidance for Reporting Requirement 1** Supplier's infrastructure (e.g., equipment, manpower, etc.) capabilities for additional capacity should be known, as well as their access to feedstock in relation to quantity targets. Issuer should also be aware of supplier's control of feedstock, and the barriers that may exist for them to access additional feedstock. Issuer should show that local suppliers demonstrate the ability to scale up either internally or through the use of external companies (such as established planting or harvesting companies).
Guidance Source	Solomon (2019, interview)

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1.5 Risk Factor: Supplier Harvesting/Collection/Processing Capacity

1.5.1 SUPPLIER'S EQUIPMENT EFFICIENCY

Rationale	**Equipment efficiency significantly influences supplier's feedstock production capacity. Understanding supplier's equipment capability enables understanding of their ability to produce feedstock of suitable quality.**
Reporting	**Reporting Requirements** 1. Issuer shall demonstrate understanding of the supplier's equipment efficiency, its potential improvement and whether it is sufficient for the Issuer's needs.
Guidance	**Guidance for Reporting Requirement 1** Efficient harvest collection and baling of certain agricultural crops and residues (such as wheat straw, corn stover or flax straw) often requires specialized equipment. Issuer should understand that local suppliers have such equipment or their ability to purchase. Risk associated with using existing equipment should also be taken into consideration. Conduct interviews with operators to understand equipment efficiency. Track the effects different machineries have on different types of feedstocks. Refer to literature and studies regarding machinery and machinery efficiency (Lee et al. 2017).
Guidance Source	Abbas and Arnosti (2013); An and Searcy (2012); Dujmovic (2019, feedback); Lee et al. (2017)

1.6 Risk Factor: Supplier Motivation

1.6.1 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 (e.g., corn stover (e.g., corn) or forest residues (e.g., pulpwood) supply may not be a top priority for a supplier.**
Reporting	**Reporting Requirements** 1. Issuer shall determine relative importance of contracted feedstock production to suppliers, especially whether production of feedstock is low margin or relatively small additional net profit. 2. **Agricultural Residues.** Issuer shall understand and model the harvesting window for the primary crop. If that harvesting window is small, then the chance that the residue harvesting and collection will be ignored by the farmer increases.
Guidance	**Guidance for Reporting Requirement 1** Suppliers with a vested interest in continually supplying the Issuer have lower risk of breach. This can be achieved through providing partial ownership of the Issuer to the supplier or long-term bonuses based on a history of consistent supply. **Guidance for Reporting Requirement 2** This is a more common situation in secondary transformation agricultural feedstocks (e.g., stover) where the supplier may need to harvest in a particular window which, if missed, may make non-harvest much more likely. In cases where the production of the primary product interferes with the supplier's ability to produce a biomass by-product (e.g., stover), risk of non-supply may increase. Additionally, in times of stretched resources, suppliers may perceive harvesting and collection of the feedstock as nuisance, potentially decreasing production levels.
Guidance Source	Hladik (2017, interview); Mills (2017, interview); Muth (2017, interview); Carollo (2017, interview); Krigstin (2017, interview)

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Category 2.0: Competitor Risk

2.1 Risk Factor: Influence on Feedstock Supply of Existing Markets

2.1.1 COMPETITOR LOCATIONS AND OVERALL GEOGRAPHICAL INFLUENCE

Rationale	**Competitors' locations relative to siting locations within a BDO Zone 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 on new plants within a BDO Zone, including competitive advantages such as short hauling.**
Reporting	**Reporting Requirements** 1. Issuer shall demonstrate competitor's location relative to the siting locations within a BDO Zone, and its impact on feedstock supply. This shall include an evaluation of competitors' ability to short haul the Issuer and otherwise exert pressure on local suppliers.
Guidance	**Guidance for Reporting Requirement 1** The risk analysis should demonstrate an understanding of the different categories for feedstock utilized by competing markets in relation to categories for which the Issuer is seeking rating. If the rating is for forest residues, do competing markets utilize that category? Analysis should consider the likelihood that they might do so in the future. Analysis should consider, location of competitor markets together with location of key suppliers in the BDO Zone to understand the competitors' ability to affect supply. Competitors located in close proximity to the Issuer may drive feedstock cost and put pressure to breach on suppliers in the BDO Zone, especially during times of shortage. Standard industry practice suggests a thorough understanding of all competing markets of material size within a 2-3-hour drive-time of the Issuer (drive-time is preferred over distance). If Issuer's or competitor's feedstock is derived from distances greater than 2 hours, then an extension of the competition zone may be warranted. A Geographic Information System (GIS) can be as useful tool to help assess 2.1.1. GIS provides a way to a way to store maps in a computer and associate each feature in the map with information from a variety of sources. GIS can be used to query the data, look at patterns in the data, overlay maps, print out maps, and keep computerized, up to date records on land-based information. "Short haul" refers to the advantage one biomass market may have over another due to proximity to a supplier and the pricing advantage less transport distance entails. Suppliers are often incented to provide feedstock to the closest market, but such incentives may be overcome by other benefits (e.g., higher price, better payment terms, more favourable unloading hours, less waiting time, etc.) provided by more distant markets. Existing markets that are closer to sources of supply than new projects will tend to be more competitive in terms of securing feedstock supply.
Guidance Source	Crummett (2017, interview); Solomon (2018, interview)

2.1.2 CURRENT AND HISTORICAL CONSUMPTION OF FEEDSTOCK QUANTITY

Rationale	**Clear understanding of feedstock consumption by key competitors for each rated type of feedstock in the BDO Zone is essential to quantifying competitor risk.** **Understanding current consumption and 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).**
Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of: 1. Current key competitor intake quantity for each type of rated feedstock.

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	Reporting Recommendations Issuer should demonstrate understanding of: 1. Historical utilization of each type for feedstock used by key competitors.
Guidance	**Guidance for Reporting Requirement 1** Not all competitors will have the same relevance to an Issuer. "Key" or "major" competitors are generally characterized by intake of similar feedstock in material quantities and are located within 150km of the Issuer; closer competitors for feedstock are in general more salient, depending on quantity utilized. "Linked feedstock" refers to feedstock not used by the Issuer but used by competing markets, and which could be used by competing markets to exert influence on suppliers. For example, during times of shortage a pulp and paper mill that utilized both chips and bark could refuse to accept a supplier's bark unless it supplied the chips otherwise being contracted to the Issuer. At minimum, data shall, for every type of feedstock utilized by the Issuer, include feedstock category and description for annual and monthly quantities. Published/public data is preferred but often unavailable. Third-party feedback is acceptable if triangulated. **Guidance for Reporting Recommendation 1** "Historical information" shall refer to data covering at least 3 years. 5 years is preferable. Most accurate information about competitors' feedstock consumption often comes from suppliers. Developing good initial relationships with suppliers can provide access to valuable information about competitors. **Guidance for Reporting Recommendation 2** A credible third-party company should be engaged to collect and/or verify the competitor's feedstock quality specifications.
Guidance Source	Abt (2018, interview); Baylies (2017, interview); Crummett (2017, interview)

2.1.3 COMPETITOR PRICING AND PRICE SENSITIVITY

Rationale	**Understanding how much competitors pay (or receive) for different feedstock types is an essential step to determining competitiveness of Issuer and to accurate assessment of the delivered cost range in the BDO Zone rating.** **Current and historical prices paid/received by competitors provide insight into their procurement behaviours and exert pressure on suppliers in the BDO Zone. Such as ability/willingness to pay premiums for feedstock during times of feedstock shortage or reduce prices (or cut off deliveries) during gluts. Competitors that have an ability to offer higher prices for feedstock during feedstock shortages can pose significant risk to Issuer.** **Knowledge of competitor pricing and price sensitivity is also an essential prerequisite to formulating a feedstock cost curve which can enable predictions of feedstock redundancy, i.e., how much feedstock could become available at different pricing levels (*see Category 3–Supply Chain Risk 3.1.3*).**
Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of: 1. Current price paid by competitors for Issuer feedstock categories. **Reporting Recommendations** Issuer should demonstrate understanding of: 1. Historical feedstock price paid by competitors. If significant price fluctuation has occurred, then Issuer shall demonstrate understanding of factors driving such fluctuation. 2. Market for competitors' end products and any relationship between market and ability of competitor to drive feedstock price over time. 3. Competitor's track record of driving feedstock cost during periods of shortage. 4. Payment terms (net 30, net 60, weekly etc.). 5. Payment history.

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Guidance	**Guidance for Reporting Requirement 1** If possible, pricing information should be acquired directly from the competitor or from published area data. However, competitors are often reluctant to supply such information. Use of a credible third-party to validate competitor feedstock price data is acceptable. **Guidance for Reporting Requirement 2** Competitors' demand for feedstock and the maximum price they can pay for it may depend on the markets for their final product. For example, a pulp and paper mill's demand for feedstock depends on the paper market. It is important to understand competitors' end-markets to understand their likelihood of expanding operations and impacting feedstock availability and price. Pass-throughs for feedstock costs are rare but it is important to understand whether this is an advantage a competitor has. A wood-to-power plant with a feedstock pass-through contract with its buyer is able to drive costs in times of shortage and may thereby constitute significant risk for an Issuer. Anecdotal feedback from local suppliers or a credible third-party expert may be useful in obtaining this kind of information. **Guidance for Reporting Recommendation 3** Third-party reports can be used to obtain historical feedstock pricing data; reliability can be acceptable if confirmed by at least three independent sources (i.e., triangulation). Suppliers can serve as sources of data validation. Understanding competitors' price sensitivity can help the Issuer understand whether it is in a favourable position to acquire feedstock at times of restricted supply availability. The sale price/value or margins of a competitor (e.g., pulp and paper) may enable it to pay higher buy prices in order to capture scarce feedstock during times of shortage (Solomon 2019). Offtake agreements that allow pass-throughs for increases in feedstock costs (e.g., Power Purchase Agreements (PPAs)) may create a non-level playing field in times of feedstock shortage. Overall, suppliers should be contacted to inquire about the competitor's ability to pay higher prices during times of shortage (Tudmand & Hvisdas 2018). A credible third-party should be engaged to collect/validate information. **Guidance for Reporting Recommendation 4** It is important to gauge Issuer's payment terms relative to competing markets. Faster payment terms can constitute a significant advantage where pricing is comparable. **Guidance for Reporting Recommendation 5** It is important to gauge competitors' payment history, in particular instances over the past 3-5 years of non-payment due to insolvencies or restructuring or history of nonpayment or short payment.
Guidance Source	Baylies (2017, interview); Crummett (2017, interview); Lowitt (2013); O'Leary (2017, interview); Tudmand & Hvisdas (2018)

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2.1.4 IMPACTS OF FUTURE DEMAND ON FEEDSTOCK AVAILABILITY AND PRICE BY CURRENT COMPETITORS

Rationale	**Feedstock utilization in a BDO Zone can change over time. Expansion of feedstock demand by current competitors can put additional pressure on feedstock and can lead to higher prices, feedstock disruptions, shortages or supplier breach or other types of supply chain disruption.** **If current markets for feedstock have been publicly signalling the potential for increased demand for feedstock (in the case of a sawmill adding a shift, or pulp mill potentially expanding into production of renewable chemicals, for example), high interest in a supply basin can make suppliers overconfident, leading to a supplier-controlled market where short-term contracting becomes the norm and supply chain reliability is compromised for the Issuer. If and when it occurs, increased demand on feedstock may decrease availability and increase cost for new plants within the BDO Zone.**
Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of: 1. Forecasted new demand on feedstock availability and price by existing markets for relevant feedstock categories. 2. Impact of potential new demand on feedstock availability. **Reporting Recommendations** 1. Issuer should review publicly available information to determine if announcements have been made. 2. If feedstock is a secondary transformation (e.g., forest residue) then the feedstock utilization scenarios shall be run based on the changes in demand for the primary product.
Guidance	**Guidance for Reporting Requirement 1** Scenario-based modelling should incorporate known information about competitors' historical and planned expansions, as well as assumptions based on anecdotal knowledge of the market and potential expansion. Information about expansions or new competitors currently under construction can often be found through press releases and local economic development agencies, or through third-party experts and existing suppliers. Error bounds on models used to make forecasts shall be available for specific locations of interest and different times of the year so that predictions are accompanied by confidence intervals (Calvert 2011). **Guidance for Reporting Recommendation 1** Modelling the impact of potential future expansion plans of existing competitors, and of market conditions that can result in competitors' desire to expand. (e.g., a surge in the housing market, increased demand for renewable natural gas (RNG), or a subsidy for green power) Are important to correctly forecast to indicate future feedstock availability and price for BDO Zone ratings.
Guidance Source	O'Leary (2017, interview), Clavert, 2011)

2.1.5 SOFT SUPPLY INFLUENCE OF EXISTING MARKETS

Rationale	**In some cases, existing markets for feedstock may be able to exert high degrees of pressure over local suppliers, effectively enabling control feedstock, especially during times of shortage. This control can derive from qualitative or "soft" factors such as long previous relationships between local suppliers and existing markets for feedstock.**
Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of: 1. The proportion of supply over which key competitors for feedstock can exert control. 2. Historical occurrences where competitors or new markets have in fact exerted control over or impacted feedstock supply and the basis for such control.
Guidance	**Guidance for Reporting Requirement 1** Suppliers are the most reliable source of information for gauging whether the competitor can exert sufficient pressure on feedstock supply to control it. **Woody Biomass.** Pulp mills may be able to exert soft control or influence over existing suppliers by virtue of the fact that they can be longstanding markets for the full spectrum of feedstocks generated. For example, sawmills may generate sawmill residual chips, sawdust, and bark. New biomass markets that require only sawdust, for example, may be at a significant disadvantage vis-à-vis the current

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	markets: current markets may refuse to accept any wood fiber by-product generated by the sawmill if the sawmill elects to sell its sawdust to a new market. The sawmill in this case is strongly incented not to do business with a new plant regardless of the price a new plant is able to offer for the sawdust, due to soft supply influence of existing markets in the BDO Zone. **Agricultural Residue and Energy Crops**. Farmers may be incented into changing the type of feedstock grown if an alternative type is more profitable. Issuer should gauge the risk of forward cropping changes. A BDO Zone for flax straw for example, may be vulnerable to the risk of farmers switching from growing flax to other crops in the future. Historical data that can indicate changes in cropping patterns are extremely useful.
Guidance Source	None

2.1.6 TEMPORARY MARKET-DRIVEN MARKETS

Rationale	**Alternative, non-traditional, market-driven competitors for feedstock can drive feedstock demand in unusual circumstances. A BDO Zone Rating Issuer based on corn stover as a feedstock, for example, would not typically compete with higher-end animal feed markets due to quality issues. However, in times of significant hay shortage (e.g., during drought), farmers use corn stover in place of hay, driving the price of feedstock and decreasing availability for bio-projects (Bergtold 2018).**
Reporting	**Reporting Requirements** 1. Any alternative, non-traditional and market-driven markets for feedstock shall be identified, and the likelihood and impact of these markets upon Issuer shall be assessed.
Guidance	None
Guidance Source	Bergtold (2018, interview)

2.2 Risk Factor: Specific Competitors' Competitive Advantage

2.2.1 RELATIVE INVENTORY CAPACITY

Rationale	**The more inventory a competing biomass facility is able to store, the more competitively pressure it can exert on supply. Ability to store large inventories allows competitors to purchase inventory when the prices are low, potentially giving it an economic advantage. Additionally, the ability to store inventory during feedstock supply surpluses can enable competitors to continue to intake feedstock when the Issuers plant (with lesser inventory capacity) may be forced to put suppliers on quota. Larger inventory capacity on the part of competing markets thereby creates supplier loyalty and can make it more difficult for new projects to secure supply without paying a significant premium.**
Reporting	**Reporting Requirements** For each key competitor, Issuer shall demonstrate understanding of: 1. Quantities of feedstock inventory that can be stored. 2. Competitive advantage due to high inventory potential. 3. Ability of new bio-based plants to carry sufficient, or greater biomass inventories.
Guidance	**Guidance for Reporting Requirement 1** Competing markets' ability/willingness to the ability to accept feedstock / store inventory during feedstock supply surpluses by maintaining large inventories which enable**s** suppliers to continue supplying when other markets impose quotas can be difficult to gauge as they are often based on verbal or "understood" agreements**.** However, understanding and planning around such soft risk factors is important. If such relationships exist in the BDO Zone, they may indicate increased risk of feedstock shortage, pricing changes or, tactically, for the need for new bio-projects in the BDO Zone to maintain similar, or superior inventory capacities. Conversely, if local suppliers have a history of being put on quota or turned away by existing biomass markets with low inventory capacities, then the ability of a new plant to maintain sufficient inventory capacities can be a strong incentive to secure supply.

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	In the absence of direct feedback about competitor's inventory capacities, and assessment of land currently used for storage, stacking equipment and pile height restrictions, multiplied by that period of time until degeneration (i.e., rot) occurs can enable a high-level determination of a competitor's feedstock inventory potential.
Guidance Source	Rainey (2017, interview)

2.2.2 RELATIVE ACCESSIBILITY/DELIVERY HOURS AND WAIT TIMES

Rationale	**The value attributed by suppliers to local competing markets for biomass is often directly related to the degree of flexibility the market provides in terms of delivery hours, and the more efficiently discharge can occur.**
Reporting	**Reporting Requirements** For each key competitor, Issuer shall assess: 1. Discharge hours 2. Average and maximum wait times to discharge. 3. Potential accessibility issues.
Guidance	**Guidance for Reporting Requirement 1** Suppliers are likely to favour end-markets that provide more logistical convenience. **Guidance for Reporting Requirement 2** For example, if competitor's price and transport distance are similar but wait time to discharge averages 2 hours versus 30 minutes for the Issuer, this would be a significant competitive advantage for the Issuer which could function to materially decrease risk. **Guidance for Reporting Requirement 3** Accessibility issues include road access, quality of yard conditions (e.g., paved, gravel or dirt), traffic and seasonal weight restrictions.
Guidance Source	None

2.2.3 RELATIVE SPECIFICATION ADVANTAGES

Rationale	**When choosing a market for biomass feedstock, suppliers not only look at price, but also at relative quality requirements or specifications. It is important to understand feedstock quality specifications for competing markets within the BDO Zone in order to accurately quantify the risk that competitors can exert on the Issuer's supply chain.**
Reporting	**Reporting Requirements** 1. Issuer shall demonstrate understanding of the specifications for each category of competing feedstock relative to that of the Issuer and shall assess the impact of any differences.
Guidance	**Guidance for Reporting Requirement 1** New projects are more competitive to the extent that their specification requirements are consistent with current typical requirements in the BDO Zone. For example, if a potential competitor has a tighter quality specification than the Issuer, then it may not be a strong competitor for feedstock. On the other hand, a wider (less stringent) specification (e.g., higher allowable fines, contamination levels, ash, or greater variation in particle sizing) may provide a competitor with a significant competitive advantage.
Guidance Source	Cook (2018, interview); Marsollek (2018, interview); Rainey (2017, interview)

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2.2.4 DEMAND FOR COMPETITORS' PRODUCTS

Rationale	**Increased demand for competitor's final product can cause an increased demand for feedstock by the competitor. For example, an increased demand for wood pellets due to high energy prices in Europe or for biofuels due to a favorable clean fuels policy can cause increased pellet/biofuel production by competing markets. Thereby driving demand for feedstock within a BDO Zone.**
Reporting	**Reporting Requirements** 1. Issuer shall demonstrate understanding of the market for competitors' final products and its potential for increased demand. Analysis should consider how easily competitor can scale production capacity to meet increased demand.
Guidance	None
Guidance Source	Khanna et al. (2011); Parrish (2018, interview)

Category 3.0: Supply Chain Risk

3.1 Risk Factor: Feedstock Availability

3.1.1 BIOMASS AVAILABILITY MULTIPLE (BAM)

Rationale	**Biomass Availability Multiple (BAM) indicates the degree of redundancy in an Issuer's supply chain in relation to the rated quantity in the BDO Zone. BAM is the mean ratio of biomass feedstock available to a project, in relation to delivered cost, divided by the Issuer's mean rated quantity. BAM is a strong indicator of supply chain resilience when stressed by supply shortage and/or supplier breach. BAMs of 1.5 or higher are generally signals of lower feedstock risk for new projects in BDO Zones.**
Reporting	**Reporting Requirements** 1. The Issuer shall demonstrate understanding of the Biomass Availability Multiple (BAM) for the BDO Zone. 2. If more than one feedstock type is rated, a separate BAM shall be understood for each feedstock type. 3. BAM shall be calculated based on feedstock which is realistically accessible for use by a Project ("Available Biomass"), rather than on theoretically available/modelled feedstock ("Produced Biomass"). 4. BAM shall be calculated within a band of economically feasible pricing as defined by the Issuer. Minimum and maximum quantity of biomass feedstock in a BDO Zone Rating shall be based on the minimum and maximum rating cost, respectively. 5. Quality of redundant feedstock used in the calculation of BAM shall be similar in specification to rated feedstock. 6. BAM shall be calculated at a sufficiently detailed geographic resolution. **Reporting Recommendations** 1. Demonstrated BAM should be at minimum 1.5, and preferably > 2.0.
Guidance	**Guidance for Reporting Requirement 1** In calculating BAM, the mean price and mean quantity shall be used. Geographic area for redundant feedstock used in the calculation of BAM should be the maximum drive-time distance at which feedstock cost attains the upper limit in the BDO Zone Rating. For example, if the BDO Zone rating was $100 - $130 per ton delivered, then calculation of BAM would be based on feedstock available within a distance no greater than that distance at which the delivered cost to new project would be greater than $130 per ton. **Guidance for Reporting Requirement 3** Hypothetical or derivative estimates of produced feedstock can provide theoretical indication of BAM. But to understand quantities of feedstock that are available, supportive granular data derived from real sources of supply regarding willingness or commitment level to provide feedstock to the Issuer are vastly superior indicators in terms of predictive accuracy.

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Just because feedstock is produced proximate to an Issuer does not mean it is necessarily available to that Issuer. A sawmill may generate 20,000 tons of chips per year but may only have 2000 tons available for purchase—or none at all.

BAM should be established using past and current market availability and trend information from established and defensible data sources. Contributing to this data can be the growth to drain (GTD) or growth removal ratio (GRR) which can serve as an indicator for assessing the long-term availability of sustainable woody feedstock from forests.

Generally, forest inventory data (including harvest licenses, biomass removals, remaining residues etc.) are collected and disseminated by provincial forestry departments (Gunn 2019). Also, National Forest Inventory is one source which can be used to acquire forest inventory data necessary to estimate GTD and GRR.

Feedstock extraction rates can vary in different locations. BDO Zoneal policy can dictate the quantity of forest residues to be left in the forest after harvest. Suppliers may choose to leave large quantities of forest or agricultural residues on land, either for environmental or economic reasons: agricultural residues provide nutrients for agricultural fields, and farmers leave portions of residue as fertilizer. Primary and secondary research should be conducted indicating BDO Zoneal feedstock extraction rates.

Thiffault et. al. (2014) analyzed the recovery rate of forest residues based on data from temperate and boreal forests from around the world. They determined that the average recovery rate was about 52.2% depending on the local policies and the type of harvesting (e.g., stem-only, bundling, whole-tree harvesting, etc.). In non-Nordic countries, the recovery rate of forest residues ranged from 35.6-60.7% depending on the recovery method.

Agricultural Residues and Energy Crops. Availability of agricultural residues can be assessed through grain yields. The following are accepted conversion ratios (list provided by Gunn 2019):

- Corn: 1 (Sokhansanj et al. 2006)
- Beans: 1 (Nelson et al. 2004)
- Wheat: 1.5 (Nelson et al. 2004)
- Grass: 1 (Sokhansanj et al. 2006)
- Barley: 1.5 (Penn State Agronomy Guide 2019-2020)
- Soybean: 1 (Penn State Agronomy Guide 2019-2020)
- Oats: 1 (Penn State Agronomy Guide 2019-2020)
- Sunflower: 3 (Helwig et al. 2002)

Guidance for Reporting Requirement 5
BAM shall not be artificially inflated. That is, calculation of BAM shall utilize consistent and identical metrics in the calculation of both the numerator and the denominator.

Quality of feedstock used in calculation of the BAM shall be fungible with primary feedstock. The BAM should not be artificially inflated by the addition of sub-standard feedstock simply because it is "available". The numerator of the BAM should reflect availability of feedstock where the usability is demonstrated by the Issuer.

Guidance for Reporting Requirements 6
Where possible, the Issuer should use data at higher than jurisdictional boundary (i.e., county, province, forest management unit) resolution. An example of such dataset is the Manitoba Bioeconomy Atlas. The Atlas uses fusion of AAFC Crop Inventory (30 m), Crop Insurance Yield ratios and Statistics Canada sector data to assess high-resolution crop production (Gunn 2019).

Guidance for Reporting Recommendation 1
If BAM is based on derivative or secondary data, and the numerator is derived from a high-level estimate of feedstock "produced" in the supply basin as opposed to what is likely to be "available" to the Issuer. Then it is recommended that BAM should be higher than 2 in order to accurately indicate supply chain redundancy. It should be noted however, that there are successful existing projects with BAMs as low as

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	1.5. While bigger tends to be better, there is no optimal BAM; an acceptable BAM depends on creditors' tolerance of risk. **Agricultural Residues**. In general, agricultural residue producers have few markets for their residue. The lack of competition for agricultural residue means that a high BAM may not be necessary to signal low-risk supply (Hladik 2017) in a BDO Zone. Note that Regenerative Agricultural Practices encourage minimal tillage to improve soil health which leads some producers to minimize residue removal. The Issuer shall take existing agricultural practices into account when making a case for residue removal. Current research can be used for such argument, particularly that long-term research shows most residue can be removed with no adverse impacts (Gunn 2019). An example of such research can be found in Lafond et al. (2012).
Guidance Source	Bloomfield (2017, interview); Carollo (2017, interview); Golecha & Gan (2016); Hladik (2017, interview); James et al. (2012); Lewandowski (2018, interview); Solomon (2019 interview); Spikes (2017, interview); Texas Forest Service (2006); Thiffault et al. (2014); Gunn (2019, feedback); Sokhansanj et al. (2006); Nelson et al. (2004); Penn State Agronomy Guide (2019-2020); Helwig et al. 2002; Lafond et al. (2012)

3.1.2 FEEDSTOCK SUPPLY CURVE/MARGINAL COST CURVE

Rationale	**The greater the feasible transport distance, the more feedstock is accessible to the Issuer, but at a higher delivered cost. The feedstock supply curve, sometimes referred to as the marginal cost 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, and the cost of replacing feedstock with substitutes located at different distances.** **Feedstock cost curves are useful in determining supply chain resilience; they provide information about the cost of feedstock availability in times of supply disturbance. Biomass supply chains are prone to supply disturbances over time; suppliers can become insolvent, or weather events can temporarily disrupt feedstock availability. When a disturbance occurs, the Issuer may need to source replacement feedstock from different suppliers at different locations and costs. A biomass supply curve indicates quantities of feedstock available at various price levels from suppliers generally located further away than core suppliers.**
Reporting	**Reporting Requirements** 1. A supply curve representing feedstock availability over price and distance shall be developed and any significant inflection points shall be adequately explained. 2. If more than one feedstock type is used, then a separate cost curve shall be developed for each feedstock type. 3. Feedstock cost curve shall incorporate realistic quantities of feedstock available to the Issuer. Feedstock cost curve shall be calculated based on feedstock that is realistically accessible for use by the Issuer ("Available Biomass") rather than on theoretically available/modelled feedstock ("Produced Biomass"). 4. Feedstock cost curve shall be calculated within a band of economically feasible pricing as defined by the Issuer. Feedstock that is available to a project shall be calculated using maximum price required to maintain ongoing operations and service financial covenants. 5. Feedstock cost curve shall be calculated using feedstock available to the Issuer that is available in a timely manner to prevent operational disruption. 6. Quality of redundant feedstock used in feedstock cost curve shall be useable by the Issuer. **Reporting Recommendations** 1. Issuer should assess economic burden on the project procuring redundant feedstock (from larger distances) under low, medium, and high supply chain stress scenarios.
Guidance	**Guidance for Reporting Requirement 1-6** Same as for 3.1.1
Guidance Source	Solomon (2019, interview)

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3.1.3 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 BDO Zone biomass supply imbalances (Golecha & Gan 2016) and can manifest in shortages and higher costs for Issuers.**
Reporting	**Reporting Requirements** 1. Understanding of seasonal feedstock supply variation shall be demonstrated for each feedstock type. **Reporting Recommendations** 1. The BDO Zone rating shall assume the adoption of a potential product of industry-standard mitigation strategies to lower the risk of seasonal feedstock supply variation through one or more of the following methods: • Maintenance of sufficient feedstock inventory. • Feedstock substitution Strategic inventory and storage planning can sustain a steady supply of feedstock to the Issuer.
Guidance	**Guidance for Reporting Requirement 1** Seasonal feedstock availability is typically more prevalent in agricultural supply chains (i.e., agricultural residues and energy crops) than in woody biomass supply chains. Optimization models can help quantify the risks of seasonal supply variation. An example of an optimization model for biomass availability can be found in Golecha & Gan (2016). Primary feedstock may be substituted with secondary feedstocks in times of seasonal feedstock shortage. If secondary feedstocks are being included in the BDO Zone Rating, then fungibility with primary feedstock should be demonstrated.
Guidance Source	Ba et al. (2016); Carollo (2017, interview); Gebresslasse et al. (2012), Golecha & Gan (2016); Rob (2017, interview); D. Smith (2019, feedback)

3.1.4 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.**
Reporting	**Reporting Requirements** 1. Projected year-to-year feedstock supply variation shall be modeled for each feedstock type. 2. Strategies to counteract estimates of year-to-year supply variation shall be assessed and may included in scoring assumptions if deemed viable. **Reporting Recommendations** 1. **Agricultural Biomass.** Issuer should obtain historical data on yields of feedstock in the supply basin to make a determination of variability. If historical data are not available for predicting future yields, mathematical models may be used. 2. **Woody Biomass.** Models used to demonstrate yield variability should be based on species, BDO Zone and stand density of timber harvest operations.
Guidance	**Guidance for Reporting Requirement 1** Variability manifests in both space and over time. Spatial variability can be judged based on physical and topographic features. For example, a BDO Zone consisting of large variations in ground surface elevations will have high potential for soil erosion with an increased risk for insufficient production. Variability in yields of crop residue can also be attributed to several factors including climate, soil, management practices and pests. The best evaluations of these factors are made at more macro-scales. Yield variability could also be high in BDO Zones consisting of flat terrain if soil properties, climate conditions or management practices are not suitable for the crops being studied. **Agricultural Biomass.** Models based on machine learning, mechanistic plant growth approaches and Bayesian techniques are available to capture variabilities on multiple scales (e.g., at county or BDO Zoneal scales) and make spatially explicit yield predictions (Newlands and Townley-Smith 2010; Phys-Org 2017; Jeong et al. 2016; Jiang et al. 2017; FAO 2017; Chawla et al. 2016; PNNL 2017; Busby et al. 2017; Jager et

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	al. 2010). While many more approaches exist to predict yields, there are no directly usable models that are available in the public domain to estimate energy crop and crop-residue yields at the farm or field scale. Depending on the crop of interest and location, a more advanced literature analysis is a prudent way of obtaining best estimates of energy crop or crop-residue yields. It should also be noted that new methods based on artificial intelligence and machine learning techniques are being developed and should be explored through a review of the relevant literature. **Woody Biomass.** An empirical forest biomass yield model has been developed by Nishizono et al. (2005). This table can be used to determine the unutilized woody biomass volume produced by a timber harvest. Treitz et al. (2012) demonstrates a tool for the estimation of forest inventory variables at the plot and stand levels for specific forest types using a LiDAR point density of 0.5 pulses·m-2. Such a tool could be applied to accurately estimate forest inventory variables and subsequently, biomass yield. Distinct tools can also be used for modelling the availability of, and suggested extraction rates for deadwood (Venier et al. 2015). Huggard & Kremstater (2007) present a synthesis of published technical literature that can be used to parameterize and model deadwood harvesting projects. **Guidance for Reporting Recommendation 2** Mitigation steps for poor yield variability could include identifying high-yielding BDO Zones nearby, improving management practices and crop rotations to improve soil fertility and prairie strips to intersperse energy crops with row crops.
Guidance Source	Abt (2018, interview); Busby et al. (2017); Chawla et al. (2016); FAO (2017); Golecha & Gan (2016); Hladik (2017, interview); Huggard & Kremsater (2007); Jager et al. (2010); Jenkins (2017, interview); Jeong et al. (2016); Jiang et al. (2017); Newlands & Townley-Smith (2010); Nishizono et al. (2005); Passmore (2017, interview); Phys-Org (2017); PNNL (2017); SOFAC (2018); Treitz et al. (2012); Venier et al. (2015)

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3.2 Risk Factor: Historical Issues

3.2.1 HISTORICAL FEEDSTOCK PRICE VARIATIONS

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 Issuer 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.**
Reporting	**Reporting Requirements** Issuer shall: 1. Identify drivers of historical feedstock price variations 2. Assess probability and impact of price drivers occurring in the future and impact on feedstock availability and price.
Guidance	**Guidance for Reporting Requirement 1** The longer the historical horizon of data provided for predictive analysis, the more accurate the results. At minimum, 5 years of historical feedstock price shall be analyzed. Risk is greater where no historical feedstock price data are available. **Guidance for Reporting Requirement 2** It is also possible to develop quantitative estimates of this probability as shown by researchers at INL using the Stochastic Techno-Economic Model (Hansen et al. 2018). Feedstock price variations can fluctuate due to multiple factors. For example, catastrophic weather events can cause spikes in feedstock price, surges in the housing market can depress cost of sawmill chips. Understanding timber supply and demand trends can aid in the understanding of variations in historical feedstock prices (Abt et al. 2000; 2009). Capital-at-Risk (CaR) and Value-at-Risk (VaR) are concepts used in financial risk assessments to evaluate the financial viability of a project (Jorion 2007). Recently, they have begun to be used to assess the financial risks of biomass supply chains. Hansen et al. (Hansen 2018) are investigating the stochastic, financial risk of biomass supply chains using the STEM model. They will be including the VaR and CaR metrics based on the work of Jorion (2007) in the model. These metrics provide quantitative estimates of financial risk at a specified confidence level.
Guidance Source	Abt et al. (2000; 2009); Carollo (2017, interview); Jenkins (2017, interview); Jorion (2007); Hansen et al. (2018); Mills (2017, interview); O'Leary (2017, interview); Santibanez-Aguilar et al. (2016)

3.2.2 LOW HISTORICAL DEMAND FOR FEEDSTOCK IN THE SUPPLY BASIN

Rationale	**If Issuer BDO Zone 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. This can be particularity true for forest residues where typically the infrastructure for collection, processing and delivery is immature.** **Where supply chains are not well-established, risk can be mitigated when new bio-based plants control a higher degree of feedstock processing. For example, if a BDO Zone rating is issued for clean wood chips and the historical demand in the Zone has been exclusively for pulpwood, then supply chain risk will be decreased for new bio-based plants that intake of pulpwood and manage log debarking and chipping internally. Rather than requiring inexperienced suppliers to deliver debarked wood chips.**
Reporting	**Reporting Requirements** 1. Understanding of historical feedstock production in the supply basin shall be demonstrated, including an assessment of the degree of risk presented by feedstock production history and supply expertise. If necessary, industry standard and economical mitigation strategies may be assumed for scoring purposes.
Guidance	**Guidance for Reporting Requirement 1** The availability of education-based training and transition programs with the local labour force should be considered in areas where lack of previous supply experience is evident.
Guidance Source	Huhnke (2017, Comment 1); Mills (2017, interview); Ralevic et al. (2010); Webster (2017, interview)

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3.2.3 HISTORY OF PRODUCTION/FEEDSTOCK IS A NEW/SECONDARY CROP OR A BY-PRODUCT

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.** **For new crop types, inexperience in planting, harvest, collection and yield data may pose higher levels of risk.** **If feedstock is a secondary transformation (i.e., wheat straw, corn stover or forest residue), then production can be subject to variables beyond suppliers' control (e.g., changing demand for sawtimber, or primary crop prices).**
Reporting	**Reporting Requirements** 1. Issuer shall determine primary product/crop production levels that are necessary to sustain feedstock production. 2. Issuer shall demonstrate understanding of the market drivers for primary product on which by-products or secondary feedstock depends.
Guidance	**Guidance for Reporting Recommendation 1 and 2** Employ primary crop yield models to determine secondary crop production. The most accurate models involve satellite data analysis (Muth 2017).
Guidance Source	Muth (2017, interview)

3.3 Risk Factor: Non-Weather Based Externalities

3.3.1 DIESEL, OIL AND PRODUCER PRICE INDEX (PPI)

Rationale	**Diesel, oil and PPI can impact feedstock cost of harvest and collection over time. Sensitivities to worst case scenarios should be run.**
Reporting	**Reporting Requirements** 1. Feedstock price risk relating to diesel/oil cost and PPI fluctuations and its impact on the Issuer shall be evaluated for a 10-year period. *NOTE: Impacts of diesel on transport cost should not be calculated here (see 3.5.3).*
Guidance	**Guidance for Reporting Requirement 1** Historical price fluctuations of feedstock in the supply basin should be modeled with/without diesel/oil prices and PPI to understand the degree to which fluctuations in fuel or labour present long-term supply chain risk. Techno-economic models can be used where feedstock markets have not yet been established, and lack of historical data does not allow for establishment of correlations. Techno-economic models include feedstock logistics and optimization models designed to estimate transportation routes and costs Lamers et al. (2015a, b).
Guidance Source	Curran (2017, interview); Lamers et al. (2015a, b); Passmore (2017, interview)

3.3.2 CURRENCY RISK

Rationale	**Where feedstock is purchased in a currency different than that which a new bio-based plant with locate in a BDO Zone, currency exchange rates and volatility can constitute risk exposure. BDO Zones that cross the US-Canada border, for example, which intake feedstock from both countries are exposed to such currency risk.**
Reporting	**Reporting Requirements** 1. Proportion of Issuer feedstock which is sourced cross-border shall be identified by quantity and cost. 2. Cross-border suppliers of particular importance shall be identified. 3. The impact of reasonable exchange fluctuations on feedstock cost shall be assessed for at least a 10-year period.
Guidance	None
Guidance Source	Solomon (2019, interview)

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3.3.3 BORDER RISK

Rationale	**Where feedstock is transported cross-border to another country, risk exposure to border closures and crossing delays becomes present. The availability of trucks willing to do cross-border runs is limited, which can decrease supply chain flexibility and resilience. Plants near the US-Canada border which intake feedstock from both countries are exposed to these risks.**
Reporting	**Reporting Requirements** 1. Proportion of Issuer feedstock which is sourced cross-border shall be identified by quantity and cost. 2. Cross-border suppliers of particular importance shall be identified. The impact of border delays/shutdown on feedstock cost shall be assessed for at least a 10-year period. 3. The impact of phytosanitary requirements should be assessed.
Guidance	**Guidance for Reporting Requirements** The ability to obtain a phytosanitary certificate, and whether the cost of doing so is economically reasonable, should be assessed. For example, if fumigation is a requirement, are the facilities required to fumigate available and scalable, and is the cost to do so feasible?
Guidance Source	Solomon (2019, interview)

3.3.4 TEMPORARY EXTERNALITY-DRIVEN MARKETS FOR FEEDSTOCK

Rationale	Alternative, non-traditional, externality-driven competitors for feedstock can drive feedstock demand (and cost) in unusual circumstances. For example, an Issuer using corn stover as a feedstock would not typically compete with the higher-end animal feed market. However, in times of significant hay shortage (e.g., during drought), farmers may use corn stover as hay replacement, driving the price of stover feedstock and decreasing its availability for bio-projects (Bergtold 2018).
Reporting	**Reporting Requirements** 1. Any alternative, non-traditional and externality-driven markets for feedstock shall be identified, and the likelihood and impact of these markets upon the Issuer shall be assessed.
Guidance	**Guidance for Reporting Requirements 1** **Agricultural Residues.** In general, demand for feedstock from high-value markets is small. For example, research in Manitoba shows that estimated maximum needs for cattle feed/bedding and livestock bedding are ~1% of available crop residues (Gunn 2019). Despite this (in most circumstances) there is a negligent impact of high-value markets on agricultural residue availability. The estimated demand should be demonstrated to ease any elevated perception of risk posed by these markets.
Guidance Source	Bergtold (2018, interview); Gunn (2019, feedback)

3.4 Risk Factor: Risks Related to Feedstock Production, Harvest and Collection

3.4.1 HARVEST AND COLLECTION PRACTICES AND 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.** **For example, agricultural feedstocks and energy crops have optimal harvesting windows to ensure minimal moisture content. In certain BDO Zones these harvesting windows may coincide with heightened weather risk such as frost or rain.** **For forestry biomass, unsightly clear cuts and slash piles (even on plantation forests and especially when located near communities) can provoke unwanted public backlash even when suitable and sustainable replanting regimes are followed.**
Reporting	**Reporting Requirements** 1. Understanding of feedstock harvest practices and schedules shall be demonstrated. 2. Understanding of weather risk and its impact on feedstock quantity and quality in relation to harvesting schedules shall be demonstrated. 3. Understanding of any potential public backlash to harvest practices shall be demonstrated.

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	Reporting Recommendations 1. Typical harvesting schedule and Issuer's planned delivery schedule for feedstock should be prepared.
Guidance	**Guidance for reporting requirement 1** Feedstock harvest schedules can be acquired directly from suppliers. Misalignment of suppliers' harvest schedules with Issuer's required feedstock quantities can create supply shortages. **Guidance for reporting requirement 2** Preferably, harvesting should be scheduled during periods of low weather risk. Harvesting, collection and delivery schedules should be based on feedstock's propensity to degrade (Huhnke 2017). **Guidance for reporting requirement 3.** Public backlash to "harvesting" due to environmental or social impacts is often the purview of the land manager. Ensure the land manager has an adequate plan to handle public input, can guarantee easements to public roads, and protect their contractors. Possible mitigants to potential public backlash should be considered such as promotion of the benefits of forest thinning to protect urban forest interface from fire, or forest improvement, where appropriate.
Guidance Source	Ebadian et al. (2011); Huhnke (2017, interview); Nguyen (2018, comment); Spikes (2017, interview)

3.4.2 HARVESTING AND COLLECTION EQUIPMENT

Rationale	**Different types of harvesting and collection equipment used by suppliers in a BDO Zone 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.**
Reporting	**Reporting Requirements** 1. Understanding of equipment requirements to produce high-quality feedstock shall be demonstrated, including all equipment typically used for harvesting, collection and processing. 2. Understanding of equipment variety in the supply chain, and its impact on feedstock quality consistency shall be demonstrated.
Guidance	**Guidance for Reporting Requirement 1** Researchers at INL, ORNL, and Antares (FOA Project) maintain a list of recommended harvest equipment, their yields and collection efficiencies, applicable to corn stover and energy crop harvests (Nair et al. 2018a, b). **Guidance for Reporting Requirement 2** A wide variety of equipment in the supply chain can make it difficult for suppliers to quickly acquire spare parts. For example, Webster (2017) suggests that variations in equipment leading to lower access to spare parts can affect the supply chain's uptime by 30%. This is because distributors of spare parts keep inventory in locations with higher demand. In BDO Zones where a large number of feedstock suppliers own the same equipment will be served better by spare-part distributors.
Guidance Source	Nair et al. (2018a, b); Smith (2017, interview); Spikes (2017, interview); Webster (2017, interview)

3.4.3 VARIATION 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. Standard feedstock densification modes for biomass consist of round or square bales, pellets, cubes, chips, or grindings. The size of wood fibre processed in a grinder is less homogenous than if a chipper is used.** **Bales of different densities can absorb moisture at different rates. In certain cases, round bales have been viewed as problematic due to their uneven moisture content distribution (Huhnke 2018).**

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Reporting	**Reporting Requirements** 1. Understanding of the impacts of different modes of feedstock densification shall be demonstrated.
Guidance	**Guidance for Reporting Requirement 1** A third-party company specializing in feedstock harvesting and use of standard densification equipment can function to ensure consistency and decrease risk if a variety of feedstock modes are present in the supply basin. *NOTE: Even if a specific mode of feedstock densification is identified as preferable, suppliers may not have an ability to densify feedstock in such a way. For example, farmers may not have an ability to produce square bales if current equipment is designed for round.*
Guidance Source	Huhnke (2018, Comment 1); Nguyen (2018, comment); Webster (2017, interview)

3.4.4 AVAILABILITY OF LABOUR FOR FEEDSTOCK PRODUCTION

Rationale	**Skilled labour shortages can be difficult to remedy in the short-term. Availability of suitable labour in an area can impact the ability to procure sufficient feedstock quantities on required schedules. Labour risks are higher where supply chains are not yet active; or for Issuer's for whom large feedstock requirements, or development of new (or expanded) supply chains, demand significant additions to the local labour force.**
Reporting	**Reporting Requirements** 1. Understanding of labour requirements necessary to produce and deliver feedstock shall be demonstrated, including: • Number of trained operators of field equipment • Number of harvesters/loggers • Experience of existing labour force • Necessary labourer certifications.
Guidance	**Guidance for Reporting Requirement 1** The Issuer should have an understanding of the number of contractors within a 120km radius, as well as contractors' total harvesting capacity.
Guidance Source	Ebadian et al. (2011)

3.5 Risk Factor: Transportation

3.5.1 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.** **Transport distances of 80-120 km for biomass feedstocks are typical but larger distances can be common. Where average transport distance from suppliers to Issuer 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 scarce feedstock from competitors closer to the source.** **Understanding average transport distance can help flag higher-risk BDO Zones where transport distance materially exceeds the average.**
Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of: 1. Average transportation cost per-unit of delivered material. 2. The percentage of total (current and projected) feedstock cost attributable to transport. 3. Forecasted transportation cost. **Reporting Recommendations** 1. Feedstock cost in relation to transportation cost drivers via a sensitivity analysis 2. Mitigation plan for escalating transportation costs should be demonstrated.

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Guidance	**Guidance for Reporting Requirement 1** Understanding of average transportation distance for evaluating feedstock transportation costs: average transportation cost will be 2/3 of the maximum drivetime distance of the BDO Zone (Ebadian, 2023, interview).
Guidance Source	Curran (2017, interview); Gan & Smith (2011); Roni et al. (2014a, b); (Ebadian, 2023, interview).

3.5.2 DIESEL COST IMPACTS

Rationale	**Changes in diesel cost impact transport cost over time. Sensitivities to worst case scenarios should be run.**
Reporting	**Reporting Requirements** 1. The impact of realistic variations in diesel cost shall be evaluated for a 10-year period.
Guidance	**Guidance for Reporting Requirement 1** None
Guidance Source	Solomon (2018, interview); US Diesel Index Sample; Canadian Diesel Index Sample; Dujmovic (2019, feedback); Gunn (2019, feedback)

3.5.3 TRANSPORT OF FEEDSTOCK REQUIRES SPECIALIZED EQUIPMENT

Rationale	**Requirements for specialized transport equipment (e.g., walking-floor trailers) 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.**
Reporting	**Reporting Requirements** 1. Understanding of a BDO Zone Rating's dependence on specialized transportation equipment and its availability in the supply chain shall be demonstrated. 2. Where the redundancy of required transportation equipment is low, indictor risk shall be scored higher, unless the following assumptions are explicitly made in the scoring of the Zone: • Purchase of own transportation equipment by BDO Zone project. • Adjustment of receiving infrastructure to lower transportation equipment requirements.
Guidance	None
Guidance Source	None

3.5.4 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 the ability BDO Zone suppliers to transport feedstock.**
Reporting	**Reporting Requirements** 1. Understanding of feedstock transportation routes in relation to current and planned residential developments shall be demonstrated, particularly in relation to downtown, residential or school areas. 2. Assessment of feedstock transportation nuisance to local communities and an associated risk of community backlash shall be made. 3. Where the risk of community backlash is significant, including alternative delivery routes should be assessed and included in the indicator risk score.
Guidance	None
Guidance Source	Daly & Halbleib (2017, interview); Tan (2018, interview); Dujmovic (2019, feedback)

3.5.5 TRANSPORTATION REGULATIONS AND LOAD WEIGHT LIMITS

Rationale	**In many BDO Zones, 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.**
Reporting	**Reporting Requirements** 1. Understanding of relevant feedstock transportation regulations, especially load weight limits and number of trucks allowed on roads, shall be demonstrated, including those involving:

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	• Seasonality (e.g., "frost laws") • Jurisdictions • Proposed changes to regulations. 2. Where feedstock transportation restrictions pose a significant risk to the Issuer, a the BDO Zone scoring may assume the adoption of an industry standard risk mitigation plan by a potential bio-based project, including: • The potential to acquire regulatory exemption. • Alternative delivery methods (e.g., use of smaller trucks) • Increasing biomass inventory piles in advance of expected seasonal restrictions.
Guidance	**Guidance for Reporting Requirement 1** All Canadian provinces and territories have increased trucking load restrictions during spring thaws, with variations based on BDO Zone, type of road, specific dates and duration. For example, Ontario roads are divided into four schedules by the Highway Traffic Act (1990). More restrictive weight limits can increase the number of deliveries required to acquire feedstock, resulting in feedstock cost variation. Regulations can change jurisdictionally on municipal and provincial levels. Route planning can be conducted according to these jurisdictional differences. **Guidance for Reporting Requirement 2** Certain municipalities, such as small towns seeking economic development, can sometimes be incented to provide regulatory exemptions to feedstock transport.
Guidance Source	Tudman & Hvisdas (2018, interview)

3.5.6 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.**
Reporting	**Reporting Requirements** 1. Understanding of transport supply routes and their effect on feedstock cost and availability shall be demonstrated, including understanding of weather patterns and their effect on road conditions.
Guidance	**Guidance for Reporting Requirement 1** Paved roads are preferable to unpaved and resource roads, especially in wet seasons. Some roads can become impassable during heavy rainfall and snowfall conditions (Huhnke 2017).
Guidance Source	Gan & Smith (2011); Huhnke (2017, interview); O'Leary (2017, interview)

3.5.7 TRANSPORTATION REDUNDANCY

Rationale	**Transport equipment redundancy is important for dealing with seasonally variable feedstock supplies as well as the risk of equipment breakdowns.**
Reporting	**Reporting Requirements** 1. Understanding of transportation redundancy in the supply basin shall be demonstrated in relation to Issuer's feedstock requirements and to feedstock production.
Guidance	**Guidance for Reporting Requirement 1** Delivery of feedstock after harvesting/processing is often time sensitive, especially when dealing with seasonal feedstocks. Transportation systems should have the capacity to transport increased volumes of seasonally variable feedstock. Scoring should be based in part on an analysis of worst-case scenarios. If risks are high, and as available, BDO Zone rating my include assumptions that may specify use of rental equipment from businesses that have a demonstrably adequate supply of similar equipment to assure redundancy. Particularly high risks can be mitigated by Issuer purchasing transport equipment, or by supporting the purchase thereof by third-party transport companies. If such assumptions are made in the scoring of a BDO Zone, they must be clear and explicit.
Guidance Source	Cook (2018, interview); (Marsollek 2018, interview)

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3.6 Risk Factor: Supply Chain Resiliency

3.6.1 SIZE, NUMBER AND LOCATION OF SUPPLIERS

Rationale	**In general, a supply portfolio involving multiple suppliers of various sizes (and from multiple BDO Zones) 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, many 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.**
Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of size and location of at least three key suppliers in BDO Zone. **Reporting Recommendations** Issuer shall demonstrate understanding of: 1. Minimum number of feedstock suppliers required to deliver the rated quantity. 2. Number of small and large suppliers in the supply chain
Guidance	**Guidance for Reporting Recommendation 1** Current best approaches to modelling biomass supply chains are based on agent-based models (Hartley 2017). Examples of such models can be found in De Meyer et al. (2014); Cambero & Sowlati (2014); An & Searcy (2012); Dunnett et al. (2007); and Gharder et al. (2016). Scenario-based models can be used to test various supply chain configurations and determine the lowest risk configuration. Supply basins should consist of at least 15-20 suppliers to adequately de-risk the supply chain (Rainey 2017).
Guidance Source	An & Searcy (2012); Cambero & Sowlati (2014); De Meyer et al. (2014); Dunnett et al. (2007); Freppaz et al. (2004); Gan & Smith (2011); Gebreslassie et al. (2012); Gharderi et al. (2016); Golecha & Gan (2016); Hartley (2017, interview); Howes (2018, interview); Jenkins (2017, interview); Nguyen (2017, interview); O'Leary (2017, interview); Passmore (2017, interview); Rainey (2017, interview); Smith (2017, interview); Webster (2017, interview); Jenkins (2017, interview)

3.6.2 SUPPLIERS SUBJECT TO SAME EXTERNAL RISK FACTORS

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 structures such that the impact of single high-risk events have varying impacts on suppliers.**
Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of: 1. The set of common risks that impact over 75% of the supply chain by feedstock quantity. 2. Factors that mitigate the set of common risks, including: • Spatial location (i.e., degree to which suppliers are clustered together) • Soil composition (i.e., drainage profile) • Land ownership • Supply chain structure • Regulatory zones 3. Proportion of suppliers and supply that are subject to the same external risk factors. 4. Maintenance of suitably sized inventory piles and pre-arrangements for redundant feedstock with non-local suppliers where a high proportion of supply is subject to the same external risk factors.
Guidance	**Guidance for Reporting Requirement 2** The more geographically compressed suppliers are in the supply chain, the more likely they are to be subject to a single risk. For example, suppliers who are clustered together in a particular area could all be

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	subject to soil condition risks (e.g., sandy versus clay-based soils) that may affect soil drainage and thus limit the ability for forestry operations to access sites after severe rains due to flooding. Having suppliers operating in areas with both types of soils can mitigate the risk of supply disruptions due to excessive rainfall. It is acknowledged that mitigation can be difficult for common occurrences that can lower the resiliency of the entire supply chain. Examples of these include: • Sawmills dependent on the housing market. • Stover producer's dependent on the markets for corn. • Energy crop producer's dependent on rainfall. **Guidance for Reporting Requirement 4** Feedstock inventory, whether at the facility yard or in satellite storage depots, acts as a buffer to supply chain disruptions. If inventory assumptions are made for the scoring of a BDO Zone, they must be clear and explicit.
Guidance Source	None

3.6.3 LAND OWNERSHIP STRUCTURES

Rationale	**The ownership (or control) of the land base on which feedstock is produced can have significant impact on Issuer's feedstock risks. Risk of long-term variation in stumpage cost for wood fibre (i.e., the cost that one pays to a landowner for the right to cut and purchase their wood fibre) for example are much higher in the US where >90% of the land is private, and thus stumpage cost is determined on a competitive auction basis. Conversely, in Canada >90% of the land is owned by the Crown and stumpage is allocated by the government.**
Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of: 1. Land ownership structures for the procured feedstock, including ownership/lease terms with growers and any changes in ownership/lease terms. 2. Impact of land ownership/control on overall long-term feedstock risk.
Guidance	**Guidance for reporting requirement 1** Direct ownership of the feedstock production land by the Issuer or suppliers lowers the risk of feedstock supply. In cases where supply chain depends on suppliers that do not directly own the land on which feedstock is produced, an understanding of relationship between supplier and landowners should be understood and history of previous feedstock supply disruptions be scrutinized. Lands that are subject to government regulations or programs should be identified. Understanding land tenure is especially important on public lands, where access to feedstock is regulated by the government. Note that some feedstock supply risks may be lowered where feedstock is sourced from public lands. Government backed long-term contracts for fixed quantities of biomass can often be acquired. These regulations can be complicated, and limit or restrict access to feedstock.
Guidance Source	Carollo (2017, interview); Curran (2017, interview); Hladik (2017, interview); Krigstin (2017, interview)

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3.7 Risk Factor: Climate and Natural Risks

3.7.1 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.** **Given the major influence that weather has on multiple aspects of growing, harvesting, and transporting biomass, it is difficult to predict the availability of biomass at a specific location at different points in the future with a high degree of certainty. However, it is still possible, using past data and statistical models, to generate reasonable upper/lower bound estimates of biomass production in any given year in a wider supply basin. Such estimates are important in assessing feedstock risk and enable accurate assessment of the efficacy of Issuer's mitigation methods.**
Reporting	**Reporting Requirements** 1. Understanding of weather patterns in the supply basin and their potential impacts to feedstock production shall be demonstrated. 2. Where high risk of feedstock shortage due to weather exists, a mitigation plan shall be demonstrated. **Reporting Recommendations** 1. Forecasting and propagation models should be applied in analyses of weather impacts.
Guidance	**Guidance for Reporting Requirement 1** Historical data is needed for credible forecasting. 10 years of weather data should be obtained if possible. Worst-case scenarios should be simulated to determine the risk of feedstock shortage. Understand how, and to what degree, seasonal weather has impacted the feedstock supply chain in the past. Historical modelling of seasonality, and weather impacts on feedstock availability, quality and price can be instructive. **Guidance for Reporting Requirement 2** Mitigation measures include inventory planning on a multi-year scale. Part of biomass collected in an excess-production year may be used as inventory to meet a lower-production event the following year if storage issues (e.g., decomposition) can be addressed. As prices drop with oversupply and rise with undersupply, such strategies can help mitigate impacts of inter-year variabilities.
Guidance Source	An & Searcy (2012); Crummett (2017, interview); Curran (2017, interview); Ebadian et al. (2011); Hladik (2017, interview); Nguyen (2017, interview); Rob (2017, interview); D. Smith (2019, feedback)

3.7.2 LONG-TERM WEATHER AND CLIMATE TRENDS

Rationale	**In certain BDO Zones, climatic trends and significant potential changes to future weather patterns can create feedstock risk.**
Reporting	**Reporting Requirements** 1. Assessment of impact of future weather patterns or climactic changes on feedstock availability and price shall be demonstrated. 2. Where risk of changing weather patterns and/or climatic trends and their detrimental impact to feedstock availability is significant, a mitigation plan shall be demonstrated.
Guidance	**Guidance for Reporting Requirements 1** In Canada, Climate Change Impacts and Adaptation Division (CCIAD) leads the development of collaborative, national and sectoral science assessments that present the latest knowledge on climate change impacts and adaptation. These assessments are scientific reports that assess, critically analyze, and synthesize the growing knowledge base on the issue. Working with subject matter experts in government, universities, and non-government organizations, CCIAD produces science assessments that are current, relevant and accessible sources of information, to help inform planning of policies, program and action. The following publications are available from Climate Change Impacts and Adaptation Division (CCIAD):

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	From Impacts to Adaptation: Canada in a Changing Climate (2008) assesses risks and opportunities presented by climate change, and actions being taken to address them, from a BDO Zoneal perspective. *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation*. An update to the 2008 report. *From Impacts to Adaptation: Canada in a Changing Climate*. Assesses literature published since 2007 on climate change impacts, adaptation, and vulnerability in Canada. It includes chapters on natural resources, food production, industry, biodiversity and protected areas, human health, and water and transportation infrastructure. *Canada's Marine Coasts in a Changing Climate:* Assesses climate change sensitivity, risks, and adaptation along Canada's marine coasts. The report includes overviews of BDO Zoneal climate change impacts, risks, and opportunities along Canada's three marine coasts, case studies demonstrating action, and discussion of adaptation approaches.
Guidance Source	Daly & Halbleib (2017, interview);

3.7.3 FOREST/CROP FIRE

Rationale	**Forest/crop fires, especially when occurring at large-scale, destroy feedstock and create shortages.** **Fire-prone conditions are predicted to increase across Canada. This could potentially result in a doubling of the amount of area burned by the end of this century compared with amounts burned in recent decades. Boreal forests, which have been historically greatly influenced by fire, will likely be especially affected by this change.** **Other climate change impacts that could add damaged or dead-wood to the forest fuel load (e.g., as a result of insect outbreaks, ice storms or high winds) may increase the risk of fire activity. New research is aimed at refining these climate change estimates of fire activity, and at investigating adaptation strategies and options to deal with future fire occurrence. There is growing consensus that as wildfire activity increases, fire agency suppression efforts will be increasingly strained. However, analyses of fire history suggest that it is the effect of climate variability on precipitation regimes that is the primary reason for the decreasing fire activity in the southern BDO Zone of Canada.**
Reporting	**Reporting Requirements** 1. Understanding of forest/crop fire risk and its impact to feedstock supply shall be demonstrated. 2. Mitigation plan to minimize forest/crop fire risk shall be demonstrated.
Guidance	**Guidance for Reporting Requirement 1** An analysis of historical forest/crop fire occurrence and the likelihood of future fire occurrence should be conducted. Rabin et al. (2018) have developed a model for predicting fire patterns in both non-agriculture land, and cropland. This model can be used for estimating the future prevalence of cropland fires across North America. Ager et al. (2018) describes statistical modelling techniques for forest fire occurrences. The model accounts for both natural and human ignition sources, as well as feedback systems and management activities. The findings of the model are also compared to other similar simulations and can be applied for many forest fire modelling applications. A general framework to assess forest wildfire risk using multiple data sources and modelling techniques can be found in Saglam et al. (2008) and Scott et al. (2013). New approaches using remote sensing (i.e., satellite and drone imagery) and digital technology can be applied to determine the risk of fire. Examples of application of high-resolution remotely sensed imagery to assess the risk of agricultural field fire can be found in Verbesselt et al. (2006); Nielsen & Rasmussen (2001); Sannier et al. (2010); Mbow et al. (2004); and Smith et al. (2005).

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	Vegetation water content (VWC) is a major factor in remotely sensed imagery analyses used to evaluate fire risk. VWC is defined as water volume per leaf, water volume per ground area (or equivalent water thickness), or water mass per mass of vegetation dry matter. Application of this analysis can be found in Agee et al. (2002); Maki et al. (2004); and Vesserbelt et al. (2006). Quantity of biomass in the forest/field is a critical factor in assessing risk of fire and can be evaluated through remotely-sensed imagery. Application of this analysis can be found in Mbow et al. (2004); Van Wilgen et al. (2000); and Vesserbelt et al. (2006). **Guidance for Reporting Requirement 2** A general framework for developing a mitigation plan for forest wildfire risk can be found in Scott et al. (2013).
Guidance Source	Agee et al. (2002); Ager et al. (2018); Bessa & Block (2017); Chuvieco et al. (2004); Leblon et al. (2001); McGill & Darr (2014); Maki et al. (2004); Maselli et al. (2003); Mbow et al. (2004); Nielsen & Rasmussen (2001); Rabin et al. (2018); Saglam et al. (2008); Sannier et al. (2010); Scott et al. (2013); Smith et al. (2005); Van Wilgen et al. (2000); Webb (2016)

3.7.4 RISK OF INFESTATION

Rationale	**Risk of future infestation, including its estimated consequences on feedstock supply, should be calculated into the overall risk profile.** **Since forest insect populations are influenced by environmental conditions, future changes in climate can be expected to significantly alter the outbreak dynamics of certain forest insect species. In some cases, larger and more frequent insect outbreaks may occur, but in other cases recurring outbreaks may be disrupted or diminished. As climate continues to change, we can expect more situations, particularly at the margins of tree ranges, where sub-optimal conditions for tree growth and reduced tree vigor can lead to outbreaks of forest insects.**
Reporting	**Reporting Requirements** 1. Historical occurrences of infestation of Issuer feedstock shall be understood along with vectors through which infestation have historically occurred. 2. Future risk and impact of infestation shall be assessed.
Guidance	**Guidance for Reporting Requirement 1** Infestation of timber forests or agricultural croplands is dependent on multiple factors, including: • Biology of pest species • Ecology of the forest or agricultural sites • Suitability of the trees or crops of interest as a sustainable habitat for the pest, • The ability of the pest species to colonize and grow as an invasive species in competition with pre-existing species. Various management practices and their effectiveness in suppressing and preventing the spread of infestation once detected have been developed. These practices include thinning, fire treatments, salvage removal and cut-and-leave (Fettig et al. 2007). **Guidance for Reporting Requirement 2** Models should be used to identify known pests that have infested and adversely impacted the tree-population or tree-growth in a forest of interest or on agricultural yields in a given BDO Zone. Models have been presented to estimate the risks of non-native invasive pest-species established after being transported via cargo, as well as invading via encroachment on a subcontinental scale (Bartell & Nair (2004); Stanaway et al, (2001); Yemshanov et al. (2009a).
Guidance Source	Bartell & Nair (2004); Bentz et al. (1993); Bone et al. (2013); Cerroni & Shaw (2012); Clarke & Nowak (2009); Cole & McGregor (1983); Curran (2017, interview); Dymond et al. (2006); Fettig et al. (2007); Gan (2004); Gansner et al. (1984); Koch et al. (2009); Krupinsky et al. (2002); Lippitt et al. (2008); Overbeck & Schmidt (2012); Reed & Errico (1987); Robertson et al. (2008); Stadelman et al. (2014); Stanaway et al. (2001); Walter & Pratt (2013); Yemshanov et al. (2010; 2009a, b)

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3.7.5 RISK OF HAIL

Rationale	**Hail has negligible impact of forestry biomass but is one of the principal destroyers of agricultural crops in North America.** **There is much uncertainty about the effects of anthropogenic climate change on the frequency and severity of extreme weather events like hailstorms and their subsequent economic losses. Some studies indicate a strong positive relationship between hailstorm activity and hailstorm damage, as predicted by minimum temperatures using simple correlations. This relationship suggests that hailstorm damage may increase in the future if global warming leads to further temperature increase.**
Reporting	**Reporting Requirements** 1. Understanding of hail risk and its potential impact on feedstock supply shall be demonstrated, including likelihood of crop failure due to hail. 2. Where risk of hail is significant, a mitigation plan shall be demonstrated.
Guidance Source	**Guidance for Reporting Requirement 1** Hail forecasts can be acquired from Environment Canada. **Guidance for Reporting Requirement 2** Where there is high risk of hail and its negative impact to feedstock supply, the feedstock procurement plan should account for this risk and inventory should be planned accordingly. Low temperature and/or crop failure insurance should also be purchased, if possible, in such situations.
Guidance Source	Daly & Halbleib (2017, interview); Botzen, W.J. Wouter & Bouwer, Laurens & van den Bergh, Jeroen. (2010)

3.7.6 RISK OF FLOOD

Rationale	**Floods can cause catastrophic disruption and delay in feedstock supply. Where there is high risk of flood and thus negative impact to feedstock supply, the BDO Zone rating should account for this risk.**
Reporting	**Reporting Requirements** 1. Understanding of the flood risk and its potential impact on feedstock supply shall be demonstrated, including locations of flood plains in relation to the Issuer. **Reporting Recommendations** 1. Where Issuer feedstock relies on levees to mitigate flood risk, the levee infrastructure should be assessed.
Guidance	**Guidance for Reporting Recommendations 1** None
Guidance Source	Hladik (2017, interview); Passmore (2017, interview)

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3.7.7 RISK OF DROUGHT

Rationale	**Droughts can cause significant disruptions to feedstock supplies across entire BDO Zones for extended periods of time, especially in case of agricultural residues and energy crops. Parts of Western Canada are experiencing more frequent and severe droughts, and scientists expect drought to affect new areas across Canada going forward.** **Tree species are adapted to specific moisture conditions. Having less water available through drought has a range of negative impacts on the health of forest ecosystems. Direct impacts include reduced growth, increased tree mortality and failure to regenerate. Indirect impacts include reduced ability to defend against insects and disease, and increased fire risk. These impacts can affect the availability of wood fibre for an Issuer.**
Reporting	**Reporting Requirements** 1. Understanding of drought risk and its potential impact on feedstock supply shall be demonstrated, including likelihood of future drought in the supply basin.
Guidance	**Guidance for Reporting Requirement 1** Vegetation water content (VWC), available from hyper-temporal satellite data, can be used to assess vegetation water stress and drought conditions (Jackson et al. (2004); Pyne et al. (1996); Tucker (1979)), and to assess fire risks; the probability of which increases during droughts under high vegetative cover. In Canada, drought forecast can be acquired from Environment Canada. Where there is high risk of drought and its negative impact to feedstock supply, the BDO Zone rating should account for this risk and scored accordingly.
Guidance Source	Jackson et al. (2004); Pyne et al. (1996); Tucker (1979)

3.7.8 RISK OF HURRICANES, TORNADOES AND STRONG WINDS

Rationale	**Hurricanes, tornadoes and strong winds can destroy timber stands, crops and feedstock piles. They can also delay forestry and agricultural operations. Hurricanes and tornadoes can indirectly cause temporary shortages of available transportation as available trucking moves to handle higher value disaster related contracts. For example, Katrina cleanup limited availability of live-bottom trailers in the North and South-East of the US for several months as truckers shifted operations to handle more lucrative government contracts.** **Although scientists are uncertain whether climate change will lead to an increase in the number of hurricanes, warmer ocean temperatures and higher sea levels are expected to intensify their impacts. Recent analyses conclude that the strongest hurricanes occurring in some BDO Zones including the North Atlantic have increased in intensity over the past two to three decades.**
Reporting	**Reporting Requirements** 1. Understanding of the hurricane, tornado and strong winds risk and its potential impact on feedstock supply shall be demonstrated, including likelihood of future hurricane, tornado and strong winds in the BDO Zone. **Reporting Recommendations** 1. Where risk of hurricane, tornado, or strong wind is significant, the BDO Zone rating may assume that a bio-based project would implement industry standard mitigation measures for this risk and score accordingly.
Guidance	**Guidance for Reporting Requirement 1** In Canada, hurricanes and tornados rarely occur. However, strong winds are common in certain BDO Zones and in certain seasons. Hurricanes, tornados and strong wind forecasts can be acquired from Environment Canada.
Guidance Source	None

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3.7.9 LOW TEMPERATURES

Rationale	**Low temperatures can cause crop failure, leading to shortages of biomass. Additionally, low temperatures can have adverse impacts on the operations of feedstock processing equipment in Northern BDO Zones.**
Reporting	**Reporting Requirements** 1. Understanding of low temperature risk and its potential impact on feedstock supply shall be demonstrated, including: • Likelihood of future low temperatures • Likelihood of crop failure due to low temperatures • Likelihood of equipment failure due to low temperatures. 2. Where risk of low temperatures is significant, the BDO Zone rating may assume that a bio-based project would implement industry standard mitigation measures for this risk and score accordingly. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirement 1** The exact applicable definition of "low temperature" depends on the type of feedstock in question. For example, certain agricultural crops fail in temperatures below zero. Low temperature forecast can be acquired from Environment Canada. Equipment suppliers should provide information about likelihood of equipment failure due to low temperatures.
Guidance Source	Rainey (2017, interview)

3.8 Risk Factor: Political and Social

3.8.1 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.** ***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 Issuer such as Loan Guarantees or to the markets for products produced by the Issuer.***
Reporting	**Reporting Requirements** 1. Issuer shall indicate any government subsidies that directly relate to feedstock. 2. Issuer shall estimate the likelihood and impact of removal of such subsidies on feedstock supply. **Reporting Recommendations** 1. In case of existing feedstock subsidies, an alternative to the subsidized feedstock should exist.
Guidance	**Guidance for Reporting Requirement 2** Understanding the likelihood of subsidy cancellation is important to determine feedstock price risks. The social and political environments in which relevant subsidies have come into effect should be understood to better predict the likelihood of their alteration or removal. The sensitivity of feedstock cost or availability to removal of subsidies shall be modeled. The resulting model shall be run against the Issuer's financial model to determine whether the subsidy removal would cause an increase beyond the "red line" feedstock cost.
Guidance Source	Bloomfield (2017, interview); Carollo (2017, interview); Mills (2017, interview); Rainey (2017, interview); USDA (2018)

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3.8.2 LOCAL, PROVINCIAL, AND NATIONAL LAWS, REGULATIONS AND 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.**
Reporting	**Reporting Requirements** 1. Issuer shall indicate direct feedstock supply dependencies on laws, regulations or permits. 2. Issuer shall assess the likelihood and impact of change of such laws, regulations on feedstock supply, including those related to: • Forest harvesting • Air quality/emissions • Land-use change regulations. • Traffic, noise, odor, dust • Wildlife protection 3. Issuer shall assess the likelihood of ability to obtain necessary permits.
Guidance	**Guidance for Reporting Requirement 1** Direct dependencies shall be those laws, regulations or permits which directly impact an Issuer's ability to procure, transport, trans-load, store, or utilize feedstock. They shall not include indirect dependencies such as laws that support markets for finished biofuels or biochemicals. Where Issuer's supply basins overlap multiple states/provinces, understanding of policies and guidelines in different state/provincial jurisdictions is necessary. The specific regulations that govern the production of a given feedstock should be evaluated and estimates made for the impacts of production on multiple resource concerns (including those that may have specific regulations). A plan for applying best practices to address all regulatory requirements should be formulated. Such an approach is described in CAAFI's *Feedstock Readiness Level Tool* (CAAFI 2018). **Guidance for Reporting Requirement 2** Certain jurisdictions have a history of changing regulations relevant to biomass. Such a history can indicate potential policy uncertainty. Issuer should conduct a thorough analysis of historical policy change in the supply basin. **Forest Harvesting.** Government regulations/restrictions exist restricting the amount of forest thinning and logging residues that can be removed from national forests and the number of agricultural residues that can be removed from a field. If an Issuer is reliant on these sources for its supply of feedstock it shall document the provisions under applicable government regulations that allow harvesting of targeted feedstocks. This includes caps on amounts that may be harvested, and allowable harvesting schedules and frequencies. **Air Quality/Emissions.** Issuer shall demonstrate understanding of local regulations relating to air quality and emissions, specifically in terms of risks regarding usage of the intended feedstock. **Land-Use Change Regulations.** Where Issuer feedstock requires land-use change (e.g., energy crop production) Issuer shall determine whether existing (and potential) regulations or policies relating to land-use change may impede access to feedstock (Kaffka 2018). **Traffic, Noise, Odor, Dust.** Issuer shall demonstrate understanding of local regulations relating to traffic, noise, odor and dust, specifically in terms of risks regarding usage of the intended feedstock. These issues are especially important when Issuer operates or intends to operate a pre-processing facility (e.g., chipping or grinding wood fibre). **Wildlife regulations.** Issuer shall determine whether existing (and potential) wildlife protection regulations may impede access to feedstock. For example, some wildlife regulations forbid forestry

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	harvesting activities when an endangered species is detected. Policies pertaining to wildlife can also change over time, increasing policy instability for the project (Kaffka 2018).
Guidance Source	CAAFI (2018); Evans et al. (2013); Howard (2018, interview); Howes (2018, interview); Kaffka (2018, interview); Mills (2017, interview); Solomon (2018, interview)

3.8.3 BACKLASH AGAINST BIOMASS DEVELOPMENT, PROCUREMENT OR USAGE IN THE BDO ZONE

Rationale	**Public backlash against biomass development in the Issuer BDO Zone can directly impact Issuer's ability to procure, transport, trans-load, store, or utilize feedstock by affecting local policies, regulations, and Issuer's ability to obtain necessary permitting.**
Reporting	**Reporting Requirements** 1. Likelihood of potential backlash against biomass development in the BDO Zone shall be assessed. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirement 1** Historical occurrence of material public backlash against biomass development in the BDO Zone, if any, shall be flagged by Issuer. If historical backlash has occurred, Issuer shall assess likelihood and impact of any current risk. If no historical backlash occurred, Issuer shall assess the likelihood of such backlash at present. Demonstrate sustainability of biomass resource processed by the project. For woody biomass, demonstrate Issuer's positive effect on forest health and acquire certification if such exists (e.g., Sustainable Biomass Partnership certification for wood-based projects). In circumstances where biomass projects have been determined to have community and social benefits, these benefits should be promoted and made clear. For example, Marinescu (2016) has demonstrated the potential for heat and/or electricity plants using logging and sawmill residues in specific British Columbia communities to generate substantial local sustainability benefits.
Guidance Source	Howes (2018, interview); Marinescu (2016); McGuire et al. (2017); VanEvery & Higgelke (2000)

3.8.4 CONSENT OF, AND CO-OPERATION WITH, INDIGENOUS COMMUNITIES AND FIRST NATIONS

Rationale	**Where new project development on or near Indigenous or First Nation land, or where near Indigenous or First Nations exert influence over feedstock producing areas, consent of, and co-operation with, Indigenous communities and First Nations decreases Issuer risk.**
Reporting	**Reporting Requirements** 1. Issuer shall demonstrate an understanding of any potential conflicts it may encounter with Indigenous land rights or First Nation communities. **Reporting Recommendations** 1. In cases where significant portions of biomass feedstock can be expected to be procured from Indigenous controlled bodies, or where Indigenous communities exert influence over lands, the BDO Zone rating should demonstrate support from relevant Indigenous communities.
Guidance	**Guidance for Reporting Recommendation 1** If feedstock is sourced from Indigenous and First Nation land, it should respect the traditions and culture of Indigenous and First Nation communities. For bio-based projects that locate in BDO Zones where the majority of land is controlled by Indigenous and First Nation groups, RSB Water Assessment may be necessary for addressing water issues related to Indigenous lands. **Water Management & Demonstrating Respect for Indigenous Rights (Section 9a, RSB 2016):** • The use of water for feedstock operations should not be at the expense of the water needed by the communities that rely on the same water source(s) for subsistence. • New projects within a BDO Zone should assess the potential impacts of the operations on water availability within the local community and ecosystems during the screening exercise of the impact assessment process and mitigate any negative impacts.

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	• Water resources under legitimate dispute shall not be used for feedstock operations until any legitimate disputes have been settled through negotiated agreements with affected stakeholders – following a free, prior, and informed consent enabling process. • Respect and protect all formal or customary water rights that exist through the Environmental and Social Management Plan (ESMP) to prevent infringement on such rights. No modification of the existing rights can happen without the free, prior and informed consent (RSB Standards 2a) of the parties affected.
Guidance Source	RSB (2016)

3.8.5 FOOD SECURITY CONCERNS

Rationale	**Despite the fact that any significant correlation between food prices and biofuel production is unclear, claims that biofuel production has driven up food prices, taken food from communities or had a negative impact on land use can fuel public backlash. For example, removal of biomass may raise public concerns relating to food security if Issuer feedstock requires the use of land that would otherwise be used for growing food.**
Reporting	**Reporting Requirements** 1. Understanding of potential public backlash from perceived or real food security concerns shall be demonstrated. **Reporting Recommendations** 1. Mitigation plan to counter the potential backlash due to perceived or real food security concerns should be developed.
Guidance	**Guidance for Reporting Requirement 1** Any historical occurrences of food security concerns among the local communities should be noted. **Guidance for Reporting Recommendation 1** Energy crop production can be integrated into agricultural operations without directly replacing food crop land if strategic land management plans are used. For example, strip farming with food and energy crops grown side by side, and growing energy crops in buffer zones and riparian areas, can mitigate food-for-fuel concerns (Nair et al. 2017; 2018a, b).
Guidance Source	Grosshans (2019, feedback); Nair et al. (2017; 2018a, b)

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3.9 Risk Factor: Sustainability and Environmental Concern

3.9.1 FEEDSTOCK SUSTAINABILITY

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.** **Canada leads all countries with 166 million hectares of certified forests, a figure that is nearly four times more than second place United States at 47 million hectares.**
Reporting	**Reporting Requirements** 1. Understanding of biomass feedstock sustainability shall be demonstrated.
Guidance	**Guidance for Reporting Requirement 1** BSCR Standards do not endorse any particular approach for determining or certifying feedstock sustainability. Issuers are referred to one of the many established schemes for establishing feedstock sustainability. The Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC) are two well-known organizations with certification programs that provide third-party verification of sustainable forest management. As well as chain of custody certification to demonstrate to the end consumer that finished forest products come from sustainably managed forests. A common feature of these programs is that they have multi-stakeholder governance, which includes participation of forest industry, environmental interests, social interests, and Indigenous communities.
Guidance Source	None

3.9.2 RISK TO SOIL QUALITY

Rationale	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 forest biomass harvesting and production. For different feedstock types, there are also different thresholds at which feedstock removal causes significant negative consequences on soil. **Poor soil quality that negatively impacts the long-term sustainability of the feedstock can entail long-term feedstock risk. Sub-optimal soil management can leave exposed soil post residue-harvest which can lead to soil wash-off and soil carbon loss from precipitation and wind. Over-harvesting of biomass also depletes the carbon stock in the soil and creates a negative feedback loop which can degrade the soil and its nutrients.**
Reporting	**Reporting Requirements** 1. Understanding of the impacts of the removal of residues on soil quality shall be demonstrated. 2. Understanding of the proportion of biomass to be left on land to minimize negative soil impacts shall be demonstrated.
Guidance	**Guidance for Reporting Requirement 1** Potential impacts of intensive forest biomass harvesting on soil include effects on physical and chemical soil parameters, and secondary effects on soil and plant biodiversity, water quality and quantity, and wood production. Physical impacts on soil include exposure of the soil surface, compaction, and erosion; while chemical impacts include loss of soil organic matter, carbon, and nutrients, and acidification. If fertilization with mineral or organic fertilizers is used to compensate for nutrient removals or to counteract acidification, then there may also be additional consequences from adding nutrients and other elements to the soil; including affects on pH, and potentially on organisms (Ozolinčius et al. 2010). Removal of residue biomass temporarily interrupts nutrient cycling until new vegetation becomes established. Regrowth of vegetation following harvesting is key to re-establishing nutrient regimes in the soil (Smith (1985); Bonner et al. (2016)). The Comprehensive Analysis of Soil Health (CASH) and the Soil Management Assessment Framework (SMAF) frameworks can be used to test soil health.

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	An example of how to model the impacts of agricultural residue removal can be found in Nair et al. (2017; 2018a, b). **Guidance for Reporting Requirement 2** **Agricultural Residues.** Residual biomass removal from crops (e.g., corn) results in increased exposure of agricultural soils to wind and water erosion, leading to loss of soil, soil carbon and nutrients from soils, into the atmosphere, surface water and groundwater. The Roundtable for Sustainable Biomaterials (Section 8a, RSB 2016) can be used as guidance for the development of an agricultural soil quality management plan. An example of modelling soil carbon and nutrient loss due to biomass removal can be found in Nair et al. (2017; 2018a, b). In the future, harvesting equipment advancements may permit variable-rate harvesting, where removal rates can be tailored to suit different soil conservation needs within a single field. **Energy Crops.** Energy crop production has shown to be beneficial to the soil because of increased organic carbon retention and lower nutrient losses (Nair et al. (2017; 2018a, b); Griffel et al. (2018)). Energy crops can be cultivated to prevent soil degradation, including carbon and nutrient losses (Griffel et al. (2018); Ssegane et al. (2015)). Nair et al. (2017; 2018a, b) show that this strategy can be economically beneficial if applied to non-profitable subfields. Harvesting time was found to be important in determining the quantity of nutrients left behind in forest soils. Whole tree harvesting after leaf fall reduced the drains of N, P, K, and Ca (Johnson et al. 1982) compared to harvesting in the growing season. Winter-only harvesting and/or a delay in slash collection to allow needles and leaves to dry can preserve nutrient budgets in the soil without hurting the biomass removal significantly (Hacker (2008); Suadicani & Gamborg (1999)).
Guidance Source	Bonner et al. (2016); Giuntoli et al. (2015); Griffel et al. (2018); Hacker (2008); Johnson & Todd (1987); Mann et al. (1988); Mroz et al. (1985); Nair et al. (2017; 2018a, b); RSB (2016); Smith (1985); Ssegane et al. (2015); Suadicani & Gamborg (1999); D. Smith (2019, feedback)

3.9.3 RISK TO SURFACE AND GROUND WATER

Rationale	**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.**
Reporting	**Reporting Requirements** 1. The likelihood of feedstock production having negative effect on aquatic systems shall be determined. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirement 1** The likelihood of feedstock production having negative effect on water systems depends on many factors and varies widely for different feedstock types. Hydrologic nutrient losses generally increase after harvest of agricultural residues, and it takes approximately 4 years before they return to normal levels (Mann et al. 1988). Fertilizer runoff from forests could pose similar issues for woody biomass production (Hacker 2008). Forestry management and certification processes for timber and pulp production ensure that managed forests do not contribute to water quality issues. All operational effluents should be contained, and overall water quality enhancement should be pursued (Mitchell et al. 2016). Buffer zones should be set between the operation site and surface or groundwater resources (Mitchell et al. 2016). Forestry management certification schemes, such as FSC or SFI, ensure that certified forests do not contribute to water quality issues. Sourcing feedstock from certified forests minimizes the risk associated with water quality issues. Where forests are not certified, forest managers should follow Best Management Practices (BMPs). BMPs provide guidance to forest management practices with an objective to protect soil and water quality. In

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	addition to following BMPs, an effective BMPs monitoring system should be implemented (Morris 2019, feedback). • Note that FSC and SFI certification schemes require participants to meet or exceed BMPs.
Guidance Source	Bonner et al. (2016); Georgia Forestry Commission (2009); Mann et al. (1988); Morris (2019, feedback); Nair et al. (2017; 2018a, b); Negri et al. (2018); Ssegane et al. (2016); D. Smith (2019, feedback)

3.9.4 WATER USE

Rationale	**Biomass feedstock operations can have significant impacts on the hydrological flux (infiltration, groundwater recharge, interception, and transpiration) of ecosystems. This can lead to water shortages, lower yields, and backlash from regulatory bodies if management plans are not properly instituted.**
Reporting	**Reporting Requirements** 1. An understanding of potential issues related to water usage shall be demonstrated, in particular an understanding of feedstock production water resource use and long-term capacities or equilibriums. 2. In case of concerns related to water use and management, a water management plan addressing those concerns shall be demonstrated.
Guidance	**Guidance for Reporting Requirement 2** The standards from the Roundtable for Sustainable Biomaterials (Section 11b, 11c, RSB 2016) can be used as guidance for the development of an on-site water management plan. The plan should be locally customized, publicly transparent, and should include annual auditing of the management plan's effectiveness.
Guidance Source	Calvert (2011, interview); Hladik (2017, interview); Hornbeck & Keskin (2011); Kaffka (2018, interview); Lattimore et al. (2013); Mitchell et al. (2016); Rob (2017, interview); RSB (2016); Ssegane et al. (2016)

3.9.5 PESTICIDE RISK TO HUMAN AND ECOSYSTEM HEALTH

Rationale	**Application of pesticides (i.e., herbicides, fungicides, and insecticides) on agricultural and forest landscapes can result in adverse health effects for humans and ecosystems. If pesticide application is required in feedstock production, the impact must be considered in the BDO Zone rating.**
Reporting	**Reporting Requirements** 1. Understanding of pesticide use in feedstock production and its potential risk to human and ecosystem health shall be demonstrated. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Recommendation 1** The ability of new BDO Zone bio-based project to comply with existing regulations should be the taken into account in BDO Zone scoring. • An example of a voluntary guidelines for pesticide management can be found in Xerces Society (2019)
Guidance Source	None

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3.9.6 RISK TO WILDLIFE AND LANDSCAPE

Rationale	**Biomass production and supply chain operations with negative impacts on wildlife and landscape are at a greater long-term risk of encountering project setbacks and disruptions.**
Reporting	**Reporting Requirements** 1. The likelihood of feedstock production having negative effects on wildlife and/or landscapes shall be determined. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirement 1** **Woody Biomass.** Harvesting of pulpwood and removal of forest residue can have both negative and positive effects on the wildlife and landscape, depending on the area and amount of residue removed. While forest thinning can be an important aspect of forest silviculture and can be beneficial to forest health and wildfire control, excessive thinning or residue removal can impact habitats for small mammals, insects and birds vulnerable to predation (Ruth & Harris 1975). Similarly, microbial actions (e.g., nitrogen fixation) also decrease with residue removal in forest soils. The retention of untreated logging slash is unsightly and could make planting, natural seeding and subsequent management activities difficult (Hacker 2008). Unsightly clear cuts can provoke unwanted public backlash even when suitable and sustainable replanting regimes are followed.
Guidance Source	Efroymson et al. (2017); Graham et al. (2017); Griffel et al. (2018); Hacker (2008); Mitchell et al. (2016); Morris (2019, feedback); Muth et al. (2012); Negri and Ssegane (2016); Nair et al. (2017; 2018 a, b); Ruth & Harris (1975); Ssegane et al. (2016); Grosshans (2019, feedback); Bi (2019, feedback)

3.9.7 BIOMASS CLASSIFIED AS A GENETICALLY MODIFIED ORGANISM (GMO)

Rationale	**There are various risks associated with GMOs such as migration or dispersion across the landscape, which can generate community backlash and create supply chain risk. GMOs can also be heavily regulated. If planning to grow or procure GMO feedstocks, especially purpose-grown energy crops, it is important to understand the risks.**
Reporting	**Reporting Requirements** 1. If feedstock is a GMO, understanding of risks associated with the production including public backlash, shall be demonstrated.
Guidance	**Guidance for Reporting Requirement 1** The Roundtable for Sustainable Biomaterials (Section 11b, 11c, RSB 2016) can be used as guidance for the development of a GMO risk management plan. The plan should be consistent with relevant laws and guidelines, ensure that harmful organisms cannot be spread throughout the environment, explain the net benefits of GMO use, and mandate collaboration and cooperation with relevant stakeholders.
Guidance Source	RSB (2016)

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Category 4.0: Feedstock Scale-Up Risk

4.1 Risk Factor: Feedstock Scale-Up

4.1.1 FEEDSTOCK QUALITY AT PRODUCTION SCALE

Rationale	**The physical and chemical properties of feedstock used in lab, pilot and field testing can fail to be representative of feedstock generated by large-scale operations.** **It is important to conduct tests on feedstock representative of that which will be produced by large-scale operations. Failure to adequately test the full range of parameter values can result in severe problems during scale-up.**
Reporting	**Reporting Requirements** 1. Lab and field tests should utilize feedstock that accurately represents feedstock variability of scale operations. Experimental design for field-scale tests should reflect all ranges of individual, and combination of, parameter values being tested.
Guidance	**Guidance for Reporting Requirement 1** Document all sampling methodology, samples and ranges used, test conditions and results, as evidence for viable scale-up.
Guidance Source	Nguyen (2017, interview); Smith (2017, interview)

4.1.2 CAPACITY OF SUPPLY CHAIN COMPONENTS AND INFRASTRUCTURE TO SCALE

Rationale	**Scale-up risk increases if supply chain components, or underlying feedstock infrastructure necessary for these components, cannot scale to handle Issuer feedstock requirements and throughput capacity. Capacity to scale should be demonstrated.**
Reporting	**Reporting Requirements** Issuer shall demonstrate that: 1. Throughput rates and efficiencies of each supply chain component are adequate for proposed plant scale. 2. Necessary underlying infrastructure component capacities are adequate for proposed plant scale. **Reporting Recommendations** 1. The bio-refinery plant size and design should be optimized with the feedstock availability.
Guidance	**Guidance for Reporting Requirement 1** Supply chain components should include (as applicable) planting, harvesting, densification, pre-processing, storage, and transport. Pre-processing refers to mechanical or chemical processes in which biomass may undergo size reduction, drying, ash removal, densification, or other operations to convert feedstock to required quality, shape and other specifications. **Guidance for Reporting Requirement 2** Underlying infrastructure components should include (as applicable) land base, roads, equipment, labour, weather, regulatory and social environments. Issuer plant size should be aligned with the feedstock availability and other relevant factors. According to Miao et al. (2013), feedstock pre-processing, and supply and storage systems need to be aligned with the biofuel plant size and its choice of pre-treatment and conversion technology, as well as the feedstock type, geography, and climate. Large-scale operations run higher risks of feedstock delivery because of potential shortage of trucks and drivers, higher costs of satellite storage, and multiple handling steps (Nguyen 2018). Based on the feedstock throughput rate and bio-refinery processes, computer-based models can be used to size, design and cost the bio-refinery operation (see models developed by Gebreslassie et al. (2012) and Chen et al. (2012)).

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Guidance Source	Chen et al. (2012); Gebreslassie et al. (2012); Malik (2017, interview); Miao et al. (2013); Passmore (2017, interview); Solomon (2019, interview)

Category 5.0: Infrastructure Risks

5.1 Risk Factor: Physical Infrastructure

5.1.1 LAND PARCEL

Reporting	**Reporting Requirements** Issuer shall identify and provide a detailed description of the land parcel(s) for development and demonstrate including location, size, shape, topography and whether: 1. Land been subdivided and ready to develop? If so, are there varying parcel sizes to choose from? 2. Parcel shape conducive to development, relative to available utilities, infrastructure, etc.? 3. Are there any restrictive covenants on title? Or easements registered on title that may restrict how the parcel can be developed? **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** Generally, industry will look for a minimum of 5–10-acre parcel or larger. In some cases, parcel size may need to be as large as 1-2 quarter sections (160-320 acres), or larger in some cases. Does the municipality have a dedicated industrial park for this type of industry? If not, does the municipality have the ability to assemble land? Does it have the ability/willingness to organize the development of all utilities and logistical requirements to supply serviced land? In some instances, there may not be sufficient land within the geopolitical boundaries of the municipality. If this is the case, what is the relationship with neighboring municipalities to access available land? Is there a regional approach in partnership with neighboring municipalities? What are the processes/timelines to achieve land assembly and readiness to accommodate industry? If the land parcel is brownfield, are existing infrastructure capacities sufficient to support a new bio-based plant? If not, what is the process, cost and timeline related to expand capacity? Has an environmental assessment of the brownfield site been completed? If not, what is the cost and timeline associated to complete one? If so, have environmental issues been identified and/or have environmental issues been mitigated? What is the cost of mitigation/environmental liability? **Guidance for Reporting Recommendations** None
Guidance Source	None

5.1.2 CITY OWNERSHIP

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of how long it takes to obtain a title transfer. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** Municipal ownership of land may be easier to deal with, since the municipality is in control of what happens on the land. On the other hand, issuer should consider what processes exist to transfer ownership from the municipality to a private landowner. Public process to transfer land from a municipality to a private owner can be time consuming. Has the municipality addressed the process

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	ahead of time so that transfer of ownership timeline is similar to timeline of a normal land transfer transaction? Is there clarity on who the developer negotiates with? If Council, it can be time consuming to arrange Council meetings, etc. More complex municipalities will have a process in place where Administration (staff) have the power to exercise sales options. Is there a land sale policy in place? If so, what does it say? The key question is how long it will take to obtain a title transfer. This should not be more than 30 days, after negotiation leading up to a mutually agreed upon deal. **Guidance for Reporting Recommendations** None
Guidance Source	None

5.1.3 INDUSTRIAL LAND USE ZONE

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of the risk of obtaining a development permit and how long it would take to obtain it. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** Is the land properly planned/zoned to accommodate industry? If so, is the proposed industry a "permitted use" or are there other processes involved to obtain permission to develop? If there are further processes, do those processes require public participation? And if so, are there appeal processes. If there are appeal processes, what are they? Time to obtain a development permit should not be more than 30-90 days. **Guidance for Reporting Recommendations** None
Guidance Source	None

5.1.4 NATURAL GAS LINE

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of the proximity and capacity of gas to proposed development sites. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** Proximity and capacity are the key questions. Capacity will be determined by the gas service provider and the municipality should know the value of the capacity (volume and pressure) in whatever measurement is used by the service provider. The capacity should be confirmed by the service provider or evidence of capacity should be supplied and on file. Utility suppliers will have a standard that suggests gas should be at a certain capacity for industrial development or an industrial subdivision, however this may/will vary from jurisdiction to jurisdiction. Some larger industries may require a volume and pressure that is greater than average/normal. If so, is there system capacity to accommodate, and if so, what are the costs/timeline associated with increasing capacity? **Guidance for Reporting Recommendations** None
Guidance Source	None

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5.1.5 ELECTRICAL

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of the proximity and capacity of electricity to proposed development sites. **Reporting Recommendations** Issuer shall demonstrate understanding of generation, transmission and distribution factors, all of which can affect the availability of electricity to proposed development sites. Limitations should be noted, including whether electricity is made from renewable sources or not. Reliance on diesel generation should be noted where applicable.
Guidance	**Guidance for Reporting Requirements** Proximity and capacity are the key questions. Capacity will be determined by the electricity service provider and the municipality should know the value of the capacity (volume) in whatever measurement is used by the service provider. The capacity should be confirmed by the service provider or evidence of capacity should be supplied and on file. Utility suppliers may have a standard that suggests electricity should be at a certain capacity for industrial development or an industrial subdivision, however this may/will vary from jurisdiction to jurisdiction. Some larger industries may require a volume that is greater than average/normal. If so, is there system capacity to accommodate, and if so, what are the costs/timeline associated with increasing capacity. **Guidance for Reporting Recommendations** None
Guidance Source	None

5.1.6 FRESH WATER SUPPLY

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of the proximity and capacity of potable water and raw water to proposed development sites. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** Water is regulated provincially in Canada, with national guidelines (Canadian Drinking Water Standards). That is, the licensing standards for potable water quality is regulated at the provincial level, while raw water is untreated water. Industry will require potable water for human consumption within the processing plant and may use potable water for processing. Issuer shall demonstrate understanding of proximity and capacity of potable and raw water. Capacity is defined as volume and pressure. Is there sufficient capacity for human consumption, processing, fire fighting? If not, what is the process, cost and timeline associated with increasing capacity? For potable water, questions go beyond supply line capacity to include water treatment plan processing capacity, and the capital costs/timeline for capacity expansion. It is more likely that industry will prefer to use raw water for any processing and treat the raw water to the standard they need for processing. For example, potable water is most often chlorinated, and chlorination often interferes with industrial processes. It can be more economical for industries to treat raw water to an industrial use standard than to de-chlorinate potable water. Is the industry capable of recycling process water? If the industry is a non food grade industry, process water recycling may be an option to manage capacity issues if there are any. **Guidance for Reporting Recommendations** None
Guidance Source	None

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5.1.7 SEWAGE DISPOSAL TRUNK LINE

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of proximity and capacity of the sewage collection system as well as sewage treatment capacity. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** If the capacity of either or both does not exist, what are the options for expansion to increase capacity? Is wastewater recycling an option? If so, what is the local/provincial attitude/regulations surrounding wastewater recycling? Are there acceptable alternatives in place for wastewater disposal (i.e., deep well injection, golf course irrigation or irrigation generally for on site treated waste water). **Guidance for Reporting Recommendations** None
Guidance Source	None

5.1.8 DRAINAGE AND STORMWATER MANAGEMENT

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of drainage and stormwater management issues. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** Issuer shall review, as possible, master drainage plan, stormwater management plan and flood risk mapping in order to understand drainage limitations or flood risk mitigation. **Guidance for Reporting Recommendations** None
Guidance Source	None

5.1.9 AVAILABLE ICT (INFORMATION & COMMUNICATION TECHNOLOGY) SERVICES

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of information and communication technology services. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** Issuer shall review availability and assess strength of fiber optic network (gigabyte bandwidth capacity) as well as network provider. **Guidance for Reporting Recommendations** ICT services are typically provided by third party service providers. What is the available capacity? If capacity is low, can the services be expanded? If so, is there willingness and funding? What is the cost and timeline?
Guidance Source	None

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5.1.10 INFRASTRUCTURE – LANDFULL/ALTERNATIVE MARKETS FOR WASTE DISPOSAL

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of proximity, capacity and costs of waste disposal options. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** Will the industrial solid waste be handled/hauled by the industry or municipality? Identify key end markets for waste disposal withing 25 miles from the center of the BDO Zone—both landfill and transfer station). Are there recycling options for the industrial waste? Compare key alternative markets to landfill (i.e., compost, anerobic digestion). Distance to landfill needs to be considered as more provincial jurisdictions have moved/are moving to regional solid waste facilities that may not be near the specified community. Are there any restrictions on the type of wastes that can be disposed of at landfill? **Guidance for Reporting Recommendations** None
Guidance Source	None

5.2 Risk Factor: Logistics

5.2.1 ROAD AND HIGHWAY ACCESS AND INTERSECTION

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of existing road and highway infrastructure that serves the land parcels. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** Quantify road types and condition of roads with a view to truck access to land parcels in BDO Zone. Is there a Traffic Master Plan in place? Review, as possible, the Traffic Impact Analysis to analyse and understand traffic impacts. Is the transportation system in the jurisdiction of the municipality, or is it in provincial jurisdiction? What approvals are needed to access provincial highways/infrastructure? Are upgrades necessary: what is the cost and timeline to upgrade? **Guidance for Reporting Recommendations** None
Guidance Source	None

5.2.2 OCEAN/RIVER ACCESS

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of suitability of ocean and river access to land parcels with special attention on proximate ports if any. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** Issuer should note location of the primary navigable waterways and ports including any difficulties with access or capacity and access to major markets. **Guidance for Reporting Recommendations** None
Guidance Source	None

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5.2.3 RAILWAY SERVICE

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of availability of rail service to land parcels. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** Determine if the land parcel connectivity to rail services (i.e., whether it has direct access to the railway or if it requires additional transport services). Identify the railway service provider that serves the land parcel. Do spur lines exist for the parcel(s) in question? Identify additional transloading capabilities that exist, if any. If possible, issuer should confirm with railway service provider whether it is able to service an existing or planned rail spur. Assess the railway infrastructure, including the condition of the tracks, the signaling systems, and the level of maintenance. Identify any bottlenecks or limitations that could affect the railway service and access to the land parcel. **Guidance for Reporting Recommendations** None
Guidance Source	None

5.2.4 ACCESSIBILITY TO AIRPORT

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of availability of airport service to land parcels. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** Identify the airport(s) located within a reasonable distance from the land parcel. Review any economic development plans or initiatives associated with each airport, including investment in infrastructure, job creation, and business attraction. Research services and amenities offered by each airport, airlines served, passenger and cargo traffic volumes, and the types of aircraft that can be accommodated. Smaller communities may have small airports that may not accommodate larger aircraft. Is the airport certified? Distance to a larger airport needs to be considered together with means of transportation to/from the airport. **Guidance for Reporting Recommendations** None
Guidance Source	None

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5.3 Risk Factor: Social Infrastructure

5.3.1 HEALTHCARE FACILITIES

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of availability and quality of healthcare facilities in the BDO Zone, including hospitals, clinics, and medical centers. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** The rating should be based on the availability of healthcare services, the quality of care, and the range of medical specialties available. **Guidance for Reporting Recommendations** None
Guidance Source	None

5.3.2 EDUCATIONAL FACILITIES

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of availability and quality of elementary, high school and post-secondary educational facilities in the area. Including elementary, middle, and high schools, as well as colleges and universities. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** The rating should be based on the availability of quality education and the range of educational programs available. **Guidance for Reporting Recommendations** None
Guidance Source	None

5.3.3 TRANSPORTATION FACILITIES

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of availability and quality of transportation facilities in the area, including roads, highways, public transportation, and airports for workforce use. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** The rating should be based on the availability and quality of transportation services, the ease of access to transportation services, and the level of congestion and traffic. **Guidance for Reporting Recommendations** None
Guidance Source	None

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5.3.4 RECREATIONAL FACILITIES

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of availability and quality of recreational facilities in the area, including parks, sports facilities, and cultural centers. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** The rating should be based on the range of recreational activities available, the quality of facilities, and the accessibility of recreational areas. What are the passive recreation opportunities? Walking trails, sidewalks, interconnection of open space(s)? **Guidance for Reporting Recommendations** None
Guidance Source	None

5.3.5 CULTURAL FACILITIES

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of availability and quality of cultural facilities in the area, including museums, theaters, and other cultural centers. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** The rating should be based on the range of cultural activities available, the quality of facilities, and the accessibility of cultural areas. **Guidance for Reporting Recommendations** None
Guidance Source	None

5.3.6 PUBLIC SAFETY FACILITIES

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of availability and quality of public safety facilities in the area, including police stations, fire departments, and emergency services. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** The rating should be based on the availability and quality of public safety services, the response time of emergency services, and the level of crime in the area. What is the Crime Severity Index for the region? Communication with the local policing agency, in many cases being the RCMP in Canada if there is no local policing agency. The municipality should be able to provide data evidence as monthly if not quarterly reports are readily available to the municipality. **Guidance for Reporting Recommendations** None
Guidance Source	None

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5.3.7 HOUSING

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of availability and access to affordable and quality housing. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** The rating should be based on the following factors: Affordability: The affordability of housing in the area, including the cost of rent and home ownership. Availability: The availability of housing in the area, including the number of available units and the vacancy rate. Quality: The quality of housing in the area, including the condition of housing stock and the availability of necessary amenities. Accessibility: The accessibility of housing in the area, including the proximity to transportation and job centers. **Guidance for Reporting Recommendations** None
Guidance Source	None

5.4 Risk Factor: Workforce and Permitting

5.4.1 LABOUR AVAILABILITY

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of workforce availability in the BDO Zone, including both skilled and unskilled labour. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** Issuer shall demonstrate understanding of the size, composition and availability of the labour force in the region, as well as any changes in the labour market that may impact labour availability. Utilization of a labour market analysis is encouraged. Are there competing interests that will affect labour availability and cost? What are local, regional and/or provincial authorities doing to retain and attract labour? Data should be available through provincial agencies if the municipality doesn't have the information. **Guidance for Reporting Recommendations** None
Guidance Source	None

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5.4.2 LABOUR COST

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of workforce costs in the BDO Zone, including both skilled and unskilled labour. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** Compare the labour cost in the region to that of other proximate regions to determine the competitiveness. What is the comparative to provincial labour rates/cost? **Guidance for Reporting Recommendations** None
Guidance Source	None

5.4.3 TRAINING PROGRAMS / COMMUNITY COLLEGE

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of education and training programs in the region, and identify any gaps or areas where additional training or education is needed to meet the future needs. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirement** The rating should be based on existence and quality of vocational education, community college programs, and apprenticeship programs. **Guidance for Reporting Recommendations** None
Guidance Source	None

5.4.4 PERMIT PROCESS

Reporting	**Reporting Requirements** Issuer shall demonstrate understanding of the process of obtaining a development permit in the BDO Zone. **Reporting Recommendations** None
Guidance	**Guidance for Reporting Requirements** Identify the relevant government agencies responsible for issuing development permits in the region. This may include city or county planning departments, zoning boards, environmental agencies, and others. What is the process and how long does it take to obtain a development permit? Are there options available to expedite the process? What are the potential appeal processes that could hinder approval? As possible, collect data on the number of permits issued by each agency, as well as the average processing time for each type of permit. This data can be gathered through public records requests or by contacting the agencies directly. Determine any history of opposition to previous development. Is local government supportive? **Guidance for Reporting Recommendations** None
Guidance Source	None

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Annex 1: Reviewed Works

1. ASIS International, (2014). ANSI/ASIS SCRM.1-2014. Supply chain risk management: a compilation of best practices. http://webstore.ansi.org/RecordDetail.aspx?sku=ANSI%2fASIS+SCRM.1-2014
2. Abbas, D., Arnosti, D. (2013) Economics and logistics of biomass utilization in the Superior National Forest. J. Sustainable Forestry, (32)1-2:41-57.
3. Aboytes-Ojeda, M., Castillo-Villar, K. K., Tun-hsiang, E. Y., Boyer, C. B., English, B. C., Larson, J. A., Kline, L. M., Labbé. N. (2016) A Principal Component Analysis in Switchgrass Chemical Composition. Energies 2016, 9, 913. https://www.mdpi.com/1996-1073/9/11/913
4. Abt, R. C., Abt, K. L. (2013) Potential impact of bioenergy demand on the sustainability of the southern forest resource. J. Sustainable Forestry. 32(1-2): 175-194. https://doi.org/10.1080/10549811.2011.652044.
5. Abt, R. C., Cubbage, F. W., Abt, K. L. (2009) Projecting timber supply for multiple products by subBDO Zone. Forest Products Journal (59) 7-8: 7-16.
6. Abt, R. C., Cubbage, F. W., Pacheco, G. (2000) Southern Forest resource assessment using the Sub-BDO Zoneal Timber Supply (SRTS) Model. Forest Products Journal, (50) 4: 25-33.
7. Agee, J. K., Wright, C. S., Williamson, N., Huff, M. H. (2002) Foliar moisture content of Pacific Northwest vegetation and its relation to wildland fire behavior. Forest Ecology and Management. 67(1-3) 57-66. https://doi.org/10.1016/S0378-1127(01)006960-9.
8. Ager, A. A., Barros, A. M. G., Day, M. A., Preisler, H. K., Spies, T. A., Bolte, J. P. (2018) Analyzing fine-scale spatiotemporal drivers of wildfire in a forest landscape model. Ecological Modelling. 384 (87-102). https://www.sciencedirect.com/science/article/pii/S0304380018302230
9. Ahumada, O., Villalobos, J.R. (2009). Application of planning models in the agri-food supply chain: A review. *European Journal of Operations Research*. Vol. 195: 1-20.
10. AIRMIC (2002). A Risk Management Standard. Available at: https://www.theirm.org/media/886059/ARMS_2002_IRM.pdf
11. Akhtari, S., Sowlati, T., Day., K. (2014). Optimal flow of BDO Zoneal forest biomass to a district heating system. *International Journal of Energy Research*. Vol. 38: 954-964.
12. Alam, M.B., Pulkki, R., Shahi, C., Upadhyay, T. (2012). Modeling woody biomass procurement for bioenergy production at the Atikokan Generating Station in Northwestern Ontario, Canada. *Energies*, 5, 5065-5085.
13. Allen, D., McKenney, DW., Yemshanov, D., Fraleigh, S. (2013). The economic attractiveness of short rotation coppice biomass plantations for bioenergy in Northern Ontario. *The Forestry Chronicle.* Vol. 89(1): 66-78.
14. Allen, S. J. Schuster, E. W. (2002). Controlling the risk for an agricultural harvest. Manufacturing and Service Operations Management, V6, 3, 225-236.
15. Altman, I. J., Boessen, C., & Sanders, D. R. (2008). Contracting for Biomass: Supply Chain Strategies for Renewable Energy. *Journal of the ASFMRA*, 1-18.
16. An, H., Searcy, S.W. (2012). Economic and energy evaluation of a logistics system based on biomass modules. *Biomass and Bioenergy*. Vol. 46: 190-202.
17. An, H., Wilhelm, W.E., Searcy, S.W. (2011). A mathematical model to design a lignocellulosic biofuel supply chain system with a case study based on a BDO Zone in Central Texas. Bioresource Technology. Vol. 102: 7860-7870.

ISBN 978-1-9991916-0-3

©2023 Ecostrat Inc

18. Athmannathan, A. (2013). An analysis of the impact of storage temperature, moisture content & duration upon the chemical components & bioprocessing of lignocellulosic biomass. PhD Dissertation, Purdue University. Open Access Dissertations. Paper 202.
19. Aubin, I. (2012) From seed size to ecosystem health: the plant trait approach. Natural Resources Canada. Canadian Forest Service. Great Lakes Forestry Centre. Sault Ste. Marie, Ontario. *Frontline Express*. Vol. 57(2).
20. Awudu, I., Zhang, J. (2013). Stochastic production planning for a biofuel supply chain under demand and price uncertainties. *Applied Energy*. Vol. 103: 189-196.
21. Awudu, I., Zhang, J. (2012). Uncertainties and sustainability concepts in biofuel supply chain management: a review. Renew Sustain Energy Rev 16(2):1359-68.
22. Ayoub, N., Martins, R., Wang, K., Seki, H., Naka, Y. (2007). Two levels decision system for efficient planning and implementation of bioenergy production. Energy Conversion and Management 48 (3), 709-723.
23. B.H., Prins, C., Prodhon, C. (2016). Models for optimization and performance evaluation of biomass supply chains: An operations research perspective. Renewable Energy. Vol 87: 977-989.
24. Badurdeen, F., Shuaib, M., Wijekoon, K., Brown, A., Faulkner, W., Amundson, J., Jawahir, I.S., Goldsby, T.J., Iyengar, D., Boden, B. (2014). Quantitative modeling and analysis of supply chain risks using Bayesian theory. *Journal of Manufacturing Technology Management*, 25(5), 631-654.
25. Baker, W. E., Sinkula, J.M. (1999). The synergistic effect of market orientation and learning orientation on organizational performance. *Journal of the Academy of Marketing Science*, 27(4), 411-427.
26. Barrette, J., Paré, D., Manka, F., Guindon, L., Bernier, P., Titus, B. (2018) Forecasting the spatial distribution of logging residues across the Canadian managed forest. *Canadian Journal for Forest Research. 48: 1470-1481.*
27. Bartell, S. M., Nair, S. K. (2004). Establishment Risk for Invasive Species. Risk Analysis, Vol 24, Issue 4, 833-845.
28. Bengtsson, J., Persson, T., Lundkvist, H. (1997) Long-term effects of logging residue addition and removal on microarthropods and enchytraeids. J. Applied Ecology (34) 4: 1014-1022.
29. Bentsen, N.S (2017). Carbon debt and payback time – Lost in the forest? *Renewable and Sustainable Energy Reviews*. Vol. 73: 1211-1217.
30. Bentz, B. J., Amman, G. D., Logan, J. A. (1993). A critical assessment of risk classification systems for the mountain pine beetle. Forest Ecology and Management, Vol 61, Issues 3-4, 349-366.
31. Berch, S. M., Bulmer, C., Curran, M., Finvers, M., Titus, B. (2011) Intensive Forest biomass harvesting and biodiversity in Canada: a summary of relevant issues. *The Forestry Chronicle*. Vol. 87(4): 478-487.
32. Berch, S.M., Bulmer, C.B., Curran, M., Finvers, M., Titus, B. (2012). Provincial government standards, criteria, and indicators for sustainable harvest of forest biomass in British Columbia: soil and biodiversity. *International Journal of Forest Engineering*. Vol. 23: 33-37.
33. Berch, S.M., Roach, J. (2014). A compilation of forest biomass harvesting and related policy in Canada. Province of British Columbia. Available at: https://www.for.gov.bc.ca/hfd/pubs/docs/tr/TR081.pdf
34. Bergtold, J. S., Fewell, J. E., Williams, J. (2014) Farmers' Willingness to Produce Alternative Cellulosic Biofuel Feedstocks Under Contract in Kansas Using Stated Choice Experiments. BioEnergy Research 7(3):876-884.

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

https://www.researchgate.net/publication/271916762_Farmers'_Willingness_to_Produce_Alternative_Cellulosic_Biofuel_Feedstocks_Under_Contract_in_Kansas_Using_Stated_Choice_Experiments

35. BETO (2016). Bioenergy Technology Office Multi-Year Plan. https://www.energy.gov/sites/prod/files/2016/03/f30/mypp_beto_march2016_2.pdf
36. Bessa, D., Block, S. N. (2017) Biomass Power Plants: What fire hazards are hidden within the fuel? The Morgan Group. https://www.femoran.com/learn-industrial-fire-protection/2017/7/5/biomass-power-plants-what-fire-hazards-are-hidden-within-the-fuel
37. Bhatti, J.S., Foster, N.W., Oja, T., Moayeri, M.H., Arp, P.A. (1998). Modeling potentially sustainable biomass productivity in jack pine forest stands. *Canadian Journal of Soil Science*. Vol. 78(1): 105-113.
38. Blunk, S. L., Yore, M. W., Summers, M. D., Lau, G. K., Tang, S. T., Jenkins, B. M. (2003) Quality and property changes in rice straw during long term storage. Paper Number 036091, 2003 ASAE Annual Meeting. doi: 10.13031/2013.15406.
39. Bone, C., Wulder, M. A., White, J. C., Robertson, C., Nelson, T. A. (2013). A GIS-based risk rating of forest insect outbreaks using aerial overview surveys and the local Moran's I Statistic. Applied Geogra[hy, Vol 40, June, 161-170.
40. Bonner, I., McNunn, G., Muth, jr, D., Tyner, W., Leirer, J., Dakins, M. (2016). Development of integrated production systems using precision conservation and multicriteria decision analysis techniques. J Soil and Water Conservation 71(3):180-191.
41. Bonner I. J., Muth D. J., Tomer M. D., James D. E., Porter S. A., Karelen, D. L. (2014) Opportunities for Energy Crop Production Based on Subfield Scale Distribution of Profitability. Energies 7(10):6509-26. PubMed PMID: doi:10.3390/en7106509.
42. Booth, M.S. (2018). Not carbon neutral: Assessing the net emissions impact of residues burned for bioenergy. *Environmental Research Letters*. Vol. 13.
43. Bowd, R., Quinn, N. W., Kotze, D. C., Guilfoyle, M. J. (2018) A systems approach to risk and resilience analysis in the woody-biomass sector: A case study of the failure of the South African wood pellet industry. Biomass and Bioenergy. 108(1) 126-137. https://doi.org/10.1016/j.biombioe.2017.10.032.
44. Brandes, E., McNunn, G. S., Schulte, I. A., Bonner, I. J., Muth, D. J., Babcock, B. A., Sharma, B., Heaton, E. A. (2016). Subfield profitability analysis reveals an economic case for cropland diversification. Environ Res Lett 11(2016):014009.
45. Bresnan, G. M., Oliveira, V. A., Hruschka, Jr, E. R., Nicoletti, M. C. (2009) Using Bayesian networks with rule extraction to infer the risk of weed infestation on corn-crop." Engineering App. Of AI, Vol 22, Issue 4, 579-592.
46. Braunscheidel, M.J., Suresh, N.C. (2009). The organizational antecedents of a firm's supply chain agility for risk mitigation and response. *Journal of Operations Management*, 27, 119-140.
47. Bressan, G. M., Olveira, V. A., Hruschka, Jr., E. R., Nicoletti, M. C. (2009) Using Beyesian networks with rule extraction to infer the risk of weed infestation in a corn-crop. Engineering Applications of Artificial Intelligence. 22 (4-5), 579-592.
48. Brechbill, S.C., Tyner, W.E., Ileleji, K.E. (2011). The economics of biomass collection and transportation and its supply to Indiana cellulosic and electric utility facilities. *Bioenergy Research*. Vol. 4: 141-152.
49. Bronson, B., Gogolek, P., Mehrani, P, Preto, F. (2016) Experimental investigation of the effect physical pre-treatment on air-blown fluidized bed biomass gasification. *Biomass and Bioenergy. 88: 77-88.*
50. Buchholz, T., Volk, T.A., Luzadis, V.A. (2007). A participatory systems approach to modeling social, economic, and ecological components of bioenergy. *Energy Policy*. Vol. 35: 6084-6094.

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

51. Busby, D., Little, R. D., Shaik, S., Martins, A., Epplin, F., Hwang, S., Baldwin, B. S., Taliaferro, C. M. (2007). *Yield and Production Costs for Three Potential Dedicated Energy Crops in Mississippi and Oklahoma Environments*. Southern Agricultural Economics Association Meeting, Mobile, Alabama, February 4–7, 2007. https://ageconsearch.umn.edu/bitstream/34854/1/sp07bu07.pdf. Last accessed April 26, 2018.
52. CAAFI (2018). Feedstock Readiness Level Tools. http://www.caafi.org/information/fuelreadinesstools.html
53. Cacho, J.F., M.C. Negri, C. Zumpf, and P. Campbell (2017). Introducing perennial biomass crops into agricultural landscapes to address water quality issues and provide other environmental services. WIREs. DOI: 10.1002/wene.275.
54. Calvert, K. (2011). Geomatics and bioenergy feasibility assessments: Taking stock and looking forward. *Renewable and Sustainable Energy Reviews*. Vol. 15: 1117 – 1124.
55. Cambero, C., Sowlati, T. (2014). Assessment and optimization of forest biomass supply chains from economic, social and environmental perspectives – A review of literature. *Renewable and Sustainable Energy Reviews*. Vol. 36: 62-73.
56. Castillo-Villar, K. K., Minor-Popocatl, H., and Webb, E. (2016). Quantifying the Impact of Feedstock Quality on the Design of Bioenergy Supply Chain Networks. *Energies,* 9, 203, 23 pp; doi:10.3390/en9030203; www.mdpi.com/1996-1073/9/3/203/pdf
57. Castillo-Villar, K. K., Eksioglu, S., Taherkhorsandi, M. (2017) Integrating biomass quality variability in stochastic supply chain modeling and optimization for large-scale biofuel production. *Journal for Cleaner Production*. 149 904-918. https://www.sciencedirect.com/science/article/pii/S0959652617303463
58. Cerroni, S., Shaw, D. (2012). Does climate change information affect stated risks of pine beetle impacts on forests? An application of the exchangeability method. Forest Policy and Economics, Vol 22, Septemeber, 72-84. https://doi.org/10.1016/j.forpol.2012.04.001.
59. Chawla, V., Naik, H. S., Akintayo, A., Hayes, D., Schnable, P., Ganapathysubramanian, B., Sarkar, S. (2016). A Bayesian network approach to county-level corn yield prediction using historical data and expert knowledge. Proceedings of the twenty-second ACM SIGKDD workshop on data science for food, energy and water, San Francisco, USA (2016).
60. Chavez, H., Castillo-Villar, K. K., Webb, E. (2017) Development of the IBSAL-SimMOpt Method for the Optimization of Quality in a Corn Stover Supply Chain. Energies 2017, 10, 1137. https://www.mdpi.com/1996-1073/10/8/1137
61. Chen, C.-W., Fan, Y. (2012). Bioethanol supply chain system planning under supply and demand uncertainties. *Transportation Research Part E*. Vol. 48: 150-164.
62. Chopra, S., Sodhi, M. (2004). Managing risk to avoid supply-chain breakdown. *MIT Sloan Management Review*, 46(1), 53-62.
63. Chuvieco, E., Aguado, I., Jurdao, S., Pettinari, M. L., Yebra, M., Salas, J., Hantson, S., de la Rive, J., Ibarra, P., Rodrigues, M., Echeverria, M., Azqueta, D., Roman, M. V., Bastarrika, A., Martinez, S., Recondo, C., Zapico, E., Martinez-Vega, F. J. (2012) Integrating geospatial information into fire risk assessment. Intl. J. Wildland Fire. 23(5) 606-619. https://doi.org/10.1071/WF12052.
64. Chuvieco, E., Aguado, I., Dimitrakopoulos, A. P. (2004) Conversion of fuel moisture content values to ignition potential for integrated fire danger assessment. Canadian J. Forest Research. 34(11) 2284-2293. https://doi.org/10.1139/x04-101.

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

65. Clarke, S. R. and Nowak, J. T. (2009). Southern Pine Beetle. In Forest Insect and Disease Leaflet 49, Revised April 2009. https://www.dec.ny.gov/docs/lands_forests_pdf/southpinebeetle.pdf, last accessed on April 30, 2018.
66. Conrad IV, J. L., Vokoun, M. M., Prisley, S. P., & Bolding, M. C. (2016). Barriers to logging production and efficiency in Wisconsin. International Journal of Forest Engineering, 28(1), 57-65.
67. Cole, W. E., McGregor, M. D. (1983). Estimating the rate and amount of tree loss from mountain pine beetle infestations. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT, Research Paper INT-318.
68. Cruz Jr., J.B., Tan, R.R., Culaba, A.B., Ballacillo, J.-A. (2009). A dynamic input-output model for nascent bioenergy supply chains. *Applied Energy*. Vol. 86: S86-S94.
69. Cucek, I., Varbanoc, P. S., Klemes, J. J., Kravanjaa, Z. (2011). Total footprints-based multi-criteria optimisation of BDO Zoneal biomass supply chains. Energy 44(1):135-44.
70. Damen, K., Faaij, A. (2006). A greenhouse gas balance of two existing international biomass import chains - The case of residue co-firing in a pulverised coal-fired power plant in the Netherlands. Mitigation and Adaptation Strategies for Global Change 11 (5-6), 1023-1050.
71. Davis, R., Tao, L., Tan, E., Biddy, M., Beckham, G., Scarlata, C., Jacobson, J., Cafferty, K., Ross, J., Lukas, J., Knorr, D., Schoen, P. (2013). Process design and economics for the conversion of lignocellulosic biomass to hydrocarbons: dilute-acid and enzymatic deconstruction of biomass to sugars and biological conversion of sugars to hydrocarbons. National Renewable Energy Laboratory (NREL), Golden, CO.; 2013.
72. Del Aguila, I. M., Canadas, J., Tunez, S. (2015). Decision making models embedded into a web-based tool for assessing pest infestation risk. Biosystems Engineering, Vol 133, May, 102-115.
73. Demczuk, A., Padula, A.D. (2017). Using system dynamics modeling to evaluate the feasibility of ethanol supply chain in Brazil: The role of sugarcane yield, gasoline prices and sales tax rates. Biomass and Bioenergy. Vol. 97: 186-211.
74. De la Torre Ugarte, D., Ray, D. E. (2000) Biomass and bioenergy applications of the POLYSYS modeling framework. Biomass and Bioenergy. 18(4):291-308.
75. De Meyer, A.D., Cattrysse, D., Rasinmaki, J., Van Orshoven, J. (2014). Methods to optimize the design and management of biomass-for-bioenergy supply chains: A review. *Renewable and Sustainable Energy Reviews*. Vol. 31: 657-670.
76. Dicks, M., Campiche, J., De la Torre Ugarte, D., Hellwinckel, C., Bryant, H., Richardson, J. (2009). Land use implications of expanding biofuel demand. J. Agricultural and Applied Economics. Vol. 41, Issue 02, 435-453.
77. Dunnett, A., Adjiman, C., Shah, N., (2007). Biomass to heat supply chains: applications of process optimization. Process Safety and Environmental Protection 85 (5), 419-429.
78. Dymond, C. C., Titus, B. D., Stinson, G., Kurz, W. A, (2010) Future quantities and spatial distribution of harvesting residue and dead wood from natural disturbances in Canada. *Forest Ecology and Management 260(2): 181-192*.
79. Dymond, C. C., Wulder, M. A., Shore, T. L., Nelson, T., Boots, B., and Riel, B. G. (2006). Evaluation of risk assessment of mountain pine beetle infestations. *Western Journal of Applied Forestry*, Vol 21. Issue 1, 5-13.
80. Ebadian, M., Sowlati, T., Sokhansanj, S., Stumborg, M., Townley-Smith, L. (2011). A new simulation model for multi-agricultural biomass logistics system in bioenergy production. *Biosystems Engineering*. Vol. 110: 280-290.
81. Edwards, D. (2015). Scaling up bioenergy technologies. AIChE Chemical Engineering Progress (CEP), March 2015 issue.

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

https://www.zeton.com/site/pdf_articles/Scaling_Up_Bioenergy_Technology_March_2015_CEP.pdf. Last accessed in May 2018.

82. Efroymson, R., M. Langholtz, K. Johnson, C. Negri, A. Turhollow, K. Kline, I. Bonner, and V. Dale (2017). Synthesis, interpretation, and strategies to enhance environmental outcomes. In: 2016 Billion Ton Report, Volume 2, Chapter 14. January 2017, U.S. Department of Energy.
83. EFSA (European Food Safety Authority). (2010). Guidance on a harmonized framework for pest risk assessment and the identification and evaluation of pest risk management option by EFSA. EFSA Panel on Plant Health (PNL> EFSA Journal, 10 February 2010. https://doi.org/10.2903/j.efsa.2010.1495.
84. Eksioglu, S. D., Acharya, A., Leightly, L. E., and Arora, S. (2009). Analyzing the design and management of biomass-biorefinery supply chain. Computers and Industrial Engineering, V57, 4, 1342-1352.
85. Emery, I. R. and Mosier, N. S. (2012). The impact of dry matter loss during herbaceous biomass storage on net greenhouse gas emissions from biofuels production. Biomass and Bioenergy. 39:237-246. DOI: 10.1016/j.biombioe.2012.01.004.
86. Eriksson, L. O., Bjorhedan, R. (1989). Optimal storing, transport, and processing for a forest-fuel supplier. Eur. J Oper Res; 43(1):26-33.
87. Evans, A. M., Perschel, R. T., Kittler, B. A. (2013) Overview of forest biomass harvesting guidelines. J. Sustainable Forestry. 32: 1-2, 89-107. DOI: 10.1080/10549811.2011.651786.
88. FAO (Food and Agriculture Organization of the United States). (2017). Recent practices and advances for AMIS crop yield forecasting at farm and parcel level: A review. ISBN 978-92-5-5109779-3.
89. Faisal, M.N., Banwet, D.K., Shankar, R. (2006). Supply chain risk mitigation: modeling the enablers. *Business Process Management Journal*, 12(4), 535-552.
90. Favaro, R., Wichman, L., Ravn, H. P., Faccoli, M. (2015). Spatial spread and infestation risk assessment in the Asian longhorned beetle*, Anoplophora glabripennis*. Entomologia Experimentalis et Applicata. Vol 155, Issue 2, 95-101.
91. Ferrero, F., Lohrer, C., Schmidt, B. M., Noll, M., Malow, M. (2009) A mathematical model to predict the heating-up of large-scale wood piles. *Journal of Loss Prevention in the Process Industries.* 22 (439 – 448).
92. Fettig, C. J., Klepzig, K. D., Billings, R. F., Munson, A. S., Nebekaer, T. E., Negron, J. F., and Nowak, J. T. (2007). The effectiveness of vegetation management practices for prevention and control of bark beetle infestations in coniferous forests of the western and southern United States. Forest Ecology and Management. Volume 238, Issues 1-3, 24-53. https://doi.org/10.1016/j.foreco.2006.10.011.
93. Fleming, R. & Candau, J. N (2004) Climatic Change and Insect Outbreaks. *Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Centre.*
94. FPInnovations (2016). Roadside residual handling guideline. Version 2.0. Available at: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/timber-tenures/forest-fibre-action-plan/roadside_residue_handling_guidelines.pdf
95. FPInnovations (2017). Value proposition for a biorefinery sector in Nova Scotia. Available at: https://fpinnovations.ca/ResearchProgram/forest-operations/flagship-initiatives/Documents/value-proposition-for-a-biorefi-nery-sector-in-nova-scotia.pdf
96. Freppaz, D., Minciardi, R., Robba, M., Rovatti, M., Sacille, R., Taramasso, A. (2004) Optimizing Forest biomass exploitation for energy supply at a BDO Zoneal level. Biomass and Bioenergy, (26) 1: 15-25.
97. Fridh, L., Volpé, S., Eliasson, L., (2014) An accurate and fast method for moisture content determination. *International Journal of Forest Engineering. 14(3)*.

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

98. Fridh, L., Volpé, S., Eliasson, L., (2017) A NIR machine for moisture content measurements of forest biomass in frozen and unfrozen conditions. *International Journal for Forest Engineering. 28(1): 42-46.*
99. Friesen, C., Volpé, S. (2012) Hog Pile Management: Effective Management Techniques for Piles of Comminuted Forest Biomass to Prevent Combustion and Degradation. *FPInnovations. Advantage Report* 13(3).
100. Frombo, F., Minciardi, R., Robba, M., Rosso, F., Sacile, R. (2009). Planning woody biomass logistics for energy production: a strategic decision model. *Biomass and Bioenergy*, 33, 372-383.
101. Gan, J., Smith, C.T. (2011). Optimal plant size and feedstock supply radius: A modeling approach to minimize bioenergy production costs. *Biomass and Bioenergy*. Vol. 35: 3350-3359.
102. Gan, G. (2004) Risk and damage of southern pine beetle outbreaks under global climate change. Forest Ecology and Management 191 (2004) 61-71.
103. Gansner, D. A., Herrick, O. W. (1984). Guides for estimating forest stand losses to gypsy moth. Northern J Applied Forestry, Vol 1, Issue 2, 21-23.
104. Gaonkar, R., Viswanadham, N. (2004). A conceptual and analytical framework for the management of risk in supply chains. In: *Proceedings of the 2004 IEEE International Conference on Robotics & Automation, New Orleans, LA, April 2004*, 2699-2704.
105. Gebreslassie, B. H., Yao, Y., and You, F. (2012). Design under uncertainty of hydrocarbon biorefinery supply chains: Multi-objective stochastic programming models, decomposition algorithm, and a comparison between CVar and downside risk. AIChE Journal, V58, 7, 2155-2179.
106. Genera Energy (2017). The Four Fundamentals of Biomass Inventory Management. Available at: https://generaenergy.com/the-four-fundamentals-of-biomass-inventory-management/
107. Ghaderi, H., Pishavaee, M.S., Moini, A. (2016). Biomass supply chain network design: An optimization-oriented review and analysis. *Industrial Crops and Products*. Vol. 94: 972-1000.
108. Giarola, S., Shah, N., Bezzo, F. (2012). A comprehensive approach to the design of ethanol supply chains including carbon trading effects. *Bioresource Technology*. Vol. 107: 175-185.
109. Giarola, S., Bezzo, F., Shah, N. (2013). A risk management approach to the economic and environmental strategic design of ethanol supply chains. *Biomass and Bioenergy*. Vol. 58: 31-51.
110. Gillenwater, M. (2012) What is Additionality? Part 1: A long standing problem. GHG Management Institute. Discussion paper No. 001. (3).
111. Giuntoli, J., Caserini, S., Marelli, L., Baxter, D., Agistini, A. (2015) Domestic heating from forest logging residues: environmental risks and benefits. J. Cleaner Production. (99) 7, 206-216). https://doi.org/10.1016/jclepro.2015.03.025.
112. Georgia's Best Management Practices for Forestry, Georgia Forestry Commission Water Quality Program, May 2009.
113. Ghaderi, H., Pishavaee, M. S., Moini, A. (2016) Biomass supply chain network design: An optimization-oriented review and analysis. *Industrial Crops and Products. 94 (972-1000).*
114. Gold, S., Seuring, S. (2011). Supply chain and logistics issues of bio-energy production. *Journal of Cleaner Production*, 19, 32-42.
115. Goldstein, N. (1996) Checking Out The Pad. *BioCycle 13(10): 58-62.*
116. Golecha, R., Gan, J. (2016). Effects of corn stover year-to-year supply variability and market structure on biomass utilization and cost. 57(C): 34-44. DOI: 10.1016/j.rser.2015.12.075.
117. Gonzales, D.S., Searcy, S.W. (2017). GIS-based allocation of herbaceous biomass in biorefineries and depots. *Biomass and Bioenergy*. Vol. 97: 1-10.

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

118. Gonzales-Andujar, J. L., Martinez-Cob, A., Lopez-Granados, F., Garcia-Torres, L. (2001). Spatial distribution and mapping of crenate broomrape infestations in continuous broad bean cropping. Weed Science, 49(6):773-779.
119. Graham, J. B., J.I. Nassauer, W. Currie, H. Ssegane, and M.C. Negri (2017). Assessing wild bees in perennial bioenergy landscapes: Effects of bioenergy crop composition, landscape configuration, and bioenergy crop area. Landscape Ecology, DOI 10.1007/s10980-017-0506-y.
120. Griffel, L. M., Hartley, D. S., Nair, S. K. (2018). Supply curves. Progress on quantification of sustainability gains in integrated landscape management to produce herbaceous biomass. Manuscript in preparation. To be submitted to Energy, Sustainability, and Society, 2018.
121. Gronalt, M., Rauch, P. (2007). Designing a BDO Zoneal forest fuel supply network. Biomass and Bioenergy 31 (6), 393e402.
122. Grosshans, R., P. Gass, R. Dohan, D. Roy, H.D. Venema, M. McCandless (2013). Cattail Harvesting for Carbon Offsets and Nutrient Capture: A "Lake Friendly" greenhouse gas project. IISD Report. International Institute for Sustainable Development, Winnipeg, Manitoba, Canada. https://www.iisd.org/library/cattails-harvesting-carbon-offsets-and-nutrient-capture-lake-friendly-greenhouse-gas-project
123. Grosshans, R., L. Grieger, J. Ackerman, S. Gauthier, K. Swystun, P. Gass, and D. Roy (2015). Cattail Biomass in a Watershed-Based Bioeconomy: Commercial-scale harvesting and processing for nutrient capture, biocarbon and high-value bioproducts. IISD Report. International Institute for Sustainable Development, Winnipeg, Manitoba, Canada. https://www.iisd.org/library/cattail-biomass-watershed-based-bioeconomy-commercial-scale-harvesting-and-processing
124. Gunnarsson, H., Ronnqvist, M. Lundgren, J. T. (2004). Supply chain modeling of forest fuel. Eur. J Oper Res; 158(1):103-23.
125. Hacker J. J. (2008) Effects of logging residue removal on forest site: a literature review. Prepared for the West Central Wisconsin BDO Zoneal Planning Commission.
126. Hamelinck, C.N., Suurs, R.A.A., Faaij, A.P.C. (2005). International bioenergy transport cost and energy balance. Biomass and Bioenergy 29 (2), 114e134.
127. Hannam, K. D., Venier, L., Allen, D., Deschamps, C., Hope, E., Jull, M., Kwiaton, M., McKenney, D., Rutherford, P. M., Hazlett, P.W., (2018) Wood ash as a soil amendment in Canadian forests: what are the barriers to utilization? *Canadian Journal for Forestry Research. 48: 1-9*;
128. Hansen, J. K., Nair, S. K., and Roni, M. (2017) Economic Analysis of Risk – WBS# 4.1.2.20. U.S. Department of Energy (DOE) Bioenergy Technologies Office (BETO). https://www.energy.gov/sites/prod/files/2017/05/f34/analysis_and_sustainability_hansen_4.1.2.20.pdf
129. Haque, M., Eppin, F. M., Biermacher, J. T., Holcomb, R. B., Kenkel, P. L. (2014). Marginal cost of delivering switchgrass feedstock and producing cellulosic ethanol at multiple biorefineries. Vol 66, July, 308-319. https://doi.org/10.1016/j.biombioe.2014.02.004.
130. Heaton, E. A., Dohleman, F. G., Long, S. P. (2008) Meeting US biofuel goals with less land: the potential of Miscanthus. Global Change biology 14(9): 2000-2014.
131. Hellwinckel, C., West, T.O., De la Torre Ugarte, D., Perlack, R. (2010). Evaluating possible cap and trade legislation on cellulosic feedstock availability. Global Change Biology Bioenergy 2, 278–287.
132. Helmers, G. A., Yamoah, C. F., Varvel, G. E. (2001). Separating the impacts of crop diversification and rotations on risk. Agronomy Journal, Vol 93, No. 6, 1337-1340. Doi: 10.2134/agronj2001.1227.
133. Henderson, J. E., Joshi, O., Parajuli, R., Hubbard, W. G. (2017) A BDO Zoneal assessment of wood resource sustainability and potential economic impact of the wood pellet market in the

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

U.S. South. Biomass and Bioenergy. (105) 10:421-427. https://doi.org/10.106/j.biombioe.2017.08.003.
134. Hernandez, M. A. and Torero, M. (2010) Examining the dynamic relationship between spot and future prices of agricultural commodities. International Food Policy Research Institute (IFPRI) Discussion Paper, 52 pages.
135. Hess, J.R., Wright, C.T., Kenney, K.L. (2007). Cellulosic biomass feedstocks and logistics for ethanol production. Biofuels, Bioproducts and Biorefining 1 (3), 181-190.
136. Hillman, M., Kentz, H. (2007). Managing risk in the supply chain - a quantitative study. *AMR Research,* January 2007. Available at http://www.scrlc.com/articles/AMR_Managing_Risk.pdf.
137. Hird, A., Kreiling, L. (2017). Expert judgement in resource forecasting: insights from the application of the Delphi method. Not published.
138. Ho, W., Zheng, T., Yildiz, H., Talluri, S. (2015). Supply chain risk management: a literature review. *International Journal of Production Research*, 53(16), 5031-5069.
139. Holtsmark, B. (2013). Quantifying the global warming potential of CO2 emissions from wood fuels. *GCB Bioenergy*. Vol. 2(2).
140. Hoque, M. M., Artz, G. M., Jarboe, D. H., Martens, B. J. (2015) Producer Participation in Biomass Markets: Farm Factors, Market Factors, and Correlated Choices. *Journal of Agricultural and Applied Economics*. 47(3). https://www.cambridge.org/core/journals/journal-of-agricultural-and-applied-economics/article/producer-participation-in-biomass-markets-farm-factors-market-factors-and-correlated-choices/07C72064547EEF4FEB16D1C559A56F06
141. Hornbeck, R., Kskin, P. (2011) The evolving impact of the Ogallala Aquifer: Agricultural adaptation to groundwater and climate. Working Paper 17625 https://www.nber.org/papers/w17625 National Bureau of Economic Research, Cambridge, MA.
142. Hosseini, S.A., Shah, N. (2011). Multi-scale process and supply chain modelling: from lignocellulosic feedstock to process and products. *Interface Focus*. Vol. 1: 255-262.
143. Huggard, D. Kremstater, L. (2007) Quantitative synthesis of rates for projecting deadwood in BC forests. *Technical Report. Forest Sciences Project # SO84000.*
144. Huusela-Veistola, E., Jauhiainen, L. (2006). Expansion of pea cropping increases the risk of pea moth (Cydia nigricana; Lep., Tortricidae) infestation. J. Applied Entomology. Vol 130, Issue 3, 142-149.
145. Hwang, S., Epplin, F. M., Lee, B., Huhnke, R. (2009) A probabilistic estimate of the frequency of mowing and baling days available in Oklahoma USA for the harvest of switchgrass for use in biorefineries. Biomass and Bioenergy. (33) 8:1037-1045. Doi.org/10.1016/j.biombioe.2009.03.003.
146. Jackson, T. J., Chen, D., Cosh, M., Li, F., Anderson, M., Walthall, C., Doriaswamy, P., Hunt, E. R. (2004) Vegetation water content mapping using Landsat data derived normalized difference water index for corn and soybeans. Remote Sensing of Environment. (92) 4:475-482. Doi.org/10.1016/j.rse.2003.10.021
147. Iakovou, E., Karagiannidis, A., Vlachos, D., Toka, A., Malamakis, A. (2010). Waste biomass-to-energy supply chain management: a critical synthesis. *Waste Management*, 30, 1860-1870.
148. ISO. (2009). ISO 31000: 2009. Risk management - principles and guidelines. Available at http://www.iso.org/iso/catalogue_detail?csnumber=43170
149. Jaffee, S., Siegel, P., and Andrews, C. (2010). Rapid agricultural supply chain risk assessment: A conceptual framework. Agriculture and Rural Development Discussion Paper 47. The International Bank for Reconstruction and Development/ The World Bank, Washington, DC.

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

150. Jager, H. I., Baskaran, L. M., Brandt, C. C., Davis, E. B. Gunderson, C. A., Wullschleger, S. D. (2010). Empirical geographic modeling of switchgrass yields in the United States. GCB Bioenergy (2010)2, 248-257. DOI: 10.1111/j.1757-1707.2010.010159. x.
151. James, N. A., Abt, R. C., Abt, K. L., Sheffield, R. M., and Cubbage, F. W. (2012). Forecasting sustainability: Growth to removal ratio dynamics. Moving from Status to Trends: Forest Inventory and Analysis Symposiym 2012. GTR-NRS-P-105, pp 54-58.
152. Jenkins, T. L. & Sutherland, J. W. (2013) A cost model for forest-based biofuel production and its application to optimal facility size determination. *Forest Policy and Economics.*
153. Jeong, J. H., Resop, J. P., Mueller, N. D., Fleisher, D. H., Yun, K., Butler, E. E., Timlin, D. J., Shim, K.-M., Gerber, J. S., Reddy, V. R., Kim, S.-H. (2016). Random forests for global and BDO Zoneal crop yield predictions. PLOS ONE, June 3, 2016. DOI: 10.1371/journal.pne.0156571.
154. Jiang, R., Wang, T.-T.-, Shao, J., Guo, W., Yu, Y.-J., Chen, S.-L., Hatano, R. (2017). Modeling the biomass of energy crops: descriptions, strengths, and perspective. J. of Integrative Agriculture, 16(6), 1197-1210.
155. Johnson, D.M., Jenkins, T.L., Zhang, F. (2012). Methods for optimally locating a forest biomass-to-biofuel facility. *Biofuels*. Vol. 3(4): 489-503.
156. Johnson, D. W., D. C. West, D. E. Todd, and L. K. Mann. (1982). Effects of sawlog vs whole-tree harvesting on the nitrogen, phosphorus, potassium, and calcium budgets of an upland mixed oak tree harvest. Soil Science Society of American Journal 46:1304-1309.
157. Johnson, D.W. and D.E. Todd. (1998). Harvesting effects on long-term changes in nutrient pools of mixed oak forests. Soil Science Society of America. 62: 1725-1735.
158. Johnson, D. W., Todd, D. E. (1987) Nutrient export by leaching and whole-tree harvesting in a loblolly pine and mixed oak forest. Plant and Soil (102) 1:99-109.
159. Jones, S. B., Meyer, P. A., Snowden-Swan L. J., Padmaperuma A. B., Tan, E., Dutta, A., Jacobson, J., Cafferty, K. (2013). Process design and economics for the conversion of lignocellulosic biomass to hydrocarbon fuels: fast pyrolysis and hydrotreating bio-oil pathway. Pacific Northwest National Laboratory (PNNL), Richland, WA (US); 2013.
160. Jorian, P. (2007) Value at risk: The new benchmark for managing financial risk. McGraw Hill, New York.
161. Joshi, C., De Leeuw, J. van Duren, I. C. (2004). Remote Sensing and GIS applications for mapping and spatial modeling of invasive species. Proceedings of ISPRS Vol 35, B7(7), Istanbul 669-677.
162. Judd, J.D., Sarin, S.C., Cundiff, J.S. (2012). Design, modeling, and analysis of feedstock logistics system. *Bioresource Technology*. Vol. 103: 209-218.
163. Junginger, M., Bolkesjø, T., Bradley, D., Dolzand, P., Faaija, A., Heinimö, J., Hektor, B., Leistad, Ø., Ling, E., Perry, M., Piacente, E., Rosillo-Calle, F., Ryckmans, Y., Schouwenberg, P.P., Solberg, B., Trømborg, E., da Silva Walter, A., de Wit, M. (2008). Developments in international bioenergy trade. Biomass and Bioenergy 32 (8), 717-729.
164. Jutsum, A. R., Heaney, S. P., Perrin, B. M., Wege, P. J. (1999). Pesticide resistance: assessment of risk and the development and implementation of effective management strategies. Pest Management Science. Special Issue: Current Research at Zeneca Agrochemicals, Vol 54, Issue 4, https://doi.org/10.1002/(SICI)1096-9063(199812)54:4<435::AID-PS844>3.0.CO;2-K.
165. Juttner, U., Peck, H., Christopher, M. (2003). Supply chain risk management: outlining an agenda for future research. International Journal of Logistics: Research and Applications, 6(4), 197-210.
166. Kaki, A., Salo, A., Talluri, S. (2015). Disruptions in supply networks: a probabilistic risk assessment approach. Journal of Business Logistics, 36(3), 273-287.

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

167. Kanzian, C., Hilzleitner, F., Stmpfer, K., Ashton, S. (2009). BDO Zoneal energy wood logistics-optimizing local food supply; 43(1):113-128.
168. Keiding, J. (1986). Prediction or resistance risk assessment. In Pesticide Resistance: Strategies and tactics for management. National Academic Press, Washington, D.C.
169. Kazemzadeh, N., Guiping, H. (2013). Optimization models for biorefinery supply chain network design under uncertainty. *Journal of Renewable and Sustainable Energy*. Vol. 5.
170. *Kenney, K. L., Smith, W. A., Gresham, G. L., and Westover, T. L. (2013). Understanding biomass feedstock variability. Biofuels, 4(1), 111-127.*
171. *Kershaw, H. M. D. M., Fleming, R. L., Luckai, N. J., (2015) Reconciling harvest intensity and biodiversity in boreal ecosystems: can intensification enhance understory plant diversity? Environmental Management. 56 (1091 – 1103).*
172. Khanna, M., Chen, X., Huang, H., & Onal, H. (2011). Supply of Cellulosic Biofuel Feedstocks and BDO Zoneal Production Pattern. *American Journal of Agricultural Economics*.
173. Kilubi, I., Haasis, H.-D. (2015). Supply chain risk management enablers – a framework development through systematic review of the literature from 2000 to 2015. International Journal of Business Science and Applied Management. Vol. 10(1): 35-54.
174. Kim, J., Realff, M.J., Lee, J.H., Whittaker, C., Furtner, L. (2011). Design of biomass processing network for biofuel production using an MILP model. *Biomass and Bioenergy*. Vol. 35: 853-871.
175. Kim, J., Realff, M.J., Lee, J.H. (2011). Optimal design and global sensitivity analysis of biomass supply chain networks for biofuels under uncertainty. *Computers and Chemical Engineering*, 35, 1738-1751.
176. Kizha, A.R., Han, H.-S. (2016). Processing and sorting forest residues: Cost, productivity and managerial impacts. *Biomass and Bioenergy*. Vol. 93: 97-106.
177. Knemeyer, A.M., Zinn, W., Eroglu, C. (2009). Proactive planning for catastrophic events in supply chains. *Journal of Operations Management*, 27, 141-153.
178. Koch, F. H., Yemshanov, D., McKenney, D. W., and Smith, D. W. (2009). Evaluating critical uncertainty thresholds in a spatial model of forest pest invasion risk. Risk Analysis, Vol 29, Issue 9, 1227-1241.
179. Krigstin, S., Wetzel, S., Jayabala, N., Helmeste, C., Madrali, S., Agnew, J., Volpe, S., (2018) Recent Health and Safety Incident Trends Related to the Storage of Woody Biomass: A Need for Improved Monitoring Strategies. *Forests. 9(538). ha*
180. Krupinsky, J. M., Bailey, K. L., McMullen, M. P., Gossen, B. D., and Turkington, T. K. (2002). Managing plant disease in diversified cropping systems. Agronomy J. 94:198-209.
181. Kumar, S., Himes, K.J., Kritzer, C.P. (2014). Risk assessment and operational approaches to managing risk in global supply chains. *Journal of Manufacturing Technology Management*, 25(6), 873-890.
182. Kumar, A., Sokhansanj, Flynn, P. C. (2006). Development of a multicriteria assessment model for ranking biomass feedstock collection and transportation systems. Applied Biochemistry and Biotechnology. Vol. 129-132
183. Lafond, G. P., Campbell, C. A., Lemke, R., May, W. E., & Holzapfel, C. B. (2012). Indian Head Long Term Crop Rotations: Indian Head Saskatchewan. *Prairie Soils and Crops Journal*, *5*, 42–50.
184. Lamers, P., Nhuyen, R. T., Hartley, D. S., Hansen, J. K., Searcy, E. M. (2018) Biomass market dynamics supporting the large-scale deployment of high-octane fuel production in the United States. GCB Bioenergy. 10(7):460-72.

ISBN 978-1-9991916-0-3

©2023 Ecostrat Inc

185. Lamers, P., Roni, M. S., Tumuluru, J. S., Jacobson, J. J., Cafferty, K. G., Hansen, J. K. (2015a) Techno-economic analysis of decentralized biomass processing depots. Bioresour Technol. 194:205-13.
186. Lamers, P., Tan, E. C. D., Searcy, E. M., Scarlata, C., Cafferty, K. G., Jacobson, J. J. (2015b) Strategic supply system design—a holistic evaluation of operational and production cost for a biorefinery supply chain. Biofuel Bioprod Bior. 9(6):648-60.
187. Langholtz, M., Graham, R., Eaton, L., Perlock, R., Hellwinkel, C., De La Torre Ugarte, D. G. (2012). Price projections of feedstocks for biofuels and biopower in the U.S. Energy Policy 41, 484-493.
188. Langholtz M., Eaton L., Davis, M., Hellwinckel C., Brant C. (2018) Biorefinery-specific feedstock price variability, Part 1: Corn stover. Manuscript In preparation.
189. Larson, J., Hellwinckel, C., English, B., De la Torre Ugarte, D., West, T.O., Menard, R. (2010). Economic and environmental impacts of the corn grain ethanol industry on the United States agricultural sector. Journal of Soil and Water Conservation 65, 12.
190. Lattimore, B., Smith, C. T., Titus, B., Stupak, I., Egnell, G. (2013) Woodfuel harvesting: A review of environmental risks, criteria and indicators, and certification standards for environmental sustainability. J. Sustainable Forestry. (32)1-2:58-88. https://doi.org/10.1080/10549811.2011.651785.
191. Lazarus, W. F. and Swanson, E. R. (1983). Insecticide use and crop rotation under risk: Rootworm control in corn. American Journal of Agricultural Economics. Vol 65, Issue 4, November, 738-747. https://doi.org/10.2307/1240462.
192. Leblon, B., Alexander, M., Chen, J., White, S. (2001) Monitoring fire danger of northern boreal forests with NOAA-AVHRR NDVI images. Intl. J. Remote Sensing, 22:14, 2839-2846. https://doi.org/10.1080/01431160121183.
193. Lee, J., Morrison, I. K., Leblanc, J.-D., Dumas, M. T., Cameron, D. A. (2002) Carbon sequestration in trees and regrowth vegetation as affected by clearcut and partial cut harvesting in a second-growth boreal mixedwood. *Forest Ecology and Management* 169: 83–101
194. Lee, E., Bisson, J. A., & Han, H. (2017). Evaluating the production cost and quality of feedstock produced by a sawdust machine. Biomass and Bioenergy, 104, 53-60.
195. Lieberman, M.B., Montgomery, D.B. (1988). First-mover advantages. *Strategic Management Journal*, 9(SI), 41-58.
196. Lin, T., Rodriguez, L.F., Shastri, Y.N., Hansen, A.C., Ting, K.C. (2013). GIS-enabled biomass-ethanol supply chain optimization: model development and Miscanthus application. *Biofuels, Bioproducts & Biorefining.*
197. Lin, T., Rodriguez, L.F., Shastri, Y.N., Hansen, A.C., Ting, K.C. (2014). Integrated strategic and tactical biomass-biofuel supply chain optimization. *Bioresource Technology*. Vol. 156: 256-266.
198. Lin, T., Rodriguez, L.F., Davis, S., Khanna, M., Shastri, Y., Grift, T., Long, S., Ting, K.C. (2016). Biomass feedstock preprocessing and long-distance transportation logistics. *GCB Bioenergy*. Vol. 8: 160-170.
199. Lin, W., Westcott, P., Skinner, R., Sanford, S., De la Torre Ugarte, D. (2000). Supply Response under the 1996 Farm Act and Implications for the U.S. Field Crops Sector. Market and Trade Economics Division, Economic Research Service, United States Department of Agriculture, Washington, DC.
200. Lindblad, M. (2001). Development and evaluation of a logistic risk model: Predicting fruit fly infestation in oats. Ecological Applications, Vol 11, Issue 5, 1563-1572.

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

201. Lippitt, C. D., Rogan, J., Toledano, J., Sngermano, F., Eastman, J. R., Mastro, V., Sawyer, A. (2008). Incorporating anthropogenic variables into a species distribution model to map gypsy moth risk. Ecological Modeling, Vol 210, Issue 2, 339-350.
202. Lockamy III, A. (2011). Benchmarking supplier risks using Bayesian networks. *Benchmarking: An International Journal*, 18(3), 409-427.
203. Lowitt, E. (2013). The collaboration economy: *How to meet business, social, and environmental needs and gain competitive advantage*. Hoboken, NJ: Wiley.
204. Luppold, W. (2014). Avoiding spurious conclusions from forest service estimates of timber volume, growth, removal, and mortality. Northern Journal of Applied Forestry (NJAF) 21(4) 2004, 194-199.
205. MacKechnie, J., Colombo, S., Chen, J., Mabee, W., MacLean, H. (2011). Forest bioenergy or forest carbon? Assessing trade-offs in greenhouse gas mitigation with wood-based fuels. *Environmental Science & Technology*, 45: 789-795.
206. Madsen, K., Bentsen, N.S. (2018). Carbon debt payback time for a biomass fired CHP plant – A case study from Northern Europe. Energies. Vol. 11(4), 807.
207. Mafakheri, F., Nasiri, F. (2014). Modeling of biomass-to-energy supply chain operations: Applications, challenges and research directions. *Energy Policy*. Vol. 67: 116-126.
208. Maheshwari, P., Singla, S., Shastri, Y. (2017) Resiliency optimization of biomass to biofuel supply chain incorporating BDO Zoneal biomass pre-processing depots. Biomass and Bioenergy. (97)2: 116-131.
209. Maki, M., Ishiahra, M., Tamura, M. (2004) Estimation of leaf water status to monitor the risk of forest fires by using remotely sensed data. Remote Sensing od Environment. 90(4) 441-450. https://doi.org/10.1016/j.rse.2004.02.002.
210. Mann, L.K., D.W. Johnson, D.C. West, D.W. Cole, J.W. Hornbeck, C.W. Martin, H. Riekerk, C.T. Smith, W.T. Swank, L.M. Tritton and D.H. VanLear. (1988). Effects of whole-tree and stem-only clearcutting on postharvest hydrologic losses, nutrient capital, and regrowth. Forest Science. 34: 412-428.
211. Mansuy, N., Barrette, J., Laganière, J., Mabee, W., Paré, D., Gautam, S., Thiffault, E., Ghafghazi, S. (2017) Estimating the spatial distribution and locating hotspots of forest biomass from harvest residues and fire-damaged stands in Canada's managed forests. *Biomass and Bioenergy. 97: 90-99.*
212. Mansuy, N. Thiffault, E., Lemieux, S., Manka, F., Pare, D., Lebel, L. (2015) Sustainable biomass supply chains from salvage logging of fire-killed standsL A case study for wood pellet production in eastern Canada. Applied Energy. (154) 9:62-73. https://doi.org/10.1016/j.apenergy.2015.04.048.
213. Marinescu, M. (2018) Guide to Developing a Science-Based Biomass Quality Control Program. *FPInnovations. Technical report no. 42*
214. Marinescu, M. (2016) Sustainability Impact Assessment of Electricity Generation from Logging Residues in British Columbia Canada and in Finland. *FPInnovations.*
215. Marinescu, M. (2013) Critical biomass attributes of the most common bioenergy and biofuel applications. FPInnovations. (14)3. https://fpinnovations.ca/Extranet/Pages/AssetDetails.aspx?item=/Extranet/Assets/ResearchReportsFO/ADV14N3.PDF#.XIa0tYhKjIU
216. Marinescu, M. & Rittich, C. (2013) Emission reduction and carbon credit methodologies in forest operations: a primer. *FPInnovations 13(10).*;
217. Marinescu, M., Volpé, S., Desrochers, L., Röser, D., (2015) Basic procedures for sampling and analyzing woody biomass. *FPInnovations. Advantage report 15(5).*

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

218. Marvin, W.A., Schmidt, L.D., Benjaafar, S., Tiffany, D.G., Daoutidis, P. (2012). Economic optimization of a lignocellulosic biomass-to-ethanol supply chain. *Chemical Engineering Science*. Vol. 67: 68-79.
219. Maselli, F., Romanelli, S., Bottai, L., Zipoli, G. (2003) Use of NOAA-AVHRR NDVI images for the estimation of dynamic fire risk in Mediterranean areas. Remote Sensing of Environment. 86(2)187-197. https://doi.org/10.1016/S0034-4257(03)00099-3.
220. Matook, S., Lasch, R., Tamaschke, R. (2009). Supplier development with benchmarking as part of a comprehensive supplier risk management framework. *International Journal of Operations & Production Management,* 29(3), 241-267.
221. Mbow, C., Goita, K. Benie, G. B. (2004) Spectral indices and fire behavior simulation for fire risk assessment in savanna ecosystems. Remote Sensing of Environment. 91(1)1-13. https://doi.org/10.1016/j.rse.2003.10.019.
222. MacLeod, A., Evans, H. F., Baker, R. H. A. (2002). An analysis of pest risk from an Asian longhorn beetle (*Anoplophora glabripennis*) to hardwood trees in the European community. Crop Protection, Vol 21, Issue 8, 635-645.
223. McDermott, C. L., Cashore, B., Kanowski, P. (2010). Global Environmental Forest Policies – An International Comparison. Earthscan Publishing. London, Washington DC.
224. McGill, J., Darr, M. (2014). Fire risk in corn stover storage. In Corn Stover Harvest, Iowa State University Extension and Outreach publication, PM 305 IF, January.
225. McGuire, J. B. Leahy, J. E., Marciano, R. J., Lilieholm, R. J., Teisi, M. F. (2017) Social acceptability of establishing forest-based biorefineries in Maine, United States. Biomass and Bioenergy. (105)10: 155-163.
226. Meixell, M. J., Gargeya, V. B. (2005). Global supply chain design: a literature review and critique. Transp. Res., Part E: Logist. Transp. Rev. 41(6):431-550.
227. Mele, F.D., Kostin, A.M., Guillen-Gosalbez, G., Jimenez, L. (2011). Multi-objective model for sustainable fuel supply chains. A case study of the sugar cane industry in Argentina. *Industrial & Engineering Chemistry Research*. Vol. 50: 4939 – 4958.
228. Meziere, D., Lucas, P., Granger, S., Colbach, N. (2013). Does integrated weed management affect the risk of crop diseases? A simulation case study with blackgrass weed and take-all disease. European J Agronomy, Vol 47, May, 33-43. https://doi.org/10.1016/j.eja.2013.01.007.
229. Miao, Z., Grift, T. E., Hansen, A. C., Ting, K. C. (2013). An overview of lignocellulosic biomass feedstock harvest, processing and supply for biofuel production. Biofuels 4(1), 5-8.
230. Miao, Z., Shastri, Y., Grift, T. E., Hansen, A. C. Ting, K. C. (2012) Lignocellulosic biomass feedstock transportation alternatives, logistics, equipment configurations, and modeling. Biofuels, Bioproducts & Biorefining, (6)3:351-362.
231. Min, H., Zhou, G. (2002). Supply chain modeling: past, present, and future. Computer Industry Engineering. 43(1-2):231-249.
232. Mississippi's BMPs. (2008). Best Management Practices for Forestry in Mississippi. Mississippi Forestry Commissions Best Management Practices Handbook, September 2008.
233. Mitchell, R. B., Schmer, M. R., Anderson, W. F., Jin, V., Blakcom, K. S., Kiniry, J. 2016. Dedicated Energy Crops and Crop Residues for Bioenergy Feedstocks in the Central and Eastern USA. Bioenerg. Res. 9:384-398. DOI 10.1007/s12155-016-9734-2.
234. Mobini, M., Sowlati, T., Sokhansanj, S. (2011) Forest biomass supply logistics for a power plant using the discrete-event simulation approach. *Applied Energy*. Vol. 88: 1241-1250.
235. Mobini, M., Sowlati, T., Sokhansanj, S. (2013) A simulation model for the design and analysis of wood pellet supply chains. *Applied Energy*. Vol. 111: 1239-1249.

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

236. Montgomery, T.D., Han, H.-S., Kizha, A.R. (2016). Modeling work plan logistics for centralized biomass recovery operations in mountainous terrain. *Biomass and Bioenergy*. Vol. 85: 262-270.
237. Moody's (2003). Moody's approach to rating the petroleum industry. https://www.scribd.com/document/254765990/Moody-s-approach-to-rating-the-petroleum-industry-2003-pdf
238. Moody's (2004). Risk management assessments. https://www.moodys.com/sites/products/AboutMoodysRatingsAttachments/2002900000432768.pdf
239. Moody's (2005). Global independent refining and marketing industry. http://sbufaculty.tcu.edu/mann/_Inv%20II%20F09/Moodys%20Refining%20Rating%20methodology%20-%20October%202005.pdf
240. Moody's (2014). Waste-to-energy projects rating methodology.
241. Mooney, D. F., Larson, J. A., English, B. C., Tyler, D. D. (2012). Effect of dry matter loss on profitability of outdoor storage of switchgrass. Biomass and Bioenergy. Biomass and Bioenergy. (44) 9:33-41. https://doi.org/10.1016/biombioe.2012.04.008.
242. Moroni, M. T., Morris, D. M., Shaw, C., Stokland, J. N., Harmon, M. E., Fenton, N. J., Merganicova, K., Merganic, J., Okabe, K., Hagemann, U., (2015) Buried Wood: A Common Yet Poorly Documented Form of Deadwood. Ecosystems 18: 605-628.
243. Mroz, G. D., Jurgensen, M. F., Frederick, D. J. (1985) Soil nutrient changes following whole tree harvesting on three northern hardwood sites. Soil Science Society of America Journal. (49) 6: 1552-1557.
244. Musa, S.N. (2012). *Supply chain risk management: identification, evaluation and mitigation techniques.* Dissertation No. 1459, Linkopeg Studies in Science and Technology. Linkoping University, Sweden, June 2012.
245. Muth, D. J., Jr., McCorkle, D. S., Koch, J. B., Bryden, K. M. (2012) Modeling sustainable agricultural residue removal at the subfield scale. Agron. J. 104: 970-981. Doi: 10.2134/agronj2012.0024.
246. Nair, S. K., Griffel, M. L., Hartley, D. S., McNunn, G., and Kunz, R. (2018a). Investigating the efficacy of integrating energy crops into non-profitable subfields in Iowa. Manuscript accepted for publication in *Bioenergy Research*, June 2018, DOI: 10.1007/s12155-018-9925-0.
247. Nair, S. K., Griffel, L., M., Hartley, D. S., McNunn, G. S., and Kunz, M. R. (2018b). Integration of Energy Crops into Corn and Soybean Subfields in Kansas to Increase Biomass Production. Submitted to *Energy Sustainability, and Society*, August 2018.
248. Nair, S. K., Hartley, D. S., Gardner, T. A., McNunn, G., and Searcy, E. M. (2017). An integrated landscape management approach to sustainable bioenergy production. *BioEnergy Research*. 10(3), 929-948, doi 10.1007/s12155-017-9854-3.
249. Narasimhan, R., Talluri, S. (2009). Perspectives on risk management in supply chains. *Journal of Operations Management*, 27, 114-118.
250. Negri, C., Nair, S., Ovard, L., and Jager, H. Editors. (2018). Bioenergy Solutions to Gulf Hypoxia, Workshop Summary Report. Joint Argonne, Idaho, and Oak Ridge National Laboratory Report. ANL-18/09, INL/EXT-18-45338. August 2018.
251. Negri, M.C. and H. Ssegane (2016). Bioenergy crops: delivering more than energy. In "Commercializing Biobased Products". S. Snyder, Editor, Royal Society of Chemistry, Cambridge, UK.
252. Neiger, D., Rotaru, K., Churilov, L. (2009). Supply chain risk identification with value-focused process engineering. *Journal of Operations Management*, 27, 154-168.

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

253. Newlands, N., Townley-Smith, L. (2010). Predicting energy crop yields using Bayesian networks. Proceedings of the 5th IASTED International Conference in Computational Intelligence (CI 2010), Maui, HI, USA. https://www.actapress.com/Abstract.aspx?paperId=43006.
254. Nganje, W. E., Bangsund, D. A., Leistritz, F. L., Wilson, W. W., Tiapo,, N. M. (2002). Estimating the economic impact of a crop disease: The case of fusarium head blight in U.S. wheat and barley. 2002 National Fusarium Head Blight Forum Proceedings, Holiday Inn Cincinnati-Airport, Estimating the economic impact of Erlanger, KY, December 7-9, 2002.
255. Nielsen, T. T., Rasmussen, K. (2001) Utilization of NOAA AVHRR for assessing the determinants of savanna fire distribution in Burkina Faso. Intl. J. Wildland Fire. 10(2)129-135.
256. Nishizono, T., Iehara, T., Kuboyama, H., Fukuda, M. (2005) A forest biomass yield table based on an empirical model. Journal of Forest Research. 10 (211-220).
257. Oakley, J. N., Cumbleton, P. C., Corbett, S. J., Saunderst, P., Green, D. I., Young, J. E. B., Rodgers, R. (1998). Prediction of orange wheat blossom midge activity and risk of damage. Crop Protection, Vol 17, Issue 2, 145-149. https://doi.org/10.1016/S0261-2194(97)00097-5.
258. Okwo, A., Thomas, V. M. (2014) Biomass feedstock contracts: Role of land quality and yield variability in near term feasibility. Energy Economics, (42)C-67-80.
259. Olsson, O., Eriksson, A., Sjostrom, J., Anerud, E. (2016). Keep that fire burning: Fuel supply risk management strategies of Swedish district heating plants and implications for energy security. *Biomass and Bioenergy*. Vol. 90: 70-77.
260. Osmani, A., Zhang, J. (2013). Stochastic optimization of a multi-feedstock lignocellulosic-based bioethanol supply chain under multiple uncertainties. *Energy*. Vol. 59: 157-172.
261. Osmani, A., Zhang, J. (2014). Economic and environmental optimization of a large scale sustainable dual feedstock lignocellulosic-based bioethanol supply chain in a stochastic environment. *Applied Energy*. Vol. 114: 572-587.
262. Osmani, A, Zhang, J. (2014). Optimal grid design and logistic planning for wind and biomass based renewable electricity supply chains under uncertainties. *Energy*. Vol. 70: 514-528.
263. Overbeck, M., Schmidt, M. (2012). Modeling infestation risk of Norway spruce by *Ips typographus* (L.) in the Lower Saxon Harz Mountains (Germany). Forest Ecology and Management, Vol 266, 15 February, 115-125.
264. Palander, T., Vesa, L. (2009). Integrated procurement planning for supplying energy plant with forest, fossil, and wood-waste fuels. *Biosystems Engineering*. Vol. 103: 409-416.
265. Paolotti, L., Martino, G., Marchini, A., Boggia, A. (2017). Economic and environmental assessment of agro-energy wood biomass supply chains. Biomass and Bioenergy. Vol. 97: 172-185.
266. Parker, W. E. and Seeny, F. M. (2008). An investigation into the use of multiple site characteristics to predict the presence and infestation level of wireworms (*Agriotes* sup., Coleoptera: Elateridae) in individual grass fields. Annals Applied Biology, Vol 130, Issue 3, 409-425.
267. Pathak, S. (2016) Benchmarking supplier network collaboration. Journal of Supply Chain Management Systems, Vol 5, Issue 1. http://www.publishingindia.com/jscms/41/benchmarking-supplier-network-collaboration/460/3289/
268. Paulo, H., Azcue, X., Barbosa-Povoa, A.P., Relvas, S. (2015). Supply chain optimization of residual forestry biomass for bioenergy production: The case study of Portugal. *Biomass and Bioenergy*. Vol. 83: 245-256.

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

269. Perpina, C., Alfonso, D., Perez-Navarro, A., Penalvo, E., Vargas, C., Cardenas, R. (2009). Methodology based on Geographic Information Systems for biomass logistics and transport optimization. *Renewable Energy*. Vol. 34: 555-565.
270. Phys-Org. (2017). County-by-county variability in bioenergy crop yields in the US. in January 20, 2017 issue of Phys-Org, Pacific Northwest Laboratory. https://phys.org/news/2017-01-county-by-county-variability-bioenergy-crop-yields.html, last accessed on April 26, 2018.
271. PNNL (Pacific Northwest National Laboratory). (2017). Climate, irrigation, and fertilization: Understanding US Crop Yields. In Atmospheric Sciences and Global Change Research Highlights, January 2017. https://www.pnnl.gov/science/highlights/highlight.asp?id=4519. Last accessed on April 26, 2018.
272. Primot, S., Vakantin-Morison, M., Makowski, D. (2006). Predicting the risk of weed infestation in winter oilseed rape crops. Weed Research, Vol 46, Issue 1, 22-33.
273. Pugliese, S., Jones, T., Preston, M. D., Hazlett, P., Tran, H., Basiliko, N., (2014) Wood ash as a forest soil amendment: The role of boiler and soil type on soil property response. *Canadian Journal of Soil Science. 94(5).*
274. Pyne, S. J., Andrews, p. L., Laven, R. D. (1996) Introduction to wildland fire. 2nd Edition, Wiley, New York.
275. Rabotyagov, S., Lin, S. (2013) Small Forest landowner preferences for working forest conservation contract attributes: A case of Washington State, USA. J. Forest Economics, (19)3:307-330.
276. Radha, K., Balakrishnan, S. (2017) The role of commodity futures in risk management: A study of select agricultural commodities. IUP J Financial Risk Management. (14) 4:7-29.
277. Rajesh, R., Ravi, V. (2015). Supplier selection in resilient supply chains: a grey relational analysis approach. *Journal of Cleaner Production*, 86, 343-359.
278. Ralevic, P. (2013) Evaluating the greenhouse gas mitigation potential and cost-competitiveness of forest bioenergy systems in Northeastern Ontario. Doctor of Philosophy. University of Toronto.
279. Ralevic, P., Ryans, M., Cormier, D. (2010). Assessing forest biomass for bioenergy: Operational challenges and cost considerations. The Forestry Chronicle, Vol. 86(1).
280. Rauch, P., Gronalt, M. (2011). The effects of rising energy costs and transportation mode mix on forest fuel procurement costs. Biomass Bioenergy 35(1):690-9.
281. Ray, D., De la Torre Ugarte, D., Dicks, M., Tiller, K. (1998). The POLYSYS Modeling Framework: A Documentation. Agricultural Policy Analysis Center, University of Tennessee, Knoxville, TN.
282. Reed, W. J., Errico, D. (1987). Techniques for assessing the effects of pest hazards on long-run timber supply. Canadian J Forest Research, 17(11): 1455-1465. https://doi.org/10.1139/x870224.
283. RENOVETEC (2011). Biomass Plants Courses. Course Catalogue. Accessed August 8, 2018: http://www.renovetec.com/trainingcourses/biomassplantscourses.html
284. Rentizelas, A.A., Tatsiopoulos, I.P., Tolis, A. (2009a). An optimization model for multi-biomass tri-generation energy supply. Biomass and Bioenergy 33 (2), 223-233.
285. Rentizelas, A.A., Tolis, A.J., Tatsiopoulos, I.P. (2009b). Logistics issues of biomass: The storage problem and the multi-biomass supply chain. *Renewable and Sustainable Energy Reviews*. Vol. 13: 887-894.
286. Rentizelas, A.A., Tatsiopoulos, I.P. (2010). Locating a bioenergy facility using a hybrid optimization method. *International Journal of Production Economics*. Vol. 123: 196-209.
287. Rentizelas, A.A., Tolis, A.I., Tatsiopoulos, I.P. (2014). Optimization and investment analysis of two biomass-to-heat supply chain structures. *Biosystems Engineering*. Vol. 120: 81-91.

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

288. Richey, C. B. Liljedahl, J. B., Lechtenberg, V. L. (1982). Corn stover harvest for energy production. Transactions of the ASAE. 25:834-839.
289. Ritchie, B., Brindley, C. (2007). Supply chain risk management and performance. A guiding framework for future development. *International Journal of Operations & Production Management*, 27(3), 303-322.
290. Roach, K. & Berch, M., (2014) A Compilation of Forest Biomass Harvesting and Related Policy in Canada. *B.C., Victoria, B.C. Tech. Rep. 081.* www.for.gov.bc.ca/hfd/pubs/Docs/Tr/Tr081.htm
291. Robertson, C., Wulder, M. A., Nelson, T. A., White, J. C. (2008). Risk Rating for mountain pine beetle infestation of lodgepole pine forests over large areas with ordinal regression modeling. Forest Ecology and Management, Vol 256, Issue 5, 900-912.
292. Roni, M., Eksioglu, S., Searcy, E., Jacobson, J., (2014a) Estimating the variable cost for high-volume and long-haul transportation of densified biomass and biofuel. Transportation Research Part D: Transport and Environment 29, 40-55.
293. Roni, M., Eksioglu, S., Searcy, E. (2014b) A supply chain network design model for biomass cofiring in coal-fired in power plants. Transportation Research Part E: Logistics and Transportation Review 61, 115-134.
294. RSB. (2016) Roundtable on Sustainable Biomaterials. http://rsb.org/wp-content/uploads/2017/04/RSB-STD-01-001_Principles_and_Criteria-DIGITAL.pdf
295. Rusch, A., Valantin-Morison, M., Roger-Estrade, J. Sarthou, J. P. (2012). Using landscape indicators to predict high pest infestations and successful natural pest control at the BDO Zoneal scale. Landscape and Urban Planning, 105, 62-73.
296. Russell, M. B., Kilgore, M. A., Blinn, C. R. (2017) Characterizing timber salvage operations on public forests in Minnesota and Wisconsin, USA. Intl J Forest Engg. (28) 1:66-72. https://doi.org/10.1080/14942119.2017.1291064.
297. Ruth, R.H. and A.S. Harris. (1975). Forest residues in hemlock/spruce forests of the Pacific Northwest and Alaska: a state-of-knowledge review with recommendations for residue management. USDA Forest Service. Gen. Tech. Rpt. PNW-GTR-39.
298. Saglam, B., Bilgili, E., Dincdurmaz, B., Kasiogullari, A. I., Kucuk, O. (2008). Spatio-temporal analysis of forest fire and danger using LANDSAT imagery. Sensors, v. 8(6): 3970-3987. doi: 10.339D/s8063970.
299. Samseemoung, G., Soni, P., Jayasuriya, H. P. W., Salokhe, V. M. (2012). Application of low altitude remote sensing (LARS) platform for monitoring crop growth and weed infestation in a soybean plantation. Precision Agriculture, Vol 13, Issue 6, 611-627. https://doi.org/10.1007/s11119-012-9271-8.
300. Sannier, C. A. D., Taylor, J. C., du Plessis, W. (2010) Real-time monitoring of vegetation biomass with NOAA-AVHRR in Etosha National Park, Namibia, for fire risk assessment. Intl. J. Remote Sensing. 23(1) 71-89. https://doi.org.10.1080/01431160010006863.
301. Santibanez-Aguilar, J.E., Guillen-Gosalbez, G., Morales-Rodriguez, R., Jimenez-Esteller, L., Castro-Montoya, A.J., Ponce-Ortega, J.M. (2016). Financial risk assessment and optimal planning of biofuels supply chains under uncertainty. Bioenergy Resources. Vol. 9: 1053-1069.
302. Sarmiento, A. M., Nagit, R. 1999. A review of integrated analysis of production-distribution system. IEEE Trans. (31): 1061-1074.
303. Scott, J., Ho, W., Dey, P.K., Talluri, S. (2015). A decision support system for supplier selection and order allocation in stochastic, multi-stakeholder and multi-criteria environments. *International Journal of Production Economics*, 166, 226-237.
304. Scott, J. H., Thompson, M. P., Calkin, D. E. (2013). A wildfire risk assessment framework for land and resource management. Gen. Tech. Rep. RMRS-GTR-315. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 83 p.

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

305. Scott, J.A., Ho, W., Dey, P.K. (2012). A review of multi-criteria decision-making methods for bioenergy systems. *Energy.* Vol. 42: 146-156.
306. Searcy, E., Flynn, P., Ghafoori, E., Kumar, A. (2007). The relative cost of biomass energy transport. *Applied Biochemistry and Biotechnology*. Vol. 136-140: 639-652.
307. Seay, J.R., Badurdeen, F.F. (2014). Current trends and directions in achieving sustainability in the biofuel and bioenergy supply chain. *Current Opinion in Chemical Engineering*, 6, 55-60.
308. Sesmero, J., Sun, X. (2016). The influence of feedstock supply risk on location of stover-based bio-gasoline plants. *GCB Bioenergy*. Vol. 8: 495-508.
309. Shabani, N., Sowlati, T., Ouhimmou, M., Ronnqvist, M. (2014). Tactical supply chain planning for a forest biomass power plant under supply uncertainty. *Energy*, 78, 346-355.
310. Shabani, N., Akhtari, S., Sowlati, T. (2013). Value chain optimization of forest biomass for bioenergy production: a review. Renew Sustain Energy Rev 23:239-311.
311. Shah, A., Datt, M. J., Webster, K. Hoffman, C. (2011) Outdoor storage characteristics of single-pass large square corn stover bales in Iowa. Energies 4(10, 1687-1695. https://doi.org/10.3390/en4101687.
312. Shahriari, K., Hessami, A.G., Jadidi, A., Lehoux, N. (2015). An approach toward a conceptual collaborative framework based on a case study in a wood supply chain. *IEEE Systems Journal*, 9(4), 1163-1172.
313. Sheffi, Y., Rice, J.B. (2005). A supply chain view of resilient enterprise. MIT Sloan Management Review, 47(1), 40-48.
314. Shinners, K. J., Binversie, B. N., Muck, R. E., Weimer, P. J. (2007). Comparison of wet and dry corn stover harvest and storage. Biomass and Bioenergy, 31:211-221.
315. Sidders, D., Joss, B., Keddy, T., (2008) Biomass Inventory and Mapping Assessment Tool (BIMAT) The Woody Biomass Inventory and Woody Biomass Information Portal. Natural Resources Canada. Project TID8 25B.
316. Silbermayr, L, Minner, S. (2014). A multiple sourcing inventory model under disruption risk. *International Journal of Production Economics,* 149, 37-46.
317. Sikkema, R., Junginger, M., van Dam, J., Stegeman, G., Durrant, D., and Faaij, A. (2014). Legal harvesting, sustainable sourcing and cascaded use of wood for bioenergy: Their coverage through existing certification frameworks for sustainable forest management. Forest 5(9), 2163-2211, doi: 10.3390/f5092163.
318. Sims, R.E.H., Venturi, P. (2004). All-year-round harvesting of short rotation coppice eucalyptus compared with the delivered costs of biomass from more conventional short season, harvesting systems. Biomass and Bioenergy 26 (1), 27-37.
319. Skees, J. R. (1999). Agricultural risk management or income enhancement? Regulation, V22 (1) 35-43.
320. Smith, A. M. S., Wooster, M. J., Drake, N. A., Dipotso, F. M., Falkowski, M. J., Hudak, A. T. (2005) Testing the potential of multi-spectral remote sensing for retrospectively estimating fire severity in African Savannahs. Remote Sensing of Environment. 97(1) 92-115. https://doi.org/10.1016/j.rse.2005.04.014.
321. Smith, C. T. (1985). Literature review and approaches to studying impacts of forest harvesting and residue management practices on forest nutrient cycles. Miscellaneous Report, Maine Agri. Expt. Station No. 305.
322. Smith, C. T., Lattimore, B., Berndes, G., Bentsen, N. S., Dimitriou, I., Langeveld, J.W.A., Thiffault, E., (2016) Opportunities to encourage mobilization of sustainable bioenergy supply chains. *WIREs Energy and Environment. 6(3).*

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

323. Smyth, C., Kurz, W. A., Rampley, G., Lemprière, T. C., Schwab, O. (2017) Climate change mitigation potential of local use of harvest residues for bioenergy in Canada. *Global Change Biology Bioenergy. 9: 817-832.*
324. Sodhi, M.S., Lee, S. (2007). An analysis of sources of risk in the consumer electronics industry. *The Journal of The Operational Research Society*, 58(11), 1430-1439.
325. Sodhi, M.S., Tang, C.S. (2012). *Managing Supply Chain Risk.* International Series in Operations Research & Management Science 172. Springer Science+Business Media.
326. Spencer, S. (2016) Best Management Practices for Integrated Harvest Operations in British Columbia. *FPInnovations. https://fpinnovations.ca/ResearchProgram/forest-operations/fibre-supply/Documents/integrated-harvest-operations-in-bc.PDF*
327. Springer, N., Kaliyan, N., Bobick, B., Hill, J. (2017) Seeing the forest for the trees: How much woody biomass can the Midwest United States sustainably produce? Biomass and Bioenergy. (105)10: 266-277.
328. SRTS. 2018. Sub-BDO Zoneal Timber Supply (SRTS) Model. Southern Forest Resource Assessment Consortium. https://research.cnr.ncsu.edu/sofac/srts.html, last accessed 09/04/2018.
329. Ssegane, H., C. Zumpf, M.C. Negri, P. Campbell, J. Heavey, and T.A. Volk (2016). The Economics of Growing Shrub Willow as a Bioenergy Buffer on Agricultural Fields. A case study in the Midwest Corn Belt. Biofuels, Bioproductsand Biorefining. DOI: 10:1002/bbb.1679.
330. Ssegane, H. and M.C. Negri (2016). An Integrated Landscape Designed for Commodity and Bioenergy Crops in a Tile-Drained Agricultural Watershed**.** Journal of Environmental Quality, published May 31, 2016, DOI:10.2134/jeq2015.10.0518.
331. Ssegane, H., M.C. Negri, J. Quinn, M. Urgun Demirtas (2015). Field scale design of multifunctional landscapes for food, bioenergy and ecosystem services*.* Biomass and Bioenergy 80, 179-190.
332. Stadelman, G., Bugmann, H., Wermelinger, B., Bigler, C. (2014). Spatial interactions between storm damage and subsequent infestations by the European spruce bark beetle. Forest Ecology and Management, Vol 318, 15 April, 167-174.
333. Stadelmann, G., Bugman, H., Wermelinger, B., Meier, F., Bigler, C. (2013). A predictive framework to assess spatio-temporal variability of infestations by the European spruce bark beetle. Ecography, Pattern and Process in Ecology, Vol 36, Issue 11, 1208-1217.
334. Stanaway, M. A., Zalucki, M. P., Gillespie, P. S., Rodriguez, C. M., Maynard, G. V. (2001). Pest risk assessment of insects in sea cargo containers. Vol. 40, Issue 2, 180-192.
335. Stasko, T. H., Conrado, R. J., Wankerl, A., Labatut,. R., Tasseff, R., Mannion, J. T., Gao, H. O., Sanborn, S. D., Knott, G. (2011). Mapping woody-biomass supply costs using forest inventory and competing industry data. Biomass and Bioenergy. Vol 35, Issue 1, January 2011, pp 263-271.
336. Stecke, K. E. and Kumar, S. (2006). Sources of supply chain disruptions, factors that breed vulnerability, and mitigating strategies. J. Marketing Channels, V16, 3, 193-226.Swafford, P.M., Ghosh, S., Murthy, N., 2006. The antecedents of supply chain agility of a firm: scale development and model testing. *Journal of Operations Management*, 24, 170-188.
337. Steiner, J. J., Lewis, K. C., Baumes, H. S., Brown, N. L. (2012) A feedstock readiness level tool to complement the aviation industry fuel readiness level tool. Bioenergy Research. (5) 2:492-503. DOI 10.1007/s12155-012-9187-1.
338. Stupak, I. & Smith, C. T., (2018) Feasibility of verifying sustainable forest management principles for secondary feedstock to produce wood pellets for co-generation of electricity in

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

the Netherlands. *IEA Bioenergy*. http://task43.ieabioenergy.com/wp-content/uploads/2018/04/TR2018-01.pdf
339. Suadicani, K. and C. Gamborg. (1999). Fuel quality of whole-tree chips from freshly felled and summer dried Norway spruce on a poor sandy soil and a rich loamy soil. Biomass and Bioenergy. 17: 3, 199-208.
340. Talluri, S., Kull, T.J., Yildiz, H., Yoon, J. (2013). Assessing the efficiency of risk mitigation strategies in supply chains. *Journal of Business Logistics*, 34(4), 253-269.
341. Tang, O., Musa, S.N. (2011). Identifying risk issues and research advancements in supply chain risk management. *International Journal of Production Economics*, 133, 25-34.
342. Tang, C., Tomlin, B. (2008). The power of flexibility for mitigating supply chain risks. *International Journal of Production Economics*, 116, 12-27.
343. Ter-Mikaelian, M.T., Colombo, S. J., Chen, J. (2015) The Burning Question: Does Forest Bioenergy Reduce Carbon Emissions? A Review of Common Misconceptions about Forest Carbon Accounting. *Journal of Forestry. 113(1):57-68.*
344. Texas Forest Service. (2006). Forest Inventory & Analysis Factsheet East Texas 2003.
345. Thiffault, E., Barrette, J., Pare, D., Titus, B. D., Keys, K., Morris, D. M., Hope, G. (2014) Developing and validating indicators of site suitability for forest harvesting residue removal. Ecological Indicators. (43) 8:1-18. https://doi.org/10.1016/j.ecolind.2014.02.005.
346. Thompson, D. N., Li, C., Aston, J. E., Lacey, J. A., Thompson, V. S., Williams, C. L., Emerson, R. M., Hoover, A. N., and Gresham, G. L. (2016). Feedstock quality: A poorly understood but critical aspect for the development of a biorefining industry. Presented at the 38th Symposium on Biotechnology for Fuels and Chemicals, April 27, 2016, Baltimore, MD.
347. Thornley, P. (2008). Airborne emissions from biomass-based power generation systems. Environmental Research Letters 3 (1), 1-6.
348. Thornley, P., Rogers, J., Huang, Y. (2008). Quantification of employment from biomass power plants. Renewable Energy 33 (8), 1922-1927.
349. Tittmann, P., & Yeh, S. (2013). A Framework for Assessing the Life Cycle Greenhouse Gas Benefits of Forest Bioenergy and Biofuel in an Era of Forest Carbon Management. Journal of Sustainable Forestry, 32(1-2), 108-129.
350. Tomlin, B. (2006). On the value of mitigation and contingency strategies for managing supply chain disruption risks. *Management Science*, 52(5), 639-657.
351. Treitz, P., Lim, K., Woods, M., Pitt, D., Nesbitt, D., Etheridge, D., (2012) LiDAR sampling density for forest resource inventories in Ontario, Canada. *Remote Sensing. 4(4): 830-848.*
352. Tsolakis, N. K., Keramydas, C. A., Toka, A. K., Aidonis, D. A., and Iakovou, E. T. (2014). Agrifood supply chain management: A comprehensive hierarchical decision-making framework and a critical taxonomy. Biosystems Engineering, V120, 47-64.
353. Tucker, C. J. (1979) Red and photographic infrared linear combinations for monitoring vegetation Remote Sensing of Environment. (84) 526-537.
354. Tumuluru, J. S., Conner, C. C., Hoover, A. N. (2016a) Method to produce durable pellets at lower energy consumption using high moisture corn stover and a corn starch binder in a flat die pellet mill. J. Visualized Experiments. (112: 54092. Doi: 10.3791/54092.
355. Tumuluru, J. S. (2016) Specific energy consumption and quality of wood pellets produced using high-moisture lodgepole pine grind in a flat die pellet mill. Chemical Engineering Research and Design. 110(6) 82-97. https://doi.org/10.1016/j.cherd.2016.04.007.
356. Tumuluru, J. S., Searcy, E., Kenney, K. L., Smith, W. A., Gresham, G. L., Yancey, N. A. (2016b) Impact of feedstock supply systems unit operations on feedstock cost and quality for bioenergy applications. In Valorization of lignocellulosic biomass in a biorefinery: From

ISBN 978-1-9991916-0-3
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logistics to environmental and performance impact. Editors: Kumar, R., Singh, S., Balan, V. Nova publishers.
357. Turkington, T. K., Morrall, R. A. A., Gugel, R. K. (1991). Use of petal infestation to forecast sclerotinita stem rot of canola: Evaluation of early bloom sampling, 1985-90. Canadian J Plant Pathology, Vol 13, Issue 1, 50-59. https://doi.org/10.1080/07060669109500965.
358. USDA (2014). The Forest Inventory and Analysis Database: Database Description and User Guids Version 6.0 for Phase 2. April 2014. https://www.fia.fs.fed.us/library/database-documentation/historic/ver6/FIADB_user%20guide_6-0_p2_5-6-2014.pdf (last accessed – August, 2018).
359. USDA. (2012). National best management practices for water quality management on National Forest System Lands. Volume 1: National Core BMP Technical Guide. United States Department of Agriculture Forest Service FS-990a, April 2012.
360. U.S. Department of Energy (2011). U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry. R.D. Perlack and B.J. Stokes (Leads), ORNL/TM-2011/224. Oak Ridge National Laboratory, Oak Ridge, TN 227p.
361. USGS GAP. (2009). USGS GAP analysis program history and overview. United States Geological Survey Gap Analysis Program. https://gapanalysis.usgs.gov/.
362. Uslu, A., Faaij, A.P.C., Bergman, P.C.A. (2008). Pre-treatment technologies, and their effect on international bioenergy supply chain logistics. Techno-economic evaluation of torrefaction, fast pyrolysis and pelletisation. Energy 33 (8), 1206-1223.
363. Van Belle, J.F., Temmerman, M., Schenkel, Y. (2003). Three level procurement of forest residues for power plant. Biomass and Bioenergy 24 (4), 401-409.
364. Van Dyken, S., Bakken, B. H., Skjelbred, H. I. (2010). Linear mixed-integer models for biomass supply chains with transport, storage, and processing, Energy 35(3):1338-50.
365. VanEvery, E. C. & Higgelke, P. (2000) Development of Integrated Forest Management/Harvesting Plans for Biomass Supply Operations in Remote Community Settings. *Frontline Forest Research Applications. Technical Note no. 102.*
366. Van Wilgen, B. W., Biggs, H., O'Regan, S. P., Mare, N. (2000) Fire history of the savanna ecosystems in the Kruger National Park, South Africa, between 1941 and 1996. South African J. Science. 96(4) 167-178.
367. Venier, L. A., Hébert, C., De Grandpré, L., Arsenault, A., Walton, R., Morris, D. M. (2015) Modeling deadwood supply for biodiversity conservation: Considerations, challenges and recommendations. *The Forest Chronicle. 91(4*).
368. Verbesselt, J. Somers, B., van Aardt, J., Jonckheere, I., Coppin, P. (2006). Monitoring herbaceous biomass and water content with SPOT VEGETATION time-series to improve fire risk assessment in savanna ecosystems. Remote Sensing Environment, Vol 101, Issue 3, pp 399-414.
369. Veres, A., Petit, S., Conord, C., Lavigne, C. (2013) Does landscape composition affect pest abundance and their control by natural enemies? A review. Agriculture, Ecosystems & Environment, Vol 166, 15 February, 110-117.
370. Vidal, C. J., Goetschalcks, M. (1997). Strategic production-distribution models: a critical review with emphasis on global supply chain models. Eur J Operat Res 98(1):1-18.
371. Volpé, S. (2018a) Manage the carbon footprint of forestry operations. FPInnovations.
372. Volpé, S. (2018b) Best Management Practices Guide for Access to Quality Forest Feedstocks. *FPInnovations. SP-534.*
373. Volpé, S. (2016a) Innovative Storage Methods for Biomass Quality Improvement - Bark Storage Trial in Nova Scotia. *FPInnovations. Technical report no. 41.*

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

374. Volpé, S. (2016b) Log seasoning to add value to bioenergy operations. *FPInnovations. Technical report no. 15.*
375. Volpé, S. (2014) Forest biomass: the quality challenge. *FPInnovations.*
376. Volpé, S. (2013a) Moisture meters for biomass. *FPInnovations. Advantage report 14(5)*;
377. Volpé, S. (2013c) Improving biomass quality: immediate payback! *FPInnovations.*
378. Volpé, S. (2012) FPJoule. *Advantage FPInnovations. 13(4).*
379. Volpé, S. (2011) FPInnovations – BiOS. *Advantage FPInnovations. 13(1).*
380. Volpé, S., Desrochers, L. (2011) Integration of biomass recovery with cut-to-length harvesting operations. FPInnovations. 12(12).
381. Walsh, M., English, B., De la Torre Ugarte, D., Jensen, K., Hellwinckel, C., Menard, R., Nelson, R. (2007). Agricultural impacts of biofuels production. *Journal of Agricultural and Applied Economics* 39, 365–372.
382. Walter, J. A., Platt, R. V. (2013). Multi-temporal analysis reveals that predictors of mountain pine beetle infestation change during outbreak cycles. Forest Ecology and Management, Vol 302, 15 August, 308-318. https://doi.org/10.1016/j.foreco.2013.03.038.
383. Wang, Y., Ebadian, M., Sokhansanj, S., Webb, E., Lau, A. (2017) Impact of the biorefinery size on logistics of corn stover supply – A scenario analysis. *Applied Energy. 198: 360-376.*
384. Wang, Y., Ebadian, M., Sokhansanj, S., Webb, E., Zerriffi, H., Lau, A. (2018) A novel risk analysis methodology to evaluate the economic performance of a biorefinery and to quantify the economic incentives for participating biomass producers. *Biofuels, Bioproducts, & Biorefining. 12(3): 453-473.*
385. Way, M. J., Cammell, M. E., Taylor, L. R., Woiwod, I. P. (1981). The use of egg counts and suction trap samples to forecast the infestation of spring-sown fields beans, *Vicia faba*, by the black bean aphid, *Aphis fabae*. Annals of Applied Biology. Vol 98, Issue 1, 21-34. https://doi.org/10.1111/j.1774-7348.1981.tb00419.x.
386. Webb, E. (2016). Addressing fire risk in biomass handling and storage. Presented at DOE Bioenergy Technology Office Biorefinery Optimization Workshop, Rosemont, IL, October 5, 2016.
387. Windisch, J., Röser, D. Mola-Yudego, B., Sikanen, L., Asikainen, A., (2013) Business process mapping and discrete-event simulation of two forest biomass supply chains. *Biomass and Bioenergy. 56 (370-381).*
388. Wright, A., Dayton, P., Bertjens, S., Wright, A., and Scherwinski, K. (2010). True costs of harvesting woody biomass in the driftless area of the Upper Midwest, Final Report. Southwest Badger Resource Conservation and Development Council, Inc. Lancanster, WI 53813. October 2010.
389. Xerces Society (2019). Agricultural Pesticide Use. https://xerces.org/pesticides/agricultural-pesticide-use/
390. Yemshanov, D., Koch, F. H., McKenney, D. W., Downing, M. C., and Sapio, F. (2009a). Mapping invasive species risks with stochastoic models: A cross-border United States-Canada application for *Sirex noctilio Fabricius*. Risk Analysis, Vol 29, Issue 6, 868-884.
391. Yemshanov, D., Koch, F. H., Ben-Haim, Y., Smith, W. D. (2010). Robustness of risk maps and survey networks to knowledge gaps about a new invasive pest. Risk Analysis. Vol 30, Issue 2, 261-276.
392. Yemshanov, D., McKenney, D. W., de Groot, P., Haugen, D., Sidders, D., Joss, B. (2009b). A bioeconomic approach to assess the impact of an alien invasive insect on timber supply and harvesting: a case study with Sirex noctilio in Eastern Canada. Canadian J Forest Research, 39(1): 154-168. https://doi.org/10.1139/X08-164.

ISBN 978-1-9991916-0-3
©2023 Ecostrat Inc

393. Yemshanov, D., McKenney, D. W., Fraleigh, S., McConkey, B., Huffman, T., Smith, S., (2014) Cost estimates of post-harvest forest biomass supply for Canada. *Biomass and Bioenergy. 69: 80-94.*
394. Yemshanov, D., McKenney, D. W., Hope, E. S. (2018a) Comparing Alternative Biomass Supply Options for Canada: What Story do Cost Curves Tell? *BioResources. 13(2): 3157-3164.*
395. Yemshanov, D., McKenney, D. W., Hope, E. S., Lempriere, T., (2018b) Renewable Energy from Forest Residues—How Greenhouse Gas Emission Offsets Can Make Fossil Fuel Substitution More Attractive. Forests 9(79)
396. Yoon, J., Yildiz, H., Talluri, S. (2016). Risk management strategies in transportation capacity decisions: an analytical approach. *Journal of Business Logistics*, 37(4), 364-381.
397. Zabowski, D., B. Java, G. Scherer, R. Everett, and R. Ottmar. (2000). Timber harvesting residue treatment: Part 1. Responses of conifer seedlings, soils and microclimate. Forest Ecology and Management. 126: 1, 25-34.
398. Zhang, Q., Vonderembse, M.A., Lim, J.-S. (2003). Manufacturing flexibility: defining and analyzing relationships among competence, capability, and customer satisfaction. *Journal of Operations Management*, 21, 173-191.
399. Zhao, X., Hansen, J.K., & Tyner, W. (2016). Quantifying supply risk at the cellulosic biorefinery: A stochastic techno-economic analysis. Unpublished manuscript.
400. Zhu, Z., Arp, P. A., Meng, F., Bourque, C. P.-A., Foster, N. W. (2003a) A forest nutrient cycling and biomass model (ForNBM) based on year-round, monthly weather conditions, part I: assumption, structure and processing. *Ecological Modelling. 169(2-3): 347-360.*
401. Zumpf C., H. Ssegane, M.C., Negri, P., Campbell, and J. Cacho (2017). Yield and Water Quality Impacts of Field-Scale Integration of Willow into a Continuous Corn Rotation System. *Journal of Environmental Quality*. Vol. 46: 811–818.

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