TAD MONTGOMERY & ASSOCIATES ECOLOGICAL ENGINEERING

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Marlboro College

Renewable Energy Project

Cost Estimates & Pre-Proposals

November 7, 2008

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INTRODUCTION

This report is to fulfill the request for cost estimates to be acquired for feasibility studies to be done at Marlboro College, for a number of different renewable energy and energy efficiency measures, namely:

- Wind power
- Solar electric and thermal energy
- Electricity efficiency
- Cogeneration (combined heat and power), biomass and district heating
- Biofuels
- Geothermal energy for heating
- Greenhouse gas audit and remediation plan

The request for estimates was made by Dan Cotter, on behalf of Marlboro College's task force on the renewable energy project: Dan Cotter, Ken Schneck and Lisa Christensen.

Cost estimates were solicited from roughly 30 businesses and engineers working in various fields of renewable energy. Roughly half responded. All firms received a one-page solicitation describing the project (see Appendix I for a sample solicitation letter). The intention of the solicitation was to create a degree of uniformity between the companies' proposals in order to make their evaluation as easy as possible, since all feasibility studies are not envisioned equally. All were asked to provide references for work done in the relevant field.

Table I is a compilation of the cost estimates given by those who responded.

In asking for the cost estimates, every effort was made to inform the potential contractor of as many factors and characteristics of the campus and project as were requested. This became difficult when responders inquired about unknown constraints that could affect their feasibility study, such as quantifying savings and payback periods if there are building envelope upgrades being implemented while feasibility studies are being done. A couple responders asked about the overarching goals of the project.

Layout of This Report

For the most part, proposals are summarized in the body of this report. The formal proposals from the individual companies are grouped in the relevant appendix. The exceptions to this are the wind and biofuels proposals and the climate change audit & remediation plan. These three only had one proposal each and are included in the body of the report.

Avoiding Technology Biases

In soliciting firms to submit cost estimates, it was attempted to choose ones that are not committed to any particular technology in order to get unbiased assessments of feasibility and true cost estimates. This was harder than expected, and it should be noted that many of the respondents either have contractual agreements with technology vendors or strong preferences with respect to particular technologies. It was not asked for responders to stipulate their company's relationships with technology vendors. Marlboro might want to pursue this further in the evaluation process in order to see what hidden profit motives might be lurking.

Parameters of the Project
Parameters developed for feasibility studies included that it is for the undergraduate campus only, and that a building envelope study not be included since Thermal House is already performing that study for Marlboro College. It was also decided by Dan Cotter not to include hydroelectricity in this list of measures to be considered. In order to make the eventual feasibility studies as comparable as possible each potential contractor was asked to design a feasibility study that would result in a cost per million Btu's or kilowatt-hours (kWh) that result from the energy generation system or conservation measure proposed.

Project Financing
Financing for large infrastructure projects is a complex and can be a determining factor of project feasibility. This is especially true for renewable energy projects, with all of the recent government and utility incentives. It should be noted that an assessment of financing options was not included in the solicitation letter for the cost estimates. Despite the lack of inclusion, a few potential contractors chose to include mention of financing in their scope of work. This should not lead people to infer that the other potential contractors do not have options for project financing that could be advantageous for Marlboro College.

Permitting
A number of the renewable energy systems proposed for Marlboro College have issues related to permitting. This can be a very sticky wicket. In reviewing the pre-proposals and evaluating potential contractors it should be noted which have expertise in this area and which include permitting issues in their feasibility study's scope of services. None were asked to provide this.

Financial Incentives
There are substantial incentives available for renewable energy installations. The solicitation letter requests that these be delineated in the feasibility studies but makes no mention of them with regard to the cost estimate/pre-proposals. It is therefore difficult to assess which of the contractors has a working knowledge of all incentives that are or will be available. The incentive scene will likely change rapidly in the coming months and years as the new administration takes over the federal government and the Regional Greenhouse Gas Initiative kicks into gear.

The Renewable Energy Industry in the Northeast Today
The field of renewable energy is exploding with growth, and many of the firms with proposals here are in the thick of this. Because of the stress that such growth creates, it is difficult for such firms to take the time to develop proposals, bids and detailed cost estimates. Many of the proposals were rushed and had holes in them that had to be painstakingly filled in by follow-up correspondence and conversations with the firms. Some of the holes never got filled in.

Environmental Parameters
The original request from the College did not include anything with regard to calculating environmental benefits. When contracts are developed with individual firms to do the feasibility studies it is suggested that Marlboro request this information so that the environmental and related financial benefits of any particular proposal are known before final decisions on systems and technologies are made. For example, Carbon offset credits would accrue to different degrees from the development of wind power or the use of biofuels.

Table I. Cost Estimates for R.E. Feasibility Studies by Contractor & Technology

	Solar	Wind	Biomass, CHP & DH	Biofuels	Geothermal	Electricity Audit	Greenhouse Gas Audit
➢ Biomass Energy Resource Center			24,000				
➢ Pearson Associates					15,600		
➢ J. F. Penney Consulting					6,000		
➢ Cx Associates						5,340+/ 26,750+[1]	
➢ Water Energy Design					12,250+		
➢ groSolar	0 - 22,520[2]						
➢ Tad Montgomery & Associates				12,500			6,000 - 12,000[3]
➢ Northeast District Energy Corp.			3,500				
➢ Hand Energy Services						15,000	
➢ Vermont Wood Heat			8,480				
➢ WindWrights & SolarWrights	1,440[4]	24,975[4]					
➢ New England Ground Source					12,000[5]		

NOTES:
+ Reimbursable expenses are not included in these estimates.
[1] Cx Associates proposed two phases for the electricity audit.
[2] groSolar presented five options with different prices in this range.
[3] TM&A offered three options for this project of $6,000, $9,000 & $12,000.
[4] WindWrights / SolarWrights provided one proposal that includes both wind and solar feasibility studies, totaling $26,415.
[5] This fee will be refunded when a contract to install is signed.

GEOTHERMAL ENERGY

Geothermal heat pumps, also known as ground source heat pumps, are a heating and/or air conditioning system that uses the Earth's ability to store heat in the ground and groundwater thermal masses. These systems operate based on the stability of underground temperatures: the ground a few feet below the surface has a very stable temperature throughout the year, depending upon the location's annual climate. A geothermal heat pump uses that available heat in the winter and puts heat back into the ground in the summer. It does this using a process that is similar to air conditioning or refrigeration. A geothermal system differs from a conventional furnace or boiler in that it transfers and consolidates heat, as opposed to the standard method of heat production by combustion. Geothermal systems provide a possible solution to pollution and rising energy costs.

Note that inherent in the design of a geothermal system is its ability to provide cooling in the summer without additional design or equipment costs, though electricity use would increase.

This report contains pre-proposals and cost estimates from four firms that do feasibility studies for geothermal systems.

Water Energy Design

2 Starwood Drive, Hampstead, N.H. 03841
Phone: (603) 329-8122, http://www.northeastgeo.com
Contact: Lauren Carelli – contract officer, lauren@northeastgeo.com
Geothermal Feasibility Study: $12,250 plus reimbursable expenses

Also knows as Water Energy Distributors, WED submitted a cost estimate pre-proposal for a 'Phase I' study only, with the assumption that a Phase II study would follow if the Phase I study results are favorable. "The report will evaluate a representative selection of buildings (six) on and off the main campus, with the goal of qualifying application to the enclosed list of (43) buildings (Enclosure A)." The following documents were included with their proposal and can be found in their section of the Geothermal Appendix:

- Phase I Feasibility Study: This document lays out the scope of their Phase I study, which includes geological surveys, occupancy studies, load analysis, future energy costs, geothermal system costs and 10-year cash flow analysis for the six representative buildings. This document also includes Monetary Parameters of the contract and Terms and Conditions.
- Custom Design Project Information Form: This form requires Marlboro College to provide substantial information for their Phase I feasibility study. It states: "Providing us a comprehensive set of requisite support information for your project will help our consulting team complete design activity within the estimated hours noted. Adjustments in project scope after work has commenced, or assistance in "mining" requisite support information, may require additional effort not included in the estimated contract hours."
- *Underground Cash:* An article reprinted from *Forbes Magazine* on geothermal heat pump systems.

- Marlboro College – List of Buildings: A list of 43 buildings at Marlboro College for the geothermal feasibility report that could be used as sample study buildings.
- Credit Application
- Retainage Document: A document specifying a fee structure.
- Technical Bulletin: A seven-page document describing the technology behind three different kinds of geothermal heat pumps: closed loop, standing column, and recirculating.

Note: WED specifies that they favor the ClimateMaster geothermal technology, and states that a client requesting a different technology would incur higher costs.

WED supplied no references for geothermal projects that they have performed.

Pearson & Associates

P.O. Box 610
Stowe, Vermont 05672
Phone: (802) 253-9607, Fax: 9290 pearson@stowevt.net
http://www.pearsonandassociates.com/
Geothermal Feasibility Study: $15,600

Pearson & Associates are mechanical & electrical engineers. They provided the following, which can be found in their section of the Geothermal Appendix:

- Pre-proposal two-page, with scope of services
- Resumes for company principals
- Statement of fees and contract conditions
- Company background in the fields of renewable energy & energy efficiency. This 10-page document includes references for three high-end projects that use geothermal heat pumps as well as a wood chip heating system for a school and other electricity conservation projects.

John F. Penney Consulting Services , P.C.

PO Box 10, 231 S. Main Street
Chester, Vermont 05143
Phone/Fax 802.875.2010, info@jfpcs.com, http://www.jfpcs.com/
Geothermal Feasibility Study: $6,000

The nine-page proposal from JFPCS is included in their section of the Geothermal Appendix. JFPCS is a mechanical engineering firm that does heating, ventilation, AC, plumbing & fire protection engineering, commissioning, TAB services and more. Their pre-proposal includes six references for projects that use geothermal heat pumps, resumes of key personnel and a company profile.

New England Ground Source

P.O. Box 521, Brattleboro, VT 05301
Contact: Dave Cardill, 802-380-1125, earthlnk@sover.net, http://www.negeothermal.com/
Geothermal Feasibility Study: $12,000, refunded if NEGS is contracted to install system(s).

New England Ground Source did not submit a formal pre-proposal, but gave a cost estimate and described their proposal through a series of correspondences between Dave Cardill and Tad Montgomery. The important elements of this exchange are quoted in their section of the Geothermal Appendix. They eventually supplied an annotated list of references.

SOLAR

Two pre-proposal/cost estimates were submitted for solar energy feasibility studies, and they are very different. The first is from groSolar, a company in White River Junction with connections to Marlboro College that has experienced exponential growth over the last few years. The second is a solar study that would be done in conjunction with a wind study by WindWrights & SolarWrights, two divisions of the Earth Friendly Energy Group, Inc.

groSolar

601 Old River Road Suite 3
White River Junction, VT 05001
Ph: 800.374.4494, F: 802.295.4417, http://www.groSolar.com
Contact: Ananda Hartzell, Engineering Manager ananda@groSolar.com

groSolar (sic) took the shotgun approach to proposal writing. They submitted five different options that are outlined in the proposal in their section of the Solar Appendix, and are summarized below. These options all assume that the campus electric distribution network is already documented and available.

Option 1: Letter of Intent - $0: If Marlboro College signs a letter of intent to work with groSolar on any solar electric and solar thermal systems to be installed at Marlboro College based on this feasibility study groSolar will perform the feasibility study without charge.

Option 2: Campus Wide Survey - $11,640: Identify preliminary solar PV & thermal options for 45 buildings as well as open spaces on campus. This option estimates installed costs and energy production but says nothing about analyzing system economics or determining payback periods.

Option 3: Detailed Study of Top 5 Capacity Sites - $10,120: This would be 5 PV and 5 solar thermal studies.

Option 4: Detailed Study of Top 3 PV Capacity Sites and Solar Hot Water for Dormitories - $12,400: It is assumed that they mean all dormitories on campus. I inferred from this option that dormitories are one of the best scenarios for SHW usage on college campuses.

Option 5: Detailed Campus-wide Solar Survey - $22,520: This would be the complete solar feasibility study and involves detailed analyses of all relevant buildings.

This proposal includes a few client references and a short overview of the company. A second six-page document, the company Fact Sheet, gives a more extensive company profile with 16 commercial client references and senior staff profiles. It is included in the Solar Appendix.

It should be noted that Jeff Wolfe, the principle of groSolar, alluded in a phone conversation to different financial mechanisms for the project that could make installation of solar systems at Marlboro very easy from a cash flow standpoint. That was before the recent financial turmoil, however.

groSolar (sic) seems to derive a substantial portion of their profit from the distribution of solar technology. Because of this it is unclear how unbiased they can be with regard to technology assessment in their feasibility study. This issue should be explored further if it is decided to go with them.

WindWrights / SolarWrights

A Division of Earth Friendly Energy Group, Inc.
Local office: 5197 Main Street, Suite 2A, Waitsfield, VT 05673
Contact: Chris Lamonia (802) 496-5157 chrisl@windwrights.com,
http://www.windwrights.com
Solar Feasibility Study: $1,440

WindWrights is a division of a company called 'Earth Friendly Energy Group'. As part of their comprehensive proposal for a wind power feasibility study they provided a cost estimate for a solar energy study at Marlboro College that includes solar hot water, PV, a feasibility study, interconnection and permitting issues if any. This includes economic & energy production assessments for the solar aspects of the project. The full proposal, which contains the wind and solar elements combined, can be found in the Wind Appendix.

Aside from the feasible study proposal(s), WindWrights provided a resume of renewable energy project photographs that is also enclosed in their section of the Wind Appendix.

Because of the wide difference in these two proposals, it is thought that obtaining other proposal/cost estimates for solar energy systems at Marlboro might be prudent.

WIND

Green Mountain Power, Marlboro College's electricity service provider, has initiated a big push to develop renewable energy. Their CEO, Mary Powell, is very receptive to talking with the College about collaborating in this area and building the infrastructure necessary.

WindWrights

A Division of Earth Friendly Energy Group, Inc.
32 Taugwonk Spur, Building 32, Unit A10
Stonington, CT 06378
(866) 682-0514 http://www.windwrights.com

Vermont Office:
5197 Main Street, Suite 2A
Waitsfield, VT 05673
(802) 496-5157
http://www.windwrights.com
Contact: Chris Lamonia chrisl@windwrights.com

Cost estimate for the wind feasibility study: $24,975

Despite numerous attempts, WindWrights was the only company able to supply a cost estimate pre-proposal for wind energy at Marlboro in time for this report. It is included in the Wind Appendix along with their company resume for renewable energy projects.

ELECTRICITY CONSERVATION AUDITS

Two proposals were submitted for power conservation feasibility studies. As can be seen in looking them over, they are somewhat different in flavor and scope. Efficiency Vermont was initially asked to perform this audit. Although they declined to participate at this stage in Marlboro College's renewable energy project, they did state that that they might be able to assist with the cost of the electricity audit. Correspondence is continuing in this regard between Chuck Clerici, Tad and Dan Cotter.

Cx Associates, LLC

110 Main Street, Studio 1B, Burlington, VT 05401
802.861.2715
Contact: Jennifer Chiodo, PE, jennifer@cx-assoc.com, http://www.cx-assoc.com/

Cx Associates' four-page proposal describes a project with six phases, from an initial walk-through to construction and savings' verification. This methodology is said to allow for a "dynamic decision-making process" that directs resources where they are best applied. In this pre-proposal they recommend that the College start with Phase 1, then proceed to Phase 2 if findings warrant it. It is not estimated what the costs for the subsequent phases would be. Note that these costs do not include reimbursable expenses, such as for travel.

Phase 1: $5,340 – Initial Opportunities Assessment. Findings in this phase could affect the scope and cost of Phase 2.

Phase 2: $26,750 – Detailed Energy Audit. This phase ranges from metering power usage on major equipment to a report detailing campus energy use patterns presented to the College.

Included along with the project pre-proposal is a 20-page statement of qualifications for the company that is quite impressive. It should be noted that Ms. Chiodo served at the Vermont Energy Investment Corp., the parent corporation for Efficiency Vermont, in both senior management and director of their commercial and multi-family buildings division.

Hand Energy Services

PO Box 157, Manchester, VT 05255
http://www.handenergyservices.com/
Contact: Jamie Hand, (802) 688-4387, info@HandEnergyServices.com
Electricity Audit Cost Estimate: $15,000

Hand Energy Services seems to be fairly new to the field of electricity auditing, but has recently bought the business Peak Energy Solutions of Dorset, VT and therefore the experience of its previous owner, Bill Calfee. Mr. Calfee has a good reputation for certain aspects of energy conservation and was on a short list of contractors provided by Efficiency Vermont for electricity audits. It is unclear how long Bill will be working with the HES team and this should be determined before signing with them.

The HES proposal includes a major audit, energy modeling to determine optimal conservation strategies, recommended efficiency measures by building and a guide to return on investments.

The principals of HES are also open to a 'performance contract' or performance-based pay, i.e. payment based on meeting a predetermined kWh reduction or return on investment goal.

HES also included a list of four references for electricity conservation work done in 2008.

BIOMASS, COGENERATION AND DISTRICT HEATING

To start, a bit of a glossary might be in order:

- *Biomass* in this context implies the use of harvested forestry and agricultural products for energy production.

- *Cogeneration,* a.k.a. 'combined heat and power' (CHP) is the development of an electricity generation plant that captures the (substantial) waste heat for productive uses.
- *District Heating* is the development of a centralized heating plant for multiple buildings.

Three proposal cost estimates were submitted for feasibility studies in this area, with substantial differences in scope and cost between them. The full proposals can be found in the Biomass/Cogeneration/District Heating Appendix.

Northeast District Energy Corporation

437 Franklin Street, Buffalo, New York 14202
585-275-4331
Contact: Morris A. Pierce, Project Manager mapi@mail.rochester.edu
B/CHP/DH Feasibility Study Cost estimate: $3,500

Morris Pierce & NDEC have been talking with Marlboro College for some time and developing a proposal for a biomass fueled cogeneration/DH plant on campus. They have traveled extensively throughout the Northeast over the last few years promoting a Danish version of this technology. In the Biomass Appendix is their proposal sheet and list of references for other jurisdictions where they have submitted feasibility studies.

It is unclear why the NDEC cost is so low. Speculation might lead to the belief that the company hopes to get its foot in the door and eventually make its profit on the design and installation of the actual system. The scope of work proposed by Morris should be carefully contrasted to the other proposals.

A couple notes on this team & proposal:

- NDEC was just awarded a $250,000 grant with Landmark College in Putney to develop a DH/CHP facility for the school and parts of the town.
- The proposal states "electric output of this plant would have to be sold externally through Green Mountain Power" but other vendors have stated that net metering laws in VT allow for more favorable options.
- While Morris and team have been prolific in their development of feasibility studies, is does not appear that they have constructed a system yet.
- This month they will be touring the Northeast with representatives of two Danish firms/agencies with extensive experience in this field, and hope to visit Marlboro College. NDEC's relationship with these entities is not described in their proposal.
- They have some interesting ideas about ownership structure for this proposed facility that bear further exploration.

Biomass Energy Resource Center

PO Box 1611, Montpelier, VT 05601-1611
Ph 802-223-7770 • fax 802-223-7772 www.biomasscenter.org
Contact: Kamalesh Doshi, Program Director, kdoshi@biomasscenter.org
B/CHP/DH Feasibility Study Cost Estimate: $24,000

BERC, a non-profit corporation, is considered a leader in the field of biomass system development, as will be seen in their extensive list of project references and the resumes of key personnel.

The 11-point work plan for their proposed study is exhaustive, covering everything from technology options to air quality permits, fuel price projections, quantification of emissions reductions and economic analysis. The result of this study will be to "inform the college's decision to further explore the potential for biomass to be an energy source and recommend a course of action for a more detailed engineering feasibility study." They state that the entire study will be performed within four months of signing the contract.

Vermont Wood Heat, LLC

1269 Bristol Rd., Bristol, VT 05443
802.453.5784
Contact: Roger Wallace, E.E., Engineering Project Manager, Vtwoodheat@gmavt.net
Biomass/DH Feasibility Study Cost estimate: $8,480

A cost estimate/pre-proposal was solicited from VTWH, despite the fact that two other substantial biomass proposals had already been received, because of VTHS's expertise with smaller biomass heating systems. It was thought that biomass systems might be feasible for Marlboro College that would avoid the tremendous capital expense of a campus-wide DH network. Roger Wallace has expertise with a wide variety of biomass heating technologies and offered this proposal with some different options.

The VTWH proposal is extensive and shows keen insight into the development of biomass projects for entities such as Marlboro College. For example, it states:

> "Seven campus buildings are responsible for 52% of campus heat load. The addition of nine more buildings increases that total to 81%. A focus on these buildings may yield the greatest financial benefit by limiting project costs."
>
> "Marlboro College has initiated energy efficiency evaluations. The life cycle cost analysis for biomass heating should include potential changes in efficiency as a risk factor."

Elements of the final feasibility report are extensive, but it should also be noted the assumptions and requirements that VTWH expresses as integral to their being able to complete the study successfully, i.e. substantial assistance will be needed by the College.

The references provided with this pre-proposal seem slim and somewhat redundant, but he has alluded to other work done in the field of renewable energy.

Please note that in the VTWH cover letter Roger discounts other possible elements of Marlboro College's renewable energy project, namely CHP and wind. He seemed to reconsider his dismissal of wind power, at least, after a conversation about the particular characteristics of the college campus. His opinions on CHP likely come from solid experience.

TAD MONTGOMERY & ASSOCIATES *ECOLOGICAL ENGINEERING*

118 WASHINGTON STREET #2, BRATTLEBORO, VT 05301 (802) 251-0502 ECO@TADMONTGOMERY.COM

GREENHOUSE GAS AUDIT & REMEDIATION STRATEGY AT MARLBORO COLLEGE

PRE-PROPOSAL AND COST ESTIMATE

According to the Intergovernmental Panel on Climate Change, in order to limit the global mean temperature increase over historical norms to 2 - 2.4 degrees Celsius, the temperature where there is a high probability of catastrophic impacts, global greenhouse gas (GHG) emissions need to be reduced 50-85% below 2000 levels by 2050, and CO_2 emissions must peak before 2015[6]. There are over 1,000 American schools who are performing greenhouse gas audits, and 588 that have signed on to the American College and University Presidents' Climate Commitment.

Tad Montgomery & Associates proposes the following greenhouse gas audit and remediation strategy for Marlboro College. This proposal is in collaboration with the College's broad renewable energy project. It is offered in conjunction with a number of other renewable energy and energy conservation systems, technologies and measures as part of the solution to help the College reduce its energy costs and lower its environmental footprint.

The proposed GHG audit will include the following[7]:

1. Initiate the development of a plan for attaining climate neutrality[8] or better as a school:
    a. Help Marlboro College to create institutional structures to guide the development and implementation of the plan.
    b. Complete a comprehensive inventory of all direct GHG including those from electricity, heating, commuting, and other travel. Create a format that can be used and refined easily by staff working on this issue in future years.
    c. Help Marlboro to develop an institutional action plan for achieving climate neutrality, which will include:
        i. A target date for achieving climate neutrality as soon as possible.
        ii. Interim targets for goals and actions that will lead to climate neutrality.
        iii. Actions and ideas to make climate neutrality and sustainability a part of the curriculum and other educational experience for all students.
        iv. Actions to expand research or other efforts necessary to achieve climate neutrality.
        v. Mechanisms for tracking progress on goals and actions.
    d. Develop a protocol for accounting for indirect greenhouse gas emissions embodied in food, machinery, construction, land use management, etc. for the

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[6] Working Group III contribution to the Intergovernmental Panel on Climate Change. Fourth Assessment Report. "Climate Change 2007: Mitigation of Climate Change." Summary for Policymakers. Bangkok, Thailand. April 30 to May 4, 2007.

[7] These protocols for auditing, reducing and remediating greenhouse gases reflect, and are compatible with, those of the *American College & University Presidents Climate Commitment*.

[8] 'Climate neutral' is a state wherein an entity is said to produce no net greenhouse gasses. It is generally achieved by a combination of energy conservation, renewable energy production, and the purchase of GHG 'offsets' or green tags.

College to become ever more accurate in its GHG auditing, reporting and remediation strategies.

2. Recommend to Marlboro College tangible strategies to reduce greenhouse gases while the more comprehensive plan is being developed.
3. Make the action plan, inventory, and periodic progress reports, when finished, publicly available to the faculty, staff, student body, alumni, the media and public organizations such as the Association for the Advancement of Sustainability in Higher Education (AASHE).
4. Assess and correlate different options for the renewable energy project at the College with regard to their effects on the GHG audit and remediation plan. Make recommendations for best strategies with regard to the multiple objectives of increasing Marlboro's use of renewable energy, lowering costs, and implementing the GHG plan.

Cost

Option 1: Tad Montgomery & Associates -- $12,000

Reliable sources estimate that the work necessary for a consultant experienced in this field to perform a comprehensive GHG audit and develop a remediation strategy for a college campus at 80-160 hours. If the average of this is taken, since Marlboro is quite small but has large areas of forested land acting as a substantial Carbon sink, 120 hours of work is estimated. This does not include the time of the College's liaison or supervising committee, and is subject to revision based on both the scope of the GHG audit that Marlboro decides on and the difficulty of finding the necessary data at the College.

Option 2: With Student Volunteers -- $6,000

Greenhouse gas audits involve a painstaking degree of research and data collection. Because of this, the high degree of interest in this project at Marlboro College, and the significant learning potential involved, it is thought that supervised student participation through class projects and/or the EAC/EQC could significantly reduce the amount of consultant time required for this project. This option would need to be highly structured to prevent inefficiencies, with significant delegation of responsibility. Aspects would need to be negotiated between TM&A and the College in order to create very clear boundaries, timelines and expectations.

Option 3: With Paid Student Labor -- $9,000

A third option is for TM&A to hire one or more Marlboro students to work on this project part-time during the school year and possibly during the summer of 2009. These students would need to be reliable, have a successful track record of independent research and good writing skills, and possess a demonstrated interest in the GHG audit and renewable energy. Again, this estimate is subject to revision based on both the scope of the GHG audit that Marlboro decides on and the difficulty of finding the necessary data at the College.

This proposal is to help Marlboro College to start the task of thinking about its impact on climate change, and what it would take to begin to take responsibility for that impact. It is the start of a conversation, a process that should lead in the direction of clarified goals and objectives that serve a number of interconnected purposes at the College. Before the goals are clear it is very difficult to estimate this project's cost.

APPENDIX I:

Sample letter to contractors

R & M Engineering
1458 Silver Rd
Hinesburg, VT 05461

Dear Ms. Keller,

Below is the quick description of the renewable energy feasibility studies that Marlboro College is looking for.

As I mentioned, Marlboro is soliciting feasibility studies for a number of renewable energy and energy efficiency projects and systems: solar (PV, hot water, hot air), wind, geothermal, biomass, biofuels, district heating/cogeneration, & electric conservation. The school is doing this in order to compare and contrast the different options for their undergraduate campus. I am helping Marlboro at this formative stage by soliciting cost estimates for these different feasibility studies.

Here is the basis of the College's thinking. The projects' feasibility studies should include estimates for the following:

- Installed cost, including incentives
- Energy savings or generation: units & cost
- Payback period
- Issues that could alter the project's final cost
- Increased or decreased maintenance requirements resulting from the project
- The major assumptions used to develop the estimate

Your eventual feasibility study, if you are chosen, should give a solid estimate of $/kWh generated or saved for each energy system so that the College will be able to look through the different options and see what makes the most sense.

I understand that this will be a complex task for multiple energy efficiency measures with varying lifetimes and savings estimates. Your feasibility study may therefore do something to the effect of ranking all of the electricity efficiency measures by cost per kWh installed and letting the school determine the cutoff value. Similarly, your feasibility study could ask what payback period the college would like and recommend a number of projects whose aggregate payback periods approaches that figure. It might even be possible to have a cumulative payback period in a column beside the ranking of all projects by $/kWh.

I am pulling together all the responses on Oct. 31 so please get me a cost estimate and pre-proposal by then if you are interested.

Note that the graduate center in downtown Brattleboro is not part of this study.

Sincerely,
Tad Montgomery

Attached:
1) Jul07-Jun08 Marlboro_College_kWh.xls -- last year's electric use by building, with descriptions of building types.
2) Energy Use Index by Building.xls -- a spreadsheet showing Marlboro College's energy use by building from 1988-2004 done by Karl Goetze.

APPENDIX II:

Geothermal Proposals

New England Ground Source
P.O. Box 521, Brattleboro, VT 05301
http://www.negeothermal.com/
Contact: Dave Cardill, 802-380-1125, earthlnk@sover.net
Geothermal Feasibility Study: $12,000
Note: this sum will be refunded if NEGS is contracted to install system(s)

New England Ground Source did not submit a formal pre-proposal, but described their proposal through corresponded between Dave Cardill and Tad Montgomery, the important elements of which are below. When asked (for the third time) they also supplied an annotated list of references, attached below.

DC: We have been designing and installing geo systems since 1980, and have installed over 1200 systems, both commercial and residential, during this time. A standard geothermal estimate for commercial construction projects includes all of the variables you have listed below. We always include the installed costs, energy savings, payback period and decreased operations and maintenance requirements. Both numeric and graph representations are used in our estimate production.

DC: For us to write this estimate for 45 buildings, with several source options, will take some time and effort, and will cost $12,000, plus applicable taxes, which I believe in this case are non existent because of Vermont's' RE tax exemptions, but I need to look that up to see if we are still tax exempt as of today's date.

TM: Note that another firm has stated that we will need to incorporate into the geothermal feasibility study a "geologic formation thermal conductivity test" and data analysis. If you aren't including this in your cost estimate, you might want to explain why.

DC: We could include this in our estimate, however, it will double the cost of this estimate, and in our opinion, is not necessary. Could you explain why you think it would be necessary? Geological data exists already for every kind of formation available, so, doubling up on work already done seems fruitless to us.

TM: Dave, I have no idea if a geologic conductivity test is necessary or not. What I was suggesting was that if your firm believes it is not necessary you might want to thoroughly explain why, so that Marlboro can make an informed decision as to whether to go with the firm that recommends that expensive measure or not.

DC: Well, the detailed work of plotting equal lines of ground temperatures has been done, for the entire continent, and the thermal conductivity of rocks is also known and has been listed in books, as well as the different soil types and their specific conductivity. For example, we know that ground temps in our region vary from 46.4 degrees to 48.7 degrees, depending on elevation, and in Texas it is closer to 70 degrees. We also know that any depth lower than 12 feet in the ground no longer has any temperature variation during the surface seasonal swings.

“Further to this end, I have the full support of the manufacturer behind me. Either Water Furnace or Climate Master, the two biggest manufacturers of geo equipment, will work with us on any project we ask them to. That is paramount in having good installations.

“And, after 27 years in this industry, we just do not get it wrong. We have been doing this for too long.

“We will produce a detailed estimate for the entire campus, c/w several options, and the associated costs and paybacks. But, there is much work in preparing the actual estimate, and I would need to have access to every building so that we would know what types of systems already exist, and what our options will be for a campus wide conversion. More than likely, we would be installing water lines throughout the whole campus, and a field of boreholes with a closed loop, and a new pump-house, and this water will feed the geo units (water is the new heating oil, but it has to be delivered to each building).

“The 12,000 dollars is refunded when a contract to install is given, and references, geesh, we have all kinds of them, but I think the manufacturers are the best you can get. And, I like to contact people ahead of time when I'm going to use them as a reference. It is a courtesy we give them in exchange for using them as reference material. Stan Marco owns Geo Smart, and they are the New England distributor for Geo Smart units, distributed through F.W. Webb, and built by Water Furnace in Indiana. He's been in this industry longer than me, can you believe it, and can be reached at SMarco@geosmartenergy.com. Just ask him about David Cardill, from New England Ground Source. It's too late in the day for me to track down the WFI guy and the Climate Master guy, but we have them as reference material too. Their websites are http://www.WaterFurnace.com, and http://www.ClimateMaster.com. Check out the tax credit information on the Water Furnace site, which says 10% of the total cost is a tax write off to any commercial building installing geo from now through to Dec. 31 2016, so, the cost, whatever it may be, just got 10% cheaper.

“Sorry about this, most people just accept that we are the go to guys in this field, and I've never had to do one of these pre-proposals ever before.

“($12,000 is) our price to prepare a detailed estimate for the entire campus, c/w the installation costs, savings details, payback period, and there may be a few issues that could affect the project’s final cost, like access to buildings, or other trades and utilities not following a suitable time line, which could add a few days to the project; and these things ARE normal; and we will provide a detailed maintenance schedule for each building, and every unit will have its' own packet with the unit information and trouble shooting guides, and when done, we will provide the final as built drawings; are all included in our price. We will also have to work with any and all regular maintenance staff for the campus, and brief them on the system and its' maintenance requirements and common trouble shooting options, but we expect this, and do it all the time, so, it is not an extraneous billing option to us either.

“I also have confirmed Stan Marco, from Geo Smart. He will be attending, and the full potential and resources of that company will be behind the design and estimate preparation. They are one of the best geo unit suppliers out there, and they have always worked with us on any commercial

project we have asked them to. It ensures that the system is designed properly and to the manufacturer's specifications, so the warranties can be extended beyond the usual for commercial buildings. And in the end, the design and drawings are produced by the suppliers, and bear their name, just like the equipment that will be installed. We maintain a great relationship with our suppliers, and they with us, so that collectively we both prosper from doing the absolute best work possible."

References:

http://www.canren.gc.ca/prod_serv/index.asp?CaId=150&PgId=769

This first link is from the government of Canada, and it talks about the subdivision I worked on in my youth, while in Canada, and for a company called Donwel. Shadow Ridge Estates in Greely, Ontario, is a subdivision of homes that are all heated and cooled by geo systems. My brothers and I installed all of the heating/cooling/hot water for every home in this 300+ home subdivision during the 80's and 90's. For a short period of time, it was the largest grouping of buildings that were all geo; that is until the U.S. military installed 3,000 of them at Fort Polk when they converted the entire base to geo back in the early 90's. The link below describes that subdivision, and they interviewed my father, Donald Cardill, for some of the commentary provided in that document.

http://www.northdundas.com/

This next link goes to one of the first off project jobs my brothers and I worked on. Most of our off project jobs were commercial, and this one, the building pictured in the link below, was originally built as the Winchester area Ontario Hydro operations building. The building has since been sold to the town, and they now have all the town offices in there. It is a 35,000 sq. ft. building, and was built in the 80's. 613-774-2105 is the number to the town hall, and the contact is the CAO (chief administrative officer) or, the head honcho as the rest of the folks in the building like to call him. He is usually in a meeting, or away from his desk, and may be the hardest reference I have listed to track down, but, he remembers more about the building than anyone else presently working there. His name is Howard Smith.

The remainder of what I have for references are all in Vermont. These are the people I was able to reach, and they all have homes that we have installed geo systems into. As a point of reference here, and as a long time contractor, I'd like to say that residential installations are far more difficult to install than commercial installations. And, the most difficult then, are those buildings that were residential, but then were converted to commercial. Experience with residential buildings, and all of the nooks and crannies that come with it, are what give you as a contractor, the most varied types of experience you can get in the building trades. Not all commercial buildings offer you wide open ceilings to hang heating and cooling systems from; and being able to work on every type of building ever built, is definitely an asset to any contractor. As well as being able to do the easy, straight forward commercial installations, you will find that there are times when you must preserve the interior fixtures and woodworking details of older, more robust, buildings. In this area, New England Ground Source truly has seen, and done, them all.

Perry and Susan Hanson, 802 388 9577, built their retirement home in Ripton, Vermont. It is a large log home, built in an area known as the snow bowl of Vermont, because of its elevation, winter comes here first, and leaves last. The Hansons chose geo systems to provide all of their

heating and domestic hot water, and then for a few days a year they actually have cooling at the touch of a button too. Theirs is a stand alone, open loop dual geo system, that has both air ducts and radiant floor heating throughout the building, with no back-up heat needed. For as long as they have been there, 4 years now, their geo system has provided all of the heat and hot water for their home.

David Pedegrossi and his family renovated a home in Plymouth, Vermont, and installed a similar system as the Hansons, only without any radiant floor heating. They get all of their heating/cooling and hot water from their closed loop geo system. David's cell number is 203 499 9808, and he and his family presently still live in CT, while maintaining this second home in VT.

Finally, Bill and Susan Moore converted a beautiful brick existing home they bought in Halifax, Vermont, from forced air oil heat, to an open loop forced air geo heating/cooling system, primarily because of the lower operating costs of geo, and the option to cool. They wanted better efficiency and better indoor climate control than oil affords. And, while we were at it, we switched their oil hot water to geo as well, again for the lower operational costs of geo. Their number is 802 368 2792

I also have thought about listing this current project I'm working on as a reference, but we won't be finished until sometime in 2009, and even then full occupancy may not happen for several more years. It is, though, a 600 building subdivision, much like the first one I worked on, except this time we are installing a field of drilled wells, with closed loop piping grouted into each hole, and a pump house, that will feed the entire project through 18" diameter send and return water lines with 1.25 " send and return water lines into each building. We have already installed the new peat bed septic system and piping for this project, and the domestic water supply and piping for the whole project. With our licensing for refrigeration and geo systems, we also have a well contractors and technicians license (domestic water system design and install) and a class 1 septic installers license (sewage system design and install). We have become your one stop resource for all things utility.

Financing

And, don't forget that geo offers at least a 60% reduction in your operations and maintenance costs. After the feasibility study is done, we will be willing to discuss financing for this campus wide installation, if the school would like. It is possible that we could finance the entire project, from start to finish, so that the school would pay no money down, no interest, and no payments: ever. What they would have to agree to, is to continue to pay the operations costs [fuel(s) + electric + yearly maintenance] at the rates they are presently paying, with a small percentage annual increase to account for inflation, to us, and then we pay the actual operations costs [electric bill], while pocketing the difference, for a period of 5-7 years, after which time they would assume ownership of the system and the operational costs themselves. Our company would make more money from this installation this way, than if the school outright bought the system themselves, so, we would definitely fund this whole project under a proper agreement. FYI geo systems, once installed, are permanent. Units and components can all be changed through the decades, and the system remains.

APPENDIX III:

Solar Proposals

APPENDIX IV:

Proposals for Electricity Audits & Conservation

APPENDIX V:

Proposals for Biomass Heating,

Cogeneration

and

District Heating