Alternative Energy Committee Report

Cape Elizabeth Lighthouse, photo by Jack Kennealy

Report prepared by:
Cape Elizabeth Alternative Energy Committee

December 31, 2008

Prepared for:
Cape Elizabeth Town Council, School Board, Town Manager, and
Town of Cape Elizabeth

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Executive Summary

In order to address rising energy costs as well as concerns for global climate change the Cape Elizabeth Town Council has created an ad hoc Alternative Energy Committee. The Council asked the committee to explore opportunities to provide alternative energy to municipal and school buildings and to provide a report to the Town Council and School Board providing specific proposals and cost estimates. The objectives of the Committee's recommendations include:

- Provide cost savings to the town
- Reduce greenhouse gas emissions and preserve the environment
- Encourage community awareness and support

Cape Elizabeth Demographics (from U.S. Census 2000)

Total Population
9,068

Average family size
3.01

Bachelor's degree or more
3,706

Median Household Income
$72,359

The study begins by conducting a cost-benefit analysis of nine alternative energy technologies. The study also estimates the reduction in greenhouse gas emissions for the alternatives. The alternative energy systems that were evaluated include: energy conservation measures, solar photovoltaic, 50 kW wind turbine, 660 kW wind turbine, solar thermal, woodchip industrial combustion, geothermal heat pump, natural gas conversions, and cogeneration. For each alternative, four sensitivity cases were performed for low borrowing cost, high borrowing cost, low energy inflation, and high energy inflation.

The cost-benefit analyses and sensitivity tests for each of the alternative energy technologies yield the following conclusions:

1. Energy Conservation Measures should be implemented first and will provide the best return on investment.
2. The woodchip industrial combustion system is economically feasible and provides the greatest reduction in CO2 emissions.
3. Conversion to natural gas appears economically feasible, however a major unknown is how much of the cost for the gas line extension would be passed on to the Town by the gas company.

4. The economic feasibility of the wind turbine system is contingent on the availability of interest-free capital[1] . A wind turbine installation with a tower that exceeds the current 100 ft ordinance will yield better economics than a 100 ft tower, due to greater wind speeds at higher elevations.
5. The geothermal heat pump system appears economically feasible assuming interest-free capital is available; however a more accurate and detailed study is required of the retrofit costs before any final conclusion can be made.
6. Solar PV and solar thermal systems are not economically feasible without additional incentives.
7. Cogeneration using natural gas microturbines is not economically feasible based on the natural gas pricing assumed in the study.

Based on these findings the committee is making the following recommendations as a path forward:

1. Third Party Consultant/Energy Audit - Hire a third party consultant to perform an investment grade energy audit, recommend energy conservation measures and validate assumptions and recommendations from this report. This work is underway. In December 2008, the Town Manager authorized CM3 to prepare an energy audit for the Town's school and municipal buildings. The audit will result in a list of energy conservation measures along with the cost/benefit for each measure. This will allow the Town to pick and choose which measures to proceed with based on return on investment. In addition the consultant will validate the technical and economic feasibility of the alternative technology analysis performed by the committee including:
    - Energy Conservation Measures
    - Solar Photovoltaic (PV)
    - Wind Turbine
    - Solar Thermal
    - Woodchip Industrial Combustion
    - Geothermal Heat Pump

[1] A potential source of this capital is the federal government's Clean Renewable Energy Bonds, zero-interest bonds provided to local governments for alternative energy projects. For details see Appendix 1 – Funding Sources for Alternative Energy Technologies.

- Natural Gas Conversion
- Cogeneration

This process will take several months to complete. Once the audit and analysis is completed, the committee will work with the Facilities Manager on the best path to proceed forward.

2. Wind Turbine Site Survey - Conduct a wind turbine site survey to measure the actual wind speed and consistency at potential sites in Cape Elizabeth as well as a detailed assessment of the costs and benefits of installing a wind turbine. An anemometer should be installed on a 30m to 40m tower at one or more potential wind turbine installation sites and operated for three months to a year to record actual average wind speed, direction and consistency. The resulting measurements can be compared with historical measurements recorded at Portland International Jetport to provide a long-term estimate of anticipated average wind speeds and consistency. Commercial vendors can install a tower and anemometer and record wind speeds for a cost of approximately $15,000. Discounted costs could potentially be obtained by installing an anemometer on an existing cell tower or using used equipment.

3. Community Awareness – Build community awareness and support for installing conservation and alternative energy and technology at school and municipal buildings to provide long-term cost or energy savings. Community awareness will need to be developed to provide members of the community with more detailed information on the costs and benefits of pursuing conservation measures or alternative energy systems. The objective will be to provide additional facts and information. Potential ways of sharing this information include:
    - News articles and op-eds placed in *The Courier*
    - Website with a discussion board, blogs, newsfeeds and other access to helpful and interesting information on alternative energy
    - Talks, forums, symposiums and other public events promoting alternative energy
    - Develop and implement “Cool Bus” school bus programs to encourage students to take the bus instead of driving or being driven to school

4. Actively Pursue Funding for Alternative Energy Projects – A major campaign issue for the incoming Presidential administration in Washington has been to step-up investment in renewable and clean energy technology and infrastructure. Assuming that this is the case, after the new administration is in place, there should be new opportunities for alternative energy funding including loans, rebates, grants and other incentives that will improve the economics for alternative energy projects within the Town. From that standpoint there has probably never been a better time to finalizing plans for developing new alternative energy infrastructure. In addition existing programs need to be explored including Clean Renewable Energy Bonds, (CREBS), Renewable Energy Credits (RECS), and Efficiency Maine, to identify and apply for these sources of funding in order to optimize the project economics.

5. Full Cost Appraisal. Based on results of third party consultants work (recommendation #1), conduct a full cost appraisal for the recommended technology options. The committee will support the Facilities Manager, working with the engineers and architects to conduct an extensive assessment of the actual costs of installing the selected technology options. This will provide the Town with accurate and detailed figures it will need to make an informed decision when the time comes and there is money to finance a large-scale alternative energy project.

6. U.S. Mayors Climate Protection Agreement. We recommend that the Town adopts a stated objective relative to greenhouse gas emissions such as the U.S. Mayors Climate Protection Agreement. Since this agreement was introduced in 2005 over 400 towns (representing more than 59 million Americans) have signed this agreement, including several towns in Maine – Portland, Saco, Kennebunk, Belfast and Biddeford.[2] The agreement states, "We will strive to meet or exceed Kyoto Protocol targets for reducing global warming pollution by taking actions in our own operations and communities…" It also recognizes that the Kyoto Protocol reduction target for the United States (had the

[2] Bartlett, Rob. 'Kennebunk Selectman sign Mayors' Climate Protection Agreement.' SEA Change Happen. February 28, 2007. http://seachangehappen.blogspot.com/2007/02/kennebunk-selectmen-sign-mayors-climate.html. (March 16, 2008).

government signed) would have been CO_2 emissions levels of seven percent below 1990 level by 2012.[3]

7. Participate with GPCOG in completing the ICLEI – Local Governments for Sustainability – Regional Assessment . Clean Air and Climate Protection (CACP) is a software product that helps local governments create greenhouse gas inventories, quantify the benefits of reduction measures and formulate local climate action plans. The software enables local governments to develop harmonized strategies to reduce both greenhouse gas and air pollution emissions, and save energy.

[3] U.S. Mayors Climate Protection Center. http://www.usmayors.org/climateprotection/agreement.htm. (April 1, 2008).

Introduction

The Charter

The Town Council of Cape Elizabeth, Maine has created an Alternative Energy Committee to explore opportunities to provide alternative energy to municipal and school buildings and vehicles. The specific charter given to the committee by the Town Council is as follows:

"The committee shall explore opportunities to provide alternative energy to municipal and school buildings and vehicles. The committee shall make recommendations in the form of a report to the Town Council and School Board providing specific proposals and cost estimates. Any recommendations with cost impacts shall include the cost to implement as well as projected costs savings. The committee will provide a report with recommendations by December 2008."

Committee members included: Wyman Briggs, Peter Cotter, Ted Hawkes, Peter Ingraham, Jack Kennealy, Bridgitte Kingsbury, Sarah Lennon (Cape Elizabeth Councilor), Alan Lishness, Ernie MacVane (Cape Elizabeth Facilities Manager), Bill Slack (Chair), and David Whitten

In addition to the committee, there were interested citizens who provided input including Rick Fontana. Cape Elizabeth Town Manager Mike McGovern attended several meetings as well.

This report is a presentation of the committee's recommendations and findings and is based on the following objectives:

- Provide cost savings to municipal and school budgets as a result of the town's use of alternative energy
- Reduce reliance on fossil fuels within Cape Elizabeth as a result of the town's use of alternative energy.
- Provide a reduction in greenhouse gas emissions within Cape Elizabeth from 2008 levels as a result of the town's use of alternative energy.
- Serve as model for other communities with the town's alternative energy program
- Tie into the school educational program with the town's alternative energy program
- Obtain community-wide buy in for the alternative energy program
- Coordinate existing and proposed energy conservation measures with the town's alternative energy program
- Incorporate lessons learned from other communities into the town's alternative energy program

Methodology

The committee commissioned Chris Ramezanpour, master's candidate at the Kennedy School of Government at Harvard University to provide a preliminary assessment of alternative energy strategies for Cape Elizabeth schools. The study resulted in a report (Ramezanpour Report) entitled "An Alternative Energy Strategy for the Public Schools of Cape Elizabeth" dated April 1, 2008. The Ramezanpour Report was prepared as part of Mr. Ramezanpour's degree work but serves as a solid foundation for the committee's report to the town council by:

- Providing a methodology to analyze an alternative energy strategy for the town.
- Presenting a technical discussion of various alternative energy options.
- Providing cost-benefit analysis and sensitivity analysis using net present value basis for five alternative energy technologies including solar photovoltaic system, solar thermal system, wind turbine, woodchip industrial combustion, and geothermal heat pump.
- Providing findings relative to technical and economic feasibility of various alternative energy options.
- Providing recommendations to the committee to develop an alternative energy strategy to the town.

The committee recognizes Mr. Ramezanpour for his outstanding work in providing a solid foundation for the committee report. The committee report leverages the work from the Ramezanpour Report by refining the recommendations and providing additional analysis.

An investment grade energy audit and implementation of energy conservation measures should be included as part of any strategy. At the time of the report, the committee helped the Town Manager in the selection of a firm to provide an investment grade audit for the municipal and school buildings. The purpose of the audit is to identify energy conservation measures (ECM's) that can be implemented in school and municipal buildings to improve energy efficiency, reduce environmental impacts and lower costs. Although the audit and resultant ECM's are yet to be determined, we have assumed for purposes of this report that there will be a 10% reduction in energy use after implementation. Therefore the amount of savings that will be achieved from an alternative energy project will assume a baseline after ECM's rather than the current baseline.

This study has selected the following renewable energy technologies for examination. Each was chosen for its ability to provide clean, renewable energy, as well as its availability, feasibility and potential long-term cost savings. These technologies are:

- Energy Conservation Measures
- Solar Photovoltaic (PV)
- Wind Turbine
- Solar Thermal
- Woodchip Industrial Combustion
- Geothermal Heat Pump
- Natural Gas Conversion
- Cogeneration

This study considers the technical and economic value of each technology as determined from cost-benefit analysis and sensitivity tests. The study also evaluates each technology's impact on greenhouse gas emissions.

These models are based on the following estimates:

- Cost of installation
- Amount of energy produced
- Electricity or heating oil offset and associated CO_2 emissions reduction
- Long-term inflation rates for: electricity, heating oil, woodchips, and consumer goods (for general inflation)
- Borrowing rate (for the cost of capital)
- Operating and maintenance cost
- Other costs to run the system
- Lifetime of equipment before replacement

Installation of any of these technologies on the scale necessary to have meaningful impact to the town will require a substantial capital investment from the town. At the time of this study there are concerns of recession, loss of funding support from the state, and cutbacks in many departments. In such a challenging environment the case for a large investment in an alternative energy project needs to be carefully measured. A final objective of the study is to identify options that are at least budget neutral. That is to say that the net energy savings from a proposed project will at a minimum cover the debt service and operating costs necessary to cover the initial investment.

This study focuses on the economic feasibility of each technology by conducting cost-benefit analysis and sensitivity tests along four different scenarios of high and low energy inflation rates, and high and low borrowing rates. The analysis is done for each system as a mutually exclusive option, however we recognize that the "right answer" will probably include deployment of several alternatives. Each of the technologies is assessed according to the results of its net present value.

The net present value (NPV) is the value today of a future stream of cash flows, discounted according to a rate that reflects the risk of the project. This study uses a discount rate of 10 percent.[4] From a strictly economic perspective, the goal of a capital investment is to maximize NPV. Therefore, projects with a negative NPV should be rejected - their discounted stream of future cash flow (cash inflow less cash outflow) is less than the cost of the original investment. Projects with a positive NPV can be approved - their discounted stream of future cash flow (cash inflow less cash outflow) is greater than the cost of the original investment.[5] In cases where more than one project returns a positive NPV, the study compares these projects according to the standardized ratio of NPV per the dollar of initial expenditure - also known as the Profitability Index.[6]

The sensitivity test will examine the NPV of each energy system under four different scenarios:[7, 8]

- <u>Least Favorable Scenario</u> (Energy Inflation Low, Borrowing Cost High)
- <u>Neutral Scenario One</u> (Energy Inflation Low, Borrowing Cost Low)

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[4] A 10 percent discount rate is the same rate used by van Vuuren, D.P.; den Elzen, M.G.J.; Lucas, P.L.; Elckhout, B.: et al. "Stabilizing greenhouse gas concentrations at low levels: an assessment of reduction strategies and costs". <u>Climatic Change</u>. 81:2 (March 2007). pg. 192.

[5] Brealey, Richard and Meyer, Stewart. <u>Principles of Corporate Finance</u>. 6th Edition. Irwin McGraw-Hill. Boston, MA. 2000. pg. 19.

[6] Brealey and Meyers. pg. 109

[7] A 0% borrowing rate is based on Cape Elizabeth's eligibility for interest-free Clean Renewable Energy Bonds from the federal government. For details see Appendix 1 – Funding Sources for Alternative Energy Technologies.

[8] The projected long-term energy inflation rate for both electricity and heating oil, according to the Energy Information Administration, was the same, 1.9575%. Energy Information Administration. Forecasts and Analysis. http://www.eia.doe.gov/oiaf/forecasting.html. Based on figures projected from 2005-2030. (March 22, 2008).

- Neutral Scenario Two (Energy Inflation High, Borrowing Cost High)
- Most Favorable Scenario (Energy Inflation High, Borrowing Cost Low)

		Energy Inflation (1.9575%, 5%)	
		Low	High
Borrowing Cost (0%,5%)	Low	Neutral	Most Favorable
	High	Least Favorable	Neutral

Payback period is not considered in the feasibility study. While easy to understand, the simplicity of this metric can be misleading because it does not discount the future cash flows. In some case there may be a payback period, but no positive NPV; in other cases the reverse may be true.[9] Based on interviews with town officials, no firm payback number was indicated, although the range was between ten and twenty years. Practically everyone emphasized the importance of economics in the review process.

Beyond the economics, our final recommendations will also consider the ability to implement an alternative energy project based on the challenges presented by a lack of funding, zoning issues, and public resistance.

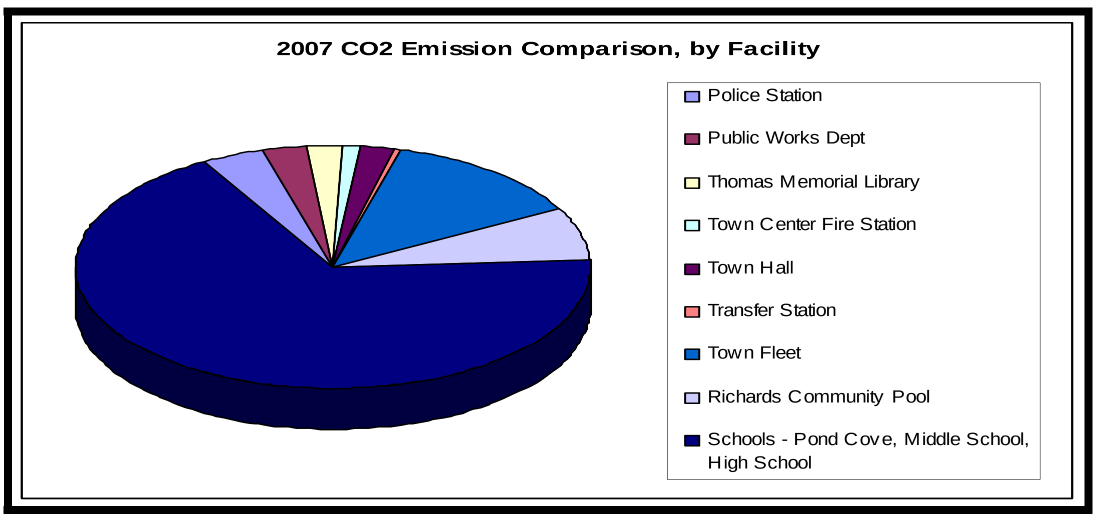
The town council charter to the committee did not specifically address reducing greenhouse gas emission and at the present time, the town does not have a stated objective on greenhouse gas emissions reductions. However, a fundamental premise in developing an alternative energy strategy is to reduce reliance on fossil fuels for economic, political and environmental reasons. One of this committee's recommendations to the council will be that the Town adopts a stated objective relative to greenhouse gas emissions such as the U.S. Mayors Climate Protection Agreement. Since this agreement was introduced in 2005 over 400 towns (representing more than 59 million Americans) have signed this agreement, including several towns in Maine – Portland,

[9] Ross, Stephen; Westerfield, Randolp; and Jaffe, Jeffrey. Corporate Finance. 6th Edition. Irwin/McGraw-Hill. Boston, MA 2002. pg. 142

Saco, Kennebunk, Belfast and Biddeford.[10] The agreement states, "We will strive to meet or exceed Kyoto Protocol targets for reducing global warming pollution by taking actions in our own operations and communities…" It also recognizes that the Kyoto Protocol reduction target for the United States (had the government signed it) would have been CO_2 emissions levels of seven percent below 1990 level by 2012.[11]

As such this report presents the various alternative energy options in terms of CO2 emission reductions as well as their technical and economic feasibility. Because the Cape Elizabeth data only goes back to 1996-97, the percent reduction target will use 1996 instead of 1990 as the base level for calculating emissions targets.

The schools are the largest energy consumer of all the town's facilities, and as such they are by far the largest contributor to CO_2 emissions.[12] Therefore, the Alternative Energy Committee has selected the schools as the priority site to demonstrate the selected alternative energy technology (or technologies). These schools are Pond Cove Elementary (K-4), Cape Elizabeth Middle School (5-8), and Cape Elizabeth High School (9-12).[13]



[10] Bartlett, Rob. 'Kennebunk Selectman sign Mayors' Climate Protection Agreement.' SEA Change Happen. February 28, 2007. http://seachangehappen.blogspot.com/2007/02/kennebunk-selectmen-sign-mayors-climate.html. (March 16, 2008).

[11] U.S. Mayors Climate Protection Center. http://www.usmayors.org/climateprotection/agreement.htm. (April 1, 2008).

[12] Facilities' CO_2 emissions come from electricity, heating oil, propane, diesel fuel and unleaded fuel.

[13] There are 598 students in the elementary school; 573 in the middle school; and 669 in the high school. Institute of Education Sciences. http://nces.ed.gov/globallocator/index.asp?search=1&State=ME&city=Cape%20Elizabeth&zipcode=&miles=&itemname=&School=1&CS=ABC1DE47. (April 1, 2008).

There are two main sources of energy consumption for the schools – electricity and heating oil. Electricity provides power for the schools and oil is used to heat the water and buildings.[14]

Consumption and CO2 Emissions of Schools				
	Elementary & Middle School		High School	
	Electricity	Heating Oil	Electricity	Heating Oil
1996-97	1,038,961 kWh	60,358 gallons	961,039 kWh	86,051 gallons
CO2 Emissions (metric tons)	642	613	594	874
TOTAL CO2 Emissions (metric tons)	1,255		1,468	
2006-07	1,150,760 kWh	65,252 gallons	1,062,240 kWh	81,974 gallons
CO2 Emissions (metric tons)	711	662	657	832
TOTAL CO2 Emissions (metric tons)	1,373		1,489	

To meet the US Mayors Climate Protection Agreement the target emissions reduction figure is calculated by first determining the level that is 7 percent below the baseline amount, and then taking the difference between that figure and the present (2006-07) figure.[15] Therefore, the seven percent CO_2 emissions reduction target requires:

- Reduction of 206 metric tons of CO_2 emissions for the elementary/middle school
- Reduction of 124 metric tons of CO_2 emissions for the high school

Assumptions

Concurrent with the development of this report, the committee is working with the town's consultant to complete an investment grade energy audit for the town school and municipal buildings. The purpose of the audit is to identify energy conservation measures to reduce the amount of energy consumed in the school and municipal buildings. For purposes of this report we have assumed that a 10% reduction in energy consumption can be realized by implementing the conservation measures that will be identified. Therefore prior to evaluating the remaining alternative energy

[14] For details see Appendix 3 – 2007 Municipal Facilities Energy and Emission Data.
[15] All energy consumption figures have been provided for this study by the Cape Elizabeth Facilities Manager, Ernie MacVane (February 13, 2008).

options we have assumed the baseline energy consumption will be reduced by 10% savings realized from energy conservation measures.

The assumptions used to develop the "Baseline" for purposes of our analysis are included as Appendix 1.

Background on Greenhouse Gas Emissions

A goal of any fossil fuel reduction strategy is to reduce greenhouse gas emissions in the earth's atmosphere. The excess levels of these gases, particularly carbon dioxide (CO_2), are largely responsible for the greenhouse effect that creates the condition of global warming.

According to the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report, the changes in the earth's climate system will include global temperature increases over the course of this century ranging from 1.4 to 5.8 degrees Celsius.[16]

At the higher end of this range we can expect more extreme weather events, including heat waves and droughts, as well as greater risk of coastal flooding, and greater threat to local ecosystems. While some of these events are unavoidable, practical steps must be taken in order to reduce the risk and intensity of these outcomes. Assuming that a temperature increase at the lower end is associated with fewer harmful environmental consequences, a proper strategy begins by assigning a target temperature increase and associated level of CO_2 emissions.

Current concentrations of CO_2 in the atmosphere are at 380 parts per million (ppm).[17] The IPCC Report indicates that to keep the increase in global temperature of 2 degrees Celsius CO_2 concentrations need to stabilize at 450 ppm (CO_2 and CO_2 equivalents).[18]

[16] van Vuuren, D.P.; den Elzen, M.G.J.; Lucas, P.L.; Elckhout, B.: et al. "Stabilizing greenhouse gas concentrations at low levels: an assessment of reduction strategies and costs". Climatic Change. 81:2 (March 2007). pg. 181.

[17] Frumhoff, Peter; McCarthy, James; et al. Confronting Climate Change in the U.S. Northeast. Union of Concerned Scientists. Cambridge, MA. 2007. pg. 106.

[18] van Vuuren, D.P.; den Elzen, M.G.J.; Lucas, P.L.; Elckhout, B.: et al. pg. 182.

Stabilization of CO_2 concentrations at 450 ppm will require serious emission reduction measures. According to the same IPCC Report "such a target would require the United States and other industrialized nations to reduce emissions by approximately 80 percent below 2000 levels by the middle of the century".[19] Achieving this target would require annual emission reductions of roughly two percent per year for the next four decades.

[19] Frumhoff, Peter; McCarthy, James; et al. pg. 106.

Chapter 1
Cost-Saving, Renewable Alternatives to Current Electricity Source

Electricity Usage in Cape Elizabeth Schools

There are three public schools in Cape Elizabeth, Maine – Pond Cove Elementary School, Cape Elizabeth Middle School and Cape Elizabeth High School. Electricity consumption for the schools was:

- 2,000,000 kWh in 1996-97
  - 1,038,539 kWh for the elementary/middle school
  - 961,461 kWh for the high school
- 2,213,000 kWh in 2006-07
  - 1,149,143 kWh for the combined elementary/middle school
  - 1,063,857 kWh for the high school [20, 21, 22]

Since the electricity usage is combined for all three schools and there is no data that separates it, this study distributed the total usage proportionally based on the square footage of each of the two facilities (elementary/middle school –168,000 ft^2; high school – 181,468 ft^2).[23] While this method may not yield the perfect breakdown of electricity usage, it at least provides a reasonable basis to establish a baseline for each facility and then determine a strategy to achieve it.

School electricity is primarily used for lighting, vending machines, computers, photocopiers, air conditioners, kitchen equipment (except for the stove), the heating circulator and the burner motor for the boiler.[24]

[20] All energy consumption figures have been provided for this study by the Cape Elizabeth Facilities Manager, Ernie MacVane (February 13, 2008).

[21] It is worth noting the slight difference between the town facilities comparative results for energy usage for each year from 2004 - 2007. The schools have also constructed a table of usage figures that goes as far back as 1996-97. Since these figures are recorded by school year (from July of one year to June of the next) they can appear slightly different from the comparative figures.

[22] Central Maine Power is the electricity provider for the schools.

[23] Square footage figures provided by the Cape Elizabeth Facilities Manager, Ernie MacVane (February 13, 2008).

[24] Information provided by Cape Elizabeth Facilities Manager, Ernie MacVane (February 13, 2008).

Based on the current electricity rate of $0.145/kWh the total cost for electricity usage was (in 2008 dollars):[25]

- $290,000 in 96-97
- $320,885 in 06-07

According to the Environmental Protection Agency, sources for the electricity provided to the schools are a mix of: non-hydro renewable energies (solar, geothermal, biomass, landfill gas, and wind), hydroelectricity, nuclear, oil, gas and coal.[26] The greenhouse gas emissions level for this electricity depends on the mix of the energies used. This study uses the EPA's national average emissions estimate for carbon dioxide of 1.363 pounds CO_2 per kWh.[27]

At this level the CO_2 emissions from the schools' electricity consumption are:

- 1,236 metric tons CO_2 in the 1996-97
    - 642 metric tons CO_2 from the elementary/middle school
    - 594 metric tons of CO_2 from the high school
- 1,365 metric tons CO_2 in 2006-07
    - 709 metric tons of CO_2 emissions from the elementary/middle school
    - 656 metric tons of CO_2 emissions from the high school

Alternative Energy Options to Reduce Electricity Use

There are both supply side and demand side alternatives to reduce electricity use in municipal and school buildings. Demand side alternatives refer to how the energy is used by the town and are generally considered Energy Conservation Measures or ECM's. As discussed earlier, we consider energy conservation as part of our overall alternative energy strategy.

Central Maine Power currently provides all of the Town's electricity.

[25] Electricity Rate provided by Cape Elizabeth Facilities Manager, Ernie MacVane. Figures in 2008 dollars (February 13, 2008).
[26] U.S. Environmental Protection Agency. Clean Energy. http://oaspub.epa.gov/powpro/ept_pack.charts. (March 16, 2008).
[27] U.S. Environmental Protection Agency. Clean Energy. http://oaspub.epa.gov/powpro/ept_pack.charts. (March 16, 2008).

Alternative electric supply technologies include self generating all or a portion of the school electrical energy using alternative technologies such as solar photovoltaic (PV), wind turbines, cogeneration, tidal power, wave power and micro hydro technology. Of these, Solar PV, wind turbines and cogeneration are all commercial technology options for power supply. The other technologies are not commercially viable and/or the school campus is not a suitable location.

Micro-hydro technology requires access to a source of running water, like a river; this is not present at the school.[28] While the campuses are not far from the ocean, tidal sites require permits from the Federal Energy Regulatory Commission, and this technology is still in the early generation of its development.[29] Wave power is another technology based on ocean access, but again this technology is early generation and not yet commercial. Progress of these emerging technologies will be worth keeping tabs on as they may become viable opportunities for the town in the future.

Demand Side Energy Conservation Measures

Estimates for savings that can be realized for ECM's that lower electrical consumption in school systems range between 10% on the low end and 40% on the high end. A 2004 survey undertaken by Anthony J. Lisa Jr of 104 Maine schools indicated that the average electrical energy consumed at Maine schools was 5.6 kwh/sq ft. At Cape High School the average is estimated at 7.6 kwh/sq ft which shows that there is potential room for improvement. We conservatively estimate that ECM's will produce a 10% savings in electrical consumption at the schools.

Demand side ECM's will be identified during the investment grade audit. However typical ECM's that we expect to see include:

- Reduction of operating hours for various energy consumers
- Reduction of supply air requirements
- Reduction of distribution system energy losses
- Reduction of electric illumination requirements
- Lighting system efficiency improvements
- Reduction of power system losses

[28] U.S. Department of Energy, Energy Efficiency and Renewable Energy. Microhydro Power. http://www.eere.energy.gov/consumer/your_home/electricity/index.cfm/mytopic=11060. (March 16, 2008).

[29] Alternative Energy News. Hydro Power. http://www.alternative-energy-news.info/technology/hydro/. (March 16, 2008).

- Energy Efficiency Motors and variable speed drives
- Vending machine controls
- Reduction of peak power demand
- Power factor control
- Energy Management System Upgrades
- New day/night control scheme modifications
- Energy Efficient Appliances
- LED Lighting

LED Lighting

An emerging alternative lighting technology that shows great promise is LED lighting. The acronym LED stands for Light-Emitting Diode, also referred to as solid –state lighting (SSL). SSL differs from the conventional light emitted from incandescent or fluorescent bulbs in that the light is produced from a semiconductor, rather than a filament in an evacuated tube or a gas.

The website *MetaEfficient* (www.metaefficient.com) characterizes the advantages and disadvantages of SSL as follows:

Advantages:

- LEDs use about 1/50th the power of standard incandescent bulbs, and half the power of compact fluorescents
- LED bulbs last 133 times longer than typical incandescents, and 10 times as long as compact fluorescents
- Because LED bulbs don't have a filament, they are more durable than incandescent bulbs
- LED bulbs run cooler, producing 3.4 BTUs/hour, compared to 85 BTUs/hour for incandesents
- Unlike fluorescents, LED bulbs do not flicker

Disadvantages:

- Although costs are coming down, LED bulbs are expensive. A single AC bulb, replacing a 25 Watt incandescent bulb, costs about $40.
- LEDs are focused, rather than radiating light in a 360-degree cone like an incandescent bulb. They are best suited for task lighting.
- Light color is cooler than the warm yellow light from an incandescent bulb. For interior use, LEDs are best-suited as task lighting.

In spite of high initial costs, LED lighting appears to make sense in municipal street-lighting applications. Three North American cities, Toronto, Raleigh, NC, and Ann Arbor Michigan have each announced plans to replace conventional street lighting with LEDs. The Ann Arbor plan is the most ambitious of the three, requiring an investment of $630,000 to replace 1,400 street lights. According to *MetaEfficient*, the city anticipates a payback period of 3.8 years.

Solar Photovoltaic Technology

A solar photovoltaic (PV) system produces electricity from sunlight. There are no emissions associated with this technology. Since the source of the energy is the sun, it is endlessly renewable.

The PV system is comprised of individual PV cells, or wafers, that are made of semiconductor materials. These cells are no more than a few inches across. They convert light energy into electric energy through a process known as the photoelectric effect. When the sunlight hits the cells a chemical reaction occurs that creates the energy.[30] A group of cells connected together form a module, or panel, a few feet wide and several feet tall. Connected panels form a solar PV array, often seen on the rooftops of homes and buildings. The overall PV system includes the array of panels as well as all the other necessary wiring, equipment, hardware, and inverter.[31]

Figure 1 - Solar PV System on rooftop[32]

The amount of power produced by a solar PV system depends on the size of the system and the insolation of the location. The insolation (also referred to as solar radiation) is a measure of the

[30] U.S. Department of Energy, Energy Efficiency and Renewable Energy. Solar Energy Technology. http://www1.eere.energy.gov/solar/pv_physics.html. (April 1, 2008).

[31] U.S. Department of Energy, Energy Efficiency and Renewable Energy. Solar Energy Technology. http://www1.eere.energy.gov/solar/pv_physics.html. (April 1, 2008).

[32] Google photographs. http://www.segen.co.uk/images/PV7.jpg. (March 21, 2008).

solar intensity of a given surface area over a given time.[33] The average solar insolation for Portland, Maine, just five minutes north of Cape Elizabeth, is 4.51 kWh/m²/day.[34]

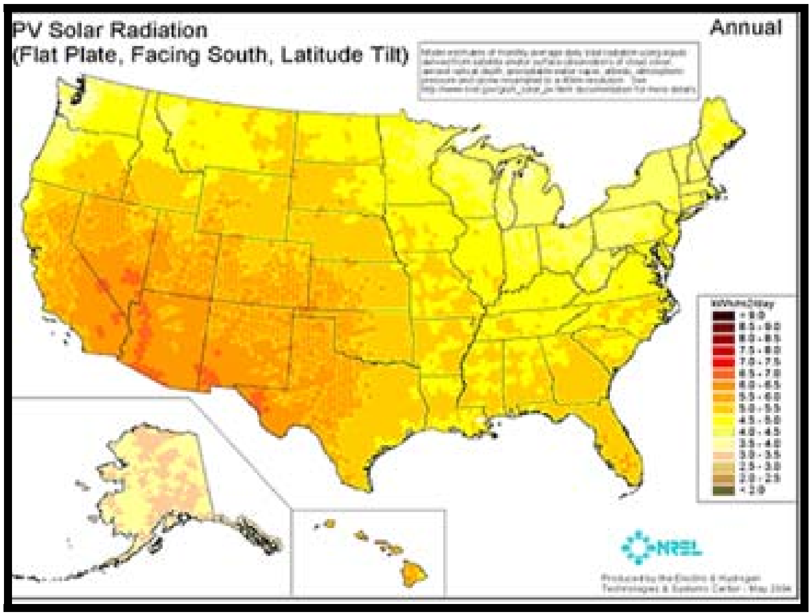


Figure 2 - United States Annual Solar Radiation Map[35]

According to ReVision Energy, at this level of insolation, each kilowatt of grid-tied PV will provide 1,200 kilowatt hours of electricity. With a grid-tied PV system the surplus electricity produced from the PV system is stored on the electrical grid, instead of in a battery bank.[36] Under Maine's Net Metering Laws participants in a grid-tied system are eligible for credits from the utility company for the electricity generated by this PV system (provided it produces less than 100 kW per hour).[37]

ReVision estimates the cost for their grid-tied system at $9,000 per PV kilowatt. Each PV kilowatt provides 1,200 kWh of electricity. The cost of the grid-tied system includes the solar panels, inverter, wiring, mounting rack and labor. [38]

[33] U.S. Department of Energy, Energy Efficiency and Renewable Energy. Solar Energy Technology. http://www1.eere.energy.gov/solar/pv_physics.html. (April 1, 2008).

[34] The Alternative Energy Store. http://howto.altenergystore.com/Reference-Materials/Solar-Insolation-Data-USA-Cities/a35/. (March 4, 2008).

[35] National Renewable Energy Lab. http://www.nrel.gov/gis/images/us_pv_annual_may2004.jpg (March 13, 2008).

[36] ReVision Energy (formerly EnergyWorks). http://www.energyworksllc.com/electricity.html. (March 13, 2008).

[37] Net Metering. http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=ME02R&state=ME&CurrentPageID=1. (March 13, 2008).

[38] Based upon interviews with Jen Hatch of ReVisions Energy (February 14, 2008).

There are several school systems in Maine that have received grants from Efficiency Maine to install small solar PV system in the schools. Applying for and receiving grants would be the path forward to install a PV system in town. A reasonable system size would be 3-4 kw, possibly up to 10 kw. For a 4 kw system, we have estimated that a grant of $28,000 would be necessary to make a solar pv system budget neutral. Without a grant a solar PV system does not show a positive net present value under any of the scenarios evaluated.

Wind Turbine Systems

Wind turbines use the power of the wind to generate electricity. The wind turns the blades of the turbine which then spin a shaft in the generator, thus making electricity. [39] Wind energy is renewable and emissions-free.

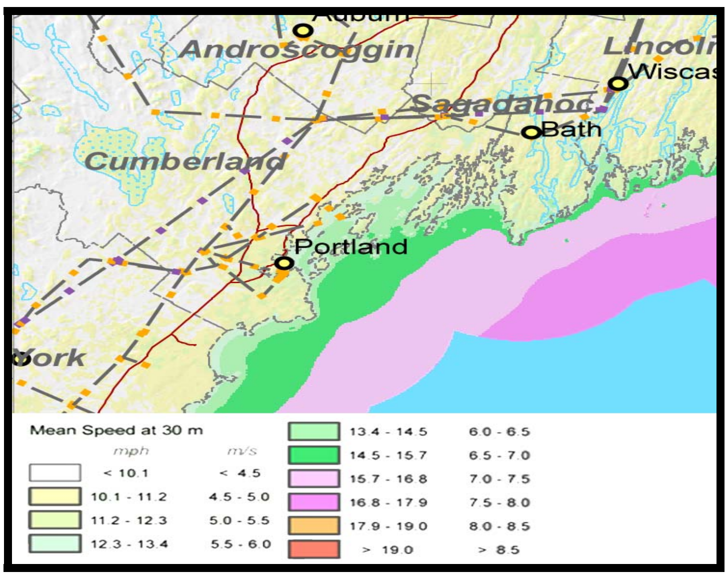


Figure 3 - Wind Resource of Maine (Average Annual Wind Speed at 30 meters)[40]

Power generation from a wind turbine is a cube function of the wind speed. For example if the wind speed doubles, the power that can be generated increases by a factor of 8. The wind resource map shows that Cape Elizabeth is likely to receive winds at speeds of approximately 4.5

[39] U.S. Department of Energy. Energy Efficiency and Renewable Energy. http://www1.eere.energy.gov/windandhydro/wind_how.html. (March 17, 2008).

[40] AWS Truewind. http://www.awstruewind.com/maps/united-states.cfm/region/46666. (March 17, 2008).

– 5.5 meters per second at 100 ft elevation. This speed range meets the specifications required of Entegrity Wind System's EW50 model, a 100-foot 50 kW turbine.[41] This is the same structure recently constructed in Saco, Maine.[42] At 70 meters elevation (210 ft) the wind speed in most Cape sites is estimated to be at 6.0 - 7.0 meters per second. Although this elevation exceeds the current municipal height ordinance for wind towers, it would provide a more economical resource by taking advantage of greater wind speeds.

In order to gain a better idea of how much energy would likely be generated by a wind turbine, it is necessary to know the capacity factor of the wind turbine first. According to the American Wind Energy Association, 25% is a practical capacity factor for calculating actual energy production (although it may vary according to average wind speed in the location).[43] Based on an estimated wind speed in Cape Elizabeth at 100 ft elevation of 5 meters/sec, we expect a capacity for our application to be 20%.

At this capacity factor the EW50 can produce 88,233 kWh of electricity per year. Each EW50 costs around $250,000, including installation. The system includes the blades, tower, foundation and generator. The system is connected to the grid and has no battery.[44] By connecting to the grid the schools receive the benefits of net metering, and can offset their utility bill by the amount of energy generated from the turbine.

[41] Entegrity Wind Systems. EW50 Wind Turbine, Wind for Schools. www.entegritywind.com. (April 1, 2008).
[42] Based on interview with Eric Coty, member of Saco Town Council (March 1, 2008).
[43] American Wind Energy Association. http://www.awea.org/faq/basicen.html. (March 17, 2008).
[44] Based on interview with Stephanie Savage, Entegrity Wind Systems (March 14, 2008).

Figure 4 - EW50 Wind Turbine[45]

The Cape Elizabeth Town Council approved amendments to the zoning ordinance allowing small wind turbines on poles of up to 100 feet on municipal property by unanimous vote on July 14, 2008. Any windmill proposed by the Town would require site-plan review by the Planning Board. Nearly all who spoke at a wind energy workshop sponsored by the Town of Cape Elizabeth in July 2008 said they favored both a pilot wind project to be carried out by the Town, and for individuals to be permitted to erect wind turbines on their own properties.

Much of the concern raised about wind turbines focuses on the noise generated by the turbine, the intrusive appearance of the wind turbine spoiling the natural beauty of the landscape, and the potential danger to wildlife.[46] Significant improvements in wind turbine technology in recent years have minimized the amount of noise that is generated by small turbines. Additionally, numerous studies have been conducted that universally indicate that wind turbines do not pose a significant danger to birds or other wildlife. Concerns with the potential impacts of placement of wind turbines on the natural beauty of Cape Elizabeth's landscape will need to be taken into account in siting decisions.

As an alternative to the single 50 kW wind turbine we have also looked at a larger wind turbine installed at 70 meters. This would require an ordinance change to allow taller wind towers in

[45] Photograph taken by Entegrity Wind Systems. www.entegritywind.com. (April 1, 2008).
[46] U.S. Department of Energy. Energy Efficiency and Renewable Energy. http://www1.eere.energy.gov/windandhydro/wind_how.html. (March 17, 2008).

municipal property. For this analysis, we have looked at a 660 kW Vestas wind turbine that would be installed at 210 ft with an average wind speed of 6.0 – 7.0 meters/sec. This machine would be capable of producing 867,821 kWh's per year.

Cogeneration

Cogeneration is an alternative energy option that provides both electrical and thermal energy from a common fuel source. Cogeneration is also referred to as combined heat and power (CHP). Because cogeneration creates useful electric and thermal energy from the same fuel source, it is much more efficient than a stand alone electric or thermal plant. Cogeneration can be accomplished with various fuel types and equipment configurations. For this analysis we have assumed small natural gas electric generators with waste heat recovery capability located at the school to reduce electricity purchases as well as fuel oil purchases for heating. Specifically for this analysis we have chosen microturbine technology (small combustion turbines). There have been great strides in developing microturbines for cogeneration applications over the past five years and there are several commercial products available in the 30kW to 250 kW range. Capstone and Ingersoll Rand both have commercially viable products for this technology. The technology is well proven.

Ingersoll Rand 250 kW microturbine.

Traditional roadblocks in developing economically viable cogeneration applications at schools include, electric and thermal matching (that is to say that the thermal and electric demand of the facility may not be coincident cogeneration system capability), variable load profile, limited operation during summer and system capital cost.

Chapter 2
Clean, Renewable Alternatives to Heating Oil Use

Heating Oil Usage in Cape Elizabeth Schools

Heating oil at the three schools is used for space heating and water heating – domestic water heating and pool heating.[47] Consumption figures for the schools are as follows:

- 146,409 gallons in 1996-97
  - 60,358 gallons for the elementary/middle school
  - 86,051 gallons for the high school
- 147,226 gallons for 2006-07
  - 65,252 gallons for the elementary/middle school
  - 81,974 gallons for the high school

Cape Elizabeth High School's boiler system is connected to Richards Community Pool to heat the water for the pool. The records for the high school's heating oil usage include the heating oil used at the pool; there is no separate data available.[48]

Based on the current heating oil price paid by the schools of $2.75/gallon, the total cost for the heating oil usage was (in 2008 dollars): [49]

- $402,624.75 in 1996-97
- $404,871.50 in 2006-07

The Energy Information Administration reports that each gallon of heating oil puts 22.384 pounds of CO_2 emissions into the earth's atmosphere.[50] At this level the CO_2 emissions from the three schools' heating oil consumption are:

[47] According to Cape Elizabeth Facilities Manager, Ernie MacVane, the boiler system for the high school serves the needs of Richard's Community Pool as well.

[48] Information based upon data provided by Cape Elizabeth Facilities Manager, Ernie MacVane (February 13, 2008).

[49] Heating oil rate provided by Cape Elizabeth Facilities Manager, Ernie MacVane (February 13, 2008).

- 1,487 metric tons of CO_2 in 1996-97
  - 613 metric tons CO_2 from the elementary/middle school
  - 874 metric tons of CO_2 from the high school
- 1,494 metric tons of CO_2 in 2006-07
  - 662 metric tons CO_2 from the elementary/middle school
  - 832 metric tons of CO_2 from the high school/pool

Alternative Energy Options to Reduce Fuel Oil Use

This study chose the Cape Elizabeth High School as the sample site for replacing heating oil use. The high school's current boiler has been used since the high school was constructed in 1969; whereas the boiler system in Pond Cove Elementary/Cape Elizabeth Middle School is less than twenty years old.[51] Since the high school's boiler has exceeded its expected lifetime there is a good argument for capital expenditure funds to replace it.

Alternative energy options for replacing the use of heating oil include solar thermal, woodchip (or wood pellet) industrial combustion, geothermal heat pump, fuel switching to natural gas, and gas-fired cogeneration Another option, the purchase of B-20 biodiesel, will not be considered in this study. While this alternative may have its benefits, it is not necessarily an alternative system so much as it is an alternative commodity purchase for an existing system. Additionally, there are concerns associated with its changing viscosity in extremely cold climates. According to Ernie MacVane, it is possible that the system pumping B-20 might need additional equipment, the cost of which is beyond the scope of analysis conducted in this study. As a result any cost-benefit estimates based solely on the cost of the fuel alone would be misleading and unhelpful. This option may warrant more consideration as more of an infrastructure becomes developed for alternative liquid fuels made from non food sustainable resources.

[50] Energy Information Administration. Voluntary Reporting of Greenhouse Gases Program. http://www.eia.doe.gov/oiaf/1605/coefficients.html. (March 25, 2008).
[51] Information provided from interview Paulina Aportria, Cape Elizabeth School Business Manager (March 4, 2008).

Demand Side Energy Conservation Measures

Similar to alternative electric options, there are both supply and demand (energy conservation measures) alternatives to consider. Estimates for savings that can be realized for ECM's in school systems range between 10% on the low end and 40% on the high end. The results of a 2004 survey undertaken by Anthony J. Lisa Jr of 104 Maine schools, indicated the average fuel consumed at Maine schools was 56.8 kBtu/sq ft. for existing schools and 29.75 kBtu/sq ft for new schools. At Cape fuel consumption is 67.67 kbtu/sq ft at the high school and 48.8 kBtu/sq ft at the middle school. This indicates that there is probably more opportunity for demand side conservation measures at the high school than the middle school. We conservatively estimate that ECM's will produce a 10% savings in fuel oil consumption at the schools.

Demand side ECM's will be identified during the investment grade audit that is underway. However typical ECM's that we expect to see for fuel oil reduction includes:

- Reduction of operating hours for various energy consumers
- Adjustment to Space Temperature and Humidity Set Points
- Reduction of heat loss through ceilings and roofs and walls
- Reduction of losses through windows and other openings
- Reduction of outside air infiltration
- Reduction of ventilation losses
- Boiler or Furnace Efficiency Improvements
- Reduction of supply air requirements
- Reduction of distribution system energy losses
- Reduction of hot water loads
- Water heating System efficiency improvements
- Installation of heat recovery systems
- Energy Management System Upgrades
- New day/night control scheme modifications

Solar Thermal System

The energy used to generate the heat for the solar thermal system comes from the sun, and is thus clean and renewable. At a smaller scale than what is needed at the high school, a typical system can provide space heating and hot water.

The main components of the solar thermal system include the solar collectors, the storage tank and a circulator pump.[52] The sun heats the antifreeze in the collectors. When the antifreeze becomes hotter than the water in the storage tank, the circulator pump turns on. The circulator pump runs the antifreeze to the heat exchanger which heats the water in the storage tank.[53]

Figure 5 - 360 Tube System at Hilltop Lodge, (Falmouth, ME)[54]

A large-scale solar thermal system for the high school will need a large enough summer load in which to dump the generated heat.[55] In this case Richards Community Pool provides that outlet. It should also be noted that the pool roof currently needs to be replaced.

Woodchip Industrial Combustion System

The woodchip industrial combustion system generates energy by burning woodchips at extremely high temperatures. The system is capable of generating enough energy to completely replace the use of heating oil for space heating and hot water for both the high school and pool. According to Ernie MacVane, the heat from combustion could connect directly into the existing heating system, requiring few if any additional components.

The system can be built as an external facility (using the existing boiler system within the school as back-up). The facility includes the boiler, combustor (furnace), multi-cyclone, unloading equipment, and chip bin. The bins can hold about 60 tons of woodchips.[56]

[52] Solar Market. www.solarmarket.com (March 21, 2008).
[53] ReVision Energy. http://www.revisionenergy.com/hotwater.html. (March 21, 2008).
[54] ReVision Energy. http://www.revisionenergy.com/hotwater.html. (March 21, 2008).
[55] Based in Interview with Phil Coupe at ReVisions Energy. (March 18, 2008).

Figure 6 - Woodchip Combustion Facility[57]

Figure 7 – Boiler, Combustor and Multi-Cyclone[58]

The woodchips travel by conveyer from the main chip bin to a smaller holding bin before being channeled by augur into the combustion area. The chips are fired in the combuster, and the heat is sent to the boiler. A multi-cyclone in the stack (chimney) spins the exhaust and removes the fine particulate matter.[59]

There are two types of woodchips - mill residue chips and bole chips. They are both green hardwood mill scrap chips with a moisture content of 35-45 percent. The chips are essentially the waste from logging, forest thinning, saw mills and paper mills.[60]

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[56] Information based on interview with Gene Jordan, Facilities Manger for Leavitt High School in Turner, Maine (March 11, 2008).
[57] Photograph from Messersmith Manufacturing, Inc. http://www.michigan.gov/documents/deq/deq-ess-p2-ag-workshop-ppt-Klope-MessersmithManufacturing_192763_7.pdf. (March 25, 2008).
[58] Photograph from Messersmith Manufacturing, Inc. http://www.michigan.gov/documents/deq/deq-ess-p2-ag-workshop-ppt-Klope-MessersmithManufacturing_192763_7.pdf
[59] Based on interview with Barry Burnstein of Better World Energy (March 5, 2008).
[60] Based on interview with Barry Burnstein of Better World Energy (March 5, 2008).

Figure 8 - Woodchips in bin[61]

Combustion of woodchips occurs at 1,600-1,800 degrees Fahrenheit. At such high temperatures there are no visible emissions. According to Paul McArdle of the Energy Information Administration, CO_2 from wood-burning (of wood drawn from sustainable, environmentally-sound logging practices), is considered by the United Nations Framework Convention on Climate Change to be part of the natural harvest cycle.[62] In other words, the same amount of CO_2 created from the burning of the wood from trees logged from sustainable forests is recaptured by the growth of the new trees planted in that forest.

The woodchip industrial combustion process is clean and renewable under proper conditions. Yet, while it may not add to the CO_2 emissions in the earth's atmosphere, it does produce other greenhouse gases, such as nitrogen oxides and carbon monoxide. The Biomass Energy Resource Center compares the emissions from woodchip industrial combustion to fuel oil and concludes that modern wood industrial combustion systems produce much less sulfur dioxide, comparable levels of nitrogen oxides, and "significantly higher levels" of carbon monoxide. This last observation, the Center notes, is "a relatively minor concern to air quality regulators, however, except in areas like cities that have high levels of CO in the air from traffic exhaust."[63]

In Vermont there are over twenty school systems that burn wood as their primary fuel source. In Maine there are several school systems that have converted to wood and currently there are many school systems evaluating a wood fired boiler application. In addition there are new industries

[61] Photograph from Messersmith Manufacturing, Inc. http://www.michigan.gov/documents/deq/deq-ess-p2-ag-workshop-ppt-Klope-MessersmithManufacturing_192763_7.pdf. (March 25, 2008).
[62] The Energy Information Administration provides the official energy statistics for the United States government. http://www.eia.doe.gov/. (April 1, 2008).
[63] Biomass Energy Resource Center. www.biomasscenter.org. (April 1, 2008).

being developed in Maine that are competing for Maine's wood resource. These new industries are wood pellet and ethanol in addition to the long standing paper, biomass and cordwood uses. This raises the question as to whether or not there is adequate wood fuel which can be obtained at economic pricing to support a commercial wood chip application at the Cape Elizabeth schools. A recent report entitled The Governor's Wood-to-Energy Task Force Report dated September 2008, stated that a recent Maine Forest Service analysis demonstrates sufficient supply to provide for an increase of wood fueled boilers for larger businesses and central heating systems. Although this indicates that the resource is available, further resource assessment should be made as part of any decisions to proceed with a wood boiler conversion.

There are several additional concerns with a large wood chip boiler installation on the school campus. Solid fuel combustion requires additional space for storage and handling. Also fuel delivery and unloading trucks could add congestion to an already busy campus. Although a wood chip boiler's fuel is considered carbon neutral, some argue that this is a simplistic analysis because fossil fuels are used during the harvesting, processing and transport of the wood. If adequate forest management practices are not utilized, problems can result from improper use of pesticides, poor sediment & erosion control practices, excessive removal of micro nutrients, and destruction of habitat. On a local level, air pollution contaminants will continue to be emitted, from even a clean burning wood chip system.

Geothermal Heat Pump System

The geothermal heat pump (GHP) system uses the heat stored in the earth to provide clean renewable energy for heating and cooling. It is capable of providing the necessary space heating and cooling for a school building, as well as for domestic hot water use.[64]

During the summer the ground temperature is cooler than the outside air, and during the winter it is warmer. In Maine the temperature in the ground below 28 feet is a relatively constant 51 degrees Fahrenheit.[65] This contrast in ground and air temperatures allows the geothermal heat pumps to

[64] Based on interview with David Preston, Worldwide Energy (March 21, 2008).
[65] Information provided in an interview with Alan Kuniholm, Principal Architect at Portland Design Team (February 11, 2008).

transfer heat into a building during the winter and put it back into the ground during the warmer months – through a process referred to as reverse refrigeration.[66]

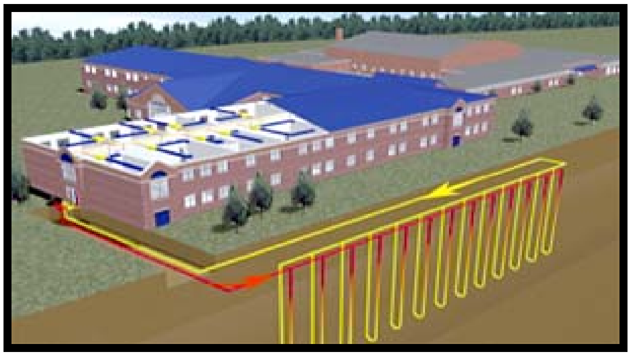

Figure 9 - Geothermal Diagram[67]

The components of the GHP system include the bore field, the ground loop piping, the heat pumps, air handling units, and the duct work in the building.[68] It can also include a backup boiler (run on heating oil) to assist with peak demand.[69] The ground loop piping is set in the bore field and provides the means for transferring heat to and from the ground. The heat pumps circulate the heat transfer fluid, a glycol-water solution, through the GHP system. The air handling units provide the ventilation for the heating and cooling of the space.[70]

There are four basic types of geothermal heat pump systems – horizontal closed-loop, vertical closed-loop, pond (or lake) closed-loop, and the open-loop system.[71] This study does not consider the pond (or lake) system since there is no suitable body of water on the campus. The open loop system presents a number of environmental concerns, most notably the threat of cross-contamination with local aquifers. It will not be considered either. [72]

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[66] Information provided by Cape Elizabeth Facilities Manager, Ernie MacVane (February 13, 2008).

[67] Tennessee Valley Authority. Geothermal Heat Pumps. http://www.tva.gov/products/business/geothermal.htm. (March 26, 2008).

[68] U.S. Department of Energy. Energy Efficiency and Renewable Energy. Geothermal Technologies Program Geothermal Basics Overview. http://www1.eere.energy.gov/geothermal/overview.html#heat_pump. (March 26, 2008).

[69] According to Mr. Kuniholm, peak demand occurs about 10% of the year when the energy demand load increases by 30-40% (February 11, 2008).

[70] Doughty, Richard. 'Gorham Middle School Independent Evaluation of Geothermal HVAC System. Combined Energies.' Augusta, ME. 2006. http://mainegov-images.informe.org/education/const/ae002.pdf. (April 1, 2008).

[71] U.S. Department of Energy. Energy Efficiency and Renewable Energy. EERE Consumer's Guide: Types of Geothermal Heat Pump Systems. http://www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12650. (April 1, 2008).

[72] Information provided in an interview with Alan Kuniholm, Principal Architect at Portland Design Team (February 11, 2008).

In both the vertical or horizontal closed-loop system there is no contact between the liquid and the ground.[73] Since it is closed-loop there are fewer environmental concerns, and therefore fewer regulations.

Deciding on which system to select – horizontal and vertical – depends on both the amount of land available, and the costs of installation. The horizontal closed-loop system is suitable where plenty of flat land is available. The design for this system sinks a looping of pipe about six feet into the ground.[74]

The vertical closed-loop system is more appropriate where land is limited. With this system a number of bore holes are drilled 100-400 feet deep (the number depends on the energy requirement of the system). Two pipes connected at the bottom are inserted into each of these holes. This vertical piping is then connected with a horizontal pipe (manifold) and connected to the heat pump in the building. This system is more expensive than the horizontal system, but may be necessary if space is limited.[75]

Cogeneration

As discussed under alternative options for electricity generation, cogeneration creates thermal and electric energy from a common fuel source.

Natural Gas Conversion

Although switching from fuel oil to natural gas is not traditionally considered an alternative energy option, it is worthy of mention here. Currently, natural gas is not available at the schools. However, there is a gas line in South Portland about two miles from the schools. The gas line is owned by Unitil. Committee members have spoken with the utility about bringing the gas to the schools and

[73] Information provided in an interview with Alan Kuniholm, Principal Architect at Portland Design Team (February 11, 2008).

[74] U.S. Department of Energy. Energy Efficiency and Renewable Energy. EERE Consumer's Guide: Types of Geothermal Heat Pump Systems. http://www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12650. (April 1, 2008).

[75] U.S. Department of Energy. Energy Efficiency and Renewable Energy. EERE Consumer's Guide: Types of Geothermal Heat Pump Systems. http://www.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12650. (April 1, 2008).

have provided preliminary estimates of $320,000, however this value must be confirmed. The town has assumed that if we did switch to natural gas, new boilers would be added at the high school because the existing boilers were installed in 1969 and are at end of their useful lives anyway. Boilers in the middle school may only require burner modifications as they are newer boilers. If natural gas is brought to the school complex, other town buildings such as town hall, police station library etc. could also be converted to natural gas, and natural gas could also become a viable option for municipal fleet vehicles.

Although natural gas is still considered a fossil fuel, emissions are much lower than fuel oil combustion including greenhouse gas emissions, and natural gas boilers do not rely on fuel coming from politically unstable regions of the world. Finally natural gas is less expensive on a $/mmBtu basis than fuel oil.

Chapter 3
Economic Feasibility of Alternative Energy Technologies

The Alternative Energy Strategy for Cape Elizabeth begins with a cost-benefit analysis of each of the selected technologies to measure their economic feasibility. Four key questions drive this analysis:

- How much does the system cost?
- How much money does each system save from offsetting electricity or heating oil usage?
- How much CO2 reduction can be achieved with the option?
- Are the benefits greater than the costs?

The economic benefits are measured by the cost savings associated with not purchasing the amount of energy (electricity or heating oil) offset by the alternative energy system. The costs include the cost of capital, and operating and maintenance costs.[76] The net present value (NPV) is calculated to determine the value of this future stream of costs and benefits over the expected lifetime of each system's equipment.

The figures generated are not the final determinant in the decision-making process; rather they are just the beginning, and are intended simply to shed light on the financial risks and rewards associated with a substantial capital expenditure for each of the alternative energy technologies under consideration. Where the rewards appear to outweigh the risks, a more in-depth appraisal by the engineers, architects and facilities manager is advised. Costs represent budgetary information based on vendor discussions and industry standards.

Further refinement of costs and savings potential must be developed with detailed consultant studies. This process is underway with the hiring of a consultant to perform an energy audit and refine the analysis of the alternative energy options.

[76] For the woodchip industrial combustion system there are additional costs for: woodchips, major repairs every 10 years, and back-up heating oil for peak demand.

Findings

The cost-benefit analyses and sensitivity tests for each of the five alternative energy technologies yield seven main conclusions:

1. Energy Conservation Measures should be implemented first and will provide the best return on investment.
2. The woodchip industrial combustion system is economically feasible and provides the greatest reduction in CO2 emissions.
3. Conversion to natural gas appears economically feasible, however a major unknown is how much of the cost for the gas line extension would be passed on to the Town by the gas company.
4. The economic feasibility of the wind turbine system is contingent on the availability of interest-free capital[77] . A wind turbine installation with a tower that exceeds the current 100 ft ordinance will yield better economics than a 100 ft tower, due to greater wind speeds at higher elevations.
5. The geothermal heat pump system appears economically feasible assuming interest-free capital is available; however a more accurate and detailed study is required of the retrofit costs before any final conclusion can be made
6. Solar PV and solar thermal systems are not economically feasible without additional incentives.
7. Cogeneration using natural gas microturbines is not economically feasible based on the natural gas pricing assumed in the study.

Alternative Energy Options – Comparative Analysis:

Energy Conservation Measures

As previously discussed, energy conservation measures need to be the first part of any energy planning. The committee is working with the Town and its consultant in providing an investment

[77] A potential source of this capital is the federal government's Clean Renewable Energy Bonds, zero-interest bonds provided to local governments for alternative energy projects. For details see Appendix 1 – Funding Sources for Alternative Energy Technologies.

grade energy audit. Based on experiences with other municipalities we believe that it is reasonable to expect a minimum of 10% reduction in energy consumption after implementation of ECM's identified in the audit. Assuming that the above reduction in energy consumption will be realized, the table below provides the economics for this alternative.

CASE NAME: Install Energy Conservation Measures (ECM's) at High School & Middle School				
	Most Favorable	Neutral	Neutral	Least Favorable
Borowing Cost	low	low	high	high
Energy Inflation	high	low	high	low
Initial Cost	$435,454			
CO2 Emissions Reduction	286			
Net Present Value	$693,679	$521,454	$595,728	$423,503
Profitability Index	159%	120%	137%	97%

Solar Photovoltaic System

As seen in the table below, there is no scenario in which the NPV is positive for a 4 kW solar PV project. However, there are renewable energy grants and incentives that are made available to municipalities for solar PV projects. Assuming that a $28,000 grant can be successfully awarded to Cape Elizabeth, then, a solar PV project would achieve break-even point..

CASE NAME: Install Solar PV at High School				
	Most Favorable	Neutral	Neutral	Least Favorable
Borowing Cost	low	low	high	high
Energy Inflation	high	low	high	low
Initial Cost	$36,000			
CO2 Emissions Reduction	3			
Net Present Value	-$12,120	-$13,771	-$20,218	-$21,869
Profitability Index	-34%	-38%	-56%	-61%

Wind Turbine System (50 kW)

The NPV for a small wind turbine project (50 kW) is positive under two scenarios – Neutral (low electricity inflation, low borrowing rate), and Most Favorable (high electricity inflation, low borrowing rate). This suggests that whether the electricity inflation rate is high or low, the project is only feasible when the borrowing rate is low – that is, when the bond rate is 0 percent (as offered under the federal government's Clean Renewable Energy Bonds Program). Access to these funds should therefore be a critical consideration for undertaking a wind turbine project.

CASE NAME: Install Wind Turbine at High School (50 kW)				
	Most Favorable	Neutral	Neutral	Least Favorable
Borowing Cost	low	low	high	high
Energy Inflation	high	low	high	low
Initial Cost	$250,000			
CO2 Emissions Reduction	54			
Net Present Value	$40,197	$9,837	-$16,038	-$46,398
Profitability Index	16%	4%	-6%	-19%

Wind Turbine System (660 kW)

The NPV for a larger wind turbine project (660 kW) is positive under three scenarios – Neutral (low electricity inflation, low borrowing rate), Neutral (high energy inflation, high borrowing rate), and Most Favorable (high electricity inflation, low borrowing rate). This suggests that whether the electricity inflation rate is high or low, the project is most feasible when the borrowing rate is low – that is, when the bond rate is 0 percent (as offered under the federal government's Clean Renewable Energy Bonds Program). Access to these funds and other sources of incentives should therefore be a consideration for undertaking a wind turbine project. Also the Town ordinance would need to be changed to accommodate turbines of greater height.

CASE NAME: Install Wind Turbine at High School (660 kW)				
	Most Favorable	Neutral	Neutral	Least Favorable
Borowing Cost	low	low	high	high
Energy Inflation	high	low	high	low
Initial Cost	$1,880,147			
CO2 Emissions Reduction	535			
Net Present Value	$475,007	$176,398	$52,085	-$246,525
Profitability Index	25%	9%	3%	-13%

Solar Thermal System

The cost-benefit analysis for the solar thermal system looks at replacing 986 gallons of heating oil currently used to heat the water in Richards Community Pool. Installing and operating a solar thermal system would cost $100,000.[78] As seen in the table there is no scenario in which the NPV is positive. However, there are opportunities for renewable energy grants and incentives for solar thermal municipal projects. We have estimated that a grant of $23,000 will provide a positive net present value for a solar thermal project if applied to the most favorable option (high energy, low inflation).

[78] For detailed analysis see Appendix 6 – Solar Thermal System.

CASE NAME: Install Solar Thermal at High School				
	Most Favorable	Neutral	Neutral	Least Favorable
Borowing Cost	low	low	high	high
Energy Inflation	high	low	high	low
Initial Cost	$100,000			
CO2 Emissions Reduction	10			
Net Present Value	-$9,738	-$16,171	-$32,233	-$38,665
Profitability Index	-10%	-16%	-32%	-39%

Woodchip Industrial Combustion System

The cost-benefit analysis for the woodchip industrial combustion system explores the costs and benefits of this system *fully* replacing the heating oil use for Cape Elizabeth High School and Richards Community Pool. The total heating oil offset by this operation is 81,848.50 gallons, which would offset 831 metric tons of CO_2 emissions.[79] This is approximately a 57 percent reduction from 1996-97 CO_2 emissions levels for the high school. The cost for this system is approximately $1.5 million.[80]

Full replacement is considered over the 7 percent reduction because of the significant upfront cost in new facility construction and equipment. As a result moderate scale-ups every few years to address ongoing demands for CO_2 emission reduction would be both difficult and uneconomical. Under all four scenarios the woodchip industrial combustion system returns a positive net present value.[81]

CASE NAME: Install Biomass Boiler at High School				
	Most Favorable	Neutral	Neutral	Least Favorable
Borowing Cost	low	low	high	high
Energy Inflation	high	low	high	low
Initial Cost	$1,500,000			
CO2 Emissions Reduction	674			
Net Present Value	$841,999	$542,717	$504,587	$205,305
Profitability Index	56%	36%	34%	14%

Geothermal Heat Pump System

The cost-benefit analysis for the geothermal heat pump system explores the costs and benefits of replacing heating oil use for Cape Elizabeth High School and Richards Community Pool. The cost for this GHP system includes costs for the wellfield as well as the costs to install multiple heat

[79] 81,848.50 gallons is the average annual heating oil use in the high school since 1996 (excluding '00-01 figure, which was an extreme outlier as a result of pool construction). The figures for heating oil and emissions do not account for the potential use of heating oil during extreme cold scenarios when the combustion system may need to be supplemented with conventional fuel burning.

[80] Based on estimates provided by Barry Burnstein, Better World Energy (March 5, 2008).

[81] For detailed analysis see Appendix 7 – Woodchip Industrial Combustion System.

pumps. The wellfield cost was estimated based on recent geothermal work performed for a new middle school in Gorham, Maine.[82] Based on the Gorham data we have assumed a cost of $795,281 for the borefield. The cost of the retrofit of the existing equipment was assumed to be $1,571,223 based on new replacement cost. This assumed replacement of the entire HVAC system based on cost data provided the Doughty report (footnoted below).

CASE NAME: Install Geothermal Heat Pump System at High School				
	Most Favorable	Neutral	Neutral	Least Favorable
Borowing Cost	low	low	high	high
Energy Inflation	high	low	high	low
Initial Cost	$2,366,504			
CO2 Emissions Reduction	401			
Net Present Value	$399,852	$115,369	-$132,472	-$416,955
Profitability Index	17%	5%	-6%	-18%

Results of the cost-benefit analysis for the GHP system show a positive NPV under scenarios based on low borrowing costs. However, there are a number of uncertainties behind the GHP numbers that deserve closer inspection. In the Gorham study the school's space heating and cooling were provided almost entirely by the geothermal heat pump system, but the system did not include hot water (although geothermal heat pump systems are capable of heating water).

While both Gorham Middle School and Cape Elizabeth High School are of comparable size, Gorham is a new school and Cape is an old school (built in 1969). The installation of the Gorham GHP system occurred during the school's construction, and therefore does not actually account for retrofitting costs. The current mechanical system and facilities at Cape Elizabeth High School might not be large enough to support the new indoor equipment needed for the GHP system. Room for new ventilation components, and other HVAC equipment might be required. In this case a certain level of demolition might be necessary to take the ceiling out and enhance the duct work piping. Cost assumptions were made for this work, but more detailed engineering estimates will be required before proceeding. We have conservatively estimated the capital cost for the retrofit work at $1,571,223 assuming a complete replacement of the heating system including ductwork and heat pumps. We are waiting for confirmation of these estimates from equipment suppliers.

[82] Doughty, Richard. 'Gorham Middle School Independent Evaluation of Geothermal HVAC System. Combined Energies' Augusta, ME. 2006. http://mainegov-images.informe.org/education/const/ae002.pdf. (April 1, 2008).

Even if the retrofit is not cost prohibitive, a geothermal project is still risky – if work conducted over the summer is not completed on time, it could substantially disrupt the classroom environment.

Clearly these uncertainties should be weighed before any final decision is made. This study recommends that the engineers, architects and the facilities manager conduct a more extensive and customized study of the Cape Elizabeth High School site for both the woodchip industrial combustion system and the geothermal heat pump system.

Cogeneration

The cogeneration analysis is based upon providing up to 500 kW of electricity simultaneously with 1.8 mmBtu/hr of thermal energy for the schools. With this system additional thermal energy will be required from the boilers to meet winter demands. Also, additional electric energy will be required to meet peak demands and also meet loads when the cogeneration equipment is out of service for maintenance. For the cogeneration analysis, we have assumed that a natural gas line will be brought to the high school which adds significantly to the capital cost for this alternative. We have estimated that the cogeneration system will be able to provide 1,991,700 kWh's per year of electricity and 8,378 mmBtu's per year of thermal energy to the school complex. Although this reduces the Town's reliance on purchased electricity and fuel oil, there is no scenario in which the NPV is positive for this alternative. The capital cost to extend a natural gas line to the school and the cost of natural gas fuel are the primary drivers that make the economics of this alternative unattractive. If natural gas process could be negotiated closer to $1.09/therm instead of current projected pricing of $1.55/therm, the economics for a cogeneration alternative begin to show positive NPV.

CASE NAME: Install Cogeneration System at High School & Middle School				
	Most Favorable	Neutral	Neutral	Least Favorable
Borowing Cost	low	low	high	high
Energy Inflation	high	low	high	low
Initial Cost	$2,360,000			
CO2 Emissions Reduction	310			
Net Present Value	-$2,312,792	-$2,336,454	-$3,061,470	-$2,867,315
Profitability Index	-94%	-99%	-130%	-121%

Natural Gas Conversion

For this analysis, we have assumed that natural gas would replace fuel for providing building heat to both the middle/elementary school and the high school. We assumed that fuel oil would remain as back-up fuel supply for 15% of the demand for periods when natural gas is curtailed or when gas boilers/burners are down for maintenance. Reduction of fuel oil use would be 112,628 gallons/year and the NPV is positive for each scenario except the least favorable option (high borrowing cost and low energy inflation). The capital costs that would be charged to the Town by the gas utility (Unitil) to extend the gas line to the Town center are unknown at this time. This will have to be confirmed before this option can be pursued any further. It may be more difficult to qualify for low interest loans with this alternative because fuel switching to natural gas is not considered a renewable energy alternative. Bringing natural gas to the town center also favorably impacts other alternative energy opportunities such as cogeneration using microturbines or fuel cells. Also there is potential to attract other large customers which would help defray a portion of the cost of extending the gas line. Furthermore, extension of the natural gas line into Cape Elizabeth would enable future conversion of other town buildings, residential customers and municipal fleet vehicles.

CASE NAME: Convert School and Municipal Buildings to Natural Gas				
	Most Favorable	Neutral	Neutral	Least Favorable
Borowing Cost	low	low	high	high
Energy Inflation	high	low	high	low
Initial Cost	$1,210,000			
CO2 Emissions Reduction	314			
Net Present Value	$302,472	$142,070	$30,294	-$130,109
Profitability Index	25%	12%	3%	-11%

Other Considerations (Parking Lot)

A number of additional ideas and concepts have been discussed and reviewed by the committee. Not all of these concepts have received the same level of analysis but are still worthy of additional consideration as the Town continues exploring alternative energy options. Some concepts may be variations/enhancement to basic analysis we have performed.

Technology Development

This study is based on data conducted at one period in time. Yet investment in these alternative energy technologies continues to increase, and the technologies continue to improve. Over time these improvements will help reduce per unit system costs and improve the efficiency of these alternative technologies.

Cogeneration with Ground Source Heat Pump

We have internally discussed an option to enhance the economics of a cogeneration alternative by using it in combination with geothermal ground source heat pumps. In the cogeneration plant there will be periods when excess thermal energy is generated and also periods when not enough thermal energy is made available. Normally if there is not a need for the thermal energy, the excess heat will be wasted to atmosphere through large radiators. If this heat could be stored when it is not needed, but then called upon when it is required by the schools, then the cogeneration plant would be more efficient and more economical. One committee member has been evaluating an option of using the ground as a heat sink and then recovering this heat when needed, i.e in the summer waste heat is discharged to the ground and in the winter the heat is recovered. This is a creative concept but we have not completed the economic and technical feasibility of the option.

Ground Source/Wastewater Heat Pump

There is a discharge line from the wastewater treatment plant that crosses near the school property. Similar to the ground, the water temperature from this line should be relatively constant. Since it is constant, it may be possible to recover this low temperature waste heat for use in heat pumps, similar to the way a geothermal ground source heat pump recovers low temperature heat from the ground. We have not completed the economic and technical feasibility of this option.

Fuel Cells

In addition to the cogeneration application using microturbines, we could also evaluate Fuel Cells which are electrochemical devices that combine a fuel (hydrogen, generally derived from natural gas) and air and electrochemically convert the fuel into direct current power without the use of combustion. Because of the lack of combustion, fuel cells do not emit noxious oxides. Fuel cell technology is expensive and is relatively new but there are many commercial applications in operation and thus warrants further analysis.[83] Waste heat or excess electricity from one of the other options could be used to generate hydrogen as a storage medium for that energy, to be used in a fuel cell when the demand rises again.

Community funded wind turbine project

The committee has been approached by at least one Cape resident with a suggested concept whereby individual residents would be afforded the opportunity to invest in a wind project on town property. The shareholders would then be able to share in savings realized by the town. There are many pros and cons to this concept but one of the biggest pros is that residents are thinking in terms of where their energy comes from, and are wiling to be more involved in the process. Cape residents may be interested in investing in energy- generating systems fueled by renewables, and this is a question we should explore if the Council and the community support a large-scale wind option. The citizens of Samso in Denmark own the wind turbines that produce their electricity. (Some are owned by citizen cooperatives, some by the municipality, and one of the turbines is owned by summer residents.) Please see Appendix 14 for a more detailed account.

A second major benefit of enabling Cape Elizabeth residents to invest in shares of larger energy projects instead of just installing smaller wind turbines on their own property is the substantial economies of scale to be gained from constructing one major wind turbine instead of making a similar investment in numerous smaller turbines."

Centralized Plant

As we consider a biomass plant, or other project, we may want to consider a Central Plant rather than individual plants at each school. There are many town buildings that are located in a central location including the high school, the elementary, the middle school, Town Hall, Police Station, Fire Station, and community services building. The central plant could serve these building-via underground steam and/or hot water piping. Central plants have significant costs because of the larger size and the necessary interconnecting underground piping. However due to the benefits of the potentially substantial economies of scale and the relative close proximity of the buildings, this may be an economically justifiable alternative.

[83] Energy Biz magazine March/April 2006 "The Coming of The Fuel Cell Revolution" Gary M. Stern

Propane Conversion

Similar to natural gas, switching to propane is not traditionally considered an alternative energy technology but is worthy of discussion. Propane conversion would not require new pipeline but would require serious storage volumes of propane in tanks on the school grounds. This could raise aesthetic and potential safety concerns which would mitigate any potential economic benefit.

CO2 Offsets

The recent concern over greenhouse gases has created a market for greenhouse gas offsets. If Cape Elizabeth can reduce their CO2 emissions there is potential to sell those reductions in the market place. Worldwide the Kyoto protocol established mandatory reductions in greenhouse gases. The U.S. did not sign on to the Kyoto agreement so carbon trading in the US is primarily a voluntary market. In the northeast the RGGI program is the first mandatory program in the US. RGGI is still in the early stages. The market is currently only paying $3 to $4 per ton of CO2 per allowance. Based on the potential CO2 reductions outlined in this report, this would be a fairly small dollar value to Cape Elizabeth, maybe $1000 to $1500. However as the market matures it is expected that this will increase. In Europe CO2 allowances are trading for 10 times what they are in the U.S.

Renewable Energy Credits

Renewable Energy Credits (RECs) are tradable environmental commodities which represent proof that a unit of electricity was generated from an eligible renewable energy resource. These credits can be sold and traded and the owner of the REC can claim to have purchased renewable energy. The energy associated with a REC is sold separately and is used by another party. So when you purchase a REC you get only a certificate. If the town produced green energy such as wind power, the REC can be sold. REC's can be sold on either the voluntary or mandatory markets and are most valuable in States that require mandatory Renewable Portfolio Standards (RPS). The RPS is a requirement that utilities operating in the State provide a certain percentage of their electricity as renewable energy. Although Maine has an RPS, REC's in Maine have little value because the State already has a substantial amount of renewable energy (Canadian hydro-power is a significant supplier to Maine' renewable portfolio standard.) However the value of REC's in States like Massachusetts and Connecticut are currently high because the RPS in those states has not been satisfied yet. REC's created in Cape Elizabeth can be sold to Massachusetts and Connecticut market-because they are all part of ISO New England.

Wood Pellets

Another option for wood chip combustion is wood pellets. Wood pellets are wood or waste wood that has been processed into a consistent fuel quality. The process consists of grinding, drying and compression. Adhesives are not required to make the pellets. By selecting high quality fuels pellets can be processed with very little ash content. The advantage of the pellets over wood chips is since they are dry and compressed they have much higher heat value than wood chips per lb and can be distributed and handled by end users more easily and also burn cleaner with lower emission rates. A wood pellet system would require fewer truck deliveries and would require less on-site storage capability. The disadvantage is that the additional processing adds significantly to the cost. International Wood Fuels has developed an interesting business model. International Wood Fuels will install a wood pellet boiler at the town schools at no cost to the town. However the town will be required to buy their wood pellet fuel from the company for a period of ten years. Pricing for wood pellets will be indexed off the price of fuel oil at a discount rate of 15% to 22%. For this scenario the oil boilers would remain in service as back-up supply.

Project Scale

In general, the larger the project size, the better the economies of scale. There has been internal discussion on the committee regarding how large of a project that we should be looking at. Some committee members believe that we should be open to a large project that would serve not only the town need but the residences in the town as well (a small municipal utility). This could be a large wind farm with multiple turbines or a large centralized biomass plant that serves schools, municipal buildings, and businesses in the area, or a large cogeneration facility that generates excess power for sale to the grid or the community. The downside to a large project is that the larger the project, the longer it takes to develop, finance, receive the requisite approvals, and to bring on line. Nevertheless we need to remain open to projects that take advantage of economy of scale.

New Administration in Washington

The Obama administration has made investment in renewable energy infrastructure one of its key platform issues. New legislation promulgated by the new administration could provide additional incentives or funding for one or all of the alternative technologies that we are evaluating. These new incentives may enable some of the alternatives that currently do not have a positive NPV to become economically attractive.

Third Party Ownership

Some renewable energy incentives are based on tax savings, such as the renewable production tax credit. The renewable production tax credit can be thought of as a reward that the federal government pays to companies that generate energy from renewable sources such as wind power. The federal government currently offers a renewable production tax credit of 1.8 cents per kilowatt-hour.

However this tax credit is not an outright payment for the production of renewable energy. As a tax credit, it can only be used to reduce the amount of taxes a firm owes. Since the town does not pay federal taxes, they cannot take advantage of this incentive. However a project could be structured with a third party that is able to take advantage of this tax credit and share these savings in terms by providing green energy at low energy rates to the town.

Municipal Fleet Options

The Committee determined that vehicle energy use is a relatively small portion of the total and therefore did not address this in this first round of options. In light of last summer's spike in gasoline and diesel prices and the likelihood that those prices will return in the not too distant future, vehicle efficiency and alternative fuels for vehicles should remain topics for future consideration. State and Federal incentives are available for reducing the cost of vehicles, fueling infrastructure and fuel.

Fuel Efficiency

The Town already does a good job of reducing vehicle miles of travel (VMT) and avoiding unnecessary trips. The next step in getting the most efficiency out of the fleet is to practice "right-sizing". This requires the manager to determine the optimum use of each vehicle in the fleet and to choose the make and model that just fulfills those requirements. There is a tendency to buy the most versatile vehicle that will perform all of the tasks that might be required, even if it never has to do the ones that it is ultimately designed for. Does everyone really need a pickup truck, or will at least one passenger vehicle improve overall fleet efficiency?

Compressed Natural Gas

One of the recommended options is to extend the natural gas pipeline to the school buildings for fuel switching for heating purposes. This would also provide the potential for switching municipal vehicles to CNG. Natural gas is the cleanest alternative vehicle fuel and it is also the most price-stable. North America has ample quantities of NG relative to the tiny reserves of petroleum.

The vehicle of choice for the **Police Department** is the Ford Crown Victoria. This is also the most frequently converted vehicle to CNG for both police and taxi vehicles. There are EPA certified conversion kits for all late and new model Crown Vics and CNG can be specified in a bid for new vehicles. There are aftermarket upfitters that will work with the dealer to provide a vehicle with a full warrantee.

Public Works Department vehicles are a mix of duty specific brands, models and configurations. However, as replacement terms approach many of them have similar CNG options available. For relatively new vehicles, there are also opportunities for engine conversion or replacement.

The **School Department** school bus fleet is also a prime candidate for conversion to CNG. In this case, the air quality benefits inside the buses make as strong an argument for conversion as the energy/cost/CO2 savings. With Maine's asthma rates among school age children among the highest in the nation, the health benefits of cleaner fuels must also be a factor in the decision making process. The City of Portland has three CNG school buses and is in the process of acquiring four more. Most of the school utility vehicles could also be replaced with CNG models.

Liquid Propane Gas – LPG

Propane is the number-one alternative fuel for vehicles in the world and in the U.S. Many models are certified for conversion and new ones are becoming certified every year. The air quality benefits are not quite as good as for CNG but the cost of LPG infrastructure is significantly lower (depending on the CNG technology) and propane fuel generally remains at or below the cost of gasoline. As it is derived from the refining process for petroleum and natural gas there will be ample quantities of "North American" propane for the foreseeable future.

Blue Bird has a factory built propane school bus offering available beginning in 2008. Roush Industries and Ford have teamed up to provide a liquid injection F150 model. Other select gasoline models may also be converted. Commercial duty mowers are another growing niche for propane. There are several manufacturers that offer both riding and walk behind propane mowers.

All Electric

Currently the all electric market is comprised of "Low Speed" or Neighborhood Electric Vehicles with ranges between 30 and 60 miles per charge. While not practical for most applications, these vehicles can fit a specific niche where speed and range requirements are low. The trick to fleet efficiency is right-sizing and there is often a place in a fleet for at least one of these NEV's. Not all are passenger vehicles either. Some manufacturers offer flat bed and utility models that could be ideal Park vehicles.

Hybrid Electric

It does not appear that there are any passenger vehicles in the municipal fleet. However, if the need arises for a vehicle that can be called upon to travel statewide or out of state where conventional fueling options are still easiest to find, a hybrid is a good option for reducing fuel use.

Biodiesel

The Town is already using B20 in its fleet. Due to the high demand for this renewable alternative to diesel there has not been a direct cost savings associated with the use of biodiesel. Studies have found that worker health is improved and the number of sick days reduced when they are exposed to the lower emissions associated with biodiesel blends. Biodiesel is a "bridge fuel", an entry level alternative that requires the least amount of change or cost, and it can be abandoned, adjusted or reapplied as the situation dictates with little or no effort. However, there is no way that biodiesel, by itself, will displace more than a small fraction of liquid diesel in the future. The agricultural base of the planet can only supply so much energy. In order to displace the vast quantities of petroleum used in transportation, all other alternative fuels will need to be utilized.

Hydrogen

Last summer, Cape Elizabeth was the staging site for a large number of vehicles operating on hydrogen fuel. On the Sunday prior to the beginning of the "Hydrogen Road Tour, 2008" more than 800 people descended on Fort Williams park to catch a glimpse of what might be the future of transportation. Although these concept cars, some of them one-of-a-kind prototypes, are not on the market yet, hydrogen remains a promising fuel for both transportation and stationary applications in the future. The significance of hydrogen from an energy conservation perspective is that it can be used as a storage medium when the production of renewable (or non-renewable) energy exceeds demand. Then, when demand for energy becomes greater, the stored hydrogen can be used in a fuel cell to reproduce electricity.

Long -Term Considerations

Long-term capital investments should consider long-term trends, long-term plans, and likely outcomes. One such long-term plan that relates to alternative energy in Cape Elizabeth is large scale wind farms combined with Ground Source Heat Pump (sometimes called geothermal) heating/cooling of homes. Former governor Angus King is promoting the Gulf of Maine as the location for a "wind farm". In combination with GSHP for heating, this Gulf of Maine wind farm is promoted as being capable of meeting the energy needs of the entire East Coast of the United States. T. Boone Pickens is proposing a similar plan for wind farms in TX. An attractive feature of this plan is that it can be initiated at a local level and integrated into the larger scale infrastructure as the system grows. Cape Elizabeth is fortunate to be located in an area windy enough to implement wind power locally and thus could be part of such a plan and take advantage of funding opportunities. Since such a system can and must be built incrementally and demonstrated in steps, it is possible that Cape Elizabeth could be part of such a demonstration and obtain funding to reduce the cost and improve the image of the town.

The use of ground source heat pumps (GSPHs) for heating in Cape Elizabeth fits well with this plan. A properly designed and implemented GSHP system requires little maintenance and only electrical energy, which can be obtained from a wide range of energy sources. There is no need for a boiler, oil tank, wood chip bins, gas pipes, delivery trucks, etc. The Abromson Center at USM utlizes only GSHP for all heating and cooling. They require connections for electricity, water, and sewer. The heating facilities room is clean, cool, and quiet in comparison with a boiler room. They are very happy with this system and are using a similar system in the new building next door. A GSHP system can be integrated with various forms of electrical energy production. Even if Cape Elizabeth does not implement a wind turbine in town, it would be part of the long-term solution.

Chapter 4
Recommendations

Based upon the cost-benefit analyses and sensitivity tests conducted for the nine alternative energy technologies under review, this study determined that the following alternatives have potential to be economically feasible.

- Energy Conservation Measures at town schools and municipal buildings based on investment grade audit
- Biomass boiler installation at high school
- Wind turbine installation on town-owned land
- Geothermal installation and retrofit at high school
- Natural gas conversion at school buildings

There are a number of barriers though to simply picking and installing any of these systems. First, the town of Cape Elizabeth is presently dealing with a challenging economic environment. Any project would need to lower costs or at least be budget neutral. That is to say that energy savings realized from a project would have to be equal to or greater than the debt service and any additional operating costs for the system.

With the passage of an amendment to Cape Elizabeth's zoning ordinance on July 14, 2008 permitting small wind turbines on poles of up to 100 feet on municipal property, zoning is no longer an obstacle to this alternative. A recommendation for a larger wind turbine would require the Town Council to again address the zoning ordinance. Concerns related to the potential aesthetic harm done to the natural scenery that defines the Cape Elizabeth landscape will need to be addressed in the specific siting of a wind turbine on municipal property.

Recommendations

The Alternative Energy Committee recommends that the Town further explore the following alternative energy options by:

1. Third Party Consultant/Energy Audit - Hire a third party consultant to perform an investment grade energy audit, recommend energy conservation measures and validate assumptions and recommendations from this report. This work is underway. In December 2008, the Town Manager authorized CM3 to prepare an energy audit for the Town's school and municipal buildings. The audit will result in a list of energy conservation measures along with the cost/benefit for each measure. This will allow the Town to pick and choose which measures to proceed with based on return on investment. In addition the consultant will validate the technical and economic feasibility of the alternative technology analysis performed by the committee including:
    - Energy Conservation Measures
    - Solar Photovoltaic (PV)
    - Wind Turbine
    - Solar Thermal
    - Woodchip Industrial Combustion
    - Geothermal Heat Pump
    - Natural Gas Conversion
    - Cogeneration

    This process will take several months to complete. Once the audit and analysis is completed, the committee will work with the Facilities Manager on the best path to proceed forward.

2. Wind Turbine Site Survey - Conduct a wind turbine site survey to measure the actual wind speed and consistency at potential sites in Cape Elizabeth as well as a detailed assessment of the costs and benefits of installing a wind turbine. An anemometer should be installed on a 30m to 40m tower at one or more potential wind turbine installation sites and operated for three months to a year to record actual average wind speed, direction and consistency. The resulting measurements can be compared with historical measurements recorded at Portland International Jetport to provide a long-term estimate

of anticipated average wind speeds and consistency. Commercial vendors can install a tower and anemometer and record wind speeds for a cost of approximately $15,000. Discounted costs could potentially be obtained by installing an anemometer on an existing cell tower or using used equipment.

3. Community Awareness - Build community awareness and support for installing alternative energy technology at the school and municipal buildings. Community awareness will need to be built to provide the public with the reality (and not the misperception) of the costs and benefits of pursuing an alternative energy system. The objective is to inform the public with the facts to reduce any resistance based on misinformation. Other ways to improve community awareness and build support for alternative energy technologies and projects include:
    - News articles and op-eds placed in *The Courier*
    - Website with a discussion board, blogs, newsfeeds and other access to helpful and interesting information on alternative energy
    - Talks, forums, symposiums and other public events promoting alternative energy

4. Actively Pursue Funding for Alternative Energy Projects – A major campaign issue for the incoming Presidential administration in Washington has been to step-up investment in renewable and clean energy technology and infrastructure. Assuming that this is the case, after the new administration is in place, there should be new opportunities for alternative energy funding including loans, rebates, grants and other incentives that will improve the economics for alternative energy projects within the Town. From that standpoint there has probably never been a better time to finalize plans for developing new alternative energy infrastructure. In addition existing programs need to be explored including Clean Renewable Energy Bonds, (CREBS), Renewable Energy Credits (RECS), and Efficiency Maine, to identify and apply for these sources of funding in order to optimize the project economics.

5. Full Cost Appraisal. Based on results of third party consultants work (recommendation #1), conduct a full cost appraisal for the recommended technology options. The committee will support the Facilities Manager, working with the engineers and architects to conduct

an extensive assessment of the actual costs of installing the selected technology options. This will provide the Town with the accurate and detailed figures it will need to make an informed decision when the time comes and there is money to finance a large-scale alternative energy project.

6. U.S. Mayors Climate Protection Agreement. We recommend that the Town adopts a stated objective relative to greenhouse gas emissions such as the U.S. Mayors Climate Protection Agreement. Since this agreement was introduced in 2005 over 400 towns (representing more than 59 million Americans) have signed this agreement, including several towns in Maine – Portland, Saco, Kennebunk, Belfast and Biddeford.[84] The agreement states, "We will strive to meet or exceed Kyoto Protocol targets for reducing global warming pollution by taking actions in our own operations and communities…" It also recognizes that the Kyoto Protocol reduction target for the United States (had the government signed) would have been CO_2 emissions levels of seven percent below 1990 level by 2012.[85]

7. Participate with GPCOG in completing the ICLEI – Local Governments for Sustainability – Regional Assessment . Clean Air and Climate Protection (CACP) is a software product that helps local governments create greenhouse gas inventories, quantify the benefits of reduction measures and formulate local climate action plans. The software enables local governments to develop harmonized strategies to reduce both greenhouse gas and air pollution emissions, and save energy.

   As a regional member of ICLEI, GPCOG is committed to working with Cape Elizabeth to pilot the new software beginning in January. Some of the inventory work has already been completed. Ultimately, GPCOG will develop inventories at the municipal and community levels for all its members with the overall goal of producing a comprehensive regional assessment. This baseline assessment is a critical tool for creating a climate action plan.

[84] Bartlett, Rob. 'Kennebunk Selectman sign Mayors' Climate Protection Agreement.' SEA Change Happen. February 28, 2007. http://seachangehappen.blogspot.com/2007/02/kennebunk-selectmen-sign-mayors-climate.html. (March 16, 2008).

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Interviews

- Alan Kuniholm, architect at Portland Design Team (February 11, 2008)
- Barry Burnstein, Better World Energy (March 5, 2008)
- David Kyle, Efficiency Maine (February 15, 2008)
- David Preston, Worldwide Energy (March 21, 2008)
- Eric Coty, member of Saco Town Council (March 1, 2008)
- Ernie MacVane, Cape Elizabeth Facilities Manager. Februrary 13, 2008.
- Gene Jordan, Facilities Manager of Leavitt High School in Turner, ME (March 11, 2008)
- James Rowe, Cape Elizabeth Finance Manager (March 4, 2008)

- Joan Saxe, Cool Communities (February 14, 2008)
- Mary Ann Lynch, Chair of Cape Elizabeth Town Council (March 4, 2008)
- Paulina Aportria, Cape Elizabeth School Business Manager (March 4, 2008)
- Phil Coupe, ReVision Energy (March 18, 2008)

Appendix 1

Assumptions

Concurrent with the development of this report, the committee is working with the town's consultant to complete an investment grade energy audit for the town school and municipal buildings. The purpose of the audit is to identify energy conservation measures to reduce the amount of energy consumed in the school and municipal buildings. For purposes of this report we have assumed that a 10% reduction in energy consumption can be realized by implementing the conservation measures that will be identified. Therefore prior to evaluating the remaining alternative energy options we have assumed the baseline energy consumption will be reduced by 10% savings realized from energy conservation measures.

The table below shows the assumptions used to develop the "Baseline" for purposes of our analysis.

Elec Load (kwh)	2003	2004	2005	2006	2007	Assumed Efficiency Savings	Baseline
Police Station	166,550	179,960	204,920	208,000	196,440	19,644	176,796
Public Works	88,780	124,120	124,120	107,480	97,720	9,772	87,948
Thomas Memorial Lil	104,292	80,558	67,709	93,905	71,937	7,194	64,743
Town Center Fire Sta	0	0	0	0	0	0	0
Town Hall	79,397	82,297	91,329	91,054	83,251	8,325	74,926
Transfer Station	0	15,219	17,460	16,158	17,497	1,750	15,747
Schools	2,229,000	2,298,000	2,280,000	2,395,000	2,213,000	221,300	1,991,700
						0	0
Total	2,668,019	2,780,154	2,785,538	2,911,597	2,679,845	267,985	2,411,861

Oil (gallons)	2003	2004	2005	2006	2007	Assumed Efficiency Savings	Baseline
Police Station	5,437	5,309	6,020	4,656	4,837	484	4,353
Public Works	11,384	8,684	6,460	7,305	5,381	538	4,843
Thomas Memorial Lil	9,458	6,730	6,730	6,974	5,788	579	5,209
Town Center Fire Sta	0	0	0	0	0	0	0
Town Hall	6,155	5,361	4,092	4,751	4,566	457	4,109
Transfer Station	0					0	0
High School	82,113	83,309	85,495	80,834	81,974	8,197	73,777
Middle School	67,302	69,584	65,508	58,256	65,252	6,525	58,727
Total	181,849	178,977	174,304	162,775	167,798	16,780	151,018

Another assumption of this report is that CO_2 is a sufficient proxy for calculating greenhouse gas emissions among the different alternative energy technologies.

The United Nations Framework Convention on Climate Change takes inventory data on six greenhouse gases: carbon dioxide (CO_2), nitrous oxide (N_20), methane (CH_4), sulphur hexafluoride (SF_6), hydroflourocarbons (HFCs), and perflourocarbons (PFCs).[86] However, it has been noted that with regard to energy consumption CO_2 is the most important gas responsible for the greenhouse effect.[87]

Another assumption included in this study concerns the future of the carbon tax. Presently carbon trades in Europe for about $30/ton.[88] Some experts believe that when the tax is ultimately implemented in the United States it will settle between $20 and $30 per ton.[89] While it is likely that a carbon tax will eventually be approved in the United States, the timing is difficult (if not impossible) to predict. This cost was therefore excluded from the analysis in this study.

In performing the economic analysis the following assumptions were made on unit pricing:

Unit Costs

Parameter	**Unit**	**Cost**
Electricity, $/kwh	$/kwh	**$0.15**
Oil, $/gal	$/gal	**$2.75**
Propane, $/gal	$/gal	**$2.00**
Water Cost, $/HCF	$/HCF	**$0.50**
Biomass Cost, $/ton	$/ton	**$50.00**
Pellet Cost, $/ton	$/ton	**$250.00**
Natural Gas	$/mmBtu	**$15.50**

In evaluating CO2 emission reductions the following factors were used:

CO2 Emission Factors

Parameter	Unit	Factor
Fuel Oil	lb/gallon	**22.384**
Electricity	lb/kwh	**1.36**
Biomass	lb/ton	**0**
Natural Gas	lb/mmBtu	**117.08**

[86] United Nations Framework Convention on Climate Change. http://unfccc.int/ghg_emissions_data/items/3800.php. (April 1, 2008).
[87] Adriatic Common Indicators Methodology Sheet (October 2004) http://www.aap2020.net/ACI%20methodology%20sheets/3ok.pdf (March 31, 2008).
[88] Aston, Adam. 'Are solar photovoltaics just too costly?' Business Week: Green Biz. February 23, 2008. http://www.businessweek.com/investing/greenbiz/archives/2008/02/is_solar_photov.html. (March 26, 2008).
[89] Wald, Matthew. 'The Carbon Calculus.' The New York Times. November 7, 2007. http://www.nytimes.com/2007/11/07/business/businessspecial3/07carbon.html?_r=1&oref=slogin (April 1, 2008).

The cost and savings estimates in this report are high level preliminary basis. Before any final decision is made a more extensive and customized analysis needs to be performed by engineers, architects and the facilities manager.

A final assumption is that the existing schools and municipal buildings will remain in service for many years such that adequate time would be available to allow return on investment for investments in energy infrastructure. For example, if there were plans to replace the high school with a new high school in the next five years or so, recommendations in this report could be different. The high school is old enough that it may soon qualify for replacement with a percentage of this replacement cost may be covered by the State. At this time the committee is not aware of plans for major changes of this nature, however, the life and replacement of the High School should be considered along with plans for major changes related to energy systems.

Appendix 2
Funding Sources for Alternative Energy Technologies

Clean Renewable Energy Bonds

The federal government has created a loan program for Clean Renewable Energy Bonds. Wind, geothermal and solar energy facilities are eligible for support under this program.[90] These bonds were designed to help public sector entities, like local governments, obtain capital funding to invest in renewable energy projects. The Clean Renewable Energy Bond is a "new form of tax credit bond in which interest on the bonds is paid in the form of federal tax credits by the United States government in lieu of interest paid by the issuer."[91] It is essentially a 0 percent interest bond. The borrower is only required to pay back the principal.

This year the Internal Revenue Service approved $800 million in bond authorization for this program (they received applications for three times this amount). A total of 610 projects were approved, including 532 government projects, ranging in size from $23,000 to $3.2 million. Of these government projects, 401 were for solar PV systems, and 99 for wind turbines. The deadline to receive funding this year has passed, but strong interest in the program is likely to ensure renewal next year.[92]

Efficiency Maine

Efficiency Maine is a statewide program to promote efficient electricity use. According to Shirley Bartlett, Program Manager for Efficiency Maine, the subsidies for solar PV systems, like those provided in the Renewable Resource Fund have been exhausted.[93] However, there is funding available to at least partially support wind and solar thermal projects. For solar thermal projects, Efficiency Maine will cover 35 percent of cost for a solar thermal project, capped at $10,500.[94] For

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[90] Oswald, Edwin and Larson, Michael. 'An Explanation of Clean Renewable Energy Bonds.' Orrick, Herrington and Sutcliffe. 2006. http://www.orrick.com/fileupload/636.PDF. (March 30, 2008).

[91] Oswald, Edwin and Larson, Michael. 'An Explanation of Clean Renewable Energy Bonds.' Orrick, Herrington and Sutcliffe. 2006. http://www.orrick.com/fileupload/636.PDF. (March 30, 2008).

[92] Environmental Law and Policy Center. Clean Renewable Energy Bonds. http://www.elpc.org/energy/farm/crebs.php. (March 25, 2008).

[93] Based on conversation with Shirley Barltlett, Program Manager for Efficiency Maine (March 20,2008).

[94] Based on interview with Richard Fortier, Efficiency Maine (February 22, 2008).

wind turbine projects, Efficiency Maine will pay for the anemometer to measure wind level at school site.[95]

Regional Greenhouse Gas Initiative

The Regional Greenhouse Gas Initiative (RGGI) is the first mandatory, market-based effort in the United States to reduce greenhouse gas emissions. Ten Northeastern and Mid-Atlantic states will cap and then reduce CO_2 emissions from the power sector 10% by 2018.

States will sell emission allowances through auctions and invest proceeds in consumer benefits: energy efficiency, renewable energy, and other clean energy technologies. RGGI will spur innovation in the clean energy economy and create green jobs in each state.

New Administration in Washington

A major campaign issue for the incoming Presidential team in Washington has been to step-up investment in renewable and clean energy technology and infrastructure. Assuming that this is the case after the administration change, there will be new opportunities for alternative energy funding including loans, rebates, grants and other incentives that will improve the economics for alternative energy projects within the Town. From that standpoint there has probably never been a better time to develop and finalize plans for investments in new alternative energy infrastructure.

Maine Clean Communities - Grants

The Clean Cities FY09 Petroleum Reduction Technologies Projects for the Transportation Sector, Funding Opportunity has been posted on Grants.gov. There are three funding categories:

- Refueling Infrastructure for Alternative Fuels
- Incremental Cost of Dedicated Alternative Fuel Vehicles
- Education and Outreach Workshops for Petroleum Reduction Fuels and Technologies

Proposals are due February 27, 2009.

[95] Based on interview with David Kyle, Efficiency Maine (February 15, 2008).

Appendix 3
2007 Municipal Facilities Energy and Emissions Data

	Electricity (kWh)	Metric Tons CO2 Emissions	Heating Oil (gallons)	Metric Tons CO2 Emissions	Propane (gallons)	Metric Tons CO2 Emissions	Diesel Fuel (gallons)	Metric Tons CO2 Emissions	Unleaded Fuel (gallons)	Metric Tons CO2 Emissions	Total Metric Tons CO2 Emissions
Police Station	196,440.00	119.38	4,837.00	49.10	0.00	0.00	0.00	0.00	0.00	0.00	**168.48**
Public Works Dept	97,720.00	59.39	5,381.00	54.63	0.00	0.00	0.00	0.00	0.00	0.00	**114.01**
Thomas Memorial Library	71,937.00	43.72	5,788.00	58.76	0.00	0.00	0.00	0.00	0.00	0.00	**102.47**
Town Center Fire Station	0.00	0.00	0.00	0.00	8,103.00	46.56	0.00	0.00	0.00	0.00	**46.56**
Town Hall	83,251.00	50.59	4,566.00	46.35	0.00	0.00	0.00	0.00	0.00	0.00	**96.94**
Transfer Station	17,497.00	10.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**10.63**
Town Fleet	0.00	0.00	0.00	0.00	0.00	0.00	36,252.00	368.01	19,869.90	176.26	**544.27**
Richards Community Pool	503,819.00	306.18	(included in Schools)	N/A	0.00	0.00	0.00	0.00	0.00	0.00	**306.18**
Schools - Pond Cove, Middle School, High School	2,298,000.00	1,396.52	147,226.00	1,494.56	0.00	0.00	0.00	0.00	0.00	0.00	**2,891.08**
Total	3,268,664.00	1,986.40	167,798.00	1,703.40	8,103.00	46.56	36,252.00	368.01	19,869.90	176.26	**4,280.62**

Appendix 4
Alternative Summary Tables

Alternative Summary Table (Most Favorable Case, low borrowing cost, high energy inflation)

Parameter	Units	Energy Conservation Measures	Geothermal	Biomass Boiler	50 kW Wind Turbine	660 kW Wind Turbine	Solar PV	Solar Thermal	Natural Gas	Cogneneration
Borrowing Cost Sensitivity	high or low?	low	low	low	low	low	low	low	low	low
Energy Inflation Sensitivity	high or low?	high	high	high	high	high	high	high	high	high
Initial Cost	$	$435,454	$2,366,504	$1,500,000	$250,000	$1,880,147	$36,000	$100,000	$1,210,000	$2,360,000
Elec Energy Savings	%	10.0%	-44.4%	0.0%	4.4%	43.6%	0.2%	0.0%	0.0%	113.7%
Elec Energy Savings	kwh/yr	221,300	-515,314	0	88,233	867,821	4,800	0	0	1,991,700
Fuel Oil Savings	%	10.0%	53.4%	50.1%	0.0%	0.0%	0.0%	0.7%	85.0%	100.0%
Fuel Oil Savings	mmBtu/yr	2,042	9,815	9,210	0	0	0	137	15,621	18,378
CO2 Emissions Reduction	%	10.0%	14.0%	23.6%	1.9%	18.7%	0.1%	0.3%	11.0%	10.8%
CO2 Emissions Reduction	metric Tons/yr	286	401	674	54	535	3	10	314	310
First Year Savings	$/yr	$50,803	-$2,730	$46,617	$294	$31,827	-$1,604	-$2,290	$7,094	-$251,014
Net Present Value	$	$693,679	$399,852	$841,999	$40,197	$475,007	-$12,120	-$9,738	$302,472	-$2,530,609
Profitability Index	%	159%	17%	56%	16%	25%	-34%	-10%	25%	-107%
CO2 Emissions Reductions Index	tons/000$	0.66	0.17	0.45	0.22	0.28	0.08	0.10	0.26	0.13

Profitability Index is the ratio of NPV/Initial Cost. The higher the number, the better the investment.

CO2 Emission reduction Index is CO2 emission reductions in metric tons divided by the intital investment times $1000. The higher the number the more effective the investment is used to reduce greenhouse gas emissions.

Appendix 4
Alternative Summary Tables- Continued

Alternative Summary Table (Neutral Case, high borrowing cost, high energy inflation)

Parameter	Units	Energy Conservation Measures	Geothermal	Biomass Boiler	50 kW Wind Turbine	660 kW Wind Turbine	Solar PV	Solar Thermal	Natural Gas	Cogneneration
Borrowing Cost Sensitivity	high or low?	high	high	high	high	high	high	high	high	high
Energy Inflation Sensitivity	high or low?	high	high	high	high	high	high	high	high	high
Initial Cost	$	$435,454	$2,366,504	$1,500,000	$250,000	$1,880,147	$36,000	$100,000	$1,210,000	$2,360,000
Elec Energy Savings	%	10.0%	-44.4%	0.0%	4.4%	43.6%	0.2%	0.0%	0.0%	113.7%
Elec Energy Savings	kwh/yr	221,300	-515,314	0	88,233	867,821	4,800	0	0	1,991,700
Fuel Oil Savings	%	10.0%	53.4%	50.1%	0.0%	0.0%	0.0%	0.7%	85.0%	100.0%
Fuel Oil Savings	mmBtu/yr	2,042	9,815	9,210	0	0	0	137	15,621	18,378
CO2 Emissions Reduction	%	10.0%	14.0%	23.6%	1.9%	18.7%	0.1%	0.3%	11.0%	10.8%
CO2 Emissions Reduction	metric Tons/yr	286	401	674	54	535	3	10	314	310
First Year Savings	$/yr	$39,298	-$65,256	$6,985	-$6,312	-$17,850	-$2,555	-$4,932	-$24,876	-$313,369
Net Present Value	$	$595,728	-$132,472	$504,587	-$16,038	$52,085	-$20,218	-$32,233	$30,294	-$3,061,470
Profitability Index	%	137%	-6%	34%	-6%	3%	-56%	-32%	3%	-130%
CO2 Emissions Reductions Index	tons/000$	0.66	0.17	0.45	0.22	0.28	0.08	0.10	0.26	0.13

Profitability Index is the ratio of NPV/Initial Cost. The higher the number, the better the investment.
CO2 Emission reduction Index is CO2 emission reductions in metric tons divided by the intital investment times $1000. The higher the number the more effective the investment is used to reduce greenhouse gas emissions.

Appendix 4
Alternative Summary Tables- Continued

Alternative Summary Table (Least Attractive case, high borrowing cost, low energy inflation)

Parameter	Units	Energy Conservation Measures	Geothermal	Biomass Boiler	50 kW Wind Turbine	660 kW Wind Turbine	Solar PV	Solar Thermal	Natural Gas	Cogneneration
Borrowing Cost Sensitivity	high or low?	high	high	high	high	high	high	high	high	high
Energy Inflation Sensitivity	high or low?	low	low	low	low	low	low	low	low	low
Initial Cost	$	$435,454	$2,366,504	$1,500,000	$250,000	$1,880,147	$36,000	$100,000	$1,210,000	$2,360,000
Elec Energy Savings	%	10.0%	-44.4%	0.0%	4.4%	43.6%	0.2%	0.0%	0.0%	113.7%
Elec Energy Savings	kwh/yr	221,300	-515,314	0	88,233	867,821	4,800	0	0	1,991,700
Fuel Oil Savings	%	10.0%	53.4%	50.1%	0.0%	0.0%	0.0%	0.7%	85.0%	100.0%
Fuel Oil Savings	mmBtu/yr	2,042	9,815	9,210	0	0	0	137	15,621	18,378
CO2 Emissions Reduction	%	10.0%	14.0%	23.6%	1.9%	18.7%	0.1%	0.3%	11.0%	10.8%
CO2 Emissions Reduction	metric Tons/yr	286	401	674	54	535	3	10	314	310
First Year Savings	$/yr	$39,298	-$65,256	$6,985	-$6,312	-$17,850	-$2,555	-$4,932	-$24,876	-$313,369
Net Present Value	$	$595,728	-$132,472	$504,587	-$16,038	$52,085	-$20,218	-$32,233	$30,294	-$3,061,470
Profitability Index	%	137%	-6%	34%	-6%	3%	-56%	-32%	3%	-130%
CO2 Emissions Reductions Index	tons/000$	0.66	0.17	0.45	0.22	0.28	0.08	0.10	0.26	0.13

Profitability Index is the ratio of NPV/Initial Cost. The higher the number, the better the investment.
CO2 Emission reduction Index is CO2 emission reductions in metric tons divided by the intital investment times $1000. The higher the number the more effective the investment is used to reduce greenhouse gas emissions.

Appendix 4
Alternative Summary Tables- Continued

Alternative Summary Table (Neutral Case, low borrowing cost, low energy inflation)

Parameter	Units	Energy Conservation Measures	Geothermal	Biomass Boiler	50 kW Wind Turbine	660 kW Wind Turbine	Solar PV	Solar Thermal	Natural Gas	Cogneneration
Borrowing Cost Sensitivity	high or low?	low	low	low	low	low	low	low	low	low
Energy Inflation Sensitivity	high or low?	low	low	low	low	low	low	low	low	low
Initial Cost	$	$435,454	$2,366,504	$1,500,000	$250,000	$1,880,147	$36,000	$100,000	$1,210,000	$2,360,000
Elec Energy Savings	%	10.0%	-44.4%	0.0%	4.4%	43.6%	0.2%	0.0%	0.0%	113.7%
Elec Energy Savings	kwh/yr	221,300	-515,314	0	88,233	867,821	4,800	0	0	1,991,700
Fuel Oil Savings	%	10.0%	53.4%	50.1%	0.0%	0.0%	0.0%	0.7%	85.0%	100.0%
Fuel Oil Savings	mmBtu/yr	2,042	9,815	9,210	0	0	0	137	15,621	18,378
CO2 Emissions Reduction	%	10.0%	14.0%	23.6%	1.9%	18.7%	0.1%	0.3%	11.0%	10.8%
CO2 Emissions Reduction	metric Tons/yr	286	401	674	54	535	3	10	314	310
First Year Savings	$/yr	$50,803	-$2,730	$46,617	$294	$31,827	-$1,604	-$2,290	$7,094	-$251,014
Net Present Value	$	$521,454	$115,369	$542,717	$9,837	$176,398	-$13,771	-$16,171	$142,070	-$2,336,454
Profitability Index	%	120%	5%	36%	4%	9%	-38%	-16%	12%	-99%
CO2 Emissions Reductions Index	tons/000$	0.66	0.17	0.45	0.22	0.28	0.08	0.10	0.26	0.13

Profitability Index is the ratio of NPV/Initial Cost. The higher the number, the better the investment.
CO2 Emission reduction Index is CO2 emission reductions in metric tons divided by the intital investment times $1000. The higher the number the more effective the investment is used to reduce greenhouse gas emissions.

Appendix 5
Energy Conservation Measures – NPV

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Energy Conservation Measures at High School & Middle School

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	low

Key Inputs				
High School Area	sq ft	**168,000**		
Middle School Area	sq ft	**181,468**		
Fuel Oil Savings	%	**10%**	assume	
Elec Savings	%	**10%**	assume	
Capital Cost	$	$435,454	assume xx yr simple payback	**6** yrs
Pipeline	$	$0		
Total Capital Cost	$	$435,454		
Interest Rate	%	0%	Based on interest free CREBS (Clean Renewable Energy Bonds)	
Term	yrs	**20**		
Debt Service	$/yr	$21,773		
NPV Discount Rate	%	**10%**		

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Existing Situation																						
Fuel Oil Use	Gal/yr		147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226
Fuel Oil Use	mmBtu/yr		20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420
Fuel Oil Cost	$/gal	5.0%	$2.75	$2.89	$3.03	$3.18	$3.34	$3.51	$3.69	$3.87	$4.06	$4.27	$4.48	$4.70	$4.94	$5.19	$5.44	$5.72	$6.00	$6.30	$6.62	$6.95
Fuel Oil Cost	$/yr		$404,872	$425,115	$446,371	$468,689	$492,124	$516,730	$542,567	$569,695	$598,180	$628,089	$659,493	$692,468	$727,091	$763,446	$801,618	$841,699	$883,784	$927,973	$974,372	$1,023,090
Elec Use	kwh/yr		2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000
Elec Rate	$/kwh	5.0%	$0.145	$0.152	$0.160	$0.168	$0.176	$0.185	$0.194	$0.204	$0.214	$0.225	$0.236	$0.248	$0.260	$0.273	$0.287	$0.301	$0.317	$0.332	$0.349	$0.366
Elec Cost	$/yr		$320,885	$336,929	$353,776	$371,464	$390,038	$409,540	$430,017	$451,517	$474,093	$497,798	$522,688	$548,822	$576,263	$605,077	$635,330	$667,097	$700,452	$735,474	$772,248	$810,860
Total Existing Cost	$/yr		$725,757	$762,044	$800,147	$840,154	$882,162	$926,270	$972,583	$1,021,212	$1,072,273	$1,125,887	$1,182,181	$1,241,290	$1,303,354	$1,368,522	$1,436,948	$1,508,796	$1,584,235	$1,663,447	$1,746,620	$1,833,951
Efficiency Measures Option																						
Fuel Oil Savings	Gal/yr		14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723
Fuel Oil Savings	mmBtu/yr		2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042
Fuel Oil Savings	$/yr		$40,487	$42,512	$44,637	$46,869	$49,212	$51,673	$54,257	$56,969	$59,818	$62,809	$65,949	$69,247	$72,709	$76,345	$80,162	$84,170	$88,378	$92,797	$97,437	$102,309
Elec Savings	kwh/yr		221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300
Elec Savings	$/yr		$32,089	$33,693	$35,378	$37,146	$39,004	$40,954	$43,002	$45,152	$47,409	$49,780	$52,269	$54,882	$57,626	$60,508	$63,533	$66,710	$70,045	$73,547	$77,225	$81,086
Total Energy Savings	$/yr		$72,576	$76,204	$80,015	$84,015	$88,216	$92,627	$97,258	$102,121	$107,227	$112,589	$118,218	$124,129	$130,335	$136,852	$143,695	$150,880	$158,424	$166,345	$174,662	$183,395
less Debt Service	$/yr		$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773
Net Savings	$/yr		$50,803	$54,432	$58,242	$62,243	$66,443	$70,854	$75,486	$80,349	$85,455	$90,816	$96,445	$102,356	$108,563	$115,080	$121,922	$129,107	$136,651	$144,572	$152,889	$161,622
CO2 emissions reductions	*tons/yr*		286	286	286	286	286	286	286	286	286	286	286	286	286	286	286	286	286	286	286	286
Net Present Value		$	**693,679**																			

Appendix 5
Energy Conservation Measures (Continued)

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Energy Conservation Measures at High School & Middle School

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	low

Key Inputs

High School Area	sq ft	**168,000**		
Middle School Area	sq ft	**181,468**		
Fuel Oil Savings	%	**10%**	assume	
Elec Savings	%	**10%**	assume	
Capital Cost	$	$435,454	assume xx yr simple payback	**6** yrs
Pipeline	$	$0		
Total Capital Cost	$	$435,454		
Interest Rate	%	0%	Based on interest free CREBS (Clean Renewable Energy Bonds)	
Term	yrs	**20**		
Debt Service	$/yr	$21,773		
NPV Discount Rate	%	**10%**		

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Existing Situation																						
Fuel Oil Use	Gal/yr		147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226
Fuel Oil Use	mmBtu/yr		20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420
Fuel Oil Cost	$/gal	*2.0%*	$2.75	$2.81	$2.86	$2.92	$2.98	$3.04	$3.10	$3.16	$3.22	$3.29	$3.35	$3.42	$3.49	$3.56	$3.63	$3.70	$3.78	$3.85	$3.93	$4.01
Fuel Oil Cost	$/yr		$404,872	$412,969	$421,228	$429,653	$438,246	$447,011	$455,951	$465,070	$474,371	$483,859	$493,536	$503,407	$513,475	$523,744	$534,219	$544,904	$555,802	$566,918	$578,256	$589,821
Elec Use	kwh/yr		2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000
Elec Rate	$/kwh	*2.0%*	$0.145	$0.148	$0.151	$0.154	$0.157	$0.160	$0.163	$0.167	$0.170	$0.173	$0.177	$0.180	$0.184	$0.188	$0.191	$0.195	$0.199	$0.203	$0.207	$0.211
Elec Cost	$/yr		$320,885	$327,303	$333,849	$340,526	$347,336	$354,283	$361,369	$368,596	$375,968	$383,487	$391,157	$398,980	$406,960	$415,099	$423,401	$431,869	$440,506	$449,316	$458,303	$467,469
Total Existing Cost	$/yr		$725,757	$740,272	$755,077	$770,179	$785,582	$801,294	$817,320	$833,666	$850,339	$867,346	$884,693	$902,387	$920,435	$938,843	$957,620	$976,773	$996,308	$1,016,234	$1,036,559	$1,057,290
Efficiency Measures Option																						
Fuel Oil Savings	Gal/yr		14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723
Fuel Oil Savings	mmBtu/yr		2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042
Fuel Oil Savings	$/yr		$40,487	$41,297	$42,123	$42,965	$43,825	$44,701	$45,595	$46,507	$47,437	$48,386	$49,354	$50,341	$51,347	$52,374	$53,422	$54,490	$55,580	$56,692	$57,826	$58,982
Elec Savings	kwh/yr		221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300
Elec Savings	$/yr		$32,089	$32,730	$33,385	$34,053	$34,734	$35,428	$36,137	$36,860	$37,597	$38,349	$39,116	$39,898	$40,696	$41,510	$42,340	$43,187	$44,051	$44,932	$45,830	$46,747
Total Energy Savings	$/yr		$72,576	$74,027	$75,508	$77,018	$78,558	$80,129	$81,732	$83,367	$85,034	$86,735	$88,469	$90,239	$92,043	$93,884	$95,762	$97,677	$99,631	$101,623	$103,656	$105,729
less Debt Service	$/yr		$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773	$21,773
Net Savings	$/yr		$50,803	$52,254	$53,735	$55,245	$56,786	$58,357	$59,959	$61,594	$63,261	$64,962	$66,697	$68,466	$70,271	$72,112	$73,989	$75,905	$77,858	$79,851	$81,883	$83,956
CO_2 emissions reductions	*tons/yr*		286	286	286	286	286	286	286	286	286	286	286	286	286	286	286	286	286	286	286	286
Net Present Value		$	**521,454**																			

Appendix 5
Energy Conservation Measures--NPV (Continued)

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Energy Conservation Measures at High School & Middle School

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	high

Key Inputs

High School Area	sq ft	**168,000**		
Middle School Area	sq ft	**181,468**		
Fuel Oil Savings	%	**10%**	assume	
Elec Savings	%	**10%**	assume	
Capital Cost	$	$435,454	assume xx yr simple payback	**6** yrs
Pipeline	$	$0		
Total Capital Cost	$	$435,454		
Interest Rate	%	5%		
Term	yrs	**20**		
Debt Service	$/yr	$33,278		
NPV Discount Rate	%	**10%**		

		Escalation	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Existing Situation												
Fuel Oil Use	Gal/yr		147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226
Fuel Oil Use	mmBtu/yr		20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420
Fuel Oil Cost	$/gal	*5.0%*	$2.75	$2.89	$3.03	$3.18	$3.34	$3.51	$3.69	$3.87	$4.06	$4.27
Fuel Oil Cost	$/yr		$404,872	$425,115	$446,371	$468,689	$492,124	$516,730	$542,567	$569,695	$598,180	$628,089
Elec Use	kwh/yr		2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000
Elec Rate	$/kwh	*5.0%*	$0.145	$0.152	$0.160	$0.168	$0.176	$0.185	$0.194	$0.204	$0.214	$0.225
Elec Cost	$/yr		$320,885	$336,929	$353,776	$371,464	$390,038	$409,540	$430,017	$451,517	$474,093	$497,798
Total Existing Cost	$/yr		$725,757	$762,044	$800,147	$840,154	$882,162	$926,270	$972,583	$1,021,212	$1,072,273	$1,125,887
Efficiency Measures Option												
Fuel Oil Savings	Gal/yr		14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723
Fuel Oil Savings	mmBtu/yr		2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042
Fuel Oil Savings	$/yr		$40,487	$42,512	$44,637	$46,869	$49,212	$51,673	$54,257	$56,969	$59,818	$62,809
Elec Savings	kwh/yr		221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300
Elec Savings	$/yr		$32,089	$33,693	$35,378	$37,146	$39,004	$40,954	$43,002	$45,152	$47,409	$49,780
Total Energy Savings	$/yr		$72,576	$76,204	$80,015	$84,015	$88,216	$92,627	$97,258	$102,121	$107,227	$112,589
less Debt Service	$/yr		$33,278	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278
Net Savings	$/yr		$39,298	$42,926	$46,737	$50,737	$54,938	$59,349	$63,980	$68,843	$73,949	$79,311
CO2 emissions reductions	*tons/yr*		286	286	286	286	286	286	286	286	286	286
Net Present Value		**$**	**595,728**									

		11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Existing Situation											
Fuel Oil Use	Gal/yr	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226
Fuel Oil Use	mmBtu/yr	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420
Fuel Oil Cost	$/gal	$4.48	$4.70	$4.94	$5.19	$5.44	$5.72	$6.00	$6.30	$6.62	$6.95
Fuel Oil Cost	$/yr	$659,493	$692,468	$727,091	$763,446	$801,618	$841,699	$883,784	$927,973	$974,372	$1,023,090
Elec Use	kwh/yr	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000
Elec Rate	$/kwh	$0.236	$0.248	$0.260	$0.273	$0.287	$0.301	$0.317	$0.332	$0.349	$0.366
Elec Cost	$/yr	$522,688	$548,822	$576,263	$605,077	$635,330	$667,097	$700,452	$735,474	$772,248	$810,860
Total Existing Cost	$/yr	$1,182,181	$1,241,290	$1,303,354	$1,368,522	$1,436,948	$1,508,796	$1,584,235	$1,663,447	$1,746,620	$1,833,951
Efficiency Measures Option											
Fuel Oil Savings	Gal/yr	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723
Fuel Oil Savings	mmBtu/yr	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042
Fuel Oil Savings	$/yr	$65,949	$69,247	$72,709	$76,345	$80,162	$84,170	$88,378	$92,797	$97,437	$102,309
Elec Savings	kwh/yr	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300
Elec Savings	$/yr	$52,269	$54,882	$57,626	$60,508	$63,533	$66,710	$70,045	$73,547	$77,225	$81,086
Total Energy Savings	$/yr	$118,218	$124,129	$130,335	$136,852	$143,695	$150,880	$158,424	$166,345	$174,662	$183,395
less Debt Service	$/yr	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278
Net Savings	$/yr	$84,940	$90,851	$97,057	$103,574	$110,417	$117,602	$125,145	$133,067	$141,384	$150,117
CO2 emissions reductions	*tons/yr*	286	286	286	286	286	286	286	286	286	286

Appendix 5
Energy Conservation Measures—NPV (Continued)

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Energy Conservation Measures at High School & Middle School

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	high

Key Inputs

High School Area	sq ft	**168,000**		
Middle School Area	sq ft	**181,468**		
Fuel Oil Savings	%	**10%**	assume	
Elec Savings	%	**10%**	assume	
Capital Cost	$	$435,454	assume xx yr simple payback	**6** yrs
Pipeline	$	$0		
Total Capital Cost	$	$435,454		
Interest Rate	%	5%		
Term	yrs	**20**		
Debt Service	$/yr	$33,278		
NPV Discount Rate	%	**10%**		

		Escalation	1	2	3	4	5	6	7	8	9	10
Existing Situation												
Fuel Oil Use	Gal/yr		147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226
Fuel Oil Use	mmBtu/yr		20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420
Fuel Oil Cost	$/gal	*2.0%*	$2.75	$2.81	$2.86	$2.92	$2.98	$3.04	$3.10	$3.16	$3.22	$3.29
Fuel Oil Cost	$/yr		$404,872	$412,969	$421,228	$429,653	$438,246	$447,011	$455,951	$465,070	$474,371	$483,859
Elec Use	kwh/yr		2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000
Elec Rate	$/kwh	*2.0%*	$0.145	$0.148	$0.151	$0.154	$0.157	$0.160	$0.163	$0.167	$0.170	$0.173
Elec Cost	$/yr		$320,885	$327,303	$333,849	$340,526	$347,336	$354,283	$361,369	$368,596	$375,968	$383,487
Total Existing Cost	$/yr		$725,757	$740,272	$755,077	$770,179	$785,582	$801,294	$817,320	$833,666	$850,339	$867,346
Efficiency Measures Option												
Fuel Oil Savings	Gal/yr		14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723
Fuel Oil Savings	mmBtu/yr		2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042
Fuel Oil Savings	$/yr		$40,487	$41,297	$42,123	$42,965	$43,825	$44,701	$45,595	$46,507	$47,437	$48,386
Elec Savings	kwh/yr		221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300
Elec Savings	$/yr		$32,089	$32,730	$33,385	$34,053	$34,734	$35,428	$36,137	$36,860	$37,597	$38,349
Total Energy Savings	$/yr		$72,576	$74,027	$75,508	$77,018	$78,558	$80,129	$81,732	$83,367	$85,034	$86,735
less Debt Service	$/yr		$33,278	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278
Net Savings	$/yr		$39,298	$40,749	$42,230	$43,740	$45,280	$46,851	$48,454	$50,089	$51,756	$53,457
CO2 emissions reductions	*tons/yr*		286	286	286	286	286	286	286	286	286	286
Net Present Value		**$**	**423,503**									

		11	12	13	14	15	16	17	18	19	20
Existing Situation											
Fuel Oil Use	Gal/yr	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226	147,226
Fuel Oil Use	mmBtu/yr	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420	20,420
Fuel Oil Cost	$/gal	$3.35	$3.42	$3.49	$3.56	$3.63	$3.70	$3.78	$3.85	$3.93	$4.01
Fuel Oil Cost	$/yr	$493,536	$503,407	$513,475	$523,744	$534,219	$544,904	$555,802	$566,918	$578,256	$589,821
Elec Use	kwh/yr	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000	2,213,000
Elec Rate	$/kwh	$0.177	$0.180	$0.184	$0.188	$0.191	$0.195	$0.199	$0.203	$0.207	$0.211
Elec Cost	$/yr	$391,157	$398,980	$406,960	$415,099	$423,401	$431,869	$440,506	$449,316	$458,303	$467,469
Total Existing Cost	$/yr	$884,693	$902,387	$920,435	$938,843	$957,620	$976,773	$996,308	$1,016,234	$1,036,559	$1,057,290
Efficiency Measures Option											
Fuel Oil Savings	Gal/yr	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723	14,723
Fuel Oil Savings	mmBtu/yr	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042	2,042
Fuel Oil Savings	$/yr	$49,354	$50,341	$51,347	$52,374	$53,422	$54,490	$55,580	$56,692	$57,826	$58,982
Elec Savings	kwh/yr	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300	221,300
Elec Savings	$/yr	$39,116	$39,898	$40,696	$41,510	$42,340	$43,187	$44,051	$44,932	$45,830	$46,747
Total Energy Savings	$/yr	$88,469	$90,239	$92,043	$93,884	$95,762	$97,677	$99,631	$101,623	$103,656	$105,729
less Debt Service	$/yr	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278	$33,278
Net Savings	$/yr	$55,191	$56,961	$58,765	$60,606	$62,484	$64,399	$66,353	$68,345	$70,378	$72,451
CO2 emissions reductions	*tons/yr*	286	286	286	286	286	286	286	286	286	286

Appendix 6
Geothermal – NPV

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Geothermal Heat Pump System at High School

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	low

Key Inputs

High School Area	sq ft	**168,000.00**	
Exist Elec Use	kwh/sq ft	7.67	
Exist Oil Use	kbtu/sq ft	67.68	
Geothermal Elec Use	kwh/sq ft	9.97	
Geothermal Oil Use	kbtu/sq ft	2.49	
Additional O&M Cost	$/yr	$0	
Major Overhauls	$/yr	**$30,000**	every **7** yrs
Bore Field Capital Cost	$	$795,281	
Retrofit Capital Cost	$	$1,571,223	
Total Capital Cost	$	$2,366,504	
Interest Rate	%	0%	Based on interest free CREBS (Clean Renewable Energy Bonds)
Term	yrs	**20**	
Debt Service	$/yr	$118,325.18	70,764
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10
Existing Situation after Energy Efficiency Improvements												
Fuel Oil Use	Gal/yr		73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777
Fuel Oil Use	mmBtu/yr		10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233
Fuel Oil Cost	$/gal	*5.0%*	$2.75	$2.89	$3.03	$3.18	$3.34	$3.51	$3.69	$3.87	$4.06	$4.27
Elec Use	kwh/yr		1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455
Elec Rate	$/kwh	*5.0%*	$0.145	$0.152	$0.160	$0.168	$0.176	$0.185	$0.194	$0.204	$0.214	$0.225
Fuel Oil Cost	$/yr		$202,886	$213,030	$223,681	$234,866	$246,609	$258,939	$271,886	$285,480	$299,755	$314,742
Elec Cost	$/yr		$168,121	$176,527	$185,353	$194,621	$204,352	$214,570	$225,298	$236,563	$248,391	$260,811
Total Existing Cost	$/yr		$371,007	$389,557	$409,035	$429,487	$450,961	$473,509	$497,184	$522,044	$548,146	$575,553
Geothermal Option												
Fuel Oil Use	Gal/yr		3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012
Fuel Oil Use	mmBtu/yr		418	418	418	418	418	418	418	418	418	418
Elec Use	kwh/yr		1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769
Fuel Oil Cost	$/yr		$8,284	$8,698	$9,133	$9,590	$10,069	$10,573	$11,102	$11,657	$12,240	$12,851
Elec Cost	$/yr		$242,841	$254,984	$267,733	$281,119	$295,175	$309,934	$325,431	$341,702	$358,787	$376,727
Additional O&M Cost	$/yr	***3.0%***	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Major Overhauls	$/yr	***3.0%***	$4,286	$4,414	$4,547	$4,683	$4,824	$4,968	$5,117	$5,271	$5,429	$5,592
Debt Service	$/yr		$118,325	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325
Total Option Project Cost	$/yr		$373,737	$386,421	$399,738	$413,718	$428,394	$443,801	$459,975	$476,955	$494,781	$513,495
Option Savings	*$/yr*		-$2,730	$3,136	$9,297	$15,769	$22,567	$29,708	$37,209	$45,089	$53,365	$62,058
CO2 emissions reductions	*tons/yr*		401	401	401	401	401	401	401	401	401	401
Net Present Value		**$**	**399,852**									

		11	12	13	14	15	16	17	18	19	20
Existing Situation after Energy Efficiency Improvements											
Fuel Oil Use	Gal/yr	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777
Fuel Oil Use	mmBtu/yr	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233
Fuel Oil Cost	$/gal	$4.48	$4.70	$4.94	$5.19	$5.44	$5.72	$6.00	$6.30	$6.62	$6.95
Elec Use	kwh/yr	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455
Elec Rate	$/kwh	$0.236	$0.248	$0.260	$0.273	$0.287	$0.301	$0.317	$0.332	$0.349	$0.366
Fuel Oil Cost	$/yr	$330,479	$347,003	$364,353	$382,571	$401,700	$421,785	$442,874	$465,018	$488,269	$512,682
Elec Cost	$/yr	$273,851	$287,544	$301,921	$317,017	$332,868	$349,512	$366,987	$385,336	$404,603	$424,833
Total Existing Cost	$/yr	$604,331	$634,547	$666,275	$699,588	$734,568	$771,296	$809,861	$850,354	$892,872	$937,515
Geothermal Option											
Fuel Oil Use	Gal/yr	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012
Fuel Oil Use	mmBtu/yr	418	418	418	418	418	418	418	418	418	418
Elec Use	kwh/yr	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769
Fuel Oil Cost	$/yr	$13,494	$14,169	$14,877	$15,621	$16,402	$17,222	$18,083	$18,988	$19,937	$20,934
Elec Cost	$/yr	$395,563	$415,341	$436,108	$457,914	$480,810	$504,850	$530,093	$556,597	$584,427	$613,648
Additional O&M Cost	$/yr	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Major Overhauls	$/yr	$5,760	$5,932	$6,110	$6,294	$6,483	$6,677	$6,877	$7,084	$7,296	$7,515
Debt Service	$/yr	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325
Total Option Project Cost	$/yr	$533,142	$553,768	$575,421	$598,154	$622,019	$647,074	$673,378	$700,993	$729,985	$760,422
Option Savings	*$/yr*	$71,189	$80,780	$90,853	$101,435	$112,548	$124,222	$136,483	$149,361	$162,887	$177,093
CO2 emissions reductions	*tons/yr*	401	401	401	401	401	401	401	401	401	401

Appendix 6
Geothermal – NPV (Continued)

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Geothermal Heat Pump System at High School

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	low

Key Inputs

High School Area	sq ft	**168,000.00**	
Exist Elec Use	kwh/sq ft	7.67	
Exist Oil Use	kbtu/sq ft	67.68	
Geothermal Elec Use	kwh/sq ft	9.97	
Geothermal Oil Use	kbtu/sq ft	2.49	
Additional O&M Cost	$/yr	$0	
Major Overhauls	$/yr	**$30,000**	every **7** yrs
Bore Field Capital Cost	$	$795,281	
Retrofit Capital Cost	$	$1,571,223	
Total Capital Cost	$	$2,366,504	
Interest Rate	%	0%	Based on interest free CREBS (Clean Renewable Energy Bonds)
Term	yrs	**20**	
Debt Service	$/yr	$118,325.18	70,764
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10
Existing Situation after Energy Efficiency Improvements												
Fuel Oil Use	Gal/yr		73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777
Fuel Oil Use	mmBtu/yr		10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233
Fuel Oil Cost	$/gal	*2.0%*	$2.75	$2.81	$2.86	$2.92	$2.98	$3.04	$3.10	$3.16	$3.22	$3.29
Elec Use	kwh/yr		1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455
Elec Rate	$/kwh	*2.0%*	$0.145	$0.148	$0.151	$0.154	$0.157	$0.160	$0.163	$0.167	$0.170	$0.173
Fuel Oil Cost	$/yr		$202,886	$206,943	$211,082	$215,304	$219,610	$224,002	$228,482	$233,052	$237,713	$242,467
Elec Cost	$/yr		$168,121	$171,483	$174,913	$178,411	$181,980	$185,619	$189,332	$193,118	$196,981	$200,920
Total Existing Cost	$/yr		$371,007	$378,427	$385,995	$393,715	$401,590	$409,621	$417,814	$426,170	$434,693	$443,387
Geothermal Option												
Fuel Oil Use	Gal/yr		3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012
Fuel Oil Use	mmBtu/yr		418	418	418	418	418	418	418	418	418	418
Elec Use	kwh/yr		1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769
Fuel Oil Cost	$/yr		$8,284	$8,450	$8,619	$8,791	$8,967	$9,146	$9,329	$9,516	$9,706	$9,900
Elec Cost	$/yr		$242,841	$247,698	$252,652	$257,705	$262,859	$268,117	$273,479	$278,949	$284,528	$290,218
Additional O&M Cost	$/yr	***3.0%***	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Major Overhauls	$/yr	***3.0%***	$4,286	$4,414	$4,547	$4,683	$4,824	$4,968	$5,117	$5,271	$5,429	$5,592
Debt Service	$/yr		$118,325	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325
Total Option Project Cost	$/yr		$373,737	$378,888	$384,143	$389,505	$394,975	$400,557	$406,251	$412,061	$417,988	$424,036
Option Savings	*$/yr*		-$2,730	-$461	$1,852	$4,210	$6,614	$9,065	$11,563	$14,110	$16,706	$19,352
CO2 emissions reductions	*tons/yr*		401	401	401	401	401	401	401	401	401	401
Net Present Value		**$**	**115,369**									

		11	12	13	14	15	16	17	18	19	20
Existing Situation after Energy Efficiency Improvements											
Fuel Oil Use	Gal/yr	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777
Fuel Oil Use	mmBtu/yr	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233
Fuel Oil Cost	$/gal	$3.35	$3.42	$3.49	$3.56	$3.63	$3.70	$3.78	$3.85	$3.93	$4.01
Elec Use	kwh/yr	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455
Elec Rate	$/kwh	$0.177	$0.180	$0.184	$0.188	$0.191	$0.195	$0.199	$0.203	$0.207	$0.211
Fuel Oil Cost	$/yr	$247,316	$252,263	$257,308	$262,454	$267,703	$273,057	$278,519	$284,089	$289,771	$295,566
Elec Cost	$/yr	$204,939	$209,037	$213,218	$217,482	$221,832	$226,269	$230,794	$235,410	$240,118	$244,921
Total Existing Cost	$/yr	$452,255	$461,300	$470,526	$479,937	$489,535	$499,326	$509,313	$519,499	$529,889	$540,487
Geothermal Option											
Fuel Oil Use	Gal/yr	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012
Fuel Oil Use	mmBtu/yr	418	418	418	418	418	418	418	418	418	418
Elec Use	kwh/yr	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769
Fuel Oil Cost	$/yr	$10,098	$10,300	$10,506	$10,716	$10,931	$11,149	$11,372	$11,600	$11,832	$12,069
Elec Cost	$/yr	$296,022	$301,943	$307,982	$314,141	$320,424	$326,833	$333,369	$340,037	$346,837	$353,774
Additional O&M Cost	$/yr	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Major Overhauls	$/yr	$5,760	$5,932	$6,110	$6,294	$6,483	$6,677	$6,877	$7,084	$7,296	$7,515
Debt Service	$/yr	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325	$118,325
Total Option Project Cost	$/yr	$430,206	$436,501	$442,924	$449,477	$456,163	$462,984	$469,944	$477,045	$484,291	$491,683
Option Savings	*$/yr*	$22,049	$24,799	$27,603	$30,460	$33,373	$36,342	$39,368	$42,454	$45,598	$48,804
CO2 emissions reductions	*tons/yr*	401	401	401	401	401	401	401	401	401	401

Appendix 6
Geothermal – NPV (Continued)

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Geothermal Heat Pump System at High School

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	high

Key Inputs

High School Area	sq ft	**168,000.00**		
Exist Elec Use	kwh/sq ft	7.67		
Exist Oil Use	kbtu/sq ft	67.68		
Geothermal Elec Use	kwh/sq ft	9.97		
Geothermal Oil Use	kbtu/sq ft	2.49		
Additional O&M Cost	$/yr	$0		
Major Overhauls	$/yr	**$30,000**	every	**7** yrs
Bore Field Capital Cost	$	$795,281		
Retrofit Capital Cost	$	$1,571,223		
Total Capital Cost	$	$2,366,504		
Interest Rate	%	5%		
Term	yrs	**20**		
Debt Service	$/yr	$180,851.78		70,764
NPV Discount Rate	%	**10%**		

		Escalation	1	2	3	4	5	6	7	8	9	10
Existing Situation after Energy Efficiency Improvements												
Fuel Oil Use	Gal/yr		73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777
Fuel Oil Use	mmBtu/yr		10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233
Fuel Oil Cost	$/gal	*5.0%*	$2.75	$2.89	$3.03	$3.18	$3.34	$3.51	$3.69	$3.87	$4.06	$4.27
Elec Use	kwh/yr		1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455
Elec Rate	$/kwh	*5.0%*	$0.145	$0.152	$0.160	$0.168	$0.176	$0.185	$0.194	$0.204	$0.214	$0.225
Fuel Oil Cost	$/yr		$202,886	$213,030	$223,681	$234,866	$246,609	$258,939	$271,886	$285,480	$299,755	$314,742
Elec Cost	$/yr		$168,121	$176,527	$185,353	$194,621	$204,352	$214,570	$225,298	$236,563	$248,391	$260,811
Total Existing Cost	$/yr		$371,007	$389,557	$409,035	$429,487	$450,961	$473,509	$497,184	$522,044	$548,146	$575,553
Geothermal Option												
Fuel Oil Use	Gal/yr		3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012
Fuel Oil Use	mmBtu/yr		418	418	418	418	418	418	418	418	418	418
Elec Use	kwh/yr		1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769
Fuel Oil Cost	$/yr		$8,284	$8,698	$9,133	$9,590	$10,069	$10,573	$11,102	$11,657	$12,240	$12,851
Elec Cost	$/yr		$242,841	$254,984	$267,733	$281,119	$295,175	$309,934	$325,431	$341,702	$358,787	$376,727
Additional O&M Cost	$/yr	***3.0%***	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Major Overhauls	$/yr	***3.0%***	$4,286	$4,414	$4,547	$4,683	$4,824	$4,968	$5,117	$5,271	$5,429	$5,592
Debt Service	$/yr		$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852
Total Option Project Cost	$/yr		$436,263	$448,948	$462,265	$476,244	$490,920	$506,327	$522,502	$539,482	$557,308	$576,022
Option Savings	*$/yr*		-$65,256	-$59,391	-$53,230	-$46,758	-$39,959	-$32,818	-$25,317	-$17,438	-$9,162	-$469
CO2 emissions reductions	*tons/yr*		401	401	401	401	401	401	401	401	401	401
Net Present Value		**$**	**(132,472)**									

		11	12	13	14	15	16	17	18	19	20
Existing Situation after Energy Efficiency Improvements											
Fuel Oil Use	Gal/yr	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777
Fuel Oil Use	mmBtu/yr	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233
Fuel Oil Cost	$/gal	$4.48	$4.70	$4.94	$5.19	$5.44	$5.72	$6.00	$6.30	$6.62	$6.95
Elec Use	kwh/yr	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455
Elec Rate	$/kwh	$0.236	$0.248	$0.260	$0.273	$0.287	$0.301	$0.317	$0.332	$0.349	$0.366
Fuel Oil Cost	$/yr	$330,479	$347,003	$364,353	$382,571	$401,700	$421,785	$442,874	$465,018	$488,269	$512,682
Elec Cost	$/yr	$273,851	$287,544	$301,921	$317,017	$332,868	$349,512	$366,987	$385,336	$404,603	$424,833
Total Existing Cost	$/yr	$604,331	$634,547	$666,275	$699,588	$734,568	$771,296	$809,861	$850,354	$892,872	$937,515
Geothermal Option											
Fuel Oil Use	Gal/yr	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012
Fuel Oil Use	mmBtu/yr	418	418	418	418	418	418	418	418	418	418
Elec Use	kwh/yr	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769
Fuel Oil Cost	$/yr	$13,494	$14,169	$14,877	$15,621	$16,402	$17,222	$18,083	$18,988	$19,937	$20,934
Elec Cost	$/yr	$395,563	$415,341	$436,108	$457,914	$480,810	$504,850	$530,093	$556,597	$584,427	$613,648
Additional O&M Cost	$/yr	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Major Overhauls	$/yr	$5,760	$5,932	$6,110	$6,294	$6,483	$6,677	$6,877	$7,084	$7,296	$7,515
Debt Service	$/yr	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852
Total Option Project Cost	$/yr	$595,669	$616,294	$637,948	$660,680	$684,546	$709,601	$735,905	$763,520	$792,512	$822,949
Option Savings	*$/yr*	$8,662	$18,253	$28,327	$38,908	$50,022	$61,695	$73,956	$86,834	$100,360	$114,567
CO2 emissions reductions	*tons/yr*	401	401	401	401	401	401	401	401	401	401

Appendix 6
Geothermal—NPV (Continued)

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Geothermal Heat Pump System at High School

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	high

Key Inputs

High School Area	sq ft	**168,000.00**		
Exist Elec Use	kwh/sq ft	7.67		
Exist Oil Use	kbtu/sq ft	67.68		
Geothermal Elec Use	kwh/sq ft	9.97		
Geothermal Oil Use	kbtu/sq ft	2.49		
Additional O&M Cost	$/yr	$0		
Major Overhauls	$/yr	**$30,000**	every	**7** yrs
Bore Field Capital Cost	$	$795,281		
Retrofit Capital Cost	$	$1,571,223		
Total Capital Cost	$	$2,366,504		
Interest Rate	%	5%		
Term	yrs	**20**		
Debt Service	$/yr	$180,851.78		70,764
NPV Discount Rate	%	**10%**		

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Existing Situation after Energy Efficiency Improvements																						
Fuel Oil Use	Gal/yr		73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777
Fuel Oil Use	mmBtu/yr		10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233
Fuel Oil Cost	$/gal	*2.0%*	$2.75	$2.81	$2.86	$2.92	$2.98	$3.04	$3.10	$3.16	$3.22	$3.29	$3.35	$3.42	$3.49	$3.56	$3.63	$3.70	$3.78	$3.85	$3.93	$4.01
Elec Use	kwh/yr		1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455	1,159,455
Elec Rate	$/kwh	*2.0%*	$0.145	$0.148	$0.151	$0.154	$0.157	$0.160	$0.163	$0.167	$0.170	$0.173	$0.177	$0.180	$0.184	$0.188	$0.191	$0.195	$0.199	$0.203	$0.207	$0.211
Fuel Oil Cost	$/yr		$202,886	$206,943	$211,082	$215,304	$219,610	$224,002	$228,482	$233,052	$237,713	$242,467	$247,316	$252,263	$257,308	$262,454	$267,703	$273,057	$278,519	$284,089	$289,771	$295,566
Elec Cost	$/yr		$168,121	$171,483	$174,913	$178,411	$181,980	$185,619	$189,332	$193,118	$196,981	$200,920	$204,939	$209,037	$213,218	$217,482	$221,832	$226,269	$230,794	$235,410	$240,118	$244,921
Total Existing Cost	$/yr		$371,007	$378,427	$385,995	$393,715	$401,590	$409,621	$417,814	$426,170	$434,693	$443,387	$452,255	$461,300	$470,526	$479,937	$489,535	$499,326	$509,313	$519,499	$529,889	$540,487
Geothermal Option																						
Fuel Oil Use	Gal/yr		3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012	3,012
Fuel Oil Use	mmBtu/yr		418	418	418	418	418	418	418	418	418	418	418	418	418	418	418	418	418	418	418	418
Elec Use	kwh/yr		1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769	1,674,769
Fuel Oil Cost	$/yr		$8,284	$8,450	$8,619	$8,791	$8,967	$9,146	$9,329	$9,516	$9,706	$9,900	$10,098	$10,300	$10,506	$10,716	$10,931	$11,149	$11,372	$11,600	$11,832	$12,069
Elec Cost	$/yr		$242,841	$247,698	$252,652	$257,705	$262,859	$268,117	$273,479	$278,949	$284,528	$290,218	$296,022	$301,943	$307,982	$314,141	$320,424	$326,833	$333,369	$340,037	$346,837	$353,774
Additional O&M Cost	$/yr	***3.0%***	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Major Overhauls	$/yr	***3.0%***	$4,286	$4,414	$4,547	$4,683	$4,824	$4,968	$5,117	$5,271	$5,429	$5,592	$5,760	$5,932	$6,110	$6,294	$6,483	$6,677	$6,877	$7,084	$7,296	$7,515
Debt Service	$/yr		$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852	$180,852
Total Option Project Cost	$/yr		$436,263	$441,414	$446,670	$452,031	$457,502	$463,083	$468,777	$474,587	$480,515	$486,562	$492,732	$499,027	$505,450	$512,003	$518,689	$525,511	$532,471	$539,572	$546,817	$554,210
Option Savings	*$/yr*		-$65,256	-$62,987	-$60,674	-$58,316	-$55,912	-$53,462	-$50,964	-$48,417	-$45,821	-$43,175	-$40,477	-$37,727	-$34,924	-$32,067	-$29,154	-$26,185	-$23,158	-$20,073	-$16,928	-$13,723
CO2 emissions reductions	*tons/yr*		401	401	401	401	401	401	401	401	401	401	401	401	401	401	401	401	401	401	401	401
Net Present Value		**$**	**(416,955)**																			

Appendix 7
Biomass Boiler – NPV

PROJECT NET PRESENT VALUE ESTIMATE
CASE NAME: Install Biomass Boiler at High School

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	low

Key Inputs

Percent of Fuel Oil Displaced	%	**90%**		
Oil Boiler Efficiency	%	**85%**		
Biomass Boiler Efficiency	%	**70%**		
Biomass Boiler Size	mmBtu/hr	**6.50**		
Biomass Moisture Content	%	**45%**		
Biomass Heating Value	Btu/lb	**9,000** (dry)	9900000	
Biomass Heating Value	Btu/lb	4,950 (as received)		
Additional O&M Cost	$/yr	**$3,500**		
Major Overhauls	$/yr	**$10,000**	every	10 yrs
Capital Cost	$	**$1,500,000**		
Interest Rate	%	5%		
Term	yrs	**20**		
Debt Service	$/yr	$114,632.27		
NPV Discount Rate	%	**10%**		

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Existing Situation after Energy Efficiency Improvements																						
Fuel Oil Use	Gal/yr		73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777
Fuel Oil Use	mmBtu/yr		10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233
Fuel Oil Cost	$/gal	*5.0%*	$2.75	$2.89	$3.03	$3.18	$3.34	$3.51	$3.69	$3.87	$4.06	$4.27	$4.48	$4.70	$4.94	$5.19	$5.44	$5.72	$6.00	$6.30	$6.62	$6.95
Fuel Oil Cost	$/yr		$202,886	$213,030	$223,681	$234,866	$246,609	$258,939	$271,886	$285,480	$299,755	$314,742	$330,479	$347,003	$364,353	$382,571	$401,700	$421,785	$442,874	$465,018	$488,269	$512,682
Total Existing Cost	$/yr		$202,886	$213,030	$223,681	$234,866	$246,609	$258,939	$271,886	$285,480	$299,755	$314,742	$330,479	$347,003	$364,353	$382,571	$401,700	$421,785	$442,874	$465,018	$488,269	$512,682
Biomass Boiler Option																						
Fuel Oil Use	Gal/yr		7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378
Fuel Oil Use	mmBtu/yr		1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023
Biomas Use	mmBtu/yr		11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183
Biomas Use	ton/yr		1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130
Biomas Cost	$/ton	*5.0%*	$50.00	$52.50	$55.13	$57.88	$60.78	$63.81	$67.00	$70.36	$73.87	$77.57	$81.44	$85.52	$89.79	$94.28	$99.00	$103.95	$109.14	$114.60	$120.33	$126.35
Biomas Cost	$/yr		$56,480	$59,304	$62,269	$65,382	$68,652	$72,084	$75,688	$79,473	$83,446	$87,619	$92,000	$96,600	$101,430	$106,501	$111,826	$117,417	$123,288	$129,453	$135,925	$142,722
Fuel Oil Cost	$/yr		$20,289	$21,303	$22,368	$23,487	$24,661	$25,894	$27,189	$28,548	$29,975	$31,474	$33,048	$34,700	$36,435	$38,257	$40,170	$42,178	$44,287	$46,502	$48,827	$51,268
Additional O&M Cost	$/yr	***3.0%***	$3,500	$3,605	$3,713	$3,825	$3,939	$4,057	$4,179	$4,305	$4,434	$4,567	$4,704	$4,845	$4,990	$5,140	$5,294	$5,453	$5,616	$5,785	$5,959	$6,137
Major Overhauls	$/yr	***3.0%***	$1,000	$1,030	$1,061	$1,093	$1,126	$1,159	$1,194	$1,230	$1,267	$1,305	$1,344	$1,384	$1,426	$1,469	$1,513	$1,558	$1,605	$1,653	$1,702	$1,754
Debt Service	$/yr		$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632
Total Option Project Cost	$/yr		$195,901	$199,874	$204,043	$208,419	$213,010	$217,827	$222,882	$228,188	$233,755	$239,597	$245,728	$252,161	$258,913	$265,999	$273,435	$281,239	$289,429	$298,025	$307,045	$316,513
Option Savings			$6,985	$13,156	$19,638	$26,447	$33,599	$41,112	$49,004	$57,293	$66,000	$75,146	$84,752	$94,842	$105,440	$116,572	$128,265	$140,546	$153,445	$166,993	$181,223	$196,169
CO2 emissions reductions	*tons/yr*		674	674	674	674	674	674	674	674	674	674	674	674	674	674	674	674	674	674	674	674
Net Present Value		$	**504,587**																			

Appendix 7
Biomass Boiler – NPV (Continued)

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Biomass Boiler at High School

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	low

Key Inputs

Percent of Fuel Oil Displaced	%	**90%**		
Oil Boiler Efficiency	%	**85%**		
Biomass Boiler Efficiency	%	**70%**		
Biomass Boiler Size	mmBtu/hr	**6.50**		
Biomass Moisture Content	%	**45%**		
Biomass Heating Value	Btu/lb	**9,000** (dry)		9900000
Biomass Heating Value	Btu/lb	4,950 (as received)		
Additional O&M Cost	$/yr	**$3,500**		
Major Overhauls	$/yr	**$10,000**	every	10 yrs
Capital Cost	$	**$1,500,000**		
Interest Rate	%	5%		
Term	yrs	**20**		
Debt Service	$/yr	$114,632.27		
NPV Discount Rate	%	**10%**		

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Existing Situation after Energy Efficiency Improvements																						
Fuel Oil Use	Gal/yr		73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777
Fuel Oil Use	mmBtu/yr		10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233
Fuel Oil Cost	$/gal	*2.0%*	$2.75	$2.81	$2.86	$2.92	$2.98	$3.04	$3.10	$3.16	$3.22	$3.29	$3.35	$3.42	$3.49	$3.56	$3.63	$3.70	$3.78	$3.85	$3.93	$4.01
Fuel Oil Cost	$/yr		$202,886	$206,943	$211,082	$215,304	$219,610	$224,002	$228,482	$233,052	$237,713	$242,467	$247,316	$252,263	$257,308	$262,454	$267,703	$273,057	$278,519	$284,089	$289,771	$295,566
Total Existing Cost	$/yr		$202,886	$206,943	$211,082	$215,304	$219,610	$224,002	$228,482	$233,052	$237,713	$242,467	$247,316	$252,263	$257,308	$262,454	$267,703	$273,057	$278,519	$284,089	$289,771	$295,566
Biomass Boiler Option																						
Fuel Oil Use	Gal/yr		7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378
Fuel Oil Use	mmBtu/yr		1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023
Biomas Use	mmBtu/yr		11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183
Biomas Use	ton/yr		1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130
Biomas Cost	$/ton	*2.0%*	$50.00	$51.00	$52.02	$53.06	$54.12	$55.20	$56.31	$57.43	$58.58	$59.75	$60.95	$62.17	$63.41	$64.68	$65.97	$67.29	$68.64	$70.01	$71.41	$72.84
Biomas Cost	$/yr		$56,480	$57,609	$58,762	$59,937	$61,136	$62,358	$63,605	$64,878	$66,175	$67,499	$68,849	$70,226	$71,630	$73,063	$74,524	$76,014	$77,535	$79,085	$80,667	$82,280
Fuel Oil Cost	$/yr		$20,289	$20,694	$21,108	$21,530	$21,961	$22,400	$22,848	$23,305	$23,771	$24,247	$24,732	$25,226	$25,731	$26,245	$26,770	$27,306	$27,852	$28,409	$28,977	$29,557
Additional O&M Cost	$/yr	***3.0%***	$3,500	$3,605	$3,713	$3,825	$3,939	$4,057	$4,179	$4,305	$4,434	$4,567	$4,704	$4,845	$4,990	$5,140	$5,294	$5,453	$5,616	$5,785	$5,959	$6,137
Major Overhauls	$/yr	***3.0%***	$1,000	$1,030	$1,061	$1,093	$1,126	$1,159	$1,194	$1,230	$1,267	$1,305	$1,344	$1,384	$1,426	$1,469	$1,513	$1,558	$1,605	$1,653	$1,702	$1,754
Debt Service	$/yr		$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632
Total Option Project Cost	$/yr		$195,901	$197,571	$199,276	$201,017	$202,794	$204,608	$206,459	$208,349	$210,279	$212,249	$214,260	$216,313	$218,409	$220,549	$222,733	$224,963	$227,240	$229,564	$231,937	$234,360
Option Savings			$6,985	$9,372	$11,806	$14,287	$16,816	$19,395	$22,023	$24,702	$27,434	$30,218	$33,056	$35,950	$38,899	$41,905	$44,970	$48,094	$51,279	$54,525	$57,833	$61,206
CO2 emissions reductions	*tons/yr*		674	674	674	674	674	674	674	674	674	674	674	674	674	674	674	674	674	674	674	674
Net Present Value		**$**	**205,305**																			

Appendix 7
Biomass Boiler –NPV (Continued)

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Biomass Boiler at High School

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	high

Key Inputs

Percent of Fuel Oil Displaced	%	**90%**		
Oil Boiler Efficiency	%	**85%**		
Biomass Boiler Efficiency	%	**70%**		
Biomass Boiler Size	mmBtu/hr	**6.50**		
Biomass Moisture Content	%	**45%**		
Biomass Heating Value	Btu/lb	**9,000**	(dry)	9900000
Biomass Heating Value	Btu/lb	4,950	(as received)	
Additional O&M Cost	$/yr	**$3,500**		
Major Overhauls	$/yr	**$10,000**	every	10 yrs
Capital Cost	$	**$1,500,000**		
Interest Rate	%	5%		
Term	yrs	**20**		
Debt Service	$/yr	$114,632.27		
NPV Discount Rate	%	**10%**		

		Escalation	1	2	3	4	5	6	7	8	9	10
Existing Situation after Energy Efficiency Improvements												
Fuel Oil Use	Gal/yr		73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777
Fuel Oil Use	mmBtu/yr		10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233
Fuel Oil Cost	$/gal	*5.0%*	$2.75	$2.89	$3.03	$3.18	$3.34	$3.51	$3.69	$3.87	$4.06	$4.27
Fuel Oil Cost	$/yr		$202,886	$213,030	$223,681	$234,866	$246,609	$258,939	$271,886	$285,480	$299,755	$314,742
Total Existing Cost	$/yr		$202,886	$213,030	$223,681	$234,866	$246,609	$258,939	$271,886	$285,480	$299,755	$314,742
Biomass Boiler Option												
Fuel Oil Use	Gal/yr		7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378
Fuel Oil Use	mmBtu/yr		1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023
Biomas Use	mmBtu/yr		11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183
Biomas Use	ton/yr		1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130
Biomas Cost	$/ton	*5.0%*	$50.00	$52.50	$55.13	$57.88	$60.78	$63.81	$67.00	$70.36	$73.87	$77.57
Biomas Cost	$/yr		$56,480	$59,304	$62,269	$65,382	$68,652	$72,084	$75,688	$79,473	$83,446	$87,619
Fuel Oil Cost	$/yr		$20,289	$21,303	$22,368	$23,487	$24,661	$25,894	$27,189	$28,548	$29,975	$31,474
Additional O&M Cost	$/yr	***3.0%***	$3,500	$3,605	$3,713	$3,825	$3,939	$4,057	$4,179	$4,305	$4,434	$4,567
Major Overhauls	$/yr	***3.0%***	$1,000	$1,030	$1,061	$1,093	$1,126	$1,159	$1,194	$1,230	$1,267	$1,305
Debt Service	$/yr		$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632
Total Option Project Cost	$/yr		$195,901	$199,874	$204,043	$208,419	$213,010	$217,827	$222,882	$228,188	$233,755	$239,597
Option Savings			$6,985	$13,156	$19,638	$26,447	$33,599	$41,112	$49,004	$57,293	$66,000	$75,146
CO2 emissions reductions	*tons/yr*		674	674	674	674	674	674	674	674	674	674
Net Present Value		**$**	**504,587**									

		11	12	13	14	15	16	17	18	19	20
Existing Situation after Energy Efficiency Improvements											
Fuel Oil Use	Gal/yr	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777
Fuel Oil Use	mmBtu/yr	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233
Fuel Oil Cost	$/gal	$4.48	$4.70	$4.94	$5.19	$5.44	$5.72	$6.00	$6.30	$6.62	$6.95
Fuel Oil Cost	$/yr	$330,479	$347,003	$364,353	$382,571	$401,700	$421,785	$442,874	$465,018	$488,269	$512,682
Total Existing Cost	$/yr	$330,479	$347,003	$364,353	$382,571	$401,700	$421,785	$442,874	$465,018	$488,269	$512,682
Biomass Boiler Option											
Fuel Oil Use	Gal/yr	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378
Fuel Oil Use	mmBtu/yr	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023
Biomas Use	mmBtu/yr	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183
Biomas Use	ton/yr	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130
Biomas Cost	$/ton	$81.44	$85.52	$89.79	$94.28	$99.00	$103.95	$109.14	$114.60	$120.33	$126.35
Biomas Cost	$/yr	$92,000	$96,600	$101,430	$106,501	$111,826	$117,417	$123,288	$129,453	$135,925	$142,722
Fuel Oil Cost	$/yr	$33,048	$34,700	$36,435	$38,257	$40,170	$42,178	$44,287	$46,502	$48,827	$51,268
Additional O&M Cost	$/yr	$4,704	$4,845	$4,990	$5,140	$5,294	$5,453	$5,616	$5,785	$5,959	$6,137
Major Overhauls	$/yr	$1,344	$1,384	$1,426	$1,469	$1,513	$1,558	$1,605	$1,653	$1,702	$1,754
Debt Service	$/yr	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632
Total Option Project Cost	$/yr	$245,728	$252,161	$258,913	$265,999	$273,435	$281,239	$289,429	$298,025	$307,045	$316,513
Option Savings		$84,752	$94,842	$105,440	$116,572	$128,265	$140,546	$153,445	$166,993	$181,223	$196,169
CO2 emissions reductions	*tons/yr*	674	674	674	674	674	674	674	674	674	674

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Biomass Boiler at High School

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	high

Key Inputs

Percent of Fuel Oil Displaced	%	**90%**		
Oil Boiler Efficiency	%	**85%**		
Biomass Boiler Efficiency	%	**70%**		
Biomass Boiler Size	mmBtu/hr	**6.50**		
Biomass Moisture Content	%	**45%**		
Biomass Heating Value	Btu/lb	**9,000** (dry)		9900000
Biomass Heating Value	Btu/lb	4,950 (as received)		
Additional O&M Cost	$/yr	**$3,500**		
Major Overhauls	$/yr	**$10,000**	every	10 yrs
Capital Cost	$	**$1,500,000**		
Interest Rate	%	5%		
Term	yrs	**20**		
Debt Service	$/yr	$114,632.27		
NPV Discount Rate	%	**10%**		

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Existing Situation after Energy Efficiency Improvements																						
Fuel Oil Use	Gal/yr		73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777	73,777
Fuel Oil Use	mmBtu/yr		10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233	10,233
Fuel Oil Cost	$/gal	*2.0%*	$2.75	$2.81	$2.86	$2.92	$2.98	$3.04	$3.10	$3.16	$3.22	$3.29	$3.35	$3.42	$3.49	$3.56	$3.63	$3.70	$3.78	$3.85	$3.93	$4.01
Fuel Oil Cost	$/yr		$202,886	$206,943	$211,082	$215,304	$219,610	$224,002	$228,482	$233,052	$237,713	$242,467	$247,316	$252,263	$257,308	$262,454	$267,703	$273,057	$278,519	$284,089	$289,771	$295,566
Total Existing Cost	$/yr		$202,886	$206,943	$211,082	$215,304	$219,610	$224,002	$228,482	$233,052	$237,713	$242,467	$247,316	$252,263	$257,308	$262,454	$267,703	$273,057	$278,519	$284,089	$289,771	$295,566
Biomass Boiler Option																						
Fuel Oil Use	Gal/yr		7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378	7,378
Fuel Oil Use	mmBtu/yr		1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023	1,023
Biomas Use	mmBtu/yr		11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183	11,183
Biomas Use	ton/yr		1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130	1,130
Biomas Cost	$/ton	*2.0%*	$50.00	$51.00	$52.02	$53.06	$54.12	$55.20	$56.31	$57.43	$58.58	$59.75	$60.95	$62.17	$63.41	$64.68	$65.97	$67.29	$68.64	$70.01	$71.41	$72.84
Biomas Cost	$/yr		$56,480	$57,609	$58,762	$59,937	$61,136	$62,358	$63,605	$64,878	$66,175	$67,499	$68,849	$70,226	$71,630	$73,063	$74,524	$76,014	$77,535	$79,085	$80,667	$82,280
Fuel Oil Cost	$/yr		$20,289	$20,694	$21,108	$21,530	$21,961	$22,400	$22,848	$23,305	$23,771	$24,247	$24,732	$25,226	$25,731	$26,245	$26,770	$27,306	$27,852	$28,409	$28,977	$29,557
Additional O&M Cost	$/yr	***3.0%***	$3,500	$3,605	$3,713	$3,825	$3,939	$4,057	$4,179	$4,305	$4,434	$4,567	$4,704	$4,845	$4,990	$5,140	$5,294	$5,453	$5,616	$5,785	$5,959	$6,137
Major Overhauls	$/yr	***3.0%***	$1,000	$1,030	$1,061	$1,093	$1,126	$1,159	$1,194	$1,230	$1,267	$1,305	$1,344	$1,384	$1,426	$1,469	$1,513	$1,558	$1,605	$1,653	$1,702	$1,754
Debt Service	$/yr		$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632	$114,632
Total Option Project Cost	$/yr		$195,901	$197,571	$199,276	$201,017	$202,794	$204,608	$206,459	$208,349	$210,279	$212,249	$214,260	$216,313	$218,409	$220,549	$222,733	$224,963	$227,240	$229,564	$231,937	$234,360
Option Savings			$6,985	$9,372	$11,806	$14,287	$16,816	$19,395	$22,023	$24,702	$27,434	$30,218	$33,056	$35,950	$38,899	$41,905	$44,970	$48,094	$51,279	$54,525	$57,833	$61,206
CO2 emissions reductions	*tons/yr*		674	674	674	674	674	674	674	674	674	674	674	674	674	674	674	674	674	674	674	674
Net Present Value		**$**	**205,305**																			

Appendix 8
50 KW Wind Turbine – NPV

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Wind Turbine at High School

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	low

Key Inputs

Wind Turbine Manucturer		**Entegrity**	
Wind Turbine Model		**EW15**	
Nominal Rating	kW	**50**	
Total no. of turbines		**1**	
Total gross output (KW)	kW	50	
Turbine Height, (30 meter)	ft	**100**	
Average Wind Speed	mph	**11**	
Net Annual Capacity Factor for	%	**20.1%**	
Net Output (KWhrs/yr)	kWH/yr	88,233	
Additional O&M Cost	$/yr	**$1,500**	starting year 6
Major Overhauls	$/yr	**$0**	
Capital Cost per Turbine	$	**$250,000**	
Capital Cost	$	**$250,000**	
Interest Rate	%	0%	Based on interest free CREBS (Clean Renewable Energy Bonds)
Term	yrs	**20**	
Debt Service	$/yr	$12,500.00	
NPV Discount Rate	%	**10%**	

		Escalation	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Savings (Avoided Cost)												
Wind Turbine Output	kWH		88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233
Elec Avoided Cost Rate	$/kWH	*5.0%*	$0.15	$0.15	$0.16	$0.17	$0.18	$0.19	$0.19	$0.20	$0.21	$0.22
Elec Savings	$/yr		$12,794	$13,434	$14,105	$14,810	$15,551	$16,329	$17,145	$18,002	$18,902	$19,847
Total Option Savings			$12,794	$13,434	$14,105	$14,810	$15,551	$16,329	$17,145	$18,002	$18,902	$19,847
Costs												
Additional O&M Cost	$/yr	***3.0%***						$1,500	$1,545	$1,591	$1,639	$1,688
Debt Service	$/yr		$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500
Total Option Cost	$/yr		$12,500	$12,500	$12,500	$12,500	$12,500	$14,000	$14,045	$14,091	$14,139	$14,188
Option Savings			$294	$934	$1,605	$2,310	$3,051	$2,329	$3,100	$3,911	$4,763	$5,659
CO2 emissions reductions	*tons/yr*		54	54	54	54	54	54	54	54	54	54
Net Present Value			**$40,197**									

		Escalation	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Savings (Avoided Cost)												
Wind Turbine Output	kWH		88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233
Elec Avoided Cost Rate	$/kWH		$0.24	$0.25	$0.26	$0.27	$0.29	$0.30	$0.32	$0.33	$0.35	$0.37
Elec Savings	$/yr		$20,840	$21,882	$22,976	$24,125	$25,331	$26,597	$27,927	$29,324	$30,790	$32,329
Total Option Savings			$20,840	$21,882	$22,976	$24,125	$25,331	$26,597	$27,927	$29,324	$30,790	$32,329
Costs												
Additional O&M Cost	$/yr		$1,739	$1,791	$1,845	$1,900	$1,957	$2,016	$2,076	$2,139	$2,203	$2,269
Debt Service	$/yr		$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500
Total Option Cost	$/yr		$14,239	$14,291	$14,345	$14,400	$14,457	$14,516	$14,576	$14,639	$14,703	$14,769
Option Savings			$6,601	$7,591	$8,631	$9,725	$10,874	$12,082	$13,351	$14,685	$16,087	$17,560
CO2 emissions reductions	*tons/yr*		54	54	54	54	54	54	54	54	54	54

Appendix 8
50 KW Wind Turbine – NPV (Continued)

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Wind Turbine at High School

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	low

Key Inputs

Wind Turbine Manuacturer		**Entegrity**	
Wind Turbine Model		**EW15**	
Nominal Rating	kW	**50**	
Total no. of turbines		**1**	
Total gross output (KW)	kW	50	
Turbine Height, (30 meter)	ft	**100**	
Average Wind Speed	mph	**11**	
Net Annual Capacity Factor for	%	**20.1%**	
Net Output (KWhrs/yr)	kWH/yr	88,233	
Additional O&M Cost	$/yr	**$1,500**	starting year 6
Major Overhauls	$/yr	**$0**	
Capital Cost per Turbine	$	**$250,000**	
Capital Cost	$	**$250,000**	
Interest Rate	%	0%	Based on interest free CREBS (Clean Renewable Energy Bonds)
Term	yrs	**20**	
Debt Service	$/yr	$12,500.00	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Savings (Avoided Cost)																						
Wind Turbine Output	kWH		88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233
Elec Avoided Cost Rate	$/kWH	*2.0%*	$0.15	$0.15	$0.15	$0.15	$0.16	$0.16	$0.16	$0.17	$0.17	$0.17	$0.18	$0.18	$0.18	$0.19	$0.19	$0.20	$0.20	$0.20	$0.21	$0.21
Elec Savings	$/yr		$12,794	$13,050	$13,311	$13,577	$13,848	$14,125	$14,408	$14,696	$14,990	$15,290	$15,596	$15,908	$16,226	$16,550	$16,881	$17,219	$17,563	$17,914	$18,273	$18,638
Total Option Savings			$12,794	$13,050	$13,311	$13,577	$13,848	$14,125	$14,408	$14,696	$14,990	$15,290	$15,596	$15,908	$16,226	$16,550	$16,881	$17,219	$17,563	$17,914	$18,273	$18,638
Costs																						
Additional O&M Cost	$/yr	***3.0%***						$1,500	$1,545	$1,591	$1,639	$1,688	$1,739	$1,791	$1,845	$1,900	$1,957	$2,016	$2,076	$2,139	$2,203	$2,269
Debt Service	$/yr		$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500
Total Option Cost	$/yr		$12,500	$12,500	$12,500	$12,500	$12,500	$14,000	$14,045	$14,091	$14,139	$14,188	$14,239	$14,291	$14,345	$14,400	$14,457	$14,516	$14,576	$14,639	$14,703	$14,769
Option Savings			$294	$550	$811	$1,077	$1,348	$125	$363	$605	$851	$1,102	$1,357	$1,616	$1,881	$2,150	$2,424	$2,703	$2,987	$3,276	$3,570	$3,869
CO2 emissions reductions	*tons/yr*		54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54
Net Present Value			**$9,837**																			

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Wind Turbine at High School

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	high

Key Inputs

Wind Turbine Manuacturer		**Entegrity**	
Wind Turbine Model		**EW15**	
Nominal Rating	kW	**50**	
Total no. of turbines		**1**	
Total gross output (KW)	kW	50	
Turbine Height, (30 meter)	ft	**100**	
Average Wind Speed	mph	**11**	
Net Annual Capacity Factor for	%	**20.1%**	
Net Output (KWhrs/yr)	kWH/yr	88,233	
Additional O&M Cost	$/yr	**$1,500**	starting year 6
Major Overhauls	$/yr	**$0**	
Capital Cost per Turbine	$	**$250,000**	
Capital Cost	$	**$250,000**	
Interest Rate	%	5%	
Term	yrs	**20**	
Debt Service	$/yr	$19,105.38	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Savings (Avoided Cost)																						
Wind Turbine Output	kWH		88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233
Elec Avoided Cost Rate	$/kWH	*5.0%*	$0.15	$0.15	$0.16	$0.17	$0.18	$0.19	$0.19	$0.20	$0.21	$0.22	$0.24	$0.25	$0.26	$0.27	$0.29	$0.30	$0.32	$0.33	$0.35	$0.37
Elec Savings	$/yr		$12,794	$13,434	$14,105	$14,810	$15,551	$16,329	$17,145	$18,002	$18,902	$19,847	$20,840	$21,882	$22,976	$24,125	$25,331	$26,597	$27,927	$29,324	$30,790	$32,329
Total Option Savings			$12,794	$13,434	$14,105	$14,810	$15,551	$16,329	$17,145	$18,002	$18,902	$19,847	$20,840	$21,882	$22,976	$24,125	$25,331	$26,597	$27,927	$29,324	$30,790	$32,329
Costs																						
Additional O&M Cost	$/yr	***3.0%***						$1,500	$1,545	$1,591	$1,639	$1,688	$1,739	$1,791	$1,845	$1,900	$1,957	$2,016	$2,076	$2,139	$2,203	$2,269
Debt Service	$/yr		$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105
Total Option Cost	$/yr		$19,105	$19,105	$19,105	$19,105	$19,105	$20,605	$20,650	$20,697	$20,744	$20,794	$20,844	$20,896	$20,950	$21,006	$21,063	$21,121	$21,182	$21,244	$21,308	$21,374
Option Savings			-$6,312	-$5,672	-$5,000	-$4,295	-$3,554	-$4,277	-$3,505	-$2,695	-$1,842	-$946	-$4	$985	$2,026	$3,119	$4,268	$5,476	$6,746	$8,080	$9,482	$10,955
CO_2 emissions reductions	*tons/yr*		54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54
Net Present Value			**-$16,038**																			

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Wind Turbine at High School

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	high

Key Inputs

Wind Turbine Manuacturer		**Entegrity**	
Wind Turbine Model		**EW15**	
Nominal Rating	kW	**50**	
Total no. of turbines		**1**	
Total gross output (KW)	kW	50	
Turbine Height, (30 meter)	ft	**100**	
Average Wind Speed	mph	**11**	
Net Annual Capacity Factor for	%	**20.1%**	
Net Output (KWhrs/yr)	kWH/yr	88,233	
Additional O&M Cost	$/yr	**$1,500**	starting year 6
Major Overhauls	$/yr	**$0**	
Capital Cost per Turbine	$	**$250,000**	
Capital Cost	$	**$250,000**	
Interest Rate	%	5%	
Term	yrs	**20**	
Debt Service	$/yr	$19,105.38	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Savings (Avoided Cost)																						
Wind Turbine Output	kWH		88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233	88,233
Elec Avoided Cost Rate	$/kWH	*2.0%*	$0.15	$0.15	$0.15	$0.15	$0.16	$0.16	$0.16	$0.17	$0.17	$0.17	$0.18	$0.18	$0.18	$0.19	$0.19	$0.20	$0.20	$0.20	$0.21	$0.21
Elec Savings	$/yr		$12,794	$13,050	$13,311	$13,577	$13,848	$14,125	$14,408	$14,696	$14,990	$15,290	$15,596	$15,908	$16,226	$16,550	$16,881	$17,219	$17,563	$17,914	$18,273	$18,638
Total Option Savings			$12,794	$13,050	$13,311	$13,577	$13,848	$14,125	$14,408	$14,696	$14,990	$15,290	$15,596	$15,908	$16,226	$16,550	$16,881	$17,219	$17,563	$17,914	$18,273	$18,638
Costs																						
Additional O&M Cost	$/yr	***3.0%***						$1,500	$1,545	$1,591	$1,639	$1,688	$1,739	$1,791	$1,845	$1,900	$1,957	$2,016	$2,076	$2,139	$2,203	$2,269
Debt Service	$/yr		$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105	$19,105
Total Option Cost	$/yr		$19,105	$19,105	$19,105	$19,105	$19,105	$20,605	$20,650	$20,697	$20,744	$20,794	$20,844	$20,896	$20,950	$21,006	$21,063	$21,121	$21,182	$21,244	$21,308	$21,374
Option Savings			-$6,312	-$6,056	-$5,795	-$5,528	-$5,257	-$6,480	-$6,242	-$6,001	-$5,754	-$5,504	-$5,249	-$4,989	-$4,725	-$4,455	-$4,181	-$3,902	-$3,619	-$3,330	-$3,035	-$2,736
CO_2 emissions reductions	*tons/yr*		54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54
Net Present Value			**-$46,398**																			

Appendix 9
660 KW Wind Turbine – NPV

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Larger Wind Turbine at High School

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	low

Key Inputs

Wind Turbine Manuacturer		**Vesta**	
Wind Turbine Model		**660 kw**	
Nominal Rating	kW	**660**	
Total no. of turbines		**1**	
Total gross output (KW)	kW	660	
Turbine Height, (100 meter)	ft	**328**	
Average Wind Speed	mph	**14.54**	
Net Annual Capacity Factor for	%	**15.0%**	
Net Output (KWhrs/yr)	kWH/yr	867,821	
Additional O&M Cost	$/yr	**$13,000**	starting year 2 (mfgr service agreement)
Major Overhauls	$/yr	**$12,000**	every 5 years
Capital Cost per Turbine	$	**$1,880,147**	
Capital Cost	$	**$1,880,147**	
Interest Rate	%	0%	Based on interest free CREBS (Clean Renewable Energy Bonds)
Term	yrs	**20**	
Debt Service	$/yr	$94,007.37	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10
Savings (Avoided Cost)												
Wind Turbine Output	kWH		867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821
Elec Avoided Cost Rate	$/kWH	*5.0%*	$0.15	$0.15	$0.16	$0.17	$0.18	$0.19	$0.19	$0.20	$0.21	$0.22
Elec Savings	$/yr		$125,834	$132,126	$138,732	$145,669	$152,952	$160,600	$168,630	$177,061	$185,914	$195,210
Total Option Savings			$125,834	$132,126	$138,732	$145,669	$152,952	$160,600	$168,630	$177,061	$185,914	$195,210
Costs												
Additional O&M Cost	$/yr	***3.0%***		$13,000	$13,390	$13,792	$26,205	$26,992	$27,801	$28,635	$29,494	$42,379
Debt Service	$/yr		$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007
Total Option Cost	$/yr		$94,007	$107,007	$107,397	$107,799	$120,213	$120,999	$121,809	$122,643	$123,502	$136,387
Option Savings			$31,827	$25,118	$31,335	$37,870	$32,739	$39,601	$46,821	$54,418	$62,412	$58,823
CO2 emissions reductions	*tons/yr*		535	535	535	535	535	535	535	535	535	535
Net Present Value			**$475,007**									

	11	12	13	14	15	16	17	18	19	20
Savings (Avoided Cost)										
Wind Turbine Output	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821
Elec Avoided Cost Rate	$0.24	$0.25	$0.26	$0.27	$0.29	$0.30	$0.32	$0.33	$0.35	$0.37
Elec Savings	$204,970	$215,219	$225,980	$237,279	$249,143	$261,600	$274,680	$288,414	$302,835	$317,976
Total Option Savings	$204,970	$215,219	$225,980	$237,279	$249,143	$261,600	$274,680	$288,414	$302,835	$317,976
Costs										
Additional O&M Cost	$43,651	$44,960	$46,309	$47,698	$61,129	$62,963	$64,852	$66,798	$68,801	$70,866
Debt Service	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007
Total Option Cost	$137,658	$138,968	$140,316	$141,706	$155,137	$156,970	$158,859	$160,805	$162,809	$164,873
Option Savings	$67,312	$76,251	$85,664	$95,573	$94,006	$104,630	$115,821	$127,609	$140,026	$153,104
CO2 emissions reductions	535	535	535	535	535	535	535	535	535	535
Net Present Value										

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Larger Wind Turbine at High School

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	low

Key Inputs

Wind Turbine Manuacturer		**Vesta**	
Wind Turbine Model		**660 kw**	
Nominal Rating	kW	**660**	
Total no. of turbines		**1**	
Total gross output (KW)	kW	660	
Turbine Height, (100 meter)	ft	**328**	
Average Wind Speed	mph	**14.54**	
Net Annual Capacity Factor for	%	**15.0%**	
Net Output (KWhrs/yr)	kWH/yr	867,821	
Additional O&M Cost	$/yr	**$13,000**	starting year 2 (mfgr service agreement)
Major Overhauls	$/yr	**$12,000**	every 5 years
Capital Cost per Turbine	$	**$1,880,147**	
Capital Cost	$	**$1,880,147**	
Interest Rate	%	0%	Based on interest free CREBS (Clean Renewable Energy Bonds)
Term	yrs	**20**	
Debt Service	$/yr	$94,007.37	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Savings (Avoided Cost)																						
Wind Turbine Output	kWH		867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821
Elec Avoided Cost Rate	$/kWH	*2.0%*	$0.15	$0.15	$0.15	$0.15	$0.16	$0.16	$0.16	$0.17	$0.17	$0.17	$0.18	$0.18	$0.18	$0.19	$0.19	$0.20	$0.20	$0.20	$0.21	$0.21
Elec Savings	$/yr		$125,834	$128,351	$130,918	$133,536	$136,207	$138,931	$141,710	$144,544	$147,435	$150,383	$153,391	$156,459	$159,588	$162,780	$166,035	$169,356	$172,743	$176,198	$179,722	$183,317
Total Option Savings			$125,834	$128,351	$130,918	$133,536	$136,207	$138,931	$141,710	$144,544	$147,435	$150,383	$153,391	$156,459	$159,588	$162,780	$166,035	$169,356	$172,743	$176,198	$179,722	$183,317
Costs																						
Additional O&M Cost	$/yr	***3.0%***		$13,000	$13,390	$13,792	$26,205	$26,992	$27,801	$28,635	$29,494	$42,379	$43,651	$44,960	$46,309	$47,698	$61,129	$62,963	$64,852	$66,798	$68,801	$70,866
Debt Service	$/yr		$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007	$94,007
Total Option Cost	$/yr		$94,007	$107,007	$107,397	$107,799	$120,213	$120,999	$121,809	$122,643	$123,502	$136,387	$137,658	$138,968	$140,316	$141,706	$155,137	$156,970	$158,859	$160,805	$162,809	$164,873
Option Savings			$31,827	$21,343	$23,520	$25,737	$15,994	$17,932	$19,901	$21,901	$23,933	$13,997	$15,733	$17,491	$19,272	$21,074	$10,899	$12,386	$13,884	$15,393	$16,913	$18,444
CO_2 emissions reductions	*tons/yr*		535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535
Net Present Value			**$176,398**																			

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Larger Wind Turbine at High School

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	high

Key Inputs

Wind Turbine Manuacturer		**Vesta**	
Wind Turbine Model		**660 kw**	
Nominal Rating	kW	**660**	
Total no. of turbines		**1**	
Total gross output (KW)	kW	660	
Turbine Height, (100 meter)	ft	**328**	
Average Wind Speed	mph	**14.54**	
Net Annual Capacity Factor for	%	**15.0%**	
Net Output (KWhrs/yr)	kWH/yr	867,821	
Additional O&M Cost	$/yr	**$13,000**	starting year 2 (mfgr service agreement)
Major Overhauls	$/yr	**$12,000**	every 5 years
Capital Cost per Turbine	$	**$1,880,147**	
Capital Cost	$	**$1,880,147**	
Interest Rate	%	5%	
Term	yrs	**20**	
Debt Service	$/yr	$143,683.71	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10
Savings (Avoided Cost)												
Wind Turbine Output	kWH		867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821
Elec Avoided Cost Rate	$/kWH	*5.0%*	$0.15	$0.15	$0.16	$0.17	$0.18	$0.19	$0.19	$0.20	$0.21	$0.22
Elec Savings	$/yr		$125,834	$132,126	$138,732	$145,669	$152,952	$160,600	$168,630	$177,061	$185,914	$195,210
Total Option Savings			$125,834	$132,126	$138,732	$145,669	$152,952	$160,600	$168,630	$177,061	$185,914	$195,210
Costs												
Additional O&M Cost	$/yr	***3.0%***		$13,000	$13,390	$13,792	$26,205	$26,992	$27,801	$28,635	$29,494	$42,379
Debt Service	$/yr		$143,684	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684
Total Option Cost	$/yr		$143,684	$156,684	$157,074	$157,475	$169,889	$170,675	$171,485	$172,319	$173,178	$186,063
Option Savings			-$17,850	-$24,558	-$18,342	-$11,807	-$16,937	-$10,076	-$2,855	$4,742	$12,736	$9,147
CO2 emissions reductions	*tons/yr*		535	535	535	535	535	535	535	535	535	535
Net Present Value			**$52,085**									

	11	12	13	14	15	16	17	18	19	20
Savings (Avoided Cost)										
Wind Turbine Output	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821
Elec Avoided Cost Rate	$0.24	$0.25	$0.26	$0.27	$0.29	$0.30	$0.32	$0.33	$0.35	$0.37
Elec Savings	$204,970	$215,219	$225,980	$237,279	$249,143	$261,600	$274,680	$288,414	$302,835	$317,976
Total Option Savings	$204,970	$215,219	$225,980	$237,279	$249,143	$261,600	$274,680	$288,414	$302,835	$317,976
Costs										
Additional O&M Cost	$43,651	$44,960	$46,309	$47,698	$61,129	$62,963	$64,852	$66,798	$68,801	$70,866
Debt Service	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684
Total Option Cost	$187,334	$188,644	$189,993	$191,382	$204,813	$206,647	$208,536	$210,481	$212,485	$214,549
Option Savings	$17,636	$26,575	$35,987	$45,897	$44,330	$54,953	$66,144	$77,933	$90,350	$103,427
CO2 emissions reductions	535	535	535	535	535	535	535	535	535	535

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Larger Wind Turbine at High School

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	high

Key Inputs

Wind Turbine Manuacturer		**Vesta**	
Wind Turbine Model		**660 kw**	
Nominal Rating	kW	**660**	
Total no. of turbines		**1**	
Total gross output (KW)	kW	660	
Turbine Height, (100 meter)	ft	**328**	
Average Wind Speed	mph	**14.54**	
Net Annual Capacity Factor for	%	**15.0%**	
Net Output (KWhrs/yr)	kWH/yr	867,821	
Additional O&M Cost	$/yr	**$13,000**	starting year 2 (mfgr service agreement)
Major Overhauls	$/yr	**$12,000**	every 5 years
Capital Cost per Turbine	$	**$1,880,147**	
Capital Cost	$	**$1,880,147**	
Interest Rate	%	5%	
Term	yrs	**20**	
Debt Service	$/yr	$143,683.71	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10
Savings (Avoided Cost)												
Wind Turbine Output	kWH		867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821
Elec Avoided Cost Rate	$/kWH	*2.0%*	$0.15	$0.15	$0.15	$0.15	$0.16	$0.16	$0.16	$0.17	$0.17	$0.17
Elec Savings	$/yr		$125,834	$128,351	$130,918	$133,536	$136,207	$138,931	$141,710	$144,544	$147,435	$150,383
Total Option Savings			$125,834	$128,351	$130,918	$133,536	$136,207	$138,931	$141,710	$144,544	$147,435	$150,383
Costs												
Additional O&M Cost	$/yr	***3.0%***		$13,000	$13,390	$13,792	$26,205	$26,992	$27,801	$28,635	$29,494	$42,379
Debt Service	$/yr		$143,684	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684
Total Option Cost	$/yr		$143,684	$156,684	$157,074	$157,475	$169,889	$170,675	$171,485	$172,319	$173,178	$186,063
Option Savings			-$17,850	-$28,333	-$26,156	-$23,939	-$33,682	-$31,744	-$29,775	-$27,775	-$25,743	-$35,680
CO2 emissions reductions	*tons/yr*		535	535	535	535	535	535	535	535	535	535
Net Present Value			**-$246,525**									

		Escalation	11	12	13	14	15	16	17	18	19	20
Savings (Avoided Cost)												
Wind Turbine Output	kWH		867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821	867,821
Elec Avoided Cost Rate	$/kWH	*2.0%*	$0.18	$0.18	$0.18	$0.19	$0.19	$0.20	$0.20	$0.20	$0.21	$0.21
Elec Savings	$/yr		$153,391	$156,459	$159,588	$162,780	$166,035	$169,356	$172,743	$176,198	$179,722	$183,317
Total Option Savings			$153,391	$156,459	$159,588	$162,780	$166,035	$169,356	$172,743	$176,198	$179,722	$183,317
Costs												
Additional O&M Cost	$/yr	***3.0%***	$43,651	$44,960	$46,309	$47,698	$61,129	$62,963	$64,852	$66,798	$68,801	$70,866
Debt Service	$/yr		$143,684	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684	$143,684
Total Option Cost	$/yr		$187,334	$188,644	$189,993	$191,382	$204,813	$206,647	$208,536	$210,481	$212,485	$214,549
Option Savings			-$33,943	-$32,185	-$30,405	-$28,602	-$38,778	-$37,291	-$35,792	-$34,283	-$32,763	-$31,233
CO2 emissions reductions	*tons/yr*		535	535	535	535	535	535	535	535	535	535

Appendix 10
Solar PV – NPV

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Solar PV at High School

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	low

Key Inputs

PV Manuacturer		**NA**	
PV Model		**NA**	
Nominal Rating	kW	4	
Total no. of systems		**1**	
Total gross output (KW)	kW	4	
Turbine Height, (30 meter)	ft	**NA**	
Average Wind Speed	mph	**NA**	
Net Annual Capacity Factor for	%	**13.7%**	
Net Output (KWhrs/yr)	kWH/yr	4,800	
Additional O&M Cost	$/yr	**$500**	
Major Overhauls	$/yr	**$0**	
Capital Cost per Unit	$	$36,000	
Grant or incentive	$	$0	-28471.37
Total Capital Cost	$	$36,000	
Interest Rate	%	0%	Based on interest free CREBS (Clean Renewable Energy Bonds)
Term	yrs	**20**	
Debt Service	$/yr	$1,800.00	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Savings (Avoided Cost)																						
Solar PV Output	kWH		4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800
Elec Avoided Cost Rate	$/kWH	*5.0%*	$0.15	$0.15	$0.16	$0.17	$0.18	$0.19	$0.19	$0.20	$0.21	$0.22	$0.24	$0.25	$0.26	$0.27	$0.29	$0.30	$0.32	$0.33	$0.35	$0.37
Elec Savings	$/yr		$696	$731	$767	$806	$846	$888	$933	$979	$1,028	$1,080	$1,134	$1,190	$1,250	$1,312	$1,378	$1,447	$1,519	$1,595	$1,675	$1,759
Total Option Savings			$696	$731	$767	$806	$846	$888	$933	$979	$1,028	$1,080	$1,134	$1,190	$1,250	$1,312	$1,378	$1,447	$1,519	$1,595	$1,675	$1,759
Costs																						
Additional O&M Cost	$/yr	***3.0%***	$500	$515	$530	$546	$563	$580	$597	$615	$633	$652	$672	$692	$713	$734	$756	$779	$802	$826	$851	$877
Debt Service	$/yr		$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800
Total Option Cost	$/yr		$2,300	$2,315	$2,330	$2,346	$2,363	$2,380	$2,397	$2,415	$2,433	$2,452	$2,472	$2,492	$2,513	$2,534	$2,556	$2,579	$2,602	$2,626	$2,651	$2,677
Option Savings			-$1,604	-$1,584	-$1,563	-$1,541	-$1,517	-$1,491	-$1,464	-$1,436	-$1,405	-$1,373	-$1,338	-$1,302	-$1,263	-$1,222	-$1,178	-$1,132	-$1,083	-$1,031	-$976	-$918
CO_2 emissions reductions	*tons/yr*		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Net Present Value			**-$12,120**																			

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Solar PV at High School

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	low

Key Inputs

PV Manucaturer		**NA**	
PV Model		**NA**	
Nominal Rating	kW	4	
Total no. of systems		**1**	
Total gross output (KW)	kW	4	
Turbine Height, (30 meter)	ft	**NA**	
Average Wind Speed	mph	**NA**	
Net Annual Capacity Factor for	%	**13.7%**	
Net Output (KWhrs/yr)	kWH/yr	4,800	
Additional O&M Cost	$/yr	**$500**	
Major Overhauls	$/yr	**$0**	
Capital Cost per Unit	$	$36,000	
Grant or incentive	$	$0	-28471.37
Total Capital Cost	$	$36,000	
Interest Rate	%	0%	Based on interest free CREBS (Clean Renewable Energy Bonds)
Term	yrs	**20**	
Debt Service	$/yr	$1,800.00	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Savings (Avoided Cost)																						
Solar PV Output	kWH		4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800
Elec Avoided Cost Rate	$/kWH	*2.0%*	$0.15	$0.15	$0.15	$0.15	$0.16	$0.16	$0.16	$0.17	$0.17	$0.17	$0.18	$0.18	$0.18	$0.19	$0.19	$0.20	$0.20	$0.20	$0.21	$0.21
Elec Savings	$/yr		$696	$710	$724	$739	$753	$768	$784	$799	$815	$832	$848	$865	$883	$900	$918	$937	$955	$975	$994	$1,014
Total Option Savings			$696	$710	$724	$739	$753	$768	$784	$799	$815	$832	$848	$865	$883	$900	$918	$937	$955	$975	$994	$1,014
Costs																						
Additional O&M Cost	$/yr	***3.0%***	$500	$515	$530	$546	$563	$580	$597	$615	$633	$652	$672	$692	$713	$734	$756	$779	$802	$826	$851	$877
Debt Service	$/yr		$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800	$1,800
Total Option Cost	$/yr		$2,300	$2,315	$2,330	$2,346	$2,363	$2,380	$2,397	$2,415	$2,433	$2,452	$2,472	$2,492	$2,513	$2,534	$2,556	$2,579	$2,602	$2,626	$2,651	$2,677
Option Savings			-$1,604	-$1,605	-$1,606	-$1,608	-$1,609	-$1,611	-$1,613	-$1,615	-$1,618	-$1,621	-$1,624	-$1,627	-$1,630	-$1,634	-$1,638	-$1,642	-$1,647	-$1,652	-$1,657	-$1,663
CO_2 emissions reductions	*tons/yr*		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Net Present Value			**-$13,771**																			

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Solar PV at High School

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	high

Key Inputs

PV Manuacturer		**NA**	
PV Model		**NA**	
Nominal Rating	kW	4	
Total no. of systems		**1**	
Total gross output (KW)	kW	4	
Turbine Height, (30 meter)	ft	**NA**	
Average Wind Speed	mph	**NA**	
Net Annual Capacity Factor for	%	**13.7%**	
Net Output (KWhrs/yr)	kWH/yr	4,800	
Additional O&M Cost	$/yr	**$500**	
Major Overhauls	$/yr	**$0**	
Capital Cost per Unit	$	$36,000	
Grant or incentive	$	$0	-28471.37
Total Capital Cost	$	$36,000	
Interest Rate	%	5%	
Term	yrs	**20**	
Debt Service	$/yr	$2,751.17	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Savings (Avoided Cost)																						
Solar PV Output	kWH		4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800
Elec Avoided Cost Rate	$/kWH	*5.0%*	$0.15	$0.15	$0.16	$0.17	$0.18	$0.19	$0.19	$0.20	$0.21	$0.22	$0.24	$0.25	$0.26	$0.27	$0.29	$0.30	$0.32	$0.33	$0.35	$0.37
Elec Savings	$/yr		$696	$731	$767	$806	$846	$888	$933	$979	$1,028	$1,080	$1,134	$1,190	$1,250	$1,312	$1,378	$1,447	$1,519	$1,595	$1,675	$1,759
Total Option Savings			$696	$731	$767	$806	$846	$888	$933	$979	$1,028	$1,080	$1,134	$1,190	$1,250	$1,312	$1,378	$1,447	$1,519	$1,595	$1,675	$1,759
Costs																						
Additional O&M Cost	$/yr	***3.0%***	$500	$515	$530	$546	$563	$580	$597	$615	$633	$652	$672	$692	$713	$734	$756	$779	$802	$826	$851	$877
Debt Service	$/yr		$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751
Total Option Cost	$/yr		$3,251	$3,266	$3,282	$3,298	$3,314	$3,331	$3,348	$3,366	$3,385	$3,404	$3,423	$3,443	$3,464	$3,485	$3,507	$3,530	$3,554	$3,578	$3,602	$3,628
Option Savings			-$2,555	-$2,535	-$2,514	-$2,492	-$2,468	-$2,443	-$2,415	-$2,387	-$2,356	-$2,324	-$2,289	-$2,253	-$2,214	-$2,173	-$2,129	-$2,083	-$2,034	-$1,982	-$1,927	-$1,869
CO_2 emissions reductions	*tons/yr*		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Net Present Value			**-$20,218**																			

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Solar PV at High School

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	high

Key Inputs

PV Manuacturer		**NA**	
PV Model		**NA**	
Nominal Rating	kW	4	
Total no. of systems		**1**	
Total gross output (KW)	kW	4	
Turbine Height, (30 meter)	ft	**NA**	
Average Wind Speed	mph	**NA**	
Net Annual Capacity Factor for	%	**13.7%**	
Net Output (KWhrs/yr)	kWH/yr	4,800	
Additional O&M Cost	$/yr	**$500**	
Major Overhauls	$/yr	**$0**	
Capital Cost per Unit	$	$36,000	
Grant or incentive	$	$0	-28471.37
Total Capital Cost	$	$36,000	
Interest Rate	%	5%	
Term	yrs	**20**	
Debt Service	$/yr	$2,751.17	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10
Savings (Avoided Cost)												
Solar PV Output	kWH		4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800
Elec Avoided Cost Rate	$/kWH	*2.0%*	$0.15	$0.15	$0.15	$0.15	$0.16	$0.16	$0.16	$0.17	$0.17	$0.17
Elec Savings	$/yr		$696	$710	$724	$739	$753	$768	$784	$799	$815	$832
Total Option Savings			$696	$710	$724	$739	$753	$768	$784	$799	$815	$832
Costs												
Additional O&M Cost	$/yr	***3.0%***	$500	$515	$530	$546	$563	$580	$597	$615	$633	$652
Debt Service	$/yr		$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751
Total Option Cost	$/yr		$3,251	$3,266	$3,282	$3,298	$3,314	$3,331	$3,348	$3,366	$3,385	$3,404
Option Savings			-$2,555	-$2,556	-$2,558	-$2,559	-$2,561	-$2,562	-$2,564	-$2,567	-$2,569	-$2,572
CO2 emissions reductions	*tons/yr*		3	3	3	3	3	3	3	3	3	3
Net Present Value			**-$21,869**									

	11	12	13	14	15	16	17	18	19	20
Savings (Avoided Cost)										
Solar PV Output	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800
Elec Avoided Cost Rate	$0.18	$0.18	$0.18	$0.19	$0.19	$0.20	$0.20	$0.20	$0.21	$0.21
Elec Savings	$848	$865	$883	$900	$918	$937	$955	$975	$994	$1,014
Total Option Savings	$848	$865	$883	$900	$918	$937	$955	$975	$994	$1,014
Costs										
Additional O&M Cost	$672	$692	$713	$734	$756	$779	$802	$826	$851	$877
Debt Service	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751	$2,751
Total Option Cost	$3,423	$3,443	$3,464	$3,485	$3,507	$3,530	$3,554	$3,578	$3,602	$3,628
Option Savings	-$2,575	-$2,578	-$2,581	-$2,585	-$2,589	-$2,593	-$2,598	-$2,603	-$2,608	-$2,614
CO2 emissions reductions	3	3	3	3	3	3	3	3	3	3
Net Present Value										

Appendix 11
Solar Thermal – NPV

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Solar Thermal at High School

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	low

Key Inputs

Manuacturer		**TBD**	
Model		**TBD**	
Nominal Rating			
Total no. of systems		**1**	
Total fuel oil saved	gal	986	
		NA	
		NA	
		NA	
		NA	
Additional O&M Cost	$/yr	**$0**	
Major Overhauls	$/yr	**$0**	
Capital Cost per Unit	$	$100,000	
Grant or Incentive	$	$0	-22877.53
Total Capital Cost	$	$100,000	
Interest Rate	%	**0%**	Based on interest free CREBS (Clean Renewable Energy Bonds)
Term	yrs	**20**	
Debt Service	$/yr	$5,000.00	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Savings (Avoided Cost)																						
Fuel Oil Savings	gasl		986	986	986	986	986	986	986	986	986	986	986	986	986	986	986	986	986	986	986	986
Fuel Oil Unit Rate	$/gal	*5.0%*	2.75	2.89	3.03	3.18	3.34	3.51	3.69	3.87	4.06	4.27	4.48	4.70	4.94	5.19	5.44	5.72	6.00	6.30	6.62	6.95
Fuel Oil Savings	$/yr		$2,710	$2,846	$2,988	$3,138	$3,295	$3,459	$3,632	$3,814	$4,005	$4,205	$4,415	$4,636	$4,868	$5,111	$5,367	$5,635	$5,917	$6,212	$6,523	$6,849
Total Option Savings			$2,710	$2,846	$2,988	$3,138	$3,295	$3,459	$3,632	$3,814	$4,005	$4,205	$4,415	$4,636	$4,868	$5,111	$5,367	$5,635	$5,917	$6,212	$6,523	$6,849
Costs																						
Additional O&M Cost	$/yr	*5.0%*	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt Service	$/yr		$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Total Option Cost	$/yr		$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Option Savings			-$2,290	-$2,154	-$2,012	-$1,862	-$1,705	-$1,541	-$1,368	-$1,186	-$995	-$795	-$585	-$364	-$132	$111	$367	$635	$917	$1,212	$1,523	$1,849
CO_2 emissions reductions	*tons/yr*		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Net Present Value			**-$9,738**																			

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Solar Thermal at High School

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	low

Key Inputs

Manuacturer		**TBD**	
Model		**TBD**	
Nominal Rating			
Total no. of systems		**1**	
Total fuel oil saved	gal	986	
		NA	
		NA	
		NA	
		NA	
Additional O&M Cost	$/yr	**$0**	
Major Overhauls	$/yr	**$0**	
Capital Cost per Unit	$	$100,000	
Grant or Incentive	$	$0	-22877.53
Total Capital Cost	$	$100,000	
Interest Rate	%	**0%**	Based on interest free CREBS (Clean Renewable Energy Bonds)
Term	yrs	**20**	
Debt Service	$/yr	$5,000.00	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Savings (Avoided Cost)																						
Fuel Oil Savings	gasl		986	986	986	986	986	986	986	986	986	986	986	986	986	986	986	986	986	986	986	986
Fuel Oil Unit Rate	$/gal	*2.0%*	2.75	2.81	2.86	2.92	2.98	3.04	3.10	3.16	3.22	3.29	3.35	3.42	3.49	3.56	3.63	3.70	3.78	3.85	3.93	4.01
Fuel Oil Savings	$/yr		$2,710	$2,765	$2,820	$2,876	$2,934	$2,993	$3,052	$3,113	$3,176	$3,239	$3,304	$3,370	$3,438	$3,506	$3,576	$3,648	$3,721	$3,795	$3,871	$3,949
Total Option Savings			$2,710	$2,765	$2,820	$2,876	$2,934	$2,993	$3,052	$3,113	$3,176	$3,239	$3,304	$3,370	$3,438	$3,506	$3,576	$3,648	$3,721	$3,795	$3,871	$3,949
Costs																						
Additional O&M Cost	$/yr	*2.0%*	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt Service	$/yr		$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Total Option Cost	$/yr		$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Option Savings			-$2,290	-$2,235	-$2,180	-$2,124	-$2,066	-$2,007	-$1,948	-$1,887	-$1,824	-$1,761	-$1,696	-$1,630	-$1,562	-$1,494	-$1,424	-$1,352	-$1,279	-$1,205	-$1,129	-$1,051
CO2 emissions reductions	*tons/yr*		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Net Present Value			**-$16,171**																			

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Solar Thermal at High School

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	high

Key Inputs

Manuacturer		**TBD**	
Model		**TBD**	
Nominal Rating			
Total no. of systems		**1**	
Total fuel oil saved	gal	986	
		NA	
		NA	
		NA	
		NA	
Additional O&M Cost	$/yr	**$0**	
Major Overhauls	$/yr	**$0**	
Capital Cost per Unit	$	$100,000	
Grant or Incentive	$	$0	-22877.53
Total Capital Cost	$	$100,000	
Interest Rate	%	**5%**	
Term	yrs	**20**	
Debt Service	$/yr	$7,642.15	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10
Savings (Avoided Cost)												
Fuel Oil Savings	gasl		986	986	986	986	986	986	986	986	986	986
Fuel Oil Unit Rate	$/gal	*5.0%*	2.75	2.89	3.03	3.18	3.34	3.51	3.69	3.87	4.06	4.27
Fuel Oil Savings	$/yr		$2,710	$2,846	$2,988	$3,138	$3,295	$3,459	$3,632	$3,814	$4,005	$4,205
Total Option Savings			$2,710	$2,846	$2,988	$3,138	$3,295	$3,459	$3,632	$3,814	$4,005	$4,205
Costs												
Additional O&M Cost	$/yr	*5.0%*	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt Service	$/yr		$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642
Total Option Cost	$/yr		$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642
Option Savings			-$4,932	-$4,796	-$4,654	-$4,504	-$4,348	-$4,183	-$4,010	-$3,828	-$3,638	-$3,437
CO2 emissions reductions	*tons/yr*		10	10	10	10	10	10	10	10	10	10
Net Present Value			**-$32,233**									

	11	12	13	14	15	16	17	18	19	20
Savings (Avoided Cost)										
Fuel Oil Savings	986	986	986	986	986	986	986	986	986	986
Fuel Oil Unit Rate	4.48	4.70	4.94	5.19	5.44	5.72	6.00	6.30	6.62	6.95
Fuel Oil Savings	$4,415	$4,636	$4,868	$5,111	$5,367	$5,635	$5,917	$6,212	$6,523	$6,849
Total Option Savings	$4,415	$4,636	$4,868	$5,111	$5,367	$5,635	$5,917	$6,212	$6,523	$6,849
Costs										
Additional O&M Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt Service	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642
Total Option Cost	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642
Option Savings	-$3,227	-$3,006	-$2,775	-$2,531	-$2,276	-$2,007	-$1,726	-$1,430	-$1,119	-$793
CO2 emissions reductions	10	10	10	10	10	10	10	10	10	10
Net Present Value										

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Solar Thermal at High School

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	high

Key Inputs			
Manuacturer		**TBD**	
Model		**TBD**	
Nominal Rating			
Total no. of systems		**1**	
Total fuel oil saved	gal	986	
		NA	
		NA	
		NA	
		NA	
Additional O&M Cost	$/yr	**$0**	
Major Overhauls	$/yr	**$0**	
Capital Cost per Unit	$	$100,000	
Grant or Incentive	$	$0	-22877.53
Total Capital Cost	$	$100,000	
Interest Rate	%	**5%**	
Term	yrs	**20**	
Debt Service	$/yr	$7,642.15	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Savings (Avoided Cost)																						
Fuel Oil Savings	gasl		986	986	986	986	986	986	986	986	986	986	986	986	986	986	986	986	986	986	986	986
Fuel Oil Unit Rate	$/gal	*2.0%*	2.75	2.81	2.86	2.92	2.98	3.04	3.10	3.16	3.22	3.29	3.35	3.42	3.49	3.56	3.63	3.70	3.78	3.85	3.93	4.01
Fuel Oil Savings	$/yr		$2,710	$2,765	$2,820	$2,876	$2,934	$2,993	$3,052	$3,113	$3,176	$3,239	$3,304	$3,370	$3,438	$3,506	$3,576	$3,648	$3,721	$3,795	$3,871	$3,949
Total Option Savings			$2,710	$2,765	$2,820	$2,876	$2,934	$2,993	$3,052	$3,113	$3,176	$3,239	$3,304	$3,370	$3,438	$3,506	$3,576	$3,648	$3,721	$3,795	$3,871	$3,949
Costs																						
Additional O&M Cost	$/yr	*2.0%*	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt Service	$/yr		$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642
Total Option Cost	$/yr		$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642	$7,642
Option Savings			-$4,932	-$4,877	-$4,822	-$4,766	-$4,708	-$4,650	-$4,590	-$4,529	-$4,466	-$4,403	-$4,338	-$4,272	-$4,205	-$4,136	-$4,066	-$3,994	-$3,921	-$3,847	-$3,771	-$3,694
CO2 emissions reductions	*tons/yr*		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Net Present Value			**-$38,665**																			

Appendix 12
Natural Gas – NPV

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Convert School and Municipal Buildings to Natural Gas

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	low

Key Inputs

Percent of Fuel Oil Displaced	%	**85%**	
Oil Boiler Efficiency	%	**85%**	
Gas Boiler Efficiency	%	**85%**	
Additional O&M Cost	$/yr	**$0**	
Additional Major Overhauls	$/yr	**$0**	every **10** yrs
Pipeline Cost	$	960000	
Conversiosn Cost	$	250000	
Total Capital Cost	$	$1,210,000	
Interest Rate	%	0%	Based on interest free CREBS (Clean Renewable Energy Bonds)
Term	yrs	**20**	
Debt Service	$/yr	$60,500.00	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10
Existing Situation after Energy Efficiency Improvements												
Fuel Oil Use	Gal/yr		132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503
Fuel Oil Use	mmBtu/yr		18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378
Fuel Oil Cost	$/gal	*5.0%*	$2.75	$2.89	$3.03	$3.18	$3.34	$3.51	$3.69	$3.87	$4.06	$4.27
Fuel Oil Cost	$/yr		$364,384	$382,604	$401,734	$421,820	$442,911	$465,057	$488,310	$512,725	$538,362	$565,280
Total Existing Cost	$/yr		$364,384	$382,604	$401,734	$421,820	$442,911	$465,057	$488,310	$512,725	$538,362	$565,280
Natural Gas Conversion Option												
Fuel Oil Use	Gal/yr		19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876
Fuel Oil Use	mmBtu/yr		2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757
Natural Gas Use	mmBtu/yr		15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621
Natural Gas Cost	$/mmbtu	*5.0%*	$15.50	$16.28	$17.09	$17.94	$18.84	$19.78	$20.77	$21.81	$22.90	$24.05
Natural Gas Cost	$/yr		$242,133	$254,240	$266,952	$280,299	$294,314	$309,030	$324,481	$340,706	$357,741	$375,628
Fuel Oil Cost	$/yr		$54,658	$57,391	$60,260	$63,273	$66,437	$69,759	$73,246	$76,909	$80,754	$84,792
Additional O&M Cost	$/yr	***3.0%***	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Major Overhauls	$/yr	***3.0%***	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,000
Debt Service	$/yr		$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500
Total Option Project Cost	$/yr		$357,291	$372,130	$387,712	$404,072	$421,251	$439,289	$458,228	$478,114	$498,995	$523,920
Option Savings			$7,094	$10,473	$14,022	$17,748	$21,660	$25,769	$30,082	$34,611	$39,367	$41,360
CO2 emissions reductions	*tons/yr*		314	314	314	314	314	314	314	314	314	314
Net Present Value		**$**	**302,472**									

		11	12	13	14	15	16	17	18	19	20
Existing Situation after Energy Efficiency Improvements											
Fuel Oil Use	Gal/yr	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503
Fuel Oil Use	mmBtu/yr	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378
Fuel Oil Cost	$/gal	$4.48	$4.70	$4.94	$5.19	$5.44	$5.72	$6.00	$6.30	$6.62	$6.95
Fuel Oil Cost	$/yr	$593,544	$623,221	$654,382	$687,101	$721,456	$757,529	$795,405	$835,176	$876,934	$920,781
Total Existing Cost	$/yr	$593,544	$623,221	$654,382	$687,101	$721,456	$757,529	$795,405	$835,176	$876,934	$920,781
Natural Gas Conversion Option											
Fuel Oil Use	Gal/yr	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876
Fuel Oil Use	mmBtu/yr	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757
Natural Gas Use	mmBtu/yr	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621
Natural Gas Cost	$/mmbtu	$25.25	$26.51	$27.84	$29.23	$30.69	$32.22	$33.83	$35.53	$37.30	$39.17
Natural Gas Cost	$/yr	$394,409	$414,130	$434,836	$456,578	$479,407	$503,377	$528,546	$554,973	$582,722	$611,858
Fuel Oil Cost	$/yr	$89,032	$93,483	$98,157	$103,065	$108,218	$113,629	$119,311	$125,276	$131,540	$138,117
Additional O&M Cost	$/yr	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Major Overhauls	$/yr	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt Service	$/yr	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500
Total Option Project Cost	$/yr	$543,941	$568,113	$593,493	$620,143	$648,125	$677,507	$708,357	$740,750	$774,762	$810,475
Option Savings		$49,603	$55,108	$60,888	$66,958	$73,331	$80,022	$87,048	$94,426	$102,172	$110,306
CO2 emissions reductions	*tons/yr*	314	314	314	314	314	314	314	314	314	314

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Convert School and Municipal Buildings to Natural Gas

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	low

Key Inputs

Percent of Fuel Oil Displaced	%	**85%**		
Oil Boiler Efficiency	%	**85%**		
Gas Boiler Efficiency	%	**85%**		
Additional O&M Cost	$/yr	**$0**		
Additional Major Overhauls	$/yr	**$0**	every	**10** yrs
Pipeline Cost	$	960000		
Conversiosn Cost	$	250000		
Total Capital Cost	$	$1,210,000		
Interest Rate	%	0%	Based on interest free CREBS (Clean Renewable Energy Bonds)	
Term	yrs	**20**		
Debt Service	$/yr	$60,500.00		
NPV Discount Rate	%	**10%**		

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Existing Situation after Energy Efficiency Improvements																						
Fuel Oil Use	Gal/yr		132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503
Fuel Oil Use	mmBtu/yr		18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378
Fuel Oil Cost	$/gal	*2.0%*	$2.75	$2.81	$2.86	$2.92	$2.98	$3.04	$3.10	$3.16	$3.22	$3.29	$3.35	$3.42	$3.49	$3.56	$3.63	$3.70	$3.78	$3.85	$3.93	$4.01
Fuel Oil Cost	$/yr		$364,384	$371,672	$379,105	$386,688	$394,421	$402,310	$410,356	$418,563	$426,934	$435,473	$444,182	$453,066	$462,127	$471,370	$480,797	$490,413	$500,222	$510,226	$520,431	$530,839
Total Existing Cost	$/yr		$364,384	$371,672	$379,105	$386,688	$394,421	$402,310	$410,356	$418,563	$426,934	$435,473	$444,182	$453,066	$462,127	$471,370	$480,797	$490,413	$500,222	$510,226	$520,431	$530,839
Natural Gas Conversion Option																						
Fuel Oil Use	Gal/yr		19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876
Fuel Oil Use	mmBtu/yr		2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757
Natural Gas Use	mmBtu/yr		15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621
Natural Gas Cost	$/mmbtu	*2.0%*	$15.50	$15.81	$16.13	$16.45	$16.78	$17.11	$17.46	$17.80	$18.16	$18.52	$18.89	$19.27	$19.66	$20.05	$20.45	$20.86	$21.28	$21.70	$22.14	$22.58
Natural Gas Cost	$/yr		$242,133	$246,976	$251,915	$256,954	$262,093	$267,334	$272,681	$278,135	$283,697	$289,371	$295,159	$301,062	$307,083	$313,225	$319,489	$325,879	$332,397	$339,045	$345,826	$352,742
Fuel Oil Cost	$/yr		$54,658	$55,751	$56,866	$58,003	$59,163	$60,346	$61,553	$62,784	$64,040	$65,321	$66,627	$67,960	$69,319	$70,706	$72,120	$73,562	$75,033	$76,534	$78,065	$79,626
Additional O&M Cost	$/yr	***3.0%***	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Major Overhauls	$/yr	***3.0%***	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt Service	$/yr		$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500	$60,500
Total Option Project Cost	$/yr		$357,291	$363,227	$369,281	$375,457	$381,756	$388,181	$394,735	$401,419	$408,238	$418,192	$422,286	$429,522	$436,902	$444,430	$452,109	$459,941	$467,930	$476,079	$484,390	$492,868
Option Savings			$7,094	$8,446	$9,824	$11,231	$12,666	$14,129	$15,621	$17,144	$18,697	$17,281	$21,896	$23,544	$25,225	$26,940	$28,688	$30,472	$32,292	$34,147	$36,040	$37,971
CO2 emissions reductions	*tons/yr*		314	314	314	314	314	314	314	314	314	314	314	314	314	314	314	314	314	314	314	314
Net Present Value			**$ 142,070**																			

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Convert School and Municipal Buildings to Natural Gas

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	high

Key Inputs

Percent of Fuel Oil Displaced	%	**85%**		
Oil Boiler Efficiency	%	**85%**		
Gas Boiler Efficiency	%	**85%**		
Additional O&M Cost	$/yr	**$0**		
Additional Major Overhauls	$/yr	**$0**	every	**10** yrs
Pipeline Cost	$	960000		
Conversiosn Cost	$	250000		
Total Capital Cost	$	$1,210,000		
Interest Rate	%	5%		
Term	yrs	**20**		
Debt Service	$/yr	$92,470.03		
NPV Discount Rate	%	**10%**		

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Existing Situation after Energy Efficiency Improvements																						
Fuel Oil Use	Gal/yr		132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503
Fuel Oil Use	mmBtu/yr		18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378
Fuel Oil Cost	$/gal	*5.0%*	$2.75	$2.89	$3.03	$3.18	$3.34	$3.51	$3.69	$3.87	$4.06	$4.27	$4.48	$4.70	$4.94	$5.19	$5.44	$5.72	$6.00	$6.30	$6.62	$6.95
Fuel Oil Cost	$/yr		$364,384	$382,604	$401,734	$421,820	$442,911	$465,057	$488,310	$512,725	$538,362	$565,280	$593,544	$623,221	$654,382	$687,101	$721,456	$757,529	$795,405	$835,176	$876,934	$920,781
Total Existing Cost	$/yr		$364,384	$382,604	$401,734	$421,820	$442,911	$465,057	$488,310	$512,725	$538,362	$565,280	$593,544	$623,221	$654,382	$687,101	$721,456	$757,529	$795,405	$835,176	$876,934	$920,781
Natural Gas Conversion Option																						
Fuel Oil Use	Gal/yr		19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876
Fuel Oil Use	mmBtu/yr		2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757
Natural Gas Use	mmBtu/yr		15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621
Natural Gas Cost	$/mmbtu	*5.0%*	$15.50	$16.28	$17.09	$17.94	$18.84	$19.78	$20.77	$21.81	$22.90	$24.05	$25.25	$26.51	$27.84	$29.23	$30.69	$32.22	$33.83	$35.53	$37.30	$39.17
Natural Gas Cost	$/yr		$242,133	$254,240	$266,952	$280,299	$294,314	$309,030	$324,481	$340,706	$357,741	$375,628	$394,409	$414,130	$434,836	$456,578	$479,407	$503,377	$528,546	$554,973	$582,722	$611,858
Fuel Oil Cost	$/yr		$54,658	$57,391	$60,260	$63,273	$66,437	$69,759	$73,246	$76,909	$80,754	$84,792	$89,032	$93,483	$98,157	$103,065	$108,218	$113,629	$119,311	$125,276	$131,540	$138,117
Additional O&M Cost	$/yr	***3.0%***	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Major Overhauls	$/yr	***3.0%***	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt Service	$/yr		$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470
Total Option Project Cost	$/yr		$389,261	$404,100	$419,682	$436,042	$453,221	$471,259	$490,198	$510,084	$530,965	$555,890	$575,911	$600,083	$625,464	$652,113	$680,095	$709,477	$740,327	$772,720	$806,732	$842,445
Option Savings			-$24,876	-$21,497	-$17,948	-$14,222	-$10,310	-$6,202	-$1,888	$2,641	$7,397	$9,390	$17,633	$23,138	$28,918	$34,988	$41,361	$48,052	$55,078	$62,456	$70,202	$78,336
CO2 emissions reductions	*tons/yr*		314	314	314	314	314	314	314	314	314	314	314	314	314	314	314	314	314	314	314	314
Net Present Value		$	**30,294**																			

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Convert School and Municipal Buildings to Natural Gas

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	high

Key Inputs

Percent of Fuel Oil Displaced	%	**85%**		
Oil Boiler Efficiency	%	**85%**		
Gas Boiler Efficiency	%	**85%**		
Additional O&M Cost	$/yr	**$0**		
Additional Major Overhauls	$/yr	**$0**	every	**10** yrs
Pipeline Cost	$	960000		
Conversiosn Cost	$	250000		
Total Capital Cost	$	$1,210,000		
Interest Rate	%	5%		
Term	yrs	**20**		
Debt Service	$/yr	$92,470.03		
NPV Discount Rate	%	**10%**		

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Existing Situation after Energy Efficiency Improvements																						
Fuel Oil Use	Gal/yr		132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503
Fuel Oil Use	mmBtu/yr		18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378
Fuel Oil Cost	$/gal	*2.0%*	$2.75	$2.81	$2.86	$2.92	$2.98	$3.04	$3.10	$3.16	$3.22	$3.29	$3.35	$3.42	$3.49	$3.56	$3.63	$3.70	$3.78	$3.85	$3.93	$4.01
Fuel Oil Cost	$/yr		$364,384	$371,672	$379,105	$386,688	$394,421	$402,310	$410,356	$418,563	$426,934	$435,473	$444,182	$453,066	$462,127	$471,370	$480,797	$490,413	$500,222	$510,226	$520,431	$530,839
Total Existing Cost	$/yr		$364,384	$371,672	$379,105	$386,688	$394,421	$402,310	$410,356	$418,563	$426,934	$435,473	$444,182	$453,066	$462,127	$471,370	$480,797	$490,413	$500,222	$510,226	$520,431	$530,839
Natural Gas Conversion Option																						
Fuel Oil Use	Gal/yr		19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876	19,876
Fuel Oil Use	mmBtu/yr		2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757	2,757
Natural Gas Use	mmBtu/yr		15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621	15,621
Natural Gas Cost	$/mmbtu	*2.0%*	$15.50	$15.81	$16.13	$16.45	$16.78	$17.11	$17.46	$17.80	$18.16	$18.52	$18.89	$19.27	$19.66	$20.05	$20.45	$20.86	$21.28	$21.70	$22.14	$22.58
Natural Gas Cost	$/yr		$242,133	$246,976	$251,915	$256,954	$262,093	$267,334	$272,681	$278,135	$283,697	$289,371	$295,159	$301,062	$307,083	$313,225	$319,489	$325,879	$332,397	$339,045	$345,826	$352,742
Fuel Oil Cost	$/yr		$54,658	$55,751	$56,866	$58,003	$59,163	$60,346	$61,553	$62,784	$64,040	$65,321	$66,627	$67,960	$69,319	$70,706	$72,120	$73,562	$75,033	$76,534	$78,065	$79,626
Additional O&M Cost	$/yr	***3.0%***	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Major Overhauls	$/yr	***3.0%***	$0	$0	$0	$0	$0	$0	$0	$0	$0	$3,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Debt Service	$/yr		$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470	$92,470
Total Option Project Cost	$/yr		$389,261	$395,197	$401,251	$407,427	$413,726	$420,151	$426,705	$433,389	$440,208	$450,162	$454,256	$461,492	$468,872	$476,400	$484,079	$491,911	$499,900	$508,049	$516,360	$524,838
Option Savings			-$24,876	-$23,525	-$22,146	-$20,739	-$19,305	-$17,841	-$16,349	-$14,826	-$13,273	-$14,689	-$10,074	-$8,426	-$6,745	-$5,030	-$3,282	-$1,498	$322	$2,177	$4,070	$6,001
CO2 emissions reductions	*tons/yr*		314	314	314	314	314	314	314	314	314	314	314	314	314	314	314	314	314	314	314	314
Net Present Value			**$ (130,109)**																			

Appendix 13
Cogeneration – NPV

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Cogeneration System at High School & Middle School

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	low

Key Inputs

High School Area	sq ft	**168,000**	
Middle School Area	sq ft	**181,468**	
Additional O&M Cost	$/yr	$38,697	
Major Overhauls	$/yr	**$50,000**	every **4** yrs
Cogen Plant	$	$1,400,000	
Pipeline	$	$960,000	
Grant or Incentive	$	$0	NG Breakeven = $10.82/mmbtu
Total Capital Cost	$	$2,360,000	
Interest Rate	%	0%	Based on interest free CREBS (Clean Renewable Energy Bonds)
Term	yrs	**20**	
Debt Service	$/yr	$118,000	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Existing Situation after Energy Efficiency Improvements																						
Fuel Oil Use	Gal/yr		132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503
Fuel Oil Use	mmBtu/yr		18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378
Fuel Oil Cost	$/gal	5.0%	$2.75	$2.89	$3.03	$3.18	$3.34	$3.51	$3.69	$3.87	$4.06	$4.27	$4.48	$4.70	$4.94	$5.19	$5.44	$5.72	$6.00	$6.30	$6.62	$6.95
Fuel Oil Cost	$/yr		$364,384	$382,604	$401,734	$421,820	$442,911	$465,057	$488,310	$512,725	$538,362	$565,280	$593,544	$623,221	$654,382	$687,101	$721,456	$757,529	$795,405	$835,176	$876,934	$920,781
Elec Use	kwh/yr		1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700
Elec Rate (Purchased)	$/kwh	5.0%	$0.145	$0.152	$0.160	$0.168	$0.176	$0.185	$0.194	$0.204	$0.214	$0.225	$0.236	$0.248	$0.260	$0.273	$0.287	$0.301	$0.317	$0.332	$0.349	$0.366
Elec Rate (Sales)		5.0%	$0.087	$0.091	$0.095	$0.100	$0.105	$0.110	$0.116	$0.122	$0.128	$0.134	$0.141	$0.148	$0.155	$0.163	$0.171	$0.180	$0.189	$0.198	$0.208	$0.219
Elec Cost	$/yr		$288,797	$303,236	$318,398	$334,318	$351,034	$368,586	$387,015	$406,366	$426,684	$448,018	$470,419	$493,940	$518,637	$544,569	$571,797	$600,387	$630,407	$661,927	$695,023	$729,774
Total Existing Cost	$/yr		$653,181	$685,840	$720,132	$756,138	$793,945	$833,643	$875,325	$919,091	$965,046	$1,013,298	$1,063,963	$1,117,161	$1,173,019	$1,231,670	$1,293,253	$1,357,916	$1,425,812	$1,497,102	$1,571,958	$1,650,555
Cogeneration Option																						
Natural gas Use, Cogen	mmBtu/yr		35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807
Natural Gas Use, Boilers	mmBtu/yr		10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001
Total Natural Gas Use	mmbtu/yr		45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808
Natural Gas Cost	$/mmBtu	5.0%	$15.50	$16.28	$17.09	$17.94	$18.84	$19.78	$20.77	$21.81	$22.90	$24.05	$25.25	$26.51	$27.84	$29.23	$30.69	$32.22	$33.83	$35.53	$37.30	$39.17
Elec Generation	kwh/yr		2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460
Elec Enery Savings	kwh/yr		1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700
Natural Gas Cost	$/yr		$710,024	$745,525	$782,801	$821,941	$863,038	$906,190	$951,499	$999,074	$1,049,028	$1,101,480	$1,156,554	$1,214,381	$1,275,100	$1,338,855	$1,405,798	$1,476,088	$1,549,892	$1,627,387	$1,708,756	$1,794,194
Purchase Elec Cost from Grid	$/yr		-$23,594	-$24,773	-$26,012	-$27,313	-$28,678	-$30,112	-$31,618	-$33,199	-$34,859	-$36,602	-$38,432	-$40,353	-$42,371	-$44,490	-$46,714	-$49,050	-$51,502	-$54,077	-$56,781	-$59,620
Utility Demand/Standby Charge	$/yr	5.0%	$48,568	$50,996	$53,546	$56,223	$59,035	$61,986	$65,086	$68,340	$71,757	$75,345	$79,112	$83,067	$87,221	$91,582	$96,161	$100,969	$106,018	$111,318	$116,884	$122,729
Additional O&M Cost	$/yr	3.0%	$38,697	$39,858	$41,054	$42,286	$43,554	$44,861	$46,207	$47,593	$49,021	$50,491	$52,006	$53,566	$55,173	$56,828	$58,533	$60,289	$62,098	$63,961	$65,880	$67,856
Major Overhauls		3.0%	$12,500	$12,875	$13,261	$13,659	$14,069	$14,491	$14,926	$15,373	$15,835	$16,310	$16,799	$17,303	$17,822	$18,357	$18,907	$19,475	$20,059	$20,661	$21,280	$21,919
Debt Service	$/yr		$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000
Total Option Project Cost	$/yr		$904,195	$942,481	$982,650	$1,024,796	$1,069,017	$1,115,416	$1,164,099	$1,215,182	$1,268,782	$1,325,023	$1,384,039	$1,445,964	$1,510,945	$1,579,133	$1,650,686	$1,725,771	$1,804,564	$1,887,249	$1,974,019	$2,065,077
Option Savings			-$251,014	-$256,641	-$262,518	-$268,658	-$275,072	-$281,773	-$288,775	-$296,091	-$303,736	-$311,726	-$320,076	-$328,804	-$337,926	-$347,463	-$357,432	-$367,855	-$378,752	-$390,147	-$402,062	-$414,522
CO2 emissions reductions	*tons/yr*		310	310	310	310	310	310	310	310	310	310	310	310	310	310	310	310	310	310	310	310
Net Present Value		$	**(2,530,609)**																			

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Cogeneration System at High School & Middle School

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	low

Key Inputs

High School Area	sq ft	**168,000**	
Middle School Area	sq ft	**181,468**	
Additional O&M Cost	$/yr	$38,697	
Major Overhauls	$/yr	**$50,000**	every **4** yrs
Cogen Plant	$	$1,400,000	
Pipeline	$	$960,000	
Grant or Incentive	$	$0	NG Breakeven = $10.82/mmbtu
Total Capital Cost	$	$2,360,000	
Interest Rate	%	0%	Based on interest free CREBS (Clean Renewable Energy Bonds)
Term	yrs	**20**	
Debt Service	$/yr	$118,000	
NPV Discount Rate	%	**10%**	

		Escalation	1	2	3	4	5	6	7	8	9	10
Existing Situation after Energy Efficiency Improvements												
Fuel Oil Use	Gal/yr		132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503
Fuel Oil Use	mmBtu/yr		18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378
Fuel Oil Cost	$/gal	*2.0%*	$2.75	$2.81	$2.86	$2.92	$2.98	$3.04	$3.10	$3.16	$3.22	$3.29
Fuel Oil Cost	$/yr		$364,384	$371,672	$379,105	$386,688	$394,421	$402,310	$410,356	$418,563	$426,934	$435,473
Elec Use	kwh/yr		1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700
Elec Rate (Purchased)	$/kwh	*2.0%*	$0.145	$0.148	$0.151	$0.154	$0.157	$0.160	$0.163	$0.167	$0.170	$0.173
Elec Rate (Sales)		*2.0%*	$0.087	$0.088	$0.090	$0.092	$0.094	$0.096	$0.097	$0.099	$0.101	$0.103
Elec Cost	$/yr		$288,797	$294,572	$300,464	$306,473	$312,603	$318,855	$325,232	$331,736	$338,371	$345,139
Total Existing Cost	$/yr		$653,181	$666,244	$679,569	$693,161	$707,024	$721,164	$735,588	$750,299	$765,305	$780,612
Cogeneration Option												
Natural gas Use, Cogen	mmBtu/yr		35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807
Natural Gas Use, Boilers	mmBtu/yr		10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001
Total Natural Gas Use	mmbtu/yr		45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808
Natural Gas Cost	$/mmBtu	*2.0%*	$15.50	$15.81	$16.13	$16.45	$16.78	$17.11	$17.46	$17.80	$18.16	$18.52
Elec Generation	kwh/yr		2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460
Elec Enery Savings	kwh/yr		1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700
Natural Gas Cost	$/yr		$710,024	$724,224	$738,709	$753,483	$768,552	$783,923	$799,602	$815,594	$831,906	$848,544
Purchase Elec Cost from Grid	$/yr		-$23,594	-$24,066	-$24,547	-$25,038	-$25,539	-$26,049	-$26,570	-$27,102	-$27,644	-$28,197
Utility Demand/Standby Charge	$/yr	*2.0%*	$48,568	$49,539	$50,530	$51,541	$52,571	$53,623	$54,695	$55,789	$56,905	$58,043
Additional O&M Cost	$/yr	***3.0%***	$38,697	$39,858	$41,054	$42,286	$43,554	$44,861	$46,207	$47,593	$49,021	$50,491
Major Overhauls		***3.0%***	$12,500	$12,875	$13,261	$13,659	$14,069	$14,491	$14,926	$15,373	$15,835	$16,310
Debt Service	$/yr		$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000
Total Option Project Cost	$/yr		$904,195	$920,431	$937,007	$953,930	$971,208	$988,849	$1,006,859	$1,025,247	$1,044,022	$1,063,191
Option Savings			-$251,014	-$254,186	-$257,437	-$260,769	-$264,184	-$267,684	-$271,271	-$274,948	-$278,717	-$282,580
CO2 emissions reductions	*tons/yr*		310	310	310	310	310	310	310	310	310	310
Net Present Value		**$**	**(2,336,454)**									

		Escalation	11	12	13	14	15	16	17	18	19	20
Existing Situation after Energy Efficiency Improvements												
Fuel Oil Use	Gal/yr		132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503
Fuel Oil Use	mmBtu/yr		18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378
Fuel Oil Cost	$/gal	*2.0%*	$3.35	$3.42	$3.49	$3.56	$3.63	$3.70	$3.78	$3.85	$3.93	$4.01
Fuel Oil Cost	$/yr		$444,182	$453,066	$462,127	$471,370	$480,797	$490,413	$500,222	$510,226	$520,431	$530,839
Elec Use	kwh/yr		1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700
Elec Rate (Purchased)	$/kwh	*2.0%*	$0.177	$0.180	$0.184	$0.188	$0.191	$0.195	$0.199	$0.203	$0.207	$0.211
Elec Rate (Sales)		*2.0%*	$0.105	$0.108	$0.110	$0.112	$0.114	$0.116	$0.119	$0.121	$0.124	$0.126
Elec Cost	$/yr		$352,041	$359,082	$366,264	$373,589	$381,061	$388,682	$396,456	$404,385	$412,473	$420,722
Total Existing Cost	$/yr		$796,224	$812,148	$828,391	$844,959	$861,858	$879,095	$896,677	$914,611	$932,903	$951,561
Cogeneration Option												
Natural gas Use, Cogen	mmBtu/yr		35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807
Natural Gas Use, Boilers	mmBtu/yr		10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001
Total Natural Gas Use	mmbtu/yr		45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808
Natural Gas Cost	$/mmBtu	*2.0%*	$18.89	$19.27	$19.66	$20.05	$20.45	$20.86	$21.28	$21.70	$22.14	$22.58
Elec Generation	kwh/yr		2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460
Elec Enery Savings	kwh/yr		1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700
Natural Gas Cost	$/yr		$865,515	$882,825	$900,482	$918,491	$936,861	$955,598	$974,710	$994,204	$1,014,088	$1,034,370
Purchase Elec Cost from Grid	$/yr		-$28,761	-$29,336	-$29,923	-$30,521	-$31,131	-$31,754	-$32,389	-$33,037	-$33,698	-$34,372
Utility Demand/Standby Charge	$/yr	*2.0%*	$59,204	$60,388	$61,596	$62,828	$64,084	$65,366	$66,673	$68,007	$69,367	$70,754
Additional O&M Cost	$/yr	***3.0%***	$52,006	$53,566	$55,173	$56,828	$58,533	$60,289	$62,098	$63,961	$65,880	$67,856
Major Overhauls		***3.0%***	$16,799	$17,303	$17,822	$18,357	$18,907	$19,475	$20,059	$20,661	$21,280	$21,919
Debt Service	$/yr		$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000	$118,000
Total Option Project Cost	$/yr		$1,082,763	$1,102,746	$1,123,150	$1,143,983	$1,165,254	$1,186,974	$1,209,151	$1,231,796	$1,254,918	$1,278,528
Option Savings			-$286,539	-$290,598	-$294,759	-$299,024	-$303,396	-$307,878	-$312,474	-$317,185	-$322,015	-$326,966
CO2 emissions reductions	*tons/yr*		310	310	310	310	310	310	310	310	310	310

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Cogeneration System at High School & Middle School

Sensitivity Test	
Energy Inflation	high
Borrowing Cost	high

Key Inputs

High School Area	sq ft	**168,000**
Middle School Area	sq ft	**181,468**
Additional O&M Cost	$/yr	$38,697
Major Overhauls	$/yr	**$50,000** every **4** yrs
Cogen Plant	$	$1,400,000
Pipeline	$	$960,000
Grant or Incentive	$	$0
Total Capital Cost	$	$2,360,000
Interest Rate	%	5%
Term	yrs	**20**
Debt Service	$/yr	$180,355
NPV Discount Rate	%	**10%**

NG Breakeven = $10.82/mmbtu

		Escalation	1	2	3	4	5	6	7	8	9	10
Existing Situation after Energy Efficiency Improvements												
Fuel Oil Use	Gal/yr		132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503
Fuel Oil Use	mmBtu/yr		18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378
Fuel Oil Cost	$/gal	*5.0%*	$2.75	$2.89	$3.03	$3.18	$3.34	$3.51	$3.69	$3.87	$4.06	$4.27
Fuel Oil Cost	$/yr		$364,384	$382,604	$401,734	$421,820	$442,911	$465,057	$488,310	$512,725	$538,362	$565,280
Elec Use	kwh/yr		1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700
Elec Rate (Purchased)	$/kwh	*5.0%*	$0.145	$0.152	$0.160	$0.168	$0.176	$0.185	$0.194	$0.204	$0.214	$0.225
Elec Rate (Sales)		*5.0%*	$0.087	$0.091	$0.095	$0.100	$0.105	$0.110	$0.116	$0.122	$0.128	$0.134
Elec Cost	$/yr		$288,797	$303,236	$318,398	$334,318	$351,034	$368,586	$387,015	$406,366	$426,684	$448,018
Total Existing Cost	$/yr		$653,181	$685,840	$720,132	$756,138	$793,945	$833,643	$875,325	$919,091	$965,046	$1,013,298
Cogeneration Option												
Natural gas Use, Cogen	mmBtu/yr		35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807
Natural Gas Use, Boilers	mmBtu/yr		10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001
Total Natural Gas Use	mmbtu/yr		45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808
Natural Gas Cost	$/mmBtu	*5.0%*	$15.50	$16.28	$17.09	$17.94	$18.84	$19.78	$20.77	$21.81	$22.90	$24.05
Elec Generation	kwh/yr		2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460
Elec Enery Savings	kwh/yr		1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700
Natural Gas Cost	$/yr		$710,024	$745,525	$782,801	$821,941	$863,038	$906,190	$951,499	$999,074	$1,049,028	$1,101,480
Purchase Elec Cost from Grid	$/yr		-$23,594	-$24,773	-$26,012	-$27,313	-$28,678	-$30,112	-$31,618	-$33,199	-$34,859	-$36,602
Utility Demand/Standby Charge	$/yr	*5.0%*	$48,568	$50,996	$53,546	$56,223	$59,035	$61,986	$65,086	$68,340	$71,757	$75,345
Additional O&M Cost	$/yr	***3.0%***	$38,697	$39,858	$41,054	$42,286	$43,554	$44,861	$46,207	$47,593	$49,021	$50,491
Major Overhauls		***3.0%***	$12,500	$12,875	$13,261	$13,659	$14,069	$14,491	$14,926	$15,373	$15,835	$16,310
Debt Service	$/yr		$180,355	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355
Total Option Project Cost	$/yr		$966,550	$1,004,836	$1,045,005	$1,087,151	$1,131,372	$1,177,770	$1,226,454	$1,277,537	$1,331,136	$1,387,378
Option Savings			-$313,369	-$318,996	-$324,873	-$331,013	-$337,427	-$344,128	-$351,129	-$358,445	-$366,091	-$374,080
CO2 emissions reductions	*tons/yr*		310	310	310	310	310	310	310	310	310	310
Net Present Value		**$**	**(3,061,470)**									

	11	12	13	14	15	16	17	18	19	20
Existing Situation after Energy Efficiency Improvements										
Fuel Oil Use (Gal/yr)	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503
Fuel Oil Use (mmBtu/yr)	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378
Fuel Oil Cost ($/gal)	$4.48	$4.70	$4.94	$5.19	$5.44	$5.72	$6.00	$6.30	$6.62	$6.95
Fuel Oil Cost ($/yr)	$593,544	$623,221	$654,382	$687,101	$721,456	$757,529	$795,405	$835,176	$876,934	$920,781
Elec Use (kwh/yr)	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700
Elec Rate (Purchased) ($/kwh)	$0.236	$0.248	$0.260	$0.273	$0.287	$0.301	$0.317	$0.332	$0.349	$0.366
Elec Rate (Sales)	$0.141	$0.148	$0.155	$0.163	$0.171	$0.180	$0.189	$0.198	$0.208	$0.219
Elec Cost ($/yr)	$470,419	$493,940	$518,637	$544,569	$571,797	$600,387	$630,407	$661,927	$695,023	$729,774
Total Existing Cost ($/yr)	$1,063,963	$1,117,161	$1,173,019	$1,231,670	$1,293,253	$1,357,916	$1,425,812	$1,497,102	$1,571,958	$1,650,555
Cogeneration Option										
Natural gas Use, Cogen (mmBtu/yr)	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807
Natural Gas Use, Boilers (mmBtu/yr)	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001
Total Natural Gas Use (mmbtu/yr)	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808
Natural Gas Cost ($/mmBtu)	$25.25	$26.51	$27.84	$29.23	$30.69	$32.22	$33.83	$35.53	$37.30	$39.17
Elec Generation (kwh/yr)	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460
Elec Enery Savings (kwh/yr)	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700
Natural Gas Cost ($/yr)	$1,156,554	$1,214,381	$1,275,100	$1,338,855	$1,405,798	$1,476,088	$1,549,892	$1,627,387	$1,708,756	$1,794,194
Purchase Elec Cost from Grid ($/yr)	-$38,432	-$40,353	-$42,371	-$44,490	-$46,714	-$49,050	-$51,502	-$54,077	-$56,781	-$59,620
Utility Demand/Standby Charge ($/yr)	$79,112	$83,067	$87,221	$91,582	$96,161	$100,969	$106,018	$111,318	$116,884	$122,729
Additional O&M Cost ($/yr)	$52,006	$53,566	$55,173	$56,828	$58,533	$60,289	$62,098	$63,961	$65,880	$67,856
Major Overhauls	$16,799	$17,303	$17,822	$18,357	$18,907	$19,475	$20,059	$20,661	$21,280	$21,919
Debt Service ($/yr)	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355
Total Option Project Cost ($/yr)	$1,446,393	$1,508,319	$1,573,300	$1,641,487	$1,713,040	$1,788,126	$1,866,919	$1,949,604	$2,036,374	$2,127,432
Option Savings	-$382,431	-$391,158	-$400,281	-$409,818	-$419,787	-$430,210	-$441,107	-$452,502	-$464,417	-$476,877
CO2 emissions reductions (*tons/yr*)	310	310	310	310	310	310	310	310	310	310

PROJECT NET PRESENT VALUE ESTIMATE

CASE NAME: Install Cogeneration System at High School & Middle School

Sensitivity Test	
Energy Inflation	low
Borrowing Cost	high

Key Inputs

High School Area	sq ft	**168,000**		
Middle School Area	sq ft	**181,468**		
Additional O&M Cost	$/yr	$38,697		
Major Overhauls	$/yr	**$50,000**	every	**4** yrs
Cogen Plant	$	$1,400,000		
Pipeline	$	$960,000		
Grant or Incentive	$	$0		NG Breakeven = $10.82/mmbtu
Total Capital Cost	$	$2,360,000		
Interest Rate	%	5%		
Term	yrs	**20**		
Debt Service	$/yr	$180,355		
NPV Discount Rate	%	**10%**		

		Escalation	1	2	3	4	5	6	7	8	9	10
Existing Situation after Energy Efficiency Improvements												
Fuel Oil Use	Gal/yr		132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503
Fuel Oil Use	mmBtu/yr		18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378
Fuel Oil Cost	$/gal	2.0%	$2.75	$2.81	$2.86	$2.92	$2.98	$3.04	$3.10	$3.16	$3.22	$3.29
Fuel Oil Cost	$/yr		$364,384	$371,672	$379,105	$386,688	$394,421	$402,310	$410,356	$418,563	$426,934	$435,473
Elec Use	kwh/yr		1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700
Elec Rate (Purchased)	$/kwh	2.0%	$0.145	$0.148	$0.151	$0.154	$0.157	$0.160	$0.163	$0.167	$0.170	$0.173
Elec Rate (Sales)		2.0%	$0.087	$0.088	$0.090	$0.092	$0.094	$0.096	$0.097	$0.099	$0.101	$0.103
Elec Cost	$/yr		$288,797	$294,572	$300,464	$306,473	$312,603	$318,855	$325,232	$331,736	$338,371	$345,139
Total Existing Cost	$/yr		$653,181	$666,244	$679,569	$693,161	$707,024	$721,164	$735,588	$750,299	$765,305	$780,612
Cogeneration Option												
Natural gas Use, Cogen	mmBtu/yr		35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807
Natural Gas Use, Boilers	mmBtu/yr		10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001
Total Natural Gas Use	mmbtu/yr		45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808
Natural Gas Cost	$/mmBtu	2.0%	$15.50	$15.81	$16.13	$16.45	$16.78	$17.11	$17.46	$17.80	$18.16	$18.52
Elec Generation	kwh/yr		2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460
Elec Enery Savings	kwh/yr		1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700
Natural Gas Cost	$/yr		$710,024	$724,224	$738,709	$753,483	$768,552	$783,923	$799,602	$815,594	$831,906	$848,544
Purchase Elec Cost from Grid	$/yr		-$23,594	-$24,066	-$24,547	-$25,038	-$25,539	-$26,049	-$26,570	-$27,102	-$27,644	-$28,197
Utility Demand/Standby Charge	$/yr	2.0%	$48,568	$49,539	$50,530	$51,541	$52,571	$53,623	$54,695	$55,789	$56,905	$58,043
Additional O&M Cost	$/yr	3.0%	$38,697	$39,858	$41,054	$42,286	$43,554	$44,861	$46,207	$47,593	$49,021	$50,491
Major Overhauls		3.0%	$12,500	$12,875	$13,261	$13,659	$14,069	$14,491	$14,926	$15,373	$15,835	$16,310
Debt Service	$/yr		$180,355	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355
Total Option Project Cost	$/yr		$966,550	$982,786	$999,362	$1,016,285	$1,033,563	$1,051,203	$1,069,214	$1,087,602	$1,106,377	$1,125,546
Option Savings			-$313,369	-$316,541	-$319,792	-$323,124	-$326,539	-$330,039	-$333,626	-$337,303	-$341,071	-$344,934
CO2 emissions reductions	*tons/yr*		310	310	310	310	310	310	310	310	310	310
Net Present Value		**$**	**(2,867,315)**									

		11	12	13	14	15	16	17	18	19	20
Existing Situation after Energy Efficiency Improvements											
Fuel Oil Use	Gal/yr	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503	132,503
Fuel Oil Use	mmBtu/yr	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378	18,378
Fuel Oil Cost	$/gal	$3.35	$3.42	$3.49	$3.56	$3.63	$3.70	$3.78	$3.85	$3.93	$4.01
Fuel Oil Cost	$/yr	$444,182	$453,066	$462,127	$471,370	$480,797	$490,413	$500,222	$510,226	$520,431	$530,839
Elec Use	kwh/yr	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700
Elec Rate (Purchased)	$/kwh	$0.177	$0.180	$0.184	$0.188	$0.191	$0.195	$0.199	$0.203	$0.207	$0.211
Elec Rate (Sales)		$0.105	$0.108	$0.110	$0.112	$0.114	$0.116	$0.119	$0.121	$0.124	$0.126
Elec Cost	$/yr	$352,041	$359,082	$366,264	$373,589	$381,061	$388,682	$396,456	$404,385	$412,473	$420,722
Total Existing Cost	$/yr	$796,224	$812,148	$828,391	$844,959	$861,858	$879,095	$896,677	$914,611	$932,903	$951,561
Cogeneration Option											
Natural gas Use, Cogen	mmBtu/yr	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807	35,807
Natural Gas Use, Boilers	mmBtu/yr	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001	10,001
Total Natural Gas Use	mmbtu/yr	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808	45,808
Natural Gas Cost	$/mmBtu	$18.89	$19.27	$19.66	$20.05	$20.45	$20.86	$21.28	$21.70	$22.14	$22.58
Elec Generation	kwh/yr	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460	2,264,460
Elec Enery Savings	kwh/yr	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700	1,991,700
Natural Gas Cost	$/yr	$865,515	$882,825	$900,482	$918,491	$936,861	$955,598	$974,710	$994,204	$1,014,088	$1,034,370
Purchase Elec Cost from Grid	$/yr	-$28,761	-$29,336	-$29,923	-$30,521	-$31,131	-$31,754	-$32,389	-$33,037	-$33,698	-$34,372
Utility Demand/Standby Charge	$/yr	$59,204	$60,388	$61,596	$62,828	$64,084	$65,366	$66,673	$68,007	$69,367	$70,754
Additional O&M Cost	$/yr	$52,006	$53,566	$55,173	$56,828	$58,533	$60,289	$62,098	$63,961	$65,880	$67,856
Major Overhauls		$16,799	$17,303	$17,822	$18,357	$18,907	$19,475	$20,059	$20,661	$21,280	$21,919
Debt Service	$/yr	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355	$180,355
Total Option Project Cost	$/yr	$1,145,118	$1,165,101	$1,185,505	$1,206,338	$1,227,609	$1,249,329	$1,271,506	$1,294,150	$1,317,272	$1,340,882
Option Savings		-$348,894	-$352,953	-$357,113	-$361,378	-$365,751	-$370,233	-$374,828	-$379,539	-$384,369	-$389,321
CO2 emissions reductions	*tons/yr*	310	310	310	310	310	310	310	310	310	310

Appendix 14

Case Study—Samso, Denmark

Building an Energy-Independent Community

In 1998, the island population of Samso, Denmark (4,300 residents, located 12 miles off the Copenhagen coast) was 100% dependent on imported oil, spending $10 million per year to meet its energy needs. Just ten years later, Samso is 100% energy independent, deriving all of its heating and electricity needs from renewable sources, offsetting its liquid fuel use with renewables and becoming a net energy exporter.

The Samso community entered and won an energy-efficient community design contest sponsored by the Danish government. With $10 million in government funds, Samso residents took on another $65 million in bonded indebtedness to implement their plan, a combination of terrestrial and offshore wind turbines to generate electricity, and a series of district-heating plants burning locally grown-biomass to provide residential space heating.

Soren Hermanson, the native Samsinger who led this effort, spoke recently in Portland and Rockland. He noted that he is frequently asked two questions: 1) What is the payback on the wind turbines? (About eight years), and 2), What about bird mortality? To this second question he notes that a significant portion of Samso is a bird sanctuary, and that there have been no negative effects on birds recorded. In fact, he notes that the population of diving seabirds has increased, due to the fishing prohibition near the submarine cable that brings power from the offshore turbines to the island. Because fish are not harvested there, there is a growing supply for seabirds.

The ownership model for the wind turbines is interesting, with some turbines owned by the municipality, some owned by electrical cooperatives made up of island residents (at least 900 residents own shares in the turbines), some owned by farmers, and one owned by summer residents of the island. Denmark has a substantial head start in renewable energy production, as 20% of Denmark's electricity is already provided by offshore wind turbines, and Danish manufacturers now control 40% of the worldwide wind turbine market.

Closer to home, the citizens of Vinalhaven and North Haven islands have voted overwhelmingly (382-5) in favor of purchasing, installing and operating three 400-foot turbines to address island electrical needs. This installation will provide important cost and operational data for other high-output coastal wind turbine installations in Maine.

Information for this article was derived from an article in the 2008 *Island Journal* by Philip Conkling, President of the Rockland-based Island Institute, (http://www.islandinstitute.org/publications/2008-Island-Journal/12488/), and an article by Elizabeth Kolbert in the July 7th, 2008 issue of *The New Yorker* magazine (http://www.newyorker.com/reporting/2008/07/07/080707fa_fact_kolbert?currentPage=all/)

Appendix 15

American School Bus Council's
Top 5 "Green" Reasons to Get on the Bus

WASHINGTON, D.C. -- Every day millions of students rely on school bus transportation to get to school. The American School Bus Council (ASBC) is calling on millions more students to ride the bus to school, thereby eliminating more cars on the road and reducing carbon emissions.

The Top Five Reasons Why YELLOW is the GREEN Way to Get to School, which are:

5) One school bus can carry up to 65 children…that's 65parents who can keep their car in the garage and emissions out of the air.

4) School buses are getting "cleaner" every year…model 2007 school buses are 60 times cleaner than those manufactured in 1990.

3) "Old" buses are going green too…since 2003 more than 12,000 school buses have been retrofitted with emissions reduction technology.

2) We're helping to reduce soot and smog…all newly constructed school buses are reducing soot and smog causing emissions by 90 and 95 percent, respectively

1) Students are safer on the bus…the National Academy of Sciences, the U.S. Department of Transportation and other authorities agree that school buses are the safest form of transportation for getting children to and from school.