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November 23, 2015

Donna Jerry, Health Care Administrator
Green Mountain Care Board
89 Main Street, Third Floor, City Center
Montpelier, VT 05620

RE: Docket No. GMBC-017-15con
Certificate of Need for replacement boiler plant at the Southwestern Vermont Medical Center

Dear Ms. Jerry,

Thank you for the opportunity to provide comments on the Certificate of Need (CON) application submitted by Southwestern Vermont Medical Center (SVMC) for the replacement of their heating plant.

The Public Service Department (PSD) offers these comments for the Green Mountain Care Board's information and consideration. The PSD herby requests admission to the SVMC heating plant CON application process (Docket No. GMBC-017-15con) in an amicus curiae capacity. The PSD is able to provide material assistance to the Green Mountain Care Board (GMCB) relevant to SVMC's CON application for a new compressed natural gas heating plant.

In reviewing the CON presented by SVMC, the PSD has comments on four issues: the analysis of alternatives, state energy goals, state economic development goals, and the State's forest management goals. The PSD developed these comments in cooperation with the Agency of Commerce and Economic Development and the Department of Forest, Parks, and Recreation for the issues related to their programs.

I. Analysis of Alternatives and Least Cost

According to the statutory criteria[1], for a CON to be issued an applicant needs to demonstrate and the GMCB needs to find that the cost of a proposed project is reasonable because less expensive alternatives do not exist, would be unsatisfactory, or are not feasible or appropriate.

The CON submitted by SVMC does not provide sufficient evidence to determine if the compressed natural gas (CNG) heating plant presented is the least cost option compared to known available alternatives.

There is preliminary evidence that an advanced biomass heating plant at SVMC would be the least cost option. Studies done specifically for SVMC, and case studies at similar locations, show that while a biomass option would increase the upfront capital costs substantially it is the least cost option over the life of the capital investment.

[1] VSA 18 §9437 (2) (C)

Indeed, SVMC's application states that a biomass option would be a cost effective solution, but concludes that biomass is not the best option. The application states that SVMC explored, compared and analyzed several fuel options for its heating needs. On page 17 of the application, a table provides a summary of the analysis of the fuel options explored.

The PSD has several questions regarding the data provided in this summary table. Primarily, the table does not include any data regarding cost, which should be a principle criteria analyzed when exploring alternatives. The PSD suggests that the SVMC be required to present a full life-cycle cost analysis of the alternatives explored (or at least for biomass and CNG) in order for the GMCB to be able to determine if the cost of the proposed CNG project is reasonable.

In addition to the lack of information on the costs of alternatives, the PSD has concerns regarding the analysis summarized in the table, specifically concerning the biomass fuel option. The application states that references to support the analysis summarized in the table appear in appendix 7. Below are PSD's comments on six of the evaluation dimensions presented in the summary table on page 17:

Estimated future change in fuel cost:
Under this dimension, the table lists biomass, propane, and CNG as "stable" and the heating oils as "rising". The PSD did not find any references in appendix 7 to support these characterizations. This evaluation category has an asterisk that is likely connected with the asterisk underneath the table that lists the US Energy Information Agency's web site but not a specific EIA resource. The PSD suggests that the GMCB request to see the specific reference (EIA or otherwise) that supports an analysis on the stability of future prices of the fuel options.

Emissions:
The table lists emissions from biomass as "very high". The reference documentation for this only includes greenhouse gas emissions. The URL provided for an EPA document does not point to a specific document, but to EPA's climate leadership web page. With the references provided it is not possible to verify what emissions SVMC had analyzed. If greenhouse gas emissions are the primary concern, the PSD can provide references on the positive impact that biomass heating has on greenhouse gas emissions compared to all the fossil fuel options.

Most often, the emission from biomass combustion of highest concern is particulates. Without advanced emission controls particulate emissions from biomass combustion are a health concern. However, the GMCB should know that test results[2] from wood-fired boilers with electro-static precipitators (ESP) show particulate matter emissions lower than #2 heating fuel and comparable to natural gas. It is likely that an ESP would be required if SVMC installed a biomass heating system.

Reliability of boilers:
The table lists the reliability of biomass-fueled boilers as being "Very Low". The PSD was not able to locate any references in the appendixes that support this analysis. The GMCB may want to ask for additional information if this is a point of interest or concern.

Availability of commercial fuel locally:

[2] Particulate test results are available from the biomass heating systems in operation at National Life, Colby College, and the Weeks Medical Center.

The table lists the availability of commercial fuel locally as "Variable" for biomass and "Medium" for CNG. The PSD did not find any reference material for this analysis in the appendixes. Without any reference material, the PSD was unsure how "medium" and "variable" compared to each other.

There are local options for the purchase of biomass fuel and a tremendous local forest resource that could supply biomass fuel to SVMC. The GMCB may want to ask for additional information if this is a point of interest or concern.

Staffing and maintenance required:
The PSD was not able to locate any reference material in the appendixes that support the analysis summarized in the table for the staffing required and boiler maintenance dimensions. Biomass is listed as "very high" and CNG as "low" for both dimensions. The PSD finds it reasonable that staffing and maintenance would be higher for biomass than CNG, however the PSD does not know which metric SVMC used that would warrant the difference presented. This dimension will directly affect the cost comparison of the alternatives. As such, the GMCB may want to ask for the reference materials used by SVMC in its analysis on this point.

Safety:
Regarding the safety of burning different fuels, SVMC's evaluation lists biomass as "Less Safe" and CNG as "Very Safe". The PSD did not find any references in Appendix 7, or in the other appendixes, that support these characterizations or on what basis the analysis measured safety. The PSD also did not find any resource in the appendixes to support the table's summary of the likelihood of fire risk for propane (which is listed as "fire risk") under the Safety dimension.

II. State Energy Goals

The PSD has drafted and submitted for public comment the 2015 update to the Vermont Comprehensive Energy Plan (CEP)[3]. The plan calls for a very substantial reduction in Vermont's fossil fuel use in order to archive the CEP goal of meeting 90% of Vermont's energy needs from renewable energy by 2050. Vermont has made significant progress increasing our use of renewable electricity, but has not made similar gains in the space-heating sector. While SVMC's application to switch to CNG from #6 oil is an improvement in energy efficiency, it would be a lost opportunity to increase our use of renewable fuel for space heating. The CEP specifically calls for the increased use of the State's woody biomass for heating and explains how to accomplish this while strengthening our forest products industry and protecting air quality and reducing greenhouse gases.

It is unclear if SVMC has investigated or attempted to make use of the resources that could substantially lower the capital costs and increase the efficiency of a new biomass system. Both the state and federal governments are working to increase the use renewable biomass fuel. Gants, subsidized loans, and technical help are all available to support the installation of advanced wood heating at locations like SVMC. To this point, the DPS asked the US Forest Service's Wood Energy Resource Center if they would look at, and provide comments on, the SVMC CON application as well as the studies completed for SVMC regarding biomass boilers at SVMC. Despite a very quick turnaround, they provided a concept-level comparison memo of a CNG plant and a biomass combined heat and power plant. Given SVMC's

[3] http://publicservice.vermont.gov/publications/energy_plan/2015_plan

proximity to the national forest the Forest Service would be especially interested in helping SVMC investigate wood energy options and could provide a more detailed feasibility study at no cost to the hospital if SVMC was interested and provided up-to-date energy and other data.

The PSD is attaching the memo to our comments, as appendix A, primarily to show that there are technically qualified non-commercial entities willing to assist SVMC in making an accurate cost comparison between biomass and CNG. The analysis shows a value in an investigation of a CHP option as part of cost comparisons of options considered by SVMC. The renewable electricity produced by a CHP plant would likely increase the cost effectiveness of the biomass option over that of any fossil fuel. The incentives and power contracts available for renewable electricity are not available for a CNG fueled combined heat and power plant.

Despite efforts by the state and federal governments, there may be a perception that biomass heating is not a tested or widely used heating technology in the health care sector. To address this point the PSD compiled a list of thirty-seven hospitals/health care facilities that use biomass for heat, or combined heat and power (the list is not exhaustive, there are likely others). The list is attached as appendix B. The PSD could supply the GMCB and/or SVMC with lists of Vermont (and regional) schools, colleges, state buildings, and/or commercial buildings that are also successfully using local biomass heat.

III. State Economic Development Goals

The economic development benefits of a biomass heat plant-purchasing Vermont grown wood vs. buying natural gas from out of state is an issue worthy of more consideration. There is strong evidence that the positive economic development impacts of a biomass heating system would outweigh the benefits of the short-term savings in capital costs with the CNG plant purposed. The economic advantages of wood-chip boilers are many:

- Support of the local forest products economy. 7,000 tons of wood chips for heating per year represent about five full time equivalents in the logging, chipping and transportation sectors. All of these jobs are likely to be local to the Bennington area. In addition to the direct impact, solidifying the demand for wood chips provides for improved management of local forest tracts with the long-term benefit of an improved high-end forest products industry.
- These new jobs are the result of diverting cash payments for out-of-state natural gas production.
- The construction of a wood chip plant is admittedly a more costly capital project than the construction of a natural gas fired plant. However, Vermont is developing a leadership position in biomass heating plant construction and another large-scale project strengthens this sector for future applications.
- The long-term demand for wood chips establishes stability for the wood chip delivery market. The existence of a wood chip heating plant and accompanying development of the wood chip harvesting and delivery system enhances the likelihood of that areas schools and larger commercial establishments in the Bennington area will choose to use wood chips for heating.
- Greater price stability – CNG will be subject to the historically wild fluctuations in commodity pricing. Wood chips are not a commodity and price changes simply reflect changes in labor costs.
- The result of price stability reduces the risk of future price spikes and the associated pressure on the hospital's budget.

IV. State Forest Management Goals

Forests are important: They dominate Vermont's landscape, covering 78% of the land; they support critical environmental services; and they provide habitat for a vast array of plant and animal species. Forests provide the recreation and aesthetic setting for which the state is famous and economic benefits to forest landowners through a wide variety of forest products.

With eighty percent of Vermont's forestland in private ownership, maintaining the economic viability of forest land ownership is one of the critical factors in keeping forests as forests and ensuring the long term forest ecosystem health and productivity. Using locally harvested and processed wood fuel helps to support local economies, minimize the threat of introducing invasive forest pests and provides markets for the products of forest management.

The Department of Forests, Parks and Recreation (FPR) supports the adoption of "modern wood heating" which encourages the use of highly efficient, clean burning/low emitting technology, while recognizing that safeguarding long-term forest health is critical to ensure that wood fuel is renewable and sustainable. Using locally harvested and processed wood fuel helps to support local economies, minimize the threat of introducing invasive forest pests and provides markets for the products of forest management, while supporting forest operations that improve wood quality, and in turn, improve opportunities for good land stewardship.

Forest management in southwestern Vermont would benefit from the expanded demand for low-grade wood that a wood-fired heating or co-generation system at SVMC would create in the region. A project the size of SVMC's with the potential for creating year round demand would help build wood fuel harvesting and processing capacity in the region benefitting both existing and future projects.

SVMC should further investigate biomass heating and cogeneration options and the implications for forests and forestry in the region. FPR and the VT State Wood Energy Team (coordinated by FPR in cooperation with the US DA Forest Service) could assist in that investigation.

Conclusion

In conclusion, the PSD recognizes that there is a great opportunity to capture many benefits with a biomass energy system at SVMC and that such a system is likely to have the lowest life cycle cost of any option available. Given the many benefits and the State's renewable energy goals, the PSD is willing to work with the GMCB and SVMC in making sure that the biomass option is not rejected without due consideration.

Sincerely,

Asa Hopkins,
Director
Planning & Energy Resource Division

Wood Energy Technical Assistance Team

Wood Education and Resource Center
310 Hardwood Lane
Princeton, WV 24720
(304) 487-1510

Memorandum

DATE: November 20, 2015

TO: Andrew Perchlick, Vermont PSD CEDF

FROM: Lew McCreery, WERC

CC: Paul Frederick, VT Department of Forests, Parks & Recreation; Dan Wilson, WES

RE: Southwestern Vermont Medical Center - Biomass CHP Concept Analysis Memorandum

At your request, the Wood Education and Resource Center Wood Energy Technical Assistance Team developed a basic concept-level analysis of a biomass steam combined heat and power (CHP) system for the Southwestern Vermont Medical Center. This memorandum summarizes this analysis, and is based on information from the following past studies / efforts:

- Biomass Feasibility Study (2009) by GDS Associates, Inc.
- BERC Third Party Review of Technical and Financial Feasibility of Biomass Heating for SVMC (February 2012)
- SVMC Boiler Plant CON Application – Project Description

A site visit and facility energy assessment was not conducted as part of this effort. Thus, all data on facility systems is obtained from the referenced information.

1-Energy System and Use Summary

Data provided shows that the existing system consists of multiple oil fired boilers operating on #6 fuel oil. These boilers are listed as all being over 35 years old with a combustion efficiency of 78%. The annual #6 fuel oil use for generating steam is listed as approximately 510,000 gallons/yr. This is an input of approximately 79,050 mmBtu/yr assuming a higher heating value of 155,000 Btu/gallon for #6 fuel oil. The required steam pressure is listed as 125 psig.

2-Energy Systems Considered

The existing system is aging, and past the point of its useful life. Several options were considered for the system's replacement, but these did not included biomass CHP. This memorandum provides a concept-level analysis of a biomass CHP option and provides a general comparison of this to the existing proposal for a new boiler plant using CNG and #2 fuel oil.

Proposed New Dual-Fuel Central Plant (CNG / Fuel Oil) - The current proposal is to replace the system with three dual-fuel fired boilers each rated at 400 hp and operating at 125 psig. The boilers would be housed in a new 2,000 ft^2 boiler plant, and the existing boilers would be demolished and removed from the existing boiler room. The main fuel would be natural gas from a CNG docking station constructed adjacent to the new plant, and #2 fuel oil would be the backup fuel.

Potential Dual-Fueled Central Plant with CHP (Wood / Fuel Oil) – A potentially more cost-effective option is to install a thermally-led combined heat and power system using a 500 hp advanced biomass steam boiler system and backpressure steam turbine along with the same new oil-fired boilers to provide backup. The biomass boiler system would produce steam at 400 psig, and a backpressure steam turbine would reduce this to the necessary distribution pressure. Based on the information about the proposed project, this distribution pressure is assumed to be 125 psig. With this outlet pressure, a backpressure steam turbine would be rated at approximately 215 kW. As previously mentioned, this is a thermally-led system, which means that the amount of electricity produced would be controlled based on the demand for steam in the hospital. Note that there may be the opportunity to reduce the steam pressure further for most of the heating and hot water demand, which would provide the opportunity to produce more electricity. If, for instance, the system only required 40 psig steam for the vast majority of the demand, the turbine generator could be sized closer to 350 kW.

3-Comparison of Annual Energy Use and Costs

Table 1 provides a comparison of the cost of thermal energy from various potential fuel options based on assumed fuel pricing.

Table 1 – Comparison of Cost Per mmBtu of Delivered Heat from Competing Fuels

Fuel/Units	Energy Content, mmBtu/unit	Assumed Price per Unit	Assumed Seasonal Efficiency	$/mmBtu of Heat Output
CNG/mmBtu	1.000	$12.00	0.80	$15.00
#6 Fuel Oil/gallon	0.155	$2.20	0.75	$18.92
#2 Fuel Oil/gallon	0.140	$2.50	0.80	$22.32
Wood Chips/green ton	10.000	$50.00	0.65	$7.69

Notes: Seasonal efficiencies should not be confused with combustion efficiencies. Seasonal efficiencies account for stand-by losses, boiler cycling, and other inefficiencies seen throughout the course of annual operations. WERC has made these assumptions base on evaluations of past facilities. The efficiencies are assumed based on the proposed operating pressures in this analysis (125 psig for CNG and oil, and 400 psig for wood chips).

Table 2 presents assumed annual fuel use values for existing operations, the proposed CNG option, and a potential biomass CHP option. Table 3 summarizes the potential annual energy cost associated with each option. The value of the electricity generated is accounted for by subtracting it from the annual energy cost. A value of $0.125/kWh is used as the assumed value of the electric generated. The exact method of tie-in, existing electric rate structure, and potential for net metering with the 215 kW backpressure steam turbine and generator will impact the value of electricity generated. It is also worth noting that if lower pressure loads can be targeted with the turbine, the amount of electricity generated could be increased.

Table 2 – Annual Energy Demands with Varying System Options

Option / Assumed Fuel Mix to Cover Heating	Annual Heat Demand	Annual Fossil Fuel Use, mmBtu	Annual Wood Chip Use, tons	Annual Electric Generated, kWh
Existing System / #6 Oil	59,288	79,050	0	0
Proposed CNG System / 100% CNG	59,288	74,109	0	0
Potential Wood CHP / 90% Wood Chips & 10% #2 Fuel Oil	59,288	7,411	8,575	609,814

Notes: Table 7 presents the key assumptions used in the calculations. The annual wood chip use includes approximately 365 tons due to electric generation shown.

Table 3 – Annual Energy Costs with Varying System Options

Option / Assumed Fuel Mix to Cover Heating	(1) Annual Fossil Fuel Cost	(2) Annual Wood Chip Cost	(3) Annual O&M Costs	(4) Annual Value of Electric Generated	Annual Energy Cost (1+2+3-4)
Existing System / #6 Oil	$1,122,000	$0	$0	$0	$1,122,000
Proposed CNG System / 100% CNG	$889,313	$0	$0	$0	$889,313
Potential Wood CHP / 90% Wood Chips & 10% #2 Fuel Oil	$132,338	$428,746	$65,000	$76,227	$549,858

Notes: Table 7 presents the key assumptions used in the calculations. The Annual Energy Cost column is calculated by adding the annual fossil fuel costs, wood fuel costs, and O&M costs, and then subtracting out the value of the electric generated. A value of $0.125/kWh is used for this concept-level analysis. This value could be higher or lower depending on the onsite use, demand charge offset, net metering, and/or electric sale options that could be pursued. The facility would not be anticipated to hire additional staff to run the biomass plant. The added O&M listed is based on operation of similar plants, and covers annual maintenance, electric use, and ash handling. Note that no operating cost is assumed for the CNG or existing options, and it is likely that the delta listed here between the biomass and other options is higher than would actually be seen. The CNG option should also have some improvement over the existing system due to installation of new boilers and a new DA system. The biomass system is being compared to the CNG system, and it is assumed that the delta of $65,000 in O&M costs between the two new systems is conservative.

Table 4 shows the potential electricity generated and value of electricity generated on an annual basis at varying required output conditions and varying dollar values. This memorandum assumes 125 psig steam output is required, and a value of $0.125 for electric generated. The electricity is generated for an energy cost of $0.03/kWh given the assumptions made for this analysis. Table 4 provides a range of potential output from the system if a lower pressure down to 40 psig can be targeted for the vast majority of the steam demand. The table also shows how the potential annual revenue changes based on the unit value of electricity. The unit value of electricity will depend on demand/energy charges and whether onsite use, net metering, direct sale, or a combination of these is targeted.

Table 4 – Potential Range of Electric Generation and Sales Value

Unit Value of Electric Generated, $/kWh	Potential Annual Electric Generation		Potential Annual Electric Value	
	125 psig Outlet Pressure	40 psig Outlet Pressure	125 psig Outlet Pressure	40 psig Outlet Pressure
$0.080	609,814	1,117,993	$48,785	$89,439
$0.100	609,814	1,117,993	$60,981	$111,799
$0.125	609,814	1,117,993	$76,227	$139,749
$0.140	609,814	1,117,993	$85,374	$156,519
$0.160	609,814	1,117,993	$97,570	$178,879

Notes: The shaded value shows the value used for this analysis. Values of 12 kWh/1,000 lbs steam and 22 kWh/1,000 lbs steam are used for the 125 and 40 psig outlet pressures respectively.

5-Capital Costs and Financing

The proposed CNG option is estimated to cost $3,275,000 Million. The cost of biomass CHP facilities with full oil back-up as discussed in this analysis has been seen to range from $5,000,000 - $7,000,000 based on similar installations.

Table 5 shows the simple paybacks of the CNG and biomass CHP options compared to existing operations. It is important to note that the biomass CHP option has the opportunity to compete for grant funding options at the federal level, and may be financed at low rates through federal or other programs. Cash flow analyses were also performed for each option assuming financing terms of 4% over 20 years. Table 6shows that the biomass CHP option provides a positive cash flow starting in year one, while the CNG option provides a cash flow that is slightly negative.

Table 5– Simple Payback of CNG and Biomass CHP Options

Option	Option Cost	Annual Savings vs. Existing System (assuming $2.20/gal #6 oil)	Simple Payback
CNG	$3,275,000	$232,688	14.1
Biomass CHP Low End Cost	$5,000,000	$572,142	8.7
Biomass CHP High End Cost	$7,000,000	$572,142	12.2

Table 6– Summary of Cash Flow Analysis of CNG and Biomass CHP Options

Option	Amount Financed	1st Year Cash Flow	25-yr Present Value
CNG	$3,275,000	($8,293)	$2,457,670
Biomass CHP Low End Cost	$5,000,000	$204,234	$10,477,672
Biomass CHP High End Cost	$7,000,000	$57,070	$8,165,481

Notes: Attachment A presents the detailed cash flows that are summarized in the table.

6-Key Assumptions Used in Analysis

Table 7 presents the key assumptions used in the analysis for this memorandum. Key values that are regularly subject to change are the volatile fossil fuel costs, and thus consideration should be given to the values used here.

Table 7– List of Key Assumptions

Item	Value	Units	Source
Annual #6 Fuel Oil Use	510,000	gallons	BERC 2012 Report
HHV #6 Fuel Oil	0.155	mmBtu/gal	WERC Assumption
Annual #6 Fuel Oil Use	79,050	mmBtu/yr	Calculated
Assumed CNG Coverage for CNG Option	100%		WERC Assumption
Assumed Biomass Coverage for Biomass CHP Option	90%		WERC Assumption
#2 Fuel Oil Coverage with Biomass CHP Option	10%		WERC Assumption
Seasonal Efficiency of #6 Oil Boilers/125 psig steam	75%		WERC Assumption
Seasonal Efficiency of New Gas/Oil Boilers/125 psig steam	80%		WERC Assumption
Seasonal Efficiency of Wood Chip System/400 psig steam	65%		WERC Assumption
HHV of Wood Chips	10	mmBtu/ton	WERC Assumption
HHV of #2 Oil	0.14	mmBtu/gal	WERC Assumption
BPS Turbine/Generator kWh per 1,000 lbs steam (400 - 125 psig)	12	kWh/klbs	WERC Estimate
Energy needed to generate lb steam	1050	Btu/lb steam	WERC Estimate
Unit Cost of Natural Gas	12.0	$/mmBtu	WERC Assumption
Unit Cost of #6 Oil	2.20	$/gal	WERC Assumption
Unit Cost of #2 Oil	2.50	$/gal	WERC Assumption
Unit Cost of Wood Chips	50.00	$/ton	WERC Assumption
Value of Electricity Generated	0.125	$/kWh	VT CEDF

7-Conclusions

The SVMC has the opportunity to substantially reduce its operating costs with either a CNG system or a biomass CHP system. Initial analysis shows that a biomass CHP option has the potential to provide a faster payback than the CNG option currently being considered. Additionally, the biomass CHP option could provide a significantly positive cash flow starting in the first year of operations if project costs are financed at 4% over 20 years. This type of financing is available through USDA Rural Development Community Facilities Program and potentially other sources for biomass CHP projects. One other point to consider is that the biomass CHP option has the potential to receive federal grant funds to support its implementation.

The biomass CHP system also provides the following benefits:

- Keeps over $425,000 spent on thermal energy (wood chip fuel) in the local economy

- Provides a market for over 8,500 tons of locally sourced, renewable wood chip fuel, which reduces local land/forest management costs
- Reduces net GHG emissions by over 5,700 metric tonnes compared to the existing system, and over 4,400 metric tonnes compared to the CNG option

The biomass CHP option has been evaluated in this memorandum at the concept-level, and the following analysis would be recommended should this option be considered further:

- Detailed thermal and electrical load modeling to determine optimum system sizing and energy coverage values.
- Detailed analysis of steam demands to determine if it is possible to minimize distribution pressure for a major portion of the load in order to maximize electric generation.
- Detailed analysis of interconnection options to ensure the value of electric generation is maximized.
- Detailed estimate of capital costs based on site visit and plant layout developed in conjunction with SVMC staff.
- Detailed estimate of annual staff costs for existing boiler plant. It is likely that the increased O&M shown for the biomass system in this analysis is overstated (conservative) when compared to existing operations.
- Evaluation of state and local boiler operator attendance requirements.
- Investigation of potential grant and financing options to include state and federal options. Some known programs are:
    - USDA Rural Development Community Facilities Grant and Loan Program
    - USDA Forest Service Wood Innovations Grant
- Visit of modern biomass CHP operations by SVMC staff and decision makers to develop a detailed understanding of the project potential and annual operations effort required.

Attachment A
Cash Flow Analyses

Cash Flow Analysis
CNG / New Boiler Project

Input Variables	Value	Units
Project Cost	3,275,000	$
Owner Contingency	0	$
Grants Received	0	$
Project Costs Financed	3,275,000	$
Financing Term	20	# years
Financing Rate (apr)	4.0%	Percent
Current #6 Fuel Oil Usage	510,000	gal
Year 1 #6 Fuel Oil Average Price	2.20	$/gal
Year 1 CNG Average Price	$12.00	$/mmBtu
Annual CNG Usage w/ New System	74,109	mmBtu/yr
Fossil Fuel / Electric Inflation Rate (apr)	3.3%	Percent
Wood Chip Inflation Rate (apr)	2.7%	Percent
General Inflation Rate (apr)	2.7%	Percent
Added Annual O&M Costs	$ -	$/yr

Year	Fossil Fuel Cost, Current System	Fossil Fuel Cost w/ CNG System	Added O&M Cost	Net Operating Savings	Annual Financing Payment	Net Cash Flow	Present Value of Cash Flow	Cumulative Present Value
1	$ 1,122,000	$ (889,313)	$ -	$ 232,688	$ (240,980)	$ (8,293)	$ (8,293)	$ (8,293)
2	$ 1,159,026	$ (918,660)	$ -	$ 240,366	$ (240,980)	$ (614)	$ (598)	$ (8,891)
3	$ 1,197,274	$ (948,976)	$ -	$ 248,298	$ (240,980)	$ 7,318	$ 6,938	$ (1,952)
4	$ 1,236,784	$ (980,292)	$ -	$ 256,492	$ (240,980)	$ 15,512	$ 14,320	$ 12,368
5	$ 1,277,598	$ (1,012,641)	$ -	$ 264,956	$ (240,980)	$ 23,976	$ 21,552	$ 33,920
6	$ 1,319,758	$ (1,046,059)	$ -	$ 273,700	$ (240,980)	$ 32,720	$ 28,639	$ 62,559
7	$ 1,363,311	$ (1,080,579)	$ -	$ 282,732	$ (240,980)	$ 41,752	$ 35,584	$ 98,143
8	$ 1,408,300	$ (1,116,238)	$ -	$ 292,062	$ (240,980)	$ 51,082	$ 42,391	$ 140,534
9	$ 1,454,774	$ (1,153,073)	$ -	$ 301,700	$ (240,980)	$ 60,720	$ 49,065	$ 189,599
10	$ 1,502,781	$ (1,191,125)	$ -	$ 311,656	$ (240,980)	$ 70,676	$ 55,608	$ 245,207
11	$ 1,552,373	$ (1,230,432)	$ -	$ 321,941	$ (240,980)	$ 80,961	$ 62,025	$ 307,233
12	$ 1,603,601	$ (1,271,036)	$ -	$ 332,565	$ (240,980)	$ 91,585	$ 68,320	$ 375,553
13	$ 1,656,520	$ (1,312,980)	$ -	$ 343,540	$ (240,980)	$ 102,559	$ 74,496	$ 450,048
14	$ 1,711,185	$ (1,356,309)	$ -	$ 354,876	$ (240,980)	$ 113,896	$ 80,555	$ 530,603
15	$ 1,767,654	$ (1,401,067)	$ -	$ 366,587	$ (240,980)	$ 125,607	$ 86,502	$ 617,106
16	$ 1,825,987	$ (1,447,302)	$ -	$ 378,685	$ (240,980)	$ 137,705	$ 92,340	$ 709,446
17	$ 1,886,245	$ (1,495,063)	$ -	$ 391,181	$ (240,980)	$ 150,201	$ 98,072	$ 807,518
18	$ 1,948,491	$ (1,544,400)	$ -	$ 404,090	$ (240,980)	$ 163,110	$ 103,701	$ 911,220
19	$ 2,012,791	$ (1,595,365)	$ -	$ 417,425	$ (240,980)	$ 176,445	$ 109,230	$ 1,020,450
20	$ 2,079,213	$ (1,648,013)	$ -	$ 431,200	$ (240,980)	$ 190,220	$ 114,662	$ 1,135,111
21	$ 2,147,827	$ (1,702,397)	$ -	$ 445,430		$ 445,430	$ 261,439	$ 1,396,550
22	$ 2,218,705	$ (1,758,576)	$ -	$ 460,129		$ 460,129	$ 262,967	$ 1,659,517
23	$ 2,291,923	$ (1,816,609)	$ -	$ 475,313		$ 475,313	$ 264,503	$ 1,924,020
24	$ 2,367,556	$ (1,876,557)	$ -	$ 490,999		$ 490,999	$ 266,048	$ 2,190,068
25	$ 2,445,685	$ (1,938,484)	$ -	$ 507,202		$ 507,202	$ 267,602	$ 2,457,670
							$ 2,457,670	

Cash Flow Analysis
$7 M Biomass CHP Project

Input Variables	Value	Units
Project Cost	7,000,000	$
Owner Contingency	0	$
Grants Received	0	$
Project Costs Financed	7,000,000	$
Financing Term	20	# years
Financing Rate (apr)	4.0%	Percent
Current #6 Fuel Oil Usage	510,000	gal/yr
Year 1 #6 Fuel Oil Average Price	2.20	$/gal
Year 1 #2 Fuel Oil Average Price	2.50	$/gal
Wood Chip Usage	8,575	tons/yr
Year 1 Wood Chip Purchase Price	50	$/ton
Annual Fuel Oil Usage w/ Wood System	52,935	gal/yr
Year 1 Electric Generation Value	76,227	$
Fossil Fuel / Electric Inflation Rate (apr)	3.3%	Percent
Wood Chip Inflation Rate (apr)	2.7%	Percent
General Inflation Rate (apr)	2.7%	Percent
Added Annual O&M Costs for Biomass Plant	65,000	$/yr

Year	Fossil Fuel Cost, Current System	Value of Electric Generated	Wood Chip Cost	Fossil Fuel Cost, w/ Wood System	Added O&M Cost	Net Operating Savings	Annual Financing Payment	Net Cash Flow	Present Value of Cash Flow	Cumulative Present Value
1	$ 1,122,000	$ 76,227	$ (428,746)	$ (132,338)	$ (65,000)	$ 572,142	$ (515,072)	$ 57,070	$ 57,070	$ 57,070
2	$ 1,159,026	$ 78,742	$ (440,323)	$ (136,705)	$ (66,755)	$ 593,985	$ (515,072)	$ 78,913	$ 76,839	$ 133,909
3	$ 1,197,274	$ 81,341	$ (452,211)	$ (141,217)	$ (68,557)	$ 616,629	$ (515,072)	$ 101,557	$ 96,287	$ 230,196
4	$ 1,236,784	$ 84,025	$ (464,421)	$ (145,877)	$ (70,408)	$ 640,103	$ (515,072)	$ 125,031	$ 115,426	$ 345,622
5	$ 1,277,598	$ 86,798	$ (476,960)	$ (150,691)	$ (72,309)	$ 664,435	$ (515,072)	$ 149,363	$ 134,264	$ 479,887
6	$ 1,319,758	$ 89,662	$ (489,838)	$ (155,663)	$ (74,262)	$ 689,657	$ (515,072)	$ 174,585	$ 152,811	$ 632,698
7	$ 1,363,311	$ 92,621	$ (503,064)	$ (160,800)	$ (76,267)	$ 715,800	$ (515,072)	$ 200,728	$ 171,075	$ 803,772
8	$ 1,408,300	$ 95,678	$ (516,647)	$ (166,107)	$ (78,326)	$ 742,898	$ (515,072)	$ 227,826	$ 189,064	$ 992,837
9	$ 1,454,774	$ 98,835	$ (530,596)	$ (171,588)	$ (80,441)	$ 770,983	$ (515,072)	$ 255,911	$ 206,788	$ 1,199,625
10	$ 1,502,781	$ 102,096	$ (544,922)	$ (177,251)	$ (82,613)	$ 800,092	$ (515,072)	$ 285,020	$ 224,254	$ 1,423,879
11	$ 1,552,373	$ 105,466	$ (559,635)	$ (183,100)	$ (84,843)	$ 830,260	$ (515,072)	$ 315,188	$ 241,471	$ 1,665,350
12	$ 1,603,601	$ 108,946	$ (574,745)	$ (189,142)	$ (87,134)	$ 861,526	$ (515,072)	$ 346,453	$ 258,446	$ 1,923,796
13	$ 1,656,520	$ 112,541	$ (590,263)	$ (195,384)	$ (89,487)	$ 893,927	$ (515,072)	$ 378,855	$ 275,187	$ 2,198,983
14	$ 1,711,185	$ 116,255	$ (606,200)	$ (201,832)	$ (91,903)	$ 927,505	$ (515,072)	$ 412,433	$ 291,701	$ 2,490,684
15	$ 1,767,654	$ 120,091	$ (622,568)	$ (208,492)	$ (94,384)	$ 962,302	$ (515,072)	$ 447,229	$ 307,995	$ 2,798,679
16	$ 1,825,987	$ 124,054	$ (639,377)	$ (215,372)	$ (96,933)	$ 998,359	$ (515,072)	$ 483,287	$ 324,077	$ 3,122,757
17	$ 1,886,245	$ 128,148	$ (656,640)	$ (222,480)	$ (99,550)	$ 1,035,723	$ (515,072)	$ 520,651	$ 339,953	$ 3,462,710
18	$ 1,948,491	$ 132,377	$ (674,370)	$ (229,821)	$ (102,238)	$ 1,074,439	$ (515,072)	$ 559,367	$ 355,631	$ 3,818,341
19	$ 2,012,791	$ 136,746	$ (692,578)	$ (237,406)	$ (104,998)	$ 1,114,555	$ (515,072)	$ 599,483	$ 371,115	$ 4,189,456
20	$ 2,079,213	$ 141,258	$ (711,277)	$ (245,240)	$ (107,833)	$ 1,156,121	$ (515,072)	$ 641,049	$ 386,414	$ 4,575,870
21	$ 2,147,827	$ 145,920	$ (730,482)	$ (253,333)	$ (110,745)	$ 1,199,188		$ 1,199,188	$ 703,847	$ 5,279,717
22	$ 2,218,705	$ 150,735	$ (750,205)	$ (261,693)	$ (113,735)	$ 1,243,808		$ 1,243,808	$ 710,844	$ 5,990,561
23	$ 2,291,923	$ 155,709	$ (770,460)	$ (270,329)	$ (116,805)	$ 1,290,038		$ 1,290,038	$ 717,881	$ 6,708,442
24	$ 2,367,556	$ 160,848	$ (791,263)	$ (279,250)	$ (119,959)	$ 1,337,932		$ 1,337,932	$ 724,960	$ 7,433,402
25	$ 2,445,685	$ 166,156	$ (812,627)	$ (288,465)	$ (123,198)	$ 1,387,551		$ 1,387,551	$ 732,080	$ 8,165,481
									$ 8,165,481	

Cash Flow Analysis
$5 M Biomass CHP Project

Input Variables	Value	Units
Project Cost	5,000,000	$
Owner Contingency	0	$
Grants Received	0	$
Project Costs Financed	5,000,000	$
Financing Term	20	# years
Financing Rate (apr)	4.0%	Percent
Current #6 Fuel Oil Usage	510,000	gal/yr
Year 1 #6 Fuel Oil Average Price	2.20	$/gal
Year 1 #2 Fuel Oil Average Price	2.50	$/gal
Wood Chip Usage	8,575	tons/yr
Year 1 Wood Chip Purchase Price	50	$/ton
Annual Fuel Oil Usage w/ Wood System	52,935	gal/yr
Year 1 Electric Generation Value	76,227	$
Fossil Fuel / Electric Inflation Rate (apr)	3.3%	Percent
Wood Chip Inflation Rate (apr)	2.7%	Percent
General Inflation Rate (apr)	2.7%	Percent
Added Annual O&M Costs for Biomass Plant	65,000	$/yr

Year	Fossil Fuel Cost, Current System	Value of Electric Generated	Wood Chip Cost	Fossil Fuel Cost, w/ Wood System	Added O&M Cost	Net Operating Savings	Annual Financing Payment	Net Cash Flow	Present Value of Cash Flow	Cumulative Present Value
1	$ 1,122,000	$ 76,227	$ (428,746)	$ (132,338)	$ (65,000)	$ 572,142	$ (367,909)	$ 204,234	$ 204,234	$ 204,234
2	$ 1,159,026	$ 78,742	$ (440,323)	$ (136,705)	$ (66,755)	$ 593,985	$ (367,909)	$ 226,077	$ 220,133	$ 424,367
3	$ 1,197,274	$ 81,341	$ (452,211)	$ (141,217)	$ (68,557)	$ 616,629	$ (367,909)	$ 248,721	$ 235,815	$ 660,181
4	$ 1,236,784	$ 84,025	$ (464,421)	$ (145,877)	$ (70,408)	$ 640,103	$ (367,909)	$ 272,194	$ 251,285	$ 911,467
5	$ 1,277,598	$ 86,798	$ (476,960)	$ (150,691)	$ (72,309)	$ 664,435	$ (367,909)	$ 296,526	$ 266,552	$ 1,178,019
6	$ 1,319,758	$ 89,662	$ (489,838)	$ (155,663)	$ (74,262)	$ 689,657	$ (367,909)	$ 321,748	$ 281,620	$ 1,459,639
7	$ 1,363,311	$ 92,621	$ (503,064)	$ (160,800)	$ (76,267)	$ 715,800	$ (367,909)	$ 347,892	$ 296,498	$ 1,756,137
8	$ 1,408,300	$ 95,678	$ (516,647)	$ (166,107)	$ (78,326)	$ 742,898	$ (367,909)	$ 374,989	$ 311,190	$ 2,067,327
9	$ 1,454,774	$ 98,835	$ (530,596)	$ (171,588)	$ (80,441)	$ 770,983	$ (367,909)	$ 403,075	$ 325,703	$ 2,393,030
10	$ 1,502,781	$ 102,096	$ (544,922)	$ (177,251)	$ (82,613)	$ 800,092	$ (367,909)	$ 432,183	$ 340,043	$ 2,733,073
11	$ 1,552,373	$ 105,466	$ (559,635)	$ (183,100)	$ (84,843)	$ 830,260	$ (367,909)	$ 462,351	$ 354,216	$ 3,087,289
12	$ 1,603,601	$ 108,946	$ (574,745)	$ (189,142)	$ (87,134)	$ 861,526	$ (367,909)	$ 493,617	$ 368,227	$ 3,455,515
13	$ 1,656,520	$ 112,541	$ (590,263)	$ (195,384)	$ (89,487)	$ 893,927	$ (367,909)	$ 526,019	$ 382,081	$ 3,837,596
14	$ 1,711,185	$ 116,255	$ (606,200)	$ (201,832)	$ (91,903)	$ 927,505	$ (367,909)	$ 559,597	$ 395,785	$ 4,233,381
15	$ 1,767,654	$ 120,091	$ (622,568)	$ (208,492)	$ (94,384)	$ 962,302	$ (367,909)	$ 594,393	$ 409,343	$ 4,642,724
16	$ 1,825,987	$ 124,054	$ (639,377)	$ (215,372)	$ (96,933)	$ 998,359	$ (367,909)	$ 630,451	$ 422,761	$ 5,065,485
17	$ 1,886,245	$ 128,148	$ (656,640)	$ (222,480)	$ (99,550)	$ 1,035,723	$ (367,909)	$ 667,814	$ 436,042	$ 5,501,527
18	$ 1,948,491	$ 132,377	$ (674,370)	$ (229,821)	$ (102,238)	$ 1,074,439	$ (367,909)	$ 706,530	$ 449,193	$ 5,950,721
19	$ 2,012,791	$ 136,746	$ (692,578)	$ (237,406)	$ (104,998)	$ 1,114,555	$ (367,909)	$ 746,646	$ 462,218	$ 6,412,939
20	$ 2,079,213	$ 141,258	$ (711,277)	$ (245,240)	$ (107,833)	$ 1,156,121	$ (367,909)	$ 788,212	$ 475,122	$ 6,888,060
21	$ 2,147,827	$ 145,920	$ (730,482)	$ (253,333)	$ (110,745)	$ 1,199,188		$ 1,199,188	$ 703,847	$ 7,591,907
22	$ 2,218,705	$ 150,735	$ (750,205)	$ (261,693)	$ (113,735)	$ 1,243,808		$ 1,243,808	$ 710,844	$ 8,302,751
23	$ 2,291,923	$ 155,709	$ (770,460)	$ (270,329)	$ (116,805)	$ 1,290,038		$ 1,290,038	$ 717,881	$ 9,020,632
24	$ 2,367,556	$ 160,848	$ (791,263)	$ (279,250)	$ (119,959)	$ 1,337,932		$ 1,337,932	$ 724,960	$ 9,745,592
25	$ 2,445,685	$ 166,156	$ (812,627)	$ (288,465)	$ (123,198)	$ 1,387,551		$ 1,387,551	$ 732,080	$ 10,477,672
									$ 10,477,672	

Wood Education and Resource Center
310 Hardwood Lane
Princeton, WV 24720
(304) 487-1510

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

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

Lew R. McCreery, Woody Biomass Coordinator
lmccreery@fs.fed.us
304-285-1538

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

Appendix B

Medical/health Care Facilities Using Wood Energy Systems			
#	**Health Care Facility**	**Town**	**State**
1	Trigg County Hospital	Cadiz	Kentucky
2	Millinocket Regional Hospital	Millinocket	Maine
3	Northern Maine Medical Center	Fort Kent	Maine
4	Veterans Administration Hospital	Togus	Maine
5	Cooley Dickinson Hospital	Northampton	Massachusetts
6	Pine Crest Medical Care Facility	Powers	Michigan
7	Battle Creek VA Medical Center	Battle Creek	Michigan
8	St. Gabrielle's Hospital	Little Falls	Minnesota
9	Clark Fork Valley Hospital	Plains	Montana
10	Mineral Community Hospital	Superior	Montana
11	Glencliff Home	Benton	New Hampshire
12	Grafton County Complex	North Haverhill	New Hampshire
13	Rockingham County Complex	Brentwood	New Hampshire
14	Sullivan County Healthcare Complex	Unity	New Hampshire
15	Crotched Mountain Rehabilitation Center	Greenfield	New Hampshire
16	Littleton Regional Hospital	Littleton,	New Hampshire
17	Androscoggin Valley Hospital	Berlin,	New Hampshire
18	Weeks Hospital	Lancaster,	New Hampshire
19	Fort Baird Medical Center	El Centro	New Mexico
20	Virginia Medical Center	Canandaigua	New York
21	Arnot Ogden Medical Center	Elmira	New York
22	Chillicothe VA Medical Center	Chillicothe	Ohio
23	Harney County Hospital	Burns	Oregon
24	Blue Mountain Hospital	John Day	Oregon
25	Watten State Hospital	Warren	Pennsylvania
26	Elk Regional Health Center	St. Marys	Pennsylvania
27	Evangelical Community Hospital	Lewisburg	Pennsylvania
28	Bradford Medical Center	Bradford	Pennsylvania
29	Eleanor Slater Hospital - Zambarano Unit	Pascoag	Rhode Island
30	North Country Hospital	Newport	Vermont
31	Veteran Administration Hospital	White River Jct.	Vermont
32	VT State Mental Hospital	Berlin	Vermont
33	Piedmont Geriatric Hospital	Burkeville	Virginia
34	Ashland Medical Center	Ashland	Wisconsin
35	Gunderson Lutheran Hospital	Lacrosse	Wisconsin
36	Sunrise Medical Long-term Care	Stephen's Point	Wisconsin
37	King's County Memorial Hospital	Montague	PEI, Canada