BIOMASS FEASIBILITY STUDY

for the

Southwestern Vermont Medical Center
100 Hospital Drive
Bennington Vermont

Prepared for:

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List of Acronyms & Abbreviations

A

B

Btu – British thermal unit

BEC – Bennington Energy Committee

BCRC – Bennington County Regional Commission

C

C – Carbon (or Carbon equivalent)

CO – Carbon Monoxide

CO_2 – Carbon Dioxide

CUP – Central Utility Plant

D

DOE – U.S. Department of Energy

E

EPC – Energy Performance Contract

ESCO – Energy Service Company

F

F&T – Fitzemeyer & Tocci Associates, Inc.

H

HP – Horsepower

HVAC – Heating, Ventilation, and Air Conditioning

I

IRR – Internal Rate of Return

ISO – Independent Systems Operator (transmissions system)

K

kW – Kilowatt (1,000 watts)

kWh – Kilowatt hour

kVA - Kilovolt Ampere

L

LBPA – Lavallee Brensinger Architects

LLC – Life Cycle Costing

M

MBH – One Thousand British Thermal Units (1,000 Btu) per Hour

MMBtu – Million British Thermal Units (1,000,000 Btu)

MW – Megawatt

N

NO_X – Nitrogen Oxide

NYMEX – New York Mercantile Exchange

S

SO_2 – Sulfur Dioxide

SP – Simple Payback

U

UPV – Uniform Present Value

V

VT ANR – Vermont Agency of Natural Resources

I. EXECUTIVE SUMMARY

GDS Associates (GDS) has been retained by Lavallee Brensinger Architects (LBPA) to evaluate the feasibility of incorporating a biomass heating system at the Southwestern Vermont Medical Center (SVMC) in Bennington, Vermont. This feasibility study expands upon a preliminary woodchip evaluation conducted by LBPA and Fitzemeyer & Tocci Associates, Inc. (F&T), in October 2008[1]. The intent of this study is to provide sufficient information and detail to assist SVMC staff and senior decision makers with the consideration of biomass heating at the SVMC Bennington Campus.

Per direction from LBPA and F&T, the scope of this study is limited to the consideration of the following woodchip and wood pellet biomass technologies:

- 500 HP Woodchip Direct Burn Boiler
- 1,000 HP Woodchip Direct Burn Boiler
- 500 HP Woodchip Gasification Boiler
- 1,000 HP Woodchip Gasification Boiler
- 500 HP Wood Pellet Boiler
- 1,000 HP Wood Pellet Boiler

In all scenarios, the evaluated biomass heating systems will be backed up by three (3) 500 HP No. 2 oil boilers to provide full redundancy. The installation of the three oil boilers in a new central utility plant (CUP) is currently in progress, thus the inclusion of these oil boilers is a given in this study.

GDS worked collaboratively with LBPA, F&T, and Forward Thinking Consultants (FTC) to develop a comprehensive analysis of the wood heating systems. This study includes detailed financial analyses of each proposed system, evaluation of present and future fuel prices, and consideration of other important factors such as system reliabilities, traffic impacts, greenhouse gas emissions and the use of regional resources.

A weighted matrix ranking system was developed to compare each of the wood heating systems taking into account each of the factors discussed above. The table below summarizes the findings of the study based on the total weighted score for each system:

[1] Summary of Current Wood Chip Fuel Analysis – Fitzemeyer & Tocci Associates, Inc., Scott LeClair, October 17, 2008

	Simple Payback	Lifecycle Costs	Capital Costs	O + M Costs	Fuel Delivery	Emissions	Regional Resources	*Total Score (100 max)*
WEIGHT (1-5)	**3**	**5**	**5**	**4**	**3**	**2**	**1**	
Wood Chip Boilers								
500 HP Direct Burn	5	4	5	2	2	1	4	***70***
500 HP Gasification	5	5	4	1	3	2	4	***70***
1,000 HP Direct Burn	4	2	1	2	2	2	4	***43***
1,000 HP Gasification	4	3	1	1	2	3	4	***45***
Pellet Boilers								
500 HP Direct	1	1	5	5	4	4	2	***65***
1,000 HP Direct Burn	1	1	4	5	4	5	2	***63***

Table 1: Study Findings

Based on the scoring matrix, the 500 HP gasification boilers are the best option for the SVMC. Detailed monthly steam load analyses were calculated as part of this study and it was determined that the 500 HP boilers are sufficient to serve nearly 92% of the hospital's future steam load. Given that the biomass systems will be backed up by three 500 HP oil boilers, the 1,000 HP boilers are not cost effective for this project. The growing demand and escalating price of wood pellets causes the wood pellet options to be similarly non-cost effective.

The 500 HP gasification woodchip boiler requires an additional capital investment of approximately $5,000,000 and an additional $320,000 in annual operating cost. The first year net savings, based on offset fuel oil costs, is approximately $684,000. The estimated 20 year internal rate of return on the investment is 14.7%.

The fuel savings are based on the 2009 futures forecast published by the Energy Information Administration (EIA). Future oil costs cannot be forecasted reliably, however the cost of oil is expected to remain above the cost of wood chips.

The final decision as to the viability of incorporating a biomass system at the SVMC will be made by the hospital. This report outlines all considerations and calculations necessary to make an informed decision to investigate further or seek related options.

II. INTRODUCTION

This study comprises a detailed feasibility analysis of six (6) different wood heating systems that are being considered for use at the Southwestern Vermont Medical Center (SVMC). This section discusses the project background, assumptions and previous studies, and the project scope.

Project Background

The SVMC is presently served by an outdated boiler and chilled water system. The average age of the steam boilers is 34 years; one boiler is over 42 years old. The boiler and chiller systems both experienced reliability issues in 2007 that impacted operations at the hospital and caused SVMC staff to consider replacement of the existing boiler and chiller systems with new systems.

Fitzemeyer and Tocci Associates, Inc. (F&T), a mechanical and electrical engineering firm based in Stoneham Massachusetts was contracted to evaluate options for the new boiler and chilled water systems and to prepare design documents. F&T considered a variety of fuels based on costs, availability, existing infrastructure, and the needs of the hospital. As discussed below, F&T was able to rule out the use of natural gas, propane, and No. 6 fuel oil and focus on No. 2 fuel oil and wood (woodchips and pellets) as viable fuels for the hospital.

SVMC and the project team for the new central utility plant (CUP) have determined that the CUP requires a minimum of three No 2 oil fired, 500 HP boilers to meet the AIA Guidelines for healthcare construction's N+1 reliability requirements for heat plants at hospitals. Regardless of the outcome of this study, the SVMC CUP will include a minimum of three No. 2 oil fired boilers to meet the Guideline requirements.

SVMC received a conditional permit from Vermont's Act 250 Environmental Commission on October 31, 2008. The condition of the permit is that the SVMC must prepare a detailed feasibility study of incorporating a wood heating system in addition to the three No. 2 fuel oil boilers that will be included for reliability reasons regardless of whether a biomass system is utilized. The detailed feasibility study is due by February 9, 2009. This study has been conducted as required by the Act 250 Environmental Commission Board conditional permit.

Previous Studies

Preliminary studies were conducted to narrow the focus of the boiler and chiller replacement. The first key issue studied was whether to simply refurbish the existing central plant or to construct a new central plant. Due to severe space and constructability limitations, it was concluded by F&T that the best option was to construct a new free standing central plant sited on campus. This arrangement allowed for maximum campus flexibility. All of the biomass heating options evaluated in this study assume that a new central utility plant will be constructed and that the existing central plant will not be refurbished.

The second key issue studied was the type of fuel to be utilized by the new equipment. F&T was able to eliminate the continued use of No. 6 fuel oil due to air quality concerns associated with burning No. 6 fuel oil, difficulties with permitting, additional maintenance, and the expected reliability of future supplies. The use of propane as a primary fuel was also studied and eliminated from consideration[2]. Propane as a primary fuel was eliminated due to a higher cost per unit energy and excessive costs for site improvements to store propane on site.

F&T also conducted a preliminary feasibility study of using wood chips as fuel for the boiler replacement[3]. The study evaluated different types of wood chips and the availability of each. The types of wood chip boiler systems were reviewed and required capital costs for the systems were estimated to gauge the cost effectiveness of utilizing wood chip boilers. F&T's preliminary study served as the basis for this detailed study and is repeatedly referenced in this analysis.

Project Scope

This study evaluated the cost effectiveness and societal impacts of multiple wood boiler technologies for the SVMC project. The wood boiler technologies included in this study are:

- 500 HP Woodchip Direct Burn Boiler
- 1,000 HP Woodchip Direct Burn Boiler
- 500 HP Woodchip Gasification Boiler
- 1,000 HP Woodchip Gasification Boiler
- 500 HP Wood Pellet Boiler
- 1,000 HP Wood Pellet Boiler

Evaluation of other biomass or renewable technologies was outside the scope of this analysis and was not considered. This was due to the availability of wood in Vermont and limitations of the existing site.

Detailed life cycle cost analyses were conducted on each type of wood boiler system using cost estimates prepared by F&T. Energy savings were calculated by estimating the amount of No. 2 fuel oil offset by the wood boilers and evaluating the future prices of No. 2 fuel oil and wood products over 5, 10 and 20 year periods. Specific societal impacts studied were traffic and transportation issues, greenhouse gas emissions, and the use of regional resources.

Assumptions

The bounds of this study were conveyed to GDS by the project team and are assumed to be givens for this project. This study is based on the following assumptions/givens:

1) The inclusion of at least three (3) No. 2 oil boilers is a requirement of Heathcare Guidelines for reliability reasons and is not negotiable. The wood burning boilers will be used to help offset the fuel usage of these boilers, not replace them.

2) The presence of any wood burning boilers, regardless of load, will not impact the fixed or variable operating costs, less variable fuel, of the three (3) oil boilers.

3) The future availability and price of mill grade wood chips is uncertain, therefore this study assumes that woodchips will be whole-tree/bole chips only.

[2] Summary of Propane Study Information – Fitzemeyer & Tocci Associates, Inc., Scott LeClair, October 7, 2008
[3] Summary of Current Wood Chip Fuel Analysis – Fitzemeyer & Tocci Associates, Inc., Scott LeClair, October 17, 2008

4) Any biomass boiler system will include a re-circulating component that will be used to maintain the oil boilers in a ready state when the biomass system is operating. No oil is burned when the biomass system is operated.

III. SYSTEM DEFINITIONS

This section defines the terms and technologies referenced in this feasibility study. Specific components of the wood burning technologies that impact system cost or performance are evaluated in greater detail in Section IV below.

Direct Burn Systems

In direct-burn systems, the furnace which powers the boiler is a single combustion chamber, generally directly underneath the boiler. Direct burn systems are relatively simple designs, and with proper design and operation can burn both cleanly and efficiently. Fuel is fed into the furnace by the stoker-auger onto a grate in a refractory lined section of the furnace, where combustion air is introduced. These hot gases then rise up into a secondary combustion zone, where the gases and any combustible particles are more completely combusted. Most new models have a baffle made of refractory material separating the primary and secondary combustion zones in order to raise the temperature in the primary combustion zone and lengthen the flame path, encouraging oxidation of the hot gases. The hot gases then pass into a heat exchanger to produce hot water or steam, and then out the chimney. The figure below illustrates a typical arrangement of a direct burn system.

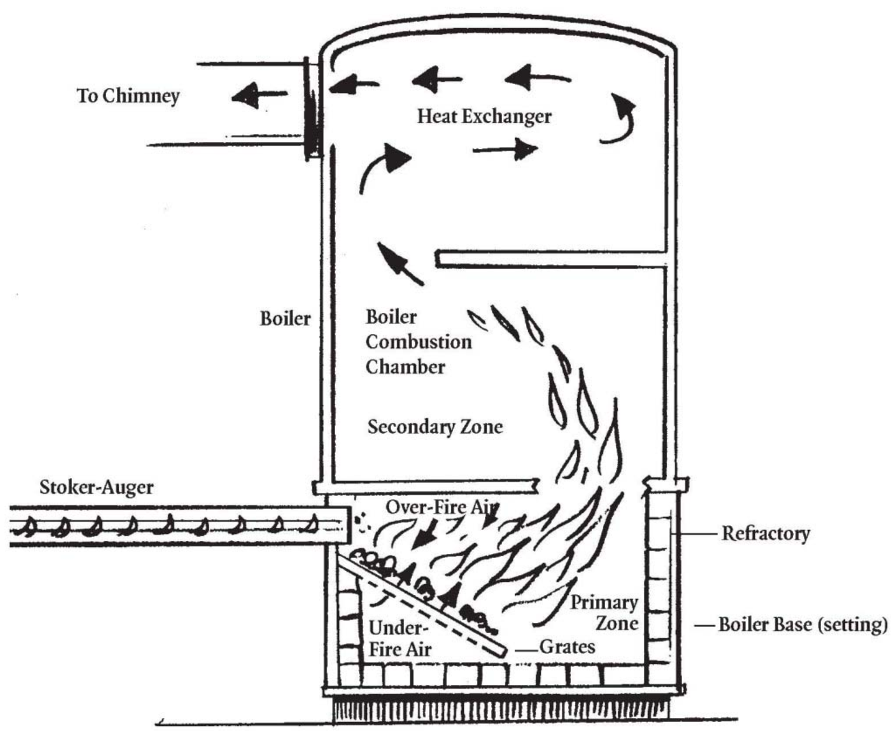

Figure 1: Direct Burn System

Gasification Systems

Gasification systems make use of multiple combustion chambers to increase efficiency and lower emissions. These systems pre-roast the woodchips (or other biomass fuel) in an oxygen starved, lower temperature environment called a gasifier. This produces a gaseous fuel that is subsequently brought into a secondary chamber where it more fully combusts when recombined with oxygen. The hot gases then pass into a heat exchanger to produce water or steam, just like with a direct burn system, and then out the chimney. Also, due to the low temperature gasification stage prior to full combustion, gasifiers can handle fuels with a wider range of moisture qualities and are less likely to fuse minerals or other materials to the metal parts of the furnace or augers. Gasification technology typically has the benefits of increased system efficiency and lower emissions due to more complete fuel combustion.

Performance Contractor

A performance contractor refers to a company that will design, build and operate a biomass heating plant with no capital costs to the SVMC. The SVMC would be responsible to make monthly payments in proportion to the overall energy savings, until the terms of the contract is fulfilled and all capital costs are repaid. The unpaid balance of the capital investment accrues interest until the balance is paid in full.

Turnkey Contract

In the context of this report, a turnkey provider refers to a company that will design, build and operate a biomass heating plant. The SVMC would sign a contract with the company to purchase steam from the provider at a set rate for a predetermined period of time. The steam purchaser incurs no capital cost. Contracting with a turnkey provider means that the SVMC would have no capital costs for the project and no ongoing maintenance or operating costs other than the price paid for steam.

Woodchips

Woodchips are among the most prevalent forms of biomass fuels utilized in the Northeast due to the relative abundance of forests, both natural and sustainably harvested. The two primary types of woodchips utilized for fuel are mill chips and whole tree/bole chips. This analysis focuses exclusively on whole tree/bole chips due to concerns over the future availability and higher per ton cost of mill chips; however both types are discussed below for reference:

<u>Mill Grade Chips</u>
Mill Chips tend to be the best-suited fuel for large biomass heating systems. Mills generally chip slab wood and other wood unsuitable for lumber. This wood is usually bark-free and uniform in size, giving it low ash content and making it unlikely to cause loading problems as it is fed into the furnace. Good mill chips are an ideal product for both combustion systems and as a feedstock for paper mills, making it more expensive than whole-tree chips. With the closing of many New England paper mills and the present state of the economy, some feel that the future supply of mill chips is unreliable, and expensive when available. It is also important to note that the majority of biomass boiler plans in Vermont use whole tree/bole chips.

<u>Whole Tree/bole Chips</u>

Whole Tree Chips, on the other hand, are made in the woods by chipping whole trees or leftovers from logging, firewood, or forestry thinning operations. Not only are the trunk and major branches chipped, but also the many smaller branches, including bark. This may cause some problems for biomass operations, as certain long slender sticks can pass through the chipper uncut. These can jam the augers that feed the biomass furnaces, leading to temporary shutdowns. Whole tree chips tend to be less expensive than mill grade chips.

<u>Key Variables</u>
There are several important factors to keep in mind when considering different varieties of woodchips. These include moisture content, density, chip size and uniformity, and mineral content.

Most biomass fuel is "green" or undried, with 30 – 55% of the delivered weight being water. High moisture levels in the fuel decrease burning efficiency for several reasons. First, a high percentage of the fuel is actually water, which is not burnable. Furthermore, a significant fraction of the energy in the wood must be used to heat up and evaporate off this moisture. Therefore, drier fuel is preferable. Softwoods tend to have higher moisture content than hardwoods, up to 10%. It is also preferable for the fuel to have fairly uniform moisture content throughout, to ensure efficient performance. Extremely dry fuels, unlike green biomass fuels, are readily combusted, even outside the furnace, and therefore if they are used do require additional safety mechanisms.

Hardwoods and softwoods have fairly similar Btu per ton characteristics, but softwoods tend to be about 10% less dense than hardwoods. Therefore, with woods that are less dense, greater volumes must be purchased and fed into the boilers than if using a denser wood. While this may not have significant impact on efficiency one way or the other, it does have important implications for storage and delivery, as well as the design and fine tuning of the furnace and boiler.

Most chips are about the size of a matchbook. High grade chips will be regular in size, as oversize chips can potentially jam the augers that feed the biomass boilers, leading to temporary shutdowns. Mill grade chips tend to be much more uniform in size than whole tree chips. However, some whole tree chips, known as "bole chips" are made from just the trunks and primary branches of trees, and are very uniform in size because they avoid chipping the slender branches than can pass through the chipper uncut. Bole chips are generally more expensive than other whole tree chips.

Minerals in the wood contribute to ash formation during combustion, and can cause problems for the equipment. In general, the lower the mineral content the better. The ash content of chips for heating should be below 3%. These minerals can be naturally occurring in the wood itself, or be picked up from the soil along with dirt during harvesting. Chips with total ash content higher than 8% will be problematic for most woodchip heating systems.

Wood Pellets

Unlike woodchips, wood pellets are a manufactured product, and have a higher Btu content than woodchips. They are easier to store and handle automatically, and pellet systems are usually simpler and less expensive to install. However, pellets are more expensive than woodchips. Wood pellets are generally made of compacted sawdust that has been pressed into very small uniform pellets. While under high pressure, a substance naturally occurring in wood called lignin melts and then hardens and sets as the material cools, binding the wood fibers together.

Since wood pellets typically have less than 10% moisture content, they have significantly more Btu's per ton of fuel than woodchips. Depending on moisture content, woodchips have energy content ranging roughly from 4,000 to 6,000 Btu/pound. Wood pellets can have 7,750 Btu/pound at six percent moisture content.

Wood pellets are typically stored in metal silos, and can be delivered in bulk via tractor trailer or 10 wheel trucks. Because of their high heat content per unit density compared to woodchips, they take up much less volume to store onsite. Unlike woodchips, wood pellets can be stored easily in outdoor silos, and be stored for up to a year. Woodchips cannot be stored reliably for more than 3-4 months, and greener or high moisture content chips may freeze together if stored above ground in the winter.

Due to the method in which wood pellets are delivered to the silos, the noise of wood pellet delivery is typically louder than for woodchip deliveries. The noise, coupled with frequent fuel deliveries, can be an irritant for neighbors.

SYSTEM CONSIDERATIONS

The design, construction and maintenance of a wood biomass system requires consideration of a variety of factors. The fuel delivery, storage and handling systems for wood biomass systems are more complicated than conventional oil systems resulting in increased capital, operating and maintenance costs and decreased reliability. This section provides a detailed evaluation of these considerations as they impact the feasibility of incorporating wood biomass at the SVMC.

Fuel Delivery / Transportation

Woodchip and wood pellet boiler systems will require substantially more frequent fuel deliveries compared to No. 2 fuel oil. Large truck traffic and overall traffic congestion are significant concerns in Bennington therefore the additional truck traffic associated with a wood biomass is a serious consideration. The map below illustrates the Town of Bennington[4].

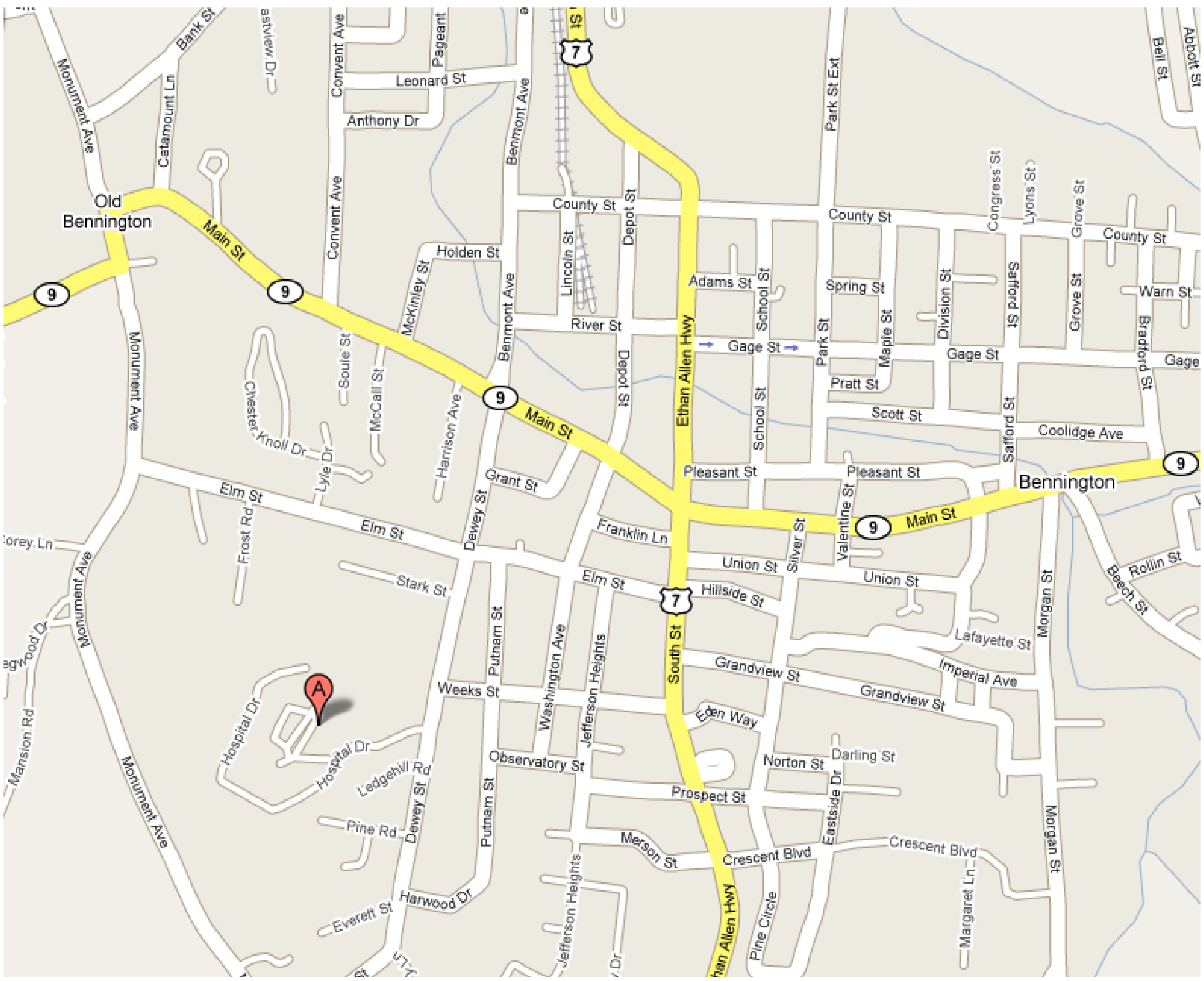

Figure 2: Bennington, Vermont

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[4] Google Maps, *Bennington Vermont*

Old Bennington, located along VT Route 9 west of US Route 7, is a key area as it represents the historic district of Bennington. Increased truck traffic through this area has affected the tranquil nature of the historic district. Increased truck traffic through Bennington caused by more frequent deliveries of biomass fuel is a consideration of this study.

Current Traffic Issues

US Route 7 and VT Route 9 represent two of the primary trucking routes in Southwestern Vermont and intersect at the busy "Four Corners" intersection in the center of town. Large trucks can have trouble making turns and cause additional traffic congestion. As a result, many drivers use smaller residential roads to bypass this intersection, creating traffic issues elsewhere[5].

To reduce the amount of traffic passing through Bennington, the Vermont and New York State Transportation Departments (VTrans and NYDOT) are in the process of constructing Vermont Route 279 (VT-279) which will allow through truck traffic to completely bypass the center of Bennington. The western segment of the bypass has been completed and construction of the northern segment is currently underway. The figure below illustrates the conceptual routing of the VT-279 bypass[6].

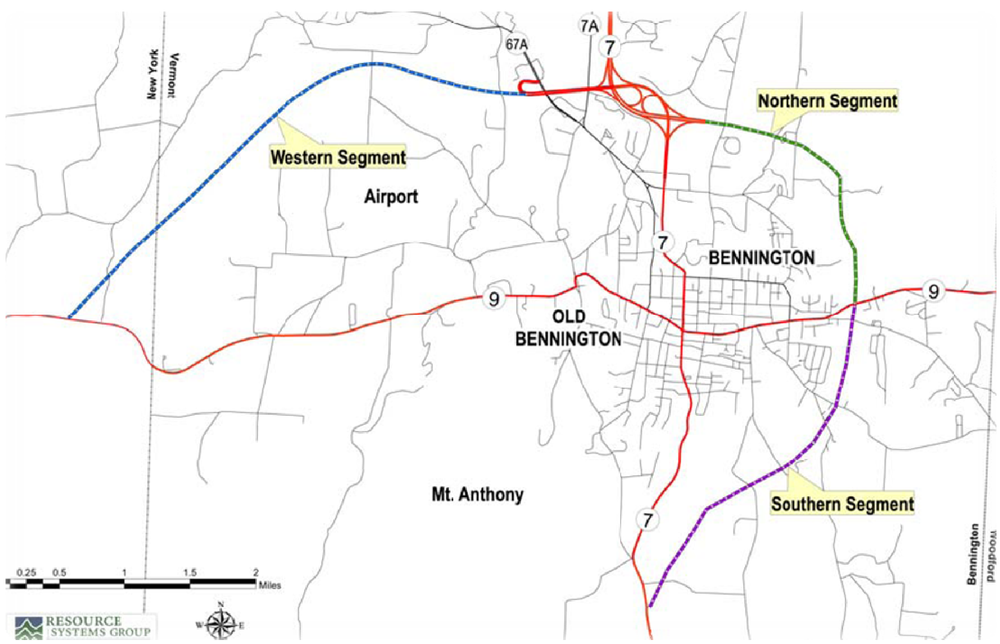

Figure 3: VT-279 Bennington Bypass

GDS was unable to determine the measured impact of the western bypass segment on Bennington traffic, although the *Resource Systems Group* in their 2003 Network Analysis report stated that 42% of eastbound NY Route 7 traffic will use the western bypass. Based on 2000 traffic volumes, this estimate translated into 4,300 vehicles diverted to the bypass that would otherwise pass through Bennington[6]. In short, the construction of the VT-279 bypass should have a substantial effect of

[5] *Proposed Small Project Prioritization List*, Transportation Advisory Committee, Bennington County Regional Commission, Fall/Winter 2007

[6] Bennington Local Roadway Network Traffic Analysis, Resource Systems Group, August 2003

reducing truck traffic through Bennington, hopefully alleviating congestion at the major intersections and calming traffic throughout.

Fuel Delivery Analysis

A focus of this study with respect to transportation issues was to quantify the increased frequency of deliveries needed for a biomass boiler compared to the existing oil boilers. Town and regional planners may utilize this information to determine the local impact of the increased delivery frequency when considering the biomass technologies evaluated in this study.

Based on the total steam load of the SVMC and the size of the delivery trucks for the wood fuels, GDS calculated the number of fuel deliveries required per year and on a peak load day in January. The peak day calculations are based on the total steam load in January, divided by 20 working days on the month. The results are illustrated in the table below.

	Fuel Delivery Truck size	Heat Content (MMBtu) per Delivery	# of Fuel Deliveries per Year	# of Fuel Deliveries on Peak Weekday
2 x 500 HP #2 Fuel Oil Boiler	8,000 Gal	1108	88	0.6
500 HP Direct Burn Woodchip	25 Ton	225.5	520	3.4
500 HP Wood Pellet	25 Ton	387.5	270	1.8
500 HP Gasification Woodchip	25 Ton	225.5	498	3.3
1,000 HP Wood Pellet	25 Ton	387.5	279	1.8
1,000 HP Direct Burn Woodchip	25 Ton	225.5	536	3.4
1,000 HP Gasification Woodchip	25 Ton	225.5	513	3.3

Table 2: Fuel Delivery Frequencies

The delivery truck sizes are based upon average delivery size for an oil truck, and information from suppliers on the capacity of woodchip and wood pellet fuels. The number of deliveries for a conventional fuel oil delivery truck is provided for reference to determine the increased frequency of the biomass systems. For example, the 500 HP Direct Burn Woodchip boiler requires (3.4/0.6) = 5.7 times as many deliveries as an oil system on a peak day. A self unloading truck (up to 53-feet) is contemplated for the woodchips, and a truck with a snorkel is assumed for wood pellet delivery (also up to 53-feet). Refer to Appendix B for the calculation and schematic drawings of the wood pellet delivery trucks.

Biomass System Impacts

The main impact of the biomass systems on transportation will be the increased frequency of deliveries as discussed above. Another consideration is the time and noise of delivery. While oil deliveries can be made at night, deliveries for woodchips and pellets are typically made during the day as it involves several operators to ensure that the biomass is unloaded successfully. The actual process of unloading via self unloading truck for woodchips or via snorkel for pellets is louder than for an oil system. This may or may not cause disruption to neighbors and should be considered if the projects move forward.

The woodchip and wood pellet suppliers that were contacted as part of this study will all be traveling from east to west along VT Route 9 to reach the hospital. It is likely that the trucks will turn off VT Route 9 onto US Route 7 at the four corners intersection in order to reach the hospital. It may be possible for the delivery trucks to take a different route at an added cost to the SVMC.

Site Requirements

Modifications to the existing site will be required should a biomass system be implemented. Required modifications include the relocation of high voltage power lines, reconfiguration of access lanes, expansion of storm water detention systems, and the provision of storage bins for woodchips or storage silos for pellets. These modifications represent additional capital cost to the project and are accounted for in the capital cost estimates in Section VII below.

The size and arrangement of storage for the woodchips or pellets is a key issue. For the woodchips, a partially below grade storage bin is contemplated. The storage bin will be sized to accommodate at least ½ week woodchip demand so that there is sufficient fuel available to supply a long weekend. The arrangement of the storage bin must be coordinated with the delivery vehicle to facilitate unloading of the truck when the storage bin is nearly full.

Wood pellets are more compact and uniform in size than woodchips are thus easier to store. Above grade silos are sufficient for wood pellets as the pellets will not freeze and jams are less likely. Wood pellet silos consume less footprint area than woodchip storage bins.

Fuel Storage and Handling

The storage and handling of woodchips and wood pellets is significantly more involved than for an oil boiler system. This section discusses the main components of storage and fuel handling systems for woodchip and pellet boiler systems.

Storage Systems

Woodchips for automated biomass facilities are most commonly stored in large rectangular concrete bins that are recessed into the ground. This keeps the bottom layers of chips below the frost line, preventing them from freezing and causing problems for the automated transporting and loading systems. It also makes delivery very easy, as self-unloading delivery trucks can quickly dump their loads directly into the bin without the need for additional mechanical equipment. Extra equipment to bring fuel from the truck to an above ground unit adds capital costs, as well as daily operating costs for electricity and labor to run the machinery. Delivery can be done extremely quickly into recessed bins, an important note as some suppliers may charge more for deliveries that take more than two hours. However, recessed bins require excavation and can be significantly more expensive to build than above grade silos or sheds. The capital cost estimates for this project are based on inside bunkers that are partially below ground.

Above grade sheds and silos are much cheaper to build than recessed bins, as they do not require any excavation. However, they do have other costs associated with them. While delivery trucks can simply back in and dump fuel into recessed bins, above grade storage units will need some form of conveying system to bring the fuel into the storage unit. This represents additional capital costs, as well as electricity costs to run additional equipment. Sheds are the cheapest to build, and fuel is typically delivered on the ground in front of the building, and is then scooped in with a tractor or front-end loader. This does require the additional daily operator labor to push the chips into the shed, and then transport it to an automated receiving bin for feeding into the boiler. For wood chips, especially those with higher moisture contents, there is a danger that the chips can freeze together or to the walls of the storage unit. Unheated sheds and outdoor silos may pose problems to wood chip systems for this reason.

Pellet systems, on the other hand, lend themselves easily to use with above ground silos. The fuel is dry enough that it won't freeze. Additionally, pellet vending trucks are specially equipped for delivering directly into above ground silos. A special extendable arm and blowing system allow the truck to unload directly into the silo. This can be a very noisy process, so delivery times generally need to be scheduled during normal business hours. Depending on the final arrangement of the storage units and delivery routes, it is possible that delivery noise could project into the patient rooms.

All automatic systems for unloading and transporting the fuel will run on electricity, and will therefore have certain variable operating costs associated with it. For the purpose of this analysis, these costs are considered additional expenses compared to the existing oil boiler systems which do not require complex fuel handling systems.

Fuel Handling Systems

The figure below[7] illustrates the schematic arrangement of a typical woodchip boiler system including key system components. The system components are discussed below in more detail.

[7] Biomass Energy Resource Center, Wood Chip Heating Systems Guide

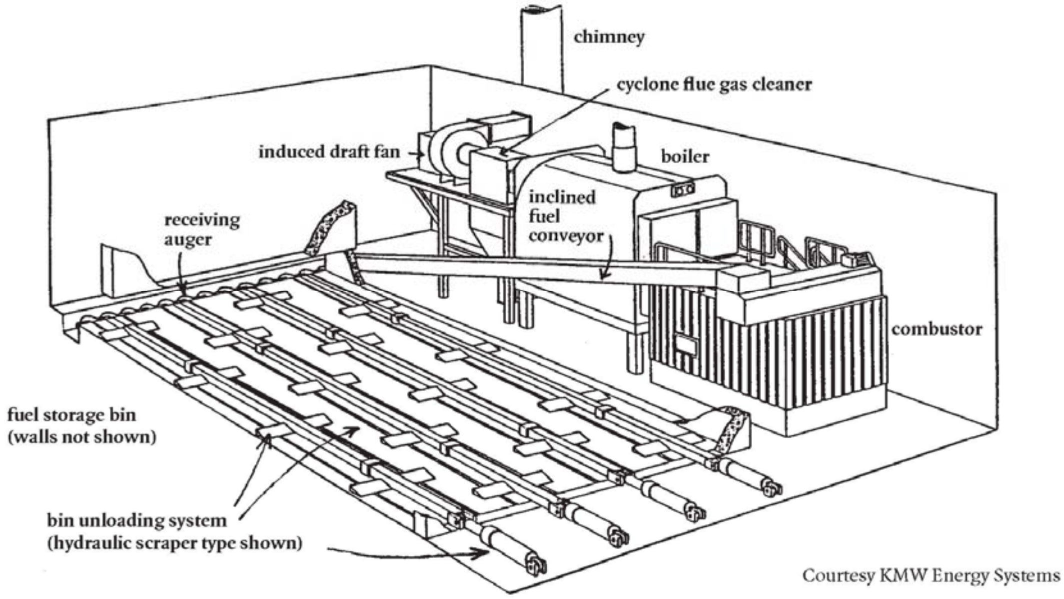

Figure 4: Woodchip Boiler Schematic Arrangement

Bin Unloading Systems

With a recessed storage bin, the most commonly used unloading systems use reciprocating hydraulic scrapers to move the chips from the bin to a receiving auger and conveyer to bring the chips to the boiler. Some systems instead use a travelling auger to sweep the flat bottom of the bin to pull out fuel and drop it in the receiving auger.

With the shed storage option, and fuel is typically delivered on the ground in front of the building, and is then scooped in with a tractor or front-end loader. This requires the additional daily operator labor to push the chips into the shed, and then transport it to an automated receiving bin for feeding into the boiler.

Above ground circular silos use a variety of methods to sweep the chips to a hole at the bottom of the silo and onto a conveyor to bring the chips to the boiler. All of these systems work best when the silo is kept in a heated place to prevent chips from freezing to the sides of the silo or to each other.

The unloading systems for wood pellets are far simpler than those needed to woodchips. For wood pellets, a conveyor system is generally used to automatically transport the pellets from the silo to the fuel hopper. This is a similar conveyor to what would be used with wood chips, using a combination of augers and conveyors. From the fuel hopper, the pellets are dispensed into the boiler at a rate controlled by operator settings. The electric load associated with a wood pellet unloading system is much lower than the electric load for a woodchip unloading system. The schematic arrangement of a wood pellet system is shown below.

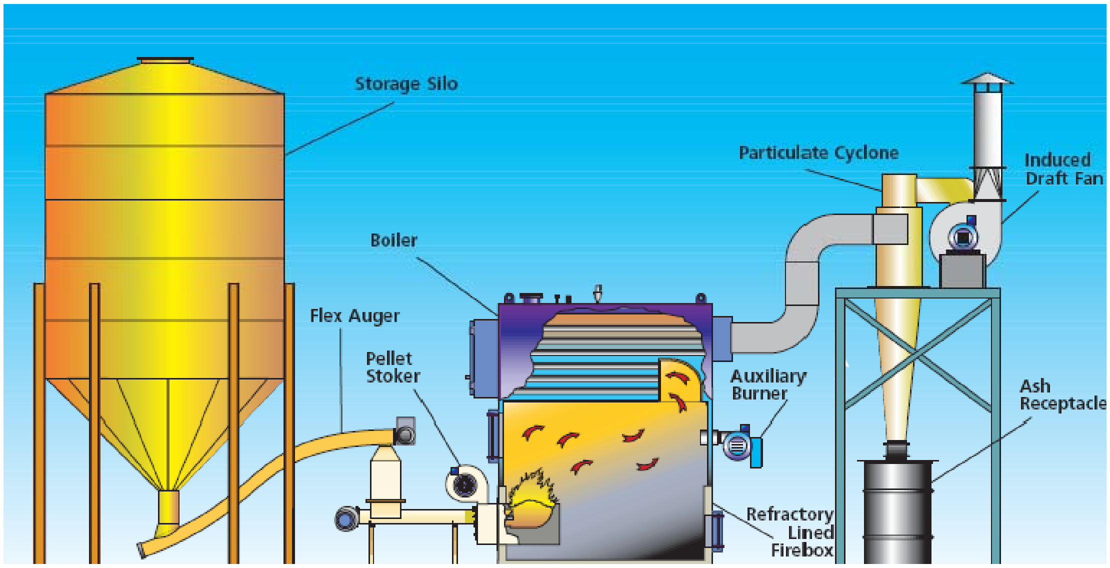

Figure 5: Wood Pellet Schematic System Arrangement

Augers

An auger is a rotating helical shaft, like a large drill bit, used to move material along its axis of rotation. In automated wood chip fuel handling systems, augers are used to collect fuel from the storage bins and deposit them on fuel conveyors. They also may be used to collect the fuel from the conveyor and feed the furnace.

Conveying Systems

If the storage bin is recessed below grade, the only conveying system needed is one to transport fuel from below ground at the bin up to the boiler. This is usually accomplished with an inclined fuel conveyor, making the process totally automatic. If woodchips are stored above ground in a silo, a separate inclined conveyer would be needed to bring fuel from the delivery vehicle up to the top of the silo where it can be deposited. Since pellet delivery trucks have capabilities to deliver into silos, this is not a concern, but a conveyor is still generally used to bring the pellets from the silo to the actual boiler.

Reprocessing

Since high quality fuels with very uniform chip size can be very expensive, some larger facilities will buy their own equipment to screen and reprocess wood chips that are too large for the machinery. This can reduce operations costs by allowing the facility to use cheaper fuels, but represents significant additional capital costs.

Ash Removal

For both woodchip and pellet systems, the ash content of the fuel should be below 3%. Higher ash contents will result in high ash buildup and potentially cause equipment problems. Every ton of green biomass that is burned will produce roughly 25 pounds of ash. This composition of unburnable material and unburned carbons will accumulate in the furnace and need to be removed on a continuous or daily basis. Most of this will accumulate in the combustion chamber. One method is the use of automated screw augers to carry the ash out of the combustion chamber. While this does add on to capital costs, it can significantly reduce maintenance time. Otherwise, this task can be done manually, typically 10-20 minutes a day, usually without needing to shut the boiler down. The ash must be shoveled and raked out of the boiler by hand. As long as the design of the boiler allows this to be done without having to shut it down and wait for it to cool off, neither the automatic or manual methods are intrinsically preferable. What makes sense for SVMC will depend on the capabilities and preferences of the operator and owner.

This ash is not a hazardous waste, but is in fact an excellent soil additive. SVMC should expect to donate their ash to the local agriculture community, as this is fairly common practice. Some larger facilities will contract to have their ash taken away by a vendor who will make commercial use of it.

Operation and Maintenance

Operation and maintenance (O&M) programs are one of the most cost-effective methods for ensuring reliability, safety, and energy efficiency. O&M goals for all boiler systems include: bringing the boiler to peak efficiency and maintaining the efficiency at the maximum level. Listed in this section are important operation and maintenance procedures needed to reach and maintain maximum efficiencies for oil, woodchip, and wood pellet boilers.

Oil Boilers

Adequate maintenance for an oil boiler includes the following weekly and yearly schedules. For an oil boiler a well functioning maintenance schedule properly mitigates any potential hazards and achieves maximum combustion efficiency.

Typical weekly maintenance requirements include:

- Check all temperature, pressure, belts, gaskets and control gauges
- Lubrication of components
- Check and clean/replace oil filters, strainers, pilot, burner and transfer lines
- Check flue gas temperatures and composition
- Check for air leaks

Typical yearly maintenance requirements include:

- Clean waterside and fireside surfaces
- Remove and recondition or replace relief values
- Clean feed-water and fuel system’s pumps, filters, pilot, and other components
- Check and replace electrical terminals and electronic controls
- Make adjustments to flue gauges to ensure optimal fuel composition
- Conduct eddy current test to asses tube wall thickness

Routing maintenance of oil boilers is conducted by existing SVMC personnel.

Wood Chip Boilers

Wood chip boiler’s installation, maintenance, and operation involve a number of steps beyond oil boilers. First, the following operational parameters are necessary to achieve during the installation period. The installation operating parameters are Btu output of the system, turn-down ratio, boiler and stack temperature, excess air levels, and steady state efficiency. Calibration of the operating parameters should be performed during full-load (mid-winter). If not, it is recommended that a provision be issued for the installer to return and readjust the system to optimize performance during full-load conditions. Second, wood chip boilers require a specially trained operator. It is imperative that the operator be fully trained in operating, maintaining, and trouble-shooting the system. Operating a wood chip boiler includes daily monitoring of gages, scheduled weekly maintenance, and the anticipation of unscheduled shutdowns due to oversize or frozen wood chips jamming the system:

Typical weekly maintenance requirements include:

- Ash removal from grates and under grates
- Boiler tube cleaning
- Fly ash removal
- Cleaning the fire box and other heat exchange surfaces
- Lubrication
- Inspection of drive chains, belts gearboxes
- Inspection of refractory
- Checking for safety devices
- Checking adjustment of fuel feed rates and combustion air

Typical yearly maintenance requirement include a complete evaluation and cleaning of the entire system by a system manufacturer's service representative. Furthermore, unscheduled shutdowns and maintenance due to oversize chips or frozen fuel jamming the auger should be anticipated.

For the woodchip boiler options, the addition of a constantly available operator available 24/7 is required. It is contemplated that multiple positions will have to be filled to accommodate the requirement for a 24/7 operator; this assumption is reflected in the operating cost assumptions in the life cycle system costs.

Wood Pellet Boilers

A wood pellet boiler, relative to a wood chip boiler, is a simple biomass system. Maintenance is predictable due to the relatively uniform size, shape, moisture and energy content of wood pellets compared to that of wood chips. On average roughly 15-30 minutes per day are required for maintenance, over the entire heating season.

Typical weekly maintenance requirements include:

- Emptying ash collection containers
- Monitoring control devices to check for combustion temperature, stack temperature, fuel consumption, and boiler operation
- Checking boiler settings and alarms, due to a problem with soot buildup

Typical yearly maintenance requirements include:

- Greasing augers, gear boxes, and other moving parts
- Checking for wear on conveyors, augers, motors, or gear boxes
- General overall cleaning and ash removal

Automatic soot blowers and ash removal systems are also an option for wood pellet boilers. Experience has shown that a wood pellet boiler does not require a full time operator to be available 24 hours a day. As an example, the Harris Center's office manager and other general staff members attend to the weekly maintenance and operation of their direct-burn, wood pellet boiler. A staff member checks the system twice a day, and removes ash if necessary in about 30-minutes. The Harris Center's wood pellet boiler is five years old and only once have they called a technician to handle an air leakage into the hopper. No operator position has been necessary. Training for the maintenance and operation has been basic.

For this analysis, it is assumed that the existing SVMC staff will be capable of maintaining the wood pellet boilers and no additional operators are required.

Emission Control

This study includes estimates of greenhouse gas emissions for each of the biomass technologies evaluated using emission factors from EPA AP 42. EPA AP 42 is a set of standards that governs how to officially calculate the emissions from various sources. It sets forth emissions factors that attempt to quantify the levels of air pollutants produced with the activity associated with their release. Section 1.6 of EPA AP-42 deals with wood residue combustion in boilers, and is the applicable section for the kind of biomass facility that SVMC would install.

Below are discussions of the proposed emission control system, and calculations of estimated emissions for the SVMC technologies.

Cyclonic Separator

The biomass options for this project will include cyclonic separators. Incorporating a cyclonic separator is a method for separating particulates from the exhaust air. Dirty exhaust air is brought into a cylindrical or conical vessel called a cyclone. The air flows in a high speed spiral pattern causing heavier particulate matter to fall out the bottom of the cyclone. Clean air passes out the top and is then sent to the chimney to be exhausted. The figure below diagrams the cyclonic separation process.

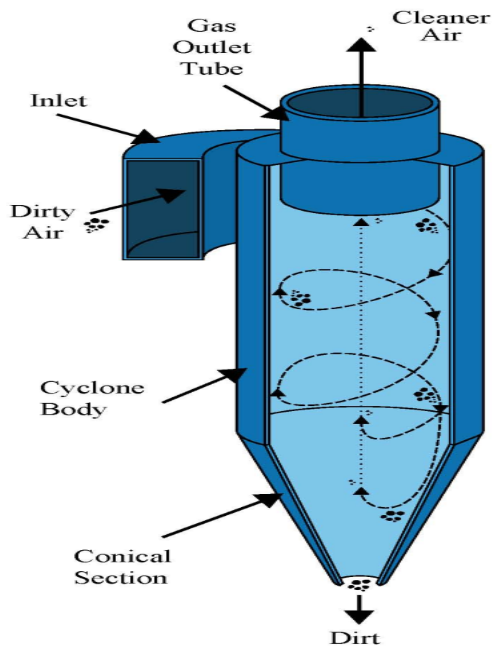

Figure 6: Cyclonic Separator

After discussion with Jeff Forward from Forward Thinking Consultants it should be noted a cyclone separator and bag house will likely be implemented for each of the woodchip options. The combination of the bag house and cyclone separator would reduce the Particulate Matter (PM) emissions by up to 98%. The bag house would add approximately $150,000 to the system cost and have an estimated additional operation cost per year of $10,000. With the potential for increased regulation it would be prudent to add the bag house at the onset of any potential project.

Bag House Filtration

A bag house filtration system is a fabric collector that is used to separate dust particulates from dusty gases to reduce the amounts and size of particulate matter entering the stack. Bag houses are one of the most efficient and cost effective types of dust collectors available and can achieve collection efficiencies of more than 98% for very fine particulates. A bag house will be required for any biomass boiler system.

Emissions

The emissions summary table below shows the comparative emissions for the technologies reviewed for this project. An important difference to note between oil (fossil fuel) and wood is that emissions from the combustion of oil are considered to be a release of carbon that would otherwise be trapped inside the earth. Wood on the other hand is part of the natural carbon cycle, such that the burning of wood does not contribute any new carbon dioxide to the air provided that the forests are sustainably managed. In other words, the carbon byproducts released during the combustion of wood fuels would otherwise be released to the atmosphere over time through the natural attrition and decay of the forest material.

Several of the published sources used for this study did not report the CO_2 levels released from the burning of wood. The source used in the study is from Chiptec equipment and is assumed to have cyclonic separators and bag options in operation. The carbon is higher for wood fuels as is with any solid fuel as compared to a liquid. Emission factors and total emissions are presented below.

Table 3: Emissions Factors

Emission Factors (lb/MMBtu)						
System Type	**CO2**	**CO**	**NOx**	**SO2**	**VOC**	**PM**
Wood Chip[a]	195	0.3	0.3	0.025	0.017	0.1
Wood Pellet[b]	-	0.51	0.272	N/A	N/A	N/A
#2 Oil[c,d,e]	164.34	0.0357	0.129	0.507	N/A	0.0143

a.) Chiptec w/PM Control
b.) MA DOER: Wood Pellet Heating Guidebook (2007)
c.) CO2 based on U.S. EPA: Greenhouse Gas Equivalencies Calculations and References (Updated December 8, 2008) http://www.epa.gov/cleanenergy/energy-resources/refs.html
d.) UMASS Industrial Assessment Center (IAC) 2005 Report used to supplement EPA calculations for NOx and SO2 emissions
e.) CO and PM factors from U.S. EPA: AP-42 Fuel Oil Combustion Emissions Factors

Table 4: Annual Emissions Estimate

Annual Emission Estimates (tons/yr)						
System Type	CO2	CO	NOx	SO2	VOC	PM
Wood Chip	7,806	12	12	1.00	0.68	4
Wood Pellet	-	20	11	-	-	-
#2 Oil	6,579	1	5	20.30	-	0.57

Reliability

Considerations regarding reliability include equipment reliability and the reliability of fuel supplies. Both considerations are discussed in detail below.

Supply Reliability

Historically, energy from woodchips has a 25-year history in Vermont and the surrounding area. During this time, woodchip prices have remained relatively flat. When the market price paid for chips are compared to the rate of inflation, chips actually have experienced a negative price growth over the past two decades in the region.[8]

In the Northeast, there are many variables that dictate the availability and reliability of wood-fuel supply: the price of diesel fuel to run harvesting and processing equipment, weather, strength of regional pulp and saw-log markets, and the strength of the US dollar. One of the most significant variables is the extent to which northeast wood-fuel is produced as a by-product from other primary processing of forest products. Currently, wood-fuel depends on the future of the pulp and paper industry. Historic and current pricing of chips have been directly tied to their status as by-products. However whole-tree chips and bole chips have the potential for becoming commodities as the logging industry ages and paper mills close. Assuming larger logging companies enter the market, so that a shortage in labor doesn't create a shortage in supply, or whole-tree chips become a commodity and are priced accordingly, Paul Frederick (Wood Utilization Specialist for Vermont Department of Forests and Recreation) notes that wood supply is ample and will continue to be well into the future.[9]

While the current consumption of low-grade wood for fuel and fiber represent a significant demand on the region's forests, the current rate of annual forests growth exceeds the annual rate of harvest by two to one.[10] Wood is a regional fuel and is not exposed directly to geopolitical issues and natural disasters.

In conjunction, the wood pellet market is changing. Wood pellet manufacturers, that have historically produced pellets exclusively from sawdust from local sawmills, have experienced a strong surge in demand from the residential pellet stove heating market. This surge is primarily in response to recent price increase in fossil fuels. In addition, the saw mill industry has seen a 6 Billion to 14 Billion dollar decrease. Therefore, the surge has almost completely exhausted sawdust supplies. Several pellet

[8] Vermont Wood Fuel Supply Study – Biomass Energy Resource Center, June 21, 2007.
[9] Personal communication, Paul Frederick - Wood Utilization Specialist for Vermont Department of Forests and Recreation
[10] Vermont Wood Fuel Supply Study – Biomass Energy Resource Center, June 21, 2007.

fuel manufactures like New England Wood Pellet have recently resorted to purchasing chips and even pulp round-wood to meet their growing needs.

Through phone surveys and personal conversations with facility managers at woodchip and wood pellet plants the current price of wood-fuel is quoted to be 52$/ton for woodchips and 216$/ton for wood pellets. It is mentioned in the surveys that price, while stable, has gone up in the last year. Additionally, the facilities surveyed experienced no problems with shortage in wood-fuel supply and communicated that their individual suppler are reliable. When possible wood pellet plants, only operating in the winter season, buy their bulk order in July when wood-fuel prices are lowest.

Physical Supply

In conversation with Jon Baker (Operations and Wood Procurement Manager for Cousineau Forest Products) two important aspects of physical wood supply were discussed. First, it is recommended that SVMC should work with a procurement company. Unlike individual loggers who cannot take the risk of signing a contract with guarantees for supply, a procurement company has many different sources for biomass fuel and is a reliable source of supply. Further, while smaller procurement companies might find it difficult to "nail down a price"[11] and are not able to contract a price in the variable market, larger procurement companies supply millions of tons of wood-fuel to power plants annually and therefore consider the supply to the hospital a 'niche market'.

Second, a stockpile needs to be considered for the weekend, holidays, and a potential snow storm. In an emergency, Cousineau Forest Products would be able to maintain a supply of 'raw' wood within 75 miles of the hospital and if necessary they could chip and get the supply to the hospital within a day or two.

Finally, phone surveys and personal conversations with facility managers at woodchip and wood pellet plants reveal the added consideration of wood-fuel delivery during mud season. Mud season can create problems for delivery trucks during pick up and drop off, therefore impacting the reliability of wood-fuel supply. The fall can be particularly variable with road closings.

Equipment Reliability

Phone surveys were conducted with facility managers of woodchip and wood pellet plants around the Northeast to determine operational and maintenance reliabilities. The following section summarizes, from personal conversations, operation and maintenance reliability considerations for both woodchip and wood pellet boilers.

Woodchip Boilers

Major concerns about the reliability of a woodchip system are due to possible jams from over sized woodchips and debris that can cause the plant to shut down for an extended amount of time. However, when talking with facility managers at woodchip plants, around the Northeast, jams are said to be rare. Overall operation and maintenance reliability of the woodchip boilers surveyed is said to be great. Dan Harrison of Cersosimo Lumber mentioned a total shut-down time of five hours over a one year period, due to fuel jams at the Brattleboro woodchip plant. Overall, woodchip plants surveyed rarely, if at all, shut-down their woodchip boilers due to unexpected woodchip jams.

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[11] Personal communication, Dan Harrison of Cersosimo Lumber

Bennington College and Brattleboro plants shut down their woodchip boilers once a week for 12-15 hours in order to perform regular maintenance, while Bridge Water Power Company and Barre Town Elementary School do not shut down their woodchip boilers weekly. Staffing operators is another consideration for reliability. The woodchip plant surveys show a wide variety in the staffing and training of woodchip operators. Bennington College uses a 400 HP gasification boiler fueled with whole-tree, mill, and bole chips. The woodchip boiler operator is the same operator who ran their oil boiler before. The operator works forty hours per week and was trained through a special class as part of the initial purchase of the system. Middlebury College is a co-generation plant with a 29.5 MMBTU (88 HP) gasification woodchip boiler, fueled by whole-tree, mill, and bole chips. They staff the same five operators and one supervisor they had before the woodchip boiler went in. However the Brattleboro plant, which uses two 600HP woodchip boilers, fueled by saw dust, whole-tree, mill, and bole chips, staffs a full time (24 hour) operator position to handle operation and maintenance due to variable fuel size.

Wood Pellet Boilers

Wood pellet boilers, relative to woodchip boilers, have greater operational and maintenance reliability. Both the Harris Center and NRG Systems proclaimed, during personal conversations, their wood pellet system to be simple and easy to operate with minimal training. Harris Center and NRG Systems have great confidence in the reliability of their wood pellet boilers. Both locations only use their wood pellet boiler during the winter heating season and no fuel jams were recorded. However, the Harris Center in their first year of operation experienced air leakage into the hopper and shut down their wood pellet boiler for a total of ten hours over the year. They eventually needed a technician to fix the air leak. Unlike some woodchip boilers, the Harris Center and NRG System's wood pellet boilers do not require weekly maintenance shut-downs and a full time operator position. The general staff attends to the daily maintenance (ash removal, gauge checking, etc.) of the wood pellet systems. The staff was given a general training and walk-through with a technician during installation. Once a year, after the winter season, the wood pellet boilers are serviced by a trained technician. It should be noted that these systems are commercial sized systems but are smaller than what would be required for SVMC and also SVMC would likely operate there system 24/7/365 as compared to The Harris Center and NRG only utilizing their systems for heating season.

Permitting

The permitting for this project with the addition of a biomass plant based on the maximum predicted annual heat load of 80,065 MMBtu/yr results in predicted emissions below the major threshold as outlined in the Air Pollution Control Permitting Handbook published by the Vermont Agency of Natural Resources (VT ANR). It is likely that the VT ANR would classify both the oil and the potential biomass as a minor source similar to what was submitted as a draft for the planed CUP with the three 500 HP No. 2 Oil fired units. The cost for permitting is further developed in the system cost section but is estimated at a first time cost of $15,000 and an annual fee of between $2,350 and $5,850.

Regional resources

At the meeting between GDS, SVMC, BEC, BCRC and others on November 11th 2008 there was a discussion about the BCRC being interested in knowing the potential impact of a biomass plant on the region. Based on the assumptions provided, there were three impacts on the region with different given scenarios. The first would be the creation of one additional full time position (FTE if 4.2) if a woodchip plant were constructed. This additional position is based on the hospital requiring that the plant is staffed 24/7 regardless of whether the project is internally financed or contracted to an energy performance company. A wood pellet plant would have increased reliability and less fuel handling equipment than a wood chip plant. This would require a 24/hr call service with 2 hr average response time. Based on this assumption, the assumed FTE for within the region is 1.5.

For any biomass project there would be an increase in truck traffic (reference Section IV, *Fuel Delivery/Transportation*). With respect to sustainable harvested bio-fuels, the only option that GDS has any confidence in would be the International Wood Fuels EPCO option. Any woodchip option could use chips from a sustainably managed forest that meet the industry standard but would be at a premium and is not typically done in other project within the region.

Incentives

There are several incentives that relate to renewable energy systems. The first would be tax deductions and credits. SVMC is a nonprofit entity and is not eligible for federal tax deductions and credits. There are other state and federal incentives that are designed to help buy down the payback of renewable energy projects. In all cased these incentives all require that combined heat and power (CHP) be part of the project. It was determined early on in the project the CHP was not a viable option for SVMC based on the lower pressure steam distribution system existing. CHP applications require higher steam pressures and would result in a required 24-7-365 boiler plant engineering.

There is potential to take advantage of consumer based carbon offset programs. If the wood option where to move forward there could be a market for the carbon offset produced form the biomass system. These carbon offset are sold to entities that in turn offer certified carbon offsets to their consumers. These consumers purchase carbon offsets to help offset their own use either personal and company based. Currently the market for carbon offsets is $3/ton-$4/ton and this project is estimated to reduce up to 5,550 ton of CO_2 /year or a potential revenue source of $16,000 -$22,000 per year.

ENGINEERING CALCULATIONS

This section outlines the engineering calculations used to determine the plant heating loads and energy consumption in addition to the variable inputs (i.e. assumed system efficiencies) used in the calculations.

SVMC Heating Load

The base heating load for the SVMC is used to calculate total fuel consumption and energy savings for the biomass systems over the next 20 years. The base heating load is calculated by evaluating the total usage of No. 6 fuel oil for the past two years, accounting for the efficiency of the old boilers (assumed to be 75%) and discounting the load of the absorption chillers which are being eliminated as part of this project. The annual fuel consumption and calculation procedure is outlined below.

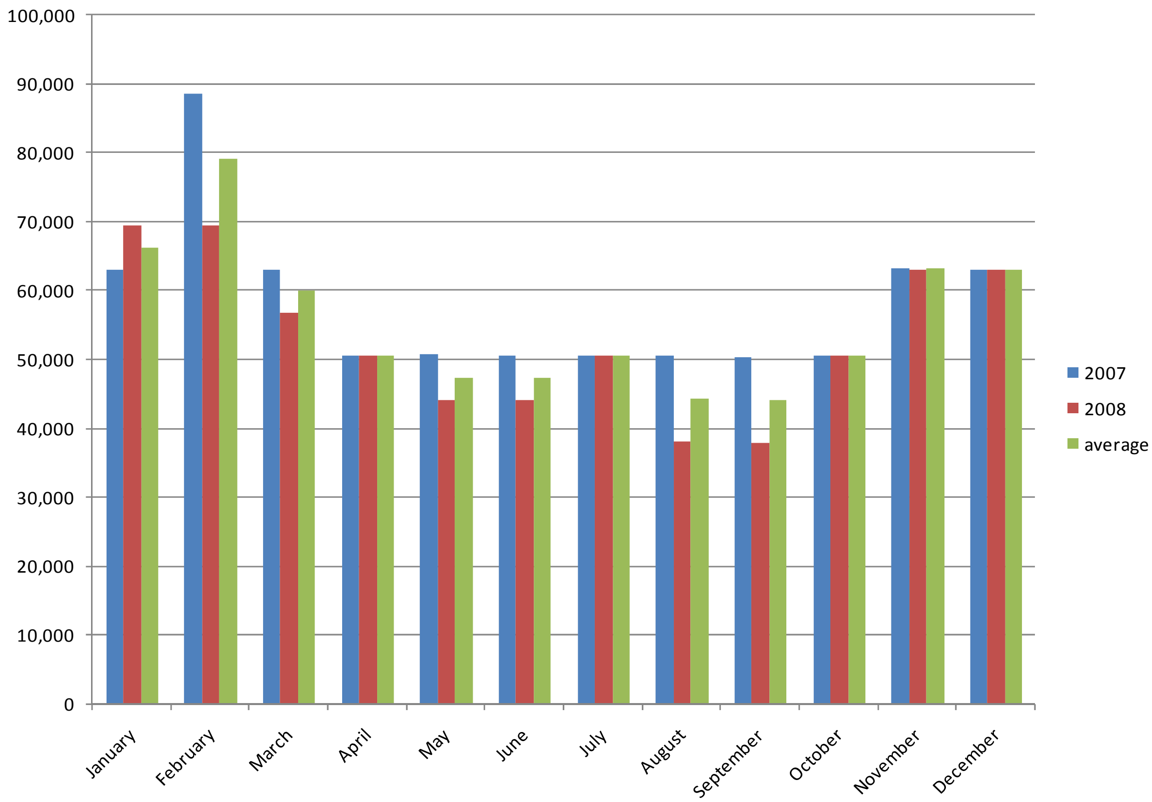

Figure 7: No. 6 Fuel Oil Usage (Gallons) for 2007, 2008, and Average Usage

The figure above shows the SVMC consumption of No. 6 fuel oil for 2007 and 2008, and the average between the two. The monthly values are based on deliveries in a given month, not metering, so the monthly consumption is not absolute but does provide a good indication of monthly base loads. The prior use of absorption chillers in the summer months results in a more constant demand of fuel oil than for systems without absorption chillers. The base heating load for the SVMC is then calculated as follows:

$$666{,}102\ Gal\ No.6\ Fuel\ Oil \times 152{,}000\frac{Btu}{Gal} = 101{,}248\ MMBtu_{\ annual\ fuel\ usage}$$

$$101{,}248\ MMBtu_{fuel\ usage} \times 75\%_{\ system\ efficiency} = 75{,}936\ MMBtu_{\ annual\ consumption}$$

The calculated heating load for the plant, before discounting the absorption chillers, is 75,936 MMBtu. The absorption chillers that are being removed are 350 Ton York Units that are 10 years old. F&T estimates that the steam load of the absorption chillers is 11 pounds of steam (@ 125 psi) per hour per ton. For this calculation, the chillers are assumed to have a coefficient of performance (COP) of 0.80 which is the typical range for absorption chillers of 0.4 to 1.2[12]. The heat content per pound of steam at 125 psi is taken from the ASME steam tables. The calculated load of the chillers, when running, is:

$$\frac{350\ ton\ \times 11\ \frac{lbs\ steam}{ton \times hr} \times 878 \frac{btu}{lbs\ steam}}{0.8_{\ coefficient\ of\ performance}} = 4.23\ \frac{MMBtu}{hr}$$

The absorption chiller is assumed to run for 600 full load hours per year based on information from the American Refrigeration Institute (ARI) and the location of the hospital. The total heating load for the existing hospital less the load of the absorption chillers is:

$$75{,}936\ MMBtu_{\ annual\ consumption} - \left(4.23\ \frac{MMBtu}{hr} \times 600\ hr\right) = 73{,}398\ MMBtu_{\ annual\ consumption}$$

The hospital is also in the process of constructing an 80,000 square foot addition that will contribute to the annual heating load. For the purpose of this analysis, a 10% safety factor was applied to account for the increased heating load of the addition. The total annual heating load is then:

$$73{,}398\ MMBtu_{\ annual\ consumption} \times 1.10 = 80{,}738\ MMBtu_{\ annual\ consumption}$$

Monthly fuel consumption was estimated using two elements. First, the base load of the hospital is estimated as 150 HP to account for the laundry system. Second, the non-base load consumption is apportioned based on the ratio of heating degree days in a given month to total heating degree days for Bennington Vermont in 2008. The monthly consumption used in this analysis is shown below:

[12] Guide to Energy Management Handbook, Barney Capehart et al, Fifth Edition, 2006

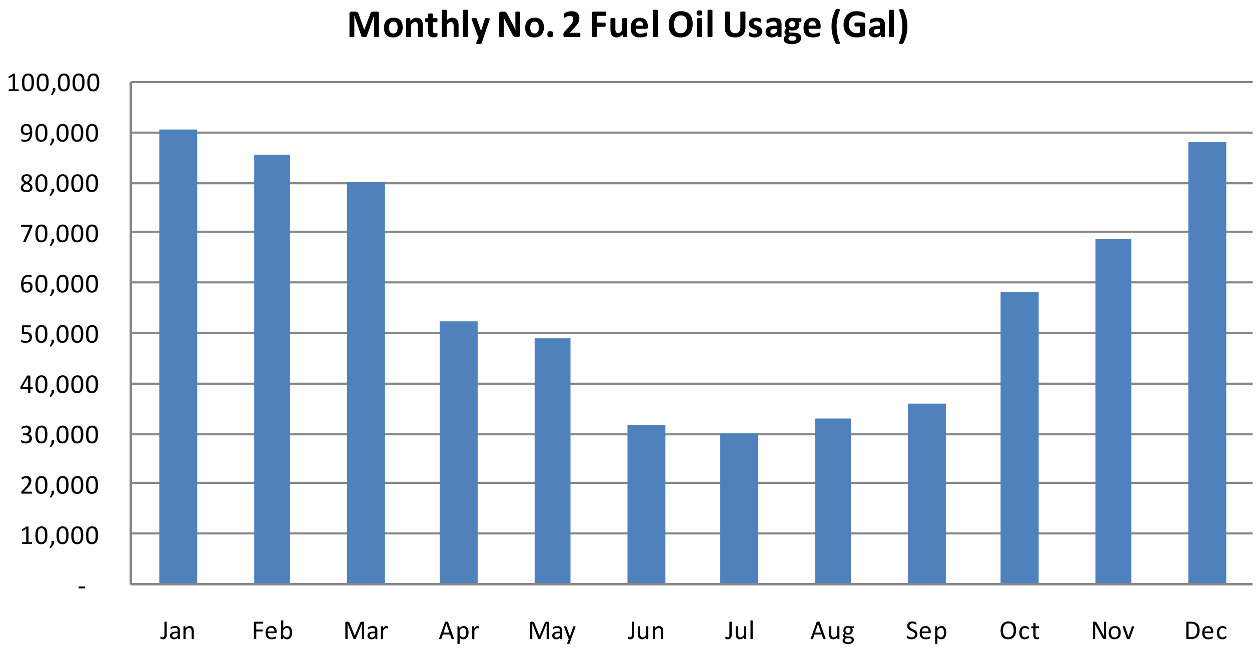

Figure 8: Adjusted Monthly Heating Load

The total estimated annual consumption of No. 2 fuel oil is 702,342 Gallons[13] with a monthly load distribution as represented above. This fuel consumption rate is used as the basis for the cost savings analysis with respect to energy usage. The full calculation is presented in Appendix A.

Variable Inputs

The energy savings calculated in this analysis are the simply the difference in cost between operating solely oil boilers and operating a combination biomass and oiler system. Key variables in this analysis include the current and future price of energy (Refer to Section VI), the heat content of the fuel, the system efficiency of the oil and biomass boilers, and the percent of the total load to be supplied by the biomass systems. Additional energy costs such as the added electric costs for operating biomass fuel handling systems have been detracted from the overall energy savings. Variable inputs used in this analysis are discussed below.

Heat Content

The heat content of No. 2 fuel oil is very constant and is taken to be 138,500 Btu/gal[14] for this analysis. The heat content of woodchips and wood pellets is more variable based upon the type of wood utilized and the moisture content. For this analysis, a heat content of 9.02 MMBtu/ton is used for woodchips. This heat content represents wood fuel with a gross heating value dry sample (GHV-DS) of 8,200 BTU/lb and a moisture content of 45%. This assumption is based upon guidance from the Biomass Energy Resource Center *Wood Chip Heating System* Guide which identifies this value as being conservative for the Northeast. The heat content of wood pellets is more stable than

[13] Based on an oil boiler efficiency of 83%

[14] 1993 ASHRAE Fundamentals Handbook, Page 15.6, Table 7

woodchips as they are manufactured. The assumed heat content for wood pellets is 15.50 MMBtu/ton[15] for pellets with a moisture content of 6%.

System Efficiencies

The efficiency with which the boiler systems convert raw fuel to usable energy is defined as the system efficiency. The system efficiencies are very important to this analysis as they directly affect the amount of fuel consumed and thus the cost of operating the systems. The system efficiencies utilized in this analysis shown below, and are based on direction from F&T and AFS, a product manufacturer who supplied the cost information for each system.

- 500 HP Oil Boiler: 83% System Efficiency
- 500 HP Woodchip Direct Burn Boiler: 67% System Efficiency
- 1,000 HP Woodchip Direct Burn Boiler: 67% System Efficiency
- 500 HP Woodchip Gasification Boiler: 70% System Efficiency[16]
- 1,000 HP Woodchip Gasification Boiler: 70% System Efficiency
- 500 HP Wood Pellet Boiler: 75% System Efficiency
- 1,000 HP Wood Pellet Boiler: 75% System Efficiency

Woodchip boilers in particular have a wide range of efficiencies depending on various factors such as the moisture content of the wood chips burned and the arrangement of emission control mechanisms. The 67% efficiency used in this analysis is conservative.

Biomass Load Capability Assumptions

GDS performed an analysis of monthly energy consumption and load capabilities of each biomass technology to estimate the percentage of the total hospital energy consumption that will be met by the biomass system and the percentage that will be met with the oil system. This percentage is a critical variable in calculating the energy savings for each system.

The load capability for the 500 HP systems was determined by calculating the monthly output capability for the boiler and comparing that to the monthly consumption of the hospital. The calculated ratio is the percent of the hospitals consumption that can be supplied by the biomass system. This percentage was then multiplied by a factor that accounts for expected downtimes of each system for scheduled and unscheduled maintenance. The table below summarizes the load capabilities and down time factors for each system:

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[15] Heat Content in based on 6% Moisture Content, as reported by Massachusetts Division of Energy Resources in the *Wood Pellet Heating Guidebook*

[16] GDS increased the efficiency of the gasification systems to 70% from 67% due to the added efficiency of preheating fuel for more complete combustion. The actual efficiency of these systems was not reported.

	Initial % Load Capability	% Down Time	Total % Load Capability
500 HP Woodchip Direct Burn	91.4%	9%	83.2%
1,000 HP Wood Chip Direct Burn	100.0%	9%	91.0%
500 HP Woodchip Gasification	93.2%	9%	84.8%
1,000 HP Wood Chip Gasification	100.0%	9%	91.0%
500 HP Wood Pellet	96.0%	5%	91.2%
1,000 HP Wood Pellet	100.0%	5%	95.0%

Table 5: Biomass System Load Capabilities

Our analysis indicates that the 500 HP systems, based strictly on horsepower and monthly demand, are capable of supplying over 91% of the total SVMC steam needs. The down time assumptions are based on the woodchip boilers being down for two planned weeks per year (5 days summer, 5 days fall) and one day per month for unscheduled maintenance. This assumption equates to 528 hours per year, or 6% of the hours in a year down time. Wood pellet systems are presumed to be down for half that time. GDs encourages SVMC to meter steam demand (total) during a peak winter night to further develop the actual demand. These factors also include an annualized 10 year major overhaul that is predicted to take 2 months for woodchip and wood pellet systems.

The detailed calculations are presented in Appendix A.

IV. FUEL PRICING

No. 2 Heating Oil

There are a number of factors that can push the No. 2 Heating fuel market up and down – typical supply and demand structures, weather, states of the economy, geopolitical issues – to name a few. While these make it difficult to predict where prices are going, the commodities markets are privy to trending, even after unpredictable events – hurricanes in the Gulf of Mexico, Middle East strife, an economic downturn – there is usually a corrective period that follows.

Webster's Dictionary defines Volatility related to price markets as tending to fluctuate sharply and regularly. When attempting to estimate future commodities prices such as oil it is crucial to consider market price volatility. The current heating fuel market certainly fits the definition of volatility. Over the past twelve months the NYMEX heating oil market has seen both historical highs and hit the lowest point in the past five years. The price of heating oil has not risen above $50/barrel for the last three months.

Future Pricing

For this study, fuel costs are a major concern of SVMC in the decision making process as the price of oil strongly influences energy savings over the life of the project. To give a fair and as accurate as possible reflection of future oil prices, GDS began by reviewing the past ten years of the average monthly NYMEX wholesale market prices for No 2 heating fuel. Although past market conditions are not a definitive indicator of future conditions, the historic trends of heating oil prices provide one method for estimating future prices. The other major consideration in attempting to estimate oil futures was to consider major factors that have impacted or believed to impact the NYMEX heating oil market (e.g. Hurricane Katrina and Rita and the market collapse of 2008).

Heating oil retail costs are a combination of the price of the particular fuel on the commodities/ wholesale market, terminal charges and transportation fees. While there are a number of pieces that build each of these, the fuel market makes up the bulk of the cost, and is also subject to the most volatility.

Historical conditions: The graph below clearly shows the price volatility and the resulting collapse of the market in 2008. In the summer of 2008 at the highest point of the market many market analysts and oil market experts predicted the price of crude oil to continue to escalate. On July 15th the market peaked. It has been a sharp decline since. In December of 2008 market experts predicted that in Q1 2009 oil prices would "settle out at $70 per barrel". In the first two weeks of 2009 the price of oil has remained at less than $42 per barrel. Experts are predicting that oil could go below $30/barrel before settling at $40/barrel.[17]

[17] Morgan Keegan, UNH CEO Forum, Sprague Energy

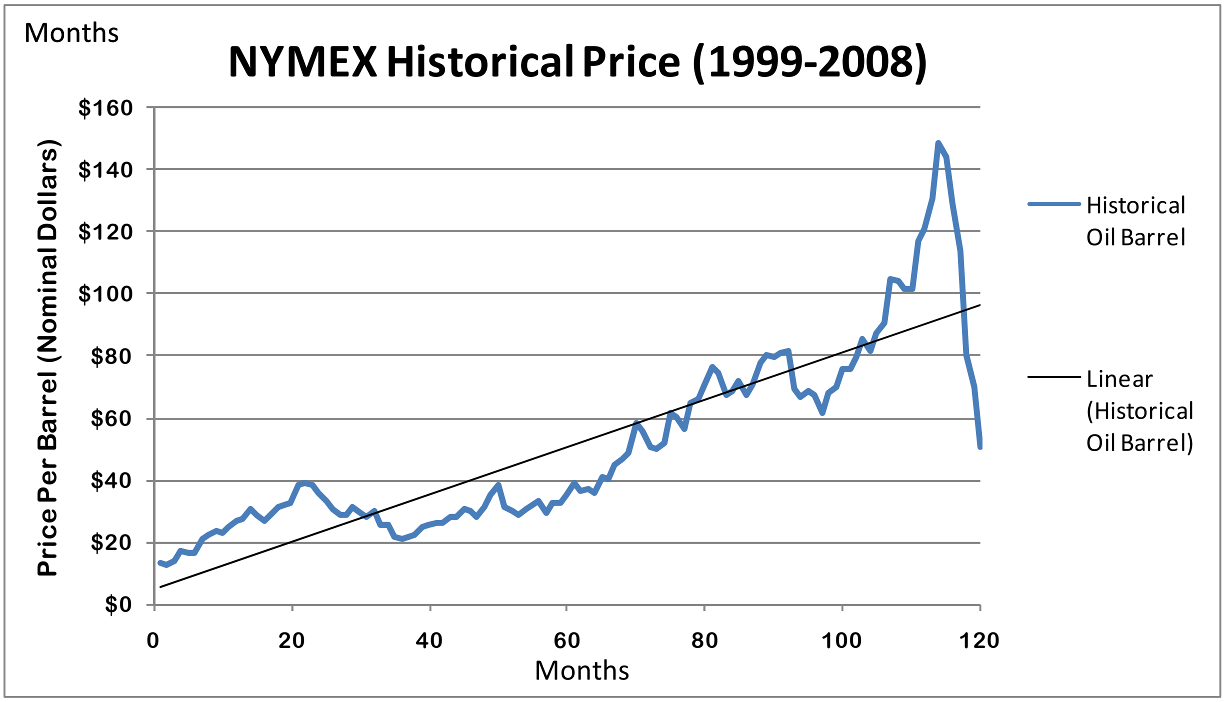

Figure 9: NYMEX Heating Oil Prices 1999-2008

The graph above illustrates the sharp increase (in months) of crude oil prices since 1999. During this period, the price of oil raised an average of 18% per year. GDS used a best fit correlation to determine the linear slope of the increase as one potential method of estimating oil future prices.

Another methodology evaluated by GDS was to remove the spike seen in the last 16 months (Q4 2007 – Current). The spike in oil prices was largely driven by market speculation rather than market demand as evidenced by the drastic decline in prices following the collapse of the stock market in September 2008. Considering the historical trend of NYMEX oil prices excluding the past 16 months yields the following:

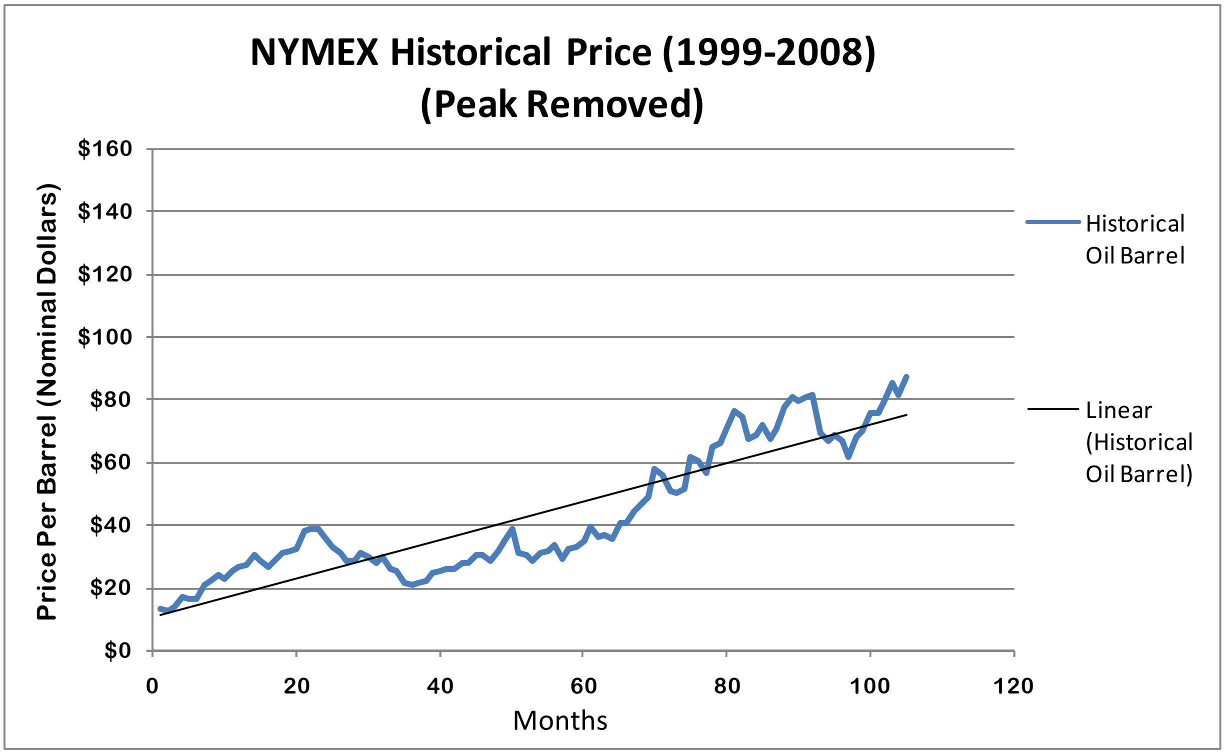

Figure 10: NYMEX Heating Oil Prices 1999-2008 (Peak Removed)

It is interesting to note that removing the peak of the past 16 months does not drastically reduce the slope of the linear best fit line. Using this scenario, the projected price per barrel of oil in 2028 is $232 per barrel, or approximately $15.00 per gallon heating oil delivered. In our opinion, this estimate is not realistic and would yield overstated energy savings in future years.

Future estimates: GDS is not able to accurately predict the future price of a volatile market such as oil futures over the next 20 years. For this reason, we relied on future heating oil prices projected by the Energy Information Administration (EIA). The EIA is the governmental agency responsible for reporting the official energy statistics of the U.S. Government. This method as compared to the above methods is the most conservative approach and should be taken into consideration during the decision making process.

The EIA utilizes the National Energy Modeling System (NEMS) to project future energy prices by geographic region for the next 25 years. The NEMS software accounts for energy supply and demand, economic competition among various energy fuels, domestic growth and public policy[18]. For this analysis, GDS used the Annual Energy Outlook 2009 for distillate fuel oil prices in the New England Region as the baseline for future prices. The graph below illustrates the EIA estimates a best fit linear approximation of the EIA estimates, and high and low price scenarios for sensitivity analysis.

[18] http://www.eia.doe.gov/oiaf/aeo/index.html

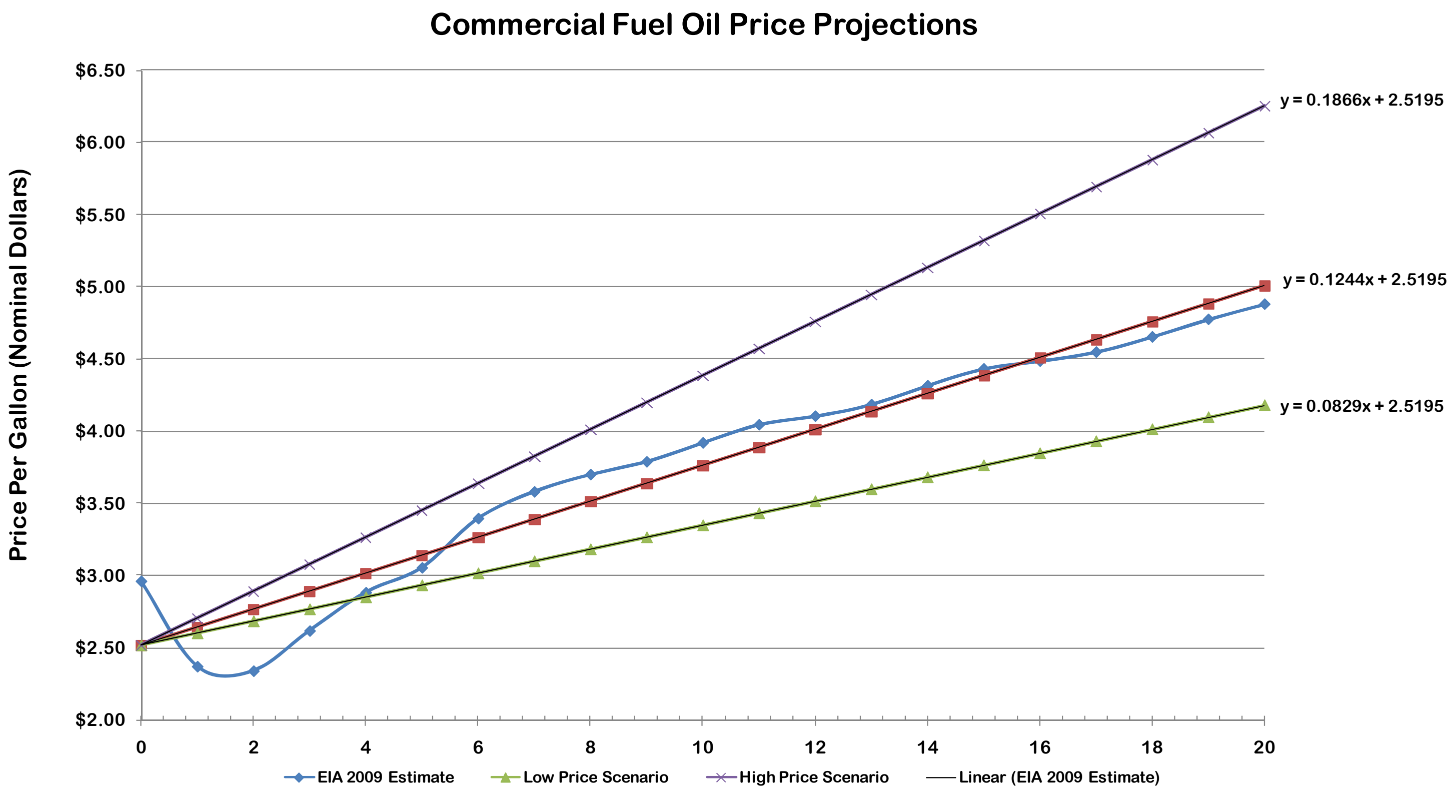

Figure 11: EIA AOE 2009 Future Oil Price Predictions

The projected price of commercial fuel oil in 2028 is $5.00 per gallon. The best fit linear approximation shown above is the baseline for oil prices in this analysis. The life cycle savings spreadsheet includes a variable that allows for consideration of high and low price scenarios as illustrated above. Given the volatility in the NYMEX oil market and in the economy as a whole, it is our opinion that following the EIA estimates is the best approach for this project.

Supply Reliability (No. 2)

No. 2 Heating Oil is traded on a maximum 36-Month contract, although most retailers only contract out 12-18 months at a time, due to the volatility of the market. While some experts clamor that the global market is nearing peak oil – the point in time when the maximum rate of global petroleum extraction is reached. Fuel switching can balance demand for a particular product by supplementing it with another. One known constant is that oil exploration peaked in the 1960's and has declined ever since.

In January and February 2000, distillate fuel oil prices in the Northeast rose sharply when extreme winter weather increased demand unexpectedly and hindered the arrival of new supply, as frozen rivers and high winds slowed the docking and unloading of barges and tankers. In July 2000, in order to reduce the risk of future shortages, the President directed the U.S. Department of Energy to establish the Northeast Heating Oil Reserve. The Reserve gives Northeast consumers adequate supplies for about 10 days, the time required for ships to carry heating oil from the Gulf of Mexico to

New York Harbor. The Reserve's storage sites are located in New Haven, Connecticut (two sites); Providence, Rhode Island (one site); and Woodbridge, New Jersey (one site)[19].

It must be recognized that the amount of oil in the world is finite. If the world continues to use oil, at some point in the future there will be little to no oil remaining. After researching several reports for this analysis nearly all reference figure 12 below. Figure 12 was published on 2000. This graph attempts to show graphically what world production and resulting use will look like in the future. This graph was developed prior to the massive expansion of China and India and it is not known if those countries expanded use of fossil fuels was taken into consideration for the analysis of this graph.

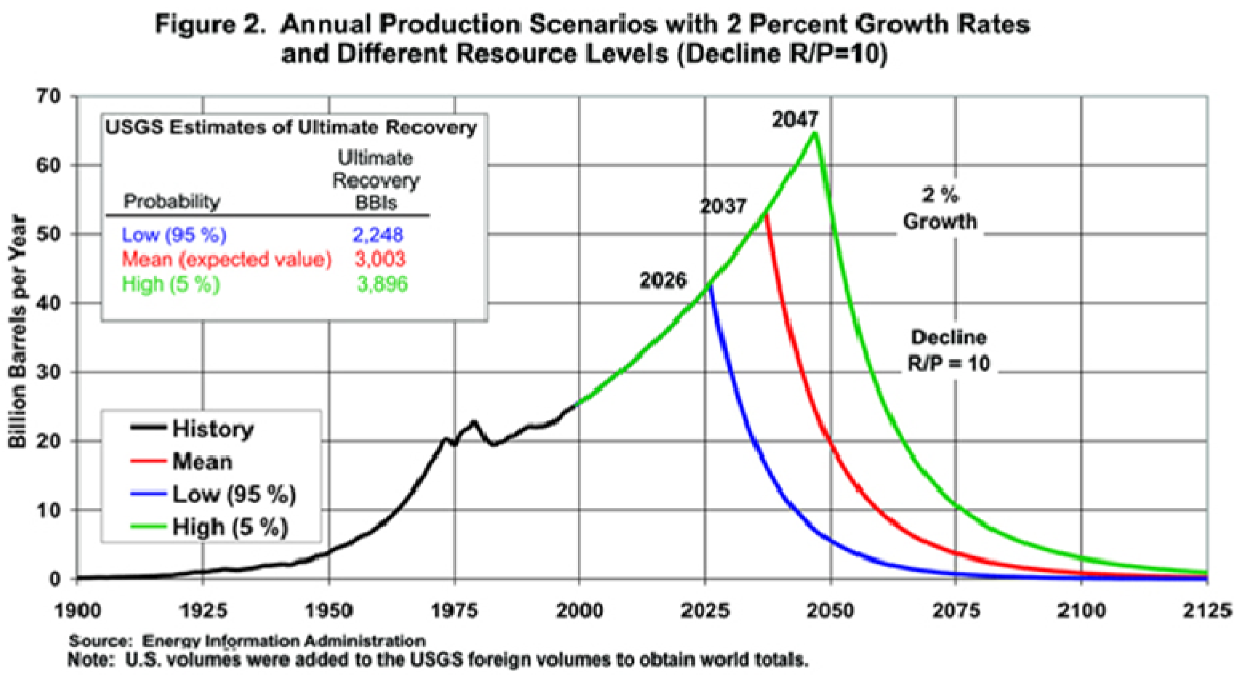

Figure 122: World Oil Supplies and Productions[20]

[19] http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=VT

[20] http://www.hubbertpeak.com/curves.htm

The following graph is shown to provide information on world oil explorations. As is shown from figure 13 below the world oil reserve exploration peaked in the 1960's and today there is little new oil discovered annually. While in some cases oil that is difficult to extract has become more cost effective, most of these reserves are known. Figures 12 and 13 clearly show a problem at some point in the next 50 years that there will likely be little oil left. It should also be noted that there are political issues that surround a large portion of the world's oil supplies. The political unrest in the middle east could have a significant impact on the price and availability of oil. This information is provided to help SVMC realize the impact of their decision to use No. 2 Oil or Wood at some point in the future.

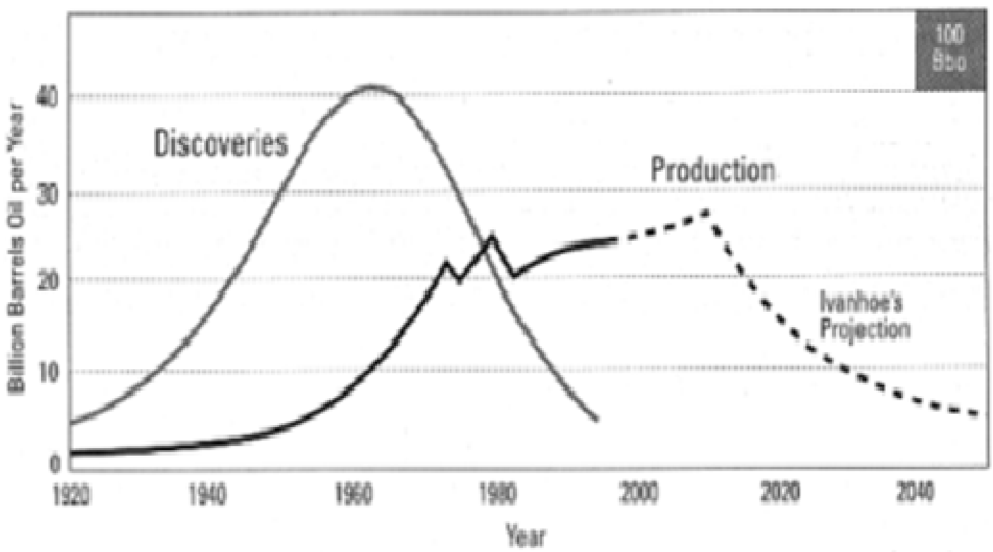

Figure 13: World oil exploration and discoveries[21]

Woodchips

Woodchip prices have been very stable over the past 10-20 years excluding the past three years. Over the past three years, there has been a steady climb in prices. This is tied to one main factor; the price of oil. The price of oil has impacted woodchip prices by driving to cost to process and transport chips up from higher diesel fuel prices and from an increase in demand from heating. Traditionally, woodchips have been a byproduct or waste product of other industries within the Northeast. Many of these industries have experienced large declines in operation in the Northeast and are moving to lower cost areas to produce products. As a result the woodchip demand has moved from a byproduct supply to a market based supply. This results in an inherent tie to oil prices and natural gas prices.

From this we have concluded that as oil prices are projected to increase so will woodchip prices. Below are graphs and tables that show the historical and projected future prices of woodchips. The future prices of woodchips were projected using the straight line method. Historical woodchip prices were developed using the following sources:

[21] Ivanhoe, **1997** http://www.hubbertpeak.com/curves.htm

Woodchips			
Price/ton	Year	Source	Type
25	1996	Barre Elementary (Supplier)	
60	2009	Barre Elementary (Supplier)	
50	2009	Cersosimo	whole-mill range
50	2009	Cousineau	whole
52	2009	Bennington College	whole, mill, bole
18	2000	Bridge Water Power Company	whole tree &bole
25	2006	Bridge Water Power Company	whole tree &bole
26	2004	Balsams/Tillitson Company	whole tree &bole

Table 6: Historical Woodchip Prices

The historical woodchip prices were graphed and a best fit linear correlation was developed. That linear correlation was used to project the future price of woodchips for this analysis. The historical and projected price of woodchips is shown below.

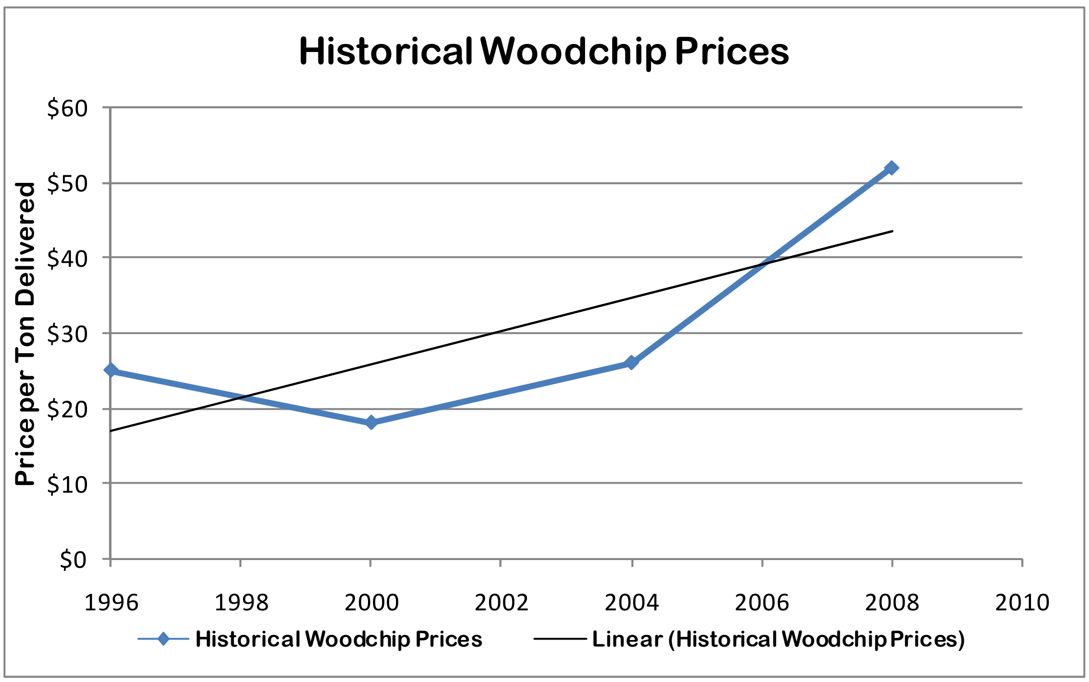

Figure 14: Historical Woodchip Prices

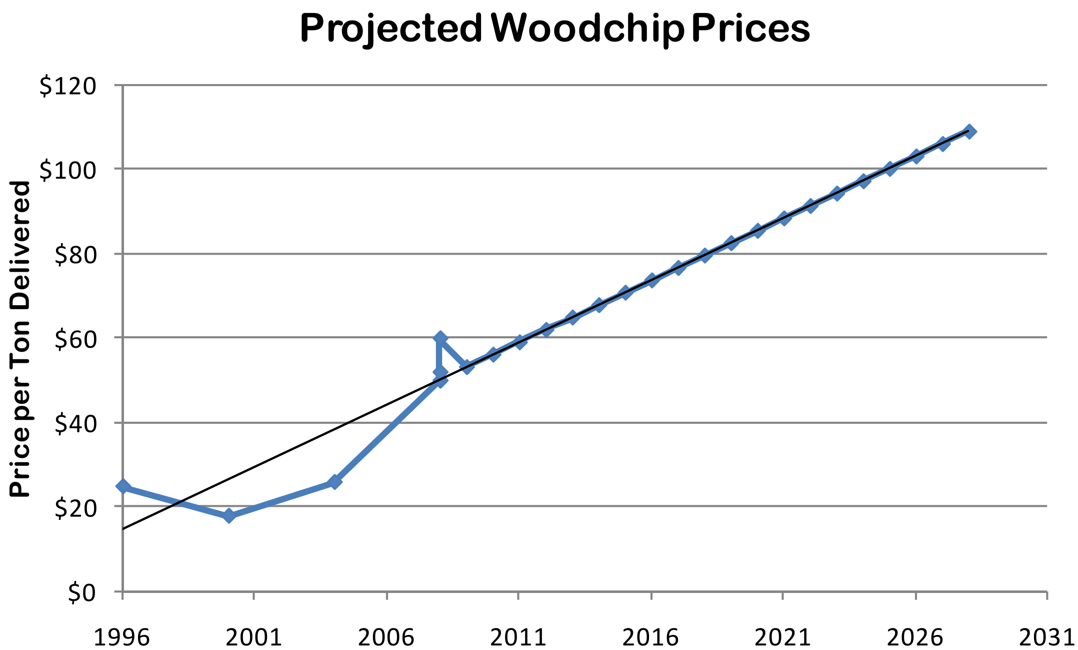

Figure 15: Projected Woodchip Prices Thru 2028

Wood Pellets

Wood pellet prices have had a limited history. Residential wood pellets have been utilized for several years but are typically sold in bags. Typically, home owners purchase a pallet of bags of pellets. The bulk delivery of wood pellets has grown to levels today where competition has developed in the market. For this study GDS contacted two bulk delivery companies and got pricing. In each case the pricing is tied to delivery costs (reference Appendix E - Pellet bulk delivery sample contract). For the historical prices, GDS was able to obtain only a few bulk pellet price points for today's price and past historical prices. These prices are shown below. In our opinion, it is reasonable to assume that the price of wood pellets will follow a straight line method for the purpose of estimating future prices. It is also worth noting that wood products, whether pellet or chips, will be closely tied to the price of the oil. Based on the limited information available, the accuracy of the future costs could be in excess of 50%.

Wood Pellets - Historical		
$/ton	Heating Season	Source
130	2005-2006	NE Wood Pellet
170	2006-2007	NE Wood Pellet
200	2007-2008	NE Wood Pellet
212	2008-2009	NE Wood Pellet

Table 7: Historical Wood Pellet Prices

Wood Pellets 2008-2009 Heating Season		
$/ton	Year	Source
200	2009	NRG
240	2009	Harris Center
232	2009	NE wood Pellet Delivered
224	Average	

Table 8: Current Wood Pellet Prices

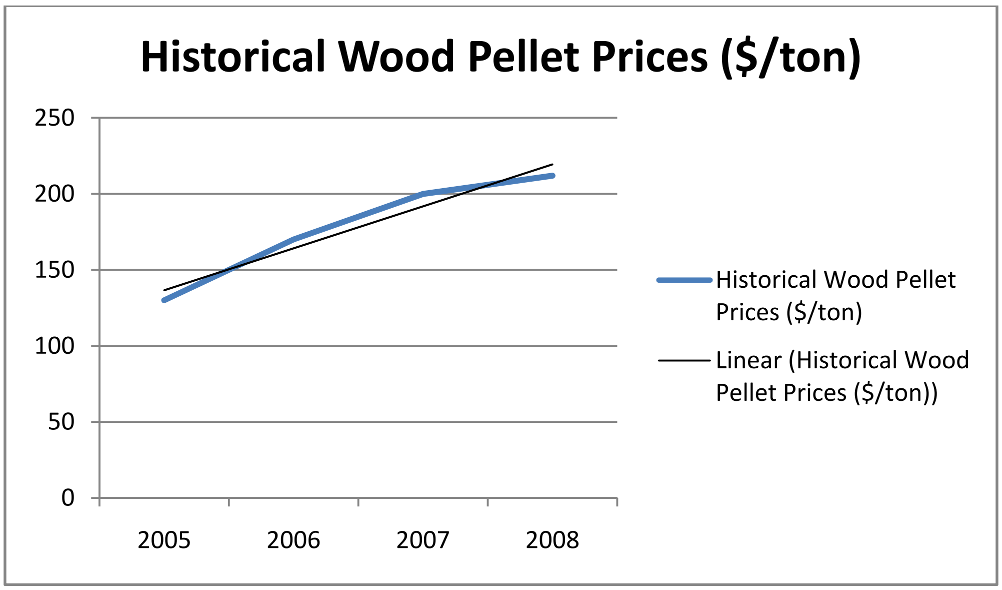

Figure 16: Historical Wood Pellet Prices

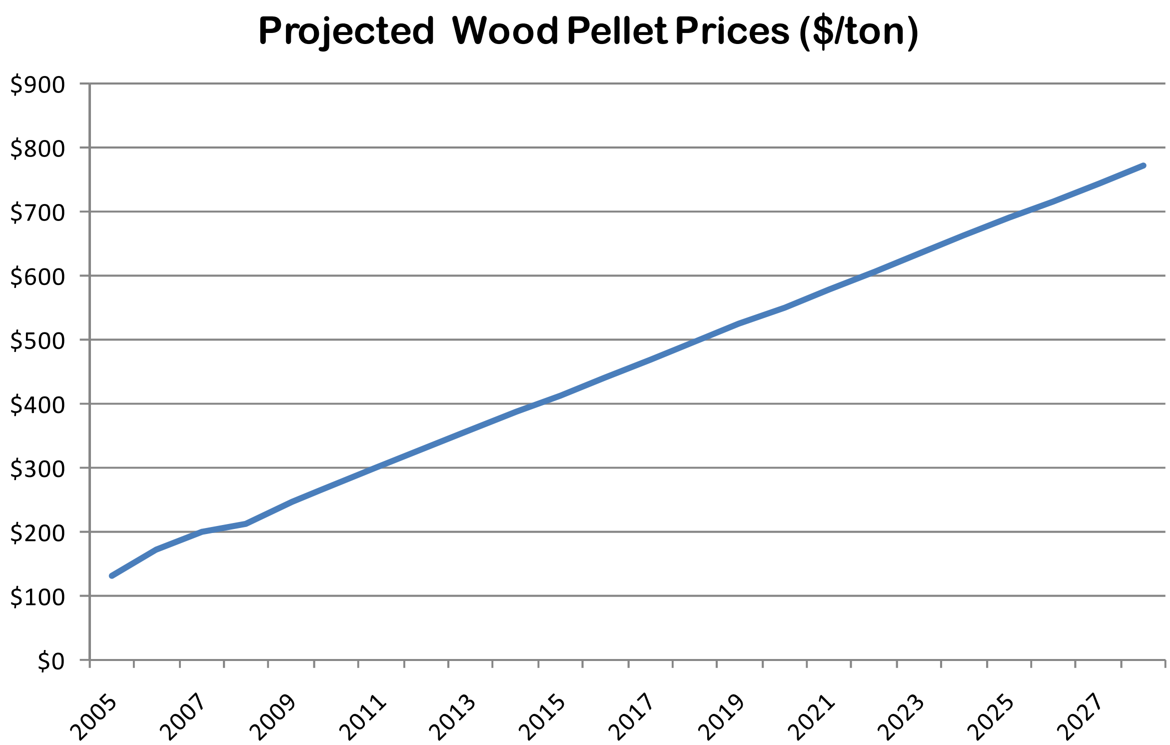

Figure 17: Projected Wood Pellet Prices

Figure 18 below is provided to show a comparison of No. 2. Heating fuel, woodchip and Pellets on as per equal heating content potential and looks at the estimate future price of each as described above.

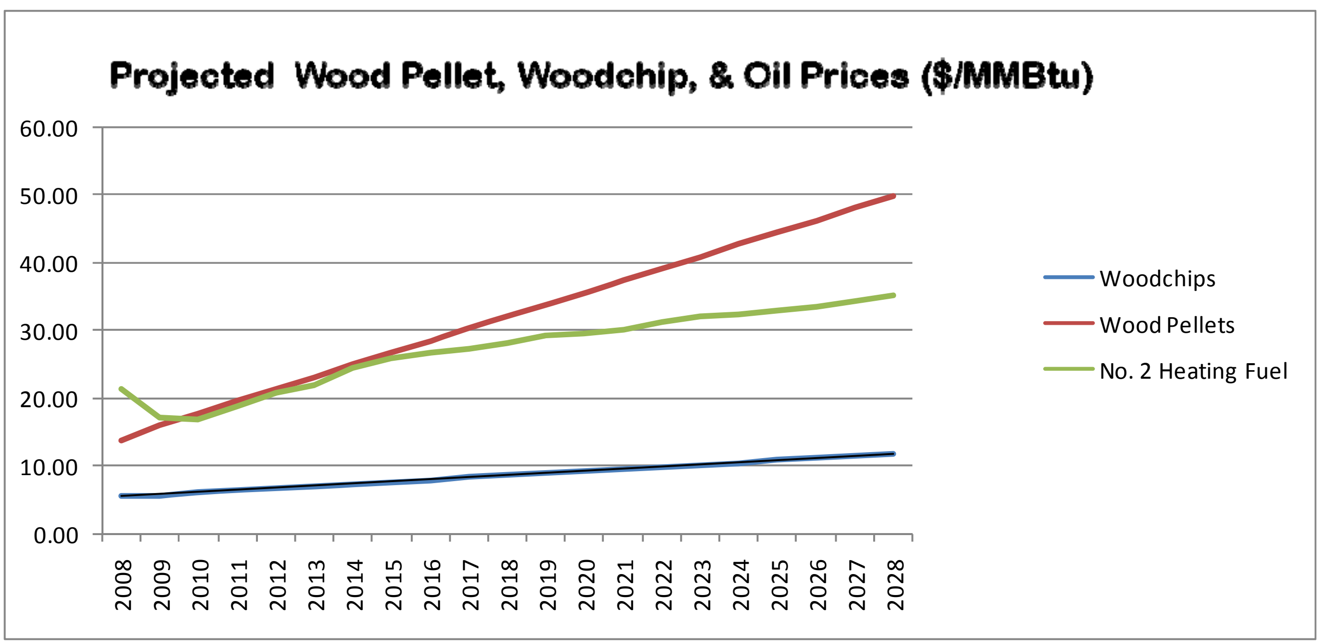

Figure 18: Projected Wood Pellet Prices

V. COST EFFECTIVENESS ANALYSIS

The cost effectiveness of any biomass system is the main consideration for the SVMC. This section discusses the cost estimates obtained through the project MEP engineer and calculations for simple payback, life cycle costs, and return on investment.

System Cost Estimates

Estimates for capital costs, operating costs, and other ancillary costs were provided by Fitzmeyer & Tocci Associates, Inc., the project MEP engineer. The table below summarizes the cost information provided:

	Direct Burn Whole Chip Systems		Gasification Whole Chip Systems		Wood Pellet Systems	
	500 HP Wood Chip Boiler	1000 Hp Wood Chip Boiler	500 HP Wood Chip Boiler	1000 HP Wood Chip Boiler	500 HP Wood Pellet Boiler	1000 HP Wood Pellet Boiler
Capital Cost for Site/Bldg Construction	$1,683,000	$1,980,000	$2,244,000	$2,640,000	$1,262,250	$1,485,000
Capital Cost for Equipment/Systems	$1,144,000	$2,673,600	$1,200,000	$3,080,000	$986,400	$2,159,700
Total Project Cost (1.4 multiplier)	$3,957,800	$6,515,040	$4,821,600	$8,008,000	$3,148,110	$5,102,580
Annual Maintenance Costs (materials, disposal, etc.)	$15,000	$20,000	$15,000	$20,000	$12,000	$16,000
Annual Personnel Operating Costs	$372,400	$372,400	$280,000	$280,000	$140,000	$140,000
Annual Electrical Cost for Material Processing/Handling *	17,500	35,000	$17,500	$35,000	15,750	31,500
Annual Emission Costs (air permit)	$2,925	$5,850	$2,350	$4,700	$2,350	$4,700
Replacment Cost in year 10 (20% of initial equip. capital)	$228,800	$534,720	$240,000	$616,000	$197,280	$431,940
Replacment Cost in year 20 (20% of initial equip. capital)	$228,800	$534,720	$240,000	$616,000	$197,280	$431,940

Table 9: F&T Cost Estimates

The cost information contained in the table above is the basis for the cost analyses presented below. This information is based upon detailed cost proposals received from AFS, a product manufacturer. A multiplier of 140% was applied to the capital cost estimates to account for "soft costs" such as engineering, permits, general conditions costs and contingency.

Simple Payback

A simple payback calculation is among the most common cost analysis methods utilized as it simply determines the number of years required to recapture a capital investment based on annual energy savings. This method is beneficial in that it allows for a simple comparison of multiple options based on known variables such as the current price of energy and calculated demands. The simple payback method is limited in that it does not take into account the future value of money, future fluctuations in the price of energy or future operating and maintenance costs.

For this study, the simple payback was calculated based upon the initial capital investment costs (assuming no financing), first year operating, maintenance and permitting costs, and first year energy savings based on the use of wood fuels in lieu of No. 2 heating oil. The table below summarizes the results of the simple payback analysis:

	500 HP Woodchip Direct Burn	1,000 HP Woodchip Direct Burn	500 HP Woodchip Gasification	500 HP Pellet Direct Burn	1,000 HP Woodchip Gasification	1,000 HP Pellet Direct Burn
Simple Payback	7.7 Years	12.4 Years	7.3 Years	n/a	11.1 Years	n/a

Table 10: Simple Payback Results

The table above considers only the initial capital investment (assuming no financing) and the first year cash flow to calculate a simple payback. The simple payback for the wood pellet systems is not applicable because the first year cash flow is negative meaning that the simple payback is infinite.

Life Cycle Cost Analysis

As opposed to simple payback which considers only the initial capital investment and first year savings to calculate return, life cycle costing (LCC) is used to evaluate the total cost of a project over an extended period of time. The total cost includes the initial capital costs, operating costs, the cost of energy, and required maintenance. A key concept of a LCC analysis is that most of the costs occur at some point in the future and must be analyzed using the time value of money. A dollar today is presumed to have greater value than a dollar in one year due to inflation and the interest that the current dollar could earn over the course of the year if it were invested.

The National Institute of Standards and Technology (NIST) defines LCC as "the total discounted dollar cost of owning, operating, maintaining and disposing of a building or a building system" over a period of time[22]. The analysis for the SVMC study comprises several considerations; capital costs associated with the central utility plant addition and major heating equipment and fuel handling equipment, and operating costs such as additional staffing, energy consumption, on-going maintenance, and permitting. The approach used in this study was to follow NIST's LCC methodology and look at the capital costs and operating costs. Each variable is explained in detail below with sample calculations. GDS developed a customized spread sheet for this project to analyze the different parameters and options as defined in meetings with the project team[23]. This analysis is based on an assumed cost savings over traditional fossil fuels (No. 2 heating fuel). As

[22] Fuller, Sieglinder K., Petersen, Stephen R., U.S. Department of Commerce, Technology Administration, The National Institute of Standards and Technology (NIST) Handbook 135, 1995 edition Life-Cycle Costing Manual of the Federal Energy Management Program

[23] The study parameters were defined in meetings held on 11/18/08 at SVMC and 12/22/08 at LBPA, attended by GDS, F&T, SVMC, BEC and the BCRC.

discussed in Section V above, the future price of No. 2 heating fuel and biomass products was estimated over the study period based on historical trends. These future costs were used in the analysis to take into account present as well as future energy cost savings.

Below are discussions of each variable used in the LCC analysis:

- Study Period: The length of time (20 years) evaluated for this project was determined by several factors. The most relevant factor is the projection period for future fuel prices. Fuel price projections going out twenty years are more art than science and going beyond 20 years becomes very unstable. For example the OMB UPV[24] fuel indices for region one show a decrease in fossil fuel pricing for out to 2038[25]. GDS believes the converse to be true. Other factors considered in selecting the study period were the expected life of the equipment (believed to be beyond 20 years), and the time between major equipment overhauls. Significant technology and regulatory changes are also likely to occur in time periods beyond 20 years. EED also recommends a time period of 20 years for energy savings equipment considerations[26].

- Initial Costs: Equipment, building, installations, construction, engineering GC Markup, permitting, community outreach, contingency.

- Operating Costs: Fuel[27], related electric, water and sewer costs, staffing costs, fuel delivery contracting, ash handling and removal form site, repairs, inspections, conveyance systems, plumbing, fire protection, controls, lighting.

- Residual Value: For the residual value in this cost saving approach as compared to a cost expense approach the factors that have a perceived value at the end of the analysis period (20 years) are counted as a negative (or savings) the building, boiler, and conveyance systems are all negative numbers because that will have a perceived value at the end of 20 years. The decommissioning of the plant (should it be needed) would be a positive number based on its perceived real costs should the plant be shut down, moved etc.

- Real Discount Rate: The real discount rate is also known as the minimum attractive rate of return for projects. The SVMC uses a real discount rate of 6.5%.

- Present Value: The present value or future energy savings is most commonly referred to as the time equivalent value of past present or future cash flows at of the beginning of the base year. For this study GDS has examined the potential costs benefits for biomass systems.

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[24] Office of Management and Budget (OMB), Uniform Present Value (UPV) , Uniform Present Value

[25] U.S. Department of Commerce, Technology Administration, The National Institute of Standards and Technology (NIST) Handbook 135, 1995 edition supplement, Energy Price Indices and Discount Factors for Life-Cycle Costing Analysis – April 2008

[26] EED Alaska Department of Education's Life Cycle Cost Analysis Handbook 1s edition 1999.

[27] The fuel costs used in the LCC are based on projected future prices. GDS makes no guaranties as to what fuel prices will do in the future.

Sample Calculations

$$P = A_o x \sum_{i-1N} \frac{I_{(2008+t)}}{(1+d)^t} = A_o x UPV *_N$$

<u>Where:</u>

A_o= Annual cost of energy as of the base date (February 2009). For this project, this variable is the annual total of capital cost in year "t" plus the total operating costs including fuel for the given year
t = Index used to designate the year of energy usage
N= Study Period (20 years)
$I_{(2008+t)}$ = Projected average fuel prices index. For this project, the fuel prices are derived independently based on historical and future contracts and normalized to an annual escalation rate
d = Real discount rate

The life cycle cost analysis for this project has one important difference from many life cycle cost analyses. Rather than considering the cost of biomass fuel simply as an expense, the avoided cost of running oil boilers is also considered such that fuel costs for the systems result in a positive cash flow. This important distinction allows the cost savings of biomass to be factored into the life cycle analysis and allows for comparison between each of the systems.

The table below summarizes the net present value in year 20 of the project. These values assume that that all capital costs are paid for at the initiation of the project. The year 20 net present value represents the value of the project, over the course of its lifetime, in 2008 dollars. For example, a net present value of zero dollars in year 20 would mean that project "breaks even" over the course of the project.

	500 HP Woodchip Direct Burn	1,000 HP Woodchip Direct Burn	500 HP Woodchip Gasification	500 HP Pellet Direct Burn	1,000 HP Woodchip Gasification	1,000 HP Pellet Direct Burn
Year 20 Net Present Value	$2,900,746	($1,041,459)	$4,027,341	($12,765,683)	$100,365	($15,540,692)

Table 11: Year 20 Net Present Value

The option with the highest net present value in year 20 is the 500 HP Woodchip gasification option. The 1,000 HP Woodchip and both wood pellet options both result in negative net present values in year 20. The complete calculation spreadsheets showing all assumptions, yearly cash flow and net present value are provided in Appendix G. The net present value trend over the duration of the study period for each option is illustrated in the graph below.

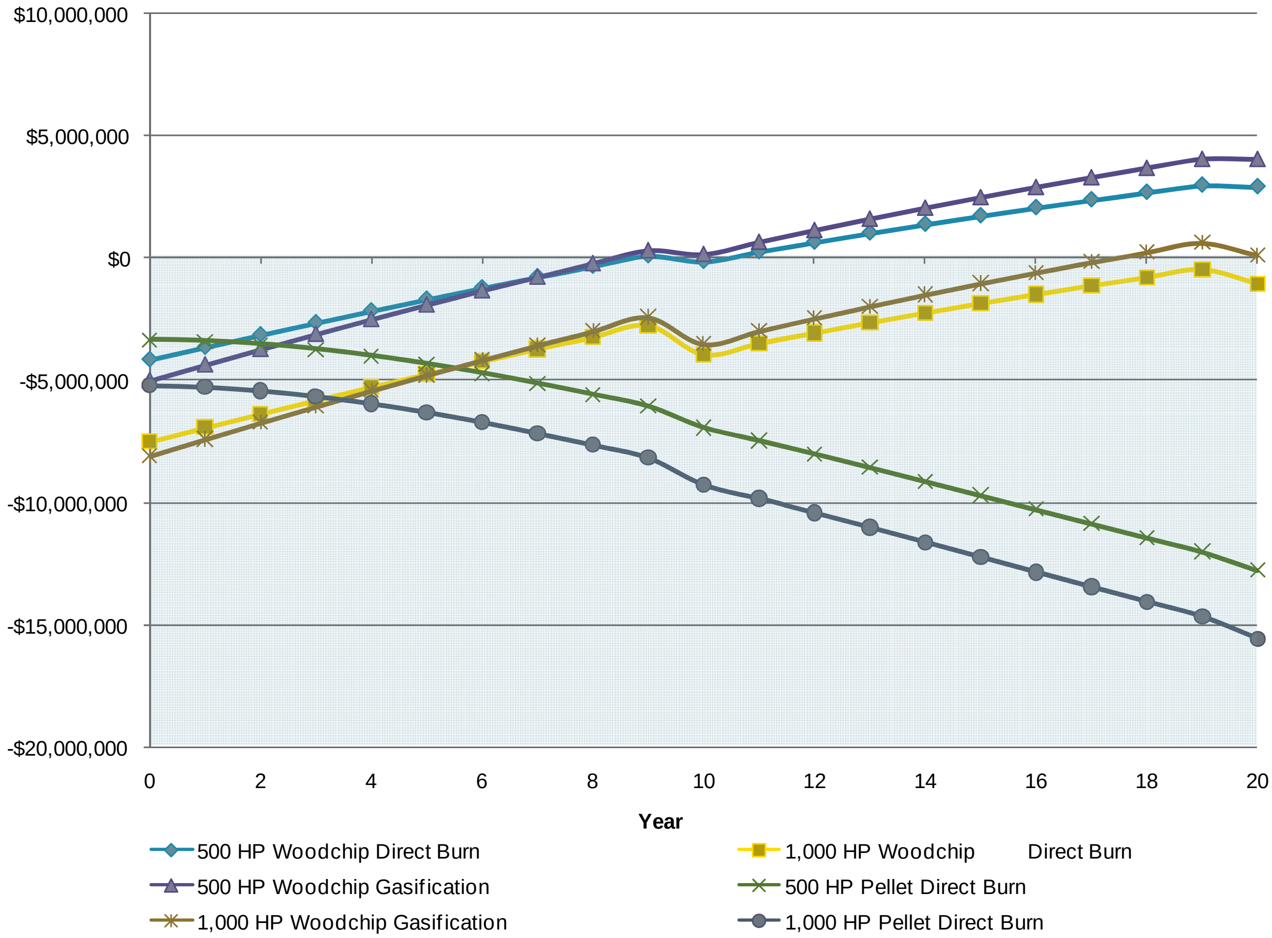

Figure 19: Net Present Values over Study Period (2008 Dollars)

Internal Rate of Return (IRR)

The Internal rate of return of an investment can vary widely based on the internal requirements of the financing entity. For example a municipality would likely have a much lower required IRR to support a project than would a manufacturing based company. This is largely based on the assumption that the primary function of a municipality is to deliver service to residents. Conversely, a manufacturing based company's primary focus it to return profits to investors and to grow the company to help to provide continued growth. Each has a different perspective on desirable short term and longer term results.

The primary measure of an investment, purchase or energy savings project is based on a yield and known as the internal rate of return (IRR). The internal rate of return can be expressed at the breakeven point interest rate which equates to the Present Worth or New Present worth of a project cash flow or savings in this case.

$$PW(i_{rr}) = PW_{saved} - PW_{cash\ out} = \frac{F_o}{(1+i_{rr})^0} + \frac{F_1}{(1+i_{rr})^1} + \frac{F_2}{(1+i_{rr})^2} + \cdots \frac{F_n}{(1+i_{rr})^n}$$

Where:
$\boldsymbol{PW}$= Present Worth
$\boldsymbol{i_{rr}}$ = Internal Rate of Return
$\boldsymbol{F}$= Cash Flow

The table below summarizes the year 20 internal rate of return for each option evaluated.

	500 HP Woodchip Direct Burn	1,000 HP Woodchip Direct Burn	500 HP Woodchip Gasification	500 HP Pellet Direct Burn	1,000 HP Woodchip Gasification	1,000 HP Pellet Direct Burn
Year 20 IRR	13.9%	4.6%	14.7%	n/a	6.7%	n/a

Table 12: Year 20 Internal Rate of Return Results

The IRR for the 500 HP Woodchip Gasification option is 14.7% and represents a very good return on investment considering the conservative nature of this analysis. An internal rate of return was not returned for the wood pellet options as each loses money on a yearly basis resulting in a negative IRR.

VI. Findings

The intent of this feasibility study was to evaluate multiple biomass technologies based on a number of considerations and identify the technology that is best suited for the SVMC. To compare each biomass technology, GDS developed a customized weighted matrix that utilizes scoring algorithms and weighting factors to quantitatively compare each technology.

Ranking Methodology

The customized weighted matrix used in this study is based on the Pugh Method. The Pugh Method, also known as the decision matrix method, is a form of prioritization matrix where options are scored relative to a baseline design. Scores are multiplied by weighting factors and are combined to evaluate options over multiple criteria. The weighted matrix utilized in this analysis varies from the Pugh Method in that no baseline option is identified. Rather, each option is directly compared to each other using a liner scoring algorithm.

Scoring for each option is from 0-5, with 5 being the score for the best option for the particular variable and 0 being the score for the least desirable option. The scoring algorithm works by assigning values of 5 to the best option and 0 to the least desirable option. For simple payback, as an example, the option with the lowest simple payback would get a 5 and the option with the highest simple payback would get a 0. Scores for the options in between are calculated by linearly interpolating between the high and low values and assigning a score (rounding to whole numbers).

The weighting factors used to assign importance to each of the criterion evaluated are more subjective and have been agreed upon by the project stakeholders. The final weighting factors and scores are presented in Table 13 below.

Results

	Simple Payback	Lifecycle Costs	Capital Costs	O + M Costs	Fuel Delivery	Emissions	Regional Resources	*Total Score (100 max)*
WEIGHT (1-5)	**3**	**5**	**5**	**4**	**3**	**2**	**1**	
Wood Chip Boilers								
500 HP Direct Burn	5	4	5	2	2	1	4	***70***
500 HP Gasification	5	5	4	1	3	2	4	***70***
1,000 HP Direct Burn	4	2	1	2	2	2	4	***43***
1,000 HP Gasification	4	3	1	1	2	3	4	***45***
Pellet Boilers								
500 HP Direct	1	1	5	5	4	4	2	***65***
1,000 HP Direct Burn	1	1	4	5	4	5	2	***63***

Table 13: Weighted Scoring Matrix Results

The weighted scoring matrix scores the 500 HP woodchip gasification boiler and the 500 HP wood chip direct burn boilers as the best options. Key observations of this table, and of this analysis, are that the 500 HP boilers are sufficient to serve nearly 92% of the steam load for the SVMC thus the additional capital investment of the 1,000 HP boilers is not cost effective. The recent drastic spike in the price of wood pellets results in the wood pellet boilers not being cost effective.

VII. Energy Performance Contracts

Working with an Energy Performance Contractor (EPC) may be an appealing option for the SVMC. An EPC will assume all capital costs and will operate the biomass boiler plant on site and sell steam to the hospital. This option eliminates capital cost considerations for the hospital, freeing up capital for other needed improvements. GDS contacted several EPC's to investigate initial interest and determine typical terms and cost structures.

Johnson Controls Inc. (JCI) was contacted and their contracts for a biomass plant would likely be based on oil prices. JCI was not able to meet the timeline of this report to provide a letter of interest or draft contract. GDS also contact Honeywell. A representative from Honeywell was interested in looking at the whole campus for energy efficiency and would include biomass as an option. Their philosophy is to first attempt to reduce the load on the electrical and heating systems through efficiency upgrades that can support themselves based on savings and then look to install a biomass plant sized for the new reduce load.

GDS was able to get a solicitation from International Wood fuels for a performance contract (reference appendix F). Based on the provided information GDS does not agree with the N+2 assumption that iWood makes in reference to not requiring the third Oil fired boiler to meet the required N+1. If this were a different application such as a school then that might be a consideration but based on the fact that this is a hospital and based on the reliability discussion in Section IV this is not a viable consideration for this project. The iWood proposal offers a ten year term for the contract with a negotiation each year on prices based on oil prices. This seems completely reasonable and would likely have a small impact on hospital staff they will be review oil prices for the No.2 system annually or possibly more frequently. GDS feels that the first years savings is over stated based on the currently delivered oil price today is $1.79/gallon[28]. This current price is lower than the price assumed in the iWood proposal.

Should SVMC consider an EPC, GDS strongly recommended that SVMC included the cost of a consulting to help develop an RFP, evaluate the RFP's support in contract negations, legal counsel to help review contracts and project management during any installations. GDS estimates this would add over $500,000 to SVMC cost of the project. This cost should not be rolled into the EPC and the consultant should report directly to a high level SVMC staff. The steam load used for this project is estimated and should be metered to help further develop a contract between a EPC and SVMC.

Energy performance contracting (EPC) has been around for many years. With the recent price spike for oil in the summer of 2008, EPC's have experienced rapid growth. Traditionally for an EPC to be of interest, the minimum project cost would need to be in excess of $1,000,000. Today with the volume of work taking place a typical project is around $10,000,000. This project would likely meet the minimum thresholds of requirements for a large EPC Company. GDS recommends that if an EPC is selected, that the hospital uses a larger company to ensure the company's economic viability over the life of the contract.

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[28] Delivered price quote by Hess on 1/14/ 2009.

VIII. Conclusion and Next Steps

Based on the findings presented in this report and discussion with representatives from SVMC, there are several viable options for SVMC to consider. With the current and future volatility in oil prices and the direct link between oil and wood prices, incorporating a biomass system is a difficult decision with many variables. Should SVMC find the financial viability appealing to their short and long range business plans, the detailed design of a biomass system would have to be developed taking into consideration the factors discussed in this report.

Energy Performance Contracts may also offer an appealing option for the SVMC. Entering into a EPC would allow for the monetary and societal benefits of a biomass system with no capital cost expenditures to the SVMC, thus freeing up capital for other endeavors. If there is interest in pursuing an EPC, GDS strongly recommends hiring a consultant with intimate knowledge of EPC's. A consultant can assist in ensuring that all assumptions are accurate and that the terms of the contract are amenable to all parties.

Finally, it has been GDS's experience that dollar for dollar the best avenue to reduce cost and emissions is to first focus on energy efficiency in the entire complex. Incorporating a biomass system has the potential for substantial cost savings over the life of the project. Incorporating an energy efficiency program would help to reduce the total base load and peak load consumption to reduce all energy costs, whether met by oil or biomass boilers.

Appendix A

SVMC Monthly Steam Load Calculations

GDS Associates 1/10/2009 (revised January 30, 2009)

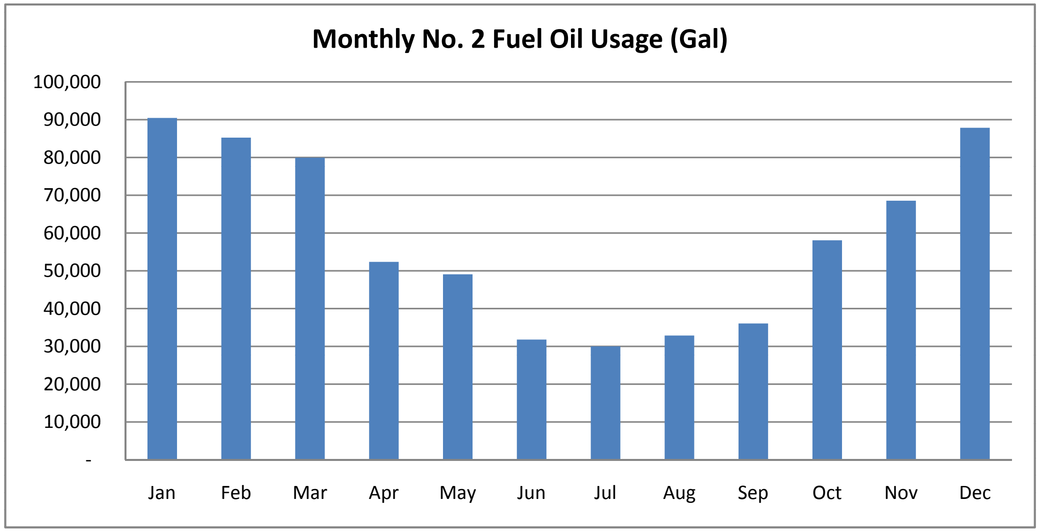
Project: Southern Vermont Medical Center

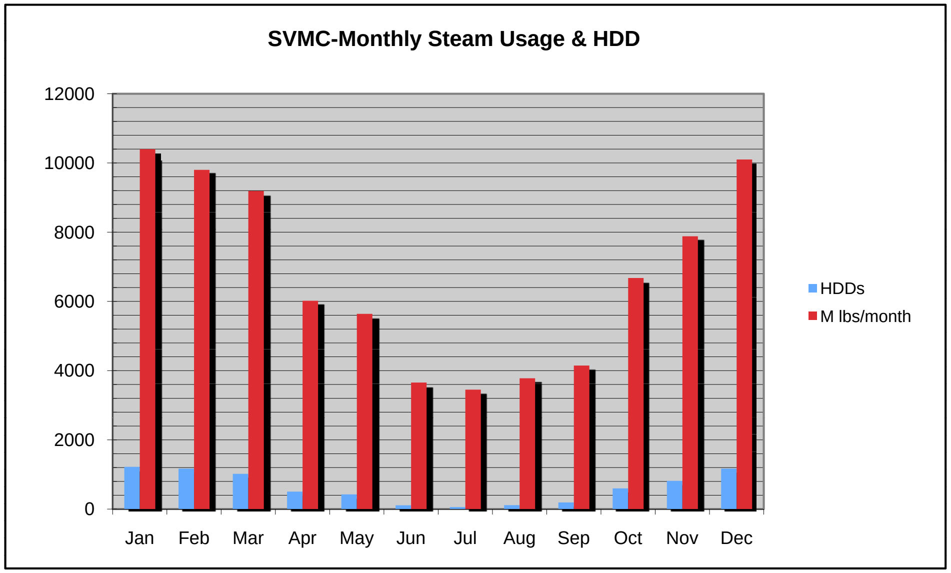
Estimating monthly steam & #2 oil requirements

Assumptions:

1. Forecasted annual use of #2 fuel =	702,342	Gallons/year	
2. Heating Value of #2 =	138,500	Btu/gal	
3. 1 mlb of steam = 1,000 lbs of steam =	1,000,000	Btu	
4. Hospital base load =	150	Bhp	24/7/365
5. 1 Boiler hp =	33,434	Btu/hr	
6. Total Bennington HDDs =	7,397		
7. Hospital operates 24/7/365 =	8,760	hours/year	
8. Conversion of annual oil to M lbs =	80,738	M lbs/year	
9. Total M lbs minus base load m lbs =	44,274	M lbs for comfort heating	
10. #2 Cleaver-Brooks efficiency =	83%		
% Downtime Biomass Boile	3%		

									500 Bhp Wood-oil offset			
			Base load	Base load	Base load	Heating	Tot. Steam	Tot. #2	500 Bhp	500 BHP	Equiv. #2 Oil	Saved #2
Month	Hours/month	HDDs	Bhp	M lbs/hr	M lbs/month	M lbs/month	M lbs/month	Gal/month	M lbs/month	capability	Gal/month	Gal/month
Jan	744	1220	150	4.16	3,097	7,302	10,399	90,462	8,333	8,333	72,490	72,490
Feb	672	1170	150	4.16	2,797	7,003	9,800	85,252	7,527	7,527	64,773	64,773
Mar	744	1018	150	4.16	3,097	6,093	9,190	79,945	8,333	8,333	71,713	79,945
Apr	720	505	150	4.16	2,997	3,023	6,020	52,365	8,064	6,020	69,400	52,365
May	744	425	150	4.16	3,097	2,544	5,641	49,069	8,333	5,641	71,713	49,069
Jun	720	110	150	4.16	2,997	658	3,655	31,799	8,064	3,655	69,400	31,799
Jul	744	59	150	4.16	3,097	353	3,450	30,012	8,333	3,450	71,713	30,012
Aug	744	114	150	4.16	3,097	682	3,779	32,876	8,333	3,779	71,713	32,876
Sep	720	192	150	4.16	2,997	1,149	4,146	36,068	8,064	4,146	69,400	36,068
Oct	744	598	150	4.16	3,097	3,579	6,676	58,077	8,333	6,676	71,713	58,077
Nov	720	816	150	4.16	2,997	4,884	7,881	68,558	8,064	7,881	69,400	68,558
Dec	744	1170	150	4.16	3,097	7,003	10,100	87,859	8,333	8,333	71,713	71,713
Annual Totals =	8760	7397			36,464	44,274	80,738	702,342		73,775	845,143	647,745
												Gal/year save
									91.38%	0.88634286		


Monthly No. 2 Fuel Oil Usage (Gal)
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


SVMC-Monthly Steam Usage & HDD
12000
10000
8000
6000
4000
2000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
HDDs
M lbs/month

Appendix B

Fuel Delivery Calculations
Delivery Truck Specifications

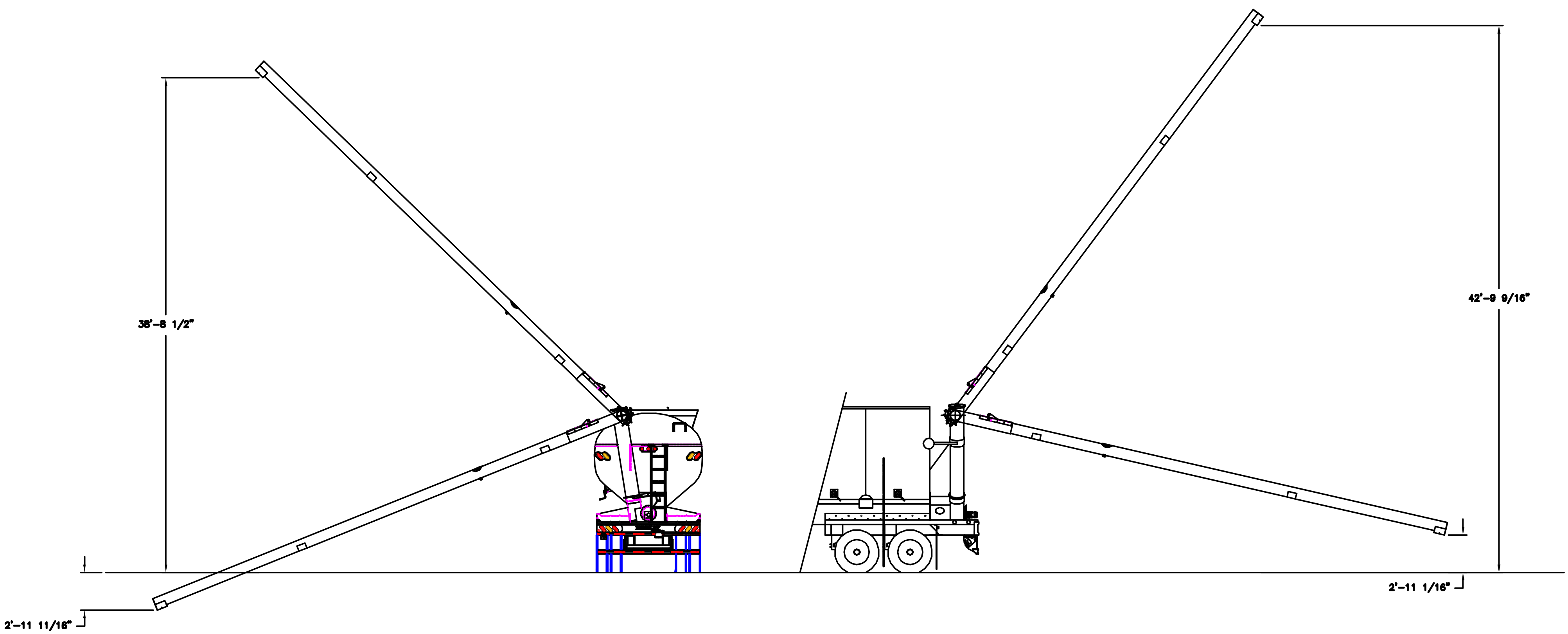
SVMC Total Heating Lo	80,989	MMBtu	#2 Fuel Oil Truck Capacity	8,000	gallons
SVMC Peak Heating Lo	517	MMBtu/day	Woodchip Truck Capacity	25	tons
			Wood Pellet Truck Capacity	25	tons
Oil Heat Content	0.13850	MMBtu/gallon			
Woodchip Heat Conte	9.02	MMBtu/ton[1]	Boiler HP Conversion Factor	33,446	Btu/hr/Bhp
Wood Pellet Heat Con	15.50	MMBtu/ton[2]			

Oil Boiler Efficiency	83%
Woodchip Direct Burn Boiler Efficiency	67%
Wood Pellet Boiler Efficiency	75%
Woodchip Gasification Boiler Efficiency	70%

	Fuel Delivery Truck size	Heat Content (MMBtu) per Delivery	# of Fuel Deliveries per Year	# of Fuel Deliveries on Peak Weekday
2 x 500 HP #2 Fuel Oil Boiler	8,000 Gal	1108	88	0.6
500 HP Direct Burn Woodchip	25 Ton	225.5	520	3.4
500 HP Wood Pellet	25 Ton	387.5	270	1.8
500 HP Gasification Woodchip	25 Ton	225.5	498	3.3
1,000 HP Wood Pellet	25 Ton	387.5	279	1.8
1,000 HP Direct Burn Woodchip	25 Ton	225.5	536	3.4
1,000 HP Gasification Woodchip	25 Ton	225.5	513	3.3

Note 1: Heat Content is As-Fired Gross Heating Value based on 45% Moisture Content and Averaged Dry Sample Gross Heating Value of 8,200 Bt

Note 2: Heat Content in based on 6% Moisture Content, as reported by Massachusetts Division of Energy Resources in the *Wood Pellet Heating*



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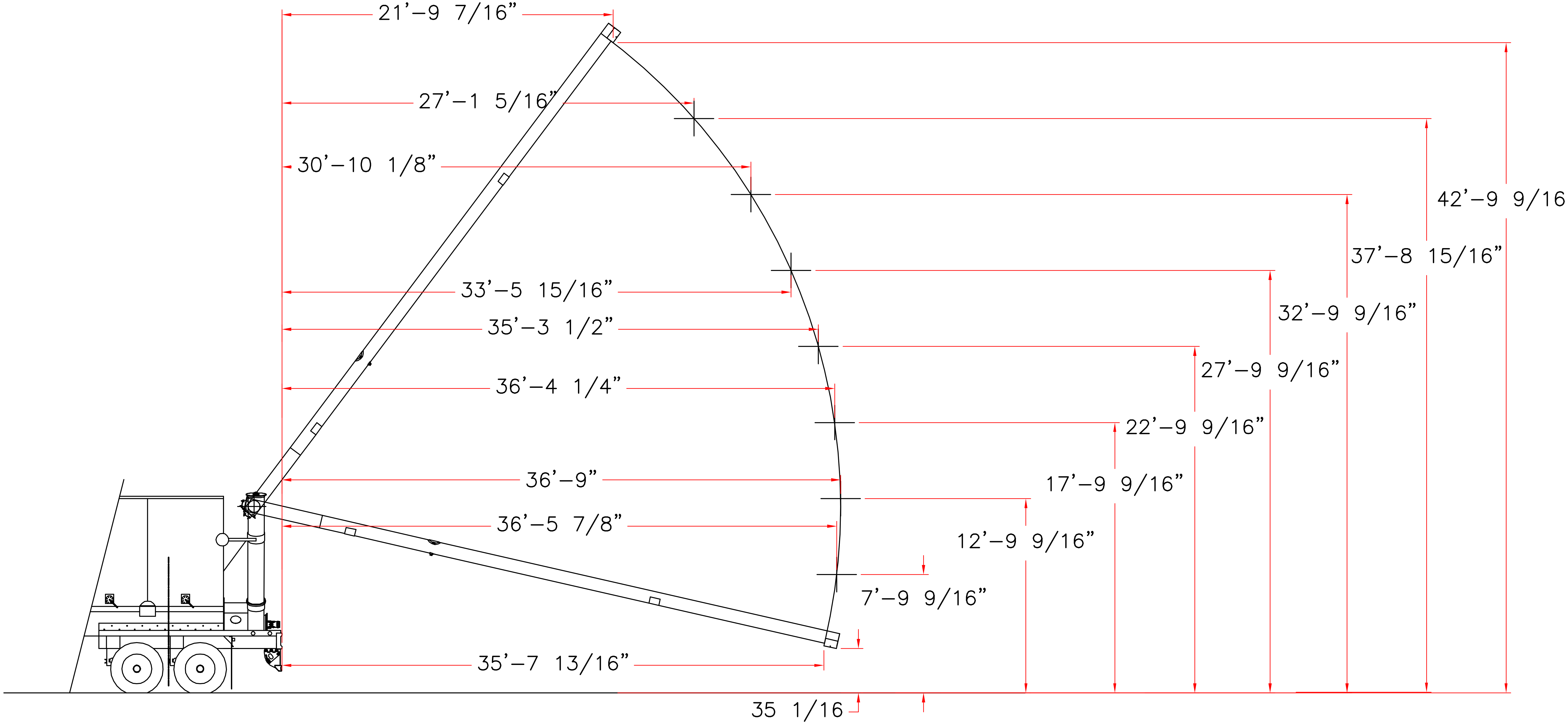

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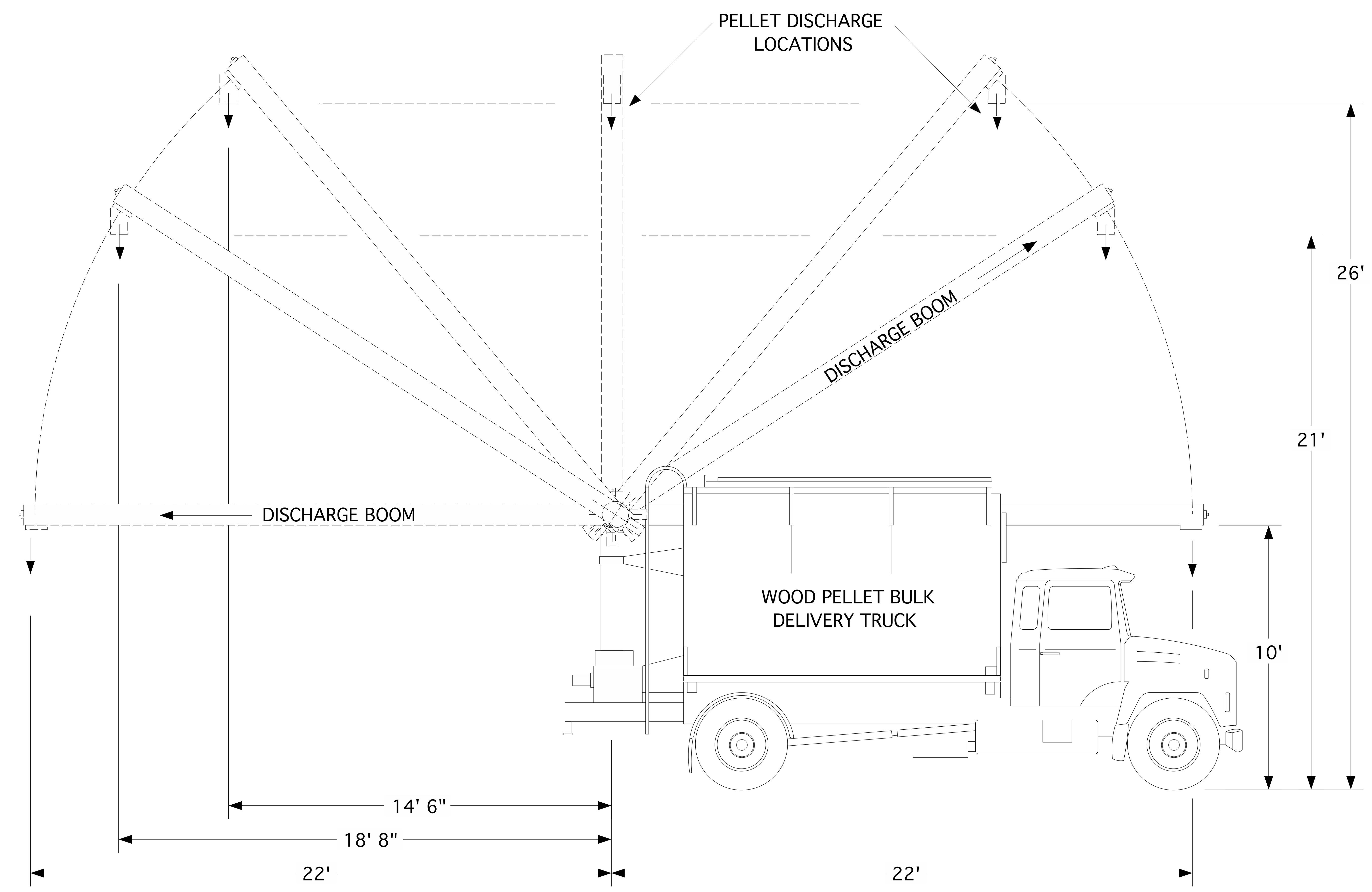
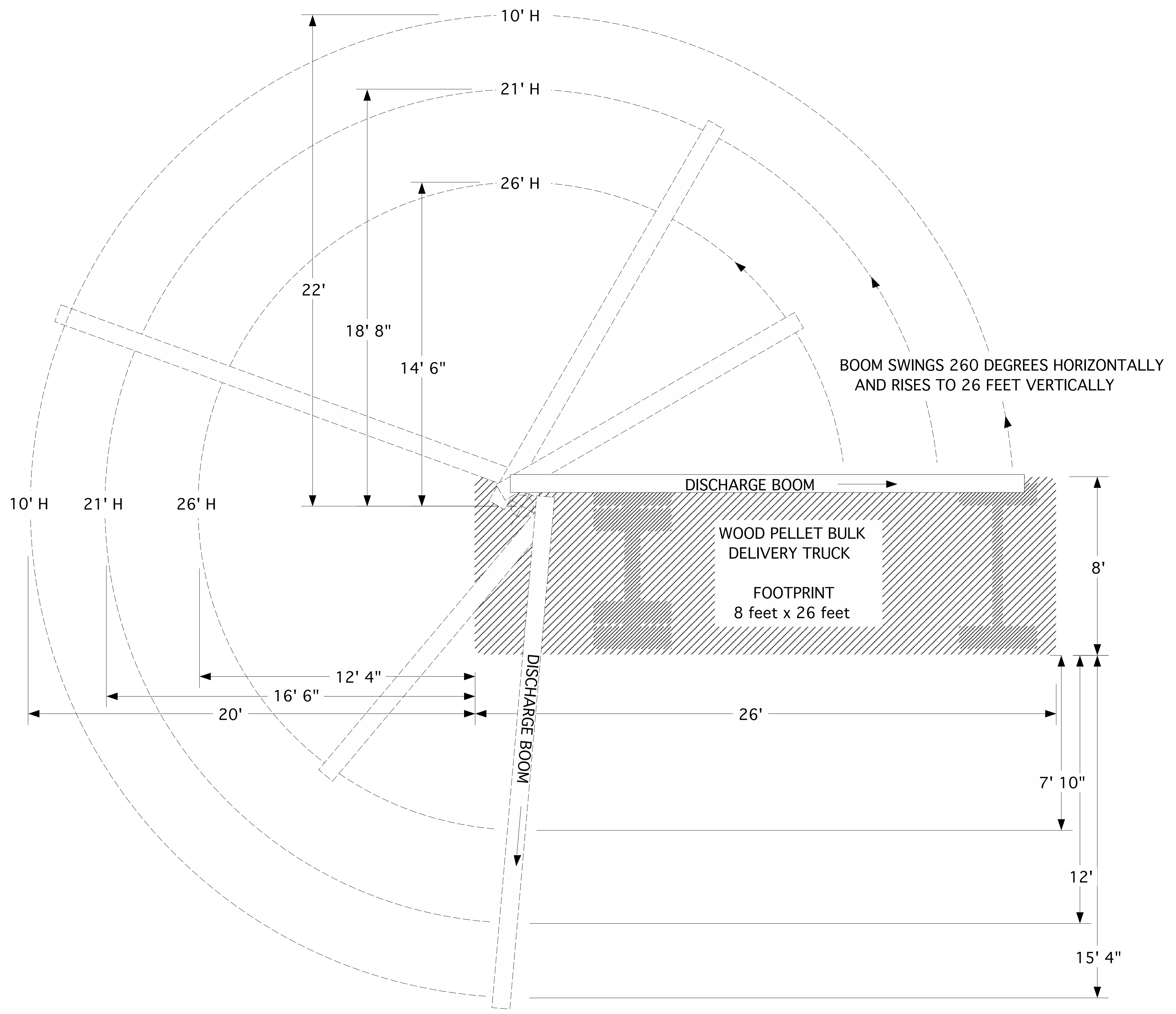




BULK PELLET DELIVERY TRUCK DIAGRAM ILLUSTRATING THE HEIGHT AND DISTANCE OF POTENTIAL LOCATIONS REACHABLE BY THE TRUCK'S DISCHARGE BOOM FOR DISPENSING WOOD PELLETS.

Appendix C

Reserved

Appendix D

500 HP Woodchip Gasification Boiler Sensitivity Analyses

- Oil Escalation at 150% (High Price)
- Oil escalation at 50% (low price)
- Discount rate of 3% (US DOE recommendation)

SouthWestern Vermont Medical Center - Biomass Feasibility Study

500 HP Wood Chip Gasification Boiler Option

30-Jan-09

500 HP Wood Chip Gasification Boiler Option - Inputs

COST	
Capital Costs:	$5,021,600
Fixed Operating Costs:	$295,000
Permitting Costs:	$2,350
Taxes:	$2,500
Insurance Premium:	$2,500

FINANCING	
Annual Inflation Rate:	3.0%
Discount Rate:	6.5%
Interest Rate:	6.0%
Financed Amount:	0.0%
Financing Term:	20

FUEL ESCALATION RATES	
Oil Escalation Rate:	150.0%
Woodchip Escalation Rate:	100.0%
Pellet Escalation Rate:	100.0%
Electricity Escalation Rate:	4.0%

ENERGY CONSUMPTION		
Total Heating Load (MMBtu):		80,989
% Biomass	85.0%	68,841
% Oil	15.0%	12,148
Electric Demand (kWH):		145,833
Oil Boiler System Efficiency:		83.0%
Wood Boiler System Efficiency:		70.0%

HEAT CONTENT	
#2 Fuel Oil (MMBtu/gal):	0.13850
Woodchips (MMBtu/ton):	9.02
Wood Pellets (MMBtu/ton):	15.50

FUEL - CURRENT PRICES	
#2 Oil ($/gal):	2.12
Chip ($/ton):	53.00
Pellet ($/ton):	216.00
Electricity ($/kWh):	0.12

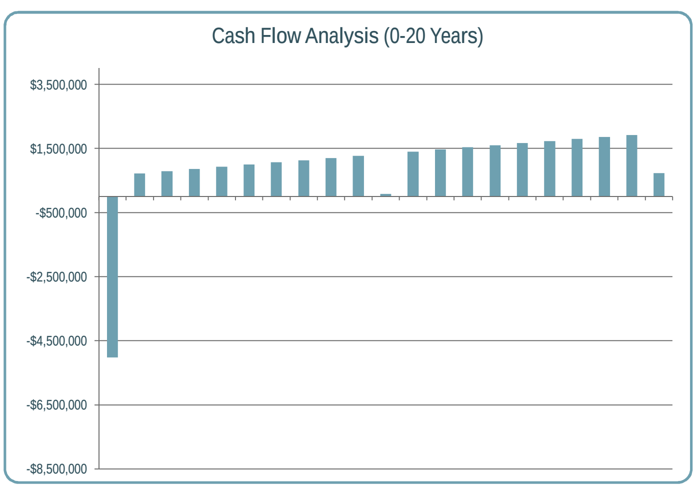
Fuel Price Futures

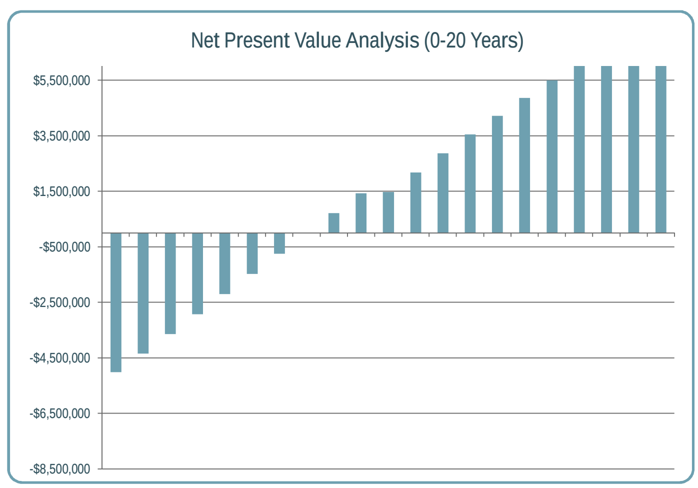
Year	#2 Oil ($/gal)	Chip ($/ton)	Pellet ($/ton)	Electric ($/kWh)
1	$2.71	$53.10	$247.00	$0.125
2	$2.89	$56.04	$274.60	$0.130
3	$3.08	$58.97	$302.20	$0.135
4	$3.27	$61.91	$329.80	$0.140
5	$3.45	$64.84	$357.40	$0.146
6	$3.64	$67.77	$385.00	$0.152
7	$3.83	$70.71	$412.60	$0.158
8	$4.01	$73.64	$440.20	$0.164
9	$4.20	$76.57	$467.80	$0.171
10	$4.39	$79.51	$495.40	$0.178
11	$4.57	$82.44	$523.00	$0.185
12	$4.76	$85.38	$550.60	$0.192
13	$4.95	$88.31	$578.20	$0.200
14	$5.13	$91.24	$605.80	$0.208
15	$5.32	$94.18	$633.40	$0.216
16	$5.51	$97.11	$661.00	$0.225
17	$5.69	$100.05	$688.60	$0.234
18	$5.88	$102.98	$716.20	$0.243
19	$6.06	$105.91	$743.80	$0.253
20	$6.25	$108.85	$771.40	$0.263

Lifecycle Cost Savings Table

Year	Capital Costs	Fixed Operating Costs	Energy Costs (Oil Only)	Energy Costs (Biomass and Oil)	Energy Savings	Electric Costs	Permitting/Taxes/ Insurance Costs	Financing Costs	Cash Flow	Discounted Cash Flow	Net Present Value
0	-$5,021,600	-	-	-	-	-	-	-	-$5,021,600	-$5,021,600	-$5,021,600
1	$0	-$295,000	$1,906,523	$864,966	$1,041,557	-$18,200	-$7,350	$0	$721,007	$677,002	-$4,344,598
2	$0	-$303,850	$2,037,988	$916,673	$1,121,315	-$18,928	-$7,571	$0	$790,967	$697,363	-$3,647,235
3	$0	-$312,966	$2,169,453	$968,379	$1,201,074	-$19,685	-$7,798	$0	$860,625	$712,468	-$2,934,767
4	$0	-$322,354	$2,300,918	$1,020,086	$1,280,832	-$20,472	-$8,032	$0	$929,973	$722,890	-$2,211,877
5	$0	-$332,025	$2,432,382	$1,071,792	$1,360,590	-$21,291	-$8,272	$0	$999,001	$729,152	-$1,482,725
6	$0	-$341,986	$2,563,847	$1,123,499	$1,440,349	-$22,143	-$8,521	$0	$1,067,699	$731,731	-$750,995
7	$0	-$352,245	$2,695,312	$1,175,205	$1,520,107	-$23,029	-$8,776	$0	$1,136,056	$731,059	-$19,935
8	$0	-$362,813	$2,826,777	$1,226,912	$1,599,865	-$23,950	-$9,040	$0	$1,204,063	$727,532	$707,597
9	$0	-$373,697	$2,958,242	$1,278,618	$1,679,624	-$24,908	-$9,311	$0	$1,271,708	$721,508	$1,429,105
10	-$1,255,400	-$384,908	$3,089,707	$1,330,325	$1,759,382	-$25,904	-$9,590	$0	$83,580	$44,525	$1,473,630
11	$0	-$396,455	$3,221,172	$1,382,031	$1,839,140	-$26,940	-$9,878	$0	$1,405,867	$703,232	$2,176,861
12	$0	-$408,349	$3,352,637	$1,433,738	$1,918,899	-$28,018	-$10,174	$0	$1,472,358	$691,541	$2,868,403
13	$0	-$420,599	$3,484,102	$1,485,445	$1,998,657	-$29,139	-$10,479	$0	$1,538,440	$678,478	$3,546,880
14	$0	-$433,217	$3,615,567	$1,537,151	$2,078,415	-$30,304	-$10,794	$0	$1,604,100	$664,258	$4,211,138
15	$0	-$446,214	$3,747,031	$1,588,858	$2,158,174	-$31,516	-$11,118	$0	$1,669,326	$649,078	$4,860,217
16	$0	-$459,600	$3,878,496	$1,640,564	$2,237,932	-$32,777	-$11,451	$0	$1,734,104	$633,113	$5,493,330
17	$0	-$473,388	$4,009,961	$1,692,271	$2,317,691	-$34,088	-$11,795	$0	$1,798,419	$616,521	$6,109,850
18	$0	-$487,590	$4,141,426	$1,743,977	$2,397,449	-$35,452	-$12,148	$0	$1,862,259	$599,442	$6,709,292
19	$0	-$502,218	$4,272,891	$1,795,684	$2,477,207	-$36,870	-$12,513	$0	$1,925,607	$582,003	$7,291,295
20	-$1,255,400	-$517,284	$4,404,356	$1,847,390	$2,556,966	-$38,345	-$12,888	$0	$733,048	$208,037	**$7,499,332**

Simple Payback: 7.0 Years | Year 20 IRR: 19.06%





SouthWestern Vermont Medical Center - Biomass Feasibility Study

500 HP Wood Chip Gasification Boiler Option

30-Jan-09

500 HP Wood Chip Gasification Boiler Option - Inputs

COST	
Capital Costs:	$5,021,600
Fixed Operating Costs:	$295,000
Permitting Costs:	$2,350
Taxes:	$2,500
Insurance Premium:	$2,500

FINANCING	
Annual Inflation Rate:	3.0%
Discount Rate:	6.5%
Interest Rate:	6.0%
Financed Amount:	0.0%
Financing Term:	20

FUEL ESCALATION RATES	
Oil Escalation Rate:	50.0%
Woodchip Escalation Rate:	100.0%
Pellet Escalation Rate:	100.0%
Electricity Escalation Rate:	4.0%

ENERGY CONSUMPTION		
Total Heating Load (MMBtu):		80,989
% Biomass	85.0%	68,841
% Oil	15.0%	12,148
Electric Demand (kWH):		145,833
Oil Boiler System Efficiency:		83.0%
Wood Boiler System Efficiency:		70.0%

HEAT CONTENT	
#2 Fuel Oil (MMBtu/gal):	0.13850
Woodchips (MMBtu/ton):	9.02
Wood Pellets (MMBtu/ton):	15.50

FUEL - CURRENT PRICES	
#2 Oil ($/gal):	2.12
Chip ($/ton):	53.00
Pellet ($/ton):	216.00
Electricity ($/kWh):	0.12

Fuel Price Futures

Year	#2 Oil ($/gal)	Chip ($/ton)	Pellet ($/ton)	Electric ($/kWh)
1	$2.58	$53.10	$247.00	$0.125
2	$2.64	$56.04	$274.60	$0.130
3	$2.71	$58.97	$302.20	$0.135
4	$2.77	$61.91	$329.80	$0.140
5	$2.83	$64.84	$357.40	$0.146
6	$2.89	$67.77	$385.00	$0.152
7	$2.95	$70.71	$412.60	$0.158
8	$3.02	$73.64	$440.20	$0.164
9	$3.08	$76.57	$467.80	$0.171
10	$3.14	$79.51	$495.40	$0.178
11	$3.20	$82.44	$523.00	$0.185
12	$3.27	$85.38	$550.60	$0.192
13	$3.33	$88.31	$578.20	$0.200
14	$3.39	$91.24	$605.80	$0.208
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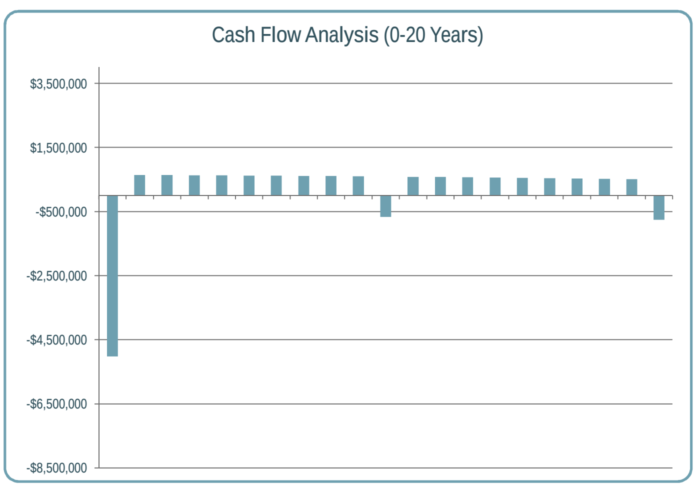
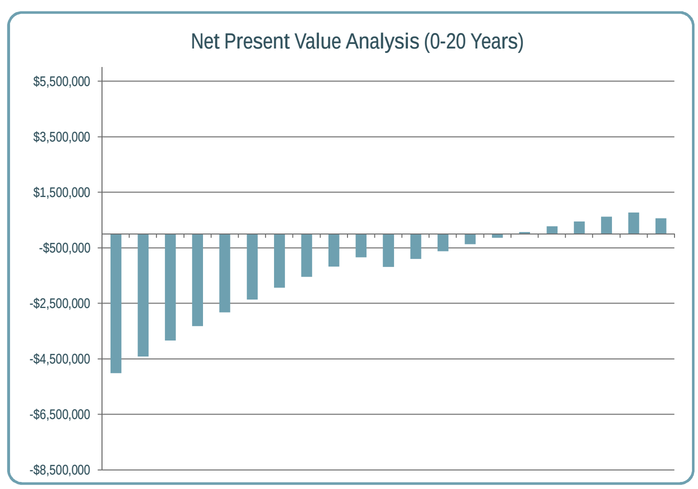
18	$3.64	$102.98	$716.20	$0.243
19	$3.70	$105.91	$743.80	$0.253
20	$3.76	$108.85	$771.40	$0.263

Lifecycle Cost Savings Table

Year	Capital Costs	Fixed Operating Costs	Energy Costs (Oil Only)	Energy Costs (Biomass and Oil)	Energy Savings	Electric Costs	Permitting/Taxes/ Insurance Costs	Financing Costs	Cash Flow	Discounted Cash Flow	Net Present Value
0	-$5,021,600	-	-	-	-	-	-	-	-$5,021,600	-$5,021,600	-$5,021,600
1	$0	-$295,000	$1,818,880	$851,820	$967,060	-$18,200	-$7,350	$0	$646,510	$607,052	-$4,414,548
2	$0	-$303,850	$1,862,701	$890,380	$972,322	-$18,928	-$7,571	$0	$641,973	$566,002	-$3,848,547
3	$0	-$312,966	$1,906,523	$928,940	$977,583	-$19,685	-$7,798	$0	$637,135	$527,452	-$3,321,095
4	$0	-$322,354	$1,950,344	$967,500	$982,845	-$20,472	-$8,032	$0	$631,986	$491,258	-$2,829,837
5	$0	-$332,025	$1,994,166	$1,006,060	$988,106	-$21,291	-$8,272	$0	$626,517	$457,283	-$2,372,554
6	$0	-$341,986	$2,037,988	$1,044,620	$993,368	-$22,143	-$8,521	$0	$620,718	$425,399	-$1,947,155
7	$0	-$352,245	$2,081,809	$1,083,180	$998,630	-$23,029	-$8,776	$0	$614,579	$395,485	-$1,551,669
8	$0	-$362,813	$2,125,631	$1,121,740	$1,003,891	-$23,950	-$9,040	$0	$608,089	$367,426	-$1,184,243
9	$0	-$373,697	$2,169,453	$1,160,300	$1,009,153	-$24,908	-$9,311	$0	$601,237	$341,114	-$843,130
10	-$1,255,400	-$384,908	$2,213,274	$1,198,860	$1,014,414	-$25,904	-$9,590	$0	-$661,388	-$352,339	-$1,195,468
11	$0	-$396,455	$2,257,096	$1,237,420	$1,019,676	-$26,940	-$9,878	$0	$586,402	$293,326	-$902,143
12	$0	-$408,349	$2,300,918	$1,275,980	$1,024,937	-$28,018	-$10,174	$0	$578,396	$271,663	-$630,480
13	$0	-$420,599	$2,344,739	$1,314,540	$1,030,199	-$29,139	-$10,479	$0	$569,981	$251,371	-$379,108
14	$0	-$433,217	$2,388,561	$1,353,100	$1,035,461	-$30,304	-$10,794	$0	$561,145	$232,370	-$146,738
15	$0	-$446,214	$2,432,382	$1,391,660	$1,040,722	-$31,516	-$11,118	$0	$551,874	$214,583	$67,845
16	$0	-$459,600	$2,476,204	$1,430,220	$1,045,984	-$32,777	-$11,451	$0	$542,155	$197,938	$265,784
17	$0	-$473,388	$2,520,026	$1,468,780	$1,051,245	-$34,088	-$11,795	$0	$531,974	$182,367	$448,151
18	$0	-$487,590	$2,563,847	$1,507,340	$1,056,507	-$35,452	-$12,148	$0	$521,317	$167,806	$615,958
19	$0	-$502,218	$2,607,669	$1,545,900	$1,061,769	-$36,870	-$12,513	$0	$510,168	$154,195	$770,153
20	-$1,255,400	-$517,284	$2,651,491	$1,584,461	$1,067,030	-$38,345	-$12,888	$0	-$756,887	-$214,802	$555,350
				Simple Payback: 7.8 Years			Year 20 IRR:	8.13%			





SouthWestern Vermont Medical Center - Biomass Feasibility Study

500 HP Wood Chip Gasification Boiler Option

30-Jan-09

500 HP Wood Chip Gasification Boiler Option - Inputs

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Wood Boiler System Efficiency:		70.0%

FINANCING	
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Financed Amount:	0.0%
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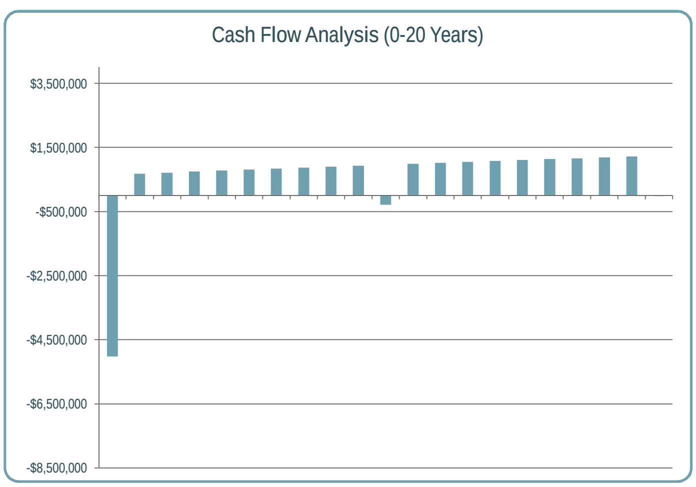
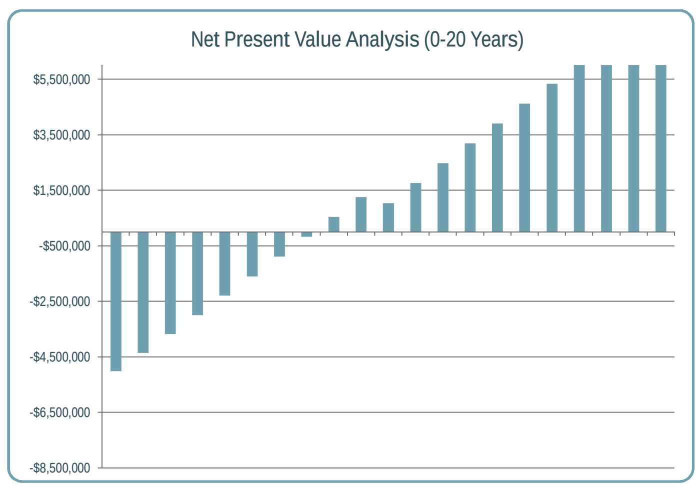
Fuel Price Futures

Year	#2 Oil ($/gal)	Chip ($/ton)	Pellet ($/ton)	Electric ($/kWh)
1	$2.64	$53.10	$247.00	$0.125
2	$2.77	$56.04	$274.60	$0.130
3	$2.89	$58.97	$302.20	$0.135
4	$3.02	$61.91	$329.80	$0.140
5	$3.14	$64.84	$357.40	$0.146
6	$3.27	$67.77	$385.00	$0.152
7	$3.39	$70.71	$412.60	$0.158
8	$3.51	$73.64	$440.20	$0.164
9	$3.64	$76.57	$467.80	$0.171
10	$3.76	$79.51	$495.40	$0.178
11	$3.89	$82.44	$523.00	$0.185
12	$4.01	$85.38	$550.60	$0.192
13	$4.14	$88.31	$578.20	$0.200
14	$4.26	$91.24	$605.80	$0.208
15	$4.39	$94.18	$633.40	$0.216
16	$4.51	$97.11	$661.00	$0.225
17	$4.63	$100.05	$688.60	$0.234
18	$4.76	$102.98	$716.20	$0.243
19	$4.88	$105.91	$743.80	$0.253
20	$5.01	$108.85	$771.40	$0.263

Lifecycle Cost Savings Table

Year	Capital Costs	Fixed Operating Costs	Energy Costs (Oil Only)	Energy Costs (Biomass and Oil)	Energy Savings	Electric Costs	Permitting/Taxes/ Insurance Costs	Financing Costs	Cash Flow	Discounted Cash Flow	Net Present Value
0	-$5,021,600	-	-	-	-	-	-	-	-$5,021,600	-$5,021,600	-$5,021,600
1	$0	-$295,000	$1,862,701	$858,393	$1,004,308	-$18,200	-$7,350	$0	$683,758	$663,843	-$4,357,757
2	$0	-$303,850	$1,950,344	$903,526	$1,046,818	-$18,928	-$7,571	$0	$716,470	$675,342	-$3,682,415
3	$0	-$312,966	$2,037,988	$948,659	$1,089,328	-$19,685	-$7,798	$0	$748,880	$685,331	-$2,997,084
4	$0	-$322,354	$2,125,631	$993,793	$1,131,838	-$20,472	-$8,032	$0	$780,980	$693,890	-$2,303,193
5	$0	-$332,025	$2,213,274	$1,038,926	$1,174,348	-$21,291	-$8,272	$0	$812,759	$701,093	-$1,602,100
6	$0	-$341,986	$2,300,918	$1,084,059	$1,216,858	-$22,143	-$8,521	$0	$844,209	$707,012	-$895,088
7	$0	-$352,245	$2,388,561	$1,129,193	$1,259,368	-$23,029	-$8,776	$0	$875,318	$711,713	-$183,375
8	$0	-$362,813	$2,476,204	$1,174,326	$1,301,878	-$23,950	-$9,040	$0	$906,076	$715,265	$531,890
9	$0	-$373,697	$2,563,847	$1,219,459	$1,344,388	-$24,908	-$9,311	$0	$936,472	$717,728	$1,249,618
10	-$1,255,400	-$384,908	$2,651,491	$1,264,592	$1,386,898	-$25,904	-$9,590	$0	-$288,904	-$214,972	$1,034,646
11	$0	-$396,455	$2,739,134	$1,309,726	$1,429,408	-$26,940	-$9,878	$0	$996,135	$719,629	$1,754,275
12	$0	-$408,349	$2,826,777	$1,354,859	$1,471,918	-$28,018	-$10,174	$0	$1,025,377	$719,179	$2,473,454
13	$0	-$420,599	$2,914,420	$1,399,992	$1,514,428	-$29,139	-$10,479	$0	$1,054,211	$717,866	$3,191,320
14	$0	-$433,217	$3,002,064	$1,445,126	$1,556,938	-$30,304	-$10,794	$0	$1,082,623	$715,741	$3,907,061
15	$0	-$446,214	$3,089,707	$1,490,259	$1,599,448	-$31,516	-$11,118	$0	$1,110,600	$712,852	$4,619,913
16	$0	-$459,600	$3,177,350	$1,535,392	$1,641,958	-$32,777	-$11,451	$0	$1,138,129	$709,245	$5,329,157
17	$0	-$473,388	$3,264,993	$1,580,526	$1,684,468	-$34,088	-$11,795	$0	$1,165,197	$704,963	$6,034,121
18	$0	-$487,590	$3,352,637	$1,625,659	$1,726,978	-$35,452	-$12,148	$0	$1,191,788	$700,050	$6,734,170
19	$0	-$502,218	$3,440,280	$1,670,792	$1,769,488	-$36,870	-$12,513	$0	$1,217,887	$694,544	$7,428,714
20	-$1,255,400	-$517,284	$3,527,923	$1,715,925	$1,811,998	-$38,345	-$12,888	$0	-$11,919	-$6,599	$7,422,115
				Simple Payback: 7.3 Years		Year 20 IRR:		14.73%			





Appendix E

Pellet Bulk Delivery Sample Contract

Wood Pellet Fuel Supply Agreement
Between BioFuel Energy Systems LLC
And
____

This wood pellet fuel supply agreement is entered into this ____ day of August, 2008 between BioFuel Energy Systems LLC, a wholly owned subsidiary of New England Wood Pellet LLC, PO Box 532, Jaffrey NH 03452 (hereinafter, "seller"), and ___________________________________(hereinafter, "buyer").

Term of Agreement; Amendment; Termination	This agreement shall commence September 1, 2008 and extend for a period of two years, to August 30, 2010. This agreement may be amended at any time by mutual consent of the buyer and seller. This agreement may be terminated at any time by the buyer or seller upon 30 days written notice.
Description of Product	Seller shall provide buyer with wood pellet fuel manufactured at seller's Jaffrey NH facility that meets or exceeds Pellet Fuels Institute premium grade standard (www.pelletheat.org).
Price	Year 1 (September 1, 2008 through August 31, 2009): $___/ton delivered to buyer's Peterborough NH facility. Price inclusive of all costs, including freight. Year 2 (September 1, 2009 through August 31, 2010): Base price $___ delivered to buyer's Peterborough NH facility. Price inclusive of all costs, including freight. Price may float up or down a maximum of 5% proportional to increase or decrease in New England Regional Average Diesel Price per USDOE Energy Information Administration (http://tonto.eia.doe.gov/oog/info/wohdp/diesel.asp). Base price of diesel shall be set on September 1, 2009.
Volume	Seller will deliver all pellet fuel requested by buyer in +/-25-ton loads. No maximum or minimum limits on total quantity of pellet fuel available under this agreement. Fuel sold under this agreement for heating buyer's Peterborough NH facility only; buyer may not resell fuel purchased under this agreement for any other purpose.
Ordering	Buyer is required to place order with seller; seller shall make delivery within five (5) working days of order placement. Order contact: Amanda Brosseau, 603-532-9400 x201
Terms; Invoicing	Net 30 days from date of invoice; seller shall invoice buyer based on delivered weight of pellet fuel. Seller shall provide buyer scale slip or other documentation of delivered weight with each delivery and invoice. Seller may withhold shipments upon failure of buyer to make timely payment on outstanding balances.
Ownership of Product; Liability for Product	Buyer takes legal ownership of product upon receipt and loading into buyer's silo and assumes all liability for product once loaded in buyer's silo.
Confidentiality	This agreement and all terms and conditions contained herein includes privileged and proprietary information and shall remain strictly confidential between the Buyer and the Seller.

Signed:

Buyer's Authorized Representative	Seller's Authorized Representative BioFuel Energy Systems LLC

Appendix F

IWood Proposal (2/2/09)
Iwood Report Comments (2/2/09)

INTERNATIONAL woodfuels LLC
A Green Path to Energy Independence

January 30, 2009

Mr. Kevin McDonald
Vice President of Marketing and Planning
Southwestern Vermont Medical Center
100 Hospital Drive
Bennington, VT 05201

RE: Renewable Space Heating Opportunity

Dear Mr. McDonald:

We appreciate the opportunity to present our services to ***Southwestern Vermont Medical Center*** starting in the winter of 2009/2010. WoodFuels is a local company which provides renewable energy space heating solutions for larger facilities such as yours. Unlike other biomass options, with the WoodFuels Green Path Solution, customers make no capital investment and only pay for energy utilized (metered).

We provide the complete package – from design costs (seamlessly integrated to your existing new oil-fired boilers in concert with your engineers), to the cost of installation (again, working closely with your existing contractors), to the ongoing operation and maintenance. The result: you pay only for the metered heat energy you use, just as you now purchase electricity. And, of course, you would have your own conventional boiler system to provide complete load redundancy for unusually cold periods of the year or when our system is off-line for routine service. Under our proposed design, we anticipate being able to provide virtually all of your steam needs.

Of particular importance to you may be the fact that our renewable energy fuel is sourced exclusively from whole logs that are sustainably harvested here in New England. These logs are processed at our pellet manufacturing facilities where the output is dedicated to supply our boilers. We do not buy pellets from third parties, nor do we use residual biomass wastes or other woody byproducts. This process ensures the highest quality, ultra-low emission biomass fuel and provides you with a dependable, carbon-neutral, renewable energy supply.

At your direction, we have worked closely with Fitzgerald & Tocci (Scott LeClaire) and GDS Associates (Keith McBrien and Ralph Draper) who have provided us with the technical information on which our analysis is based. Using this data, we have developed an approach to serve all of the Medical Center's needs for steam. This is discussed in further detail in the attached proposal.

Our service -- requiring a significant WoodFuels capital investment -- is based on an initial fifteen-year agreement where the discounted energy price is adjusted every August to reflect the then-current cost of No. 2 heating oil. Under this arrangement, the Medical Center will achieve a pricing formula for thermal energy which ensures the fairest economic option for the next decade or longer. As a result, you will realize assured energy savings, protection as prices fluctuate, <u>and</u> fifteen (or longer) years of reliable, community-sourced renewable energy.

A typical installation of this nature requires substantial lead time to organize the engineering and installation, and to allocate sufficient pellet production capacity to a limited number of customers. We therefore hope that this option will have your timely review and approval given all the other work that's currently underway for the Central Utility Plant.

We are particularly excited about the timing of this proposal for the ***Southwestern Vermont Medical Center,*** and hope you and your board will find this option to be a meaningful, fiscally-prudent and environmentally sound component of your overall renovation.

We look forward to becoming your integrated energy partner.

Sincerely,

Steven Jay Mueller
President

BENEFITS OF RENEWABLE HEAT ENERGY

A Recommended Service for Southwestern Vermont Medical Center

January 09

The benefits associated with the conversion of the Medical Center from heating oil to the WoodFuels Green Energy service are summarized as follows:

Key Benefits

- **Substantial conversion to renewable wood pellet based energy** beginning in the late fall of 2009
- **No capital cost** to Southwestern Vermont Medical Center
- Existing and conventional boiler systems to remain in place for **increased system redundancy**
- **Locally sourced & supplied** pellet fuel **dedicated to the Medical Center**
- **Fully automated** green energy system operations
- **Real-time monitoring** of green energy system performance and energy consumption
- **24/7 maintenance & emergency services** included at no cost
- Creation of jobs and **economic development** in rural New England areas
- Support the logging/landowner community in Vermont who practice **sustainable forest management and harvesting**
- **By converting to wood pellet energy,** the Medical Center will permanently **avoid carbon taxes** (surcharges that are expected to add 10-15% to future heating oil costs by 2010)

Metered Energy = Even More Savings

Unlike conventional systems WoodFuels measures and charges the energy consumed (not the fuel) by its customers. This distinction means that both the Medical Center and WoodFuels are aligned in seeking the most efficient and reliable performance.

The WoodFuels Green Energy System's microprocessor and web-based controls incorporate an advanced, real-time metered energy monitoring and billing system. Secure web access will permit your personnel to continuously track thermal energy consumption and make selective conservation investments at the Medical Center to further reduce energy use. We believe that this feature will permit the Southwestern Vermont Medical Center to lower its energy usage and costs even more in the future.

WoodFuels Green Energy System

Presently, the Medical Center is mid-way through a major expansion and renovation project including the construction of the Central Utility Plant (CUP). The projected peak steam capacity requirement is 1,000 HP. The contingency standard for the Medical Center is N+1, so the design team originally proposed installing three 500 HP boilers. In the current plan, there is an additional (fourth) equipment pad for another boiler in the event of future growth.

It was originally proposed to WoodFuels that the spare pad be used for the single wood pellet boiler (either 500 or 1000 HP). WoodFuels recommends providing up to 100% of the Medical Center's normal steam requirements, irrespective of the configuration. Hence, based on the preliminary information we have received, we think the correct option is for WoodFuels to install two 500 HP steam pellet boiler systems and for the Medical Center to either install two 500 HP or one 1000 HP oil-fired units. This design option provides significant capital savings to the Medical Center and 100% capacity redundancy (N+2). If the option is to use a single 1000 HP boiler, there will be a spare pad for future expansion.

WoodFuels will provide AFS boilers (or equal) for this project. AFS has been selected because of their experience, knowledge, and reputation, as well as the fact that they have similar sized equipment already in operation nearby.

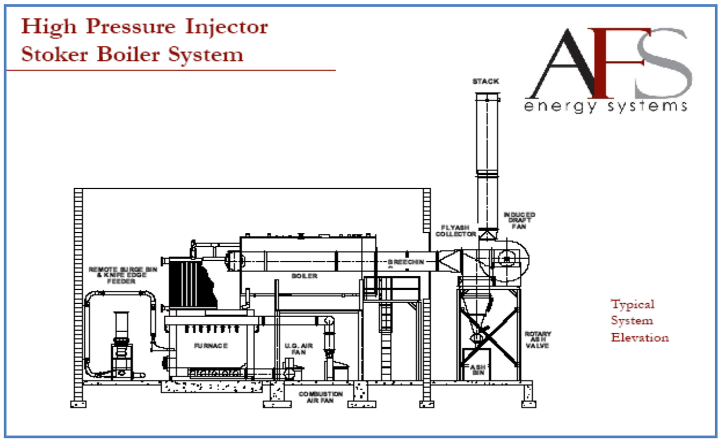
We have not been provided specific information about the size of the pad for the boiler or the dimensions of the CUP but are confident that either the 500 or 1000 HP boiler(s) can be configured to fit into the allotted space.

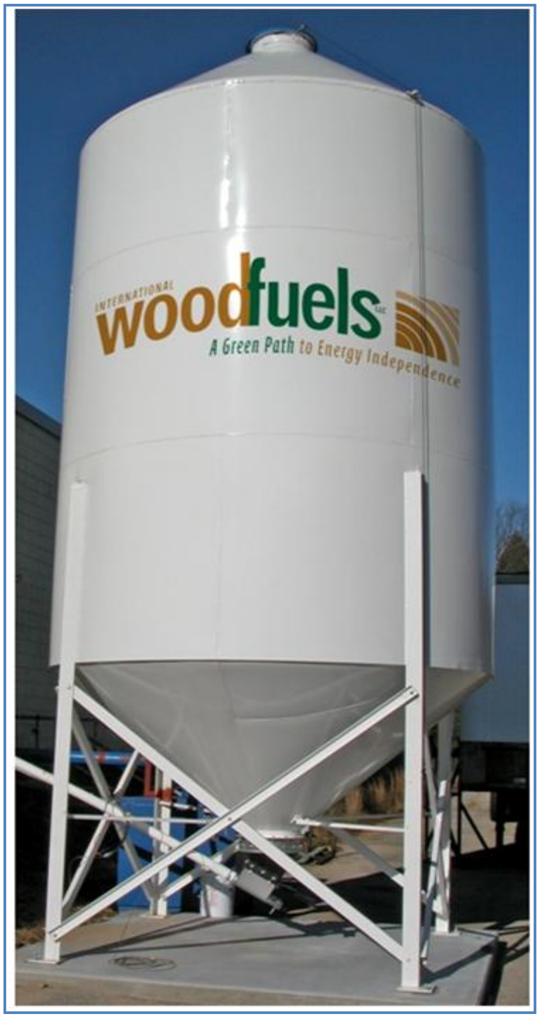
The CUP is ideally situated for us to install our wood pellet silos adjacent to the plant to provide the boilers with fuel. WoodFuels typically would size these silos as large as is practical and permissible, but would work to enable a one to two week supply based on full load input. The Medical Center provided 98,800 mmbtu per year as the projected fuel consumption.

The logical boundary limitations would be the isolation valve(s) at the main steam header for and feed water supply to our Green Energy System. We would meter the BTU values of the feedwater input and the steam output and you would be invoiced for the net energy used.

WoodFuels Green Energy System

The principal components of the WoodFuels Green Energy System are the furnace/boiler, exhaust post treatment and stack (which are depicted to the right) as well as the storage silo (pictured below).





The systems come in several sizes and can be used individually or in combinations to address most needs.

The WoodFuels Green Energy System is delivered to its site in modules for ease of assembly and installation and is equipped with all piping, pumps, valves, specialties, and controls needed for easy integration into your existing steam system.

The core of the WoodFuels Green Energy System is the wood pellet furnace/boiler. This tried and proven technology employs very robust construction to provide for safe and reliable operations, even under severe usage. Most subsystems are fully automated and the need for periodic maintenance is minimal and straightforward.

Defining Your Energy Savings

A distinct difference between the present and previously planned situation for the Medical Center and the proposed program is that WoodFuels is completely responsible for the fuel supply, fuel delivery, ash removal/disposal, operations, and maintenance of the Green Energy System. The Medical Center only pays for the energy it consumes.

Once installed, the WoodFuels Green Energy System will be fully integrated to your existing systems to ensure that Medical Center is delivered its steam requirements on demand 24 hours a day. The conventional boilers remain interconnected and can be brought online at any time that its capacity is needed, in the unlikely event that such a circumstance should arise.

The heat energy delivered by our system is metered, just like your electricity, via a BTU meter and you are invoiced for the quantity of energy required monthly. The cost of this metered service is calculated at a discount to the comparable price of No. 2 heating oil delivered to your facility. The comparative price of heating oil is adjusted annually, thus ensuring that your contract with WoodFuels remains highly competitive throughout the 15 year term of the agreement.

The potential savings for a range of fuel price points are shown below. The WoodFuels Green Energy Price and discount are revised each August. The new price and corresponding savings are directly connected to the regional quoted price for commercial supply of your No. 2 heating oil. The table below illustrates how the discount varies with the cost of No. 2 oil.

No. 2 Oil Savings Matrices[1]

Price of No. 2 Heating Oil	$1.75	$2.00	$2.25	$2.50	$2.75	$3.00	$3.25
Boiler Inefficiency Reduction	$0.44	$0.50	$0.56	$0.63	$0.69	$0.75	$0.81
True Cost / Gallon	$2.19	$2.50	$2.81	$3.13	$3.44	$3.75	$4.06
WoodFuels Green Energy Price	$2.00	$2.00	$2.18	$2.36	$2.54	$2.72	$2.90
Effective Savings	$0.19	$0.50	$0.63	$0.76	$0.90	$1.03	$1.16
Effective Discount	**8.6%**	**20.0%**	**22.5%**	**24.4%**	**26.0%**	**27.4%**	**28.5%**

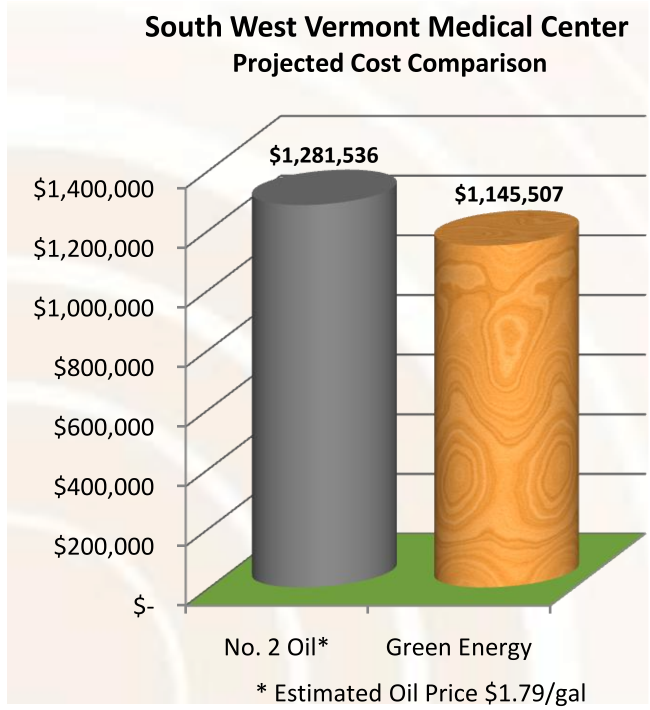
Price of No. 2 Heating Oil	$3.50	$3.75	$4.00	$4.25	$4.50	$4.75	$5.00
Boiler inefficiency Reduction	$0.88	$0.94	$1.00	$1.06	$1.13	$1.19	$1.25
True Cost/ Gallon	$4.38	$4.69	$5.00	$5.31	$5.63	$5.94	$6.25
WoodFuels Green Energy Price	$3.08	$3.27	$3.45	$3.63	$3.81	$3.99	$4.17
Effective Savings	$1.29	$1.42	$1.55	$1.69	$1.82	$1.95	$2.08
Effective Discount	**29.5%**	**30.3%**	**31.1%**	**31.7%**	**32.3%**	**32.8%**	**33.3%**

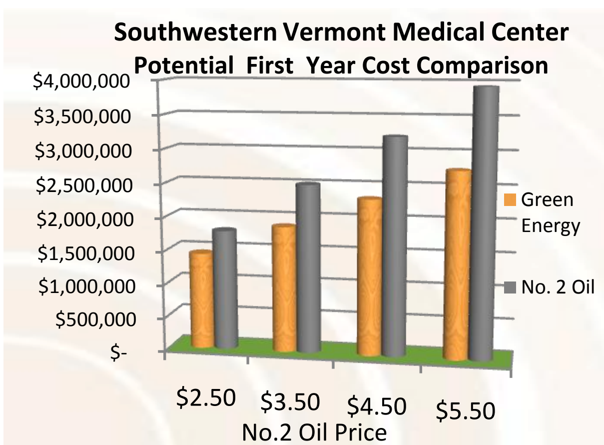
Keep in mind that the discount will also increase if the amount of No. 2 oil displaced grows as a result of adding new loads to the service.

[1] "True Cost / Gallon" is arrived at by assuming a boiler efficiency of 80%.

Defining Your Energy Savings (Continued)

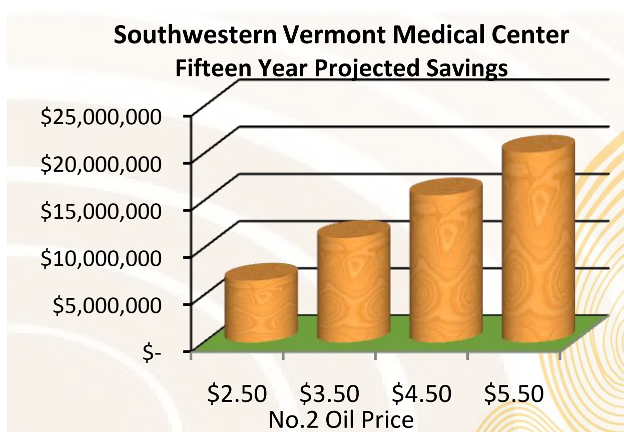
The estimated first year savings for the Medical Center is over $136,029 – an approximate 11% reduction from the costs the property will incur at the estimated prices of heating oil in the fall of 2009. This savings calculation is based on the pricing matrix shown on the previous page and assumes that No. 2 heating oil will be $1.79/gallon in August of 2009. These savings are certainly significant in a single year, but they become even more impressive when viewed over the 15 year term of the agreement. Presuming this reduction will be attained each year for the duration of the contract, the potential savings would be nearly **1,360,000.**





While current oil prices are extremely volatile, it seems likely that the long term trend will be for prices to steadily increase. This will be further exacerbated by the likelihood that some form of Federal carbon tax will be enacted in the near future. As can be seen in the chart on the left, the more No. 2 oil cost increases, the greater the savings with WoodFuels Green Energy.

Just as the single year analysis shows that savings are significantly affected by an increase in the price of No. 2 oil, so are the savings when projected over the 15 year contract period. As can be seen in the chart to the right, if the price of No. 2 oil averages $5.50 per gallon over the term of the contract the aggregate savings are in excess of **$20,000,000**.



Real Savings Today + Long –Term Benefits

The WoodFuels program delivers immediate cash savings for Southwestern Vermont Medical Center, plus a no-cost financial hedge against No. 2 oil prices, which are assured to fluctuate widely over the next several years.

Of equal but intangible value is the fact that by making this change, Southwestern Vermont Medical Center will switch to locally produced fuel from an integrated energy supplier who is able to offer more stable pricing with assured delivery and quality. And, of course, this fuel conversion will improve the environmental emissions for the Medical Center as well as the New England region for decades to come.

Your decision to proceed with this program will clearly establish Southwestern Vermont Medical Center as a regional leader in the use of sustainable renewable energy, and help to create 70 new, high quality jobs in the local economy. These tangible and intangible benefits add up to a significant value for consideration by SWVTMC:

- Establish the Medical Center as a national environmental leader for the use of innovative renewable energy from sustainable fuel sources
- Lock in an immediate financial hedge against uncertain future fuel costs
- Reduce current boiler maintenance costs
- Obtain state-of-the-art, ultra-low emission, highly efficient heating boilers
- Eliminate the need for new boiler capital investment for a decade or more under this program
- Reduce regional GHG emissions by millions of pounds every year

Why Act Now?

A decision to purchase metered heat energy from renewable energy source requires a large investment of capital and significant advance planning for the purchase and installation of the commercial wood pellet fired system complete with boilers and storage.

Regional pellet production is very likely in tight supply and mostly dedicated to residential heating needs. As a direct result, there will be limited long-term pellet contract supply available on the bid market, if any. The WoodFuels program offers a dedicated production capacity together with a fleet of specialized delivery vehicles to ensure service to its commercial space heating customers. In conclusion, we are the only company that offers:

- A large investment of our capital by mid-2009 at your location for new pellet boilers
- A fifteen year guaranteed supply of renewable energy, locally produced pellets
- A clearly defined pricing plan for the next 15 years or longer (with a renewal option)

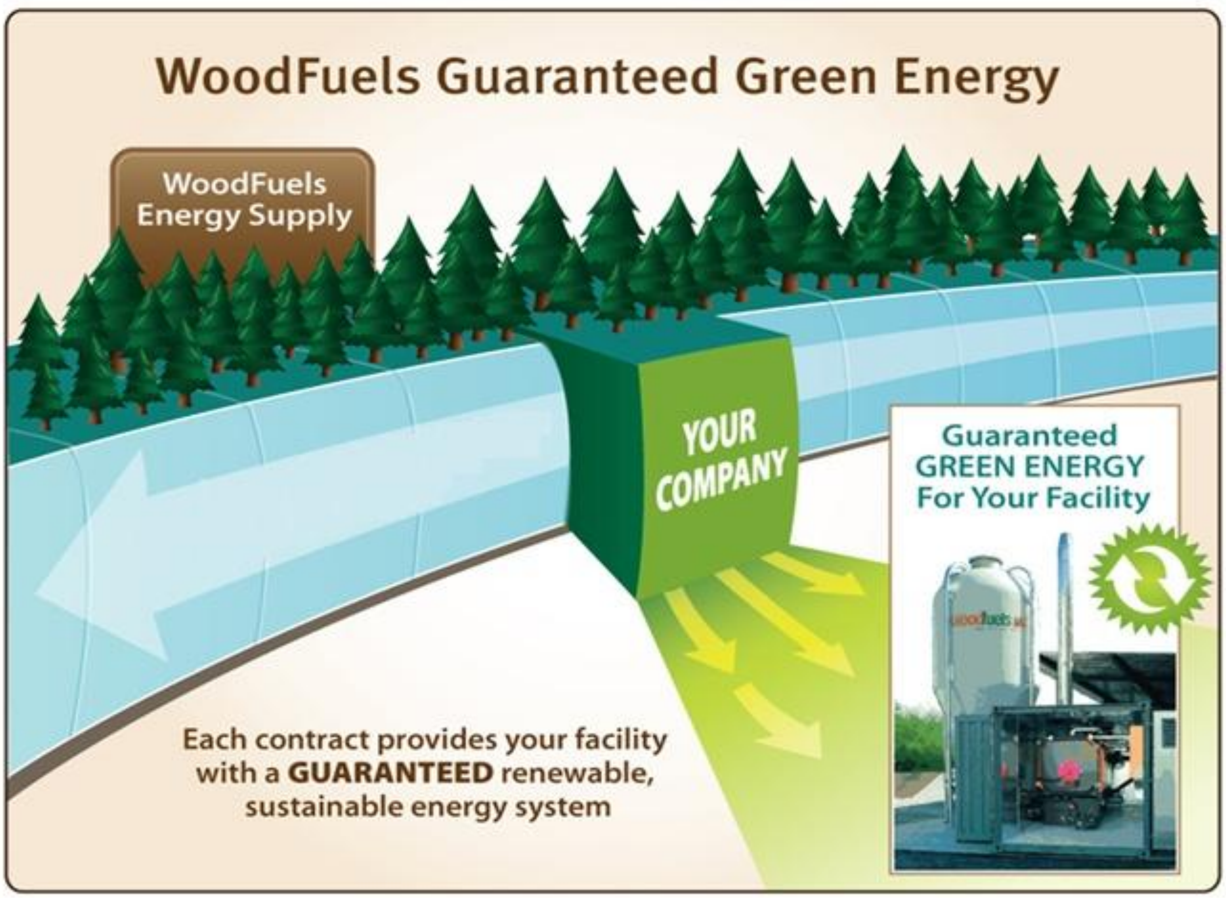
In short, WoodFuels offers a true 'end-to-end' renewable energy solution for Southwestern Vermont Medical Center – connecting a high-technology pellet boiler to a long-term, fairly-priced source of premium, low-emission pellets manufactured by our company.

Carbon Footprint Reduction

Given that the WoodFuels Energy System is carbon-neutral, your greenhouse gas emissions will effectively be reduced to zero. Based on your annual heating oil consumption and the emissions coefficients for oil provided by the U.S Energy Information Administration, our system will reduce your CO_2 output by about **8,018 tons/year.**

WoodFuels Supply Program

WoodFuels business is organized into Community Energy Facilities (CEFs). A CEF consists of sustainably harvested timber lands, premium pellet production facilities, and Green Energy Customers in a specific locale.



The total capacity of WoodFuels-owned pellet plants limits the number of contracts WoodFuels is offering, thus guaranteeing supply to our customers of the highest grade wood pellets for the duration of the contract. Southwestern Vermont Medical Center is, in effect, buying one of a limited number of portions of our pellet plants' capacity.

The WoodFuels Commitment to Sustainable Forestry

WoodFuels supports sustainable forestry practices through its whole log purchasing practices. Although such programs may vary from state to state, WoodFuels works closely with local Certified Foresters and Master Loggers to provide a source of stable, predictable purchasing for timber sourced from such practices.

Our goal through this commitment is to ensure long-term, well-paying, quality employment in our rural communities. WoodFuels will invest its capital to maximize support for sustainable harvesting and to offer the highest value for the full range of forest products.

As a key element of our sustainable forest practices commitment, WoodFuels endeavors to arrange its purchases and finished product shipments to minimize truck traffic, utilize available rail systems; and by keeping its business sized to serve a community within a 200 mile radius of each pellet production facility.

Where feasible, WoodFuels will further reduce its carbon footprint by incorporating biodiesel and/or LNG fuel for its delivery fleet, and for trucks owned by participating logging contractors.

In summary, our environmental goals are to

- permanently lower greenhouse gas emissions,
- maximize the value of sustainable harvest yields,
- create long-term employment in rural forest service communities, and
- ensure professional logging capacity through significant direct investment

Kenworth LNG Prime Mover

Vermont Railways

The WoodFuels program truly offers a community based green path to energy independence.

Community Based Solutions

From forest, to pellet manufacturing, to each customer's boilers, and back to the earth, the entire conversion process is contained within roughly a 200-mile radius, creating a **truly community-based energy service**. Our process supports substantial **local economic development through job creation**.

- Our process begins with our long-term log supply, secured from local forests that engage in **sustainable forestry practices**. This not only ensures a reliable supply of raw materials for our customers; it's also part of our commitment to **carbon-neutral renewable energy**.
- WoodFuels' dedicated manufacturing facility convert **whole logs into ultra-low emission wood pellets**. We do not use any landfill sourced biomass or construction debris. Our pellets are manufactured **additive-free**, to ensure the cleanest finished pellet product possible.
- WoodFuels' pellets are shipped to customer's locations in company-owned, specially designed transport vehicles. WoodFuels installs and uses only the most **advanced and efficient wood pellet boilers** available in the industry.
- WoodFuels is committed to closing the renewable energy loop, by collecting the ash produced in each boiler as part of our **free maintenance service**, and offering it to organic composting companies.

Most beneficially, the WoodFuels Green Energy program **reduces dependence on foreign energy sources** and reduces carbon emissions while **utilizing local resources** and contributing to long-term local economic growth. This program is being offered at **no capital cost to Southwestern Vermont Medical Center**, truly making it a **WIN-WIN proposition**.

ENERGY SERVICES AGREEMENT TERMS

Southwestern Vermont Medical Center

January 09

Description of Service

A metered heat energy service dedicated to the Southwestern Vermont Medical Center facility in Bennington Vermont. The service includes all costs to install, operate, and maintain a highly efficient, renewable energy pellet-fired system which will be owned by WoodFuels.

Pricing and Annual Energy Adjustments

The contract price for thermal energy will be based on a discount to the prices of No. 2 heating oil. This price will be adjusted annually on August 1st to reflect increases or decreases in the cost of No. 2 oil. As the price of heating oil increases, the applicable discount will increase. As the commercial cost of such No. 2 oils decreases in any particular future year, the discount would be reduced.

Base Price

The Base Price is $2.00 per equivalent gallon of No. 2 heating oil for contracts beginning on August of 2009. This amount will be adjusted each August based on a combination of the regional CPI as published by the US Department of Labor and adjustments to the average cost of whole log supply (based on a third-party wood price index). This price, therefore, is the lowest cost at which energy may be sold during the 15 year term of the contract.

Other Pertinent Contract Terms:

- *No capital investment:* WoodFuels will bear all costs associated with the permits, engineering, installation and ongoing maintenance of the Green Energy System
- *Guaranteed source of fuel supply:* WoodFuels owns and operates the source of pellet production and is thus able to provide the highest quality and assured supply
- *Existing boilers remain in place for system redundancy*
- *Metered energy supply data available via the internet*
- *Remote monitoring assures timely maintenance, repair, and fuel delivery*

Contract Renewal Options

At the conclusion of the initial 15 year term*, WoodFuels offers three options:

1. Extend the existing contract for an additional five years under the then-current pricing and adjustment program; or
2. Purchase the boiler systems at a Fair Market Value price, together with a five-year maintenance and fuel supply agreement; or
3. Removal by WoodFuels at its sole cost and reasonable restoration of the site.

* given the substantial capital investment, WoodFuels is willing to offer a longer contract term to the Southwestern Vermont Medical Center if desired.

GDS Associates, Inc. ("GDS") provided International WoodFuels, LLC ("WoodFuels") a draft copy of the BIOMASS FEASIBILITY STUDY for the Southwestern Vermont Medical Center, 100 Hospital Drive, Bennington, Vermont, Prepared for: Lavallee Brensinger Architects, 155 Dow Street, Manchester, NH, January 20, 2009 (the "Study") on Thursday, January 28 for its review.

The Study was prepared by GDS on an expedited schedule in line with the Southwestern Vermont Medical Center ("the Medical Center") requirements. GDS attempts to cover a pretty broad range of issues in a thorough and objective manner.

The Study conducted a generalized examination of woody biomass boiler systems and comparison with a No. 2 heating oil fired system. Since the Study looked at typical systems in many cases some of the disadvantages sited would not apply to the Green Energy System ("GES") employed under the WoodFuels program. The Woodfuels GES would perform considerably better then the levels indicated for both air emissions and ash production. Additionally, some of the concerns raised about noise and delivery scheduling would be dealt with so as not to be an issue for the Medical Center.

With regard to the price forecasting included for No. 2 oil and woody biomass, the methods employed by EIA (for fuel oil) and the linear regression used by GDS (for biomass) have no correlation and, as a result, we are concerned that that any conclusions derived from this information has limited efficacy. GDS qualifies that this is not a particular area of expertise for them. It should be noted that fuel price forecasting, even by the "experts", has proven to be a very "hit or miss" affair over the past decade. We would recommend, therefore, that the projections provided to the client are done on a comparable basis in order to be relevant.

Additionally we note that the No. 2 fuel oil pricing forecast does not include the addition of a carbon tax which will no doubt be coming in the next several years.

The above comments are general in nature, but WoodFuels would be happy to provide a more thorough discussion of its concerns in this regard, if requested.

GDS briefly summarizes the WoodFuels proposal in Section IX, Performance Contracting, on page 43 of the study. We wish to point out several clarifications to this paragraph.

> "Based on the provided information GDS does not agree with the N+2 assumption that iWood makes in reference to not requiring the third Oil fired boiler to meet the required N+1. If this were a different application such as a school then that might be a consideration but based on the fact that this is a hospital and based on the reliability discussion in Section IV this is not a viable consideration for this project."

> The Medical Center in its own judgment (and/or along with the recommendations of its consultants) can decide that it does not want to rely on WoodFuels as its baseline capacity

(although we do not believe there is any technical justification for such a position). Never-the-less, good engineering standards and practices define N+ contingency standards as the number of units (starting with the largest and proceeding in descending size order) that can be inoperative while still maintaining normal operation at peak load. Since the hospital peak load in defined as 1000 HP, having four 500 HP boilers (irrespective of what is their fuel source) would qualify as 100% redundant and an N+2 contingency standard.

"The iWood proposal offers a ten year term for the contract with a negotiation each year on prices based on oil prices. This seems completely reasonable and would likely have a small impact on hospital staff they will be review oil prices for the No.2 system annually or possibly more frequently."

Woodfuels agrees with the GDS assessment, but wishes to clarify here that the adjustment mechanism is not a 'negotiation' but rather by formula. As such it offers a certainty and transparency that is favorable to the customer. Additionally, would like to add that we are willing to work with the Medical Center to develop a price adjustment interval that the Medical Center and its consultants are comfortable with.

"GDS feels that the first years savings is over stated based on the currently delivered oil price today is $1.79/gallons. This current price is lower than the price assumed in the iWood proposal."

WoodFuels was not provided with a reference price previously. Along with this commentary we have provided revised proposal which makes use of the $1.79 per gallon heating oil price and shows a savings of over $136,000 in the first year. (Incidentally this assumed $1.79 per gallon price does not appear to dovetail with the GDS used EIA forecast of oil prices which indicates a 2009 oil price in the range of $2.25-3.00). Based on the EIA forecast of No. 2 oil pricing used in the Study, the Medical Centers savings would be about $8,000,000 over the life of the WoodFuels ESA, while avoiding about $5,000,000 to $8,000,000 of upfront capital investment (per GDS Table 9, F&T Cost Estimates, on page 36).

It is worth noting that even using the GDS underlying assumptions the WoodFuels program offers significant benefits to the Southwestern Vermont Medical Center, from day one, without requiring any capital investment on the part of the Medical Center.

Appendix G

Life Cycle Cost Analysis Summary Sheets

- 500 HP Woodchip Direct Burn
- 1,000 HP Woodchip Direct Burn
- 500 HP Woodchip Gasification
- 1,000 HP Woodchip Gasification
- 500 HP Wood Pellet
- 1,000 HP Wood Pellet

SouthWestern Vermont Medical Center - Biomass Feasibility Study

500 HP Wood Chip Direct Burn Boiler Option

30-Jan-09

500 HP Wood Chip Direct Burn Boiler Option - Inputs

COST	
Capital Costs:	$4,157,500
Fixed Operating Costs:	$387,400
Permitting Costs:	$2,925
Taxes:	$2,500
Insurance Premium:	$2,500

ENERGY CONSUMPTION		
Total Heating Load (MMBtu):		80,989
% Biomass	83.0%	67,221
% Oil	17.0%	13,768
Electric Demand (kWH):		145,833
Oil Boiler System Efficiency:		83.0%
Wood Boiler System Efficiency:		67.0%

FINANCING	
Annual Inflation Rate:	3.0%
Discount Rate:	6.5%
Interest Rate:	6.0%
Financed Amount:	0.0%
Financing Term:	20

HEAT CONTENT	
#2 Fuel Oil (MMBtu/gal):	0.13850
Woodchips (MMBtu/ton):	9.02
Wood Pellets (MMBtu/ton):	15.50

FUEL ESCALATION RATES	
Oil Escalation Rate:	100.0%
Woodchip Escalation Rate:	100.0%
Pellet Escalation Rate:	100.0%
Electricity Escalation Rate:	4.0%

FUEL - CURRENT PRICES	
#2 Oil ($/gal):	2.12
Chip ($/ton):	53.00
Pellet ($/ton):	216.00
Electricity ($/kWh):	0.12

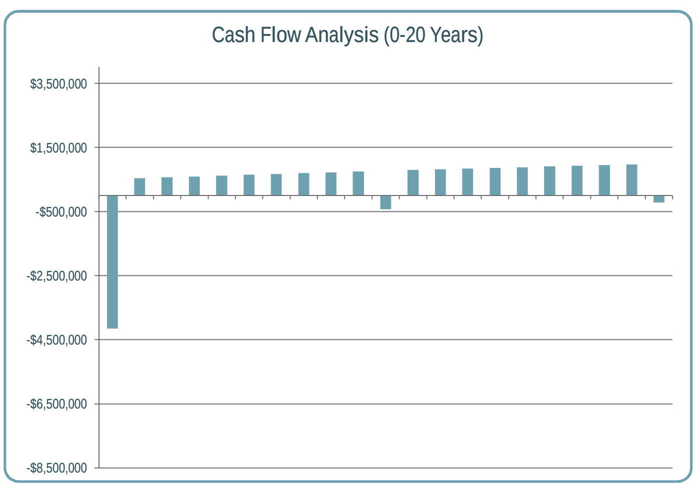
Fuel Price Futures

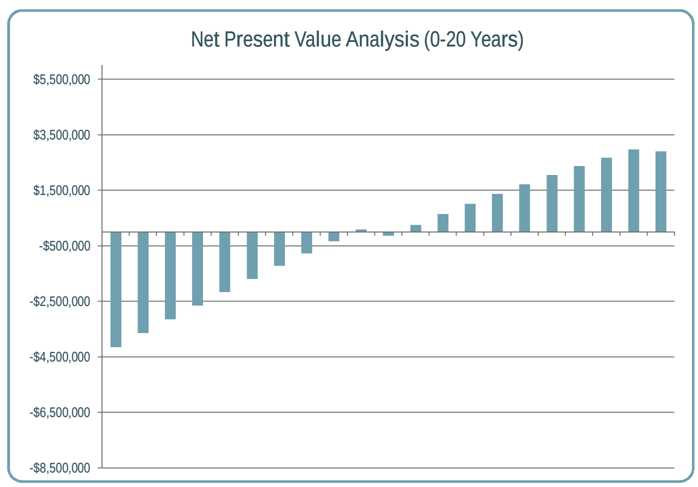
Year	#2 Oil ($/gal)	Chip ($/ton)	Pellet ($/ton)	Electric ($/kWh)
1	$2.64	$53.10	$247.00	$0.125
2	$2.77	$56.04	$274.60	$0.130
3	$2.89	$58.97	$302.20	$0.135
4	$3.02	$61.91	$329.80	$0.140
5	$3.14	$64.84	$357.40	$0.146
6	$3.27	$67.77	$385.00	$0.152
7	$3.39	$70.71	$412.60	$0.158
8	$3.51	$73.64	$440.20	$0.164
9	$3.64	$76.57	$467.80	$0.171
10	$3.76	$79.51	$495.40	$0.178
11	$3.89	$82.44	$523.00	$0.185
12	$4.01	$85.38	$550.60	$0.192
13	$4.14	$88.31	$578.20	$0.200
14	$4.26	$91.24	$605.80	$0.208
15	$4.39	$94.18	$633.40	$0.216
16	$4.51	$97.11	$661.00	$0.225
17	$4.63	$100.05	$688.60	$0.234
18	$4.76	$102.98	$716.20	$0.243
19	$4.88	$105.91	$743.80	$0.253
20	$5.01	$108.85	$771.40	$0.263

Lifecycle Cost Savings Table

Year	Capital Costs	Fixed Operating Costs	Energy Costs (Oil Only)	Energy Costs (Biomass and Oil)	Energy Savings	Electric Costs	Permitting/Taxes/ Insurance Costs	Financing Costs	Cash Flow	Discounted Cash Flow	Net Present Value
0	-$4,157,500	-	-	-	-	-	-	-	-$4,157,500	-$4,157,500	-$4,157,500
1	$0	-$387,400	$1,862,701	$907,338	$955,363	-$18,200	-$7,925	$0	$541,838	$508,768	-$3,648,732
2	$0	-$399,022	$1,950,344	$954,870	$995,474	-$18,928	-$8,163	$0	$569,361	$501,983	-$3,146,749
3	$0	-$410,993	$2,037,988	$1,002,403	$1,035,585	-$19,685	-$8,408	$0	$596,500	$493,812	-$2,652,938
4	$0	-$423,322	$2,125,631	$1,049,935	$1,075,696	-$20,472	-$8,660	$0	$623,242	$484,460	-$2,168,477
5	$0	-$436,022	$2,213,274	$1,097,467	$1,115,808	-$21,291	-$8,920	$0	$649,574	$474,112	-$1,694,365
6	$0	-$449,103	$2,300,918	$1,144,999	$1,155,919	-$22,143	-$9,187	$0	$675,486	$462,933	-$1,231,432
7	$0	-$462,576	$2,388,561	$1,192,531	$1,196,030	-$23,029	-$9,463	$0	$700,962	$451,074	-$780,358
8	$0	-$476,453	$2,476,204	$1,240,063	$1,236,141	-$23,950	-$9,747	$0	$725,991	$438,667	-$341,692
9	$0	-$490,747	$2,563,847	$1,287,595	$1,276,252	-$24,908	-$10,039	$0	$750,559	$425,832	$84,140
10	-$1,205,675	-$505,469	$2,651,491	$1,335,127	$1,316,364	-$25,904	-$10,340	$0	-$431,025	-$229,618	-$145,478
11	$0	-$520,633	$2,739,134	$1,382,659	$1,356,475	-$26,940	-$10,651	$0	$798,251	$399,295	$253,816
12	$0	-$536,252	$2,826,777	$1,430,191	$1,396,586	-$28,018	-$10,970	$0	$821,346	$385,772	$639,588
13	$0	-$552,340	$2,914,420	$1,477,723	$1,436,697	-$29,139	-$11,299	$0	$843,919	$372,183	$1,011,771
14	$0	-$568,910	$3,002,064	$1,525,255	$1,476,808	-$30,304	-$11,638	$0	$865,956	$358,593	$1,370,364
15	$0	-$585,977	$3,089,707	$1,572,787	$1,516,919	-$31,516	-$11,987	$0	$887,439	$345,060	$1,715,423
16	$0	-$603,557	$3,177,350	$1,620,320	$1,557,031	-$32,777	-$12,347	$0	$908,350	$331,634	$2,047,058
17	$0	-$621,663	$3,264,993	$1,667,852	$1,597,142	-$34,088	-$12,717	$0	$928,673	$318,361	$2,365,418
18	$0	-$640,313	$3,352,637	$1,715,384	$1,637,253	-$35,452	-$13,099	$0	$948,389	$305,277	$2,670,695
19	$0	-$659,523	$3,440,280	$1,762,916	$1,677,364	-$36,870	-$13,492	$0	$967,480	$292,415	$2,963,110
20	-$1,205,675	-$679,308	$3,527,923	$1,810,448	$1,717,475	-$38,345	-$13,897	$0	-$219,749	-$62,364	$2,900,746

Simple Payback: 7.7 Years | Year 20 IRR: 13.85%





SouthWestern Vermont Medical Center - Biomass Feasibility Study

1,000 HP Wood Chip Direct Burn Boiler Option

30-Jan-09

1,000 HP Wood Chip Direct Burn Boiler Option - Inputs

COST	
Capital Costs:	$7,515,040
Fixed Operating Costs:	$392,400
Permitting Costs:	$5,850
Taxes:	$2,500
Insurance Premium:	$2,500

ENERGY CONSUMPTION		
Total Heating Load (MMBtu):		80,989
% Biomass	91.0%	73,700
% Oil	9.0%	7,289
Electric Demand (kWH):		291,666
Oil Boiler System Efficiency:		83.0%
Wood Boiler System Efficiency:		67.0%

FINANCING	
Annual Inflation Rate:	3.0%
Discount Rate:	6.5%
Interest Rate:	6.0%
Financed Amount:	0.0%
Financing Term:	20

HEAT CONTENT	
#2 Fuel Oil (MMBtu/gal):	0.13850
Woodchips (MMBtu/ton):	9.02
Wood Pellets (MMBtu/ton):	15.50

FUEL ESCALATION RATES	
Oil Escalation Rate:	100.0%
Woodchip Escalation Rate:	100.0%
Pellet Escalation Rate:	100.0%
Electricity Escalation Rate:	4.0%

FUEL - CURRENT PRICES	
#2 Oil ($/gal):	2.12
Chip ($/ton):	53.00
Pellet ($/ton):	216.00
Electricity ($/kWh):	0.12

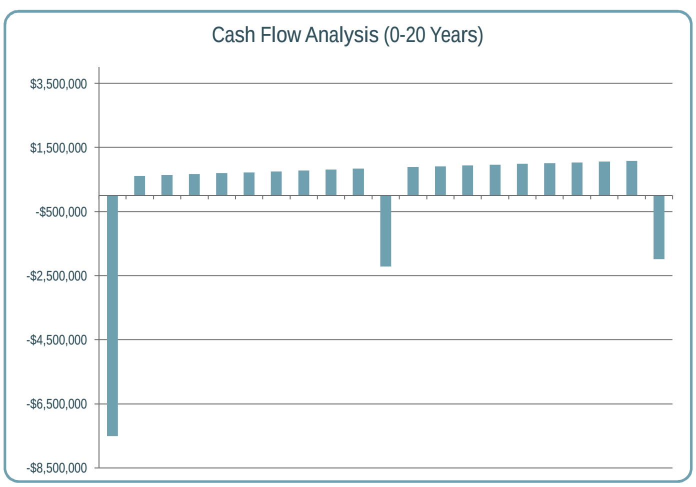
Fuel Price Futures

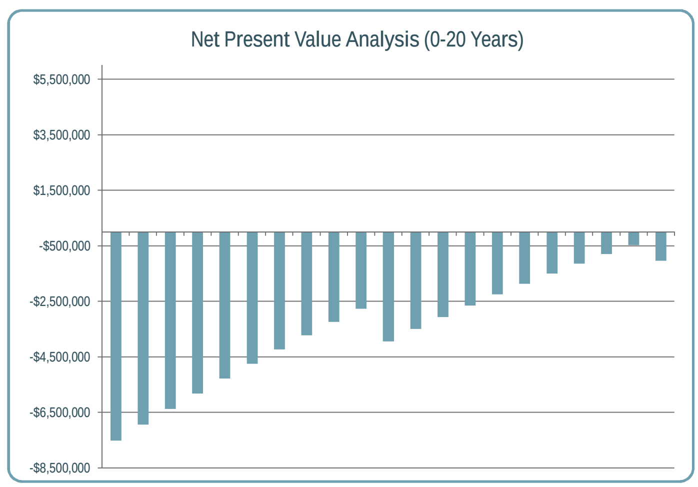
Year	#2 Oil ($/gal)	Chip ($/ton)	Pellet ($/ton)	Electric ($/kWh)
1	$2.64	$53.10	$247.00	$0.125
2	$2.77	$56.04	$274.60	$0.130
3	$2.89	$58.97	$302.20	$0.135
4	$3.02	$61.91	$329.80	$0.140
5	$3.14	$64.84	$357.40	$0.146
6	$3.27	$67.77	$385.00	$0.152
7	$3.39	$70.71	$412.60	$0.158
8	$3.51	$73.64	$440.20	$0.164
9	$3.64	$76.57	$467.80	$0.171
10	$3.76	$79.51	$495.40	$0.178
11	$3.89	$82.44	$523.00	$0.185
12	$4.01	$85.38	$550.60	$0.192
13	$4.14	$88.31	$578.20	$0.200
14	$4.26	$91.24	$605.80	$0.208
15	$4.39	$94.18	$633.40	$0.216
16	$4.51	$97.11	$661.00	$0.225
17	$4.63	$100.05	$688.60	$0.234
18	$4.76	$102.98	$716.20	$0.243
19	$4.88	$105.91	$743.80	$0.253
20	$5.01	$108.85	$771.40	$0.263

Lifecycle Cost Savings Table

Year	Capital Costs	Fixed Operating Costs	Energy Costs (Oil Only)	Energy Costs (Biomass and Oil)	Energy Savings	Electric Costs	Permitting/Taxes/ Insurance Costs	Financing Costs	Cash Flow	Discounted Cash Flow	Net Present Value
0	-$7,515,040	-	-	-	-	-	-	-	-$7,515,040	-$7,515,040	-$7,515,040
1	$0	-$392,400	$1,862,701	$815,255	$1,047,446	-$36,400	-$10,850	$0	$607,796	$570,701	-$6,944,339
2	$0	-$404,172	$1,950,344	$858,921	$1,091,423	-$37,856	-$11,176	$0	$638,220	$562,693	-$6,381,647
3	$0	-$416,297	$2,037,988	$902,587	$1,135,401	-$39,370	-$11,511	$0	$668,223	$553,187	-$5,828,460
4	$0	-$428,786	$2,125,631	$946,253	$1,179,378	-$40,945	-$11,856	$0	$697,791	$542,409	-$5,286,051
5	$0	-$441,650	$2,213,274	$989,919	$1,223,355	-$42,583	-$12,212	$0	$726,911	$530,558	-$4,755,492
6	$0	-$454,899	$2,300,918	$1,033,585	$1,267,333	-$44,286	-$12,578	$0	$755,569	$517,817	-$4,237,675
7	$0	-$468,546	$2,388,561	$1,077,251	$1,311,310	-$46,058	-$12,955	$0	$783,751	$504,349	-$3,733,326
8	$0	-$482,603	$2,476,204	$1,120,917	$1,355,287	-$47,900	-$13,344	$0	$811,441	$490,298	-$3,243,028
9	$0	-$497,081	$2,563,847	$1,164,583	$1,399,265	-$49,816	-$13,744	$0	$838,624	$475,796	-$2,767,232
10	-$3,081,166	-$511,993	$2,651,491	$1,208,249	$1,443,242	-$51,808	-$14,157	$0	-$2,215,883	-$1,180,458	-$3,947,691
11	$0	-$527,353	$2,739,134	$1,251,915	$1,487,219	-$53,881	-$14,581	$0	$891,404	$445,891	-$3,501,799
12	$0	-$543,173	$2,826,777	$1,295,581	$1,531,197	-$56,036	-$15,019	$0	$916,968	$430,684	-$3,071,115
13	$0	-$559,469	$2,914,420	$1,339,246	$1,575,174	-$58,277	-$15,470	$0	$941,958	$415,419	-$2,655,696
14	$0	-$576,253	$3,002,064	$1,382,912	$1,619,151	-$60,609	-$15,934	$0	$966,356	$400,168	-$2,255,527
15	$0	-$593,540	$3,089,707	$1,426,578	$1,663,129	-$63,033	-$16,412	$0	$990,144	$384,994	-$1,870,533
16	$0	-$611,346	$3,177,350	$1,470,244	$1,707,106	-$65,554	-$16,904	$0	$1,013,301	$369,952	-$1,500,581
17	$0	-$629,687	$3,264,993	$1,513,910	$1,751,083	-$68,176	-$17,411	$0	$1,035,809	$355,088	-$1,145,493
18	$0	-$648,577	$3,352,637	$1,557,576	$1,795,061	-$70,903	-$17,933	$0	$1,057,646	$340,445	-$805,048
19	$0	-$668,035	$3,440,280	$1,601,242	$1,839,038	-$73,740	-$18,471	$0	$1,078,792	$326,058	-$478,989
20	-$3,081,166	-$688,076	$3,527,923	$1,644,908	$1,883,015	-$76,689	-$19,026	$0	-$1,981,942	-$562,469	-$1,041,459

Simple Payback: 12.4 Years — Year 20 IRR: 4.57%





SouthWestern Vermont Medical Center - Biomass Feasibility Study

500 HP Wood Chip Gasification Boiler Option

30-Jan-09

500 HP Wood Chip Gasification Boiler Option - Inputs

COST	
Capital Costs:	$5,021,600
Fixed Operating Costs:	$295,000
Permitting Costs:	$2,350
Taxes:	$2,500
Insurance Premium:	$2,500

FINANCING	
Annual Inflation Rate:	3.0%
Discount Rate:	6.5%
Interest Rate:	6.0%
Financed Amount:	0.0%
Financing Term:	20

FUEL ESCALATION RATES	
Oil Escalation Rate:	100.0%
Woodchip Escalation Rate:	100.0%
Pellet Escalation Rate:	100.0%
Electricity Escalation Rate:	4.0%

ENERGY CONSUMPTION		
Total Heating Load (MMBtu):		80,989
% Biomass	85.0%	68,841
% Oil	15.0%	12,148
Electric Demand (kWH):		145,833
Oil Boiler System Efficiency:		83.0%
Wood Boiler System Efficiency:		70.0%

HEAT CONTENT	
#2 Fuel Oil (MMBtu/gal):	0.13850
Woodchips (MMBtu/ton):	9.02
Wood Pellets (MMBtu/ton):	15.50

FUEL - CURRENT PRICES	
#2 Oil ($/gal):	2.12
Chip ($/ton):	53.00
Pellet ($/ton):	216.00
Electricity ($/kWh):	0.12

Fuel Price Futures

Year	#2 Oil ($/gal)	Chip ($/ton)	Pellet ($/ton)	Electric ($/kWh)
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3	$2.89	$58.97	$302.20	$0.135
4	$3.02	$61.91	$329.80	$0.140
5	$3.14	$64.84	$357.40	$0.146
6	$3.27	$67.77	$385.00	$0.152
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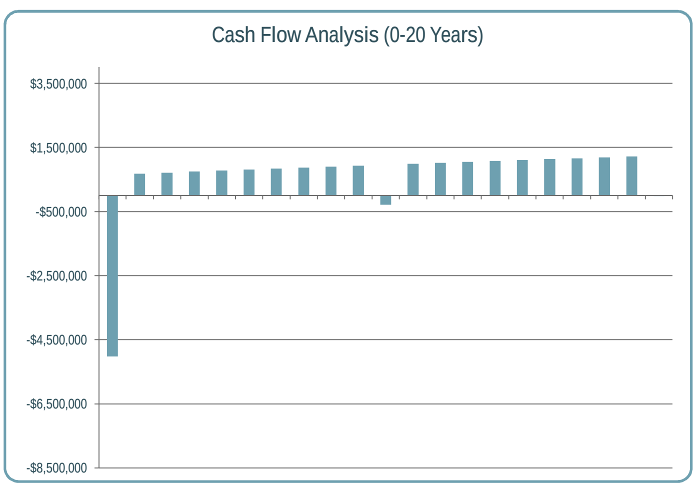
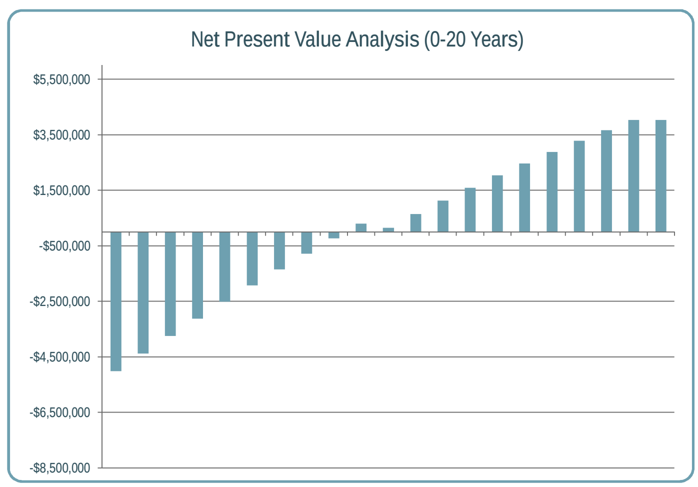
8	$3.51	$73.64	$440.20	$0.164
9	$3.64	$76.57	$467.80	$0.171
10	$3.76	$79.51	$495.40	$0.178
11	$3.89	$82.44	$523.00	$0.185
12	$4.01	$85.38	$550.60	$0.192
13	$4.14	$88.31	$578.20	$0.200
14	$4.26	$91.24	$605.80	$0.208
15	$4.39	$94.18	$633.40	$0.216
16	$4.51	$97.11	$661.00	$0.225
17	$4.63	$100.05	$688.60	$0.234
18	$4.76	$102.98	$716.20	$0.243
19	$4.88	$105.91	$743.80	$0.253
20	$5.01	$108.85	$771.40	$0.263

Lifecycle Cost Savings Table

Year	Capital Costs	Fixed Operating Costs	Energy Costs (Oil Only)	Energy Costs (Biomass and Oil)	Energy Savings	Electric Costs	Permitting/Taxes/ Insurance Costs	Financing Costs	Cash Flow	Discounted Cash Flow	Net Present Value
0	-$5,021,600	-	-	-	-	-	-	-	-$5,021,600	-$5,021,600	-$5,021,600
1	$0	-$295,000	$1,862,701	$858,393	$1,004,308	-$18,200	-$7,350	$0	$683,758	$642,027	-$4,379,573
2	$0	-$303,850	$1,950,344	$903,526	$1,046,818	-$18,928	-$7,571	$0	$716,470	$631,682	-$3,747,891
3	$0	-$312,966	$2,037,988	$948,659	$1,089,328	-$19,685	-$7,798	$0	$748,880	$619,960	-$3,127,931
4	$0	-$322,354	$2,125,631	$993,793	$1,131,838	-$20,472	-$8,032	$0	$780,980	$607,074	-$2,520,857
5	$0	-$332,025	$2,213,274	$1,038,926	$1,174,348	-$21,291	-$8,272	$0	$812,759	$593,217	-$1,927,640
6	$0	-$341,986	$2,300,918	$1,084,059	$1,216,858	-$22,143	-$8,521	$0	$844,209	$578,565	-$1,349,075
7	$0	-$352,245	$2,388,561	$1,129,193	$1,259,368	-$23,029	-$8,776	$0	$875,318	$563,272	-$785,802
8	$0	-$362,813	$2,476,204	$1,174,326	$1,301,878	-$23,950	-$9,040	$0	$906,076	$547,479	-$238,323
9	$0	-$373,697	$2,563,847	$1,219,459	$1,344,388	-$24,908	-$9,311	$0	$936,472	$531,311	$292,987
10	-$1,255,400	-$384,908	$2,651,491	$1,264,592	$1,386,898	-$25,904	-$9,590	$0	-$288,904	-$153,907	$139,081
11	$0	-$396,455	$2,739,134	$1,309,726	$1,429,408	-$26,940	-$9,878	$0	$996,135	$498,279	$637,359
12	$0	-$408,349	$2,826,777	$1,354,859	$1,471,918	-$28,018	-$10,174	$0	$1,025,377	$481,602	$1,118,961
13	$0	-$420,599	$2,914,420	$1,399,992	$1,514,428	-$29,139	-$10,479	$0	$1,054,211	$464,925	$1,583,886
14	$0	-$433,217	$3,002,064	$1,445,126	$1,556,938	-$30,304	-$10,794	$0	$1,082,623	$448,314	$2,032,200
15	$0	-$446,214	$3,089,707	$1,490,259	$1,599,448	-$31,516	-$11,118	$0	$1,110,600	$431,831	$2,464,031
16	$0	-$459,600	$3,177,350	$1,535,392	$1,641,958	-$32,777	-$11,451	$0	$1,138,129	$415,526	$2,879,557
17	$0	-$473,388	$3,264,993	$1,580,526	$1,684,468	-$34,088	-$11,795	$0	$1,165,197	$399,444	$3,279,001
18	$0	-$487,590	$3,352,637	$1,625,659	$1,726,978	-$35,452	-$12,148	$0	$1,191,788	$383,624	$3,662,625
19	$0	-$502,218	$3,440,280	$1,670,792	$1,769,488	-$36,870	-$12,513	$0	$1,217,887	$368,099	$4,030,724
20	-$1,255,400	-$517,284	$3,527,923	$1,715,925	$1,811,998	-$38,345	-$12,888	$0	-$11,919	-$3,383	$4,027,341
				Simple Payback: 7.3 Years			Year 20 IRR:	14.73%			





SouthWestern Vermont Medical Center - Biomass Feasibility Study

1,000 HP Wood Chip Gasification Boiler Option

30-Jan-09

1,000 HP Wood Chip Gasification Boiler Option - Inputs

COST	
Capital Costs:	$8,108,000
Fixed Operating Costs:	$300,000
Permitting Costs:	$4,700
Taxes:	$2,500
Insurance Premium:	$2,500

ENERGY CONSUMPTION		
Total Heating Load (MMBtu):		80,989
% Biomass	91.0%	73,700
% Oil	9.0%	7,289
Electric Demand (kWH):		291,666
Oil Boiler System Efficiency:		83.0%
Wood Boiler System Efficiency:		70.0%

FINANCING	
Annual Inflation Rate:	3.0%
Discount Rate:	6.5%
Interest Rate:	6.0%
Financed Amount:	0.0%
Financing Term:	20

HEAT CONTENT	
#2 Fuel Oil (MMBtu/gal):	0.13850
Woodchips (MMBtu/ton):	9.02
Wood Pellets (MMBtu/ton):	15.50

FUEL ESCALATION RATES	
Oil Escalation Rate:	100.0%
Woodchip Escalation Rate:	100.0%
Pellet Escalation Rate:	100.0%
Electricity Escalation Rate:	4.0%

FUEL - CURRENT PRICES	
#2 Oil ($/gal):	2.12
Chip ($/ton):	53.00
Pellet ($/ton):	216.00
Electricity ($/kWh):	0.12

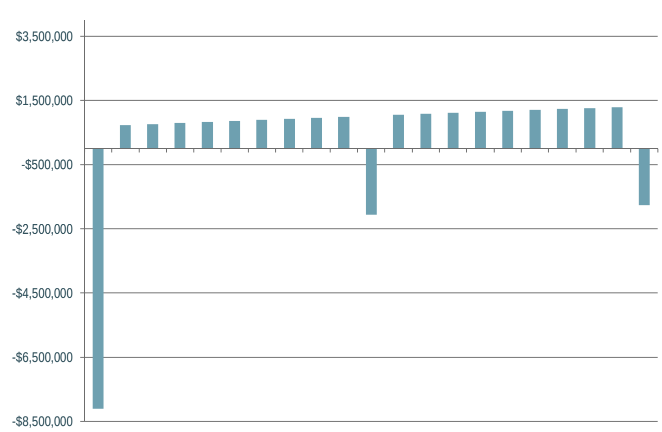
Fuel Price Futures

Year	#2 Oil ($/gal)	Chip ($/ton)	Pellet ($/ton)	Electric ($/kWh)
1	$2.64	$53.10	$247.00	$0.125
2	$2.77	$56.04	$274.60	$0.130
3	$2.89	$58.97	$302.20	$0.135
4	$3.02	$61.91	$329.80	$0.140
5	$3.14	$64.84	$357.40	$0.146
6	$3.27	$67.77	$385.00	$0.152
7	$3.39	$70.71	$412.60	$0.158
8	$3.51	$73.64	$440.20	$0.164
9	$3.64	$76.57	$467.80	$0.171
10	$3.76	$79.51	$495.40	$0.178
11	$3.89	$82.44	$523.00	$0.185
12	$4.01	$85.38	$550.60	$0.192
13	$4.14	$88.31	$578.20	$0.200
14	$4.26	$91.24	$605.80	$0.208
15	$4.39	$94.18	$633.40	$0.216
16	$4.51	$97.11	$661.00	$0.225
17	$4.63	$100.05	$688.60	$0.234
18	$4.76	$102.98	$716.20	$0.243
19	$4.88	$105.91	$743.80	$0.253
20	$5.01	$108.85	$771.40	$0.263

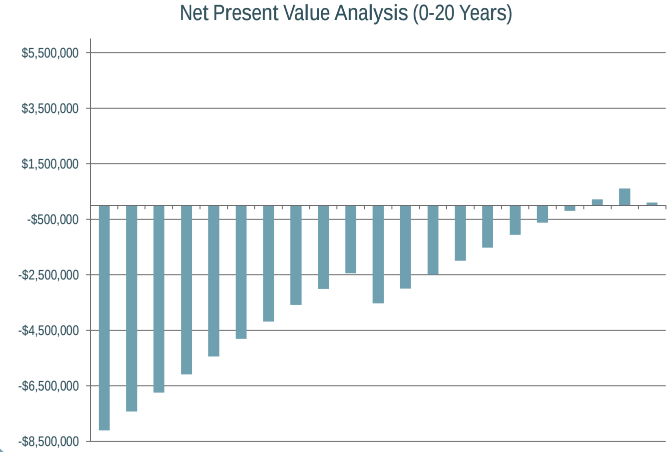
Lifecycle Cost Savings Table

Year	Capital Costs	Fixed Operating Costs	Energy Costs (Oil Only)	Energy Costs (Biomass and Oil)	Energy Savings	Electric Costs	Permitting/Taxes/ Insurance Costs	Financing Costs	Cash Flow	Discounted Cash Flow	Net Present Value
0	-$8,108,000	-	-	-	-	-	-	-	-$8,108,000	-$8,108,000	-$8,108,000
1	$0	-$300,000	$1,862,701	$787,500	$1,075,201	-$36,400	-$9,700	$0	$729,101	$684,602	-$7,423,398
2	$0	-$309,000	$1,950,344	$829,633	$1,120,711	-$37,856	-$9,991	$0	$763,865	$673,468	-$6,749,930
3	$0	-$318,270	$2,037,988	$871,766	$1,166,222	-$39,370	-$10,291	$0	$798,291	$660,865	-$6,089,065
4	$0	-$327,818	$2,125,631	$913,898	$1,211,733	-$40,945	-$10,599	$0	$832,370	$647,021	-$5,442,045
5	$0	-$337,653	$2,213,274	$956,031	$1,257,243	-$42,583	-$10,917	$0	$866,091	$632,143	-$4,809,902
6	$0	-$347,782	$2,300,918	$998,163	$1,302,754	-$44,286	-$11,245	$0	$899,441	$616,418	-$4,193,484
7	$0	-$358,216	$2,388,561	$1,040,296	$1,348,265	-$46,058	-$11,582	$0	$932,409	$600,011	-$3,593,473
8	$0	-$368,962	$2,476,204	$1,082,429	$1,393,776	-$47,900	-$11,930	$0	$964,984	$583,073	-$3,010,400
9	$0	-$380,031	$2,563,847	$1,124,561	$1,439,286	-$49,816	-$12,288	$0	$997,152	$565,737	-$2,444,662
10	-$3,081,040	-$391,432	$2,651,491	$1,166,694	$1,484,797	-$51,808	-$12,656	$0	-$2,052,140	-$1,093,228	-$3,537,891
11	$0	-$403,175	$2,739,134	$1,208,826	$1,530,308	-$53,881	-$13,036	$0	$1,060,216	$530,333	-$3,007,558
12	$0	-$415,270	$2,826,777	$1,250,959	$1,575,818	-$56,036	-$13,427	$0	$1,091,085	$512,464	-$2,495,094
13	$0	-$427,728	$2,914,420	$1,293,092	$1,621,329	-$58,277	-$13,830	$0	$1,121,493	$494,597	-$2,000,497
14	$0	-$440,560	$3,002,064	$1,335,224	$1,666,840	-$60,609	-$14,245	$0	$1,151,426	$476,806	-$1,523,691
15	$0	-$453,777	$3,089,707	$1,377,357	$1,712,350	-$63,033	-$14,672	$0	$1,180,868	$459,153	-$1,064,538
16	$0	-$467,390	$3,177,350	$1,419,489	$1,757,861	-$65,554	-$15,112	$0	$1,209,804	$441,694	-$622,844
17	$0	-$481,412	$3,264,993	$1,461,622	$1,803,372	-$68,176	-$15,566	$0	$1,238,218	$424,476	-$198,367
18	$0	-$495,854	$3,352,637	$1,503,754	$1,848,882	-$70,903	-$16,033	$0	$1,266,092	$407,542	$209,174
19	$0	-$510,730	$3,440,280	$1,545,887	$1,894,393	-$73,740	-$16,514	$0	$1,293,410	$390,925	$600,100
20	-$3,081,040	-$526,052	$3,527,923	$1,588,020	$1,939,904	-$76,689	-$17,009	$0	-$1,760,886	-$499,734	$100,365
				Simple Payback: 11.1 Years		Year 20 IRR:		6.66%			

Cash Flow Analysis (0-20 Years)



Net Present Value Analysis (0-20 Years)



SouthWestern Vermont Medical Center - Biomass Feasibility Study

500 HP Wood Pellet Gasification Boiler Option

30-Jan-09

500 HP Wood Pellet Gasification Boiler Option - Inputs

COST	
Capital Costs:	$3,348,110
Fixed Operating Costs:	$152,000
Permitting Costs:	$2,350
Taxes:	$2,500
Insurance Premium:	$2,500

ENERGY CONSUMPTION		
Total Heating Load (MMBtu):		80,989
% Biomass	91.0%	73,700
% Oil	9.0%	7,289
Electric Demand (kWH):		131,250
Oil Boiler System Efficiency:		83.0%
Wood Boiler System Efficiency:		75.0%

FINANCING	
Annual Inflation Rate:	3.0%
Discount Rate:	6.5%
Interest Rate:	6.0%
Financed Amount:	0.0%
Financing Term:	20

HEAT CONTENT	
#2 Fuel Oil (MMBtu/gal):	0.13850
Woodchips (MMBtu/ton):	9.02
Wood Pellets (MMBtu/ton):	15.50

FUEL ESCALATION RATES	
Oil Escalation Rate:	100.0%
Woodchip Escalation Rate:	100.0%
Pellet Escalation Rate:	100.0%
Electricity Escalation Rate:	4.0%

FUEL - CURRENT PRICES	
#2 Oil ($/gal):	2.12
Chip ($/ton):	53.00
Pellet ($/ton):	216.00
Electricity ($/kWh):	0.12

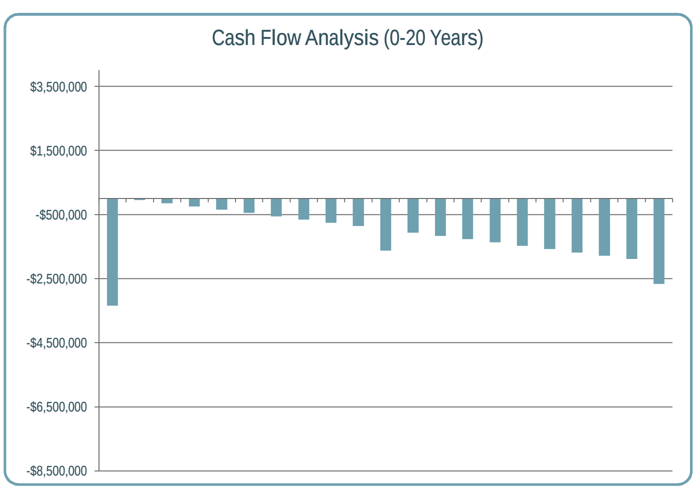
Fuel Price Futures

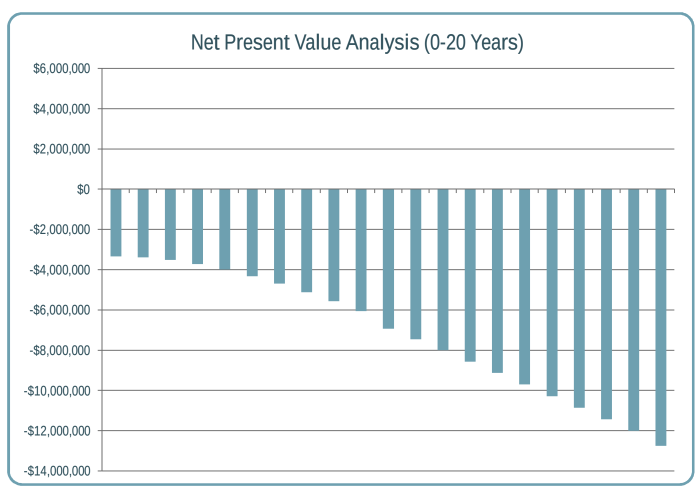
Year	#2 Oil ($/gal)	Chip ($/ton)	Pellet ($/ton)	Electric ($/kWh)
1	$2.64	$53.10	$247.00	$0.125
2	$2.77	$56.04	$274.60	$0.130
3	$2.89	$58.97	$302.20	$0.135
4	$3.02	$61.91	$329.80	$0.140
5	$3.14	$64.84	$357.40	$0.146
6	$3.27	$67.77	$385.00	$0.152
7	$3.39	$70.71	$412.60	$0.158
8	$3.51	$73.64	$440.20	$0.164
9	$3.64	$76.57	$467.80	$0.171
10	$3.76	$79.51	$495.40	$0.178
11	$3.89	$82.44	$523.00	$0.185
12	$4.01	$85.38	$550.60	$0.192
13	$4.14	$88.31	$578.20	$0.200
14	$4.26	$91.24	$605.80	$0.208
15	$4.39	$94.18	$633.40	$0.216
16	$4.51	$97.11	$661.00	$0.225
17	$4.63	$100.05	$688.60	$0.234
18	$4.76	$102.98	$716.20	$0.243
19	$4.88	$105.91	$743.80	$0.253
20	$5.01	$108.85	$771.40	$0.263

Lifecycle Cost Savings Table

Year	Capital Costs	Fixed Operating Costs	Energy Costs (Oil Only)	Energy Costs (Biomass and Oil)	Energy Savings	Electric Costs	Permitting/Taxes/ Insurance Costs	Financing Costs	Cash Flow	Discounted Cash Flow	Net Present Value
0	-$3,348,110	-	-	-	-	-	-	-	-$3,348,110	-$3,348,110	-$3,348,110
1	$0	-$152,000	$1,862,701	$1,733,570	$129,131	-$16,380	-$7,350	$0	-$46,599	-$43,755	-$3,391,865
2	$0	-$156,560	$1,950,344	$1,916,436	$33,909	-$17,035	-$7,571	$0	-$147,257	-$129,830	-$3,521,695
3	$0	-$161,257	$2,037,988	$2,099,302	-$61,314	-$17,717	-$7,798	$0	-$248,085	-$205,377	-$3,727,072
4	$0	-$166,095	$2,125,631	$2,282,168	-$156,537	-$18,425	-$8,032	$0	-$349,088	-$271,354	-$3,998,426
5	$0	-$171,077	$2,213,274	$2,465,034	-$251,759	-$19,162	-$8,272	$0	-$450,271	-$328,644	-$4,327,070
6	$0	-$176,210	$2,300,918	$2,647,899	-$346,982	-$19,929	-$8,521	$0	-$551,641	-$378,058	-$4,705,129
7	$0	-$181,496	$2,388,561	$2,830,765	-$442,205	-$20,726	-$8,776	$0	-$653,203	-$420,340	-$5,125,469
8	$0	-$186,941	$2,476,204	$3,013,631	-$537,427	-$21,555	-$9,040	$0	-$754,963	-$456,172	-$5,581,641
9	$0	-$192,549	$2,563,847	$3,196,497	-$632,650	-$22,417	-$9,311	$0	-$856,927	-$486,180	-$6,067,821
10	-$669,622	-$198,326	$2,651,491	$3,379,363	-$727,873	-$23,314	-$9,590	$0	-$1,628,724	-$867,664	-$6,935,485
11	$0	-$204,275	$2,739,134	$3,562,229	-$823,095	-$24,246	-$9,878	$0	-$1,061,495	-$530,973	-$7,466,457
12	$0	-$210,404	$2,826,777	$3,745,095	-$918,318	-$25,216	-$10,174	$0	-$1,164,112	-$546,763	-$8,013,221
13	$0	-$216,716	$2,914,420	$3,927,961	-$1,013,541	-$26,225	-$10,479	$0	-$1,266,961	-$558,751	-$8,571,972
14	$0	-$223,217	$3,002,064	$4,110,827	-$1,108,763	-$27,274	-$10,794	$0	-$1,370,048	-$567,337	-$9,139,309
15	$0	-$229,914	$3,089,707	$4,293,693	-$1,203,986	-$28,365	-$11,118	$0	-$1,473,382	-$572,890	-$9,712,199
16	$0	-$236,811	$3,177,350	$4,476,559	-$1,299,209	-$29,499	-$11,451	$0	-$1,576,970	-$575,744	-$10,287,943
17	$0	-$243,915	$3,264,993	$4,659,425	-$1,394,431	-$30,679	-$11,795	$0	-$1,680,821	-$576,206	-$10,864,150
18	$0	-$251,233	$3,352,637	$4,842,291	-$1,489,654	-$31,907	-$12,148	$0	-$1,784,942	-$574,554	-$11,438,704
19	$0	-$258,770	$3,440,280	$5,025,157	-$1,584,877	-$33,183	-$12,513	$0	-$1,889,342	-$571,042	-$12,009,746
20	-$669,622	-$266,533	$3,527,923	$5,208,023	-$1,680,099	-$34,510	-$12,888	$0	-$2,663,653	-$755,937	-$12,765,683

Simple Payback: -71.9 Years   Year 20 IRR: #DIV/0!





SouthWestern Vermont Medical Center - Biomass Feasibility Study

1,000 HP Wood Pellet Gasification Boiler Option

30-Jan-09

1,000 HP Wood Pellet Gasification Boiler Option - Inputs

COST	
Capital Costs:	$5,202,580
Fixed Operating Costs:	$156,000
Permitting Costs:	$4,700
Taxes:	$2,500
Insurance Premium:	$2,500

FINANCING	
Annual Inflation Rate:	3.0%
Discount Rate:	6.5%
Interest Rate:	6.0%
Financed Amount:	0.0%
Financing Term:	20

FUEL ESCALATION RATES	
Oil Escalation Rate:	100.0%
Woodchip Escalation Rate:	100.0%
Pellet Escalation Rate:	100.0%
Electricity Escalation Rate:	4.0%

ENERGY CONSUMPTION		
Total Heating Load (MMBtu):		80,989
% Biomass	95.0%	76,940
% Oil	5.0%	4,049
Electric Demand (kWh):		262,500
Oil Boiler System Efficiency:		83.0%
Wood Boiler System Efficiency:		75.0%

HEAT CONTENT	
#2 Fuel Oil (MMBtu/gal):	0.13850
Woodchips (MMBtu/ton):	9.02
Wood Pellets (MMBtu/ton):	15.50

FUEL - CURRENT PRICES	
#2 Oil ($/gal):	2.12
Chip ($/ton):	53.00
Pellet ($/ton):	216.00
Electricity ($/kWh):	0.12

Fuel Price Futures

Year	#2 Oil ($/gal)	Chip ($/ton)	Pellet ($/ton)	Electric ($/kWh)
1	$2.64	$53.10	$247.00	$0.125
2	$2.77	$56.04	$274.60	$0.130
3	$2.89	$58.97	$302.20	$0.135
4	$3.02	$61.91	$329.80	$0.140
5	$3.14	$64.84	$357.40	$0.146
6	$3.27	$67.77	$385.00	$0.152
7	$3.39	$70.71	$412.60	$0.158
8	$3.51	$73.64	$440.20	$0.164
9	$3.64	$76.57	$467.80	$0.171
10	$3.76	$79.51	$495.40	$0.178
11	$3.89	$82.44	$523.00	$0.185
12	$4.01	$85.38	$550.60	$0.192
13	$4.14	$88.31	$578.20	$0.200
14	$4.26	$91.24	$605.80	$0.208
15	$4.39	$94.18	$633.40	$0.216
16	$4.51	$97.11	$661.00	$0.225
17	$4.63	$100.05	$688.60	$0.234
18	$4.76	$102.98	$716.20	$0.243
19	$4.88	$105.91	$743.80	$0.253
20	$5.01	$108.85	$771.40	$0.263

Lifecycle Cost Savings Table

Year	Capital Costs	Fixed Operating Costs	Energy Costs (Oil Only)	Energy Costs (Biomass and Oil)	Energy Savings	Electric Costs	Permitting/Taxes/ Insurance Costs	Financing Costs	Cash Flow	Discounted Cash Flow	Net Present Value
0	-$5,202,580	-	-	-	-	-	-	-	-$5,202,580	-$5,202,580	-$5,202,580
1	$0	-$156,000	$1,862,701	$1,727,894	$134,808	-$32,760	-$9,700	$0	-$63,652	-$59,768	-$5,262,348
2	$0	-$160,680	$1,950,344	$1,914,945	$35,399	-$34,070	-$9,991	$0	-$169,342	-$149,302	-$5,411,650
3	$0	-$165,500	$2,037,988	$2,101,997	-$64,009	-$35,433	-$10,291	$0	-$275,233	-$227,852	-$5,639,501
4	$0	-$170,465	$2,125,631	$2,289,048	-$163,417	-$36,851	-$10,599	$0	-$381,333	-$296,419	-$5,935,920
5	$0	-$175,579	$2,213,274	$2,476,100	-$262,826	-$38,325	-$10,917	$0	-$487,647	-$355,924	-$6,291,844
6	$0	-$180,847	$2,300,918	$2,663,151	-$362,234	-$39,858	-$11,245	$0	-$594,183	-$407,214	-$6,699,058
7	$0	-$186,272	$2,388,561	$2,850,203	-$461,642	-$41,452	-$11,582	$0	-$700,948	-$451,065	-$7,150,123
8	$0	-$191,860	$2,476,204	$3,037,254	-$561,050	-$43,110	-$11,930	$0	-$807,950	-$488,189	-$7,638,312
9	$0	-$197,616	$2,563,847	$3,224,306	-$660,459	-$44,834	-$12,288	$0	-$915,197	-$519,240	-$8,157,552
10	-$1,040,516	-$203,545	$2,651,491	$3,411,358	-$759,867	-$46,628	-$12,656	$0	-$2,063,212	-$1,099,127	-$9,256,678
11	$0	-$209,651	$2,739,134	$3,598,409	-$859,275	-$48,493	-$13,036	$0	-$1,130,455	-$565,467	-$9,822,146
12	$0	-$215,940	$2,826,777	$3,785,461	-$958,684	-$50,433	-$13,427	$0	-$1,238,484	-$581,695	-$10,403,840
13	$0	-$222,419	$2,914,420	$3,972,512	-$1,058,092	-$52,450	-$13,830	$0	-$1,346,790	-$593,957	-$10,997,797
14	$0	-$229,091	$3,002,064	$4,159,564	-$1,157,500	-$54,548	-$14,245	$0	-$1,455,384	-$602,675	-$11,600,472
15	$0	-$235,964	$3,089,707	$4,346,615	-$1,256,908	-$56,730	-$14,672	$0	-$1,564,274	-$608,231	-$12,208,703
16	$0	-$243,043	$3,177,350	$4,533,667	-$1,356,317	-$58,999	-$15,112	$0	-$1,673,471	-$610,976	-$12,819,680
17	$0	-$250,334	$3,264,993	$4,720,718	-$1,455,725	-$61,359	-$15,566	$0	-$1,782,984	-$611,229	-$13,430,909
18	$0	-$257,844	$3,352,637	$4,907,770	-$1,555,133	-$63,813	-$16,033	$0	-$1,892,823	-$609,280	-$14,040,189
19	$0	-$265,580	$3,440,280	$5,094,822	-$1,654,542	-$66,366	-$16,514	$0	-$2,003,000	-$605,395	-$14,645,584
20	-$1,040,516	-$273,547	$3,527,923	$5,281,873	-$1,753,950	-$69,020	-$17,009	$0	-$3,154,042	-$895,108	-$15,540,692

Simple Payback: -81.7 Years   Year 20 IRR: #VALUE!