U.S. Forest Service Wood Innovations Application – FY 2020

Part 1: Cooperator Contact Information

1. Project Title: Long Falls Paperboard Biomass Combined Heat & Power Conversion Project – Flue Gas Condensation Alternate to Achieve Maximum Efficiency

2. Check one:

☐ Wood Products
☒ Wood Energy

3. Project Cost & Cooperator Funding

A. Cooperator Funding (Match, $): 420,000

B. Requested Forest Service Funding ($): 500,000

C. Cooperator Funding as a Percentage of Requested Forest Service Funding (A/B x 100, %): 84%

D. Total Project Cost (A + B, $): 920,000

4. Contact Information

<u>**Financial Agreement Applicant**</u> (*Responsible official for the financial administration of the project*)

Name: Michael Cammenga
Title: Principal
Organization/Company: Long Falls Paperboard LLC
Bureau/Division:
Section/Program:
Street Address/P.O. Box: 161 Wellington Road
City, State Zip: Brattleboro VT 05301
Phone: 802.257.0365 (work), (b)(6) (cell)
E-mail Address: mike.cammenga@longfallsgroup.com

<u>**Project Contact**</u> (*Responsible for management/coordination of project; if listed above, check box* ☒)

U.S. Forest Service Wood Innovations Application – FY 2020

A. Basic Project Information

Project Title: ***Long Falls Paperboard Biomass Combined Heat & Power Conversion Project – Flue Gas Condensation Alternate to Achieve Maximum Efficiency***

Project Length: Two years from date of final approval of contract, if awarded.

Abstract: Long Falls Paperboard seeks WIG matching funds to enable the incorporation of flue gas condensation (FGC) into the design and operation of its proposed wood biomass CHP plant in Brattleboro VT. Long Falls is building this plant to eliminate its use of non-renewable fossil fuels (chiefly compressed natural gas) in heat and power generation, and to dramatically lower its operating costs. This technology involves the installation of a system to condense the water vapor in the flue gas, while capturing the latent heat available from this water vapor to provide preheating of plant process water, or other low temperature thermal energy needs in the plant. Depending on the option, and conditions achieved, this will reduce wood fuel costs at the facility by 20-25% on an annual basis. FGC is a common design feature of plants in Europe, but not in the United States. We believe this will be the first such installation in an industrial biomass CHP plant in the country. FGC will result in even lower operating costs for the plant, which will utilize up to 131,000 tons of low grade wood resources annually. This new market will be of enormous regional value to forest health and productivity treatments on the nearby Green Mountain National Forest and other private and public forestlands in the procurement region for the plant.

B. Project Goals and Objectives and Relevance to Intent of Wood Innovation Program

Statement of need. This proposal seeks grant funds in support of implementation of flue gas condensation (FGC) on the Long Falls Paperboard (LFP) Biomass Combined Heat and Power (CHP) Energy Project, estimated at a total capital cost of between $14.8 and 26.4 million, depending on the scope of project. The project will replace fossil fuel energy use at LFP's paperboard plant in Brattleboro, VT with a new state-of-the-art, highly efficient wood biomass CHP plant, providing a new market for forest product residuals, supporting existing and creating new jobs, and enhancing the long-term profitability and economic vitality of this important forest product manufacturer.

The project will require between 47,431 and 130,985 tons of low-grade wood chips annually (depending on percentage of thermal and electric load served by CHP plant) from the regional forest products industry, rebuilding a new market for wood residuals in a region that has seen declines in these markets in recent years. Both the Green Mountain and White Mountain NFs will be within the fuel procurement woodshed for this project, with forest health treatments benefiting from access to this new market for low grade wood.

The exact scope of the project has yet to be determined by LFP. A comprehensive feasibility study conducted by Wilson Engineering Services (attached) has identified three design options that will allow LFP to generate up to 100% of its thermal and electric energy needs. FGC is a technical design alternative that is recommended for all three energy plant options. FGC is a desirable project component because it will greatly increase overall output efficiency, thereby reducing fuel costs by 20-25% to achieve the same combined thermal and electric energy output.

Specific Goals and Objectives

a. Incorporate FGC into energy plant design to demonstrate the applicability of this technology in an industrial scale biomass CHP installation in the United States;
b. Enhance the efficiency and performance of LFP's plant to maximize economic benefits to the future operation of the plant and the jobs and economic activity it supports;

c. Fully commission the FGC and document performance and return on investment in close cooperation with USFS so that other entities may learn from LFP's experience.

The project directly addresses a primary goal of the Wood Innovation Grant program, which is to stimulate or expand wood energy markets that support the long-term management of National Forest System and other forest lands. The plant is located 30 miles east of the southern unit of the Green Mountain NF, which is embarking on an ambitious natural resource management plan called the Somerset Integrated Resource Plan. GMNF forest management will generate large volumes of low grade wood residues through the implementation of diverse practices. The LFP project will provide a new market for up to approximately 131,000 tons per year, a market that will be essential to the achievement of forest health and productivity practices on the GMNF as well as other public and private forestlands in a three state region (VT, NH, MA). The project will also promote economic and environmental benefits in this region by displacing non-renewable fossil fuels with renewable, low carbon biomass, and enhancing the profitability of LFP, thereby supporting jobs, economic output, taxes and other benefits in the region.

C. Project Description

LFP is moving forward to implement the CHP project through these steps over the next 18 months:

- In June 2019, LFP's project development partner, the Brattleboro Development Credit Corporation (BDCC), **was awarded a $1 million grant from the Northern Border Regional Commission to fund all pre-construction design, engineering and permitting**.
- In September 2019, LFP engaged Wilson Engineering to conduct a feasibility analysis of three design options for the plant. This analysis was made possible through the US Forest Service Wood Education and Resource Center and completed in December and is attached. LFP management will make a decision in Q1/CY2020 on which of the three design options it will pursue.
- BDCC will then hire a project technical manager/owner's representative through a competitive solicitation. Wilson Engineering is expected to bid for this role.
- The project technical manager/owner's representative will prepare and issue a detailed design specification for bidding by engineering/ procurement/construction (EPC) contractors. This is expected in Q3/CY2020.
- BDCC will then hire an EPC contractor to complete final design, engineering and permitting.
- Construction is expected to begin in Q2/Q3 CY2021, with commissioning in CY2022.

If the WIG grant is awarded, the final design and engineering will incorporate FGC into the energy plant design. This waste heat capture will be utilized to preheat boiler water, provide space heating for the plant, provide supplemental heat for paperboard drying, and/or potentially provide district heat to the adjacent Brattleboro Industrial Park. Once the plant is operational, performance and efficiency gains of the FGC unit will be monitored with data collected, compiled and made available to the USFS for evaluation of the operating economic and performance of the technology.

Budget Alignment/Timeline. LFP seeks $500,000 in WIG funds toward a total project cost for the addition of FGC of at least $920,000. Actual project cost will likely exceed this depending on diversity of means of full utilization of waste heat. LFP acknowledges that this exceeds the maximum grant amount, but respectfully asks the USFS's consideration given this will be the first such application of flue gas technology in a biomass CHP plant anywhere in the U.S. The total energy plant project cost is estimated by Wilson Engineering at between $14.8 and $26.4 million depending on which CHP option is chosen. The >$920,000 cost of the FGC installation includes the unit itself, mechanical installation and site work specific to the installation of FGC, electrical and controls, contractor profit and overhead, and contingency (detailed budget is attached). Long Falls is committing a minimum of $420,000 in cash match because of some uncertainty around final cost of these project components, including engineering and infrastructure to fully utilize waste heat. The FGC installation is estimated to have a simple payback of 4 years without the WIG grant funding, and 1.8 years with the WIG grant funding. The basis for this simple payback analysis is below (from Wilson):

Item	Value	Units
Heat available to offset (40°F to 95°F*300 gpm*7,905 hrs)	65,276	mmBtu/yr
Wood fuel savings	10,104	tons/yr
Estimated fuel cost savings	$287,951	$/yr
A - Savings discounted 20% for uncalculated items	$230,361	$/yr
B - Estimated increase to project costs for installation	$920,000	$
Simple Payback (B/A)	4.0	yrs
C - Wood Innovations Grant Amount	$500,000	$
Simple Payback with Wood Innovations Grant [(B-C)/A]	1.8	yrs

Importantly, if the FGC is able to substantively reduce the overall heat demand in the facility, it may be possible to downsize the rated steam capacity of the boilers in each option, which could reduce overall capital cost. Also, while it may be difficult to quantify ahead of time with respect to impacting any emission control costs, there will be emissions benefits from condensing the flue gases prior to their leaving the stack.

LFP will provide 100% of the required match funding as cash from already approved project financing, which is in the form of VT Economic Development Agency Solid Waste Disposal bonds.

Progress will be monitored closely by LFP management and by BDCC, which has oversight responsibility of pre-construction design and engineering. The Project Technical Manager/Owner's Rep will have direct oversight of the EPC contractor who will do final engineering and installation of the FGC. LFP is eager to adhere to an aggressive implementation timeline because of the dramatic reduction in annual operating costs that will result from the biomass CHP project.

Forestry and land management interests throughout the region are watching this project with great anticipation of the substantial new market for low grade biomass fuels it will create.

Subgrant or subcontracting activity. At this time, it is difficult to know exactly how or to what extent subcontractors will be engaged in the installation of the flue gas condensation technology. The project is still more than a year away from hiring the EPC contractor who will do final design, engineering, permitting and construction. It is likely that this firm will engage multiple subcontractors for specific components of this large and complex energy plant retrofit.

Communication and Outreach. Long Falls recognizes that the operation of flue gas condensation in an industrial biomass CHP plant is uncommon in the United States. Long Falls is committed to sharing documentation of system performance with the US Forest Service and with other entities that want to learn more about this technology and how it can boost efficiency in situations where low temperature thermal energy can be used cost effectively.

D. Project Impact

The main deliverable of this project is the incorporation of state-of-the-art flue gas condensation technology into Long Falls $14.8 to $26.4 million proposed biomass combined heat and power plant. The desired outcome is vastly increased total plant energy utilization efficiency, which is conservatively estimated to reduce fuel operating cost by 20 to 25% for equivalent energy output (thermal and electric combined), depending on which plant design option is chosen.

The Long Falls biomass plant will have a major impact on low grade wood markets in the region, which have seen steady decline in recent years due to the closure of commercial wood fired power plants. The GMNF is well within the economic trucking distance of the Brattleboro plant location, and will benefit greatly from access to markets for low grade wood derived from their forest health and productivity management practices. Other private/public forest owners will also benefit greatly from this stronger market.

The LFP project is expected to have significant job impacts. The grant submission to the Northern Border Regional Commission estimated that conversion of LFP's energy generation to biomass will create over 57 new jobs and help to secure the 100 current worker positions at the plant. The biomass plant project is directly designed to reduce energy costs while increasing production at the plant – both critical to long-term sustainability, profitability, and retention/expansion of jobs at the plant. The project will help retain jobs in forestry and related work such as logging and trucking the wood chips from the forest to the plant that are at significant risk of being lost due to declining low-grade wood markets. It will create economic value for existing forestry entities and workers as an outlet for an otherwise underutilized forest residuals. The project will use as much low-grade as all the schools and other commercial/institutional users in Vermont combined.

The LFP facility was at risk of closing and losing 100 well-paying jobs before BDCC stepped in to secure the property and then sell the business to LFP. LFP currently purchases $8 million annually in virgin pulp from mills in Maine. At full operation – anticipated in the near future - the plant will purchase some $12 million annually in raw pulp from mills in the region as its paperboard feedstock. The project is integral to lowering operating costs in support of increased production and job growth.

The total cost of the FGC is >$920,000. LFP will provide 100% of the >$420,000 to match the WIG grant funds requested in cash from other project financing. LFP has secured a commitment of Vermont Solid Waste Disposal industrial revenue bonds to finance the majority of the project. Other grant funds already secured include $1 million from the Northern Border Regional Commission (to BDCC for pre-construction design, engineering and permitting), and $500,000 in US EPA brownfield environmental remediation funds (also to BDCC).

E. Qualifications of Team and Partners

Michael Cammenga – Project Manager. Senior Leader with diverse experience in engineering, facility management, process optimization, strategic purchasing, sales, leveraging best practices, and business operations. 30 years of paper industry experience, overseeing and planning major rebuilding and process improvement projects with budgets as high as $150 million.

Lee Hill – Construction Manager. Experience of over 26 years in the field of Industrial Maintenance with professional level skills in preventantive maintenance, alignment, lubrication, precision, as well as installation and repairs of numerous types of equipment. Overhead crane rigging and lifting experience. OSHA 10 and MSHA certified.

John Brooke – Controls Engineer. 40 years of experience in the industry including 20 years with Honeywell Measurex Corp as a Senior Service Specialist and 12 years with Rock Tenn/West Rock as a Senior Process Controls Engineer. Thorough knowledge and experience of DCS process control systems, systems integration, PLC programming, and project management.

Edward Champagne – Project Engineer. Certified Project Management Professional with extensive experience in project leadership, cost control and budgets, equipment and facility maintenance, business development and power plant supervision. Over 30 years of maintenance and engineering experience.

Gabriela Constantin – Process and Environmental Engineer. Recent Chemical Engineering graduate with 2 years of on-site experience working on process and product improvement, energy and resource reduction projects, environmental testing, monitoring, reporting and assesments. Certified Pollution Abatement Facility Operator Industrial Paper Grade II.

F. Annual Progress Reports and Final Reports. Recognizing the precedent setting nature of this new FGC technology, LFP is prepare to work closely with the Forest Service to fully document all aspects of installation, operation, maintenance and performance for a period of at least three years after the system is installed. If awarded, LFP will develop a plan for outreach and demonstration including tours for others interested in learning about the technology, case studies once performance data is in hand, and financial analysis of the impact on plant efficiency. LFP will also comply fully with all WIG reporting requirements.

G. Budget Summary and Justification in Support of SF–424A

1. Budget Table

Categories	I. Forest Service Share	II. Cooperator's Share	III. Total
1. Personnel			
2. Fringe benefits			
3. Travel			
4. Equipment (flue gas condensation unit)	500,000	50,000	550,000
5. Supplies/Materials			
6. Contractual (identify below)		370,000	370,000
7. Construction	N/A		
8. Other (identify below)			
9. Direct charges	500,000	420,000	420,000
10. Indirect charges			
11. Total	500,000	420,000	920,000
12. Percentage of Total	54.3%	45.7%	100%

Explanation and details for use of Forest Service Requested Funds in Category 6 (Contractual):

The contractual item is for added design associated with integration of the FGC system. The specific costs identified as matching are a portion of the total cost of the design and installation which will be paid by LFP. The total project cost is estimated by Wilson Engineeering at $920,000 (budget breakdown in appendix), but Long Falls expects it to be higher than this due to infrastructure and engineering to fully utilize waste heat captured by the FGC.

2. Cooperator (Matching) Contributions Table

*NOT including Forest Service contributions

Cooperator Name	Cash	Materials	In-Kind Services	Total
Long Falls Paperboard LLC	$420,000			$420,000
Totals	**$420,000**			**$420,000**

Appendices – Table of Contents

LONG FALLS PAPERBOARD

January 15, 2020

Mr. Lew McCreery
USDA Forest Service
Wood Education and Resource Center
Princeton WV

Dear Mr. McCreery:

Long Falls Paperboard LLC ("LFP") respectfully submits this Letter of Commitment to serve as a formal understanding regarding LFP's financial and corporate investment in the development of a biomass fueled combined heat and power facility at 161 Wellington Road, Brattleboro, VT (the "CHP"), and specifically in the commitment of a minimum of $420,000 in cash match toward a grant request of $500,000 from the 2020 Wood Innovations Funding Opportunity to finance the engineering and installation of flue gas condensation in the final CHP project.

LFP is committed to working in collaboration with the Brattleboro Development Credit Corporation to complete preconstruction design, engineering and permitting of the CHP facility, work that is supported in part by a $1 million grant from the Northern Border Regional Commission awarded in 2019. During the planned 18-month predevelopment phase and the ensuing construction phase, LFP is hereby committing cash of at least $420,000 toward engineering, site work, electrical, controls and ancillary project costs related to the installation of flue gas condensation.

LFP is pleased to report that in 2019 the Vermont Economic Development Agency ("VEDA") passed an inducement resolution to finance this project with Solid Waste Disposal Bonds. Following the completion of the predevelopment work, LFP will work with the underwriter who will sell the bonds in the private market. Upon bond funding LFP will proceed with the construction and operation of the project, including the installation of the flue gas condensation unit and related infrastructure.

LFP recognizes that our 2020 Wood Innovations Grant request exceeds the generally permissible maximum grant amount of $250,000. We note that the funding opportunity indicates that the Forest Service may consider awarding more to a proposal that shows significant impact, where the project closely aligns with program goals and yields significant hazardous fuels reduction in a timely manner. We have been advised that the installation of advanced flue gas condensation technology is without precedent in an industrial biomass CHP plant in the United States. Such technology innovation is commonplace in Europe. LFP is committed to documenting and sharing performance data once the system is installed so that others in the U.S., including the Forest Service, may evaluate the efficacy of a similar investment. Once operational, the new plant will require up to 131,000 tons per year of low-grade wood biomass fuel, providing an invaluable new market in a region that has suffered recent dramatic declines in low grade wood utilization. The consumption of wood biomass raw material is expected to continue every year for the operational life of the project, which is expected to exceed 30 years. The current fossil fuel boilers have been operating for more than 50 years. The project will benefit public and private landowners across a three-state region for years to come in the practice of sustainable forestry and the implementation of forest health treatments. The Green Mountain National Forest, the southern unit of which is only 30 miles to the west of Brattleboro, expressed enthusiastic support for this proposal in an attached letter.

We appreciate that competition for WIG grants is great but respectfully ask your favorable consideration of our request.

LONG FALLS PAPERBOARD LLC
161 Wellington Road
Brattleboro, VT 05301

Michael P Cammenga

____

Michael Cammenga, Principal, duly authorized

VERMONT ECONOMIC DEVELOPMENT AUTHORITY

Vermont Agricultural Credit Corporation
Vermont Small Business Loan Program
Vermont 504 Corporation

February 26, 2019

Ben Rankin
Long Falls Paperboard, LLC
618 Powers Road
Starbuck, WA 99359

Dear Ben:

AMENDED APPROVAL LETTER

Enclosed is a copy of the first Amendment Approval Letter relative to the Inducement Resolution, "preliminary approval", adopted by VEDA at its meeting of February 22, 2019 for the issuance by VEDA of up to $27,500,000 of Industrial Revenue Bonds on behalf of Long Falls Paperboard, LLC.

VEDA's final approval is contingent upon completion of the arrangements for the issuance, sale, security for and credit enhancement (if any) of the bonds to be issued, among other things, in a manner and form satisfactory to VEDA and its Bond Counsel. Naturally, any funds expended by Long Falls Paperboard, LLC prior to final approval are "at risk" pending formal final action by VEDA.

An issuance fee of 5/8 (.625%) of 1% of the bond amount) will be payable to VEDA at the bond closing.

Please do not hesitate to call me (802-859-3017) if you have questions about the Resolution or the process going forward. I look forward to working closely with you to finance this exciting project.

Sincerely,

Marie Dussault
Senior Commercial Loan Officer

Enclosure

cc: Tony Martini, Hinckley Allen

s/monthly/2019/commitment ltrs/Long Falls Paperboard Inducement

USDA United States Department of Agriculture | Forest Service | Green Mountain and Finger Lakes National Forests Supervisor's Office | 231 North Main Street Rutland, VT 05701 802-747-6700 Fax: 802-747-6766

File Code: 3000
Date: January 6, 2020

To Whom it May Concern
USDA Forest Service
Wood Innovation Grant Program
Wood Education and Resource Center
301 Hardwood Lane
Princeton WV 24740

To Whom It May Concern:

I am submitting this letter in support of the grant application of Long Falls Paperboard LLC to the USDA Forest Service Wood Innovation Grant Program, to provide funds for installation of flue gas condensation technology at Long Falls Paperboard's proposed biomass fueled combined heat and power plant in Brattleboro VT.

The proposed plant would provide important additional markets for low grade and small diameter wood products in southern Vermont. These markets are needed for supporting sustainable forest management and local economic growth in an area facing significant economic and demographic challenges. Forests on the Green Mountain National Forest and elsewhere in southern Vermont supply high quality saw logs, however the majority of wood presently in these forests is considered low grade, and is typically used for pulp to make paper or chipped for heat or electricity. There are markets for low grade wood in southern Vermont, however these markets are not currently strong. This is the result of a sharp recent decline in the region's pulp industry, the low price of oil/ gas, and a move away from expanding electric-only biomass in the region. There are still markets for high quality sawtimber, but these will not singularly sustain Vermont's forest products industry. Without healthy markets for low grade wood and a healthy logging industry, southern Vermont is likely to see a continued decline of forest products industry infrastructure, the local jobs it sustains and the forest management service it provides. This service is critical to meeting objectives on National Forest Lands.

Market demand from this plant would directly support forest management activities for the Somerset Integrated Resource Project, which includes landscape restoration work on over 70,000 acres in southern Vermont. The National Forest is currently developing a Collaborative Forest Landscape Restoration Program (CFLRP) grant proposal to support collaborative, science-based restoration of this landscape. If successful, grant funding from the CFLRP program can be used for planning, implementation and monitoring of projects on National Forest System (NFS) lands. The proposed plant is only about 35 miles from the Somerset Project Area and would provide an additional market for low grade wood harvested there and a new market for small diameter wood. The plant in turn would benefit from a sustainably harvested supply.

Grant funding will help move this project forward and make it more viable by supporting the installation of technology that will dramatically increase the efficiency of energy production.

The Green Mountain National Forest supports development of this proposed plant and the application for Wood Innovation Grant Program funding to install flue gas condensation technology.

Sincerely,

JOHN A. SINCLAIR
Forest Supervisor

cc: Lew Mcreery, Jeff Tilley

BRATTLEBORO DEVELOPMENT CREDIT CORPORATION

Developing the Economic Landscape

January 8, 2020

USDA Forest Service
Wood Innovation Grant Program
Wood Education and Resource Center
301 Hardwood Lane
Princeton, WV 24740

To Whom It May Concern:

I am submitting this letter in support of the grant application of Long Falls Paperboard LLC to the USDA Forest Service Wood Innovation Grant Program, to provide funds for installation of flue gas condensation technology at Long Falls Paperboard's proposed biomass fueled combined heat and power plant in Brattleboro, VT. BDCC, as the owner of 161 Wellington Road, Brattleboro, Vermont, is supporting Long Falls Paperboard LLC as it looks to improve upon its paper making facility seeking efficiency improvements and cost saving measures. BDCC is also partnering with Long Falls Paperboard LLC as the recipient of record of a $1M federal grant award from the Northern Borders Regional Commission supporting the pre-development of the biomass fueled combined heat and power plant project.

BDCC, established in 1954, is a private, nonprofit economic development organization that serves as a catalyst for industrial and commercial growth throughout Southeastern Vermont. The primary objective of BDCC is to create and retain a flourishing business community that supports vibrant fiscal activity and improves the quality of life of all its residents.

The announcement of Long Falls Paperboard's proposed CHP plant is very good news at a time when wood biomass markets are declining and facing increasing uncertainty in our region. As 1 of 12 Regional Development Corporation's in the State of Vermont, BDCC supports all types of businesses and marketplaces, as well as giving consideration to our local environment, and as such we are sensitive to the fact that our surrounding forest landowners need new markets for low grade timber to practice good forestry and support the logging infrastructure that is so vital to markets for all other forest products.

It is exciting to see this important manufacturer prepared to make a $20 +/- million investment in state-of-the-art cogeneration technology that will generate both electricity and heat for their paperboard manufacturing. It's important that we reduce our dependence on imported fossil fuels in this region and keep fuel dollars in our economy. Our region cannot afford to lose these jobs because of high energy costs, when a more affordable, renewable and sustainable alternative exists with wood biomass.

The WIG grant will help move this project forward and specifically support the installation of flue gas condensation technology that will dramatically increase the efficiency of the energy production. BDCC supports this project and urges the Forest Service's favorable consideration of this proposal.

Thank you for considering my views.

Adam Grinold
Executive Director
Brattleboro Development Credit Corporation

76 Cotton Mill Hill Brattleboro, VT 05301 T 802.257.7731 F 802.257.0294 www.brattleborodevelopment.com

WINDHAM
REGIONAL
COMMISSION

January 10, 2020

USDA Forest Service
Wood Innovation Grant Program
Wood Education and Resource Center
301 Hardwood Lane
Princeton WV 24740

To Whom It May Concern:

The Windham Regional Commission has reviewed the grant application of Long Falls Paperboard LLC to the USDA Forest Service Wood Innovation Grant Program, to provide funds for installation of flue gas condensation technology at Long Falls Paperboard's proposed biomass fueled combined heat and power plant in Brattleboro VT. Staff has found the project fits well the goals and policies of the Windham Regional Plan as amended April, 2018, which incorporates the Regional Energy Plan, which has specific targets for fuel switching the heat and electric sectors from fossil fuels to renewable fuels including biomass (page 286).

Energy Policies

3. Support the State in achieving its Total Renewable Energy and Comprehensive Energy Plan goals through avenues that maintain an adequate, reliable, and economical energy supply without causing undue adverse impacts to humans and the environment. (pg 18)

12. Encourage a shift toward zero and low-GHG emission energy sources, including the capture of methane gas and its conversion to useful energy. (pg 19)

Natural Resources

2. Support the harvest and use of lower grade timber to ensure full use of the forest resource and help protect the region from the threat of wildfire destruction. (pg 31)

Economic Development

2. Promote activities and development that contribute to a strong and diverse economy, providing satisfying and rewarding job opportunities for citizens in all parts of the region and supporting a strong municipal tax base, while maintaining environmental standards and promoting environmental justice. (pg 23)

The WIG grant will help move this project forward and specifically support the installation of flue gas condensation technology that will dramatically increase the efficiency of the energy production. Our company/organization supports this project and urges the Forest Service's favorable consideration of this proposal.

Please note that specific development proposals under the purview of Act 250 or Section 248 may need to be reviewed by the WRC Project Review Committee for conformity with all Windham Regional Plan policies. Thank you for expanding this grant opportunity to include the whole state of Vermont.

Sincerely,

Chris Campany

Executive Director
Cc: Tim Arsenault, WRC Chair Energy Committee
Sue Fillion, WRC Commissioner - Town of Brattleboro
Tom Mosakowski, WRC Commissioner - Town of Brattleboro

Long View Forest

48 Picz Road Westminster, VT 05158
Ph: (802) 428-4050 Fax: (802) 428-4051
www.longviewforest.com

January 10, 2020

USDA Forest Service
Wood Innovation Grant Program
Wood Education and Resource Center
301 Hardwood Lane
Princeton WV 24740

To Whom It May Concern:

I am submitting this letter in support of the grant application of Long Falls Paperboard LLC to the USDA Forest Service Wood Innovation Grant Program, to provide funds for installation of flue gas condensation technology at Long Falls Paperboard's proposed biomass fueled combined heat and power plant in Brattleboro VT.

I am the General Manager of Long View Forest. We are a 20-year old employee owned business with headquarters in Westminster and Hartland VT. We operate in the greater Connecticut River Valley of Vermont, New Hampshire, and Massachusetts from Saint Johnsbury, VT in the north to Springfield, MA in the south.

Long View currently employs approximately thirty people working in forest management, woodland services, and cut-to-length timber harvesting. Our foresters manage roughly 30,000 acres of private forests for landowner clients. Our woodland services crews do invasive plant control, tree pruning, tree planting, pre-commercial thinning, clearing, and trailwork on lands we manage as well on lands managed by other private and public foresters. Our logging crews harvest approximately 25,000 cords of logs per year. We hope to continue expanding and diversifying our operations in the years to come with a fundamental goal of building a business that persists through generations of people and trees to better match the timescale of forests.

The announcement of Long Falls Paperboard's proposed CHP plant is very good news at a time when wood biomass markets are declining and facing increasing uncertainty in our region. Our company, forest landowners in VT and NH, and our industry need new markets for low grade timber to practice good forestry and support the logging infrastructure that is so vital to markets for all other forest products. It is exciting to see this important manufacturer prepared to make a $20 +/- million investment in state-of-the-art cogeneration technology that will generate both electricity and heat for their paperboard manufacturing. It's important that we reduce our dependence on imported fossil fuels in this region and keep fuel dollars in our economy. Our region cannot afford to lose these jobs because of high energy costs, when a more affordable, renewable and sustainable alternative exists with wood biomass.

The WIG grant will help move this project forward and specifically support the installation of flue gas condensation technology that will dramatically increase the efficiency of the energy production. Our company supports this project and urges the Forest Service's favorable consideration of this proposal.

Thank you for considering my views.

Jack Bell
General Manager

D.H. Hardwick & Sons, Inc.

301 Francestown Road, Bennington NH 03442

P.O. Box 430, Antrim NH 03440 * 603-588-6618 * info@dhhardwick.com

January 3, 2020

USDA Forest Service
Wood Innovation Grant Program
Wood Education and Resource Center
301 Hardwood Lane
Princeton WV 24740

To Whom It May Concern:

I am submitting this letter in support of the grant application of Long Falls Paperboard LLC to the USDA Forest Service Wood Innovation Grant Program, to provide funds for installation of flue gas condensation technology at Long Falls Paperboard's proposed biomass fueled combined heat and power plant in Brattleboro VT.

D.H. Hardwick & Sons, Inc. is a NH Logging firm, established in 1978. We have been a major supplier of wood chips for over 30 years. We have become reliant on the local biomass facilities as they are highly regarded markets for low grade wood. We have 22 employees that depend on a stable low-grade wood market to carry us into this new decade and beyond. New technologies will help make this happen.

The announcement of Long Falls Paperboard's proposed CHP plant is very good news at a time when wood biomass markets are declining and facing increasing uncertainty in our region. Our company owns and manages over 7500 acres of forestland here in NH, which is all in close proximity of this proposed facility. The harvesting of low-grade wood must be included in our harvest prescriptions to maintain healthy forests. We are in great need of local biomass plants that operate year round. These facilities keep the flow of low grade wood moving which keeps other high grade sawlogs flowing. All raw forest products must have a place to go, to keep things running smoothly in our huge forest industry. Our company output of forest products (wood chips and sawlogs) is approximately 100 loads per week. We have been hoping a new, viable, local low grade wood market would come online soon. If this project becomes operational it will help fill a much needed void for low grade wood markets in our area.

It is exciting to see this important manufacturer prepared to make a $20 +/- million investment in state-of-the-art cogeneration technology that will generate both electricity and heat for their paperboard manufacturing. We must reduce our dependence on imported fossil fuels in this region and keep fuel dollars in our economy. Our region cannot afford to lose these jobs because of high energy costs, when a more affordable, renewable and sustainable alternative exists with wood biomass.

I am grateful that grants like this are available to assist new, modernized facilities. The WIG grant will help move this project forward and specifically support the installation of flue gas condensation technology that will dramatically increase the efficiency of the energy production. Our company supports this important technology that will be utilized by this project and urges the Forest Service to award this grant to Long Falls Paperboard LLC. This would have a very positive impact on our local markets and our ability to fully utilize our home grown forest products with the greatest of efficiency!

Thank you for your consideration.

Teresa J. Hardwick,

President

January 3, 2020

USDA Forest Service
Wood Innovation Grant Program
Wood Education and Resource Center
301 Hardwood Lane
Princeton, WV 24740

To Whom It May Concern:

On behalf of the New Hampshire timberland Owners Association (NHTOA) I am submitting this letter in support of the grant application of Long Falls Paperboard LLC to the USDA Forest Service Wood Innovation

s

proposed biomass fueled combined heat and power plant in Brattleboro VT.

Founded in 1911, the NHTOA represents forest landowners and the forest products industry in New Hampshire. This sector of New Hampshire's economy represents the third-largest sector of manufacturing in the state. The total forest products industry in New Hampshire employs more than 7,700 people directly, and contributes nearly $1.4 billion dollars to the state's economy.

The announcement of Long Falls Paperboard's proposed CHP plant is very good news at a time when woody biomass markets are declining and facing increasing uncertainty in our region. Having markets for woody biomass is an economic underpinning of sustainable forestry. These markets enable land managers to practice good forestry, enable landowners to economically justify timberland ownership, and support the logging infrastructure that is so vital to markets for all other forest products. It is exciting to see this important manufacturer prepared to make a $20 +/- million investment in state-of-the-art cogeneration technology that will generate both electricity and heat for their paperboard manufacturing. It's important that we reduce our dependence on imported fossil fuels in this region and keep fuel dollars in our economy. Our region cannot

alternative exists with wood biomass.

The

gy production. The NHTOA supports this project and urges the Forest Service's favorable consideration of this proposal.

Thank you for considering my views.

Sincerely,

Jasen A. Stock
Executive Director

NEW HAMPSHIRE TIMBERLAND OWNERS ASSOCIATION
54 PORTSMOUTH ST., CONCORD, N.H. 03301
PHONE (603) 224-9699 • FAX (603) 225-5898 • WWW.NHTOA.ORG

Jan 13 2020

The Long Fall's paperboard biomass project, would be a great boost for the local forest products industry. Our company, Goodnow Trucking Inc. Is excited about a potential new market, especially since it's only about 15 miles from our shop in Winchester NH. In the past few months two of the biomass plants we supplied chips to have closed the Whitefield and Springfield plants. The Fitchburg biomass plant will run through the winter but beyond that my guess is they will shut down. These three plants have been our only biomass markets in the past 5 years. Without these markets we loose the ability to provide the services that our clients desire most of the time. Biomass chipping gives us the ability to help with our clients long term forest management plans, by removing unmerchantable trees and provide clean neat looking jobs. Also gives us the ability to clean up from major storm damage. Wildlife restoration projects typically require biomass chipping as well. Our current production is down around 30% do to the biomass markets. It is my belief that projects like the Long Fall's project are going to be the new future of biomass in the northeast. It is my hope that more projects like this one come along if not I'm afraid the forest health in the northeast will suffer.

My father, Lloyd Goodnow started Goodnow Trucking Inc.(GTI). In 1986. After working mostly in sawmills and some logging, he decided to start transporting forest products, lumber, and mill chips. In 1997, After my completion of high school GTI moved into wastewood recycling, primarily grinding scrap pallets and selling the chips to biomass chip plants. By the early 2000s we were producing 600 tons of pallet grinding week. In 2003 GTI started handling chip's for Concord Steam, handling stockpiling and delivery of chip's. GTI also worked to keep Concord Steams whole tree chip suppliers moving. GTI purchased any whole tree chip's concord steam didn't need, transported and sold them to other biomass plants. In the mid to late 2000s markets changed significantly, recycled pallet chips became less desirable at biomass plants. Diesel prices went up significantly. Concord Steam took over the stockpile and transporting of their chips. GTI downsized some and started a timber harvesting operation. Currently GTI employs 5 people, producing around 15 loads a week, of bole chip's, pulp, and logs. We haven't produced any biomass chips in close to 3months due to the trucking distance and price at the Fitchburg plant. I am the immediate past chairman of the NH timber harvesting council. The THC is the loggers and truckers arm of the NH timberland association. The THC works to promote safety and professionalism in the logging industry.

Thank you for considering my views

Chris Goodnow

Goodnow Trucking Inc.

440 Athol Rd

Richmond,NH 03470

USDA
United States Department of Agriculture

Preliminary Feasibility Report

Long Falls Paperboard
Wood Energy System

Brattleboro, Vermont

Version: **Final**
Date: January 2, 2020

United States
Department of Agriculture Forest Service
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The Wood Education and Resource Center is located in Princeton, WV and administered by the Northeastern Area State and Private Forestry unit of the U.S. Department of Agriculture Forest service. The center's mission is to work with the forest products industry towards sustainable forest products production for the eastern hardwood forest region. It provides state-of-the-art training, technology transfer, networking opportunities, applied research, and information. Visit www.na.fs.fed.us/werc for more information about the Center.

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1.0 EXECUTIVE SUMMARY

This study is provided by the USDA Forest Service's Wood Education and Resource Center (WERC), which provides technical assistance to support projects that promote the sustainable use of forest resources for value added products and energy.

The owners of the Long Falls Paperboard (LFP) paper mill recently purchased the mill, and are currently investing in the plant to increase its capacity, maximize profitability, and provide positive impact for the local economy. One key area of concern for the facility is the high energy cost associated with operations in Brattleboro, VT. LFP owners are pursuing the potential for using locally sourced wood energy to provide thermal and electric energy for the facility in a way that will reduce the long-term energy cost for the facility, keep dollars spent on energy within the local economy, provide significant net reductions in greenhouse gas emissions, reduce air pollutant emissions, and provide a needed outlet for forest management and forest product industry residues.

Three biomass (wood) system options and three alternates were evaluated for this study and tailored to achieve the aforementioned goals. An overview of each is provided below. Each alternate can be implemented as part of any of the options. The biomass systems were sized and evaluated based on the thermal and electric demand models described in Section 5.0.

Option 1 – Biomass Thermally-Led CHP: The goal of this option is to provide over 95% of the annual thermal energy demand for the facility with locally sourced wood energy, while also adding a backpressure steam turbine to replace the line shaft turbine drive in the mill. The wood boiler system will be sized at ~52.5 mmBtu/hr. The wood boiler or boilers will be rated at 300 psig, and trimmed to operate at ~225 psig. A backpressure turbine will be installed to drop up to 16,000 pph of header pressure steam to ~40 psig steam, which will produce on the order of 200-275 kW. The two existing gas/oil boilers, which are each rated at 30 mmBtu/hr, will be converted to propane, providing backup and covering the remaining 5% of the annual thermal demand.

Option 2 – Biomass Thermally-led High Pressure CHP: The goals of this option are to provide over 95% of the annual thermal energy demand for the facility with locally sourced wood energy, and to increase the amount of low cost electric produced by the system. The wood boiler system will be sized at ~57 mmBtu/hr. For this level of evaluation, it is assumed the wood boiler will be operated at 600 psig, 750°F. The exact boiler size and operating pressure would be determined in the design phase. This option will provide in the range of 500-800 kW in additional backpressure generation over and above the 200-275 kW discussed in Option 1. The two existing gas/oil boilers, which are each rated at 30 mmBtu/hr, will be converted to propane, providing backup and covering the remaining 5% of the annual thermal demand.

Option 3 – Biomass Electrically-led CHP: The goal of this option is to provide over 95% of the annual thermal and electric energy for the facility with locally sourced wood energy. The wood boiler system will be sized at ~125 mmBtu/hr. For this level of evaluation, it is assumed the wood boiler will be operated at 600 psig, 750°F. The exact size and operating pressure would be determined in the design phase. This option will provide condensing steam turbine capacity to increase the net overall electric generation capacity to ~4.9 MW. The two existing gas/oil boilers, which are each rated at 30 mmBtu/hr, will be converted to propane, providing backup and covering the remaining 5% of the annual thermal demand.

Alternate 1 – Flue Gas Condensation: The goal for this alternate is to increase the operating efficiency for the biomass boiler in each option. This alternate would include installation of a system to condense the water vapor in the flue gas, while capturing the latent heat available from this water vapor to provide preheating of plant process water or makeup air. Depending on the option, exact demand for low temperature thermal energy, and stack conditions achieved, this will reduce wood energy use for thermal process heat at the facility by 20-25% on an annual basis.

Alternate 2 – Net Metering: Instead of using power generated onsite through the CHP options discussed, LFP could send power to the adjacent Brudies Road substation through a new interconnection. This would potentially allow LFP to access a higher value for up to 500 kW of the generation.

Alternate 3 – District Heating: LFP has neighboring entities that are fairly large thermal energy consumers. With locally sourced wood energy, LFP will have significantly lower cost, and renewable, thermal energy that could be leveraged to benefit the local community.

Conclusions and Recommendations

The installation of a wood energy system at the Long Falls Paperboard mill provides the opportunity to reduce operating costs, while also reducing net greenhouse gas emissions, improving the local economy, and benefitting local forest management activities. This study examined three biomass options and three alternates. Development of these options and alternatives was guided by focusing on providing overall value to LFP, reducing operating costs, and providing value to the local community.

Each option is compared to the current operating approach, which uses grid supplied electric, CNG, and #6 fuel oil to meet facility energy demands. The options evaluated in this study have the potential to provide a number of benefits to LFP, as described in the following list:

Option 1 includes installation of an automated wood energy system covering over 95% of the thermal demand at the facility, and will also provide a small amount of very efficient power generation in the plant. This project would provide a first-year net operating savings of approximately $2.1 million (M). The $14.8 M project would be financed, and while considering incentives and financing payments, would offer 5 and 30 year NPVs of $8.7 and $29.4 M respectively. The project would provide over 21,500 metric tonnes of net GHG offsets annually. The option addresses deferred maintenance on fossil fuel steam systems, while providing LFP with a modern, highly efficient renewable energy plant with low operating costs and a 30-year life.

Option 2 includes installation of an automated wood energy system covering over 95% of the thermal demand at the facility, and will also provide on the order of 7% of the electric needs at the facility. This project would provide a first-year net operating savings of approximately $2.4 M. The $17.9 M project would be financed, and while considering incentives and financing payments, would offer 5 and 30 year NPVs of $8.7 and $30.4 M respectively. The project would provide over 22,000 metric tonnes of net GHG offsets annually. The option addresses deferred maintenance on fossil fuel steam systems, while providing LFP with a modern, highly efficient renewable energy plant with low operating costs and a 30-year life.

Option 3 includes installation of an automated wood energy system covering over 95% of the thermal demand at the facility, and will also provide 95% of the electric needs at the facility. This project would provide a first-year net operating savings of approximately $3.5 M. The $26.4 M project would be financed, and while considering incentives and financing payments, would offer 5 and 30 year NPVs of $12.0 and $42.3 M respectively. The project would provide over 30,857 metric tonnes of net GHG offsets annually. Importantly, this option would provide certainty for LFP with regard to long-term electric costs for the project's 30-yr life. The option addresses deferred maintenance on fossil fuel steam systems, while providing LFP with a modern, highly efficient renewable energy plant with low operating costs and a 30-year life.

Alternative 1 includes installation of a flue gas condensation unit on the Options considered. Given the significant need for very low quality thermal energy at the facility, this Alternative would substantially improve the performance of any of the options. The level of added investment is on the order of $0.9 M, and would provide on the order of $230,000 in annual fuel savings. The improvement of Option 3 economics may be greater than discussed if the potential use for low quality thermal energy in the plant is higher than that assumed in this report. It is also important to note that implementing this alternative would likely directly reduce the overall boiler demand and capacity need, depending on how the energy from preheating the water is used in the plant.

Alternative 2 includes interconnection of one of the backpressure turbine generators for each option to the Brudies Road Substation as a Net Metering system. This allows LFP to likely capture a higher value for the power generated. This is expected to have a payback in the range of 3-5 years depending on the option considered.

Alternative 3 includes installation of a district heating system to serve neighboring thermal energy users with renewable, and low cost thermal energy. More information from neighboring building owners needs to be obtained to analyze this option. In addition to the cost of heat from the renewable wood energy options being on the order of 3-5 times lower than that of competing fossil fuels, this would also increase the potential for generating Tier III credits.

Financial performance of the evaluated options is dependent upon a number of factors, including the tradeoff between capital costs for automation and reduction of operating costs, tradeoff between capital costs and electrical efficiency/heat rates, the cost of wood fuel, the cost of competing fossil fuels, and electric rates. A sensitivity analysis of operating savings based on varying wood and fossil fuel prices is provided in Appendix C, and additional sensitivity analyses will be discussed with LFP to assist with their consideration of the options.

Beyond the direct project economics, there are a host of additional benefits from the options to LFP and the local community and region, including the following:

- Between $1.4 and $3.5 M would be spent each year on wood energy within the local economy through wood residue purchases. It is estimated that this supports between 30 and 70 FTEs in the local forestry industry, depending on the option selected.
- The purchase of local forest management and industry residues provides an outlet for low-value residues, which is critical in the region for providing opportunities for forest management activities to reduce pests and disease, prevent fires, and manage ecological diversity, soil health, and water quality.
- The options would stabilize LFP operating cost volatility and risk due to wide fluctuations in natural gas and fuel oil costs, and due to potential future increases in electric costs.

Should Long Falls Paperboard be interested in pursuing a wood energy system option, WERC recommends that staff visit other modern wood energy system installations to develop a detailed understanding of the equipment and its capabilities. As Long Falls Paperboard continues to pursue wood energy options, WERC recommends that the next level of evaluation includes detailed consideration of the following items:

- Consider updating and increasing metering of steam demands to inform refinement of options. Potential items to target include:
    - Calibrate the existing steam meters at the boilers and the existing line shaft turbine to confirm their accuracy.

    - Add steam metering on the load side of the main PCV that is shown at 100 psig and other points of pressure reduction as appropriate.
    - Log boiler makeup water daily, and perhaps electronically.
    - Log flows and temperatures that will allow for assessing opportunities to use low grade thermal energy (both for process water and makeup air).
- Work with local, regional, and federal stakeholders to identify any additional potential alternative funding sources (low interest loans, grants, and other incentives).
    - Detailed review of the reinstated Section 45d and Section 48 tax benefits for open loop biomass should be conducted with LFP's tax accountant and incorporated into project decision making.
- Continue discussions with local building owners to evaluate the potential for the district heating alternative.
- Closely evaluate equipment redundancy in the mix/number of boilers and/or turbines used to meet the targeted demands, while considering capital cost impacts.

2.0 INTRODUCTION

2.1 WERC PROGRAM

The USDA Forest Service Wood Education and Resource Center (WERC) provides technical assistance to support projects that promote the sustainable use of forest resources for value added products and energy. Energy projects are supported through the Wood Energy Technical Assistance Team. Team goals are to support Forest Service forest restoration efforts, ensure the sustainable and efficient use of wood as a renewable energy resource, and accomplish greenhouse gas reduction. This assistance is available to public and private entities (clients) interested in and committed to efficient use of local wood for energy. This report was developed under the WERC program by Wilson Engineering Services, PC.

2.2 LONG FALLS PAPERBOARD OPPORTUNITY

The Long Falls Paperboard (LFP) facility was purchased out of bankruptcy by a group of investors in partnership with the Brattleboro Development Credit Corporation (BDCC) in a joint effort to save the the jobs at the mill. The mill has historically been underperforming with respect to its potential output, and the LFP owners are currently investing in the plant to increase its capacity, maximize profitability, and provide positive impact for the local economy. One key area of concern for the facility is the high energy cost associated with operating in Brattleboro, VT. LFP owners are pursuing the potential for using locally sourced wood energy to provide thermal and electric needs for the facility in a way that will reduce the long-term energy cost for the facility, keep dollars spent on energy within the local economy, provide significant net reductions in greenhouse gas emissions, reduce air pollutant emissions, and provide a needed outlet for forest management and forest industry residues. The USFS sees this project as an opportunity to promote efficient use of renewable wood energy in the Brattleboro community to the benefit of local forest management activities and the local economy.

3.0 PLANT OVERVIEW

Long Falls Paperboard has a single paper machine, two coating lines, and a pulping process onsite. The paper machine anecdotally makes up 75% of the steam demand at the facility, with the remaining 25% comprised by the remaining processes and space heating demands. The facility has a design capacity of 160 tons per day (tpd) of production. Currently the facility is running on average around 65 tpd, and plans to reach closer to 100 tpd by early 2020. The goal is to bring the facility closer to an average of 150 tpd over time.

3.1 STEAM SYSTEMS

The facility has two 900 hp steam boilers able to fire on natural gas and #6 oil, as described in Table 1. The boilers produce steam at approximately 225 psig saturated, with one boiler set as lead with a set point of 225 psig, and the second boiler set back by about 5 psig. The boilers share an economizer in a common stack.

Table 1 – Existing Boilers at the Facility

Boiler	Fuels	Boiler Input Rating, mmBtu/hr	Boiler Rating	Boiler Output Rating, mmBtu/hr	Boiler Rated Pressure, psig	Boiler Operating Pressure, psig	Construction Year
Bigelow #1	gas / #6	38	2,874 boiler sf, 451 water wall sf - ~900 hp	30.1	250	225	1960
Bigelow #2	gas / #6	38	2,875 boiler sf, 451 water wall sf - ~900 hp	30.1	250	225	1960

Notes: *The boiler input rating is taken from the air permit. The estimated output rating is based on the heat surface of the heat exchanger as stamped. Actual output with current burners and boiler tuning may be lower than the estimate of the rating as identified here.*

The 2009 single-line steam drawing was reviewed in detail, and shows that the 225 psig steam is distributed directly to Coater 2 with reduction right at Coater 2, and is also fed to the thermocompressors. The remainder of steam demands are shown to be met from 100 psig steam or 40 psig steam. There are three points shown where main header 225 psig steam is reduced to either 100 psig or 40 psig, and these are the "Main Pressure Control Valve (PCV)", the existing turbine, and a PCV upstream of Coater 1, space and water heating, and starch units. It appears there are some errors in the 2009 steam drawing, and WERC recommends a detailed review of the 2009 single-line steam drawing with facility staff to identify key use pressures, as this will drive the potential for backpressure turbine options for the central plant. The only other fired equipment in the facility is an oven for the laminating line, which has a 3 mmBtu/hr input gas burner, according to the air permit.

3.2 Electric Infrastructure

Electric power is supplied from a 69 kV transmission line owned by National Grid. The branch from the transmission line to the main transformer at the plant, however, is owned and metered by Green Mountain Power (GMP), who is the local utility. The main transformer is a single 7.5 MVA unit which steps the voltage down to 4160 V, which is shown in Figure 1. There are 5 additional step down transformers totaling 8 MVA of capacity which further reduce the voltage to 480Y/277 V and feed various motor control centers. All motor loads are 480 V or lower.

Figure 1 – Main Transformer (Boiler Stack in Background)

GMP operates the Brudies Road substation which is on the river side of the road between the railroad crossing and the plant. This substation is connected to the same 69 kV transmission line, and provides distribution-level service to the local business park (but not LFP) as well as interconnection to the 5 MW solar farm on the old landfill across the tracks. The capacity of the substation is 10-14 MW (depending on the cooling provided to the transformer) and currently is handling about 6 MW of distributed generation according to GMP.

3.3 FUEL SOURCES

The facility currently has two fuel sources that may be used for the boilers. These are natural gas from a CNG station that is operated by NG Advantage, and #6 fuel oil. The CNG evaporation station is located just outside the boiler room, and has parking allocated for three CNG over the road trailers at the docking station. The #6 fuel oil is stored in two 20,000 gallon underground tanks that are also just outside the boiler room. The facility is considering a changeover to propane as a backup fuel. The facility currently only has an 18,000 gallon propane tank, and does not have any evaporation capacity beyond that which occurs in the tank.

4.0 HISTORICAL ENERGY USE AND COST

A detailed memorandum summarizing historical fuel use, comparing it to production at the time, and projecting energy loads at future, higher production levels is provided in Appendix D. The following section provides a brief summary of the historical data in the memorandum.

4.1 THERMAL ENERGY DEMAND AND COST

Table 2 shows the current energy use for the facility for the first 4 months of 2019 along with production. The steam energy per ton of production averages 12.0 mmBtu/ton for these months. From a boiler fuel input energy perspective, the approximate cost of steam is $12.45/mmBtu for these months. This unit cost for steam does not include other costs such as chemicals, manpower, parasitic electric, etc.

Table 2 - Summary of Boiler Fuel Use, Steam Production, and Mill Production

Month	Production, tons	# Days	Gas Use, mmBtu	Gas Cost	Oil Use, mmBtu	Oil Cost	Steam Output, mmBtu	Plant Efficiency
Jan	1,602	22	16,222	$155,374	8,639	$146,229	18,877	0.76
Feb	1,330	20	20,202	$175,172	2,699	$45,687	16,971	0.74
Mar	1,591	21	23,101	$199,636	1,200	$20,311	18,007	0.74
Apr	1,233	21	19,932	$169,464	0	$0	15,269	0.77
Total	**5,756**	**84**	**79,457**	**$699,645**	**12,538**	**$212,228**	**69,124**	**0.75**

Notes: Production is obtained from a 2019 summary sheet. The daily production records provided do not exactly match with this summary sheet, and the values should be confirmed. The gas use is from bills and verified by the daily meter readings. The oil use is from the air emissions tracking sheet, and a unit cost of $2.5/gallon is assumed for its cost. The steam output is from the steam meters for each boiler, and assumes a 1,006 Btu/lb rise as the steam meters are before the takeoff to the DA tank, and DA temperature was shown as 227°F while onsite.

A detailed review of the steam metering, gas use, fuel oil use, and makeup water use records showed that steam output from the steam meters looks to be a reliable number. This is often not the case with steam meters, but it tracks very well with the daily gas use records when fuel oil is not used as well as the other data from the records. The efficiency value obtained by comparing energy input and steam output looks reasonable given the combustion analyzer readings provided by the facility. While onsite, the temperature reading on the economizer outlet was not accurate (1,100 °F), so performance was not verified. The steam meters record the steam flow out of each boiler prior to it entering the main header, and the feed to the DA tank is after this. Thus, the enthalpy rise provided by the economizer and boilers is from that at the state of temperature of the feedwater from the DA tank to the outlet of the boilers at 225 psig saturated. The temperature listed in the DA tank was 227°F while WERC was onsite. The enthalpy rise is approximately 1,006 Btu/lb.

Table 2 shows how the cost of delivered CNG has varied over the course of the past year. The highest monthly rate was $11.50/mmBtu, and the lowest monthly rate was $6.83/mmBtu. Note that the highest cost is in the winter when the overall facility thermal demand is the highest. The weighted average cost is $8.70/mmBtu.

Table 3 – Historical Cost of Natural Gas

Last Day of Billing Period	Cost	Use, mcf	Use, mmBtu	Unit Rate, $/mmBtu
9/15/2018	$45,045	6,401	6,593	$6.83
9/30/2018	$26,077	3,300	3,399	$7.67
10/15/2018	$71,838	8,483	8,737	$8.22
10/31/2018	$68,415	7,855	8,091	$8.46
11/15/2018	$90,544	9,272	9,550	$9.48
11/30/2018	$87,318	7,370	7,591	$11.50
12/15/2018	$25,933	2,209	2,297	$11.29
12/31/2018	$60,475	5,356	5,570	$10.86
1/15/2019	$109,940	11,040	11,482	$9.58
1/31/2019	$45,434	4,549	4,740	$9.59
2/15/2019	$87,632	9,697	10,104	$8.67
2/28/2019	$87,540	9,700	10,098	$8.67
3/15/2019	$99,331	11,073	11,505	$8.63
3/31/2019	$100,304	11,182	11,596	$8.65
4/15/2019	$104,644	11,895	12,252	$8.54
4/30/2019	$64,819	7,456	7,680	$8.44
5/15/2019	$74,513	9,027	9,298	$8.01
5/31/2019	$90,565	10,968	11,297	$8.02
6/15/2019	$73,823	8,982	9,251	$7.98
6/30/2019	$82,371	10,030	10,331	$7.97
7/15/2019	$44,589	5,531	5,697	$7.83
Weighted Average Unit Rate, $/mmBtu				**$8.70**

Figure 2 shows the hourly steam output for the period data was available (July 2018-July 2019). Figure 3 shows the hourly steam output on a load duration curve for the facility. This shows how many hours in the year the facility hit a specific load. It is critical to note that the loads presented are based on a very low production rate compared to what the target is for LFP as the owners invest in the plant. The attached load memorandum provides analysis of the loads with respect to production as the basis for the final load model, which is used as the basis for the economics in this report.

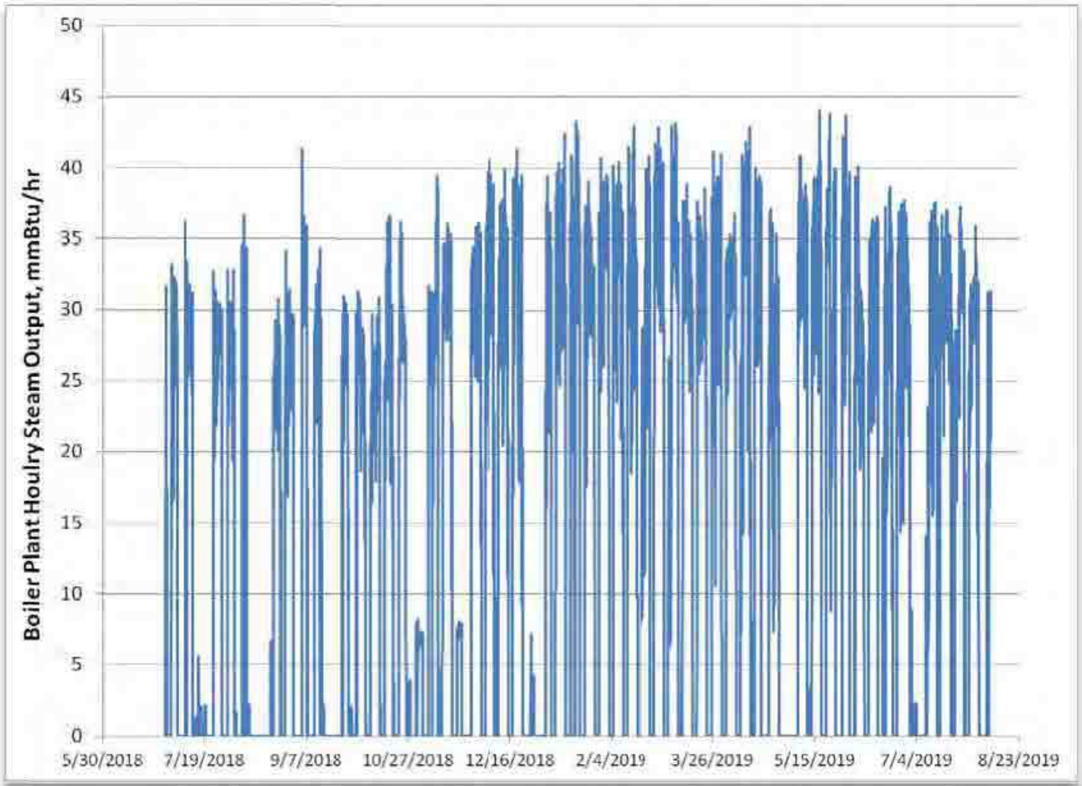

Figure 2 - Total Hourly Boiler Plant Steam Output

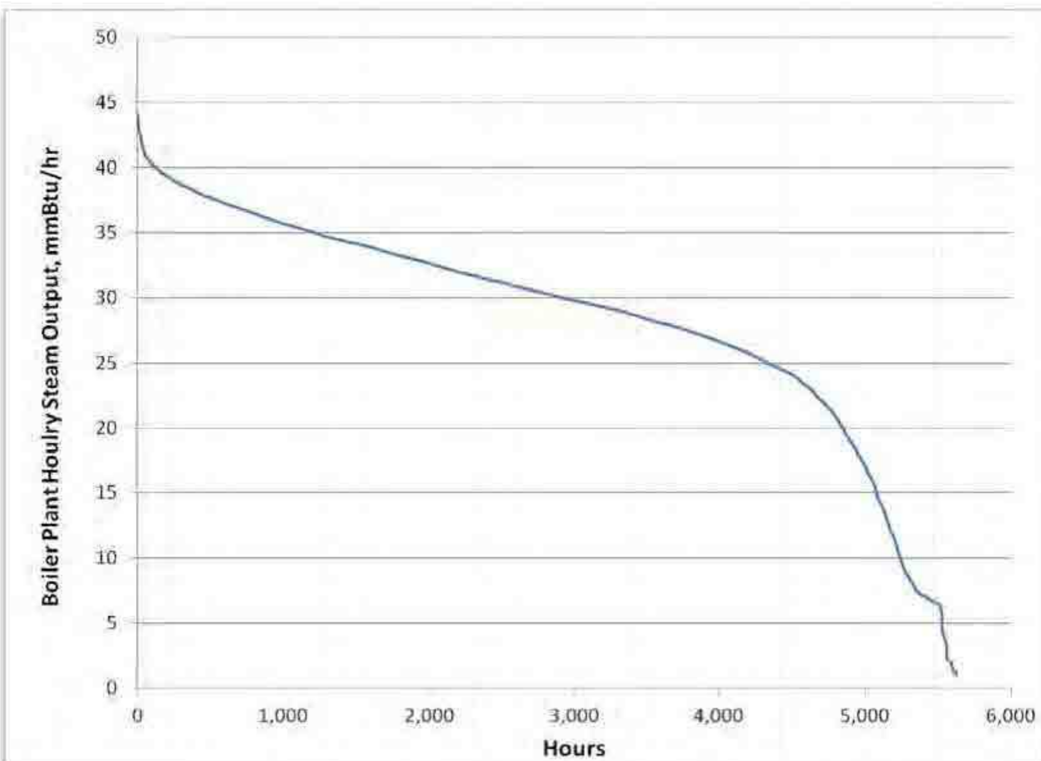

Figure 3 - Total Hourly Boiler Plant Steam Output Load Duration Curve July 18-July 19

Notes: This figure shows how many hours out of the total recorded data set a specific load was required by the plant.

4.2 Electric Demand and Cost

Table 4 shows the historical electric use and cost for the facility based on the utility bills provided.

Table 4 – Historical Electric Usage and Cost

Month	kWh	Peak KW	Cost	Blended Unit Rate, $/kWh	Temporary Incentive	Cost w/o Incentive	Blended Unit Rate, $/kWh
Jan 2018	1,558,707	4,084	$190,573	$0.122		$190,573	$0.122
Feb 2018	1,825,987	NR	$210,576	$0.115		$210,576	$0.115
Mar 2018	1,498,858	4,498	$188,860	$0.126		$188,860	$0.126
Apr 2018	1,575,126	3,951	$185,577	$0.118		$185,577	$0.118
May 2018	1,587,525	3,884	$186,634	$0.118		$186,634	$0.118
Jun 2018	1,130,908	3,866	$151,821	$0.134		$151,821	$0.134
Jul 2018	1,261,565	3,956	$163,064	$0.129		$163,064	$0.129
Aug 2018	1,290,066	4,084	$168,002	$0.130		$168,002	$0.130
Sep 2018	1,034,817	4,095	$147,738	$0.143		$147,738	$0.143
Oct 2018	1,435,633	3,969	$177,243	$0.123		$177,243	$0.123
Nov 2018	1,189,312	3,913	$156,725	$0.132		$156,725	$0.132
Dec 2018	1,453,572	3,992	$180,602	$0.124		$180,602	$0.124
Jan 2019	1,645,431	3,967	$144,890	$0.088	$50,771	$195,661	$0.119
Feb 2019	1,528,238	4,059	$137,949	$0.090	$48,533	$186,482	$0.122
Mar 2019	1,562,859	4,048	$141,812	$0.091	$47,047	$188,860	$0.121
Apr 2019	1,577,544	4,308	$143,618	$0.091	$48,992	$192,610	$0.122
May 2019	1,456,045	3,920	$132,992	$0.091	$45,319	$178,311	$0.122
Jun 2019	1,526,064	3,963	$136,983	$0.090	$46,761	$183,743	$0.120
Jul 2019	1,606,022	3,752	$143,511	$0.089	$46,851	$190,363	$0.119

Notes: NR = Not Reported

Figure 4 shows the overall electric cost over time in terms of usage ($/kWh). The actual electric bills were based on both usage (kWh) and demand (peak kW). Note that the price from January 2019 to the present is the result of an incentive provided by Green Mountain Power.

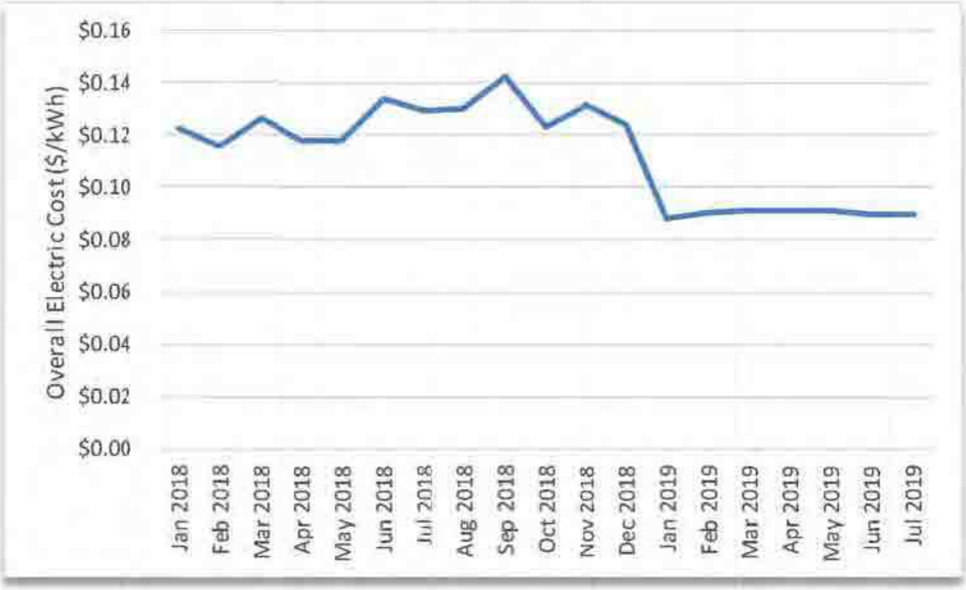

Figure 4 – Electric Cost Over Time

Figure 5 shows the load duration curve for the facility for 1 minute interval data from July 2018 – July 2019. Figure 6 shows the electric demand over the course of the highest production day when records were available at the facility. Overall, the total kWh used in a day is fairly consistent when production is in the range of 60 to 130 tons/day based on records from the plant. It is again critical to note that these operational profiles are very different from the projected operating scenario of an average of 150 tons/day with only outages as the annual downtime. Further, the plant is investing in additional equipment to improve the production that will increase electric demand in the facility when operating.

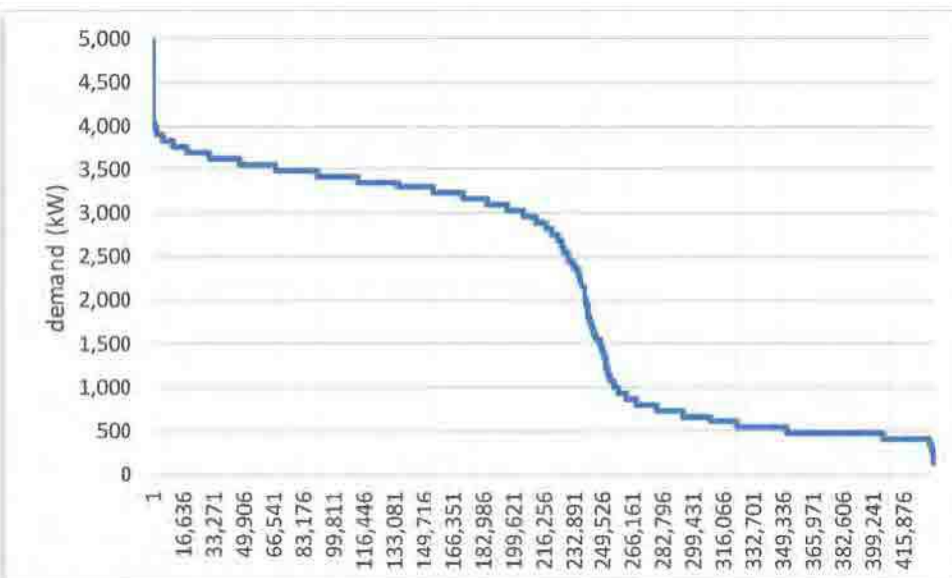

Figure 5 – Load Duration Curve of 1-min Electric Demand Data (July 18 – July 19)

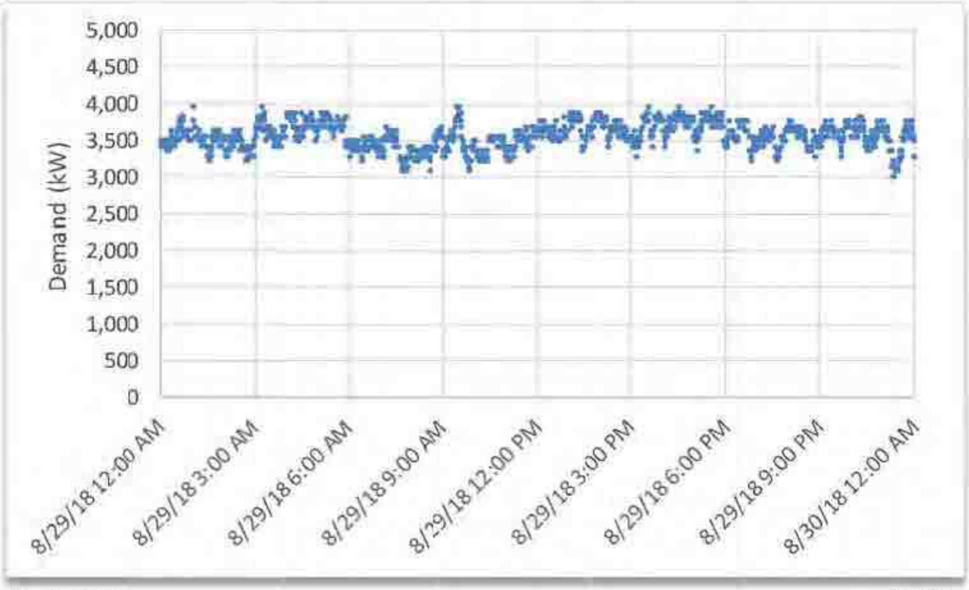

Figure 6 – 8-29-18 Electric Demand – Highest Production Day
(daily values of 139 tons production and 85,736 kWh electric usage)

5.0 PROJECTED ENERGY DEMANDS

A detailed memorandum summarizing historical fuel use, comparing it to production at the time, and projecting energy loads at future, higher production levels is provided in Appendix D. The following section provides a brief summary of the projections for energy use as detailed in the memorandum.

5.1 THERMAL DEMAND AND COST

The facility has a design capacity of 160 tons per day of production. Currently the facility is running on average around 65 tpd, and plans to reach closer to 100 tpd by early 2020. The goal will be to bring the facility closer to 150 tpd in the coming years. Thus, the projection here uses historical data to project what the steam demand will be with a 150 tpd production rate, and the sizing of equipment will be required to cover this load. The following are other factors that could impact the demand for the facility:

- The facility may have opportunities for energy efficiency, which include items such as:
    - Insulation (being pursued for some sections of plant currently through Efficiency Vermont supported effort)
    - Steam leaks
    - Pre-heating of process water
    - Heat capture from air exhaust or effluent going to water treatment
- There has been discussion of additional equipment and processes that may increase steam demand as well.
- There was discussion of using the capacity of the plant to help supply low cost heat to neighboring facilities.

LFP identified the following items that will influence steam demand. The line shaft drive includes a 325 hp rated steam turbine with stamped conditions of 200 psig inlet and 45 psig outlet that is being removed. At maximum output this turbine would consume approximately 0.8 mmBtu/hr of heat, and demand on the boiler will be reduced by this amount once it is converted to electric. LFP also identified that there are a number of factors that are ongoing on the efficiency side that will reduce the steam demand. Conversely, there will be process adjustments to increase production that will increase the demand over time, and thus, having some excess steam capacity is desired.

As discussed in the attached load memorandum, the boiler system at the facility should be able to cover a range of loads from ~20 mmBtu/hr to 52 mmBtu/hr, while providing steam to the plant at 225 psig, saturated.

The design peak daily steam demand is 33% higher than the highest demand day seen over July 2018 – July 2019, and 18% higher than the highest demand day seen (when only gas was used) based on daily gas use records from November 2014 – July 2019. Note that the peak absolute potential day from a space heating and makeup air perspective would likely not be seen in the daily gas use records.

Annual Energy Demand for Evaluating Economics of Various Plant Options - Figure 7 presents the daily load model based on the following: assuming that the process load with high production ranges from 5 mmBtu/tpd at 80°F OAT and 6 mmBtu/tpd at 50°F; a constant average daily production rate of 150 tons per day; and adding heat load and increased makeup air heating for days when the average OAT is below 50°F based on a peak adder of 8 mmBtu/hr. The 8 mmBtu/hr is based on comparing days of similar production but different outdoor air temperatures from historical records, and typical space heating requirements. Table 5 presents the projected annual heat demand as displayed by Figure 7, and while assuming 5% downtime for the year or approximately ~2.5 weeks.

It is important to note that the production carried is an average of 150 tons per day, and this will vary daily based on a large number of factors, including the mix of product being produced. It is expected that the daily production will vary from around 60 tons per day to as much as 190 tons per day, and the steam system will need to cover this range of production.

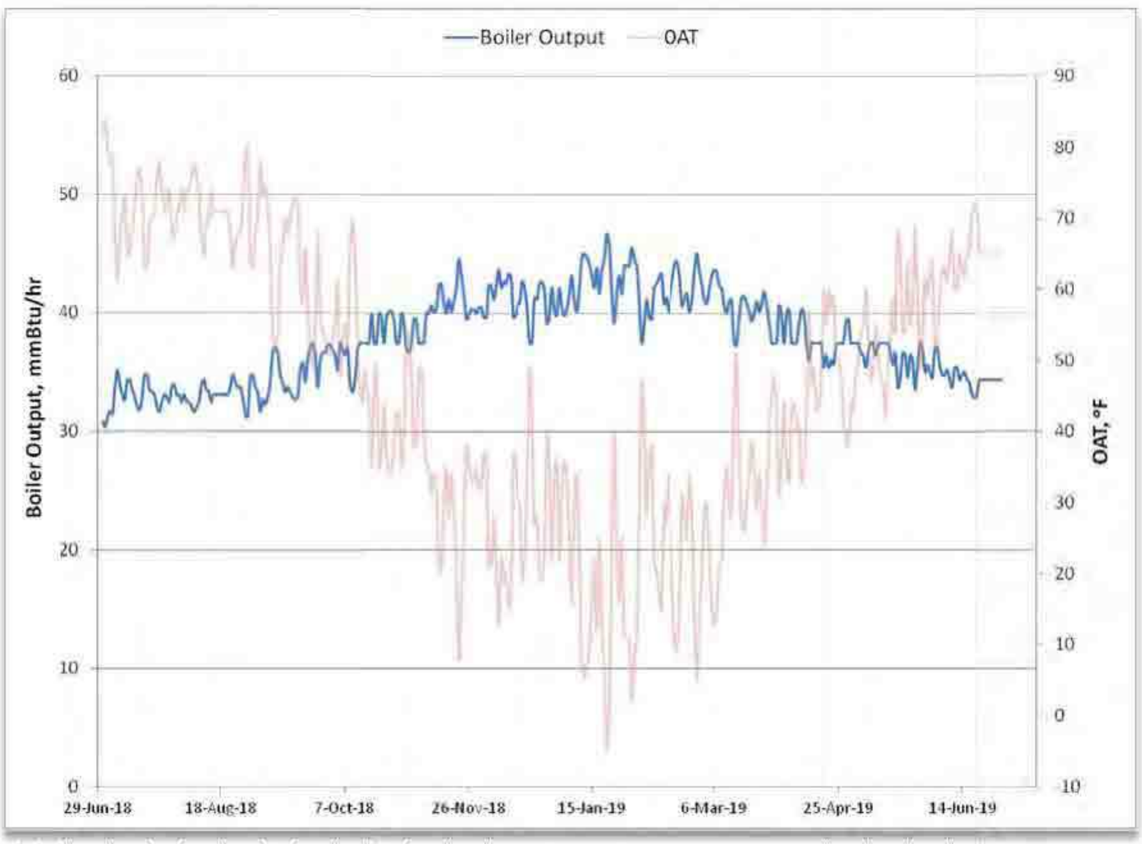

Figure 7 – Estimated Daily Average Boiler Output with 150 tpd Production and 2018-19 Weather

Note: OAT = outdoor air temperature

Table 5 – Estimated Annual Steam Demand, Fuel Use, and Cost for Average 150 tpd Production

Average Daily Production, tpd	Downtime	Annual Production, tons	Heat Demand, mmBtu	Boiler Output/ton, mmBtu/ton	Gas/Oil Use, mmBtu	Cost of Fuel (95% gas/5% oil)
150	5%	52,013	317,311	6.10	423,081	$3,841,067

5.2 ELECTRIC DEMAND AND COST

For current operations, typical daily electric usage and demand at an average of 150 tons/day are estimated to be ~90,000 kWh and 4.3 MW, while non-production days are assumed to carry an average of 15,000 kWh/day. Note that the peak demand overall is assumed to be 4.5 MW with the current facility configuration. Efficiency measures, production changes, or new equipment will impact the average use and peak values, and direction from LFP on changes in equipment are discussed along with the impacts to energy demands and use.

The minute data measured at the facility showed several values above 4.5 MW, but these occurrences were very limited in number. The highest utility peak demand (on or off peak) recorded for billing was 4.5 MW in March 2018, during the overall period of March 2018 – June 2019.

LFP has identified several potential scenarios that will impact electric demands in the plant, some portions of which are currently underway. Based on the increased demand as identified by LFP, the electric use per day was identified as shifting up proportionally. For the purposes of estimating loads for economics, the typical electric use is being increased from 90,000 kWh/day (150 tpd average) to 108,000 kWh/day by adding a constant 750 kW over what is currently used over a 24-hr period. This is a daily average demand of 4.5 MW. The projected peak demand at the facility is being increased from 4.5 MW to 5.6 MW based on the addition of 1,125 kW of demand during normal operations as identified by LFP.

Given the potential for efficiency gains, production changes, and potential increase in electric demand, the facility has the potential to run within a range that is bound by current demands if running just under 150 tpd average and demands ~10% above the projected level with respect to annual electric use. Table 6 shows the potential range of load scenarios. Note that the projected value is used for economics in this analysis.

Table 6 – Annual Electric Use and Cost after 4/1/2020 without GMP Incentive

Item	Projected	Low End	High End
Annual Electric Use, MWh	37,723	31,065	41,495
MWh/ton (52,000 tpy)	0.725	0.597	0.798
Annual Cost, $	$4,188,792	$3,490,443	$4,605,239

Based on estimated use for production and off days, and assuming 5% downtime and average production of 150 tpd otherwise, the annual electric use is estimated at 37,723 MWh. Using the rate schedule that goes into effect after 4/1/2020, the total annual cost is estimated at $3,300,000 with the current GMP 20% incentive. Without the current GMP incentive, the annual cost would be approximately $4,200,000. These costs are estimated using the rate schedule that is applied after 4/1/2020 (GMP Rate 63/65 transitioned from Legacy CVPS Rate 5), and this analysis is provided in Appendix E.

6.0 LOCALLY AVAIALBLE FUEL AND PRICING

LFP currently uses both #6 fuel oil and compressed natural gas (CNG) delivered by trucks. LFP plans to use the wood energy project as an opportunity to convert to a combination of wood and propane for the thermal energy demands at the facility. CNG serves as the primary boiler fuel currently, with #6 fuel oil being used when there is a disruption in the CNG supply.

Natural gas pricing varies throughout the year, ranging from about $6.50 per mmBtu to over $11.50 per mmBtu, with the highest prices seen in the winter months when regional demand for gas is high. The gas supplier has the ability to curtail LFP's gas use during periods when system demand is too high, and has had periodic delivery gaps. This typically only happens when outdoor temperatures are very low for a sustained period of time, or there is an issue with delivery.

Sustainably sourced biomass is locally available for LFP. The region has a robust forest products industry, and a critical need for outlets for low value wood residues from forest management and industry. The range of residues vary widely, from forest management and logging residues; to sawmill residues including bark, sawdust, and wood chips; to other industry residuals that consist of clean wood. It is important for wood energy systems to be fuel flexible, as markets and industry residues can change over time. Overall wood residue pricing in the region has been stable over a long period of time, with regional power plant costs for wood fuel purchases actually dropping in real terms since the early 1980s. Quotes were obtained from several local forest products companies, and currently in-woods chips are widely available residues that do not have adequate markets. The delivered price quoted in both walking floor and van trailers ranged from the low $20's/ton as received to as high as $30/ton as received. The bulk of quotes were stated as low $20's to mid $20's. A cost of $28.5/ton as received for the smaller project options is assumed in this analysis, and a cost of $26.5/ton as received for the larger project is assumed.

A comparison of fuel pricing and the cost to produce steam with various fuels is presented in Table 7.

Table 7: Fuel Pricing and Cost of Steam

Fuel, units	Delivered Unit Cost	Unit Heating Value (mmBtu/unit)	Estimated Seasonal Boiler Efficiency	Fuel Cost of Steam ($/mmBtu)
Green wood chips, ton (Options 1 and 2)	$28.50	9.2	70%	$4.41
Green wood chips, ton (Option 3)	$26.50	9.2	73%	$3.93
Natural gas (low 18-19), mmBtu	$6.83	1.0	75%	$9.11
Natural gas (avg 18-19), mmBtu	$8.70	1.0	75%	$11.60
Natural gas (high 18-19), mmBtu	$11.50	1.0	75%	$15.34
#6 Fuel Oil (2019 price), gal	$2.50	0.1536	75%	$21.70
Propane, gal	$1.00	0.09133	75%	$14.60

Notes: The difference in boiler efficiency between the wood options is due to the assumption that more will be done to capture flue gas heat with the larger unit. The 75% seasonal boiler efficiency is the calculated value for the existing boilers based on historical fuel use and steam demand.

7.0 EVALUATED BIOMASS SYSTEM OPTIONS

Three biomass system options and two alternates were evaluated for this study. An overview of each is provided below. Each alternate can be implemented as part of any of the options. The biomass systems were sized and evaluated based on the thermal and electric demand models described in Section 5.0.

Option 1 includes installation of an automated wood energy system covering over 95% of the thermal demand at the facility, and will also provide a small amount of very efficient power generation in the plant. This project would provide a first-year net operating savings of approximately $2.1 million (M). The $14.8 M project would be financed, and while considering incentives and financing payments, would offer 5 and 30 year NPVs of $8.7 and $29.4 M respectively. The project would provide over 21,500 metric tonnes of net GHG offsets annually. The option addresses deferred maintenance on fossil fuel steam systems, while providing LFP with a modern, highly efficient renewable energy plant with low operating costs and a 30-year life.

Option 2 includes installation of an automated wood energy system covering over 95% of the thermal demand at the facility, and will also provide on the order of 7% of the electric needs at the facility. This project would provide a first-year net operating savings of approximately $2.4 M. The $17.9 M project would be financed, and while considering incentives and financing payments, would offer 5 and 30 year NPVs of $8.7 and $30.4 M respectively. The project would provide over 22,000 metric tonnes of net GHG offsets annually. The option addresses deferred maintenance on fossil fuel steam systems, while providing LFP with a modern, highly efficient renewable energy plant with low operating costs and a 30-year life.

Option 3 includes installation of an automated wood energy system covering over 95% of the thermal demand at the facility, and will also provide 95% of the electric needs at the facility. This project would provide a first-year net operating savings of approximately $3.5 M. The $26.4 M project would be financed, and while considering incentives and financing payments, would offer 5 and 30 year NPVs of $12.0 and $42.3 M respectively. The project would provide over 30,857 metric tonnes of net GHG offsets annually. Importantly, this option would provide certainty for LFP with regard to long-term electric costs for the project's 30-yr life. The option addresses deferred maintenance on fossil fuel steam systems, while providing LFP with a modern, highly efficient renewable energy plant with low operating costs and a 30-year life.

Alternative 1 includes installation of a flue gas condensation unit on the Options considered. Given the significant need for very low quality thermal energy at the facility, this Alternative would substantially improve the performance of any of the options. The level of added investment is on the order of $0.9 M, and would provide on the order of $230,000 in annual fuel savings. The improvement of Option 3 economics may be greater than discussed if the potential use for low quality thermal energy in the plant is higher than that assumed in this report. It is also important to note that implementing this alternative would likely directly reduce the overall boiler demand and capacity need, depending on how the energy from preheating the water is used in the plant.

Alternative 2 includes interconnection of one of the backpressure turbine generators for each option to the Brudies Road Substation as a Net Metering system. This allows LFP to likely capture a higher value for the power generated. This is expected to have a payback in the range of 3-5 years depending on the option considered.

Alternative 3 includes installation of a district heating system to serve neighboring thermal energy users with renewable, and low cost thermal energy. More information from neighboring building owners needs to be obtained to analyze this option. In addition to the cost of heat from the renewable wood energy options being on the order of 3-5 times lower than that of competing fossil fuels, this would also increase the potential for generating Tier III credits.

7.1 Option 1 – 52.5 mmBtu/hr, 300 psig Wood Boiler / Thermally-Led CHP

Option 1 would install a new, 52.5 mmBtu/hr wood boiler system rated at 300 psig which would serve as LFP's primary boiler year-round. The boiler would be installed in a new plant constructed in the field to the east of the existing facility. The goal of this option is to provide over 95% of the annual thermal energy demand for the facility with locally sourced wood energy, while also adding a backpressure steam turbine to replace the line shaft turbine drive.

Wood Boiler System

A 52.5 mmBtu/hr wood boiler system, rated for 300 psig and operating at 225-250 psig, would be installed in the new boiler plant. The boiler is sized to cover 100% of the load at the facility as modeled in Section 5. It would be expected to operate for approximately 95% of the time that the mill is operating. This system would be expected to be able to cover loads ranging from 20 – 52.5 mmBtu/hr, and cover a minimum of 95% of the thermal demand at the facility, while assuming the paper making process itself has an uptime of 95%.

The overall wood energy plant would be designed to minimize staffing requirements. It is anticipated the system would be selected with a traveling or stepped grate system, which would automatically remove ash from the grates to the ash pit and ultimately remove it from the system. This would remove the need to routinely rake ash from the combustor grates. Grates would still require periodic cleaning. An electrostatic precipitator (ESP) would be installed to control particulate emissions to meet permit requirements. The system will require a continuous opacity monitoring system (COMS) to meet permit requirements.

The new boiler plant and wood storage would be constructed in the field to the east of the facility, and a steam line would be run above ground to the mill to connect into the existing 225 psig steam header in the existing boiler plant. The two 900 hp gas/oil boilers would be converted to run on either gas or propane, and would be used only as backup to the wood energy system. Appendix A includes a generic single-line diagram to show the basics of interconnection of steam infrastructure for this option.

The plant will require significant improvement to the access road to the field area, and a new turnaround in the vicinity of the clarifier to ensure access for both wood and raw material delivery vehicles. Infrastructure to receive wood deliveries and place them in storage with automatic reclaim would include a truck scale, trailer tipper and receiving bin, screening, side stream fuel sizing (hog) for overs recovery, and tramp metal removal. The auto-reclaim storage will also have access for direct delivery by walking floor trailers without the need for handling onsite by LFP staff. This would be accomplished either through at- or below-grade bulk storage. The storage will target a minimum volume of approximately 32,000 cy, which is equivalent to two full days of storage with a constant load of 40 mmBtu/hr. A maximum of ~7 truck loads per day would be needed on the peak day in the winter, and 4-6 trucks per day would be expected as required during the majority of the year. Appendix A includes a general arrangement drawing for how this plant may be configured. Please note that the configuration, type of automatic reclaim, and boiler system layouts will vary significantly depending on the vendors and systems selected and final option design.

Steam Turbines

A new backpressure steam turbine will be added in the paper mill to reduce boiler plant steam pressure from ~225 psig to 40 psig. For now it is assumed that a turbine in the range of 200-275 kW would be installed to reduce 10-15,000 pph from 225 psig to 40 psig. There may also be an opportunity to install a turbine to reduce some flow from 225 psig down to 100 psig in parallel with the main pressure control valve in the plant, but the steam flows are not known. It is recommended that steam metering of lower pressure loads in the plant at both the 100 psig line and the 40 psig headers be considered for final selection of the best mix of turbine capacity to maximize overall efficiency. There are a couple types of turbines that can be evaluated for this application with varying installation costs and performance. The turbine(s) under this option would operate as thermally-led, which means their electric output would be dictated by the steam demands in the plant. All power generated would be used behind the meter, with relays to ensure that power is not able to be sent back to the grid.

7.2 Option 2 – 57 mmBtu/hr, 600 psig Wood Boiler / Thermally-Led CHP

Option 2 would install a new, ~57 mmBtu/hr wood boiler system operating at 600 psig which would serve as LFP's primary boiler year-round. The boiler would be installed in a new plant constructed in the field to the east of the existing facility. The goal of this option is to increase the potential electric generation onsite as compared to Option 1 by adding a backpressure steam turbine to reduce the higher pressure down to main plant header pressure of ~225 psig. .

Wood Boiler System

A ~57 mmBtu/hr wood boiler system, providing steam at 600 psig, 750°F, would be installed in the new boiler plant. This steam would be reduced in pressure down to distribution pressure and conditioned as needed for connection to the existing main steam header. The boiler is sized to cover 100% of the load at the facility as modeled in Section 5. It would be expected to operate for approximately 95% of the time that the mill is operating. This system would be expected to be able to cover thermal demands in the paper mill ranging from 20 – 52.5 mmBtu/hr, and cover a minimum of 95% of the thermal demand at the facility, while assuming the paper making process itself has an uptime of 95%.

This system would be very similar to Option 1. Please refer to the description of the system layout; fuel receiving, storage, and handling; and operations.

Appendix A includes a general arrangement drawing for how this plant may be configured. Please note that the configuration, type of automatic reclaim, and boiler system layouts will vary significantly depending on the vendors and systems selected and final option design.

Steam Turbines

The same backpressure turbine(s) would be installed as in Option 1 out in the paper mill. In addition, a backpressure turbine would be operated in the wood boiler plant to generate power by dropping the steam out of the wood boiler down to the conditions needed at the main plant steam header (225 psig). Depending on the final selection of operating conditions, and whether net metering is targeted, this option could have between 500 – 800 kW of additional generation. The turbine(s) under this option would operate as thermally-led, which means their electric output would be dictated by the steam demands in the plant. All power generated would be used behind the meter, with relays to ensure that power is not able to be sent back to the grid.

7.3 Option 3 – 125 mmBtu/hr, 600 psig Wood Boiler / Electrically-Led CHP

A 125 mmBtu/hr wood boiler system, providing steam at 600 psig, 750°F, would be installed in the new boiler plant. The boiler would be installed in a new plant constructed in the field to the east of the existing facility. The goal of this option is to provide over 95% of both the annual thermal and electric energy demand for the facility with locally sourced wood energy.

Wood Boiler System

A 125 mmBtu/hr wood boiler system, providing steam at 600 psig, 750°F, would be installed in the new boiler plant. An extraction steam turbine generator will provide for extraction of steam just above distribution pressure at the main plant header in order to cover 100% of the thermal demand at the facility as modeled in Section 5. The remaining steam would be reduced to approximately 2 psia through a condensing section in order to meet the electric needs of the facility. The system would be expected to operate for approximately 95% of the time that the mill is operating. This system would be expected to be able to cover thermal demands in the paper mill ranging from 20 – 52.5 mmBtu/hr, and cover a minimum of 95% of both the electrical and thermal demands at the facility, while assuming the paper making process itself has an uptime of 95%.

The overall wood energy plant would be designed to minimize staffing requirements. It is anticipated the system would be selected with a traveling or stepped grate system, which would automatically remove ash from the grates to the ash pit and ultimately remove it from the system. This would remove the need to routinely rake ash from the combustor grates. Grates would still require periodic cleaning. An electrostatic precipitator (ESP) would be installed to control particulate emissions to meet permit requirements, and selective non-catalytic reduction (SNCR) would be used to reduce NOx to allow the system to fall below the emissions threshold at which federal Major Source permitting would apply. A continuous emissions monitoring system (CEMs) for NOx will be required.

The new boiler plant and wood storage would be constructed in the field to the east of the facility, and a steam line would be run above ground to the mill to connect into the existing 225 psig steam header in the existing boiler plant. The two 900 hp gas/oil boilers would be converted to run on either gas or propane, and would be used only as backup to the wood energy system. Appendix A includes a generic single-line diagram to show the basics of interconnection of steam infrastructure for this option.

The plant will require significant improvement to the access road to the field area, and a new turnaround in the vicinity of the clarifier to ensure access for both wood and raw material delivery vehicles. Infrastructure to receive wood deliveries and place them in storage with automatic reclaim would include a truck scale, trailer tipper and receiving bin, screening, side stream fuel sizing (hog) for overs recovery, and tramp metal removal. The auto-reclaim storage will also have access for direct delivery by walking floor trailers without the need for handling onsite by LFP staff. This would be accomplished either through at- or below-grade bulk storage. The storage will target a minimum volume of approximately 70,000 ft^3 in covered storage with automatic reclaim. This is equivalent to around 1.75 days of storage with a constant process load of 40 mmBtu/hr. A maximum of ~17 truck loads per day would be needed on the peak day in the winter, and around 15 trucks per day would be expected as required during the majority of the year. Appendix A includes a general arrangement drawing for how this plant may be configured. Please note that the configuration, type of automatic reclaim, and boiler system layouts will vary significantly depending on the vendors and systems selected and final option design.

Steam Turbines

The same backpressure turbine(s) would be installed as in Option 1 out in the paper mill. The extraction turbine in the wood boiler plant would be sized at approximately 5 MW, and would be controlled to provide the majority of the electric demands at the facility. The average demand in the mill is estimated to be approximately 4.5 MW. All power generated would be used behind the meter, with relays to ensure that power is not able to be sent back to the grid.

The mill's current electric rate is for customers that use over 7,600 kWh per month and have a monthly demand of 200 kW. The backpressure steam turbine(s) in the mill would operate based on the thermal demands, and the extraction turbine will be controlled to meet plant demands, parasitic loads from the wood energy plant, and ensure that these levels of electric purchase are met or exceeded each month. Note that LFP will be removed from this rate class if demand falls below 150 kW and usage is less than 6,600 kWh for 12 consecutive months.

7.4 ALTERNATE 1 – FLUE GAS CONDENSATION

The goal for this alternate is to increase the operating efficiency for the biomass boiler in each option. This alternate would include installation of a system to condense the water vapor in the flue gas, while capturing the latent heat available from this water vapor to provide preheating of plant process water.

Depending on the option, and conditions achieved, this will reduce wood energy use at the facility for process heat use by 20-25% on an annual basis. A main driver of the potential for this option is the amount of low temperature thermal load that may be captured at the facility. Initial discussions with facility staff indicated that between 400 – 700 gpm of process water may be able to be heated to allow for a direct reduction in steam use, and that makeup air preheating may be able to be achieved as well.

This approach to heat capture from wood energy systems is common in Europe where there are higher energy costs, and there are more opportunities to capture very low quality thermal energy. In addition to the basic economics of heat capture, this alternative can have substantive impacts on the overall boiler capacity required for the mill process demand and can reduce a number of emissions immediately at the stack. One negative of this alternative is that it generates a wastewater stream that will require treatment, but since the facility already has an effluent treatment system, this may not turn out to be a major issue. For the purposes of this report, it is assumed that a constant load of 300 gpm of process water may be able to be heated from 40°F to 95°F in a way that directly reduces overall steam load on the boilers.

7.5 ALTERNATE 2 – NET METERING

The goal for this alternate is to increase the value for electric generated onsite. Instead of using power generated onsite through the CHP options discussed, LFP could send power to the adjacent Brudies Road substation through a new interconnection. This would potentially allow LFP to access a higher value for up to 500 kW of the generation. Each Option includes backpressure steam turbine(s) that are below the 500 kW level or could be slightly downsized to stay under the 500 kW level. In order to Net Meter under the RES, the main added cost to each option would be for a new, independent connection to the closest point on Green Mountain Power's distribution. The closest point is the Brudies Road Substation that abuts the LFP property, which is at the entrance to the LFP plant.

7.6 ALTERNATE 3 – DISTRICT HEATING

The goal for this alternate would be to assist local businesses by providing low cost thermal energy, while providing a return for LFP. LFP has neighboring entities that are fairly large thermal energy consumers. With locally sourced wood energy, LFP will have significantly lower cost, and renewable, thermal energy that could be leveraged to benefit these entities. Table 7 shows that heat from the wood energy system will be on the order of 1/3rd to 1/5th the cost of competing fossil fuels in the region. LFP has reached out to the BDCC and local businesses on their thermal energy demands, and the results of many of those contacts are pending.

The BDCC provided their fuel oil use for the business park that is immediately adjacent to the LFP plant. The average annual oil use there is ~22,000 gallons with a cost of $52,800. With heat supplied by a wood system, the annual fuel cost would be ~$10,000. This does not consider any pumping or infrastructure costs.

There is a neighboring plant near LFP that spends on the order of $325,000 on fuel oil annually to provide 105 psig steam to its facility. If the LFP wood energy system produced the heat to offset all this use, the wood cost would be on the order of $65,000. This does not consider any infrastructure or operating costs.

Between the identified facilities, annual fuel savings on the order of $300,000 could be available to cover the operating and infrastructure costs for a district energy system, and provide energy savings to the neighboring facility owners. As this project moves forward, these savings may be attractive enough to warrant further investigation of this alternate.

8.0 INCENTIVES AND MONETIZING RENEWABLE ATTRIBUTES

This section discusses potential incentive programs and pathways for monetizing the renewable attributes of the project options. Table 8 provides a brief summary of the main programs that would be leveraged, including: grants, tax credits, and monetization of the renewable attributes of the project. This table was developed assuming that the compliance mechanisms will be pursued, as they will typically have more value than the voluntary markets for renewable energy attributes.

Table 8 – Summary of Targeted Incentive Programs

Incentive	Value	Units	Timing
NBRC	1,000,000	$	during design
REAP Grant	500,000	$	following commissioning
USDA WIG	250,000	$	following commissioning
Electric RECs	10	$/MWh	9 months after generation
Bonus Depreciation	100% in year 1	%	tax years following completion
ITC for CHP	10% eligible costs	%	tax years following completion
Tier III RECs	875,000	$/yr	annual for 15 years

8.1 NORTHERN BORDER REGIONAL COMMISSION (NBRC) GRANT

The project, through the Brattleboro Development Credit Corporation, has received a $1,000,000 grant. This funding is for pre-construction activities for the project. It is anticipated that this funding will be used to complete design and permitting of the facility under the first phase of a design-build project.

8.2 VERMONT RENEWABLE ENERGY STANDARD AND ELECTRIC RECS

The Renewable Energy Standard (RES) in Vermont provides incentives for both electrical and thermal renewable energy. The main avenues for this project to receive incentives are the following programs:

Tier III – Distribution Utilities must provide energy transformation projects that qualify under the RES for a percentage of their retail electric sales annually. The percentage started at 2% in 2017 and climbs by 2/3rds of a percent each year until 12% by 2032. Each utility negotiates the value and offsets associated with specific projects or incentive programs with a project owner and with a technical advisory group that has been established. The alternative compliance payment for the utility not meeting the requirement is $60/MWh. Some of the prescriptive programs are providing the Tier III compliance for around $40/MWh, while others are in the $15-20/MWh range. In determining the incentive they will provide, the utility considers how a project will impact the overall costs to their ratepayers.

Net Metering – The RES establishes a standard way under which distributed generators can connect and benefit from energy sales in Vermont with Net Metering. This program is available for renewable generators that are under 500 kW. The program also allows for access to higher value streams than just offsetting onsite electric use. GMP has identified potential values in the range of $130-150/MWh, and this price includes the value of the Tier II RECs, which GMP claims.

Electric RECs – The RES has Tier II RECs that are from distributed generation that is smaller than 5 MW. The requirement for this program increases from 1% of retail electric sales in 2017 by 3/5ths of a percent annually until reaching 10% in 2032. The value for these is less transparent than for the electric RECs in other ISO New England connected states. Depending on the option and the state, the projects will qualify for Tier I RECs in most New England states. In addition to Vermont Tier II and qualification in other states for compliance RECs, there is also the potential to provide voluntary RECs through entities such as Green-e. The value for the compliance RECs or Green-e RECs varies over time. It is possible the most value will come from Tier II Vermont RECs, but the Tier I compliance RECs in some states may increase as their renewable requirements continue to increase annually. The value is expected to be able to range from ~$5/MWh to as much as $20/MWh in the future, depending on many factors. A value of $10/MWh is assumed for this report.

8.3 TAX INCENTIVES

Section 48 Energy Credit (Investment Tax Credit or ITC)

This federal investment credit is determined as a percentage of the basis for qualifying energy property. Qualifying combined heat and power system property is for a system that uses the same energy source for simultaneous generation of electrical and/or mechanical shaft power, and thermal energy. To qualify as combined heat and power system property the following thresholds must be met per federal code:

- Produces at least 20% of its total useful energy in the form of thermal energy that isn't used to produce electrical or mechanical power; and
- Produces at least 20% of its total useful energy in the form of electrical or mechanical power (or a combination of the two); and
- The thermal energy efficiency of the system is 60% or greater – note that biomass systems can proportionally meet the reduced efficiency level for a proportional credit.
    - The efficiency threshold is based on the lower heating value of the fuel.

Options 1 and 2 are both systems that meet the 60% efficiency standard, but they do not meet the 20% threshold for production of electrical and mechanical energy. Option 3 should be able to show that it both produces at least 20% of its total useful energy in the form of thermal energy that isn't used to produce electric or mechanical power, and 20% of its total useful energy in form of electrical power. Option 3 is also able to meet the 60% threshold based on lower heating value of the wood energy depending on the level of flue gas heat capture. For the purposes of this analysis, this credit is ignored for Options 1 and 2, and the credit is assumed as available for Option 3. Note that a tax accountant specializing in the energy credit should be consulted for more accurate assessments of the value that can be captured with each Option.

The Section 45d Energy Credit (Production Tax Credit or PTC) has been retroactively granted and the date by which construction must start for eligibility has been extended from January 1, 2018 to January 1, 2021. This makes the biomass project at LFP eligible for the open loop biomass portion of the PTC, and there is a provision of the ITC that allows the project to take a 30% investment tax credit in lieu of the PTC. There are a number of aspects associated with qualifying for and capturing the value from this credit, including project financing sources, project schedule, and the disposition of the electric that is produced. It is recommended that this development be discussed with the owner's tax accountant to determine how this impacts the project considerations, and the result of those discussions be incorporated into the decision making process for the project.

Bonus Depreciation

The new 2017 tax law increased the bonus depreciation percentage from 50 percent to 100 percent for qualified property acquired and placed in service after Sept. 27, 2017, and before Jan. 1, 2023. For the purposes of this report, it is assumed that 90% of the project cost would be eligible. Additionally, it is conservatively assumed in this report that a corporate entity would value the tax offset in a manner that provides 20% of the depreciable value back to the project. The method for and entity monetizing the tax benefit would impact the ultimate value. Note that a tax accountant should be consulted for more accurate assessments of the value that can be captured with each Option.

8.4 USDA Wood Innovations

The Wood Innovations Grant (WIG) targets proposals which grow or expedite sustainable wood products and wood energy markets throughout the United States. The funding originates from the USDA Forest Service, which awarded a total of $8 million dollars to over 40 recipients in 2019; however, the total funds may vary from year to year. The typical maximum for each award is $250,000, and a minimum of 50% of the total requested funds must be matched by the applicant. Funds can be used to cover costs such as money spent for applied research, stationary wood equipment, and some site development if it does not increase the real value of the property. LFP would be pursuing funding which expands wood energy markets and wood energy projects. Within this category the intention is to support proposals which, "stimulate, expand or support wood energy markets that depend on forest residues or forest byproducts generated from all land types." Wood energy projects must use commercially proven technology and preference will be given to those which combine or bundle multiple energy projects. Additional goals of the Wood Innovations Program are to decrease forest management costs as well as promote the economic and environmental health of communities.

8.5 USDA Rural Energy for America Program (REAP)

The Rural Energy for America Program (REAP) is administered by the USDA and provides grant and/or loan funding to for-profit small businesses for energy projects in rural areas. Note that USDA's website identifies the LFP address as being in a qualifying area, and the threshold for being a small business under NAICS code 322121 is 1,250 employees. Grant funding of up to $500,000 per project can be used to cover up to 25% of total project costs. Guaranteed loan financing is available up to a maximum of $25 million, with rates and terms negotiated between the lender and the applicant, and subject to approval by the USDA. For loan and grant combinations, the applicant must provide at least 25% of the project costs.

8.6 Voluntary Carbon Market

The projects being considered will provide very significant levels of carbon offsets. These are marketable on the voluntary market. The value for the offsets will depend on the goals of the ultimate buyer, and to some extent, the standard under which the offsets are qualified. The value could range from $5 - $12 / metric tonne of GHG equivalent offsets.

9.0 ECONOMIC ANALYSIS

9.1 Project Costs

9.1.1 Capital Cost Estimates

Estimated capital costs for each option are presented in Table 9. Capital cost estimates include all equipment, labor, material, and professional services associated with the installation of each option. Cost estimates were established using budget quotes from manufacturers and service providers. A general breakout of capital costs for each option is provided in Appendix B.

Table 9: Estimated Capital Cost Summary

Option	Estimated Capital Cost, Millions
1 - CHP	$14.8
2 - CHP High Pressure	$17.9
3 - Electric-led CHP	$26.4

Notes: This report has not included consideration for avoided costs. It is anticipated that not implementing one of these projects would mean that the existing steam infrastructure would need to be improved (boilers, feedwater system, etc.) at some point in the first half of the 30 year life of the identified projects. Those investments would be put off in time significantly through implementation of the options discussed.

9.1.2 Operations and Maintenance Costs

Estimated incremental changes in operations and maintenance (O&M) costs for the facility are presented in Table 10. These estimated costs are the estimated O&M costs that are over and above the cost to run the existing steam plant.

Biomass combustions systems use more electricity than comparably sized fossil fuel boilers, primarily due to a relatively higher amount of air required for combustion, the need for backend emission controls for particulate matter, and for motor use associated with fuel handling. Since each of the options generate electricity, the increase in electric use from adding each option is subtracted from the generation, and is not carried as an O&M cost in Table 10.

The combustion of wood fuel produces ash which must be removed from the site. An ash content of 1.0-3.0% could be expected, depending on the fuel. The wood ash from clean wood is a beneficial product. LFP would be a "large generator" of wood ash for any of the options considered, and would be required to register with DEC and to follow the Comprehensive Wood Ash Management Procedure. Following the procedure requires composite testing of wood ash. The wood ash production is expected to be on the order of 800 – 4,000 tons per year depending on the option and the source of the wood fuel. A cost of $7/ton is carried to cover the cost of testing and managing wood ash for beneficial reuse.

The values identified for the annual cost for maintenance and wear parts are for the newly constructed plants. These include sensor eyes, chains, belts, and other parts that customarily wear or require occasional replacement, as well as routine maintenance items. For all of the options, it is assumed the boiler manufacturer will be hired for planned maintenance during outages, and for at least one annual boiler tuning, as well as remote support. It is also assumed that a maintenance contract with the steam turbine generator manufacturer or integrator will be carried for Option 3. Each of the options also has annual testing and maintenance associated with COMs or CEMs, as well as period stack testing.

The State of Vermont does not require attendance of steam plants. Currently the facility has plant maintenance staff that oversees the existing operation of the two 900 hp steam boilers onsite. With the added tasks associated with the smaller wood boiler options, it is assumed that one additional staff member will be added, and that a significant portion of their duties will be associated with the boiler plant. For the larger wood boiler operation, it is assumed that there will be two full time staff members hired who will have significant portions of their duties associated with operation of the wood energy system.

Table 10: Estimated Incremental Change in Operations and Maintenance Costs

Option	Ash Beneficial Reuse Cost	Maintenance, Wear Parts, Consumables, Permit Compliance	Increased Staff Costs	Total Added O&M Cost
1 - CHP	$9,961	$58,022	$90,000	**$157,983**
2 - CHP High Pressure	$10,358	$61,240	$90,000	**$161,598**
3 - Electric-led CHP	$27,507	$208,340	$180,000	**$415,847**

Notes: See text for discussion of what is included in each of the items.

9.2 Economic Analysis of Options

Table 11 presents the existing energy purchases for the facility, as well as the annual energy profiles for each proposed system option. Economic analyses presented in this study are based on the energy profiles shown in the table.

Table 11: Proposed System Options Annual Energy Profile

Option	Annual Gas/Propane/Oil Use, mmBtu	Annual Wood Use, tons	Annual Electric Generation, MWh	Annual Electric Generation Net of Parasitic Electric Load, MWh	Annual Electric Purchased, MWh
Existing Systems	423,081	0	0	0	37,723
1 - CHP	21,154	47,431	1,248	107	37,616
2 - CHP High Pressure	21,154	49,323	4,303	3,064	34,659
3 - Electric-led CHP	21,154	130,985	39,987	35,216	2,507

Notes: The annual wood use for Option 3 assumes that increased load at the DA tank is in large part met with flue gas heat capture to heat condenser water, and capital costs reflect the ability to capture this heat. The performance of generation units is based on operating conditions and performance data provided by manufacturers.

A summary of estimated net operating savings for each system option in this study is presented in Table 12. These options are compared to the existing boiler system energy costs, and include additional O&M costs, electric generation value, and expected value of renewable energy attributes from the electric generation. Sensitivity analyses of net energy cost savings at varying boiler fuel prices are provided in Appendix C.

Table 12: Net Annual Operating Savings

Option	Gas / Propane / Oil Cost	Wood Cost	Electric Cost	Increased O&M	Value of Electric RECs	Total Operating Cost	Operating Cost Savings
Existing Systems	$3,840,761	$0	$4,188,792			$8,029,554	
1 - CHP	$231,622	$1,351,792	$4,178,104	$157,983	$12,483	$5,907,018	$2,122,536
2 - CHP High Pressure	$231,622	$1,405,701	$3,882,368	$161,598	$43,035	$5,638,255	$2,391,299
3 - Electric-led CHP	$231,622	$3,471,114	$745,073	$415,847	$352,155	$4,511,501	$3,518,053

Notes: The value of electric renewable attributes is based on the electric generation metered at the generator for Options 1 and 2, and the net generation for Option 3.

Table 13 presents the incentives and programs assumed to be leveraged for the project options, and the value streams generated for each. These values are used in developing the cash flows for the options.

Table 13 – Summary of Incentives Carried in Cash Flows

Program	Opt 1	Opt 2	Opt3
NBRC, $	1,000,000	1,000,000	1,000,000
REAP/WIG Total, $	500,000	500,000	500,000
Electric RECs, $/MWh	10	10	10
Bonus Depreciation, $	2,659,037	3,219,663	4,751,350
ITC for CHP, $	0	0	1,955,311
Tier III RECs, $/yr	875,000	875,000	875,000

Notes: See section 8 for description of each incentive program.

A summary of net present value for the proposed system options is presented in Table 14. The cash flows and 30-year net present values were developed using energy price indices from the National Institute of Standards and Technology's 2019 Annual Supplement to NIST Handbook 135. The financing fees associated with the project are assumed to be wrapped into the financing, and the total is assumed to be financed at 6.5% APR with a 15 year amortization. The financing fees are assumed to be 7% of the capital cost, and then one year of cash for loan repayment is assumed to also be financed. Analyses assume a real discount rate of 6.5% for the cash flows generated by the project. Pro-forma cash flow analyses and inputs are provided in Appendix C.

Table 14: Net Present Value Summary

Option	Capital Cost, $ Millions	5-Year Net Present Value[1]	30-Year Net Present Value[1]
1 - CHP	$14.8	$8.7	$29.4
2 - CHP High Pressure	$17.9	$8.7	$30.4
3 - Electric-led CHP	$26.4	$12.0	$42.3

Notes: The assumptions with respect to incentives for each option are detailed in each cash flow spreadsheet, and in the incentives section. The financing fees associated with the project are assumed to be wrapped into the financing, and the total is assumed to be financed at 6.5% APR with a 15 year amortization. Cash flow analyses assume a real discount rate of 6.5% for the cash flows generated by the project.

9.3 ECONOMIC ANALYSIS OF ALTERNATIVES

The following presents initial analysis of the alternatives. Based on this analysis it is recommended that any selected option for implementation should carry all three alternatives for more detailed analysis, since all are shown to have reasonable economic performance. These alternatives are considered to each be additional items that could be added to any one of the three main options considered.

9.3.1 Alternative 1 – Flue Gas Condensation

Table 15 provides a brief analysis of the potential for incorporating flue gas condensation. Key assumptions here are the level of low temperature water heating that is available, the cost of the installation, and the flue gas heat that is available for capture. As further analysis of this alternative is pursued, LFP should investigate where low quality heat can be used in the facility, what amount, and at what temperature. For the purposes of this report, it is assumed that a constant load of 300 gpm of process water may be able to be heated from 40°F to 95°F in a way that directly reduces overall steam load on the boilers. It is likely that the potential for low quality heat use is greater than shown here, but this requires further investigation within the plant.

Table 15 – Analysis of Flue Gas Condensation

Item	Value	Units
Heat available to offset (40°F to 95°F*300 gpm*7,905 hrs)	65,276	mmBtu/yr
Wood fuel savings	10,104	tons/yr
Estimated fuel cost savings	$287,951	$/yr
A - Savings discounted 20% for uncalculated items	$230,361	$/yr
B - Estimated increase to project costs for installation	$920,000	$
Simple Payback (B/A)	4.0	yrs
C - Wood Innovations Grant Amount	$250,000	$
Simple Payback with Wood Innovations Grant [(B-C)/A]	2.9	yrs

Notes: Cost estimate is based on preliminary budget numbers with an allowance for installation, and savings are based on the fuel cost and boiler efficiency for Options 1 and 2. There are minor changes in paybacks between the options if the values for Option 3 are used, and if the overall electric generation totals and efficiencies are incorporated.

The impact of Wood Innovations Grant funding on this Alternative is identified since LFP is seeking a Wood Innovations Grant to help implement this portion of the project. The impact on the payback of the Wood Innovations Grant is substantial for improving the financial benefit of a project component that, while common in Europe and well demonstrated commercially, is not typical for wood energy system providers in the US at this scale.

Importantly, if the flue gas heat capture is able to substantively reduce the overall heat demand in the facility, it may be possible to downsize the rated steam capacity of the boilers in each option. Also, while it may be difficult to quantify ahead of time with respect to impacting any upfront emission control costs, there will be emissions benefits associated with condensing the flue gases prior to their leaving the stack. This alternative will create a wastewater stream that will need to be treated.

9.3.2 Alternative 2 – Net Metering

Table 16 provides a brief analysis of the potential for setting up a Net Metering system under each option. For each option, an independent connection to the closest point on GMP's distribution is required. The Brudies Road Substation is the closest of these, abuts the LFP property, and is at the entrance to the LFP plant. For Options 1 and 3, the connected capacity would be from the small backpressure steam turbine located in the LFP plant for reducing main header steam to around 40 psig for lower pressure process loads and space heating. For Option 2, the larger backpressure steam turbine in the wood boiler plant would be slightly downsized to stay under the 500 kW threshold and connected.

Table 16 – Analysis of Net Metering for Each Option

Option	1	2	3
Connected Capacity, MW	250	500	250
Estimated Annual Generation, MWh	1,248	3,055	1,248
Assumed Value Obtained, $/MWh	$140	$140	$140
Carried Value of Use Onsite, $/MWh	$110	$110	$110
A-Net Value Increase for Generation, $	$37,449	$91,656	$37,449
B-Ball Park Costs for Connection	$200,000	$275,000	$200,000
Simple Payback (B/A)	5.3	3.0	5.3

Note that GMP stated they would need to review whether it would be permissible for a Net Metering interconnection to be used with Option 2 or 3, but it was thought that it could be permissible under the rules. The difference is that the overall facility has more than 500 kW of generation, but since those are not setup to ever put electric back to the grid it is assumed that they may be able to be ignored when looking at the 500 kW cap.

9.3.3 Alternative 3 – District Heating

The goal for this alternate would be to assist local businesses by providing low cost thermal energy, while providing a return for LFP. LFP has neighboring entities that are fairly large thermal energy consumers. With locally sourced wood energy, LFP will have significantly lower cost, and renewable, thermal energy that could be leveraged to benefit these entities. LFP has reached out to the BDCC and local businesses on their thermal energy demands, and the results of those contacts are pending. To date, facilities with a total of approximately $$375,000 in fuel oil heating costs have been identified, and this same heat could be provided for a wood energy cost of approximately $75,000 in one of the options being considered by LFP. This wood energy heat cost does not consider any pumping, infrastructure costs/paybacks, or savings for potential owners connected. This potential energy savings on the order of $300,000/yr demonstrates that there are possibly savings that could be achieved, but whether or not this alternative is viable will depend on the amount, quality (temperature and pressure), and cost of thermal energy needed at the neighboring businesses. Should sufficient annual loads be identified, this alternate will be further evaluated.

10.0 PERMITTING AND EMISSIONS

10.1 Air Permitting

The WERC team worked with GeoInsight, Inc. to review the air quality permitting options for the facility, and the GeoInsight memorandum summarizing their analysis is provided in Appendix D. A brief summary of the permitting for each of the options is provided here.

- Option 1: modify air permit and retain Minor Source status.
    - Timeframe: approximately 3 to 5 months.
    - Required equipment: ESP and COMS.
- Option 2: modify air permit and retain Minor Source status (possibly trigger Vermont Major Source status for NOx).
    - Timeframe: approximately 3 to 7 months depending on whether Facility is a Minor or Major Source.
    - Required equipment: ESP and COMs.
- Option 3: modify air permit and be reclassified as a Vermont and possibly federal Major Source due to exceeding the CO federal Major Source threshold, and NOx Vermont Major Source.
    - Timeframe: approximately 5 to 7 months.
    - Required equipment: ESP, COMS, CEMS, and SNCR (to reduce NOx below Federal Major Source threshold).

Overall, this project and the current low cost of propane are allowing the facility the flexibility to switch away from having #6 fuel oil as a key fuel onsite. When compared to past energy use, where #6 oil was the predominant heating fuel, the biomass options provide a significant reduction of criteria pollutants for meeting the thermal process needs. For example, Option 1 provides a total reduction of over 110 tons of criteria pollutants annually, including reduced levels of NOx, SOx, and PM. This is before any consideration of the emissions reductions provided by implementing a flue gas condensation alternative.

Note that GeoInsight reviewed the ability to use cores or other potentially clean industry residues as an energy source in the three options. It was determined that this may be permissible if material testing shows that the industry residues are clean and equivalent to clean wood with respect to any pollutants. It should be noted that the beneficial use of ash from the facility may be impacted through use of these residues as well, and review of those potential impacts should be conducted with Vermont regulators.

10.2 Greenhouse Gas Emissions

Compared to the existing system, the proposed options would result in a reduction of LFP's annual net Scope 1 and Scope 2 greenhouse gas (GHG) emissions. A summary of the reduction in net GHG emissions for each option is presented in Table 17.

Although combustion of wood releases CO_2, the use of wood fuel ultimately provides a net reduction in GHG emissions compared to fossil fuels as long as the fuel is sourced in a sustainable manner. The accounting for wood fuels in this report directly follows that used by the voluntary carbon markets for sale of carbon credits and reporting of Scope 1, Scope 2, and Scope 3 GHG emissions. Please see the Climate Registry for details. Factors for CO_2 equivalent values presented in this report include CO_2, as well as CH_4 and N_2O adjusted for their 100-year global warming potentials relative to CO_2. These values are listed in Table 19.

The cost per metric ton of carbon offset is also presented in Table 17. This figure is calculated based on the 30-year net present value with renewable incentives removed and the total net reduction of GHG emissions over the 30 years. A positive cost per ton indicates that LFP has to accept negative financial returns to offset the GHG emissions, while a negative cost per ton indicates that the GHG offset would save money while also offsetting GHG emissions.

Table 17: Greenhouse Gas Emissions Summary

Option	Current System	With Proposed Biomass System			Net Reduction in Scope 1 & 2 CO_2 Equivalent Emissions (tonnes/year)	Life Cycle Cost of Carbon Offsets
	Scope 1 Fossil Fuel CO_2 Equivalent Emissions (tonnes/year)	Scope 1 Biomass CO_2 Equivalent Emissions (tonnes/year)	Scope 2 Reduction in Electric CO_2 Equivalent Emissions (tonnes/year)	Scope 1 Fossil Fuel CO_2 Equivalent Emissions (tonnes/year)		
1 - CHP	22,942	59	-29	1,335	21,576	($32)
2 - CHP High Pressure	22,942	62	-819	1,335	22,364	($32)
3 - Electric-led CHP	22,942	164	-9,414	1,335	30,857	($33)

Note 1: Net Scope 2 electric emissions represent the difference in emissions from utility electric use and net generation by the proposed energy system.
Note 2: The 30-year cost of carbon offset is calculated by dividing the 30-year net present value by the total mass of CO_2 equivalent offset over the 30-year period with all renewable attribute payments removed. A negative value indicates that the option saves money while also reducing net carbon emissions.

10.3 Act 250 and Act 248 Permitting

Any of the project options identified in this report would trigger Act 250 permitting. The options would not likely be required to go through the Section 248 process since electric generation facilities would be operated solely for on-site electricity consumption by the owner of the facilities. This would change in some respects if net metering was to be implemented with any of the options. Either process requires a detailed evaluation of impacts associated with the project. Act 250 is Vermont's land use and development control law, and would consider the development's impact on any of the following: town & regional plans; necessary wildlife habitat; town & regional growth; primary agricultural soils;

municipalities & governmental services; historic & archeological sites; energy & water conservation; air & water quality; streams & shorelines; educational facilities; public investments; endangered species; soil erosion; utilities; waste disposal; water supplies; wetlands; floodways; forest soils; transportation; aesthetics; natural areas; and earth resources. While the projects would have impacts in many of these areas, the impacts would be expected to either be minor or positive in nature. Regardless, this permitting process will be of critical importance to a project, and it is strongly recommended that LFP consult with an attorney that specializes in Act 250 permitting as a key first step in pursuing any of the options identified in this report.

The facility currently has an Act 250 permit that has been amended several times. Since BDCC is the current owner of the facility, their participation in the Act 250 permitting process will be important.

10.4 UTILITY INTERCONNECTION

GMP has worked with LFP to review the general options for the facility with respect to utility interconnection. Additionally, GMP setup a joint call with National Grid, which owns the transmission line that feeds the LFP facility. The result of those calls and meetings has been the following understanding with respect to the process through which an interconnection agreement would be pursued for the projects.

All of the project options would be setup to only use energy onsite, and would be designed without the ability to transfer power to the grid. Based on this, both GMP and National Grid have stated that regardless of the size of the systems, the interconnection review process will follow the Vermont 5.500 rule. This rule has a prescribed process and associated timeframes for the interconnection agreement. GMP indicated that while these timeframes may be aggressive given the backlog they have for review of interconnection agreements, they did not envision hiring outside consultants for review of projects of this nature. National Grid would be treated as an affected party to the proposed interconnection, and would be included by GMP in the interconnection agreement review process. National Grid reviewed the connection point, and indicated that since the power would all remain onsite they would not likely see a concerning impact to their system.

11.0 CONCLUSIONS AND RECOMMENDATIONS

The installation of a wood energy system at the Long Falls Paperboard mill provides the opportunity to reduce operating costs, while also reducing net greenhouse gas emissions, improving the local economy, and benefitting local forest management activities. This study examined three biomass options and three alternates. Development of these options and alternatives was guided by focusing on providing overall value to LFP, reducing operating costs, and providing value to the local community.

Each option is compared to the current operating approach, which uses grid supplied electric, CNG, and #6 fuel oil to meet facility energy demands. The options evaluated in this study have the potential to provide a number of benefits to LFP, as described in the following list:

> **Option 1** includes installation of an automated wood energy system covering over 95% of the thermal demand at the facility, and will also provide a small amount of very efficient power generation in the plant. This project would provide a first-year net operating savings of approximately $2.1 million (M). The $14.8 M project would be financed, and while considering incentives and financing payments, would offer 5 and 30 year NPVs of $8.7 and $29.4 M respectively. The project would provide over 21,500 metric tonnes of net GHG offsets annually. The option addresses deferred maintenance on fossil fuel steam systems, while providing LFP with a modern, highly efficient renewable energy plant with low operating costs and a 30-year life.

Option 2 includes installation of an automated wood energy system covering over 95% of the thermal demand at the facility, and will also provide on the order of 7% of the electric needs at the facility. This project would provide a first-year net operating savings of approximately $2.4 M. The $17.9 M project would be financed, and while considering incentives and financing payments, would offer 5 and 30 year NPVs of $8.7 and $30.4 M respectively. The project would provide over 22,000 metric tonnes of net GHG offsets annually. The option addresses deferred maintenance on fossil fuel steam systems, while providing LFP with a modern, highly efficient renewable energy plant with low operating costs and a 30-year life.

Option 3 includes installation of an automated wood energy system covering over 95% of the thermal demand at the facility, and will also provide 95% of the electric needs at the facility. This project would provide a first-year net operating savings of approximately $3.5 M. The $26.4 M project would be financed, and while considering incentives and financing payments, would offer 5 and 30 year NPVs of $12.0 and $42.3 M respectively. The project would provide over 30,857 metric tonnes of net GHG offsets annually. Importantly, this option would provide certainty for LFP with regard to long-term electric costs for the project's 30-yr life. The option addresses deferred maintenance on fossil fuel steam systems, while providing LFP with a modern, highly efficient renewable energy plant with low operating costs and a 30-year life.

Alternative 1 includes installation of a flue gas condensation unit on the Options considered. Given the significant need for very low quality thermal energy at the facility, this Alternative would substantially improve the performance of any of the options. The level of added investment is on the order of $0.9M, and would provide on the order of $230,000 in annual fuel savings. The improvement of Option 3 economics may be greater than discussed if the potential use for low quality thermal energy in the plant is higher than that assumed in this report. It is also important to note that implementing this alternative would likely directly reduce the overall boiler demand and capacity need, depending on how the energy from preheating the water is used in the plant.

Alternative 2 includes interconnection of one of the backpressure turbine generators for each option to the Brudies Road Substation as a Net Metering system. This allows LFP to likely capture a higher value for the power generated. This is expected to have a payback in the range of 3-5 years depending on the option considered.

Alternative 3 includes installation of a district heating system to serve neighboring thermal energy users with renewable, and low cost thermal energy. More information from neighboring building owners needs to be obtained to analyze this option. In addition to the cost of heat from the renewable wood energy options being on the order of 3-5 times lower than that of competing fossil fuels, this would also increase the potential for generating Tier III credits.

Financial performance of the evaluated options is dependent upon a number of factors, including the tradeoff between capital costs for automation and reduction of operating costs, tradeoff between capital costs and electrical efficiency/heat rates, the cost of wood fuel, the cost of competing fossil fuels, and electric rates. A sensitivity analysis of operating savings based on varying wood and fossil fuel prices is provided in Appendix C, and additional sensitivity analyses will be discussed with LFP to assist with their consideration of the options.

Beyond the direct project economics, there are a host of additional benefits from the options to LFP and the local community and region, including the following:

- Between $1.4 and $3.5 M would be spent each year on wood energy within the local economy through wood residue purchases. It is estimated that this supports between 30 and 70 FTEs in the local forestry industry, depending on the option selected.

- The purchase of local forest management and industry residues provides an outlet for low-value residues, which is critical in the region for providing opportunities for forest management activities to reduce pests and disease, prevent fires, and manage ecological diversity, soil health, and water quality.
- The options would stabilize LFP operating cost volatility and risk due to wide fluctuations in natural gas and fuel oil costs, and due to potential future increases in electric costs.

Should Long Falls Paperboard be interested in pursuing a wood energy system option, WERC recommends that staff visit other modern wood energy system installations to develop a detailed understanding of the equipment and its capabilities. As Long Falls Paperboard continues to pursue wood energy options, WERC recommends that the next level of evaluation includes detailed consideration of the following items:

- Consider updating and increasing metering of steam demands to inform refinement of options. Potential items to target include:
    - Calibrate the existing steam meters at the boilers and the existing line shaft turbine to confirm their accuracy.
    - Add steam metering on the load side of the main PCV that is shown at 100 psig and other points of pressure reduction as appropriate.
    - Log boiler makeup water daily, and perhaps electronically.
    - Log flows and temperatures that will allow for assessing opportunities to use low grade thermal energy (both for process water and makeup air).
- Work with local, regional, and federal stakeholders to identify any additional potential alternative funding sources (low interest loans, grants, and other incentives).
    - Detailed review of the reinstated Section 45d and Section 48 tax benefits for open loop biomass should be conducted with LFP's tax accountant and incorporated into project decision making.
- Continue discussions with local building owners to evaluate the potential for the district heating alternative.
- Closely evaluate equipment redundancy in the mix/number of boilers and/or turbines used to meet the targeted demands, while considering capital cost impacts.

12.0 ASSUMPTIONS

The key assumptions and values used in this study are presented in Table 18 and Table 19.

Table 18: Key Values and Assumptions

Item	Value	Units	Notes
Gas boiler/economizer efficiency HHV	0.75	decimal	LFP records
Average cost of gas	8.7	$/mmBtu	LFP records
Average cost of oil	2.5	$/gallon	LFP records
HHV of #6 oil	0.1536	mmBtu/gallon	WERC Assumption
Average cost of propane	1	$/gallon	WERC Assumption
HHV of propane	0.09133	mmBtu/gallon	WERC Assumption
Wood boiler efficiency HHV (Options 1 & 2)	0.70	decimal	WERC Assumption
Wood boiler efficiency HHV (Option 3)	0.73	decimal	WERC Assumption
Wood cost (Options 1 & 2)	28.5	$/ton	WERC Assumption
Wood cost (Option 3)	26.5	$/ton	WERC Assumption
Wood HHV bone dry average	8650	Btu/lb	WERC Assumption
Average delivered moisture content	0.45	MCwb	WERC Assumption
Average ash content	0.03	decimal	WERC Assumption
HHV of wood on average	9.2	mmBtu/ton	WERC Assumption
Electric REC value	10.0	$/MWh	WERC Assumption
Wood uptime / load coverage	0.95	decimal	WERC Assumption
Gas boiler coverage	0.95	decimal	WERC Assumption
Average cost of electric - all-in with subsidy	0.0888	$/kWh	LFP / rate schedule
Average cost of electric - all-in no subsidy	0.1110	$/kWh	LFP / rate schedule
Average all-in value of electric offset with Options 1 & 2	0.100	$/kWh	Analysis of Rates
Condensate returned	0.55	decimal	Boiler logs
Enthalpy of steam at 225 psig	1,201	Btu/lb	WERC Assumption
Assumed makeup water temperature	40	°F	WERC Assumption
Assumed condensate return temperature	200	°F	WERC Assumption
Enthalpy of feedwater mix prior to DA	96	Btu/lb	WERC Assumption
Enthalpy of feedwater after DA	195	Btu/lb	227°F - site visit
Enthalpy change per lb across existing boilers	1,006	Btu/lb	Calc
Enthalpy of 225 psig steam superheated to 622oF	1,331	Btu/lb	WERC Assumption
Enthalpy of 600 psig steam superheated to 750oF	1,379	Btu/lb	WERC Assumption
Blowdown percentage	0.03	decimal	WERC Assumption

Table 19: GHG Assumptions and Values

Assumption	Value	Unit	Source
CO_2 emitted during combustion of Natural Gas	53.06	kg/mmBtu	EPA Emissions Factors 2018
CH_4 emitted during combustion of Natural Gas	0.001	kg/mmBtu	EPA Emissions Factors 2018
N_2O emitted during combustion of Natural Gas	0.0001	kg/mmBtu	EPA Emissions Factors 2018
CO_2 emitted during combustion of Propane	62.87	kg/mmBtu	EPA Emissions Factors 2018
CH_4 emitted during combustion of Propane	0.003	kg/mmBtu	EPA Emissions Factors 2018
N_2O emitted during combustion of Propane	0.0006	kg/mmBtu	EPA Emissions Factors 2018
CO_2 emitted during combustion of Wood	93.8	kg/mmBtu	EPA Emissions Factors 2018
CH_4 emitted during combustion of Wood	0.0072	kg/mmBtu	EPA Emissions Factors 2018
N_2O emitted during combustion of Wood	0.0036	kg/mmBtu	EPA Emissions Factors 2018
CO_2 emitted during combustion of #6 Oil	75.1	kg/mmBtu	EPA Emissions Factors 2018
CH_4 emitted during combustion of #6 Oil	0.003	kg/mmBtu	EPA Emissions Factors 2018
N_2O emitted during combustion of #6 Oil	0.0006	kg/mmBtu	EPA Emissions Factors 2018
CO_2 emitted due to use of Electricity (includes line losses)	0.26	kg/kWh	EPA 2016 eGrid (Total Output)
CH_4 emitted due to use of Electricity (includes line losses)	0.000043	kg/kWh	EPA 2016 eGrid (Total Output)
N_2O emitted due to use of Electricity (includes line losses)	0.000006	kg/kWh	EPA 2016 eGrid (Total Output)
Line losses	4.49%	Percent	EPA 2016 eGrid
CH_4 100-year Global Warming Potential	25	* CO_2	IPCC
N_2O 100-year Global Warming Potential	298	* CO_2	IPCC

Appendix A

Site / Plant Layouts and System Schematics

- A.1: Site Plan View
- A.2: Option 1 – Site Layout
- A.3: Option 1 – Boiler Plant Layout
- A.4: Option 1 – Single-line Diagram
- A.5: Option 2 – Site Layout
- A.6: Option 2 – Boiler Plant Layout
- A.7: Option 2 – Single-line Diagram
- A.8: Option 3 – Site Layout
- A.9: Option 3 – Boiler Plant Layout
- A.10: Option 3 – Single-line Diagram

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Long Falls Paperboard
Brattleboro, VT
Site Plan

DATE: 10/17/19

A.1

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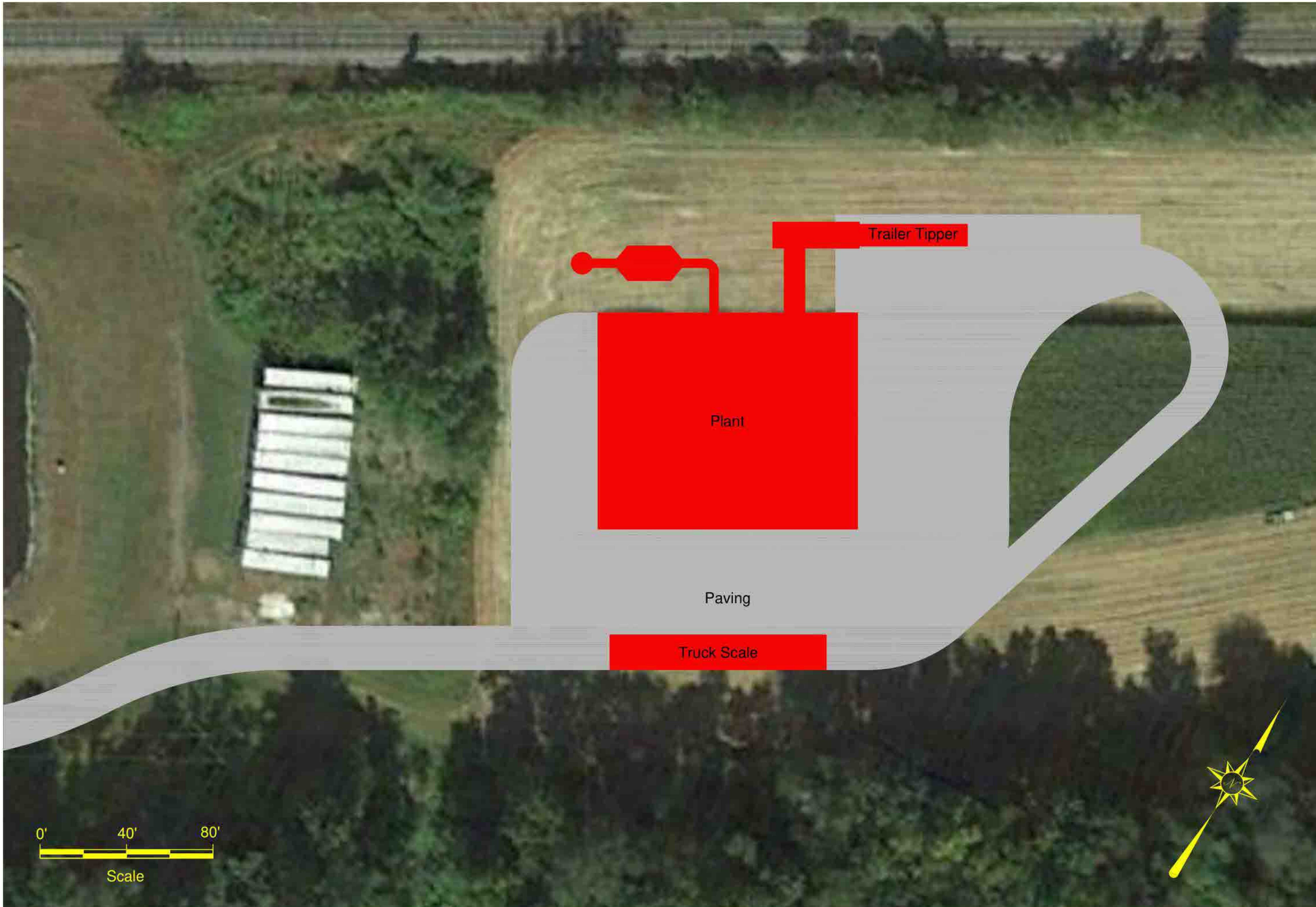

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Long Falls Paperboard
Brattleboro, VT
Option 1 - Boiler Plant Site Plan

DATE: 10/17/19

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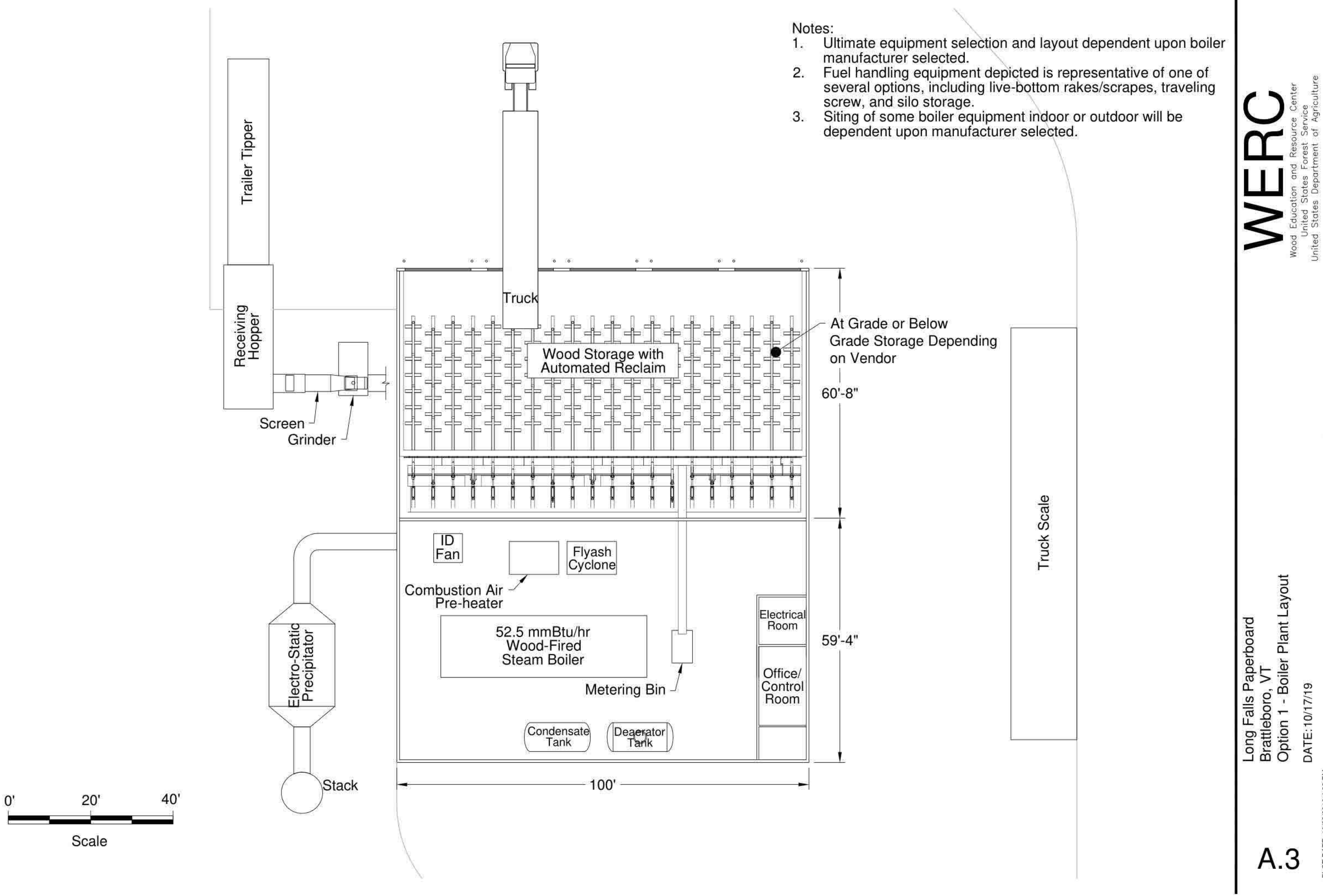
A.2


Notes:
1. Ultimate equipment selection and layout dependent upon boiler manufacturer selected.
2. Fuel handling equipment depicted is representative of one of several options, including live-bottom rakes/scrapes, traveling screw, and silo storage.
3. Siting of some boiler equipment indoor or outdoor will be dependent upon manufacturer selected.
Trailer Tipper
Receiving Hopper
Screen
Grinder
Truck
Wood Storage with Automated Reclaim
At Grade or Below Grade Storage Depending on Vendor
60'-8"
59'-4"
100'
Truck Scale
ID Fan
Flyash Cyclone
Combustion Air Pre-heater
52.5 mmBtu/hr Wood-Fired Steam Boiler
Metering Bin
Electrical Room
Office/ Control Room
Condensate Tank
Deaerator Tank
Electro-Static Precipitator
Stack
0'
20'
40'
Scale
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Long Falls Paperboard
Brattleboro, VT
Option 1 - Boiler Plant Layout
DATE: 10/17/19
A.3
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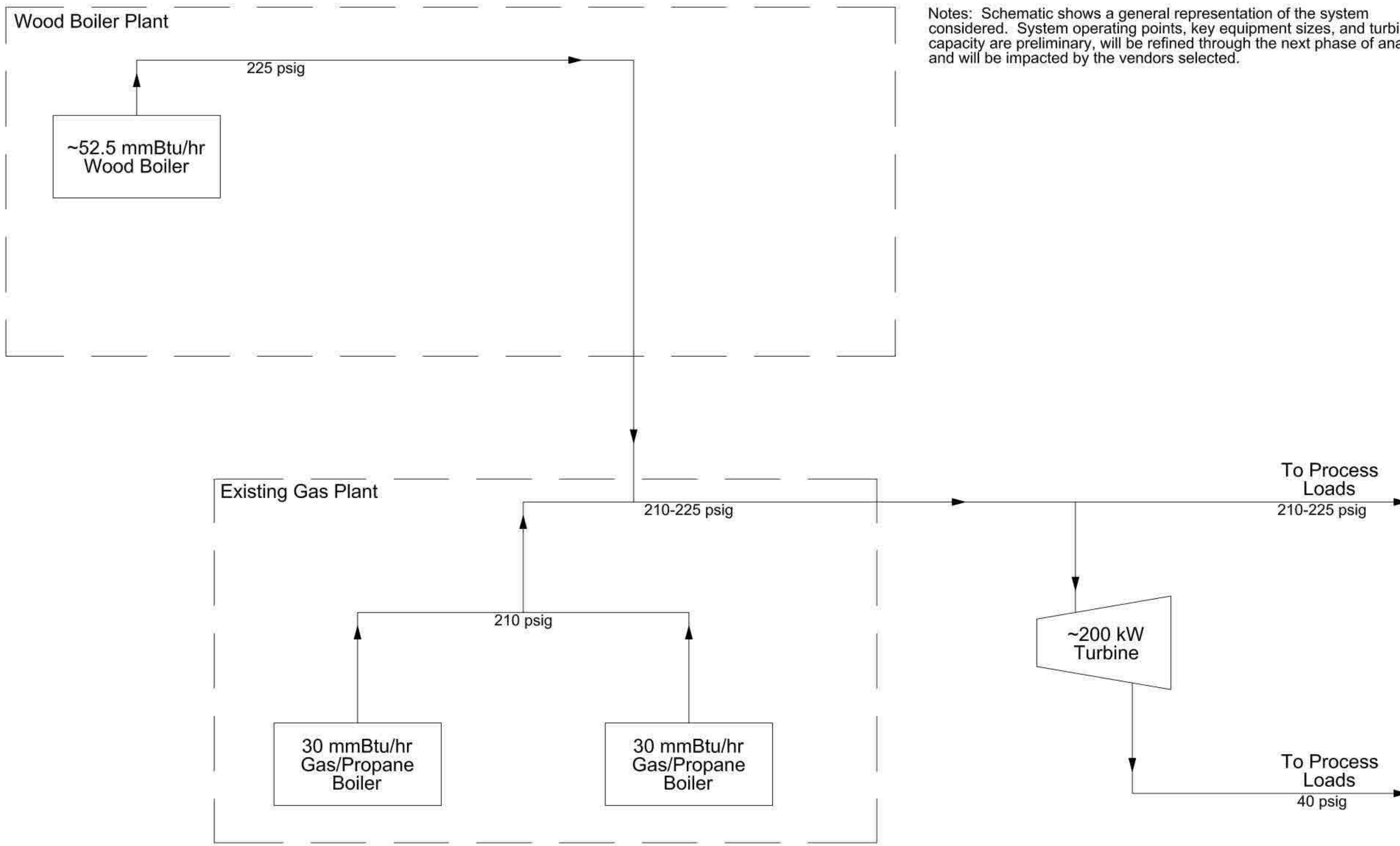

Notes: Schematic shows a general representation of the system considered. System operating points, key equipment sizes, and turbine capacity are preliminary, will be refined through the next phase of analysis, and will be impacted by the vendors selected.

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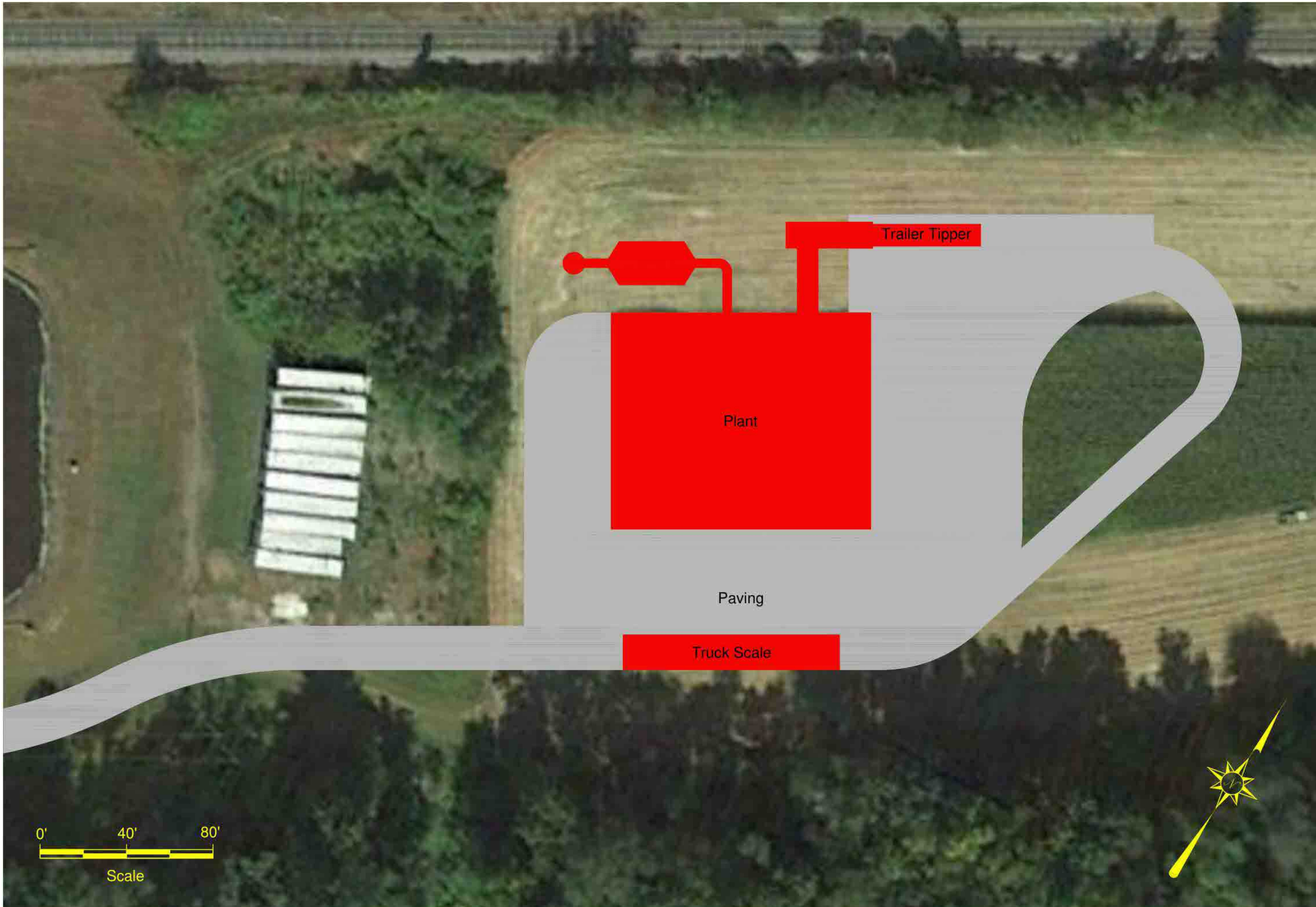
LFP Wood Energy Project
Brattleboro, VT
Option 1 - Single-Line Diagram

DATE: 10/22/19 - DRAFT



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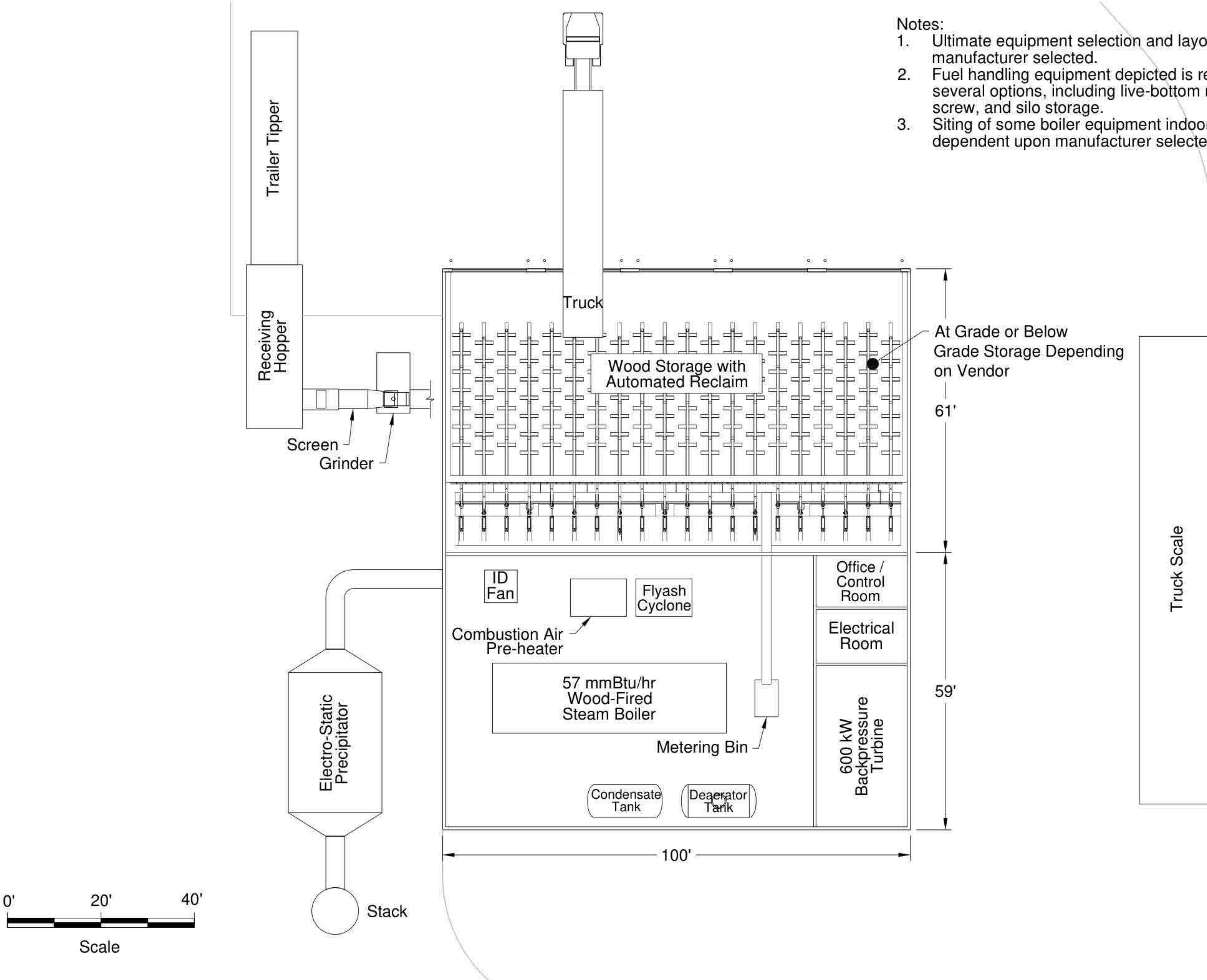
Long Falls Paperboard
Brattleboro, VT
Option 2 - Boiler Plant Site Plan

DATE: 10/17/19

A.5

PLOT DATE: 10/23/2019 4:43 PM

Notes:
1. Ultimate equipment selection and layout dependent upon boiler manufacturer selected.
2. Fuel handling equipment depicted is representative of one of several options, including live-bottom rakes/scrapes, traveling screw, and silo storage.
3. Siting of some boiler equipment indoor or outdoor will be dependent upon manufacturer selected.



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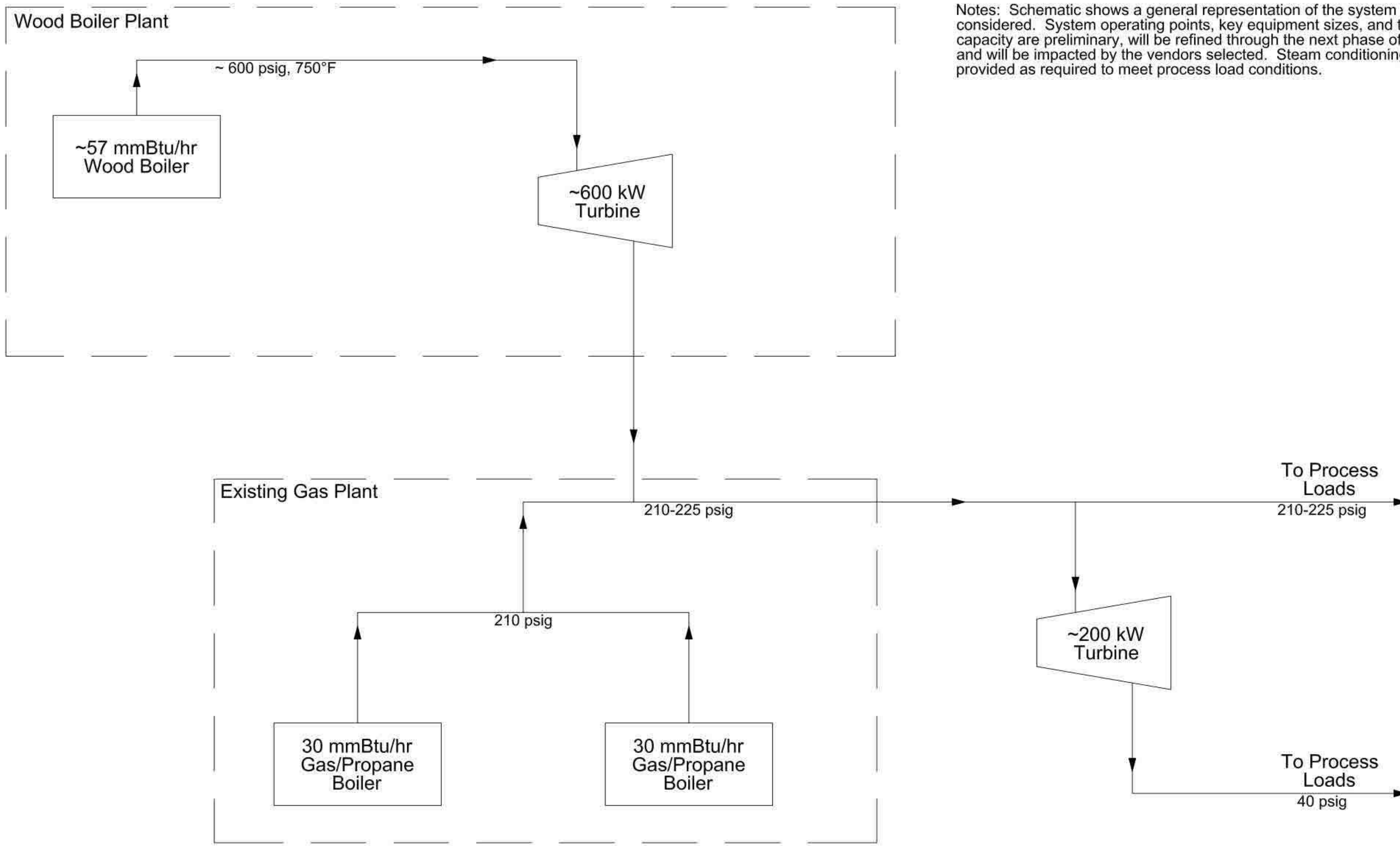
Long Falls Paperboard
Brattleboro, VT
Option 2 - Boiler Plant Layout

DATE: 10/17/19

A.6

PLOT DATE: 10/23/2019 4:33 PM

Notes: Schematic shows a general representation of the system considered. System operating points, key equipment sizes, and turbine capacity are preliminary, will be refined through the next phase of analysis, and will be impacted by the vendors selected. Steam conditioning to be provided as required to meet process load conditions.



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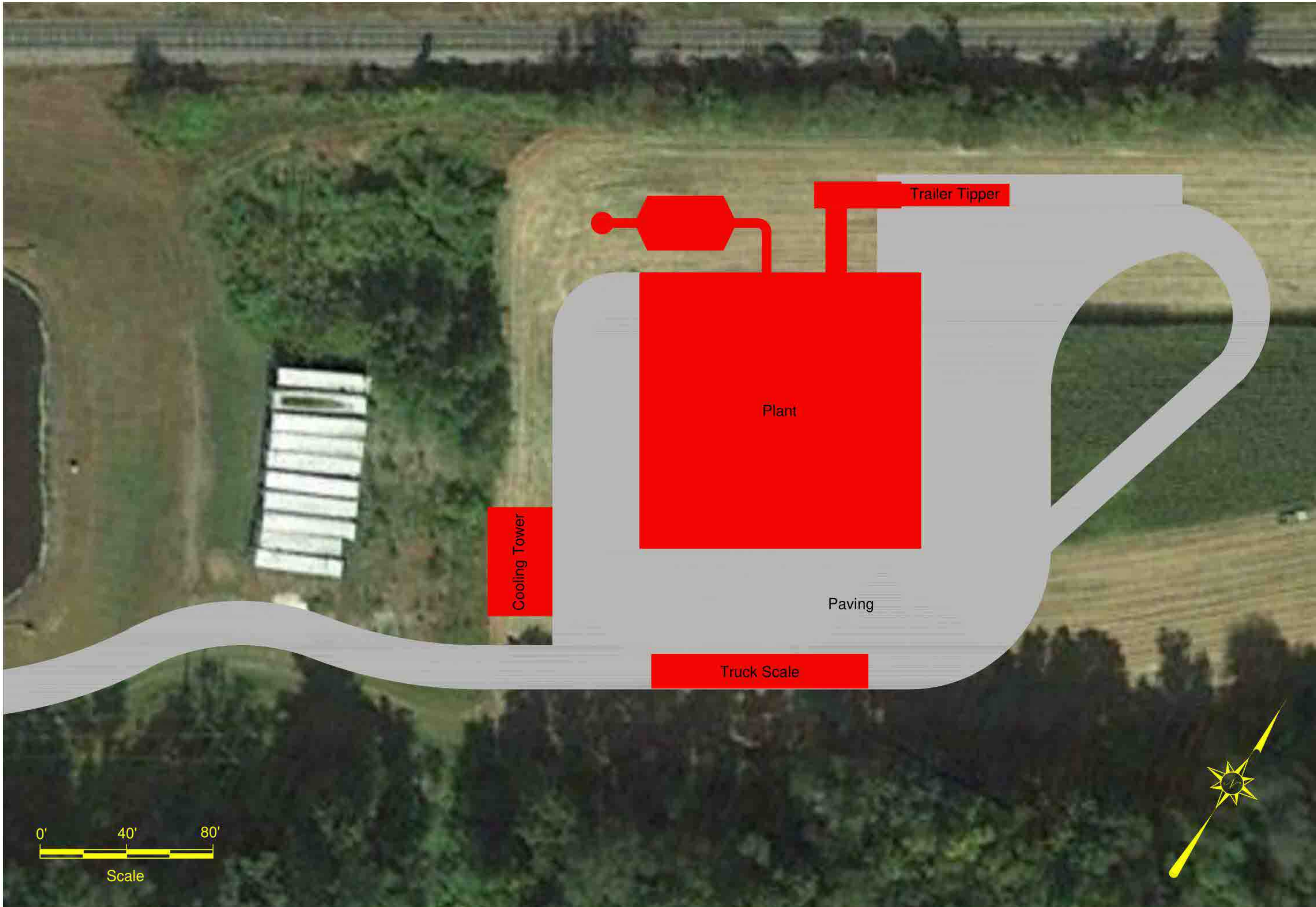
LFP Wood Energy Project
Brattleboro, VT
Option 2 - Single-Line Diagram

DATE: 10/22/19 - DRAFT



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Brattleboro, VT
Option 3 - Boiler Plant Site Plan

DATE: 10/17/19

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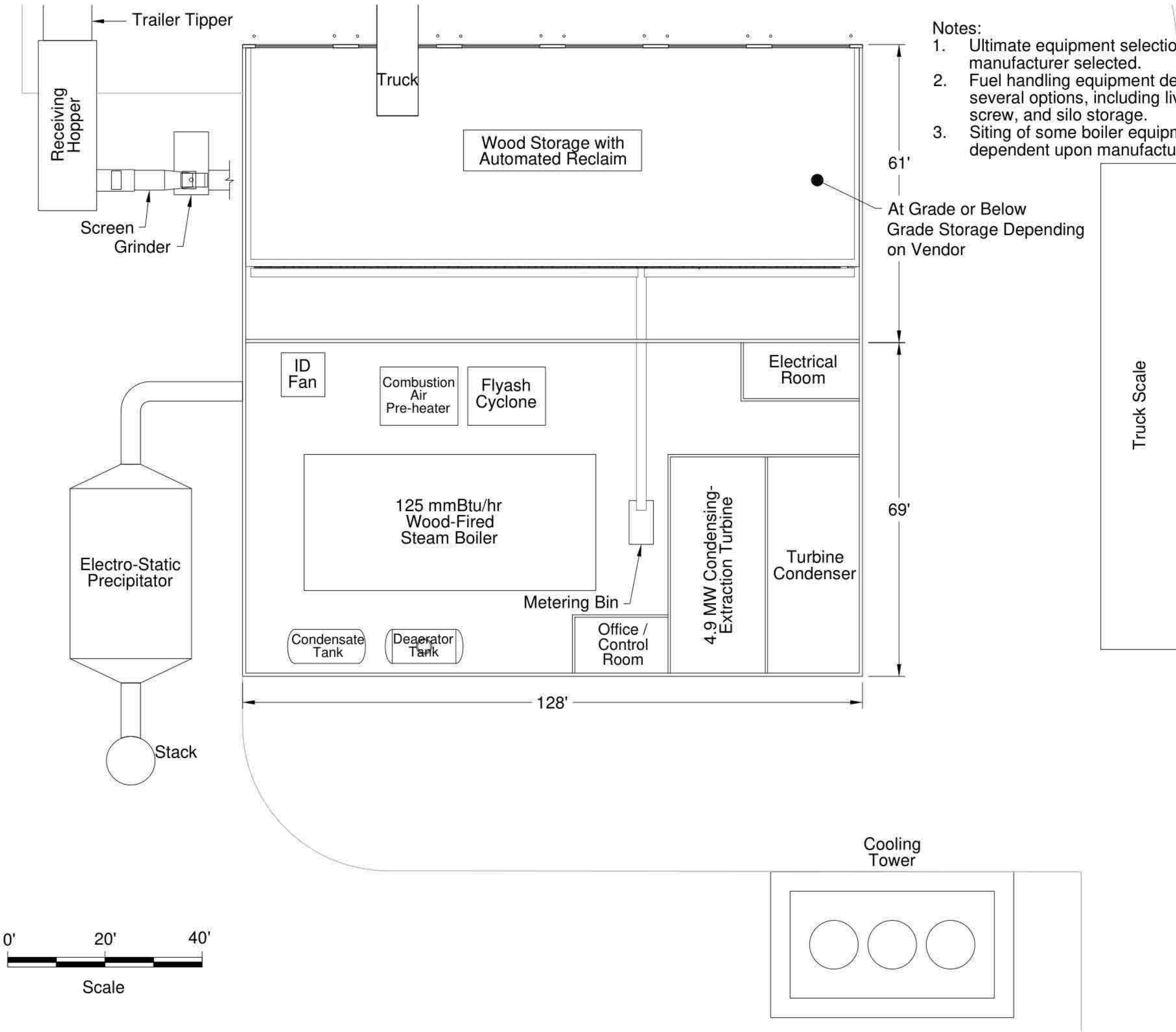

Notes:

1. Ultimate equipment selection and layout dependent upon boiler manufacturer selected.
2. Fuel handling equipment depicted is representative of one of several options, including live-bottom rakes/scrapes, traveling screw, and silo storage.
3. Siting of some boiler equipment indoor or outdoor will be dependent upon manufacturer selected.

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Option 3 - Boiler Plant Layout

DATE: 10/17/19

A.9

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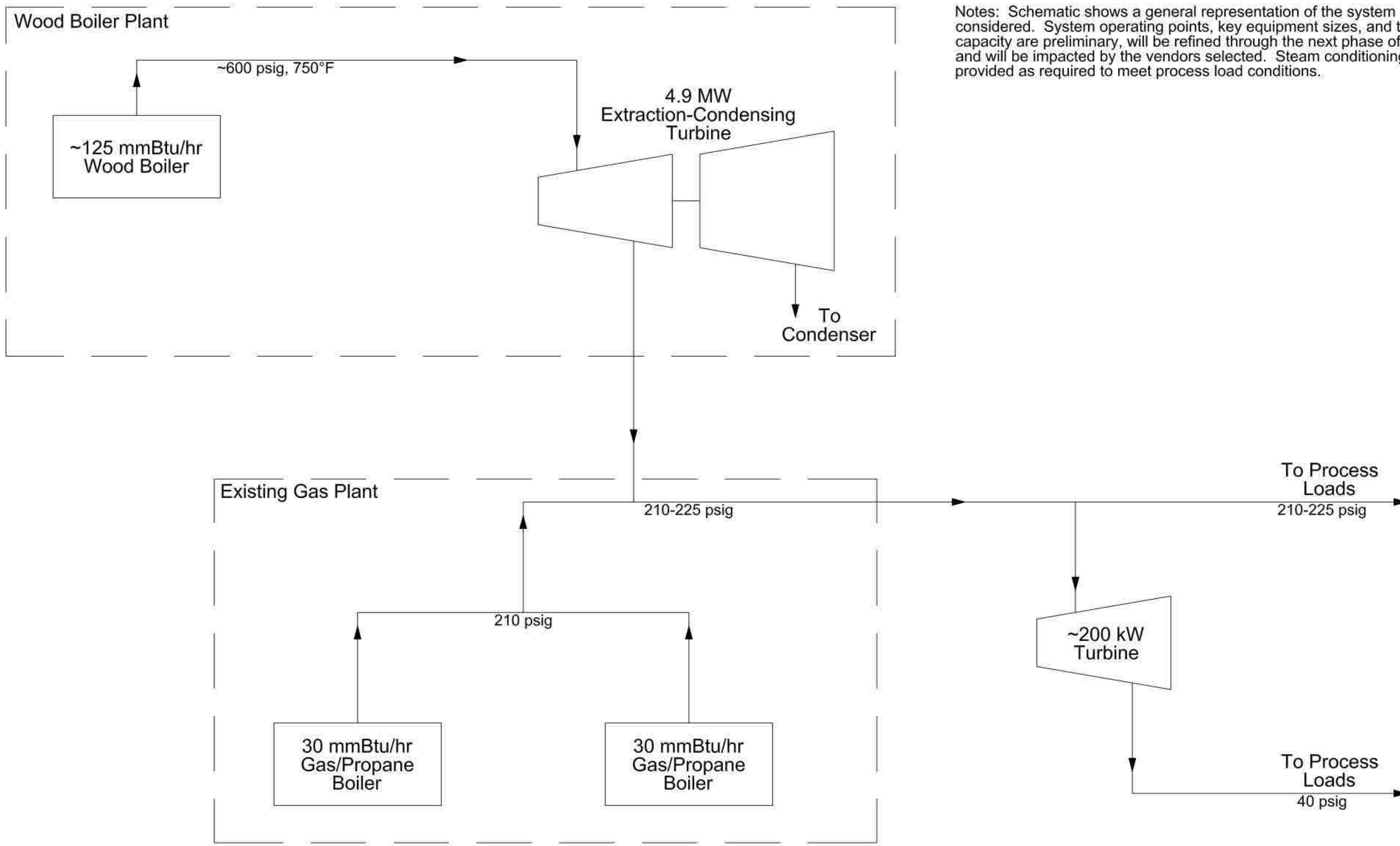
Notes: Schematic shows a general representation of the system considered. System operating points, key equipment sizes, and turbine capacity are preliminary, will be refined through the next phase of analysis, and will be impacted by the vendors selected. Steam conditioning to be provided as required to meet process load conditions.



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LFP Wood Energy Project
Brattleboro, VT
Option 3 - Single-Line Diagram
DATE: 10/22/19 - DRAFT

Appendix B

Capital Cost Estimates

- B.1: Option 1 - 52.5 mmBtu/hr, 300 psig Wood Boiler / Thermally-led CHP
- B.2: Option 2 - 57 mmBtu/hr, 600 psig Wood Boiler / Thermally-led CHP
- B.3: Option 3 - 125 mmBtu/hr, 600 psig Wood Boiler / Electrically-led CHP
- B.4: Alternate 1 – Incremental Cost Increase for Flue Gas Condensation

Capital Cost Estimate: Option 1 - 52.5 mmBtu/hr, 300 psig Wood Boiler / Thermally-Led CHP

Biomass Boiler Manufacturer Contract

Line Item			Cost
~52.5 mmBtu/hr biomass combustion unit and 300 psig rated steam boiler, steam specialties, new DA/feedwater system, moving grate, ash handling, multi-cyclone, ESP, fluegas heat recovery to reach 70%, stack, platforms, ladders, stairs, installed		$	6,024,425
Trailer tipper/receiving, screening, magnet, side-stream hog, distribution into auto-reclaim storage, and minimum of 32,000 ft3 of covered storage with auto-reclaim and access by walking floor trailers for backup, installed		$	2,880,000
Total Boiler Manufacturer Contract		**$**	**8,904,425**

General Contract

Line Item			Cost
Central steam plant building, covered wood storage, interior equipment foundations [1]		$	1,500,000
Site work, paving, foundations outside of building		$	698,000
Medium pressure steam line above ground (1,400 lf)		$	280,000
BPST (225 down to 45, 15,000 pph)		$	350,000
Electrical balance of plant		$	300,000
Mechanical balance of plant		$	300,000
Sub-Total		$	3,428,000
Contractor profit, bond, overhead, and insurance	*20%*	*$*	*686,000*
Sub-Total		$	4,114,000
Contingency	*10%*	*$*	*411,000*
Total General Contract Building, Site, BOP		**$**	**4,525,000**

Total Project Cost

Line Item			Cost
Project Sub-Total (Boiler and General Contracts)		$	13,429,425
Professional Services [2]	*10%*	*$*	*1,343,000*
Total Project Cost[3,4,5]		**$**	**14,772,425**

Notes:

1 - The building is assumed to be a simple pre-engineered building.

2 - Professional Services includes engineering, permitting, interconnection agreement, legal, and project management.

3 - Assumes design build project with owner purchase of wood boiler and fuel handling contract directly.

4 - General contract costs are approximate. A detailed geotechnical investigation is required to identify final site and building costs.

5 - Estimate is based on open competitive bidding.

Capital Cost Estimate: Option 2 - 57 mmBtu/hr, 600 psig Wood Boiler / Thermally-Led CHP

Biomass Boiler Manufacturer Contract

Line Item			Cost
~57 mmBtu/hr biomass combustion unit and 600 psig/750oF operating steam boiler, steam specialties, new DA/feedwater system, moving grate, ash handling, multi-cyclone, ESP, fluegas heat recovery to reach 70%, stack, platforms, ladders, stairs, installed		$	7,668,015
Truck scale, trailer tipper/receiving, screening, magnet, side-stream hog, distribution into auto-reclaim storage, and minimum of 32,000 ft3 of covered storage with auto-reclaim and access by walking floor trailers for backup, installed		$	2,880,000
Total Boiler Manufacturer Contract		**$**	**10,548,015**

General Contract

Line Item			Cost
Central steam plant building, covered wood storage, interior equipment foundations [1]		$	1,500,000
Site work, paving, foundations outside of building		$	698,000
Medium pressure steam line above ground (1,400 lf)		$	280,000
BPST (225 down to 45, 15,000 pph)		$	350,000
BPST (600/750 down to 225, 45,000 pph)		$	600,000
Electrical balance of plant		$	500,000
Mechanical balance of plant		$	400,000
Sub-Total		$	4,328,000
Contractor profit, bond, overhead, and insurance	*20%*	*$*	*866,000*
Sub-Total		$	5,194,000
Contingency	*10%*	*$*	*519,000*
Total General Contract Building, Site, BOP		**$**	**5,713,000**

Total Project Cost

Line Item			Cost
Project Sub-Total (Boiler and General Contracts)		$	16,261,015
Professional Services [2]	*10%*	*$*	*1,626,000*
Total Project Cost[3,4,5]		**$**	**17,887,015**

Notes:

1 - The building is assumed to be a simple pre-engineered building.

2 - Professional Services includes engineering, permitting, interconnection agreement, legal, and project management.

3 - Assumes design build project with owner purchase of wood boiler and fuel handling contract directly.

4 - General contract costs are approximate. A detailed geotechnical investigation is required to identify final site and building costs.

5 - Estimate is based on open competitive bidding.

Capital Cost Estimate: Option 3 - 125 mmBtu/hr, 600 psig Wood Boiler / Electrically-Led CHP

Biomass Boiler and STG Provider Contract

Line Item		Cost
~125 mmBtu/hr biomass combustion unit and 600 psig/750oF operating steam boiler, steam specialties, new DA/feedwater system, moving grate, ash handling, SNCR, multi-cyclone, ESP, fluegas heat recovery to reach 73%, stack, platforms, ladders, stairs, installed	$	11,237,641
Truck scale, trailer tipper/receiving, screening, magnet, side-stream hog, distribution into auto-reclaim storage, and minimum of 70,000 ft3 of covered storage with auto-reclaim and access by walking floor trailers for backup, installed	$	3,380,000
5 MW extraction turbine, condenser, cooling tower, and ancillary equipment, installed	$	4,028,750
Total Contract	**$**	**18,646,391**

General Contract

Line Item			Cost
Central steam plant building, covered wood storage, interior equipment foundations [1]		$	2,100,000
Site work, paving, foundations outside of building		$	760,000
BPST (225 down to 45, 15,000 pph)		$	350,000
Medium pressure steam line above ground (1,400 lf)		$	280,000
Electrical balance of plant		$	600,000
Mechanical balance of plant		$	300,000
Sub-Total		$	4,390,000
Contractor profit, bond, overhead, and insurance	*20%*	*$*	*878,000*
Sub-Total		$	5,268,000
Contingency	*10%*	*$*	*527,000*
Total General Contract Building and Site		**$**	**5,795,000**

Total Project Cost

Line Item			Cost
Project Sub-Total (Boiler/STG and General Contracts)		$	24,441,391
Professional Services [2]	*8%*	*$*	*1,955,000*
Total Project Cost[3,4,5]		**$**	**26,396,391**

Notes:

1 - The building is assumed to be a simple pre-engineered building.

2 - Professional Services includes engineering, permitting, interconnection agreement, legal, and project management.

3 - Assumes design build project with owner purchase of power island and fuel handling contract directly.

4 - General contract costs are approximate. A detailed geotechnical investigation is required to identify final site and building costs.

5 - Estimate is based on open competitive bidding.

Estimate of Incremental Changes in Capital Cost: Alternate 1 - Flue Gas Condensation

Equipment Procurement

Line Item			Cost
Flue gas condensation unit and shipping		$	500,000
Contractor mark-up	*10%*	$	50,000
Total Boiler Manufacturer Contract		**$**	**550,000**

General Contract

Line Item			Cost
Increased site work, buildings, paving, foundations, and utility connections		$	80,000
Increased mechanical installation (crane, rigging, setting, flue gas breeching, insulation, hydraulic systems, by-pass, etc.)		$	150,000
Increased electrical and controls		$	50,000
Sub-Total		$	280,000
Contractor profit, bond, overhead, and insurance	*20%*	*$*	*56,000*
Sub-Total		$	336,000
Contingency	*10%*	*$*	*34,000*
Total General Contract Building, Site, BOP		**$**	**370,000**

Total Project Cost

Line Item		Cost
Total Project Cost	**$**	**920,000**

Notes:

1 - This is intended to be incremental in cost to the main options as presented.

Appendix C

Cash Flow and Sensitivity Analyses

- C.1: Option 1 – 25-Year Cash Flow Analysis
- C.2: Option 1 – Net Operating Savings Sensitivity Analysis
- C.3: Option 2 – 25-Year Cash Flow Analysis
- C.4: Option 2 – Net Operating Savings Sensitivity Analysis
- C.5: Option 3 – 25-Year Cash Flow Analysis
- C.6: Option 3 – Net Operating Savings Sensitivity Analysis

Option 1 - 52.5 mmBtu/hr, 300 psig Wood Boiler / Thermally-Led CHP
30-Year Cash Flow Analysis ($1,000s)

Description	Value	Units
Total Project Costs	$14,772,425	$
Financing Costs	$1,034,070	$
Cash In Escrow	$1,800,000	$
Grant Funding Received Up Front	($1,000,000)	$
Project Costs Financed	$16,606,495	$
Bond Financing Rate	0.065	decimal
Bond Financing Term	15	yrs
Electric Demand/yr	37,723	MWh
Heat Demand (Boiler Output)/yr	317,311	mmBtu
Proposed Wood Use/yr	47,431	tons
Proposed Propane Use/yr	21,154	mmBtu
Proposed Electric Cost - Net of REC Value	4,165,621	$
Initial Wood Cost	$28.5	$/ton
Initial Natural Gas / Oil Blended Cost	$9.08	$/mmBtu
Initial Propane Cost	$10.95	$/mmBtu
Initial Electric Power Cost	$0.111	$/kWh
Tier III Credit Value/yr	$875,000	$/year
Added O&M Cost	$157,983	$/year
Assumed Inflation	2.0%	percent
Discount Rate	6.5%	percent

Year	Business-As-Usual		Proposed System				Net Operating Savings	Bond Payment Schedule	Incentives (see summary)	Cash Flow	Present Value of Cash Flow
	Boiler Fuel Cost	Electric Cost	Wood Cost	Propane Cost	Electric Cost, Net RECs	Added O&M Cost					
1	$ 3,841	$ 4,189	$ 1,352	$ 232	$ 4,166	$ 158	$ 2,123	$ (1,732)	$ 1,348	$ 1,739	$ 1,633
2	$ 3,879	$ 4,147	$ 1,352	$ 232	$ 4,124	$ 158	$ 2,161	$ (1,698)	$ 3,397	$ 3,860	$ 3,403
3	$ 3,956	$ 4,147	$ 1,352	$ 225	$ 4,124	$ 158	$ 2,245	$ (1,664)	$ 825	$ 1,405	$ 1,163
4	$ 4,110	$ 4,147	$ 1,352	$ 218	$ 4,124	$ 158	$ 2,405	$ (1,632)	$ 808	$ 1,582	$ 1,230
5	$ 4,263	$ 4,189	$ 1,352	$ 213	$ 4,166	$ 158	$ 2,564	$ (1,600)	$ 793	$ 1,756	$ 1,282
6	$ 4,455	$ 4,273	$ 1,352	$ 213	$ 4,249	$ 158	$ 2,756	$ (1,568)	$ 777	$ 1,965	$ 1,347
7	$ 4,532	$ 4,356	$ 1,352	$ 218	$ 4,332	$ 158	$ 2,829	$ (1,538)	$ 762	$ 2,053	$ 1,321
8	$ 4,571	$ 4,440	$ 1,352	$ 222	$ 4,416	$ 158	$ 2,863	$ (1,507)	$ 747	$ 2,102	$ 1,270
9	$ 4,571	$ 4,482	$ 1,352	$ 229	$ 4,457	$ 158	$ 2,856	$ (1,478)	$ 732	$ 2,111	$ 1,197
10	$ 4,609	$ 4,566	$ 1,352	$ 232	$ 4,541	$ 158	$ 2,893	$ (1,449)	$ 718	$ 2,162	$ 1,152
11	$ 4,609	$ 4,566	$ 1,352	$ 236	$ 4,541	$ 158	$ 2,888	$ (1,420)		$ 1,468	$ 734
12	$ 4,609	$ 4,566	$ 1,352	$ 239	$ 4,541	$ 158	$ 2,886	$ (1,393)		$ 1,493	$ 701
13	$ 4,609	$ 4,608	$ 1,352	$ 241	$ 4,582	$ 158	$ 2,884	$ (1,365)		$ 1,518	$ 670
14	$ 4,609	$ 4,650	$ 1,352	$ 243	$ 4,624	$ 158	$ 2,882	$ (1,339)		$ 1,543	$ 639
15	$ 4,647	$ 4,691	$ 1,352	$ 246	$ 4,665	$ 158	$ 2,918	$ (1,312)		$ 1,606	$ 624
16	$ 4,686	$ 4,733	$ 1,352	$ 248	$ 4,707	$ 158	$ 2,954	$ -		$ 2,954	$ 1,079
17	$ 4,686	$ 4,775	$ 1,352	$ 250	$ 4,749	$ 158	$ 2,952	$ -		$ 2,952	$ 1,012
18	$ 4,686	$ 4,775	$ 1,352	$ 252	$ 4,749	$ 158	$ 2,950	$ -		$ 2,950	$ 950
19	$ 4,724	$ 4,817	$ 1,352	$ 252	$ 4,790	$ 158	$ 2,989	$ -		$ 2,989	$ 903
20	$ 4,724	$ 4,817	$ 1,352	$ 252	$ 4,790	$ 158	$ 2,989	$ -		$ 2,989	$ 848
21	$ 4,724	$ 4,817	$ 1,352	$ 255	$ 4,790	$ 158	$ 2,986	$ -		$ 2,986	$ 796
22	$ 4,724	$ 4,817	$ 1,352	$ 257	$ 4,790	$ 158	$ 2,984	$ -		$ 2,984	$ 747
23	$ 4,724	$ 4,817	$ 1,352	$ 257	$ 4,790	$ 158	$ 2,984	$ -		$ 2,984	$ 701
24	$ 4,763	$ 4,859	$ 1,352	$ 259	$ 4,832	$ 158	$ 3,020	$ -		$ 3,020	$ 666
25	$ 4,763	$ 4,859	$ 1,352	$ 259	$ 4,832	$ 158	$ 3,020	$ -		$ 3,020	$ 626
26	$ 4,801	$ 4,901	$ 1,352	$ 259	$ 4,874	$ 158	$ 3,059	$ -		$ 3,059	$ 595
27	$ 4,839	$ 4,901	$ 1,352	$ 259	$ 4,874	$ 158	$ 3,097	$ -		$ 3,097	$ 566
28	$ 4,839	$ 4,901	$ 1,352	$ 257	$ 4,874	$ 158	$ 3,100	$ -		$ 3,100	$ 532
29	$ 4,878	$ 4,901	$ 1,352	$ 257	$ 4,874	$ 158	$ 3,138	$ -		$ 3,138	$ 505
30	$ 4,916	$ 4,901	$ 1,352	$ 257	$ 4,874	$ 158	$ 3,176	$ -		$ 3,176	$ 480
										30-Year Net Present Value	**$ 29,371**

Notes:
1. All prices are presented in real terms (inflation-adjusted). This includes the bond repayment and incentive cash flows
2. Fossil fuel prices are escalated according to energy price indices presented in the 2019 Annual Supplement to Nist Handbook 135 - Table Ca-1
3. Wood chip prices and O&M costs are not escalated beyond general inflation rate.

Incentive Assumptions
1. The Tier III credit is assumed as being provided by GMP over a 10 year period with an annual payment of $875,000
2. Benefit from bonus depreciation is realized in Year 2.
3. Grants totaling $500,000 are assumed to be recovered in year 1 following completion of the project.
4. The $1,000,000 grant received by BDCC is assumed to directly reduce the cost of the project as carried in the bond

Option 2 - 57 mmBtu/hr, 600 psig Wood Boiler / Thermally-Led CHP
30-Year Cash Flow Analysis ($1,000s)

Description	Value	Units
Total Project Costs	$17,887,015	$
Financing Costs	$1,252,091	$
Cash In Escrow	$2,200,000	$
Grant Funding Received Up Front	($1,000,000)	$
Project Costs Financed	$20,339,106	$
Bond Financing Rate	0.065	decimal
Bond Financing Term	15	yrs
Electric Demand/yr	37,723	MWh
Heat Demand (Boiler Output)/yr	317,311	mmBtu
Proposed Wood Use/yr	49,323	tons
Proposed Propane Use/yr	21,154	mmBtu
Proposed Electric Cost - Net of REC Value	3,839,333	$
Initial Wood Cost	$28.5	$/ton
Initial Natural Gas / Oil Blended Cost	$9.08	$/mmBtu
Initial Propane Cost	$10.95	$/mmBtu
Initial Electric Power Cost	$0.111	$/kWh
Tier III Credit Value/yr	$875,000	$/year
Added O&M Cost	$161,598	$/year
Assumed Inflation	2.0%	percent
Discount Rate	6.5%	percent

Year	Business-As-Usual		Proposed System				Net Operating Savings	Bond Payment Schedule	Incentives (see summary)	Cash Flow	Present Value of Cash Flow
	Boiler Fuel Cost	Electric Cost	Wood Cost	Propane Cost	Electric Cost, Net RECs	Added O&M Cost					
1	$ 3,841	$ 4,189	$ 1,406	$ 232	$ 3,839	$ 162	$ 2,391	$ (2,121)	$ 1,348	$ 1,619	$ 1,520
2	$ 3,879	$ 4,147	$ 1,406	$ 232	$ 3,801	$ 162	$ 2,426	$ (2,079)	$ 3,936	$ 4,283	$ 3,776
3	$ 3,956	$ 4,147	$ 1,406	$ 225	$ 3,801	$ 162	$ 2,510	$ (2,038)	$ 825	$ 1,296	$ 1,073
4	$ 4,110	$ 4,147	$ 1,406	$ 218	$ 3,801	$ 162	$ 2,671	$ (1,998)	$ 808	$ 1,481	$ 1,151
5	$ 4,263	$ 4,189	$ 1,406	$ 213	$ 3,839	$ 162	$ 2,832	$ (1,959)	$ 793	$ 1,666	$ 1,216
6	$ 4,455	$ 4,273	$ 1,406	$ 213	$ 3,916	$ 162	$ 3,031	$ (1,921)	$ 777	$ 1,888	$ 1,294
7	$ 4,532	$ 4,356	$ 1,406	$ 218	$ 3,993	$ 162	$ 3,111	$ (1,883)	$ 762	$ 1,989	$ 1,280
8	$ 4,571	$ 4,440	$ 1,406	$ 222	$ 4,070	$ 162	$ 3,151	$ (1,846)	$ 747	$ 2,052	$ 1,240
9	$ 4,571	$ 4,482	$ 1,406	$ 229	$ 4,108	$ 162	$ 3,148	$ (1,810)	$ 732	$ 2,070	$ 1,174
10	$ 4,609	$ 4,566	$ 1,406	$ 232	$ 4,185	$ 162	$ 3,191	$ (1,775)	$ 718	$ 2,134	$ 1,137
11	$ 4,609	$ 4,566	$ 1,406	$ 236	$ 4,185	$ 162	$ 3,186	$ (1,740)		$ 1,447	$ 724
12	$ 4,609	$ 4,566	$ 1,406	$ 239	$ 4,185	$ 162	$ 3,184	$ (1,706)		$ 1,478	$ 694
13	$ 4,609	$ 4,608	$ 1,406	$ 241	$ 4,223	$ 162	$ 3,185	$ (1,672)		$ 1,513	$ 667
14	$ 4,609	$ 4,650	$ 1,406	$ 243	$ 4,262	$ 162	$ 3,186	$ (1,639)		$ 1,547	$ 641
15	$ 4,647	$ 4,691	$ 1,406	$ 246	$ 4,300	$ 162	$ 3,226	$ (1,607)		$ 1,619	$ 629
16	$ 4,686	$ 4,733	$ 1,406	$ 248	$ 4,338	$ 162	$ 3,266	$ -		$ 3,266	$ 1,192
17	$ 4,686	$ 4,775	$ 1,406	$ 250	$ 4,377	$ 162	$ 3,267	$ -		$ 3,267	$ 1,120
18	$ 4,686	$ 4,775	$ 1,406	$ 252	$ 4,377	$ 162	$ 3,264	$ -		$ 3,264	$ 1,051
19	$ 4,724	$ 4,817	$ 1,406	$ 252	$ 4,415	$ 162	$ 3,306	$ -		$ 3,306	$ 999
20	$ 4,724	$ 4,817	$ 1,406	$ 252	$ 4,415	$ 162	$ 3,306	$ -		$ 3,306	$ 938
21	$ 4,724	$ 4,817	$ 1,406	$ 255	$ 4,415	$ 162	$ 3,304	$ -		$ 3,304	$ 880
22	$ 4,724	$ 4,817	$ 1,406	$ 257	$ 4,415	$ 162	$ 3,302	$ -		$ 3,302	$ 826
23	$ 4,724	$ 4,817	$ 1,406	$ 257	$ 4,415	$ 162	$ 3,302	$ -		$ 3,302	$ 776
24	$ 4,763	$ 4,859	$ 1,406	$ 259	$ 4,454	$ 162	$ 3,341	$ -		$ 3,341	$ 737
25	$ 4,763	$ 4,859	$ 1,406	$ 259	$ 4,454	$ 162	$ 3,341	$ -		$ 3,341	$ 692
26	$ 4,801	$ 4,901	$ 1,406	$ 259	$ 4,492	$ 162	$ 3,383	$ -		$ 3,383	$ 658
27	$ 4,839	$ 4,901	$ 1,406	$ 259	$ 4,492	$ 162	$ 3,422	$ -		$ 3,422	$ 625
28	$ 4,839	$ 4,901	$ 1,406	$ 257	$ 4,492	$ 162	$ 3,424	$ -		$ 3,424	$ 587
29	$ 4,878	$ 4,901	$ 1,406	$ 257	$ 4,492	$ 162	$ 3,462	$ -		$ 3,462	$ 557
30	$ 4,916	$ 4,901	$ 1,406	$ 257	$ 4,492	$ 162	$ 3,501	$ -		$ 3,501	$ 529
										30-Year Net Present Value	**$ 30,384**

Notes:
1. All prices are presented in real terms (inflation-adjusted). This includes the bond repayment and incentive cash flows
2. Fossil fuel prices are escalated according to energy price indices presented in the 2019 Annual Supplement to Nist Handbook 135 - Table Ca-1
3. Wood chip prices and O&M costs are not escalated beyond general inflation rate.

Incentive Assumptions
1. The Tier III credit is assumed as being provided by GMP over a 10 year period with an annual payment of $875,000
2. Benefit from bonus depreciation is realized in Year 2.
3. Grants totaling $500,000 are assumed to be recovered in year 1 following completion of the project.
4. The $1,000,000 grant received by BDCC is assumed to directly reduce the cost of the project as carried in the bond

Option 3 - 125 mmBtu/hr, 600 psig Wood Boiler / Electrically-Led CHP
30-Year Cash Flow Analysis ($1,000s)

Description	Value	Units
Total Project Costs	$26,396,391	$
Financing Costs	$1,847,747	$
Cash In Escrow	$3,300,000	$
Grant Funding Received Up Front	($1,000,000)	$
Project Costs Financed	$30,544,139	$
Bond Financing Rate	0.065	decimal
Bond Financing Term	15	yrs
Electric Demand/yr	37,723	MWh
Heat Demand (Boiler Output)/yr	317,311	mmBtu
Proposed Wood Use/yr	130,985	tons
Proposed Propane Use/yr	21,154	mmBtu
Proposed Electric Cost - Net of REC Value	392,917	$
Initial Wood Cost	$26.5	$/ton
Initial Natural Gas / Oil Blended Cost	$9.08	$/mmBtu
Initial Propane Cost	$10.95	$/mmBtu
Initial Electric Power Cost	$0.111	$/kWh
Tier III Credit Value/yr	$875,000	$/year
Added O&M Cost	$415,847	$/year
Assumed Inflation	2.0%	percent
Discount Rate	6.5%	percent

Year	Business-As-Usual		Proposed System				Net Operating Savings	Bond Payment Schedule	Incentives (see summary)	Cash Flow	Present Value of Cash Flow
	Boiler Fuel Cost	Electric Cost	Wood Cost	Propane Cost	Electric Cost, Net RECs	Added O&M Cost					
1	$ 3,841	$ 4,189	$ 3,471	$ 232	$ 393	$ 416	$ 3,518	$ (3,185)	$ 1,348	$ 1,681	$ 1,579
2	$ 3,879	$ 4,147	$ 3,471	$ 232	$ 389	$ 416	$ 3,519	$ (3,122)	$ 7,287	$ 7,683	$ 6,774
3	$ 3,956	$ 4,147	$ 3,471	$ 225	$ 389	$ 416	$ 3,602	$ (3,061)	$ 825	$ 1,366	$ 1,131
4	$ 4,110	$ 4,147	$ 3,471	$ 218	$ 389	$ 416	$ 3,763	$ (3,001)	$ 808	$ 1,570	$ 1,221
5	$ 4,263	$ 4,189	$ 3,471	$ 213	$ 393	$ 416	$ 3,959	$ (2,942)	$ 793	$ 1,809	$ 1,321
6	$ 4,455	$ 4,273	$ 3,471	$ 213	$ 401	$ 416	$ 4,227	$ (2,885)	$ 777	$ 2,119	$ 1,453
7	$ 4,532	$ 4,356	$ 3,471	$ 218	$ 409	$ 416	$ 4,375	$ (2,828)	$ 762	$ 2,309	$ 1,486
8	$ 4,571	$ 4,440	$ 3,471	$ 222	$ 416	$ 416	$ 4,485	$ (2,773)	$ 747	$ 2,459	$ 1,486
9	$ 4,571	$ 4,482	$ 3,471	$ 229	$ 420	$ 416	$ 4,516	$ (2,718)	$ 732	$ 2,530	$ 1,435
10	$ 4,609	$ 4,566	$ 3,471	$ 232	$ 428	$ 416	$ 4,628	$ (2,665)	$ 718	$ 2,681	$ 1,428
11	$ 4,609	$ 4,566	$ 3,471	$ 236	$ 428	$ 416	$ 4,623	$ (2,613)		$ 2,011	$ 1,006
12	$ 4,609	$ 4,566	$ 3,471	$ 239	$ 428	$ 416	$ 4,621	$ (2,561)		$ 2,060	$ 967
13	$ 4,609	$ 4,608	$ 3,471	$ 241	$ 432	$ 416	$ 4,657	$ (2,511)		$ 2,145	$ 946
14	$ 4,609	$ 4,650	$ 3,471	$ 243	$ 436	$ 416	$ 4,692	$ (2,462)		$ 2,230	$ 924
15	$ 4,647	$ 4,691	$ 3,471	$ 246	$ 440	$ 416	$ 4,766	$ (2,414)		$ 2,353	$ 915
16	$ 4,686	$ 4,733	$ 3,471	$ 248	$ 444	$ 416	$ 4,840	$ -		$ 4,840	$ 1,767
17	$ 4,686	$ 4,775	$ 3,471	$ 250	$ 448	$ 416	$ 4,876	$ -		$ 4,876	$ 1,672
18	$ 4,686	$ 4,775	$ 3,471	$ 252	$ 448	$ 416	$ 4,874	$ -		$ 4,874	$ 1,569
19	$ 4,724	$ 4,817	$ 3,471	$ 252	$ 452	$ 416	$ 4,950	$ -		$ 4,950	$ 1,496
20	$ 4,724	$ 4,817	$ 3,471	$ 252	$ 452	$ 416	$ 4,950	$ -		$ 4,950	$ 1,405
21	$ 4,724	$ 4,817	$ 3,471	$ 255	$ 452	$ 416	$ 4,948	$ -		$ 4,948	$ 1,318
22	$ 4,724	$ 4,817	$ 3,471	$ 257	$ 452	$ 416	$ 4,945	$ -		$ 4,945	$ 1,237
23	$ 4,724	$ 4,817	$ 3,471	$ 257	$ 452	$ 416	$ 4,945	$ -		$ 4,945	$ 1,162
24	$ 4,763	$ 4,859	$ 3,471	$ 259	$ 456	$ 416	$ 5,019	$ -		$ 5,019	$ 1,107
25	$ 4,763	$ 4,859	$ 3,471	$ 259	$ 456	$ 416	$ 5,019	$ -		$ 5,019	$ 1,040
26	$ 4,801	$ 4,901	$ 3,471	$ 259	$ 460	$ 416	$ 5,096	$ -		$ 5,096	$ 991
27	$ 4,839	$ 4,901	$ 3,471	$ 259	$ 460	$ 416	$ 5,134	$ -		$ 5,134	$ 938
28	$ 4,839	$ 4,901	$ 3,471	$ 257	$ 460	$ 416	$ 5,137	$ -		$ 5,137	$ 881
29	$ 4,878	$ 4,901	$ 3,471	$ 257	$ 460	$ 416	$ 5,175	$ -		$ 5,175	$ 833
30	$ 4,916	$ 4,901	$ 3,471	$ 257	$ 460	$ 416	$ 5,213	$ -		$ 5,213	$ 788
										30-Year Net Present Value	**$ 42,274**

Notes:

1. All prices are presented in real terms (inflation-adjusted). This includes the bond repayment and incentive cash flows
2. Fossil fuel prices are escalated according to energy price indices presented in the 2019 Annual Supplement to Nist Handbook 135 - Table Ca-1
3. Wood chip prices and O&M costs are not escalated beyond general inflation rate.

Incentive Assumptions

1. The Tier III credit is assumed as being provided by GMP over a 10 year period with an annual payment of $875,000
2. Benefit from the ITC and bonus depreciation is realized in Year 2.
3. Grants totaling $500,000 are assumed to be recovered in year 1 following completion of the project.
4. The $1,000,000 grant received by BDCC is assumed to directly reduce the cost of the project as carried in the bond

Option 1 - 52.5 mmBtu/hr, 300 psig Wood Boiler / Thermally-Led CHP
Sensitivity Analysis - Net Operating Savings

Sensitivity of Annual Operating Savings to Boiler Fuel Costs ($1,000's)

Wood Chip Price ($/ton) \ Fossil Fuel Price ($/mmBtu)	$6.00	$7.00	$8.00	$9.08	$10.00	$11.00	$12.00
$15.0	$1,461	$1,884	$2,307	$2,763	$3,153	$3,576	$3,999
$20.0	$1,223	$1,647	$2,070	$2,526	$2,916	$3,339	$3,762
$25.0	$986	$1,409	$1,832	$2,289	$2,679	$3,102	$3,525
$28.5	$820	$1,243	$1,666	$2,123	$2,513	$2,936	$3,359
$30.0	$749	$1,172	$1,595	$2,051	$2,441	$2,865	$3,288
$35.0	$512	$935	$1,358	$1,814	$2,204	$2,627	$3,050
$40.0	$275	$698	$1,121	$1,577	$1,967	$2,390	$2,813
$45.0	$38	$461	$884	$1,340	$1,730	$2,153	$2,576
$50.0	-$199	$224	$647	$1,103	$1,493	$1,916	$2,339

Option 2 - 57 mmBtu/hr, 600 psig Wood Boiler / Thermally-Led CHP
Sensitivity Analysis - Net Operating Savings

Sensitivity of Annual Operating Savings to Boiler Fuel Costs ($1,000's)

Wood Chip Price ($/ton)	Fossil Fuel Price ($/mmBtu) $6.00	$7.00	$8.00	$9.08	$10.00	$11.00	$12.00
$15.0	$1,755	$2,178	$2,601	$3,057	$3,447	$3,870	$4,293
$20.0	$1,508	$1,931	$2,354	$2,811	$3,201	$3,624	$4,047
$25.0	$1,262	$1,685	$2,108	$2,564	$2,954	$3,377	$3,800
$28.5	$1,089	$1,512	$1,935	$2,391	$2,781	$3,204	$3,628
$30.0	$1,015	$1,438	$1,861	$2,317	$2,707	$3,130	$3,554
$35.0	$768	$1,192	$1,615	$2,071	$2,461	$2,884	$3,307
$40.0	$522	$945	$1,368	$1,824	$2,214	$2,637	$3,060
$45.0	$275	$698	$1,121	$1,578	$1,968	$2,391	$2,814
$50.0	$29	$452	$875	$1,331	$1,721	$2,144	$2,567

Option 3 - 125 mmBtu/hr, 600 psig Wood Boiler / Electrically-Led CHP
Sensitivity Analysis - Net Operating Savings

Sensitivity of Annual Operating Savings to Boiler Fuel Costs ($1,000's)

Wood Chip Price ($/ton)	Fossil Fuel Price ($/mmBtu)						
	$6.00	$7.00	$8.00	$9.08	$10.00	$11.00	$12.00
$15.0	$3,722	$4,145	$4,568	$5,024	$5,414	$5,838	$6,261
$20.0	$3,067	$3,490	$3,913	$4,369	$4,760	$5,183	$5,606
$25.0	$2,412	$2,835	$3,258	$3,715	$4,105	$4,528	$4,951
$26.5	$2,216	$2,639	$3,062	$3,518	$3,908	$4,331	$4,754
$30.0	$1,757	$2,180	$2,604	$3,060	$3,450	$3,873	$4,296
$35.0	$1,102	$1,526	$1,949	$2,405	$2,795	$3,218	$3,641
$40.0	$448	$871	$1,294	$1,750	$2,140	$2,563	$2,986
$45.0	-$207	$216	$639	$1,095	$1,485	$1,908	$2,331
$50.0	-$862	-$439	-$16	$440	$830	$1,253	$1,676

Appendix D

Technical Memoranda

- Thermal and Electrical Load Summary – USFS Wood Energy Tech Assistance Team
- Air Emissions Evaluation for LFP, LLC – by GeoInsight, Inc.

F I N A L   M E M O R A N D U M

DATE: September 10, 2019

TO: Ben Rankin, LFP; Phil Farmer, LFP

FROM: Peter Oven, WES; Dan Wilson, WES

CC: Lew McCreery, USFS

RE: Thermal and Electrical Load Summary

This document identifies the current energy use, cost, and demands for the Long Falls Paperboard (LFP) facility, and then provides a projection of energy use, cost, and demand under a future operational scenario that is to be the basis for sizing of key equipment for wood energy system options.

Please see Sections 2 and 4 for the projected demands, energy use, and costs for the facility when operating at 150 tpd with 5% downtime in a year. The peak steam demand including contingencies for future loads is assessed at 52 mmBtu/hr, and the peak electric demand accounting for upcoming changes to the equipment onsite is assessed at 5.6 MW. Please note that these values are not constant, and are not the complete answer for consideration of utility plant sizing. There are multiple questions regarding future facility operating schedules, turn-down flexibility required due to operating schedules, efficiency projects, and equipment/process additions that influence selection of energy plant equipment. Also, please note that this future scenario is drastically different than current operations, which would merit a notably different sizing approach to any wood energy system. Currently the loads served vary most weeks from ~4 mmBtu/hr – 30-40 mmBtu/hr of steam demand and ~0.5 – 3.0-4.0 kW of electric demand.

1.0 CURRENT FACILITY STEAM DEMAND, USE, AND COST

Table 1 shows the current energy use for the facility for the first 4 months of 2019 along with production. The steam energy per ton of production averages 12.0 mmBtu/ton for these months. From a boiler fuel input energy perspective, the approximate cost of steam is $12.45/mmBtu for these months. This unit cost for steam does not include other costs such as chemicals, manpower, parasitic electric, etc.

The steam is produced at approximately 225 psig saturated. The 2009 single-line steam drawing shows that the that 225 psig steam is distributed directly to Coater 2 with reduction right at Coater 2, and is fed to the thermocompressors. The remainder of steam demands are show to be met from 100 psig steam. There are three points shown where main header 225 psig steam is reduced to 100 psig, and these are the "Main Pressure Control Valve (PCV)", the existing turbine, and a PCV upstream of Coater 1, space and water heating, and starch units. There is a later drawing that calls out the same 100 psig steam line as a 45 psig steam line, and plant staff referred to a main 40 psi steam line. WERC will review the 2009 single-line steam drawing with facility staff to identify key use pressures, as this will potentially drive potential for backpressure turbine options for the central plant.

Table 1 - Summary of Boiler Fuel Use, Steam Production, and Mill Production

Month	Production, tons	# Days	Gas Use, mmBtu	Gas Cost, $M	Oil Use, mmBtu	Oil Cost, $M	Steam Output, mmBtu	Plant Efficiency
Jan	1,602	22	16,222	$155,374	8,639	$111,070	18,877	0.76
Feb	1,330	20	20,202	$175,172	2,699	$34,702	16,971	0.74
Mar	1,591	21	23,101	$199,636	1,200	$15,428	18,007	0.74
Apr	1,233	21	19,932	$169,464	0	$0	15,269	0.77
Total	**5,756**	**84**	**79,457**	**$699,645**	**12,538**	**$161,200**	**69,124**	**0.75**

Notes: Production is obtained from a 2019 summary sheet. The daily production records provided do not exactly match with this summary sheet, and the values should be confirmed. The gas use is from bills and verified by the daily meter readings. The oil use is from the air emissions tracking sheet, and a cost of $1.80/gallon is assumed for its cost (please provide the correct cost). The steam output is from the steam meters for each boiler, and assumes a 1,006 Btu/lb rise as the steam meters are before the takeoff to the DA tank, and DA temperature was shown as 227°F .

A detailed review of the steam metering, gas use, fuel oil use, and makeup water use records showed that steam output from the steam meters looks to be a reliable number. This is often not the case with steam meters, but it tracks very well with the daily gas use records when fuel oil is not used as well as the other data from the records. The efficiency value obtained by comparing energy input and steam output looks reasonable given the combustion analyzer readings. While onsite, the temperature reading on the economizer outlet was not accurate (1,100 °F), so performance was not verified.

The steam meters record the steam flow out of each boiler prior to it entering the main header, and the feed to the DA tank is after this. Thus, the enthalpy rise provided by the economizer and boilers is from that at the state of temperature of the feedwater from the DA tank to the outlet of the boilers at 225 psig saturated. The temperature listed in the DA tank was 227°F while WERC was onsite. The enthalpy rise is approximately 1,006 Btu/lb.

Figure 1 shows the hourly steam output for the period data was available (July 2018-July 2019). Figure 2 shows the hourly steam output on a load duration curve for the facility. This shows how many hours in the year the facility hit a specific load. Figure 3 shows the steam data vs. production for the month of April when production data was available and no fuel oil was listed as being used.

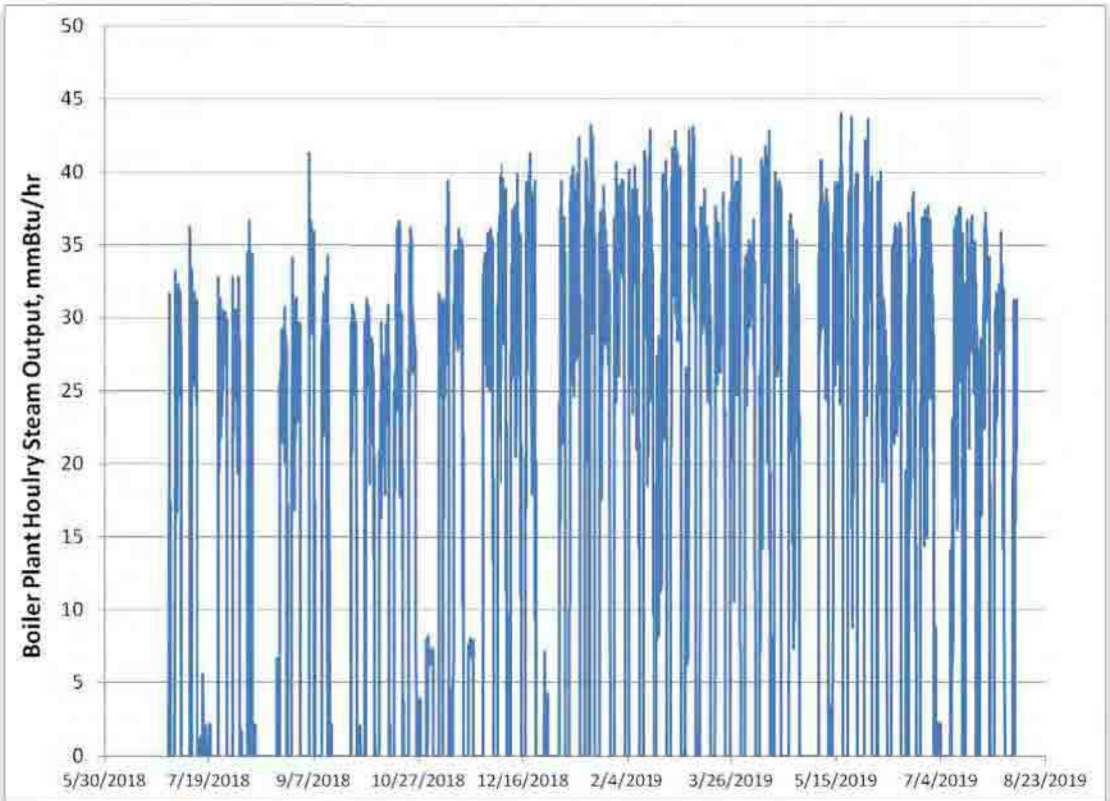

Figure 1 - Total Hourly Boiler Plant Steam Output

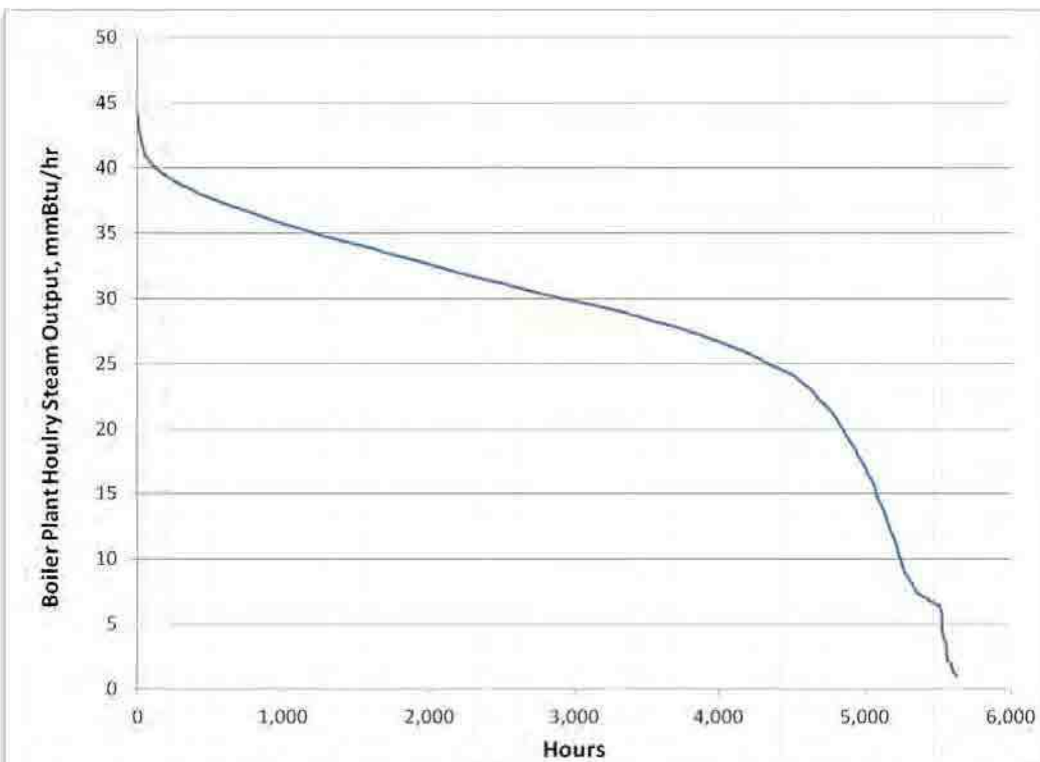

Figure 2 - Total Hourly Boiler Plant Steam Output Load Duration Curve July 18-July 19

Notes: This figure shows how many hours out of the total recorded data set a specific load was required by the plant.

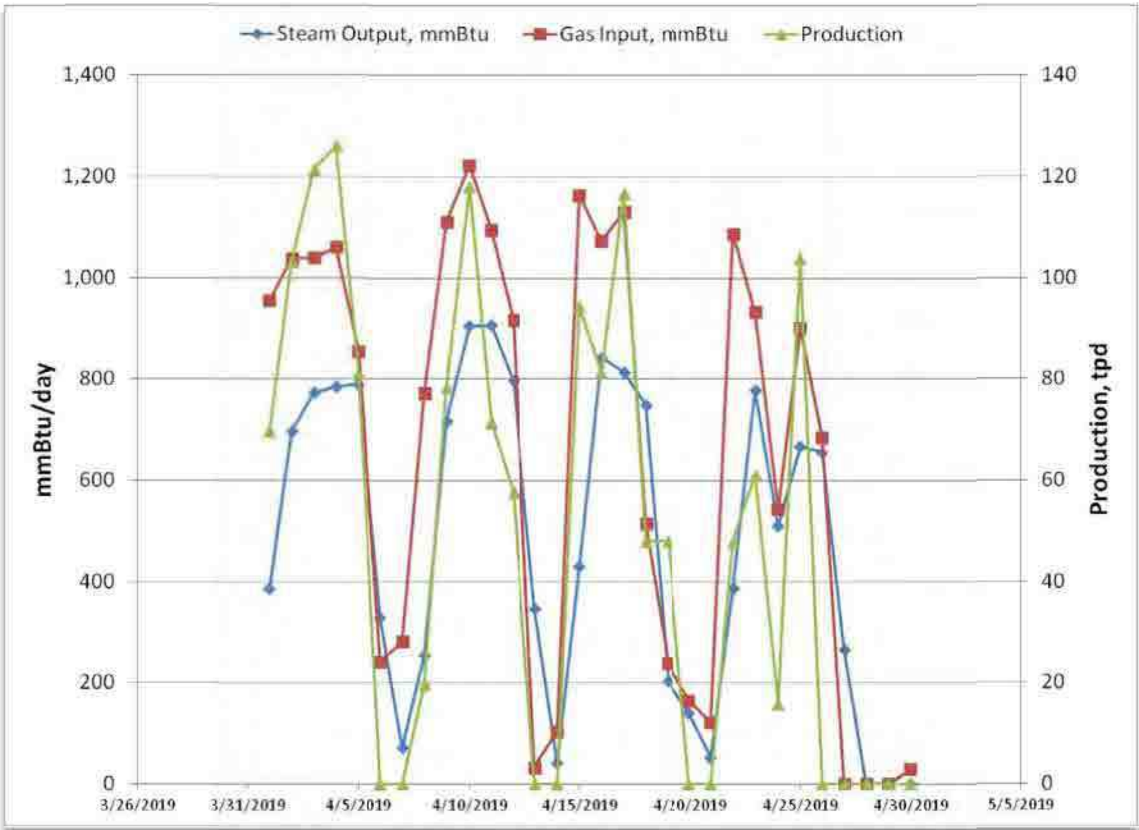

Figure 3 – April 2019 Daily Production, Gas Input, and Steam Output

There are a number of factors that play into the use of steam per ton of production for this facility, including production rate, grade, downtime, other processes using heat, overall efficiency, and the ambient weather conditions since space heating for the entire facility is from the boiler plant. Figure 4 shows a plot of the steam use per ton of production verses the daily production for the days which steam output and production were available. This included most days when there was production from July 2018 to April 2019. As would be expected, this shows that as production rate increases, the steam use per ton of production will drop significantly.

Several data points of interest were identified from Figure 4, and examined on an hourly basis vs. outdoor air temperature. Data from these days is presented in Figure 5 – Figure 7. Based on this data, it is estimated that the facility at its current state would be expected to require about 6.0 mmBtu of steam per ton of production with mild winter conditions. It is estimated that approximately 8 mmBtu/hr is required to be added to meet peak weather conditions (ASHRAE 99% Heating DB = 2.1°F).

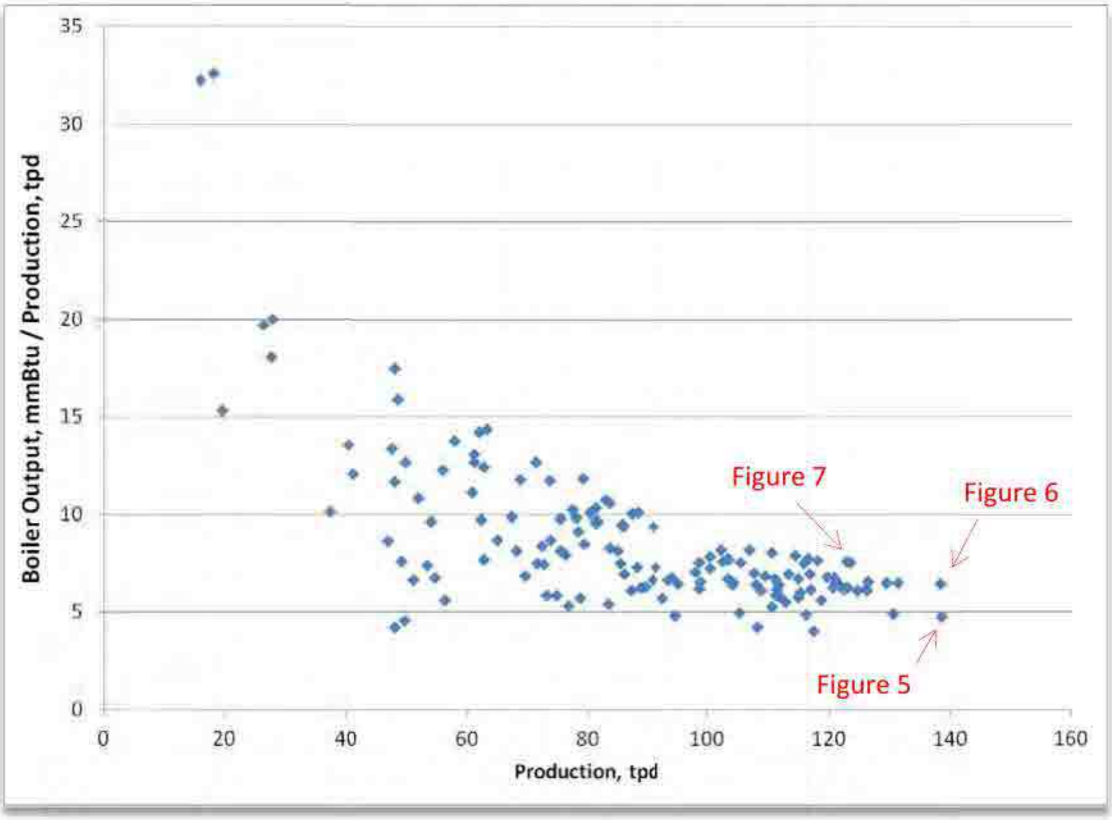

Figure 4 – Production Rate vs. Steam Demand/ton Production

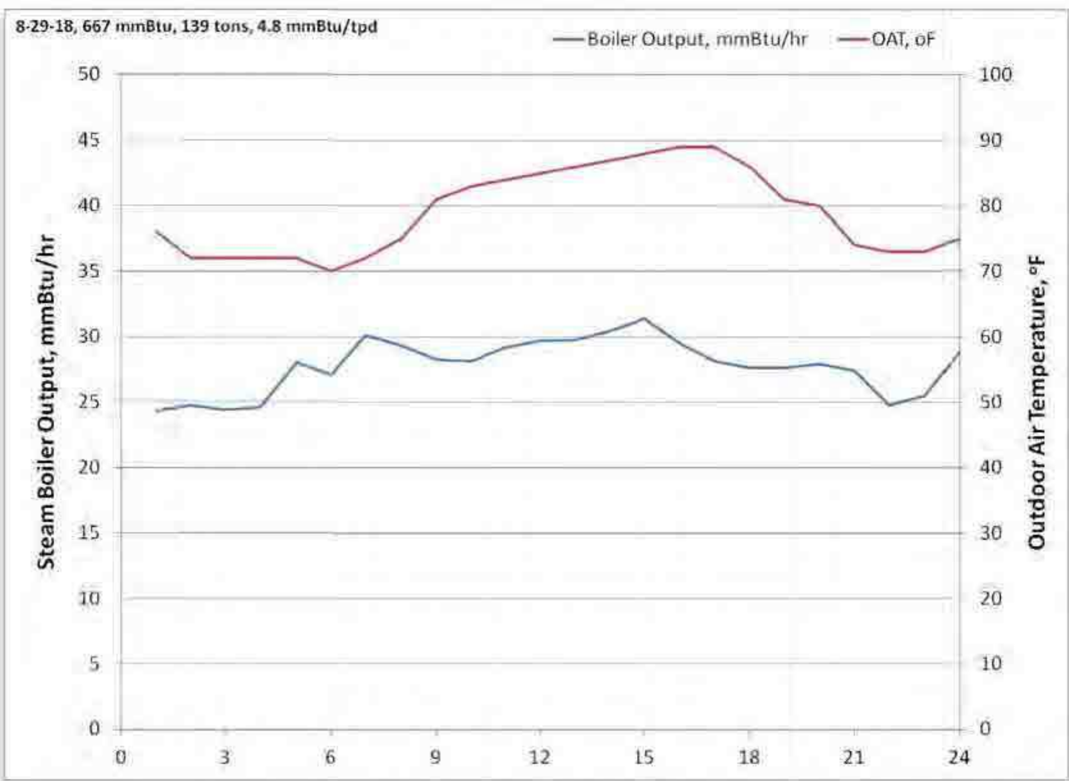

Figure 5 – 8-29-18 Hourly Steam Data vs. OAT – Highest Production Day

(daily values of 139 tons production and 667 mmBtu of heat demand)

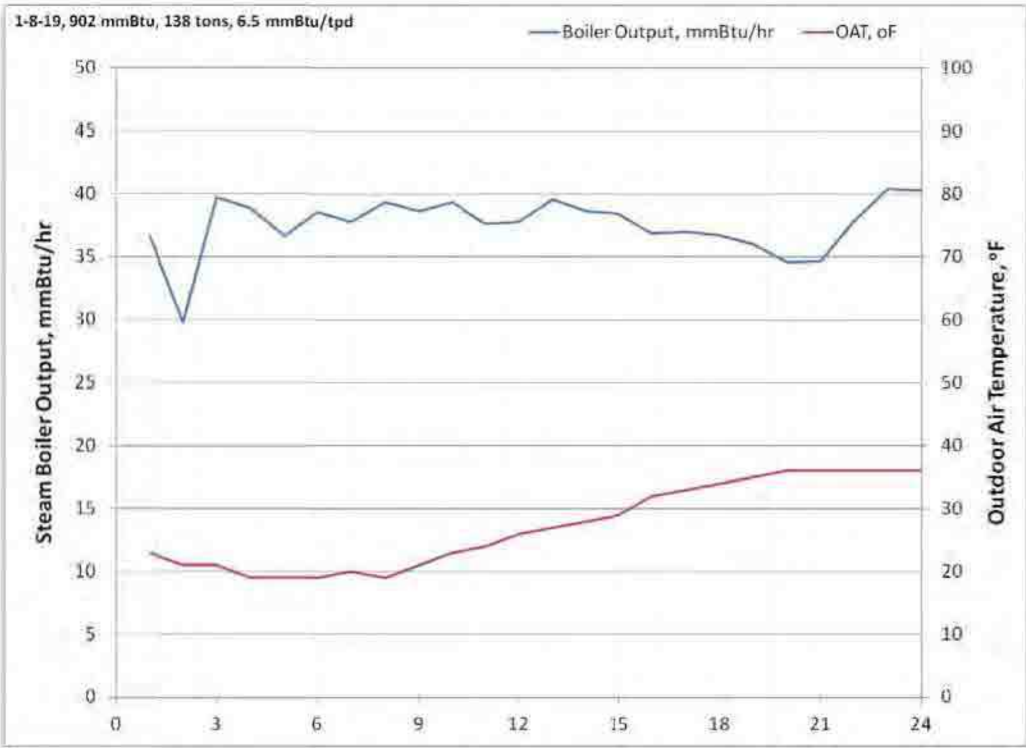

Figure 6 – 1-8-19 Hourly Steam Data vs. OAT – Near Highest Production Day
(daily values of 138 tons production and 902 mmBtu of heat demand)

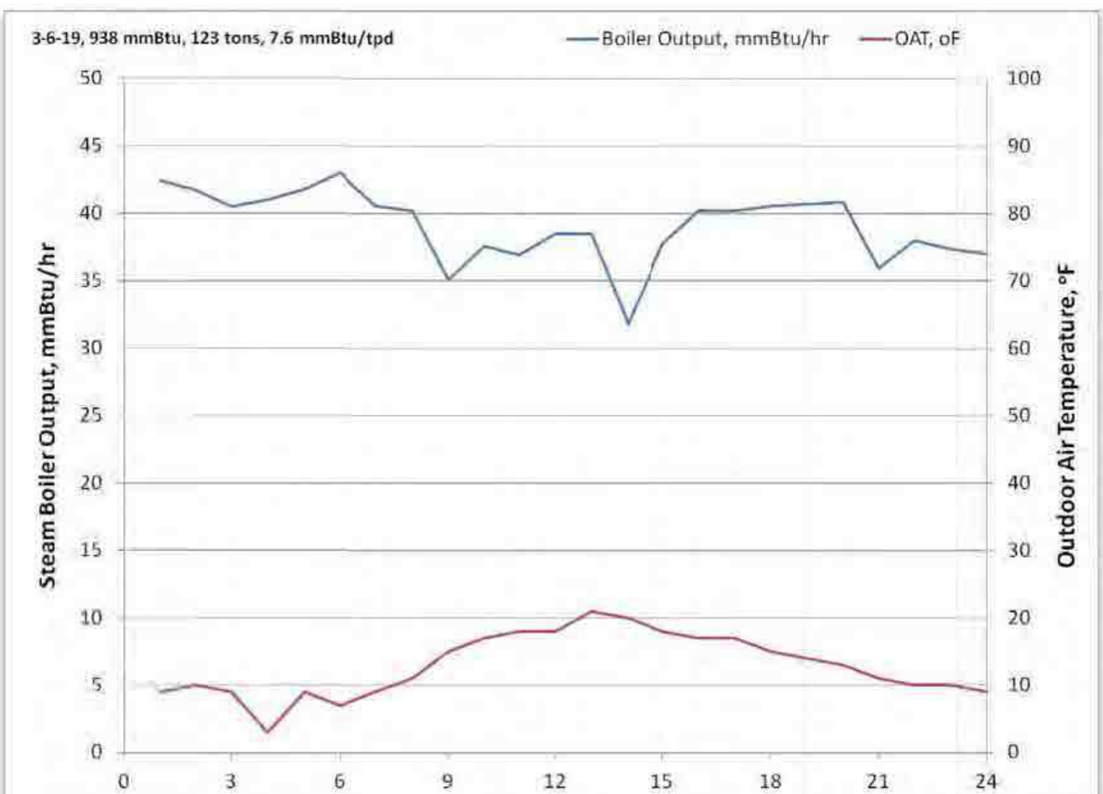

Figure 7 – 3-6-19 Hourly Steam Data vs. OAT – Coldest Day with Higher Production
(daily values of 123 tons production and 938 mmBtu of heat demand)

2.0 PROJECTED FACILITY STEAM DEMAND AND COST

The facility has a design capacity of 160 tons per day of production. Currently the facility is running on average around 65 tpd, and plans to reach closer to 100 tpd by early 2020. The goal will be to bring the facility closer to 150 tpd over time. Thus, the projection here uses historical data to project what the steam demand will be with a 150 tpd production rate, and the sizing of equipment will be required to cover this load. The following are other factors that could impact the demand for the facility:

- The facility may have opportunities for energy efficiency, which include items such as:
    - Insulation (being pursued for some sections of plant currently through Efficiency Vermont supported effort)
    - Steam leaks
    - Pre-heating of process water
    - Heat capture from air exhaust or effluent going to water treatment
- There has been discussion of additional equipment and processes that may increase steam demand as well.
- There was discussion of using the capacity of the plant to help supply low cost heat to neighboring facilities.

LFP identified the following items that will influence steam demand. The line shaft drive includes a 325 hp rated steam turbine with stamped conditions of 200 psig inlet and 45 psig outlet. This unit would need approximately 16,000 pph to provide that shaft power. The exact operating points are not directly known, but while onsite the steam flow meter for this drive showed a reading of approximately 10,000 pph. At maximum output this turbine would consume approximately 0.8 mmBtu/hr of heat, and demand on the boiler will be reduced by this amount once it is converted to electric. LFP also identified that there are a number of factors that are ongoing on the efficiency side that will reduce the steam demand. Conversely, there will be process adjustments to increase production that will increase the demand over time, and thus, having some excess steam capacity is desired.

Operating Range for Boiler System Design - Table 2 provides a summary of the values considered and checked when estimating the peak steam demand for design purposes. The demand across a 24-hr period on the higher production days, for which data is available, has ranged from 25-32 mmBtu/hr during a hot summer day with 139 tons of production in 2018 to 32-43 mmBtu/hr on a cold winter day in 2019 with 123 tons of production. Figure 2 shows that over the last year of recorded steam data, there have only been 125 hours at or above 40 mmBtu/hr in the plant. Based on this data and future projections of load at 150 tpd of production, it is estimated that the peak heat demand will be 46 mmBtu/hr without considering drops in demand due to efficiency. **To provide contingency and room for added demands, the wood energy system is recommended to be sized for a peak daily average load of approximately 52 mmBtu/hr (1248 mmBtu/day). This wood energy system would be able to cover a range of loads from ~20 mmBtu/hr to 52 mmBtu/hr.** Steam is to be provided at 225 psig, saturated.

The design peak daily steam demand is 33% higher than the highest demand day seen over July 2018 – July 2019, and 18% higher than the highest demand day seen (when only gas was used) based on daily gas use records from November 2014 – July 2019. Note that the peak absolute potential day from a space heating and makeup air perspective would likely not be seen in the daily gas use records.

Table 2 – Data Considered and Assumptions for Estimating Peak Daily Average Boiler Demand

Item	Value	Units
Historical Average Heat Use per Ton of Production (2015-April 2019)	10.3	mmBtu/ton
Historical Average Electric Use per Ton of Production (2018-April 2019)	1,174	kWh/ton
Existing boiler rated capacity from two gas boilers	60	mmBtu/hr
Estimated peak boiler output rate required at full production capacity (150 tpd)	**6.0**	**mmBtu/tpd**
Peak potential production in the future	150	tpd
Peak boiler output needed for peak production	900	mmBtu/day
Estimated peak heat demand due to weather on top of peak production needs	197	mmBtu/day
Peak estimated daily demand, current operations, 150 tpd, and ASHRAE 99% temp	**1,097**	**mmBtu/day**
Peak steam use per day from existing steam records (steam data 18-19)	939	mmBtu/day
Peak steam use per day from daily CNG records and 75% boiler eff (2014-2019) - no oil	1,021	mmBtu/day
Estimated peak daily average output (weather and production), current operations	***46***	***mmBtu/hr***
Minimum average demand as seen each weekend – this is not to be covered by a wood boiler, and LFP has identified that weekend shutdowns are not a normal operating condition	***2-6***	***mmBtu/hr***
Design peak load (1,248 mmBtu/day) which includes ~15% contingency	**52**	**mmBtu/hr**
Assumed minimum load that will need to be able to be met during operations	**20**	**mmBtu/hr**

Annual Energy Demand for Evaluating Economics of Various Plant Options - Figure 8 presents the daily load model based on the following: assuming that the process load with high production ranges from 5 mmBtu/tpd at 80°F OAT and 6 mmBtu/tpd at 50°F; a constant daily production rate of 150 tons per day; and adding heat load and increased makeup air heating for days when the average OAT is below 50°F based on a peak adder of 8 mmBtu/hr. The 8 mmBtu/hr is based on comparing days of similar production but different outdoor air temperatures from historical records, and typical space heating requirements. Table 3 presents the projected annual heat demand as displayed by Figure 8, and while assuming 5% downtime for the year or approximately ~2.5 weeks.

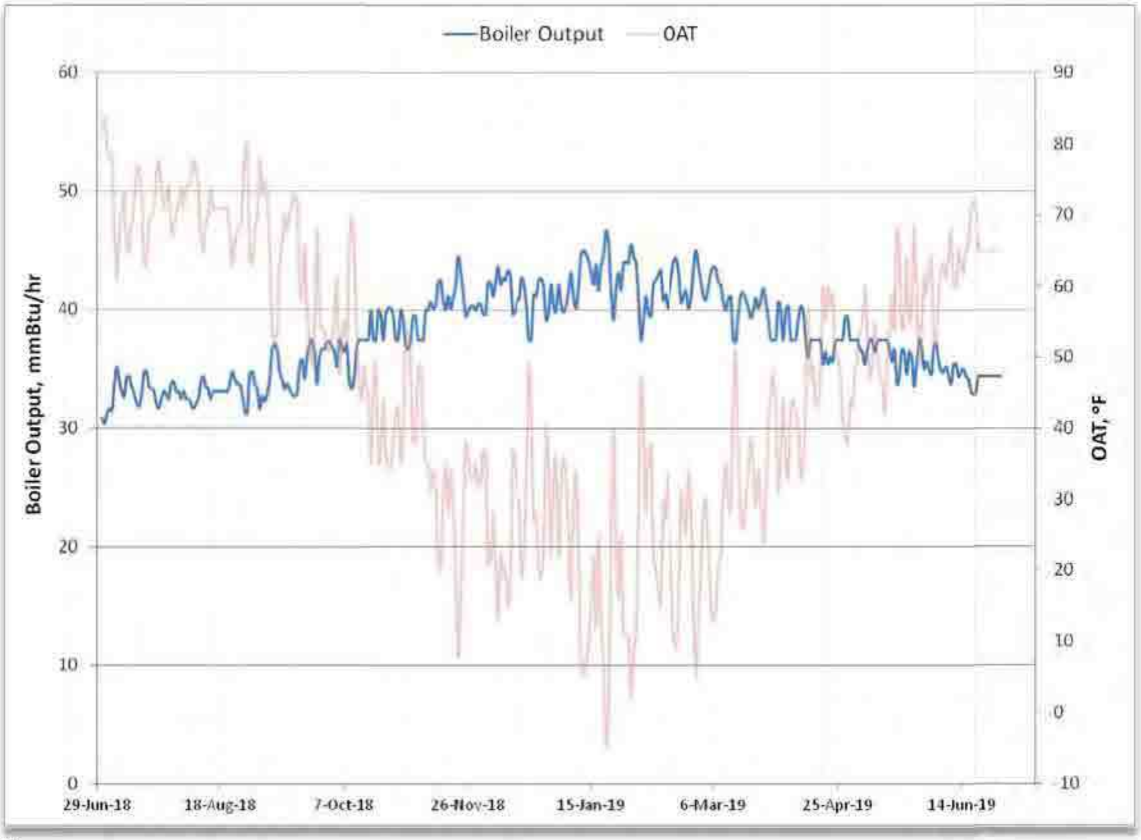

Figure 8 – Estimated Daily Average Boiler Output with 150 tpd Production and 2018-19 Weather
Note: OAT = outdoor air temperature

Table 3 – Estimated Annual Steam Demand, Fuel Use, and Cost for 150 tpd Production

Average Daily Production, tpd	Downtime	Annual Production	Heat Demand	Boiler Output/ton, mmBtu/ton	Gas/Oil Use, mmBtu	Cost of Fuel (95% gas/5% oil)
150	0.05	52,013	317,311	6.10	423,081	$3,744,662

Table 4 - Assumptions

Item	Value	Units	Notes
Condensate returned	0.55	decimal	boiler logs
Enthalpy of steam at 225 psig	1,201	Btu/lb	target pressure
Assumed makeup water temperature	40	°F	WERC Assumption
Assumed condensate return temperature	200	°F	WERC Assumption
Enthalpy of feedwater mix prior to DA	96	Btu/lb	WERC Assumption
Enthalpy of feedwater after DA	195	Btu/lb	227oF - site visit
Enthalpy change by boiler for metered steam flow	1,006	Btu/lb	Calc
HHV of #6 oil	0.1536	mmBtu/lb	WERC Assumption
Cost of oil	$1.80	$/gal	WERC Assumption
Average cost of gas	$8.70	$/mmBtu	LFP records
Existing boiler/economizer efficiency	0.75	decimal	LFP records

3.0 CURRENT FACILITY ELECTRIC DEMAND, USE, AND COST

Table 5 shows the historical electric use and cost for the facility based on the utility bills provided.

Table 5 – Historical Electric Usage and Cost

Month	kWh	Peak KW	Cost
Mar 2018	1,498,858	4,498	$188,860
Apr 2018	1,575,126	3,951	$185,577
May 2018	1,587,525	3,884	$186,634
Jun 2018	1,130,908	3,866	$151,821
Jul 2018	1,261,565	3,956	$163,064
Aug 2018	1,290,066	4,084	$168,002
Sep 2018	1,034,817	4,095	$147,738
Oct 2018	1,435,633	3,969	$177,243
Nov 2018	1,189,312	3,913	$156,725
Dec 2018	1,453,572	3,992	$180,602
Jan 2019	1,645,431	3,967	$144,890
Feb 2019	1,528,238	4,059	$137,949
Mar 2019	1,562,859	4,048	$141,812
Apr 2019	1,577,544	4,308	$143,618
May 2019	1,456,045	3,920	$132,992
Jun 2019	1,526,064	3,963	$136,983
Jul 2019	1,606,022	3,752	$143,511

Figure 9 shows the overall electric cost over time in terms of usage ($/kWh). The actual electric bills were based on both usage (kWh) and demand (peak kW). Note that the price from January 2019 to the present is the result of an incentive provided by Green Mountain Power (GMP).

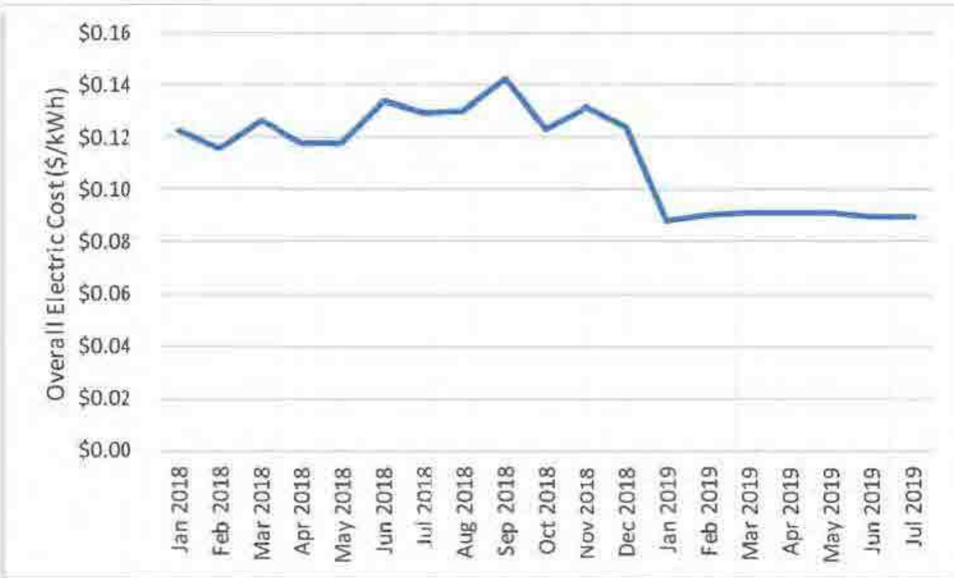

Figure 9 – Electric Cost Over Time

Figure 10 and Figure 11 show the daily average and daily peak kW demand respectively. Note that the days with no production have a very similar average and peak demand, just under 500 kW.

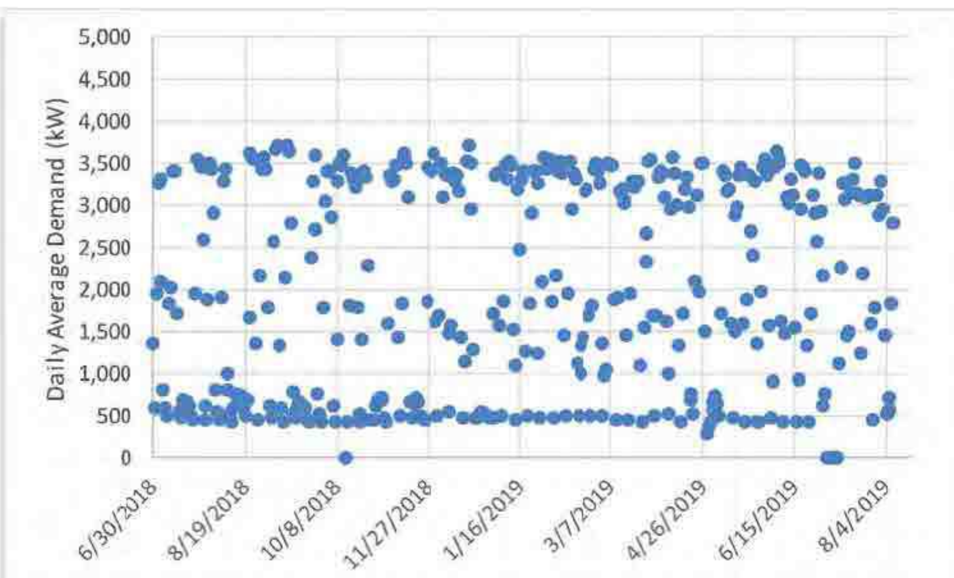

Figure 10 – Daily Average Electric Demand

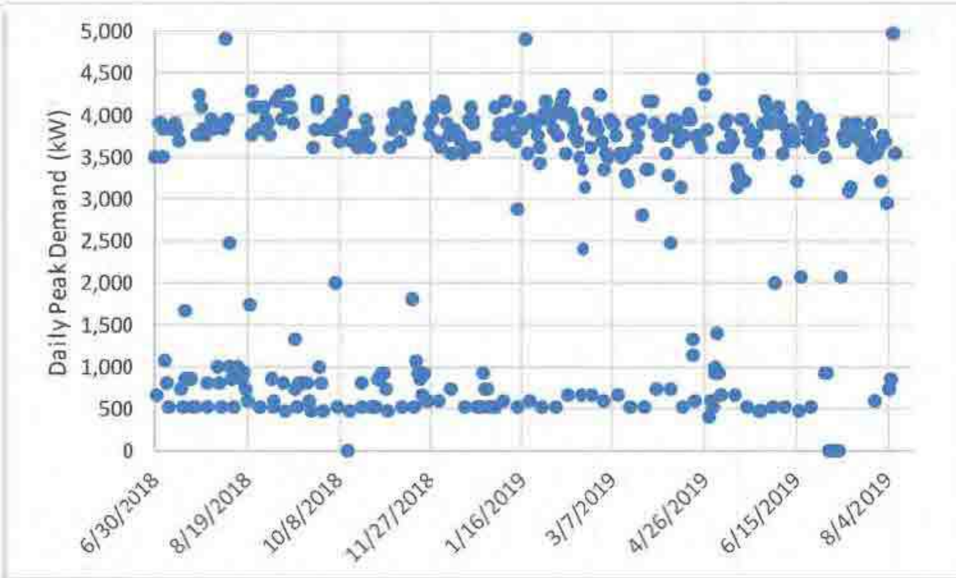

Figure 11 – Daily Peak Electric Demand

Figure 12, Figure 13, and Figure 14 show the electric usage and demand compared to daily board machine production. It appears that there were gaps in the daily production data, because of the days with large usage but no apparent production. These are the data points on the bottom edges of the figures.

On days with production, Figure 12 shows that maximum demand falls within the range of 3.5-4.3 MW. If the machine runs for the entire day, then the lowest demand that day may be as high as 3 MW, as shown for many days in Figure 14. The overall amount of production in a day does not appear to be correlated to the peak demand of the plant as shown by Figure 13.

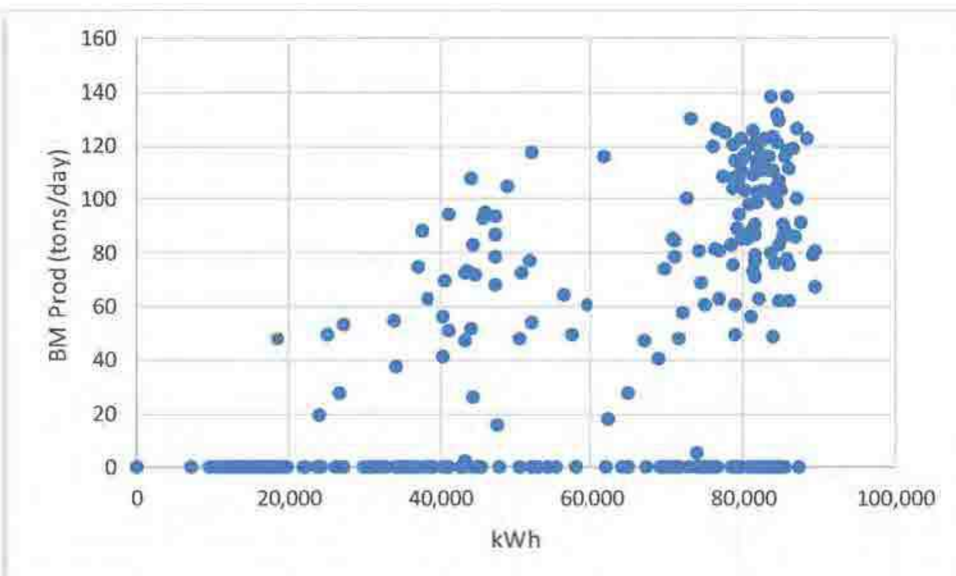

Figure 12 – Production versus Usage

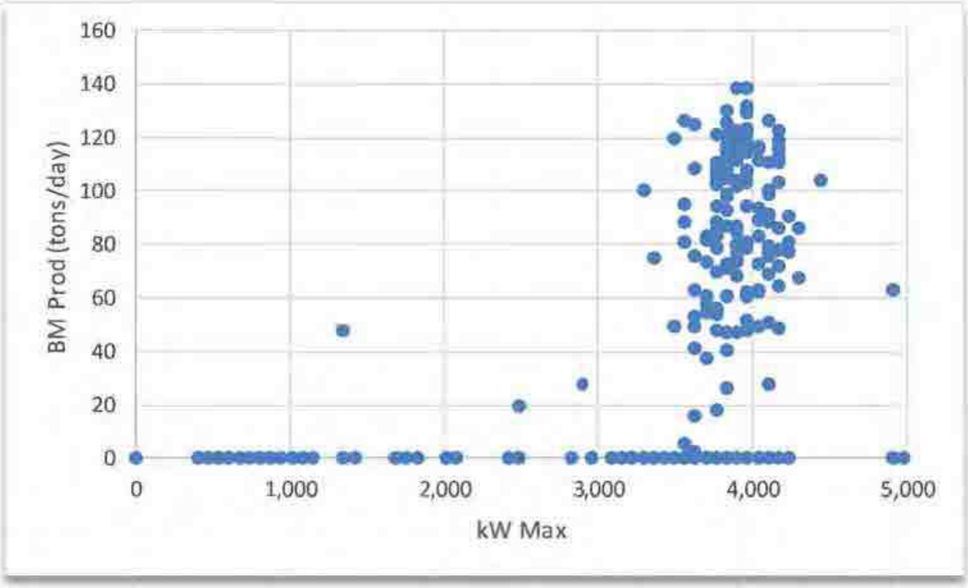

Figure 13 – Production versus Daily Maximum Demand

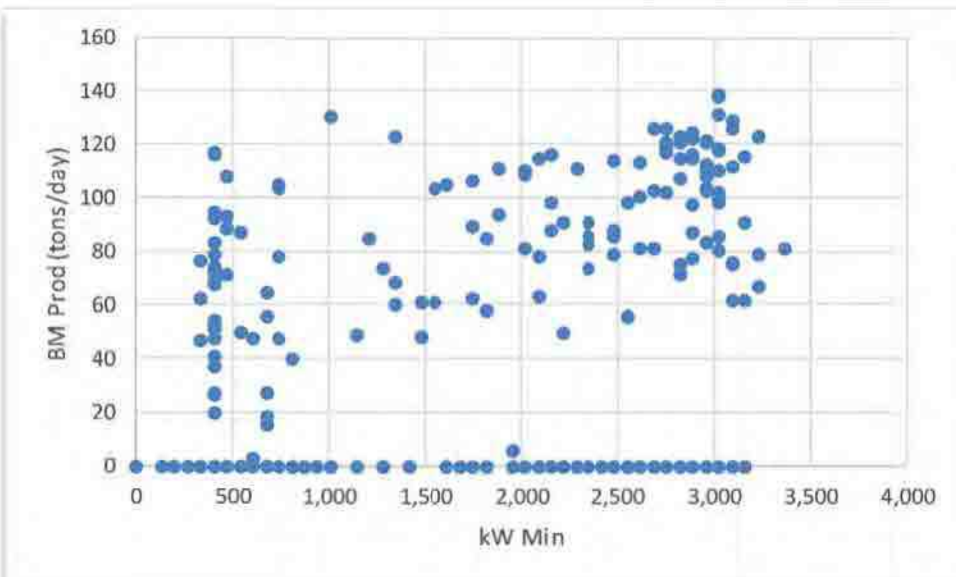

Figure 14 – Production versus Daily Minimum Demand

Figure 15, Figure 16, Figure 17, and Figure 18 show daily profiles of the electric demand for four different days with high production or high electric use. The sampling period in these figures is 1 minute.

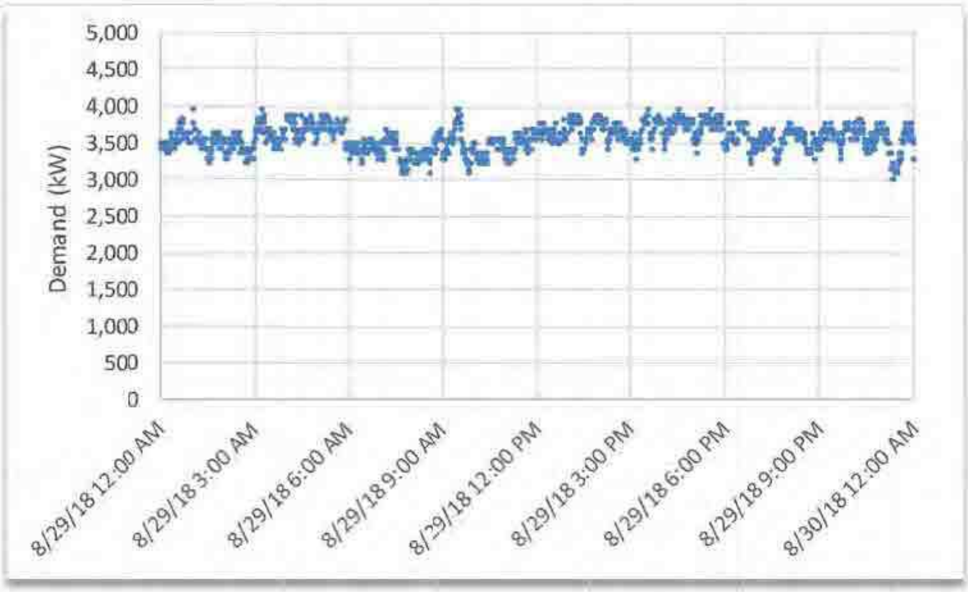

Figure 15 – 8-29-18 Electric Demand – Highest Production Day
(daily values of 139 tons production and 85,736 kWh electric usage)

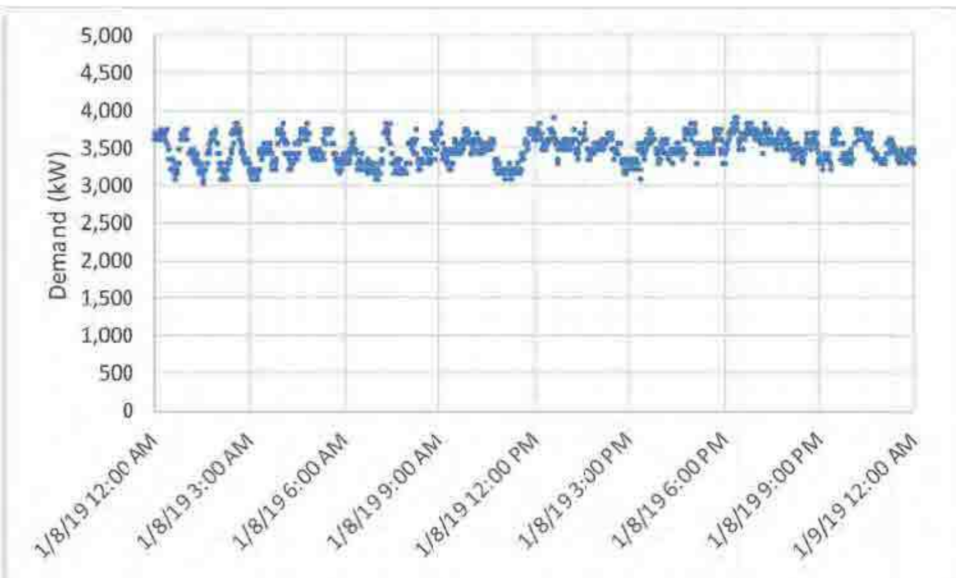

Figure 16 – 1-8-19 Electric Demand – Near Highest Production Day
(daily values of 138 tons production and 83,706 kWh electric usage)

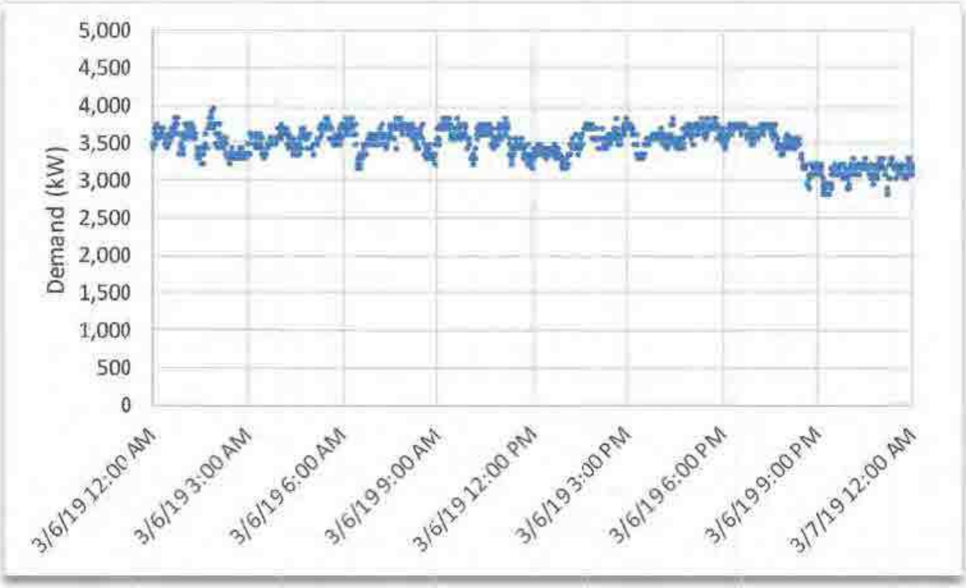

Figure 17 – 8-29-18 Electric Demand – Coldest Day with Higher Production
(daily values of 123 tons production and 83,907 kWh electric usage)

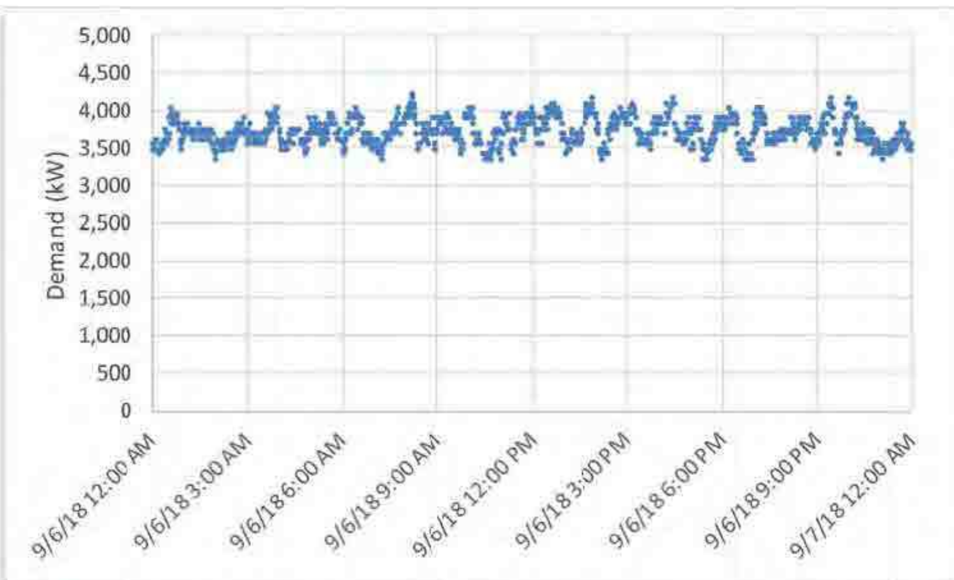

Figure 18 – 9-6-18 Electric Demand – Highest Electric Usage
(daily values of 81 tons production and 89,494 kWh electric usage)

4.0 PROJECTED FACILITY ELECTRIC DEMAND, USE, AND COST

Summary of Past Use/Demand Data for Comparison: The total kWh used in a day (Figure 12) is fairly consistent when production is in the range of 60 to 130 tons/day. This is likely due to the fact that on the lower tonnage days, closer to 60 tons/day, equipment continues to operate, but without feedstock, during production downtimes. The past use data suggests that electric demand (kW) is unlikely to change significantly as a result of increased production, and would only be significantly affected if additional processing equipment is installed or existing equipment is modified.

Figure 19 shows the load duration curve for the facility for 1 minute interval data from July 2018 – July 2019, and Figure 20 shows the daily electric consumption for this same period, all based on the current plant operations. Note that these operational profiles are very different from the projected operating scenario of 150 tons/day with only outages as the annual downtime.

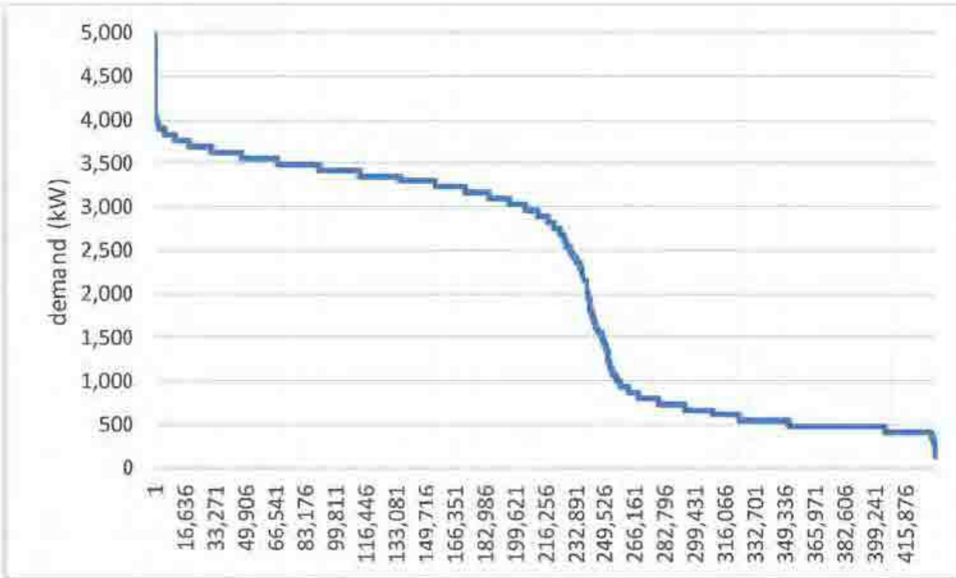

Figure 19 – Load Duration Curve of 1-min Electric Demand Data (July 18 – July 19)

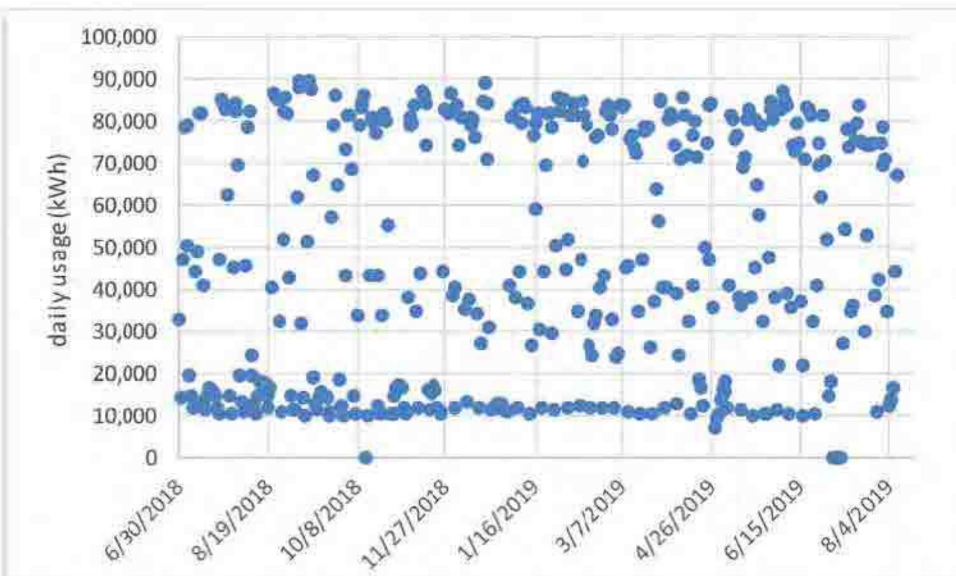

Figure 20 – Daily Electric Usage

As the plant comes up to higher production rates, use of electricity should become more efficient with respect to production levels, as shown in Figure 21. For Jan 2018 – Apr 2019, the specific usage was 1,174 kWh/ton.

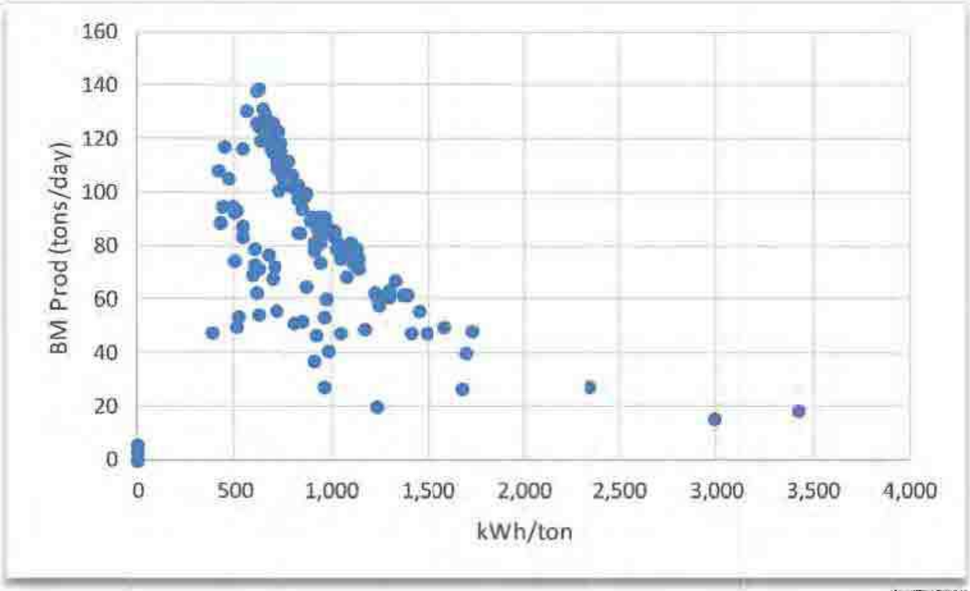

Figure 21 – Production versus Specific Usage

Projected Demand, Use, and Cost: For current operations, typical daily electric usage and demand at 150 tons/day are estimated to be ~90,000 kWh and 4.3 MW, while non-production days are assumed to carry an average of 15,000 kWh/day. Note that the peak demand overall is assumed to be 4.5 MW with the current facility configuration. Efficiency measures or new equipment will impact this peak value, and direction from LFP on changes in equipment are discussed along with the impacts to energy demands and use. The minute data measured at the facility showed several values above 4.5 MW, but these occurrences were very limited in number. The highest utility peak demand (on or off peak) recorded for billing was 4.5 MW in the data provided, which was for March 2018 – June 2019.

LFP plans to increase demand at the plant by 750 kW to 1,125 kW under normal running conditions through changes to equipment to improve operations and production. Some planned changes include the following items, and there are other potential future modifications that may be pursued. The steam turbine drive on the line shaft is being removed, and this would have a maximum increase of 244 kW compared to current operations depending on the steam flow and operating conditions. The refiner motors are also being upgraded, and this was identified as an increase of approximately 375 kW.

Based on the increased demand as identified by LFP, the electric use per day was identified as shifting up proportionally. For the purposes of estimating loads for economics, the typical electric use is being increased from 90,000 kWh/day (150 tpd) to 108,000 kWh/day by adding a constant 750 kW over what is currently used over a 24-hr period (see Figures 15 and 16 for current daily loads with production near 140 tpd). This is a daily average demand of 4.5 MW. The potential peak demand at the facility is being increased from 4.5 MW to 5.6 MW based on the potential addition of 1,125 kW as identified by LFP.

Based on estimated use for production and off days, and assuming 5% downtime and 150 tons/day otherwise, the annual electric use is estimated at 37,723 MWh. Using the rate schedule that goes into effect after 4/1/2020, the total annual cost is estimated at $3,300,000 with the current GMP 20% incentive. Without the current GMP incentive, the annual cost would be approximately $4,200,000. These costs are estimated using the rate schedule that is applied after 4/1/2020 (GMP Rate 63/65 transitioned from Legacy CVPS Rate 5).

For More Information or To Obtain Technical Assistance on Your Project Contact:

US Forest Service -WERC
Wood Energy Technical Assistance Team
180 Canfield St.
Morgantown, WV 26501

Lew R. McCreery, Woody Biomass Coordinator
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304-285-1538

WERC Woody Biomass Website:
http://na.fs.fed.us/werc/biomass/index.shtm

GeoInsight®
Environmental Strategy & Engineering

PROJECT MEMORANDUM
161 WELLINGTON ROAD
BRATTLEBORO, VERMONT

DATE: October 21, 2019

TO: Dan Wilson, Wilson Engineering Services

FROM: John A. Hinckley, QEP, Suzanne L. Pisano, PE, LEED AP, GeoInsight, Inc.

RE: Air Emissions Evaluation for Long Falls Paperboard, LLC

INTRODUCTION

At your request, GeoInsight, Inc. (GeoInsight) performed an evaluation of potential air emissions permitting requirements for a fuel conversion project at Long Falls Paperboard, which produces a variety of paperboard products at 161 Wellington Road in Brattleboro, Vermont (the "Facility"). The Facility is currently regulated by Title V Air Pollution Control Permit to Construct and Operate number AOP-14-032 (the "Title V Permit") and has submitted an application to the Vermont Air Quality & Climate Division (AQCD) to be re-permitted as a Minor Source by agreeing to burn natural gas or propane in lieu of No. 6 oil in its existing boilers for process and space heat.

GeoInsight was retained by Wilson Engineering Services (WES) to evaluate potential state and federal air pollution control requirements that would be triggered if the Facility installed a new biomass-fired boiler (biomass boiler) and burned between approximately 46,500 and 120,000 tons per year of biomass in addition to approximately 213,000 gallons per year of propane (the "Project").

ASSUMPTIONS

The evaluation was based upon the following assumptions:

1. the Facility will burn biomass in the form of natural wood chips with varying quantities of bark, and a heat content of approximately 4,750 British thermal units per pound (Btu/lb);

2. an Electrostatic precipitator (ESP) will be installed to control filterable particulate matter emissions from the biomass boiler down to a level of 0.03 pounds emitted per million British Thermal Units (lb/MMBtu) of wood chips burned;
3. the Facility will burn biomass as its primary fuel and propane as a back-up fuel; and
4. the Facility would like to burn wooden cores from its production process within the biomass boiler.

OPTIONS EVALUATED

The following options were evaluated:

- **Option 1**: burn 231,192 gallons/year of propane in the two existing boilers and 46,500 tons/year of biomass in one new boiler with a design heat input of 75 million British thermal units per hour (MMBtu/hr);

- **Option 2:** burn 231,192 gallons/year of propane in the two existing boilers and 50,000 tons/year of biomass in one new boiler with a design heat input of 85 million British thermal units per hour (MMBtu/hr); and

- **Option 3**: burn 231,192 gallons/year of propane in the two existing boilers and 130,000 tons/year of biomass in one new boiler with a design heat input of 175 million British thermal units per hour (MMBtu/hr).

METHODOLOGY

GeoInsight estimated emissions for three classes of air pollutants for the three options: Criteria Pollutants, Hazardous Air Pollutants (HAPs), and Hazardous Air Contaminants (HACs), which are regulated by the AQCD. The United States Environmental Protection Agency (USEPA) regulates Criteria Pollutants and HAPs,but does not regulate HACs. Emissions were estimated using the USEPA's AP-42: Compilation of Air Emissions Factors (AP-42 factors) and the National Council for Air and Steam Improvement (NCASI) emission factors. The latter have been used by the AQCD in estimating emissions from comparably sized biomass projects in Vermont. Annual emissions were estimated and compared with the Vermont and federal Major Source Thresholds to evaluate Minor Source/Major Source designation for the Facility for the three options.

GeoInsight also reviewed the Vermont Air Pollution Control Regulations and the federal New Source Performance Standards for boilers found in the Code of Federal Regulations (CFR) Title 40, Part 60, Subpart Db (40 CFR 60, Db and 40 CFR 60, Dc) and the federal solid waste fuel use regulations in 40 CFR Part 241 to identify potential air emissions monitoring, testing, and control requirements.

Lastly, GeoInsight participated in telephone conversations with the AQCD and USEPA to discuss potential requirements. Site specific details were not disclosed to USEPA, but were to the AQCD.

PRELIMINARY FINDINGS

GeoInsight's preliminary findings follow.

1. Burning wooden cores in the biomass boiler may be possible if the wooden cores can be classified as a "Non-Hazardous Secondary Material (NHSM)." Otherwise, burning wooden cores will trigger state and federal solid waste permitting requirements that could significantly increase the complexity and length of the air permitting process, result in more regulatory compliance requirements, potentially require more pollution control equipment, and potentially trigger public opposition to the Project.

2. Wooden cores can potentially be classified as a NHSM if they meet the following criterion:
    a. they are managed as a valuable commodity (must be stored for a reasonable amount of time, must be managed consistent with the primary fuel and in a manner where it will not be released into the environment);
    b. must have meaningful heating value and be used as a fuel to recover energy; and
    c. must have comparable contaminant levels to traditional fuels.

3. Biomass boilers with a heat input equal to or greater than 30 MMBtu/hr must install a Continuous Opacity Monitoring System (COMS) to measure the level of opacity of the biomass boiler's exhaust in its chimney (stack). Therefore, the biomass boiler for all three options would trigger a COMS. In addition to monitoring opacity, the COMS would have to electronically log opacity data. The opacity data will have to be evaluated by the Facility for completeness and accuracy, with corresponding opacity evaluation reports submitted to the AQCD and USEPA on a quarterly basis.

4. Biomass boilers with a heat input equal to or greater than 100 million Btu/hour must install a Continuous Emission Monitoring System (CEMS) for measuring the concentration nitrogen oxide (NOx) emissions in the biomass boiler exhaust in its stack. Therefore, Option 3 would trigger a CEMS. In addition to monitoring NOx emissions, the CEMS would have to electronically log NOx emissions data. The NOx emissions data will have to be evaluated by the Facility for completeness and accuracy, with corresponding NOx evaluation reports submitted to the AQCD and USEPA on a quarterly basis.

5. The estimated HAP emissions for the three options are below state and federal Major Source Thresholds; therefore, it appears unlikely that the Project would trigger Major Source permitting for HAPs.

6. For Option 3, the estimated emissions of hydrogen chloride (hydrochloric acid) exceed the federal Major Source HAP Threshold when estimating emissions with the AP-42 emission factor for hydrogen chloride, but do not exceed the federal Major Source HAP Threshold when estimating emissions with the NCASI emission factor for hydrogen

chloride. The AQCD allows estimating hydrogen chloride emissions with the latter emission factor.

7. Option 1 estimated Criteria Pollutant and HAP emissions do not exceed Major Source emission thresholds; therefore, Scenario 1 could be permitted as a Minor Source.

8. Option 2 estimated NOx emissions are approximately 8 percent above the Vermont NOx Major Source Threshold; therefore, the Facility would have to be permitted as a Vermont Major Source for NOx emissions. NOx emissions could be reduced below the Major Source Threshold by reducing the design heat input, the annual fuel use, or the not-to-exceed NOx emission rate by at least 8 percent.

9. Option 3 estimated NOx and carbon monoxide (CO) emissions exceed the Vermont and federal NOx and CO Major Source thresholds; therefore, the Facility would have to be permitted as a Vermont and federal Major Source for NOx and CO emissions.

10. Selective Non-Catalytic Reduction (SNCR) would likely be required by the AQCD and USEPA if estimated uncontrolled NOx emissions exceeded the federal NOx Major Source threshold (this would apply to Option 3).

11. Installing SNCR would reduce estimated NOx emissions for Option 3 below the federal Major Source threshold for NOx, but may not be capable of reducing NOx emissions below the Vermont Major Source Threshold.

12. The estimated CO emissions for Scenario 3 exceed the Federal Major Source Threshold by approximately 12 percent. CO emissions could be reduced below the Federal Major Source Threshold by reducing the design heat input, the annual fuel use, or the not-to-exceed NOx emission rate by at least 12 percent.

13. The estimated emissions of HACs for all three options will exceed Vermont Action Levels and trigger Vermont's Hazardous Most Stringent Emission Rate (HMSER) requirements that will likely include the use of an ESP and combustion efficiency testing on a monthly or quarterly basis. Combustion efficiency testing is a fairly straightforward test the Facility can perform with a portable analyzer.

14. The AQCD requires air emissions dispersion modeling (air modeling) on a case by case basis. The AQCD has an internal policy of requiring air modeling when emissions of a criteria pollutant exceeds 10 tons per year. The estimated emissions exceed 10 tons per year for at least two criteria pollutants for the three options; therefore, it is possible the AQCD could require air modeling. That said, the Facility's estimated emissions are lower overall given the Facility no longer burns No. 6 oil.

15. Air modeling is used to identify project design parameters such as the stack height, stack location, and degree of emission control needed by pollution control devices.

Even if air modeling is not required by the AQCD, it could still be used for informing the project design and to address concerns if there is public opposition to the project.

16. The timeframe for obtaining an air permit for either of the three options is somewhat difficult to predict. In the absence of public opposition, an air permit could be issued approximately 3 to 5 months after a Minor Source permit application has been submitted and 5 to 7 months after a Vermont or Federal Major Source permit application has been submitted.

SUMMARY

The timeframe for the AQCD to process an air permit application (barring public opposition) and the equipment requirements for the three options can be summarized as follows.

- Option 1: modify air permit and retain Minor Source status.
  - Timeframe: approximately 3 to 5 months.
  - Required equipment: ESP and COMS.

- Option 2: modify air permit and retain Minor Source status (possibly trigger Vermont Major Source status for NOx).
  - Timeframe: approximately 3 to 7 months depending on whether Facility is a Minor or Major Source.
  - Required equipment: ESP and COMs.

- Option 3: modify air permit and be reclassified as a Vermont and possibly federal Major Source due to exceeding the CO federal Major Source threshold, and NOx Vermont Major Source.
  - Timeframe: approximately 5 to 7 months.
  - Required equipment: ESP, COMS, CEMS, and SNCR (to reduce NOx below Federal Major Source threshold).

RECOMMENDATIONS

GeoInsight recommends the following.

1. Develop a laboratory sampling plan for the wooden cores with input from the AQCD and USEPA.

2. Perform laboratory sampling of the wooden cores to evaluate the higher heating value (HHV) and the levels of the following constituents: ash, moisture, heavy metals, chlorides, nitrogen, and sulfur. Sampling of additional constituents may be warranted based upon the input gathered from the AQCD and USEPA.

3. We recommend including in the Project design:

a. an ESP which is designed to reduce filterable particulate matter emissions to 0.03 (lb/MMBtu),
b. a COMS for the three options, and
c. a CEMS and SNCR for Option 3.

4. Request not-to-exceed criteria pollutant emission quotations from perspective biomass boiler and pollution control equipment vendors for particulate matter less than or equal to ten microns in diameter (PM_{10}), particulate matter less than or equal to two and one half microns in diameter ($PM_{2.5}$), CO, and NOx.

5. Consider performing air modeling to identify project design parameters that would enable the Facility to meet ambient air quality standards.

6. Schedule a pre-application meeting with the AQCD once the preferred option has been chosen to confirm state and federal permitting requirements.

TABLES

TABLE 1
SUMMARY OF BIOMASS BOILER EMISSION OPTIONS
LONG FALLS PAPERBOARD
BRATTLEBORO, VERMONT

Option 1

Pollutant	New Biomass Boiler	Propane Boilers	Total	VT Major Source Threshold	Major Source Title V Threshold	Below VT Major Source Threshold?	Below Major Source Title V Threshold?
NO_2	48.6	1.5	50.1	50	100	No	Yes
SO_2	5.5	0.002	5.5	50	100	Yes	Yes
CO	39.8	0.9	40.6	50	100	Yes	Yes
PM_{10}	8.2	0.08	8.3	50	100	Yes	Yes
$PM_{2.5}$	7.2	0.02	7.2	50	100	Yes	Yes
VOC	3.8	0.02	3.8	50	100	Yes	Yes
HAPs	2.1	0.09	2.2	25	25	Yes	Yes
CO_2e	44,042.3	1,476.5	45,518.8	NA	NA	NA	NA

Option 2

Pollutant	New Biomass Boiler	Propane Boilers	Total	VT Major Source Threshold	Major Source Title V Threshold	Below VT Major Source Threshold?	Below Major Source Title V Threshold?
NO_2	52.3	1.5	53.8	50	100	No	Yes
SO_2	5.9	0.002	5.9	50	100	Yes	Yes
CO	42.8	0.9	43.6	50	100	Yes	Yes
PM_{10}	8.8	0.08	8.9	50	100	Yes	Yes
$PM_{2.5}$	7.7	0.02	7.7	50	100	Yes	Yes
VOC	4.0	0.02	4.1	50	100	Yes	Yes
HAPs	2.3	0.09	2.4	25	25	Yes	Yes
CO_2e	47,357.3	1,476.5	48,833.8	NA	NA	NA	NA

Option 3

Pollutant	New Biomass Boiler	Propane Boilers	Total	VT Major Source Threshold	Major Source Title V Threshold	Below VT Major Source Threshold?	Below Major Source Title V Threshold?
NO_2	135.9	1.5	137.4	50	100	No	No
SO_2	15.4	0.002	15.4	50	100	Yes	Yes
CO	111.2	0.9	112.0	50	100	No	No
PM_{10}	22.8	0.08	22.9	50	100	Yes	Yes
$PM_{2.5}$	20.0	0.02	20.0	50	100	Yes	Yes
VOC	10.5	0.02	10.5	50	100	Yes	Yes
HAPs	6.0	0.09	6.0	25	25	Yes	Yes
CO_2e	123,128.9	1,476.5	124,605.4	NA	NA	NA	NA

TABLE 2
BIOMASS BOILER EMISSIONS - OPTION 1
LONG FALLS PAPERBOARD
BRATTLEBORO, VERMONT

DESIGN INPUTS AT 100% LOAD:

		Notes
4,750	Higher Heating Value (Btu/lb)	Provided by Wilson Engineering Services.
75	Heat input (MMBtu/hr)	Provided by Wilson Engineering Services.
7.9	Fuel consumption rate (tons/hr)	Calculated with the heat input and higher heating value.
80%	Thermal Efficiency (percent)	Assumed.
60	Heat Output Capacity (MMBtu/hr)	Calculated with the heat input and thermal efficiency.

EMISSION RATES & FACTORS:

	lb/hr	lb/ton	lb/MMBtu		
NO_2	16.5	2.1	0.220		
SO_2	1.9	0.2	0.025		
CO	13.5	1.7	0.180		
PM_{10}	2.8	0.4	0.037		
$PM_{2.5}$	2.4	0.3	0.032		
VOC	1.3	0.2	0.017		
HAPs	0.7	0.1	0.010		
CO_2	14,625.0	1,852.5	195.000	1	Global
CH_4	1.6	0.2	0.021	25	Warming
N_2O	1.0	0.1	0.013	298	Potentials
CO_2e	14,954.9	1,894.3	199.399		

ANNUAL EMISSION RATES & FUEL USE:

	Projected TPY (estimate)	*Potential TPY (unrestricted)*
NO_2	48.6	72.3
SO_2	5.5	8.2
CO	39.8	59.1
PM_{10}	8.2	12.2
$PM_{2.5}$	7.2	10.6
VOC	3.8	5.6
HAPs	2.1	3.2
CO_2	43,070.6	64,057.5
CH4	4.6	6.9
N_2O	2.9	4.3
CO_2e	44,042.3	65,502.6

Projected:		
100% load:	7.9 tph	46,500 tpy
Potential:		
100% load:	7.9 tph	69,158 tpy

Emission Factor Sources:

1. NO_2 and SO_2: AP-42 Tables 1.6-1 and 1.6-2.
2. CO_2, CH_4, N_2O and VOC: AP 42, Table 1.6-3.
3. CO: Vermont Hazardous Most Stringent Emission Rate (HMSER) limit.
4. PM_{10} and $PM_{2.5}$ emissions reflect the sum of filterable and condensable PM.
5. Filterable PM_{10} and $PM_{2.5}$: New Source Performance Standard (NSPS) for biomass boilers with heat input greater than 30 MMBtu/hr.
6. Condensable PM_{10} and $PM_{2.5}$: AP-42 Table-1.6-1.
7. Condensable emission factor of 0.017 lb/MMBtu was used to estimate condensable $PM_{2.5}$ and PM_{10}.
8. Filterable $PM_{2.5}$ emissions estimated by muliplying the filterable PM_{10} emission factor by 88%, which is the ratio of the filterable $PM_{2.5}$ divided by filterable PM_{10} emission factors for ESP's in AP-42 Table 1.6-1.
9. HAPs: AP-42 Tables 1.6-3 and 1.6-4.
10. Global warming potentials: Table A-1 in 40 CFR Part 98 Subpart A.

TABLE 3
BIOMASS BOILER EMISSIONS - OPTION 2
LONG FALLS PAPERBOARD
BRATTLEBORO, VERMONT

DESIGN INPUTS AT 100% LOAD:

		Notes
4,750	Higher Heating Value (Btu/lb)	Provided by Wilson Engineering Services.
85	Heat input (MMBtu/hr)	Provided by Wilson Engineering Services.
8.9	Fuel consumption rate (tons/hr)	Calculated with the heat input and higher heating value.
80%	Thermal Efficiency (percent)	Assumed.
68	Heat Output Capacity (MMBtu/hr)	Calculated with the heat input and thermal efficiency.

EMISSION RATES & FACTORS:

	lb/hr	lb/ton	lb/MMBtu	Global Warming Potentials
NO_2	18.7	2.1	0.220	
SO_2	2.1	0.2	0.025	
CO	15.3	1.7	0.180	
PM_{10}	3.1	0.4	0.037	
$PM_{2.5}$	2.8	0.3	0.032	
VOC	1.4	0.2	0.017	
HAPs	0.8	0.1	0.010	
CO_2	16,575.0	1,852.5	195.000	1
CH_4	1.8	0.2	0.021	25
N_2O	1.1	0.1	0.013	298
CO_2e	16,948.9	1,894.3	199.399	

ANNUAL EMISSION RATES & FUEL USE:

	Projected TPY (estimate)	*Potential TPY (unrestricted)*
NO_2	52.3	81.9
SO_2	5.9	9.3
CO	42.8	67.0
PM_{10}	8.8	13.8
$PM_{2.5}$	7.7	12.1
VOC	4.0	6.3
HAPs	2.3	3.6
CO_2	46,312.5	72,598.5
CH4	5.0	7.8
N_2O	3.1	4.8
CO_2e	47,357.3	74,236.2

Projected: 100% load:	8.9 tph	50,000 tpy
Potential: 100% load:	8.9 tph	78,379 tpy

Emission Factor Sources:

1. $NO_{2\ and}$ SO_2: AP-42 Tables 1.6-1 and 1.6-2.
2. CO_2, CH_4, N_2O and VOC: AP 42, Table 1.6-3.
3. CO: Vermont Hazardous Most Stringent Emission Rate (HMSER) limit.
4. PM_{10} and $PM_{2.5}$ emissions reflect the sum of filterable and condensable PM.
5. Filterable PM_{10} and $PM_{2.5}$: New Source Performance Standard (NSPS) for biomass boilers with heat input greater than 30 MMBtu/hr.
6. Condensable PM_{10} and $PM_{2.5}$: AP-42 Table-1.6-1.
7. Condensable emission factor of 0.017 lb/MMBtu was used to estimate condensable $PM_{2.5}$ and PM_{10}.
8. Filterable $PM_{2.5}$ emissions estimated by muliplying the filterable PM_{10} emission factor by 88%, which is the ratio of the filterable $PM_{2.5}$ divided by filterable PM_{10} emission factors for ESP's in AP-42 Table 1.6-1.
9. HAPs: AP-42 Tables 1.6-3 and 1.6-4.
10. Global warming potentials: Table A-1 in 40 CFR Part 98 Subpart A.

TABLE 4
BIOMASS BOILER EMISSIONS - OPTION 3
LONG FALLS PAPERBOARD
BRATTLEBORO, VERMONT

DESIGN INPUTS AT 100% LOAD:

		Notes
4,750	Higher Heating Value (Btu/lb)	Provided by Wilson Engineering Services.
175	Heat input (MMBtu/hr)	Provided by Wilson Engineering Services.
18.4	Fuel consumption rate (tons/hr)	Calculated with the heat input and higher heating value.
80%	Thermal Efficiency (percent)	Assumed.
140	Heat Output Capacity (MMBtu/hr)	Calculated with the heat input and thermal efficiency.

EMISSION RATES & FACTORS:

	lb/hr	**lb/ton**	**lb/MMBtu**		
NO_2	38.5	2.1	0.220		
SO_2	4.4	0.2	0.025		
CO	31.5	1.7	0.180		
PM_{10}	6.5	0.4	0.037		
$PM_{2.5}$	5.7	0.3	0.032		
VOC	3.0	0.2	0.017		
HAPs	1.7	0.1	0.010		
CO_2	34,125.0	1,852.5	195.000	1	Global
CH_4	3.7	0.2	0.021	25	Warming
N_2O	2.3	0.1	0.013	298	Potentials
CO_2e	34,894.8	1,894.3	199.399		

ANNUAL EMISSION RATES & FUEL USE:

	Projected TPY (estimate)	*Potential TPY (unrestricted)*
NO_2	135.9	168.6
SO_2	15.4	19.2
CO	111.2	138.0
PM_{10}	22.8	28.4
$PM_{2.5}$	20.0	24.8
VOC	10.5	13.0
HAPs	6.0	7.4
CO_2	120,412.5	149,467.5
CH4	13.0	16.1
N_2O	8.0	10.0
CO_2e	123,128.9	152,839.3

Projected:		
100% load:	18.4 tph	130,000 tpy
Potential:		
100% load:	18.4 tph	161,368 tpy

Emission Factor Sources:

1. $NO_{2\ and}$ SO_2: AP-42 Tables 1.6-1 and 1.6-2.
2. CO_2, CH_4, N_2O and VOC: AP 42, Table 1.6-3.
3. CO: Vermont Hazardous Most Stringent Emission Rate (HMSER) limit.
4. PM_{10} and $PM_{2.5}$ emissions reflect the sum of filterable and condensable PM.
5. Filterable PM_{10} and $PM_{2.5}$: New Source Performance Standard (NSPS) for biomass boilers with heat input greater than 30 MMBtu/hr.
6. Condensable PM_{10} and $PM_{2.5}$: AP-42 Table-1.6-1.
7. Condensable emission factor of 0.017 lb/MMBtu was used to estimate condensable $PM_{2.5}$ and PM_{10}.
8. Filterable $PM_{2.5}$ emissions estimated by muliplying the filterable PM_{10} emission factor by 88%, which is the ratio of the filterable $PM_{2.5}$ divided by filterable PM_{10} emission factors for ESP's in AP-42 Table 1.6-1.
9. HAPs: AP-42 Tables 1.6-3 and 1.6-4.
10. Global warming potentials: Table A-1 in 40 CFR Part 98 Subpart A.

TABLE 5
EMISSION CALCULATIONS - PROPANE BOILERS
LONG FALLS PAPERBOARD
BRATTLEBORO, VERMONT

Two Bigelow Boilers Burning Propane

DESIGN INPUTS AT 100% LOAD:

91,500	Fuel Higher Heating Value (Btu/gal)	Assumed.
830.6	Fuel Consumption Rate (gal/hr)	Calculated with the heat input and higher heating value.
76.00	Heat Input Capacity (MMBtu/hr)	Provided in current air permit.
0.18	Sulfur content (gr/100^ft3)	Assumed.

EMISSION RATES:

	lb/Kgal	lb/hr	lb/MMBtu		
NOx	13.0	10.80	0.142		
SO_2	0.02	0.01	0.0002		
CO	7.5	6.23	0.082		
PM10	0.7	0.58	0.008		
PM2.5	0.2	0.17	0.002		
VOC	0.8	0.66	0.009		
HAPs	0.2	0.14	0.002		
CO_2	12,500.00	10,382.51	136.61	1	Global
CH_4	0.2	0.17	0.002	25	Warming
N_2O	0.9	0.75	0.010	298	Potentials
CO_2e	12,773.20	10,609.43	139.60		

OPERATING SCHEDULE:

24	hrs/day
5	days/wk
52	wks/yr
8,760	hours/yr (based on fuel use at 100% load)
100%	capacity factor

ANNUAL ER & FUEL USE:

	Actual tpy (last yr's use)	*Potential tpy (unrestricted)*
NOx	1.50	47.29
SO_2	0.00	0.07
CO	0.87	27.29
PM10	0.08	2.55
PM2.5	0.02	0.73
HAPs	0.02	0.62
VOC	0.09	2.91
CO_2	1444.95	45475.41
CH4	0.02	0.73
N_2O	0.10	3.27
CO_2e	1476.53	46469.32

Projected:		
100% load:	830.6 gph	231,192 gpy
Potential):		
100% load:	830.6 gph	7,276,066 gpy

Emission Factor Sources:

1. NO_2, SO_2, CO, PM10, and PM2.5: AP 42 Table 1.5-1.
2. CO_2, CH_4, N_2O and VOC: AP 42, Table 1.5-1.
3. PM_{10} and $PM_{2.5}$ emissions reflect the sum of filterable and condensable PM.
4. Condensable PM_{10} and $PM_{2.5}$: AP-42 Table-1.6-1.
5. HAPs: AP-42 Tables 1.4-3 and 1.4-4. Emission factors for natural gas used to estimate HAPs emitted from propane due to lack of propane emission factors.
6. Global warming potentials: Table A-1 in 40 CFR Part 98 Subpart A.

TABLE 1
HISTORIC VERSUS PROJECTED EMISSIONS
LONG FALLS PAPERBOARD
BRATTLEBORO, VERMONT

Comparison Based Upon 2008 Btu's of No. 6 Oil Burned

Pollutant	Biomass	No. 6 Oil	Difference
NO_2	32.3	53.9	-21.6
SO_2	3.7	153.8	-150.2
CO	26.5	4.9	21.6
PM_{10}	5.4	12.2	-6.7
$PM_{2.5}$	4.8	6.6	-1.8
VOC	2.5	0.3	2.2
HAPs	1.4	0.4	1.0
CO_2e	29,308.0	24,663.3	4,644.7

Option 1

Pollutant	New Biomass Boiler	Propane Boilers	Biomass + Propane	2008 No. 6 Oil	Difference
NO_2	48.6	1.5	50.1	53.9	-3.8
SO_2	5.5	0.0	5.5	153.8	-148.3
CO	39.8	0.9	40.6	4.9	35.7
PM_{10}	8.2	0.1	8.3	12.2	-3.9
$PM_{2.5}$	7.2	0.0	7.2	6.6	0.6
VOC	3.8	0.0	3.8	0.3	3.5
HAPs	2.1	0.1	2.2	0.4	1.8
CO_2e	44,042.3	1,476.5	45,518.8	24,663.3	20,855.4

Option 2

Pollutant	New Biomass Boiler	Propane Boilers	Biomass + Propane	2008 No. 6 Oil	Difference
NO_2	52.3	1.5	53.8	53.9	-0.1
SO_2	5.9	0.002	5.9	153.8	-147.9
CO	42.8	0.9	43.6	4.9	38.7
PM_{10}	8.8	0.08	8.9	12.2	-3.3
$PM_{2.5}$	7.7	0.02	7.7	6.6	1.2
VOC	4.0	0.02	4.1	0.3	3.8
HAPs	2.3	0.09	2.4	0.4	1.9
CO_2e	47,357.3	1,476.5	48,833.8	24,663.3	24,170.5

Option 3

Pollutant	New Biomass Boiler	Propane Boilers	Biomass + Propane	2008 No. 6 Oil	Difference
NO_2	135.9	1.5	137.4	53.9	83.5
SO_2	15.4	0.002	15.4	153.8	-138.4
CO	111.2	0.9	112.0	4.9	107.1
PM_{10}	22.8	0.08	22.9	12.2	10.8
$PM_{2.5}$	20.0	0.02	20.0	6.6	13.5
VOC	10.5	0.02	10.5	0.3	10.2
HAPs	6.0	0.09	6.0	0.4	5.6
CO_2e	123,128.9	1,476.5	124,605.4	24,663.3	99,942.1

Appendix E

Estimate of Projected Electric Cost

- Analysis of Rate Schedule with Projected Electric Use Profile – Basis for Comparison
- Estimate of Utility Electric Costs with Option 3

Review of Projected Demand with Future Rate Schedule - Total Annual Use of 37,723 MWh with monthly peak of 5,600 kW

Item - Bill 8/1/2019 for Comparison	**Transitioned to Rate 63/65 from Legacy CVPS Rate 5 applies 4/1/20 and forward**			**Existing System - Projected Operations for 11 months/yr**			**Existing System - Projected for Month with Planned Outage**		
Rate: Industrial Energy and Demand Rate E63PF	**Value**	**Units**	**Notes**	**Metered**	**Cost**	**Notes**	**Metered**	**Cost**	**Notes**
Customer Charge 33 Days @ $11.852 $391.12	3.885	$/day	from rate schedule		$118.25			$118	
867,583 On Peak KWH @ $0.10767 $93,412.66	0.10784	$/kWh Peak	from rate schedule	1,564,286	$168,692.57	Avg 4500 kW demand at all times	756,071	$81,535	Assumes 4500 kW demand at all times
738,440 Off Peak KWH @ $0.08183 $60,426.55	0.08195	$/kWh Off Peak	from rate schedule	1,720,714	$141,012.54	Avg 4500 kW demand at all times	831,679	$68,156	Assumes 4500 kW demand at all times
3,752 On Peak KW @ $16.679 07/12/2019 13:30 $62,579.61	15.282	$/kW Peak	from rate schedule	5600	$85,579.20		5600	$85,579	
3,665 Off Peak KW @ $4.867 07/13/2019 07:45 $17,837.56	4.401	$/kW Off Peak	from rate schedule	5600	$24,645.60		5600	$24,646	
Power Factor Percentage 83.6%									
Power Factor Adjustment $4,791.38		((95%/PF)-1) * kW Peak Charge		83.6	$11,669.89	PF is assumed	83.6	$11,670	PF is assumed
Transformer Ownership Discount -$3,078.52	0.821	$/kW (Peak or Off Peak whichever is larger)	from rate schedule		($4,597.60)			($4,598)	
Sub Transmission Discount -$54,815.99	21.65%	% of all kWh and all kW charges	from rate schedule		($90,914.82)			($56,272)	
Total Energy Efficiency Charge $12,935.37	0.00522	$/kWh (Peak + Off Peak)	from rate schedule		$17,147.70			$8,288	
	1.2132	$/kW (Peak or Off Peak whichever is larger)	from rate schedule		$6,793.92			$6,794	
Total Power Adjustment $1,734.51		varies by quarter							
Electric Assistance Program Fee $55.50	55.5	$/month			$55.50			$56	
1-1919 GMP Light:LED 92W @ $16.53/light for mo. $16.53	16.53	$/month			$16.53			$17	
1-1921 GMP Light:LED 140W @ $28.68/light for mo. $28.68	28.68	$/month			$28.68			$29	
Late Payment Charge $2,232.14	not necessary								
Energy Efficiency Charge 85 x $0.01091 $0.93	0.93	$/month	EEC for street lighting		$0.93			$1	
VT State Tax $11,116.38	cancels								
VT State Manufacturing Tax Credit -$11,116.38	cancels								
VT State Tax $2.61	2.61	$/month	not sure what this is		$2.61			$3	
City Tax $1,852.73	cancels								
City Manufacturing Tax Credit -$1,852.73	cancels								
City Tax $0.43	0.43	$/month	not sure what this is		$0.43			$0	
Federal Tax Reform Credit -$10,996.73			did not carry			did not carry			
Federal Tax Reform Credit $2,811.08			did not carry			did not carry			
Federal Tax Reform Credit -$2.71			did not carry			did not carry			
Economic Development Incentive Credit -$46,851.27	20%	of bill			($72,050)			($45,204)	
New Charges/Adjustments				**Unit Rates - $/kW effective**					
due by 08/28/19 $143,511.44				**0.088**	**$288,202**	includes ED Incentive Credit		**$180,817**	includes ED Incentive Credit
				0.110	**$360,252**	excludes ED Incentive Credit		**$226,021**	excludes ED Incentive Credit

Discounted Blended Rate Projected Year 0.05 downtime, $/kWh			
11 months	$3,170,217	37,722,750 kWh/yr	
+ 1/2 ops month	$3,351,034		**$0.0888 $/kWh**
Blended Rate Projected Year 0.05 downtime, $/kWh			
11 months	$3,962,771	37,722,750 kWh/yr	
+ 1/2 ops month	$4,188,792		**$0.1110 $/kWh**

Review of Future Monthly Bill with Future Rate Schedule - Option 3 Operations - As Assumed in Report

Item - Bill 8/1/2019 for Comparison	**Transitioned to Rate 63/65 from Legacy CVPS Rate 5 applies 4/1/20 and forward**			**Standard Month - Elec Led CHP - 8 Months**			**Standard Month - Elec Led CHP - Miss Peak - 3 Months**			**Month with Downtime (Boiler/Partial Plant)**		
Rate: Industrial Energy and Demand Rate E63PF	**Value**	**Units**	**Notes**	**Metered**	**Cost**	**Notes**	**Metered**	**Cost**	**Notes**	**Metered**	**Cost**	**Notes**
Customer Charge 33 Days @ $11.852 $391.12	3.885	$/day	from rate schedule		$118.25			$118			$118	
867,583 On Peak KWH @ $0.10767 $93,412.66	0.10784	$/kWh Peak	from rate schedule	9,524	$1,027.05	use 20,000 kWh total	9,524	$1,027	use 20,000 kWh total	1,089,265	$117,466	use 2,287,457 kWh total
738,440 Off Peak KWH @ $0.08183 $60,426.55	0.08195	$/kWh Off Peak	from rate schedule	10,476	$858.52	use 20,000 kWh total	10,476	$859	use 20,000 kWh total	1,198,192	$98,192	use 2,287,457 kWh total
3,752 On Peak KW @ $16.679 07/12/2019 13:30 $62,579.61	15.282	$/kW Peak	from rate schedule	1000	$15,282.00	1 MW peak hit	5600	$85,579	5.6 MW peak hit	5600	$85,579	5.6 MW peak hit
3,665 Off Peak KW @ $4.867 07/13/2019 07:45 $17,837.56	4.401	$/kW Off Peak	from rate schedule	1000	$4,401.00	1 MW peak hit	5600	$24,646	5.6 MW peak hit	5600	$24,646	5.6 MW peak hit
Power Factor Percentage 83.6%												
Power Factor Adjustment $4,791.38		((95%/PF)-1) * kW Peak Charge		83.6	$2,083.91	PF is assumed	83.6	$11,670	PF is assumed	83.6	$11,670	PF is assumed
Transformer Ownership Discount -$3,078.52	0.821	$/kW (Peak or Off Peak whichever is larger)	from rate schedule		($821.00)			($4,598)			($4,598)	
Sub Transmission Discount -$54,815.99	21.65%	% of all kWh and all kW charges	from rate schedule		($4,669.60)			($24,272)			($70,554)	
Total Energy Efficiency Charge $12,935.37	0.00522	$/kWh (Peak + Off Peak)	from rate schedule		$104.40			$104			$11,941	
	1.2132	$/kW (Peak or Off Peak whichever is larger)	from rate schedule		$1,213.20			$6,794			$6,794	
Total Power Adjustment $1,734.51		varies by quarter										
Electric Assistance Program Fee $55.50	55.5	$/month			$55.50			$56			$56	
1-1919 GMP Light:LED 92W @ $16.53/light for mo. $16.53	16.53	$/month			$16.53			$17			$17	
1-1921 GMP Light:LED 140W @ $28.68/light for mo. $28.68	28.68	$/month			$28.68			$29			$29	
Late Payment Charge $2,232.14	not necessary											
Energy Efficiency Charge 85 x $0.01091 $0.93	0.93	$/month	EEC for street lighting		$0.93			$1			$1	
VT State Tax $11,116.38	cancels											
VT State Manufacturing Tax Credit -$11,116.38	cancels											
VT State Tax $2.61	2.61	$/month	not sure what this is		$2.61			$3			$3	
City Tax $1,852.73	cancels											
City Manufacturing Tax Credit -$1,852.73	cancels											
City Tax $0.43	0.43	$/month	not sure what this is		$0.43			$0			$0	
Federal Tax Reform Credit -$10,996.73			did not carry			did not carry						
Federal Tax Reform Credit $2,811.08			did not carry			did not carry						
Federal Tax Reform Credit -$2.71			did not carry			did not carry						
Economic Development Incentive Credit -$46,851.27	20%	of bill	**Not included for Option 3**		$0			$0				
New Charges/Adjustments				**Unit Rates - $/kW effective**								
due by 08/28/19 $143,511.44				**0.985**	**$19,702**			**$102,032**			**$281,359**	

Estimated Annual Electric Cost **$745,074**

Estimate of Incremental Changes in Capital Cost: Alternate 1 - Flue Gas Condensation

Equipment Procurement

Line Item			Cost
Flue gas condensation unit and shipping		$	500,000
Contractor mark-up	*10%*	$	50,000
Total Boiler Manufacturer Contract		**$**	**550,000**

General Contract

Line Item			Cost
Increased site work, buildings, paving, foundations, and utility connections		$	80,000
Increased mechanical installation (crane, rigging, setting, flue gas breeching, insulation, hydraulic systems, by-pass, etc.)		$	150,000
Increased electrical and controls		$	50,000
Sub-Total		$	280,000
Contractor profit, bond, overhead, and insurance	*20%*	*$*	*56,000*
Sub-Total		$	336,000
Contingency	*10%*	*$*	*34,000*
Total General Contract Building, Site, BOP		**$**	**370,000**

Total Project Cost

Line Item		Cost
Total Project Cost	**$**	**920,000**

Notes:
1 - This is intended to be incremental in cost to the main options as presented.

A **Report** from:

Innovative Natural Resource Solutions, LLC

FINAL September 10, 2015

For an Initial Wood Supply Analysis

For the **Windham Wood Heat Initiative**

Innovative Natural Resource Solutions, LLC

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Contents

Executive Summary

The Windham Wood Heat Initiative (WWHI) is designed to help at least 20 municipal and school buildings in the County convert facility heating to local, sustainable wood fuel using advanced wood heating systems over the next several years. It seeks to do this while addressing building energy efficiency and durability needs in the buildings where assistance is to be provided as well as assuring that the wood fuel supply which will feed these new users of wood fuel, is available and sustainable.

In this report, Innovative Natural Resource Solutions, LLC, one of the WWHI partners, presents an initial wood supply analysis that will serve to inform the WWHI team and the users of WWHI's services.

For the purposes of this wood supply analysis, we are concentrating on the 7-county area in Vermont, New Hampshire and Massachusetts depicted at right. This area contains over 2.2 million acres of timberland[1], over 80% of which is privately owned.

It is anticipated that the 20 schools and municipal buildings that may switch to wood fuel may use - on the high end – 8,000 new green tons of wood fuel per year.

Should the WWHI be successful in reaching its goal, our analysis indicates that there is ample additional supply of low grade wood resource available.

Our analysis, which excludes all public land and additional acreage due to regulatory and physical constraints, shows that between 252,000 green tons and 578,000 green tons are currently available in the Region.

A series of computer model runs suggest between 589,000 and 982,000 green tons will be available in the year 2035 – much larger volumes than today - because the forests of the seven-county region are growing much more wood than is being used each year.

[1] Timberland – forest capable of producing commercial timber crops on a continued basis.

I. Introduction

The Windham Wood Heat Initiative (WWHI) is designed to help at least 20 municipal and school buildings in the County convert to heating with local, sustainable wood fuel using advanced wood heating systems over the next several years. It seeks to do this while addressing building energy efficiency and durability needs in the buildings where assistance is to be provided as well as assuring that the wood fuel supply which will feed these new users of wood fuel, is available and sustainable.

Innovative Natural Resource Solutions, LLC, one of the WWHI partners, is an expert in wood supply analyses, having conducted over 100 such analyses throughout the continental United States and Alaska in the last 20 years. This report represents an initial wood supply analysis that will serve to inform the WWHI team and the users of WWHI's services.

Given the goals of the WWHI, it is important to develop a clear understanding of the available wood supply from the forests of the WWHI region. For the purposes of this wood supply analysis, we are concentrating on the 7-county area in Vermont, New Hampshire and Massachusetts depicted in Figure 1 below.

Figure 1. Windham Wood Heat Wood Supply Analysis Area

This study evaluates and draws its conclusions from four different data and information sources:

- Existing information previously generated on the topic;
- Current data and information from the USDA Forest Service Forest Inventory and Analysis (FIA);
- Possible future scenarios using the Biomass Project Evaluator tool; and
- A review of large low-grade wood users in the project wood supply area.

II. Review of existing work

The relevant recent work on the topic of timber resource availability for use in Windham County, Vermont includes the following three analyses:

a. Master's thesis (2012) entitled "The Forest Products Industry of Windham County, Vermont: Status, Challenges, and Opportunities[i]", Doug Morin

In this study, the author, a Master's candidate at the University of Vermont in Natural Resources at the time, reviewed the full spectrum of the forest resources and forest products industry in Windham County. The thesis looked at all uses of timber resources in the County, not just the use of low-grade woody material or wood fuel. Morin's 86-page study's purpose was stated in the document:

> "Through the synthesis of existing data and key-informant interviews, this study seeks to provide a foundation of information on the condition of Windham County's forests and forest industry, and to explore the important factors, challenges, and opportunities for the industry."

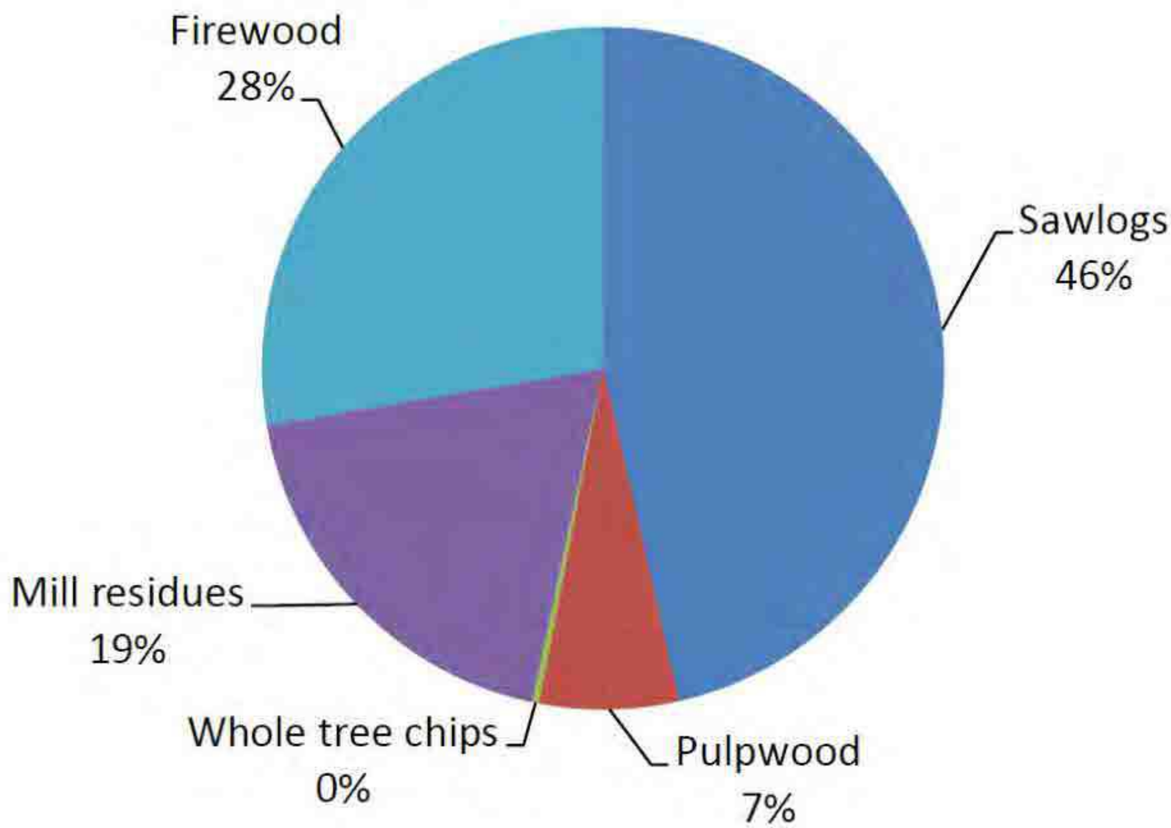
Morin used 2008 vintage data from the USDA Forest Inventory and Analysis (FIA) in his study. Our study (see Sections III & IV) uses the latest data set from FIA, providing the basis for more accurate and relevant conclusions.

Morin concluded that Windham County has the most volume of standing trees of any Vermont county at 1.6 billion cubic feet and grows over 20 million cubic feet per year (approximately 250,000 cords). The forests in Windham County are more productive than other Vermont counties because they are found at lower elevations characterized by richer soils.

Morin also used data on harvest levels in Windham County from the annual surveys conducted by the Vermont Department of Forests, Parks and Recreation. From these data, he concludes that harvest volume for all products in Windham County in the year 2008 was 108,000 cords or 43% of growth. As a result, he concludes that forests in the County are gaining in volume.

Of that 2008 harvest level, Morin shows the breakdown of products from data provided by the VT Dept. of Forests, Parks and Recreation (Figure 2). We should note that we do not believe the "Whole tree chips 0%" is accurate.

Figure 2 Windham County 2008 timber harvest by product



Source: VT Department of Forests, Parks & Recreation, graph by Doug Morin 2012

Morin completed his study with a review of the wood using manufacturing sectors in the County and the workforce that harvests the wood and transports it to the manufacturing markets. He concluded that within the County there were 33 loggers and firewood producers, 14 foresters, 1 log yard, 30 primary wood using mills, 43 secondary processors, 4 lumber yards, and 5 biomass heating facilities. The primary wood chip users in the County then included four schools: Brattleboro Union, Whitingham Elementary, Leland & Gray Union, and Westminster Center.

Morin concludes by saying that the County's forests, though covering over 90% of the land area, have been high graded[2] due to lack of low-grade wood markets. He believed that the "…best prospect for creating low-grade wood markets in Windham County may be biomass energy."

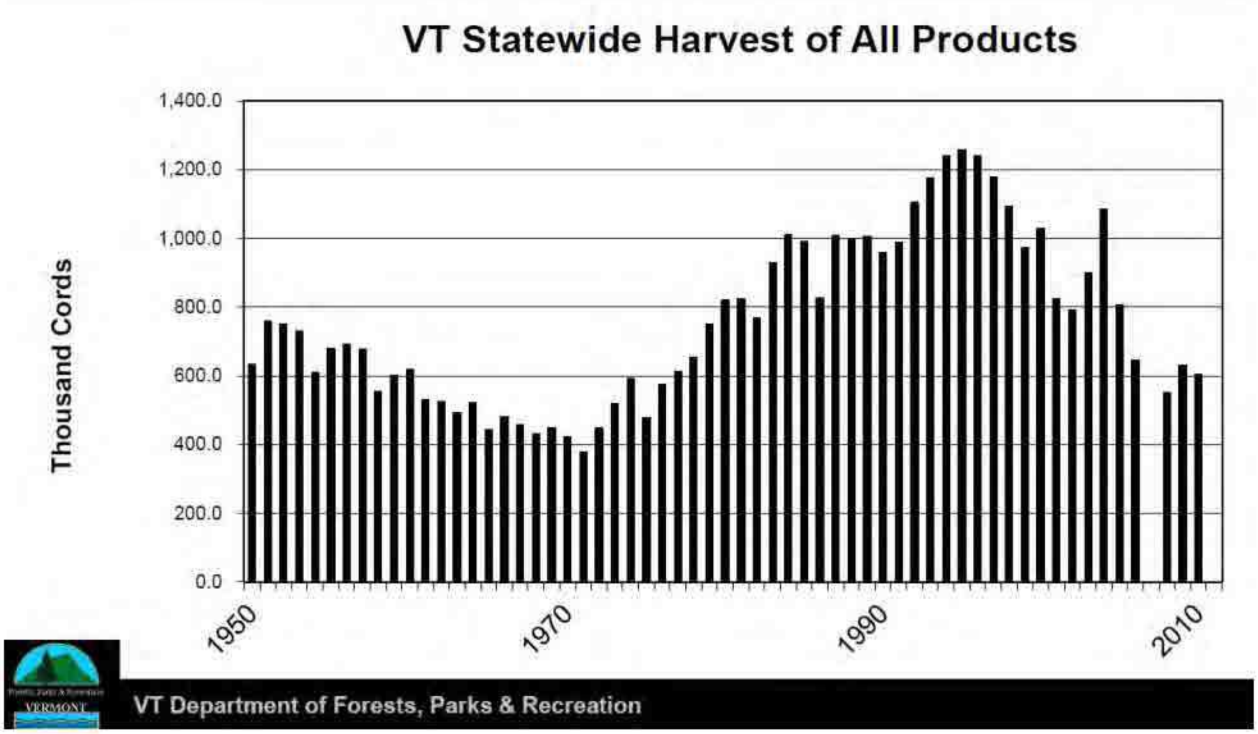
[2] High grading means harvesting the best quality trees while leaving the lower quality trees resulting in a lower quality forest after the harvest compared to pre-harvest.

b. Paul Frederick, VT Dept. of Forests, Parks & Recreation presentation on Windham County wood supply, January, 2014

Paul Frederick, the Forest Markets and Utilization Forester for the Vermont Department of Forests, Parks and Recreation, produced a PowerPoint presentation[ii] and delivered it to a group of the Sustainable Energy Outreach Network in January, 2014.

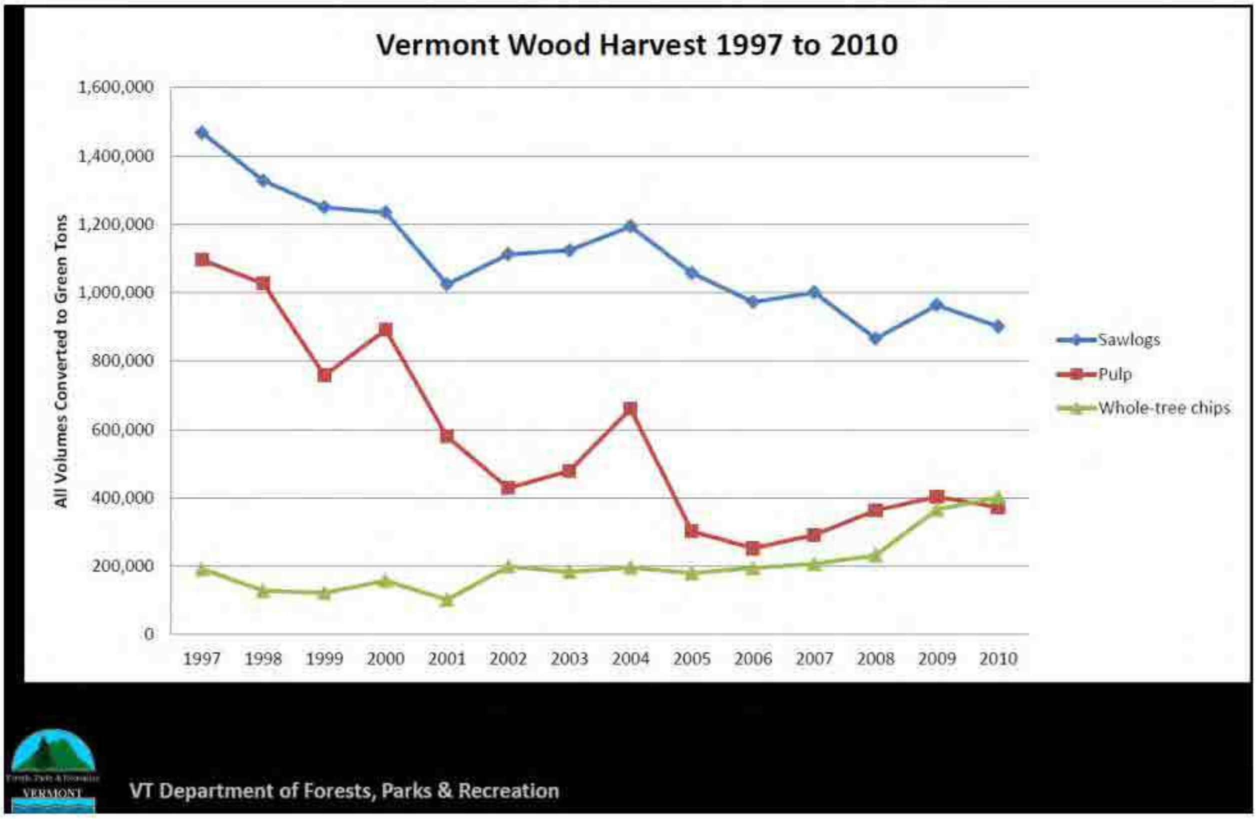
In Figures 3 and 4 of his presentation, Frederick reviewed harvesting trends from data his agency collects.

Figure 3 Timber Harvesting Trends in Vermont



According to Frederick, in 2010, Windham County grew over 275,000 cords of wood per year while over 80,000 cords (including firewood harvest) were removed through harvesting. Harvest volume could be higher than 80,000 cords but good county data on firewood harvests is lacking.

Figure 4 VT timber harvesting trend by product



Frederick also reviewed Windham County specific data and information. The most relevant of these for the WWHI are contained in the Figures below.

Figure 5 Windham County major wood users

Source: Paul Frederick, VT Dept. of Forests, Parks and Recreation

Frederick concluded his presentation with the results of a model run using the Biomass Project Evaluator. Please see Section IV of this report for a more up-to-date set of runs using the model.

c. BERC 2010 Vermont Wood Supply Study[3].

The Biomass Energy Resource Center (BERC) conducted a study in 2007 entitled "*The Vermont Wood Fuel Supply Study: An Examination of the Availability and Reliability of Wood Fuel for Biomass Energy in Vermont*". The 2010 study is an update of the 2007 work using updated data from the USDA Forest Service, FIA dataset.

The purpose of the original 2008 study and the update are summarized from the report's executive summary:

> *"While the original 2007 study examined a wide spectrum of issues affecting the supply of wood fuel, this update focuses solely on the recalculation of the potential for further wood fuel from Vermont's forests using updated data made available by the USDA Forest Service in the time since the completion of the 2007 study.*
>
> *The original 2007 study utilized the most up to date data available at that time (from 1997) for forestland area, ownership, inventory, and growth data; newer data (using slightly different methods) are now available from the USDA Forest Service Forest Inventory and Analysis (FIA) program. This is the primary reason for conducting an updated study.*
>
> *The objective of this study was to calculate supply of Net Available Low-grade Growth (NALG) wood—wood that would be appropriate for use as biomass fuel above and beyond current levels of harvesting—available annually in the State of Vermont, including assessment of both Vermont's counties alone and a larger study area comprising Vermont and the adjoining 10 counties of New Hampshire, Massachusetts, and New York."*

The update is a statewide report, as was the 2007 study, and makes some major conclusions about availability of additional wood from the forest for energy purposes. These are best captured in the following two Figures (6 & 7). The study concluded that Windham County had the largest net available low-grade growth of any VT county.

---

[3] It should be noted that the Northern Forest Biomass Project Evaluator (BPE) referenced above in the Frederick presentation and in much more detail below in Section IV with new model runs, had its origins in the methodology of the BERC 2007 study. Though similar in approach to the BERC study, which was innovative in its approach, the BPE model design and approach was changed from the original BERC study design for a variety of reasons with the intent of delivering results that were more accurate, more user-friendly and interactive for the user.

Figure 6 BERC 2010 Study update – Net Available Low-grade Growth (green tons)

Green Tons of NALG Wood			
	Conservative Scenario	**Moderate Scenario**	Intensive Scenario
Vermont Counties	246,800	**894,900**	1,940,700
Vermont and 10 Surrounding Counties of NH, MA & NY	1,332,400	**3,107,600**	5,822,500

Source: Biomass Energy Resource Center, 2010

Figure 7 BERC 2010 Study update - spatial distribution of the NALG wood resource

Source: Biomass Energy Resource Center, 2010

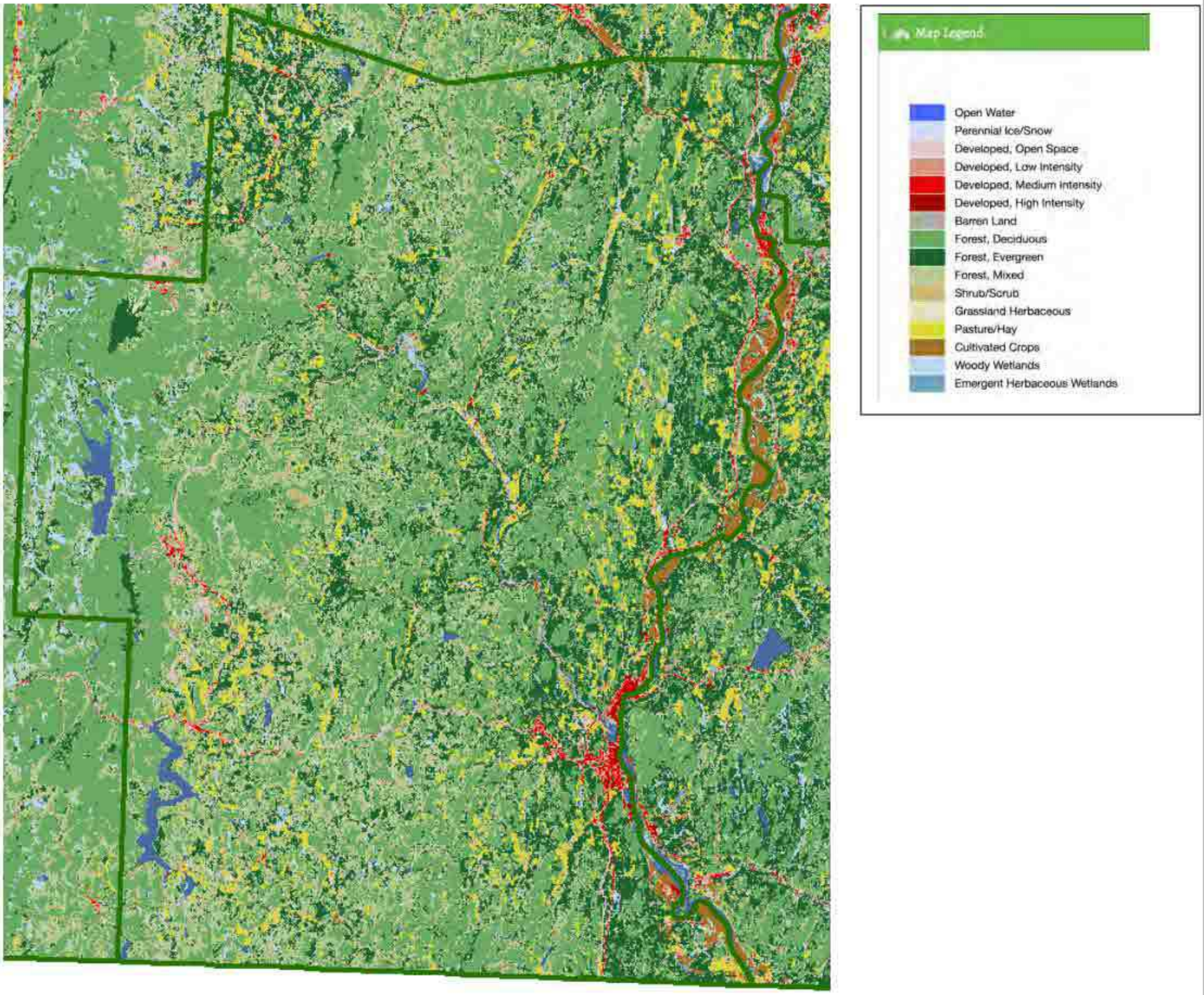
III. New analysis using FIA data

In this section we use the most updated information and data from the USDA Forest Service, FIA dataset to run an analysis of forest acreage, standing volume and growth and removals in the WWHI seven-county wood supply area. The goal is to provide the most up-to-date analysis of wood availability to assure clear understanding of the wood fuel availability for new users of wood fuel that will result from the WWHI.

A good place to start this review is to gain an understanding of the characteristics of the forests of the WWHI wood supply region, first starting with Windham County itself.

A very helpful way to get a snapshot of the forests of Windham County is to review an image of land cover data for the area. Land cover data, used in Geographic Information System (GIS) analyses, comes from a national dataset developed by the U.S. Geological Survey of the U.S. Dept. of Interior. These data are easier to read than looking at satellite photography since the color gradations in such a photograph are subtle compared to those in the Land Cover image. Below, in Figure 8, the Land Cover image shows a county dominated by 93% forests (all shades of green) and, particularly, hardwood forests (medium green).

Figure 8 Land Cover map – Windham County, Vermont

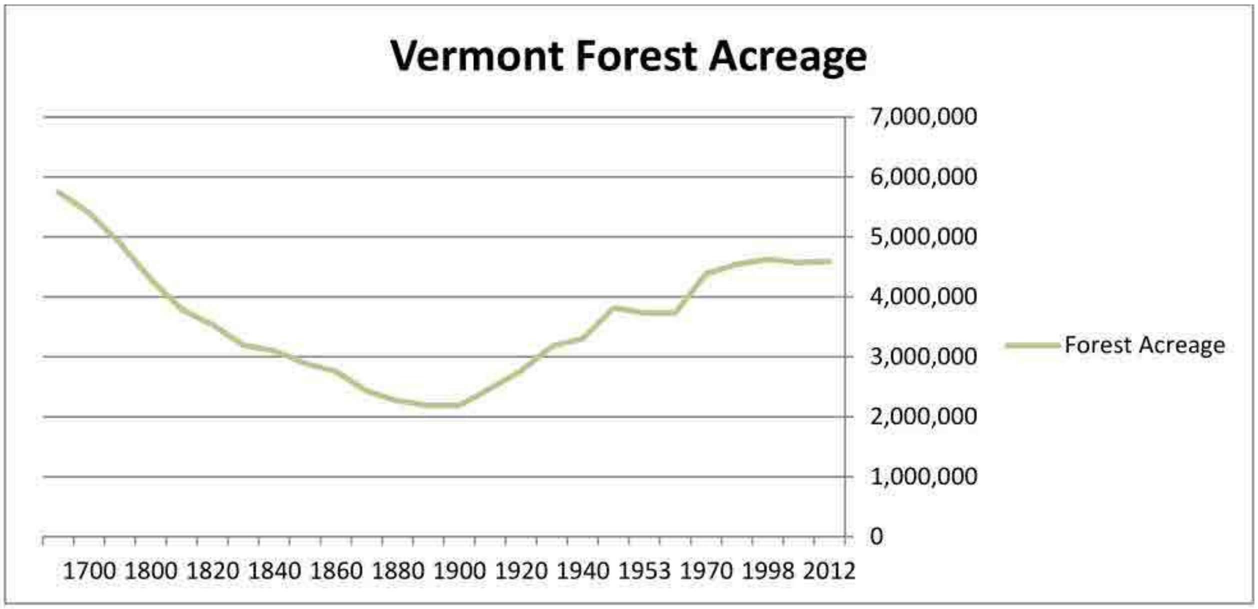


Source: U.S. Geological Survey

Compared to the distant past, Windham County's forests have rebounded from much lower acreage in the mid-1800s when much more farm land existed. Figure 9 shows the trend of forestland cover in Vermont since the 1600s from a dataset developed and maintained by the Harvard Forest in Petersham, Massachusetts.

Windham County has mirrored this statewide Vermont trend.

Figure 9 Forest Acreage Trends – Vermont



Source: Harvard Forest – multiple data sources

<u>Area of Analysis</u>

This FIA-based analysis focuses on the wood supply for Windham County, Vermont, as well as the counties surrounding Windham County (the "Region" see Figure 10):

- Bennington, Rutland and Windsor Counties in Vermont;
- Cheshire and Sullivan Counties in New Hampshire; and
- Franklin County in Massachusetts.

Figure 10. Area of Analysis

INRS used the FIA EVALIDator tool (version 1.6.0.01[iii]) to estimate for the Region:

- Land ownership;
- Annual forest growth (how much wood grows each year, less mortality);
- Annual forest removals (how much wood is currently harvested annually); and
- Volumes of low-grade material (wood not suitable for sawlog or other higher value markets).

The factors above allow INRS to calculate the volume of woody biomass that is growing in the region that can be harvested and used as biomass fuel today, while recognizing that some material is of a higher quality such that landowners and loggers will not chip it for forest-derived biomass fuel.

In Section IV, we expand these FIA analyses with use of the Biomass Project Evaluator which uses the same data as we have used in this Section and further analyzes them to better understand likely future projections based on various assumptions.

Forest Growth and Removals

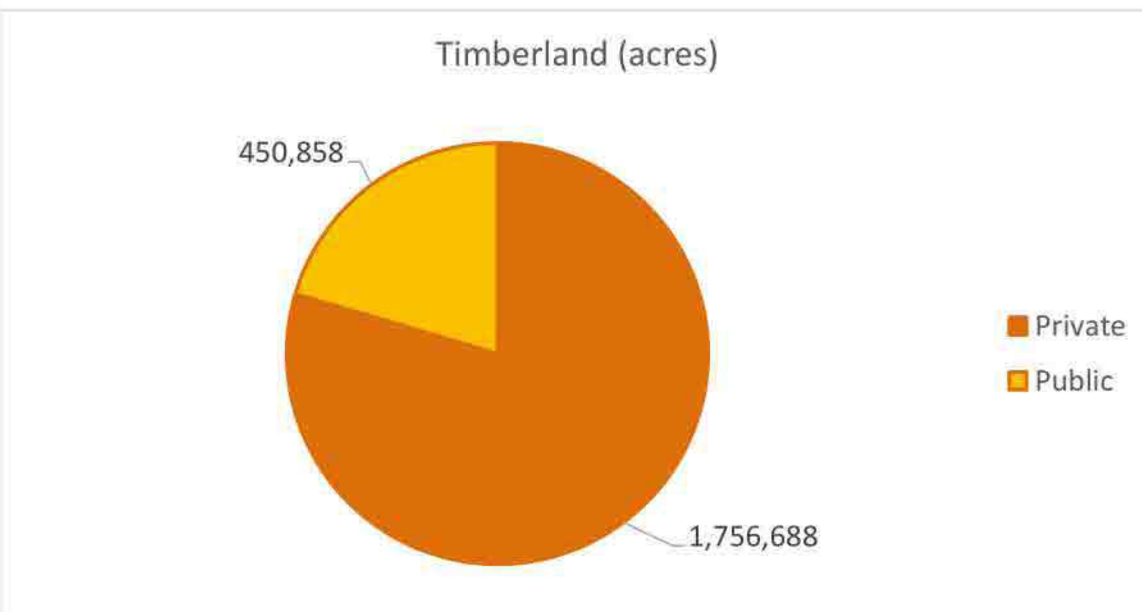
Using the FIA database, INRS determined the growth and loss (harvest and mortality) for the Region.

The FIA database is developed from information collected annually from a subset of permanent plots, and is used to provide an estimate of changes in the forest resource over time. A complete re-inventory of all plots occurs approximately every five years. INRS used the most recent complete FIA information, which uses data collected between 2009 and 2013[iv]. The FIA data accessed includes estimates of the area of timberland, ownership type, and annual growth and removals of wood by species group.

Using the FIA database described above, INRS estimates that over 2.2 million acres of "timberland" - land capable and legally available for growing commercial forest products - are within the Region of analysis.

Of this, the vast majority of this timberland – 1,756,688 acres (80%)- is owned by private landowners. Private landowners are a highly preferable landownership class for a wood using facility to locate near, as they are able to harvest timber absent most political and government budget considerations, and generally react rationally to market signals. Importantly, timberland excludes any lands where commercial timber harvesting is prohibited by statute or regulation, so that these lands are excluded from the analysis below.

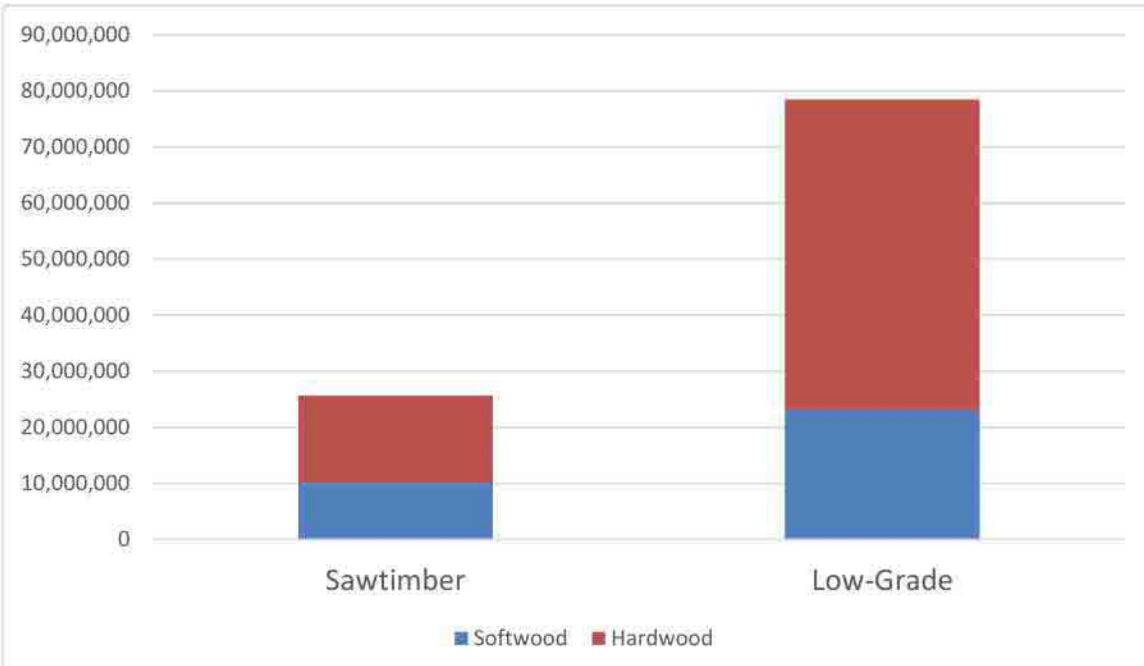
Figure 11. Regional Timberland Ownership (acres)



In an effort to evaluate only those lands likely to be available for timber harvesting, INRS limited this analysis to only private lands with a slope of less than or equal to 35 percent. It is possible that biomass fuel for thermal applications will come from public lands or lands with steep slopes, but this analysis is conservative and assumes that this will not occur.

On these lands, about three quarters of the standing timber is low-grade, unsuitable for use in lumber manufacturing or other high-value applications.

Figure 12. Standing Volume, by Species Type, in Green Tons[4]



[4] Green tons – means tons of wood in its live or recently live state. Live or recently live timber contains as much as 55% of its weight in water.

With all current area markets in place and operating in the Region of analysis, additional annual growth levels of low-grade material[v] that can be used as forest-derived fuel (and are not currently being used) exceed harvest (removal) levels by +/- 578,000 green tons.

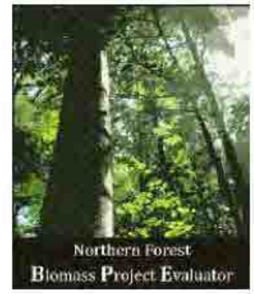
Table 1. Standing Timber and Annual Net Growth[5] - Removals for Region (green tons)

	Softwood	Hardwood *Green tons*	Total
Standing Volume			
all	33,219,504	70,912,195	104,131,700
sawlog	10,094,121	15,574,148	25,668,269
non sawlog	23,125,383	55,338,047	78,463,430
Net Growth			
all	846,553	1,346,931	2,193,484
sawtimber	339,291	589,276	928,567
non-sawtimber	507,263	757,655	1,264,917
Removals			
all	286,414	611,816	898,230
sawtimber	78,876	132,702	211,578
non-sawtimber	207,538	479,113	686,652
Net Growth - Removals			
all	560,139	735,115	1,295,255
sawtimber	260,415	456,574	716,989
non-sawtimber	299,724	278,541	578,266

It should be noted that the above estimate does not include the volume of the tops and branches of the trees in the Region although an estimate of those additional volumes could be developed. Given the size of the facilities likely to switch to wood fuel heat as a result of WWHI efforts, the probable fuels will be wood pellets, green bole wood chips (no tops) and semi-dry wood chips (no tops). Top wood material (so-called whole tree chips), produced as part of whole tree harvesting operations, are generally unsuitable for use in these smaller facility biomass heating systems.

[5] Net Growth – annual growth of wood in the forest area less mortality

IV. Possible Future Forest Biomass Availability Scenarios – Biomass Project Evaluator



The Northern Forest Biomass Project Evaluator (BPE) model was created by INRS on behalf of the North East *State* Foresters Association[6] (www.nefainfo.org) through grant support from the USDA Forest Service. The BPE tool is intended to be used as a decision support tool for analyses of wood supply under different conditions for a geographic area, including the supply of low-grade wood for energy projects.

The power of the BPE model is its ability to project possible forest future scenarios using varying assumptions. All three scenarios outlined below are conservative in that they do not include any public land and they further discount 9% of the private timberland remaining for various factors (see Appendix for details). These are more conservative assumptions than provided for in Section III above and, hence, the available biomass material is less in the current year compared to the Section III results. All scenarios here look at the next 20 years. For the purpose of this report, we have chosen to conduct three "runs" of the model[7].

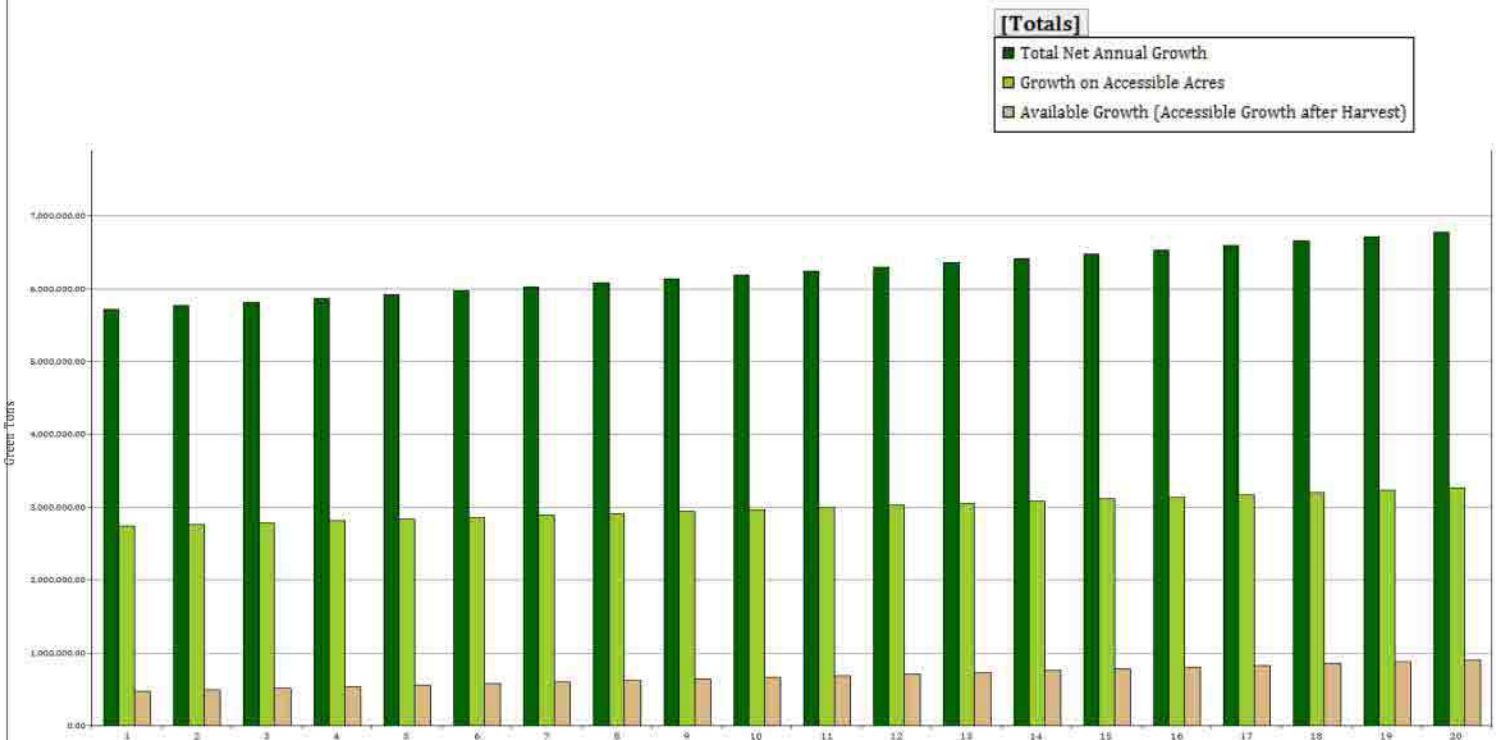
Run 1 ***Reduced growth run*** – assumes that wood use remains constant but that forest growth is reduced by .2 % per year over the run period. This choice reflects factors such as insects and diseases (hemlock wooly adelgid, emerald ash borer) or invasive plants and their possible future effects on forest growth. The land acreage available for timber harvesting with this run is as follows –

Ownership Category	Total Acres of Timberland	Accessible Acres	Net Accessible Timberland:
Federal	263,105.84	0.00	
State	170,483.18	0.00	
Municipal	78,973.31	0.00	
Corporate	106,172.35	95,555.12	
Farm	42,468.94	21,234.47	
Other Private:			
Parcels 1-50acres	592,441.73	296,220.87	
Parcels 50+acres	1,382,364.05	967,654.83	
Total:	2,636,009.41	1,380,665.29	1,256,405.41

Percent Discount: 52.3%

Available[8] woody biomass for energy in year 2015 – 474,281 green tons
Available woody biomass for energy in year 2035 – 902,093 green tons

[6] The North East *State* Foresters Association is: The State Foresters of Maine, New Hampshire, Vermont, and New York cooperating with the US Forest Service State & Private Forestry.
[7] More details about the assumptions in these BPE model runs can be found in the Appendix.
[8] After existing harvests are accounted for and not accounting for available sawlog (high value) material.

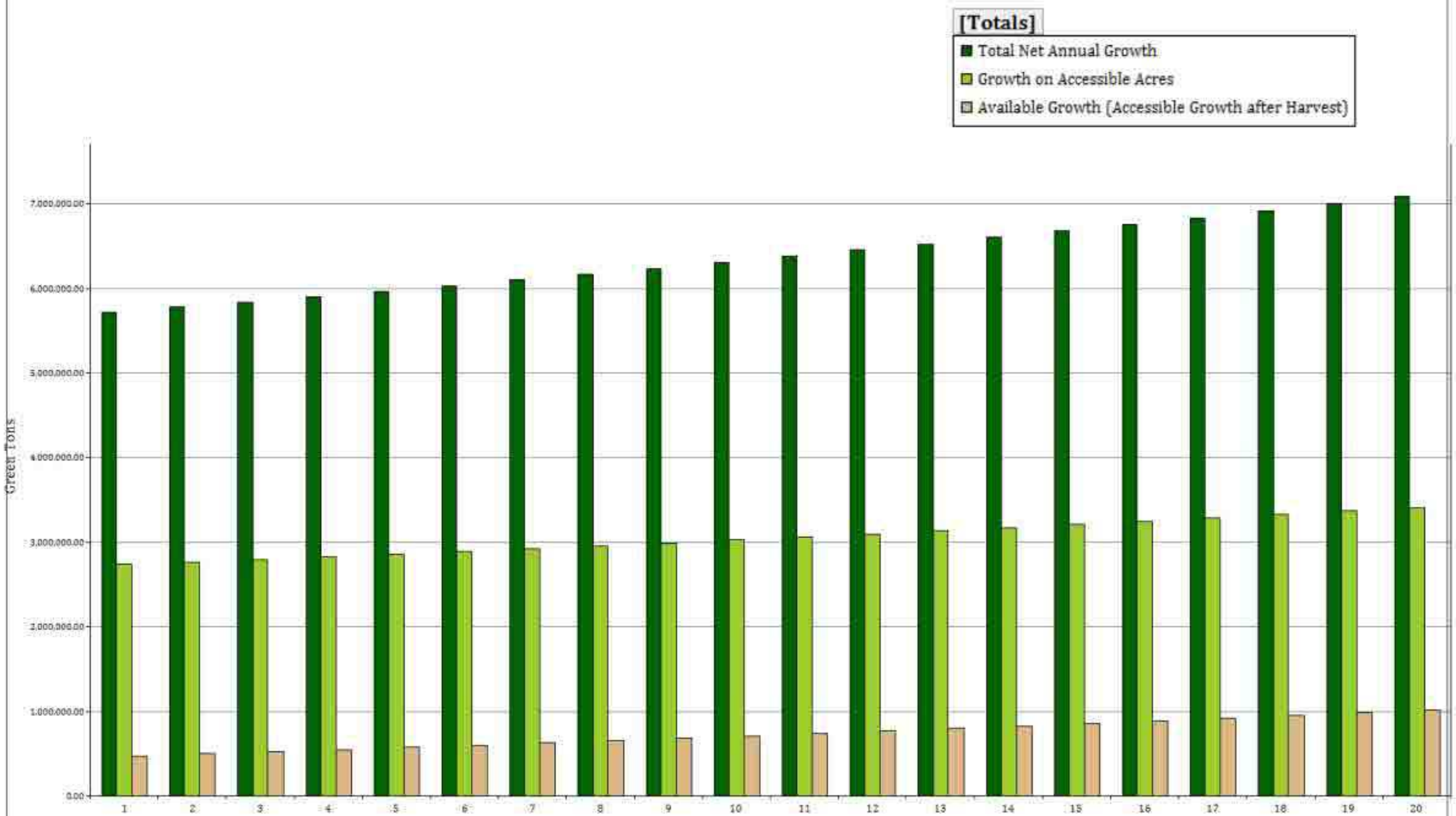


Year of Model Run 1 (year 1 is 2015)

<u>Run 2</u> ***<u>The constant run</u>*** – assumes that wood use from the Region will continue at the same levels as are experienced today and that growth and mortality of trees will continue as today. The land acreage available for timber harvesting with this run is as follows –

Ownership Category	Total Acres of Timberland	Accessible Acres	Net Accessible Timberland:
Federal	263,105.84	0.00	
State	170,483.18	0.00	
Municipal	78,973.31	0.00	
Corporate	106,172.35	95,555.12	
Farm	42,468.94	21,234.47	
Other Private:			
Parcels 1-50acres	592,441.73	296,220.87	
Parcels 50+acres	1,382,364.05	967,654.83	
Total:	**2,636,009.41**	**1,380,665.29** →	**1,256,405.41**
		Percent Discount:	52.3%

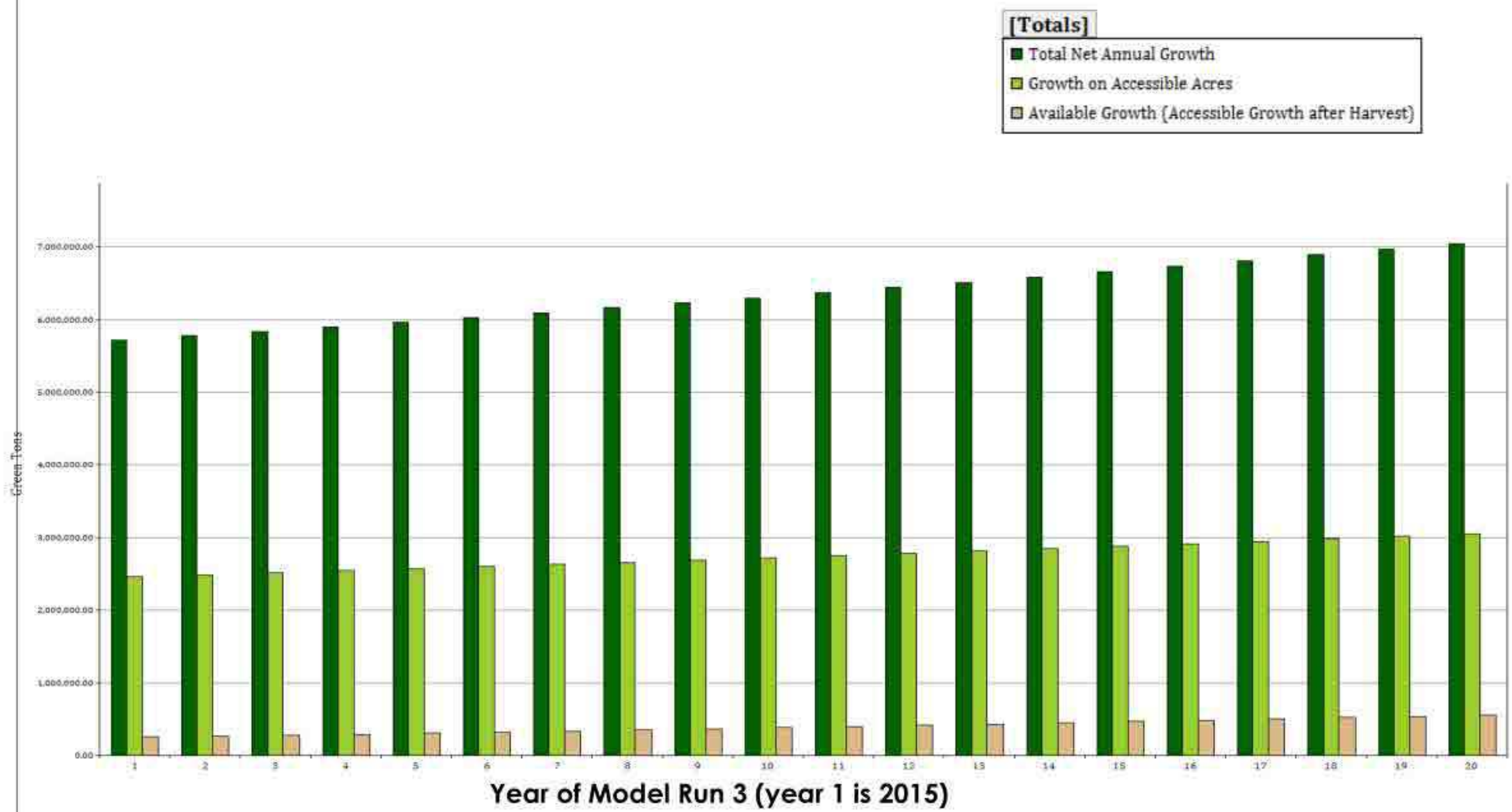
Available woody biomass for energy in year 2015 – 474,281 green tons
Available woody biomass for energy in year 2035 – 1,021,026 green tons



Year of Model Run 2 (year 1 is 2015)

Run 3 ***Increased demand run*** – assumes an annual increase of .5 % wood use in the Region while keeping growth and mortality at current levels and reducing forest land available by 10% for the Region. While significant and not currently anticipated, a .5% per year increase in wood consumption might occur if, for instance, one or two large-scale (such as the Ryegate wood-fired power plant) power plants were built in the region, or several large sawmills of the size of the Cersosimo mill in Brattleboro were to locate in the area.

Available woody biomass for energy in year 2015 – 252,037 green tons
Available woody biomass for energy in year 2035 – 588,897 green tons


[Totals]
Total Net Annual Growth
Growth on Accessible Acres
Available Growth (Accessible Growth after Harvest)
Green Tons
Year of Model Run 3 (year 1 is 2015)

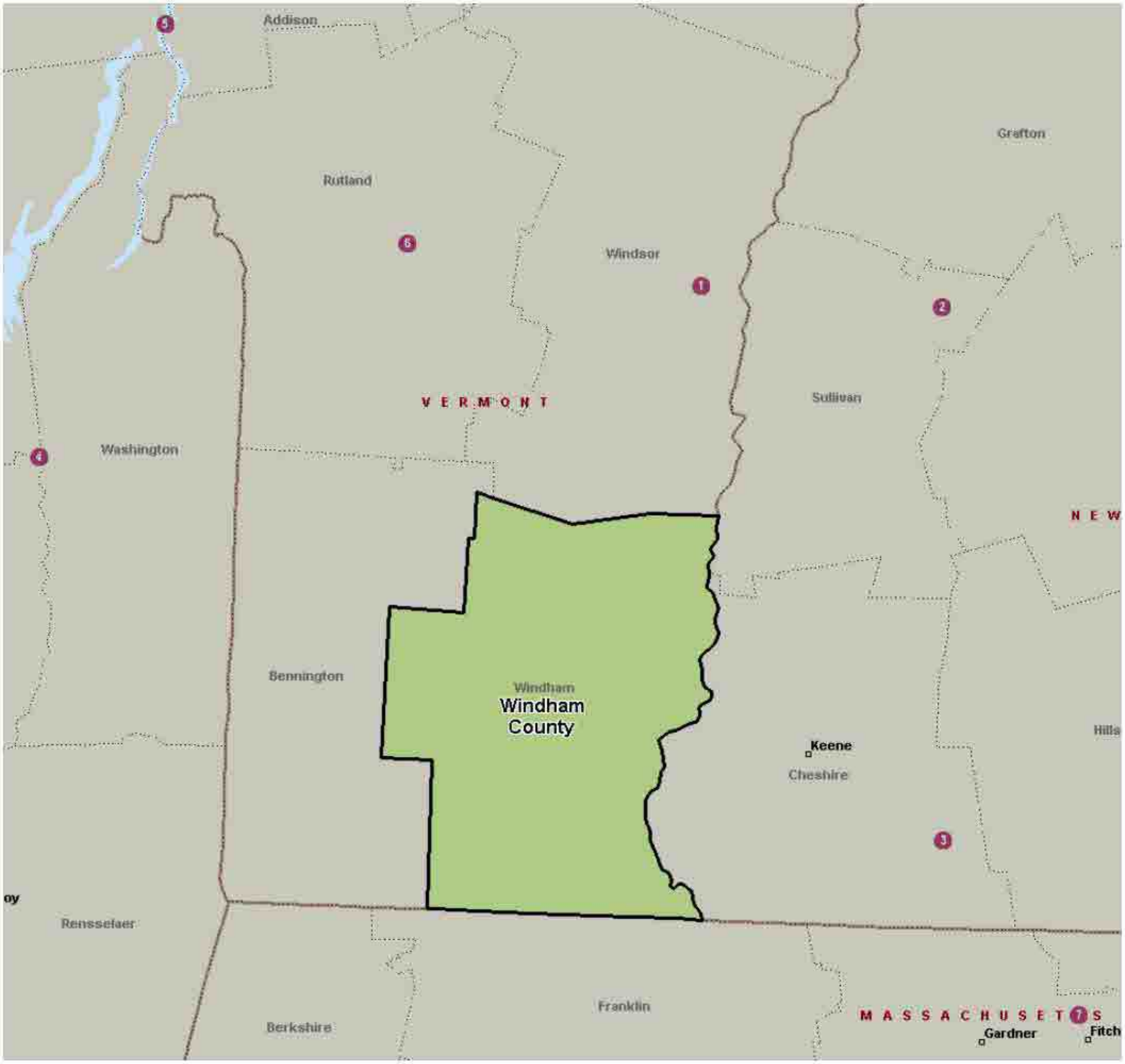
V. Large wood users in the WWHI area

Understanding the population of existing large users of wood from the forests of the WWHI Region is important to the project goals. In Section I on page 10 we excerpted the list of wood users in Windham County from the Frederick presentation. Only two of those in the county are significant users of the timber resource in the region: Cersosimo Lumber and Allard Lumber. The remaining on that list are very small wood users.

Below is a listing and map of the largest facilities using lower grade wood in the region and their approximate annual wood use. Collectively, these seven (7) facilities use approximately 2.1 million tons of wood from within and outside the Region. While some of these facilities have been operating for many decades and some for a shorter time, during the last 50 years the FIA data shows significantly increasing standing timber supplies throughout the region over and above the wood used by all facilities and as documented in Sections III and IV above.

The volumes of wood that might be used by the 20+ new facilities switching to wood from fossil fuel at the encouragement of the WWHI would be in the 5,000 - 8,000 tons per year range, relatively insignificant relative to the continued growth in the forest inventory in the region (see section IV. above).

Figure 13. Location of large users of low grade wood in WWHI region



Tally of large wood using facilities in the WWHI Region:

1.	Queston Wood Pellets, http://www.questonwoodpellets.com/
Location	West Windsor, Vermont
Product	Wood pellets
Wood Use	+/- 38,000 green tons of pine per year
Wood quality	Mill residue and clean chips

2.	Springfield Power (formerly Hemphill Power)
Location	Springfield, NH
Product	Electricity (19 MW)
Wood Use	+/- 200,000 green tons per year
Wood quality	Whole-tree chips, wood chipped on site, and sawmill residue

3.	New England Wood Pellet, www.pelletheat.com
Location	Jaffrey, New Hampshire
Product	Wood pellets
Wood Use	+/- 200,000 green tons (less when accounting for purchase of dry material)
Wood quality	Sawmill and secondary manufacturing residues, pulp quality chips, roundwood bole chips

4.	Finch Paper, www.finchpaper.com
Location	Glens Falls, New York
Product	Paper
Wood Use	+/- 640,000 green tons of pulpwood (primarily roundwood) +/- 50,000 tons of biomass fuel
Wood quality	Roundwood, pulp quality chips and whole-tree chips

5.	International Paper – Ticonderoga Mill
Location	Ticonderoga, NY
Product	Paper
Wood Use	+/- 700,000 green tons of pulpwood (~2/3 hardwood) +/- 80,000 green tons of biomass
Wood quality	Roundwood, pulp quality chips and whole-tree chips

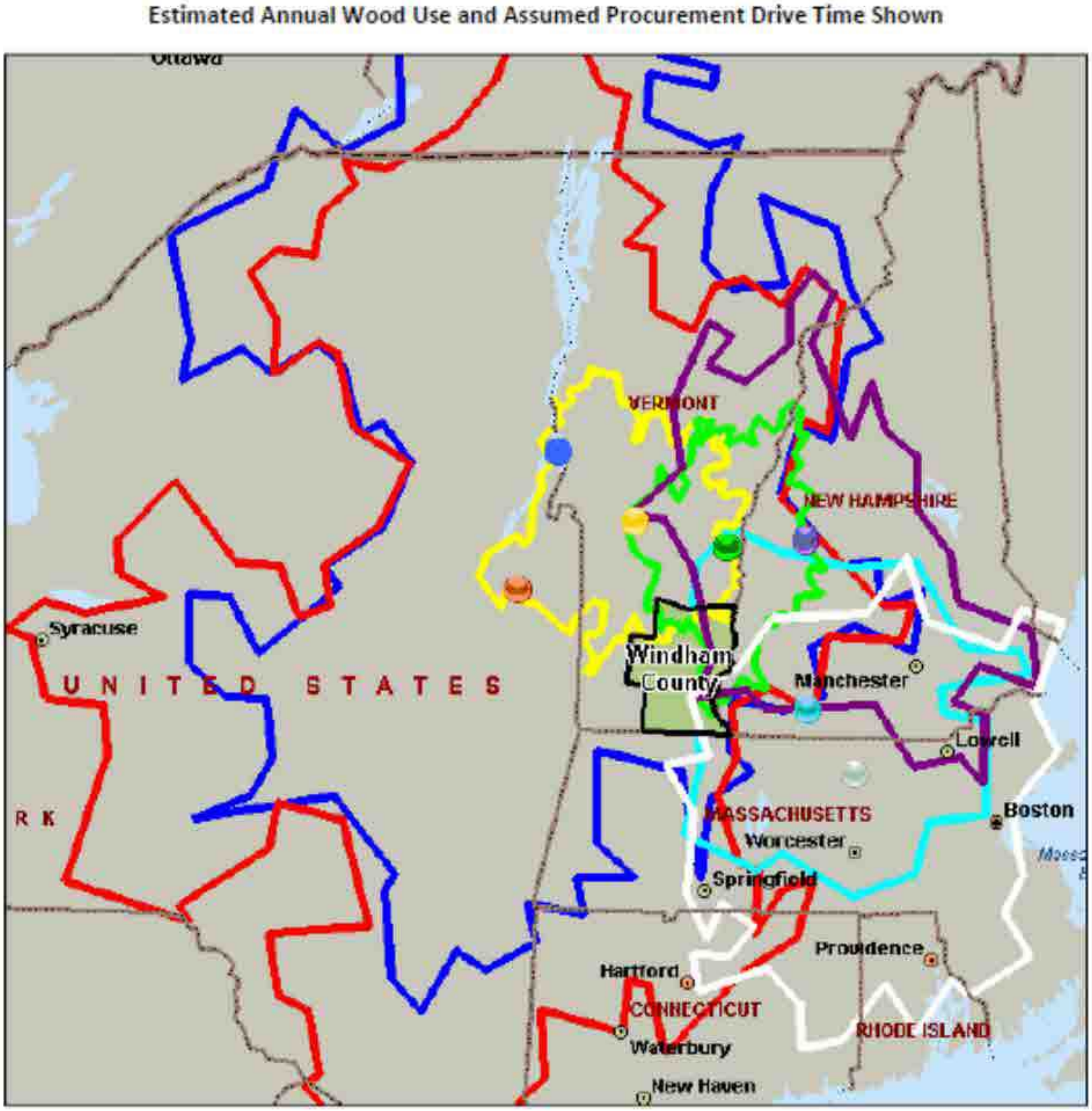
6.	Vermont Wood Pellets
Location	North Clarendon, VT
Product	Wood Pellets
Wood Use	+/- 40,000 green tons per year
Wood quality	Mill residue and clean chips

7.	Pinetree Power Fitchburg
Location	Fitchburg, MA
Product	Electricity
Wood Use	+/- 225,000 green tons per year
Wood quality	Whole tree chips and other wood sources

Though not direct competitors for lower grade wood material that might be destined for wood chips or wood pellets, the two large sawmills located in the county, both in Brattleboro, Cersosimo Lumber and Allard Lumber, produce high quality sawed wood products and together procure between 15 and 25 million board feet of logs a year for lumber products while also procuring other timber products and supplying low grade wood fuel material as residue from the sawmilling process and some additionally as large buyers of standing timber. Cersosimo also has a chipping facility that procures low-grade logs for chipping. Overall, these two mills account for the use of over 125,000 tons of timber per year. This timber comes from within Windham County and the surrounding counties as identified in this analysis as well as counties beyond the seven chosen for the WWHI Region.

Figure 14 shows the extent to which each of these large low-grade markets reach for their wood supply.

Figure 14 Wood Supply Procurement areas for major low-grade wood users



Color	Facility	Wood Use (g tons, est.)	Drive Time (min)
(green)	Queston Wood Pellets	38,000	60
(purple)	Springfield Power	200,000	90
(cyan)	New England Wood Pellets	200,000	90
(red)	Finch Paper	690,000	180
(blue)	International Paper -Ticonderoga	1,500,000	180
(yellow)	Vermont Wood Pellets	40,000	60
(white)	Pinetree Power – Fitchburg	225,000	90

VI. Conclusions

Given the relatively small amount of new timber resource that might be needed if WWHI is successful in its goal to encourage at least 20 schools and municipal buildings in the County to switch to advanced wood fueled heating systems – fuel needs for these are estimated on the high end at 8,000 greens tons per year – there is ample additional supply of low grade wood resource available.

Our analyses show that between 252,000 green tons and 578,000 green tons are currently available in the Region. The BPE model runs suggest between 589,000 and 982,000 green tons will be available in the year 2035 because the forests of the Region are growing much more wood than is being used each year and will continue to do so into the future.

Though not included as a separate model run, a constant model run (like BPE model run #2) with only Windham County, VT included yielded well over 100,000 green tons of low grade wood material available today. Though it is unrealistic that all new wood fuel for the WWHI-encouraged wood heat projects would come from only Windham County, it is helpful to understand what the County is potentially capable of producing.

Appendix

End Notes

[i] Morin, Douglas, The Forest Products Industry of Windham County, Vermont: Status, Challenges, and Opportunities, pg 5.

[ii] Frederick, Paul, Forests, Forests Products & Wood Energy in Windham County Biomass Energy Opportunities in Windham County , [for the] Sustainable Energy Outreach Network , January 28, 2014

[iii] http://apps.fs.fed.us/Evalidator/evalidator.jsp

[iv] USDA Forest Service data is presented in cubic feet. INRS calculated green tons assuming 85 cubic feet of solid wood per cord, and that a green cord of wood weighs 2.6 tons for hardwood and 2.3 tons for softwood.

[v] For purposes of this discussion, "low-grade" is material unable to meet a sawlog specification.

BPE Model Run Assumptions:

Run 1 Reduced growth run – assumes that wood use (harvest levels) remains constant but that forest growth is reduced by .2 % per year over the run period;

- All 7 counties
- No public land is available for harvesting
- Private landownership data (percentages etc) is the default
- Reduced growth by .2% per year (compounded)
- Accessible for harvesting: Farmer 50%; Corporate 90%; Private 1-50ac 50%; Private 50+ ac 70%
- Other deductions (% of acres removed from availability):
  - Slope 5%
  - Elevation 1%
  - Wetlands .5%
  - Distance to Roads 1%
  - Deer yards 0%
  - Stream Buffers 1%
  - Easements .5%

  TOTAL 9%

Run 2 The constant run – assumes that wood use (harvest levels) from the Region will continue at the same levels as are experienced today and that growth and mortality of trees will continue as today;

- All 7 counties
- No public land is available for harvesting
- Private landownership data (percentages etc) is the default
- Accessible for harvesting: Farmer 50%; Corporate 90%; Private 1-50ac 50%; Private 50+ ac 70%
- Other deductions (% of acres removed from availability):
  - Slope 5%
  - Elevation 1%
  - Wetlands .5%
  - Distance to Roads 1%
  - Deer yards 0%
  - Stream Buffers 1%
  - Easements .5%

  TOTAL 9%

Run 3 Increased demand run – assumes an annual increase of .5 % wood use (harvest levels) in the Region while keeping growth and mortality at current levels and reducing available acres by 10% over the run period.

- All 7 counties
- No public land is available for harvesting
- Private landownership data (percentages etc) is reduced by 10%
- Accessible for harvesting: Farmer 50%; Corporate 90%; Private 1-50ac 50%; Private 50+ ac 60%
- Other deductions (% of acres removed from availability):
  - Slope 5%
  - Elevation 1%
  - Wetlands .5%
  - Distance to Roads 1%
  - Deer yards 0%
  - Stream Buffers 1%
  - Easements .5%

  TOTAL 9%

MICHAEL CAMMENGA

(b)(6)

Senior Leader with track record of success delivering business-driven process and system solutions. Demonstrated accomplishments in building peak-performing teams that achieve cross-functional business objectives. Recognized change agent with talent for making rapid assessments then moving quickly from vision and strategy to execution and follow-through. **Diverse background in sales, engineering, facility management, process optimization, strategic purchasing, leveraging best practices, and business operations**. Vast experience with driving out process costs, changing cultures, improving business processes, and building self-directed teams.

Significant Areas of Expertise

- Leadership & Team Building
- Business Operations Improvement
- Supply Chain Optimization
- Lean 6 Sigma
- Labor Negotiations
- Business Process Redesign
- Product Sales Strategy/Execution
- Program & Project Management
- Capital Resource Allocation
- 6 Sigma Black Belt
- Customer Relationships
- SOX Control & Compliance
- Process Troubleshooting
- Process Efficiency Improvements
- Vendor & Contract Negotiations
- Organization Design/Restructuring
- Environmental Systems Management
- Plant Efficiency Optimization

Professional Experience

LONG FALLS GROUP • *Seattle, WA* — 2018 – Present

A $20 million private company with paperboard manufacturing and converting operations.

LONG FALLS PAPERBOARD, PRINCIPAL • *Brattleboro, VT*

Owner / Operator of independent specialty paperboard mill with integrated converting operations. Directed staff of 102 across multiple disciplines including safety, environmental, quality, productivity, capital needs, training, financial, and execution.

- Start-up operation in January 2019
- Expanded product base by 40%
- Implemented new financial and shop floor IT systems
- Executed numerous energy reduction projects and efficiency improvement projects

CARTHAGE SPECIALTY PAPERBOARD • *Carthage, NY* — 2015 – 2017

A $40 million private company manufacturing specialty matte-board, high-value packaging, and anti-septic products for the pharmaceutical industry. The Company operates 1 specialty paper mill with world-wide niche markets having only competitors outside of the United States.

VICE PRESIDENT OF OPERATIONS • *Carthage, NY*

Directing staff of 75 including safety, environmental, quality, productivity, maintenance, capital needs, and execution on annual sales of approximately $40 million

- Reporting directly to the Board of Directors along with VP of Finance, VP of Sales
- Successfully led re-engineering effort to redesign and rebuild paper machine forming section after catastrophic failure (2017)
- Salvaged major customer account through development of personal relationships, education of customer teams, and detailed use of data and process capability
- Leading the effort to drastically change the safety culture across the entire Company
- Implementing industry best practices to improve productivity and drive out cost across all sectors of the business
- Successfully rebuilding the Operations team after 90% turnover
- Implemented a mill-wide process improvement system which generated more than $1.5 million in annual opportunity

JLM ADVANCED TECHNICAL SERVICES • Appleton, *Wisconsin* **2012 – 2015**
A $25 million private company with engineering, fabrication, contract maintenance, and project management services. The company is fully integrated with engineering through construction services.

BUSINESS DEVELOPMENT MANAGER / OPERATIONS MANAGER-WOOD PRODUCTS • *Fairfax, South Carolina*

Developed new market strategy and business wood products business. Directed staff of 12 across multiple sites including safety, environmental, quality, productivity, capital needs, training, and execution.

- Developed $1.8 million in new market sales across 5 new Wood Products customers
- Identified $50,000 in annual rental cost reduction through contract negotiations
- Project planner for $150 million paper machine rebuild and restart
- Project Manager for $4.5 million dryer section replacement
- Project Manager for $4.2 million pulp mill bleach plant upgrade
- Project Manager for $2.5 million Washer Drum & Upgrade project

NATIONAL GYPSUM • *Charlotte, North Carolina* **2011 – 2012**
A $500 million private company manufacturing building products for use in residential and industrial construction projects. The company is fully integrated with rock quarry supply, 3 paper mills, and more than 3 dozen drywall plants throughout the US and Canada.

PLANT MANAGER • *Pryor, Oklahoma*
Directed staff of 75 including safety, environmental, converting cost, quality, productivity, capital needs, and execution on annual internal and external sales of approximately $68 million; 100% recycled paper manufacturing plant

- Successfully led team responsible for redesign of steam & condensate handling system improving condensate return from zero to 80%. Improved product drying capacity by 35%.
- Redesigned plant effluent system to eliminate excessive discharge of fiber and water. Also, reduced fiber cost by an expected $3,000,000 through the use of this system redesign.
- Negotiated effluent plant redesign with local DEQ, eliminating the need to spend more than $10 million in fines and excavations
- Implemented stock prep best operating practices to drive monthly yield results from the historically low mid 80's to >92%.

TEMPLE INLAND • *Austin, Texas* **2009 – 2011**
A $3.8 billion public company which manufactures packaging and building products; triple wall and bulk bin corrugated manufacturing plant

PLANT MANAGER • *Bogalusa, Louisiana*
Directed staff of 153 including safety, environmental, converting cost, quality, productivity, capital needs, and execution on annual sales of approximately $85 million; corrugated box plant

- Successfully led team responsible for redesign and capital expansion of plant.
- Increased productivity by 35% through development and implementation of SOP's.
- Increased corrugator uptime by 12% through execution of maintenance best practices.
- Executed plant wide improvements to secure AIB certification.
- Improved plant profits by $3.5 million annualized.

ROCK-TENN COMPANY • *Norcross, Georgia* **2001 – 2009**
A $3.1 billion public company which manufactures packaging products, shipping containers, merchandising displays, and virgin and recycled paperboard in over 120 facilities throughout the United States, Canada, Mexico and South America.

GENERAL MANAGER • *Dallas, Texas* 2007 – 2009

GENERAL MANAGER • *Stroudsburg, Pennsylvania* 2005 – 2007

GENERAL MANAGER • *Otsego, Michigan* 2003 – 2005
PRODUCTION MANAGER 2002 – 2003
TECHNICAL DIRECTOR 2001 – 2002

Directed a 115 - 124 person staff and managed all aspects of the business including safety, environmental, financial results, quality, sales, productivity, capital needs and execution. Strategically involved with all Corporate technical sourcing teams. Oversaw annual budgets of approximately $70 million. Successfully led over 5 years of Six Sigma projects.

- Improved plant's profit position by 800% through organizational alignment of staff, execution of best practices, labor negotiations, and improved asset management. (2007-2009)
- Generated over $3 million in annualized benefits by execution of quality and operations improving Six Sigma projects. (2002-2009)
- Successfully completed development and implementation of Millennium. (2005-2009)
- Reduced spare part inventory carrying costs by 25% through execution of best practices and supply chain optimization. (2004, 2007, 2008) Reduced operating expenses by over 10% through consistent membership in the corporate Technical Sourcing Team, collaborative supplier negotiations, and strategic execution of the agreements. (2001-2008)
- Managed resources to successfully execute a $6 million paper mill rebuild after a catastrophic 500-year flood. (2006)
- Reduced plant's annual operating expenses by over $5.4 million over a three year period with a redesign in transportation systems. (2002-2005)
- Led plant to elimination of largest customer quality issue resulting in $1 million annual savings and improved customer's margins by 15%. (2002)
- Leveraged best operating practices across 4 manufacturing operations resulting in $10 million in cost reduction and more than $30 million in retained business.

ROCKFORD PAPERBOARD, INC • *Rockford, Michigan* 1999 – 2001

$35 million private company which manufactures sheet and roll-fed coated and specialty recycled paperboard.

PLANT MANAGER 2000 – 2001
PLANT SUPERINTENDENT 2000
MACHINE SUPERINTENDENT 1999

Directed staff of 96, including all aspects of the business including safety, environmental, financial results, quality, productivity, capital needs, and execution. Oversaw annual budget of approximately $35 million.

- Successfully led team responsible for design, rebuild, and installation of plant's first winder. (2001)
- Increased productivity by 22% through development and implementation of SOP's and plant-wide training systems. (2000-2001)
- Increased maintenance effectiveness by 25% through execution of maintenance best practices. (2000)
- Successfully commissioned start-up of idled mill. Hired all plant personnel, developed all plant SOP's, Company policies, rules, and regulations. (1999)

CROWN VANTAGE • *Parchment, Michigan* 1998 – 1999

$1 billion public company, a leading manufacturer of value-added papers for printing, publishing and specialty packaging.

PAPER MACHINE & COATING SUPERINTENDENT 1998
COATING SUPERINTENDENT 1998

Directed staff of 68, including all operations and scheduling of 2 paper machines, 3 off-machine coaters, and 3 salvage winders.

- Successfully developed white and fluorescent thermal transfer and release papers. (1998)
- Reduced waste from 32% to 17%. (1998)

FORT JAMES CORPORATION • *Kalamazoo, Michigan* **1992 – 1998**

A $7 billion public company of 30,000 employees which manufactures packaging products, specialty papers, consumer papers, and virgin and recycled paperboard throughout the United States, Canada, Mexico, and Europe.

TECHNICAL LAB MANAGER	1997 – 1998
DISTRIBUTION MANAGER	1995 – 1997
PROJECT MANAGER	1995
SHIFT SUPERVISOR	1993 – 1995
K-1 PROCESS ENGINEER	1992

Directed a 13 - 18 person team of operations, technical, and OTR drivers. Managed all aspects of regional transportation system including safety, environmental, financial results, quality, sales, productivity, capital needs and execution. Oversaw annual transportation budget of approximately $6 million.

- Reorganized and grew dedicated trucking fleet resulting in over $1 million in annual freight savings. (1996)
- Conceived and implemented joint freight venture with local manufacturer resulting in annualized savings of $287,000. (1996)
- Authored and implemented Plan of Control for K-1 machine. (1995)

Education / Certification / Community

Six Sigma Black Belt • (b)(6)

Six Sigma Green Belt •

(b)(6)

Executive MBA Program, Finance for Operations (one week course)

(b)(6)

BS in Engineering (Pulp & Paper Technology)

- Dual majors in Chemistry & Mathematics
- (b)(6)

(b)(6)

Lee Allen Hill

(b)(6)

Objective

I have over 26 years of experience in the Industrial Maintenance Field. I have been deeply involved primarily in the Paper Industry performing daily duties very similar, if not the same as the duties required by your site. I am eager to learn different processes and technology's, I am a team player, strive to do my best in all areas. If given the opportunity to join your team, I am confident that my excellent work ethic, dependability, knowledge and overall experiences will make a positive impact on your workforce, machine run ability your business overall bottom line.

Abilities

- Managed & preformed preventive maintenance tasks in the following industries; Paper Mills, Water, Generated Power, Aggregate, Wood and Cement equipment (gear reducers, pumps, refiners, rolls, agitators, fans, conveyors, motors, bearings, guide assemblies, etc.)
- Managed & performed repairs and installations for the following industries; Paper Mill, Water, Generated Power, Aggregate, Wood and Cement equipment (gear reducers, pumps, refiners, rolls, agitators, fans, conveyors, motors, guide assemblies, new equipment/systems, motor bases and cement piers etc.)
- Collected vibration readings on paper mill equipment as part of our preventive maintenance program. This would be analyzed by others and then a report generated to plan for next down day or outage to address issues.
- Perform alignment with indicators and laser equipment on rotating shafts and couplings.
- Perform rigging and lifting with overhead crane reaching weights up to 160,000lbs.
- Operate mobile equipment such as backhoe, forklift, carry deck cranes, boom trucks,
- Perform welding duties on structures when needed.
- I have the ability to overcome adversity and to function well under stress. I always have a plan B and C if needed, I do not give up easily. I enjoy a good challenge and like to work problems to a root cause, so they can be fixed properly and not patched. Understanding that a patch may be required in order to fix correctly at a later date.
- Manage small to large groups of people during the course of down days, outages or capital projects.
- I'm organized and thorough with excellent planning and executing skills.
- There's' no job to small or too big that I can't manage well.
- I'm a leader that leads by example, I hold myself accountable as well as the people around me.

Training Courses Completed

- Bearing -Lubrication Training
- Bearings I -Proper Handling and Identification Training
- Bearings II -Installation and Application Training
- Centrifugal Pump- Rebuild Training
- Gear I- Identification and Rebuild Training
- Gear II- Handling and Installation Training
- Precision Maintenance Class
- Coupling/ Shaft Alignment Class
- Confined Space Training
- Lockout/ Tagout Training
- Supervisor training
- OSHA 10 Training
- MSHA Training
- TAPI Safe
- Rigging Training
- Precision Measuring Tool Training
- CPR First Responder Training

Certificates

- Timken- Bearing Maintenance Training
- Falk School –Hands On Gear and Coupling Training
- Reliability Solutions- Precision Maintenance and Craft Skills Training
- Boom Truck Crane Certifications, GLG Lift, Scissor Lift, Carry Deck Crane, Lowell and Forklifts

Education

(b)(6) [redacted] Automotive Technology

High School Diploma – (b)(6) [redacted]

2017–Present –B&D Field Service Division Macon GA

- Operation's Manager –Responsible for overseeing daily operations of (4) Field Service locations (Macon GA, Savannah GA, West Monroe LA & Tacoma Washington)
- Manage 35 fulltime employees along with 30- 40 sub-contractor employees and part-time employees on a daily basis.
- Manage the scheduling and pre-planning for the upcoming Down Days, Outages and Capitol Projects.
- In-Field Support by filling in as a Project Manager or Technical Resource when other resources are not available due to schedule conflicts and or workload volumes are high.
- Manage and support the billing and accounts payable for all jobs in our division.
- Generate reports by using Microsoft Word, Microsoft Excel and Outlook.
- Manages operating cost for our division from day to day and month by month basis. Always looking for ways to save and to increase the bottom-line.
- Responsible for identifying employee training needs by performing quarterly evaluations on each employee and then scheduling the training identified in a timely matter to meet the needs of employee and employer.
- Responsible for managing & scheduling On-Call Crews for emergency breakdowns. (24hr/7 day)
- Responsible for success and through put of $11,000,000 in Annual Sales for the Field Service Division.

2015-2017 -B&D Reducer Repair Division Macon GA

- Operations Manager- Responsible for overseeing of the Reducer Repair / Machine Shop daily operations.
- Managed the scheduling of calibrating of shop precision tools and equipment.
- Manage the repairs and replacement of damaged tooling and equipment.
- Managed the ordering of shop materials and consumables to include managing cost and overhead.
- Managed the daily schedules for 12 fulltime employees,
- Managed the login process for all equipment entering our facility.
- Schedule and assigned all equipment to be inspected and tore down.
- Responsible for taking all the inspection data to create a failure report and a repair quote for the customer.
- Managed ordering parts, components and materials for approved repair jobs.
- Created shop work orders per the steps required to start the repair ie, scheduled all machine work, clean / prep work, rebuild of equipment, quality assurance checklist and prep/ paint process.
- Responsible for managing the documentation of all the Quality Assurance checks, during this process.
- Responsible for scheduling the delivery's for all completed jobs back to customer sites.
- Responsible for managing & scheduling On-Call Crews for emergency breakdowns. (24hr/7 day)
- Responsible for the success and through put of $6,500,000 in Annual Sales for Reducer / Machine Repair Shop.

2012 – 2015 – Resolute Forest Products Paper Mill Augusta GA

(Note: Resolute Forest Products decommissioned the #1 Paper Machine middle 2016 and laid off several employees. I was being proactive and left the company before the time came where I too would have been let go due to my seniority.

- Maintenance Supervisor #1 Paper Machine
- Planned, Scheduled and Managed the daily work load for (12) Mill Maintenance Mechanics for #1 Paper Machine
- Planned, Scheduled and Managed the monthly down days & annual outages for the #1 Paper Machine
- Responsible for ordering components, materials, equipment for each job planned & scheduled for #1 Paper Machine.
- Manage operating cost for all work being planned & scheduled for the #1 Paper Machine.
- Responsible for covering On-Call Duty (1) week a month, this was a duty that was rotated and supported by Maintenance Supervisors.
- Responsible for calling in mill resources and or sub-contractors to support the unexpected breakdown.

2008- 2012 – Versa Corp Mechanical / CR Meyer Byron GA

(Note: CR Meyer bought Versa Corp Mechanical in 2010, CR Meyer allowed the employees of Versa Corp Mechanical an opportunity to continue working as CR Meyer Employees after the buyout.)

2008-2010-Versa Corp Mechanical

- Partnership / Owner
- Managed the Eastern Division
- Responsible for generating sales, planning, scheduling and executing mechanical jobs sold.
- Managed 15 fulltime employees along with 25 part-time employees on a daily basis.
- Responsible for ordering components, materials, equipment for each job planned & scheduled.
- Projects I managed averaged from 2,000 to 250,000 per job. Total sales generated for the year was $1,800.000.

2010-2012- CR Meyer

- Project Manager
- Responsible for quoting down day, outage and capital projects for customers throughout the United States.
- Responsible for ordering all materials, components, equipment and tooling associated with the project.
- Responsible for scheduling manpower for the project.
- Worked with state union officials on manpower utilized from local union halls.
- Responsible for all the pre-planning, execution and billing for project.
- Responsible for all reports, quality assurance forms and work permits associated with project.
- Responsible for managing the projects to the quoted profit margins and looking for ways to be more efficient during projects.
- Projects I managed averaged from 2,000 to $3,500,000 per job. Total sales generated for the year was $5,000,000.

2004-2008- B&D Field Service Division Macon GA

Project Manager (2 yrs) 2004-2006

- Responsible for quoting down day, outage and capital projects for customers throughout the United States.
- Responsible for ordering all materials, components, equipment and tooling associated with the project.
- Responsible for scheduling manpower for the project.
- Worked with state union officials on manpower utilized from local union halls.
- Responsible for all the pre-planning, execution and billing for project.
- Responsible for all reports, quality assurance forms and work permits associated with project.
- Responsible for managing the projects to the quoted profit margins and looking for ways to be more efficient during projects.
- Projects I managed averaged from $5,000 to $500,000. Total sales generated for the year was $1,500,000.

Promoted to Operations Manager (2yrs) 2006-2008

- Operation's Manager –Responsible for the operations of (2) Field Service locations (Macon GA and Savannah GA)
- Manage 24 fulltime employees along with 15- 25 sub-contractor employees.
- Manage the scheduling and pre-planning for the upcoming down days and outages.
- Manage and support the billing and accounts payable for all jobs.
- Generate reports by using Microsoft Word, Microsoft Excel and Outlook.
- Manages operating cost for division on a day to day and month by month basis. Always looking for ways to save and to increase the bottom-line.
- Responsible for identifying employee training needs by performing quarterly evaluations on each employee and then scheduling the training identified in a timely matter to meet the needs of employee and employer.
- Responsible for success and through put of $5,500,000 in Annual Sales for the Field Service Division.

1991-2004- Procter & Gamble Paper Products Albany GA

2000-2004- Paper Machine Planner

- Maintenance Planner for #1 Paper Machine
- Planned, Scheduled and Managed the daily work load for (6) Mill Maintenance Mechanics for #1 Paper Machine
- Planned, Scheduled and Managed the monthly down days & annual outages for the #1 Paper Machine
- Responsible for ordering components, materials, equipment for each job planned & scheduled for #1 Paper Machine.
- Manage operating cost for all work being planned & scheduled for the #1 Paper Machine.

1991-2000 -Paper Machine Mechanic

- Perform daily preventive maintenance inspections on Paper Machine Equipment.
- Replaced / Repaired Paper Machine Rolls, Reducers, Motors, Fans, Pumps, Bearings, Gears, Gear Casings, Guide Assemblies and Conveyors etc.
- Performed daily and monthly lubrication routes for the machine.
- Performed Laser Alignments on all types of rotating equipment to include belts sheaves and sprockets.
- Installation of new equipment / systems.
- Flowed to work from one paper machine to another during down days and outages.
- Flowed to work in pulp mill area, converting lines, utilities and warehouse areas, when needed throughout the year.

Sincerely,

Lee A. Hill

RESUME OF: **JOHN ARTHUR BROOKE**

Phone: (b)(6)
(b)(6)

Primary: (b)(6)

Alternate:

OBJECTIVE: Position as a DCS Controls Engineer or related discipline specializing in Process Controls with an organization that recognizes self-motivation and thoroughness in performance.

SUMMARY: Thorough knowledge and experience of DCS Process Control Systems, Systems Integration, PLC programming, and Project Management in the Continuous and Batch Process Industries, with emphasis on Complex Systems, Installations, Troubleshooting Skills, Variable Frequency Drives, and Controls Engineering. Excellent record in customer satisfaction.

EDUCATION (9 years of College):

(b)(6) (b)(6) **High School -** (b)(6)

(b)(6)
-Data Processing & Computer Language Concepts, Earned 'Best Programmer' Award.

(b)(6)
-Basic Electronics Concepts, Graduated first in a class of 34, Meritoriously Promoted.

(b)(6)
-Advanced Digital Electronics Concepts, Distinguished Graduate; first in a class of 24.

(b)(6)
-Business Administration & Accounting Concepts, **Associates Degree**, GPA=(b)(6)

(b)(6)
-Ongoing Studies toward Chemistry degree w/minor in Computer Engineering (b)(6) Credit Hours, GPA=(b)(6)
-Emphasis on Computer Engineering/Physics, Chemistry, Programming, Digital Circuit Design

(b)(6) **Training:** (b)(6) Unitronics Advanced Training. Advanced HMI Graphics on Weintek, Maple Systems, KEP, Uticor, Automation Direct, and Panelviews touchscreens.

(b)(6) **Training:** Control Logix (b)(6) CEU. CCP152 Studio Logix Designer, CCP143 Control Logix Project Development, CCP146 Control Logix System Fundamentals, CCP151 Basic Ladder Logic, CCV204 Factory Talk & PVP Programming, CCP154 Structured Text/Sequential Function Chart.

EXPERIENCE (40 years Industry Experience):

1977-1980 **United States Marine Corps - Kaneohe Air Station, Hawaii, and DMZ, Korea**

-Cryptographic Technician in Charge

Directly responsible for cryptographic enciphering systems & equipment valued at $1.5 million.
Directed and assisted other technicians in troubleshooting and repair to the component level.
Installed & maintained cryptographic communications systems.
Had top secret special intelligence security clearance by the National Security Agency.

1980-2000 **Honeywell Measurex Corp. - Western Michigan Area**

-Senior Service Specialist / Technical Representative (on 24-hour call)

Sole responsibility for maintenance & emergency troubleshooting of six computer-based industrial process control computer systems valued in excess of $7 million. For Sappi Fine Papers: Bleach Plant (1980-2000), Kamyr Digester (1983-2000), #5 Paper Machine (1999-2000), and MDDC Roll Tracking System (1986-1995). For Rockford Paperboard: the Paperboard Machine (1992-2001), and Marquip Online Sheeter (1993-2001).
Installation/startups of these systems, process troubleshooting, and implementation of retrofits. Occasional acting Software/Process Engineer/Consultant called upon to solve difficult control problems/strategies.
Calibration and verification of sensors & gauges, including: basis weight, moisture, caliper, ash, coat weight, temperature, color, brightness, & chemical strength. Have developed improved gauge algorithms.
Extensive knowledge of scanners, chillers, power tracks, web inspection systems, bar code lasers, and printers.
Electrical repair to the board level, mechanical and pneumatic repairs, and timely generation of monthly reports.
Wrote Operator Manuals for multiple sites and trained employees.

2000-2003 **Rockford Paperboard Corp. - Rockford, Michigan - Process Engineer**

Sole responsibility for identifying and devising solutions for all process control problems, including engineering capital upgrades and retrofits, and overseeing implementation of associated projects.
Identical responsibilities as listed for Honeywell Measurex, only exclusively for Rockford Paperboard.
Sole responsibility for maintenance & emergency troubleshooting of all mill equipment/instrumentation and computer-based industrial process control computer systems valued in excess of $4 million.

2002-2004 **Rock Tenn - Otsego, Michigan - DCS Controls Engineer**

Team Responsibility for identifying and devising solutions for process control problems, including engineering capital upgrades and retrofits, and overseeing implementation of associated projects.
Sole responsibility for Honeywell Measurex Gauging system; including calibration and dynamic verification of sensors and gauges, inventory control, preventive maintenance, and emergency troubleshooting.
Oversight of Delta-V DCS system, including experience in custom Programming and Graphical design.

2004-2016 **Rock Tenn / WestRock - Delaware Water Gap, Pennsylvania**

-Senior Process Controls Engineer / DCS Engineer (on 24-hour call)

Manage all phases of mill process controls & capital projects, including engineering & project scoping, procuring quotes and cost estimation, selection of devices & protocols, design, PLC programming, preparing schematics & wiring schedules, procuring parts, testing, implementation, installation, interfacing field instrumentation, tuning control loops, startup support, and bringing multiple projects online on time and within budget constraints.
Coordinate with electrical and maintenance departments to ensure seamless implementation and robust operation.
Projects include complete design, systems integration, PLC programming, installation and start up support of systems including Fiber Cleaning/Screening systems, Water Treatment Plants, DCS replacement, Paper Machine Wet End Weight Controls, Speed/Draw Drive Coordination, Batch Recipes, and SCADA data collection.
Documenting of Procedures and Lockouts. Wrote Operator Manual for Water Treatment Plant project.
Responsible for interfacing and coordinating services with 3rd party contractors for ICS, DCS, and QCS systems.
Manage JDE Equipment Database, PI Tag Database, Camera Systems, and oversight of Honeywell DaVinci system.
Responsible for maintaining health of all PI data collection communications and mill networks. Developed hundreds of OSISoft PI displays with extensive graphics and trend plots. Active member of the Safety Committee.
Extensive programming experience of Allen Bradley, Unitronics, and Control Microsystems Scadapack PLC's, and communication protocols. interfacing with field instrumentation, tuning control loops, scanners, VFD's, etc. (Control Logix, Compact Logix, SLC500, Micrologix, PLC5, Telepace, Telepace Studio, Visilogic, Factory Talk ME Panelview, and HMI Easy Builder 500/5000, Powerflex 700, Eaton SV9000, Altivar drives, etc).
Emergency troubleshooting and support of all mill instrumentation and process control systems 24/7.

2013-2014 **Carlisle Consulting Inc - Carlisle, Pennsylvania**

-PLC Systems Integrator (concurrent with Rock Tenn/Westrock)

SCADA PLC Programming for Municipal Water Treatment Plants, including radio links to multiple remote lift stations, interface with multiple different systems, instrumentation, and equipment.
Projects include Pine Creek Water Treatment in Jersey Shore, Pennsylvania which networked 16 SCADA PLC's.
Emergency troubleshooting of SCADA systems and lift stations.

2016-2018 **Carthage Specialty Paperboard - Carthage, New York- Plant Engineer**

-Also acting Senior Process Controls Engineer (on 24-hour call)

Manage all phases of mill engineering & capital projects, including project scoping, procuring quotes and cost estimation & justification, selection of equipment, design, PLC programming, preparing schematics & wiring schedules, procuring parts, testing, implementation, overseeing installation, interfacing field instrumentation, startup support, and bringing multiple projects online on time and within budget constraints.
Timely Generation of Energy TEEP Reports (Total Effective Equipment Performance).
Coordinate with electrical and maintenance departments to ensure seamless implementation and robust operation.
Projects include complete design, systems integration, PLC programming, installation and start up support of systems including Profile Controls, DC Drives Upgrade, Speed/Draw Coordination, and Consistency Controls.
Manage Plex Equipment Database and oversight of Honeywell DaVinci system. Responsible for coordinating services with 3rd party contractors for projects, QCS systems, and maintaining health of mill DCS network.
Additional programming experience with Automation Direct PLC's & HMI's, Unitronics, VFD's (Direct Logic 6, Do More PLC, C-More EA7 & C-More EA9, Yaskawa, Powerflex 700, Frenic drives, etc).
Emergency troubleshooting and support of mill instrumentation, process controls, and electrical systems 24/7.
Active member of the Safety Committee. Wrote safety policies i.e. Lockout Tagout Policy.

2018-2019 **Pratt Industries - Valparaiso, Indiana – DCS Engineer**

DNA Administrator of Metso Valmet DCS for entire Paper Mill and Boiler, which includes Valmet Function Block programming of Automation Modules and Operator Workstation Graphical Interfaces, tuning of PID Controls, Interlock Logic, Calibration of Transmitters, maintenance of DCS and Network health and reliability.
Maintained Valmet Scanner with Basis Weight, Moisture, Color, and Fiber Orientation Sensors.
Worked with Allen Bradley Drives using Device Net, and TMEIC Drive Innovation Controllers and Software.
Projects include complete design, systems integration, function block programming, installation and start up support of systems including upgrading DCS Servers & Workstations, creation and modification of custom graphics, and DCS Network upgrades, and documentation of existing DCS network.
Coordinate with production and maintenance departments to ensure seamless implementation and robust operation.
Emergency troubleshooting and support of mill instrumentation, process controls, and electrical systems 24/7.

2019-Date **Long Falls Paperboard - Brattleboro, Vermont – Process Controls Engineer**

Manage all phases of mill process controls, including project scoping, procuring quotes and cost estimation & justification, selection of equipment, design, PLC & DCS programming, preparing schematics & wiring schedules, procuring parts, testing, implementation, overseeing installation, interfacing field instrumentation, startup support, and bringing projects online on time and within budget constraints.

Projects include complete design, systems integration, programming, installation and start up support of systems including DC Drives Upgrade (migration from MaxPak, FlexPak, AutoMax, Unico, Electroflyte), Speed/Draw Coordination, and VFD Energy Savings.

System Administrator for Delta-V DCS, Measurex Plantscape DCS, MXOpen QCS systems and scanners, and associated profiling equipment including Devron Autoslice, VIB, and Impact systems.

Emergency troubleshooting and support of mill instrumentation, process controls, and electrical systems 24/7.

EDWARD P. CHAMPAGNE, PMP

(b)(6)

SUMMARY

Senior level manager with extensive experience in project leadership, cost control and budgets, equipment and facility maintenance, business development and power plant supervision. Strong technical skills with knowledge of several process industries. Excellent team leadership and communication capabilities.

EXPERIENCE

Long Falls Paperboard/Neenah Paper, Brattleboro, VT **2017 - Current**

Manager of Maintenance and Engineering
Manage all maintenance functions and project engineering activities for a 90 TPD board machine and converting equipment. Lead cost reduction and reliability improvement efforts.

Southworth Company, Agawam & Turners Falls, MA **2008 - 2017**

Engineering Manager
Responsible for all engineering and maintenance activities for paper mill and converting facility. Key accomplishments:

- Coordinated all activities of the annual mill outages.
- Led the design, construction and startup of one of the first commercial size cellulose nano fibril systems.
- Created capital budgets and managed projects for winder and calendar controls upgrades, suction press rebuild, waste water surge tank, office construction and water wheel rebuild.
- Established preventive and predictive maintenance programs to reduce paper machine downtime.

EAC Operations, LLC., Division of EnergyAnswers Corp., Albany, NY **2000 - 2007**

Manager, Technology Programs
Responsible for design, development and on-going improvement of the company's technology products marketed under the EnergyAnswers name. This included proprietary equipment and systems for liquid waste recycling, modular mass burn combustors for disposal of municipal solid waste, processed refuse fuel systems, re-use of combustion residue, and value added coloring of landscape materials. Developed marketing materials and performed sales calls throughout the northeast USA. Conducted feasibility studies and prepared proposals for systems and equipment.

Manager, Capital Projects
Responsible for managing capital projects and conducting engineering studies related to EAC Operations "Energy from Waste" facilities and technology/business development activities. Provided construction management and contract administration, including responsibility for project budget and schedule. Defined design criteria, scopes of work, engineering estimates and permit requirements. Conducted engineering studies to support business development activities, facility operations enhancements and technology development.

Prior to 2000

International Paper/Strathmore Paper, Woronoco, Westfield, and Millers Falls Paper Mills

Various Positions:

Capital Projects Manager

Plant Engineer

Senior Project Engineer

Manager of Engineering & Maintenance

EDUCATION

MBA, General Business, (b)(6)

BSEM, Engineering Management (Industrial Engineering), (b)(6)

ADDITIONAL TRAINING

- Project Management
- Contractor Management
- Team Leader Training
- Ergonomics
- Process Hazard Recognition
- Paper Machine Rebuilding
- NFPA 70E Safety Training
- OSHA 10 Hour

AFFILIATIONS and LICENSES

Member, Technical Association of the Pulp and Paper Industry

Massachusetts Industrial Waste Water License, Grade 3

Certified Project Management Professional (PMP)

Additional Details – Project Management

1. Managed design, installation and start up for paper manufacturing equipment including: stock prep and refiners, headboxes, fourdrinier sections, cleaner systems, process piping and pumps, suction and press rolls, paper machine sectional drives, dryer drainage systems and rewinders.
2. Managed design, installation and start-up of converting equipment including: manual and automated wrapping and packaging equipment, paper trimmers, super calendar, embossers, envelop manufacturing equipment, die cutting, balers, shrink wrapping and warehouse rack systems.
3. Managed the relocation of envelop converting operations from Dalton and West Springfield MA to Agawam MA, to improve efficiencies. Managed the relocation of a die cutting operation from Holyoke MA to Agawam MA and a converting/bindery business from Baltimore to Agawam, MA. These projects required extensive modifications to the building electrical infrastructure as well as detailed scheduling to minimize impact on operations.
4. Managed the design, installation, start up and continued operation of the first large scale cellulose nano-fibril system.
5. Building infrastructure projects: hydro penstock rehabilitation, water wheel restoration, trash rack and forebay repairs, high voltage open buss replacement, structural upgrades, hoisting equipment, elevator hydraulic and ram upgrades, roof and window replacement and energy efficiency improvement projects utilizing numerous utility grants.
6. Managed design, installation and start-up of the first large scale liquid waste disposal system at a waste-to-energy power plant. Also, managed projects for new and rebuilt back pressure steam turbines, ash handling, air pollution control equipment including powdered carbon injection, bag house restoration, boiler tube replacement and solid waste combustion equipment. Was the team leader/project manager for obtaining four United States patents related to solid waste equipment improvements on behalf of Energy Answers Corp.
7. Operations and maintenance support: managed projects for boiler repairs, heat exchanger optimization, chimney restoration, and have planned nearly two dozen paper mill annual outages comprising hundreds of individual utility, production and maintenance projects. Continue to manage purchases of electricity and natural gas for two facilities.

GABRIELA CONSTANTIN

(b)(6)

EDUCATION

(b)(6) – BS in Chemical Engineering, GPA (b)(6)
(b)(6) – Associate Degree in Liberal Studies, GPA (b)(6)

EXPERIENCE

Process and Environmental Engineer – Long Falls Paperboard, LLC (Brattleboro, VT, 2019 – Present)

- Capital project design and implementation of plant-wide energy reduction projects
- Managing all environmental requirements for the facility, including daily/weekly/monthly/quarterly/annual testing, monitoring and reporting
- Managing all the facility state and federal permit compliance requirements, permit modifications and renewals for wastewater, stormwater, air pollution, hazardous waste, sludge management, radiation, underground storage tanks, ACT 250 permits
- Chief wastewater treatment facility operator overseeing and ensuring the safe and proper operation of the wastewater treatment plant
- Researching and applying for grants to support process improvement objectives
- Investigating different equipment and process setup options to meet most efficient results for the proposed applications
- Drafting P&IDs for the water and stock systems in the paper making process
- Traveling for equipment research and design efforts
- Facilitating plant-wide chemical trials and communication with chemical suppliers
- Leading training sessions and creating training procedures for managers, operators, and new hires
- Leading the Company's university recruiting efforts
- Reviewing, updating and creating company standard operating procedures
- Maintaining and updating the database containing the raw materials recipes for all the mill's products
- Data collection and statistical analysis to capture and interpret paper making process parameters, effectiveness of various chemicals such as polymers, drainage aid and defoamers
- Sample testing using numerous lab techniques (pH, turbidity, total suspended solids, dissolved oxygen, vacuum filtration, consistency measurements, charge analysis, ash testing, moisture analysis, freeness testing, handsheet moulding)

Process Engineer– Neenah Northeast, LCC (Brattleboro, VT, 2017-2018)

- Collaborated on the installation, static calibration and ongoing dynamic calibration of a microwave moisture sensor on the Honeywell MX Scanner used at the paper machine reel
- Implemented a dye inventory tracking and ordering system

- Tracking and identification of product contamination, made recommendations for corrective actions (product quality reviews, contamination action projects)
- Project work geared towards cost improvements and implementation of newer technologies (reducing fiber waste by tracking daily effluent flow suspended solids content, analyzing sludge press efficiency)
- Identified spares and critical parts in the maintenance department
- Monitoring, collecting, analyzing, and periodic reporting of both Delta V process control system data and routine test results (daily effluent fiber loss, paper manufacturing efficiencies)
- Developed technical training procedures for numerous continuous improvement projects

Engineering Research Assistant – (b)(6)
(b)(6)

- Led research consisting of reactions on biomass feedstock with the objective of creating diesel fuel via the thermal deoxygenation (TDO) process
- Performed reactions in a small-scale trickle (packed) bed reactor and ran them under different sets of temperature and pressure conditions
- Compared metal catalysts such as Iridium and Nickel-Iridium on a silica-alumina substrate and evaluated differences in reaction effectiveness
- Validated results of nearly 100% conversion to a mixture of saturated and cracked products suitable for diesel fuel
- Analyzed final products using gas chromatography/mass spectroscopy (GCMS) to compare the efficiency of catalysts in molecule hydrocracking
- Kept daily lab records of all reaction parameter data, any condition or equipment changes and created an experiment log documenting the methods and results of the research
- Maintained reactor and related lab equipment and tools
- Worked with hazardous and flammable chemicals and took all the proper precautions for safe handling of those substances, including online OSHA level trainings for hazardous materials training
- Presented the study results at a university research symposium

Peer Tutor (Level II) Mathematics and Chemistry – (b)(6)
(b)(6)

- Improved academic standing of students by reviewing class material, solving problems, teaching test taking strategies, time management and note-taking skills
- Led a General Chemistry recitation class during which in-depth explanations of class concepts were provided

SKILLS & CERTIFICATIONS

Awards

- (b)(6) Student Research Symposium – First Place in Engineering for academic achievement and dedication to research (b)(6)
- (b)(6)
- (b)(6)

Certifications

- Pollution Abatement Facility Operator Industrial Paper Grade II (2019)

(b)(6) [redacted]

Languages

(b)(6) [redacted]

Computer Skills

Skilled MS Office and MS Visio

Working knowledge of PTC Mathcad Prime, Aspen Plus, MiniTab, Emerson DeltaV DCS, Honeywell MX QCS, MS Project

ACTIVITIES AND INTERESTS

(b)(6) [redacted]

View Burden Statement

OMB Number: 4040-0004
Expiration Date: 12/31/2019

Application for Federal Assistance SF-424

* 1. Type of Submission:	* 2. Type of Application:	* If Revision, select appropriate letter(s):
☐ Preapplication	☒ New	
☒ Application	☐ Continuation	* Other (Specify):
☐ Changed/Corrected Application	☐ Revision	

* 3. Date Received: 01/15/2020	4. Applicant Identifier: Long Falls Paperboard LLC
5a. Federal Entity Identifier:	5b. Federal Award Identifier:

State Use Only:

6. Date Received by State:	7. State Application Identifier:

8. APPLICANT INFORMATION:

* a. Legal Name: Long Falls Paperboard LLC

* b. Employer/Taxpayer Identification Number (EIN/TIN): 32-0575389	* c. Organizational DUNS: 1169348660000

d. Address:

* Street1:	161 Wellington Road
Street2:	
* City:	Brattleboro
County/Parish:	Windham
* State:	VT: Vermont
Province:	
* Country:	USA: UNITED STATES
* Zip / Postal Code:	05301-7052

e. Organizational Unit:

Department Name:	Division Name:

f. Name and contact information of person to be contacted on matters involving this application:

Prefix:		* First Name:	Michael
Middle Name:	P.		
* Last Name:	Cammenga		
Suffix:			

Title: Principal

Organizational Affiliation:
Long Falls Paperboard LLC

* Telephone Number: 940-329-0808	Fax Number: 802-257-5973

* Email: mike.cammenga@longfallsgroup.com

Application for Federal Assistance SF-424

*** 9. Type of Applicant 1: Select Applicant Type:**

Q: For-Profit Organization (Other than Small Business)

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

* Other (specify):

*** 10. Name of Federal Agency:**

USDA Forest Service

11. Catalog of Federal Domestic Assistance Number:

10.674

CFDA Title:

Wood Utilization Assistance

*** 12. Funding Opportunity Number:**

USDA-FS-WERC-2020

* Title:

2020 Wood Innovations Funding Opportunity

13. Competition Identification Number:

Title:

14. Areas Affected by Project (Cities, Counties, States, etc.):

Add Attachment | Delete Attachment | View Attachment

*** 15. Descriptive Title of Applicant's Project:**

Long Falls Paperboard Biomass Combined Heat & Power Conversion Project - Flue Gas Condensation Alternate to Achieve Maximum Efficiency

Attach supporting documents as specified in agency instructions.

Add Attachments | Delete Attachments | View Attachments

Application for Federal Assistance SF-424

16. Congressional Districts Of:

* a. Applicant: VT CD1

* b. Program/Project: VT CD1

Attach an additional list of Program/Project Congressional Districts if needed.

Add Attachment | Delete Attachment | View Attachment

17. Proposed Project:

* a. Start Date: 08/01/2020

* b. End Date: 08/01/2022

18. Estimated Funding ($):

* a. Federal	500,000.00
* b. Applicant	420,000.00
* c. State	0.00
* d. Local	0.00
* e. Other	0.00
* f. Program Income	0.00
* g. TOTAL	920,000.00

*** 19. Is Application Subject to Review By State Under Executive Order 12372 Process?**

☐ a. This application was made available to the State under the Executive Order 12372 Process for review on .

☐ b. Program is subject to E.O. 12372 but has not been selected by the State for review.

☒ c. Program is not covered by E.O. 12372.

*** 20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes," provide explanation in attachment.)**

☐ Yes ☒ No

If "Yes", provide explanation and attach

Add Attachment | Delete Attachment | View Attachment

21. *By signing this application, I certify (1) to the statements contained in the list of certifications and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances** and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 218, Section 1001)**

☒ ** I AGREE

** The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

Authorized Representative:

Prefix:

* First Name: Michael

Middle Name: P.

* Last Name: Cammenga

Suffix:

* Title: Principal

* Telephone Number: 940-329-0808

Fax Number: 802-257-5973

* Email: mike.cammenga@longfallsgroup.com

* Signature of Authorized Representative:

* Date Signed: 01/13/2020

BUDGET INFORMATION - Non-Construction Programs

OMB Number: 4040-0006
Expiration Date: 02/28/2022

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. 2020 Wood Innovations Funding Opportunity USDA-FS-WERC-2020		$	$	$ 500,000.00	$ 420,000.00	$ 920,000.00
2.						
3.						
4.						
5. Totals		$	$	$ 500,000.00	$ 420,000.00	$ 920,000.00

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY				Total
	(1)	(2)	(3)	(4)	(5)
	2020 Wood Innovations Funding Opportunity USDA-FS-WERC-2020				
a. Personnel	$	$	$	$	$
b. Fringe Benefits					
c. Travel					
d. Equipment	550,000.00				550,000.00
e. Supplies					
f. Contractual	370,000.00				370,000.00
g. Construction					
h. Other					
i. Total Direct Charges (sum of 6a-6h)	920,000.00				$ 920,000.00
j. Indirect Charges					$
k. TOTALS (sum of 6i and 6j)	$ 920,000.00	$	$	$	$ 920,000.00
7. Program Income	$	$	$	$	$

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SECTION C - NON-FEDERAL RESOURCES

	(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e)TOTALS
8.	2020 Wood Innovations Funding Opportunity	$ 420,000.00	$	$	$ 420,000.00
9.					
10.					
11.					
12. TOTAL (sum of lines 8-11)		$ 420,000.00	$	$	$ 420,000.00

SECTION D - FORECASTED CASH NEEDS

	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	$	$	$	$	$
14. Non-Federal	$				
15. TOTAL (sum of lines 13 and 14)	$	$	$	$	$

SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT

	(a) Grant Program	FUTURE FUNDING PERIODS (YEARS)			
		(b)First	(c) Second	(d) Third	(e) Fourth
16.	2020 Wood Innovations Funding Opportunity	$	$ 500,000.00	$ 0.00	$
17.					
18.					
19.					
20. TOTAL (sum of lines 16 - 19)		$	$ 500,000.00	$ 0.00	$

SECTION F - OTHER BUDGET INFORMATION

21. Direct Charges:

22. Indirect Charges:

23. Remarks: Actual purchase and installation of the flue gas condensation unit is not expected until Q2, federal FY2021

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USDA

Certification Regarding Debarment, Suspension, and Other Responsibility Matters Primary Covered Transactions

AD-1047

The following statement is made in accordance with the Privacy Act of 1974 (5 U.S.C. § 552a, as amended). This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, and 2 C.F.R. § 180.335, Participants' responsibilities. The regulations were amended and published on August 31, 2005, in 70 Fed. Reg. 51865-51880. Copies of the regulations may be obtained by contacting the Department of Agriculture agency offering the proposed covered transaction.

According to the Paperwork Reduction Act of 1995 an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0505-0027. The time required to complete this information collection is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. The provisions of appropriate criminal, civil, fraud, privacy, and other statutes may be applicable to the information provided.

(Read instructions on page two before completing certification.)

A. The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:
   1. Are not presently debarred, suspended, or proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
   2. Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;
   3. Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (A.2.) of this certification; and
   4. Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

B. Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

ORGANIZATION NAME	PR/AWARD NUMBER OR PROJECT NAME
Long Falls Paperboard LLC	2020 Wood Innovations Funding Opportunity

NAME(S) AND TITLE(S) OF AUTHORIZED REPRESENTATIVE(S)

Prefix:	Mr.
First Name:	Michael
Middle Name:	P.
Last Name:	Cammenga
Suffix:	
Title:	Principal

SIGNATURE(S)	DATE
Michael P. Cammenga	01-09-2020

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at How to File a Program Discrimination Complaint (https://www.ascr.usda.gov/filing-program-discrimination-complaint-usda-customer) and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442.

Instructions for Certification

(1) By signing and submitting this form, the prospective primary participant is providing the certification set out on page 1 in accordance with these instructions.

(2) The inability of a person to provide the certification required below will not necessarily result in denial of participation in this covered transaction. The prospective participant shall submit an explanation of why it cannot provide the certification set out on this form. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective primary participant to furnish a certification or an explanation shall disqualify such person from participation in this transaction.

(3) The certification in this clause is a material representation of fact upon which reliance was placed when the department or agency determined to enter into this transaction. If it is later determined that the prospective primary participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

(4) The prospective primary participant shall provide immediate written notice to the department or agency to which this proposal is submitted if at any time the prospective primary participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

(5) The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of the rules implementing Executive Order 12549, at 2 C.F.R. Parts 180 and 417. You may contact the department or agency to which this proposal is being submitted for assistance in obtaining a copy of those regulations.

(6) The prospective primary participant agrees by submitting this form that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency entering into this transaction.

(7) The prospective primary participant further agrees by submitting this form that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion -Lower Tier Covered Transactions," provided by the department or agency entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

(8) A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the System for Award Management (SAM) database.

(9) Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

(10) Except for transactions authorized under paragraph (6) of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

This form is available electronically.

OMB Control No. 0505-0027
Expiration Date: 04/30/2022

USDA

Certification Regarding Drug-Free Workplace Requirements (Grants)
Alternative I – For Grantees Other Than Individuals

AD-1049

The following statement is made in accordance with the Privacy Act of 1974 (5 U.S.C. § 552a, as amended). This certification is required by the regulations implementing §§ 5151-5160 of the Drug-Free Workplace Act of 1998 (Pub. L.100-690, Title V, Subtitle D: 41 U.S.C. § 8101 et seq.), and 2 C.F.R. Parts 182 and 421. The regulations were amended and published on June 15, 2009, in 74 Fed. Reg. 28150-28154 and on December 8, 2011, in 76 Fed. Reg. 76610-76611. Copies of the regulations may be obtained by contacting the Department of Agriculture agency offering the grant.

According to the Paperwork Reduction Act of 1995 an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0505-0027. The time required to complete this information collection is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. The provisions of appropriate criminal, civil, fraud, privacy, and other statutes may be applicable to the information provided.

(Read instructions on page three before completing certification.)

A. The grantee certifies that it will or will continue to provide a drug-free workplace by:

1. Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

2. Establishing an ongoing drug-free awareness program to inform employees about –

   a. The dangers of drug abuse in the workplace;

   b. The grantee's policy of maintaining a drug-free workplace;

   c. Any available drug counseling, rehabilitation, and employee assistance programs; and

   d. The penalties that may be imposed upon employees for drug-abuse violations occurring in the workplace.

3. Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph A.1.

4. Notifying the employee in the statement required by paragraph A.1 that, as a condition of employment under grant, the employee will –

   a. Abide by the terms of the statement; and

   b. Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;

5. Notifying the agency in writing, within ten calendar days after receiving notice under subparagraph A.4.b from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification number(s) of each affected grant;

6. Taking one of the following actions, within 30 calendar days of receiving notice under subparagraph A.4.b, with respect to any employee who is so convicted –

   a. Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or

   b. Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or, local health, law enforcement, or other appropriate agency;

7. Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs A.1 through A.6.

B. The grantee may insert in the space provided below the site(s) for the performance of work done in connection with the specific grant:

PLACE OF PERFORMANCE *(Street Address, City, County, State, Zip Code)*

Delete Entry

Street1:	161 Wellington Road
Street2:	
City:	Brattleboro
County:	Windham
Country:	USA: UNITED STATES
State:	VT: Vermont
Province:	
Zip / Postal Code:	05301

Add Place of Performance

Check ☐ if there are workplaces on file that are not identified here.

ORGANIZATION NAME	PR/AWARD NUMBER OR PROJECT NAME
Long Falls Paperboard LLC	2020 Wood Innovations Funding Opportunity

NAME(S) AND TITLE(S) OF AUTHORIZED REPRESENTATIVE(S)

Prefix:	Mr.
First Name:	Michael
Middle Name:	P.
Last Name:	Cammenga
Suffix:	
Title:	Principal

SIGNATURE(S)	DATE
[signature]	01-09-2020

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at How to File a Program Discrimination Complaint (https://www.ascr.usda.gov/filing-program-discrimination-complaint-usda-customer) and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442.

Instructions for Certification

(1) By signing and submitting this form, the grantee is providing the certification set out on pages one and two in accordance with these instructions.

(2) The certification set out on pages one and two is a material representation of fact upon which reliance is placed when the agency awards the grant. If it is later determined that the grantee knowingly rendered a false certification, or otherwise violates the requirements of the Drug-Free Workplace Act, the agency, in addition to any other remedies available to the Federal Government, may take action authorized under the Drug-Free Workplace Act.

(3) Workplaces under grants, for grantees other than individuals, need not be identified on the certification. If known, they may be identified in the grant application. If the grantee does not identify the workplaces at the time of application, or upon award, if there is no application, the grantee must keep the identity of the workplace(s) on file in its office and make the information available for Federal inspection. Failure to identify all known workplaces constitutes a violation of the grantee's drug-free workplace requirements.

(4) Workplace identifications must include the actual address of buildings (or parts of buildings) or other sites where work under the grant takes place. Categorical descriptions may be used (e.g., all vehicles of a mass transit authority or State highway department while in operation, State employees in each local unemployment office, performers in concert halls or radio studios).

(5) If the workplace identified to the agency changes during the performance of the grant, the grantee shall inform the agency of the change(s). If it previously identified the workplaces in question, see paragraph (3) above.

(6) Definitions of terms in the Nonprocurement Suspension and Debarment common rule and Drug-Free Workplace common rule apply to this certification. Grantees' attention is called, in particular, to the following definitions from these rules:

- "Controlled substance" means a controlled substance in Schedules I through V of the Controlled Substances Act, 21 U.S.C. § 812, and as further defined by 21 C.F.R. §§ 1308.11-1308.15.
- "Conviction" means a finding of guilt (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statutes.
- "Criminal drug statute" means a Federal or non-Federal criminal statute involving the manufacture, distribution, dispensing, use, or possession of any controlled substance.
- "Employee" means the employee of a grantee directly engaged in the performance of work under a grant, including: (i) all "direct charge" employees (ii) all "indirect charge" employees unless their impact or involvement is insignificant to the performance of the grant and, (iii) temporary personnel and consultants who are directly engaged in the performance of work under the grant and who are on the grantee's payroll. This definition does not include workers not on the payroll of the grantee (e.g., volunteers, even if used to meet a matching requirement, consultants or independent contractors not on the grantee's payroll, or employees of subrecipients or subcontractors in covered workplaces).

This form is available electronically.

OMB No. 0505-0025
Expiration Date: 06/30/2022

AD-3030

Representations Regarding Felony Conviction and Tax Delinquent Status for Corporate Applicants

Note: You only need to complete this form if you are a corporation. A corporation includes, but is not limited to, any entity that has filed articles of incorporation in one of the 50 States, the District of Columbia, or the various territories of the United States including American Samoa, Federated States of Micronesia, Guam, Midway Islands, Northern Mariana Islands, Puerto Rico, Republic of Palau, Republic of the Marshall Islands, or the U.S. Virgin Islands. Corporations include both for profit and non-profit entities.

The following statement is made in accordance with the Privacy Act of 1974 (5 U.S.C. § 552a, as amended). The authority for requesting the following information for U.S. Department of Agriculture (USDA) agencies and staff offices is in § 744 and 745 of the Consolidated Appropriations Act, 2019, Pub. L. 116-6 as amended and/or subsequently enacted. The information will be used to confirm applicant status concerning entity conviction of a felony criminal violation, and/or unpaid Federal tax liability status.

According to the Paperwork Reduction Act of 1995 an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0505-0025. The time required to complete this information collection is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. The provisions of appropriate criminal, civil, fraud, privacy, and other statutes may be applicable to the information provided.

PART A - APPLICANT

1. APPLICANT'S NAME	2. APPLICANT'S ADDRESS *(Including Zip Code)*	3. TAX ID NO. *(Last 4 digits)*
Long Falls Paperboard LLC	161 Wellington Road Brattleboro VT 05301	5389

4A. Has the Applicant been convicted of a felony criminal violation under any Federal law in the 24 months preceding the date of application? ☐ YES ☒ NO

4B. Does the Applicant have any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability? ☐ YES ☒ NO

Providing the requested information is voluntary. However, failure to furnish the requested information will make the applicant ineligible to enter into a contract, memorandum of understanding, grant, loan, loan guarantee, or cooperative agreement with USDA.

PART B - SIGNATURE

5A. APPLICANT'S SIGNATURE (BY)	5B. TITLE/RELATIONSHIP OF THE INDIVIDUAL IF SIGNING IN A REPRESENTATIVE CAPACITY	5C. DATE SIGNED *(MM-DD-YYYY)*
Michael P. Connors	Principal	01-09-2020

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at How to File a Program Discrimination Complaint (https://www.ascr.usda.gov/filing-program-discrimination-complaint-usda-customer) and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442.

CERTIFICATION REGARDING LOBBYING

Applicants should also review the instructions for certification included in the regulations before completing this form. Signature on this form provides for compliance with certification requirements under 4 CFR Part 418 Appendix A, Certification Regarding Lobbying. The certifications shall be treated as a material representation of fact upon which reliance will be placed when the U.S. Forest Service determines to award the covered transaction, grant, or cooperative agreement.

Lobbying

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, 'Disclosure Form to Report Lobbying.' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

As the duly authorized representative of the applicant, I hereby certify that the applicant will comply with the above applicable certification.

SIGNATURE		
APPLICANT'S SIGNATURE (BY) Michael P Cammenga	TITLE/RELATIONSHIP OF THE INDIVIDUAL IF SIGNING IN A REPRESENTATIVE CAPACITY Principal	DATE SIGNED *(MM-DD-YYYY)* 01-09-2020

Burden Statement

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0217. The time required to complete this information collection is estimated to average 9 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call toll free (866) 632-9992 (voice). TDD users can contact USDA through local relay or the Federal relay at (800) 877-8339 (TDD) or (866) 377-8642 (relay voice). USDA is an equal opportunity provider and employer.

USDA Forest Service

OMB 0596-0217
FS-1500-22

FINANCIAL CAPABILITY QUESTIONNAIRE
FISCAL YEAR: 2020

Adequate accounting systems should meet the following criteria as outlined in the Office of Management and Budget's (OMB) Circular of Uniform Administrative Requirements, Cost Principles, and Audit Requirements found in 2 CFR Part 200, as implemented by USDA regulations 2 CFR Part 400.

(1) Accounting records should provide information needed to adequately identify the receipt of funds under each grant awarded and the expenditure of funds for each grant.

(2) Entries in accounting records should refer to subsidiary records and/or documentation which support the entry and which can be readily located.

(3) The accounting system should provide accurate and current financial reporting information.

(4) The accounting system should be integrated with an adequate system of internal controls to safeguard the funds and assets covered, check the accuracy and reliability of accounting data, promote operational efficiency, and encourage adherence to prescribed management policies.

APPLICANT ORGANIZATIONAL INFORMATION

1. Name of Organization and Address:

Long Falls Paperboard LLC
161 Wellington Road
Brattleboro VT 05301

2. Authorized Representative's Name and Title: Mr. Michael Cammenga

3. Phone: 940 - 329 - 808 ext.	4. Fax: - -	5. Email: mike.cammenga@longfallsgroup.com
6. Year Established: 2019	7. Employer Identification Number (EIN): 32 - 0575389	8. DUNS Number: - -

9. Type of Organization: For Profit Business, Limited Liability Corporation

10. Approximate Number of Employees: 100 Full Time (Paid): 100 Full Time (Volunteer): 0	Part Time (Paid): 0 Part Time (Volunteer): 0

FEDERAL AUDIT DATA

11. Have you been audited by a Federal agency?: ☐ Yes ☒ No

If yes, please indicate the type:

☐ OMB A-133 Single Audit (required of institutions that annually expend over $750,000 in federal funds

☐ Incurred Cost ☐ Accounting System ☐ Timekeeping

12. Date of Last Federal Audit/Review *(m/d/yyyy)*:	Audit Agency/Firm:

If findings are reported, explain:

FINANCIAL STATEMENT AUDIT DATA

13. Date of Last Financial Statement Audit:		Fiscal Period Audited:
Audit Firm:		
Auditor's Opinion on Financial Statement:	☐ Unqualified Opinion	☐ Qualified, Disclaimer or Adverse Opinions

If other than unqualified, state reason:

If you have not had an audit completed in the last two years, please submit a copy of your most recent tax forms (990 for non-profits). If you do not have a current tax form, please explain: 2019 is the first year of the operation of the business and first year taxes have not been completed yet.

ACCOUNTING SYSTEM	
14. Has any Government Agency rendered an official written opinion concerning the adequacy of the accounting system for the collection, identification and allocation of costs under Federal contracts/grants? ☐ Yes ☒ No	
15. If yes, provide name and address of Agency performing review:	**Attach a copy of the latest review and any subsequent correspondence, clearance documents, etc.**
16. Which of the following best describes your accounting system: ☐ Manual ☒ Automated ☐ Combination	
17. Does the accounting system identify the receipt and expenditure of program funds separately for each grant?	☒ Yes ☐ No ☐ Not Sure
18. Does the accounting system provide for the recording of expenditures for each grant/contract by budget cost categories shown in the approved budget?	☒ Yes ☐ No ☐ Not Sure
19. Does the accounting system provide for the recording of cost sharing or match for each grant? Can you ensure that documentation is available to support recorded match or cost share?	☒ Yes ☐ No ☐ Not Sure
20. Are time distribution records maintained for each employee that specifically identify effort charged to a particular grant or cost objective?	☒ Yes ☐ No ☐ Not Sure
21. Does the accounting/financial system include budgetary controls to preclude incurring obligations or costs in excess of total funds available for a grant?	☒ Yes ☐ No ☐ Not Sure
22. Does the accounting/financial system include budgetary controls to preclude incurring obligations or costs in excess of total funds available for a budget cost category (e.g. Personnel, Travel, etc.)?	☒ Yes ☐ No ☐ Not Sure
23. Is your organization generally familiar with the existing regulation and guidelines containing the Cost Principles and procedures for the determination and allowance of costs in connection with Federal grants?	☒ Yes ☐ No ☐ Not Sure
FUNDS MANAGEMENT	
24. Is a separate bank account maintained for Federal grant funds?	☐ Yes ☒ No
25. If a separate bank account is not maintained, can the Federal grant funds and related expenses be readily identified?	☒ Yes ☐ No
PROPERTY STANDARDS, PROCUREMENT STANDARDS, AND TRAVEL POLICIES	
PROPERTY STANDARDS	

26. Does your property management system(s) provide for maintaining: (1) a description of the equipment; (2) an identification number; (3) source of the property, including the award number; (4) where title vests; (5) acquisition date; (6) federal share of property cost; (7) location and condition of the property; (8) acquisition cost; & (9) ultimate disposition information?	☒ Yes ☐ No ☐ Not Sure
27. Does your property management system(s) provide for a physical inventory and reconciliation of property at least every two years?	☒ Yes ☐ No ☐ Not Sure
28. Does your property management system(s) provide controls to insure safeguards against loss, damage or theft of the property?	☒ Yes ☐ No ☐ Not Sure
PROCUREMENT STANDARDS	
29. Does your organization maintain written procurement procedures which (1) avoid unnecessary purchases; (2) provide an analysis of lease and purchase alternatives; and (3) provide a process for soliciting goods and services?	☒ Yes ☐ No ☐ Not Sure
30. Does your procurement system provide for the conduct to ensure selection on a competitive basis and documentation of cost or price analysis for each procurement action?	☒ Yes ☐ No ☐ Not Sure
31. Does your procurement system include provisions for checking the "Excluded Parties List" system for suspended or debarred sub-grantees and contractors, prior to award? www.sam.gov	☒ Yes ☐ No ☐ Not Sure
TRAVEL POLICY	
32. Does your organization maintain a standard travel policy or, if no policy exists, does your organization adhere to rates and amounts established under 5 U.S.C. 5701–11, ("Travel and Subsistence Expenses; Mileage Allowances"), and policies under the Federal Acquisition Regulations at 48 CFR 31.205– 46(a)?	☒ Yes ☐ No ☐ Not Sure
SUBRECIPIENT MANAGEMENT	
33. (For Pass-through entities only). Does your organization have controls in place to monitor activities of subrecipients, as necessary, to ensure that Federal awards are used for authorized purposes in compliance with laws, regulations, and the provisions of the award and that performance goals are achieved.	☒ Yes ☐ No ☐ Not Sure
INDIRECT COSTS	
34. My organization has an established indirect cost rate	☒ Yes ☐ No ☐ Not Sure
35. If my organization chooses to charge indirect costs to the Federal award or use indirect costs as a match, you understand that you must prepare an indirect cost rate proposal and submit it to your cognizant Federal agency for approval. Alternatively, you may use a de minimus rate of 10% of modified total direct costs (MTDC).	☒ Yes ☐ No ☐ Not Sure

STANDARDS FOR FINANCIAL MANAGEMENT SYSTEMS AND APPLICANT CERTIFICATION

I certify that the above information is complete and correct to the best of my knowledge.

Signature:	Michael P Cammenga
Name:	Michael P Cammenga
Title:	Principal

Burden Statement

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0217. The time required to complete this information collection is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

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Create Individual Account

Account Confirmation

Confirmation
Thu Jan 09 14:18:32 EST 2020
You have successfully created your SAM account. There is no further action required. You will receive a confirmation email with your username. Select Done to return to the SAM homepage.