make neutrality a reality

CO_2 2016

Climate Action Implementation Plan

Middlebury College

Prepared by MiddShift Implementation Working Group
Adopted
August 28, 2008

-- Acknowledgements –

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Global Warming Mitigation Factoids

A ton of CO_2e* is emitted when you:

- Travel 2,000 miles in an airplane
- Drive 1,350 miles in a large sport utility vehicle
- Drive 1,900 miles in a mid-sized car
- Drive 6,000 miles in a hybrid gasoline-electric car
- Run an average U.S. household for 60 days
- Have your computer on for 10,600 hours
- Graze one Ugandan dairy cow for eight months

To offset 1,000 tons of CO_2e you could:

- Move 145 drivers from large SUVs to hybrids for one year
- Run one 600 kW wind turbine for an average year
- Replace 500 100-watt light bulbs with 18-watt compact fluorescent lights (10-year life)
- Replace 2,000 refrigerators with the highest efficiency model (10-year life)
- Install 125 home solar panels in India (20-year life)
- Plant an acre of Douglas fir trees (50 years of growth)
- Protect four acres of tropical rainforest from deforestation

Average CO_2e emissions per year:

- 4.5 tons for the average U.S. car
- 4.5 tons for the average global citizen
- 6.2 tons for electricity use of the average U.S. household
- 21 tons for the average U.S. resident
- 1.5 million tons for a 500 MW gas power plant
- 8.3 million tons for an older 1,000 MW coal plant
- 6 billion tons for the U.S. as a whole
- >25 billion tons for the planet as a whole

*CO_2e – carbon dioxide equivalent – carbon dioxide and other molecules emitted to the atmosphere, such as methane, cause atmospheric warming. Each type of molecule has a different warming potential (methane, for example, has 21 times more warming effect than CO_2.) The combined warming effect of all these molecules is expressed in carbon dioxide equivalents.

Source: *A Consumers' Guide to Retail Carbon Offset Providers*, Clean Air-Cool Planet, 2007.

Glossary

Biofuel: as used in this report, refers to liquid forms of biomass used as fuel for heating or transport.

Biomass: – refers to living and recently dead biological material that can be used as fuel or for industrial production. Most commonly, biomass refers to plant matter grown for use as biofuel, but it also includes plant or animal matter used for production of fibres, chemicals or heat. Biomass may also include biodegradable wastes that can be burnt as fuel. It excludes organic material which has been transformed by geological processes into substances such as coal or petroleum.

Carbon Dioxide Equivalent: in addition to carbon dioxide, other molecules emitted to the atmosphere, such as methane, also cause atmospheric warming with more or less effect than carbon dioxide molecules. The combined effect of all these molecules are expressed as carbon dioxide equivalents.

Carbon Footprint: The estimated emissions of carbon dioxide (CO_2) and other GHGs associated with a particular activity (*e.g.*, a plane trip), use of your car, your family's overall lifestyle, or use of a particular product or service. The scope of carbon footprint analyses can vary, and may or may not include all GHGs or reflect a "life cycle" approach to quantifying "upstream" and "downstream" GHG emissions. When it includes all GHGs, the footprint is commonly expressed in "CO_2 equivalent" (CO_2e) units. The personal carbon footprint of a typical individual in the United States is approximately 10 tons of CO_2e per year, reflecting emissions from the activities listed above that are under a person's direct control, *e.g.*, home energy use and personal transport. U.S. per capita emissions (calculated by dividing total national GHG emissions by total population) are more than 20 tons per year.

Carbon Offset: The act of reducing or avoiding GHG emissions in one place in order to "offset" GHG emissions occurring somewhere else. Unlike most conventional pollutants, GHGs mix well in the atmosphere and can travel around the planet quickly. As a result, it doesn't really matter from the standpoint of global warming mitigation where a reduction takes place. Carbon offsets are intended to take advantage of the radically different costs and practicalities of achieving GHG emission reductions by sector and geography.

Carbon Neutrality: refers to a net of zero of carbon released from Middlebury College's operations. In Middlebury's case, it means achieving actual reductions in the amount of carbon emitted from College activities as far as feasible. Whatever remains that cannot be reduced will then be addressed by offsets (see below).

Conservation: the practice of decreasing the quantity of energy used. It may be achieved through efficient energy use, in which case energy use is decreased while achieving a similar outcome, or by reduced consumption of energy services.

Efficiency: using less energy to provide the same level of energy service.

 # 6 Fuel Oil (and #2 Fuel Oil): fuel oil is any liquid petroleum product that is burned in a furnace or boiler for the generation of heat or used in an engine for the generation of power. The #6 is part of a numbering system to distinguish different types, or fractions, of fuel oil that result from the distillation of crude oil. # 6 fuel oil is what remains of the crude oil after gasoline and the distillate fuel oils (like #2 fuel oil) are extracted through distillation.
#2 fuel oil – see above

Greenhouse Gas (GHG): The primary gases (both naturally existing and man-made) that contribute to global warming by trapping more energy in the earth's atmosphere than would occur in their absence. Greenhouse gases covered by the Kyoto Protocol are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). Chlorofluorocarbons are also powerful GHGs, but are regulated separately as a means of addressing stratospheric ozone depletion. Water vapor is a powerful GHG that responds automatically to changes in temperature and other conditions, but it cannot be directly influenced by human activities. It is therefore not generally considered a greenhouse gas for global warming mitigation purposes.

Kilowatt: The kilowatt (symbol: kW), equal to one thousand watts, is typically used to state the power output of engines and the power consumption of machines. A kilowatt is roughly equivalent to 1.34 horsepower. An electric heater with one heating-element might use 1 kilowatt.

Kilowatt hour: a unit of energy use. A machine that requires 1 kilowatt to run, if it runs for an hour, would use 1 kilowatt hour.

LEED: Leadership in Energy and Environmental Design – a set of guidelines produced by the US Green Building Council that are used to rate the energy efficiency and environmental design elements of new building projects and renovations.

LEED MC Plus: LEED (see above) guidelines with an additional set of criteria added by Middelbury College to reflect its unique circumstances and requirements for sustainably designed buildings and renovations.

MTCDE: metric tonnes of carbon dioxide equivalents (see Carbon Dioxide Equivalents above). A metric tonne is 2200 pounds.

Offset: see Carbon Offset

Renewables: sources of energy from natural resources such as sunlight, wind, rain, tides and geothermal heat, which may be naturally replenished. Renewable energy technologies range from solar power, wind power, hydroelectricity/micro hydro, biomass and biofuels for transportation.

■ Executive Summary and Key Items –

"If you want to go fast, go alone. If you want to go far, go together."

– African proverb

This report focuses on how best to go about implementing the Middlebury College Trustees' resolution to achieve carbon neutrality by 2016. This resolution charged the entire College community with achieving carbon neutrality "through energy conservation and efficiency, renewable fuel sources, technology innovations, educational programming and learning, and offset purchases after all other feasible measures have been taken."

Previous efforts by students, faculty, and staff in 2003 and 2007 identified various options and strategies for achieving carbon neutrality. This report provides further study of some of those options and others that have been identified since. We have not made any detailed assessments of the costs and benefits of the various solutions and options outlined in this report. The previous work done in the MiddShift report of February, 2007 (see Appendix 4) and the Carbon Reduction Initiative of 2003 provide useful guidance in that regard. The MiddShift Implementation Working Group (MSIWG) recognized that for many of the recommended solutions to reach the implementation stage, the first step in the project management process is a detailed cost/benefit analysis developed by industry professionals.

Our primary charge was to develop an implementation plan and process. As such, the report also focuses on a process by which implementation can be carried out with specific roles and responsibilities for people who will make all the difference in achieving carbon neutrality by 2016. This has not been addressed in previous efforts that were mainly about the various technical and behavioral solutions that were relevant in terms of achieving carbon emissions reductions.

The MSIWG worked from a conceptual framework described as follows:

> <u>Engaging the campus community</u>
> The core of successful implementation will be a continuously aware, engaged and active College community. Neutrality by 2016 suggests a single point in time; however, once we achieve it, we will need a way to assure that every person in the College community is thinking innovatively and making choices and decisions that are aligned with and in support of carbon neutrality. Therefore, we need to devise and carry out an ongoing, comprehensive outreach and engagement program to inform and inspire

people about how to achieve and maintain carbon neutrality and to acknowledge their innovations and contributions to success.

The pursuit of carbon neutrality should be kept in the larger context of being a leader in campus sustainability. We need to assure that as we go about making decisions on how to achieve neutrality, we are considering the overall ecological and social consequences and opportunities they afford the College and others. Our solutions should be economically sound and should, to the greatest extent feasible, demonstrate how to achieve economic benefits in terms of ecological restoration, increase social capital and equity, and take calculated risk that will help others in the region learn how they can advance their own efforts to create a more sustainable future.

Project management and oversight

The development of new, green technologies is advancing at an increasing pace. The widespread recognition and acceptance of the threats of human caused climate change is driving greater investment in research, development and deployment of new technologies. We need to pay attention to the many possibilities that will arise as we go about implementing solutions. However, due to the amount of time between project identification and completion, we also need to assess the options available in a relatively short window of two to three years and commit to actions that will get us to our goal by 2016.

We need a process by which we can efficiently evaluate technological solutions and opportunities and their feasibility for achieving neutrality at Middlebury College. That process should take possible solutions from idea to implementation or rejection. In order for such a process to work we need a team of people responsible for assuring that the process is followed and to monitor and report on our progress in achieving carbon neutrality. This report recommends a specific process and those who should be involved in leading and guiding the initiative.

Renewables and the “Million Gallon Question”

Our biggest source of carbon emissions comes from the fuel we burn to heat and cool building space. We know that after the biomass gasification plant comes online in 2008 we will significantly reduce the College's carbon footprint of 30,000 metric tonnes of carbon dioxide equivalents (2006-07) by about 40% and eliminate the consumption of 1,000,000 gallons of #6 fuel oil. That leaves roughly 1,000,000 million gallons of #6 fuel oil to be eliminated - the so called "Million Gallon Question." The report addresses that issue as well, noting that a feasibility study to look at how biomass and biofuels can address that question is already in process. It also addresses issues related to the sustainable production of biomass from forests and farmlands.

<u>Travel Emissions</u>

Once the "million gallon question" is addressed, the other sources of Middlebury's carbon emissions will take on a greater proportion of the remaining total. The next biggest piece of our footprint is College Travel and the vehicles in our fleet. We know that while some reductions can be found by conservative behaviors, we cannot entirely eliminate our carbon emissions from this source. In the absence of a national "carbon" tax on transportation fuels, this will require some use of offsets either from bona fide third parties, or by the development of an internal offset program. The report addresses those options.

<u>Electricity</u>

The next biggest source of emissions comes from fuels burned to generate the electricity we use. Electricity is currently only 1% of the total footprint primarily because Vermont's electricity comes mainly from carbon neutral sources – nuclear power and hydroelecticity. These two sources are provided by: 1– Vermont Yankee whose nuclear reactor license expires in 2012 and may or may not be renewed; and 2 – HydroQuebec whose contracts with Vermont begin to expire starting in 2012 and on into 2016. This creates uncertainty about how carbon free Middlebury's future electricity will be. Summertime use of electricity can drastically change this percentage. When demand for electricity to run air conditioning exceeds the supply from these two sources (and others that make up the rest of the mix) our power comes from the national grid beyond Vermont and this power is much higher in its carbon intensity since much of it comes from coal powered generators. The College should vigorously pursue opportunities and technologies that can provide electricity from renewable sources such as biomass, wind, solar, etc. It should conduct some small scale pilot projects and demonstrations of technologies that look appropriate and promising on a small but scaleable basis.

<u>Waste Reduction</u>

We do a very good job of recycling at Middlebury. However, what we don't recycle goes to landfills and that waste, when it decomposes, causes carbon emissions. The less waste we generate and the more we reuse and recycle, the smaller our footprint. Significant reductions in waste and higher reuse and recycle rates can be achieved by coordinated efforts on the part of individuals, College purchasing policies, and operational practices. The comprehensive outreach, information and acknowledgement effort mentioned earlier will be instrumental in success in this area.

<u>Efficiency and Conservation</u>

There is a significant role to be played by increasing the efficiency by which we use energy. The College recently conducted an energy audit of 2/3 of the building space on campus which provides a useful rating of the energy performance of most of the buildings on campus relative to the current state energy code. They range from "red" buildings that perform very poorly to "orange" that are more efficient but could be better to "green" buildings that exceed that reference code. The report also provides a list of the efficiency measures for each building audited and a rough assessment of the cost and length of payback time for each measure. The implementation of these measures will take longer than the eight years between now and our target date of 2016. However, there is much to be gained by making buildings more energy efficient. The report provides recommendations for how this process can be done over the long run.

Conservation

Finally, and this has been addressed previously but bears repeating, the role of conservation is paramount to achieving and holding carbon neutrality. How members of the College community approach the use of the resources needed to carry out the business of the institution has a direct bearing on the quantities of energy and materials consumed every day. A conservation ethic and practice that is wide and deep on the campus will make a significant difference in the effort. Small reductions in consumption at the individual level do matter, especially when they are aggregated across the entire 4,000 member community of people who work, live and study on campus, as well as the growing number of summer language school students who are also part of this community. The report also addresses how to broaden and deepen a culture of sustainability on an ongoing basis to provide a foundation of innovation and stewardship of energy and resources.

Summary of Recommendations

The Million Gallon (or less) Question

1. Using the analysis completed by the ECON265 students and working with the College's Master Planning team, develop a decision-support model to determine how to displace the remaining million gallons of fuel oil using biofuels and/or other renewable options. The model should reflect the criteria outlined in section I.c.: CO_2 reduction, social and ecological benefits and costs, economic benefits and costs, and educational value and visibility.
2. Implement alternative strategies to minimize the energy consumption of new buildings. These strategies should address building design and siting, landscape design, and building systems.
3. Conduct assessment of renewable energy opportunities available on the main Bread Loaf campuses. Investigate economic and technological feasibility of solar thermal and geothermal applications and their educational potential.
4. Identify both small and large scale demonstration projects:

- Example of small demonstration project: among buildings not served by the central heating system, identify candidates for solar water heating.
- Example of large scale demonstration project: at the athletics complex, reduce reliance on central heating system through solar thermal or geothermal technologies

5. Provide any support needed to complete the willow shrub cultivation pilot project and make it a high priority to develop this into an alternative fuel source, and other possible local biomass cultivation projects.
6. Develop recommendations to be presented to Trustees at October 2008 Board meeting.
7. Begin project implementation/capital planning process.

Building Efficiency Upgrades

1. Adopt the LEED MC-Plus guidelines system for all renovation projects
2. Improve the energy performance of existing campus buildings through improvements to their envelopes and building systems; assign priorities for improvements based on the energy audit of buildings on campus and on academic program and availability
3. Encourage behavioral changes for students, faculty, and staff, including adjustments to indoor temperatures and use of air-conditioning
4. Meter all buildings for water, power, and steam; install "Building Dashboards" and "Campus Dashboards": displays that show building and campus energy use and production in real time, and the corresponding greenhouse gas emissions, along with water use, comparative historical data, environmental conditions, etc.
5. Minimize the use of air-conditioning in campus buildings by evaluating the air-conditioning set-point, minimizing the need for air-conditioning by using shading, natural ventilation, and mechanically-assisted ventilation, and strategically planting deciduous shade trees on south side of buildings to help reduce daytime solar heat gain during the summer months
6. Where appropriate, utilize energy efficient means of cooling, such as geothermal, shading, natural, and mechanical ventilation, etc.
7. Based on the assessment described in section II.a.i., apply energy efficient alternative systems for specialized functions in individual buildings such as a purified water system for Kenyon Arena's ice sheet, which will reduce the energy required to create and keep the ice, a solar hot water heating system for the Natatorium, heat exchangers to recapture waste heat, for example at the campus data center and if possible in food service areas. Investigate the feasibility of solar heating for domestic hot water
8. Consider adaptive reuse of buildings before removal. When building removal is required, employ deconstruction methodologies in order to minimize the quantity of materials entering the waste stream and using salvaged materials for future building projects
9. Continue collaborating with Efficiency Vermont to obtain greatest efficiency for both new and renovated buildings.

10. Monitor, measure, and verify that reduction in energy consumption and carbon reduction targets were achieved.

New Construction – LEED MC-Plus

1. Adopt the LEED MC-Plus guidelines system for all new construction projects
2. Design new buildings to be carbon neutral
3. Encourage behavioral changes for students, faculty, and staff, including adjustments to indoor temperatures and use of air-conditioning
4. Equip all new buildings with metering for water, power, and steam; install in all new buildings “Building Dashboards” and “Campus Dashboards”: displays that show building and campus energy use and production in real time, and the corresponding greenhouse gas emissions, along with water use, comparative historical data, environmental conditions, etc.
5. Minimize the use of air-conditioning in new buildings by evaluating the air-conditioning set-point, minimizing the need for air-conditioning by using shading, natural ventilation, and mechanically-assisted ventilation, and strategically planting deciduous shade trees on south side of buildings to help reduce daytime solar heat gain during the summer months
6. Where appropriate, when sighting and designing new buildings, utilize energy efficient means of cooling, such as geothermal, shading, natural, and mechanical ventilation, etc.
7. Utilize materials salvaged from deconstructed buildings in new construction projects.
8. Continue collaborating with Efficiency Vermont to obtain greatest efficiency for new and building construction.

Electricity

1. Closely monitor the relicensing request by Vermont Yankee and the contract renewal process with HydroQuebec and possible impacts on the College’s cost and carbon emissions of its electricity.
2. Implement the electricity conservation and efficiency recommendations provided in section 5.2 of the “Middlebury College Campus Energy Efficiency Evaluation,” November 5, 2007.
3. Develop information resources for building occupants that will equip them with a working knowledge of the energy efficiency devices and controls to assure proper operation and optimal performance.
4. Continue working to establish a partnership with the Middlebury Electric Company and the Town of Middlebury to reestablish the hydroelectric station on the Otter Creek in Middlebury and purchase electricity from this source.
5. Conduct a feasibility assessment of wind power at Worth Mountain site develop recommendations for establishing a wind turbine there.
6. Conduct an analysis and identify options that would make the most sense from a carbon emissions and cost perspective for various future scenarios that could plausibly occur with regard to different mixes and costs of

electricity from CVPS, local hydroelectric, wind, and increased generation of electricity by the biomass plant.

Vehicles

1. Set targets to reduce per vehicle fuel consumption and increase efficiency of College owned and operated vehicles.
2. Adopt a purchasing policy that replaces the current rental fleet with new vehicles with reduced carbon emissions.
3. Adopt policy of using B20 as a minimum level of biodiesel to replace current diesel use.
4. Test higher blends of biodiesel (B40 or B80) for suitability in vehicles. Once determined, adopt the higher level blends as policy.
5. Augment vehicle database to include information on fuel use and mileage used each year in order to help inform future purchasing decisions.

College Travel

1. Education
   - Inform departments of their annual air miles traveled and increase awareness of the resulting impact on the environment.
   - Encourage people to be conscious of their decisions and to be conservative when planning number or frequency of trips requiring air travel
2. Videoconferencing
   - Administrative business meetings, including Schools Abroad and other programs with multiple locations.
   - Student Interviews
3. Travel Policies
   - Attend conferences that require air travel every other year, instead of annually
   - Combine events for Athletics; men's and women's compete at same location
   - Offer incentives for departments to use alternative modes of transportation
4. Travel Alternatives
   - Train travel for feasible locations, such as New York City
   - Supplement train spur to Middlebury
   - Carpool / Trip share – post upcoming trips on Campus Community Travel Board
   - Bus or Van Rental to locations within reasonable driving distance

Waste Minimization

1. Create a post graduate position whose job will be to cultivate a culture around waste reduction and recycling – somewhat like a CRA with a waste management and reduction focus and outreach to students, faculty, and staff.

2. Increased integration of sustainability and waste minimization into the residential life system.
3. Comprehensive educational awareness campaign about waste minimization.
4. Service requirement for freshmen at the recycling center, the dining hall, etc. to give new students an understanding of the scale of waste at Middlebury College and to instill a value for reducing it.
5. Add scales and accompanying software to recycling center trucks in order to easily provide data about waste and recycling for each dorm.

Offsets and Sequestration

1. Develop offset purchasing guidelines in order to ensure the College is making quality carbon reducing investments.
2. Prioritize locally focused projects in purchasing decisions.
3. Develop internal offset program, with appropriate internal support
4. Quantify sequestration of carbon on College owned lands and potential for increased sequestration

Winning the Race Together

1. Cultivate a culture of conservation choices and decisions.
2. Develop comprehensive outreach and engagement plan (see section III.a. for recommendations).
3. Ensure institutional practices and policies are consistent with carbon neutrality (see section III.b for recommendations).
4. Adopt a project management organizational structure to provide leadership, oversight, and accountability for achieving carbon neutrality by 2016 (see section IV for recommendations).
5. Work with peer institutions who are also working toward carbon neutrality and create a learning network to foster greater success and leadership in meeting and solving the challenge of global climate change.

-- I. Introduction –

Never before has humanity faced such a challenging outlook for energy and the planet. This can be summed up in five words: "more energy, less carbon dioxide".

– Shell Global energy Scenarios 2050

a. Overview: Carbon Neutrality at Middlebury College

This report comes on the shoulders of previous work done by students, staff, and faculty during 2007 leading to a resolution by the Middlebury College Board of Trustees to achieve carbon neutrality by 2016 (Appendix 2).

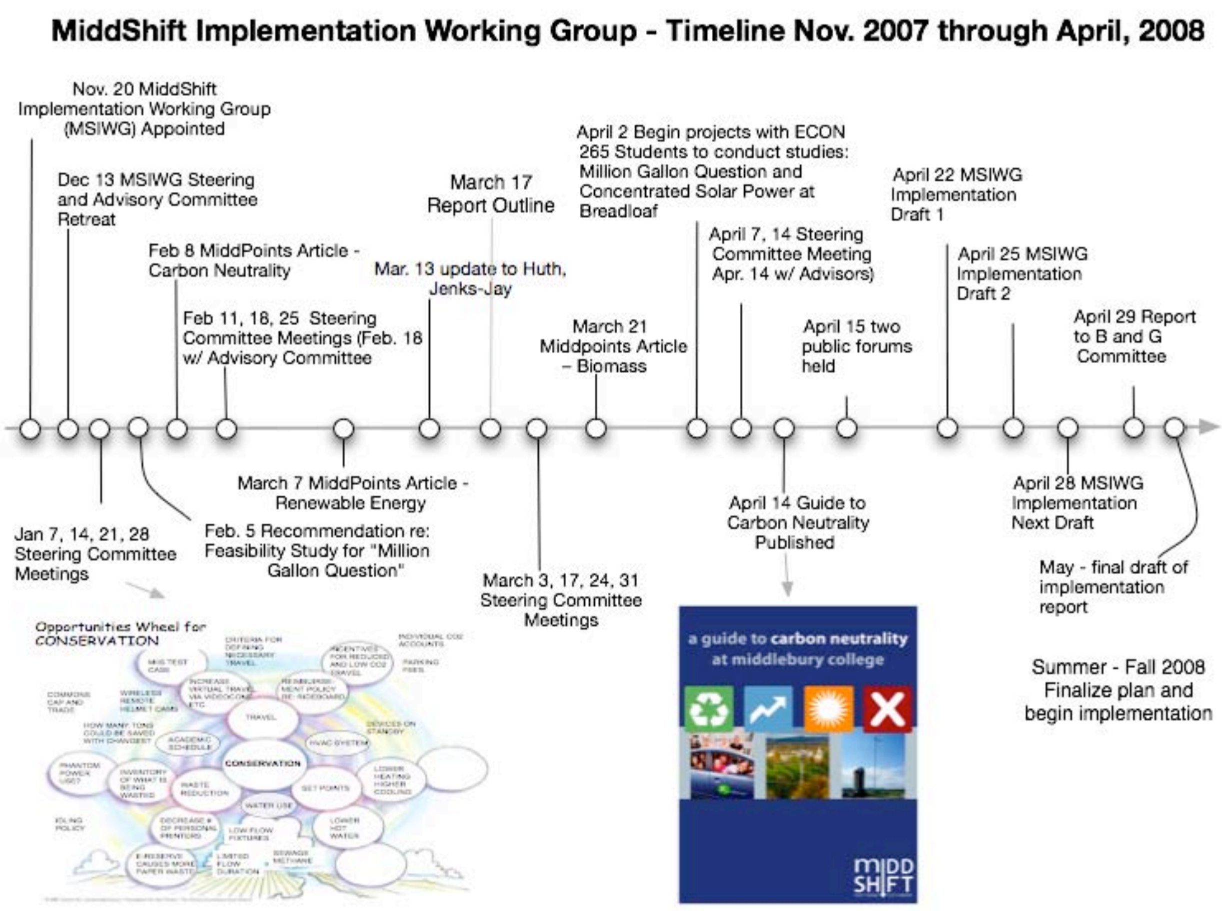
A report was produced and presented to the Trustees in February 2007 *(MiddShift – A Proposal for Carbon Neutrality at Middlebury College).* It provides a clear rationale and case for adopting such an ambitious goal, an analysis of various actions that could be taken to reduce carbon emissions and their costs and benefits. (see Appendix 4)

A follow up team of students and staff was formed at the Trustees' request and led by the College's Executive Vice President and Treasurer to summarize the risks and mitigants associated adopting a goal of carbon neutrality by 2016 and to gauge the degree of support for such a goal from within the College Community. That assessment also included a winnowing and refinement of the proposed actions presented in the MiddShift February, 2007 report and their costs and benefits. That assessment was presented to the Trustees at their May, 2007 meeting where they adopted the resolution and charged the President and the entire College community to go forward in implementing the resolution. (Appendix 3). Middlebury College's President Ronald D. Liebowitz also subsequently signed the American College and Universities Presidents Climate Commitment.

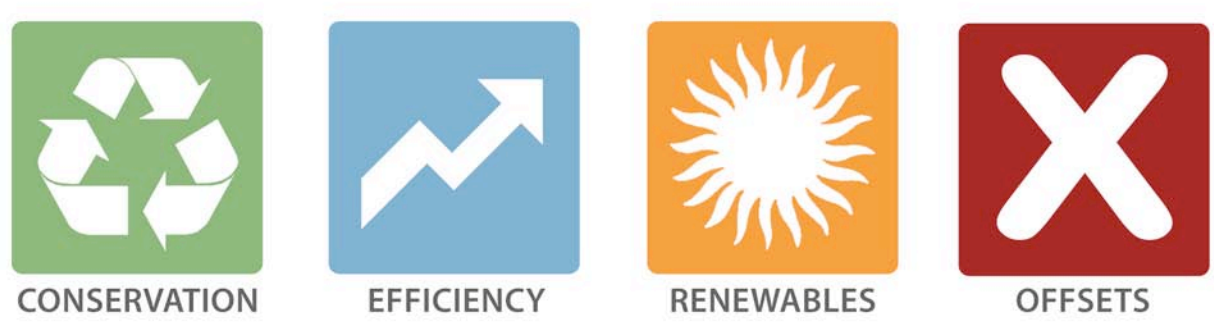
In parallel to these efforts, the College was in the midst of a comprehensive Master Plan process that embraces sustainability and reduction of greenhouse gas emissions as a core and cross cutting element. This process also included a wealth of related studies and assessments that provide a valuable set of resources to the carbon neutrality implementation effort that will occur over the coming years. These resources include an energy audit and recommendations for efficiency improvements of about two-thirds of the 2.2 million square feet of built space on the main campus, a utilities study, a sustainability study, and a landscape study. These documents and their recommendations have been incorporated into the Master Plan and its adoption is anticipated at the May 2008 Trustees meeting. This report incorporates many of the recommendations and some of the information associated with the Master Planning process.

In November of 2007, President Liebowitz formed the MiddShift Implementation Working Group (MSIWG) to develop recommendations about how to assure that the goal of carbon neutrality would be achieved by 2016. Sixteen people representing faculty, staff and students were appointed to work on this task and to report to the President on their results in late April, 2008. The MSIWG began its work in December, 2007 with a retreat to learn from outside experts in the corporate, academic and municipal sectors about energy and greenhouse gas emissions issues and perspectives and to discuss the challenges and opportunities that we face in achieving the 2016 goal. MSIWG is composed of two committees: Steering and Advisory with eight people each. The Steering Committee took on the task of developing this implementation report and the Advisory Committee provided feedback and perspective on the work of the Steering Committee. See timeline of activities.

Fig. 1: MiddShift Implementation Working Group Timeline Nov. 2007-April 2008



The MSIWG reviewed the recommendations and actions in the previous reports and did some early brainstorming around four major themes:



This resulted in a set of priority strategies that are provided in section II of this report. MSIWG also recognized early on that a key element of getting to carbon neutrality by 2016 will require a creative solution to “The Million Gallon Question.” Our biggest source of carbon emissions comes from the fuel we burn to heat and cool building space. We know that after the biomass gasification plant comes online in 2008 and will significantly reduce the College's carbon footprint of 30,000 metric tonnes of carbon dioxide equivalents (2006-07) by about 40% and eliminate the consumption of 1,000,000 gallons of #6 fuel oil. That leaves roughly 1,000,000 million gallons of #6 fuel oil to be eliminated - the so called "Million Gallon Question." The MSIWG recommended in February, 2008 that the College immediately begin a feasibility study to determine how this question should be answered. The recommendation was accepted and such a study is underway. It is being conducted jointly by a team of students from Jon Isham’s Econ265 class and a team of professional consultants who have been involved in the Master Plan. The students are conducting preliminary studies and analyses that will be used by the consultants to complete the feasibility report.

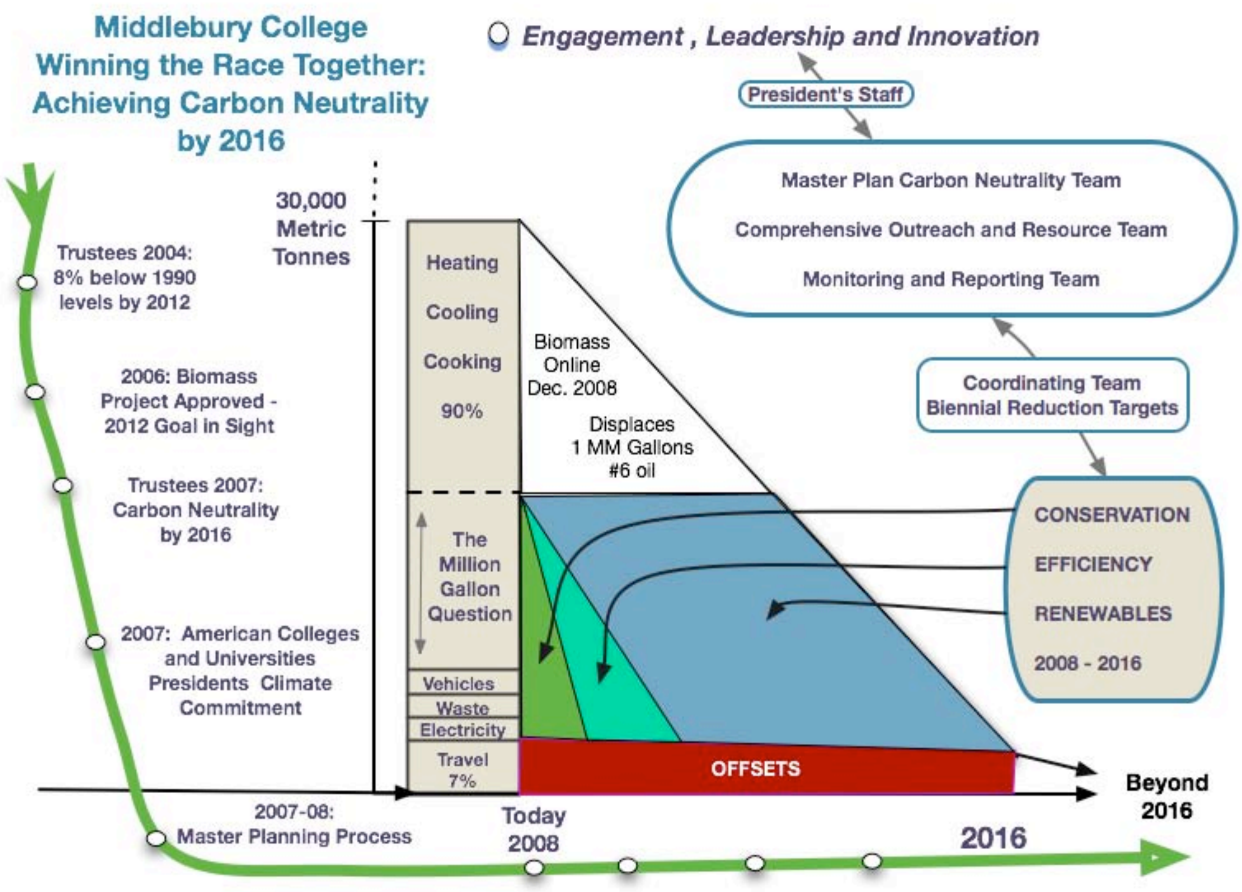
MSIWG also established a set of criteria by which future projects should be evaluated to assure that decisions and actions related to achieving carbon neutrality goal be done so to assure that broader principles and objectives related to sustainability are served. These are in section

The MSIWG heard clearly from the Advisory Committee and from participants in two public forums that carbon neutrality needs to be in the consciousness and decision-making process of everyone in the College Community if we are going to succeed in getting there. Engagement, understanding, and commitment are key to putting all the good ideas, information and analysis that has been produced through the Master Planning process and the carbon neutrality studies and efforts that have preceded this report.

As a result, this report places emphasis on the implementation process that should ensue. Section IV provides recommendations about the structure and function of teams of College people to drive the implementation process from now to 2016 and beyond.

See Figure 2 for a graphic summary of the history of carbon neutrality at Middlebury and an overview of the implementation goals and strategies for addressing various portions of the College's carbon footprint.

Fig. 2: "Winning the Race Together" Achieving Carbon Neutrality by 2016 at Middlebury



b. Middlebury College Carbon Footprint

Middlebury's greenhouse gas emissions come primarily from the fuels it burns to heat and cool the campus.

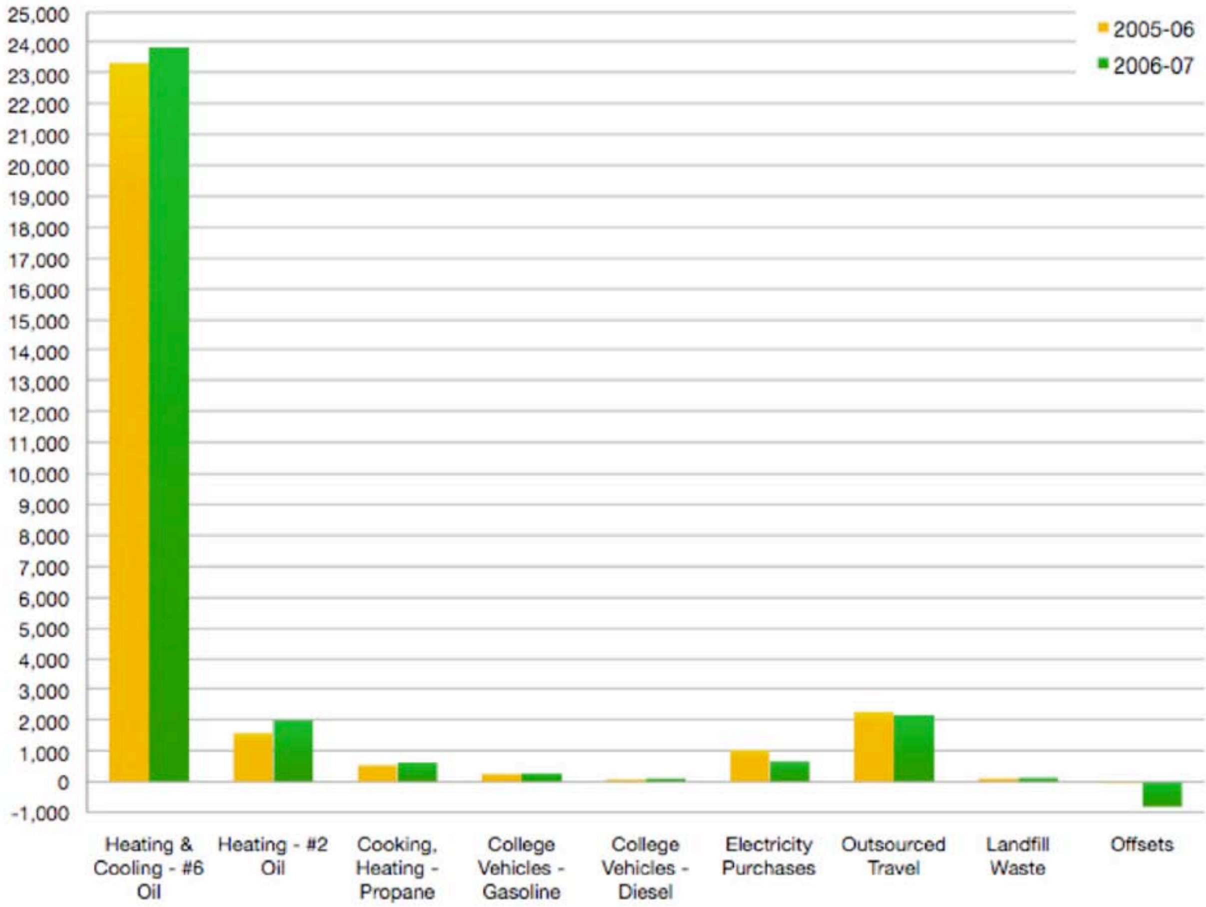
- Nearly 90% of the College's carbon footprint comes from these sources which consists of:
  - # 6 fuel oil (approximately 2,000,000 gallons per year),
  - #2 fuel oil/biofuel blend (approximately 175,000 gallons of 20% biofuels/80% #2 oil per year), and
  - a smaller quantity of propane.

- Of the remaining 10% of greenhouse gas emissions:
  - about 7% is due to College related travel (trips paid for by the College for conferences, athletic events, fundraising, recruitment, etc.)
  - the remaining 3% comes about equally from fuels burned to generate electricity, fuels burned to power College owned vehicles and work machines, and from decomposition of the waste sent to landfill disposal.

The small portion due to electricity comes from the fact that Vermont's sources for electricity are primarily nuclear and hydroelectric both sources that directly emit very little greenhouse gas. Both sources of this electricity have an uncertain future. The Entergy/Vermont Yankee nuclear power plant in Vernon, VT is due for decommissioning in 2012. The owners are seeking a 25 year extension of their operating license. Vermont's contracts with HydroQuebec which provides most of the state's hydroelectric power, begin to expire in 2012 running to 2016 and will be up for renegotiation. The College also cogenerates about 20% of its electricity at its central heating system on campus.

The College also purchased offsets in FY2005/06 and FY2006/07, with a significant increase in 2006-07 due to its decision to make the Snow Bowl ski area completely carbon neutral. Smaller quantities were purchased in both years to offset miscellaneous events.

Figures 3 and 4: Middlebury College Greenhouse Gas Emissions by Source (metric tonnes carbon dioxide equivalents)



Scope	Source	2005-06	2006-07
Scope 1A - Direct Emissions from Stationary Sources	Heating & Cooling - #6 Oil	23,372	23,877
	Heating - #2 Oil	1,605	2,009
	Cooking, Heating - Propane	548	623
Scope 1B - Direct Emissions from Mobile Sources	College Vehicles - Gasoline	261	285
	College Vehicles - Diesel	85	123
Scope 2 - Indirect Emissions from Electricity Purchases	Electricity Purchases	1,034	676
Scope 3A - Indirect Emissions from Outsourced Travel	Outsourced Travel	2,302	2,179
Scope 3B - Indirect Emissions from Landfill Waste	Landfill Waste	125	137
Renewable Energy Certificates and Offsets	Offsets	-36	-839
TOTAL (metric tonnes carbon dioxide equivalents - MTCDE)		**29,296**	**29,070**

c. Criteria for Implementation Strategies

While this report focuses primarily on a structure and process for achieving carbon neutrality, the MiddShift Implementation Working Group addressed the question of what criteria should be considered in the selection and implementation of strategies for carbon emissions reductions. The following are those criteria:

● **CO_2 reduction** – the estimated reduction of greenhouse gas emissions (expressed as metric tons of carbon dioxide equivalents (MTCDE))

Social and Ecological Benefits and Costs (Costanza 2006) expressed in terms of:

Natural Capital – which includes ecological systems, mineral deposits, and other aspects of the natural world.

Human Capital – which includes the health and education of the human population, both the physical labor of humans and the know-how stored in their brains.

Social (or cultural) Capital – which is a recent concept that includes the web of interpersonal connections, institutional arrangements, rules, and norms that allow individual human interactions to occur (Berkes and Folke 1994).

● **Economic Benefits and Costs (From ES 401 2003)**

Lifetime – the estimated years of the strategy. (recognizing that some strategies have the potential to be reactivated after they expire.

Payback time – (the absolute value of) the ratio of the fixed cost to the net annual benefit. In cases with no fixed cost and a net annual benefit (for example, lowering thermostat set points) this is labeled ‘immediate’. In cases with no payback (that is, where the strategy has a net total cost), this is labeled ‘none’.

Fixed cost – the start-up cost for the strategy.

Net variable cost or benefit – the difference between the annual variable cost and annual variable benefit.

Lifetime variable cost or benefit – the product of the strategy lifetime and the net variable cost or benefit.

Total cost or benefit – the sum of the fixed cost and the lifetime variable cost or benefit.

Average total cost or benefit – the ratio of the total cost or benefit to the strategy lifetime.

Total cost per tonne – the ratio of the average total cost or benefit to annual tonnes CDE.

- **Educational Value and Visibility**

The degree to which the strategy provides opportunities for active involvement and engagement in learning about impacts of personal and institutional choices.

The degree of visibility of the strategy to the campus community and general public as a demonstration of our ongoing efforts and commitment to achieve carbon neutrality. Also to provide others with lessons learned and how these strategies can be deployed by others in the region and beyond.

d. Financing Options

This report outlines the many steps that we will need to take to achieve carbon neutrality. Some of these steps will be budget-neutral or may reduce costs, while others will require significant amounts of funding. There are a number of financing options that may be used, either alone or in combination with others. For those projects that directly reduce costs we recommend that the savings be moved into a revolving loan fund that may provide financing for other carbon neutrality projects. These options are listed below by type of financing method; revenue generating, expense reallocation and other. As projects are finalized for implementation over the coming years appropriate financing packages from the following options will be selected.

i. Revenue Generating

1. Grants: *Identify external grants that will fund carbon neutrality projects*

2. 1% for Carbon Neutrality: *Similar to the 1% for Art fund, 1% of all construction projects greater than $1 million is transferred to a carbon neutrality fund*

3. Fund-Raising: *Identify projects that have donor appeal. Raise money from donors for endowed funds and restricted gifts to support carbon neutrality projects.*

4. Debt: *Issue tax-exempt bonds to finance large-scale projects*

5. Sale of Services: *Provide consulting services to external clients, speaking fees ticket sales for events and sales of publications*

6. Student Fees: *Charge additional fees for specified projects or general carbon neutrality fund*

ii. Expense Reallocation

1. Campus Utility Budgets (Tax on energy): *Allocate a portion of utility budgets, either additional or savings from reduced usage to support carbon neutrality or implement a percentage charged for non-renewable energy used*

2. Capital Project Budget: *Allocate a portion of the Capital Budget to carbon neutrality projects*

3. Capital Equipment Budget: *This may be used for new and replacement equipment, such as vehicles*

4. One-Time Appropriations: *Allocate a supplement from the operating budget*

5. Departmental Contributions: *Department operating budget dollars are specifically allocated to support carbon neutrality*

6. Expense Reduction: *Implement policies to reduce carbon-related expenses (e.g. travel) and allocate savings to carbon neutrality projects*

iii. Other

1. Internal Revolving Loan Fund: *Savings from projects are deposited into a fund from which future projects can draw upon to fund the new projects. Any savings from the new projects is then deposited back into the revolving loan fund.*

2. Payback: *Carbon neutrality projects may generate savings which can support the payment of the project over a specified time period*

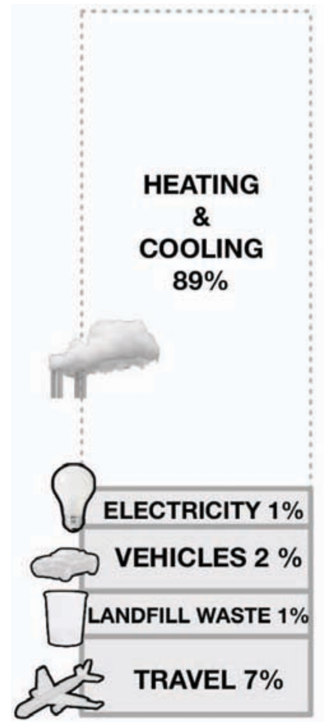
3. Partnerships with Utilities: *Enter into agreements with providers to share in the savings*

4. Partner with Efficiency Vermont: *Efficiency Vermont is interested in partnering with Middlebury on mutually beneficial projects*

5. Collaboration with Towns *Work with municipalities to identify projects that will have mutual financial benefits*

6. Pilot Projects: *Manufacturers of new technology provide new products at a free or reduced cost in order to gain publicity, prove product viability and gain a foothold in the market*

-- II. Implementation Strategies --



a. Heating and Cooling

Potential Carbon Reduction: *89%*

Financing Options:
Payback, Expense Reduction/Reallocation, Debt, Partnerships, Fund-Raising, Capital Project Budget

a. Heating and Cooling
i. The Million Gallon (or less) Question
1. Biomass and Biofuels

The Biomass energy project approved by the Trustees in 2007 will come on-line in early 2009. As a result, approximately one million gallons (or 50%) of the College's #6 oil annual consumption will be displaced with approximately 20,000 tons per year of wood chips.

The MiddShift Implementation Working Group has identified the College's remaining annual consumption of one million gallons of #6 fuel oil as a key parameter to be addressed to meet our carbon neutrality 2016 goal.

Biomass and biodiesel are two realistic sources of renewable energy that could displace one million gallons of nonrenewable #6 fuel oil as part of our central plant operation. All other options for renewable energy sources also need to be reviewed and evaluated.

Early on in its deliberations, the MSIWG recognized that if we are to achieve carbon neutrality we will need to find a viable solution to eliminating the need for the million gallons of fuel oil burned for heating and cooling which will remain after the Biomass energy project goes online, i.e., we need to find an answer to "The Million Gallon Question." The MSIWG recommended that a feasibility study commence immediately given the lead time that is required to address an infrastructure issue of this magnitude (Appendix 1). That recommendation was accepted and a feasibility study has begun which involves preliminary work done by students in Professor Jon Isham's Spring '08 Environmental Economics 265 class. This work will then be used by a team of consultants who will complete the feasibility study based on the direction that comes from the student's work.

The following ideas are currently being evaluated to propose an operating strategy that would include either or both of these renewable energy sources. Students in the spring semester '08 ENV265 class are developing a model that will allow analysis of the many variables associated with these ideas.

1) What is the availability of biodiesel? In simple terms 1.2 millions gallons per year of B100 biodiesel would displace 1 million gallons per year of #6 fuel oil. *ENV265*

2) What is the local, regional, and global environmental impact of Middlebury College procuring 1.2 million gallons per year of a B100 biodiesel fuel source? *ENV265*

3) What is the local, regional, and global economic impact of Middlebury College procuring 1.2 million gallons per year of a B100 biodiesel fuel source? *ENV265*

4) What technical challenges need to be addressed to receive, handle (store), consume (combust) 1.2 million gallons per year of a B100 biodiesel fuel source in our existing Central Heating Plant? *College Master Planning Team*

5) Items #1 – #4 should also be evaluated for other annual consumption quantities of B100 biodiesel, and other annual consumption quantities of biodiesel blends (i.e.: B20, B50). This evaluation will include the resulting impact on our Carbon Neutrality 2016 goal, and options for achieving this goal (i.e.biodiesel / biomass split). *ENV265 & College Master Planning Team*

6) What is the availability of a biomass fuel to displace another 1 million gallons of #6 fuel oil? In simple terms, 20,000 ton per year of 45% moisture content wood chips would displace 1 million gallons per year of #6 fuel oil. *ENV265*

7) What is the local and regional environmental impact of Middlebury College procuring an additional 20,000 tons per year of biomass fuel? *ENV265*

8) What is the local and regional economic impact of Middlebury College consuming an additional 20,000 tons per year of biomass fuel? *ENV265*

9) What technical challenges need to be addressed to receive, handle (store), consume (combust) an additional 20,000 tons per year of biomass fuel? *College Master Planning Team*

- Where would an additional biomass plant be constructed? Additional biomass construction at the current Service Building site would involve displacement of existing facilities / personnel, and construction of new facilities to address this displacement. Additional biomass construction at another site on or near campus needs to also be evaluated. The College Master Plan Team must consider these concepts relative to the Master Plan.

- How will this site impact Central Heating Plant operations?

- Existing biomass plant design includes baseline operation and steam production and a fairly constant output to meet campus steam demand. Existing biomass on site fuel supply receiving and storage design includes minimal capacity (2 days for current operating design). What size (steam generating capacity) biomass plant and fuel receiving / storage needs to be designed to reliably meet all campus steam demands (winter peak steam demand of 80,000 lbs / hr, and an acceptable capacity of onsite fuel storage)?

10) How do different consumption quantities of biodiesel and biomass impact the final design, plant operating strategy, and Carbon Neutrality Initiative 2016 Goals? *College Master Planning Team*

11) Items #1 – #10 relate to the source of renewable energy. What is the true impact of energy conservation and building energy efficiency in terms of design strategies for items #1 – #10 and as identified in the Master Plan? What is the impact of additional building as identified in the Master Plan? What is the impact air conditioning as identified in the Master Plan? *College Master Planning Team*

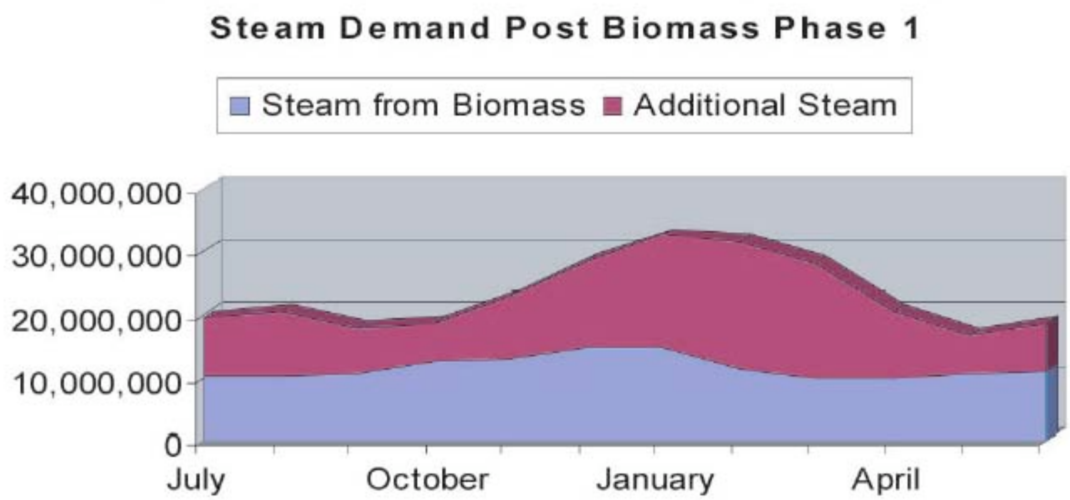
12) What other technical options exist to solve "the 1 million gallon question"? *ENV265 & College Master Planning Team*

Summary of Study and Recommendations of Environmental Economics 265 Consulting Team, May 8, 2008

After construction began on the Middlebury College biomass facility, attention immediately shifted to the next question: How can Middlebury further reduce its consumption of fuel oil to achieve its carbon neutrality goal by 2016? The burning of fuel oil contributes 89% of the college's CO2 emissions to heat and cool the campus. The new biomass facility will cut this number in half and leave one million gallons of number 6 fuel oil to displace per year. "The Million Gallon Question," as posed by Assistant Director of Facilities Mike Moser, became the focus of this study group and subsequent report.

The current viable options for Middlebury to displace these gallons include the construction of an additional biomass facility or the use of existing infrastructure to burn biodiesel. For the purposes of this report, it would be too difficult to study alternatives given this group's limited resources and time. This led to the agreement with our client to focus the report on biomass and biodiesel. Each option presents economic, environmental, and social costs for the college to delicately weigh through their decision-making process. It is the object of this report to weigh the economic costs quantitatively while providing some qualitative analysis of the environmental and social.

The Million Gallon Question has become the multimillion-dollar question, as the rising cost of fuel will make alternatives for heating and cooling more cost effective. The current system provides steam to heat and cool every building on campus with a peak demand for steam during the winter months. Given Vermont's variable climate, this demand reaches a minimum during the fall and spring. As seen in the graph below, the new biomass facility will be able to meet only a fraction of the campus demand at full capacity. Reaching the peak demand for steam requires the production of 90 MMBTUs of energy. The current biomass facility produces 30 MMBTUs meaning an additional 60 MMBTUs is required from any alternative at peak times. This implies that an additional burning with the capacity of producing 60 MMBTUs is necessary to meet the demand entirely through the use of biomass. The existing heating plant infrastructure is fully capable of producing the additional 60 MMBTUs by burning biodiesel and will provide the college a backup system in the event that the biomass facility is inoperable.



Our answer to Middlebury's Million Gallon Question:

A full switch to biomass from #6 fuel oil is the most efficient solution economically, environmentally, and socially.

<u>Financial Analysis</u>

- Three options were examined:
  1. A full switch to biomass (new 60 MMBTU Plant)
  2. A combination of biomass (new 30 MMBTU Plant) and a switch to biodiesel (using a B50 blend)
  3. A full switch to biodiesel (B50 blend)

- Economically, Option 1 is the optimal choice. Over the 25 year lifecycle, the college's investment will break even and potentially start saving money even when comparing biomass to the current #6 fuel.
- Option 2 and 3 do not make economic sense due to the extremely high cost of B100 and #2 fuel oil to make B50. Middlebury College will continue to lose money under these alternatives.
- Three interest rates were used to analyze the present day value of savings, 5%, 7%, and 9%. As a guide, Middlebury College used a 5% interest rate in their cost-benefit analysis of building the current biomass plant.
- These figures are very likely to change due to the increasing cost of fuel, however it can be said with confidence that biodiesel will never be a cost-effective fuel, and should not be considered an option in displacing one million gallons of #6 oil that is currently used to heat the campus.

PDV of Savings for a 60MMBTU Biomass Plant

Interest Rate	PDV of Savings
5%	$436,220
7%	-$3,102,304
9%	-$5,757,260

With the assumption that #6 fuel costs $2.25/gallon, wood chips cost $40/ton, and the cost of building a 60MMBTU plant is $20M.

PDV of Savings for a 30MMBTU Biomass Plant and 50% Biodiesel Substitute (B50)

Interest Rate	PDV of Savings
5%	-$15,913,741
7%	-$15,279,366
9%	-$14,803,394

With the assumption that #6 fuel costs $2.25/gallon, wood chips cost $40/ton, biodiesel costs $3.85/gallon, the cost of building a 30MMBTU plant is $12M and the cost to alter the current plant for biodiesel is $250,000.

PDV of Savings for a Full Conversion to Biodiesel (B50)

Interest Rate	PDV of Savings
5%	-$28,013,702
7%	-$23,206,427
9%	-$19,599,528

With the assumption that #6 fuel costs $2.25/gallon, biodiesel costs $3.85/gallon, and the cost to alter the current plant for biodiesel is $250,000.

PDV of Savings Comparing Full Biomass Switch to Full Biodiesel (B50) Switch

Interest Rate	PDV of Savings
5%	$25,631,897
7%	$17,730,750
9%	$11,802,519
IRR	15.77%

With the assumption that #6 fuel costs $2.25/gallon, wood chips cost $40/ton, biodiesel is $3,85/gallon, the cost of building a 60MMBTU plant is $20M and the cost to alter the current plant for biodiesel is $250,000.

<u>Costs and Benefits of Biodiesel and Biomass Options</u>

Biodiesel

Environmental and Social Benefits

The environmental and social benefits of bio-diesel are the absorption of carbon dioxide from the atmosphere during production of the fuel, the slight reduction of dependence on foreign oil, and the enhancement of agribusiness within the United States. While growing, any bio-diesel crop (such as corn) absorbs carbon dioxide from the atmosphere; this is obviously an environmental benefit as our world faces the challenge of global warming. The benefit of slightly reducing the nation of its dependence on foreign oil is tied to the fact that the United States is the world's largest energy consumer and imports approximately 65% of its oil, 32% of which is from the Persian Gulf (EIA, 2006). This foreign dependence on oil has led to conflicts and susceptibility to unpredictable change in prices. Especially in the current setting of the Iraq War and rising fuel prices, domestic alternatives to foreign oil are beneficial in their separating us from the inherent consequences of dependence. Promotion of domestic alternatives such as bio-diesel is also a benefit because it creates rural jobs by re-invigorating local agribusiness through an increased demand.

Environmental and Social Costs

The environmental and social costs of bio-diesel are the actuality of bio-diesel requiring significant amounts of fossil fuels for production, the rapid amount of deforestation and ecosystem loss occurring in response to the increased demand for bio-diesel, and the global food crisis transpiring as a result of increased prices of staple foods such as rice, corn, and wheat. Originally conceived as an important component of action to stop global warming, increased production of bio-diesel is yielding unforeseen, unfavorable consequences.

Growing crops for fuel currently involves so much fossil fuel for the production of fertilizers, irrigation, and transport that the carbon absorbed during fuel growth is now estimated to be less than carbon emissions of the all-encompassing fuel production. Carbon emissions from production of bio-diesel are not its only source of greenhouse gases; the increased demand for bio-diesel has sparked rapid deforestation of some of the world's primary carbon sinks resulting in enormous releases of carbon dioxide into the atmosphere. With global crop prices at record highs, international agriculture is expanding, especially in developing countries such as Brazil where the Amazon rainforest is quickly being plowed down to meet increased demand for soy beans. Describing the immense carbon emissions resulting from bio-fuel frenzied deforestation, a recent study by Dr. Renton Righelato of the World Land Trust, and Dominick Spracklen of the University of Leeds states that, "Between two and nine times more carbon emissions are avoided by trapping carbon in trees and forest soil than by replacing fossil fuels with biofuels." (Farrow, pg. 11). In addition to destroying essential carbon sinks, the increased deforestation due to the boosted demand for agricultural land to produce biofuels also results in such environmental and social costs as a loss of habitat, species, soil quality, water quality, livelihoods, cultures, and traditions.

An increase in the demand for bio-diesel has produced the environmental and social cost of a global food crisis. Competition between production of fuel and production of food on the world's finite areas of arable land has increased global food prices beyond the possible purchasing power of the world's poor. Food riots have broken out and the United Nations continues meetings on how to address the global food crisis. A Google News Report on April 28, 2008 estimated that the current global food crisis poses threats of malnutrition and starvation to one billion people. In addition to the increase in demand for biofuels, the growing population and the increase in the occurrences of floods and droughts are also contributing factors to the food crisis.

Many of the environmental and social costs of bio-diesel fall upon developing nations; these costs are very pertinent and should be taken into consideration even if Middlebury is getting its ethanol locally because it is still re-locating other's demands for biofuels, and re-allocating food-producing land to fuel-producing land. Describing the costs of biofuels, Mike McCarthy, a journalist for *The Independent* of London, writes, "The key point is this: a certain amount of biofuels can be produced to make a difference at the margin of CO2 emissions, without major changes in land use, but to make a real, substantive difference to emissions, vast amounts of new cropland would be necessary." This vast amount of cropland is coming at the expense of the world's great carbon sinks. The environmental and social costs of biodiesel seem to be growing daily, as many note that we may have hurried ahead with biofuels without fully understanding the implications.

Biomass

Environmental and Social Benefits

The environmental and social benefits of using biomass include a reduction in the greenhouse gas emissions of Middlebury College, a decrease in the amount of wood waste going to landfills, a large contribution to the local economy, a preservation of forests that otherwise might not have otherwise been economically feasible, and an extension of the college's providing education on and demand for sustainable forestry and action on global warming.

If the college chooses to build a second biomass plant to replace the remaining 1 million gallons of #6 fuel oil, it will reduce net carbon emissions by 50 million Ibs per year (not taking transportation and production of biomass chips into account), yielding an enormous environmental benefit. Also, by increasing the demand of the low-grade waste wood of sawmills, it would reduce the amount of waste wood in land fills, which takes up land fill space and releases methane into the atmosphere (a gas with a greenhouse effect 21 times that of carbon dioxide). Further, biomass as a source of fuel is environmentally and socially amiable because it is not subject to terrorism, pollution taxes, or international disputes.

Middlebury College's choice to build an additional biomass plant would result in the infusion of an additional $500,000 into the local economy. The biomass plant would also create more local jobs, both for the logging and the transport of the biomass. There would also be the benefits of more loggers having work, and being paid more to provide a more sustainable standard of biomass. Private landowners interested in providing low-quality wood for biomass fuel would be able to maintain and sustain their forests, which may not have otherwise been possible.

A biomass plant provides the college with the opportunity to educate local industries on sustainable forestry practices and the importance of such practices, and educate students, visitors, faculty, alumni, and staff on the issue of global warming and the implementation of actions to stabilize greenhouse gases in the atmosphere. It further provides the opportunity to set an example on local, national, and even international scales. The environmental and social benefits of setting an example and providing education on issues, practices, and standards would be further amplified by a second biomass plant, but should not be as heavily weighted as they were when considering the construction of the first biomass plant.

Environmental and Social Costs

The environmental and social costs of using biomass center on questions of sustainability and future demand. Although the biomass provider has stated that it can provide biomass fuel from more sustainable sources in the short-term, this is not guaranteed for the long-term. Also, as Middlebury College infuses its demand for biomass into the local setting, it is unpredictable whether previous buyers of the low-grade wood chips such as International Paper Company would be forced to resort to other, less sustainable sources located at greater distances. In other words, it is important to consider what potential an increased demand of biomass by the college has to fuel unsustainable forestry practices elsewhere.

Another cost to consider in terms of sustainability, is that as energy prices continue to rise, there will most likely be an increased demand for firewood to heat homes in Vermont. As a result of this increased demand, Middlebury College's demand for biomass chips could result in resorting to unsustainable supplies of biomass and a more limited option for Vermont landowners in their choice to switch to firewood. The prospect of firewood use by Vermont residents is important to consider because it gives opportunity to individuals to contribute to overall community carbon emission reductions.

The overall environmental and social costs of building an additional biomass plant are that the fuel would come from a less local woodshed, and there would be an increased susceptibility to shortages and competition, a general greater demand on forests, and a decreased potential for others in the area to burn firewood. The definition of sustainable forest practice is essential in defining the environmental cost.

Switching the remaining million gallons of fuel oil to biomass is the best approach to pursue.

Minimizing the Economic Risks and Environmental Impacts Associated with the Supply of Biomass Fuel by Developing a Local Supply of Biomass

Locating a nearby (50 mile radius), single, reliable source of 20,000 tons of sustainably produced and reasonably priced woodchips per year for the approved Biomass energy project was an important challenge leading up to the

Trustees' decision to go forward in 2007. It was also important to understand the capacity of local forests to provide this supply. The College also does not have a suitable place to stockpile woodchips, so we wanted a supplier who would deliver when the College needed chips "just in time." The biomass plant itself has a 2 to 3 day storage capacity but that is not sufficient capacity to smooth out availability shortages that could occur due to weather, etc. A team of Middlebury staff from various departments worked on the supply questions to assess the situation and to find an acceptable solution.

The College hired the Vermont Family Forests to conduct a study of the supply capacity for biomass fuel from suitable forestland in Addison and Rutland counties and a study of how much of that capacity is currently being used. The 2005 study found that there were 269,250 tons of low quality wood available per year and that they demand this wood was 109,592 tons/yr., or a net capacity of about 160,000 tons per year.

While there is a sufficient supply of wood that is best suited for use as fuel (i.e., not better suited for value added use, or that should not be harvested due to environmental or other unacceptable impacts). The choice was made to contract with a broker who will manage a supply from a number of sources within a 50 to 75 mile radius and deliver it to the College. The broker will also establish a stockpile with a 6 to 8 week supply of chips near the College. And they will select suppliers with a preference for those who practice sustainable forestry. They will also inform the College of who the suppliers are and provide access to them if the College wants to verify their practices.

While there seems to be sufficient capacity within 50 to 75 miles of the College, that capacity is likely to fluctuate. Given the appeal of using wood as a locally available fuel source and, as it seems plausible that the historically high price of oil will not be dropping back to its earlier lower price structure, the College must consider the possibility that the supply of wood in the region for fuel use may grow tighter or costlier. What might we do to assure that we can provide biomass fuel that meets our criteria?

One option that looks promising is the possibility of growing biomass on fallow farmland in Addison County. In 2006, Middlebury's Campus Sustainability Coordinator and the Director of Business Operations toured an experimental willow shrub plantation in northern New York operated by the SUNY College of Environmental Science and Forestry (SUNY ESF).

Middlebury subsequently established a joint effort with SUNY-ESF to conduct a pilot project on 10 acres of College-owned farmland to the west of the campus. In Spring 2007 we planted 30 different varieties of willow. In Spring 2008 the plantings will be cut back to the base to force the growth of more branches. They will then grow for another two years reaching 15 to 20 feet in height. In the fourth year they will be cut and chipped for use in the biomass burner. The regrowth from the willows will be harvested every three years for up to 21 years thereafter.

Harvest will be done with standard corn harvesting equipment using a modified cutting head. The results of the pilot and the lessons learned will be shared with agricultural landowners and farmers in the region so that they could eventually go into business producing willows for energy. The pilot project is also looking carefully at how to minimize or eliminate the use of fertilizers and pesticides in the cultivation of willows through different combinations of plantings of different varieties of willows.

A literature review of the environmental impacts was funded by the Environmental Council and conducted by Assistant Professor Marc Lapin and several students. Their review found that the cultivation of willows on active agricultural lands either lessens or adds no additional degrading influences on the environment. A land use change from abandoned agricultural fields or wild lands presents greater degradation than the present land use, but not as much as row-crop agriculture. (see *Environmental Impacts and Agronomic Methods of Short Rotation Willow Crop Cultivation: A Review of Literature and Web Based Literature* by Sarah Fortin, Kate Macfarlane, Marc Lapin and Matt Landis. Report available from the Middlebury College Sustainability Integration Office).

Early (therefore likely to change) estimates of the amount of acreage that would be needed to produce enough willow biomass for the Middlebury biomass project (20,000 tons) are that it would take three 800 acre plots of land for a total of 2,400 acres. Each 800 acre plot would be harvested once every three years and one plot would be harvested each year to provide that year's supply. The final results of the pilot project will be known in 2011. The yearly yields of the test plots are being collected and will provide preliminary information about the feasibility of a future supply.

We recommend that this study be given as much support as needed to be completed and that a high priority be placed on developing this, and other possible local biomass cultivation, projects. The benefits of developing an economic and environmentally sound local energy crop are very appealing not only in terms of providing a good solution to the carbon neutrality goal, but also for the potential it has for stimulating the development of a local bioenergy economy.

a. Heating and Cooling

i. The Million Gallon (or less) Question

2. Solar

a. Solar Thermal Energy

Among the most established and cost-effective of solar energy technologies are so-called solar-thermal systems, designed for heating. Solar heating systems range from simple passive building designs through flat-plate collectors to technologically advanced concentrating solar power systems. Here we emphasize solar-thermal systems that could produce hot water for domestic use and for space heating at Middlebury.

The solar resource is substantial, even in Middlebury's relatively poor climate. Direct mid-day sunlight delivers energy at the rate of about 1000 watts on every square meter of surface oriented perpendicular to the incoming light. Accounting for night and day, cloudy and clear weather, and varying Sun angles gives an average rate that is considerably lower. Still, on a surface tilted at our latitude (just about 45°, and a common roof angle) statistics for Burlington list the average available solar power at 121 W/m^2 in January, 225 W/m^2 in June, and 200 W/m^2 in September. The corresponding values for Albuquerque, NM (for surfaces tilted at the local latitude) are 221 W/m^2, 296 W/m^2, and 283 W/m^2, respectively. Our Vermont location is not ideal, but we do get about two-thirds of Albuquerque's supply of solar energy. Relatively simple systems can convert, on average, about half of the incident solar energy into useful heat.

b. Solar Water Heating

The technology for producing domestic hot water is simple: water or an antifreeze solution is pumped through pipes bonded to black metal absorber plates mounted on southward-facing structures. Glass covers minimize energy loss. Hot water is stored in an insulated tank. In the antifreeze-based systems appropriate to our cold climate, a heat exchanger in the tank transfers heat from the circulating antifreeze to the water. A more advanced collector design uses evacuated glass tubes that further reduce energy loss.

A properly sized system can supply some 90 percent or more of a typical Vermont household's domestic hot water from May through October, and can boost water temperatures enough to reduce significantly fuel or electricity usage during the remainder of the year.

An obvious application for solar domestic water heating are the outlying College houses that are not connected to the central steam system. For those that also use oil or propane heating systems to provide hot water, installation of solar hot-water systems would cut our use of these fossil fuels, and thus lower our carbon emissions. However, many houses have electric water heaters and, given Vermont's electricity mix, switching them to solar hot water would have much less effect on carbon emissions. Furthermore, the time of peak solar input is summer, when these houses may not see as much occupancy as they do during the academic year. Finally, some of the houses may be unsuited, by reason of location or architecture, to the installation of solar domestic water heating.

A more dramatic and visible solar-thermal application would be on central campus buildings that have significant hot-water usage throughout the entire year, including summer. Dormitories and athletic facilities are obvious examples. Although these buildings are on the steam system, use of solar energy would reduce their need for steam and, in turn, would reduce fuel consumption at the steam plant. However, a decision to burn only sustainable biomass in all steam-plant boilers would negate this carbon advantage and thus render solar-thermal systems inappropriate as means toward carbon neutrality. They would, however, be visible reminders of a widely available renewable energy option with less environmental impact than even the best-managed biomass operation.

Although solar-thermal systems could, in principle, operate in conjunction with or as supplements to, the central steam plant, there are significant technological issues to be explored to determine the practicability of this approach.

c. Concentrated Solar Power

Environmental Economics 265 students Benjamin Estabrook, Emily Hendrick and Hye Min Ryu conducted a preliminary assessment of the potential for a beta test site at the Bread Loaf Inn for a concentrated solar power array that would provide heated water for the Inn. Their preliminary conclusions about the feasibility of a beta test site follow the discussion below.

Background Technology

Flat-plate solar collectors like those used in domestic water systems can reach temperatures close to the boiling point of water—sufficient for domestic use but marginal for space heating or direct replacement of steam from a central heating plant.

The use of concentrating solar power systems (CSP) can overcome this limitation. These more advanced systems use mirrors to concentrate sunlight, resulting in higher temperatures. Their concentrating capabilities require movement of at least some system components so as to track the Sun. So-called single-axis systems concentrate sunlight in a line, and pivot on a single axis to follow the Sun. Two-axis systems concentrate sunlight more or less to a point, and require tracking motions in two dimensions.

Single-axis tracking concentrators have been used successfully for several decades in the California desert, producing temperatures high enough to operate turbines that drive electric generators. These systems are currently producing electrical energy at the rate of several hundred megawatts. Two-axis systems have been built in a variety of sizes, from small steerable parabolic mirrors to huge fields of individual, flat Sun-tracking mirrors called heliostats. Obviously these systems are more technologically complex than single-axis concentrators, which in turn are more complex than flat-plate collectors.

A new Vermont-based company, Solaflect Energy, claims to have developed a heliostat and central receiver CSP system whose heliostat design makes it less expensive than traditional systems of this sort. Solaflect hopes their system will become a serious alternative technology to fossil fuels.

Concentrated solar energy has a number of advantages over traditional energy systems and even over other solar technologies. In terms of environmental impacts, CSP's main requirement is land. Although a site will typically need more land than a comparable fossil fuel facility, it does not require extensive road access or mining operations, and it does not produce greenhouse gases. In comparison to other power technologies, CSP closely resembles the nation's current electric power and thermal energy plants in several significant ways. For example, CSP fpr electricity production can use much of the equipment in place at conventional fossil fueled plants, and can be integrated into existing electrical grids. CSP for electricity generation is particularly valuable in "sunshine" states like California.

Like other heliostat and central receiver systems, Solaflect's steerable heliostat mirrors automatically follow the Sun in order to continue reflecting light onto a fixed spot. The resulting temperatures can exceed 600º F. This is sufficient to generate electricity, and at a cost less than that of photovoltaic panels, although in Middlebury's case we would use the hot water to replace centrally-generated steam.

Solaflect Energy's patent-pending technology consists of new heliostat called SunTrakker™, which boasts half the cost and weight of its closest competitor. It uses tension-compression technology to ensure durability, lightweight, modularity, ease of transport, quick assembly, and low cost. Solaflect Energy was founded in Norwich, VT by William Bender, a summa graduate of Dartmouth and a Rhodes Scholar Ph. D., who spent many years as an international consultant. He founded ODC and was a senior executive at DataSage before devoting his time to solar energy. Solaflect has a team of technical professionals, as well as a senior advisory board with experts in law, finance, sales, marketing, regulatory environments, manufacturing, and engineering. The company, to date, is completely internally funded. Solaflect is one of the twenty semi-finalists in MIT's Clean Energy Entrepreneurship Prize (CEEP).

Bread Loaf Beta Site Proposal

Solaflect is now hoping to begin beta-testing their technology. They are looking for three beta-test sites, two in the Southwest (their principal market) and one in the Northeast. Solaflect has approached Middlebury College about using us as their Northeast test site. The company is particularly interested in studying the ability of their system to withstand our climate's ice and wind. As a beta technology the conditions of this project are rather unique. Solaflect would fund the construction, operation, and permitting of the site. In return Middlebury would provide the land and enter a three-year agreement to purchase the output of the site at the cost per BTU equivalent to that of heat produced with #2 fuel oil. (We use #2 oil in our outlying buildings, but much cheaper #6 oil in our central steam plant.) Solaflect would also be guaranteed the right to say they have a beta site with the college and will enter a two-way sharing of academic information from research performed at the site.

Solaflect technology, if successful, could help Middlebury meet our goal of carbon neutrality. This technology is especially relevant in light of the inclusion in the Trustees' resolution citing "technology innovations" as one of the building principles for achieving carbon neutrality. Demonstration and then widespread use of a technology that has heretofore been limited largely to sunny, desert regions would certainly put Middlebury on the map as a major innovator in energy technology.

We propose that the College agree to be a Solaflect beta test site, and that we consider having their CSP system installed at the Bread Loaf campus. At Bread Loaf, each building relies on its own boiler, burning #2 fuel oil, for its hot water and heat. In order to attain carbon neutrality on the campus, each individual boiler must be modified to burn a sustainable fuel, or the current system must be replaced with a centralized system based on non-carbon energy sources.

In 2007 the Bread Loaf Campus used 19,089 gallons of #2 fuel oil, resulting in a carbon footprint of 195 MTCDE (metric tons carbon dioxide equivalent). The Bread Loaf Campus is responsible for only 0.76% of the college's total heating and cooling footprint (25,507 MTCDE), because of its limited use during the winter months. Only the Rikert Ski Touring Center is utilized year round. The Bread Loaf Inn is generally open only between April and November. The campus's most intensive usage is due to the Bread Loaf Writers Conference and the Bread Loaf School of English which take place in June, July and August. We propose that the Solaflect installation be used to provide heat for the Bread Loaf Inn, which In 2007 used 8,180 gallons of #2 fuel oil, resulting in a carbon footprint of 83 metric tons or 43% of the Bread Loaf Campus's total carbon emissions from heating.

Land Requirements for Large-scale Solar Energy Systems

At the beginning of this section we gave figures comparing solar energy input at Middlebury with that of Albuquerque, NM. Using that paragraph's September value 200 W/m2 as a rough average gives an average available power of about 750 kW per acre. Assuming that only 50% of the area is covered with solar collectors (to allow room to move around among them), that the collectors are oriented at 45°, and that the collectors are about 50% efficient, this gives an actual average energy yield rate of somewhat over 200 kW per acre. By comparison, the Middlebury steam plant currently produces thermal energy at the rate of 10 MW. Therefore a 50-acre solar installation could replace the steam plant. Note that this is considerably less than the 2400 acres required to fuel the biomass steam plant that will come online in early 2009 with photosynthetically produced solar energy from willow shrubs (according to the estimates above in the biomass fuel supply section). Middlebury clearly has the land resources for large-scale solar energy production.

This does not mean that Solaflect or any other solar-thermal technology will prove both technologically and economically feasible. But it does show that the energy resource is more than adequate. Use of solar-thermal technology at any scale—the larger the better—would make Middlebury College a true innovator in carbon-neutral energy.

Preliminary Summary of Study and Findings from Environmental Economics 265 students Benjamin Estabrook '09, Emily Hendrick '08 and Hye Min Ryu '08

Economic Analysis & Viability

At this point, we recognize that there are two distinct possibilities for the project. Here we outline how we created each model based on different scenarios and explain the methodology behind our models.

Scenario 1: the Beta Site performs as expected and Middlebury College decides to purchase the equipment from Solaflect Energy

There are six components in this model:

• First, there are the initial upfront costs of the three year agreement. Middlebury College must cover the upfront cost of the pipeline connection between the solar thermal installation and the boiler in the Bread Loaf inn. These costs include the cost of the piping, road crossing, building penetrations, utility relocation, internal piping and contingency and soft costs.
• Second, after the three-year contract period, Middlebury College has to provide the additional investment cost of the purchase price of the equipment from Solaflect. This cost will be determined through negotiations with the company, but was estimated based on the price of $200 per heliostat.
• Third, we also considered the potential benefits the College might gain from offsetting carbon emissions. We converted energy generated through solar power and calculated avoided carbon emissions. Then multiplying the avoided carbon offsets with the ongoing price of carbon traded through Chicago Climate Exchange (CCX), we calculated the sale price. However, there is one potential problem. Since carbon is traded on CCX in tons, the college may not be able to enter the CCX as an active participant and the income from selling carbon credits may be insignificant. Nonetheless, we examined whether the monetary revenues from selling carbon credits adds to the viability of the project.
• Fourth, the principle benefit of the installation is the reduction of fuel costs. After the third year the College will received the energy produced at no marginal cost. The number of heliostats installed is highly dependent on the desired energy output. In this analysis we chose sixty heliostats in an attempt to minimize the payback time.
• Fifth, we combined the initial costs, additional investment costs, and revenues from selling carbon credits to calculate the total revenues of the project.
• Sixth, with the discount rate of 2%, we calculated the Net Present Value of the project. This is the ultimate test of the project's economic viability. We then

calculated the payback time, with a thirty-year time period as our time frame to test whether the project is economically viable.

Scenario 2: the Beta Site does not perform as expectedly and the project halts.

This may be of more importance as we think about risks involved with pursuing the project. Solaflect will cover the costs of removing the equipment and restoring the area to its original state. However, Middlebury will still be responsible for the upfront costs. As pipeline installation and storage unit may prove to be costly, it is important to make sure that even when the College decides not to pursue solar energy on Bread Loaf after the initial three-year period, the losses are minimal. Components of this model do not differ significantly except for four elements. One is that our discount rate must be higher than the first model, for we only examined the short term cost and benefit (three-year period) rather than the next thirty-year period. Second, along the line of discount rate, the pipeline and storage unit are depreciated at a much higher rate, as they will be obsolete when the project halts. Third, there are no additional investments cost as the project would not proceed after the initial three-year period. Fourth, the revenues from carbon credits may play a more significant role in determining the short-term economic viability of the project.

Conclusion

In our economic analysis we found that the payback time will be an estimated nineteen years, which is much longer than we expected. This is due to the high upfront costs of pipe installation. If the technology does not perform as expected, this poses a major issue for the College because it will be left with high sunk costs with no reduction in carbon emissions. In order to ensure that this does not happen, further guarantees or investigation of the company may be needed before we decide to proceed with this project. Additionally, we may face opposition from the Bread Loaf School of English and Writer's Conference given the aesthetic impacts that the installation will have. However, Bread Loaf does have significant possibilities in respect to achieving the College's carbon neutrality goals due to its decentralized heating system and dated infrastructure, and there is something unique about fueling a historic inn with new clean technology. Given the College's carbon initiative goals to be carbon-neutral by 2016, this technology may still be worth pursuing.

Editor's note: A new site on the main campus close to a steam line has been identified to the east of the junction of Bicentennial Way and Rt. 125 and the College is working with Solaflect to develop a plan for an installation at this site.

d. Solar Absorption Chillers

Absorption chillers are refrigerators or air conditioners that use heat energy rather than an electrically-driven compressor to operate the refrigeration cycle that transfers energy from cooler to hotter—against the direction it "naturally" wants to go. The propane-powered refrigerators in recreational vehicles provide one example. At larger scales, absorption chillers operating off waste heat from electricity generation provide air conditioning in some industrial buildings. And several Middlebury buildings—including Bicentennial Hall and the Center for the Arts—use absorption chillers powered by steam from our central steam plant. The heat source for absorption chilling can be anything capable of temperatures on the order of 190˚F—a range that includes efficient solar-thermal collectors, especially concentrators such as the Solaflect technology. Although solar cooling technology is still evolving, there are a number of examples of commercial-scale buildings that are cooled by this method. The new Los Angeles Audubon Center—the first building to receive the platinum designation under the latest LEED standards—features a solar absorption chiller for all its air conditioning.

Since Middlebury's cooling needs occur in the months of maximum solar energy input, it would be worth investigating the use of solar absorption chillers for space cooling. Absorption chillers might be able to work alongside the steam-powered chillers now in use in individual buildings, thus reducing fuel consumption at the steam plant. Even if it proved technologically or economically unfeasible to add solar chilling to existing buildings, it is worth considering this technology for new buildings or when retrofitting existing buildings with air-conditioning systems.

a. Heating and Cooling

i. The Million Gallon (or less) Question

3. Geothermal

Several meters down, the temperature of the ground remains constant at the year-round average temperature for a region (about 45˚F for Middlebury). It's possible to circulate water through buried pipes and use this low-temperature resource directly for cooling. Alternately, low-temperature water can be pumped from wells and through buildings for cooling, as is done in the Franklin Environmental Center at Hillcrest.

The geothermal resource can also provide heating. Although 45˚F is too cool for building interiors, it is possible to "pump" energy from the low-temperature ground to the higher temperatures needed for building heating. So-called heat pumps are systems designed to do just this. Conceptually, a heat pump is just a refrigerator run in reverse. A household refrigerator removes energy from its contents and dumps it to the surrounding kitchen; that's why it's warm around the back or bottom of the refrigerator. A heat pump removes energy from the ground and dumps it into the house at a higher temperature. Since heat doesn't naturally flow from cooler to hotter, it's necessary to provide extra energy to pump the heat. Normally that's in the form of electricity (an exception is the absorption chiller discussed above under solar thermal energy).

During the summer, it is possible to reverse a heat pump so it provides air conditioning. In fact, the original heating systems in Kirk Alumni Center and the now-demolished Meredith Wing of Starr Library were reversible heat pumps that stored energy pumped out of the building in the summer in a water-saturated region below the building. Some of this energy was recycled by being pumped back in during the heating season.

The efficiency of a geothermal heat pump—called the coefficient of performance (COP)— depends on the temperature difference between the ground and the highest temperature the pump produces. In Vermont's climate, a typical heat pump might have a COP of 3 to 4. This means that for every unit of electrical energy the pump uses, it supplies the building with 3 or 4 units of heat energy. One of those units came from the electricity, but the rest were "free," pumped out of the ground. Thus a heat pump can multiply the effectiveness of each unit of electrical energy in providing heat.

Heat pumps could help Middlebury achieve carbon neutrality in two ways. First, since they're electrically powered, they reduce carbon emissions over fossil-fuel combustion because Vermont's electricity mix is largely carbon-free. Furthermore, they're much more efficient than direct use of electricity for heating, because they supply several units of heat energy for each unit of electricity used.

Energetically a heat pump with a COP of 3 is no more efficient overall than the direct combustion of a fuel for heating, when the inefficiency of a typical thermal (fossil or nuclear) power plant is accounted for. In Vermont that's less of an issue because our hydroelectricity has no thermal inefficiencies and our nuclear electricity is carbon-free even though the power plant has only about 33-percent efficiency.

Geothermal technology is mature and available, although it's expensive compared with many other options. If geothermal heat pumps could be used in conjunction with our steam system to provide building heat, then it could make sense to retrofit existing buildings with geothermal heating, if only to reduce but not eliminate fuel use at the heating plant. But again, this would impact our carbon emissions only if we were still burning some fossil fuels in the central steam plant. Given costs and technological compatibility issues, geothermal heating and/or cooling might make more sense for new buildings that are off the steam system.

Finally, we note that the term "geothermal" is a bit of a misnomer here. True geothermal energy systems—like the Geysers power plants in California, or the systems that provide much of Iceland's energy—exploit Earth's interior heat. But the energy stored in the upper layers of the ground is largely stored solar energy that flows into the ground in the summer and out in winter. So any geothermal energy we use at Middlebury would be yet another application of the plentiful solar energy resource.

Recommendations: The Million Gallon (or less) Question

1. Using the analysis completed by the ENV265 students and working with the College's Master Planning team, develop a decision-support model to determine how to displace the remaining million gallons of fuel oil using biofuels and/or other renewable options. The model should reflect the criteria outlined in section I.c.: CO2 reduction, social and ecological benefits and costs, economic benefits and costs, and educational value and visibility.
2. Implement alternative strategies to minimize the energy consumption of new buildings. These strategies should address building design and siting, landscape design, and building systems.
3. Conduct assessment of renewable energy opportunities available on the main Bread Loaf campuses. Investigate economic and technological feasibility of solar thermal and geothermal applications and their educational potential.
4. Identify both small and large scale demonstration projects:
    - Example of small demonstration project: among buildings not served by the central heating system, identify candidates for solar water heating.
    - Example of large scale demonstration project: at the athletics complex, reduce reliance on central heating system through solar thermal or geothermal technologies
5. Provide any support needed to complete the willow shrub cultivation pilot project and make it a high priority to develop this into an alternative fuel source, and other possible local biomass cultivation projects.
6. Develop recommendations to be presented to Trustees at October 2008 Board meeting.
7. Begin project implementation/capital planning process.

a. Heating and Cooling

ii. Building efficiency upgrades

As part of the master planning process, the exterior envelopes and energy systems of thirty-eight campus buildings were analyzed for their energy performance, and rated from good to poor based on building energy code standards. These thirty-eight buildings represent nearly 80% of the approximately 2.2 million square feet on campus. **Of the buildings studied, 37% of the total square footage performs below 50% of the current building energy code standards, and 16% performs at 25%-50% below the energy code.** As the Master Plan notes, it is not surprising that most of the older campus buildings fall into this category with leaky, poorly insulated exterior walls and antiquated mechanical and electrical systems. In addition, the fact that the campus consists of mostly small, widely spaced buildings distributed over a large geographic area contributes to energy efficiency.

There are many buildings that would benefit from non-invasive upgrades such as continuing to add weatherstripping to doors, replacing single glazing, and adding loading dock air control, and **we recommend that these upgrades be made as soon and as completely as possible.** These kinds of improvements will have a short payback period and are the 'low hanging fruit' to address building efficiency. The results and recommendations of the audit are available in PDF format (see Resources Appendix).

We also recommend that the more comprehensive building efficiency upgrades be incorporated in the renovation plans for the older buildings. Although the payback period for making capital improvements such as increasing the amount of wall insulation is fairly long, given the many decades that these buildings will be in use, this is an obvious and prudent course of strategic course of action. The possibility of escalating increases in the cost of oil may very well make the return on efficiency upgrades much more compelling as well.

Recommendations: Building Efficiency Upgrades

1. Adopt the LEED MC-Plus guidelines system for all renovation projects
2. Improve the energy performance of existing campus buildings through improvements to their envelopes and building systems; assign priorities for improvements based on the energy audit of buildings on campus and on academic program and availability
3. Encourage behavioral changes for students, faculty, and staff, including adjustments to indoor temperatures and use of air-conditioning
4. Meter all buildings for water, power, and steam; install "Building Dashboards" and "Campus Dashboards": displays that show building and campus energy use and production in real time, and the corresponding

greenhouse gas emissions, along with water use, comparative historical data, environmental conditions, etc.

5. Minimize the use of air-conditioning in campus buildings by evaluating the air-conditioning set-point, minimizing the need for air-conditioning by using shading, natural ventilation, and mechanically-assisted ventilation, and strategically planting deciduous shade trees on south side of buildings to help reduce daytime solar heat gain during the summer months
6. Where appropriate, utilize energy efficient means of cooling, such as geothermal, shading, natural, and mechanical ventilation, etc.
7. Based on the assessment described in section II.a.i., apply energy efficient alternative systems for specialized functions in individual buildings such as a purified water system for Kenyon Arena's ice sheet, which will reduce the energy required to create and keep the ice, a solar hot water heating system for the Natatorium, heat exchangers to recapture waste heat, for example at the campus data center and if possible in food service areas. Investigate the feasibility of solar heating for domestic hot water
8. Consider adaptive reuse of buildings before removal. When building removal is required, employ deconstruction methodologies in order to minimize the quantity of materials entering the waste stream and using salvaged materials for future building projects
9. Continue collaborating with Efficiency Vermont to obtain greatest efficiency for both new and renovated buildings.
10. Monitor, measure, and verify that reduction in energy consumption and carbon reduction targets were achieved.

a. Heating and Cooling

iii. New Construction – LEED

The Master Plan suggests that approximately 135,000 square feet of new construction could be completed by 2016. An estimated 700 MTCDEs will be added to the College's footprint as a result of this new construction (after the new biomass system is running).

We support the recommendation that LEED MC-Plus guidelines system be adopted for all new construction projects. Approximately 80,000 of the new square footage is anticipated to be dorm space. Given that thermal comfort is an important consideration in living spaces, we recommend that all alternatives to air conditioning be first employed, such as using shading, natural ventilation, and mechanically-assisted ventilation, and strategically planting deciduous shade trees on south side of buildings to help reduce daytime solar heat gain during the summer months.

Fig. 5: Middlebury College Estimated MTCDE per Building Square Feet

	Pre-Biomass	Post-Biomass
Fiscal Year 2005/2006		
Total Existing Square Feet:	2,200,000	2,200,000
Exist MTCDE associated with Building		
#6 Oil	23,351	8,351
#2 Diesel	1,607	1,607
Propane	548	548
Electricity	1,032	1,032
	26,538	11,538
MTCDE Per 1 sf of Building	0.012063	0.005245
MTCDE Per 1000 sf of Building	12.06	5.24
Potential New Building by 2016		
60 Bed Dormitory	30,000	30,000
100 Bed Dormitory	50,000	50,000
Academic Building	25,000	25,000
	105,000	105,000
Field House/Fitness Ctr/Squash Ct.	30,000	30,000
Total New Building	135,000	135,000
MTCDE Associated with New Building	1,628	708

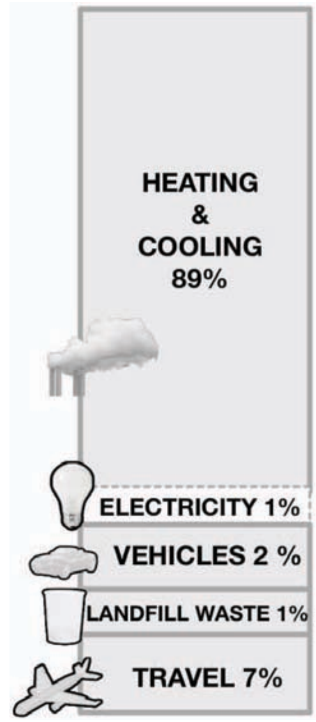
Source: Michael Dennis Associates

Recommendations: New Construction – LEED

1. Adopt the LEED MC-Plus guidelines system for all new construction projects
2. Design new buildings to be carbon neutral
3. Encourage behavioral changes for students, faculty, and staff, including adjustments to indoor temperatures and use of air-conditioning

4. Equip all new buildings with metering for water, power, and steam; install in all new buildings "Building Dashboards" and "Campus Dashboards": displays that show building and campus energy use and production in real time, and the corresponding greenhouse gas emissions, along with water use, comparative historical data, environmental conditions, etc.
5. Minimize the use of air-conditioning in new buildings by evaluating the air-conditioning set-point, minimizing the need for air-conditioning by using shading, natural ventilation, and mechanically-assisted ventilation, and strategically planting deciduous shade trees on south side of buildings to help reduce daytime solar heat gain during the summer months
6. Where appropriate, when siting and designing new buildings, utilize energy efficient means of cooling, such as geothermal, shading, natural, and mechanical ventilation, etc.
7. Utilize materials salvaged from deconstructed buildings in new construction projects.
8. Continue collaborating with Efficiency Vermont to obtain greatest efficiency for new and building construction.

b. Electricity



Potential Carbon Reduction: *1%*

Financing Options:
Payback, Fund-Raising, Partnerships,
Pilot Projects, Expense Reduction/Reallocation

Middlebury College purchases about 80% of its electricity from Central Vermont Public Service Corporation, which is currently around 20,500,000 kilowatt hours per year). The other 20% is co-generated at the College's central heating facility on campus (currently about 5,000,000 kilowatt hours per year). The purchased electricity currently has a comparatively small carbon footprint because about 80% of the electricity provided to its customers comes from two sources that emit very little greenhouse gas in the generation of electricity: the Vermont Yankee/Entergy nuclear power plant in Vernon HydroQuebec which provides electricity from massive hydroelectric projects in northern Quebec. The remaining sources of the electricity Middlebury uses comes from the combustion of fuel oil, coal, biomass, and natural gas.

The greenhouse gas emissions associated with Middlebury College's purchase of electricity constitutes 2 to 3% of the College's overall footprint of about 30,000 metric tonnes of carbon dioxide equivalents (MTCDE's) per year. This is considerably small compared to the impact of electricity in many other states whose generation comes more heavily from high carbon sources like coal.

An important variable in the percentage of carbon-free electricity generation available to the College is the overall demand for power at any given time. If the demand exceeds the supply coming from relatively carbon free sources additional power is purchased by CVPS from regional and national sources which tend to be dominated by coal and other carbon intensive sources of generation. This becomes critical in the summer when demand for air conditioning rises and the distribution system is pushed to its limits and raising the risk of a disruption in power supply as occurred in the 2006 summer blackouts in the eastern US. This puts the College at greater risk of electricity use becoming both more costly and increasing the share of its overall carbon footprint due to purchased electricity. As the need to provide thermal comfort for its summer language school students grows it is important that Middlebury adopt solutions that are both effective and that minimize or avoid the consumption of greater quantities of electricity.

The College will need to pay close attention to the situation regarding Vermont Yankee and HydroQuebec in the coming years. Vermont Yankee was built in 1972 with a 40 year life-span and its contract with the state terminates in 2012. Its owner, Louisiana based Entergy Corporation, is seeking a 25 year extension of its operating license following a successful effort to increase the operating output of the facility at 120% of its designed capacity in 2005. There is some opposition to such an extension and the facility has had some visible problems, such as the recent collapse of a portion of a cooling tower. Entergy is also proposing to sell the facility to a subsidiary and there is concern about the prospective owner's ability, as well as the ability of the current owner, to cover its required contributions to a decommissioning fund to cover the cost of dismantling and securing the site when its time comes.

The State's long-term contracts with HydroQuebec for what is comparatively low-cost electricity begin to expire in 2012 running to 2016. It is quite possible that the cost of electricity under any new contracts will be significantly higher than current pricing and this will be passed through to CVPS customers like the College. According to the CVPS 2006 annual report:

"There is a risk that future sources available to replace these contracts may not be as reliable and the price of such replacement power could be significantly higher than what we have in place today. Planning for future power supplies with other Vermont utilities and our regulators is a key initiative for us."[1]

Given these uncertainties regarding electricity sources and the College's carbon neutrality goals it would be prudent to begin taking steps to find alternative sources of electric power generated from renewable sources and to reduce consumption of electricity through efficiency efforts and conservation measures. A number of options should be investigated, assessed and implemented in a timely manner:

<u>i. Conservation and Efficiency First</u>

As has been often said, but perhaps not often enough: the cheapest energy is the energy you do not use. Conservation and efficiency measures are addressed in the heating and cooling section of this report. Using the information from the recent energy audit of the campus, which is quite comprehensive and detailed, the implementation team recommended in the Implementation section that the College should focus on working with Efficiency Vermont and develop a priority list and a schedule for completing those efficiency measures that affect electricity consumption (sec. 5.2). The implementation team should also develop a brief information and training session that is provided to key occupants of the

[1] CVPS Annual Report, 2006

buildings where these measures are installed so that they understand how things work and their role in properly operating them where user control is required.

ii. Local hydroelectric partnership with Middlebury Electric

Dr. Anders Holm is proposing a 1 megawatt run-of-river hydroelectric generating station on the western side of Otter Creek Falls in Middlebury. The project would make use of an existing diversion structure that leads from the base of the bridge (on the western side of the falls) and which was used to generate electricity from the 1890's until 1966 when it was dismantled by CVPS due to low power prices from other sources. A very good analysis of the potential of this site and various options for how the College might partner with Anders Holm was done by students in Jon Isham's Economics 265 class in 2007.

The College currently purchase somewhere in the range of 20,500,000 kilowatt hours of electricity each year for the main campus. The potential power that could be generated from this site is probably on the order of 3,000,000 kWh per year (Scott Kessler '08 Thesis). See Graphs from Kessler below. Note: power charts are based on an assumed efficiency of 0.81. Actual values could range from 0.5 to 1.0.

Fig. 6: Average Monthly Power Production (S. Kessler '08, Senior Thesis)

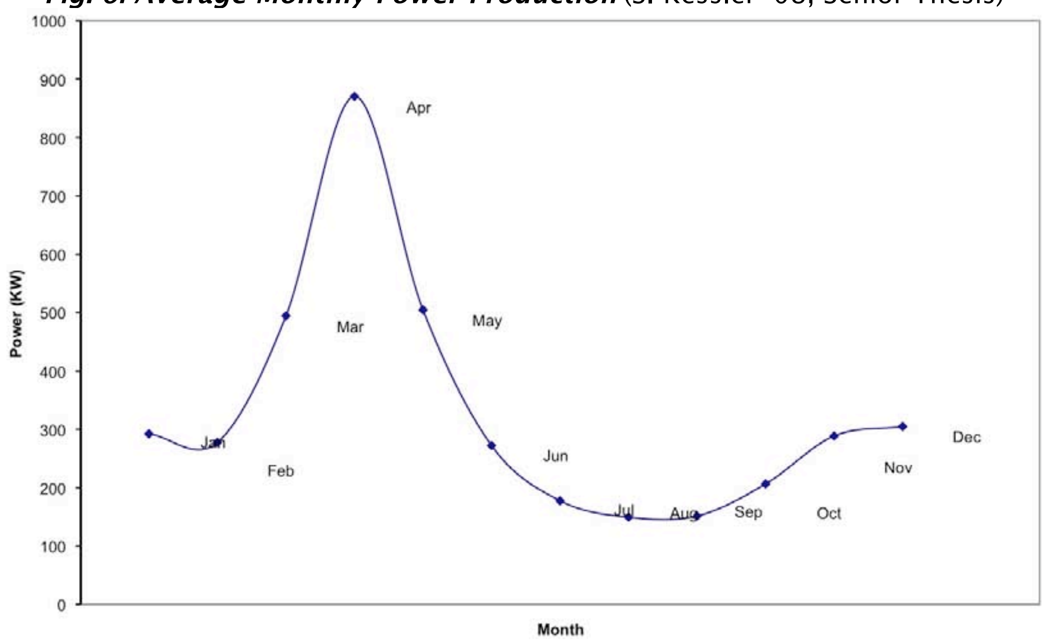
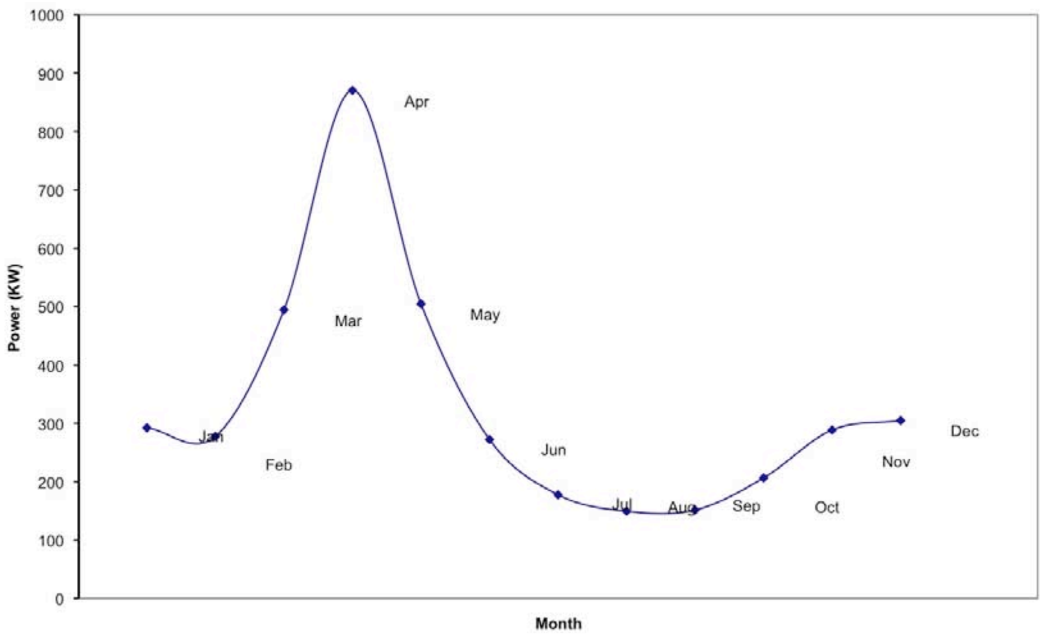
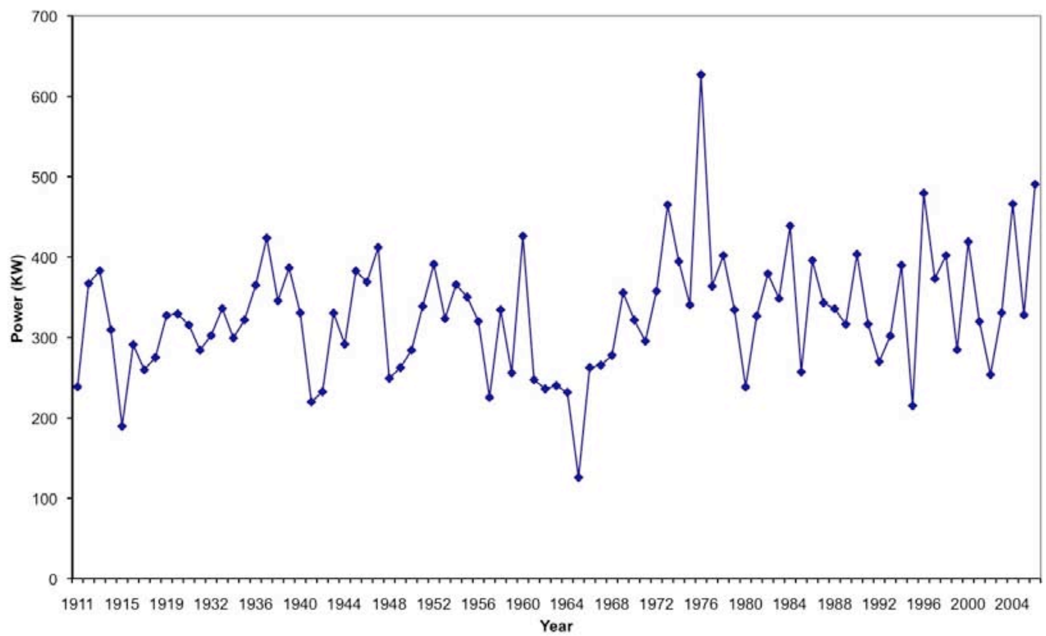


Fig. 7: Average Power Production from Yearly Average
(S. Kessler '08, Senior Thesis)





As can be seen from these graphs the quantity of electricity that would be available at any given time of the year will vary with the flow of the Otter Creek. The College pays varying rates for the power it uses depending on the time of day and time of year. It is conceivable that electricity from this proposed site could displace the need for base rate power as well as higher priced power. Some analysis of historical patterns of flow and theoretical generation against Middlebury's historical use and cost for power would provide a better picture of the cost-benefits of acquiring this electricity.

The Town of Middlebury should also be consulted and included in discussions about the possibilities for a partnership with Anders Holm and how a joint project could be developed in a way to maximize the benefits to the Town, the College and the owner of the hydroelectric project if it were to be permitted and built.

iii. Wind Power at Worth Mountain/Snow Bowl

The College has long considered the possibility of a wind turbine at Worth Mountain and installed meteorological equipment and anemometers at elevations of 10, 20, and 30 m. in 2003. Lauren Throop '04's thesis entitled "A Multi-dimensional analysis of wind energy potential at Middlebury College's Worth Mountain." Among her findings are:

> *"Approximately 6.5 months of wind speed data were analyzed, 88.48% of which remained after obvious icing data had been filtered out. Two NorthWind 100KW turbines, the 19 and 20 m blade varieties, were used in this analysis. Two significant caveats for the findings were outlined: that extrapolating 6.5 months of winter wind speed data to the entire year would be an overestimate of the wind resource, and that using winter data from unheated anemometers—even with obvious icing events filtered out—would significantly undervalue the wind resource. These two factors may counter each other to some degree."*

Based on her analysis of the data obtained and filtered she calculated an average wind speed of 6.39 m/s over the 6.5 month period measured. On its face, this approaches the requirements for industrial scale wind. The potential power generation she calculated from such a turbine was in the range of 200 to 224 megawatts per year which represents somewhere in the range of 50% of the electricity used at the Snow Bowl when it is open.

Throop qualified her findings with the following:

> *"Because the data I analyzed spans only 6.5 months and may contain inaccuracies due to icing events and/or extrapolation of data, and because a cost-benefit analysis has not been performed, I am stopping short of fully recommending this option to the college. However, my data indicate that the site at Worth Mountain is a significant wind resource with few associated wildlife and visual impacts. It is my hope that this thesis serves as a preliminary tool for students, staff, and faculty at Middlebury College as they continue to assess the issues at hand, ultimately concluding that the associated economic, environmental, and educational benefits make a clear case for wind energy development at Worth Mountain."*

Throop's thesis covers many other aspects of siting a wind tower at Worth Mountain including impacts on aesthetics, wildlife and the larger context of wind as a resource in a global and local economy. It provides an excellent source of information for a feasibility study to help the College decide whether to go forward with this project.

We recommend that the implementation team quickly complete a feasibility assessment with NRG Systems of Hinesburg, VT who have indicated an interest in a cooperative project, and move forward accordingly.

iv. Biomass Cogeneration

As mentioned above, the College currently co-generates about 20% of the power it consumes annually at the central heating plant on the main campus (about 3,000,000 kilowatt hours). The turbine that generates this electricity has a capacity of about 1500 kilowatts. If it ran at capacity all year it would generate 13,140,000 kilowatt hours which is about a four-fold increase compared to the actual generation per year. This is because the turbine is powered in response to the demand for steam for heating an cooling and as such, the electricity is a by-product of the steam generated for other needs.

At present, it does not make sense to increase the quantity of co-generated electricity because the power the College purchases from CVPS is very low in its carbon content compared to burning more #6 fuel oil to increase generation at the College plant. It would also likely cost more to increase electricity generation by burning more fuel oil compared to the cost of purchasing it from CVPS.

When the biomass project currently under construction comes online in late 2008, the cogeneration of electricity at the plant will be powered in part by a carbon neutral source of fuel (wood). The College will displace the consumption of around 1,000,000 gallons of # 6 fuel oil with around 20,000 tons of wood chips. That will also make the electricity co-generated at the plant "green" power. It won't reduce our carbon footprint any further, however, since the reduction in carbon emissions from wood is based on the displacement of the fuel oil which already accounts for fuel used for co-generation of electricity.

As the price of fuel oil increases, and perhaps the price of the electricity we buy, and if our purchased electricity becomes more carbon intensive, there may be scenarios where it would make sense to burn more wood to generate more electricity on campus independent of the demand for heating and cooling. The possible sourcing of hydroelectric power from the Otter Creek site discussed above would also have a bearing on these scenarios. So will the outcome of the pilot project currently underway to assess the feasibility of growing willow shrubs as a local source of fuel for the biomass system.

We recommend that the implementation team conduct an analysis of the current situation with regard to cogeneration of electricity at the central system and possible scenarios that involve various mixes of electricity from CVPS, local hydroelectric, and increased generation by the biomass plant. The purpose of this analysis would be to identify options that would make the most sense from a carbon emissions and cost perspective for various future scenarios that could plausibly occur.

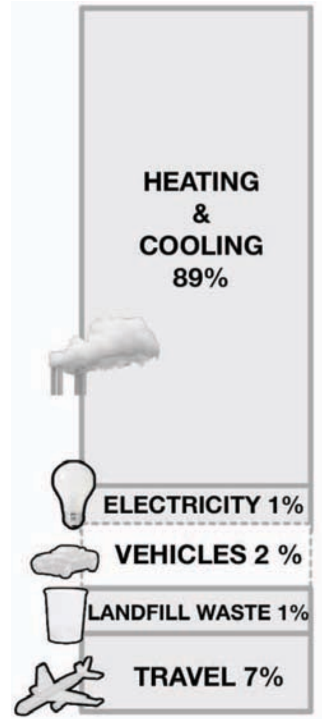
Recommendations: Electricity

1. Closely monitor the relicensing request by Vermont Yankee and the contract renewal process with HydroQuebec and possible impacts on the College's cost and carbon emissions of its electricity.
2. Implement the electricity conservation and efficiency recommendations provided in section 5.2 of the "Middlebury College Campus Energy Efficiency Evaluation," November 5, 2007.
3. Develop information resources for building occupants that will equip them with a working knowledge of the energy efficiency devices and controls to assure proper operation and optimal performance.
4. Continue working to establish a partnership with the Middlebury Electric Company and the Town of Middlebury to reestablish the hydroelectric station on the Otter Creek in Middlebury and purchase electricity from this source.
5. Conduct a feasibility assessment wind power at the Worth Mountain site and develop recommendations for establishing a wind turbine there.
6. Conduct an analysis and identify options that would make the most sense from a carbon emissions and cost perspective for various future scenarios that could plausibly occur with regard to different mixes and costs of electricity from CVPS, local hydroelectric, wind, and increased generation of electricity by the biomass plant.

c. Vehicles

Potential Carbon Reduction: *2%*

Financing Options:
Capital Equipment Budget,
Pilot Projects, Fund-Raising



Middlebury College owns and operates a large number of vehicles that contribute to our carbon emission profile by burning various forms of liquid fossil fuels. Vehicles which burn gasoline and diesel account for about 280 and 120 MTCDEs per annum, respectively. Carbon emissions from mobile sources are a small portion of our total carbon footprint, but they represent emissions that can be substantially reduced if we adopt a sound vehicle replacement policy which emphasizes vehicles with higher fuel efficiencies and fuel use standards that require higher fractions of renewable fuels like biodiesel.

The College currently owns and operates about 48 gasoline powered vehicles in a variety of on-campus and off-campus applications. Rental vehicles comprise roughly one-third of gasoline powered vehicles, and efforts aimed at reducing carbon emissions for these mobile sources should target those vehicles most frequently used. In all applications where fossil fuels are being burned for transportation, we recommend the incremental replacement of gasoline powered vehicles with those capable of burning renewable fuels, such as biodiesel from waste vegetable oil, or those with reduced fuel consumption demands, such as hybrids and electric cars. The College should strive to adopt a purchasing policy that replaces the current rental fleet with new vehicles that will help reduce carbon emissions from these mobile sources.

For diesel powered vehicles, biodiesel use should be increased to the highest level possible. Currently, the College buys B20 from a producer that uses waste vegetable oil to make biodiesel. This represents one of the best fuel sources for carbon neutral transportation, and the College should continue to source and use biodiesel that derives from waste oil sources. B20 can be used in any modern diesel engine without prior modification, and the College should adopt a policy of using B20 as a minimum level of biodiesel to replace current diesel use. In the future, higher blends of biodiesel (B40 or B80) should be tested in our diesel vehicles and adopted once deemed suitable. There is little to no reason to assume our diesel fleet will have trouble operating at higher biodiesel blends, except during the coldest months of the year.

While the college maintains an accurate list of vehicles that it owns and operates, it would be helpful to classify these vehicles based on fuel use and mileage used each year. This database would help direct future purchasing decisions and target the most used vehicles for replacement.

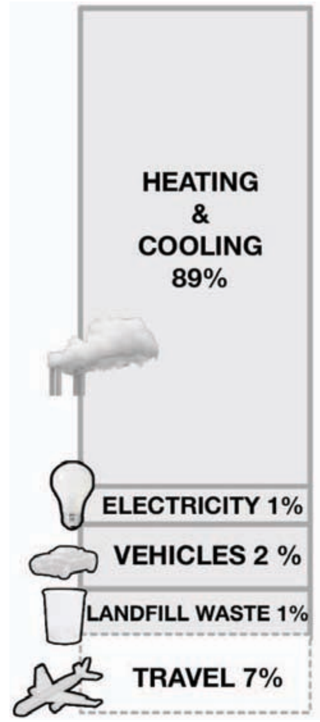
Recommendations: Vehicles

1. Set targets to reduce per vehicle fuel consumption and increase efficiency of College owned and operated vehicles
2. Adopt a purchasing policy that replaces the current rental fleet with new vehicles with reduced carbon emissions.
3. Adopt policy of using B20 as a minimum level of biodiesel to replace current diesel use.
4. Test higher blends of biodiesel (B40 or B80) for suitability in vehicles. Once determined, adopt the higher level blends as policy.
5. Augment vehicle database to include information on fuel use and mileage used each year in order to help inform future purchasing decisions.

d. College Travel

Potential Carbon Reduction: *7%*

Financing Options:
1% for Carbon Reduction,
Expense Reduction

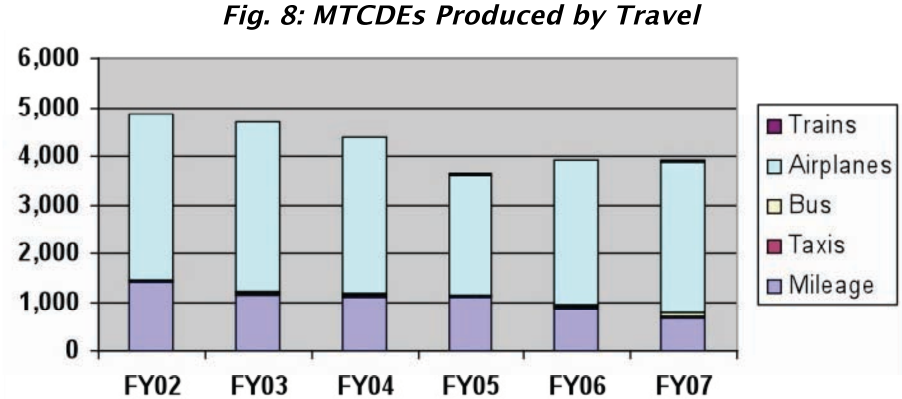


Travel is essential to what we do as students, faculty and staff. As it is unrealistic to consider eliminating all travel, we need to consider how to address the remaining carbon that we produce.

i. Travel Footprint

Airline travel contributes the most by far to our travel carbon footprint, with mileage reimbursement, or automobile travel, coming in a somewhat distant second. Taxis, trains and bus travel contribute small portions to our MTCDE production.

Fig. 8: MTCDEs Produced by Travel

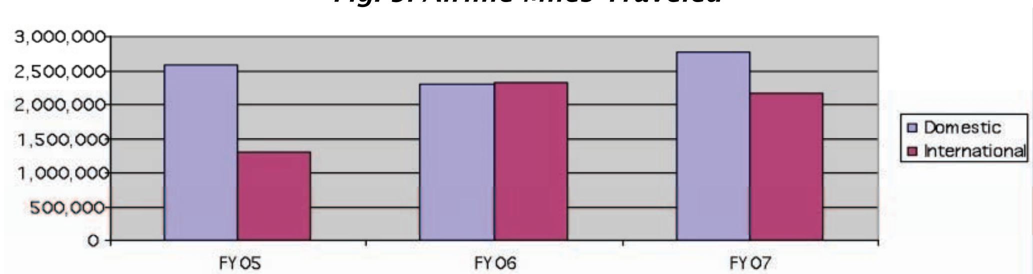


ii. How much do we travel?

In order to calculate how many airline miles were flown the airline travel cost is divided by average cost per mile obtained from Accent Travel industry data to calculate total airline miles traveled.

Domestic vs. International Airline Miles Traveled

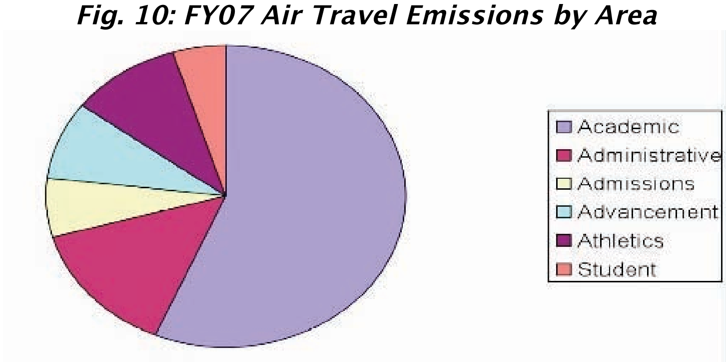
Fig. 9: Airline Miles Traveled



College Travel includes all travel paid directly by Middlebury College. This does not include Monterey-sponsored travel, Grants or Student Activity Funds

iii. Who travels and why?

Fig. 10: FY07 Air Travel Emissions by Area



As you can see the largest amount of travel is for academic purposes, followed by Administrative, Athletics, Advancement, Admissions and Student Services.

FY07 Total Airline Miles Traveled 4,934,000
Total Airline Emissions 3467.1 MTCDE

<u>Academic travel (Represents half of college airline miles traveled)</u>
FY07 = 2,610,000 miles or 1955.3 MTCDE

- Student Research – Curriculum related travel
- Language Schools – Faculty and program administrators
- Bread Loaf School of English – Faculty and program administrators
- Schools Abroad – Off campus study, faculty and program administrators
- Faculty – Curriculum development, enrichment and recruiting,
- Institutional Diversity, Environmental Affairs, CFA Museum /Art

<u>Administrative travel</u>
FY07 = 710,000 miles or 493.3 MTCDE

- Business meetings
- Institutional support

- Professional development
- Employee recruitment

Admissions travel
FY07 = 320,000 miles or 217.6 MTCDE
- Student recruiting
- Professional development

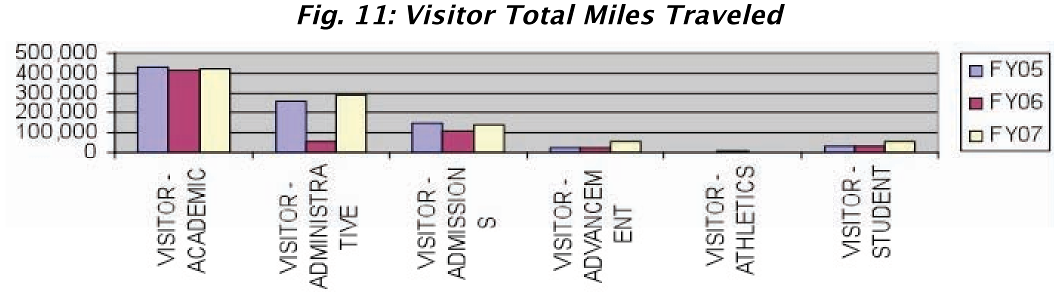
Advancement
FY07 = 470,000 miles or 293.8 MTCDE
- Alumni Relations
- Donor Solicitation
- Gift Planning

Athletics
FY07 = 569,000 miles or 344.5 MTCDE
- Post-season playoffs / championship events
- Spring training trips
- Club sports trips

Student Services
FY07 = 255,000 or 162.6 MTCDE
- Career Services
- Commons Events
- Civic Engagement

In addition to our own faculty, students and staff traveling we also bring many different groups of people to the College. This travel consists of 20% of total airline miles traveled. This includes speakers for Commencement, Lecturers, Rohatyn Center for International Affairs, Alliance for Civic Engagement and Career Services. It also includes Language School Faculty, Faculty Recruiting and Student Recruiting.

Fig. 11: Visitor Total Miles Traveled



Recommendations: College Travel

1. Education
- Inform departments of their annual air miles traveled and increase awareness of the resulting impact on the environment.

- Encourage people to be conscious of their decisions and to be conservative when planning number or frequency of trips requiring air travel

2. Videoconferencing
- Administrative business meetings, including Schools Abroad and other programs with multiple locations.
- Student Interviews

3. Travel Policies
- Attend conferences that require air travel every other year, instead of annually
- Combine events for Athletics; men's and women's compete at same location
- Offer incentives for departments to use alternative modes of transportation

4. Travel Alternatives
- Train travel for feasible locations, such as New York City
- Supplement train spur to Middlebury
- Carpool / Trip share – post upcoming trips on Campus Community Travel Board
- Bus or Van Rental to locations within reasonable driving distance

Funding

If we are able to reduce the amount traveled, we will be able to reduce the amount spent. This is an area where the savings of reduced travel could be reallocated to fund other options, such as travel alternatives and incentives. Any additional savings could be added to the carbon neutrality revolving loan fund.

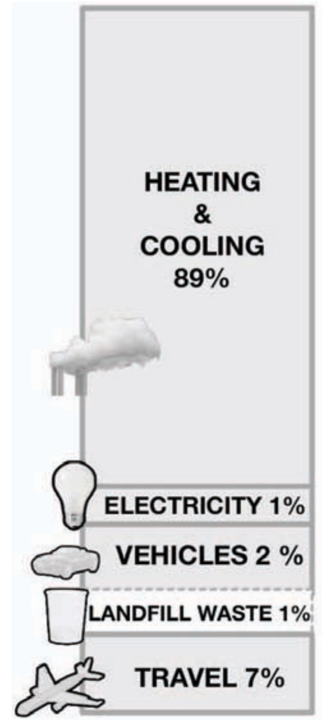
Indicators and measures of success for future reporting

- Reduced overall travel
- Increased usage of alternative forms of more environmentally-friendly travel
- Reductions in travel, or uses of alternative forms of travel will likely reduce the amount spent on travel.

Travel for Students Studying Abroad and Employee Commuting

While the carbon footprint for the College does not include travel for students studying abroad or employee commuting as the costs are incurred by the individuals, we do believe it is important to encourage members of the community to be aware of their individual impact on the environment. The College currently supplements Addison County Transit Resources (ACTR) to provide low-cost, convenient commuting opportunities for employees as well as transportation for students to Burlington. We should continue to expand these opportunities as they become available. In addition, an option for students traveling oversees is a "Sail Abroad" program, which would encourage students to sail, instead of fly, to their destination. This option dramatically reduces their footprint while still being able to enjoy their educational experience outside of the United States. The Study Abroad office is also experimenting with ways to offset student air travel. Options for this should be identified and implemented.

e. Waste Minimization



Potential Carbon Reduction: *1%*

Financing Options:
Grants, Fund-Raising,
1% for Carbon Neutrality, Partnerships

While Middlebury College has long been a leader among its peers in the recycling arena with its in-house recycling program, staff and facility, there are still significant opportunities for reducing the amount of waste created and the rate of recycling. The waste that we send to the landfill emits methane into the atmosphere as it decomposes, or it is burned and then sent up as carbon dioxide.

A common campus culture that supports and practices waste minimization is most important to reducing carbon emissions from landfill waste. And for what waste is generated, a common culture that supports and practices recycling and reuse of materials will also be significant. Recycling is a very visible aspect of life on campus and it is an environmental subject about which many people are aware. As such, it presents an opportunity to make the carbon neutrality message visible on an ongoing basis.

The table below shows the total waste and recycling amounts at Middlebury over the past three years in tons. Total waste is the amount of material taken to the landfill. As can be seen, Middlebury generates about 1400 tons of waste material each year and about 60% of that is recycled. The recycling amount includes food waste that is sent to the compost facility and it averages around 310 tons per year or about 38% of the total recycled. So, while more than half of the waste we create is recycled, we are still generating a considerable amount of wasted material. Our goal is to move in two directions: reduce the amount of waste generated, and increase the percentage recycled.

	2005	**2006**	**2007**
Total Waste	617	567	560
Total Recycling	799	819	864
Total Weight	1416	1386	1424
Recycling %	56%	60%	60%

In order to move in the desired direction of waste minimization and recycling maximization, we need to both review and revise our current practices and we have to be more effective in informing and motivating students, faculty and staff.

While it is unlikely that the College will achieve a zero waste state in the future, we can still make some very large gains toward such a goal. The following strategies will help move us in that direction.

Recommendations: Waste Minimization

1. Create a post graduate position whose job will be to cultivate a culture around waste reduction and recycling – somewhat like a CRA with a waste management and reduction focus and outreach to students, faculty, and staff.

   This position would give a young face to issues of waste minimization to which students can relate. This person would foster relationships with the Commons and students in general while coordinating competitions and exhibits pertaining to waste minimization. The position would also entail coordination of events for faculty and staff to increase their participation in recycling and waste reduction. Though the responsibilities of this position are not yet defined, his or her general purpose would be to work with the Office of Environmental Affairs and College Communications to increase student, faculty, and staff awareness and interest in waste reduction and to tell their stories.

2. Increased integration of sustainability and waste minimization into the residential life system.

   Res-life has a unique opportunity to interact with students in an informal though authoritative setting. The res-life staff should be responsible for discussing recycling and reducing overall waste with their halls, and for speaking up when these values are not upheld. The res-life staff could work with the new position (previously mentioned) to develop strategies for encouraging participation.

3. Comprehensive educational awareness campaign about waste minimization.

   Students, faculty, and staff need to understand in different terms the impact of their waste. An educational campaign that puts waste in real terms that people understand and care about, with a dose of fun and humor, would increase awareness and participation.

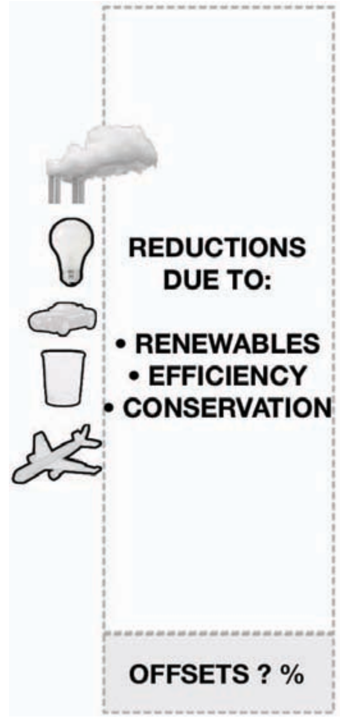
4. Service requirement for freshmen at the recycling center, the dining hall, etc. to give new students an understanding of the scale of waste at Middlebury College and to instill a value for reducing it.

   Students would gain a better understanding of the processes underlying the services provided to them and of the waste we generate. Staff would have the opportunity to educate students about their jobs and the overall importance of reducing waste.

5. Add scales and accompanying software to recycling center trucks in order to easily provide data about waste and recycling for each dorm.

   These scales would make publicizing the waste problem easier because we could more precisely quantify a student's role in it. This data would allow the recycling center to send emails like those of Count Paper to each dorm, and would allow inter-dorm/inter-commons reduction contests to include solid waste as a component.

f. Offsets and Sequestration



Potential Carbon Reduction: *100% of what remains after all other feasible reduction actions have been taken.*

Financing Options:
1% for Carbon Neutrality, Expense Reduction, Partnerships, Pilot Programs

In our pursuit of carbon neutrality we will significantly reduce the amount of carbon produced through many steps; however, we will still produce some greenhouse gas emissions. Therefore, offsets will inevitably factor into the achievement of our carbon neutrality goal and it is important that we invest responsibly in commercial offsets and pursue opportunities for internal and local offsets that are third-party certified. The following strategies should be pursued as part of the overall carbon neutrality effort.

i. Commercial Offsets

1. Develop offset purchasing guidelines in order to ensure the College is making quality carbon reducing investments.
   Because the type and quality of offsets change as projects are added and completed for each retail provider, the discussion of offset selection and costs should take place at the time that the offsets are being purchased. At this point, a set of criteria by which we judge an offset should be developed to facilitate offset selection in the future. A Consumer's Guide to Retail Carbon Offset Providers by Clean-Air Cool-Planet may be a helpful resource to consult when finalizing criteria.

2. Prioritize locally focused projects in purchasing decisions.
   Middlebury College could use its purchasing power to collaborate with a locally based offset retailer to develop and prioritize clean energy projects that would benefit the local economy.

ii. Middlebury College Internal Offset Program

The College could develop projects independently of an offset retailer and directly invest in local carbon reducing infrastructure (i.e. decreasing employee commuting miles, a biomass plant in the local high school, cow power at local farms, a methane digester at Middlebury sewage plant). These local offset projects would strengthen the College's ties to the community while providing countless educational opportunities for students, faculty, staff and the larger Middlebury community. An internal offset program would also provide the College with greater control over the projects and ensure the quality of our investments.

iii. Basic project criteria

1. Must have a measurable carbon reduction that can be certified by a third-party and deducted from the total carbon footprint.
2. Must demonstrate additionality, meaning that the offset project is not financially viable on its own. It cannot be something that we are already doing, or something that would happen without our investment. This may be tricky given the College’s commitment to and involvement in increasing public transportation options, for example.

iv. Internal Offset Project Manager

The partnership of the College with the local community to create clean energy projects that will green local infrastructure while reducing our carbon footprint will require additional work that does not currently fall in a particular position. This responsibility could be added in the Facilities, Treasurer, or Environmental Affairs areas. The creation of this responsibility to develop and manage offset projects would be the best way to successfully pursue this offset option.

Carbon Sequestration

The College owns thousands of acres of agricultural and forest lands. These lands are sequestering carbon but there is no measurement or modeling of the quantities of carbon that are being transferred and held in these soils. Nor is their any effort underway to better understand what kinds of land management practices might be used to increase the transfer and capture of carbon in the soil. We recommend that the College immediately begin to investigate the methods available for estimating and measuring carbon sequestration on agricultural and forest lands and determine the potential that active management to increase sequestration has for producing offsets that could be applied the goal of carbon neutrality by 2016. Sequestration at the pilot willow site and any scale-up projects should also be pursued.

-- III. Fostering Conservation Choices and Decisions --

a. Comprehensive Outreach and Engagement Plan

Goal: Design an information campaign for the entire campus community and external audiences that will build and sustain awareness without creating message fatigue

The extent to which the campus community and various external groups understand and embrace the carbon neutrality goal will have a direct impact on the success of the initiative. A well informed campus community will also help maximize the learning and institutional leadership opportunities that are inherent in this project. High awareness on campus will translate to high awareness off-campus as carbon neutrality becomes part of the college's identity.

There are many examples of successful, well-designed, and comprehensive educational/communication campaigns (for example, campaigns intended to affect attitudes and behaviors about smoking, wearing seat belts, drinking and driving, recycling). We recommend that a similar public information campaign be developed to support carbon neutrality and individual behavior change.

The following list of actions should be considered in a campaign designed to engage, inform and sustain knowledge about the carbon neutrality initiative:

<u>President sets tone and agenda for MiddShift initiative as an institutional priority</u>

- Works with president's staff to instill message and goals
- President's staff work with department managers
- President articulate importance of goals and need for community participation at all appropriate forums (i.e. trustee meetings, faculty meetings, staff association, and campus governance committees)

<u>Initiate a news pipeline</u>

- Ongoing news releases to external media
- Issuing regular stories to campus media (The Campus, MiddPoints)
- Create a web-based video series profiling significant events or projects (biomass plant, willow project etc.)

<u>Create compelling information resources</u>

- Web site
- Web video series
- Annual progress report
- Printed and electronic guide to carbon neutrality at MC

<u>Build/increase campus awareness</u>

- Implement a strategic signage program throughout campus that demonstrates and celebrates Middlebury's commitment to CO_2 reduction. Program could include basic awareness-raising signage, possibly in building entries common areas, dining areas and light switches, as well as at special events to positively promote composting and recycling as the Middlebury way. Encourage people to do their part in ways they may not have considered before -- busing their dishes to the composting area, for example.
- Create and identify ways to engage students through curricular, co-curricular, and extracurricular activities
- Create central interpretive display that includes a visual representation of progress
- Create interactive video display that could appear in multiple locations on campus
- Seek out all relevant campus committees for information and training
- Create a Midd Dialogue group for carbon neutrality around specific issues related to how institutional practices could change and evolve to reach carbon neutrality goal
- In MiddPoints, recognize employee achievements in carbon reduction
- Reminder magnets for light switches
- Events – staging some, being present at others
- Merchandising (t-shirts, mugs etc.)
- Employee pedometer contest
- Departmental carbon reduction contest
- Student contests related to energy, conservation and recycling (Do it in the Dark, Recyclemania etc.)

<u>Institutionalize the message</u>

- Incorporate carbon neutrality goals into curriculum
- Create a "sustainable energy tour" that could be guided or self-guided to incorporate bio-mass plant, composting, recycling, wind turbine, garden, and a building with cutting edge energy design (Atwater Commons?)
- Integrate sustainability and carbon neutrality goals into orientation for new students, parents, new faculty, trustees, staff
- Discuss carbon neutrality initiative at annual Bread Loaf faculty meeting
- Build message into Admissions tours (walk by biomass plant?)
- HR incorporate carbon neutrality message and information into employee training sessions
- Conduct periodic assessments of campus awareness of the carbon neutrality goal (focus groups, person-on-the sidewalk interviews etc. no complex surveys)

b. Institutional Practices and Policies

It is important to ensure that all of our policies and practices are consistent with carbon reduction/neutrality. Our comprehensive approach must not only address large, infrastructural issues, but also departmental and individual decision-making.

Reducing waste of all kinds, but in particular, energy and products/services that consume energy, needs to be become a part of our everyday culture. As individuals, we make decisions everyday that affect the amount of carbon that is consumed by the institution as a whole. We need to ensure that these decisions are informed and conscious. The Outreach and Engagement section outlines how we can actively involve the community as a whole in achieving carbon neutrality. College policies and practices also need to support "green decision-making". The following are areas and issues that we have identified that should be reviewed and/or revised. We recommend that this be one of the areas of focus for the Community Engagement and Leadership Team.

Student Life

- Educate students about the silent electrical draw of their equipment and ways they can reduce this draw
- Establish policies that support efficient energy usage, such as reducing use of dorm refrigerators and increasing use of carbon fluorescent light bulbs
- Reduce waste. To provide a hands-on perspective, require that 1st years spend one hour working in the materials recycling facility (and/or include a graduation requirement of four hours of work in the recycling facility over their four years at Middlebury
- Reduce vandalism which in turn reduces waste
- Encourage use of Zipcars
- Explore the feasibility of bike patrols by Public Safety in lieu of vehicle patrolling

Food/Dining

- Reduce food waste. Catered lunches, for example, generate a great deal of waste.
- Serve only local foods and beverages, when available. Look at local food production options.
- Create a positive perception of composting/recycling – set expectation of recycling at all events.
- Reduce other wastes. In calendar year 2007, $16,000 worth of dishes were inappropriately thrown into the recycling/waste stream

Equipment and Purchasing Policies

- Implement policies to reduce the use of redundant equipment – network versus personal printers, multipurpose printers/copies/fax machines.
- Require double-sided printing, where possible
- Include energy efficiency as part of the selection rationale for high cost/high volume purchases
- Centralized printer purchases
- Establish protocols with key vendors to ensure green, energy-efficient purchases

Operations Policies

- Consolidate work-order response to reduce unnecessary vehicular activity
- Utilize those spaces designed for a particular use rather than transporting equipment and materials to other spaces
- Observe black/grey-out periods – keep in mind mission-criticality
- Include energy efficiency and affect on carbon neutrality as part of standard business decision making criteria
- When developing workspace recommendations, consider workflow processes and relationships/dependencies on other departments for most efficient layout
- Ensure internal procedures support energy efficient operational decisions.
- Educate faculty and staff about the silent electrical draw of their equipment and ways they can reduce this draw

Transportation

- Implement student parking fee to reduce unnecessary vehicles
- Encourage use of Zipcars
- Create more incentives for public transportation to campus
- Increase use of campus shuttle
- Develop carpool program
- Reduce per vehicle fuel consumption by a significant percentage by 2016

Athletics

- Explore alternatives to new playing fields and turf
- Install energy efficient lighting

Academics

- Establish book adoption policies to support use of used textbooks
- Explore what to use video and other technology to enhance the teaching experience and potentially reduce travel
- Examine policies regarding academic field trips

<u>College Travel</u>

- Education: inform departments of their annual air miles traveled and increase awareness of the resulting impact on the environment; encourage people to be conscious of their decisions and to be conservative when planning number or frequency of trips requiring air travel
- Videoconferencing: administrative business meetings, including Schools Abroad and other programs with multiple locations, student interviews
- Travel Policies: attend conferences that require air travel every other year, instead of annually; combine events for Athletics; men's and women's compete at same location, offer incentives for departments to use alternative modes of transportation
- Travel Alternatives: train travel for feasible locations, such as New York City, supplement train spur to Middlebury, carpool / trip share – post upcoming trips on Campus Community Travel Board, bus or van rental to locations within reasonable driving distance

-- IV. Implementation Structure and Function --

a. Roles and Responsibilities

Achieving carbon neutrality will require a constant, concerted effort across the College community in three broad areas: Technology and Infrastructure, Community Engagement and Leadership, and Measurement-Verification-Reporting.

Technological and infrastructure solutions will play a key role. The biomass plant will come online in 2008 and by 2009 we should have a good understanding of how that technology works and what further role it could play in getting us to our goal. Many other relevant technologies are also available. Some are proven and some are just emerging and may offer feasible options for renewable energy. These options need to be evaluated and narrowed down to those that are appropriate and feasible for Middlebury. As the Master Plan is implemented it will also require that every project has an energy and greenhouse gas reduction component that is inherent in the project and that is successfully completed for each project.

Conservation awareness and innovative thinking and action will require an ongoing outreach and information effort to provide the necessary motivation, understanding, resources and acknowledgements for individuals and their departments in the College. An engaged and active community will provide ideas and innovations that, in the aggregate, will make a significant difference in the reduction of energy used on campus and associated greenhouse gas emissions. It will also distinguish Middlebury as an institution where leadership and commitment is evident at all levels of the community.

To help assure that we are reaching and maintaining carbon neutrality it is essential that we track our progress and provide quantitative information and analysis to the College community. This information and analysis will show how we are doing in our efforts to achieve carbon neutrality and will provide the necessary information for use at more local scales, such as how much energy was saved by an efficiency upgrade to a particular building. It will also help see what difference our efforts make, whether in how people use their buildings or the installation of a renewable technology, and to learn from what we do.

To carry out these functions the MSIWG recommends that three teams be formed to do this work. Each team could be composed of 6 to 8 people from within the staff, faculty and student populations on campus and chaired by a member of the President's Staff. Team members' job descriptions would be modified to include their service on their respective teams. The Chairs would report directly to the President on the efforts and achievements of each team in affecting success toward carbon neutrality. Additionally, a coordinating team would also be formed by two members of each of the three teams. The objectives and tasks of each team would be as follows.

i. Master Plan Implementation Team – Carbon Neutrality Group

<u>Objectives</u>

- Reduce the amount of energy consumed for heating and cooling the campus
- Reduce the amount of electricity consumed on campus
- Shift the fuels used for heating and cooling from carbon positive to carbon neutral through the use of renewable fuels and technologies

<u>Tasks</u>

- Seek out innovative solutions to infrastructure needs, review and recommend projects that will increase efficiency, reduce energy consumption and carbon emissions
- Establish baseline goals for efficiency and energy/carbon reduction targets, measure baselines, measure performance, report on successes and lessons learned
- Identify decision support tool(s) for use by measuring and reporting team

<u>Member Representation</u>

- Chair: Associate Vice President, Facilities Services
- Dean of Environmental Affairs
- Controller's Office/Finance
- Business Affairs
- Student – SGA Appointed
- Sustainability Integration Office

ii. Community Engagement and Leadership Team

<u>Objectives</u>

- Reduce the amount of energy used/carbon emitted by individuals in their residential halls, offices, laboratories, etc.,
- Reduce the amount of carbon emitted due to College related travel
- Raise the level of carbon neutrality awareness and leadership behavior of students, faculty, staff and trustees

<u>Tasks</u>

- Provide ongoing education, information and training for students, faculty, staff, trustees on why and how to reduce energy use and carbon emissions

- Assess information needs of constituents and provide tools and resources that addresses needs
- Document successes and challenges and acknowledge individual and team efforts that have contributed to achieving carbon neutrality

<u>Member Representation</u>

- Chair: Vice President, Communications
- Dean of the College
- Internal Communications
- Arts
- Human Resources
- Sustainability Integration Office
- Athletics
- Student – SGA appointed

iii. Carbon Neutrality Measurement and Reporting Team

<u>Objectives</u>

- Measure and track the College's carbon emissions and energy consumption in detail
- Work with the Master Plan and Engagement Teams to provide information needed to help accomplish their objectives

<u>Tasks</u>

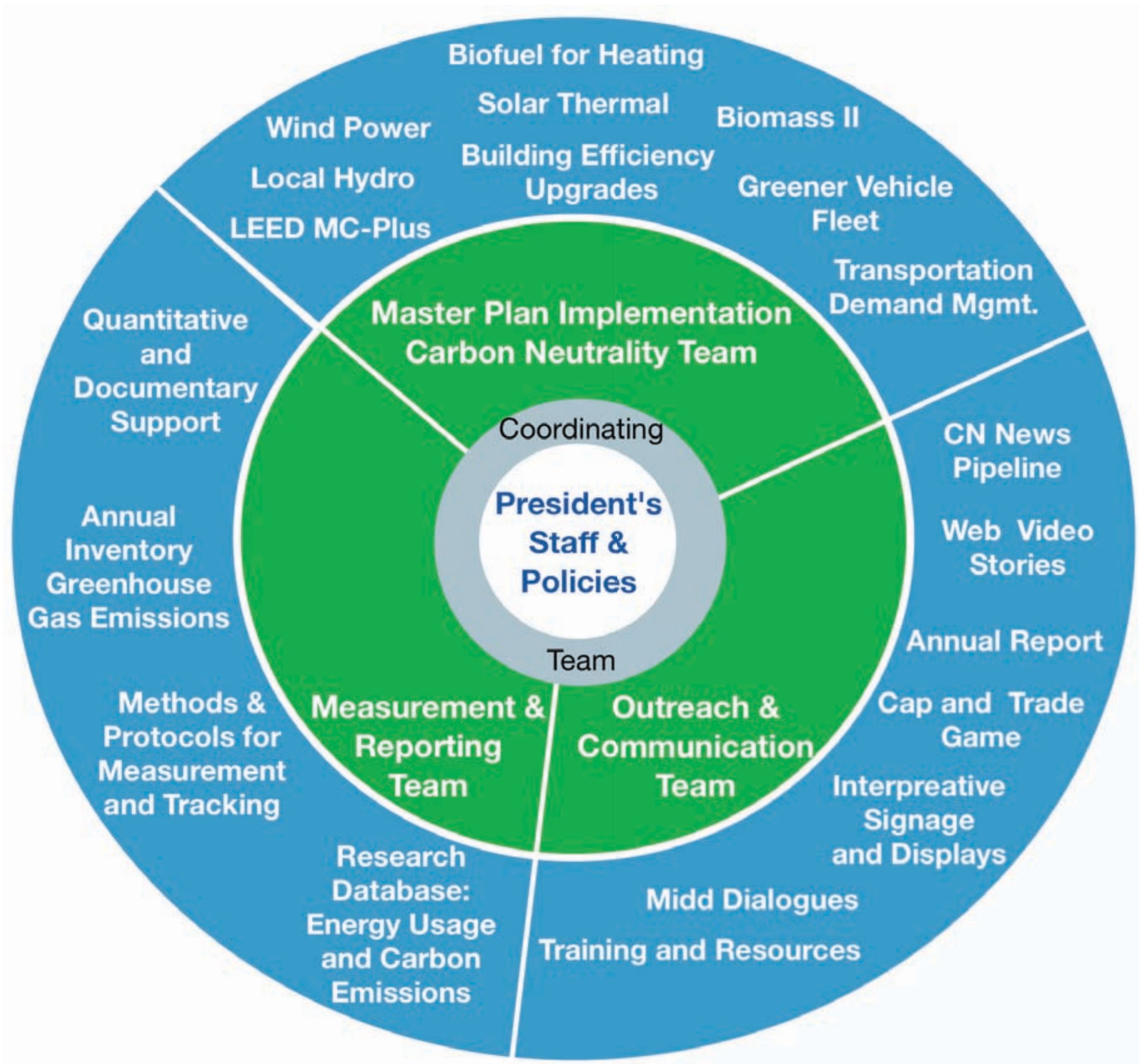
- Conduct annual inventory of carbon emissions and report on progress toward neutrality
- Develop methods and protocols for measuring and reporting energy consumption and carbon emissions to support efforts by the Master Plan and Engagement Teams
- Develop a searchable database of energy and carbon emissions data, referencing individual buildings, to support research, comparison and analysis needs of faculty, students and staff.

<u>Member Representation</u>

- Chair: Vice President for Finance
- Office of Facilities Services
- Physics
- Library and Information Services
- Sustainability Integration Office
- Institutional Research
- Student – SGA appointed

iv. MiddShift Coordinating Team

Each team would appoint two people to serve on a MiddShift Coordinating Team whose primary function would be to set biennial reduction targets, goals and objectives for the carbon neutrality effort and to assure that the work of each team is integrated and coordinated and to look for innovative and effective ways to work together. The Coordinating Team would also serve as a sounding board and editorial advisors for the annual report of progress produced by the Measurement and Reporting Team described below. Additionally, the Coordinating Team would monitor the composition of the three working teams described further below and assure that vacancies are filled when necessary.



b. Next Steps for Implementation Process: 2008 – 2010

2008

April 28: MSIWG Steering Committee Review/Revision of Draft 1.2

April 29: Report to Trustees' Building and Grounds Committee

May 12: Draft 1.4 distributed to College Community for comments

May 24: Final comments

May 31: Final report

July: President's Staff Discusses and Adopts Final Report

August – September: Appointment letters to members of implementation teams

September – October: President's Report to Trustees on progress

September – October: Implementation phase 2 begins with orientation and goal setting session for all teams. Establish biennial reduction target schedule.

November – Coordinating Team meets to review progress summaries by implementation teams. Prepares report for President

2009

January: Coordinating Team meets to review progress summaries by implementation teams. Prepares report for President

March – April: Coordinating team meets to review draft annual report of progress prepared by implementation teams

May – June: Annual Report of Progress to Trustees. All teams meet to review successes and lessons learned and outline of work for 2009-2010.

Appendix 1.

MiddShift Implementation Working Group Recommendation to Address "The Million Gallon Question"

February, 2008

Dealing with the "Million Gallon Question" at Middlebury College:
Options for Solving the Challenge with Regard to their Economic, Ecological, and Social Implications

February 5, 2008

The MiddShift Implementation Steering Committee has been reviewing options and possibilities for various solutions to achieving the goal of carbon neutrality by 2016 adopted by the Middlebury College Trustees in May '07. While the working group is the early stages of its efforts and is developing an initial list of strategies for discussion, one important strategy has emerged as a priority. It has become evident that in order to meet its 2016 goal it is essential that the College undertake a study of how to replace its use of fossil fuels for heating and cooling with carbon neutral, renewable fuels, particularly by looking at further opportunities to expand on the use of biomass and biofuels.

The Committee has done an initial review of the various renewable fuels and technologies currently available for heating and cooling an institution of Middlebury's size and structure and concludes that further development of its capacity to use biomass and biofuels is the most promising and substantive option for meeting the carbon neutrality goal.

We do want to emphasize that while this is a significant part of the ***set of solutions*** that we will need to pursue. It is equally important that we pursue strategies that will make our buildings more energy efficient and that we are operating them as conservatively as possible. This is important in that this will reduce our overall need for consuming fuels. We do not want to cause any more harvesting of forests or crops for fuel than is truly needed. We will also be developing such strategies for consideration and discussion.

We believe this study should begin immediately for several reasons:

- Fossil fuels used for heating and cooling constitute about three-quarters of the College's carbon emissions footprint. A "Biomass/Biofuel II" feasibility study will help the College to address the most significant portion of its greenhouse gas emissions and enable it to better focus its efforts on the remaining one-quarter of its carbon footprint from electricity, vehicle usage, employee travel and waste disposal. These activities are more dispersed and less in direct control of the College and will require more creative and broad based solutions.

- When the biomass project currently under construction goes online in December '08 the college's carbon footprint for heating and cooling will be cut in half leaving about another 1,000,000+ gallons of fossil fuels to displace with renewable, carbon neutral fuels.

- There are currently no other viable and cost effective options for significantly addressing this portion of the College's footprint other than the use of biomass and biofuels. This is not to say that efficiency, other renewables, and conservation will not be an important part of the solutions. Given the timeframe for achieving neutrality, biomass/biofuel is the most promising solution since it is a proven technology with which the College has and will soon have more experience and expertise, and there is an ample fuel supply nearby in forests and great potential for growing fuel on agricultural lands which the College is currently exploring via its test plots with SUNY-ESF on College lands.

- The goal of neutrality is to be achieved in 8 years. The timeframe for studying, developing, financing, contracting and completing projects of a scale like the biomass project is on the order of 4 to 8 years.

- A project of this scale will represent a significant use of land that will require careful study and analysis to find the best solution.

- A study undertaken now affords greater opportunity to discover ways in which the biomass project currently under construction could be modified to accommodate future capacity. It would also allow us to use the expertise of the architects, engineers, and biomass experts involved in the current project.

A study could also identify what transition or supplemental strategies might be employed over the next 8 years, such as using increasing percentages of biofuel in the existing oil burners to help achieve carbon neutrality.

The key questions that need to be addressed are:

1. What can be done to maximize the carbon neutrality of the existing heating and cooling plant including the new biomass gasification system being installed? How far toward are goal can it take us?

2. Where else on campus would a separate facility work best? What options do we have and what are their strengths and weaknesses?

3. How do the various options that emerge compare in terms of their effects on the College and the greater community's economic, ecological, and social assets?

The first question may be an item for the engineers, architects, and contractors working on the biomass project. The second question may be a Master Plan item that could be addressed by the team working on the Plan.

There are other important questions related to the actual fuel supply (sustainability and land use and impacts of the biomass and biofuels available, for example). This is an area that the ad hoc Energy Procurement Group could address as it has done in regard to the current biomass project.

The Steering Committee looks forward to discussing this further and would be happy to provide more information to help define the scope and outcomes of a feasibility study.

Steering Committee Members:

Jack Byrne, Campus Sustainability Coordinator, co-chair
Drew Macan, Director of Human Resources, co-chair
Kristen Anderson, Budget Director
Billie Borden ‘09
Stephen Diehl, Assistant Director, Public Affairs
Bobby Levine ‘08
Mike Moser, Assistant Director Facilities Services
Rich Wolfson, Professor of Physics

Appendix 2.

Board of Trustees Resolution for Carbon Neutrality by 2016

May, 2007

Trustees of Middlebury College
Resolution on Achieving Carbon Neutrality
May 5, 2007

Whereas Middlebury College has committed itself to integrating environmental stewardship into both its curriculum and its practices on campus. (Mission Statement, 2006), and

Whereas Middlebury College has committed itself to leadership in environmental sustainability by providing an exemplary education that incorporates scholarship, research, and applied experience spanning from local to global issues, and preparing its students for a world in which environmental issues are embedded in every decision. (Knowledge Without Boundaries: The Middlebury College Strategic Plan, p.56), and

Whereas Middlebury College has previously recognized the threat posed by climate change and that the College is positioned, through its academic and institutional strengths, to rise to this challenge by applying the collective motivated intellects of its students, faculty, staff, administration, governing body, and graduates. The shift away from a worldwide fossil fuel based economy will require the best of the liberal arts tradition. (Middlebury College's Commitment to Carbon Reduction, 2004), and

Whereas Middlebury College was one of the earliest academic institutions in the United States to set a specific goal and timeline for reduction of global warming pollution when it adopted a resolution endorsing the College's Carbon Reduction Initiative Working Group's recommendation to reduce greenhouse gas emissions by 8% below 1990 levels by 2012, adjusted on a student (per capita) basis, and recognizing that at then levels of energy use would require attaining carbon emission levels 35% below FY 00-01 levels by 2012, and

Whereas the diligent efforts of the administration, staff, faculty and students have resulted in reductions of global warming pollution that puts the College on track to meet its 2012 reduction goals, and

Whereas Middlebury College recognizes the broad consensus within the international scientific community that there is an urgent need to significantly reduce the amount of global warming pollution in the earth's atmosphere to avoid the most severe consequences of climate change, and

Whereas, at the Trustees' request, a Carbon Neutrality Initiative Task Force comprised of students, faculty and staff was formed to review a proposal from MiddShift entitled "A Proposal for Carbon Neutrality at Middlebury College" outlining a plan to eliminate the College's net carbon emissions by 2016, and

Whereas the Carbon Neutrality Initiative Task Force has done that review and concluded that a goal of carbon neutrality for Middlebury College by 2016, while challenging, is feasible through energy conservation and efficiency, renewable fuel sources, technology innovations, educational programming and learning, and offset purchases after all other feasible measures have been taken, and

Whereas over 1,250 signatures representing 70 different departments, teams, clubs, residences and individuals have endorsed the College's carbon neutrality goal and are committed to reducing their personal energy use.

Be it therefore resolved that:

the Trustees of Middlebury College support a goal of carbon neutrality by 2016 for the College's Vermont Campus as a priority of the Middlebury College community, recognizing that achievement of the goal will require a commitment of resources to achieve necessary technological and behavioral shifts; and

We believe the College should take a leadership stance on carbon neutrality and should build and expand upon the strategies it has in place to attain carbon neutrality and take further actions to develop and implement sound strategies that ultimately advance sustainability for this institution and our planet.

Appendix 3.

Carbon Neutrality Initiative Task Force Report to Trustees

May, 2007

Middlebury College
Carbon Neutrality by 2016
Carbon Neutrality Initiative Task Force

Summary and Recommendation

May 1, 2007

At the February, 2007 Board meeting, MiddShift presented "A Proposal for Carbon Neutrality at Middlebury College" which outlined a plan to eliminate the College's net carbon emissions by 2016. MiddShift noted that, "This goal fulfills the College's mission, secures its reputation and leadership among peer institutions, rises to the challenge of global climate change, and is financially feasible."

Since that meeting the administration has reviewed the proposal and has prepared this report. A Carbon Neutrality Initiative Task Force chaired by Bob Huth and comprised of seven students and eight administrative staff (see appendix A), analyzed the risks associated with undertaking a goal of carbon neutrality by 2016 and identified mitigants (Appendix B). Significant effort was devoted to reviewing measurement data for accuracy and verifying economics and accuracy of the various projects included in the original proposal. As a result, a quantifiable list of probable projects and a list of possible projects were analyzed (Appendix C). Several projects listed in the original proposal were not included due to the inability to quantify costs and results at this time.

As the result of the above review, the following became clear:

- The College's emissions of 30,000 MTCDE (metric tons of carbon dioxide equivalents) are reasonably stated. They can be defined and measured. The largest emission components are #6 fuel oil (78%), College travel (9%), #2 fuel oil (5%), and electricity (3%). These four components aggregate over 95% of the College's carbon emissions.
- The Biomass Boiler should reduce these emissions by more than 40% (12,280 MTCDE) when it is on-line in late fall of 2008.
- If nothing other than Biomass were done, the remaining emissions could be resolved by high quality, verifiable offsets that currently would cost less than $150,000 per year.
    - As identified in the CNI proposal, offsets should only be used after all economically feasible efforts have been exhausted.
    - Offset prices will most likely increase over time as the low-cost, high impact solutions will be undertaken first. Native Energy, one of three U.S. retail offset providers included in the world's top eight such providers by Clean Air – Cool Planet, estimates that offset prices could increase in cost five-fold within ten years.
- There is student participation and involvement toward this goal currently.
    - Energy saving contests among residence halls started last year and continue.
    - "68 degrees – It's Cool" campaign generated by students during Winter of 2006.

- SGA contributions to ACTR to provide bus trips to Boston and New York during breaks, weekend bus transport to Burlington for students, and ski slope buses.
- SGA policy change to allow student clubs to offset their travel related carbon by using their student activity fees.
- 64 students/families who voluntarily contributed $36 to the College to be used to offset the carbon emissions of those students.
- Apparent student body willingness to absorb a $100 per year parking fee. A fee of this size would generate $85,000 that could be used to support a campus transportation infrastructure thereby reducing carbon emissions.
- The Sunday Night Group is action oriented with strong following, a track record of sustained interest and willingness to invest time and energy.

- There are several significant opportunities for future carbon reduction.
  - Educational programming for the College community.
  - Energy efficiency opportunities in campus buildings and steam pipe infrastructure.
  - Hydroelectric generation facility below Battell Bridge.
  - Technological innovations.
  - Additional biomass capacity.
- Challenges
  - Increases in air-conditioning.
  - Increases in off-set pricing.
  - Potential increases in carbon emissions could occur as electricity contract with Vermont Yankee being decommissioned in 2012 and the current Hydro-Quebec contract starts a process of termination in 2015. If Battell Bridge hydro-electric generation is possible, it would significantly mitigate this challenge.
- Reputation
  - As an "Environmental College", the College should continue to demonstrate environmental leadership. The above goal of carbon neutrality by 2016 would exceed the "President's Climate Commitment" goal statement (Appendix D) which has been signed by 178 College and University Presidents.

Appendix A

Carbon Neutrality Initiative Task Force

Billie Jayne Borden	Student'09
Jack Byrne	Campus Sustainability Coordinator
Tiziana Jimena Dominguez	Student'07
David Dolginow	Student'09
Mark Gleason	Project Manager
Chester Wollaeger Harvey	Student'09
Bob Huth	Executive Vice President and Treasurer
Nan Jenks-Jay	Dean of Environmental Affairs
Jason Kowalski	Student'07
Robert Bernard Levine	Student'08
Beth McDermott	Associate Director of Principal Gifts
Michael McKenna	Vice President for Communications
Michael Moser	Assistant Director of Facilities Service/Central Heating/Utilities
Patrick Norton	Associate Vice President for Finance and Controller
Susan Personette	Associate Vice President for Facilities
Clayton Paul Reed	Student'08

Appendix B

Risk 1 – The College's carbon footprint is not easily defined given its international operation.
Mitigant – The College has some ability to define exactly what it means by carbon neutrality by 2016. The World Research Institute in 2003 identified that whoever purchases carbon is responsible for it. This means that electricity, energy for heating, cooling, and use in College vehicles and equipment would be included, but employee commuting and student travel would not. Employees and students would be responsible for their own carbon footprints. The College could choose to have the carbon neutrality by 2016 goal apply specifically to its Vermont campus (including Bread Loaf, Golf Course and the Snow Bowl).*

Risk 2 – Is the College's footprint of approximately 30,000 MTCDE (metric tons carbon dioxide equivalents) and the index of potential projects to reduce carbon accurate?
Mitigant – The carbon measurements have been audited by Michael Moser, Assistant Director of Facilities Services, Central Heating and Utilities, and appear reasonably stated. The reasonableness of the measurements were also confirmed through the results of a "desk audit" performed by Clean Air/Cool Planet (a science based, non-partisan 501(c)3) and a review by Arup, the College's master plan sustainability consultants. Patrick Norton, Associate Vice President for Finance and Controller has reviewed the assumptions for initial capital investment and annual cost/savings for the probable projects and determined that they appear reasonably stated. The caveat is that as probable projects, other than the new biomass gasification system, are discussed with service providers the initial capital investment and annual cost/savings may increase/decrease – making the project more/less economically feasible. There are also additional possible projects such as development of commercial residual biofuel, hydroelectricity generation below the Battell Bridge, landfill to gas projects, and carbon aware construction (see Appendix C).

Risk 3 – Goal success requires not only institutional action, but personal actions as well. How engaged is the student community in this goal today and tomorrow? What level of participation do current students have for this initiative? Will this interest be a "flash in the pan" or span future student generations? How engaged is the non-student community?
Mitigant – A significant portion of the student community is involved. Examples are:

- Inter-Commons Initiative to Consume Less Energy (ICICLE) in which 1,700 light bulbs were replaced by students and they competed to reduce usage.
- Sunday Night Group meets weekly with 50 to 95 students attending and a mailing list of over 300.
- Student Government Association (SGA) is aware of carbon reduction and currently funds local public transportation enabling students to travel to Burlington on Saturdays without using their cars. SGA is currently considering expansion of this service as well as supporting additional buses to Boston during breaks.
- Goal awareness and necessary actions can be incorporated into Orientation and Resident Assistant responsibilities.
- Opportunities exist to incorporate carbon neutrality topics and issues in winter term courses and other student academic/research work.
- A Steering Committee would be established to oversee institutional measurement and reporting to the College community.

- Although the non-student community is not as engaged as students, this can be resolved through education such as a proposed series of articles in *The Campus and MiddPoints*.
- The national and global context is likely to mean that student/faculty/staff awareness of and commitment to these environmental challenges can only increase in future years.

Risk 4 – Purchased certified carbon offsets currently cost $xx per MTCDE however could increase significantly in cost in next 10 years as the low cost, high impact carbon reduction projects will have been undertaken. Ann Hambleton, '84 the Senior Manager, Business Development of Native Energy, estimates that the cost could increase up to five-fold by 2016.
Mitigant – The College should minimize use of offsets by undertaking projects and changes that the College controls directly.

Risk 5 – Carbon profile of electricity purchased may worsen significantly as HydroQuebec contract ends and Vermont Yankee is decommissioned if coal or other carbon intensive energy is used to produce electricity.
Mitigant – There are opportunities for greater efficiencies both in building systems and education of occupants. Potential mitigants include the Otter Creek hydro project and methane digestion.

Risk 6 - Carbon profile could increase due to new construction and air-conditioning.
Mitigant – There is significant opportunity to reduce energy consumption in many buildings on campus when they are renovated. New technologies can be built into new buildings and air conditioning can be accomplished using the most environmentally responsible technology.

Risk 7 – The financial resources needed to accomplish this goal will compete with other College initiatives.
Mitigant – There is significant support to create a student parking fee which could finance carbon reducing activities. Energy efficiency measures are cost effective and can provide resources for carbon reducing projects that have a net cost.

*Although not directly included in the goal, other carbon reduction efforts would occur in the areas of employee and student commuting as well as at other Middlebury College locations beyond the Vermont campus.

Appendix C

Project Index

Timeline	Probable Projects	Initial Capital Investment	Year 1 Savings/(Cost)	IRR	NPV over 20 yr timeframe	MTCDE Reduced	$/MTCDE over timeframe
1 - 3 years	New Biomass Gasification System	($11,100,000)	$794,231	6.5%	$1,504,506	12,280	$6.13
1 - 3 years	Lighting Efficiency Measures	($3,369)	$11,000	326.5%	$117,354	5	$1,227.56
1 - 3 years	Monitoring and Control Systems	($18,720)	$18,000	96.2%	$195,809	8	$1,250.54
1 - 3 years	Native Energy Offsets (high price @ $6.50 per ton)	$0	($113,029)	N/A	($2,260,580)	17,389	($6.50)
1 - 3 years	All B20 burned in the college fleet	$0	($1,125)	N/A	($9,422)	19	($25.33)
3 - 5 years	Building efficiency upgrades (replace windows)	($205,000)	$9,600	N/A	($81,298)	220	($18.48)
3 - 5 years	Convert college fleet from gas to B20	$0	($13,000)	N/A	($108,873)	80	($68.39)
	Total	($11,327,089)	$705,677		($642,502)	30,000	

5.00% Discount Rate

20 Timeframe (yr)

Possible Projects	Initial Capital Investment	Year 1 Savings/(Cost)	IRR	NPV over 20 yr timeframe	MTCDE Reduced	$/MTCDE over timeframe
B20 Biodiesel Blend to Replace #6 Oil (post-biomass)*	$0	($795,000)	N/A	($9,435,674)	3,248	($145.25)
B100 Biodiesel to Replace #6 Oil (post-biomass *	$0	($1,490,000)	N/A	($17,684,470)	11,685	($75.67)
Residual biofuel to replace #6 oil (college and energy supplier to jointly test commerical feasibility of 'inexpensive' residual biofuel).	?	?	?	?	?	?
Landfill Gas to Energy Projects	?	?	?	?	?	?
Methane Digester Projects on Local Farms	?	?	?	?	?	?
Investment in Hydroelectricity downtown	?	?	?	?	?	?
Carbon aware construction and renovations	?	?	?	?	?	?

* Select either B20 or B100 solution

Appendix D

American College & University Presidents Climate Commitment

We, the undersigned presidents and chancellors of colleges and universities, are deeply concerned about the unprecedented scale and speed of global warming and its potential for large-scale, adverse health, social, economic and ecological effects. We recognize the scientific consensus that global warming is real and is largely being caused by humans. We further recognize the need to reduce the global emission of greenhouse gases by 80% by mid-century at the latest, in order to avert the worst impacts of global warming and to reestablish the more stable climatic conditions that have made human progress over the last 10,000 years possible.

While we understand that there might be short-term challenges associated with this effort, we believe that there will be great short-, medium-, and long-term economic, health, social and environmental benefits, including achieving energy independence for the U.S. as quickly as possible.

We believe colleges and universities must exercise leadership in their communities and throughout society by modeling ways to minimize global warming emissions, and by providing the knowledge and the educated graduates to achieve climate neutrality. Campuses that address the climate challenge by reducing global warming emissions and by integrating sustainability into their curriculum will better serve their students and meet their social mandate to help create a thriving, ethical and civil society. These colleges and universities will be providing students with the knowledge and skills needed to address the critical, systemic challenges faced by the world in this new century and enable them to benefit from the economic opportunities that will arise as a result of solutions they develop.

We further believe that colleges and universities that exert leadership in addressing climate change will stabilize and reduce their long-term energy costs, attract excellent students and faculty, attract new sources of funding, and increase the support of alumni and local communities. Accordingly, we commit our institutions to taking the following steps in pursuit of climate neutrality:

1. Initiate the development of a comprehensive plan to achieve climate neutrality as soon as possible.

    a. Within two months of signing this document, create institutional structures to guide the development and implementation of the plan.

    b. Within one year of signing this document, complete a comprehensive inventory of all greenhouse gas emissions (including emissions from electricity, heating, commuting, and air travel) and update the inventory every other year thereafter.

    c. Within two years of signing this document, develop an institutional action plan for becoming climate neutral, 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 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.

2. Initiate two or more of the following tangible actions to reduce greenhouse gases while the more comprehensive plan is being developed.

a. Establish a policy that all new campus construction will be built to at least the U.S. Green Building Council's LEED Silver standard or equivalent.

b. Adopt an energy-efficient appliance purchasing policy requiring purchase of ENERGY STAR certified products in all areas for which such ratings exist.

c. Establish a policy of offsetting all greenhouse gas emissions generated by air travel paid for by our institution.

d. Encourage use of and provide access to public transportation for all faculty, staff, students and visitors at our institution

e. Within one year of signing this document, begin purchasing or producing at least 15% of our institution's electricity consumption from renewable sources.

f. Establish a policy or a committee that supports climate and sustainability shareholder proposals at companies where our institution's endowment is invested.

3. Make the action plan, inventory, and periodic progress reports publicly available by providing them to the Association for the Advancement of Sustainability in Higher Education (AASHE) for posting and dissemination.

In recognition of the need to build support for this effort among college and university administrations across America, we will encourage other presidents to join this effort and become signatories to this commitment.

Signed,

The Signatories of the American College & University
Presidents Climate Commitment

Appendix 4.

MiddShift Proposal for Carbon Neutrality

January, 2007

A Proposal for Carbon Neutrality at Middlebury College

January 2007
Middlebury College
Middlebury, Vermont

Table of Contents

Executive Summary

This proposal outlines a plan to eliminate Middlebury College's net carbon emissions by 2016. This goal fulfills the College's mission, secures its reputation and leadership status, rises to the climate change challenge, and is financially feasible.

The first section delineates the educational opportunities associated with carbon neutrality, which strongly reinforce the College's mission and build awareness for and experience with energy and climate issues. This section suggests incorporating student, faculty, and staff led projects to institutionalize carbon neutral behavior and using competition through grants as a means to create efficiency and facilitate this necessary change.

The following sections suggest several infrastructural projects to reduce Middlebury's carbon footprint resulting from heating and cooling, electricity, transportation, waste and purchasing, and architecture and planning. Although the previously approved biomass gasification system will reduce the College's heating and cooling footprint by half, this section suggests several other projects which will build on this momentum and continue to reduce carbon emissions. We also suggests a three-tiered strategy to offset the College's irreducible carbon emissions. This approach avoids the risk of bypassing the important stages of emissions reduction through both behavioral and infrastructural change and the fiscally irresponsible decision to invest money in offsets prior to completing on-site carbon reduction.

Following these recommendations, there is a preliminary analysis of the proposed projects featuring estimated costs, internal rates of return, carbon reductions, and costs related to offsets. This analysis is a starting point for further research into which projects are most cost effective in reducing the College's carbon footprint. According to our calculations, including the recent investment in the biomass gasification system, the goal of carbon neutrality is both an asset to our educational mission and within our financial grasp. For example, in addition to biomass, if the College were to invest in the reduction projects with a positive internal rate of return recommended in this document, the total net present value of the College's carbon reduction expenditures after a 20 year period would only be $835,000 shy of the return on the value of the expenditures had they been invested in our endowment instead.

Following this section, there are several recommendations on how to finance carbon neutrality, which principally involves using the class of '07 gift, the Green Fund, to create a separate endowment for environmental initiatives. The proposal the following recommendations:

- Institutional commitment to achieving carbon neutrality by 2016. (February 2007)
- Develop and implement plan for continued collaboration with MiddShift students. (February 2007)
- Develop and approve funding strategy. (May 2007)
- Approve recommended offset policy. (May 2007)
- Prioritize recommendations delineated in this proposal. This will enable the Middlebury College community to utilize Summer 2007 to begin implementation. (May 2007)

	Discount Rate: 9.00%			Timeframe: 20 yrs		
Project Index	**Initial Capital Investment**	**Annual Cost/Savings**	**IRR**	**NPV over 20 yr timeframe**	**MTCDE Reduced**	**$/MTCDE over timeframe**
Employee Commuting/Parking Fee (high compliance)	$0	$14,700	Infinity	$123,110	1260	N/A
Silver LEED cert. -- integrated design	$0	$36,188	Infinity	$303,068	7435	N/A
Employee Commuting/Parking Fee (low compliance)	$0	$379,350	Infinity	$3,176,985	970	N/A
Lighting Efficiency Measures	($3,369)	$10,158	302%	$81,981	5	$17,171
Monitoring and Control Systems	($18,720)	$18,000	96.2%	$133,572	8	$17,061
Landfill Gas to Energy Projects	($65,000)	$19,000	29.1%	$99,488	6250	$16
Replacing steam pipes	($800,000)	$122,316	14.2%	$290,429	1022	$284
New Biomass Gasification System	($11,000,000)	$1,093,153	7.7%	($936,792)	15000	($62)
Silver LEED cert.-- no integrated design	($375,000)	$36,188	7.3%	($40,969)	7435	($6)
Bright Card	$0	($51,900)	N/A	N/A	9047	($6)
Retail Offsets (low price)	$0	($138,858)	N/A	N/A	19380	($7)
Retail Offsets (high price)	$0	($192,265)	N/A	N/A	19380	($10)
Waste Reduction Fund	$0	($1,000)	N/A	N/A	82	($12)
All B20 burned in the college fleet	$0	($1,125)	N/A	N/A	19	($60)
Purchasing policy for college fleet	$0	($13,000)	N/A	N/A	80	($163)
B100 Biodiesel Blend to Replace #6 Oil	$0	($3,837,011)	N/A	N/A	23370	($164)
B20 Biodiesel Blend to Replace #6 Oil	$0	($3,020,781)	N/A	N/A	6496	($465)
Investment in Hydroelectricity downtown	($2,000,000)	$0	N/A	($1,834,862)	880	($2,085)

Foreword

Two weeks passed during Middlebury College's beloved winter term before any of us felt the crunch of snow beneath our feet. The snowless Vermont landscape could not have been a more appropriate backdrop for our research into carbon neutrality. We all experienced a taste of what it is we are working to prevent—the effects of climate change.

In May of 2006, the Sunday Night Group (SNG), Middlebury's student organization dedicated to climate change activism, decided to take on the challenge of making the College carbon neutral. After meeting with you in September, we began a carbon neutrality educational campaign—MiddShift—for Middlebury students and community members. Since then, over 300 students from SNG have built awareness and support for this campaign by screening "An Inconvenient Truth", tabling at hockey games, and a door-to-door exchange of thousands of light bulbs. This January term, we have developed an internship with the Sierra Student Coalition to formally pursue carbon neutrality.

The eleven students who have participated in this internship have spent the month researching the many facets of pursuing carbon neutrality at the College. We have also hosted a conference for students across the Northeast who are working towards carbon neutrality at their own schools. From this conference and from our own findings, we will create a resource kit with fundamental information about carbon neutrality strategies for other schools.

The following report is our assessment of the steps Middlebury is already taking to achieve its carbon reduction goals, and the opportunities for further carbon reduction that would result in carbon neutrality within the decade. We believe that carbon neutrality is critical to the advancement of Middlebury College as a current leader in higher education. Finding solutions to climate change is the challenge of our time. By accepting our proposal, you, as a Trustee of Middlebury College, have the opportunity to lead the College towards a sustainable future.

Thank you for your time and consideration,

Kelly Blynn, '07
Environmental Studies/Geography
Berwyn, PA
May Boeve, '06.5
Political Science
Sonoma, CA
Billie Borden, '09
Undeclared
Huletts Landing, NY
David Dolginow, '09
Geography
Leawood, KS
Tiziana Dominguez, '09
Economics
Ourense, Spain
Jamie Henn, '07
History
Cambridge, MA
Caitlin Littlefield, '07.5
Environmental Studies/Conservation Biology
Andover, MA
Will Martin, '07.5
International Studies/Economics
Englewood, CO
Claire Polfus, '08
Environmental Studies/Literature
Lake Tomahawk, WI
Clayton Reed, '08
Environmental Studies/Economics
Stowe, VT
Emily Wheeler, '07
Sociology/Anthropology
East Burke, VT

When the Trustees of Middlebury College approved the proposal for the Carbon Reduction Initiative in 2004, the College became one of the first educational institutions in the nation to respond to the threat of global climate change. With the decision to implement a biomass burner, the College will reduce its oil-related emissions by almost half—the most remarkable reduction thus far by any college in the Northeast. Now, in 2007, we are asking you to take the next step and approve carbon neutrality for the College by 2016. By adopting our proposal, this college will continue to lead peer institutions in the fight against climate change while paving the way for an economically vibrant and environmentally sustainable future.

What is Carbon Neutrality?

For an institution such as Middlebury College to achieve carbon neutrality, *it must effectively eliminate its net greenhouse gas emission*s. This is accomplished through using sustainable energy sources, conservation and efficiency measures and ultimately the purchase of carbon offsets for those 'irreducible' components of its carbon footprint (see the Offset section for a further explanation).

The World Research Institute (WRI) has developed a protocol with three scopes for the inventory of greenhouse gases for corporations. In this protocol, Scopes One and Two are necessary to carbon neutrality and Scope Three is optional, but recommended. Jason Kowalski '07 followed this framework during an independent study to calculate the College's carbon footprint, measured in metric tonnes of carbon dioxide equivalents (MTCDE). Because the College is an educational institution rather than a corporation, certain sectors of its emissions footprint did not correspond directly to the WRI model. For various reasons, student transportation and emissions released at Middlebury institutions outside of the main campus—such as the Monterey Institute and the C.V. Starr Middlebury Schools abroad—were not included in Kowalski's 2005-2006 carbon inventory. Middlebury may consider including these emissions when calculating carbon footprints in the future.

Scope	Emissions Included
Scope 1- Direct Emissions	Heating and Cooling
	College Fleet
Scope 2- Imported Emissions	Purchased Electricity
Scope 3- Other Indirect Emissions	Outsourced Travel
	Waste Emissions
	Employee Commuting

Why Carbon Neutrality?

In October of 2006, the Stern Review on the Economics of Climate Change calculated that under a business-as-usual scenario, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and in perpetuity. According to NASA research, 2006 was the hottest year on record in the U.S. and the fifth hottest globally. Leading climate scientist, James Hansen projects that we have ten years to drastically reduce carbon emissions before climate change becomes irreversible. Building on Middlebury College's existing commitment to significantly reduce carbon emissions, we now believe the College must set the precedent for campuses across the nation and pursue carbon neutrality within ten years.

Middlebury College is already known as a leader in environmental sustainability. The College runs a unique recycling and composting facility, implements high recovery building methods, utilizes sustainable forestry on college lands and includes biofuels in both heating and transportation. With the decision to implement a biomass burner, the College will reduce its oil-related emission by almost half—the most remarkable reduction thus far by any college in the Northeast.

In the four short months since student representatives presented the goal of carbon neutrality to the Board of Trustees the following events have taken place:

September 30, 2006 – Focus the Nation, a nationwide day of discussion aimed at global warming policy change, launches at Middlebury.
October 4-6, 2006 – Middlebury College students and staff attended the Association for the Advancement of Sustainability in Higher Education conference entitled "The Role of Higher Education in Creating a Sustainable World."
October 23, 2006 – Middlebury College students featured in *Chronicle of Higher Education* for their efforts on behalf of sustainability.

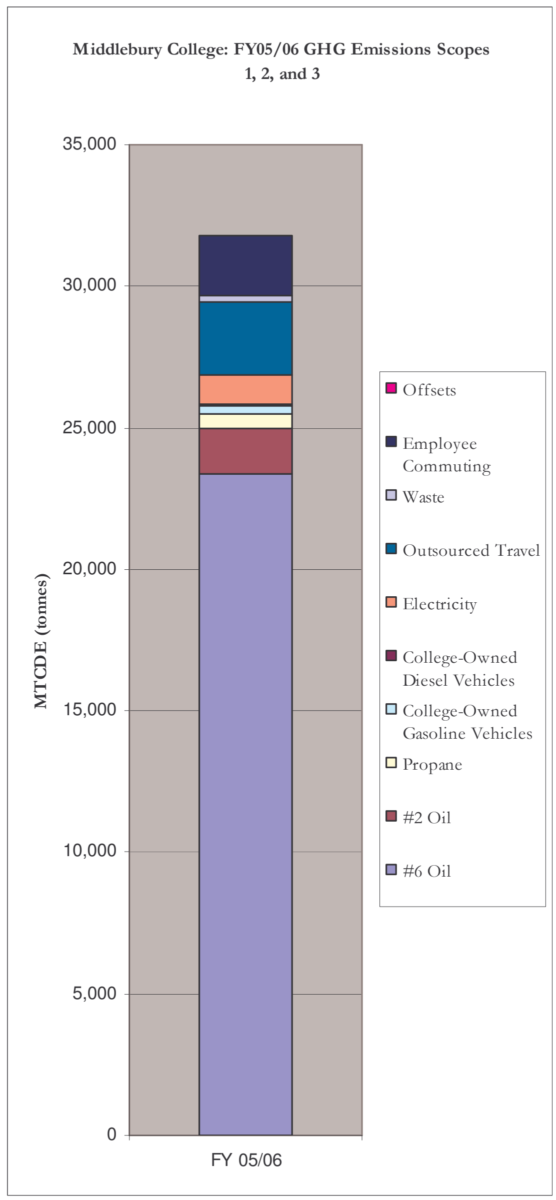
October 30, 2006 – Middlebury College ski facility, as well as alpine and Nordic ski teams, become carbon neutral, garnering publicity in *U.S. News and World Report, The San Francisco Chronicle*, and many Vermont publications.
November 4, 2006 – Middlebury students and faculty organize "Save Your Vermont" as part of the International Day of Action on Climate Change, eliciting participation from 500 people at 30 locations throughout the state.
January, 2007 – Professor Jonathon Isham and visiting professor Eban Goodstein host winter-term class "Focus the Nation," where forty Middlebury students participate in planning the national day of discussion on climate change in 2008.
January 19, 2007 – Students' MiddShift initiative featured on ABCnews.com.
January 19-21, 2007 – Middlebury students host Carbon Neutrality Summit for over 85 students from 25 schools in the East.

Middlebury College's drive to create solutions to climate change is constantly reinforced by the strongest student climate change activist group in the country. We, as members of the Sunday Night Group, have organized and participated in local, statewide, national and international campaigns to fight climate change and have established ourselves as leaders in the climate change movement. We must rise to the challenge of our respective reputations and lead collegiate efforts to achieve carbon neutrality.

The movement for carbon reduction has spread to over 300 colleges and universities nationwide. Several have already adopted carbon neutrality goals, including the University of Florida and College of the Atlantic this fall. However, Middlebury College still can be one of the first institutions of higher education to adopt a comprehensive plan for *how* to achieve carbon neutrality. Middlebury's reputation as a leader would help ensure that other institutions pursue similar goals and match our commitment. Joining leadership circles of compacts such as the Association for Advancement of Sustainability in Higher Education President's Pledge would reinforce this endeavor.

Carbon Neutrality in Ten Years

The following document does not delineate one specific plan for carbon neutrality at Middlebury, but rather provides a variety of steps that we can take to achieve our goals. At this point in time, we cannot predict the appropriate solutions for the entire carbon neutrality process. Climate change has reached a level of national importance and we can expect many changes that will influence the ways we may pursue carbon neutrality, including innovative technology, federal grants and subsidies, and national legislation on climate change. In the following proposal, we make strong suggestions for the steps that we believe should be taken to eliminate our carbon emissions over the next ten years. Please commit to carbon neutrality within ten years, knowing that this pursuit rests upon the collaborative efforts of the entire college community.



Pursuing carbon neutrality will create many unique and dynamic educational opportunities for students and faculty at Middlebury College. Carbon neutrality, as a campus-wide endeavor, will enhance the Middlebury education across the academic disciplines. By giving Middlebury students the opportunity to help design and implement carbon reduction projects, the College would connect the critical thinking intrinsic to the liberal arts curriculum with tangible solutions to climate change.

The following mission statement was adopted by the board of trustees in 2006,

> We strive to engage students' capacity for rigorous analysis and independent thought within a wide range of disciplines and endeavors, and to cultivate the intellectual, creative, physical, ethical, and social qualities essential for leadership in a rapidly changing global community.

To adhere to this mission, Middlebury must recognize that climate change and energy challenges are becoming the most important issues of our time. The global community is in need of leaders who understand the scope of these problems. With carbon neutrality as a strong component of our education, Middlebury students will have the necessary skills and innovative solutions to address climate change. This project can extend across all disciplines: cost-benefit analyses of efficiency measures in economics, spatial feasibility studies in geography, explorations of the moral consequences of climate change in philosophy and more. By making climate education a focus of the institution, Middlebury will establish a unique identity as a leader in this growing field.

Each department at Middlebury can begin to undertake the development and continuation of climate curriculum. We are proposing four programs that would motivate professors and students to incorporate carbon neutrality into their studies. We recommend that these programs be implemented within the next academic year:

Faculty and Curriculum Development Program: This program would include a series of faculty seminars on carbon neutrality which would promote interdisciplinary thought, study and intellectual exchanges among faculty. The seminars would challenge faculty to consider how carbon neutrality initiatives may empower their scholarly work and increase the College's contributions to the state and the world.

Carbon Neutrality Innovations Fund: The Innovations Fund would provide grants of $1,000 to $4,000 to faculty and staff to develop creative new programs for the carbon neutrality initiative. The fund would also offer Faculty Fellowships each year to faculty to support their course development and research. The Innovations Fund would be designed to keep the program vibrant and to shift the initiative to a higher level of impact each year.

Carbon Neutrality Undergraduate Research Program: Talented, creative undergraduates would undertake entrepreneurial research projects focused on climate change and carbon neutrality. Research proposals would be competitively evaluated and funded to support summer fellowship or research during the academic year.

Community Partnership for Carbon Neutrality: Through this program, the Alliance for Civic Engagement office and the Coordinator for Community Based Environmental Studies would support cooperation between community groups and Middlebury students through service learning and extracurricular service projects based on carbon reductions. Service projects are emphasized in the College's Strategic Plan and benefit the students, the community partners and the College's relationship with its neighbors.

In order to facilitate these programs, an online resource collaborative should be created for interested parties. With this resource, faculty could find information about developing climate curriculum, community partners could post project ideas that could benefit from student input and students could find out which courses and faculty members are already addressing climate change or get ideas for independent research projects.

To strengthen the institutionalization of carbon neutrality, the College should be mindful of the projects in hiring new professors. The educational benefits of carbon neutrality would be greatly enhanced by more professors with relevant experience. This is an exceptional opportunity to integrate solution-based curriculum into the classroom. By integrating carbon neutrality into the Middlebury education, the work of students and faculty will serve as accountability measures for this project.

The movement towards carbon neutrality is gathering momentum on campuses across the country. By making an early commitment, Middlebury will realize extensive benefits in attracting talent and preparing its students for the challenges that lie ahead.

Space heating and cooling, including domestic hot water heating, is responsible for about 80.2% of Middlebury College's carbon footprint (25,507 MTCDE). The college uses approximately 2,000,000 gallons of residual oil #6 per year, emitting CO_2 at a rate of 25.22 pounds per gallon combusted—that's 50,440,000 pounds of CO_2 per year– making it our largest greenhouse gas emitting activity. In addition to #6 oil, the annual burning of 150,000-175,000 gallons of B20 oil—20% biodiesel, 80% distillate oil #2—and other fuel sources like natural gas and propane make up the College's heating and cooling fuel portfolio. In pursuing carbon neutrality, we must tackle this primary component of our total emissions.

The College has already taken admirable steps towards reducing its heating and cooling footprint. The $11 million biomass burner will reduce carbon emissions by nearly 12,500 tonnes per year, cutting the College's residual oil #6 use from 2 million to 1 million gallons. The College has made other significant improvements to the heating and cooling footprint by replacing virtually all of its distillate #2 oil use with B20; by lowering the set point for the heating systems from 70°F to 68°F; and by installing low-flow showerheads and valve setting in the residence halls. Nevertheless, there are still many ways to improve energy use on campus

Fuel Use

Biodiesel and #6 Oil: Replacing #6 oil with biodiesel reduces the amount of CO_2 emitted by 20.83 pounds per gallon. The Vermont Department of Buildings and General Services (BGS) conducted emissions testing of biodiesel blends with #6 oil in February 2006, and found that "biodiesel mixes readily with #6 fuel oil,…[that] blends of biodiesel and #6 fuel oil burn without modification to either boiler or burner,…[and that blends result in] easier measurement of fuel in tanks, easier routine cleaning of the burners and strainers, lower emissions, lower demand for imported oil, and reduction of fossil CO_2 emitted."[5] Investigating the supply and testing the efficiency of biodiesel blends with #6 oil at the College could yield a cleaner energy option than straight #6 oil.

Biodiesel and #2 Oil: The College currently uses B20 in almost all buildings—use of pure #2 oil cannot be further reduced. The College can, however, design trials to test the effectiveness of increasing the biodiesel content in #2 oil blends. Last winter, the Vermont Biodiesel Association sponsored a trial comparing pure #2 oil, B5, B10 and B20 at different campus locations. We recommend a trial of higher biodiesel contents to determine the maximum fossil fuel displacement by adopting this cleaner fuel source. Michael Moser, the Assistant Director of Facilities Services, Central Heating/Utilities has stated that he is excited to work with students as early as this spring to design trials for the two aforementioned projects.

Future Biomass Usage: If the biomass project successfully meets its projected portion of the college's energy needs, and both a feasible location and sufficient supply of biomass are available, then installing a second biomass burner to replace our remaining #6 oil use, or increasing the amount of biomass burned would significantly shrink the footprint. Students have also expressed interest in investigating the potential of an algae photobioreactor, which could create a biofuel source and displace fossil fuels.

Infrastructure and Building Envelopes

Pipe Replacement: Fuel is burned to create steam that passes through a turbine and then transferred to campus buildings through pipes, which leak about 35% of the energy. Increasing the rate at which the College is currently replacing these pipes would improve the efficiency of transferring steam, thereby wasting less energy.

Monitoring and Control Systems: Inefficiencies in building infrastructure lead to much wasted energy, too. Room temperature set at 68°F is monitored at the Service Building using a master control linked to sensors located in each building. The ability to fine-tune room temperature is impeded by the small quantity of sensors per building—Starr Hall has only four sensors to monitor the entire dormitory. Installing more sensors in each building, ideally one in each room as is planned for the Starr-Axinn project, would allow for closer monitoring of temperature and prevent unnecessary heating. Variable speed drives (VSD) would increase the amount of control over heat distribution while reducing the amount of electricity expended. These installations could occur while the buildings are in use.

Facilities Services is currently seeking a fast solution to the growing pressure for cooling systems from the Language Schools, especially residents of the upper floors of dormitories. Investing in a high quality, centrally controlled air-conditioning system would allow Facilities Services to regulate cooling related energy use in campus buildings.

Building Envelopes: The efficiency of a building is determined in part by the quality of its envelope, defined as that which mediates between exterior environmental conditions and interior environmental conditions, including insulation, windows, doors and seals.[7] The Master Planners have conducted an energy audit through EarthTech, examining 40 buildings totaling about 1.75 million square feet of campus space in order to identify buildings that have insufficient envelopes and wasting energy. Using this audit as a diagnostic tool, the College can decrease the amount of wasted energy by targeting those buildings most in need of retrofitting.

Future Construction and Renovation: Energy efficiency and consequent emissions reduction are essential components of the initial design and planning phases of new construction and renovation projects. For instance, the College should assess the impact upon the carbon footprint of the estimated 250,000 square feet called for by the Master Planners and further discussed in the Architecture and Planning chapter. Lastly, each building renovation should concurrently include all necessary efficiency improvements.

Electricity at the College accounts for 3.2% of our carbon footprint (1,032 MTCDE). This small percentage is due to the fact that most power in Vermont is derived from the hydroelectric generation of Hydro-Quebec and the nuclear generation of Vermont Yankee Nuclear Power Corporation. The College is generating 15-25% of its electricity through cogeneration at the campus heating plant.

While electricity currently comprises a small percentage of our carbon footprint, the future is uncertain. Vermont Yankee is set to decommission in 2012. Vermont's contract with Hydro-Quebec ends the same year; if the state renews the contract, the cost of power is likely to rise. In pursuing carbon neutrality and seeking the most cost-effective options the College must be prepared for upcoming changes in electricity sources.

Lighting Systems: The College has already made great strides in electrical efficiency. For example, most light bulbs on campus are energy-saving compact fluorescents. The student-run CFL Exchange Program launched in 2005 has replaced 2,300 incandescent bulbs with CFLs in dormitories. Each semester, a competition called the Inter-Commons Initiative to Consume Less Energy (ICICLE) encourages students to reduce their electricity use.

Major electricity renovations are not currently cost-effective. However, lighting accounts for 30-50% a building's carbon footprint. The best plan to further electrical efficiency entails updating lighting systems during future building retrofitting. Occupancy sensors, for example, could save energy in hallways and spaces that do not see constant traffic. Ultimately, however, electricity-related energy savings are largely contingent upon individual behavior. Educating college community members on the importance of shutting off lights and computers, for instance, can reduce wasted energy.

Hydroelectricity Downtown: Electricity production through a local hydroelectric project is now an option for the College. Where there were previously 1,000 dams for electricity in use during Vermont's industrial age, there are now only 106. Middlebury harbors one of these sites near the old mill on Otter Creek. The owner of the building, Dr. Anders Holm, has recently determined that installing a hydro plant at this location could yield one megawatt—enough to provide up to half of the College's electricity needs.

Vermont's complex permit application process had made it difficult for the project to get off the ground. However, Vermont H.70 is currently before the state legislature to streamline the permitting process for small hydroelectric plants, reducing the fee from $250,000-$500,000 to just $5,000. The College is in a unique position to aid in funding this clean electricity project.

Facing an upfront cost of $4 million, Dr. Holm needs help launching this clean energy project. If the College were to become an equity partner, it would not only be receiving clean, locally-generated electricity, but it would also ensure a consistent electricity price for the duration of the contract. Central Vermont Public Service would only be willing to pay 8 cents per kWh for the power which does not make the project economically feasible. A price of 9.8 cents per kWh is what the College currently pays for power and could pay to make the project a viable one, meanwhile gaining the benefit of fuel diversification in a potentially volatile energy market.

A small-scale "run of the river" hydroelectric plant such as this does not carry with it much of the concerns regarding larger hydro plants. This plant would not change the flow of the main falls. Indeed, the infrastructure for turbine installation already exists. Furthermore, new turbine technology has filters and chutes to minimize harm to fish, and because of the modest use of water flow, the falls will continue to aerate the water, providing dissolved oxygen for aquatic life. Lastly, sophisticated monitor controls can change the water flow during dry months.

Future Electricity in Vermont: With the future of Vermont Yankee and Hydro-Quebec no longer certain, Vermont faces major electricity generation decisions. Without these plants, it is likely that a new coal power plant will be installed to meet the state's power needs. Coal power plants are a large operation requiring millions of tons of coal to be imported every year and ash to be exported, meanwhile emitting large amounts of carbon dioxide, sulfur dioxide and nitrogen dioxide, the main compounds responsible for acid rain.

The College is in a position to be a role model in keeping Vermont's energy portfolio clean. Future study on other sources of power such as solar and wind should also be conducted. Indeed, the College already boasts its own small 10-kW wind turbine. Currently, the government is subsidizing solar water heating systems. The coming years should also see a decrease in the cost of solar power. Feasibility studies would provide excellent opportunities for student-driven independent study.

Despite the small percentage of the carbon footprint that electricity currently comprises, the College must acknowledge impending changes in electricity sources and prices. As a long-lasting institution, the College should continue to look for ways to diversify its energy portfolio.

Transportation makes up 14.3% of the College's carbon footprint and includes college fleet use, employee commuting, and outsourced travel. Middlebury demonstrated a commitment to developing sustainable transportation options and reducing reliance on personal vehicles through its Strategic Plan of 2006. The College has taken the lead in purchasing fuel efficient vehicles and using biodiesel in its fleet. Transportation is a complicated sector; therefore, we follow the aforementioned World Resources Institute three scope model used in Jason Kowalski's emissions inventory.

Scope 1 – Direct Mobile Emissions: This scope includes emissions from all fuel burned in vehicles owned or controlled by the College. In FY 2005-2006, the college fleet emitted a total of 345 MTCDE from diesel and gasoline fuel consumption, accounting for 1.1% of the college footprint.

Purchasing Policy for College Fleet: Recent 'green' transportation purchases include a new Honda Civic Hybrid as a rental vehicle, an Escape Hybrid for Public Safety, and fuel efficient "mini-trucks" for intra-campus deliveries. While the college fleet accounts for a small percentage of total emissions, it is a highly visible component of our footprint, with Middlebury College written on our vans and trucks. As discussed in the Strategic Plan, a policy for purchasing the most fuel efficient vehicles will demonstrate the College's commitment to sustainable transportation to faculty, staff, students and the outside world. While hybrid and diesel vehicles still have higher initial costs than conventional vehicles, there are significant financial savings from less fuel use and fuel diversification.

More Biodiesel Use in the College Fleet: While the College has begun using biodiesel blends to reduce carbon emissions, such blends currently accounts for only 1.3% of all fuel burned in diesel vehicles. In FY 05-06, diesel vehicles burned 200 gallons of B5 and 500 gallons of B20. Facilities Services hopes to use B20 in all college vehicles as soon as possible, as long as warranties apply and biodiesel can be properly stored on-site.

We recommend supporting Facilities Services with the necessary funding and institutional backing to overcome costs and infrastructural challenges to achieve this goal of using B20 in all campus vehicles. As discussed under Heating and Cooling, we also recommend experimentation with higher blends of biodiesel (such as B50 or B100) through encouraging student research in collaboration with Facilities Services and our fuel distributor, Champlain Valley Heating and Plumbing.

Scope 3 – Indirect Emissions

Outsourced Travel: Outsourced travel includes emissions from fossil fuels combusted in vehicles not owned by the College, but whose services are directly solicited from College operations, such as air travel, car rentals and bus charters for Admissions, sports, College Advancement and conference travel. In FY 05-06, outsourced travel accounted for 6.8% of total college emissions. Several departments, sports teams and student organizations currently offset their travel but this accounts for minimal and is not well documented.

Substituting or significantly reducing emissions from outsourced travel is very difficult. As discussed further under the Offset chapter, we therefore recommend offsetting this sector by the next fiscal year.

Employee Commuting: Last year, college employees drove 4.5 million cumulative miles to work, accounting for 6.4% of the College's carbon footprint. The College currently supports the only public transportation in the area, Addison County Transit Resources (ACTR). Only 1% of the College's 1,500 employees use the ACTR shuttle on a regular basis. According to the Human Resources department, little is being done to facilitate ridesharing and use of clean transportation. An on-line survey conducted this year (20% response rate) demonstrates that 85% of Middlebury employees commute alone to work in personal cars, while 15% regularly commute by walking, biking, carpooling, or the ACTR shuttle.

Reducing emissions from personal travel is a significant challenge as it relates to individual behavior and requires a wide range of convenient and flexible strategies. As the Strategic Plan recommends the College to minimize its reliance on private vehicles, we suggest a comprehensive, flexible, and well-funded program that encourages employee commuting via walking, biking, carpooling, and the ACTR shuttle. Such a strategy not only reduces emissions but also eases local congestion, while improving town relations and providing cheaper and healthier commuting options.

Based on survey responses, a large majority of employees would leave their car at home if there were financial incentives (64%) or if alternative modes of transportation were more convenient (56%). We propose an array of strategies, including a ride-share program; financial incentives for not driving alone to work; free passes for shuttles to Rutland and Burlington; ZipCars or some car-sharing service for commuter's use; more affordable housing closer to the College; and better bike facilities.

Future Considerations – Student Travel: For a variety of reasons, emissions related to student travel are not currently in the greenhouse gas inventory. Because it is a highly visible source of emissions, the College should consider including parts of student travel in the future. This is also a significant educational opportunity. The College should consider such strategies as a student parking fee which could help finance other carbon reduction projects such as offering financial incentives to employee commuters (see Financing). Additionally, the College should work to improve student ride-sharing and increase access to public transportation.

Models to Consider: Comprehensive transportation strategies at other schools can serve as models for Middlebury College. For example, Cornell University raised parking fees, gave free public transport passes to anyone who does not use a parking pass, and integrated the school's transit system with that of the city, cutting emissions significantly and saving $36 million. At Cornell, 36% of employees commute by means other than driving alone.

Stanford University offers a well-supported, flexible "Commute Club" that rewards club members with up to $216 per year for not commuting alone. The program is open to employees and students and offers financial incentives coupled with free transit passes, a guaranteed ride home program for emergencies, rental cars, and easily accessible on-line references about a variety of alternative transportation.

The Tufts Climate Initiative aids departments in purchasing vehicles of zero or near-zero emissions and currently leases two electric vehicles for on-campus deliveries, as well as ZipCars for employee and student use.

Nearly all of Middlebury's peer schools charge parking fees for students and/or ban freshman cars. Parking fees range from $25 at Bowdoin to $135 at Wellesley. Vermont Law School will soon institute a parking fee and use the revenue to provide incentives for employees who decline a parking pass and commute via alternative transportation.

Solid waste accounts for 0.8% of the College's carbon footprint (244 MTCDE). Middlebury already neutralizes much of its waste-related emissions by processing 60% of its solid waste through its state-of-the-art composting and recycling facilities. The remaining 40% of waste is left to decompose in landfills, contributing to our carbon footprint through the methane and carbon dioxide generated during decomposition. Such emissions can be captured with readily available technology that the College should implement. Additionally, in a nation where each person creates about one million pounds of waste every year, it is essential to impress the values of waste reduction upon faculty, staff and students. In order to achieve these goals, we recommend the following policies and projects.

Environmentally Sound Purchasing Policy: As the purchasing departments at the College are decentralized, the College should create an online resource to guide individual departments towards environmentally sound purchasing options. The site would include numerous sustainable options for general products bought by the College, and direct links to suppliers. A student could easily undertake this, following the lead of similar projects at Harvard and Duke. The reusable and long-lasting attributes of sustainable products will compensate for their greater initial cost through reductions in landfill fees while reducing emissions.

Waste Reduction Fund: All members of the college community have a responsibility for their waste. Employee and student initiatives should continue to be promoted through a competitive fund modeled after the Environmental Council Grants or the Treehouse Fund. Prior student awareness campaigns have succeeded in diminishing wasteful behavior. One such campaign weighed each student's food waste as they left the dining hall. Director of Dining Services Matthew Biette observed a 'significant reduction' of food waste within a week of the event. MiddShift is working to repeat this initiative.

Melissa Beckwith, Supervisor of Waste Management, will soon launch a pilot waste reduction competition among staff. Future projects could include a waste reduction inter-dorm competition modeled on current energy reduction competitions, a mandatory teach-in at the recycling centre during Freshman Orientation, and the establishment of Eco-Reps in every dorm. Furthermore, the College needs adequate recycling signage across the campus to target areas where the recycling infrastructure is currently underutilized.

Landfill Gas to Energy Project: Unfortunately, the College cannot entirely eliminate its waste. Once waste leaves the College, it enters the landfill and emits methane, a potent greenhouse gas. Landfill Gas to Energy (LFGTE) projects sequester and combust this methane in order to produce electricity (which is then sold back into the grid) and co-generate thermal energy. Although a quarter of all Vermont landfills have LFGTE technology, out-of-district fees make it ineffective to utilize them.

The College should invest in LFGTE technology at a local landfill and negotiate for at least half of the carbon offsets and half of the electricity-related profits. Tom Badowski, Vice President of the Moretown landfill, plans to start an LFGTE project at his landfill in 2007 and would welcome Middlebury College as a partner in the project.

A student-generated cost-benefit analysis in 2003 determined the total cost of this project to be $50,000 to $80,000. Given a negotiation to obtain half of the offsets and half of the revenues, the project would pay for itself within 3.4 years and earn the College 6,250 tonnes of carbon offsets per year, at a price of $2.50 per MTCDE. Since 2003, the landfill has grown substantially. In order to pursue this option, the current details of the project need to be discussed with the representatives of the landfill, and student independent study ought to reevaluate the economic feasibility of it.

Models from other schools can serve as an impetus for this process. In April 2004, Hudson Valley Community College invested in an $8.5 million LFGTE project at a neighboring landfill which has a payback period of less than fifteen years and will continue to save the College money on electricity bills. Additionally, New York State funded $2.5 million of the project and the College is no longer subjected to wavering price levels from the electric grid.

Future green building at the College presents a key opportunity to ensure long-term energy efficiency and financial savings in fuel expenditures as well as create a more productive and meaningful built environment for faculty, staff, students and community members. New buildings should not only embody the institution's values but also address the global imperative of reducing carbon emissions and safeguarding the natural environment.

Although maximizing energy efficiency has been a goal in recent building projects, no institutional standards have been followed to ensure an appropriate level of efficiency. Because efficiency measures are not properly prioritized, unforeseen budgetary constraints result in their exclusion. For example, the rising price of copper forced many efficiency measures, particularly regarding heating and cooling, to be cut from final construction of the Starr-Axinn project. Fortunately, the new Hillcrest Environmental Center has maintained higher efficiency measures because of the department's focus. However, environmental stewardship is not only a goal of the Environmental Studies program, but also of the College itself—a goal that building practices must reflect.

The College currently stands at a crossroads in terms of campus development. With a lull in future building plans and the drafting of a Master Plan by Michael Dennis & Associates, the College has a prime opportunity to set any new building on a greener course. Proposed goals such as the expansion of the arts facility as well as the completion of the Commons System—requiring roughly 250,000 new square feet—could easily expand the carbon footprint, but proper planning can avoid this issue.

Internal Efficiency Guidelines:

At a minimum, the College must commit to specific and strict efficiency guidelines for new buildings to which architects and engineers will be held accountable from the start of the planning process. These guidelines could be developed in the classroom in a joint student and faculty effort. Thus, efficiency measures will be incorporated into budget constraints from a project's inception. As the client, Middlebury must take a leadership role in monitoring and accountability, ensuring that such guidelines are continually prioritized. Furthermore, with detailed tracking of efficiency through energy modeling and past-compliance commissioning, the exact carbon footprint of each new building can be tracked and accounted for continuously.

By establishing such comprehensive guidelines, green buildings need not come at a premium cost. Furthermore, the College may opt to enter into an Energy Saving Performance Contract (as detailed under Finance), which ensures such standards throughout the entire planning and building processes without initial capital costs.

LEED Standards: Energy efficiency is only one component of green building. The U.S. Green Building Council has established a point-based framework for the construction and certification of green buildings called the Leadership in Energy and Environmental Design (LEED), which has quickly become a national standard. By certifying future buildings through LEED, the College will not only ensure the green qualities of its buildings, but it also outfits itself with a powerful marketing tool to attract future students for whom sustainability and environmental stewardship is a major concern.

We recommend that Middlebury College commits to certifying all future buildings to a minimum Silver certification through LEED, as do other competitive schools such as Harvard, Duke and Emory as well as all University of California campuses. Although LEED certification does entail the additional costs of consulting and processing fees, we believe that the benefits such as increased human productivity within such buildings, admissions marketability and other collateral benefits of energy efficiency vastly outweigh these costs.

The Architecture Program: Green building—whether LEED certified or abiding by internally established guidelines—will be an important educational tool for students of the College's architecture program, particularly as the demand for LEED certified architects and engineers grows. Students can take an active, hands-on role in guideline development and building processes, thereby gaining valuable professional experience on campus. Student excitement for such work is demonstrated by a recently added Environmental Studies concentration: Architecture and the Environment. Adopting future green building standards clearly provides a host of benefits to the College, both within and beyond the classroom.

No matter how many emission reduction measures an institution such as Middlebury College takes, carbon emissions are inevitable given the restraints of current technology. The voluntary offset market was thus created to enable individuals and institutions to decrease or fully neutralize emissions by investing in renewable energy and emissions reduction projects. By obtaining offsets in addition to pursuing energy efficiency and fuel reduction measures as detailed in the other chapters, the College can effectively negate its contribution to climate change while demonstrating its continued leadership in the arena of environmentally conscious education.

Various sectors of the College have already obtained offsets and achieved internal carbon neutrality, including the Snow Bowl, Middlebury Outdoor Orientation (MOO), the weekly ES Woodin Colloquium series and recent climate change-oriented conferences such as "What Works?" and "Focus the Nation." Furthermore, families of over 30 first-year students opted to offset the students' school year through the Environmental Affairs Office. At an institutional level, obtaining local offsets necessary to achieve carbon neutrality can not only meet the College's educational goals, but can also directly benefit local communities.

Offset Policy: In light of the imminent threats of climate change and the need for renewable energy development, we recommend an offset policy with a three tiered commitment.

Tier 1 – 'Irreducible' Transportation Emissions
Deadline: FY 2007

This tier involves emissions from outsourced travel that the College cannot directly eliminate. If all outsourced travel was purchased through Bright Card (to be described fully below), 70% of the emissions would be automatically offset. The remaining emissions would cost an estimated $4670-$6470 to offset each year.

Tier 2 – 'Reducible' Transportation Emissions
Deadline: FY 2011

Emissions from sources such as the college fleet, employee commuting, and sports team travel can be reduced through clean fuel use, carpooling and use of fuel-efficient vehicles such as hybrids. Offsets to compensate for reducible emissions in 2011 would be obtained with the assumption that actual emission reductions could and ought to be pursued.

Tier 3 – Infrastructure Emissions
Deadline: FY 2016

By 2016 emission reductions for all aspects of the College infrastructure should be maximized. The offsets in this category will therefore be minimal; when obtained, they will fully eliminate the College's carbon footprint.

Obtaining Offsets: There are countless ways the College may pursue this offset strategy. The strongest options achieve not only the associated carbon reductions, but moreover, educational opportunities, local economic stimulation, and local fuel source diversification.

Working, for instance, with a retail offset provider such as *Native*Energy, of Charlotte, Vermont, the College would be the direct benefactor of a "cow-power" project that can generate both electricity and thermal energy by capturing and combusting methane, a potent greenhouse gas, from cow manure. Depending on the scope and scale of such a project, the price per ton of emissions reductions could range from $6.50 - $9.00. With such a purchase, the College would be the proximate cause of methane emissions reduction.

Community Partnerships: Other options for local offsets include, for instance, the installation of a biomass burner in Middlebury Union High School or the conversion of the Monument Farms fleet, which supplies the College's milk, to biodiesel vehicles. Such offsetting partnerships between the College and local enterprises are mutually beneficial, providing educational opportunities through both project development and outreach in addition to stimulating the local economy and diversifying local fuel sources.

Bright Card: In addition to directly purchasing retail offsets, the College could obtain offsets through college credit card purchasing. Bright Planet, a company launched in a Middlebury classroom, will soon offer the Bright Card purchasing card. When used for procurement and expenses, this corporate credit card will direct 1% of the College's purchases towards obtaining offsets on the College's behalf. This is a drop-in replacement for existing purchasing cards, will be issued by a leading national financial institution, and will maintain all of the robust use and reporting capabilities provided by the current purchasing cards.

Using Bright Card for procurement—roughly 3% of 2007 budget expenditures—would yield a 25% reduction in the College's current carbon footprint. While the actual card will not be available until late 2007, Bright Planet has the capability to immediately simulate the process by utilizing the returns from the '1% cash back' program currently attached to the College's credit card portfolio to purchase offsets. Ultimately, the offsets obtained in any of these strategies will be the critical step required to fully negate the College's contribution to climate change.

Cost Analysis

The table below provides a preliminary analysis of estimated costs, internal rates of return, carbon reductions, and costs related to offsets. The numbers are estimates based on data collected and analyzed by various faculty, staff and students who have completed relevant cost analysis research. It is important to note that some of these numbers could vary widely over the lifespan of this project, due to the unstable nature of the fossil fuel, energy and voluntary offset markets. Furthermore, other strategies such as educational programs have less financially quantifiable benefits. This table provides a starting point from which to conduct further research and prioritize these initiatives to become carbon neutral over the proposed ten year period.

Summary of Costs for Proposed Projects

Sector	Project	Initial Capital Investment	Annual Cost/ Savings	IRR	NPV over 20 yr timeframe	MTCDE Reduced	$/MTCDE over timeframe	Notes and Sources:
Education	Faculty and Curriculum Development Program	$0	-$20,000	N/A	N/A	N/A	N/A	Academic Outreach Endowment Grants offer up to $4,000 per grant. We propose $20,000, for up to five curriculum development grants per year. Source: Pete Ryan, Academic Outreach Endowment Grants.
Education	Carbon Neutrality Undergraduate Research	$0	-$6,000	N/A	N/A	N/A	N/A	Proposal to allot $6,000 per year for undergraduate research grants for up to 4 large projects. Source: Senior Work Fund.
Heating and Cooling (78.7%)	New Biomass Gasification System	-$11,000,000	$1,093,153	7.7%	-$936,792	15,000	-$62	Assumptions: 20,200 tons wood chips/yr., 45% moisture content, $35/ton. Assumed $1.40/gal #6 oil. Sources: CRI Working Group; Ian Hough '07 and Jason Kowalski '07 2006, Biomass Decision Support Tool (DST); Mike Moser's FY05-06 Energy Report; Jason Kowalski '07, Middlebury College GHG Inventory for FY05-06 (JK GHG Inventory FY05-06).
Heating and Cooling (78.7%)	B20 Biodiesel Blend to Replace #6 Oil	$0	-$3,020,781	N/A	N/A	6,496	-$465	Sources: Jason Kowalski '07, 2007. Fuel Mix Analysis.
Heating and Cooling (78.7%)	B100 Biodiesel Blend to Replace #6 Oil	$0	-$3,837,011	N/A	N/A	23,370	-$164	Sources: Jason Kowalski '07, 2007. Fuel Mix Analysis.
Heating and Cooling (78.7%)	Replacing steam pipes	-$800,000	$122,316	14.2%	$290,429	1,022	$284	Assumptions (Jason Kowalski): 800 ft. of pipe replacement assumed to halve inefficiency of steam transport to BiHall. Sources: Mike Moser, Jason Kowalski '07, Hanley et al, 2003. Carbon Neutrality at Middlebury College.
Heating and Cooling (78.7%)	Monitoring and Control Systems	-$18,720	$18,000	96.2%	$133,572	8	$17,061	Source: Pepper, Jake et al. 2006. Environmental Economics consulting project with Lucid Designs; JK GHG Inventory FY05-06.
Electricity (3.2%)	Lighting Efficiency Measures	-$3,369	$10,158	302%	$81,981	5	$17,151	Source: Bobby Levine '08, 2006. CFL Lightbulb Exchange Program data; JK GHG Inventory FY05-06.
Electricity (3.2%)	Investment in Hydroelectricit y downtown	-$2,000,000	$0	N/A	-$1,834,862	880	-$2,085	No projected savings at this time, but benefit of a stable future energy price, and a diversified, local electricity portfolio. Source: Dr. Anders Holm and Clayton Reed '08; JK GHG Inventory FY05-06.

Transportation (14.3%)	All B20 burned in the college fleet	$0	-$1,125	N/A	N/A	19	-$60	Assumption: Cost whole diesel fleet on B20 with est. cost of $0.15 more per gal of B20. Source: Mike Moser; JK GHG Inventory FY05-06; Kelly Blynn '07.
	Purchasing policy for college fleet	$0	-$13,000	N/A	N/A	80	-$163	Assumption: Example based on 13 veh, 10,000 gal diesel/year and 2.6 new 15 passenger vans per yr. in past 6 yrs. $5,000 premium for diesel over gasoline vans. Assumed 20% reduction in MTCDE from B20. Sources: Skip Brush, 2006, Vehicle Inventory; Tom Corbin; JK GHG Inventory FY05-06.
	Employee Commuting Incentive and Parking Fee (High compliance)	$0	$379,350	Infinity	$3,176,985	970	$3,275	Assumption: $75 parking fee with $350 rebate for employees who leave personal cars at home. Assumed 65% participation in incentive program, based on employee commuting survey data. Sources: Kelly Blynn '07, 2007, Employee Commuting Survey; JK GHG Inventory FY05-06
	Employee Commuting Incentive and Parking Fee (Low compliance)	$0	$14,700	Infinity	$123,110	1260	$98	Assumption: Same as above, but 20% participation rate in incentive program as lower bound. Sources: Kelly Blynn '07, 2007, Employee Commuting Survey; JK GHG Inventory FY05-06.
Waste (3.9%)	Waste Reduction Fund	$0	-$1,000	N/A	N/A	82	-$12	Assumption: Decreases waste by 10%, Allot $1,000/year similar to Tree House Fund. Sources: Dominguez, Tiziana '09; David S. Stone '74 Tree House Fund; JK GHG Inventory FY05-06.
	Landfill Gas to Energy Projects	-$65,000	$19,000	29.1%	$99,488	6250	$16	Source: Tiziana Dominguez, '09. Hanley et al. 2003. Carbon Neutrality at Middlebury College.
Architecture	Silver LEED certifications in new buildings	-$375,000	$36,188	7.3%	-$40,969	7435	-$6	Assumption: Based on $5/ton reduction for total money spent on project. Current projections of 125,000 sq ft of new building in 10 yrs. from master planners. Source: Kats, Greg, et al. 2003. "The Cost and Financial Benefits of Green Buildings".
	Silver LEED certifications in new buildings (integrated design)	$0	$36,188	Infinity	$303,068	7435	$41	
Offsets	Retail offsets (low price)	$0	-$138,858	N/A	N/A	19,380	-$7	Represents the cost of offsets after biomass boiler has gone on-line. Source: personal communication with retail offset provider.
	Retail offsets (high price)	$0	-$192,265	N/A	N/A	19,380	-$10	Ibid.
	Bright Card	$0	-$51,900	N/A	N/A	9047	-$6	Source: Jake Whitcomb '05, Bright Planet. Carbon reduction estimate based on a $173,000,000 budget, of which 3% is spent on Bright Card purchasing cards. The estimated cost for implementing Bright Card is based on the yearly-accrued opportunity cost of replacing the current 1% cash-back purchasing cards with Bright Cards.

Discount Rate: 9.00%. Timeframe: 20 years.
N/A=does not apply (nonnumeric savings and benefits).
Offset price assumed to be $6.50-$9/short ton.

Committing to carbon neutrality is an institutional change that entails considering the environmental externalities of each action the College takes. The financial strategy should facilitate this shift in behavior. With a slightly different and creative approach to financing, Middlebury College can continue to build our reputation as one of the nation's most environmentally conscious and eventually carbon neutral campuses.

Green Fund: This year the senior class is raising money for a Green Fund. We endorse the idea of including this fund as part of the upcoming capital campaign and then using it to pay for most of the campus' environmental programs and initiatives. Directing a percentage of this fundraising effort toward the environment, including carbon neutrality, could draw new donors and eventually free up money in other areas of the College's budget. This approach is also preferable because it formally institutionalizes environmental behavior and carbon neutrality, specifically. It is also a powerful statement to other institutions and to future students that Middlebury is committing a percentage of its largest capital campaign to environmental initiatives. Furthermore, we would like to collaborate with the Advisory Committee for Socially Responsible Investment to ensure that the Green Fund reflects socially responsible investment decisions.

Comprehensive Fee: Although incorporating a new cost into the Comprehensive Fee reflects a difficult decision based on competition to use the funds elsewhere and to make the College affordable, we suggest reallocating or increasing the Comprehensive Fee in order to direct appropriate funding toward projects related to carbon neutrality. This measure is important because of its immediacy; several carbon neutrality research initiatives could begin as early as this summer, for instance. We recommend amending this amount as more cost analysis research is available and eventually incorporating it directly into the Green Fund.

Bright Card: This credit card will also help institutionalize carbon neutral behavior by obtaining offsets with each College purchase. Although this card would eliminate the current cash return, incorporating it allows the College to receive a cheaper offset policy and spend less employee time developing the offset projects, while supporting the entrepreneurship of Middlebury alumni.

Miscellaneous Fees: Becoming carbon neutral involves engaging the entire College community. The administration could encourage students to utilize environmentally friendly transportation with financial incentives such as a parking fee with a discount for using the ride board or driving a fuel-efficient vehicle. Moreover, the New Haven Municipal Government earmark income derived from parking for public transportation. In a similar manner, income from Middlebury's parking tickets could be directed toward environmental projects or offsets related to carbon neutrality. Lastly, the College could initiate several voluntary fees. For instance, when inviting alumni to Middlebury events such as Homecoming, the College could offer the option of offsetting their travel with a small fee. The names of participating alumni could then be published in the Middlebury Magazine. Such fees create awareness for carbon neutrality, while also generating capital to fund green projects.

Creative Financing: There are several less conventional methods to finance carbon neutrality. As discussed under Offsets and as suggested by the National Association of College and University Business Officers, the College could fund a project within the local community—for instance, a biomass burner at a local school—and then apply the resulting offsets toward the campus' carbon footprint. A coalition of colleges pursuing carbon neutrality could apply this model among themselves, too.

Revolving Loan: Harvard University uses its Green Campus Loan Fund of $12 million to encourage efficiency measures through a revolving loan. To receive the loan, a department must submit a project proposal with a payback plan of 5 years or less. It is a competitive process, which forces the departments to make efficiency measures a priority. Harvard reports that there is an average Return on Investment of 27.9%, suggesting a strong correlation between fiscal and environmental responsibility. This model may not be appropriate for Middlebury College as many spending projects are highly centralized; however, it demonstrates the viability of using competition to encourage behavioral change.

Government Subsidies: There are several state subsidies currently available for a variety of environmentally efficient measures. For instance, Efficiency Vermont, an independent non-profit organization under contract to the Vermont Public Service Board, provides homes and businesses with technical and financial assistance for energy saving projects. Additionally, Governor Douglas' Commission on Climate Change is currently meeting to develop a climate change policy for Vermont. Although in its nascent stages, there is a proposal to include subsidies for green construction and other such measures. Senator Bernie Sanders is also planning to modify the Higher Education Fund to include funding for campus sustainability and carbon reduction projects. Middlebury College should monitor this policy's development and look to capitalize on funding for future building projects. Given the new climate in Washington D.C., it is also possible that more comprehensive federal subsidies will become available within the next few years.

Performance Contracts: Energy Saving Performance Contracts (ESPC) would allow Middlebury College to pursue energy efficiency projects without the initial capital costs. The agreement occurs between the College and an Energy Services Company (ESCO). The ESCO does an energy audit, designs and constructs a project by our standards, organizes the financing, and guarantees that the savings will pay off the project in less than 25 years. Savings from that point forward belong to the College. This option may or may not be feasible depending on the project and the amount of money that could alternatively be made through investment of the saved initial capital.

Conclusion

In the Spring of 2006, the Middlebury Board of Trustees included the following in its mission statement for the College: "The College's Vermont location offers an inspirational setting for learning and reflection, reinforcing our commitment to integrating environmental stewardship into both our curriculum and our practices on campus."

This has certainly been true for the eleven of us who have researched and written this proposal. In our short time at the College, we have witnessed the rapid change that climate change has caused; at Professor John Elder's sugar-bush, for example, where syrup runs later each year or at Breadloaf, where the first snow fell in late January. Middlebury's beloved broomball is now known only to juniors and seniors.

Here at the College, we not only see the stakes of climate change, but also the possibilities for a sustainable and enriching community. Middlebury's resources can be counted beyond the material: our talent, creativity and commitment make this College and community uniquely prepared to engage this challenge.

In conclusion, we request that the following steps be taken:

February 2007:

- Institutional commitment to achieving carbon neutrality by 2016
- Develop and implement plan for continued collaboration with MiddShift students

May 2007:

- Develop and approve funding strategy
- Approve recommended offset policy
- Prioritize recommendations delineated in this proposal. This will enable the Middlebury College community to utilize Summer 2007 to begin implementation.

We thank you for your commitment to environmental stewardship and carbon reduction thus far, and for helping to inspire a new generation of conscientious leaders, on campus and beyond. Bill McKibben, Middlebury Scholar in Residence, is right in calling Vermont's Champlain Valley "America's most hopeful landscape." By adopting a comprehensive plan for carbon neutrality by 2016, Middlebury College will honor its place within our community, local and global.

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