Market designs for long-term biomass feedstock pricing

Illustrative examples of price management within long-term biomass agreements in California

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Abstract

This report reviews a collection of literature, conversations, and other sources on a contracting approach for long-term feedstock price management. An illustrative example on a long-term biomass price formula is developed to support discussions. Due to the sensitivity of biomass prices to various interrelated variables such as inflation and diesel prices, identifying a price point throughout the life of the contract is challenging and requires research on suitable market designs to improve price stability, reliability, and risk over time. This research reviews two forward market mechanisms that are used in commodity markets in order to assess their application to the goal of de-risking biomass supply chains. A formula-based rate (FBR) and an index-based price (IBP) formula were both discussed, and a demonstrative index-based pricing approach for forest biomass was created to support discussions. Additionally, a new approach to de-risking biomass supply called a Feedstock Supply Insurance (FSI) is briefly discussed. An FSI model focuses on *guaranteeing* feedstock delivery and includes aspects of feedstock price forecasting, although this is something separate from biomass price adjustment designs.

Overview

This report reviews literature, conversations, and other sources on a contracting approach for long-term feedstock price adjustments. Due to the sensitivity of biomass prices to various interrelated variables such as inflation and diesel prices, identifying a price point throughout the life of the contract is challenging and requires research on suitable market designs to improve price stability, reliability, and risk over time. This research reviews two forward market mechanisms that are used in commodity markets in order to assess their application to the goal of de-risking biomass supply chains. A formula-based rate (FBR) and an index-based price (IBP) formula were both discussed, and a demonstrative index-based pricing approach for forest biomass was created to support discussions. The index-based pricing does not reflect real spot market prices or precise representations of the market as it exists today. Indexes were collected from multiple sources, where each index was weighted according to its influence on a delivered feedstock price. Price changes were modeled based on inflationary changes between 2013-2023. A price floor and price ceiling of 10% of baseline price is applied to demonstrate how risk fluctuations can be further hedged over the lifetime of the contract.

The methods described in this report represent one option for new feedstock managing entities to build their own transparent identification and price tracking system, thereby de-risking feedstock supply contracts. There are other options to manage supply risk and price tracking available through private firms as well, such as those offered by Ecostrat USA Inc. This report will briefly review Ecostrat's product and services in context to de-risking the biomass supply chain.

Purpose

The purpose is to build upon previous research which tested the UC Davis Forest Residue for Renewable Energy Decision Support System (FRREDSS) model as a price mechanism for long-term biomass feedstock price negotiation. Objectives include:

- Review information on forward markets to support long-term feedstock contract designs
- Explore approaches to incorporate an index-based pricing structure for forest-based biomass
- Examine single component and multiple component contract designs
- Build an example formula to represent price changes for biomass contract prices over a 10-year period
- Explain the newly emerging idea of a feedstock supply insurance product and compare its utility to a biomass price formula

Background

Discussions on long-term feedstock supply often focus on how to better enable landowners to manage their land or work with federal partners on innovative partnerships (Jolley, n.d). However, there is little focus on private sector-based solutions to support long-term agreements and de-risking feedstock supply.

In 2021, the Office of Planning and Research (OPR) launched a pilot project across five regions in the state to study how existing or newly created government entities might improve biomass management and derisk biomass supply. A component of this work is to investigate whether a publicly managed price mechanism could establish a common ground between buyers and sellers to enter a fair process for long-term contract price negotiation. Original concept papers about the market design discussed the potential to adapt the formula rate mechanism commonly used in electricity transmission rate procedures for the purposes of biomass procurement (CLERE, 2023). In 2023, the Northeastern OPR Pilot Project team partnered with UC Davis on the use of the Forest Resource and Renewable Energy Decision Support System (FRREDSS)[1] to test its effectiveness as a formula rate tool to determine price forecasting within a specific topography while additional research further reviewed a potentially more suitable market design.

FRREDSS was stress tested by the Watershed Research and Training Center (WRTC)—in partnership with UC Davis— by analyzing the 20-year profit and loss statement for a facility end-user across silvicultural and harvest types, expansion factors, and across a variety of locations in the Central Tahoe Sierra region. More information on this process can be found in the *FRREDSS Price Mechanism Final Report.* Recommendations were developed to further improve the FRREDSS model to act as a transparent process for long-term feedstock price forecasting, however, it was ultimately determined that a new tool customized to long-term feedstock contract price forecasting would better serve contract negotiation. The FRREDSS model still serves as a valuable tool for pilot regions to utilize when estimating costs for facility development. If recommendations are incorporated into the next version of FRREDSS, pilot regions may find new and additional value to the decision support system.

Among the recommendations developed by the WRTC, the most important component underserved within the FRREDSS model is the accurate tracking of inflation over time. Inflation can also be referred to as the "escalation factor" and can be described within a feedstock agreement under the "price adjustment clause". This report is a companion report to the analysis conducted by WRTC and provides more detail to price adjusting design for long-term contracting of biomass supply. Reasoning on why the escalation factor was identified in the FRREDSS model as needing more research is copied from the *FRREDSS Price Mechanism Final Report*, described below.

(1) "Escalation factor. Inflation rates were found to be one of the more influential factors impacting prices calculated in the FRREDSS model over time. While harvest methods, transportation distance and diesel price still constitute a significant component to the price of delivered biomass, simple inflation rates escalated prices rapidly over a 20 year period. At a fixed inflation rate of 2.1%, average prices changed by $69 per BDT over a 20-year period. When compared to a zero-inflation rate scenario, prices only changed $7 per BDT showing the impact of a simple and constant escalation factor. Identifying the correct escalation factor will be the most important variable in determining a regular price increase, otherwise referred to as the price adjustment design. Due to the heavy influence diesel prices play on the supply chain, one suggestion is to tie escalation rates to the

[1] Users can access FRREDSS 1.0 through this link.

fluctuations in diesel listed on commodity markets (Solomon, 2017; Mason, 2023). This approach is referred to as index-based pricing (IBP)."

Finally, a new approach to de-risking biomass supply has been proposed in 2024. A Feedstock Supply Insurance (FSI) model focuses on *guaranteeing* feedstock delivery and includes aspects of feedstock price forecasting, although this is something separate from biomass price adjustment designs.

Long-term contract price adjustment design

Accounting for fluctuations in markets is an essential task in a long-term supply contract. Without price adjustments, contracts may fail and result in lost profits or even bankruptcy. In a contract with fixed prices, the seller (the logger) absorbs all the risk from market volatility. If costs go up, then they lose money. A more nimble contract design that contains a floating price based on a formula or indices would share risk with the buyer (the biomass facility). This way, when prices fluctuate, the buyer pays less or more depending on the direction of the fluctuation, although extreme fluctuations may be mitigated through price floors and ceilings.

There are a variety of methods and mechanisms that attempt to hedge risk for long-term contracts in commodity markets. When looking at price mechanisms for commodity markets, many options to hedge risk rely on trading on an exchange (ie. options, futures, etc.) and are not appropriate for physical delivery. For physical deliveries, wholesale electricity markets are a good example. But electricity markets are heavily reliant on sophisticated market designs and price mechanisms to ensure delivery, adequacy and the constant tracking of prices per locality in real-time. Biomass supply chains share similar challenges to long-term risk as energy markets, albeit in much less time-sensitive markets. Biomass facilities often store at least 5 months of their feedstock demand on-site and therefore feedstock delivery does not need to be managed as rigorously as electricity markets. Many of the electricity market designs were not selected for review because they were either not suitable for biomass procurement or were thought to be too complicated to incentivize participation. However, a "forward contract" is often used in electricity markets and offers the most potential for biomass markets to employ. Fortunately, a forward contract is not a new concept to the biomass industry.

Forward contracts or "buying forward" de-risks supply chains by buying a certain good supply when plentiful, stockpiling, then selling when the supply dwindles. A forward contract is a customized contract between two parties that specifies the asset to be purchased at a later date, along with the agreed-upon price. Establishing a forward contract allows for transparency on changes to input costs, defining economic uncertainties through an established methodology, and ensuring price changes are well understood (and agreed to) before they occur. Forward contracts provide certainty for both buyers and sellers and function to inject stability into specific markets. Two forward contract options reviewed in this paper are **formula-based rates** and **index-based pricing**. Added protection for each party through the use of price floors and price ceilings (referred to as a "price collar") are also reviewed in this paper and could further incentivize participation.

Formula-based rates

Original concept papers about developing a price mechanism for biomass management talked about the potential for a formula-based rate (FBR) contract with price collars to define contract procedures (CLERE Inc, 2023). In one example, FBRs are used as an alternative for utilities to issue a new rate case for customers. The Federal Energy Regulatory Commission (FERC) reviews and accepts the formula design (including clear definitions of inputs and process for updating rates) thereby reducing the expense and burden for FERC and the utility to update transmission rates. This mechanism is designed to calculate a utility's cost of providing transmission service, which is then used to set rates (FERC, accessed June 13, 2024). A utility's cost of transmission service generally consists of (1) the return to investments or investors, (2) operation and maintenance, (3) depreciation and other expenses, and (4) income and other taxes. A formula rate would combine these variables to create a "cost of service", or in other words, the annual revenue a utility requires to provide transmission service.

Applying this method to the biomass supply chain, the logger is in the position of the utility company as the supplier. In this situation, a FBR would need to account for all the costs of delivering biomass to the buyer's site location. Because transportation distance is one of the most significant variable costs and definitive harvest locations are not possible to predict over a 10 year period, a FBR would need to average all transportation possibilities within likely areas of operation. The FRREDSS model, created by UC Davis, uses an optimization-based algorithm to determine potential harvest sites and average haul costs across all harvest-site pixels. See Figure 1 for a screenshot of a FRREDSS model run. As such, FRREDSS was seen as a promising decision support tool to test this FBR price mechanism. FRREDSS provides 17 input variables to calculate biomass delivery costs across a spatially referenced landscape. An average price could then be calculated across the 20-year profit and loss (P&L) statement, as a proxy for distance[2]. However, through stress testing the model for this purpose, the WRTC identified a number of items for the FRREDSS model to modify in order to better simulate the biomass supply chain and function as a FBR. In their final report, the WRTC recommended building a new tool based on the FRREDSS model but more customized to the purposes of a FBR tool.

[2] The FRREDSS model calculates biomass delivery costs by assuming that each year of operation would require procuring biomass further away from the site location than the previous year.

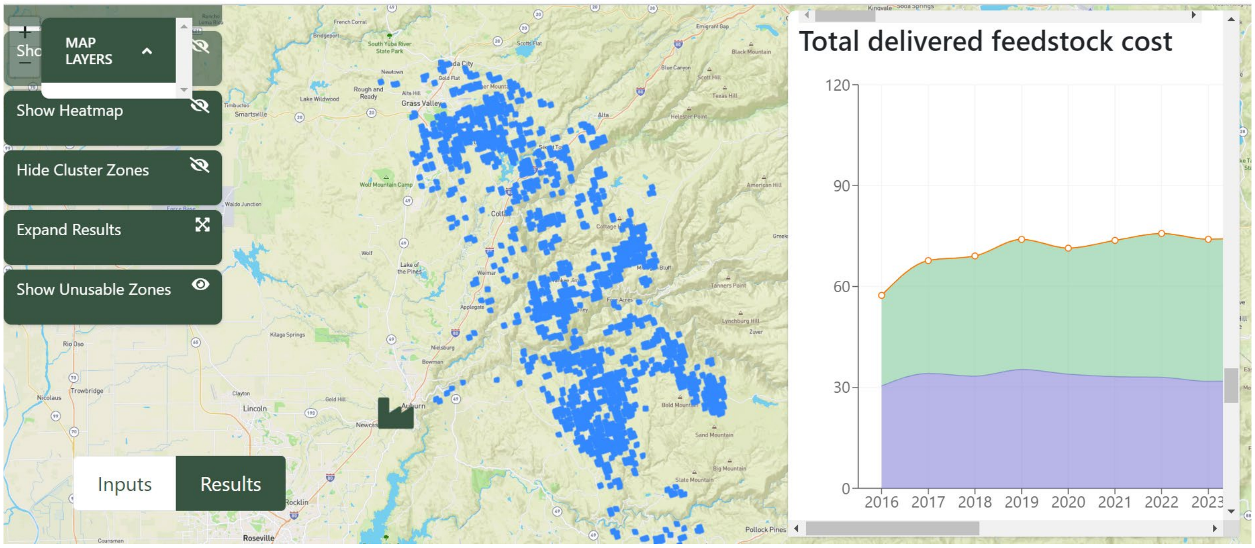

Figure 1: Snapshot image of FRREDSS interface as a potential formula-based rate

With modifications to the FRREDSS model, the tool can still be useful as a FBR process as it exists today. In order to account for price adjustments, prices would need to be recalculated based on a recurring time interval (ie. monthly, quarterly, bi-annually) as specified by the contract agreement, and follow a pre-approved methodology when interacting with the FRREDSS model. The methodology would require specifics on how to determine the "escalation factor" (which influences least-cost optimization), the location of biomass (is the biomass procured immediately around the site location, or at a separate biomass coordinate?), and additional features. Updates to input variables would pull in data from pre-approved sources and reflect real time market prices.

Prices would still need to be agreed to by each party and a price collar would need to be determined which would trigger additional action. A baseline price would need to be determined as well to anchor the price collar. The pricing could be determined every 3 to 5 years as an example.

Nevertheless, using the FRREDSS model as a FBR price mechanism might be more time intensive, would require a detailed understanding of model assumptions, and is subject to compounded inaccuracies based on how the calculations are carried across the model environment[3]. Furthermore, underperformance of the model would ideally be immediately corrected with a team of software developers or forest biometricians. For this reason, another forward contracting mechanism, called index base pricing, may provide a better alternative for price adjustments within a contract.

[3] When comparing harvest costs with reported contractor estimates, there was a notable difference in prices with no clear explanation. One potential reason for this difference is that the costs could be based on a harvest cost formula built in the 1980s for a specific tree species. More research is needed.

Index based pricing

Index-based pricing (IBP) is not a new concept. It has been a topic of consideration for long-term biomass procurement pricing across the United States and is frequently used in fuel, chemical, metals and energy commodity markets. It's a transparent method for predicting and tracking price fluctuations based on key cost components that comprise the product under contract. Deloitte's (2016) fact sheet is worth quoting at length:

> "By definition, Index Based Pricing is the use of a market or raw material index (or group of indices) to calculate and regularly refresh prices. Certain industries like Chemicals, Metals, and Industrial Products are inherently cyclical in nature, and cost volatility of underlying raw materials have led to difficult and frequent price negotiations between suppliers and their customers. Index Based Pricing evolved as a means to aid these contract negotiations and enable buyers and sellers to enter into longer-term contracts with fewer hassles. It helped suppliers protect their margins in volatile markets, reduced hassling negotiations and offered a transparent pricing mechanism."

Deloitte's illustrated example (Figure 2) reviews the types of IBP methods, which are employed based on how sensitive the product price is to a single or multiple component that make up the overall cost of the product. When using an index-based formula, it is important to account for each major cost component in order to have a fair value and to ensure the index or data used to inform the formula accurately represent the costs. Without proper due diligence on price changes, companies risk margin erosion or contract failure. However, keeping the formula simple and tied to as few indexes as possible will ease administrative and updating indexes less complex.

Additional mechanisms can be added to index-based formulas to decrease volatility even further. Price increase or decrease caps can be applied so that drastic changes in price are capped within the contract. There is also a price collar which would trigger additional action within the contract if prices broke through a specified range. Price collars will be discussed in the following section.

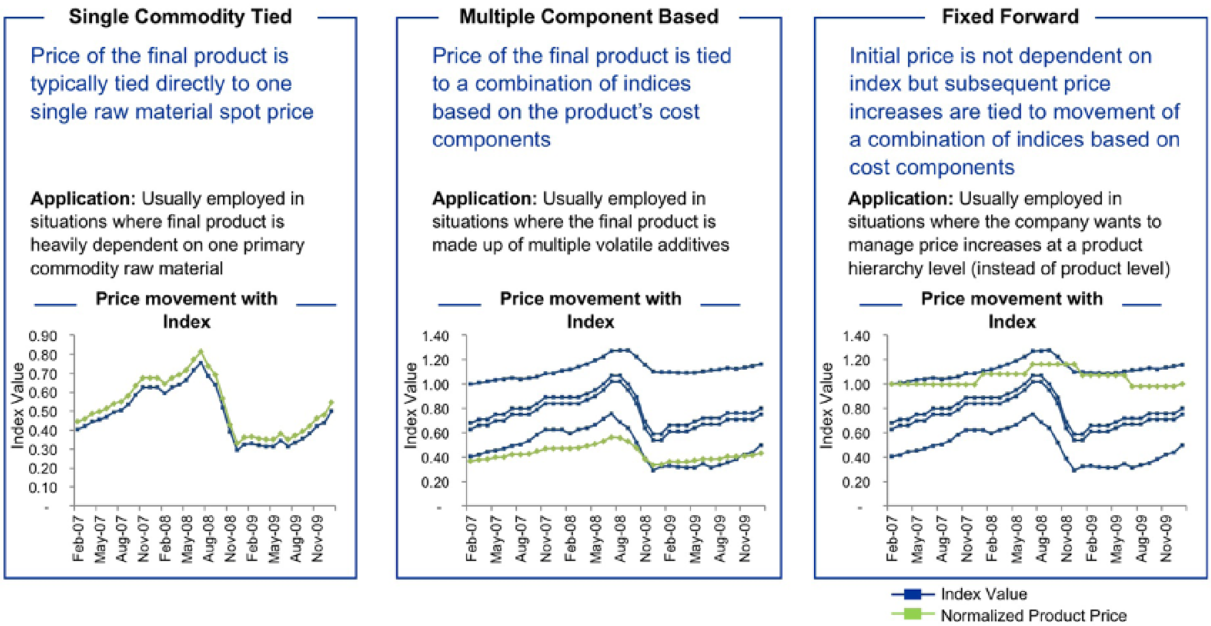

Figure 2: Different forms of index-based pricing as summarized by Deliotte (2016)

The producer price index (PPI) is a frequently used family of indexes compiled by the Bureau of Labor Statistics (BLS) to be considered in an index-based formula. Because BLS measures price changes objectively, both at the aggregated level and for particular products, free from possible manipulation by either of the contracting parties, the PPI is widely recognized among business people, economists, statisticians, and accountants as useful in price adjustment clauses (BLS, accessed June 17, 2024). BLS has put a price adjustment guideline on their website to support contract development with their data. General steps include:

(1) Establish the base selling price subject to adjustment.
(2) Select an appropriate index or indexes. (Clearly identify the selected index and cite an appropriate source.)
(3) Specify whether seasonally adjusted indexes or unadjusted indexes are to be used.
(4) State the frequency of price adjustment.
(5) Provide for missing or discontinued data.
(6) Specify that calculations of price adjustments shall always use the latest version of the PPI data published as of the date specified for such calculations. This requires contracting parties to explicitly agree on the base and comparison months employed by the price adjustment, as well as the precise month and the approximate date that the price adjustment calculations are to be made

It is essential to specify not only frequency/interval for price adjustment, but also the approximate date on which the price adjustment is to be made. Currently, PPI data are usually published between the 9th and the 16th of the month following the reference month in question. All indexes for four months earlier, are considered final on their day of release, and should be considered official data that will not be updated from that point forward.

Price collars

Price collars (or "commodity collars") is a hedging structure that places a price floor and a price ceiling on a formula which can either place a hard cap on price fluctuation or trigger additional action if prices break through the collar. It limits both potential gains and potential loss for both parties entering into a contract. Defining the width of the price collar depends on a variety of factors, mainly dealing with each party's ability to absorb the fluctuation. Ultimately, this will be determined within the contract, and quantified through expert analysis. Additional information on price collars is found in the following section.

Illustrative examples of index-based pricing for biomass

To contextualize the performance of an index-based formula, illustrative examples for how it could work were created for the California biomass market. These are preliminary calculations and do not reflect a rigorous due diligence process on index selection, contract terms, or baseline cost estimates. This formula could be useful for both existing and new facility development. Existing facilities may be more interested in using this type of price for a part of their feedstock demand, whereas new facilities may be interested in using it for full coverage of their demand.

The following figures are examples to support discussion on the effect of a single commodity formula and a multi-component formula. Baseline prices begin at $50 per bone dry ton (BDT) and illustrate what a 10-year biomass contract could look like from 2013 to 2023 if using an index-based formula.

Finding the Baseline Price at Year Zero

Determining the price at the beginning of the contract is arguably the most important component of IBP. Once this price is agreed upon, the formula will modulate the fluctuation of prices on a 3-year moving average. In this exercise, I relied on previous research conducting with the FRREDSS model produced by UC Davis (Stevenson, 2023). While the FRREDSS model contains a number of recommendations to improve its accuracy to model the full range of supply chain economics, it can still be valuable as a placeholder for this demonstration of an IBP.

The research that went into validating the FRREDSS model relied on a sensitivity analysis of location, forest treatment and harvest system combination, the inflation rate, as well as the wood basket size. After averaging results across all site locations for the full 20-year modeled period, FRREDSS found that the price to deliver biomass to a facility (based on 2023 market prices) is about $76 per BDT. This will price will represent the baseline price at year zero for this report.

Single Commodity Index Based Pricing

Diesel Prices

Transportation costs is the most significant variable cost for biomass procurement. A single component IBP mechanism can change feedstock price based on the changes in diesel price. Quarterly diesel prices for California were acquired from the Environmental Information Agency (EIA) on April 25, 2024, and percent change in diesel price are based on Q1 2013 prices. 2022 contained the largest percent change in diesel with an increase of over 25% from 2013 prices. Figure 2 depicts the quarterly changes in price.

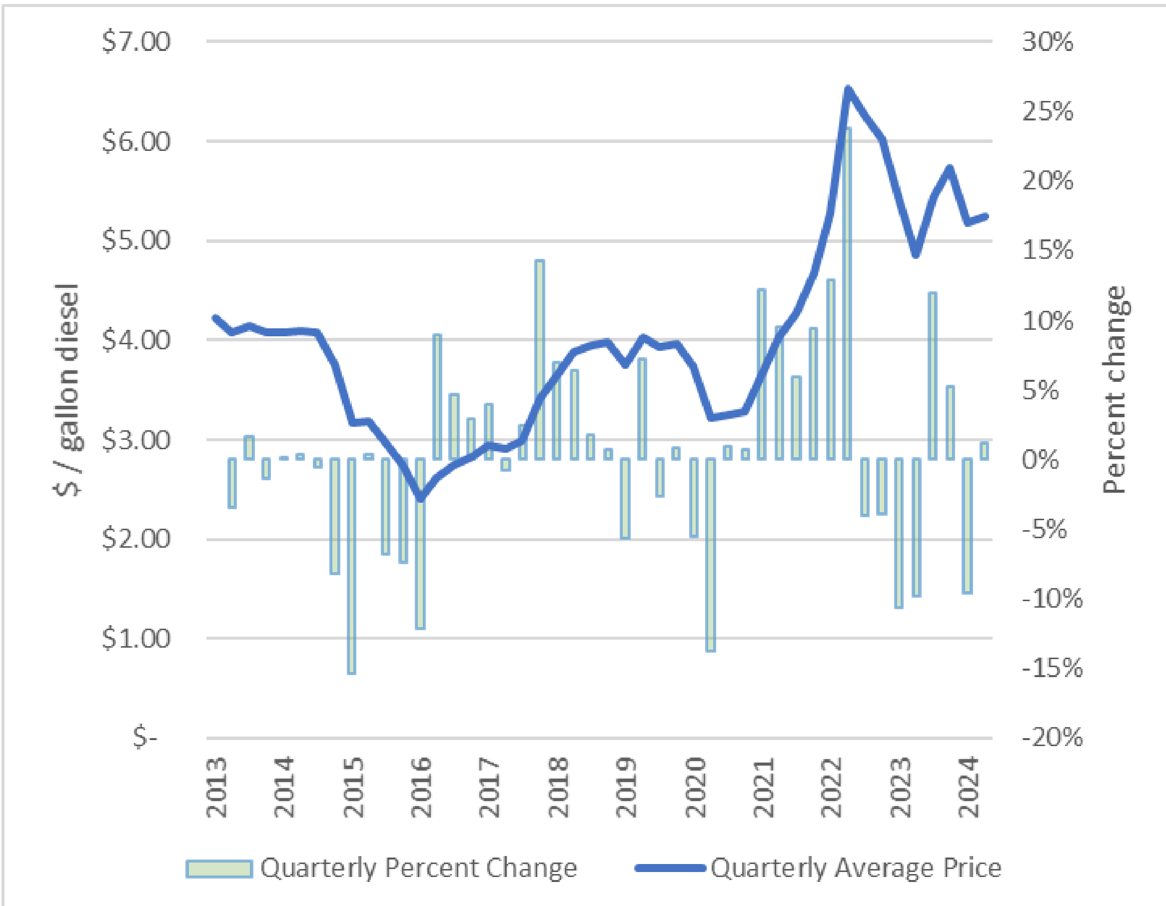

Figure 2: Quarterly average price changes to diesel. Data acquired from EIA.

Quarterly changes to diesel price were then applied to biomass feedstock assuming that prices were $50 per BDT in 2013. Figure 3 illustrates the changes with the green line. Furthermore, a moving average baseline price was applied to the formula in order to have a more representative price be reflected throughout the life of the contract (labeled number 1 in Figure 3). Finally, a 10% price collar on either side of the moving average baseline can either cap the extreme fluctuations to feedstock price or otherwise trigger a new action in the contract (labeled as 2). The price that is paid to sellers for delivered feedstock is the 3 year moving average price.

When prices cross the price collar, this can trigger an action by the managing contract holder. Triggered actions can include the use of an insurance-based product, or another provision as determined by the signing parties (labeled as number 3). In the situation where an insurance-based product is attached to this formula, a more sophisticated process would be required to determine if feedstock was deemed insured[4]. Like in label 3, a price that breaks through the ceiling would require compensation to be given to the buyer. If it breaks through the floor, compensation is given to the seller.

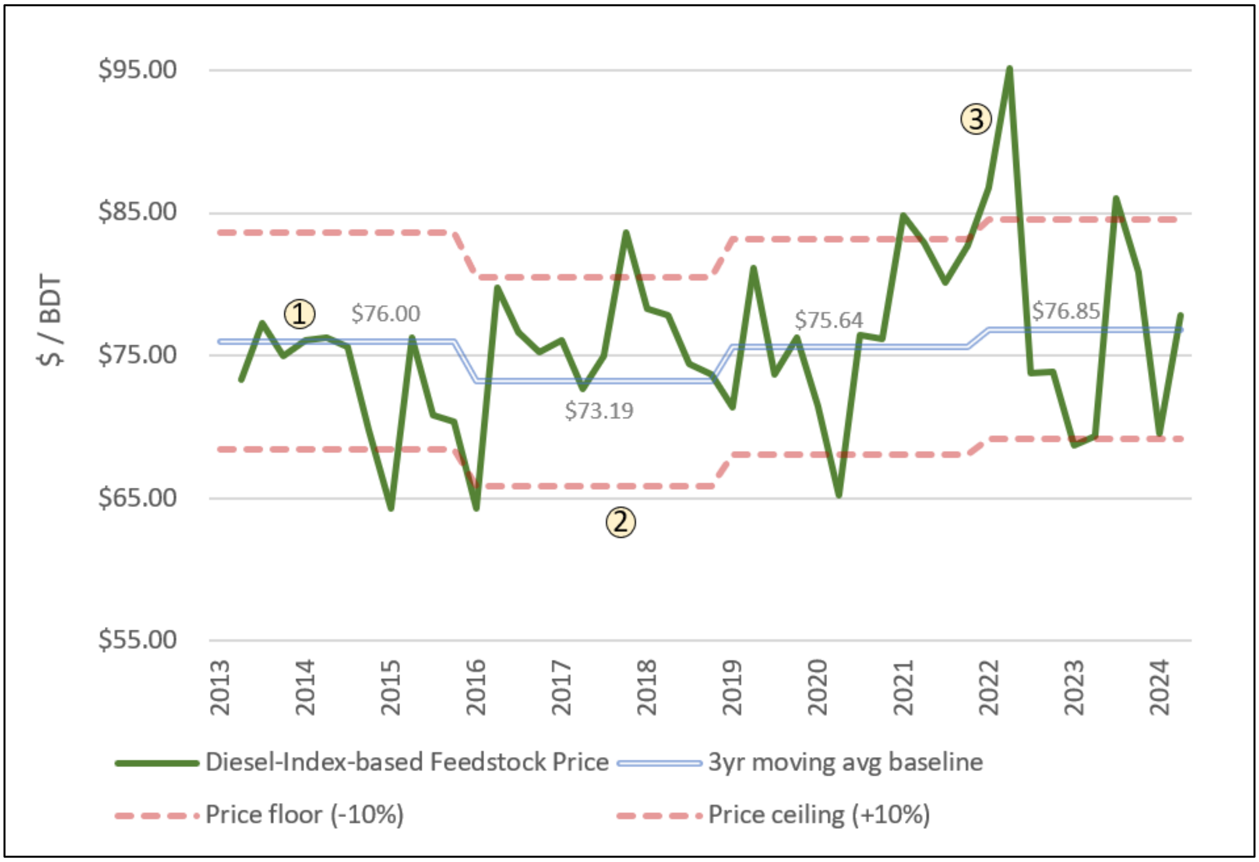

Figure 3: Feedstock price changes based on quarterly diesel price. (1) A moving average baseline price averages the previous 3 years of prices. (2) A 10% price collar is applied to either side of the moving average. (3) if prices break through the ceiling, additional contract features could be written into the agreement to moderate influences on the moving average price.

As illustrated by Figure 3, relying on the diesel index as the only index to influence feedstock price may result in high volatility of prices. Regularity of price changes could also be made on a biannual basis as well, which may smooth out the price curve.

[4] More on this topic is covered in the Feedstock Supply Insurance Model section

California Forestry Job Wages

The Consumer Price Index (CPI) can also be used to estimate general changes in biomass prices as a representation of income, wages, and costs of living[5]. To hone in on California-specific dynamics, occupational wages for the California Employment Development Department (EDD) for a range of forestry jobs in California were used instead of the CPI collected by the BLS. Data was acquired on May 6th, 2024 and only contains annualized prices. There is an upward trend in wages across a variety of forestry positions in CA. On average salaries have increased 3% per year as illustrated in Figure 4.

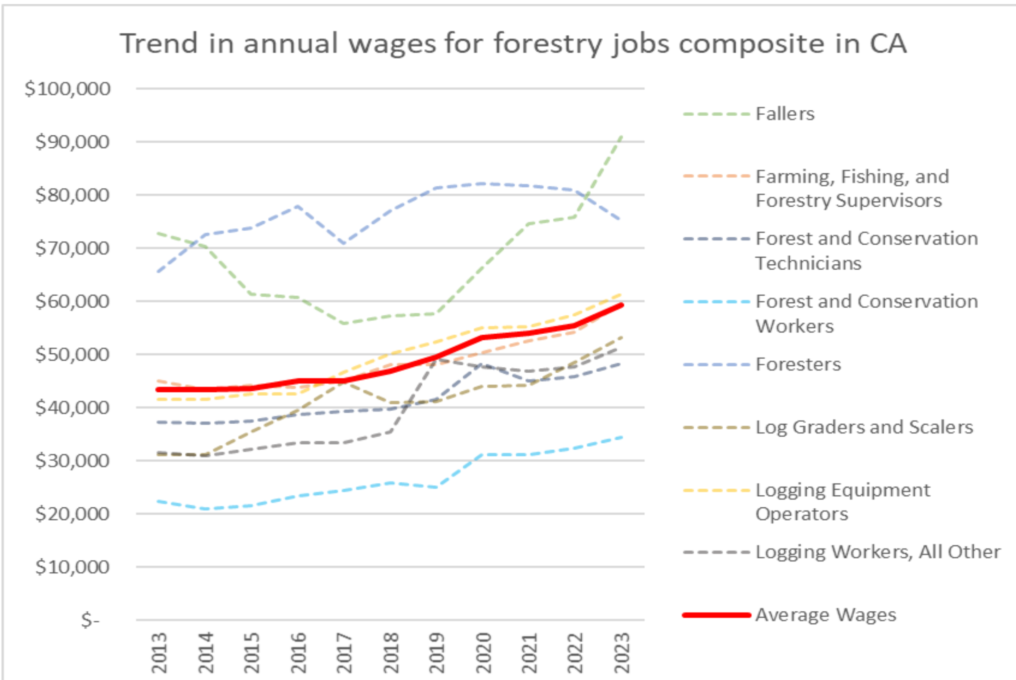

Figure 4: Trends in annual wages for various jobs within the forest industry. Weighted averages were calculated by finding each occupation's influence on the sum of wages across occupation types.

In order to normalize the impact price change had per job code, a weighted average was applied when accounting for percent change per year. Table 1 shows that the Foresters job classification has the largest influence on the forest jobs composite.

[5] Note: Beginning July 1, 2026, prevailing wages will be enacted for fuel reduction projects as enacted by AB 332 (Aguiar-Curry).

Table 1: Weighted influence of job classifications on a customized California EDD forest job composite index

Job Title	Weighted Influence on Composite Index
Fallers	17%
Farming, Fishing, and Forestry Supervisors	12%
Forest and Conservation Technicians	11%
Forest and Conservation Workers	7%
Foresters	20%
Log Graders and Scalers	11%
Logging Equipment Operators	13%
Logging Workers, All Other	10%

Figure 5 shows the percent change in the weighted average for forestry jobs in California based on the state's EDD data. Forestry wages increased by 8% in 2020, which is just under double the amount of change that typically occurred over the last decade.

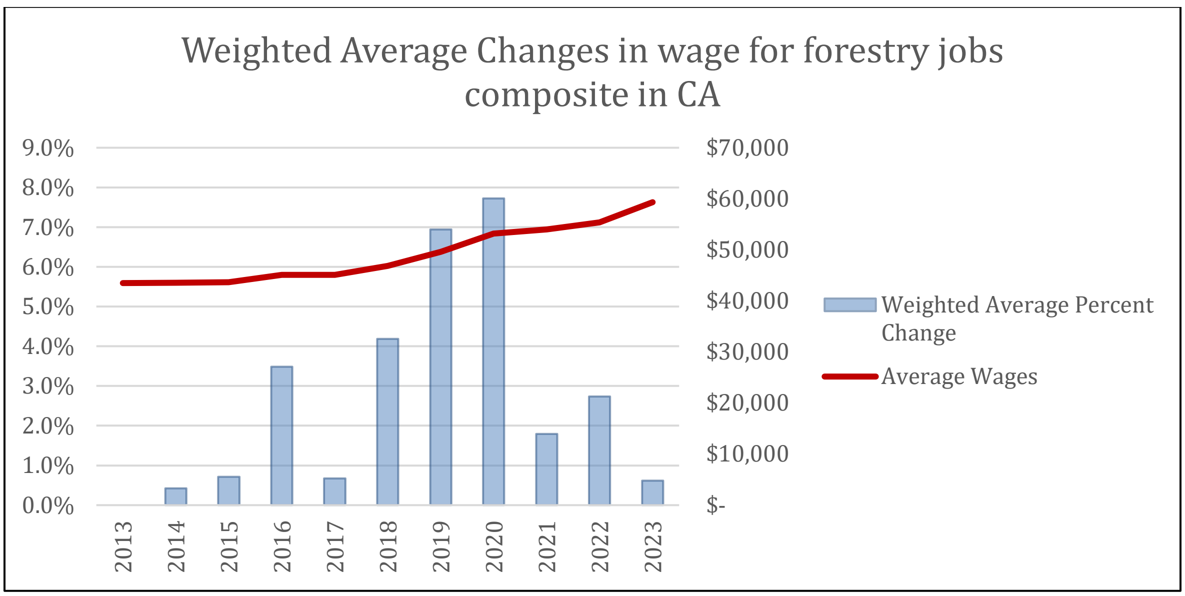

Figure 5: Weighted averages changes in wage across the forestry job composite in CA.

As shown in Figure 6, 2020 had the largest increase in forestry job wages after accounting for the weighted influence of each job classification. Figure 7 illustrates how a feedstock price would change if tied exclusively to changes in forest job wages.

Figure 6: Changes in feedstock prices based on changes in forestry job composite wages.

Motor Parts and Tires PPI Index

Lastly, a motor vehicle and parts dealers (PCU441---441) and tire dealers (PCU44134-44134) Producer Price Index (PPI) was applied in order to represent general operation and maintenance (O+M) costs that a logger may encounter. While both indexes were added together to get a single representative index, it does not reflect the methods that would be used in a multi-component index formula. As Figure 7 shows, prices were fairly steady until 2020 and 2021 where prices ballooned up to 6%.

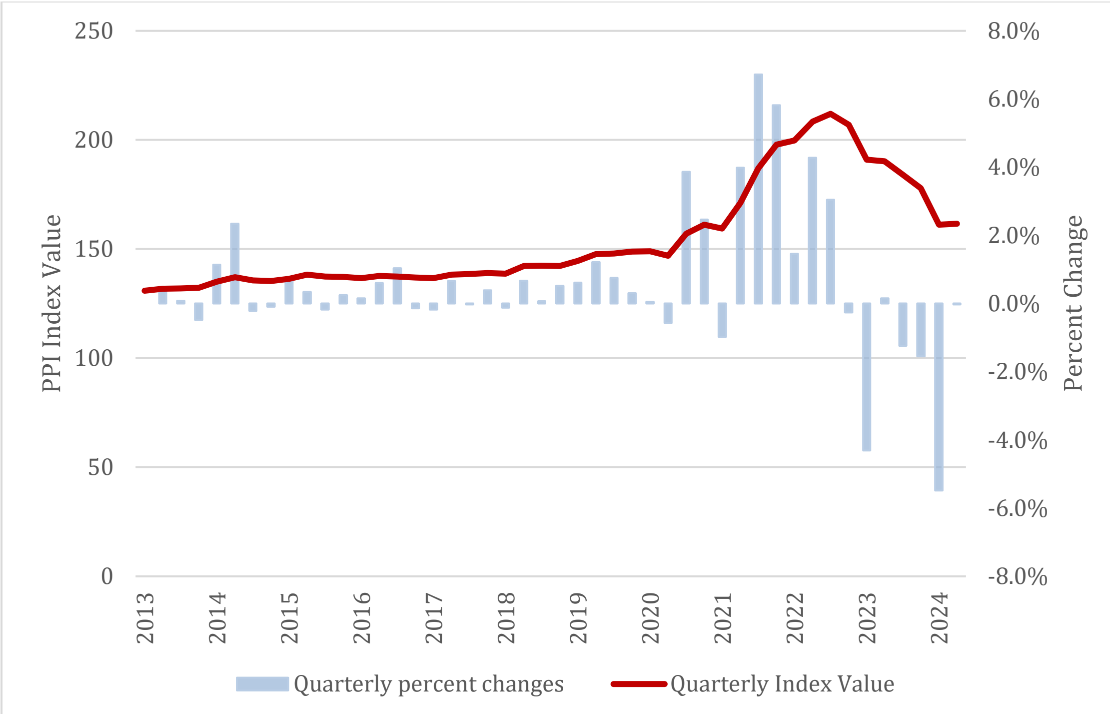

Figure 7: PPI Index Value of motor parts and tire dealers between 2013-2024. Motor parts and tire dealers were summed together to get a coupled index, but this is not representative of a multi-component index formula.

Figure 8 depicts how feedstock prices would change based on the coupled indexes of motor parts and tire dealers. There is significant volatility in prices between 2020 and 2024, however, nothing that breaks through the price collar.

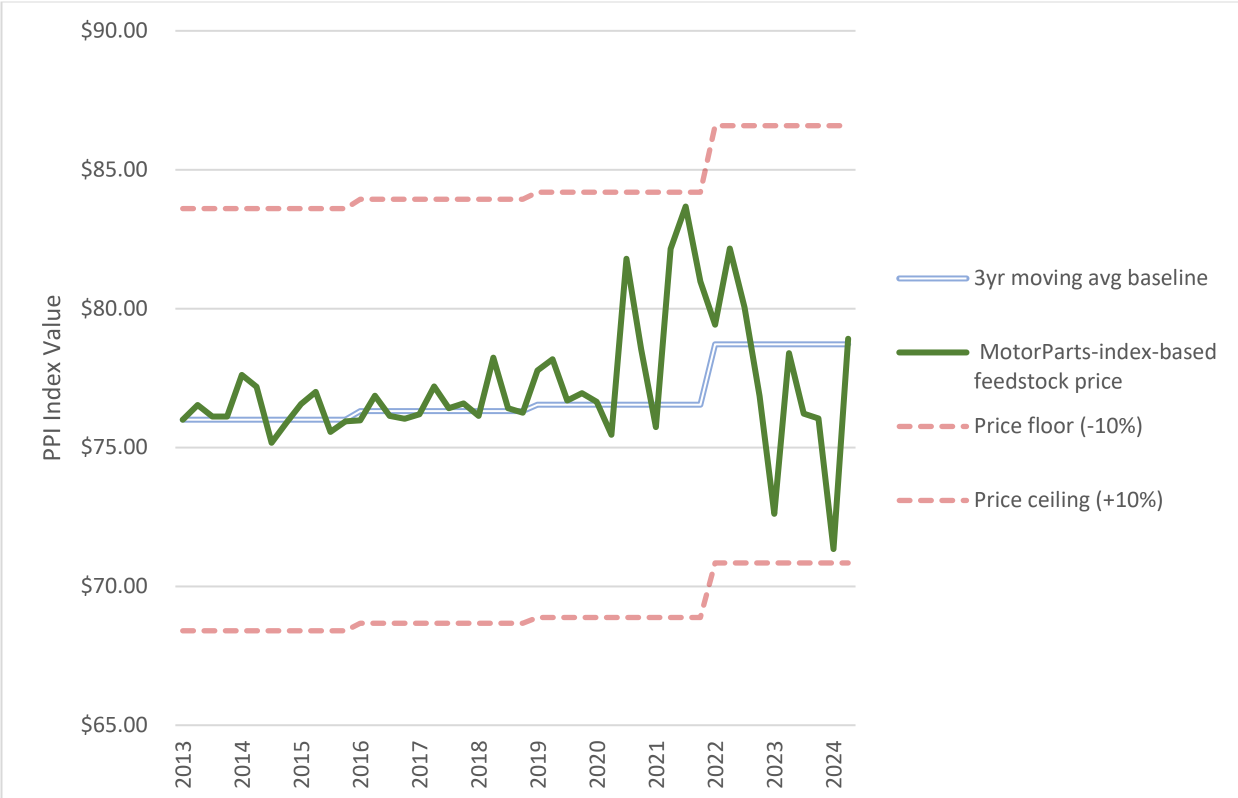

Figure 8: Changes in feedstock prices based on changes in a motor parts and tire dealers PPI composite index.

Multi-component Index Based Pricing

Using the three indexes in the previous section, a multi-component index-based formula was generated to exemplify price behavior. Weighted influence of each index on the final cost of biomass delivery is summarized in Table 2. Estimates are not based on scientific literature but are rather a placeholder to demonstrate the formula's function. Calculations take the weighted influence of each component and multiply it by the percent change of each index component on a quarterly basis. Furthermore, in order for price changes to be normalized, they are baselined to the 3 year moving average price. As such, every 3 years, price changes have a new baseline and therefore operate on a more regular appraisal of prices influenced by inflation. Within the terms of a contract, this would mean a new baseline price would be created and each party would be notified of the changes. Prices to suppliers for delivered feedstock would be the 3 year moving average price.

Table 2: Summary table of weighted influence of cost components on a multi-component index-based formula

Cost components	Weighted influence on final costs
Diesel	40%
Wages	25%
Motor and tires	15%
Other costs*	20%

**Not included in the formula*

Figure 9 graphs what a multi-component index-based formula could look like over a 10-year period. With diesel driving the majority of the price changes, there are significant fluctuations, but only one Quarter has prices breakthrough the price ceiling. In these circumstances, prices would require additional action to kick in as determined by the signing parties. Under these assumptions, price fluctuations are mostly contained within a 5% variance of the moving average.

Figure 9: Changes in feedstock prices using a multi-component index-based formula with diesel (quarterly), wages (annual), motor parts (quarterly), and tires (quarterly).

Feedstock Supply Insurance Model

As mentioned throughout this report, a long-term contract can enable a supplier of biomass to confidently bid on forest management projects knowing there is a guaranteed outlet and price for their material. Simultaneously, emerging biomass facilities can benefit from long-term biomass contracts and prove operational feasibility to obtain debt-financing. An FBR or IBP looks at managing price adjustments within the contract agreement. However, a Feedstock Supply Insurance (FSI) Model is another approach to de-risking the supply chain.

An FSI Model would be able to absorb the shock of market level disturbance to the suppliers by ensuring biomass delivery for participating facilities. Essentially, money would be given to the facility to pass through to the suppliers to ensure that any risk to the facility's supply chain is mitigated. While an FBR or IBP attempts to manage prices within an acceptable range, it does not necessarily address more catastrophic risks that could drastically alter the financial feasibility of a woodbasket. The FSI model attempts to solve this issue by providing a payout as a tool to *guarantee* feedstock delivery. An insurance product of this sort would rely on sophisticated risk assessments within a specified woodbasket to determine the distance at which feedstock would be deemed safe for insurance.

Funds will likely be sourced from the state and kept in a "Contract Guarantee Fund". This fund would serve as "first in line" to accept a risk of loss up to a certain amount, as determined by the FSI holders, and any other contributing funder. Funds can be linked to a particular offtake facility or could be more generally available.

The purpose of the Contract Guarantee Fund is to soften the blow for the insurance carrier's risk associated with business interruptions, "Acts of God", or other emergencies[6]. Figure 10 depicts a public-private partnership feedstock supply insurance framework with a biomass aggregation Joint Powers Authority (JPA) acting as a supply manager, an Insurance Carrier issuing the FSI term sheet and policy, and a "Supply Co" holding the FSI policy and managing a "Master Supply Contract"—an insured contract to guarantee feedstock delivery by bundling multiple contracts together. This framework is intended to create a publicly backed insurance product that can be used to ensure long term feedstock contract viability.

[6] Parametric Insurance may also be useful in this instance although more research is needed. According to Swiss Re, Parametric Insurance is a type of insurance that covers the probability or likelihood of a loss-causing event happening (like a wildfire) instead of indemnifying the actual loss incurred from the event. It is an agreement to make a payment upon the occurrence of a covered event meeting or exceeding a pre-defined intensity threshold, as measured by an objective value (or parameter – hence the name 'parametric insurance'). Objective parameters that could be measured in the event of a fire could be burn severity for example. Parametric is not the same as an FSI model.

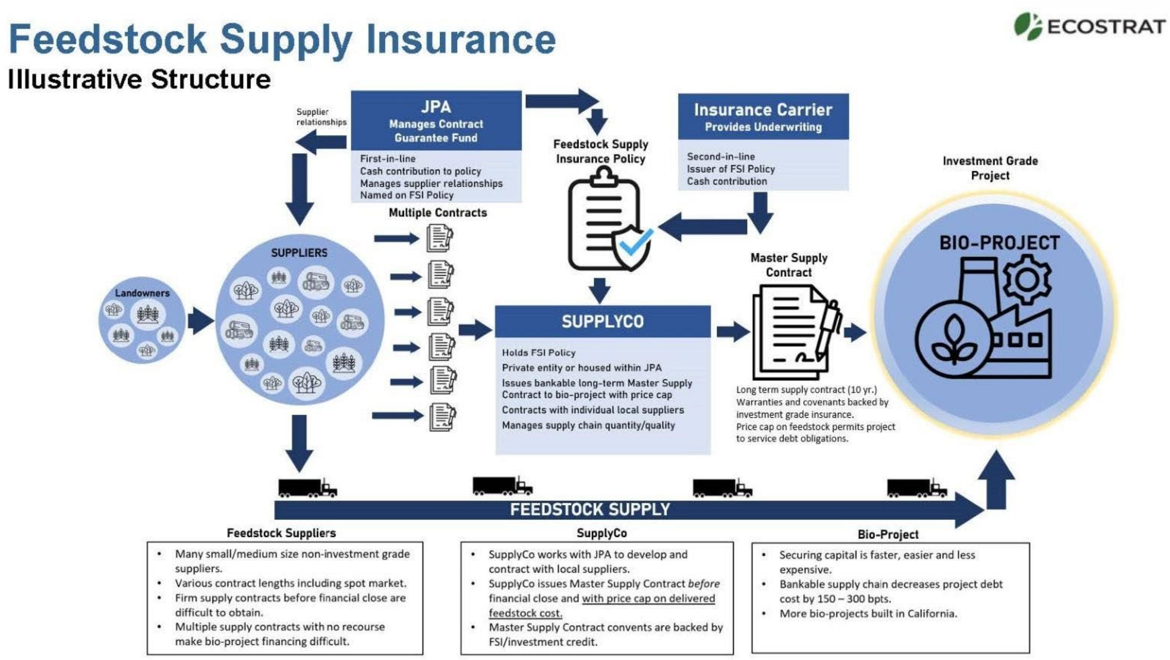

Figure 10: Public-Private Partnership with Biomass Feedstock Supply Insurance Using the JPA's Contract Guarantee Fund Combined with Insurance Underwriting (used with permission of Ecostrat Inc and CLERE Inc.)

In this framework, a public manager (like a JPA) would manage the Contract Guarantee Fund and support a private contracting entity (referred to as "Supply Co" in Figure 10) which would enter into contracts with suppliers and off takers. Supply Co could also be either the JPA or another entity, for example a private entity, non-profit organization or tribal enterprise. Supply Co warranties would be guaranteed by the feedstock insurance policy. Shifting contract risk from individual suppliers to a single, credible counterparty (Supply Co or JPA) that issues guaranteed master supply contracts could help to lower the cost of debt for emerging facilities seeking capital and streamline contract administration for facilities.

Discussion

Either IBP or FSI contract designs should be tested for feasibility within existing operations in California. However, IBP has been examined in the California biomass industry before[7], and there was no mention of anyone in the state actively engaged in an IBP contract design through this research effort. According to the review team, facilities have attempted to use index-based pricing but found it to be too complicated and ultimately too opaque for contractors to be comfortable. Buyers found a simpler way to incentivize and support contractors. Buyers found that bulk purchasing diesel and offering below-market prices for diesel on site in exchange for biomass is simpler and more agreeable to suppliers than developing an

[7] Anecdotally, an IBP was examined in the Central Valley neighboring the Northern and Southern Sierra by a large industrial landowner.

index-based pricing structure. In these situations, biomass price is discounted by suppliers if they choose to fill their trucks up at the facility. Proposing an IBP contract design may require additional discussion on what has been done before and where opportunities for improvement exist.

Additionally, there has been some discussion from regional partners and interviewees on the utility of either a price formula or FSI contract design for new and existing facilities. Some new facilities may be interested in utilizing these contract designs to satisfy 100% of their feedstock demand. A contract of this design does not need to sustain 100% of the feedstock demand though. Existing facilities may be more interested in satisfying 10%-30% of their feedstock demand, for example.

Nevertheless, the price formula or FSI would be developed in order to provide emerging facilities enough security in their supply contracts to receive debt-financing. Therefore, developing a price management scheme such as this would also require developing trusted relationships with the financial sector, or proof of concept before underwriters deem it as legitimate. While this is not a significant roadblock for anyone interested in this prospect, it is something to consider.

When researching other examples of private sector solutions for long-term feedstock agreements, one entity stands out. Enviva is the world's largest woody biomass producer for industrial energy and relies on long-term supply contracts for its business. Enviva declared bankruptcy in March 2024. The collapse of Enviva is felt in both the US markets as a key pellet producing nation and in many International markets as more coal plants are converting to biomass energy. Enviva entered into several long-term supply contracts tied to indices with at least one buyer based out of Japan. According to *Biomass Magazine*, Enviva encountered financial troubles based on "some bad bets on future pellet prices" (Voegele March 13, 2024). The company maintained enough long-term contracts that contained such a "negative spread between [their] sale and purchase prices of the agreements" that it resulted in a breach in contract. One expert reviewer of this paper had this to say on Enviva's bankruptcy:

> "…they went long on shipping prices and they had fixed buy prices overseas for their pellets. Therefore, when their shipping costs went through the roof they couldn't make money.
>
> …If it is in fact the case that the reason for the insolvency was fluctuations in ocean freight price and being tied up in fixed long-term ocean freight contracts, then I'm not sure what the lesson learned here is for feedstock supply insurance [or long-term price adjustment design]."

Nevertheless, the insolvency of a major biomass user uniquely engaged in long-term biomass contracting stands as a note of caution.

Finally, it is important to note that indices were selected in order to represent seller costs (logger), not buyer costs (facility). This is because the research contained in this report is focused on feedstock risk, not the collective risks that impact facility startup and operations. A buyer-centric index formula would focus on different indexes, result in a different price point, and may result in little buy-in from the seller. Alternatively, a buyer is more invested in the viability of sellers to continue operating. There are several instances in California where end-users have directly invested in sellers in order to maintain their supply chain and build trust within the seller community (Stevenson, 2024). This suggests that there is more likelihood of a seller-centric index formula being adopted than another. Furthermore, defining the original price baseline, determining price update intervals, and the width of the price collars will be key in determining contract function. Developing a strong relationship with facilities and operators in the region will help identify baseline prices. More specific recommendations are suggested in the next section.

Next Steps

Within this paper, there are two dominant approaches to reducing feedstock supply risk: (1) create a price formula to manage contract terms over a 10 year period, and (2) assess "less-risky" biomass and underwrite an insurance backstop in order to guarantee material within a certain distance from the facility. They both involve price management, although the feedstock supply insurance approach goes beyond price management and creates an insurance product to ensure delivery of biomass when markets experience significant disruption.

Feedstock Supply Insurance Model

The FSI Model is currently being developed through the Office of Planning and Research's Woody Feedstock Aggregation Pilot Program. An FSI policy term sheet is being created by Ecostrat USA, Inc. and CLERE Inc. in partnership with regional stakeholders. More information on insurance products and establishing a FSI policy will be made available by the end of 2025.

Developing and managing a price formula

New entities who would like to develop and manage a price formula will need to develop models using their own assets and constraints. This report illustrates a basic example on what that could look like, but additional technical support would be required to build the model and verify its effectiveness. There are consultants who develop these types of formulas, like Deloitte, and may be available for a consultation. Further research could consider the following topics:

- AB 332 (Aguiar-Curry) was passed in October 2023 and establishes prevailing wage requirements for fuel reduction work. Beginning July 1, 2026, new wages will be enacted which will increase the influence of wages on biomass costs. However, it will also provide regular and predictable forecasts for wage rates that an IBP can depend on.
- Collect biomass price history over the last 10 years and compare price trends to the back-calculations illustrated in this report
- Identify potentially more suitable indices to tie feedstock prices
- Identify more suitable weights for each index's influence on costs
- Collect data on spot market biomass prices and harvest costs to determine an appropriate starting baseline for feedstock price for specific targeted regions.
- Consider the methodology for a moving price baseline to anchor the price collar on a 3 year or 5 year interval
- Consider additional variables that may impact the ability to accomplish accurate pricing

    - Volume availability and consistency. Biomass availability multiple (BAM) / or required redundancy factor
    - Timber values influence on biomass pricing
    - Public subsidy outlook (5-10 years) weighted influence on pricing
- Consider a "fair cost premium" for using the price mechanism service, or incorporate it into the baseline price.
- In a circumstance where the price formula fails due to unforeseen market factors, consider exploring additional contract provisions that allow for price modifications that are not included in the IBP formula. A certain level of proof would be required in order to enact a provision that changes prices outside of the terms of the price formula.
- Validate and engage with industry professionals on the methodology of the formula and its usefulness. Explore other options if unagreeable.

References

- California Employment Development Department (EDD). (2024, May 6). Occupational Wages (2013-2023). Accessed May 6th, 2024. https://labormarketinfo.edd.ca.gov/cgi/dataanalysis/oesWageReport.asp?menuchoice=OESWAGE
- Deloitte (2016). "Index Based Pricing: Managing Risk and Profitability". https://www2.deloitte.com/content/dam/Deloitte/us/Documents/process-and-operations/us-operations-index-based-pricing.pdf
- Federal Energy Regulation Commission. (2024, June 13). "Formula rates electric transmission proceedings key concepts and how to participate". FERC. https://www.ferc.gov/formula-rates-electric-transmission-proceedings-key-concepts-and-how-participate
- Jolley, A., Hann, E., Kusel, J. (n.d) "USFS Acquisition Mechanisms and Potential for Increased Local Contracting". Sierra Institute for Community and Environment.
- Stevenson, C., Yeo, BL (2024). "FRREDSS Price Mechanism: Utilizing bioenergy siting and economic optimization tool to support long-term feedstock procurement price contracting". The Office of Planning and Research.
- US Environmental Information Agency. California Diesel Prices. Accessed April 25, 2024 https://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_sca_w.htm
- U.S. Bureau of Labor Statistics. (2024, June 17). Price Adjustment Guide for Contracting Parties. Retrieved June 17, 2024. https://www.bls.gov/ppi/publications/price-adjustment-guide-for-contracting-parties.htm
- U.S. Bureau of Labor Statistics. (2024, June 17). Producer Price Index: Industry Data: Motor Vehicle and Parts Dealer PCU441---441. Retrieved June 17, 2024. https://www.bls.gov/ppi/databases/
- U.S. Bureau of Labor Statistics. (2024, June 17). Producer Price Index: Industry Data: Tire Dealers PCU 44134-44134. Retrieved June 17, 2024. https://www.bls.gov/ppi/databases/
- Voegele, Erin (2024, March 13). "Enviva Files For Chapter 11 Bankruptcy, Aims To Complete Restructuring By Q4. Biomass Magazine. https://biomassmagazine.com/articles/enviva-files-for-chapter-11-bankruptcy-aims-to-complete-restructuring-by-q4