An Analysis of the Feasibility of Producing and Exporting Wood Pellets from Two Northern and Central California Sites

Produced for

Golden State Finance Authority

July 6, 2020

Produced by FutureMetrics

Introductory Summary

The purpose of this report is to provide the Golden State Finance Authority (GSFA) with information and analysis in support of the decision-making and project development process with regards to the development of a project for producing and exporting industrial wood pellets.

GSFA has requested an analysis of the feasibility of building two large industrial pellet factories; each producing about 460,000 metric tonnes per year of pellets[1].

This report contains a high-level analysis of the potential cash flows and a review of the sustainability requirements that may be required for the project to export pellets.

If the project proceeds, GSFA should have no problems with achieving acceptable sustainability credentials in any of the major industrial wood pellet importing markets.

This report is not intended to be a final analysis of the project. **There are many critical cost inputs that need further refinement. Those inputs will be further refined if the project proceeds beyond this first stage in the development process.**

Two of the critical inputs are the (1) delivered wood costs (including the average moisture content of the delivered wood), and (2) the cost to move the pellets from the pellet factories to a port terminal where they are stored and eventually loaded onto ships.

(1) Source of Wood Costs Assumptions - Under the direction of GSFA, a wood study was completed by Forest2Market that estimated the quantities of wood available for pellet factories in two locations: One in northern California in the vicinity of Lassen/Bieber and the other farther south in the central sierra in the vicinity of Jamestown/Tuolumne. That study provides the delivered wood costs estimate used in the financial analysis.

(2) Source of Logistics Costs Assumptions - GSFA provided the preliminary estimate for the cost of transporting the pellets from the factory sites to the port by rail. GSFA also choose two potential ports: the port of Stockton and the port of West Sacramento. GSFA's cost estimate to move the pellets from the factory sites to the port provides the mill-to-port logistics cost used in the financial analysis.

Other cost input assumptions are based on either data from the region or on typical cost profiles for similar sized projects. The top line revenue assumption is based on current and expected market conditions for long-term agreements for the purchase of wood pellets.

Under the assumptions for the values of the input costs that are used in this analysis, the results of the analysis show that the GSFA pellet production and export projects would not be expected to produce sufficient cash flows and are therefore <u>not feasible</u> at either site.

[1] The main body of this report assumes that the factory will produce white pellets. The appendix of this report contains a brief summary and cash flow analysis for an alternative production process that produces so-called black pellets.

The report explains the reasons for this conclusion in detail. The report also provides guidance to help GSFA focus on and mitigate those cost issues that contribute to the conclusion.

Table of Contents

Capital and Operating Cost Analysis

The capital costs and operation costs for the project are based on a number of project and site-specific characteristics. The actual costs can only be estimated at this stage of the project cycle. **Capital cost and operating costs (CAPEX and OPEX) estimates and/or assumptions are discussed in detail in the financial analysis section of this report**.

For an overview of a 500,000 metric tonne per year pellet factory, including photos of key equipment, view the PDF document at this link ➔ HERE (about 5MBs). Each of the production centers in the overview has to be costed. Conveyance systems are typically somewhat unique to each site. Site preparation, utility interconnections, construction costs, plumbing and wiring costs, and many other costs will contribute to the final capital cost schedule.

If the project proceeds beyond the early stage development, GSFA should engage with an engineering firm with experience in pellet factory design for a detailed FEED[2] analysis. The engineering analysis, including site specific requirement for the preparation of the foundation, utilities interconnections, and permitting, will be the foundation of the capital cost estimate.

FutureMetrics' has extensive operations experience and has used that experience to estimate the plant's operating costs (other than delivered wood costs). **Delivered wood costs are based on expert analysis by Forest2Market (F2M). Mill-to-port rail costs are based on information supplied by GSFA**.

For this analysis, FutureMetrics is using the two sites identified by GSFA that are the basis of the F2M wood study: One in northern California in the vicinity of Lassen/Bieber and the other farther south in the central sierra in the vicinity of Jamestown/Tuolumne.

The F2M analysis shows identical delivered wood costs for the three major categories of feedstock for both sites. The GSFA information on logistics that FutureMetrics has been directed to use shows identical per tonne costs for the rail delivery of wood pellets from both sites to one of two potential ports[3]. The labor costs, based on California data on average wage rates in the northern and central areas around the pellet factory sites, are almost identical between the two sites. Thus, **the capital and operating costs for the two sites are essentially identical.**

All references to quantities of pellets are in metric tonnes. The estimated delivered wood costs provided by Forest2Market used below in the financial analysis section are converted from US short tons to metric tonnes. Metrics tonnes (1,000 kilograms or about 2,200 pounds) are the common quantity measurements in the international industrial wood pellet sector.

[2] Front end engineering and design.

[3] This assumption by GSFA is likely to change. The final port location is not determined and the distances from the two sites areas to the two potential ports are significantly different. FutureMetrics has been directed to use the single number provided by GSFA for this analysis.

Logistics Analysis

The cost of moving pellets from the pellet factory to the port, and the cost of port storage and ship loading are significant components of the supply chain costs. The location of the pellet factory and the location of the pellet export terminal are important considerations in the development of a pellet export project.

Mill-to-Port Costs

Mill-to-port costs are significant in the supply chain costs. The maps on the next pages show the approximate locations of the two sites as well as the rail to the two potential port locations.

The ports that GSFA has directed FutureMetrics to use are in West Sacramento and Stockton.

	Estimated Distance (miles)
Southern site to West Sacramento	124
Southern site to Stockton	75
Nothern site to West Sacramento	257
Nothern site to Stockton	300

GSFA has had discussions with both port operators regarding their ability to berth handymax[4] ships. The ports have assured GSFA that handymax vessels can be birthed and loaded at their terminals.

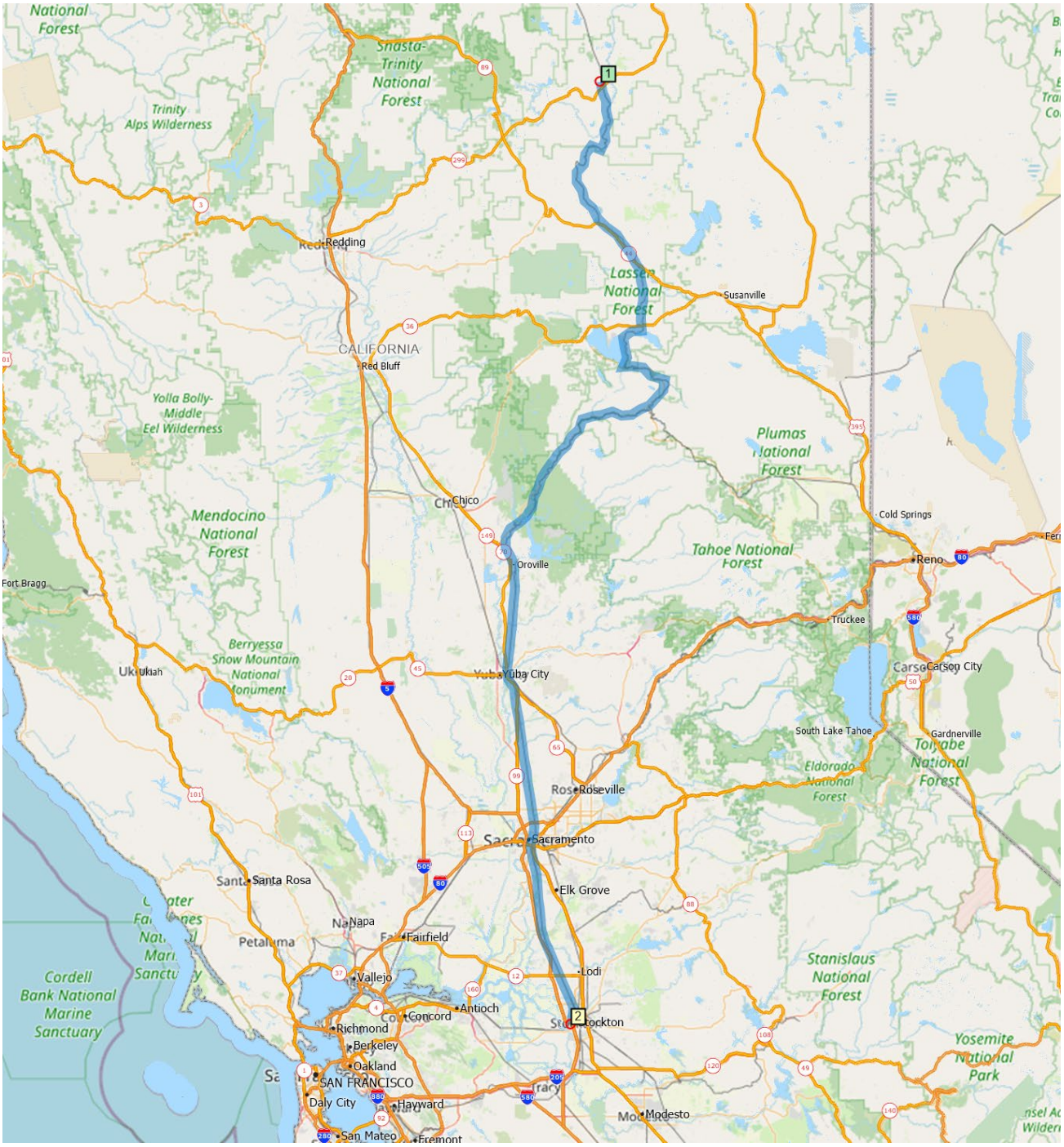
This should be carefully verified. The port of West Sacramento lists the depth of their channel at 30 feet (9.14 meters). The port of Stockton lists their mean low tide channel depth at 35 feet (10.7 meters) and maximum draft at the berths of 35 feet (10.7 meters).

The typical handymax ship will have a draft of 11 to 12 meters (36 to 39 feet).

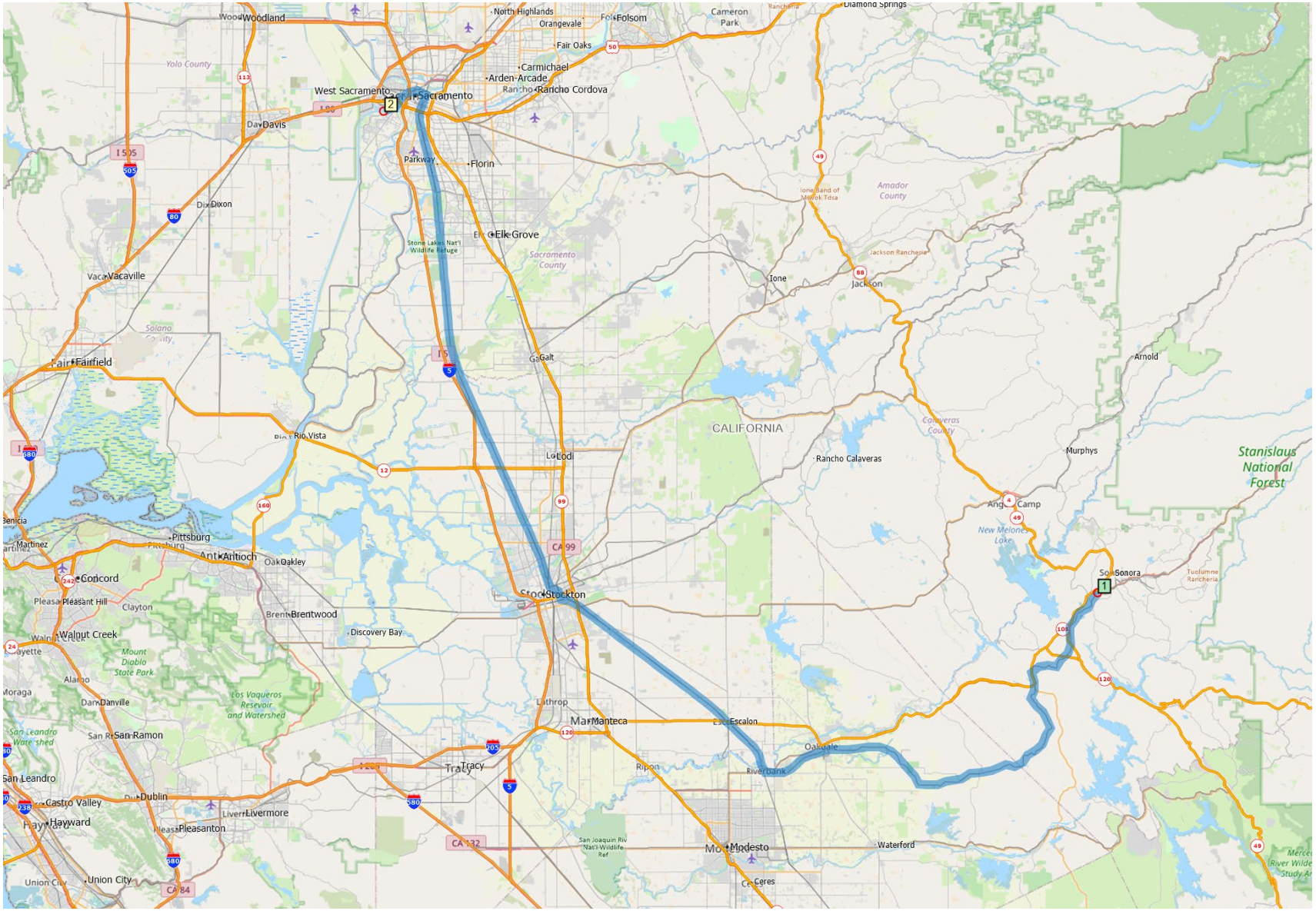
GSFA should get written assurance from the port operators that the ports are capable of berthing a handymax vessel and filling it with wood pellets.

[4] A handymax vessel typically has a capacity between 35,000 and 50,000 DWT. These ships are well suited for smaller ports with length and draft restrictions. The Japanese market is expected to be supplied primarily by handymax sized vessels (see the Japanese Biomass Outlook report appendix on ports importing pellets into Japan). These vessels should not be confused with handysize ships which are smaller.

Rail from the northern site passes through the Sacramento area on the way to Stockton. Both routes are identical except for the extra rail distance from Sacramento to Stockton.



Rail from the central Sierra site passes through Stockton on the way to West Sacramento. Both routes are identical except for the extra rail distance from Stockton to W. Sacramento.



The choice of location for the export terminal will be based on discussions with the ports and the terminal operators regarding storage, unloading systems, and ship loading infrastructure.

GSFA has directed FutureMetrics to use $34.00 per short ton ($37.40 per metric tonne) for the total cost of moving pellets by rail from either of the sites to either of the ports.

RECOMMENDATION – GSFA should obtain a conditional binding quote from the rail lines for mill-to-port costs for both sites before proceeding with project development.

Port Storage and Ship Loading

The terminal has to have sufficient space for storing a shipload of pellets and must have the ship loading systems that can safely move at least 1200 tonnes per hour.

The storage for white pellets must be enclosed to prevent rain or snow from landing on the pellets. GSFA has directed FutureMetrics to assume that the port will use two 35,000 tonne domes.

Based on a recent quote from a major supplier of storage domes, FutureMetrics estimates that two 35,000 metric tonne domes, not including electrical and civil work nor the cost of permitting the site, is about $12,00,000[5]. Constraints on space and location at the terminal are not known at this time. The port site may have restrictions on height and/or footprint.

The added cost of civil works, electrical work, and permitting is assumed to be 35% of the cost of the domes. Actual costs will depend on the location, soil conditions, local regulations, wage rates, etc.

It is not known at this time what entity will develop and own the port infrastructure. It is common for the port or for an independent entity to develop the infrastructure based on the known flow of pellets over a known number of years. For this analysis, it is assumed that the capital costs for the port infrastructure are not part of the pellet projects' capital costs.

The table below shows the estimated costs per tonne that the pellet project will pay the terminal operator based on the estimated capital costs for the ship loader (including conveyance) and the domes. The analysis assumes the investment will be amortized over 10 years (to match a potential Japanese offtake agreement). The analysis also assumes a 10% markup on the annualized cost to provide a return on investment to the owner of the port infrastructure.

The actual costs of the domes and ship loading infrastructure and the actual cost per tonne will be determined after a FEED document is produced and bids are received.

The table below assumes that both pellet factories will ship out of the same port infrastructure. That is, the costs will be spread over 920,000 tonnes per year (the expected output of two 500,000 tonne per year factories running at 92% of nameplate which is about 8,000 hours per year).

[5] Estimate is based on a quote from Dome Technology that came with a ±35% contingency.

In the review of the critical assumptions that follow, those assumptions that are inputs to the financial model are in the yellow highlighted cells.

Ship Loader (1,200 tonnes per hour)	
Estimated CAPEX	$3,500,000
Term (years)	10
Discount Rate	6%
Annualized Cost with a 10% Markup	$523,092
Cost per Tonne	$0.57
Stevedoring	$3.00
Total	**$3.57**

White Pellet Storage - two 35,000 Tonnes	
Estimated	$16,200,000
Term (years)	10
Discount Rate	6%
Annualized Cost with a 10% Markup	$2,421,167
Cost per Tonne	**$2.63**

Total Port and Ship Loading Cost per tonne	**$6.20**

These logistics costs are used in the financial analysis that follows.

Logistical Assumptions		
	Escalation	
Shipping Cost ($/MT)	1.5%	$0.00
Mill to Port Rail/Trucking Cost ($/MT)	1.5%	$37.40
Port Storage ($/MT)	1.5%	$2.63
Port loading (amortized capex plus stevedoring $/MT)	1.5%	$3.57
Total Logistics ($/MT)		**$43.60**

Financial Analysis

The financial analysis uses the inputs discussed above, some other assumptions discussed below, and the delivered wood cost data provided by Forest2Market (F2M).

Wood Supply Costs

F2M has identified significantly more than enough volumes of feedstock in the region to provide an annual input to the two pellet mills for many decades. The table below summarizes their findings.

Northern California and Central Sierras Regions

Estimation of material volumes and cost (at assumed 60-mile transport distance)

Northern California	Price ($ per bone dry ton) Mortality Tree Chips	Green Tree Roundwood	Green Tree Chips
Delivered	$68.01	$60.59	$68.01
Freight	$24.77	$24.77	$24.77
Stumpage & Harvesting	$43.24	$35.83	$43.24
Miles	60	60	60
Annual bone dry tons (20 years)	125,464	2,737,324	
Fiber Mix	4%	96%	
Coverage Ratio	5.7		
Mortality-Green Blended Cost (years 1-5)	$64.46		
Green Roundwood/Chip Cost (years 6+)	$64.30		

Central Sierras	Price ($ per bone dry ton) Mortality Tree Chips	Green Tree Roundwood	Green Tree Chips
Delivered	$68.01	$60.59	$68.01
Freight	$24.77	$24.77	$24.77
Stumpage & Harvesting	$43.24	$35.83	$43.24
Miles	60	60	60
Annual bone dry tons (20 years)	777,505	1,435,652	
Fiber Mix	35%	65%	
Coverage Ratio	4.4		
Mortality-Green Blended Cost (years 1-5)	$65.60		
Green Roundwood/Chip Cost (years 6+)	$64.30		

* green roundwood and chip mix assumed to be 50/50

It is assumed that the pellet factories will use the green roundwood and chips and the ORC turbine/generator (CHP) will use the "mortality" wood. The breakdown of the average costs and average moisture content[6] (MC) is shown below. Note that the F2M analysis shows that the delivered wood costs for both sites are identical.

Pellet Feedstock

	BDT	MC	Green short ton	Green MT
Northern	$64.30	50.0%	$32.15	$35.37
Central Sierra	$64.30	50.0%	$32.15	$35.37

CHP Fuel Feedstock

	BDT	MC	Green short ton	Green MT
Northern	$68.01	35.0%	$44.21	$48.63
Central Sierra	$68.01	35.0%	$44.21	$48.63

[6] Assumed average moisture content is from F2M.

The actual costs will not be known until wood supply agreement terms have been provided by potential suppliers.

It is assumed that each tonne of roundwood will generate 10% by weight of bark from debarking. The bark will be used as fuel for the thermal oil heater that supplies energy to the ORC turbine[7].

Pellet Plant Fundamental Costs

Since both proposed sites have the same assumed cost structures, the financial modeling for either plant location, and for either port, will yield the same results. Labor costs (discussed below) are almost identical as well.

The GSFA project pellet mills will have to be designed with operating woodyards to manage the incoming logs (roundwood). Those logs will have to be inventoried (stacked) and reclaimed and then debarked and chipped prior to entering the pellet mill[8]. The power demand modeled for each mill's debarking and chipping operations are proportional to the expected ratio of chips to roundwood. As the F2M analysis shows, the assumption is 50% roundwood and 50% chips for pellet feedstock.

The first table below shows the basic assumptions for the size of the plant, the capital cost of the plant in terms of cost per tonne per year of nameplate capacity, and the production ramp up over the first two years of operation. The capital cost is based on an equipment cost per tonne per year of nameplate capacity plus the costs of engineering and construction as a percent of the equipment cost.

Pellet Production WITH CHP			Annually (MT/yr)	
Pellet Plant Nameplate Tonnage				500,000
Actual Tonnage at 92% capacity			White Pellet Output =>	460,000
			Production Ramp Up	**Avg. capacity Factc**
Pellet Factory Equip Cost/Tonne/Year WHITE	$146		0 - 6 months	35%
			7 - 24 months	65%
Engineering and Construction as percent of CAPEX ===>	35%		All other Years	92%
Engineering and Construction as $/Tonne/Year => **$51.10**		Hours per Year at full operation =>		8,059
Pellet Plant CHP Equip and Construction Cost per Tonne of Installed capacity/Year ===>				**$273**

The table below shows the estimated breakout of the costs and a tentative timeline for the project.

[7] The organic Rankine cycle (ORC) turbine receives the energy to spin the turbine via a hot oil system and heat exchanger. The hot oil is heated by a thermal oil heater that is fueled with biomass. See HERE for a description of a typical system.

[8] The overview of a 500,000 tpy mill that is available via a download link in the "Capital and Operating Costs" section above has photos of radial crane systems used for roundwood management. It also has photos of debarkers and chippers.

Project Cost Assumptions (in $ Millions) and Development Timeline for a 500,000 Tonne per Year (nameplate) Pellet Factory				
White Pellet Factory - With CHP	**Begin**	**Months**	**End**	**Amount**
Project Cost				
Initial Business Development	Jan-21	6	Jul-21	$0.300
Development Engineering and Permitting	Jan-21	6	Jul-21	$0.200
ORC Turbine System	Jul-21	0	Jul-21	$14.792
Development Contingency	Jul-21	0	Jul-21	$0.250
Pellet Plant CAPEX	Jul-21	18	Jan-23	$73.000
Engineering, Construction	Jul-21	18	Jan-23	$25.550
Start up Costs	Jan-23	0	Jan-23	$1.000
Other (legal, etc.)	Jan-23	0	Jan-23	$0.500
Commissioning Contingency	Jan-23	0	Jan-23	$0.500
Working capital Cost	Jan-23	1	Feb-23	$1.000

Until each site undergoes a detailed engineering analysis, the actual equipment cost and the engineering and constructions costs (also called "balance of plant" or BOP) and the timing of the construction schedule are not known. The estimates above are based on FutureMetrics experience with similar sized plants. The impact of changes in the assumed cost per tonne per year of capacity and the BOP costs are analyzed in the section below containing the sensitivity analyses.

Variable and Fixed Costs other than Wood Costs

Grid supplied electricity cost is assumed to average $0.0816/kWh[9]. However, since the plants will each have an ORC turbine/generator, power will only need to be purchased during cold startups or if there is an unplanned shutdown of the ORC systems.

The table below shows the assumptions that drive the capital and operating costs for the ORC system. Note that the ORC turbine/generator is sized to meet dryer demand. The output of the ORC will then be about 10.3 MW[10]. The amount of heat the belt dryer will need is what determines the size of the ORC system.

CHP data - assuming a belt dryer efficiency of 80% for White Pellet Factory	
Tonnage for CHP (Gt)	150,179
MW Output	**10.28**
CAPEX/MW of Installed capacity	$1,390,000
Interconnection Substation Cost	$500,000
Wood (CHP Fuel) Cost/Tonne	$48.63
Power Sales Price/MWh	$0
Power Sales Price Escalator	2.0%
Operating Cost/MWh	$0.020
Gross Efficiency of TG set	17.5%
Heat Losses	10.0%
Belt dryer efficiency	80%

The plant will use on average an estimated 9.3 MW of electricity which is less than the ORC T/G generates. GSFA has stated that sales of power to the grid are unlikely. Therefore, on average the generator output will

[9] https://www.electricitylocal.com/states/california/industry/

[10] The actual size of the ORC system may be larger or smaller depending on the units offered by the ORC supplier.

be slightly less than the output required to produce sufficient heat for drying. The thermal oil circulation system can be designed to divert the heat that is not needed by the turbine to the belt dryer.

The average usage factor (see table below) is assumed to be 75%. Thus, there will likely be periods when the power demands of the motors are greater than 75% of their maximum demand.

The proportion of incoming wood fiber than has to be debarked and chipped influences the overall power demand.

Note that the actual power demand will be defined after detailed engineering is done for the plants and detailed motor lists and load factors are calculated. Estimated demand is based on an average of data from operating pellet plants. The estimated demand of 163 KWh per tonne of pellets produced is a normal value for a plant with front end debarking and chipping.

Both the central sierra site and the Northern California site have the same costs that are shown for the central sierra site below.

White Pellet Plant Variable Operating Costs for the Central Sierra site		
Operating and maintanence Per Tonne		$5.00
Fuel and Oil Expense		$5.00
Total Operating and maintanence Per Tonne		**$10.00**
Electricity capacity and Usage calculation		
HP by equipment	Includes Chipping?	16,675
KW (1hp = 0.7457kW)	Yes at 50.0% of total for Central Sierra	12,435
capacity Average Usage Factor		75%
KW capacity		**9,326**
KWh/t		163
Electricity Price per kWh		$0.0816

SG&A

Selling, general, and administrative (SG&A) costs are assumed as shown in the next table. Note that the assumed costs may require significant revision after more focused work on the potential pellet plant sites and on defining how the production will be certified to comply with sustainably criteria.

SG&A Allocation and Other Operating Assumptions		
Insurance Expense		$500,000
Property Taxes		$0
SG&A Allcaocation		$100,000
Other Miscellaneous Expenses		$50,000
Management Travel and Support		$50,000
Front Office and Sustainablity Certification Costs ($/mt and total)	$2.50	$1,150,000
SG&A ($/annually)		**$1,850,000**

Labor

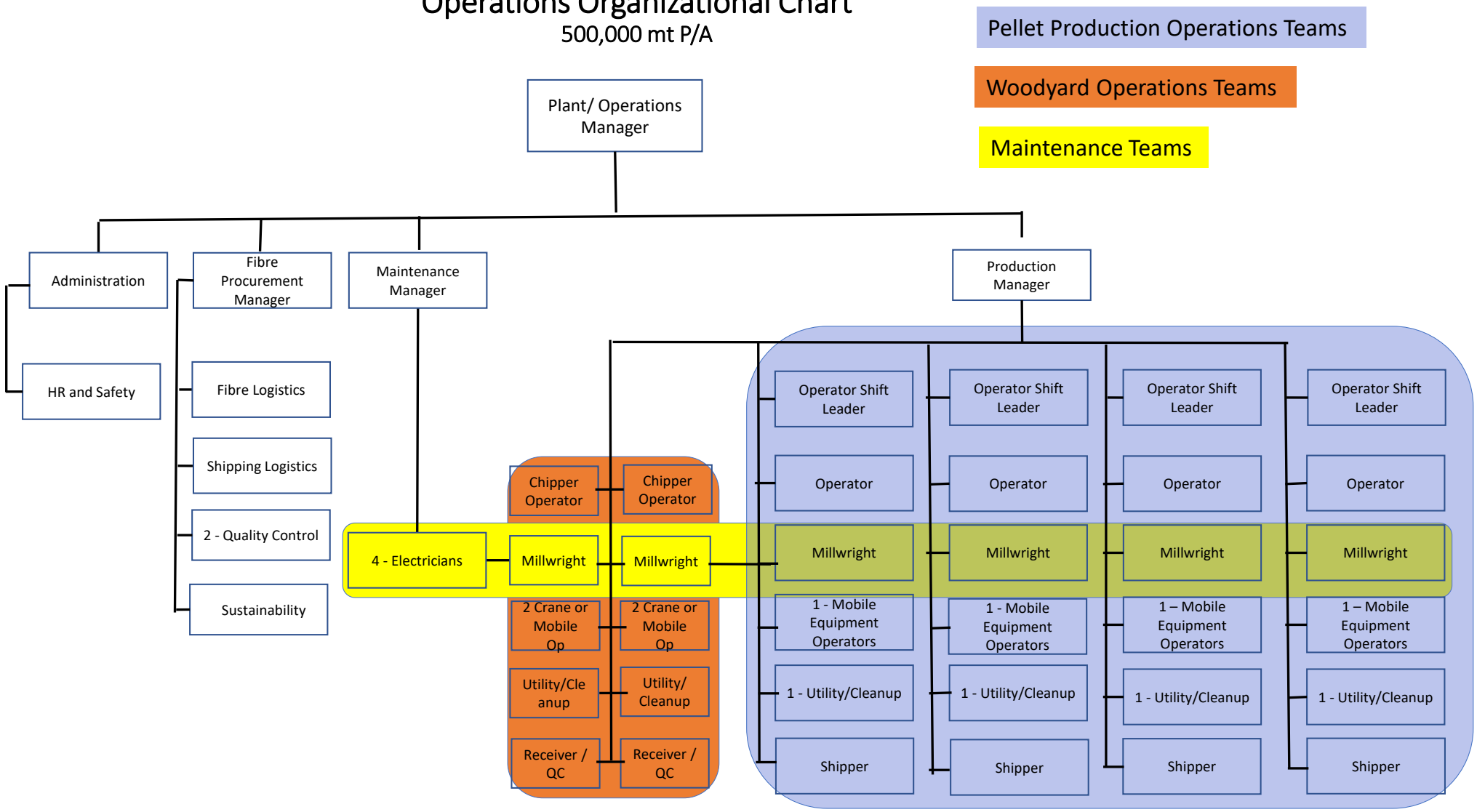
Labor costs at both plants are based on US Department of Labor data from the 2019 Occupational Employment Statistics (OES) survey released June 2020. There are small differences in labor rates between the northern and central sites. However, the weighted average wage bills per tonne of pellets produced are almost identical. For the northern site it is $8.96/tonne and for the central site it is $8.76/tonne.

There is only a $0.20 per tonne impact on cash flows of one site over the other. For the cash flow analysis and sensitivity analysis that follows, the northern site labor structure is used.

The chart on the next page shows how the staffing is organized.

Operations Organizational Chart

500,000 mt P/A



The labor cost schedule for the northern site that is used in this analysis is shown below. The central sierra site schedule is similar and yields an estimated cost per tonne that is twenty cents lower.

Labor - Northern California				
	# of Employees	Annual Salary	Overtime Factor	Benefits etc.
Plant and Wood Yard Operations				
Plant Manager	1	$103,000	1.00	20%
Maintenance Manager	1	$80,000	1.00	20%
Operator Shift Leaders	4	$66,000	1.00	20%
Process Operators	4	$50,000	1.00	20%
Millwrights	4	$55,000	1.00	20%
Electricans	4	$67,000	1.00	20%
Mobile Equipment Operators	4	$50,000	1.00	20%
Shippers - Rail or Truck	4	$32,000	1.00	20%
Utility Worker (cleanup - etc)	4	$32,000	1.00	20%
Chipper Operators	2	$32,000	1.00	20%
Millwrights	2	$55,000	1.00	20%
Mobile Equipment Operators	4	$50,000	1.00	20%
Receiver - QC & Scaler	2	$32,000	1.00	20%
Utility Worker	2	$31,000	1.00	20%
Total Employees	42	$2,091,000	plus OT and Beni =>	$418,200
	Labor per Tonne	$8.96	Total Labor Bill	$4,122,257

Financing and Other Operating Assumptions

Financing Assumptions	
Equity Financing - Construction	25.0%
Debt Financing - Construction	75.0%
	100%
Construction Debt Placement Fees	
Equity	0.25%
Debt	0.50%
Revolving Line of Credit	
Interest Expense	6.00%
Construction Loan	
Interest Expense	6.00%
% cash Sweep for Loan Repayment	40.0%
Construction Loan Funding Date	Jul-21
Minimum Capacity Factor for Equity Distributions	75%
Equity Distributions as % of Free cash Flow	100%

Other Operating Assumptions	
Years Interest Expense in DSR (debt service reserve)	0.50
Annual Ongoing CAPEX (Yr 2 and beyond)	$1,000,000
Years Mandatory Amortization in DSR	0.50
Months COGS / Expenses in Operating Reserve	1.0
Minimum cash (millions)	$0.50
Book Tax Rate	0%
Discount Rate for NPV calculations (WACC)	7.00%

Note that the project is expected to not pay any income-based or property taxes.

Weighted Avg. Cost of Capital (WACC)	
Equity Required Return	10.00%
Interest Rate on Construction Loan	6.00%
WACC	**7.00%**

Offtake Pricing

The assumed FOB pellet pricing is shown in the table below. Note that the basis for the FOB price is tonnes but the actual value of the pellets in the offtake transaction is based on dollars per gigajoule ($/GJ). A typical off-take agreement will specify a basis $/GJ (usually 17 GJ/tonne) and if the delivered pellets have a higher energy density per tonne, the price per tonne will be pro-rated based on the difference between the basis and the actual GJ/tonne.

In the table below, the actual GJ/tonne is assumed to be 18.0. This is a reasonable assumption given the predominance of softwood in the feedstock in the area from which the pellet plants will draw wood.

Off-Take Contract Assumptions White Pellets					
		Pricing		**Escalation**	**Adjusted Price**
				1.5%	
	2021 White Pellet Price FOB	$160.00	per Metric Tonne		
	Mid 2024 price for White Pellets	$177.15	per Metric Tonne		
Actual GJ/MT	18.00	Contracted GJ/MT			17.00
		Actual GJ/MT			18.00
		Adjusted Off-take Price			**$169.41**

It is assumed that the FOB pellet revenue per tonne increases at a rate of 1.5% per year. This is consistent with currently negotiated 12 or more year offtake agreements for Japan. **For shorter terms, the negotiated escalation rate may be higher.**

Source and Uses of Funds

Based on the capital cost assumptions and some of the financing assumptions, the following shows the estimated sources and uses of funds.

Sources and Uses				White Pellet Plant		
Total Cost per Ton Installed Capacity	**$273**	**Plant Nameplate in TPY**	**500,000**			
Sources ($MM)	***Total***	***%***		***Uses ($MM)***	***Total***	***%***
Equity				**Project Capital Costs**		
Project Equity Funding	$34.47	25%		Initial Business Development	$0.30	0.22%
Total	**$34.47**	**25%**		ORC Turbine System	$14.79	10.84%
				Development Contingency	$0.25	0.18%
				Pellet Plant CAPEX	$74.45	54.54%
Debt						
Construction Loan	$102.04	75%		Engineering, Construction	$26.06	19.09%
				Start up Costs	$1.02	0.75%
Total Debt	**$102.04**	**75%**		Other (legal, etc.)	$0.51	0.37%
				Commissioning Contingency	$0.52	0.38%
Other (Grants, Programs, etc.)	**$0.00**	**0%**		Working capital Cost	$1.03	0.76%
				Initial Inventory	$2.96	2.17%
				Total	**$121.89**	**89.3%**
				Financing Costs		
				Interest During Construction	$5.55	4.07%
				Debt Service Reserve	$5.58	4.09%
				Debt Placement Fees	$0.51	0.37%
				Equity Placement Fees	$0.09	0.06%
				Total	**$14.62**	**10.7%**
Total Sources	**$136.51**	**100%**		**Total Uses**	**$136.51**	**100%**

Note that the financing costs are based on assumptions for interest rates and reserve funding that has not as yet been determined. The ramp up schedule for the project defines the needs for financing of cash flows prior to the sale of the first shipment pellets.

Cash Flow Analysis

The analysis assumes that plant construction begins in July 2021 and takes 18 months until startup.

The summary cash flows in the next table are for the northern site. The cash flows for the central site are identical except that the labor cost per tonne is estimated to be twenty cents lower.

The table shows the "pre-tax" financial returns. There is no "after-tax" analysis since the two plants will not pay taxes.

Electricity is assumed to be produced by the CHP. In this analysis, electricity cost is zero.

However, the plant will need grid power for a cold start up. It is recommended that GSFA engage with the utility to determine what the costs will be for several cold starts during a year.

Summary Financial Results

Pellet Factory with a Nameplate of 500,000 Tonnes per Year -North California		
Pre Tax Financial Returns (NPV in $ millions at 7.0%) with no exit strategy		
Based on 10 yr S/L amort depreciation schedule in millions	**NPV (@7.00%)**	**IRR**
Project cash Flow Returns based on Full Project Finance Cost	$ (91.82)	-2.6%
Project cash Flow Return for Equity Investors	$ (29.77)	Low

Estimated cash Flows - based on a 10 yr S/L amort depreciation schedule							
($ millions)	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**$/T 2026**
Total Revenue	$ -	$ 7.50	$ 47.95	$ 81.49	$ 82.71	$ 83.95	$ 182.50
Minus Cost of Goods							
Pellet Fibre	$ -	$ 2.99	$ 18.99	$ 32.43	$ 32.91	$ 33.41	$ 72.62
CHP Fuel	$ -	$ 0.71	$ 4.53	$ 7.74	$ 7.86	$ 7.98	$ 17.34
Logistics Costs	$ -	$ 1.96	$ 12.45	$ 21.26	$ 21.58	$ 21.90	$ 47.62
Total COGS	$ -	$ 5.65	$ 35.97	$ 61.43	$ 62.35	$ 63.28	$ 137.57
Gross Profit	$ -	$ 1.85	$ 11.98	$ 20.06	$ 20.36	$ 20.67	$ 44.93
Gross Margin	0.0%	24.6%	25.0%	24.6%	24.6%	24.6%	
Minus Operating Expenses							
Labor	$ -	$ 0.62	$ 2.49	$ 4.26	$ 4.32	$ 4.39	$ 9.54
Electricity	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Maintenance, consumables, and fuel costs	$ -	$ 0.58	$ 3.69	$ 6.30	$ 6.40	$ 6.49	$ 14.12
SG&A	$ -	$ 0.46	$ 1.87	$ 1.91	$ 1.94	$ 1.97	$ 4.28
Other Costs	$ -	$ 0.02	$ 0.12	$ 0.20	$ 0.21	$ 0.21	$ 0.46
Operating Expenses	$ -	$ 1.68	$ 8.17	$ 12.68	$ 12.87	$ 13.06	$ 28.39
EBITDA	**$ -**	**$ 0.2**	**$ 3.80**	**$ 7.39**	**$ 7.50**	**$ 7.61**	**$ 16.54**
EBITDA Margin		2.2%	7.9%	9.1%	9.1%	9.1%	
Cash Flow							
Changes Net Working Capital	$ -	$ (1.47)	$ (4.29)	$ (4.01)	$ 0.14	$ (0.19)	$ (0.41)
Interest Expense	$ -	$ (1.51)	$ (5.86)	$ (5.55)	$ (5.25)	$ (4.94)	$ (10.75)
Cash Taxes	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Operating cash Flow	$ -	$ (2.82)	$ (6.35)	$ (2.18)	$ 2.39	$ 2.48	$ 5.38
Total Capital	$ (25.28)	$ (101.72)	$ (8.68)	$ -	$ -	$ -	$ -
Debt Financing	$ 18.62	$ 76.29	$ 6.51	$ -	$ -	$ -	-
Ongoing CAPEX	$ -	$ (0.25)	$ (1.01)	$ (1.03)	$ (1.04)	$ (1.06)	$ (2.30)
Debt Repayment	$ -	$ (1.27)	$ (5.07)	$ (5.07)	$ (5.07)	$ (5.07)	$ (11.02)
Other	$ -	$ 5.25	$ 14.11	$ 8.28	$ 3.72	$ 3.65	$ 7.94
Free Cash Flow to Equity	**$ (6.66)**	**$ (24.52)**	**$ (0.49)**	**$ -**	**$ 0.00**	**$ -**	**$ -**

The financial summary on the following page is also contained in the Excel workbook that accompanies this report. In addition to the financial summary shown on the following page, the workbook has tabs containing an income statement, balance sheet, and cash flow statement that are monthly for 18 months and then annual to 2041.

Financial Summary

(Dollars in $ Millions)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
Income Statement and Cash Flow																					
Total Revenue	**$0.00**	**$7.50**	**$47.95**	**$81.49**	**$82.71**	**$83.95**	**$85.21**	**$86.49**	**$87.79**	**$89.10**	**$90.44**	**$91.80**	**$93.17**	**$94.57**	**$95.99**	**$97.43**	**$98.89**	**$100.37**	**$101.88**	**$103.41**	**$104.96**
Growth				*69.95%*	*1.50%*	*1.50%*	*1.50%*	*1.50%*	*1.50%*	*1.50%*	*1.50%*	*1.50%*	*1.50%*	*1.50%*	*1.50%*	*1.50%*	*1.50%*	*1.50%*	*1.50%*	*1.50%*	*1.50%*
Pellet Fibre	$0.00	$2.99	$18.99	$32.43	$32.91	$33.41	$33.91	$34.42	$34.93	$35.46	$35.99	$36.53	$37.08	$37.63	$38.20	$38.77	$39.35	$39.94	$40.54	$41.15	$41.77
Dryer Fuel	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
CHP Fuel	$0.00	$0.71	$4.53	$7.74	$7.86	$7.98	$8.10	$8.22	$8.34	$8.47	$8.59	$8.72	$8.85	$8.98	$9.12	$9.26	$9.40	$9.54	$9.68	$9.83	$9.97
Steam Generator Fuel	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Shipping Costs	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Port Charges	$0.00	$0.28	$1.77	$3.02	$3.07	$3.11	$3.16	$3.21	$3.26	$3.31	$3.36	$3.41	$3.46	$3.51	$3.56	$3.62	$3.67	$3.72	$3.78	$3.84	$3.89
Rail/Trucking Costs	$0.00	$1.68	$10.68	$18.24	$18.51	$18.79	$19.07	$19.36	$19.65	$19.94	$20.24	$20.55	$20.85	$21.17	$21.48	$21.81	$22.13	$22.47	$22.80	$23.15	$23.49
Total COGS	**$0.00**	**$5.65**	**$35.97**	**$61.43**	**$62.35**	**$63.28**	**$64.23**	**$65.20**	**$66.18**	**$67.17**	**$68.18**	**$69.20**	**$70.24**	**$71.29**	**$72.36**	**$73.45**	**$74.55**	**$75.67**	**$76.81**	**$77.96**	**$79.13**
Gross Profit	**$0.00**	**$1.85**	**$11.98**	**$20.06**	**$20.36**	**$20.67**	**$20.98**	**$21.29**	**$21.61**	**$21.93**	**$22.26**	**$22.59**	**$22.93**	**$23.28**	**$23.63**	**$23.98**	**$24.34**	**$24.70**	**$25.07**	**$25.45**	**$25.83**
Gross Margin		*24.62%*	*24.98%*	*24.62%*	*24.62%*	*24.62%*	*24.62%*	*24.62%*	*24.62%*	*24.62%*	*24.62%*	*24.61%*	*24.61%*	*24.61%*	*24.61%*	*24.61%*	*24.61%*	*24.61%*	*24.61%*	*24.61%*	*24.61%*
Labor	$0.00	$0.62	$2.49	$4.26	$4.32	$4.39	$4.45	$4.52	$4.59	$4.66	$4.73	$4.80	$4.87	$4.94	$5.02	$5.09	$5.17	$5.25	$5.32	$5.40	$5.49
Electricity Demand by Mill	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Operating and Maintenance Expense	$0.00	$0.58	$3.69	$6.30	$6.40	$6.49	$6.59	$6.69	$6.79	$6.89	$7.00	$7.10	$7.21	$7.32	$7.43	$7.54	$7.65	$7.77	$7.88	$8.00	$8.12
Bagging Cost for Heating Pellets	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
SG&A	$0.00	$0.46	$1.87	$1.91	$1.94	$1.97	$2.00	$2.03	$2.06	$2.09	$2.12	$2.15	$2.18	$2.22	$2.25	$2.28	$2.32	$2.35	$2.39	$2.43	$2.46
Other Variable	$0.00	$0.02	$0.12	$0.20	$0.21	$0.21	$0.21	$0.22	$0.22	$0.22	$0.23	$0.23	$0.23	$0.24	$0.24	$0.24	$0.25	$0.25	$0.25	$0.26	$0.26
Operating Expenses	**$0.00**	**$1.68**	**$8.17**	**$12.68**	**$12.87**	**$13.06**	**$13.26**	**$13.45**	**$13.66**	**$13.86**	**$14.07**	**$14.28**	**$14.49**	**$14.71**	**$14.93**	**$15.16**	**$15.39**	**$15.62**	**$15.85**	**$16.09**	**$16.33**
EBITDA	**$0.00**	**$0.16**	**$3.80**	**$7.39**	**$7.50**	**$7.61**	**$7.72**	**$7.84**	**$7.95**	**$8.07**	**$8.19**	**$8.31**	**$8.44**	**$8.56**	**$8.69**	**$8.82**	**$8.95**	**$9.09**	**$9.22**	**$9.36**	**$9.50**
EBITDA Margin		*2.20%*	*7.93%*	*9.06%*	*9.06%*	*9.06%*	*9.06%*	*9.06%*	*9.06%*	*9.06%*	*9.06%*	*9.06%*	*9.06%*	*9.06%*	*9.06%*	*9.05%*	*9.05%*	*9.05%*	*9.05%*	*9.05%*	*9.05%*
EBITDA Growth				*94.16%*	*1.50%*	*1.50%*	*1.50%*	*1.46%*	*1.50%*	*1.50%*	*1.50%*	*1.46%*	*1.50%*	*1.50%*	*1.50%*	*1.46%*	*1.50%*	*1.50%*	*1.50%*	*1.46%*	*1.50%*
Cash Flow Statement																					
Changes in Net Working Capital	$0.00	($1.47)	($4.29)	($4.01)	$0.14	($0.19)	($0.19)	($0.18)	($0.21)	($0.20)	($0.20)	($0.19)	($0.22)	($0.21)	($0.22)	($0.21)	($0.24)	($0.23)	($0.23)	($0.22)	($0.25)
Interest Expense	$0.00	($1.51)	($5.86)	($5.55)	($5.25)	($4.94)	($4.64)	($4.34)	($4.03)	($3.73)	($3.42)	($3.12)	($2.81)	($2.51)	($2.21)	($1.90)	($1.60)	($1.29)	($0.99)	($0.68)	($0.38)
Cash Taxes	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Operating Cash Flow	**$0.00**	**($2.82)**	**($6.35)**	**($2.18)**	**$2.39**	**$2.48**	**$2.89**	**$3.32**	**$3.71**	**$4.14**	**$4.57**	**$5.00**	**$5.40**	**$5.84**	**$6.27**	**$6.71**	**$7.12**	**$7.57**	**$8.00**	**$8.45**	**$8.87**
Total Capital Investment	($25.3)	($101.7)	($8.68)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Debt Financings	18.6	76.3	$6.51	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Capital Expenditures	0.0	(0.3)	($1.01)	($1.03)	($1.04)	($1.06)	($1.07)	($1.09)	($1.11)	($1.12)	($1.14)	($1.16)	($1.17)	($1.19)	($1.21)	($1.23)	($1.25)	($1.26)	($1.28)	($1.30)	($1.32)
Debt Repayment	0.0	(1.3)	($5.07)	($5.07)	($5.07)	($5.07)	($5.07)	($5.07)	($5.07)	($5.07)	($5.07)	($5.07)	($5.07)	($5.07)	($5.07)	($5.07)	($5.07)	($5.07)	($5.07)	($5.07)	($5.07)
Other financing cash flow	0.0	5.3	$14.11	$8.28	$3.72	$3.65	$3.25	$2.84	$2.46	$2.05	$1.64	$1.23	$0.84	$0.42	$0.01	($0.41)	($0.80)	($1.23)	($1.65)	($2.08)	($2.47)
Free Cash Flow to Equity Holders	**($6.7)**	**($24.5)**	**($0.49)**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**($0.00)**	**($0.00)**	**$0.00**	**$0.00**	**$0.00**	**($0.00)**	**($0.00)**	**$0.00**	**($0.00)**	**$0.00**	**$0.00**	**$0.00**	**$0.00**

The results suggest that, given the assumptions used in the analysis, the projects are not financially viable.

The sensitivity analysis that follows highlights several critical inputs. Based on this analysis, unless the two pellet factory projects address one or more of those critical inputs, the projects would appear to be unfeasible.

Sensitivity Analysis

There are several critical inputs that have strong impacts on the project cash flows. The analysis below looks are the rail cost assumption, wood cost, FOB pellet price, the annual escalator on the pellet offtake price, and the capital cost assumptions.

Rail

With all other inputs held constant, the impact of rail costs on the unleveraged and leveraged IRR are shown in the next two tables [11].

Unleveraged IRR (20 Years) at a nameplate capacity of 500,000 TPY for White - Northern California

Rail cost per tonne =>	$22	$24	$26	$28	$30	$32	$34	$36	$38	$40
	7.9%	6.9%	5.9%	4.9%	3.8%	2.6%	1.3%	-0.9%	-3.4%	-6.5%

Leveraged IRR (20 Years) at a nameplate capacity of 500,000 TPY for White - Northern California

Rail cost per tonne =>	$22	$24	$26	$28	$30	$32	$34	$36	$38	$40
	9.7%	7.9%	5.9%	3.7%	0.8%	-4.5%	Low	Low	Low	Low

GSFA has directed FutureMetrics to use $34 per short ton ($37.40 per metric tonne) as the assumed cost to move pellets by rail from both sites to either of the selected ports. Compared to other successful projects this rate is an outlier at the high end. As the sensitivity table above shows, with all other inputs held constant, the project will not be financially viable at that rate or even at rates that are marginally lower.

FOB Escalator

With all other inputs held constant, including holding the rail cost at the assumed $37.40/tonne, changes in the FOB offtake price adjuster have the following impact on the estimated leveraged IRR.

Leveraged IRR (20 Years) at a nameplate capacity of 500,000 TPY for White - Northern California

FOB price adjust =>	1.20%	1.30%	1.40%	1.50%	1.60%	1.70%	1.80%	1.90%	2.00%	2.10%
	Low	Low	Low	Low	Low	-19.0%	-3.3%	1.1%	3.6%	5.5%

If rail costs cannot be lowered significantly, the project may still be viable financially if the annual price adjustment can be near 2% or higher.

[11] Excel's IRR function returns an error with some cash flow series that have zero or very low future cash flows. The workbook returns the word "low" if the IRR function returns an error.

Delivered Wood Cost and the FOB Price of Pellets

The cost of wood and the FOB price of the pellets have a significant impact on the project's cash flows. The following three tables show the sensitivity of the leveraged IRR with rail costs at the rate used in the financial analysis, with rail costs at $25/tonne, and with rail costs at $25/tonne and the annual FOB price adjuster at 2.0%.

The FOB price used in the tables below is the white pellet price in 2020 at the basis energy density of 17.0 GJ/MT. The actual FOB price is based on the added energy density above 17.0 GJ/tonne.

Basis White Pellet Price		Leveraged IRR (20 Years) at a nameplate capacity of 500,000 TPY for White - Northern California								
FOB $/GJ=>		$9.85	$10.19	$10.53	$10.87	$11.21	$11.55	$11.89	$12.23	$12.57
FOB $/MT=>		$145	$150	$155	$160	$165	$170	$175	$180	$185
Average Delivered Wood Cost/MT	$ 30.00	Low	Low	-6.1%	4.7%	9.8%	14.0%	17.7%	21.2%	24.5%
	$ 32.00	Low	Low	Low	-1.0%	6.2%	10.9%	14.9%	18.6%	22.0%
	$ 34.00	Low	Low	Low	Low	1.4%	7.5%	12.0%	15.9%	19.5%
	$ 36.00	Low	Low	Low	Low	-14.6%	3.4%	8.8%	13.0%	16.8%
	$ 38.00	Low	Low	Low	Low	Low	-4.8%	5.0%	9.9%	14.0%
	$ 40.00	Low	Low	Low	Low	Low	Low	-0.5%	6.4%	11.0%
	$ 42.00	Low	Low	Low	Low	Low	Low	Low	1.8%	7.7%
	$ 44.00	Low	Low	Low	Low	Low	Low	Low	-11.4%	3.6%
	$ 46.00	Low	Low	Low	Low	Low	Low	Low	Low	-3.6%

With Rail Costs at $37.40/tonne
Annual FOB Adj = 1.5%

Yellow to Red cells are below the WACC which is 7.00%

Basis White Pellet Price		Leveraged IRR (20 Years) at a nameplate capacity of 500,000 TPY for White - Northern California								
FOB $/GJ=>		$9.85	$10.19	$10.53	$10.87	$11.21	$11.55	$11.89	$12.23	$12.57
FOB $/MT=>		$145	$150	$155	$160	$165	$170	$175	$180	$185
Average Delivered Wood Cost/MT	$ 30.00	0.3%	6.9%	11.5%	15.5%	19.1%	22.5%	25.8%	29.0%	32.1%
	$ 32.00	Low	2.4%	8.2%	12.6%	16.4%	20.0%	23.3%	26.6%	29.7%
	$ 34.00	Low	-8.9%	4.2%	9.4%	13.6%	17.3%	20.8%	24.1%	27.3%
	$ 36.00	Low	Low	-2.2%	5.7%	10.5%	14.6%	18.2%	21.6%	24.9%
	$ 38.00	Low	Low	Low	0.7%	7.1%	11.6%	15.5%	19.1%	22.5%
	$ 40.00	Low	Low	Low	Low	2.8%	8.4%	12.7%	16.4%	20.0%
	$ 42.00	Low	Low	Low	Low	-7.0%	4.5%	9.5%	13.7%	17.3%
	$ 44.00	Low	Low	Low	Low	Low	-1.5%	5.9%	10.7%	14.6%
	$ 46.00	Low	Low	Low	Low	Low	Low	1.1%	7.3%	11.7%

With Rail Costs at $25.00/tonne
Annual FOB Adj = 1.5%

Yellow to Red cells are below the WACC which is 7.00%

Basis White Pellet Price		Leveraged IRR (20 Years) at a nameplate capacity of 500,000 TPY for White - Northern California								
FOB $/GJ=>		$9.85	$10.19	$10.53	$10.87	$11.21	$11.55	$11.89	$12.23	$12.57
FOB $/MT=>		$145	$150	$155	$160	$165	$170	$175	$180	$185
Average Delivered Wood Cost/MT	$ 30.00	9.1%	13.0%	16.6%	19.9%	23.1%	26.2%	29.3%	32.3%	35.3%
	$ 32.00	6.0%	10.3%	14.1%	17.5%	20.8%	24.0%	27.0%	30.1%	33.1%
	$ 34.00	1.9%	7.4%	11.5%	15.1%	18.4%	21.7%	24.8%	27.8%	30.9%
	$ 36.00	-10.0%	3.9%	8.7%	12.5%	16.0%	19.3%	22.5%	25.6%	28.6%
	$ 38.00	Low	-2.2%	5.5%	9.9%	13.6%	17.0%	20.2%	23.4%	26.4%
	$ 40.00	Low	Low	1.2%	6.9%	11.0%	14.6%	17.9%	21.1%	24.2%
	$ 42.00	Low	Low	-14.9%	3.3%	8.2%	12.1%	15.5%	18.8%	22.0%
	$ 44.00	Low	Low	Low	-3.8%	5.0%	9.4%	13.1%	16.5%	19.7%
	$ 46.00	Low	Low	Low	Low	0.4%	6.4%	10.5%	14.1%	17.4%

With Rail Costs at $25.00/tonne
Annual FOB Adj = 2.0%

Yellow to Red cells are below the WACC which is 7.00%

Equipment and Engineering Cost

To see the impact of the assumed equipment cost and balance of plant (BOP) costs, the model has to have the rail cost input set to $25/tonne. Otherwise most of the cells in the sensitivity table throw off IRR function errors and simply show "low". The table below shows the impact on the leveraged IRR across different project cost assumptions.

Leveraged IRR (20 Years) at a nameplate capacity of 500,000 TPY for White - Northern California

BOP as Percent of Equipment Cost	Pellet Factory Equipment Cost per Tonne per Year of Nameplate Capaity								
	$135	$140	$145	$150	$155	$160	$165	$170	$175
25%	9.8%	9.1%	8.5%	7.9%	7.3%	6.7%	6.1%	5.5%	4.9%
30%	9.1%	8.4%	7.8%	7.2%	6.5%	5.9%	5.3%	4.7%	4.1%
35%	8.4%	7.7%	7.1%	6.4%	5.8%	5.2%	4.6%	3.9%	3.3%
40%	7.7%	7.1%	6.4%	5.7%	5.1%	4.4%	3.8%	3.1%	2.5%
45%	7.1%	6.4%	5.7%	5.0%	4.4%	3.7%	3.0%	2.3%	1.6%
50%	6.4%	5.7%	5.0%	4.3%	3.6%	2.9%	2.2%	1.5%	0.7%
55%	5.8%	5.1%	4.4%	3.6%	2.9%	2.2%	1.4%	0.6%	-0.2%
60%	5.2%	4.4%	3.7%	2.9%	2.2%	1.4%	0.6%	-0.3%	-1.3%

With Rail Costs at $25.00/tonne

The project's rates of return are less sensitive to changes in equipment, engineering, and construction costs than to changes in operating costs. Nonetheless, if there is a decision to proceed, a FEED study will define the actual costs to build the project.

These sensitivity tables provide guidance to the GSFA team as to the critical inputs that need focused attention.

The following section adds to the guidance.

Monte Carlo Simulation Analysis[12]

The simulation analysis that follows brings some depth to the understanding of the project's risks. Rather than use a single value for critical input costs, each is assigned a probability distribution. The result is a set of data that allows insight into how each critical input cost contributes to the project's success or failure.

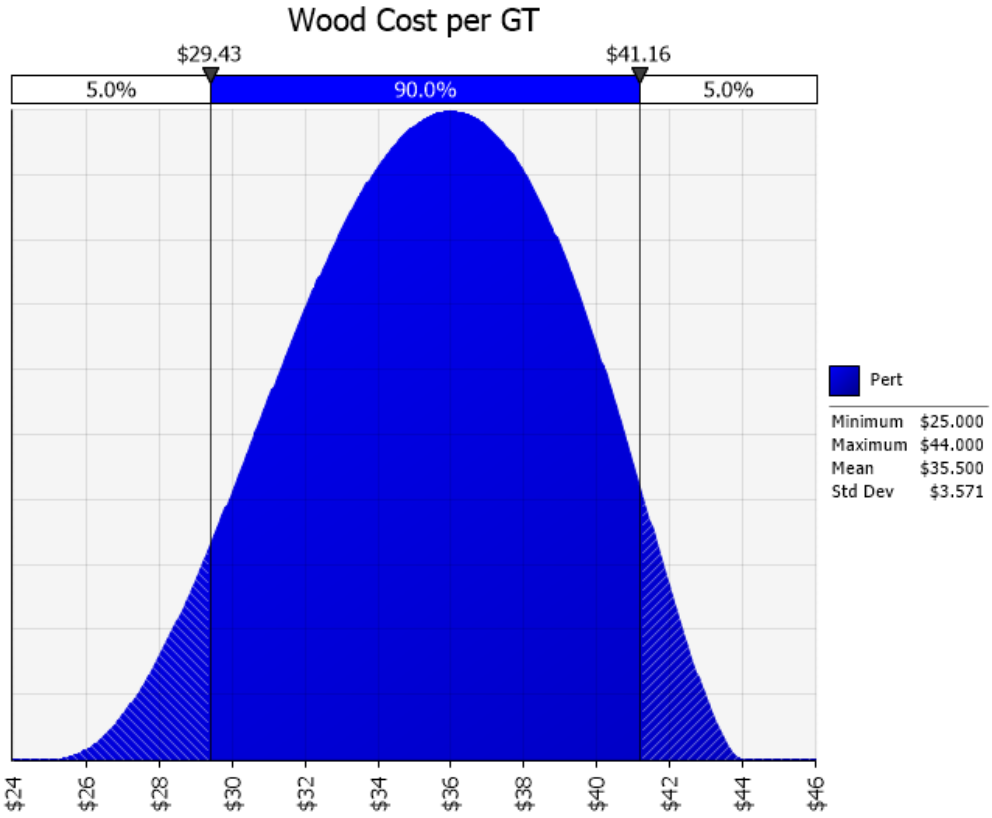
Input Probability Distributions

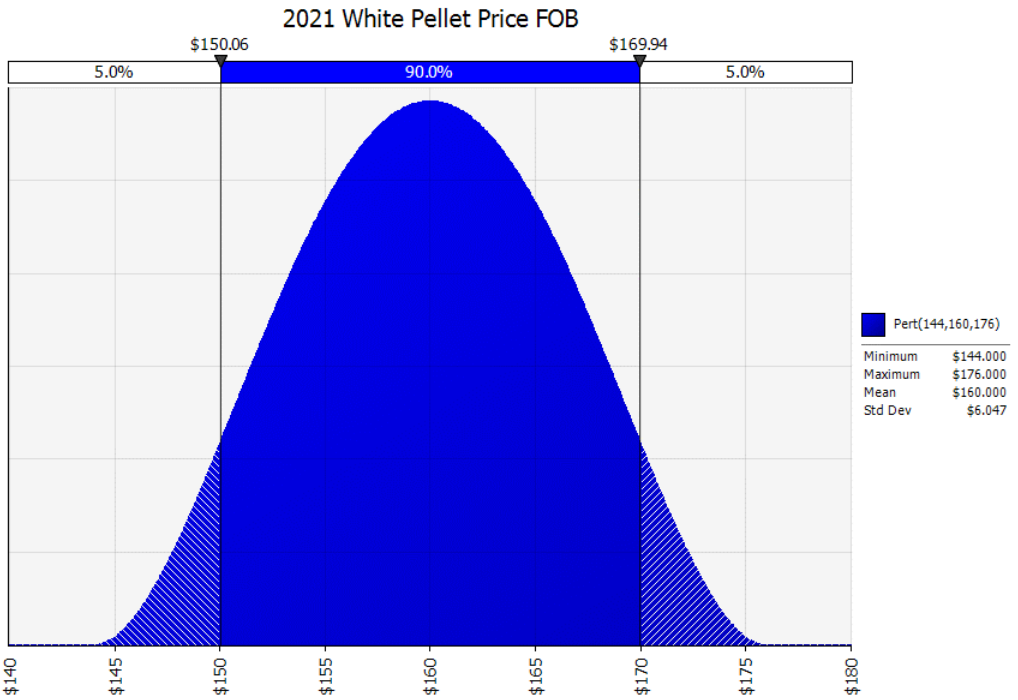
Following are charts that show the assumed probability distributions for the critical inputs to the financial model. All of the curves are PERT distributions[13] with maximum, minimum, and most likely

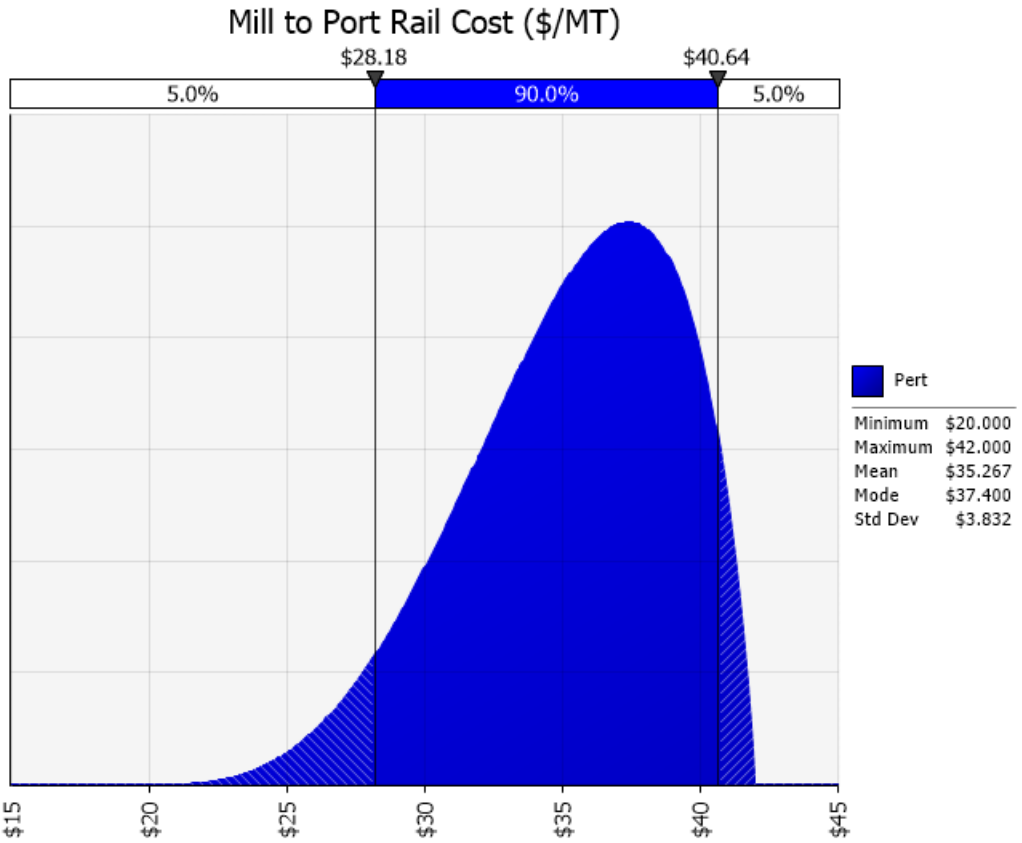
[12] FutureMetrics uses Palisade Corporation's Decision Tools Suite. "Monte Carlo simulation performs risk analysis by building models of possible results by substituting a range of values—a probability distribution—for any factor that has inherent uncertainty. It then calculates results over and over, each time using a different set of random values from the probability functions. Depending upon the number of uncertainties and the ranges specified for them, a Monte Carlo simulation could involve thousands or tens of thousands of recalculations before it is complete. Monte Carlo simulation produces distributions of possible outcome values." From https://www.palisade.com/risk/monte_carlo_simulation.asp

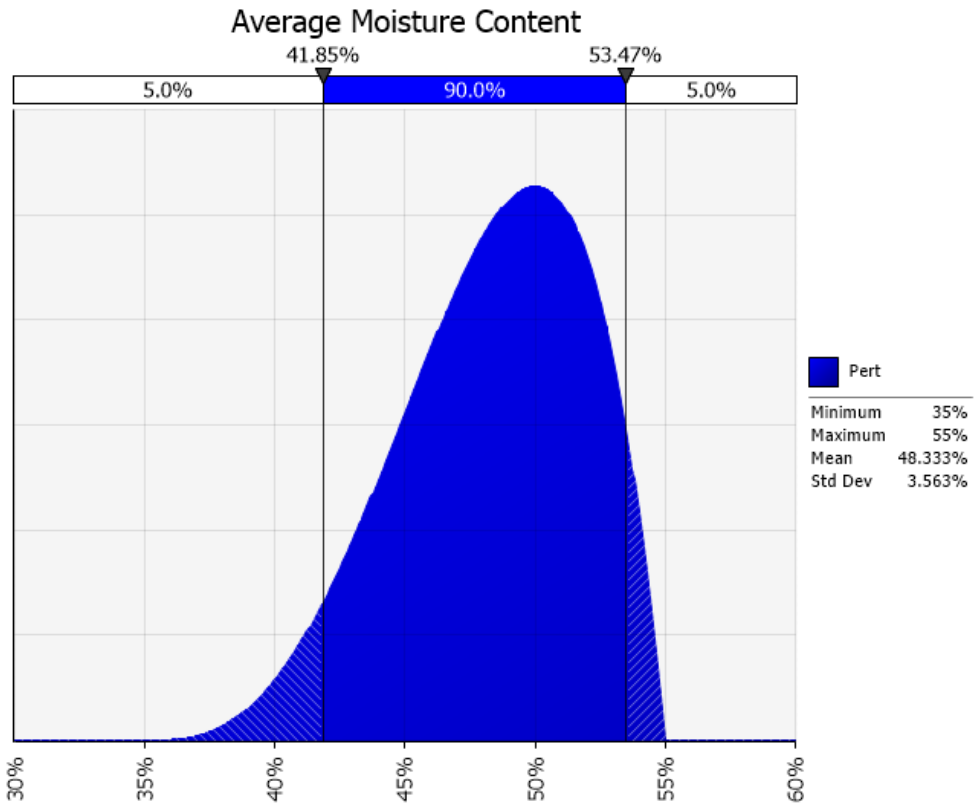
[13] https://en.wikipedia.org/wiki/PERT_distribution

values. Note that the means of asymmetrical distributions will not match the single values used in the financial analysis above (the mode will match).

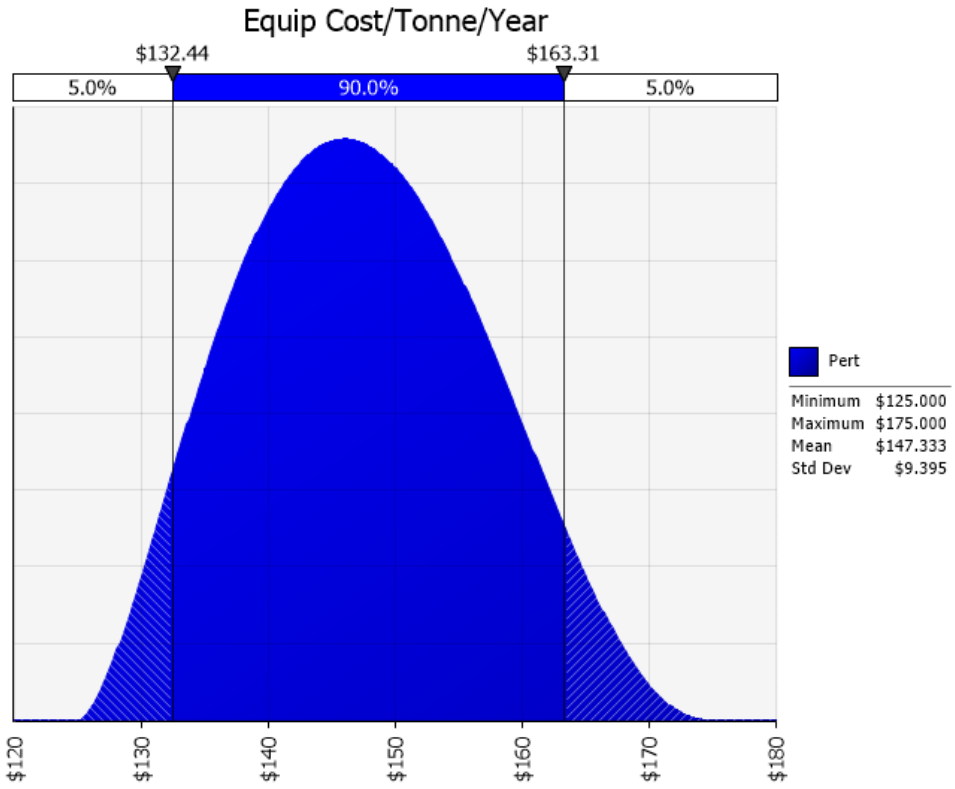


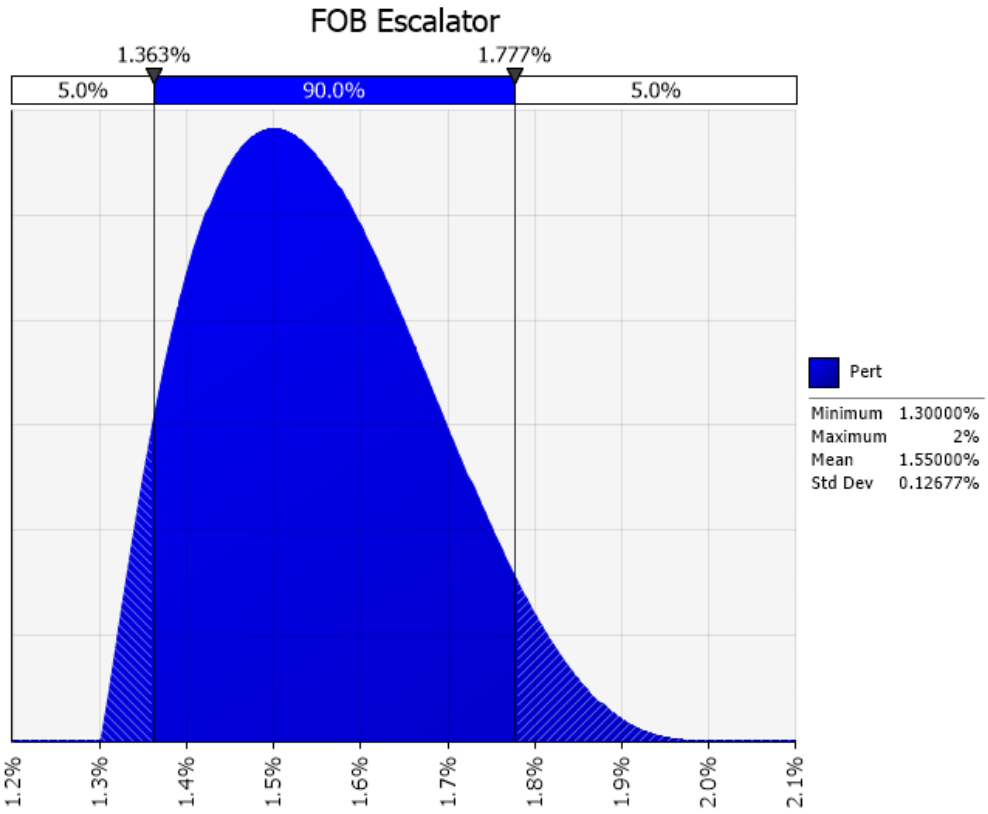

2021 White Pellet Price FOB
$150.06
$169.94
5.0%
90.0%
5.0%
$140
$145
$150
$155
$160
$165
$170
$175
$180
Pert(144,160,176)
Minimum $144.000
Maximum $176.000
Mean $160.000
Std Dev $6.047


Mill to Port Rail Cost ($/MT)
$28.18
$40.64
5.0%
90.0%
5.0%
$15
$20
$25
$30
$35
$40
$45
Pert
Minimum $20.000
Maximum $42.000
Mean $35.267
Mode $37.400
Std Dev $3.832



Average moisture content not only impacts drying energy demand but also changes the wood costs. As moisture content increases, more tonnes of green wood must be purchased to make the same quantity of wood pellets. The solution to that cost risk is to index the price paid for the green tonnes to its moisture content. GSFA has stated that the price paid for incoming wood will be based on a baseline for green wood moisture content and will be indexed up or down if the moisture content is lower or higher. The simulation makes that adjustment as the moisture content input varies around the probability distribution in the chart above.

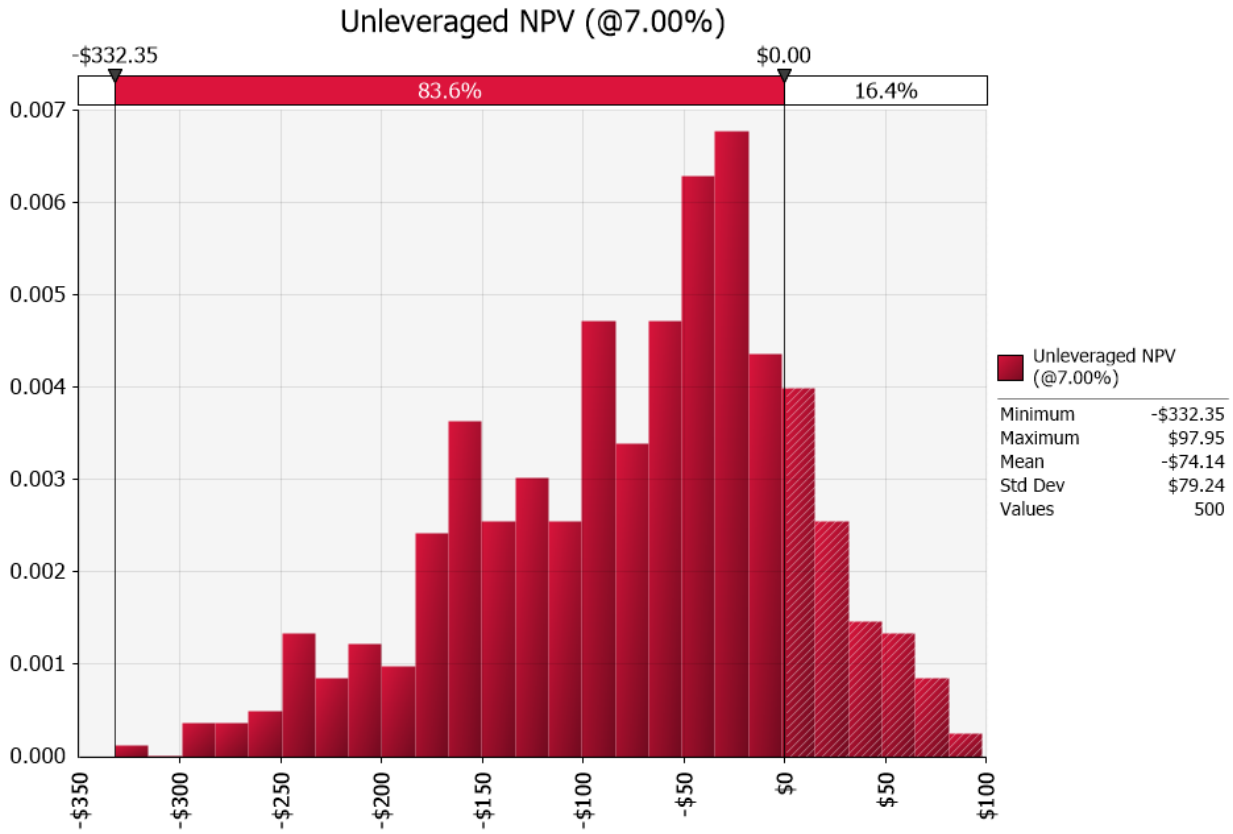

Equip Cost/Tonne/Year
$132.44
$163.31
5.0%
90.0%
5.0%
$120
$130
$140
$150
$160
$170
$180
Pert
Minimum $125.000
Maximum $175.000
Mean $147.333
Std Dev $9.395


FOB Escalator
1.363%
1.777%
5.0%
90.0%
5.0%
1.2%
1.3%
1.4%
1.5%
1.6%
1.7%
1.8%
1.9%
2.0%
2.1%
Pert
Minimum 1.30000%
Maximum 2%
Mean 1.55000%
Std Dev 0.12677%

Results of the Simulations

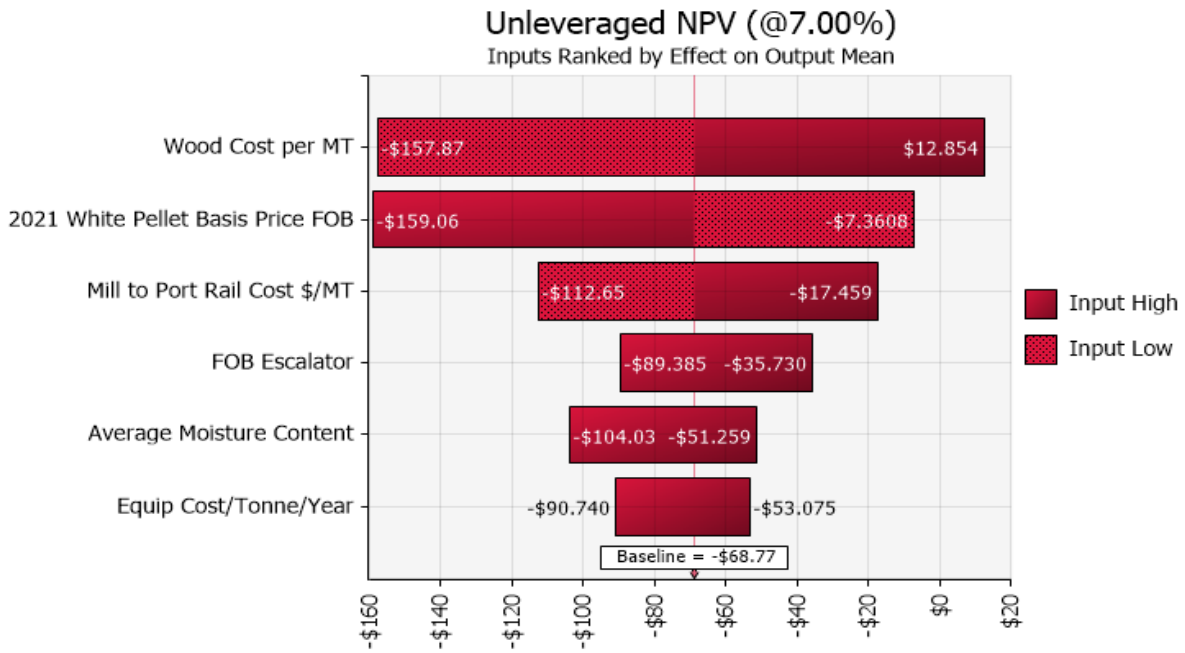
The simulation output metric is the NPV. IRRs that are significantly less than zero throw out errors in the Excel IRR function and thus would not be measured by the simulation.

The simulations are each run for 500 iterations.



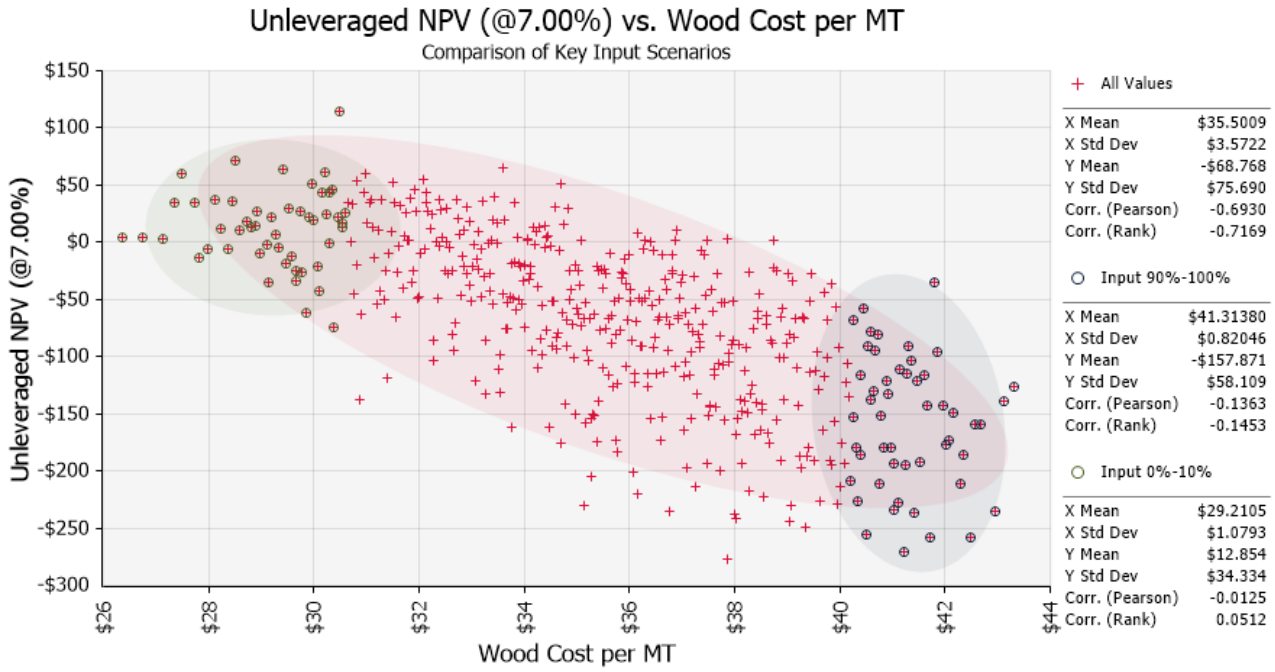
The results of the simulation show that as modeled the project has a 83.6% chance of a negative NPV (or IRR less than 7%). Note that the mean unleveraged NPV in the simulation is lower than the value in the financial summary data above. This is due to the asymmetrical input probability distributions.

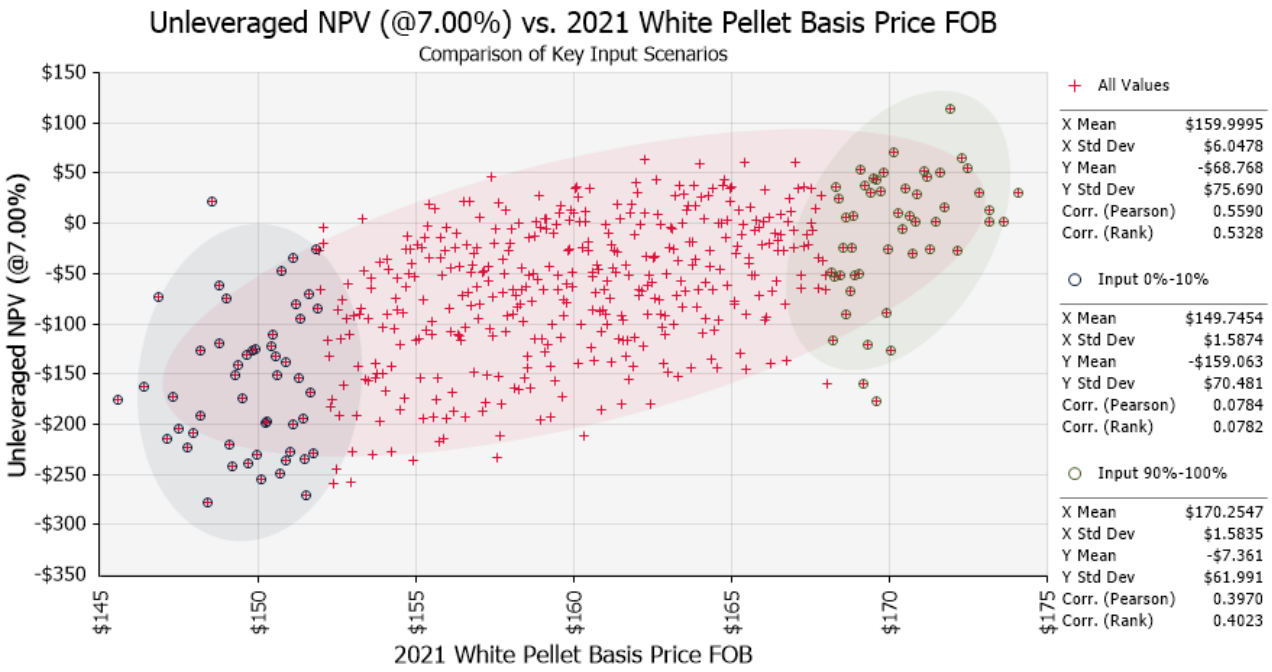
The relative impacts of the uncertain variables used in the simulation are illustrated in the following "tornado" chart. The bars show the impact of the variable as it varies from its minimum to maximum values in the simulation with all other inputs held constant.

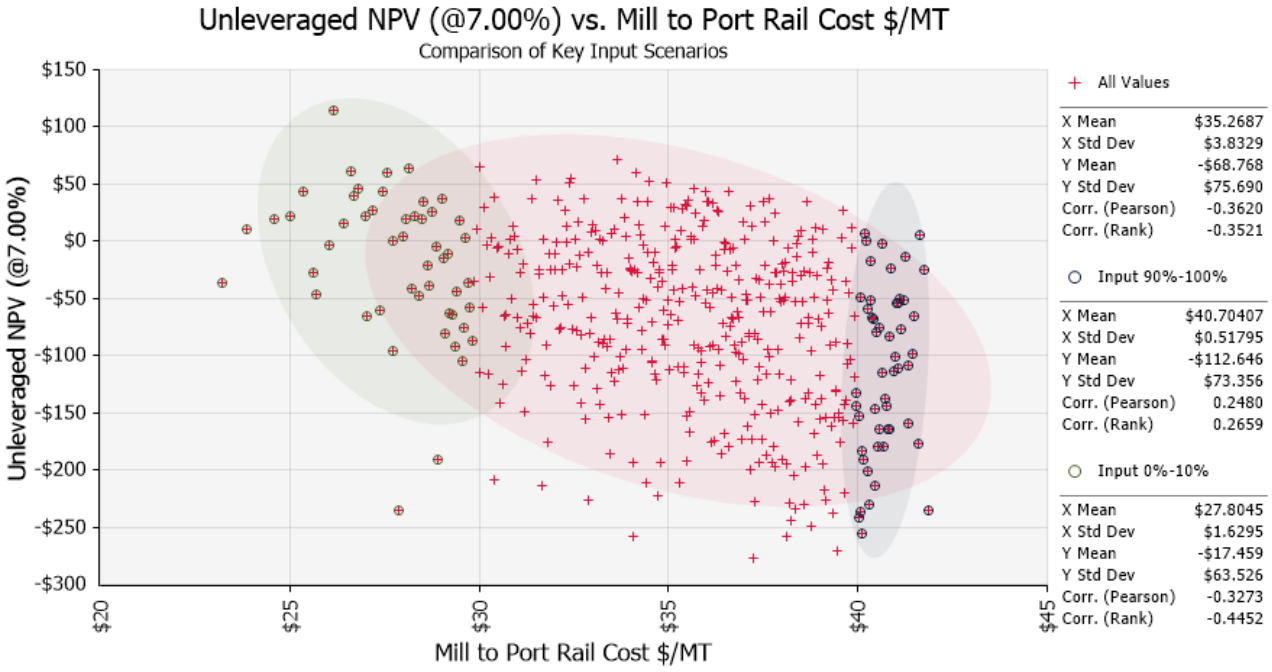


It is noteworthy that the equipment capital cost per tonne per year has a relatively low impact on the ROI metrics.

The top three influences in the tornado chart are shown below in scatter plots illuminating their relationship with the NPV. The shaded ellipses contain 90% of the simulation outcomes. Those results in the top and bottom 10% of the outcomes have a unique dot on the scatter plots and their own 90% eclipse.





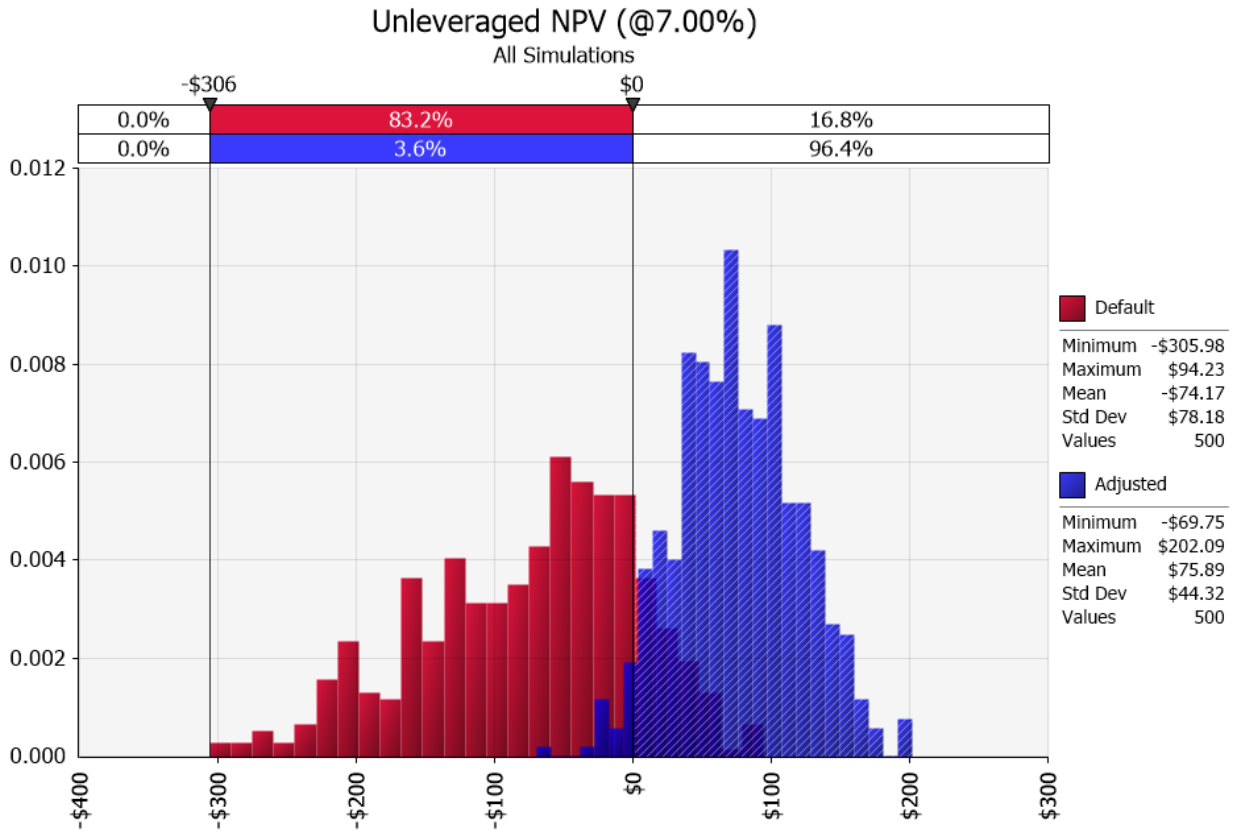


To illustrate the impact of different mean values for the top four influencers in the tornado chart, and the importance of addressing these areas of project cash flow risk, the probability distributions are adjusted to the following parameters.

	Default		
	Lowest	Most Likely	Highest
Wood Costs	$25.00	$35.37	$44.00
Base FOB Price	$144.00	$160.00	$176.00
Rail Cost	$20.00	$37.40	$42.00
FOB Escalator	1.3%	1.5%	2.0%

	Adjusted		
	Lowest	Most Likely	Highest
Wood Costs	$22.00	$32.00	$40.00
Base FOB Price	$155.00	$165.00	$180.00
Rail Cost	$20.00	$25.00	$37.00
FOB Escalator	1.4%	1.8%	2.2%

If all four inputs followed the adjusted distributions, there would be virtually no project risk.



Conclusion to the Financial Analysis

This report has shown that the GSFA concept for producing pellets from forest treatment by-products is <u>not feasible</u> if the current set of critical input costs remain in place.

The results of this report do not necessarily mean that the project should terminate.

The results are intended to inform GSFA about those critical inputs that need to be refined before a major investment decision is made.

If the project proceeds, they should have no issues with achieving acceptable sustainability credentials in any of the major industrial wood pellet importing markets.

Sustainability Certification Strategy

Introduction

This section of the report provides GSFA with an overview of the foundations for sustainability policies and the schemes for certifying compliance with a focus on Japan. Having a clear understanding of how the GFSA project can fit into the certification policies will guide the tactics for wood procurement, tracking and tracing the wood supply, and potentially to provide a valuable enhancement to the value of the wood pellets in the Japanese market.

The appendix to this report has details on sustainability criteria for other countries' that import pellets.

The use of biomass for energy and materials as well as for food, feed and fiber is increasing, especially as governments and industry look for alternatives to fossil fuels. In this context, wood pellets are a biomass category which is already subject to various countries' sustainability standards or will likely be added in the near future. This is due to rising concerns regarding the sustainability of bioenergy materials in general with regard to total GHG emission balances as well as impact on biodiversity. While the highest scrutiny is currently applied to palm oil and palm kernel shell sustainability, wood pellets will become another focus as per FutureMetrics' market intelligence.

Sustainability requirements for biomass vary by country, including in the European Union. While there is the EU RED initiative, various EU countries have their own standards.

The trade in biomass is covered by WTO rules. Countries have the right to adopt standards they deem to be appropriate to, for example, safeguard bioenergy against environmental and social problems which could arise from purely economically driven development. In numerous markets, the key tool to enforce such standards is the requirement of appropriate certification of biomass used for power generation in order to qualify for Feed-in Tariffs (FITs) or renewable energy certificates RECs).

However, herein lies the major challenge for suppliers and purchasers: there is no 'one fits all' standard that is accepted in all major markets, but instead numerous standards which are applicable in some markets and not in others. The reasons for this are manifold but in general it can be said that the respective domestic biomass market as well as respective environmental groups on the one hand and industrial-scale suppliers and operators on the other hand have various levels of influence in each major market. Thus, biomass producers and suppliers need to look at specific regions and countries to evaluate where their product might best meet the sustainability requirements and therefore enable customers to qualify for the respective renewable energy offtake prices.

The following outlines the expected key components of sustainability standards for Japan. Other major pellet importing countries are reviewed in the appendix

Sustainability Criteria and Indicators for Bio Energy[14]

All standards use various building blocks in the form of criteria that are reviewed as part of the certification process. The following criteria are applicable for forest and agricultural biomass, though some may be more appropriate for forest biomass than others.

For the current projects, some of the criteria and indicators could be interpreted as major strong points. It is important to note that not all sustainability standard cover all key criteria. This is the reason why some countries only accept specific standards and not do recognize standards which they view as omitting key aspects. As with all regulatory environments, the biomass sustainability segment is dynamic with new developments and changes. This is one reason why GSFA should have some advantage in the Japanese markets. The changing environment in PKS markets such as in Japan may positively impact the demand for GSFA's biomass from well-respected forest management.

Criterion 1: Sustainable Resource Use

Biomass is a renewable resource, but with two distinguished differences compared to all other renewable energy sources:

- The conversion efficiency of solar energy into chemical energy in plants is only 1-3% which means that significantly more land area is needed to indirectly harvest solar energy through terrestrial biomass cultivation than through concentrated hydro, direct solar or wind energy systems.

- Biomass is the "stuff of life" on this planet. Changes in biomass production, e.g. replacing natural vegetation with cultivated plant varieties, collecting forest residues, or improving crop yields, can have both positive or negative impacts on the ecosystem, carbon balances, and human livelihoods.

Thus, land is a fundamental issue closely related to biomass in general, and to bioenergy in particular. Therefore, the productivity of the land use is one sustainability factor.

Since bioenergy can also be derived from biogenic residues and waste stemming from various flows of biomass which was previously being grown, harvested and processed for non-energy purposes, the efficiency of converting such "secondary" biomass resources into useful energy products is another aspect of sustainable resource use.

Indicator: Land Use Efficiency

The productivity of converting cultivated bioenergy feedstocks into useful energy products such as gaseous, liquid or solid bioenergy carriers, expressed in terms of available bioenergy carriers per hectare of cultivated area, can be set to a minimum net energy yield.

Indicator: Secondary Resource Use Efficiency

For bioenergy carriers stemming from the conversion of secondary biomass resources such as residues and waste, a minimum efficiency, expressed in terms of the heating value of the bioenergy output

[14] See also *Sustainable Bioenergy: Key Criteria and Indicators,* Oeko Institut e.V., 2012

divided by the heating value of the secondary resource input, can be set to increase the resource-efficient use of those resources.

Criterion 2: Biodiversity

The possible effects of biomass cultivation on biodiversity are manifold, ranging from land use change (LUC) related impacts to landscape-level agrobiodiversity effects. Furthermore, extraction and use of biogenic residues (e.g., straw) could indirectly affect biodiversity through impacts on habitats and soil.

Indicator: Conservation of land with significant biodiversity values
The loss of valuable habitats continues to be a key factor for declines in biodiversity, with agriculture and unsustainable forest management being key drivers. It is necessary to protect high-biodiverse areas, including existing protection areas.

Indicator: Land management without negative effects on biodiversity
It is internationally acknowledged that protecting biodiversity in protected zones alone is insufficient to halt the decline of global biodiversity, and especially agro- and forest biodiversity. Therefore, specific activities to cultivate and harvest bioenergy crops and to manage agricultural and wood residue extraction have to be addressed in terms of their compatibility with biodiversity in general, and agrobiodiversity in particular. Buffer zones have to be established to protect sensitive areas, and corridors and steppingstone biotopes must be preserved on cultivated land in order to improve the exchange of species between habitats and movement along migration paths.

For the extraction of forest residues, the discussion on limitations and thresholds to protect forest biodiversity is an ongoing discussion subject.

Criterion 3: Climate Protection

From the environmental policy point of view, sustainable use of bioenergy can contribute to climate change mitigation. This requires proof that bioenergy contributes to reducing greenhouse gas (GHG) emissions throughout the entire life cycle. **It should be noted that the GSFA project has the added benefit/purpose of restoring forest health and thereby reducing the risk of catastrophic wildfire and related climate issues**.

Indicator: Life cycle GHG emissions and direct land use changes
To ensure that GHG emission reductions from bioenergy are compatible with the longer-term requirement to decarbonize economies by more than 80%, minimum reduction levels for bioenergy need to be set, using fossil fuel comparators to reflect the different market conditions in the electricity, heat and transport fuel sectors.

Indicator: GHG emissions throughout the supply chain
The assessment of total GHG emissions in the biomass supply chain or what to include is currently a discussion topic in numerous markets and with different approaches. In the EU, a tool for calculating GHG emissions is provided at https://www.biograce.net/ and a UK tool can be found at http://www.e4tech.com/b2c2temp/ .

Indicator: Inclusion of GHG effects from indirect land use changes
Indirect land use changes (iLUC) occur if a current land use such as food or feed cultivation is crowded out by bioenergy feedstock cultivation. The calculation of CO_2 emissions from displaced land uses is

basically the same as for direct LUC. However, displacement effects may occur outside a region or country due to global trade and reduced exports so that they can only be allocated to bioenergy cultivation through a model exercise. Consequently, calculating CO_2 implications of iLUC is highly controversial both in scientific and political discussions.[15]

Criterion 4: Soil Quality

Soils are the literal fundament of cultivating both bioenergy feedstocks, and biomass for food, feed and fiber. Thus, ensuring and sustaining soil quality is fundamental for the future productive use of land as well as for biologically sequestering carbon, and for hydrological functions such as buffering and filtering.

Indicator: Erosion Avoidance
The harvest of bioenergy crops including during forest management can lead to soil erosion. Different standards provide guidance for sustainable growth areas as well as harvesting techniques.

Indicator: Soil Organic Carbon
To assure that the cultivation systems and practices maintain or improve soil quality, the soil organic carbon content of land being used for bioenergy feedstock cultivation or for extracting surplus biomass growth needs to be maintained.

Indicator: Nutrient Balance of Forested Soils
For the extraction of forest residues, the discussion on limitations and thresholds to protect forest soils with regard to nutrient balances is an important aspect and discussed within regional context.

Criterion 5: Water Use and Quality

Cultivating biomass with high productivity and as well as conversion facilities for bioenergy carriers both need water. Furthermore, pollutant discharge to water bodies and negative environmental consequences of (inappropriate) irrigation can occur.

Indicator: Water Availability and Use Efficiency
Water for irrigation of bioenergy feedstock cultivation and for process water used in bioenergy conversion facilities must, together with existing agricultural, industrial and human (residential) water uses, not exceed the average replenishment from natural flow in a watershed, expressed in total actual renewable water resources (TARWR).

Furthermore, the establishment of new bioenergy cropping systems and bioenergy conversion facilities must be placed outside of areas with severe water stress levels. Seasonal variations of water flows must be considered.

Indicator: Water Quality
The monitoring and limitation of pollutant loadings to waterways and water bodies attributable to bioenergy feedstock cultivation and effluents from bioenergy processing is important.

[15] In the EU.

Criterion 6: Limit Airborne Emissions

Airborne life-cycle emissions of non-GHG pollutants from bioenergy are subject to different benchmarks per region such as, for example, compared to modern gas-fired systems in the EU.

Indicator: Emissions of SO_2 equivalents

Economic operators must demonstrate that the life cycle emissions of SO_2, NOx, NH_3 and HCl/HF from bioenergy provision, expressed in SO_2 equivalents and calculated in accordance with the life cycle emission methodology for GHG, are lower than the respective benchmark. If parts of the bioenergy life cycle emissions occur in non-EU or non-OECD countries, this share is to be compared to the respective benchmarks of the non-OECD countries.

Indicator: Emissions of PM_{10}

The methodology to quantify and limit emissions of particulates in the micro scale can be the same as for SO_2 equivalents.

Criterion 7: Food Security

Food security is a key element of social sustainability, and is defined by FAO as follows:
"Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life".[16]

In the context of forest biomass, this criterion is of importance if arable land is converted to tree farms and this land for food production is converted to energy crop production. This will not be an issue for the GSFA projects.

Indicator: Price and supply of national food basket

The indicator aims to measure the impact of bioenergy use and domestic production on the price and supply of a food basket in the context of all relevant factors. The food basket is defined on a regional and/or national level and includes staple crops, i.e. the crops that constitute the dominant part of the diet and supply a major proportion of the energy and nutrient needs of the individuals in a given country. In addition, the indicator aims to assess the impact of changes in the prices of the food basket components on the national, regional and household welfare levels.

Criterion 8: Social Use of Land

Land use is not only a key issue for biodiversity and climate protection, but also has direct implications on society in general. The social use of land is primarily related to the theme of access to land, water and other natural resources. Land access is a consequence of land tenure.

Indicator: Allocation and tenure of land

This indicator aims to measure the percentage of land – total and by the land-use types which has been leased by the state or a domestic authority and/or sold through one-to-one negotiations to individual or corporate investors for new bioenergy production. Therefore, these investors will want to secure their new lands and will intend to receive some kind of formal contract or titles from the government. This indicator would serve as a proxy to assess how new bioenergy production and use influence land tenure as well as local communities' livelihood conditions and land customary rights.

[16] World Food Summit, Rome 1996

The indicator can be based on the following data collection:

- Land area (ha and percentage of total country land area) used as common or open access land by local population, and land privately owned by local population, then given in concession to new bioenergy investments in bioenergy production areas (BEPA). Special relevance should be given to the overlap of BEPA and community forests and indigenous or poor communities as these are likely to be most dependent on forest resources.
- Titles, contracts and any other formal registration of land tenure held by bioenergy investors and companies that have been registered in a national or local registry
- Existence of community/local population rights to lands, amount (ha and %) of lands legally recognized as community/common lands
- Information about qualitative aspects of the issuing of new bioenergy concessions, in particular whether (FAO, 2002):
  a) land rights are granted by constitutions, statutes and official tribunals;
  b) land rights are granted by other laws – customary, informal, secondary, tertiary;
  c) there is security of the aforementioned rights in terms of enforcement and application;
  d) there are land-related or subsidiary rights that women are free to exercise without specific mention in formal or informal laws;
  e) there is effective access to fair adjudication, including the court system or other dispute resolution processes;
  f) the public land allocation procedure has followed due process
  g) land rental and sales contracts including contracts for temporary use agreements are accessible to all;
  h) periodic monitoring is carried out to assess the impacts of bioenergy on changes in access to and use of natural resources by local communities;

If the land used by investors is recognized as community/common land, it is important to gather information regarding mechanisms of participation or consultation carried out by the investors with the local community. If the land is recognized as land with secure rights by national legislation, it is important to gather the evidence of the negotiation agreement for any contingent compensation between the investor and the landowner. These data can be gathered at the national level through national/international accounts if available, or through interviews and surveys at the household, villages or local government units (districts or regions) level, since these resources tend to stretch beyond administrative boundaries.

Criterion 9: Healthy Livelihoods and Labor Conditions

Human health and labor conditions are closely related, as crop cultivation and harvesting procedures can expose work force to health risks and accident risks.

Indicator: Adherence to ILO Principles for Labor Rights

A common denominator are the rights set by the International Labor Organization in addition to applicable local laws, rules and legislation.

Sustainability Policy Framework in Japan

For more detail on the Japanese market, refer to the Japan Biomass Outlook report that accompanies this report.

Key Legislation[17]:
Guideline for Verification on Legality and Sustainability of Wood and Wood Products (2006)
Guideline of woody biomass for power generation (2012)
Guideline for business plan - Biomass power (2012; latest revision 2018)
Law on Promotion of Distribution and Use of Legally Logged Wood (2017)

In July 2012, Japan introduced Feed-in Tariffs (FITs) for renewable energy, including biomass. While the FITs for new biomass power generation plants using PKS, wood chips or wood pellets have been replaced with a tender process, the FITs for biomass power generation from (domestic) forest residues and wood thinnings is still current with 32 Yen/kWh (ca. 29 cents/kWh) for plants >2MW.

The forest biomass from the GSFA project could potentially be classified in this category and consequently could allow Japanese buyers of the wood pellets to qualify for this high FIT.

However, consultations with the Japanese government would be required in order to confirm that the GSFA woody biomass could be added as a category for this specific FIT which was originally introduced to support the domestic forestry sector.

With regard to sustainability guidelines for biomass to be used for power generation, GHG emissions and indirect land-use (iLUC) criteria are currently not covered. For both domestic and imported woody biomass, the required sustainability reporting covers legality and land use, forest management certification and traceability. The approved certification schemes are FSC, FSC Mix (controlled), PEFC and CSA. Wood pellets sold into Japan must be Forest Management (FM) certified.

Japanese law prohibits the use of illegally logged wood, whether domestic or imported. The key legislation is the law of 2017 on distribution and use of legally logged wood. This law requires timber-related businesses to confirm the legality of the timber they handle in order to promote the distribution and use of legally harvested timber. Japan domestic wood can comply by submitting a certificate of origin based on the “Guidelines for Woody Biomass Certification which confirms that it was legally cut based on the Japan Forestry Law by including the official notice of logging, etc.

The Japanese government guidelines for woody biomass for power generation outline the following process[18]:

Businesses that handle fuel materials need to properly separate and manage biomass derived from thinned wood, etc. and general woody biomass, issue woody biomass-derived certificates, and link them.

- When issuing a certificate, the business must be certified by an accredited organization as having the ability to properly separate and manage it.
- Organizations that certify businesses need to establish and publish a voluntary code of conduct.
- It is also possible for the company to set its own code of conduct and issue a certificate from woody biomass. In this case, it is necessary to take measures to ensure reliability, such as ongoing audits by a third party.

[17] None of the Japanese legislation is available in English
[18] Translation by FutureMetrics from
https://www.rinya.maff.go.jp/j/riyou/biomass/attach/pdf/hatudenriyou_guideline-3.pdf

This process is required in order for the woody biomass to qualify for the respective FIT.
That means, the woody biomass producer issues a basic document and a certificate at the starting point of the certification chain, from landowner to harvester to the processing / distributor each time a consignment is being transported.

- The processing / distributor confirms the certificate from upstream, prepares the certificate, and issues it to the downstream business operator.
- The certificate does not require the attachment of documents on the upstream side, but it is necessary to prepare documents so that it can be traced back to the logging location as necessary.
- If there is no certificate, it will be the same category as building material waste.

It is anticipated that the Government's Biomass Sustainability Working Group will issue requirements regarding GHG emissions for woody biomass in the not too distant future, i.e. 2020 or 2021. The current focus is on sustainability requirements for PKS. The latest proposed as published in November 2019 suggests adding GHG emission calculations in the future for biomass for agricultural products such as PKS and makes specific reference to EU REDII. The working group considers biomass fuel generated by harvesting agricultural products as "cultivation (excluding land use change)", "processing", "transportation (sea transportation and transportation in Japan)", "combustion (N_2O and CH_4 (E.g. non-CO_2 emissions) over the lifecycle and CoC as well as the effect of land use change on palm oil and suggest GHG calculation accordingly. With regard to all types of biomass, the working group states:[19]

> *In assessing the impact on the global environment, for life cycle GHGs, it is ideal to compare all biomass fuels with fossil fuels that can be replaced at each life cycle according to respective circumstances. However, in practice, life cycle GHG varies depending on the conditions of the cultivated land, transportation route, processing method, etc. There are various methods for calculating life cycle GHG emissions, and there is no established method.*
> *For this reason, it is not realistic at this time for the government to make individual confirmations uniformly. For this reason, it is appropriate to first confirm that measures have been taken to mitigate the impact on the global environment by confirming that the emission is not significantly increased.*

So, while the Japanese government's working group has reviewed the various European rules, the committee at this point does not seem to support the same stringent level of adoption for Japan. This is most likely due to lobbying by the biomass power sector as well as the realistic assessment that the majority of biomass is, just like other fuels, being imported with the respective GHG emission impact. Environmental group are pushing a GHG emission calculation criterion for biomass.

From a GSFA project perspective, the key aspect to verify and discuss with the Japanese government is therefore how GSFA biomass would be classified with regard to FIT categorization.

[19] Translation by FutureMetrics from General Resources and Energy Research Committee, Energy Conservation and New Energy Subcommittee, New Energy Subcommittee, Biomass Sustainability Working Group, Interim Report (総合資源エネルギー調査会, 省エネルギー・新エネルギー分科会 新エネルギー小委員会, バイオマス持続可能性ワーキンググループ, 中間整理), November 2019

Standards approved by region

The following matrix highlights which sustainability standards for biomass are approved in key markets (click HERE to download in Excel).

	EU	UK	NL	DK	D	Japan
ISCC	approved		partially approved for Cat 1 -5			may be approved
Better Biomass (NTA 8080)	approved		partiall approved for Cat 1 - 5			
RSB	approved				approved	may be approved
REDcert	approved				approved	
ATFS American Tree Farm System		approved	partially approved for Cat 1 and 2			approved (agricultural)
GGL Greengold label (RWE / Essent)			partially approved for Cat 1 - 5			approved (agricultural)
Drax Sustainability Requirements						
SPB Sustainable Biomass Programm			partially approved for Cat 1 -5	approved		approved (agricultural)
SFI Sustainable Forestry Initiative		approved	partially approved for Cat 1 and 2			
CSA Canadian Standards Association		approved				approved
PEFC Programme for the Endorsement of Forest Certification	expected to be approved	approved		approved		approved
FSC Forest Stewardship Council	expected to be approved	approved	partially approved for Cat 1 and 2	approved		approved
Tools:						
GHG Calculations	https://www.biograce.net/	http://www.e4tech.com/b2c2temp/	https://www.biograce.net/biograce2/			
Reporting					https://nabisy.ble.de/nabima-web/app/start	

Which standard the GSFA project should adopt, will depend on the primary market(s) and thus the market's respective requirement and consequently what customers in those markets demand.

Based on the matrix, Programme for the Endorsement of Forest Certification (PEFC) https://www.pefc.org/ and Forest Stewardship Council (FSC) https://fsc.org/en are the most widely adopted standards.

It is likely but not certain that Japan will allow SBP certified pellets to meet their sustainability criteria.

Noteworthy is the GHG emission criterion: it is, as of January 2020, only covered in the RSB ISCC and PEFC standards.

RECOMENDATION - At this stage FutureMetrics does not make a recommendation as to which standard should be selected. FutureMetrics' recommendation is for GSFA to approach this question as follows:

a) **Utilization of standards expert, including case study of required initial and ongoing documentation requirements and cost impact on operations.**
b) **Calculation via modeling of GHG emissions for sample consignments to different markets (UK, NL, D but most importantly, Japan).**
c) **Government consultations, especially with the Government of Japan (focus un FIT acceptance).**

Potential Pathway for Forest certification by GSFA

Certification standards are generally developed, reviewed and revised in consultation with stakeholders. Global standards may be adapted to suit national conditions; for example, the FSC adapts its global standards through a network of national working groups. Despite many differences in scope, content and procedures, all credible forest certification programs require compliance with existing laws and regulations; the protection of biodiversity, endangered species and wildlife habitats; sustainable harvesting levels; the protection of water quality; respect for the rights of local people and employees; economic viability in forest operations; an adequate management plan; and the monitoring of operations. In addition, certifiers are required to make audit summaries available to the public and to establish mechanisms for complaints and appeals.

As part of the certification process applicants must take the following steps to demonstrate full compliance with the specified forest management certification standards, although the sequence and intensity of these steps may vary between schemes and operations:

1. Preparation: establishment of requirements
2. Identify qualify certifiers, get requirements, timeline and quote
3. Decide on certification scheme (based on target market as well as timeline and cost)
4. Preliminary audit: Once contracted, the certifier checks relevant documentation to ensure that the documentation requirements of the certification standard are met.

5. On-site assessment: certifier undertakes a detailed on-site assessment, checking forest operations and consulting with relevant stakeholders, including employees and local community. The team produces a report on the performance of the operator according to the relevant standards.
6. Adjustments: Define and introduce adjustments, based on on-site assessment (corrective actions)
7. Issuance of certification after implementation of corrective actions which is normally valid for several years
8. Verification audits: inspection visits by the certifier which may result in new recommendations for corrective actions. In the case of non-compliance with requirements, certification may be suspended.
9. Renewal: new audit to renew certifications

Chain of custody certification

In the PEFC system, chain-of-custody certification is included into the forest management certificate; under the FSC system, the two certificate types have separate standards but can be combined in a joint certificate where applicable (e.g. when an operator is vertically integrated).

Summary and Conclusion to the Sustainability Analysis

Based on FutureMetrics' review of the various markets and standards, the biomass from GSFA projects should qualify for the required sustainability criteria in all standards. The question mark is how GSFA biomass ranks with regard to GHG emissions related to different target markets. This may require case study calculation and analysis.

In addition to expert advice from a sustainability standard expert, FutureMetrics views consultations with government authorities of target markets as essential.

Overview of Sustainability Requirements (click HERE to download in Excel)

Overview of Forest Biomass Sustainability Requirements						as of Jan 12, 2019
	EU	**UK**	**NL**	**DK**	**D**	**Japan**
	European Commission https://ec.europa.eu	**Department for Business, Energy & Industrial Strategy (former UK's Department of Energy and Climate Change (DECC)) and Ofgem (Office for Gas and Electricity Markets) https://www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy and https://www.ofgem.gov.uk/**	**Dutch Ministry of Economic Affairs and Climate Policy https://business.gov.nl/contact/ministry-of-economic-affairs-and-climate-policy/**	**Ministry of Environment and Food of Denmark https://en.mfvm.dk/the-ministry/**	**Federal office for Agriculture and Food https://www.ble.de**	**Ministry of Economy, Trade and Industry (METI) https://www.meti.go.jp and Ministry of Agriculture, Forestry and Fisheries https://www.maff.go.jp**
Key Legislation:		Biomass Feedstocks under the Renewables Obligation (RO)	Dutch Energy Agreement: 3.5 million MT of pellets to come from wood biomass from certified forests	Guidelines follow EU law and also UK guidelines		
Legistlation Title 1	EU Renewable Energy Directive (RED)	Guidance: Sustainability standards for electricity generation from biomass	Dutch Energy Accord	Guidelines on securing sustainable timber in public procurements of goods and services	Biomass Electricity Sustainability Ordinance -BioSt-NachV	Guideline for business plan (Biomass power)
Year passed/ came into force	2009; revised 2018	2013; revised 2018	2013	2016	2009; revised 2018	Latest revision April 2018
Link to document	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0082.01.ENG&toc=OJ:L:2018:328:TOC	https://www.ofgem.gov.uk/system/files/docs/2018/04/ro_sustainability_criteria.pdf		English not available	Free of charge German text not available; English not available	English not available
Link to summary/fact sheet	https://ec.europa.eu/energy/sites/ener/files/documents/directive_renewable_fact sheet.pdf		https://www.government.nl/binaries/government/documents/publications/2013/09/06/energy-agreement-for-sustainable-growth/Energy+Agreement+for+Sustainable+Growth.pdf		not available in English; German at https://www.ble.de/SharedDocs/Downloads/DE/Klima-Energie/Nachhaltige-Biomasseherstellung/LeitfadenNachhaltigeBiomasseherstellung.pdf?__blob=publicationFile&v=1	
Legistlation Title 2	EU Timber Regulation	Range of guidance documents for operators of fuelled generating stations to meet the sustainability requirements under the Renewables Obligation (RO) of 2009: Sustainability Criteria Guidance, Sustainability Reporting Guidance, Annual Sustainability Template	Stimulation of Sustainable Energy Production - SDE+	The Danish Industry Agreement for SustainableBiomass; voluntary approach and to be fully implemented by 2019	Guideline to the common decree on the procurement of wood products	Guideline for Verification on Legality and Sustainability of Wood and Wood Products
Year passed/ came into force	2013	2009	2017	2016	2010	2006
Link to document	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012R0607	https://www.ofgem.gov.uk/system/files/docs/2018/04/sustainability_reporting_guidance.pdf	https://english.rvo.nl/sites/default/files/2018/02/SDE_Verification%20protocol-12-2017_ENG.pdf	https://ens.dk/sites/ens.dk/files/Bioenergi/the_danish_industry_agreement.pdf		https://www.rinya.maff.go.jp/j/boutai/ihoubatu/pdf/gaido1_e.pdf
Link to summary/fact sheet	https://ec.europa.eu/environment/forests/timber_regulation.htm		https://english.rvo.nl/subsidies-programmes/sde			https://www.goho-wood.jp/world/outline/
Legislation Title 3		Wood Fuel Guidance	Sustainability criteria for solid biomass under the SDE+ scheme			Guideline of woody biomass for power generation
Year passed/ came into force		2017				2012
Link to document		https://www.gov.uk/government/publications/woodfuel-guidance-version-2	https://english.rvo.nl/subsidies-programmes/sde/sustainability-criteria			
Challenges:	EU member countries can have their own respective regulations, as long as these cannot be challenged against EU regulations.	Current legislation refers to various EU requirements and standards. Impact of BREXIT re. potential changes unknown.			German legislation in general focused on agricultural biomass (for biogas based power generation) and bio fuels. Solid biomass and forest biomass detailed legislation less developed. Gov website referring to EU regulations. See also https://www.ble.de/EN/Topics/Climate-Energy/Sustainable-Biomass-Production/sustainable-biomass-production_node.html	Target annual biomass power generation based on 2018 energy plan is 3.7-4.6% (Capacity: 602 to 7.28 million kW). Target is likely to be surpassed.
Approved Certification Scheme						
Minimum CoC method for certification	Mass balance method	Mass balance method	Mass balance method		Mass balance method	
Recognized voluntary certification systems and certification entities						
ISCC https://www.iscc-system.org/	approved		partially approved for Cat 1 -5			may be approved
Better Biomass (NTA 8080) https://www.betterbiomass.com/	approved		partiall approved for Cat 1 - 5			
RSB https://rsb.org/	approved				approved	may be approved
REDcert https://www.redcert.org/en/	approved				approved	
treefarmsystem.org/certification-american-tree-farm-system		approved	partially approved for Cat 1 and 2			approved (agricultural)
Gold label (RWE / Essent) http://www.greengoldcertified.org/			partially approved for Cat 1 - 5			approved (agricultural)
irements https://www.drax.com/sustainability/environment/						
SPB Sustainable Biomass Programm https://sbp-cert.org/			partially approved for Cat 1 -5	approved		approved (agricultural)
stainable Forestry Initiative (SFI) https://www.sfiprogram.org/		approved	partially approved for Cat 1 and 2			
adian Standards Association (CSA) https://www.csagroup.org/		approved				approved
sement of Forest Certification (PEFC) https://www.pefc.org/	expected to be approved	approved		approved		approved
Forest Stewardship Council (FSC) https://fsc.org/en	expected to be approved	approved	partially approved for Cat 1 and 2	approved		approved
Tools:						
GHG Calculations	https://www.biograce.net/	http://www.e4tech.com/b2c2temp/	https://www.biograce.net/biograce2/			
Reporting					https://nabisy.ble.de/nabima-web/app/start	

APPENDIX

Sustainability Policy Frameworks in Major Markets

All policy is based on the criteria outlined above.

With regard to pellets, countries view pellets differently based on the wood source for the pellets. In the European Union, GHG emissions are one of the key environmental indicators. If pellets reduce the use of fossil fuels, then pellets score high if the GHG emissions are benchmarked against coal. The particularly stringent sustainability requirements in the Netherlands can be understood on this background. On December 10th, 2019, The Netherlands announced that the country will close its 4.8 GW of coal-fired capacity by 2030, amid efforts to meet emissions reduction targets even though affected utilities announced litigation against this measure.

Therefore, if the focus is on GHG reduction, biomass energy scores well. If the focus is on energy balance, biomass energy has a lower net energy balance compared to wind and solar.

EUROPEAN UNION (EU)

Key Legislation:
EU Renewable Energy Directive (RED) of 2009, revised 2018 (EU RED II)
EU Timber Regulation of 2013

RED II defines a series of sustainability and GHG emission criteria that bioliquids used in transport must comply with to be counted towards the overall 14% target and to be eligible for financial support by public authorities. Some of these criteria are the same as in the original RED, while others are new or reformulated. In particular, the RED II introduces sustainability for forestry feedstocks as well as GHG criteria for solid and gaseous biomass fuels. The Greenhouse gas savings thresholds in RED II require member countries to achieve GHG savings for electricity, heating and cooling of 70% by 2021 and 80% by 2026. In order to avoid impact from indirect land use change (ILUC), RED II has specific limits re. biomass crops but also introduces an exemption from these limits for biofuels, bioliquids and biomass fuels certified as low ILUC-risk.

Because the RED II legislation covers a wide range of biomass used for energy, it provides a basic framework. It is however up to EU member states to provide detailed legislation for specific biomass energy types. This includes the right to select different sustainability certification standards as accepted standards.

UNITED KINGDOM (UK)

Key Legislation:
Renewables Obligation (RO) (2002, 2005; all renewables)
Sustainability standards for electricity generation from biomass (2013; revised 2016 and 2018)

The Renewables Obligation (RO) is one of the main support mechanisms for large-scale renewable electricity projects in the UK and came into effect in 2002 in England and Wales, and Scotland, followed by Northern Ireland in 2005. It places an obligation on UK electricity suppliers to source an increasing proportion of the electricity they supply from renewable sources.

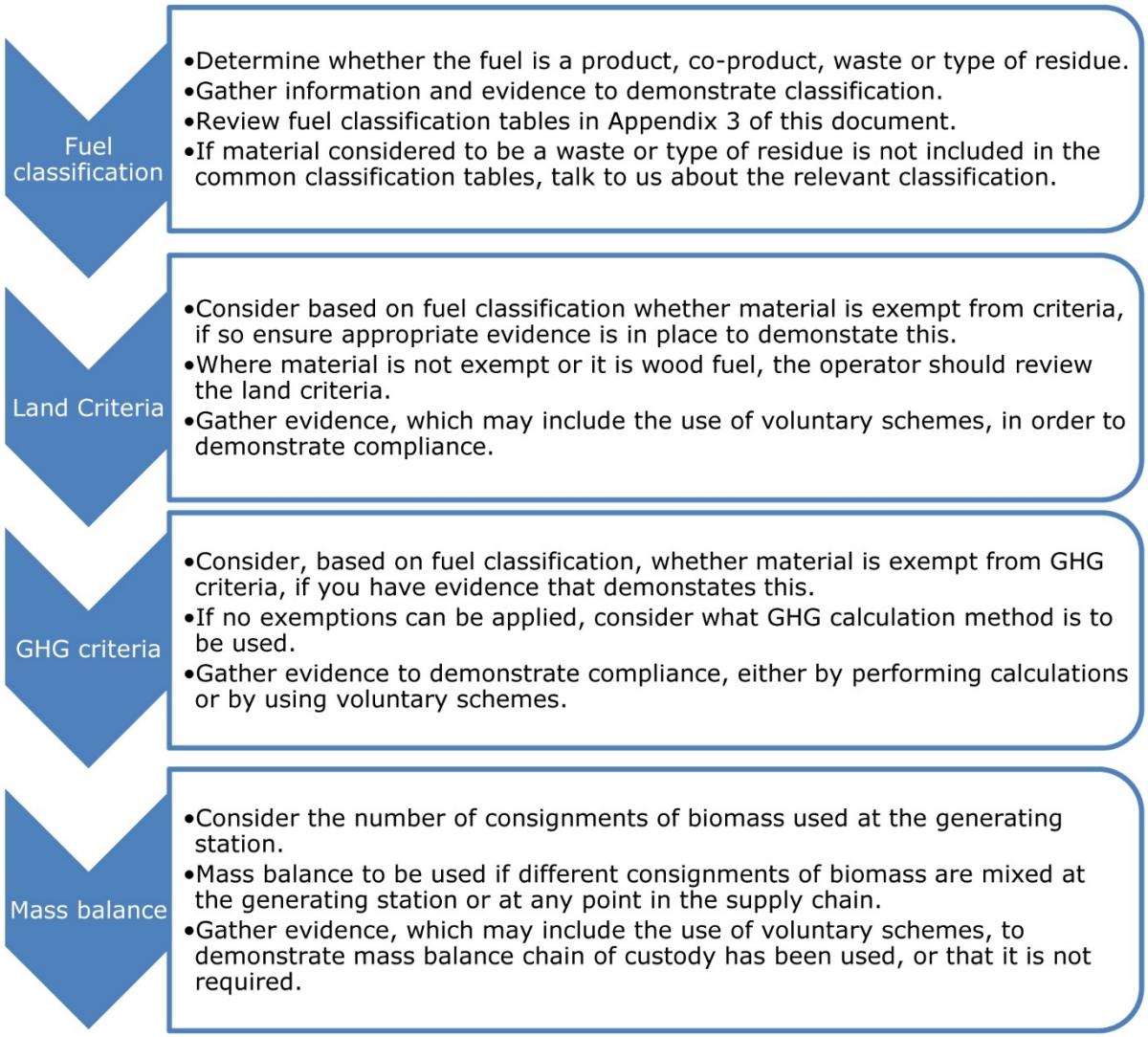
The latest document of 2018[20] document describes the sustainability requirements to operators of generating stations, independent auditors and other interested parties.

The sustainability criteria consider the land from which the biomass is sourced, as well as the life-cycle greenhouse gas emissions associated with the biomass. In addition, the Orders specify that the sustainability information must be gathered for each consignment of biomass. So, where consignments are mixed, the operator will need to use a suitable method to track the individual consignments and their associated sustainability information. The legislation requires operators of generating stations with a total installed capacity ≥1MW using solid biomass and biogas, to report against, and meet, the sustainability criteria to get support under the Renewables Obligation scheme.

Overview of sustainability considerations in 2018 document[21]:

[20] Renewables Obligation: Sustainability Criteria Publication (2018)

[21] Renewables Obligation: Sustainability Criteria Publication (2018), p. 11



The UK requires fuel classification reporting, which in case of woody biomass looks as follows:

Fuel Classification Solid Biomass

Fuel Category	**Land Criteria**	**GHG Criteria**
Residues from forestry	Reporting required	Emissions during and from the process of collection only
Processing residues	From wood: reporting required	Emissions during and from the process of collection only

Definition of residues[22]: The RO defines residues from processing in line with the RED.

"Processing residue" means a substance that is not the end product(s) that a production process directly seeks to produce; it is not a primary aim of the production process and the process has not been deliberately modified to produce it.

"Forestry residues" means residues that are directly generated by forestry and does not include residues from related industries or residues from processing".

This definition of residues from forestry can be interpreted to mean that such residues are those generated in harvesting the material being sought. Once the product has been harvested and further processing occurs, any residues generated from this are considered processing residues.

Allocating emissions – process of collection[23]:

In calculating the GHG emissions, the Orders use the term 'process of collection' when setting out for certain materials that full lifecycle GHG calculations are not required.

'Process of collection' includes all emissions involved in collecting the waste or residue, further processing and transport. This is not necessarily the same as the point of collection, which is considered to be the point where the material is collected by another party. For the 'process of collection' any emissions arising after the waste/residue was created but before it is collected should also be taken into account. For example, there may be emissions associated with machinery used to gather the waste/residue into storage containers ready for collection.

Land criteria reporting[24]:

To be eligible for ROCs, all biomass fuels used for generating electricity will have to report against the land criteria. The land criteria refer specifically to the production of the raw material, i.e. at the farm, forest or plantation. They do not apply to any other steps further down the supply chain.

There are two types of land criteria. These are the land criteria for woody biomass and the land criteria for non-woody biomass. Depending on the type of fuel used, will affect which type of land criteria to report against.

If the biomass used to generate electricity was wood or derived from wood (other than an energy crop), the operator is required to report against the land criteria for woody biomass. The only exception to the land criteria for woody biomass is where the biomass is waste or wholly derived from waste. All other biomass that is wood or derived from wood (including processing residues, residues from forestry and residues from arboriculture) must report against the land criteria for woody biomass. There are two wood types that are 'deemed sustainable'.

Evidence to demonstrate compliance with the land criteria for woody biomass should include evidence that traces the biomass from the source to the end user. For woody biomass this can be achieved through the

[22] Renewables Obligation: Sustainability Criteria Publication (2018), p. 15
[23] Renewables Obligation: Sustainability Criteria Publication (2018), p. 15
[24] Renewables Obligation: Sustainability Criteria Publication (2018), p. 19ff

use of Forest Stewardship Council (FSC) certificate scheme or the Programme for the Endorsement of Forest Certification (PEFC) certification scheme.

If the wood is arboricultural arisings or from trees removed from an area for ecological reasons, they are deemed to be sustainable, and therefore meet the land criteria for woody biomass. It is important that evidence is gathered to show that the wood has come from these types.

Guidance on the woody biomass land criteria has been provided by BEIS[25].This is split into three documents and explains how the land criteria for woody biomass can be met. These are:

1. The wood fuel advice notes: provides a summary of the requirements and how to comply with these.
2. Consignment and mass balance approach: sets out how to operate mass balance systems and how to determine consignments.
3. Risk based regional assessment: a checklist approach: sets out how to use a checklist approach to operate a risk based regional assessment, and the types of evidence acceptable.

To demonstrate compliance with the land criteria, the operator can use relevant voluntary schemes and/or collect evidence to support the land use from where the biomass was sourced. Several voluntary schemes were benchmarked against the land criteria in 2012.[26]

Green House Gas (GHG) criteria[27]:

Operators using solid biomass, biogas and bioliquids can use the actual measured values to calculate the carbon intensity of their biomass. The methodology for this calculation is set out in the legislation. For bioliquids the Orders refer to Part C of Annex 5 to the RED for the GHG calculation methodology. For solid biomass and biogas, the methodology in the Orders refers to an amended version of the bioliquid GHG calculation methodology.

The methodology specifies which GHG emissions must be accounted for when determining the carbon intensity of the biomass. In calculating emissions, the actual value method does not specify that all values must be actual data. An operator can use the actual data relevant to their specific supply chain alongside standard input data from relevant sources such as academic literature.

According to the methodology, the total carbon intensity of biomass is the sum of the following, minus any emission savings:

- emissions from the extraction or cultivation of raw materials,
- annualized emissions from carbon stock changes caused by land use change (if applicable),
- emissions from processing, and
- emissions from transport and distribution.

These can be broadly categorized into three main stages, as shown below:

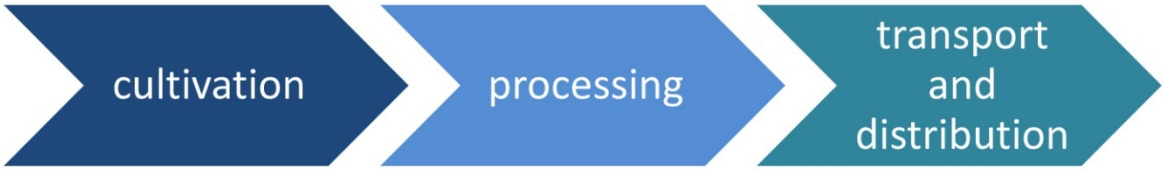
Summary of key steps in GHG calculations[28]

[25] https://www.gov.uk/government/publications/woodfuel-guidance-version-2

[26] A matrix which relevant schemes are approved in which market is provided later in this document.

[27] Renewables Obligation: Sustainability Criteria Publication (2018), p. 40ff

[28] Renewables Obligation: Sustainability Criteria Publication (2018), p. 41



The document provides an example of steps for GHG calculation for wood pellets from short rotation coppice[29]:

(KEY: Dark blue: Cultivation and harvesting, Teal: Transport and distribution, Blue: Processing, Orange: Electricity generation.)

Detailed allocation formulas are provided in the UK document and calculation tools can be downloaded from the OFGEM website.[30]

Consignment and mass balance[31]

The Orders specify that operators must report per consignment in relation to the sustainability criteria. Operators are required to report per consignment of biomass. To report accurately against the sustainability criteria for each consignment of biomass, and for the information to be independently verified, the sustainability information must be able to be traced through the supply chain. This concept of traceability from raw material to end product is known as the 'chain of custody' (CoC).

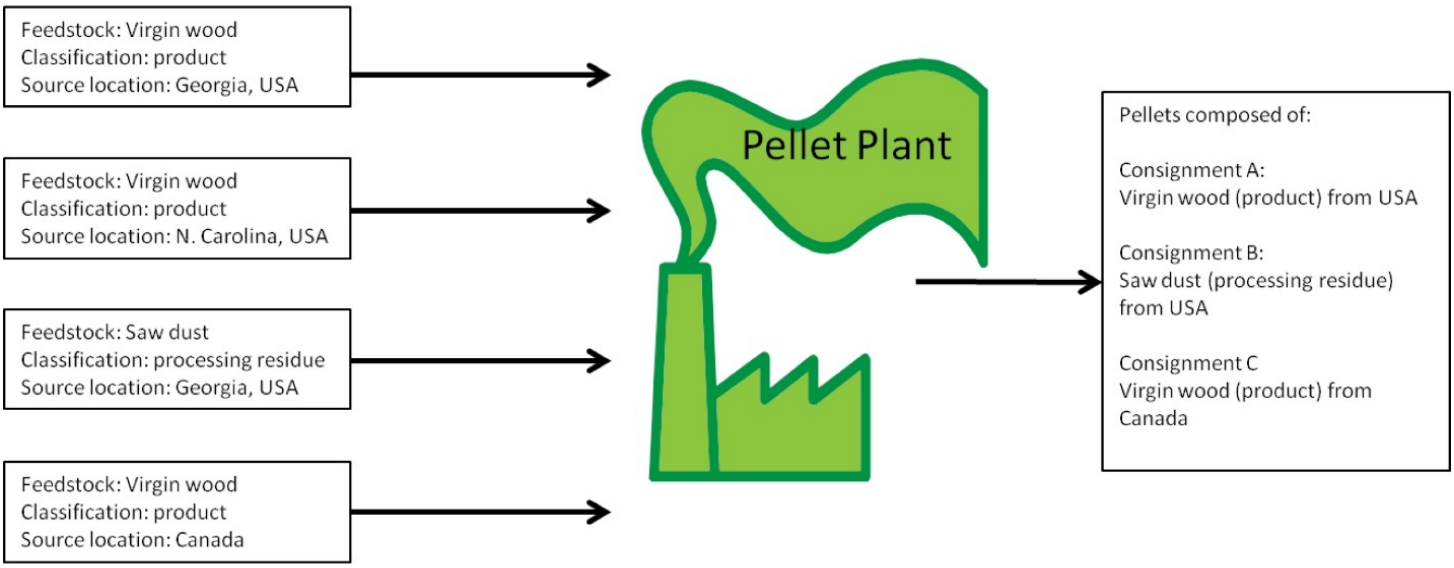
For solid biomass, the Orders do not expressly state that operators must use a mass balance system. However, this method is recommended.

To determine a consignment of woody biomass for production of wood pellets, the following has to be included:

- feedstock type
- biomass form (solid biomass only),
- country of origin
- classification of the fuel (waste, residue, product etc.),
- compliance with land criteria,
- compliance with GHG criteria

[29] Renewables Obligation: Sustainability Criteria Publication (2018), p. 42
[30] https://www.ofgem.gov.uk/environmental-programmes/ro/applicants/biomass-sustainability
[31] Renewables Obligation: Sustainability Criteria Publication (2018), p. 58ff

The UK document provides an example for a biomass consignment for a pellet plant[32]:



A mass balance system is a system in which sets of sustainability characteristics remain assigned to consignments. The sum of all consignments withdrawn from the mixture is described as having the same sustainability characteristics, in the same quantities, as the sum of all consignments added to the mixture. A party in the chain of custody cannot sell more output with certain biomass data than its sourced input with the same biomass data. Mass balance systems should be used where a mixing of consignments takes place, either at the operator's site **or down the supply chain**. This is to ensure that the biomass and its associated sustainability data are verifiable. It is the operator's responsibility to implement the appropriate process and procedures. Each party in the supply chain, which is at any point the legal owner of the product, will need to have the administration necessary to maintain the mass balance chain of custody.

In summary:

The UK sustainability criteria require extensive data collection and reporting throughout the supply chain. The required processes and information are clearly presented in the Renewables Obligation: Sustainability Criteria document of April 2018[33] from which we have quoted. The UK criteria were developed to also be in compliance with EU RED II. It is unknown whether changes will be imminently made following BREXIT.

The Netherlands (NL)

Key Legislation:
Dutch Energy Accord (2013)
Stimulation of Sustainable Energy Production - SDE+ (2017)
Sustainability criteria for solid biomass under the SDE+ scheme (2016/2017)

[32] Renewables Obligation: Sustainability Criteria Publication (2018), p. 61
[33] Online accessible at https://www.ofgem.gov.uk/system/files/docs/2018/04/ro_sustainability_criteria.pdf

The 'Energy Agreement for Sustainable Growth' of 2013, also referred to as the Dutch Energy Accord, was concluded by the government with employers, trade unions, environmental organizations and others and contains provisions on energy conservation, boosting energy from renewable sources and job creation. In 2017, the government introduced the SDE+ scheme. SDE+ is an operating subsidy. Energy producers can receive financial compensation for the renewable energy they generate. With regard to biomass used under this scheme, the Dutch government specified sustainability criteria for solid biomass in 2017. **They are viewed as the most stringent requirements currently in force in Europe and as well as the rest of the world**.

The Netherlands Enterprise Agency (RVO.nl) requires operators to demonstrate that the biomass used meets the applicable legal sustainability criteria. This applies to the following categories:

- co-firing and co-gasification of biomass in power stations;
- wood pellet steam boiler ≥ 5 MW;
- wood pellet burner ≥ 5 MWth and ≤ 100 MWe;
- wood pellet boiler for district heating (added in 2019).

To demonstrate that the biomass used comes from sustainable sources, the operator needs to purchase biomass that is certified according to an approved certification scheme and/or ensuring that the supply chain is verified or additionally verified. Various combinations are possible:

- an approved certification scheme;
- a combination of several approved certification schemes;
- a combination of one or more approved certification schemes and additional verification;
- only verification.

It is up to the operator to cover all the sustainability criteria for all biomass consignments. A number of certification schemes was approved by the Dutch Minister of Economic Affairs and Climate Policy and the recognized Conformity Assessment Bodies (CABs) for certification and verification.[34] The operators needs to demonstrate that the biomass complies with sustainability criteria by either

- submitting an annual report to RVO.nl on the sustainability characteristics of all consignments of solid biomass used in your installation, for which a standard format and guide is available on mijn.rvo.nl;

or

- providing a conformity year statement along with this report, where this statement must be issued by a recognized Conformity Assessment Body (CAB).

The requirements to be met by the conformity year statement and the verification method to be applied are set out in the Verification Protocol for Sustainability of Solid Biomass for Energy Applications.
All relevant information throughout the biomass chain, from the Forest Management Unit/First Collection Point to the energy producer, must be provided in order to demonstrate the sustainability of the biomass.

[34] A matrix which relevant schemes are approved in which market is provided later in this document.

Requirements are also defined for how this information needs to be passed on within the chain (chain management, Chain of Custody)[35].

The role of the Conformity Assessment Bodies (CABs) as defined by the Dutch government is the authorization to perform three types of activities:

- Issuing a certificate to economic operators based on a certification scheme that has been fully or partially approved by the Minister of Economic Affairs and Climate Policy. Claims/statements of conformity from such a scheme may be used to demonstrate compliance with the legal sustainability criteria. These activities are carried out within the context of the relevant certification scheme;
- Issuing a verification statement to an economic operator based on the requirements of the Verification Protocol for Sustainability of Solid Biomass for Energy Applications, with the aim of demonstrating compliance with the legal sustainability criteria or a part thereof;
- Issuing a conformity year statement to an energy producer, based on the requirements of the Verification Protocol for Sustainability of Solid Biomass for Energy Applications. This statement is required for obtaining the SDE+ subsidy for the part of the generated electricity and/or heat demonstrated as being sustainable.

For the sustainability framework as applied in the Netherlands, only certificates and statements issued by CABs officially recognized by the Minister of Economic Affairs and Climate Policy shall be considered valid.

The Dutch Emissions Authority (NEa) is responsible for monitoring this private system of sustainability certification, and therefore also the activities performed by CABs.

With regards to the types of biomass applicable for the SDE+ scheme, the Dutch government has defined the following categories:

Category 1: Woody biomass from Forest Management Units (FMU)
This includes branches, tops, trees and primary felling residues sourced directly from forests. This shall also include unused wood that has the same composition as wood growing in the forest and that has not been mixed with or contaminated by foreign materials or substances.

Category 2: Woody biomass from small Forest Management Units (FMU <500 hectares)
This includes branches, tops, trees and primary felling residues sourced directly from forests of less than 500 ha. This shall also include unused wood that has the same composition as wood growing in the forest and that has not been mixed with or contaminated by foreign materials or substances.
Category 2 biomass is distinguished from Category 1 biomass based on the size of the forest management units. Biomass from FMUs smaller than 500 hectares can also be submitted as Category 1 biomass, in which case the sustainability criteria for Category 1 biomass shall apply. This differentiation is important for markets such as Japan and some European countries where forest ownership is spread across many owners with small plots.

Category 3: Residues from nature and landscape management
These are biomass residues (branches, tops, trees) produced in the course of managing urban and rural

[35] The Dutch government issued detailed CoC guidelines in English which are available at https://english.rvo.nl/sites/default/files/2018/02/Guidance-Chain-of-Custody-EN.pdf

green spaces and nature areas, other than forests designated for the preservation, restoration or enhancement of specific natural, recreational or aesthetic functions. These also include biomass residues produced during routine maintenance of public green spaces and parks.

Category 4: Agricultural residues

This concerns biomass consisting of residues obtained directly from agricultural business. Short rotation crops are excluded, with the exception of the residues thereof.

Category 5: Biogenic residues and waste flows
These are waste flows and residues from the agro-food and timber industry (secondary residual flows) and tertiary residual flows such as waste wood.

The GSFA biomass would fall under Category 1 and also potentially under Category 3 of the Dutch scheme.

Regarding the CoC for Category 1 (Woody biomass from Forest Management Units), the Dutch government document outlines the CoC management as follows[36]:

The biomass in this category comes from forests in which a single Forest Management Enterprise conducts forest management responsibility in a uniform fashion. This area may concern one parcel of woodland; however, it may also pertain to multiple parcels of forest that are managed as a whole.

The Chain of Custody for category 1 always starts at the Forest Management Unit itself, with the first link being the organization that trades the biomass first, as that organization is the initial legal owner. In practice, the first link need not necessarily be the owner of the forest, but it may also be the organization that conducts the harvesting on behalf of the owner. This party is the first legal owner of the biomass at the time of the trees being harvested. The biomass in this category may consist of logs, tops, branches and other primary residues from forests. Primary residual flows are residues that are released at the source.

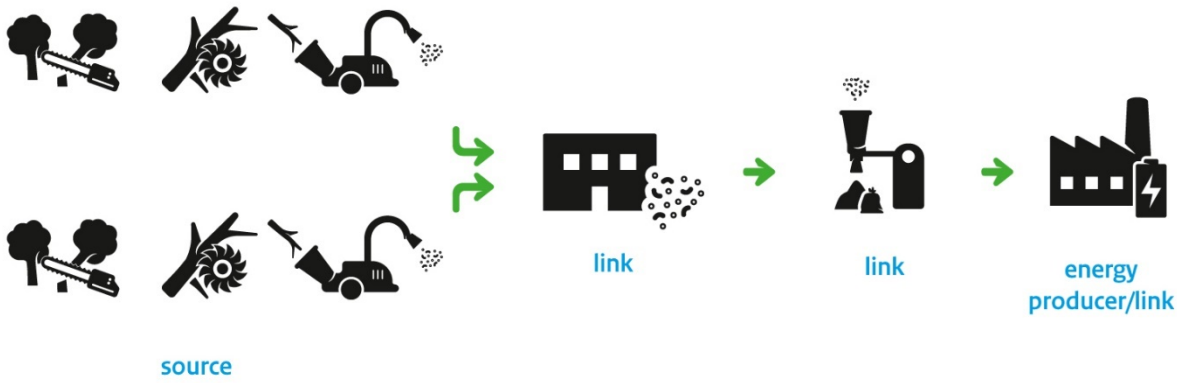
For Category 3 (Residues from nature and landscape management), the CoC outline defined as follows[37]:

This category comprises biomass that is produced during the management of urban and rural green spaces or nature areas other than forests, e.g. cuttings. The biomass comes from activities that are aimed at the

[36] Guidance Chain of Custody - sustainability criteria for solid biomass for energy applications. Commissioned by the ministry of Economic Affairs and Climate Policy (Feb. 2018), p. 7
[37] Guidance Chain of Custody - sustainability criteria for solid biomass for energy applications. Commissioned by the ministry of Economic Affairs and Climate Policy (Feb. 2018), p. 9

preservation, restoration or enhancement of specific natural, recreational or aesthetic functions. It also includes biomass residues produced during routine maintenance of public green spaces and parks. Compliance with sustainability requirements may be assessed using the information of a predefined (larger) collection area. In this category, the Chain of Custody begins at the First Collection Point. This link is the party that is the first to collect the biomass directly from the source.

Example: Cuttings and biomass residue are produced during routine maintenance activities by municipal landscaping company A. If economic operator B were to collect these cuttings in order to supply that biomass eventually to other economic operators C for co-firing and co-gasification, economic operator B would be the first link in the Chain of Custody.



Demonstrating compliance with sustainability criteria and certification

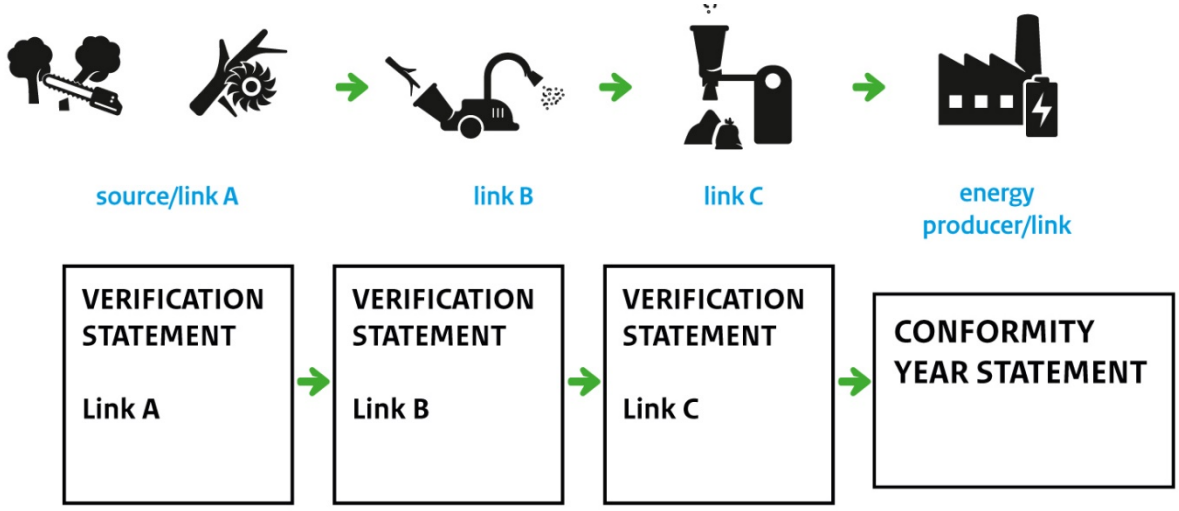
In order to be granted subsidy under the SDE+ Scheme, the energy producer must demonstrate conformity to the sustainability criteria. An independent verifier is charged with assessing this aspect. If the verifier is able to confirm that the sustainability criteria have been met, a conformity year statement can be issued. The information that is required to determine whether the sustainability criteria have been met comes from previous links in the supply chain. These links in the supply chain have two options, namely certification and verification.

Economic operators may choose to become certified for an existing certification scheme. Certification schemes for Sustainable Forest Management often have two types of certificates, namely a certificate for the source (Forest Management) and a certificate for the Chain of Custody (CoC).

If an economic operator wishes to make use of the fact that their supplier is certified, they will have to submit proof that the supplier was in possession of a valid certificate at the time of the delivery (to be verified via the database above). Forest Management Units have a so-called “Forest Management” certificate, while other links in the chain have a Chain of Custody certificate. The latter is a certificate that guarantees a continuous and controlled supply chain. Independent auditors of the relevant scheme will also verify whether the links in the supply chain comply with the requirements of the scheme. If a certified economic operator supplies biomass, a claim will be supplied with the supply and sales documentation alongside the biomass. This claim will provide information on the sustainability of the biomass to a certain

extent. Unfortunately, not all information required for the SDE+ subsidy is automatically delivered by all the certification schemes in the chain. Additional verification of the links in the chain is required in such cases.

Verified Chain of Custody[38]



[38] Guidance Chain of Custody - sustainability criteria for solid biomass for energy applications. Commissioned by the ministry of Economic Affairs and Climate Policy (Feb. 2018), p. 12

Regional risk-based approach

For biomass in category 2, there is also the option of working on the basis of a risk-based approach. This process means that the pellet manufacturer rather than the Forest Management Enterprise, for example, is responsible for determining on the basis of a risk assessment whether there is a low risk of non-compliance with the sustainability criteria by its suppliers. The Verification Protocol for Sustainable Solid Biomass is used to assess whether the correct method has been applied for that purpose. Some certification schemes such as SBP apply a regional risk-based approach and will be assessed on that aspect with a view to obtaining approval.

Certification and verification

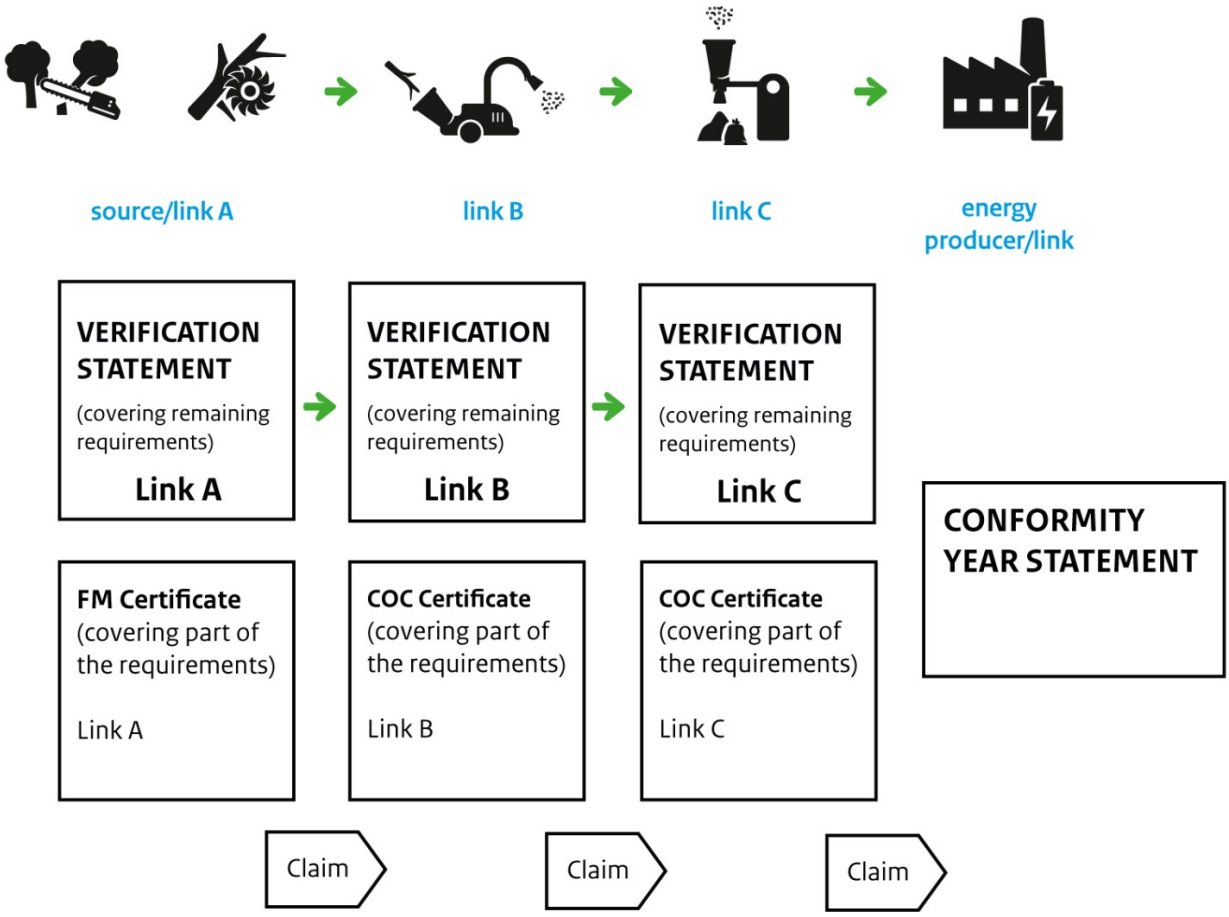
Certain certified links in the Chain of Custody may also be required to have verification carried out in addition to being certified. This situation may be the case if:

a) the certified link wishes to supply a non-certified physical consignment of biomass as sustainable or controlled to the next link;

b) the physically delivered biomass has been certified using a certification scheme that is only approved for part of the requirements.

In such cases, all subsequent links must conduct a verification for the consignments in addition to their audit of the certification scheme. To this end, the verification statement and the claim from the certification scheme must always be linked to the relevant consignment of biomass.

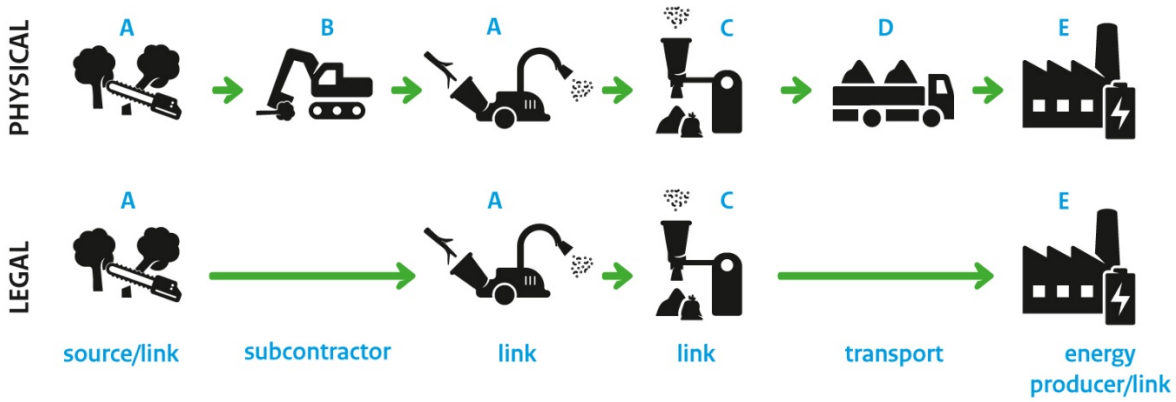
Certified and verified Chain of Custody[39]



In the case of transport and subcontracting, the responsibility for passing on the sustainability information corresponding to the physical biomass consignment always rests with the principal, authorizing link in the Chain of Custody. That link will need to ensure that the correct sustainability information is passed on to the next link. The amount of the consignment (even if it is conducted via a transport company or subcontractor) on the mass balances must be identical to the physical amount that is being traded. By checking the delivery and sales documentation, the correct sustainability information and amounts are registered and recorded (increase and decrease) administratively.

[39] Guidance Chain of Custody - sustainability criteria for solid biomass for energy applications. Commissioned by the ministry of Economic Affairs and Climate Policy (Feb. 2018), p. 13

Physical flow versus legal flow (Chain of Custody) of solid biomass[40]



Consignment reporting requirements

Sustainability information on a physical consignment of biomass must be added by way of documentation, including the following:
• Biomass category (one of 1 to 5);
• Application of the risk-based approach (yes/no)[41]
• Biomass type (sustainable or controlled);
• Country of origin for the biomass;
• Data in order to calculate the greenhouse gas emissions of the supplied biomass using the EU BioGrace II tool[42]
• Claim in relation to the certification scheme (if applicable);
• Verification statement issued by a conformity assessment body that is recognized by the Minister of Economic Affairs and Climate Policy (if applicable).

Information requirement

For the first link in the chain:
• Data on the source of the biomass that indicate whether the biomass is sustainable or controlled (claims from certification schemes may be used in this instance);
• Regional risk assessment and outcomes (if applicable and only for category 2 biomass);
• For category 5 biomass; data that demonstrate that secondary and tertiary residual flows are involved.

For all links in the chain:
• Names and addresses of suppliers and recipients;
• If the previous link uses certification, a demonstrably verified CoC certificate from the previous link;

[40] Guidance Chain of Custody - sustainability criteria for solid biomass for energy applications. Commissioned by the ministry of Economic Affairs and Climate Policy (Feb. 2018), p. 14
[41] This risk-based approach was subject to phasing out but as per the press release of SBP on December 20th, 2019, agreement was obtained from the Dutch government for 'the complete solution for compliance with the biomass sustainability requirements of the Netherlands' SDE+ subsidy programme.' See https://sbp-cert.org/sbp-offers-complete-solution-for-sde-compliance/.
[42] See https://www.biograce.net/biograce2/

• If the previous link uses verification, a verification statement issued by a conformity assessment body that is recognized by the Minister of Economic Affairs and Climate Policy (if applicable).
• If the link itself does not use certification, a demonstrably valid certificate including the most recent audit report;
• If the link itself uses verification, a verification statement issued by a conformity assessment body that is recognized by the Minister of Economic Affairs and Climate Policy (if applicable).
• Relevant delivery documentation (such as weighbridge tickets, delivery notes, and so on) stating the physically delivered amounts of incoming and outgoing biomass;
• Mass balance calculations, including data with which to link the mutations on the mass balance to the physical and administrative consignments;
• Description of proven processes that ensure that the CoC requirements are adequately implemented.

Mass balance requirement and CoC[43]

Every link in the CoC must draw up a mass balance. The source (even if it is also a link) and the energy producer occupy a unique position, as they only have to deal with a "halved" mass balance, since the source has no incoming biomass (which is generated by nature) and the energy producer has no outgoing biomass. Nevertheless, both have to keep a record of the outgoing (source) and incoming (energy producer) consignments respectively, which must meet the requirements of the regulations for the conformity assessment of solid biomass for energy applications.

For the individual consignments, the mass balance registers the quantities of biomass that are added alongside the corresponding sustainability information.

In summary:

The Dutch sustainability regime is stringent and has very detailed reporting requirements. **However, the biomass from the GSFA project should qualify under the Dutch categories** and in addition meet the sustainability requirements as long as all tracking and documentation along the CoC is properly managed.

A challenge is that none of the standards are approved for all categories and all criteria. Thus, supplying the Dutch market will require a detailed review and detailed consulting regarding how to combine different standards to meet the requirements.[44] Such work needs to be done under consideration for the Dutch biomass demand which under the Dutch Energy Agreement is set at 3.5 million MT of pellets to come from wood biomass from certified forests.

[43] Guidance Chain of Custody - sustainability criteria for solid biomass for energy applications. Commissioned by the ministry of Economic Affairs and Climate Policy (Feb. 2018), p. 18
[44] An overview (available in Dutch only) on the criteria per standard that are approved by the Dutch government are available for categories 1 and 1 at https://www.rvo.nl/sites/default/files/2019/10/Overzichtstabel%20goedkeuringen%20cat%201%20en%202.pdf and for categories 3 and 4 at https://www.rvo.nl/sites/default/files/2019/10/Overzichtstabelgoedkeuringen%20cat%203%20en%204.pdf

Denmark (DK)

Key Legislation:
Guidelines on securing sustainable timber in public procurements of goods and services (2016)
The Danish Industry Agreement for Sustainable Biomass (voluntary approach of 2016 and to be fully implemented by 2019)[45]

The requirements for sustainable biomass, as defined in the 2016 guidelines includes all plants that generate heat and electricity using biomass and whose rated thermal input exceeds 20 MW. These plants are subject to documentation requirements which are the UK requirements as published in 2014.[46]

The Danish industry agreement covers the following criteria:

1) Legality
Legality of forest management and utilization is safeguarded through:

- Logging from legally designated areas
- Payment of all relevant taxes and duties related to the forest sector
- Logging complies with applicable legislation governing the environment and forest areas
- Logging respects the rights acquired by prescription and the civil rights of indigenous people
- Compliance with the trade and customs legislation governing the forest sector.

2) Protection of the forests' ecosystems
Forest management must ensure the preservation of the fundamental conditions of the ecosystem through:

- Assessment of the environmental (e.g. water, soil) impact related to clearance of wood
- Impact assessment of the influence of management on ecosystem and biodiversity
- Scheme to minimize negative impact on ecosystems and biodiversity, including impact from fertilizers, pesticides and waste disposal.

3) The forests' productivity and ability to contribute to the global carbon cycle must be maintained.
Management of forests must ensure the least negative impact on the forest's productivity and carbon sequestration through:

- Maintaining the forest's ability to produce wood for future generations
- Balancing logging and growth rates
- Establishing a system for measuring the forest's productivity
- Education and training of producers and subcontractors
- Refraining from using wood from forests which cannot be replanted/rejuvenated
- Refraining from converting land with forest status

45

The agreement to ensure sustainable biomass applies only to wood pellets (compressed wood shavings and saw-dust) and wood chips (comminuted wood) including wood supplied as logs to the utility which are comminuted after arrival at the utility. The agreement covers biomass from forest defined as areas greater than 0.5 hectares with a minimum width of 20 m with trees higher than 5 meters with a crown cover of more than 10 per cent or trees that are potentially able to achieve these values to the locus. The definition does not include areas dominated by agricultural or urban use, including holiday home areas.

[46] The Danish documents refers to https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/278372/Timber_Standard_for_Heat_and_Electricity_under_RO_and_RHI_-_10-Feb-2014_for_pdf_-_FINAL_in_new_format.pdf

- Refraining from converting forests with high carbon content [1]

4) The forests must be healthy and well-functioning
Forest management must ensure healthy and well-functioning forests through:

- Maintaining or increasing forest health and vitality
- Management of natural processes, including forest fires, pests and diseases
- Protection against illegal logging and mining operations

5) Protection of biodiversity, sensitive areas and areas worthy of preservation
Forest management must ensure protection of biodiversity, sensitive areas and areas worthy of preservation through:

- Identification of particularly vulnerable areas or areas which are particularly worthy of preservation
- Protection of designated areas through forest management with due consideration to sensitive areas and areas worthy of preservation

Areas may have special value if they e.g. protect against soil erosion, protect water resources, have high biodiversity, have special scenic values and/or comprise particularly valuable animal or plant species.

6) Social and work-related rights must be respected
Forest management must safeguard respect for social and work-related rights by:

- Identifying, documenting and respecting original inhabitants with a traditional or legal forest easement
- Establishing complaint mechanisms, if not already available, to regulate disagreements in connection with the identified forest easements and working environment
- Employees shall be entitled to organize themselves and child labor, forced labor or discrimination are not permitted
- The work must be organized and executed in such a way that the employees' health and safety are taken into due consideration.

7) CO_2 emissions limits from biomass value chain
Biomass may only be used where CO_2 emissions from the biomass value chain in question do not exceed the applicable limits resulting from the agreement at any given time. The BIOGRACE model is chosen as the method of calculation CO_2 emissions from the biomass value chain[47], as the method and tool recommended by the European Commission.

8) Additional requirements targeted at carbon cycle, maintenance of forest carbon stock, Indirect land use change (ILUC) and Indirect wood use change (IWUC)
In addition to the biomass value chain, the use of biomass as a form of energy can have indirect implications for global carbon balance. In May 2014, the Danish Energy Agency published an analysis of the use of biomass for energy in Denmark: ”Analyse af bioenergi i Danmark” (Analysis of bioenergy in Denmark.) The analysis highlights a number of biomass types, where the use of energy will have varying effects on carbon balance, and therefore the climate benefits that will be obtained by using biomass to replace fossil fuels.
To ensure a climate-appropriate carbon balance in addition to the actions in the above 7 items and based on the conclusions of the analysis, the industry aims to not use biomass:

- where there regionally exists an actual alternative demand for high-value production (including the production of timber)

[47] The document provides the link to BioGrace 2 at (http://www.biograce.net/biograce2/).

- which comes from trees that are grown on fertile soil, which has been unwisely convert-ed from agriculture to forestry
- is to blame for deforestation in the region
- that negatively affects the quantity and quality of forest resources in the medium and long terms

If standardized methods for documenting retention of forest carbon stock, IWUC- and ILUC effects, are developed, the industry must accept these methods before they can be incorporated into the industry agreement as documentation requirements.

Criterion 4 is highly applicable to the GSFA project.

Certification

For documentation re. the criteria 1 - 6, the certification system developed by the Sustainable Biomass Partnership can be used. The Sustainable Biomass Partnership certification system is a certification of the production and purchase of wood pellets and wood chips. The certification scheme is the result of a collaboration between a number of energy companies including DONG Energy (now Orsted), Vattenfall and E.ON. Certification schemes, which are widely used world-wide and are recognized as documentation of sustainability by the Danish Nature Agency may also be used. Currently, only FSC and PEFC are recognized. FSC and PEFC set standards for forest management, tracking and labelling, which means that timber sold to the end user that has certified traceability from one of these schemes will be deemed to satisfy requirements 1-6.

Requirements for criterion 7 (CO_2 emissions in the value chain)
The requirements for CO_2 emissions in the value chain are calculated both as an absolute limit and as a percentage in comparison with a fossil reference. Both calculation and reporting are as per the UK regulations and tools (BioGrace tool).

According to the Danish guidelines, the requirements for emissions will be continuously tightened up to 2020 in line with expected increased imports of wood pellets and wood chips.

Germany (D)

Key Legislation:
Biomass Electricity Sustainability Ordinance -BioSt-NachV (2009; revised 2018)
Guideline to the common decree on the procurement of wood products (2010)

The German legislation reflects the types and use of biomass for power generation which is different to e.g. UK, NL and DK. The legislation in general is focused on agricultural biomass (for biogas-based power generation) and biofuels. Solid biomass and forest biomass detailed legislation is less developed and where appropriate, the German legislation and guidelines refer back to EU regulations.[48] Germany does have a market for wood pellets but it is focused on residential heating and not electricity generation. In this context, Germany together with Sweden and Austria were in the lead to initiate a European wood pellet quality standard which was created with EN 14961-2. Pellet demand for residential heating is covered by woody biomass which is processed to pellets in domestic pellet mills.

Woody biomass resources are predominantly domestic (from German forests or short rotation coppice) or from other EU countries. Consequently, the annual update by the German Federal Office for Agriculture and Food has no reference to forest biomass.[49]

One of Germany's major biomass energy related R&D institutions with government funding is the German Biomass Research Centre (DBFZ). A review of their publication list also highlights the German focus on agricultural biomass; references for woody biomass including wood pellets focus on heating and not electricity generation.[50] However, some of the DBFZ staff have been co-authors of international papers discussing wood pellet manufacturing and import into the EU. An example is a paper of 2017[51] which as conclusion states the following:

> *The balance of evidence, some of which is reviewed here, suggests that current levels of wood-pellet production in the SE USA have had a benign effect on forest ecosystem services. Future production has the potential for positive effects when it builds landowner commitment to retain land in forest cover and when wood-pellet production becomes more efficiently integrated into proactive forest management plans. Regulatory and voluntary provisions exist to protect forests. Nonetheless, systematic monitoring and evaluation of managed forests are essential to ensure that intended outcomes are achieved. Knowledge gained from monitoring and rigorous scientific research should be used to inform continual improvement of forest management and should be reflected in decision making in both the USA and the EU.*

In 2019, the German Federal government in essence decided to phase out all coal power generation by 2038. However, the detailed phase out plan and respective law has not been finalized; also due to strong opposition by German states with lignite mining operations. It is therefore not clear if and when Germany might convert coal power plants to biomass and the respective demand. Standards can be assumed to be similar to UK or Danish regulations.

[48] See e.g. https://www.ble.de/EN/Topics/Climate-Energy/Sustainable-Biomass-Production/sustainable-biomass-production_node.html
[49] See e.g. the latest 2019 report at https://www.ble.de/SharedDocs/Downloads/EN/Climate-Energy/EvaluationAndProgressReports2018.pdf?__blob=publicationFile&v=2
[50] See also https://www.dbfz.de/en/press-media-library/publications-directory/
[51] Dale, Virginia H. et al. (2017): Status and prospects for renewable energy using wood pellets from the southeastern United States. In: GCB Bioenergy 9, S. 1296–1305.

Steam Exploded Pellet Discussion

See the accompanying report on steam exploded pellets for a detailed discussion about the technology, the costs, and the benefits.

The GSFA may consider steam exploded (SE) pellets as an option. This section contains the summary cash flow information if one of the two pellet projects used that technology.

The two key assumptions drive the difference between a white pellet and SE pellet project.

(1) The project depends on the sales of the biochemical products. The project due diligence prior to choosing SE pellets should be to investigate the markets, the potential for long-term offtake of the biochemicals, and the strategy for delivering the biochemicals to the markets.
(2) The value of the SE pellets carries a 3% premium over white pellets for same energy density. This is due to the ability of power plants to avoid significant modification costs and the need for dry storage domes. The accompanying report describes the characteristics of the SE pellets that allow them to command the premium. The project due diligence prior to choosing SE pellets should be to investigate the willingness to pay by potential long-term SE pellet offtakers.

It is assumed that the plant is built well, and that the technology performs as noted in the accompanying report.

Comments of the Biochemicals

The biochemical value stream is critical for a SE project if it is to be competitive with white pellets.

The biochemical revenue assumptions for the SE project is based on the following yields and revenues from the biochemical production[52].

END PRODUCTS	Based on a nameplate of 500,000 and actual production at 92% or 460,000 tonnes per year			
Chemical	**kg/h**	**tonnes/year**	**price (US$/tonne)**	**revenue (US$ M/year)**
Furfural	609	4,905	$1,500.00	$7.357
Methanol	203	1,635	$600.00	$0.981
Acetone	7	54	$400.00	$0.022
Other (used as burner fuel)	338	2,725	$0.00	$0.000
SUM	**1,156**	**9,319**		**$8.360**
			additional revenue per metric tonne equivalent	**$18.17**

Net cash flow from biochemical production is estimated as follows:

[52] Yield quantities based on data from Arbaflame that have been verified by FutureMetrics. Yield of furfural can be increased slightly if the plant economics suggest that as a profit maximizing strategy. Yield of pellets will fall slightly as a consequence. The prices are assumed to be FOB the factory.

BioChem Summary of Operating Cash Flows	$Millions per Year	Per Tonne Equiv.
Biochem Revenues with furfural at $1,500 /MT	$8.36	$18.17
Total Biochem OPEX	$1.60	$3.48
Net Contribution	$6.76	$14.70

Under these assumptions, the biochemical revenue stream is the equivalent of adding $14.70 to the per tonne price of the pellets.

Furfural Market

In 2018 North America's consumption of furfural was valued at about $90 million with a forecast annual growth rate to 2025 of 3.5% (or about $3.15 million per year)[53]. The global market in 2018 was about $731 million and is expected to reach $1.05 billion in 2025 (a CAGR of 4.96%).

There is a premium between 98.5% and 99% purity. For 98.5% in 2025, price is estimated to be $2,030/tonne. For 99% purity, price is estimated to be $2,125/tonne in 2025.

North America produced about 45,000 tonnes in 2018.

North America Furfural Capacity, Production (K MT), Revenue (Million USD), Price (USD/MT) and Gross Margin (2014-2019)

North America	2014	2015	2016	2017	2018	2019E
Production(K MT)	39	39.8	42.3	42.9	44.6	45.7
Price(USD/MT)	1554	1456	1247	1750	1837	1883
Revenue(Million USD)	60.59	57.95	52.77	75.06	81.93	86.05
Gross Margin	22.32%	25.31%	24.91%	29.97%	30.52%	29.32%

Source: Secondary Sources and QYResearch, Aug 2019

Global production in thousands of metric tonnes is below.

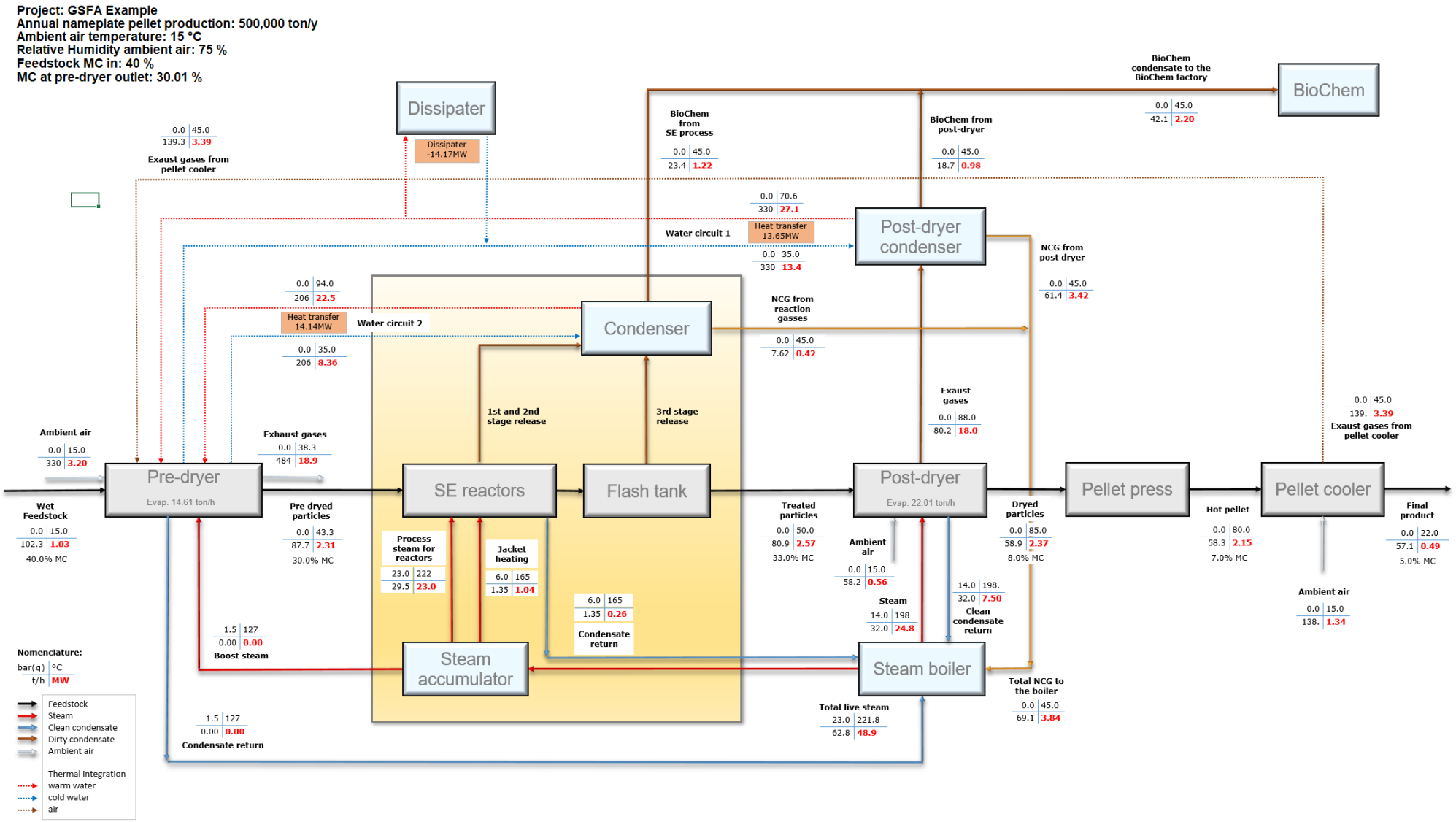
Global Furfural Production (K MT) by Regions (2014-2019)

	2014	2015	2016	2017	2018	2019E
China	364	376.5	360.16	298.1	319.8	341.7
North America	39	39.8	42.3	42.9	44.6	45.7
Europe	21.3	21.5	21.8	21.5	22	21.8
South America	2.9	3.1	2.9	3	3.1	3.2
Rest of Asia	2.6	2.6	2.9	3.1	3.2	3.3
Middle East and Africa	14.1	15.8	18.4	19.7	19.5	20.4
Global Total	443.9	459.3	448.46	388.3	412.2	436.1

Source: Secondary Sources and QYResearch, Aug 2019

The diagram on the next page shows the estimated mass and energy flows for a 500,000 tpy SE pellet factory. The biochemicals capture the mass loss from the steam explosion reaction.

[53] Data from a report purchased by FutureMetrics from QYResearch.


Project: GSFA Example
Annual nameplate pellet production: 500,000 ton/y
Ambient air temperature: 15 °C
Relative Humidity ambient air: 75 %
Feedstock MC in: 40 %
MC at pre-dryer outlet: 30.01 %
Dissipater
Dissipater -14.17MW
0.0 | 45.0
139.3 | 3.39
Exaust gases from pellet cooler
BioChem condensate to the BioChem factory
0.0 | 45.0
42.1 | 2.20
BioChem
BioChem from SE process
0.0 | 45.0
23.4 | 1.22
BioChem from post-dryer
0.0 | 45.0
18.7 | 0.98
0.0 | 70.6
330 | 27.1
Water circuit 1
Heat transfer 13.65MW
0.0 | 35.0
330 | 13.4
Post-dryer condenser
NCG from post dryer
0.0 | 45.0
61.4 | 3.42
0.0 | 94.0
206 | 22.5
Heat transfer 14.14MW
Water circuit 2
0.0 | 35.0
206 | 8.36
Condenser
NCG from reaction gasses
0.0 | 45.0
7.62 | 0.42
1st and 2nd stage release
3rd stage release
Exaust gases
0.0 | 88.0
80.2 | 18.0
0.0 | 45.0
139. | 3.39
Exaust gases from pellet cooler
Ambient air
0.0 | 15.0
330 | 3.20
Exhaust gases
0.0 | 38.3
484 | 18.9
Pre-dryer
Evap. 14.61 ton/h
SE reactors
Flash tank
Post-dryer
Evap. 22.01 ton/h
Pellet press
Pellet cooler
Wet Feedstock
0.0 | 15.0
102.3 | 1.03
40.0% MC
Pre dryed particles
0.0 | 43.3
87.7 | 2.31
30.0% MC
Process steam for reactors
23.0 | 222
29.5 | 23.0
Jacket heating
6.0 | 165
1.35 | 1.04
6.0 | 165
1.35 | 0.26
Condensate return
Treated particles
0.0 | 50.0
80.9 | 2.57
33.0% MC
Ambient air
0.0 | 15.0
58.2 | 0.56
Steam
14.0 | 198
32.0 | 24.8
14.0 | 198.
32.0 | 7.50
Clean condensate return
Dryed particles
0.0 | 85.0
58.9 | 2.37
8.0% MC
Hot pellet
0.0 | 80.0
58.3 | 2.15
7.0% MC
Final product
0.0 | 22.0
57.1 | 0.49
5.0% MC
Ambient air
0.0 | 15.0
138. | 1.34
1.5 | 127
0.00 | 0.00
Boost steam
Steam accumulator
Steam boiler
Total live steam
23.0 | 221.8
62.8 | 48.9
Total NCG to the boiler
0.0 | 45.0
69.1 | 3.84
1.5 | 127
0.00 | 0.00
Condensate return
Nomenclature:
bar(g) | °C
t/h | MW
Feedstock
Steam
Clean condensate
Dirty condensate
Ambient air
Thermal integration
warm water
cold water
air

Estimated Steam Exploded Project Cash Flow.

Steam Exploded Pellet Factory with a Nameplate of 500,000 Tonnes per Year -North California		
Pre Tax Financial Returns (NPV in $ millions at 7.0%) with no exit strategy		
Based on 10 yr S/L amort depreciation schedule in millions	**NPV (@7.00%)**	**IRR**
Project cash Flow Returns based on Full Project Finance Cost	$ (77.38)	0.7%
Project cash Flow Return for Equity Investors	$ (35.20)	Low

Estimated cash Flows - based on a 10 yr S/L amort depreciation schedule							
($ millions)	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**$/T 2026**
Total Revenue	$ -	$ 9.08	$ 58.01	$ 98.59	$ 100.07	$ 101.57	$ 220.81
Minus Cost of Goods							
Pellet Fibre	$ -	$ 3.39	$ 21.58	$ 36.85	$ 37.40	$ 37.96	$ 82.52
CHP Fuel	$ -	$ 0.49	$ 3.12	$ 5.32	$ 5.40	$ 5.49	$ 11.92
Logistics Costs	$ -	$ 1.91	$ 12.15	$ 20.75	$ 21.06	$ 21.37	$ 46.47
Total COGS	$ -	$ 6.85	$ 43.59	$ 74.44	$ 75.56	$ 76.69	$ 166.72
Gross Profit	$ -	$ 2.22	$ 14.42	$ 24.15	$ 24.51	$ 24.88	$ 54.09
Gross Margin	0.0%	24.5%	24.9%	24.5%	24.5%	24.5%	
Minus Operating Expenses							
Labor	$ -	$ 0.62	$ 2.49	$ 4.26	$ 4.32	$ 4.39	$ 9.54
Electricity	$ -	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00
Maintenance, consumables, and fuel costs	$ -	$ 0.70	$ 4.45	$ 7.60	$ 7.72	$ 7.83	$ 17.03
SG&A	$ -	$ 0.46	$ 1.87	$ 1.91	$ 1.94	$ 1.97	$ 4.28
Other Costs	$ -	$ 0.02	$ 0.15	$ 0.25	$ 0.25	$ 0.25	$ 0.55
Operating Expenses	$ -	$ 1.81	$ 8.96	$ 14.02	$ 14.23	$ 14.44	$ 31.40
EBITDA	**$ -**	**$ 0.4**	**$ 5.46**	**$ 10.13**	**$ 10.28**	**$ 10.44**	**$ 22.69**
EBITDA Margin		4.6%	9.4%	10.3%	10.3%	10.3%	
Cash Flow							
Changes Net Working Capital	$ -	$ (2.12)	$ (4.99)	$ (4.68)	$ 0.19	$ (0.22)	$ (0.48)
Interest Expense	$ -	$ (1.79)	$ (6.94)	$ (6.58)	$ (6.22)	$ (5.86)	$ (12.74)
Cash Taxes	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Operating cash Flow	$ -	$ (3.49)	$ (6.48)	$ (1.14)	$ 4.25	$ 4.35	$ 9.47
Total Capital	$ (22.78)	$ (128.25)	$ (9.74)	$ -	$ -	$ -	$ -
Debt Financing	$ 16.74	$ 96.18	$ 7.30	$ -	$ -	$ -	-
Ongoing CAPEX	$ -	$ (0.25)	$ (1.01)	$ (1.03)	$ (1.04)	$ (1.06)	$ (2.30)
Debt Repayment	$ -	$ (1.50)	$ (6.01)	$ (6.01)	$ (6.01)	$ (6.01)	$ (13.07)
Other	$ -	$ 6.16	$ 15.18	$ 8.17	$ 2.80	$ 2.71	$ 5.90
Free Cash Flow to Equity	**$ (6.04)**	**$ (31.15)**	**$ (0.75)**	**$ -**	**$ -**	**$ 0.00**	**$ 0.00**

The SE option is not feasible given the assumptions used in the financial model.